# GEOHYDROLOGICAL ASSESSMENT

*FOR THE PROPOSED UPGRADE OF THE ROCKY DRIFT WWTW,*

*MBOMBELA LOCAL MUNICIPALITY, EHLANZENI DISTRICT,*

*MPUMALANGA*


**Compiled by**

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**DRAFT REPORT**




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## Acronyms

| | |
|---|---|
| **DWA** | Department of Water Affairs |
| **DWAF** | Department of Water Affairs & Forestry |
| **DWS** | Department of Water & Sanitation |
| **GIS** | Geographical Information Systems |
| **GPS** | Global Positioning System |
| **QC** | Quaternary Catchment |
| **MAP** | Mean Annual Precipitation |
| **NFEPA** | National Freshwater Ecosystem Priority Areas |

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# Specialist Details & Declaration

This report has been prepared in accordance with Section 13: General Requirements for Environmental Assessment Practitioners (EAPs) and Specialists as well as per Appendix 6 of GNR 982 – Environmental Impact Assessment Regulations and the National Environmental Management Act (NEMA, No. 107 of 1998 as amended 2017) and Government Notice 704 (GN 704). It has been prepared independently of influence or prejudice by any parties.

The details of Specialists are as follows –

Table 1 Details of Specialist

| Specialist | Task | Qualification and accreditation | Client | Signature |
|---|---|---|---|---|
| Bruce Scott-Shaw NatureStamp | Fieldwork, Assessments & report | PhD, Hydrology | SLR Consulting (Africa) (Pty) Ltd | Date: 30/12/2020 |
| Nick Davis Isikhungusethu Environmental Services | Design & GIS | BSc, BSc Hon, MSc Hydrology | SLR Consulting (Africa) (Pty) Ltd | Date: 30/12/2020 |

Details of Authors:

Bruce is a hydrologist; whose focus is broadly on hydrological perspectives of land use management and climate change. He completed his MSc under Prof. Roland Schulze in the School of Bioresources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, South Africa. Throughout his university career he has mastered numerous models and tools relating to hydrology, soil science and GIS. Some of these include ACRU, SWAT, SWAT-MODFLOW ArcMap, Idrisi, SEBAL, MatLab and Loggernet. He has some basic programming skills on the Java and CR Basic platforms. He has spent most of his spare time doing field work for numerous companies and researchers. Bruce has completed his PhD which focuses on rehabilitation of alien invaded riparian zones and catchments using indigenous trees. Bruce has worked on numerous groundwater projects, which has included micrometeorological work, borehole testing, borehole siting, groundwater modelling, EIAs and wetland mapping. Bruce has presented his research around the world, where most recently he represented South Africa in Cambodia on surface water and groundwater model.

Details of Reviewer:

Nicholas Davis is a hydrologist whose focus is broadly on hydrological perspectives of land use management, climate change, estuarine and wetland systems. Throughout his studies and subsequent work at UKZN he has mastered several models and programs such as ACRU, HEC-RAS, ArcMap, QGIS, Indicators of Hydrologic Alteration software (IHA) and Idrisi. He has moderate VBA programming skills, basic UNIX and python programming skills.

# 1. INTRODUCTION

## 1.1 Project Background and Description of the Activity

The project area is located approximately 12km north of the city of Nelspruit, Mbombela Municipality, Mpumalanga Province (Figure 2). The project area is located in the X22F quaternary catchment, within the Inkomati-Usuthu Water Management Area (Husted, 2017). There are two small watercourses that the proposed sewer pipeline would traverse. A previous flood assessment study was undertaken by JG Afrika (2017) and a water resources assessment (The Biodiversity Company, 2017) but did not cover the recent addition of the bulk sewer line. Due to the nature of the transported effluent, a Geohydrological assessment is required.

The dimensions of the proposed and existing infrastructure are as follows-

- Proposed 500mm uPVC Bulk Sewer Pipe; and
- Existing 160 Ø Bulk Sewer Pipeline to be upgraded to 500 Ø and realigned.

The key requirements for this study are as follows:

1. Desktop Geohydrological assessment.
2. Hydrocensus (investigation of boreholes within 5 km).
3. Groundwater monitoring programme.
4. Reporting (report & maps in pdf format).

The coordinates for the development are:
25.367471 S & 30.970472 E.

The proposed bulk line additions can be seen in Figure 1 with the layout of the proposed development and associated infrastructure in Figure 2.

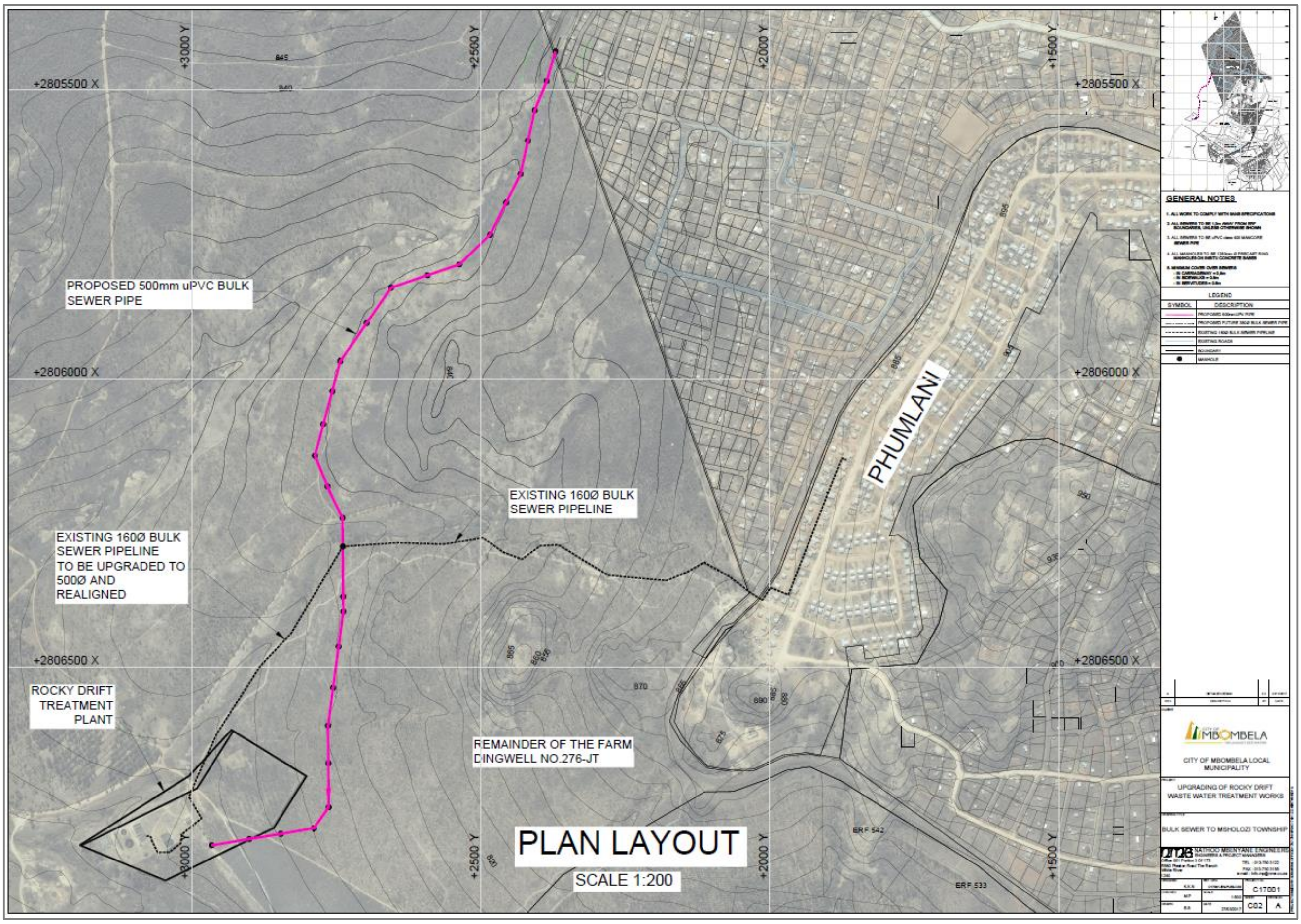



Figure 1 Layout of the proposed bulk sewer line

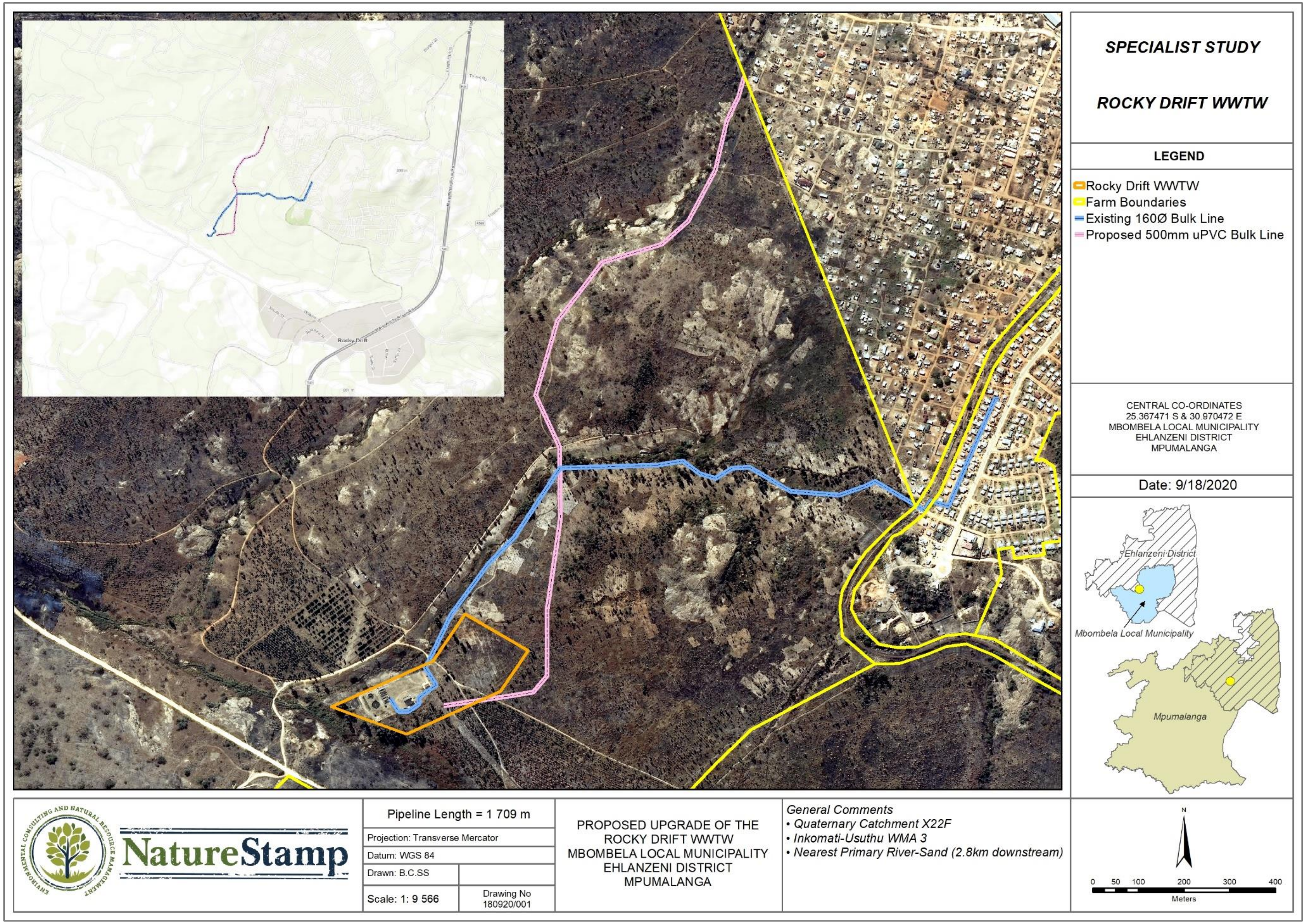



Figure 2 Locality map of the existing WWTW and proposed bulk line

## 1.2 Terms of reference

The terms of reference are as follows:

i. **Geo-hydrological Investigation**

a. Background & Data Collection:
- Current status of groundwater quality on site;
- Possible impact on down-gradient resources;
- Geological Investigation
- Requesting and gathering data from the local Municipality, Department of Water and Sanitation, Department of Agriculture, and possibly private consultants and drilling and pump-testing companies;
- Collation of gathered data and existing database data for the compilation of a groundwater database; and

b. Geo-hydrological assessment of the water use activity/impact in terms of:
- Groundwater pollution potential;
- Possible impact on down-gradient resources;
- Hydrocencus (5 km radius); and
- Surrounding groundwater users potentially impacted.

c. Groundwater Monitoring Programme & Management Plan:
- Compile a Groundwater Monitoring programme -Monitor boreholes available to assess groundwater flow regimes upstream, downstream and at the site.
- Management plan submitted in terms of groundwater quality and quantities
- Impacts and mitigation measures

# 2. ALLOWABLE ABSTRACTIONS AND WATER REGISTRATION

Quaternary Catchment (QC) site: X22F (Inkomati).

According to GN 538 (2016), the General Authorization (GA) limits for this QC are as follows–

- Abstraction of surface water: 2 000 $m^3$ / year @ 1 l/s throughout the year.
- Storage of water: 2 000 $m^3$
- Groundwater abstraction: 45 $m^3$/ha/year (allowed under GA).

These limits show that this catchment area is water limited and restricted water use applies. The groundwater in this area is currently being over utilized.

# 3. STUDY SITE

The site is located 12 km north of Nelspruit in Mpumalanga. The existing development area sits within Quaternary Catchment (QC) X22F of the Crocodile River catchment (Inkomati-Usuthu).

The site sits on a non-perennial tributary of the Sand, approximately 2.44 km to the north. The site has been significantly modified for settlements, brick/granite factories and agricultural activities. According to desktop information (DWS, 2017), the activities in the area and local land uses have impacted the aquatic system, which have rendered the system as moderately modified. The associated watercourse is predominantly representative of a wetland system, but a site was selected for the analysis of water (in situ) and to collect a water sample. However, this study assessed the reach of the watercourse adjacent to the WwTW (JG Afrika, 2017).

According to Mucina and Rutherford (2006), the area is dominated by Legogote Sour Bushveld (SVi 9), which falls under the lowveld Savanna (SV) bioregion. The vegetation type has been classified as 'endangered', and 1.6 % receives formal protection. Of the remaining 50 % only a small percentage is statutorily protected in reserves.

Rainfall is not variable throughout the small catchment area (9 km$^2$) with 720 mm occurring during an average year at the site (Table 2). Temperatures range from an average of 19.3 °C [41 – 9.6 °C max range] in the summer to 14 °C [30.9 – -3.3 °C min range] in the winter months. The soils within the property boundary range from Mispah, to Hutton and Clovelly forms, which dominate most of the site. Some Oakleaf forms occur within the wetland edges. The underlying geological formation is intrusive Mpuluzi Granite of the Archaean Eon and the Swazian Era.

Table 2 Mean monthly rainfall and temperature observed near Rocky Drift(derived from historical data)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean Rainfall (mm) | 139.4 | 107.8 | 88.4 | 41.8 | 15.0 | 7.0 | 9.8 | 7.1 | 21.6 | 60.3 | 100.4 | 121.9 | **720.6** |
| Mean Temperature (°C) | 23.2 | 23.0 | 22.1 | 19.6 | 16.7 | 14.1 | 14.1 | 15.9 | 18.7 | 20.0 | 21.1 | 22.5 | **19.3** |


Figure 3 Typical setting of the surrounding site showing extensive disturbances

## 4. METHODOLOGY

A detailed description of the methods has been provided. The regional context and desktop analysis were used as the point of departure. A detailed desktop assessment was undertaken. Subsequently, a site visit was undertaken to assess groundwater infrastructure (if present). A site visit on the 20th October 2020 was conducted to provide necessary in-field procedures including: soil sampling, the recording of dominant vegetation and topography/ terrain analysis, assessments of existing hydrological infrastructure and water sampling. This assessment was undertaken during a dry period. Additional groundwater databases are provided in Annexures A, B and C.

The assessment of these systems considered the following databases where relevant:

Table 3 Data type and source for the geohydrological assessment

| Data Type | Year | Source/Reference |
|---|---|---|
| Aerial Imagery | 2013, 2016 | Surveyor General |
| 1:50 000 Topographical | 2011 | Surveyor General |
| 5m Contour | 2010 | Surveyor General |
| River Shapefile | 2011 | NFEPA |
| Geology Shapefile | 2011 | Council of Geoscience, 2015/National Groundwater Archive |
| Borehole Data | Ongoing | National Groundwater Archive, WARMS |
| Land Cover | 2006 | SANBI |
| Water Registration | 2013, 2016 | WARMS - DWS |

*Data will be provided on request

Table 4 Equipment used during the site visit

| Equipment Used | Description |
|---|---|
| Bailer | Used to abstract water from a borehole. 10 abstractions are undertaken before a sample is taken to ensure that the water abstracted is recharged water representative of the site. |
| Dip Meter | Used to measure the depth of the water table in a borehole. |
| GPS (GPSMAP 64) | Used to mark points of interest such as boreholes and auger points. |
| Auger (Bucket) | Used to take soils samples as well as identifying soil form and family. |
| Munsell Colour Chart | Used to determine soil value, hue and chroma. |

## 4.1 Background Data/Regional Context

It is extremely important that, when a development occurs or operates near water resources or using water resources, downstream or nearby users are considered. The extent of downstream users dependent on the delivery of sufficient amounts of water and of a sufficient quality will determine if the development has a negative impact. A desktop study was undertaken to determine the climatic conditions and geological formations. A brief analysis of nearby users was undertaken.

## 4.2 Site Visit

A site visit was conducted by Bruce Scott-Shaw of NatureStamp (Pty) Ltd on the 20th October 2020. Previous site visits have been undertaken by other specialists and are referenced where necessary. The current condition was assessed as follows -

- The vegetation characteristics of the linear site was assessed for the determination of cover characteristics, changes in geology and soils that drive the vegetation growth;
- The presence and dimensions of any hydrological infrastructure such as dams, boreholes and irrigation schemes were documented and recorded;
- The overall state of drainage channels, streams and rivers was assessed;
- The slope of the study site as well as proximity to water resources were noted;
- The state of existing gauging stations (nearby) was assessed to determine if the structure is accurately recording streamflow (e.g. evidence of under cutting or damaged features); and
- The identification of any obvious faults or outcrops that may influence the geohydrology was recorded.

### 4.2.1 Groundwater Infrastructure

An assessment of any existing groundwater infrastructure was undertaken. The assessment determined the current state of each site and the potential in relation to the underlying geology and annual rainfall. Sites were assessed as:

- Is the pump/borehole currently working?
- If not, when did it stop working?
- If not why did it stop working?
- What are the operational boreholes being used for?
- For operational boreholes the following information was obtained where available:
    - pump installation depth,
    - borehole depth;
    - depth of water level;
    - yield of the borehole;
    - depth of water strike(s); and
    - volume abstracted.

#### 4.2.2 Local Drillers

A meeting was held between NatureStamp and SBK drilling in White River. This allowed for data to be obtained on borehole depth (including casing depth), water strike, static water level, expected yield and lithology. Unfortunately, limited yield tests have been conducted in the area.

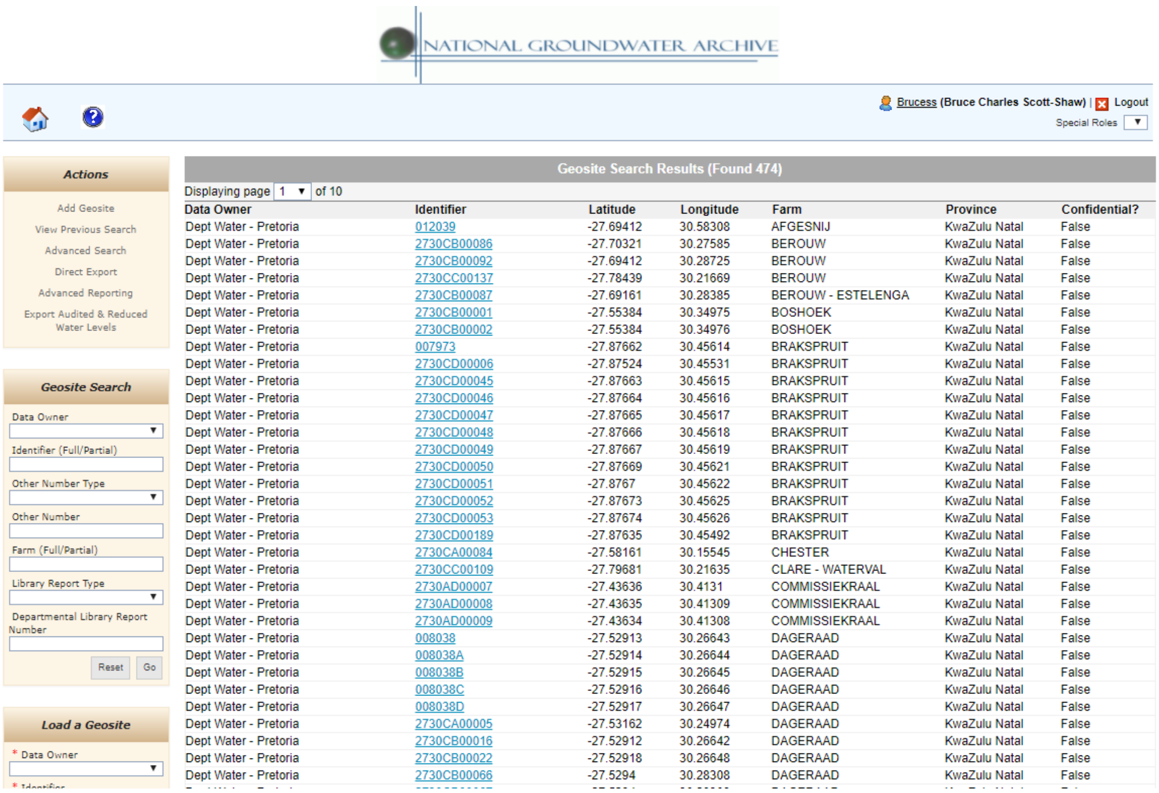
### 4.3 Groundwater (Hydrogeological) Assessment

#### 4.3.1 Hydrocensus

In order to analyse the potential for groundwater options, a hydro-census of all boreholes within 5 km was undertaken (a more detailed assessment of boreholes within 1 km of the site was undertaken). A borehole bailer and a dip meter were used where boreholes were accessible and still active. Borehole sites were obtained through the desktop investigation and 'ground-truthed' on site.

The National Groundwater Archive (Department of Water and Sanitation) was utilized to collate historical groundwater depths, recharge rates, water quality and site details (Figure 4). Notable boreholes were marked using a GPS. Access was considered for these boreholes and potential borehole sites.

Historical boreholes that were observed on or near sites were marked and investigated. The final yield data was compiled into a GIS database for the production of groundwater maps.


NATIONAL GROUNDWATER ARCHIVE

Brucess (Bruce Charles Scott-Shaw) | Logout
Special Roles

Actions
Add Geosite
View Previous Search
Advanced Search
Direct Export
Advanced Reporting
Export Audited & Reduced Water Levels

Geosite Search
Data Owner
Identifier (Full/Partial)
Other Number Type
Other Number
Farm (Full/Partial)
Library Report Type
Departmental Library Report Number
Reset Go

Load a Geosite
* Data Owner

Geosite Search Results (Found 474)

Displaying page 1 of 10

| Data Owner | Identifier | Latitude | Longitude | Farm | Province | Confidential? |
|---|---|---|---|---|---|---|
| Dept Water - Pretoria | 012039 | -27.69412 | 30.58308 | AFGESNIJ | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CB00086 | -27.70321 | 30.27585 | BEROUW | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CB00092 | -27.69412 | 30.28725 | BEROUW | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CC00137 | -27.78439 | 30.21669 | BEROUW | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CB00087 | -27.69161 | 30.28385 | BEROUW - ESTELENGA | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CB00001 | -27.55384 | 30.34975 | BOSHOEK | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CB00002 | -27.55384 | 30.34976 | BOSHOEK | KwaZulu Natal | False |
| Dept Water - Pretoria | 007973 | -27.87662 | 30.45614 | BRAKSPRUIT | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CD00006 | -27.87524 | 30.45531 | BRAKSPRUIT | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CD00045 | -27.87663 | 30.45615 | BRAKSPRUIT | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CD00046 | -27.87664 | 30.45616 | BRAKSPRUIT | KwaZulu Natal | False |
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| Dept Water - Pretoria | 2730CD00049 | -27.87667 | 30.45619 | BRAKSPRUIT | KwaZulu Natal | False |
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| Dept Water - Pretoria | 2730CD00052 | -27.87673 | 30.45625 | BRAKSPRUIT | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CD00053 | -27.87674 | 30.45626 | BRAKSPRUIT | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CD00189 | -27.87635 | 30.45492 | BRAKSPRUIT | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CA00084 | -27.58161 | 30.15545 | CHESTER | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CC00109 | -27.79681 | 30.21635 | CLARE - WATERVAL | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730AD00007 | -27.43636 | 30.4131 | COMMISSIEKRAAL | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730AD00008 | -27.43635 | 30.41309 | COMMISSIEKRAAL | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730AD00009 | -27.43634 | 30.41308 | COMMISSIEKRAAL | KwaZulu Natal | False |
| Dept Water - Pretoria | 008038 | -27.52913 | 30.26643 | DAGERAAD | KwaZulu Natal | False |
| Dept Water - Pretoria | 008038A | -27.52914 | 30.26644 | DAGERAAD | KwaZulu Natal | False |
| Dept Water - Pretoria | 008038B | -27.52915 | 30.26645 | DAGERAAD | KwaZulu Natal | False |
| Dept Water - Pretoria | 008038C | -27.52916 | 30.26646 | DAGERAAD | KwaZulu Natal | False |
| Dept Water - Pretoria | 008038D | -27.52917 | 30.26647 | DAGERAAD | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CA00005 | -27.53162 | 30.24974 | DAGERAAD | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CB00016 | -27.52912 | 30.26642 | DAGERAAD | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CB00022 | -27.52918 | 30.26648 | DAGERAAD | KwaZulu Natal | False |
| Dept Water - Pretoria | 2730CB00066 | -27.5294 | 30.28308 | DAGERAAD | KwaZulu Natal | False |

Figure 4 National Groundwater Archive

This process not only assisted in determining the general state, condition and productivity, but allowed for the identification of key boreholes for sampling, yield assessments and potential operational and construction use. Additionally, any groundwater users that may be impacted upon were identified.

#### 4.3.3 Groundwater Recommendations

Results from the hydrogeological assessment were used to provide recommendations on impacts of the proposed development and feasibility of groundwater resources.

# 5. LIMITATIONS AND ASSUMPTIONS

In order to apply generalized and often rigid scientific methods or techniques to natural, dynamic environments, a number of assumptions are made. Furthermore, a number of limitations exist when assessing such complex ecological systems. The following constraints may have affected this assessment –

- A Garmin GPSMAP 64 was used in the mapping of waypoints on-site. The accuracy of the GPS is affected by the availability of corresponding satellites and accuracy ranges from 1 to 3 m after post-processing corrections have been applied.

- A Munsell Soil Colour Chart was used to assess soil morphology. This tool requires that a dry sample of soil be assessed. However, due to in-field time constraints, slightly wet soil samples were assessed. Wet samples would have consistently lower values than dry soils; and this is taken into consideration.

- Limited data was available at times (particularly on groundwater infrastructure). As such, some assumptions were made in the absence of data. These assumptions used data from nearby areas. Reliance was placed the landowner's recollection and on the models used in the absence of suitable data.

# 6. RESULTS AND DISCUSSION

Results detailing the desktop assessment done as well as findings from this updated study with the site visit are provided in this Section.

## 6.1 Background Data/Regional Context

### 6.1.1 Terrain & Vegetation

Contour lines (2 meter) and the Alos Palsar 12.5 meter DEM were used to derive the surface terrain (Figure 5). The soils and geology were obtained from GIS layers obtained from national databases and site samples. Various vegetation databases were used to determine the likely or expected vegetation types (Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011). A number of recognized databases were utilized in achieving a comprehensive review.

This site is dominated by Legogote Sour Bushveld (SVl 9, Mucina and Rutherford, 2006). This occurs within the lowveld savanna biome. The desktop analysis revealed that the area is endangered, with the potential for some flagged fauna and flora (e.g. red data species and endangered wildlife) being found from the C-plan, SEA and MINSET databases. The following information was collected for the vegetation unit SVl 9 (Mucina & Rutherford, 2006). The characteristics of this grassland are described as:

- The vegetation type occurs on gently to moderately sloping upper pediment slopes with dense woodland including many medium to large shrubs often dominated Parinari curatellifolia and Bauhinia galpinii with Hyperthelia dissolute and Panicum maximum in the undergrowth.
- Short thicket dominated by Acacia ataxacantha occurs on less rocky sites.
- Exposed granite outcrops have low vegetation cover, typically with Englerophytum magalismontanum, Aloe petricola and Myrothamnus flabellifolia.
- It has been greatly transformed, mainly by plantations and also cultivated areas and urban development.
- Scattered alien plants include Lantana camara, Psidium guajava and Solanum mauritianum.
- Important taxa includes:
    - Tall trees: *Pterocarpus angolensis (d), Sclerocarya birrea subsp. caffra (d);*
    - small trees: *Acacia davyi (d), A. sieberiana var. woodii (d), Combertum zeyheri (d), Erythrina latissima (d), Parinari curatellifolia (d), Terminalia sericea (d), Trichilia emetica (d), Verononia amygdalina (d), Acacia caffra, Antidesma venosum, Erythroxylum emarginatum, Faurea rochetiana, F. saligna, Ficus burikei, F. glumosa, F. glumosa, F. ingens, F. petersii, Heteropyxis natalensis, Peltophorum africanum, Piliostigma thonningii, Pterocarpus rotundifolius, Schotia brachypetala;*
    - succulent tree: *Euphorbia ingens;*
    - tall shrubs: *Diospyros lycioides subsp. sericea, Erythroxylum delagoense, Olea europaea subsp. africana, Pachystigma macrocalyx, Pseudarthria hookeri var. hookeri, Rhus pentheri;*
    - low shrubs: *Diospyros galpinii (d), Flemingia grahamiana (d), Agathisanthemum bojeri, Eriosema psoraleoides, Gymnosporia heterophylla, Hemizygia punctata, Indigofera filipes, Myrothamnus flabellifolius, Rhus rogersii; succulent shrubs: Aloe petricola, Euphorbia vandermerwei, Huernia kirkii;*
    - woody climbers: *Acacia ataxacantha (d), Bauhinia galpinii (d), Helinus intergrifolius, Sphedamnocarpus pruriens subsp. Pruriens;*
    - graminoids: *Bothriochloa bladhii (d), Cymbopogon caesius (d), C. nardus (d), Hyparrhenia cymbaria (d), H. poecilotricha (d), Hyperthelia dissolute (d), Panicum maximum (d), Andropogon schirensis, Paspalum scrobiculatum, Schizachyrium sanguineum;*
    - herbs: *Gerbera ambigua, G. viridifolia, Hemizygia persimilis, Hibiscus sidiformis, Ocimum gratissimum, Waltheria indica; succulent herbs: Orbea carnosa subsp. carnosa, Stapelia gigantean; and geophytic herbs: Gladiolus hollandii, Hypoxis rigidula.*
    - Endemic Taxon: Succulent herb: *Aloe simii.*

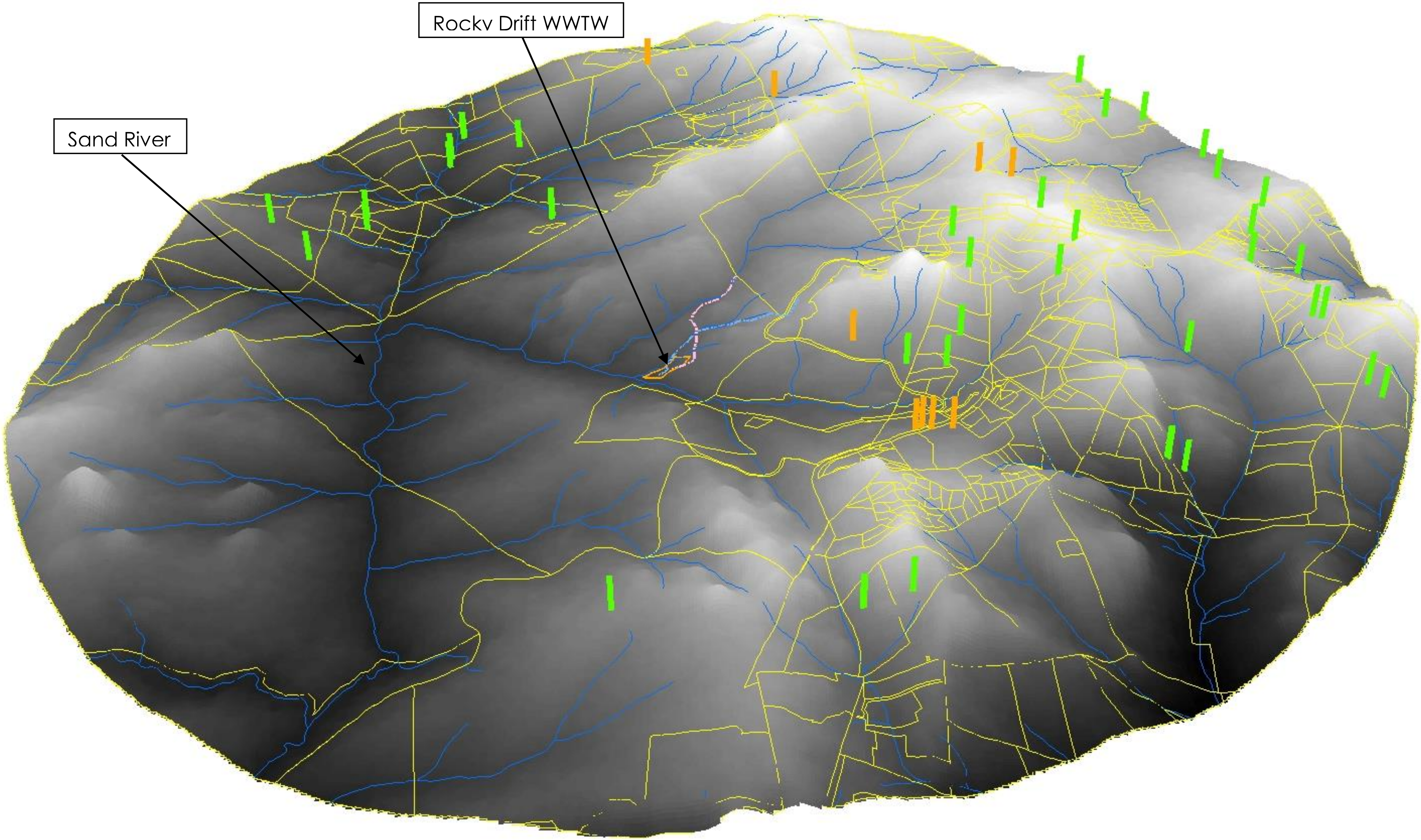


Figure 5 Exaggerated terrain model for the 5 km hydrocensus area (WARMS registered users – orange; geosites – green)

### 6.1.2 Prevailing Soils and geology

The Rocky Drift site is underlain by Porphyritic Potassic Granite of the Nelspruit Suite (Zmz). This is considered intrusive of the Archaean Eon and the Swazian Era. This granite is grey to white. According to Cairncross (2004), Granite is a coarse-grained igneous rock that forms from the crystallization of molten magma rich in silica. It is composed mainly of quartz and feldspars, notably the potassium-bearing varieties orthoclase and microcline. Other minerals include mica and hornblende. Granitic outcrops were identified around the site. This is further substantiated by the Afrimat quarry which is 850 meters north west of the site.

This system has a relatively low groundwater yield. The average saturated hydraulic conductivity of the soils was 6.16 mm.h$^{-1}$. This soil has a moderate conductivity and a porosity of 0.4. This indicates that the storage of water in the soil will be low although infiltration to the subsurface will be limited due to confining layers. Additionally, lateral flow would be promoted due to the sandy orthic topsoil.

The site is constrained with potential for:

- Soil collapse;
- Shallow seepage;
- Perched water table;
- Compressed soils;
- Erodible and dispersive soils.

Figure 8 provides shows the changes in geological formations within a 5 km area of the site.

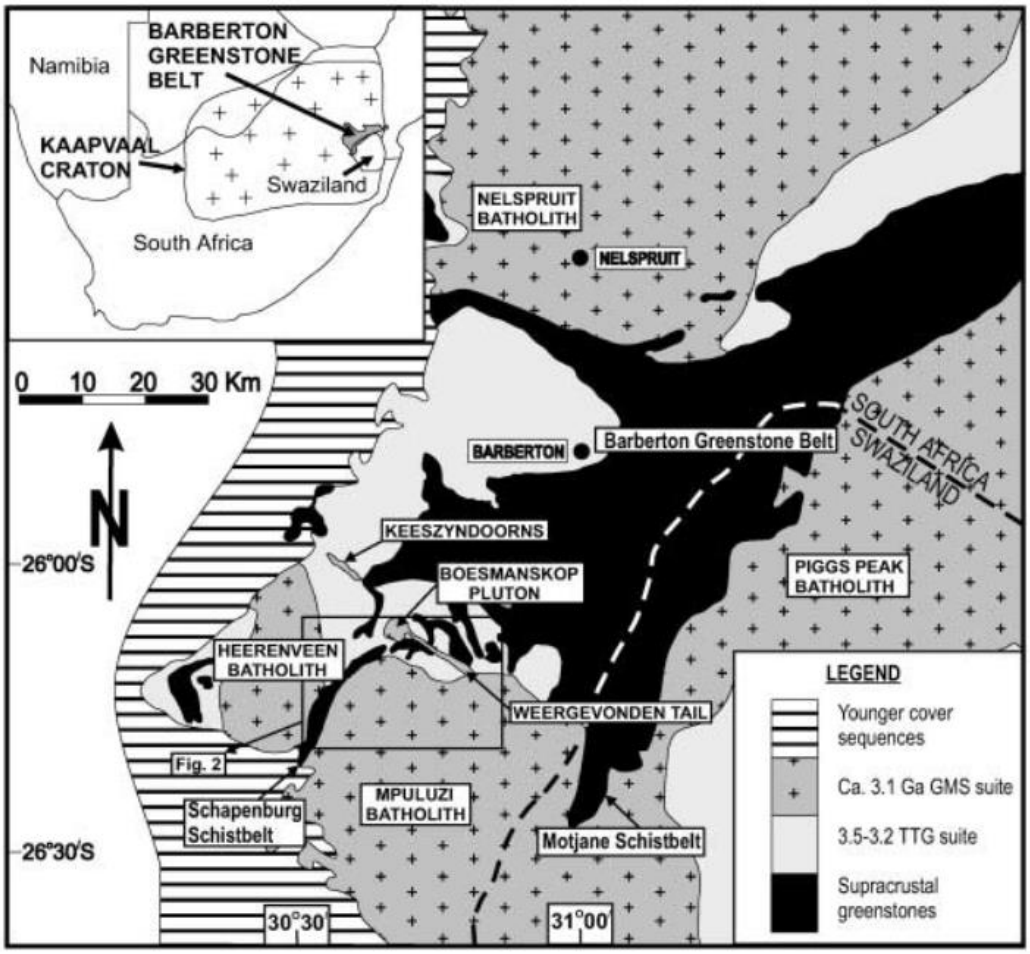


Figure 6 Geological formations around Nelspruit (Westraat *et al.*, 2005)

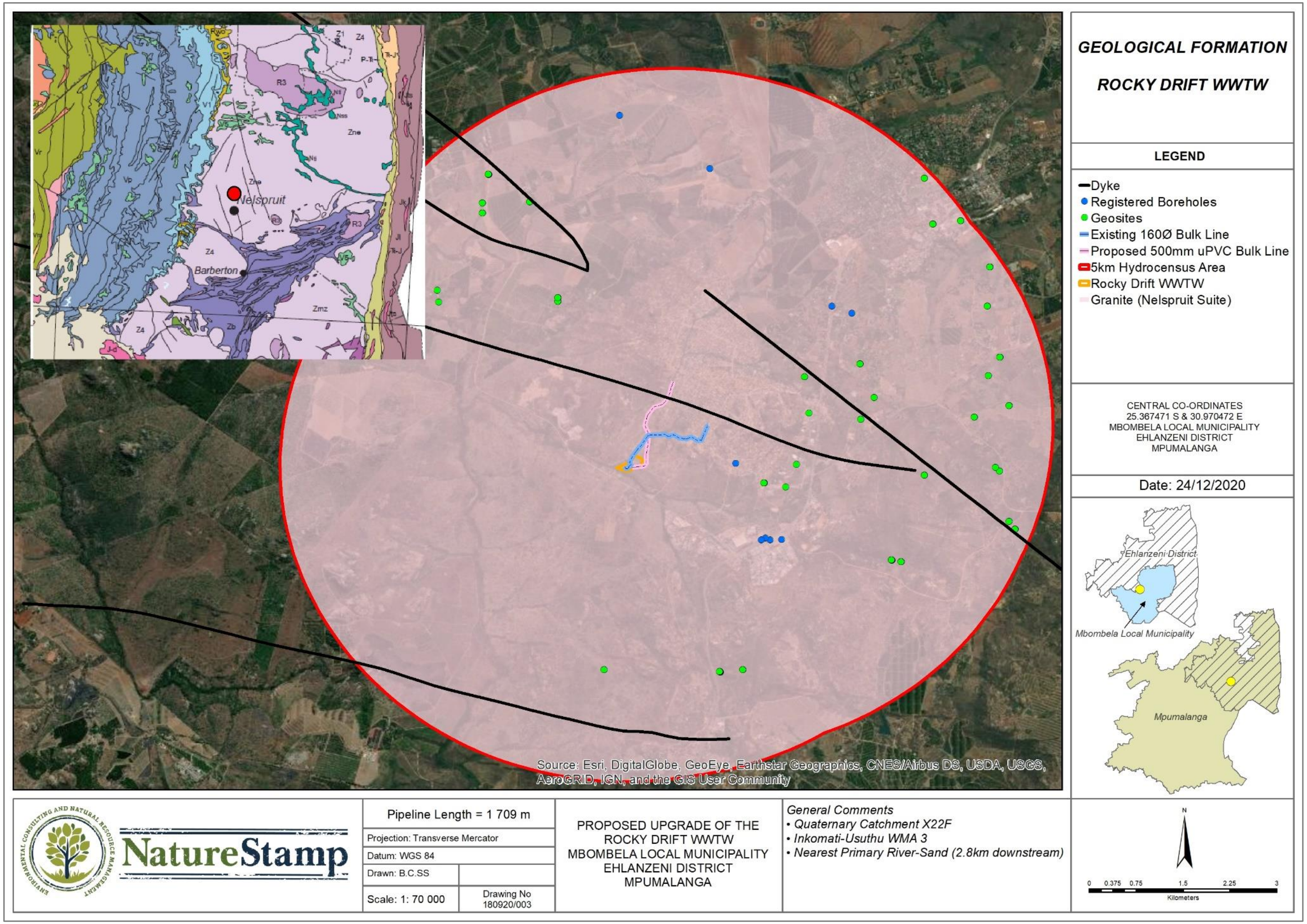


Figure 7 Geological formations and boreholes within 5 km of the study area

### 6.1.4 Climate Data

A detailed assessment of the climate was undertaken. Rainfall stations were considered based on their proximity to the site, altitude and length/reliability of the data record. The long term mean annual rainfall of the site that was used in the design was 712 mm (Figure 8).

Table 5 Comparison of values from some of the rainfall stations that were assessed during the data analysis

| Station No. | Estimated MAP (mm) | Years | Reliable | Altitude (m) | Station Name |
|---|---|---|---|---|---|
| **0555799 W** | 935 | 96 | 7.9 | 807 | Heidelberg |
| **0555837 A** | 708 | 96 | 51.6 | 660 | Nelspruit Res |
| **0555837 W** | 708 | 96 | 52.3 | 660 | Nelspruit |
| **0555866 W** | 632 | 96 | 21.3 | 756 | Friedenheim |
| **0555889 W** | 851 | 96 | 14.4 | 934 | Dipgate |
| **05556020 W** | 852 | 96 | 34.3 | 962 | Witrivier (Pol) |

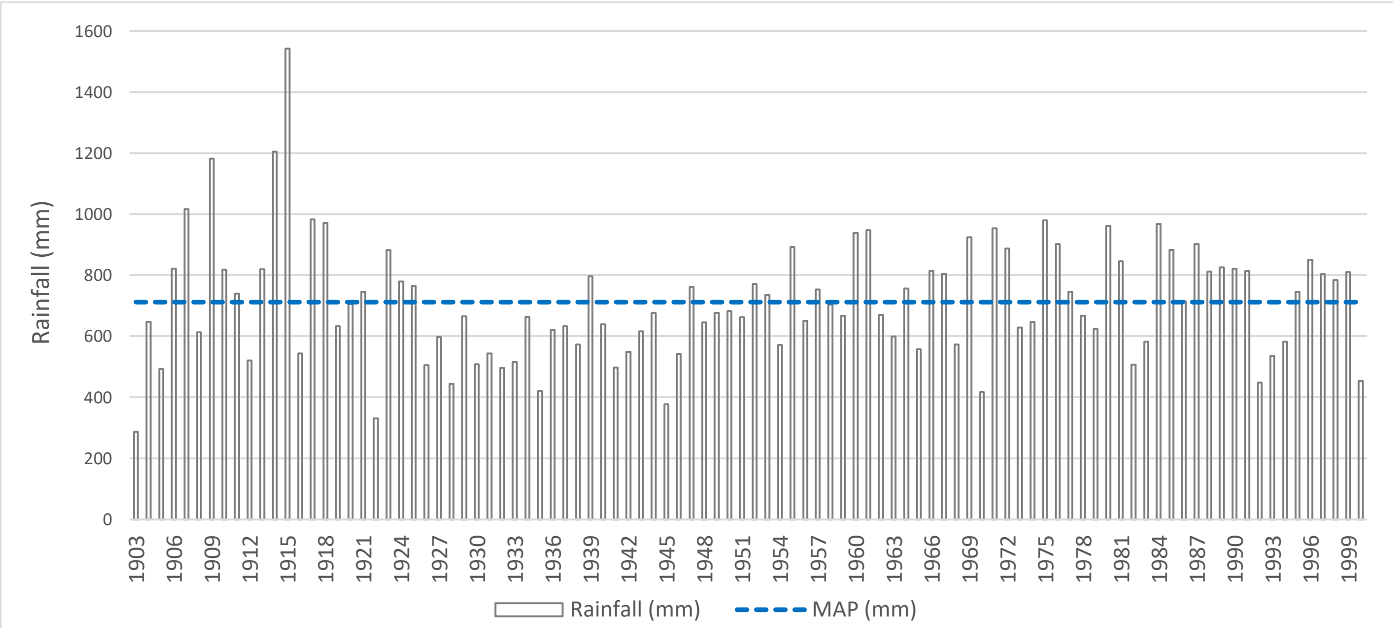


Figure 8 Long term synthesized annual rainfall values with the mean annual precipitation indicated in blue

## 6.2 Groundwater Characteristics of the Study Area

In South Africa, there are upwards of 400 000 boreholes each yielding an average of 2 681 $L.day^{-1}$ (0.75 $L.s^{-1}$). Approximately one in three boreholes drilled are regarded as a failure (Mountain, 1968). However, the success rate has been improved with the introduction of more advance survey equipment. There is a correlation between areas of higher rainfall and areas that have higher yielding boreholes. Additionally, yield varies with geological formation. The following formations are known to produce high yields:

- Dolomite formations;
- Ventersdorp formation (basic lavas);
- Quartzite and shale (alternate) – providing a reliable yield but limited due to cracks; and
- Dolorite dikes (obtained on the upper side of the dike).

Formations that are known to provide poor yields are as follows:

- Granite sheets;
- Dolorite sheets;
- Shale (particularly shale that has been weathered at the surface resulting in an low infiltration clay surface); and
- Dwyka tillite.

The study area consists of a variable aquifer type. It is a weathered and fractured aquifer with an estimated yield of between 0.1 to 2 $L.s^{-1}$.

### 6.2.1 Potential Groundwater Yield

The groundwater yield in the area would not be adequate to meet irrigation or mining requirements. However, basic potable needs could be met on-site. Data obtained from the groundwater archives are provided in Table 6. Based on the information obtained from the site and desktop assessment, the expected sustainable yield would be **0.55 $\ell.s^{-1}$.**

Table 6 Groundwater resources for the X22F aquifer

| Aquifer Yield ($Mm^3/a$) | Allocable ($Mm^3/a$) | Firm Yield ($l/s/km^2$) | Existing Use (l/s) | GW Level (mbgl) | Recharge (%) | Baseflow/EWR ($Mm^3/a$) |
|---|---|---|---|---|---|---|
| Unknown | Unknown | 0.009 | 0.5 | 17.9 | 7.9 | 46.1 |

Based on the data extracted for each geosite (Table 7), The following information was obtained:

- The lithology is Sandy or soil (0-2m))/Granite (up to 48m)
- Average water level (28 m)
- Average yield (0.55 ℓ/s) for successful boreholes

Although the investigation also includes investigating the impact of the development on groundwater resources, investigating the yield provides an insight into potential contamination issues and provides an indication to the developers/operators on their expected requirements for licencing and infrastructure.

Figure 9 provides the site model showing the boreholes (blue) within 5 km of the site as well as the water level below the ground surface, with light blue indicating a shallow level and purple/white indicating a deeper level. This is not necessarily correlated to borehole yield (which is also dependent on geology).

The data associated with each borehole has been provided in Tables 7 and 8.

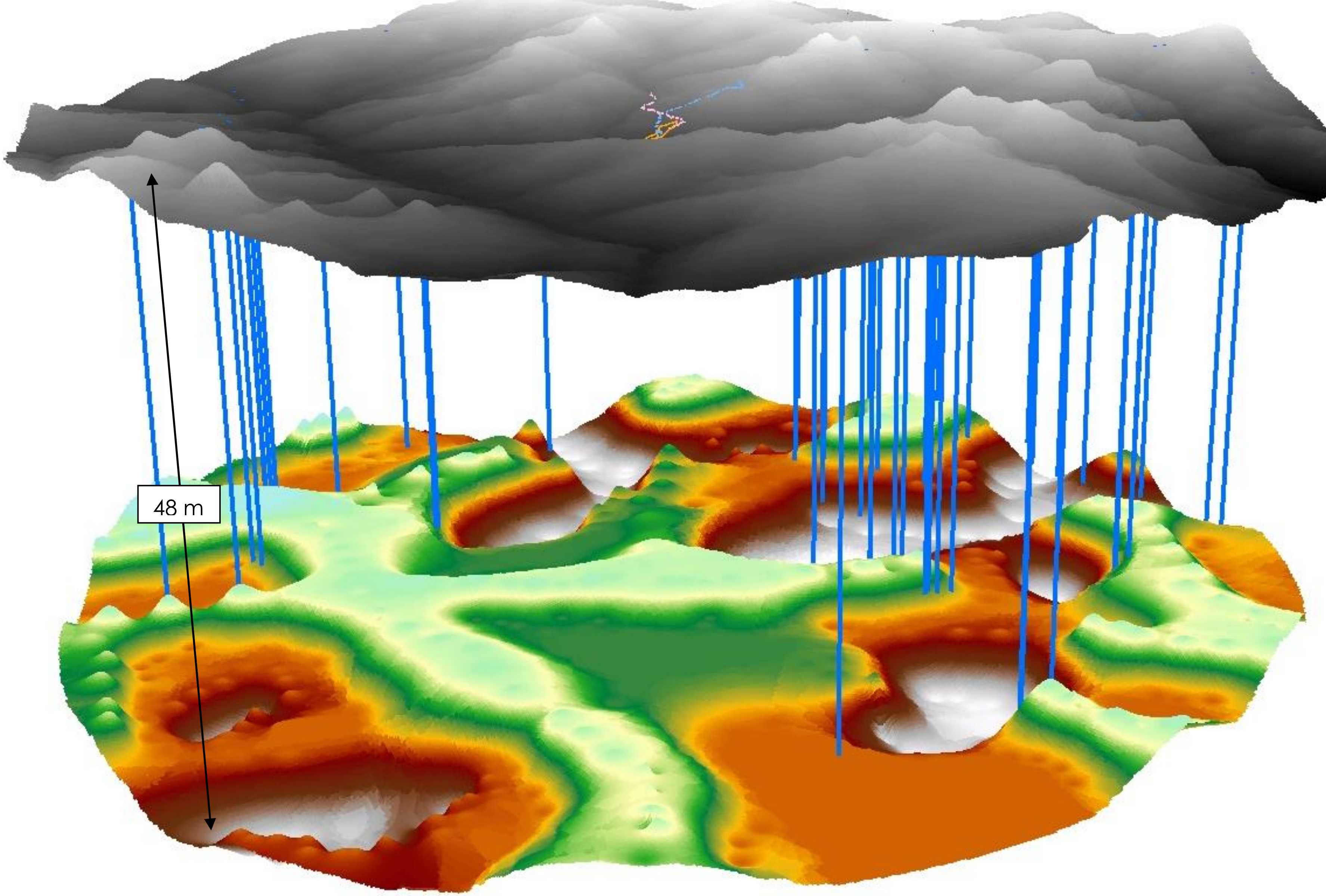


Figure 9 Water table level within 5 km of the Rocky Drift WWTW

Table 7 Recorded geosites and their yields within 5 km of the existing WWTW

| Map Code | Latitude | Longitude | FarmName | FarmNumber | WMA | Completion Date | Water Level (m) | Discharge (L/s) | Depth (m) | Diameter | Seepage | Water Strike | Lithology |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2300 | -25.32620 | 31.01259 | WITRIVIER SKOOL | 6 | Inkomati | 5/4/1950 | 18.28 | 0.01 | 48.8 | 152 mm (6.0)" | 0.01 | 0.00 | Granite |
| 2300 | -25.32620 | 31.01259 | WITRIVIER SKOOL | 6 | Inkomati | 5/4/1950 | 18.28 | 0.01 | 48.8 | 152 mm (6.0)" | 0.01 | 0.00 | Boulders |
| 2300 | -25.32620 | 31.01259 | WITRIVIER SKOOL | 6 | Inkomati | 5/4/1950 | 18.28 | 0.01 | 48.8 | 152 mm (6.0)" | 0.01 | 0.00 | Granite |
| 2530BD00012 | -25.39702 | 30.98645 | STONEYRIDGE | 281 | Inkomati | 11/20/1967 | 15.24 | 0.06 | 53.3 | 152 mm (6.0)" | 0.06 | 0.00 | SOIL |
| 2530BD00012 | -25.39702 | 30.98645 | STONEYRIDGE | 281 | Inkomati | 11/20/1967 | 15.24 | 0.06 | 53.3 | 152 mm (6.0)" | 0.06 | 0.00 | Granite |
| 2531AC00019 | -25.36064 | 31.01982 | HOOGGELEGEN | 105 | Inkomati | 1/16/1964 | 13.10 | 0.07 | 57.9 | 152 mm (6.0)" | 0.07 | 0.00 | Boulders |
| 2531AC00019 | -25.36064 | 31.01982 | HOOGGELEGEN | 105 | Inkomati | 1/16/1964 | 13.10 | 0.07 | 57.9 | 152 mm (6.0)" | 0.07 | 0.00 | Granite |
| 2531AC00019 | -25.36064 | 31.01982 | HOOGGELEGEN | 105 | Inkomati | 1/16/1964 | 13.10 | 0.07 | 57.9 | 152 mm (6.0)" | 0.07 | 0.00 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.11 | 34.0 | 219 mm (8.75)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.11 | 34.0 | 219 mm (8.75)" | | 0.11 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.11 | 90.0 | 165 mm (6.5)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.11 | 90.0 | 165 mm (6.5)" | | 0.11 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.11 | 34.0 | 219 mm (8.75)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.11 | 34.0 | 219 mm (8.75)" | | 0.11 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.11 | 90.0 | 165 mm (6.5)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.11 | 90.0 | 165 mm (6.5)" | | 0.11 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.21 | 34.0 | 219 mm (8.75)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.21 | 34.0 | 219 mm (8.75)" | | 0.11 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.21 | 90.0 | 165 mm (6.5)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.21 | 90.0 | 165 mm (6.5)" | | 0.11 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.25 | 34.0 | 219 mm (8.75)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.25 | 34.0 | 219 mm (8.75)" | | 0.11 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.25 | 90.0 | 165 mm (6.5)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.25 | 90.0 | 165 mm (6.5)" | | 0.11 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 150.0 | 165 mm (6.5)" | | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 150.0 | 165 mm (6.5)" | | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 150.0 | 165 mm (6.5)" | 0.0001 | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 150.0 | 165 mm (6.5)" | 0.0001 | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 16.0 | 219 mm (8.75)" | | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 16.0 | 219 mm (8.75)" | | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 16.0 | 219 mm (8.75)" | 0.0001 | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 16.0 | 219 mm (8.75)" | 0.0001 | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 150.0 | 165 mm (6.5)" | | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 150.0 | 165 mm (6.5)" | | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 150.0 | 165 mm (6.5)" | 0.0001 | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 150.0 | 165 mm (6.5)" | 0.0001 | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 16.0 | 219 mm (8.75)" | | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 16.0 | 219 mm (8.75)" | | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 16.0 | 219 mm (8.75)" | 0.0001 | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.28 | 16.0 | 219 mm (8.75)" | 0.0001 | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 150.0 | 165 mm (6.5)" | | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 150.0 | 165 mm (6.5)" | | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 150.0 | 165 mm (6.5)" | 0.0001 | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 150.0 | 165 mm (6.5)" | 0.0001 | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 16.0 | 219 mm (8.75)" | | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 16.0 | 219 mm (8.75)" | | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 16.0 | 219 mm (8.75)" | 0.0001 | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 16.0 | 219 mm (8.75)" | 0.0001 | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 150.0 | 165 mm (6.5)" | | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 150.0 | 165 mm (6.5)" | | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 150.0 | 165 mm (6.5)" | 0.0001 | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 150.0 | 165 mm (6.5)" | 0.0001 | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 16.0 | 219 mm (8.75)" | | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 16.0 | 219 mm (8.75)" | | 0.10 | Granite |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 16.0 | 219 mm (8.75)" | 0.0001 | 0.10 | SOIL |
| 2531AC00282 | -25.38147 | 31.00925 | MIDDENIN REST GED 1 | 109 | Inkomati | 4/18/1995 | 40.00 | 0.29 | 16.0 | 219 mm (8.75)" | 0.0001 | 0.10 | Granite |
| 2531AC00264 | -25.35297 | 31.00331 | WITRIVIER PTN. HOLDINGS 95 | 0 | Inkomati | 5/26/1995 | 40.00 | 0.30 | 25.0 | 219 mm (8.75)" | | 0.30 | SOIL |
| 2531AC00264 | -25.35297 | 31.00331 | WITRIVIER PTN. HOLDINGS 95 | 0 | Inkomati | 5/26/1995 | 40.00 | 0.30 | 25.0 | 219 mm (8.75)" | | 0.30 | Granite |
| 2531AC00264 | -25.35297 | 31.00331 | WITRIVIER PTN. HOLDINGS 95 | 0 | Inkomati | 5/26/1995 | 40.00 | 0.30 | 54.0 | 165 mm (6.5)" | | 0.30 | SOIL |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2531AC00264 | -25.35297 | 31.00331 | WITRIVIER PTN. HOLDINGS 95 | 0 | Inkomati | 5/26/1995 | 40.00 | 0.30 | 54.0 | 165 mm (6.5)" | | 0.30 | Granite |
| 2531AC00264 | -25.35297 | 31.00331 | WITRIVIER PTN. HOLDINGS 95 | 0 | Inkomati | 5/26/1995 | 40.00 | 0.30 | 25.0 | 219 mm (8.75)" | | 0.30 | SOIL |
| 2531AC00264 | -25.35297 | 31.00331 | WITRIVIER PTN. HOLDINGS 95 | 0 | Inkomati | 5/26/1995 | 40.00 | 0.30 | 25.0 | 219 mm (8.75)" | | 0.30 | Granite |
| 2531AC00264 | -25.35297 | 31.00331 | WITRIVIER PTN. HOLDINGS 95 | 0 | Inkomati | 5/26/1995 | 40.00 | 0.30 | 54.0 | 165 mm (6.5)" | | 0.30 | SOIL |
| 2531AC00264 | -25.35297 | 31.00331 | WITRIVIER PTN. HOLDINGS 95 | 0 | Inkomati | 5/26/1995 | 40.00 | 0.30 | 54.0 | 165 mm (6.5)" | | 0.30 | Granite |
| 2531AC00342 | -25.33230 | 31.01781 | WITRIVIER PTN. HOEWE 13 | 0 | Inkomati | 11/16/1994 | 24.00 | 0.33 | 18.0 | 219 mm (8.75)" | | 0.50 | SOIL |
| 2531AC00342 | -25.33230 | 31.01781 | WITRIVIER PTN. HOEWE 13 | 0 | Inkomati | 11/16/1994 | 24.00 | 0.33 | 18.0 | 219 mm (8.75)" | | 0.50 | Granite |
| 2531AC00342 | -25.33230 | 31.01781 | WITRIVIER PTN. HOEWE 13 | 0 | Inkomati | 11/16/1994 | 24.00 | 0.33 | 60.0 | 165 mm (6.5)" | | 0.50 | SOIL |
| 2531AC00342 | -25.33230 | 31.01781 | WITRIVIER PTN. HOEWE 13 | 0 | Inkomati | 11/16/1994 | 24.00 | 0.33 | 60.0 | 165 mm (6.5)" | | 0.50 | Granite |
| 2531AC00342 | -25.33230 | 31.01781 | WITRIVIER PTN. HOEWE 13 | 0 | Inkomati | 11/16/1994 | 24.00 | 0.33 | 18.0 | 219 mm (8.75)" | | 0.50 | SOIL |
| 2531AC00342 | -25.33230 | 31.01781 | WITRIVIER PTN. HOEWE 13 | 0 | Inkomati | 11/16/1994 | 24.00 | 0.33 | 18.0 | 219 mm (8.75)" | | 0.50 | Granite |
| 2531AC00342 | -25.33230 | 31.01781 | WITRIVIER PTN. HOEWE 13 | 0 | Inkomati | 11/16/1994 | 24.00 | 0.33 | 60.0 | 165 mm (6.5)" | | 0.50 | SOIL |
| 2531AC00342 | -25.33230 | 31.01781 | WITRIVIER PTN. HOEWE 13 | 0 | Inkomati | 11/16/1994 | 24.00 | 0.33 | 60.0 | 165 mm (6.5)" | | 0.50 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.35 | 34.0 | 219 mm (8.75)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.35 | 34.0 | 219 mm (8.75)" | | 0.11 | Granite |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.35 | 90.0 | 165 mm (6.5)" | | 0.11 | SOIL |
| 2531AC00262 | -25.35197 | 31.02348 | WITRIVIER PTN. HOLDINGS 61 | 0 | Inkomati | 5/24/1995 | 40.00 | 0.35 | 90.0 | 165 mm (6.5)" | | 0.11 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | 0.0001 | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | 0.0001 | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | 0.0001 | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 14.0 | 203 mm (8.0)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | 0.0001 | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.44 | 96.0 | 165 mm (6.5)" | 0.0001 | 0.20 | Granite |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 11.0 | 219 mm (8.75)" | | 0.40 | SOIL |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 11.0 | 219 mm (8.75)" | | 0.40 | Granite |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 11.0 | 219 mm (8.75)" | 0.0001 | 0.40 | SOIL |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 11.0 | 219 mm (8.75)" | 0.0001 | 0.40 | Granite |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 66.0 | 165 mm (6.5)" | | 0.40 | SOIL |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 66.0 | 165 mm (6.5)" | | 0.40 | Granite |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 66.0 | 165 mm (6.5)" | 0.0001 | 0.40 | SOIL |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 66.0 | 165 mm (6.5)" | 0.0001 | 0.40 | Granite |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 11.0 | 219 mm (8.75)" | | 0.40 | SOIL |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 11.0 | 219 mm (8.75)" | | 0.40 | Granite |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 11.0 | 219 mm (8.75)" | 0.0001 | 0.40 | SOIL |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 11.0 | 219 mm (8.75)" | 0.0001 | 0.40 | Granite |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 66.0 | 165 mm (6.5)" | | 0.40 | SOIL |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 66.0 | 165 mm (6.5)" | | 0.40 | Granite |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 66.0 | 165 mm (6.5)" | 0.0001 | 0.40 | SOIL |
| 2531AC00278 | -25.37675 | 31.02564 | HIGHLANDS GED 5 | 115 | Inkomati | 2/27/1995 | 40.00 | 0.45 | 66.0 | 165 mm (6.5)" | 0.0001 | 0.40 | Granite |
| 2531AC00234 | -25.33281 | 31.01381 | HOLDINGS | 44 | Inkomati | 11/4/1994 | 12.00 | 0.47 | 48.0 | 165 mm (6.5)" | | 0.10 | SOIL |
| 2531AC00234 | -25.33281 | 31.01381 | HOLDINGS | 44 | Inkomati | 11/4/1994 | 12.00 | 0.47 | 48.0 | 165 mm (6.5)" | | 0.10 | Granite |
| 2531AC00234 | -25.33281 | 31.01381 | HOLDINGS | 44 | Inkomati | 11/4/1994 | 12.00 | 0.47 | 48.0 | 165 mm (6.5)" | 0.0001 | 0.10 | SOIL |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2531AC00234 | -25.33281 | 31.01381 | HOLDINGS | 44 | Inkomati | 11/4/1994 | 12.00 | 0.47 | 48.0 | 165 mm (6.5)" | 0.0001 | 0.10 | Granite |
| 2531AC00234 | -25.33281 | 31.01381 | HOLDINGS | 44 | Inkomati | 11/4/1994 | 12.00 | 0.47 | 48.0 | 165 mm (6.5)" | | 0.10 | SOIL |
| 2531AC00234 | -25.33281 | 31.01381 | HOLDINGS | 44 | Inkomati | 11/4/1994 | 12.00 | 0.47 | 48.0 | 165 mm (6.5)" | | 0.10 | Granite |
| 2531AC00234 | -25.33281 | 31.01381 | HOLDINGS | 44 | Inkomati | 11/4/1994 | 12.00 | 0.47 | 48.0 | 165 mm (6.5)" | 0.0001 | 0.10 | SOIL |
| 2531AC00234 | -25.33281 | 31.01381 | HOLDINGS | 44 | Inkomati | 11/4/1994 | 12.00 | 0.47 | 48.0 | 165 mm (6.5)" | 0.0001 | 0.10 | Granite |
| 2531AC00063 | -25.36898 | 31.01259 | KAFFERSKLOOF | 106 | Inkomati | 2/17/1967 | 9.14 | 0.54 | 37.5 | 152 mm (6.0)" | | 0.54 | Granite |
| 2531AC00063 | -25.36898 | 31.01259 | KAFFERSKLOOF | 106 | Inkomati | 2/17/1967 | 9.14 | 0.54 | 37.5 | 152 mm (6.0)" | | 0.54 | Sand |
| 2531AC00063 | -25.36898 | 31.01259 | KAFFERSKLOOF | 106 | Inkomati | 2/17/1967 | 9.14 | 0.54 | 37.5 | 152 mm (6.0)" | | 0.54 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 14.0 | 203 mm (8.0)" | | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 14.0 | 203 mm (8.0)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 14.0 | 203 mm (8.0)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 14.0 | 203 mm (8.0)" | 0.0001 | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 14.0 | 203 mm (8.0)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 14.0 | 203 mm (8.0)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 96.0 | 165 mm (6.5)" | | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 96.0 | 165 mm (6.5)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 96.0 | 165 mm (6.5)" | | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 96.0 | 165 mm (6.5)" | 0.0001 | 0.20 | SOIL |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 96.0 | 165 mm (6.5)" | 0.0001 | 0.20 | Granite |
| 2530BD00167 | -25.34396 | 30.93395 | HEIDELBERG GED 60 | 249 | Inkomati | 1/12/1995 | 25.00 | 0.57 | 96.0 | 165 mm (6.5)" | 0.0001 | 0.20 | Granite |
| 2531AC00304 | -25.33897 | 31.02203 | WITRIVIER PTN. HOLDING 2 | 0 | Inkomati | 1/19/1995 | 6.00 | 1.33 | 24.0 | 203 mm (8.0)" | | 1.53 | SOIL |
| 2531AC00304 | -25.33897 | 31.02203 | WITRIVIER PTN. HOLDING 2 | 0 | Inkomati | 1/19/1995 | 6.00 | 1.33 | 24.0 | 203 mm (8.0)" | | 1.53 | Granite |
| 2531AC00304 | -25.33897 | 31.02203 | WITRIVIER PTN. HOLDING 2 | 0 | Inkomati | 1/19/1995 | 6.00 | 1.33 | 36.0 | 165 mm (6.5)" | | 1.53 | SOIL |
| 2531AC00304 | -25.33897 | 31.02203 | WITRIVIER PTN. HOLDING 2 | 0 | Inkomati | 1/19/1995 | 6.00 | 1.33 | 36.0 | 165 mm (6.5)" | | 1.53 | Granite |
| 2531AC00304 | -25.33897 | 31.02203 | WITRIVIER PTN. HOLDING 2 | 0 | Inkomati | 1/19/1995 | 6.00 | 1.33 | 24.0 | 203 mm (8.0)" | | 1.53 | SOIL |
| 2531AC00304 | -25.33897 | 31.02203 | WITRIVIER PTN. HOLDING 2 | 0 | Inkomati | 1/19/1995 | 6.00 | 1.33 | 24.0 | 203 mm (8.0)" | | 1.53 | Granite |
| 2531AC00304 | -25.33897 | 31.02203 | WITRIVIER PTN. HOLDING 2 | 0 | Inkomati | 1/19/1995 | 6.00 | 1.33 | 36.0 | 165 mm (6.5)" | | 1.53 | SOIL |
| 2531AC00304 | -25.33897 | 31.02203 | WITRIVIER PTN. HOLDING 2 | 0 | Inkomati | 1/19/1995 | 6.00 | 1.33 | 36.0 | 165 mm (6.5)" | | 1.53 | Granite |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 23.0 | 203 mm (8.0)" | | 1.10 | SOIL |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 23.0 | 203 mm (8.0)" | | 1.10 | Granite |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 23.0 | 203 mm (8.0)" | 0.0001 | 1.10 | SOIL |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 23.0 | 203 mm (8.0)" | 0.0001 | 1.10 | Granite |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 48.0 | 165 mm (6.5)" | | 1.10 | SOIL |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 48.0 | 165 mm (6.5)" | | 1.10 | Granite |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 48.0 | 165 mm (6.5)" | 0.0001 | 1.10 | SOIL |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 48.0 | 165 mm (6.5)" | 0.0001 | 1.10 | Granite |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 23.0 | 203 mm (8.0)" | | 1.10 | SOIL |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 23.0 | 203 mm (8.0)" | | 1.10 | Granite |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 23.0 | 203 mm (8.0)" | 0.0001 | 1.10 | SOIL |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 23.0 | 203 mm (8.0)" | 0.0001 | 1.10 | Granite |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 48.0 | 165 mm (6.5)" | | 1.10 | SOIL |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 48.0 | 165 mm (6.5)" | | 1.10 | Granite |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 48.0 | 165 mm (6.5)" | 0.0001 | 1.10 | SOIL |
| 2530BD00168 | -25.35007 | 30.93839 | HEIDELBERG GED 10 | 249 | Inkomati | 12/9/1994 | 12.00 | 1.67 | 48.0 | 165 mm (6.5)" | 0.0001 | 1.10 | Granite |
| 2531AC00064 | -25.36899 | 31.01259 | KAFFERSKRAAL | 106 | Inkomati | 9/22/1964 | 14.93 | 2.56 | 33.5 | 152 mm (6.0)" | | 2.56 | Granite |
| 2531AC00064 | -25.36899 | 31.01259 | KAFFERSKRAAL | 106 | Inkomati | 9/22/1964 | 14.93 | 2.56 | 33.5 | 152 mm (6.0)" | | 2.56 | Granite |

Table 8 Registered boreholes and their allocated volumes within 5 km of the existing WWTW

| wma | Quat | RegNo | WUN | Sector | Vol_period | Vol_m3_a | PeriodNo | Sgcode | Lat | Long | Reg_WUN | StartDt | Source_1 | AbstractNa |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INK | X22F | 24097736 | 2 | LIV | 3650.00000000000 | 3650.00000000000 | Yearly | T0JT00000000024900072 | -25.31714000000 | 30.96870000000 | 24097736/2 | 2008/06/01 | BH | |
| INK | X22F | 24000091 | 2 | INU | 609.00000000000 | 609.00000000000 | Yearly | T0JT00000000028000005 | -25.37824000000 | 30.99203000000 | 24000091/2 | 1981/01/01 | BH | NOVABORD BOREHOLE 2 |
| INK | X22F | 24000091 | 3 | INU | 1407.00000000000 | 1407.00000000000 | Yearly | T0JT00000000028000005 | -25.37831000000 | 30.99038000000 | 24000091/3 | 1981/01/01 | BH | NOVOBORD BOREHOLE 3 |
| INK | X22F | 24000091 | 10 | INU | 1266.00000000000 | 1266.00000000000 | Yearly | T0JT00000000027600003 | -25.36729000000 | 30.98544000000 | 24000091/10 | 1981/01/01 | BH | NOVOBORD BOREHOLE 4 |
| INK | X22F | 24000091 | 5 | INU | 2533.00000000000 | 2533.00000000000 | Yearly | T0JT00000000028000005 | -25.37803000000 | 30.98967000000 | 24000091/5 | 1981/01/01 | BH | NOVOBORD BOREHOLE 6 |
| INK | X22F | 24000091 | 6 | INU | 844.00000000000 | 844.00000000000 | Yearly | T0JT00000000028000005 | -25.37829000000 | 30.98912000000 | 24000091/6 | 1981/01/01 | BH | NOVOBORD BOREHOLE 7 |
| INK | X22F | 24010320 | 1 | INU | 2190.00000000000 | 2190.00000000000 | Yearly | T0JT00000000027700002 | -25.34562000000 | 31.00216000000 | 24010320/1 | 1975/01/01 | BH | BOREHOLE |
| INK | X22H | 24085446 | 1 | WSS | 3850.00000000000 | 3850.00000000000 | Yearly | T0JU00000000008200000 | -25.34463000000 | 30.99927000000 | 24085446/1 | 2002/04/01 | BH | |
| INK | X22H | 24009662 | 8 | WSS | 750000.00000000000 | 750000.00000000000 | Yearly | | -25.32480000000 | 30.98168000000 | 24009662/8 | 1982/12/01 | SCH | WITKLIP DAM |

### 6.2.2 Groundwater Recharge

The groundwater recharge, as modelled in Aquiworx, indicates that the groundwater recharge as a ratio of the rainfall, is approximately 5.9 % of the water balance (Figure 10). This means that on average, 5.9 % of rainfall contributes towards groundwater recharge. Most of the recharge is during peak rainfall months. This is low and suggests that most of the rainfall is evaporated and partially contributes to streamflow.

Compared to groundwater recharge, there is a high soil water storage and lateral contribution to surface water. This indicates that if spills or contamination occured at the site, it would impact upon surface water resources (wetlands and streams) significantly more than groundwater resources.

The steady state water level (Figure 11) indicates that the water level is highly variable. The more recent borehole data show that the water level has started to drop in recent years. This is largely due to excess water usage in the catchment and long-term drought.

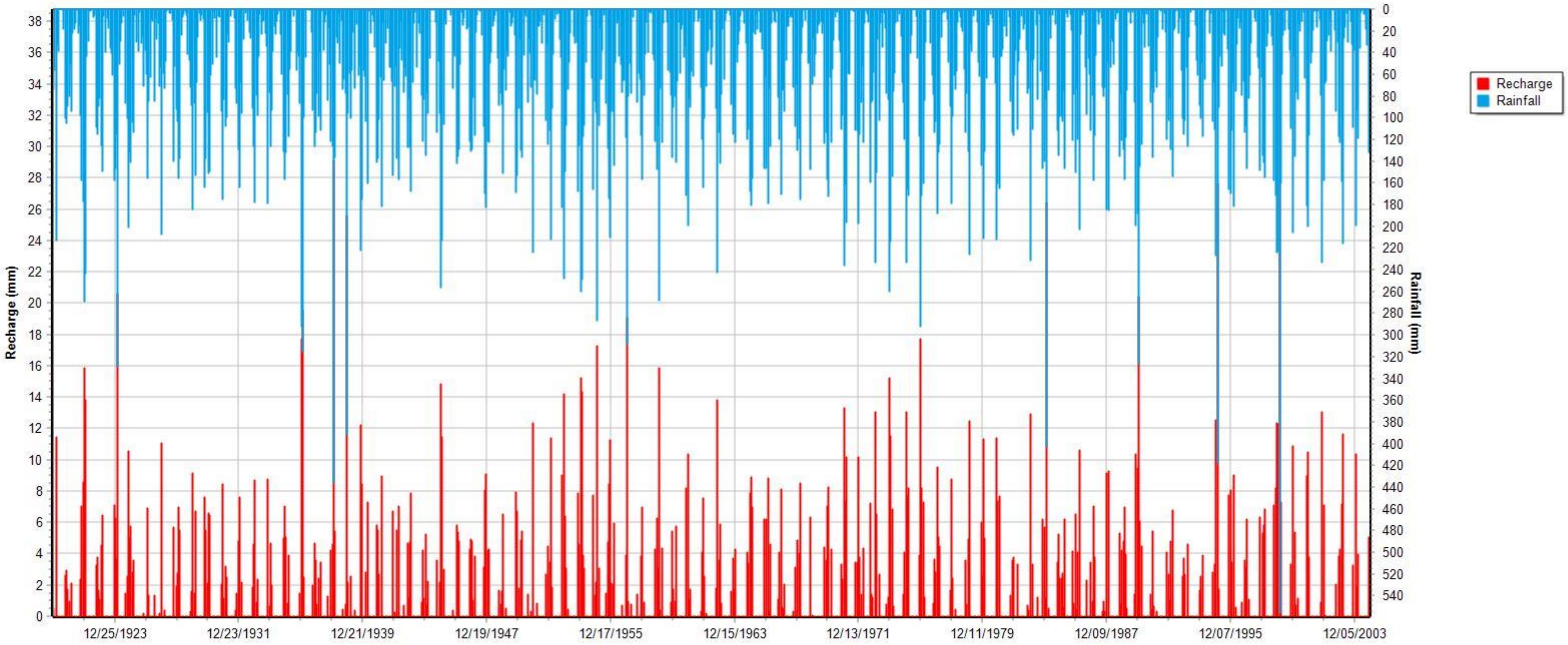


Figure 10 Monthly groundwater recharge (red) at Rocky Drift

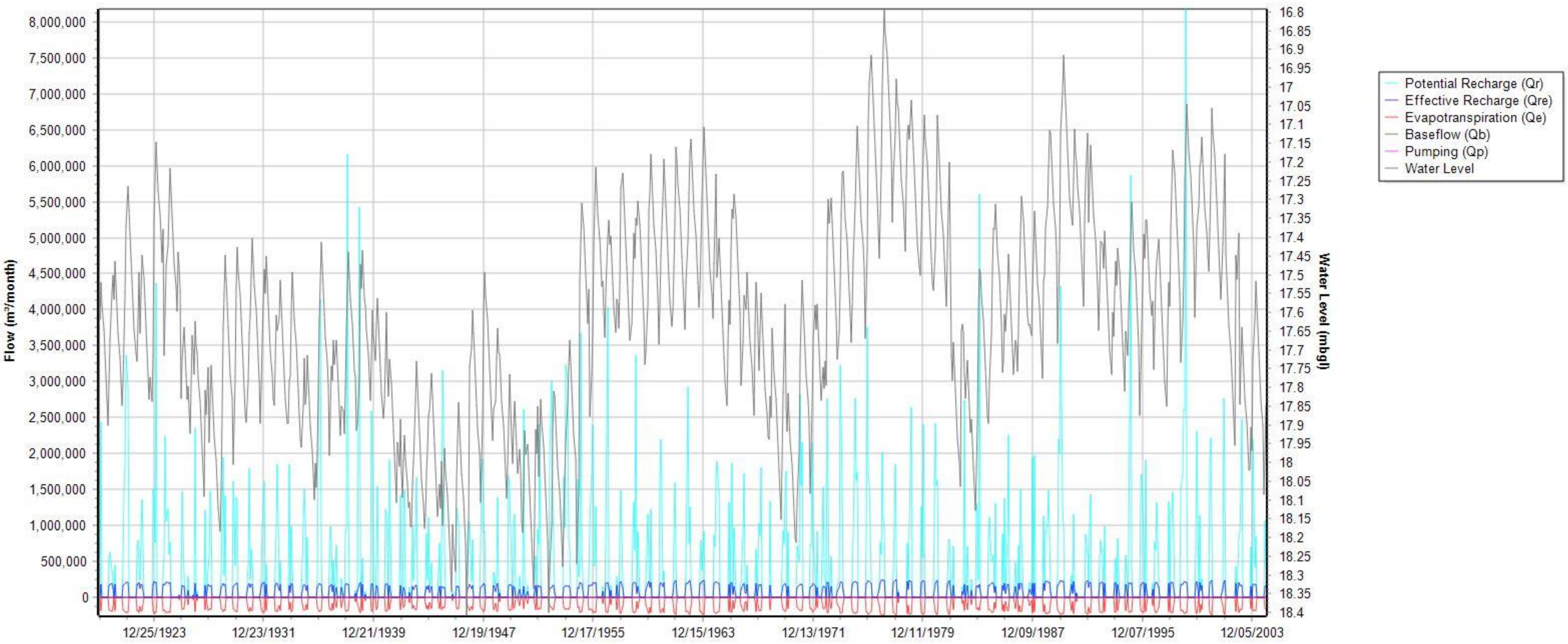


Figure 11 Steady state water level at Rocky Drift

## 6.3 Potential Groundwater Impacts & Mitigation

### 6.3.1 Potential Groundwater Quality Concerns

The specialist recommendations need to address the following key questions:

- Will downstream water users be affected by contamination of the watercourses or groundwater?
- Will the proposed development result in a change in the groundwater quality?
- What actions can be taken to ensure no impact on groundwater resources occurs?

From a **groundwater quality** perspective, nearby groundwater users **would not have been** affected by the **construction** of the bulk line. This is based on the following findings/reasons:

- The proposed site is already transformed and is subject to continual effluent discharge from the neaby Phumlani settlement;
- The connection of this area will result in a net gain as less untreated effluent will be discharged throughout the site;
- The site is a suitable distance away from any active boreholes to have any direct impacts. There are no groundwater users down gradient of the site; and
- The infiltration rate is low.

From a **groundwater quality** perspective, the downstream users **will not be** affected by the **operation** of the bulk line. This is based on the following findings/reasons:

- The connection of this area will result in a net gain as less untreated effluent will be discharged throughout the site;
- The site is a suitable distance away from any active boreholes to have any direct impacts. There are no groundwater users down gradient of the site;
- The development would follow suitable contamination measures to ensure no contamination occurs;

From a **groundwater quantity** perspective, the downstream users **will not be** affected by the **construction or operation** of the bulk line as the construction requires very little water and the operation does not require water.

It is unnecessary for an observation borehole to be installed to monitor the groundwater quality. There is already a borehole on-site adjacent to the WWTW (Figure 12). This borehole should be tested every 6 month for the WWTW (not the bulk line), to ensure that groundwater contamination does not occur with the addition of more effluent. Focus should also be placed on ensuring the integrity of sensitive surface water resources.

Figure 12 Existing borehole adjacent to Rocky Drift WWTW

### 6.3.2 Potential Risks

The risk of the following impacts on groundwater resources were assessed. This was based on the extent of the development, assumed spills/overflow from poor maintenance and the potential modelled groundwater recharge rate -

Table 9 Risk matrix assessment for the impacts identified for potential leaks from the bulk line

| | Activity | Aspect | Severity | Consequence | Likelihood | Significance | Risk Rating |
|---|---|---|---|---|---|---|---|
| **OPERATION** | Discharge of waste into the sub-surface | Contamination during spills/leaks from poor maintenance of infrastructure | 2.25 | 5.25 | 10 | 52.5 | **L** |

### 6.3.3 Proposed Mitigation

Although there is a low risk of groundwater contamination, it is still important to apply mitigation measures to ensure that even slight risks are addressed. The following measured are proposed by the specialist for operation:

- Regular maintenance linked to the WWTW and bulk line must be carried out to ensure that accidental spills are avoided.
- Absorbent materials such as "Drizit" must be readily available in the event of any accidental spills, and all contaminated material including soil must be disposed of at a registered waste disposal site.
- In locations were cement is required to be used for the bulk line, cement must be mixed in lined containers to prevent sub-surface contamination.
- Any remnant rubbish, spoil, machinery and contaminants need to be removed from the operation area.
- In the event of excess waste being present, waste must be transported off-site by a waste removal company.
- Regular maintenance and checks of the bulk line should be undertaken.
- In the event of a spill/leak, a contingency plan should be implemented.
- Clean and dirty water should be separated on site.

# 7. CONCLUSION

The overall objective of the study was to determine the impacts of the proposed development on groundwater resources.

The results show that the geology of the site provides a low groundwater yield. The prevailing geology of the area is dominated by Nelspruit granite. Due to the long-term drought, the yields in this area may have reduced significantly. Infiltration rates are low. The site is known for poor quality groundwater and there are few groundwater users in the area. Many of the identified geosites no longer exist.

Given the small extent of the development, the location and adherence to specialist recommendations, the site is of low risk of negative groundwater impacts during construction. Additionally, should regular checks be undertaken, the risk during operation would be low. However, appropriate preventative measured need to be taken to ensure that this low risk is still minimised.

# 8. REFERENCES


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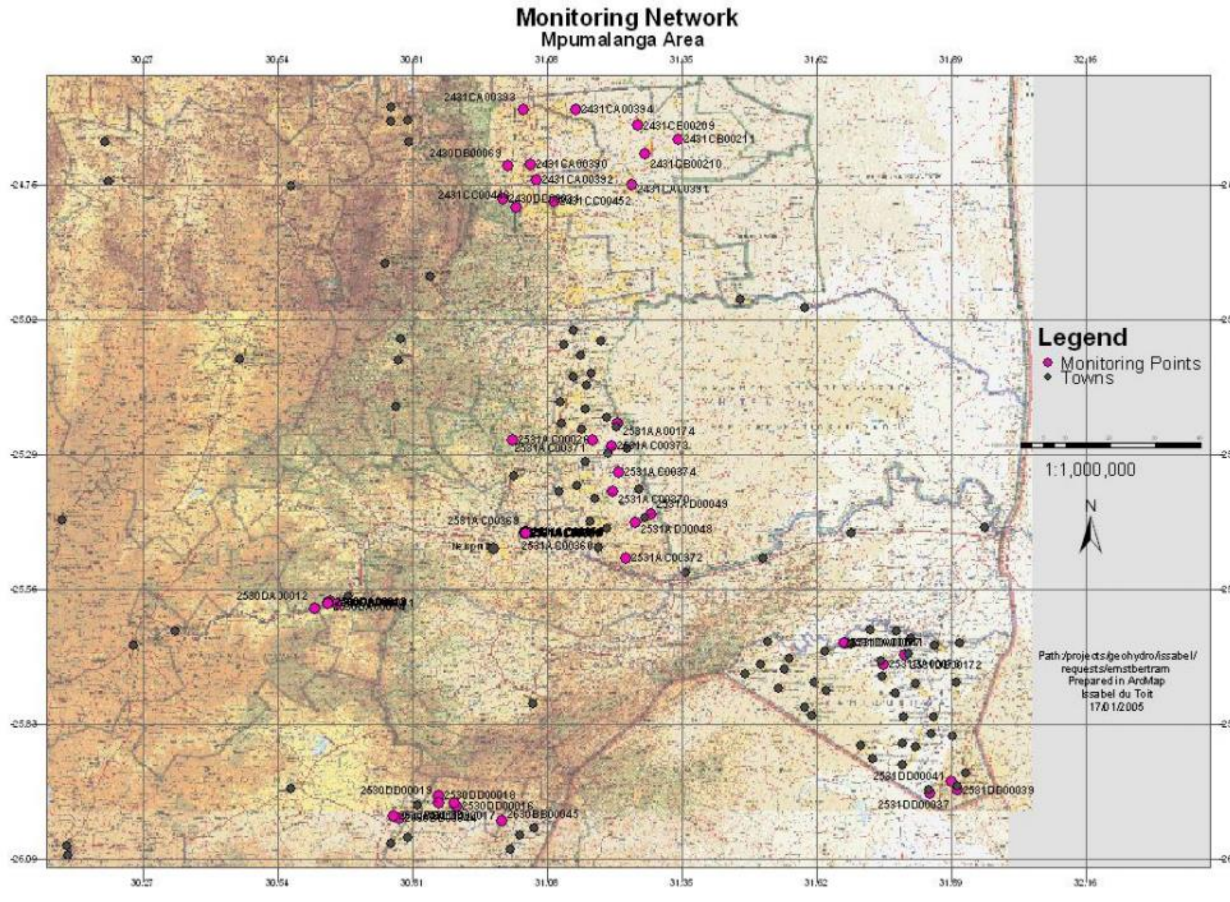
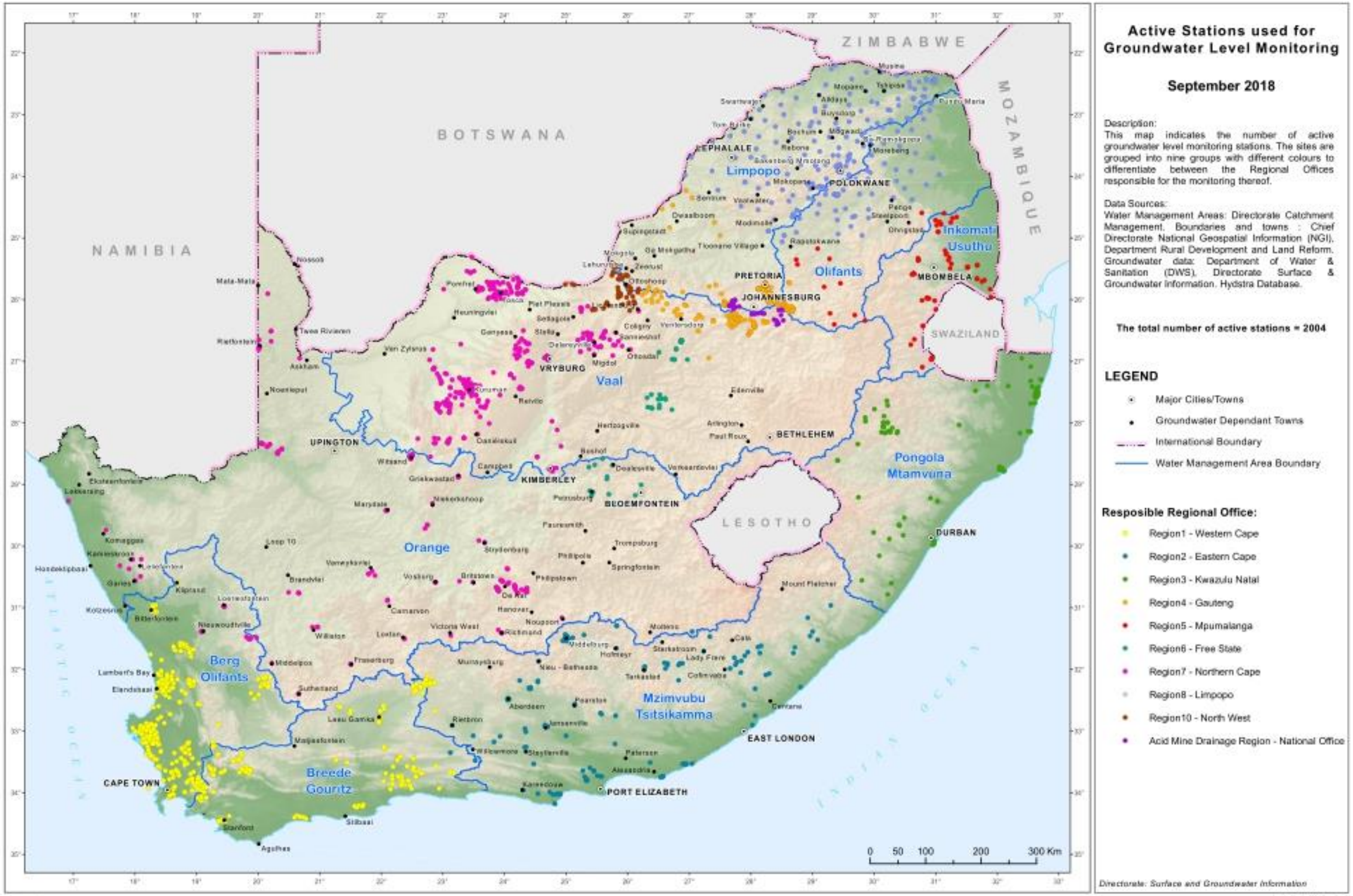
## ANNEXURE A Mpumalanga groundwater quality monitoring programme



## ANNEXURE B Active groundwater level monitoring sites



## ANNEXURE C Groundwater reserve determination map