# GEOHYDROLOGICAL ASSESSMENT REPORT FOR ER294 PROJECT FREE STATE

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For:

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**SYNOPSIS**

Specialist geohydrological assessment for ER294 Rhino Oil and Gas Project in the Free State

**KEY WORDS:**

Geology, geohydrology, hydrocensus, water quality status quo, numerical groundwater model, risk and impact



**QUALITY VERIFICATION**

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO9001: 2015 which has been independently certified by DEKRA Certification

| Verification | Capacity | Name | Signature | Date |
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# GEOHYDROLOGICAL ASSESSMENT REPORT FOR ER294 PROJECT FREE STATE

## 1 INTRODUCTION

This report presents the results of a geohydrological assessment carried out for the exploration right ER294 for Rhino Oil and Gas near Welkom and Kroonstad in the Free State. The geohydrological report has been prepared as a specialist study in support of environmental authorisation. The scope of work incorporated the following key phases:

1. Desktop Study
2. Hydrocensus
3. Conceptual and Numerical Modeling
4. Site Sensitivity Screening and Groundwater Impact Assessment.

We refer to our revised proposal reference 005324 2117104.2/rs, titled "Geohydrological Proposal for ER 294 for Rhino Oil & Gas Exploration Welkom to Kroonstad Area", dated 17 February 2022. JG Afrika (Pty) Ltd were appointed to proceed with the assessment under purchase order DBKM20-44627,4724677083 dated 7 March 2022.

## 2 INFORMATION SUPPLIED

The following information has been used in the preparation of this report:

<u>Reports, Documents and Guidelines</u>

- Report reference 720.18034.00020 of SLR Consulting (South Africa) (Pty) Ltd, titled " Rhino Oil and Gas - Project Description", draft report No.1, January 2023
- Government Notice No. 326 of April 2017. National Environmental Management Act, 1998 (Act No. 107 Of 1998). Amendments to the Environmental Impact Assessment Regulations, 2014
- Government Notice R267 of March 2017. National Water Act, 1998 (Act No. 36 of 1998). Regulations Regarding the Procedural Requirements for Water Use Licence Applications and Appeals
- The Department of Water Affairs, First Edition, February 2010. Operational Guideline: Integrated Water and Waste Management Plan
- Parsons RP (1995). A South African Aquifer System Management Classification. WRC Report No. 77/95, Water Research Commission, Pretoria
- Craig, H. (1961). Isotopic Variations in Meteoric Waters. Science, 133, 1702–1703.

<u>Maps and Drawings</u>

- Map Sheet titled, "2726 Kroonstad", at a scale of 1:250 000, digital version, of the Geological Map Series, supplied by the Department of Mineral and Energy Affairs
- Map Sheet titled, "Kroonstad 2726", at a scale of 1:500 000, first edition, dated 2000, of the Hydrogeological Map Series of the Republic of South Africa, supplied by the Directorate: Geohydrology, of the Department of Water Affairs and Forestry.

<u>Data</u>

- Digital files of SLR Consulting (South Africa) (Pty) Ltd named ER294_Rev.shp and EIA_First22wells_toSLR_Nov22.kmz received on 7 March 2022 and 15 November 2022 respectively

- National Groundwater Archive (NGA) digital information, as supplied by The Department of Water and Sanitation (DWS) as at November 2022
- Water Allocation Resource Management System (WARMS) digital information, as supplied by The Department Water and Sanitation (DWS) as at January 2023
- Google Earth Pro version 7.3.3 of July 2021.

# 3 SITE DESCRIPTION

The ER294 project comprises six (6 No.) sites spread over five (5 No.) farms. The spatial extent of the sites is approximately 107000 ha. The project area extends approximately 47 km east and 22 km south of the town of Kroonstad in the Free State. The distribution of the sites is present in Figure 1, and the site list is presented in Table 1.

*Table 1: Summary Site List*

| Site Designation | ER |
|---|---|
| Site O | ER294 |
| Site P | ER294 |
| Site Q | ER294 |
| Site R | ER294 |
| Site S | ER294 |
| Site T | ER294 |

The project comprises the drilling of six (6 No.) exploratory wells within the identified target areas to determine the commercial viability of the sites and the project areas as a whole. Viable wells will be capped and secured, while unsuccessful wells will be decommissioned. Drilling will be carried out using the rotary air percussion and/or mud rotary drilling techniques to anticipated depths of up to 1000 m. The wells will be drilled by telescoping to smaller diameters as the depth progresses. The initial drill diameter of 273 mm will extend to an anticipated depth of 50 m and will be cased off with a conductor pipe to isolate any shallow water bearing fractures. The second drill diameter of 168 mm will be extended within the conductor pipe to between 400 and 800 m depth and additional casing installed within the conductor casing and cemented in place to seal the hole from surface. The final drill diameter of 137 mm will extend within the casing to between 600 and 1200 m depth and will be open. The detailed project description and methodology is given in the SLR Project Description Report[1].

[1] Report reference 720.18034.00020 of SLR Consulting (South Africa) (Pty) Ltd, titled " Rhino Oil and Gas - Project Description", draft report No.1, January 2023

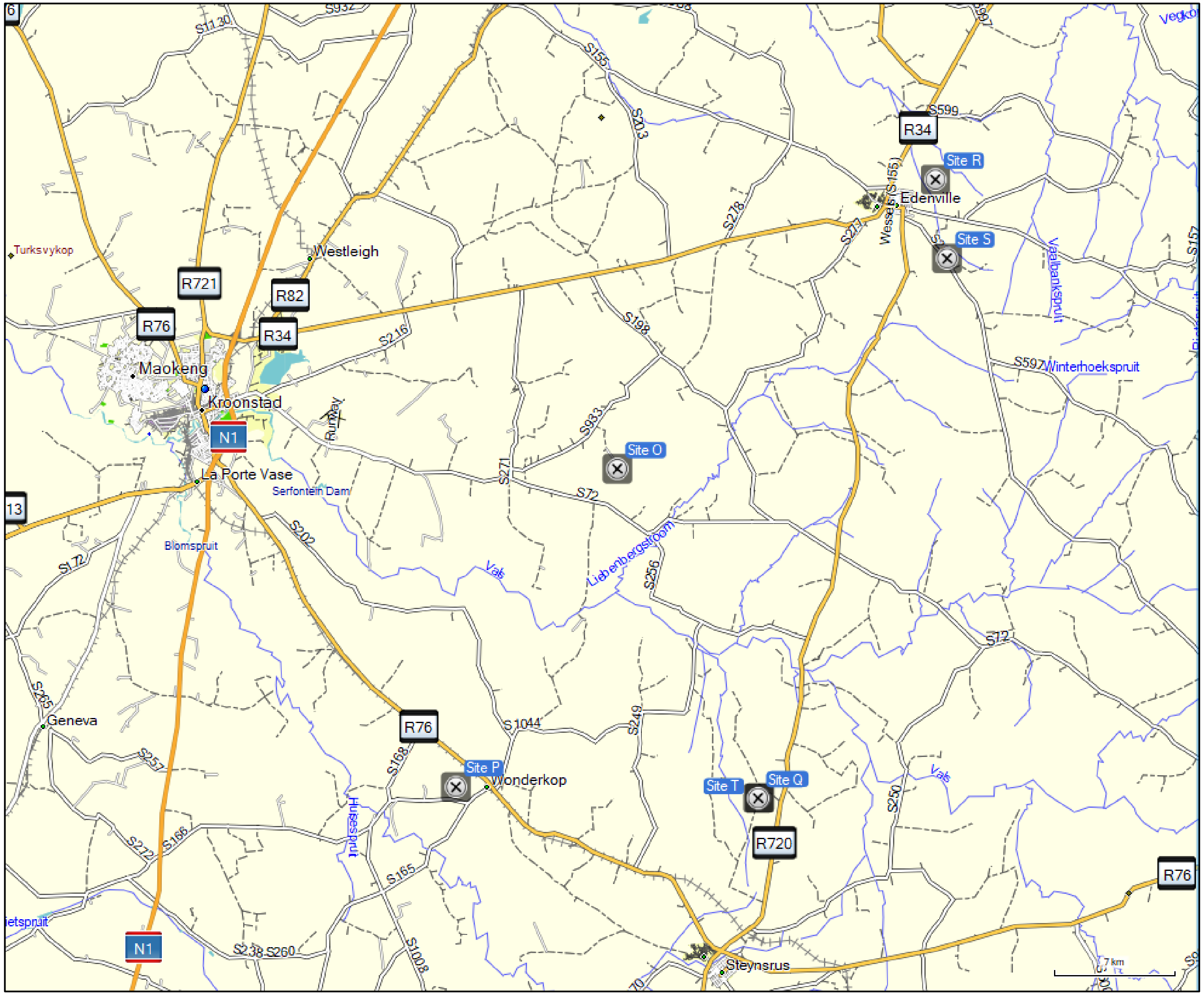



*Figure 1: Site Locality*

# 4 DESKTOP REVIEW AND SITE ASSESSMENT

## 4.1 Introduction

The information gathered from the desktop and site assessment has been used for the development of a numerical groundwater model as presented in Section 5 and 6. The purpose of the numerical groundwater model is to establish groundwater flow directions at each site and to assess mass transport of potential contaminants to guide the risk assessment.

## 4.2 Topography and Drainage

The topography and drainage of the project area is presented in Figure 2. Quaternary catchments and the rainfall station used in the model development are also shown. A summary of the quaternary catchment hydrological parameters are presented in Table 2.

*Table 2: Summary of Quaternary Hydrological Parameters*

| Quaternary | MAP (mm/a) | MAR (mm/a) | MAE (mm/a) | Recharge (mm/a) |
|---|---|---|---|---|
| C60C | 571 | 25.8 | 1550 | 18.5 |
| C60D | 550 | 23.4 | 1600 | 15.4 |
| C60F | 556 | 24.7 | 1580 | 13.1 |
| C70D | 586 | 27.0 | 1620 | 19.6 |

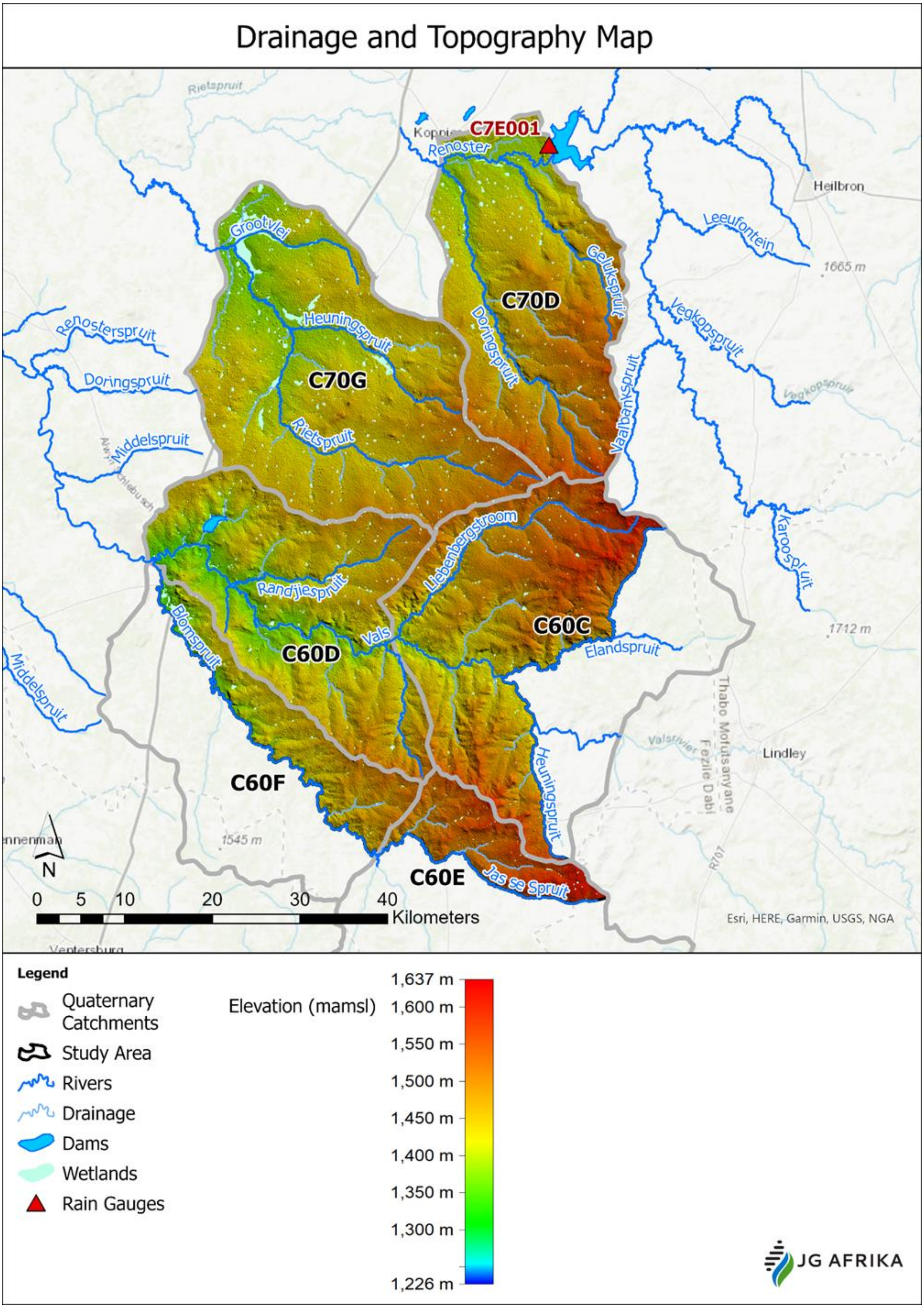



*Figure 2: Topography and Drainage*

### 4.3 Rainfall

The mean annual precipitation (MAP) values for the quaternary catchments are presented in Table 2. In addition, rainfall station C7E001 was identified in the project area. The rainfall gauge information is presented in Table 3.

*Table 3: Rainfall Gauge Information*

| Gauge | Description | Longitude | Latitude | Monthly Data Range |
|---|---|---|---|---|
| C7E001 | Fischer @ Koppies D | 27.66861 | -27.24694 | 1967-12-06 to 2021-12-30 |

A comparison of the MAP for each of the quaternaries and the rainfall station are presented in Figure 3 and Figure 4. Only precipitation values related to water level monitoring are presented here and the light blue bars relate to the gauging station. The long-term (1968 - 2021) monthly average rainfall based on the rain gauge is presented in Figure 4. The respective rain gauge MAP is slightly higher than the average of the quaternary MAP values.

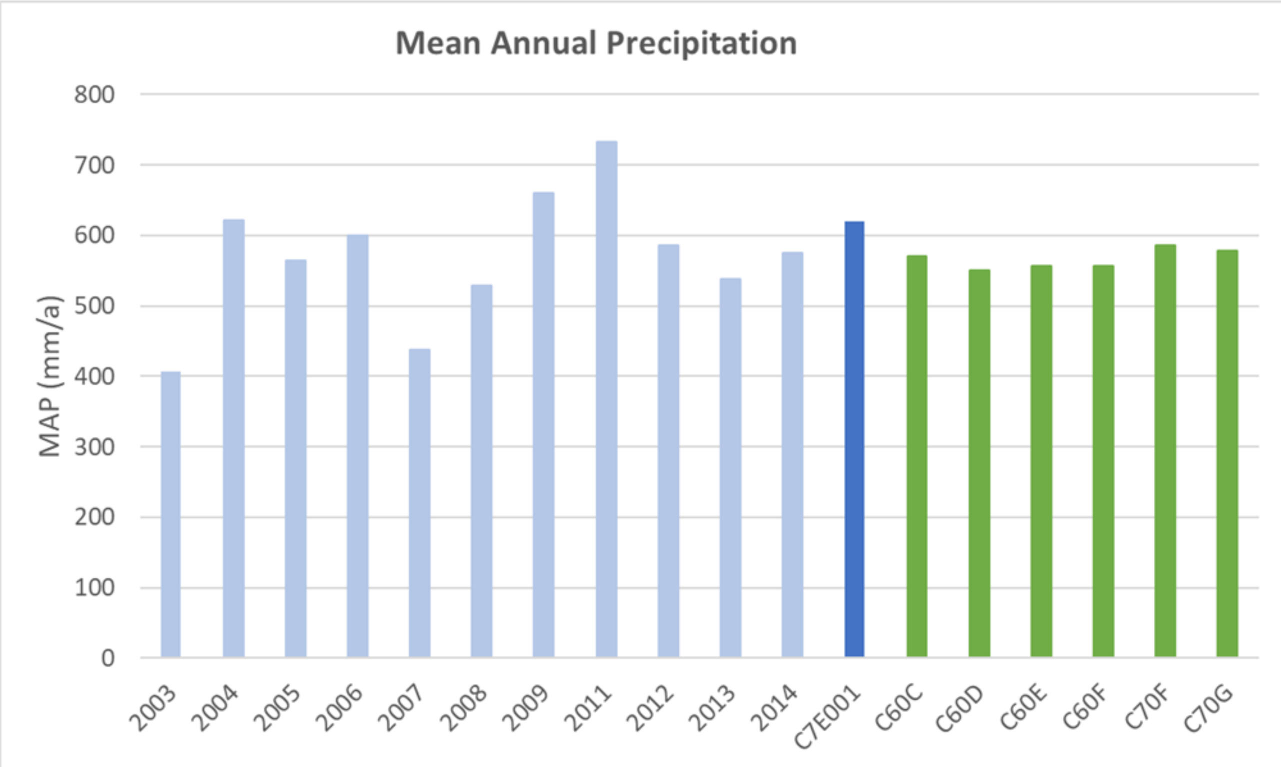



*Figure 3: Mean Annual Precipitation*

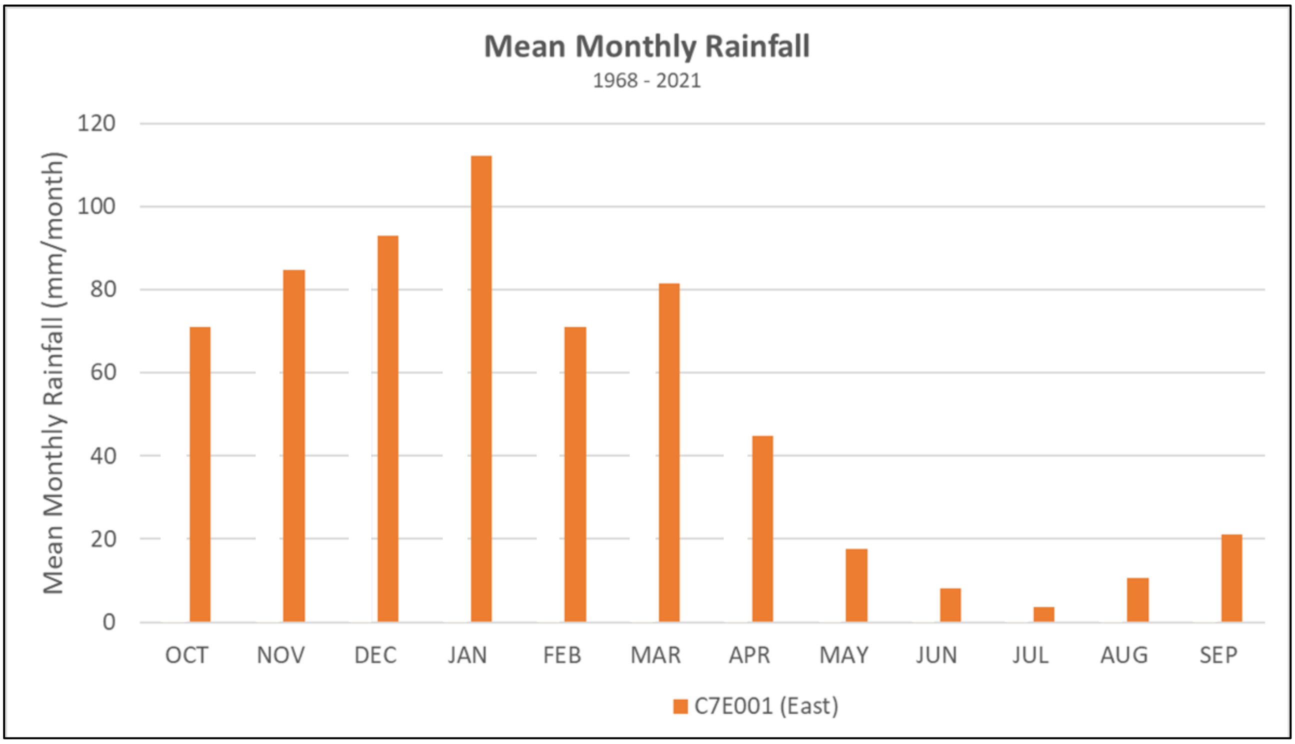



*Figure 4: Monthly Average Rainfall*

## 4.4 Regional Geology

The regional geology of the area comprises mudstone and sandstone of the Estcourt and Normandien Formations of the Ecca Group. The mudstone and sandstone is overlain extensively by Quaternary aged sand of aeolian origin in the north western parts of the project area. The mudstone and shale has been intruded by large masses of Post Karoo dolerite in the southern and eastern areas. The mudstone is typically underlain by Volksrust Formation mudstone and shale. An isolated outcrop of Klipriviers Group lava occurs in the west of the project area, due south east of Kroonstad. The regional geology is presented in Figure 5.

The borehole logs extracted from NGA boreholes in the project area are presented in Annexure B. The geological lithologies were used to construct the layers in the groundwater model development discussed in Section 6.

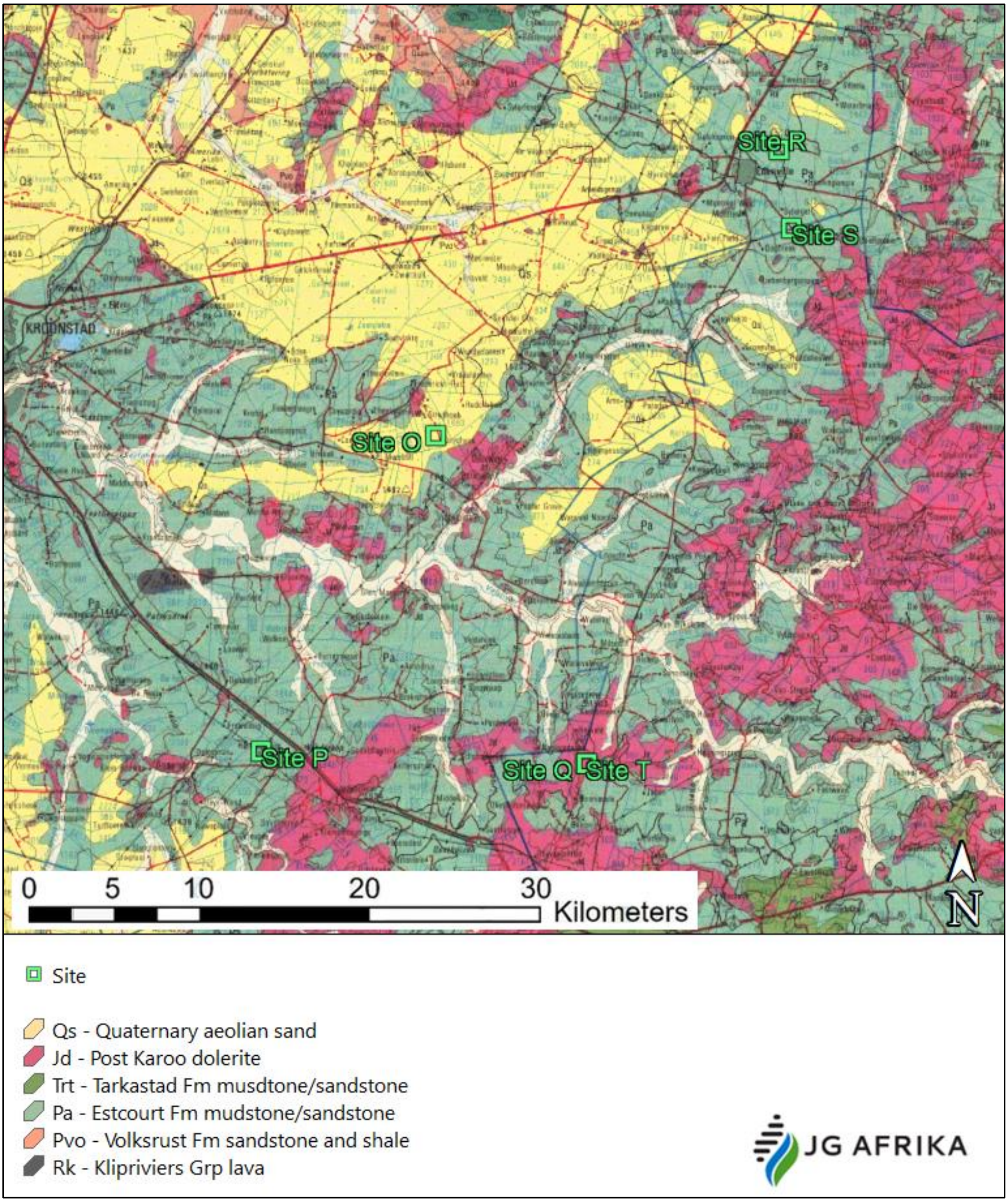



*Figure 5: Regional Geology*

## 4.5 Regional Geohydrology

The regional geohydrology of the project area can be broadly described as predominantly argillaceous rocks (d2) comprising shale and mudstone. The principal groundwater occurrence is from an intergranular and fractured aquifer type, with median borehole yields in the range 0.1 to 0.5 l/s. The aquifer is characterised as a low yielding Minor aquifer in terms of the South African Aquifer Classification System. Two zones od argillaceous rock (d4) occur around the towns of

Edenville in the north and Steynsrus to the south. These zones have median borehole yields in the range 2.0 to 5.0 l/s. The aquifers in these areas are medium yielding Minor aquifers in terms of the South African Aquifer Classification System. The regional geohydrology of the project area is presented Figure 6.

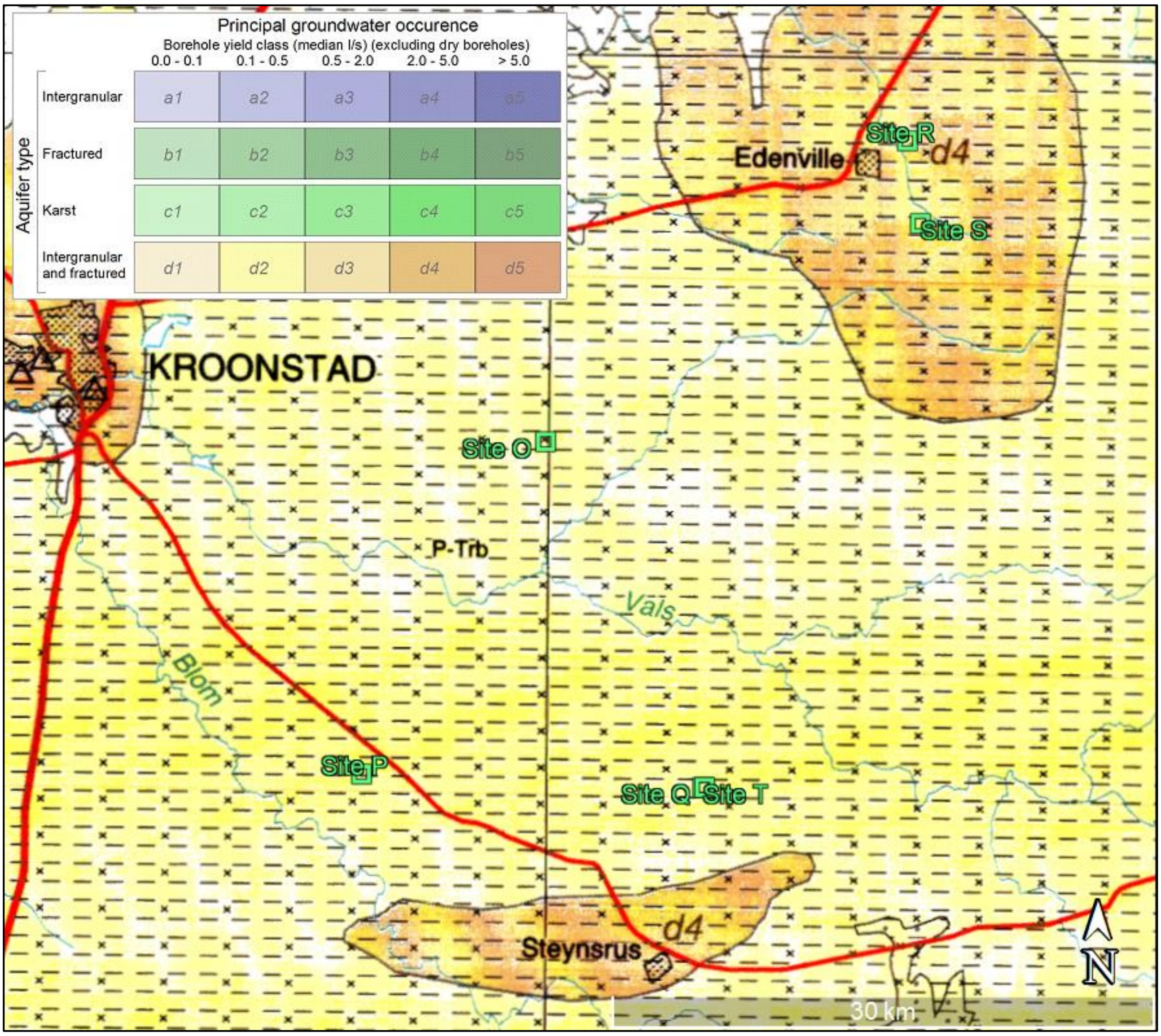



*Figure 6: Regional Geohydrology*

### 4.6 Regional Magnetic Mapping

Regional magnetic mapping is presented in Figure 7. The mapping indicates that magnetic flux across the project area has a range of 29636 to 31963 nT. The magnetic mapping indicates distinct and major structures in the project area. The structure orientations are variable, with a west north west to east south east trending feature across the centre of the project area, a north to south feature along the western and southern boundaries, a north north west to south south east feature along the south western boundary, and a west to east feature in the southern portion.

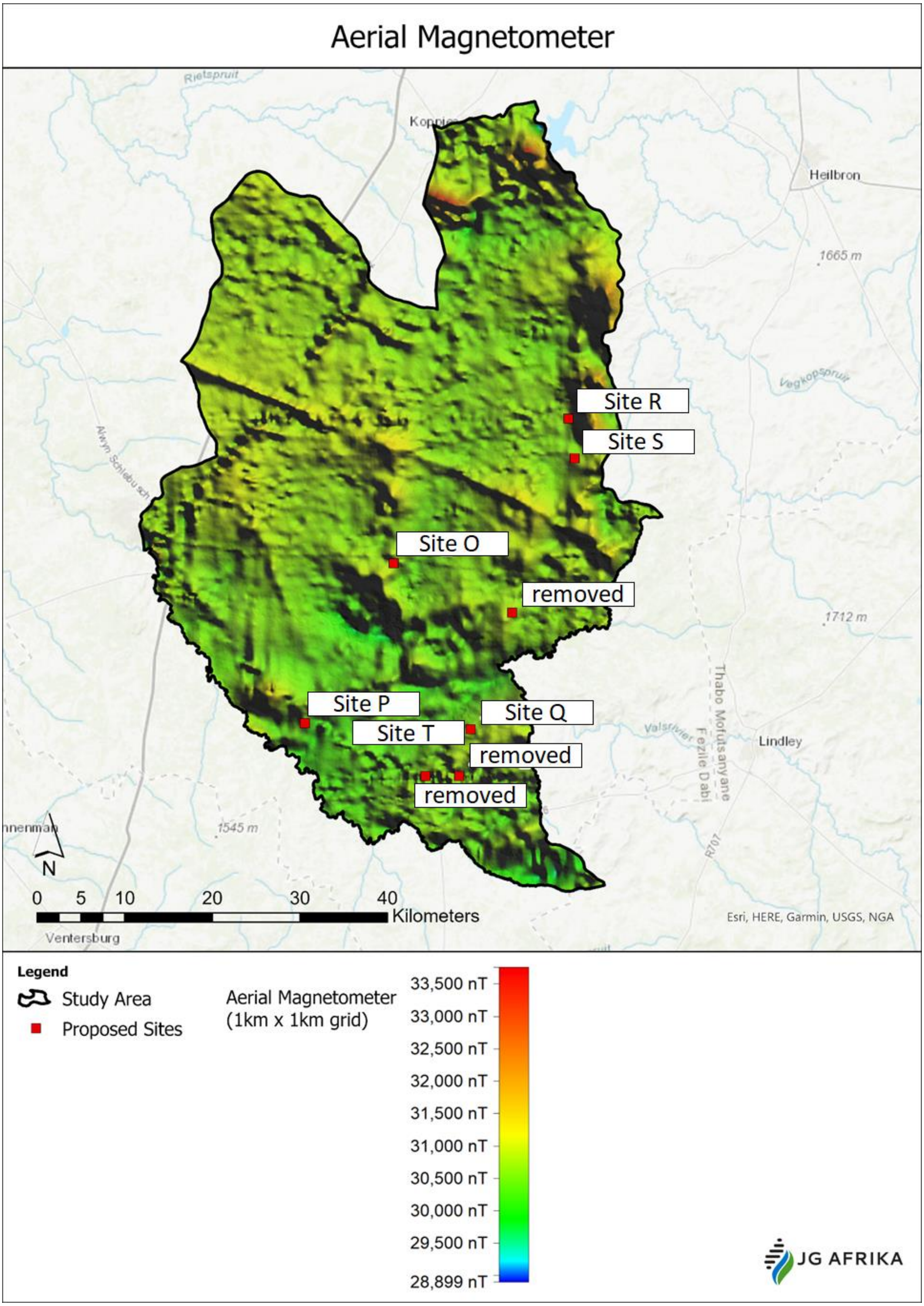



*Figure 7: Regional Magnetic Mapping*

### 4.7 Existing Groundwater Resources

The National Groundwater Archive (NGA) and Water Allocation Resource Management System (WARMS) of the DWS were interrogated to establish the existence of any groundwater resources and groundwater use in proximity to the sites. The resource information was used for the groundwater model development discussed in Section 6. NGA and WARMS resource information is presented in Annexure C.

Field verified resources identified during the site assessment for sampling are presented in Table 4. The distribution of the NGA, WARMS and field verified resources are presented in Figure 8.

*Table 4: Summary Field Hydrocensus Information*

| Right | Site ID | SAMPLE ID | Resource Latitude | Resource Longitude | Accuracy (m) | Status | Water Level (m) | Equipment | Comment (condition, observed use, etc) |
|---|---|---|---|---|---|---|---|---|---|
| ER294 | Site O | S16 | -27.69359 | 27.49700 | 10 | In use | 13.35 | windmill | livestock watering |
| ER294 | Site P | S12 | -27.85455 | 27.36731 | 10 | In use | 35.20 | windmill | livestock watering |
| | | S13 | -27.85883 | 27.38236 | 10 | In use | | windmill | livestock water, piped underground |
| ER294 | Site Q and T | S15 | -27.86233 | 27.58015 | 10 | In use | 0.00 | submersible | livestock watering, solar installation, bh in stream, sample from tank |
| removed | removed | S14 | -27.91271 | 27.58209 | 10 | In use | 3.88 | submersible | livestock water, solar installation |
| ER294 | Site R | S17 | -27.55762 | 27.71150 | 10 | In use | 13.45 | submersible | domestic use |
| ER294 | Site S | | | | | | | | |

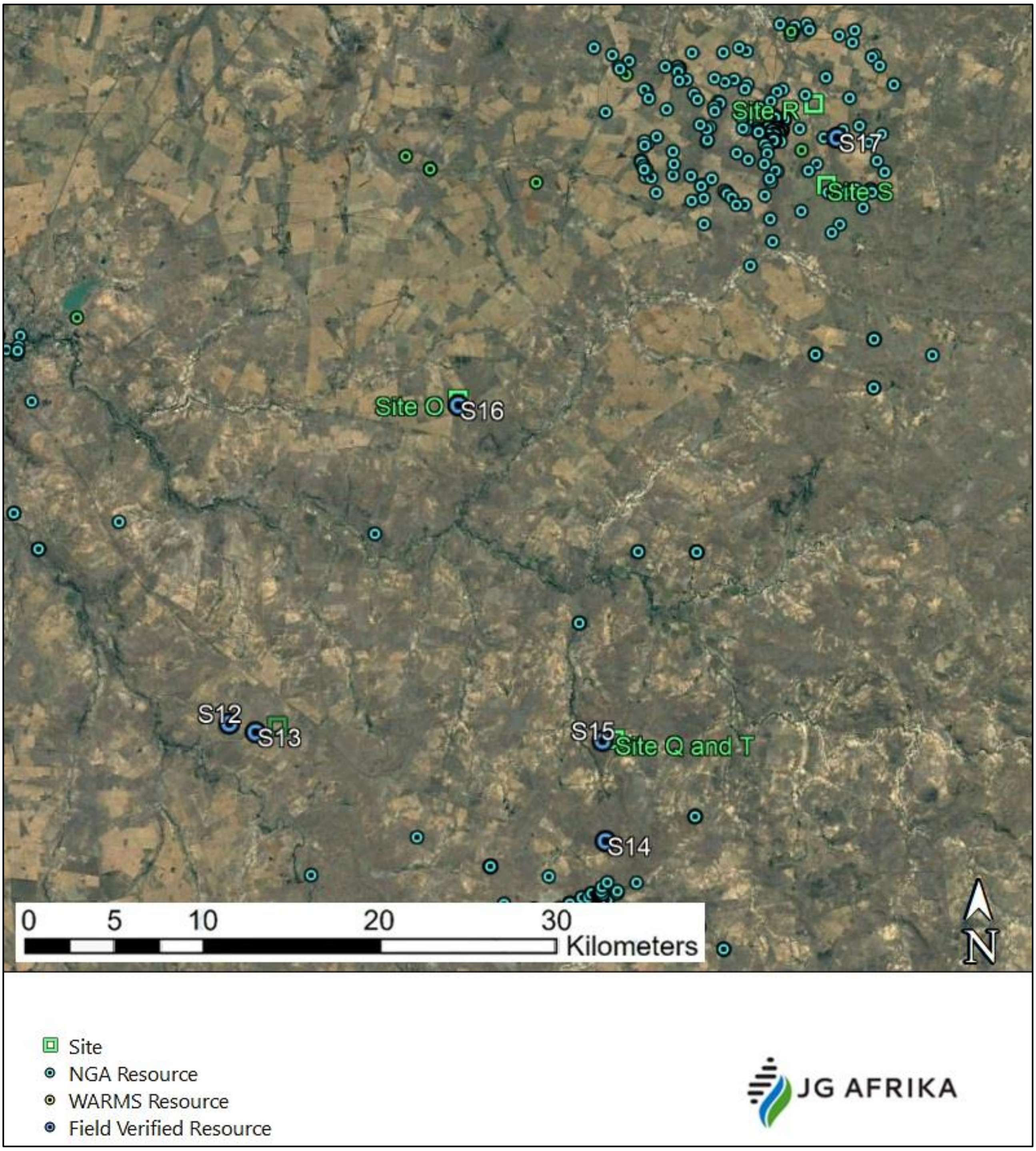



*Figure 8: Hydrocensus*

## 4.8 Water Quality Status Quo

Groundwater samples were collected by JG Afrika from boreholes identified and field verified during the site assessment, to establish the baseline groundwater quality status quo. Sampling was carried out from 29 November 2022 to 1 December 2022. Samples were submitted to EPL Laboratory for analysis of selected compounds of the Domestic Consumption SANS241 (2015) suite, to assess the potability and suitability of use. Samples were also submitted to iThemba labs for isotope analysis.

The results of analysis were compared to the SANS241 (2015) Drinking Water Standards screening guidelines. The summary results of analysis are presented in Table 5 and the laboratory certificates of analysis are presented in Annexure D.

## *Table 5: Summary Results of Groundwater Analysis*

| Sample Position | | Site P | | Removed | Site Q / T | Site O | Site R | SANS 241 : 2015 Drinking Water | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | 02-Dec-22 | 02-Dec-22 | 02-Dec-22 | 02-Dec-22 | 02-Dec-22 | 03-Dec-22 | | | |
| Sampled by | | BS | BS | BS | BS | BS | BS | | | |
| Sample Method | | windmill | windmill | submersible | submersible | windmill | submersible | Upper Limits | | |
| Report Date | | 21-Dec-22 | | | | | | | | |
| Laboratory Certificate Number | | 41076 | | | | | | | | |
| Laboratory Sample Reference | | S12 | S13 | S14 | S15 | S16 | S17 | Acute health / Chronic health | Aesthetic | Operational |
| Determinand | Unit | | | | | | | | | |
| **Micro biological determinands** | | | | | | | | | | |
| E. coli or faecal coliforms | Count per 100 mL | 0 | 0 | 0 | 0 | 200 | 0 | Not detected | | |
| Total coliforms | Count per 100 mL | 400 | 100 | 0 | 0 | 11700 | 400 | | | ≤10 |
| Heterotrophic plate count | Count per mL | 32 | 151 | 4 | 39 | 156 | 12 | | | 1 000 |
| **Physical and aesthetic determinands** | | | | | | | | | | |
| Colour | mg/L Pt-Co | <10 | <10 | <10 | 26.8 | 122 | <10 | | 15 | |
| Conductivity at 25 °C | mS/m | 159 | 171.2 | 66.7 | 56.8 | 58.4 | 122.2 | | 170 | |
| Total dissolved solids | mg/L | 1092 | 1078 | 443 | 399 | 628 | 701 | | 1200 | |
| Turbidity | NTU | 1.09 | 39.49 | 0.11 | 51.59 | 4.09 | 2.74 | | 5 | 1 |
| pH at 25 C | pH units | 8.09 | 7.51 | 7.84 | 7.97 | 8.74 | 8.15 | | | 5 to 9.7 |
| **Chemical determinands — macro-determinands** | | | | | | | | | | |
| Nitrate as N | mg/L | <0.5 | 4.86 | <0.5 | <0.5 | <0.5 | 11.1 | 11 | | |
| Nitrite as N | mg/L | <0.13 | <0.13 | <0.13 | <0.13 | <0.13 | <0.13 | 0.9 | | |
| Combined nitrate-nitrite | - | <0.5 | 4.86 | <0.5 | <0.5 | <0.5 | 11.1 | 1 | | |
| Sulphate as SO42– | mg/L | 329.2 | 340.3 | 41.92 | 32.55 | 23.81 | 66.52 | 500 | 250 | |
| Fluoride as F– | mg/L | 1.43 | 0.62 | 0.1 | 0.27 | 0.28 | 0.77 | 1.5 | | |
| Ammonia as N | mg/L | 0.04 | <0.02 | <0.02 | <0.02 | 0.15 | <0.02 | | 1.5 | |
| Chloride as Cl– | mg/L | 71.57 | 49.16 | 25.18 | 10.53 | 19.06 | 112.7 | | 300 | |
| Calcium as Ca | mg/L | 57.19 | 128.2 | 50.42 | 37.72 | 10.45 | 96.29 | | 150/300* | |
| Magnesium as Mg | mg/L | 22.44 | 47.83 | 26.38 | 18.11 | 17.34 | 39.25 | 70/100* | | |
| Potassium as K | mg/L | 4.59 | 14.04 | 0.99 | 1.36 | 28.24 | 19.69 | 50/100* | | 50/100* |
| Sodium as Na | mg/L | 249.1 | 197.3 | 38.83 | 47.02 | 75.99 | 108.9 | | 200 | |
| Zinc as Zn | mg/L | 0.13 | 0.1 | <0.05 | 0.05 | 0.05 | 0.05 | | 5 | |
| **Chemical determinands — micro-determinands** | | | | | | | | | | |
| Aluminium as Al | µg/L | 170 | 120 | 140 | 210 | 150 | 240 | 300 | | |
| Antimony as Sb | µg/L | <10 | <10 | <10 | <10 | <10 | <10 | 20 | | |
| Arsenic as As | µg/L | <10 | <10 | 10 | <10 | <10 | <10 | 10 | | |
| Barium as Ba | µg/L | <50 | <50 | 120 | 190 | <50 | 70 | 700 | | |
| Boron as B | µg/L | <500 | <500 | <500 | <500 | <500 | <500 | 2400 | | |
| Cadmium as Cd | µg/L | <3 | <3 | <3 | <3 | <3 | <3 | 3 | | |
| Total chromium as Cr | µg/L | <50 | <50 | <50 | <50 | <50 | <50 | 50 | | |
| Cobalt as Co | µg/L | <50 | <50 | <50 | <50 | <50 | <50 | 500* | | |
| Copper as Cu | µg/L | 100 | 60 | 70 | 80 | 160 | 150 | 2000 | | |
| Cyanide (recoverable) as CN– | µg/L | <2 | <2 | 8 | 6 | <2 | 3 | 200 | | |
| Iron as Fe | µg/L | 80 | 640 | 80 | 760 | 280 | 80 | 2000 | 300 | |
| Lead as Pb | µg/L | <10 | <10 | <10 | <10 | <10 | <10 | 10 | | |
| Manganese as Mn | µg/L | 110 | <50 | <50 | <50 | <50 | <50 | 400 | 100 | |
| Mercury as Hg | µg/L | <5 | <5 | <5 | <5 | <5 | <5 | 6 | | |
| Nickel as Ni | µg/L | <5 | <5 | <5 | <5 | <5 | <5 | 70 | | |
| Selenium as Se | µg/L | <10 | 10 | <10 | <10 | <10 | <10 | 40 | | |
| Uranium as U | µg/L | <10 | <10 | <10 | <10 | <10 | <10 | 30 | | |
| Vanadium as V | µg/L | <50 | <50 | <50 | <50 | <50 | <50 | 200* | | |
| **Chemical determinands — organic determinands** | | | | | | | | | | |
| Total organic carbon as C | mg/L | <10 | <10 | <10 | <10 | 12.52 | <10 | 10 | | |
| Phenols | µg/L | <10 | <10 | <10 | <10 | <10 | <10 | | 10 | |
| **Isotopes** | | | | | | | | | | |
| d D | (‰) | -28.7 | -28.5 | -21.7 | -20.8 | -13.9 | -35.2 | | | |
| $d^{18}O$ | (‰) | -4.7 | -4.8 | -3.9 | -3.6 | -1.8 | -5.8 | | | |

| | |
|---|---|
| * SANS 241:2006 Limits - | Class I |
| * SANS 241:2011 Limits - | chronic health |

The results of analysis indicate that for the compounds analysed, nitrate and combined nitrate/nitrate exceeded the acute health screening limit in selected samples, and *E.Coli* exceeded the acute health limit in a single sample. Total organic carbon exceeded the chronic health limit in a single sample.

The operational and aesthetic limits were exceeded in numerous samples for total coliforms, colour, and turbidity, while conductivity, sulphate, sodium, iron and manganese were exceeded in isolated cases.

Typically the groundwater is unsuitable for potable use and the likely sources of compounds of concern are related to agricultural activities.

For the isotope analysis, the results are presented in the common delta-notation, expressed as per mil deviation relative to the known mean ocean water standard (SMOW). The $\delta^{18}O$ versus δD space relative to the Global Meteoric Water Line (GMWL, Craig, 1961) is presented in Figure 9.

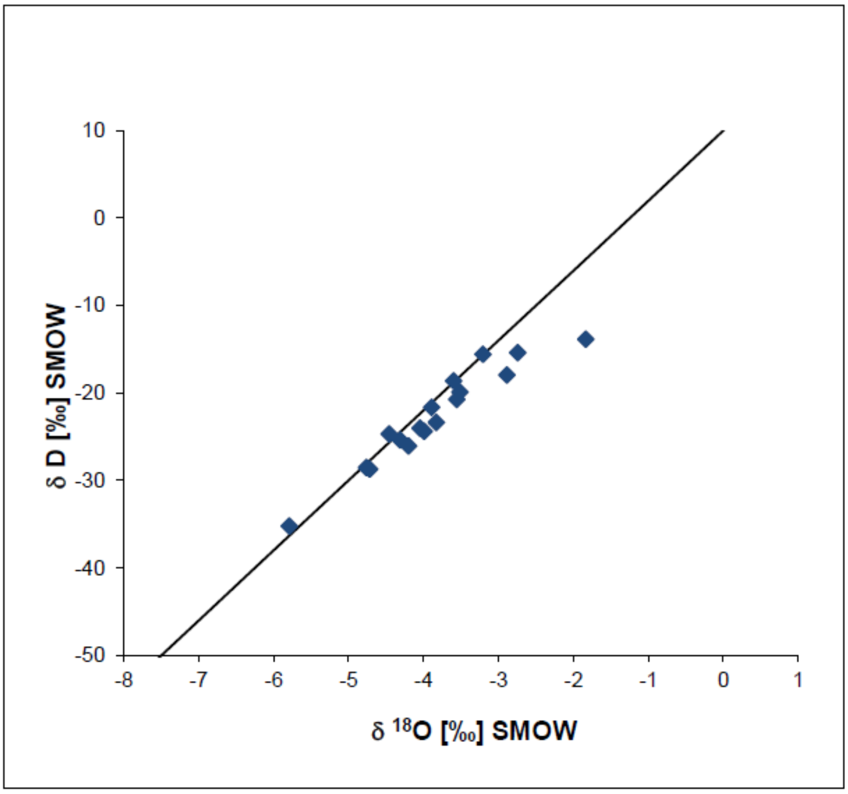



*Figure 9: Stable Isotope Data Relative to Global Meteoric Water Line (Craig, 1961)*

### 4.9 Groundwater Occurrence

The groundwater occurrence for the project area is presented in Figure 10. These delineations form the basis for the distribution of hydraulic conductivities and recharge in the groundwater model development discussed in Section 6. NGA and field verified boreholes are shown for spatial reference. It is evident from the NGA boreholes that the higher yielding aquifers were mostly targeted during drilling programmes.

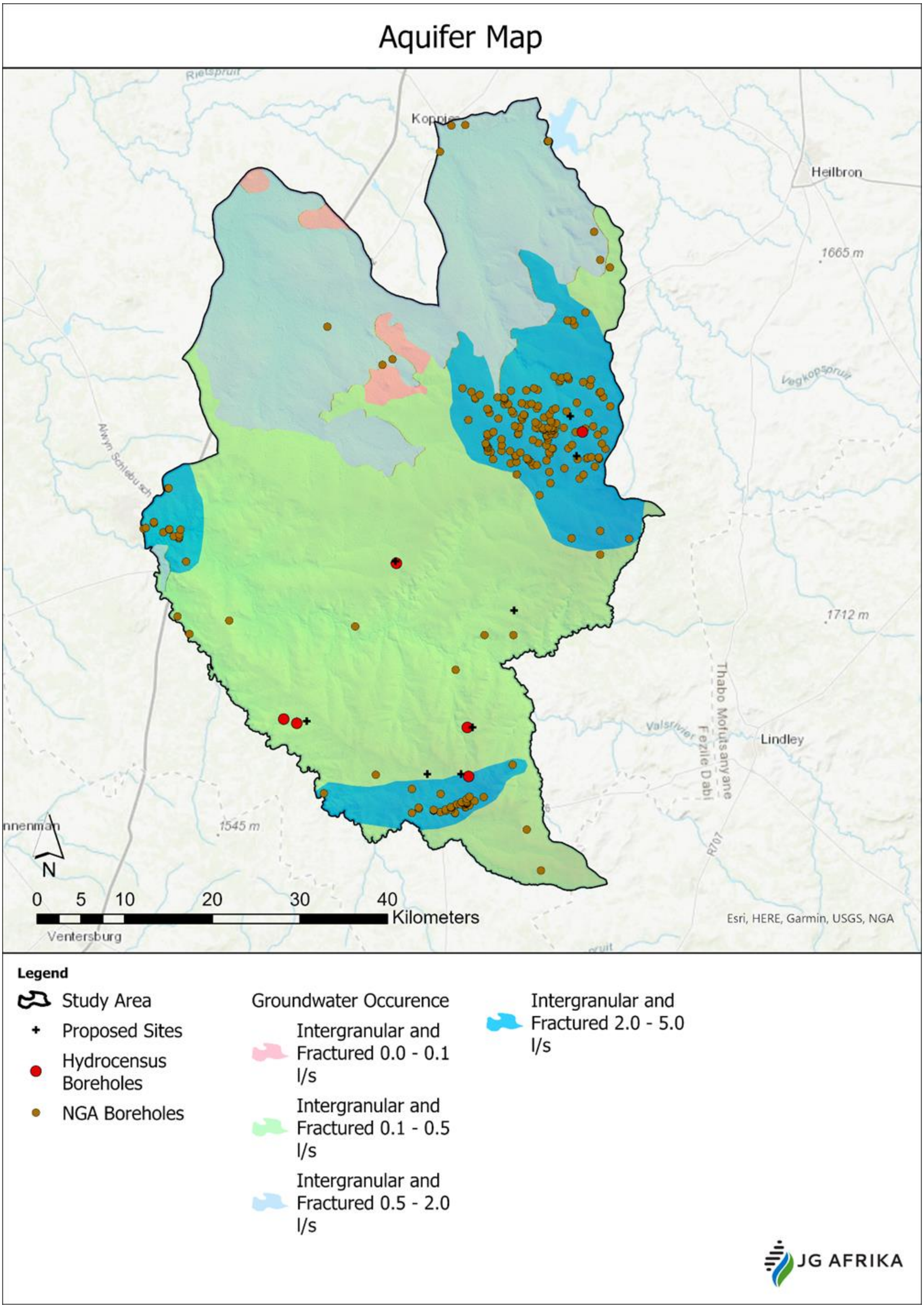



*Figure 10: Groundwater Occurrence*

### 4.10 Aquifer Vulnerability

The DRASTIC aquifer vulnerability method makes use of seven (7) factors to calculate the vulnerability index value:

- Depth to groundwater (D) – determines the maximum distance contaminants travel before reaching the aquifer
- Net recharge (R) – the amount of water that is able to travel from ground surface to the water table
- Aquifer (A) – the composition of the aquifer material
- Soil media (S) – the uppermost portion of the unsaturated zone
- Topography (T) – the slope of the ground surface
- Impact of vadose zone (I) – the type of material present between the bottom of the soil zone and water table
- Hydraulic conductivity of the aquifer (C) – indicates the aquifer's ability to allow for the flow of water to occur.

This vulnerability index is used to determine the aquifer's vulnerability to pollution with the index range from 1 to 200, where 200 represents the theoretical maximum aquifer vulnerability. The DRASTIC map for the project area is presented in Figure 11. The maximum index in the project area is 50% of the vulnerability scale.

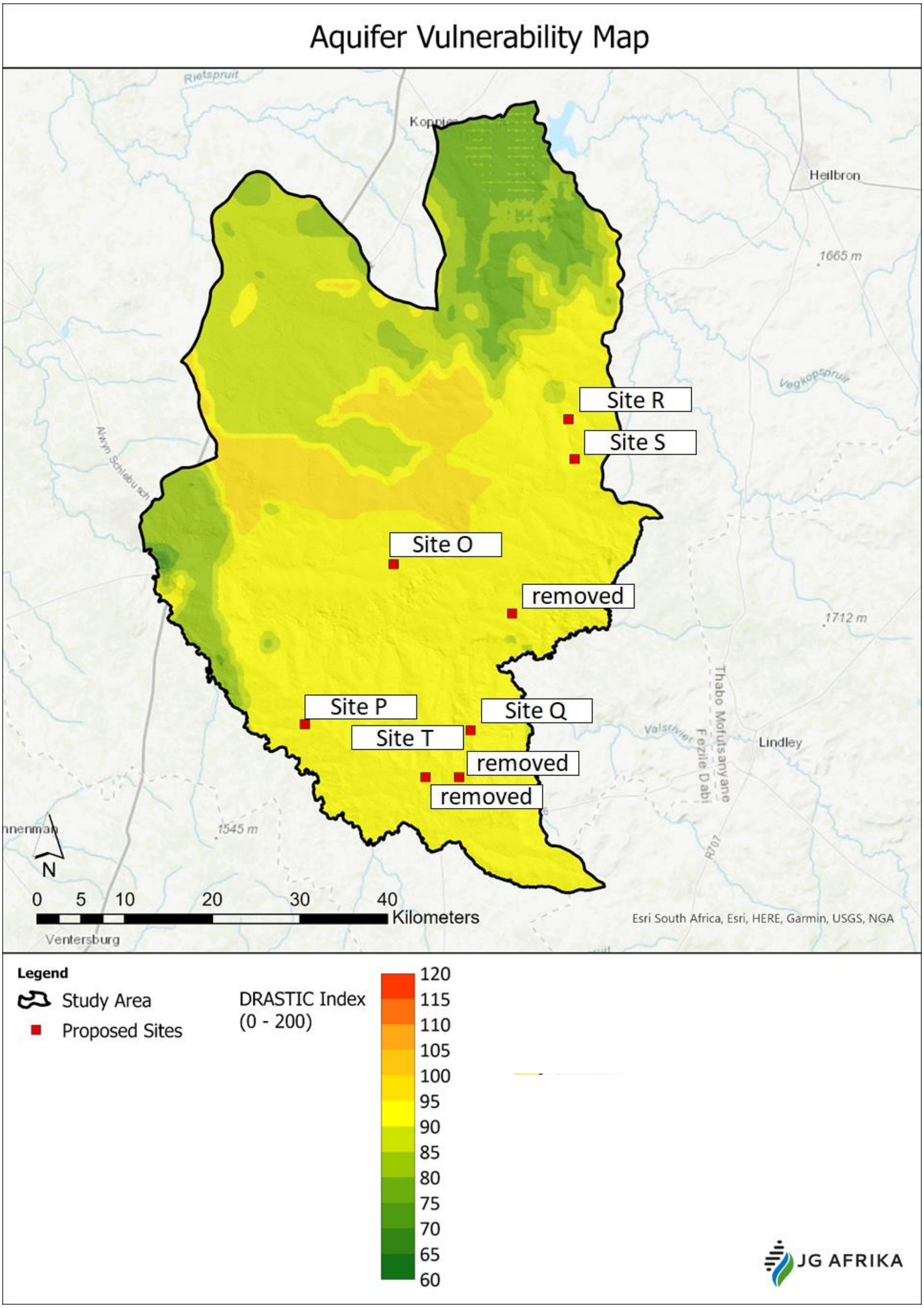



*Figure 11: Aquifer Vulnerability*

## 4.11 Regional Water Levels

There exists a high correlation between surface elevation and groundwater levels across the project area as presented in Figure 12. Both historic water levels from NGA as well as the field verified data support this trend. Due to limited water level information, resources with water level data as far back as 1994 were considered. A high density of boreholes exist in the project area.

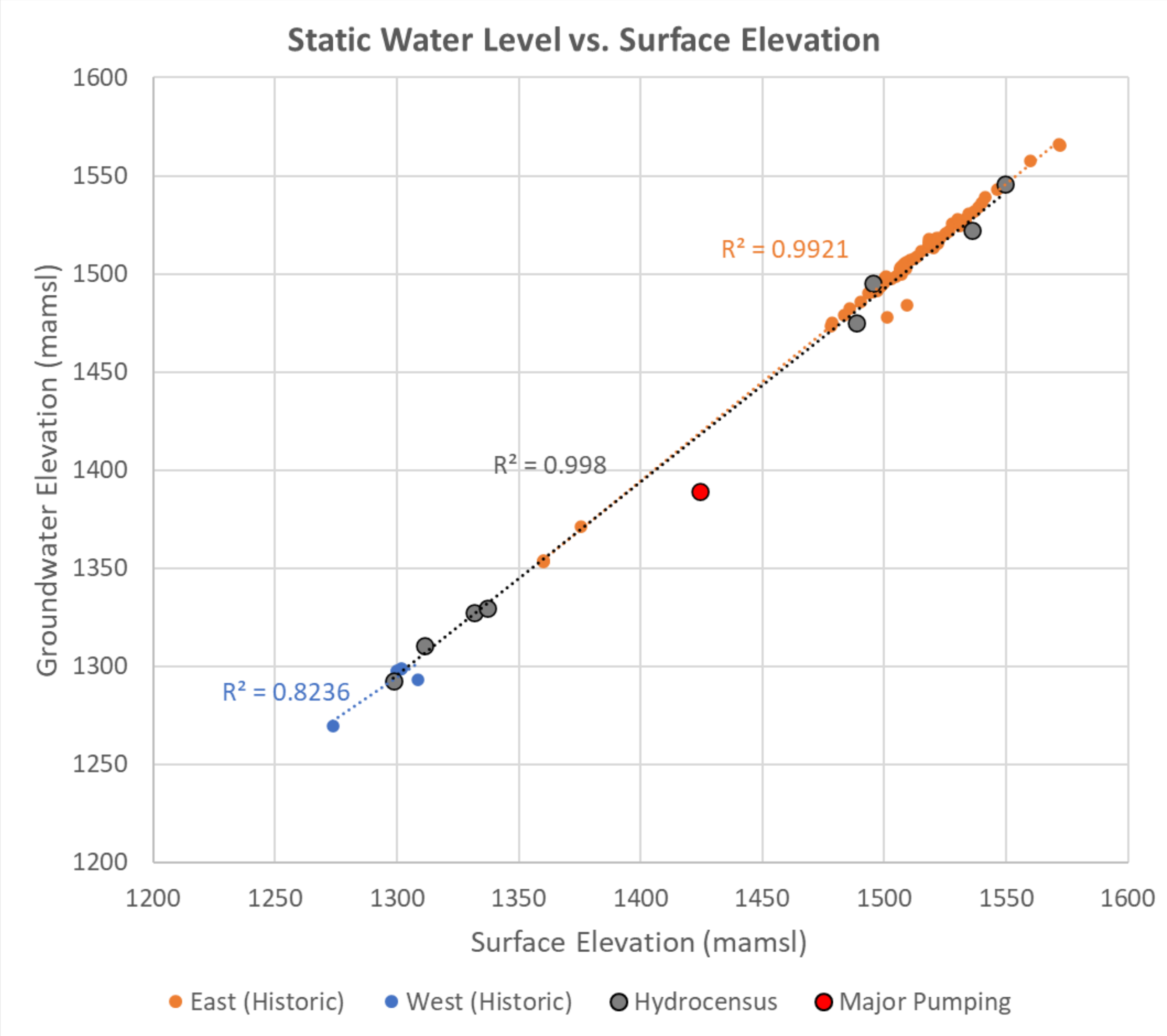



*Figure 12: Groundwater Level Correlation with Surface Elevation*

Many historic resources within the NGA plot on top of each other or in a L shape with only an offset of a few meters between each borehole. Historically, before GPS technology, surveyors assigned all the boreholes within a farm boundary to the farm centroid. This resulted in many resources not being found in the field due to inaccurate coordinates. The implication of this is that the associated data does not relate to the coordinate specified. These boreholes were excluded from the groundwater model development, therefore the calibration dataset is smaller than the actual number of boreholes presented in Annexure C.

# 5 CONCEPTUAL MODEL DEVELOPMENT

## 5.1 Introduction

The development of the conceptual model relies on the availability of geological data. The borehole logs used in the model development are presented in Annexure B and used in setting up a three layer conceptual model. All borehole logs were simplified into three layers as shown in Table 6. Not all three layers exist everywhere in the model domain.

*Table 6: Layer Distribution of Conceptual Model*

| Layer Number | Description |
|---|---|
| 1 | Sandstone |
| 2 | Shale |
| 3 | Sandstone |

## 5.2 Visualization of Model Layers

The visualization of the conceptual model layers for the project area is presented in Figure 13 looking from south to north over the project area. The top sandstone layer is not present across the entire domain and the middle shale layer and bottom sandstone layer also pinches out in certain parts of the model domain. The conceptual model relied on the interpolation of the borehole logs since no field verification was carried out.

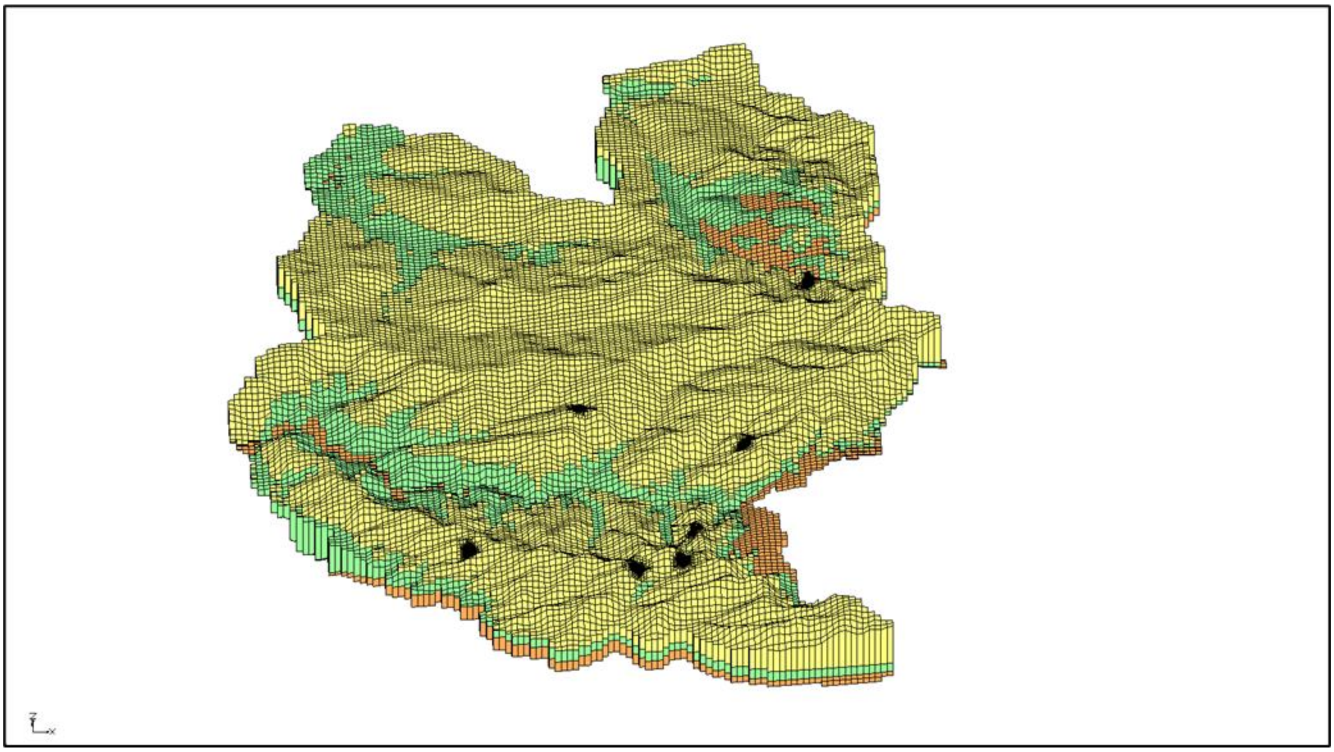


*Figure 13: Three Layer Conceptual Model*

# 6 NUMERICAL GROUNDWATER FLOW MODEL

## 6.1 Assumptions and Limitations

The numerical groundwater model is based on the layered conceptual model presented in Section 5, which was derived from the review of the information presented in the desktop and site assessment.

For the model setup, the following typically needs to be described:

- Geological and hydrogeological features
- Boundary conditions of the study area (based on the geology and hydrogeology)
- Initial water levels of the study area
- The processes governing groundwater flow
- Assumptions for the selection of the most appropriate numerical code.

Field data is essential in solving the conditions listed above and developing the numerical model into a site-specific groundwater model. Specific assumptions related to the available field data include:

- The top of the aquifer is represented by the generated groundwater heads
- The available geological/hydrogeological information was used to describe the different aquifers. The available information on the geology and field measurements are considered as correct. Limited hydrocensus sites were available, thus the NGA data was used as the status quo of the study area. Since the NGA also lacks timeseries water levels, all data after 2000 was used to obtain water levels over the project area. Contradicting water levels in areas with a high borehole density were evident, as this relates to a different rainfall recharge from 2000 to 2022. The general water level trend in the project area was assumed to be correct
- Aquifer parameters have not been determined in the field and therefore have to be estimated. In the absence of pump test data, aquifer parameters and hydraulic conductivities were determined through the model calibration process.

In order to develop a model of an aquifer system, certain assumptions have to be made. These include:

- The system is initially in equilibrium and therefore in steady state[2], even though natural conditions have been disturbed
- No abstraction boreholes were included in the initial model
- The boundary conditions assigned to the model are considered correct
- The impacts of other activities (e.g. agriculture) have not been taken into account.

A numerical groundwater model is a representation of the real system. It is therefore at most an approximation, and the level of accuracy depends on the quality of the data that is available. This implies that there are always errors associated with groundwater models due to uncertainty in the data, and the capability of numerical methods to describe natural physical processes.

In addition to the model limitations, the following limitation and assumptions apply to the modelling:

- No transient calibration could be done in the absence of time series monitoring data, only steady-state conditions were considered
- Specific storage and porosity values were taken from literature as these were not available for a transient mass transport simulation
- As no pumping rates were available from production boreholes, estimates were used in the scenario modelling.

[2] In steady state systems, inputs and outputs are in equilibrium so that there is no net change in the system with time. In transient simulations, the inputs and outputs are not in equilibrium so there is a net change in the system with time. Steady state models provide average, long-term results. Transient models should be used when the groundwater regime varies over time.

## 6.2 Generation of a Finite Difference Network

In order to investigate the behaviour of aquifer systems in time and space, it is necessary to employ a mathematical model. MODFLOW, a modular three-dimensional finite difference groundwater flow model was applied during this investigation. It is an internationally accepted modelling package, which calculates the solution of the groundwater flow equation using the finite difference approach.

The simulation model used in this modelling study is based on three-dimensional groundwater flow as described by the following equation:

$$\frac{\partial}{\partial x}(K_x\frac{\partial h}{\partial x})+\frac{\partial}{\partial y}(K_y\frac{\partial h}{\partial y})+\frac{\partial}{\partial z}(K_z\frac{\partial h}{\partial z})\pm W=S\frac{\partial h}{\partial t}$$

where,

| | | |
|---|---|---|
| h | = | Hydraulic head |
| Kx, Ky, Kz | = | Hydraulic conductivity in different directions |
| S | = | Storage coefficient |
| t | = | Time |
| W | = | Source (recharge) or sink (pumping) per unit area |
| x, y, z | = | Coordinate into model |

For steady state conditions the groundwater flow equation reduces to the following:

$$\frac{\partial}{\partial x}(K_x\frac{\partial h}{\partial x})+\frac{\partial}{\partial y}(K_y\frac{\partial h}{\partial y})+\frac{\partial}{\partial z}(K_z\frac{\partial h}{\partial z})\pm W=0$$

Groundwater Modelling System (GMS) 10.7 was used to develop the conceptual and numerical models. GMS is a groundwater modelling application from Aquaveo in Utah, United States of America, for building and simulating groundwater models. It features 2D and 3D geostatistics, stratigraphic modeling and a unique conceptual model approach. Currently supported models include MODFLOW, MODPATH, MT3DMS, RT3D, FEMWATER, SEEP2D, and UTEXAS. Esri Arc GIS was used to generate output maps.

## 6.3 Model Grid

The network was constructed using a cell size of 500 x 500 m over the model extent with a grid refinement of 25m x 25m over a 1km radius around the proposed sites. The model grid for the project area is presented in Figure 14.

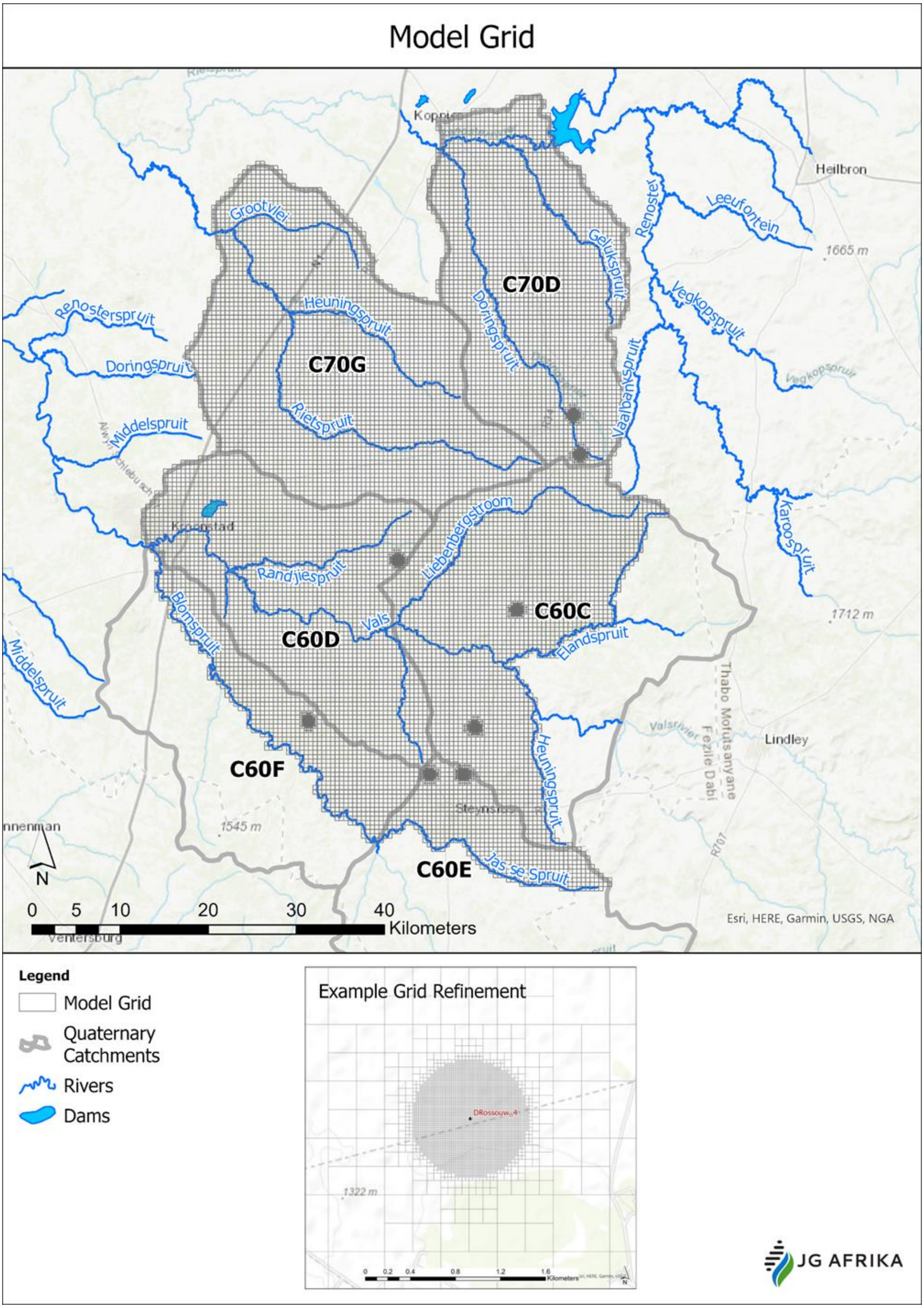



*Figure 14: Model Grid*

## 6.4 Boundary Conditions

One of the first and most demanding tasks in groundwater modelling is that of identifying the model area and its boundaries. A model boundary is the interface between the model area and the surrounding environment. Conditions on the boundaries have to be specified. Boundaries occur at the edges of the model area and at locations in the model area where external influences are represented, such as rivers, wells, and leaky impoundments.

Criteria for selecting hydraulic boundary conditions are primarily topography, hydrology and geology. The topography and/or geology may yield boundaries such as impermeable strata or a potentiometric surface controlled by surface water, or recharge/discharge areas such as inflow boundaries along mountain ranges. The flow system allows the specification of boundaries in situations where natural boundaries are a great distance away.

Boundary conditions must be specified for the entire boundary and may vary with time. At a given boundary section just one type of boundary condition can be assigned. As an example, it is not possible to specify groundwater flux and groundwater head at an identical boundary section. Boundaries in groundwater models can be specified as:

- Dirichlet (also known as fixed head or constant concentration) boundary conditions
- Neuman (or specified flux) boundary conditions
- Cauchy (or a combination of Dirichlet and Neuman) boundary conditions
- General Head Boundary (GHB) (also known as a head dependant flux boundary).

The rivers in the model grid were considered constant head boundaries and the wetlands and drainage lines were treated as drains in the model domain. The north western boundary of the project area was treated as a general head boundary.

Dykes were not explicitly accounted for in the model although there are major magnetic structures visible in the magnetic mapping. Generally, dykes are modelled as no flow boundaries, but it is unlikely that these major structures are all no flow boundaries. Further, the depth of these structures was not available.

## 6.5 Model Parameters

Groundwater models consists of sources and sinks to add and remove water from the domain to maintain the overall model water balance. This section describes the model parameters assigned to each layer of the model.

### 6.5.1 Recharge

As no groundwater chloride concentrations were available for use in the chloride mass-balance method, and no time series water levels were available for the use in a water balance method, recharge could not be calculated, and the default recharge values obtained from the GRAII project were used. The recharge values are presented in

Table 7.

*Table 7: Recharge Values*

| Quaternary | MAP (mm/a) | Recharge as % MAP | Recharge (m/d) |
|---|---|---|---|
| C60C | 571 | 3.2% | 0.00005006 |
| C60D | 550 | 2.8% | 0.00004219 |
| C60E | 557 | 2.9% | 0.00004425 |
| C60F | 556 | 2.4% | 0.00003656 |
| C70F | 586 | 3.4% | 0.00005459 |
| C60C | 578 | 4.1% | 0.00006493 |
| Average | 566 | 3.1% | 0.00004807 |

Recharge zones were chosen to align with the groundwater occurrence areas within the model boundaries. The zone numbers are presented in Figure 15 and summarised in Table 8.

*Table 8: Summary of Recharge Values*

| Zone | Study Area | Recharge (m/d) | Recharge % |
|---|---|---|---|
| 4 | East | 0.00003511 | 2.1% |
| 5 | East | 0.00005053 | 3.0% |
| 6 | East | 0.00003393 | 2.0% |
| 7 | East | 0.00001636 | 1.0% |
| 8 | East | 0.00006956 | 4.1% |

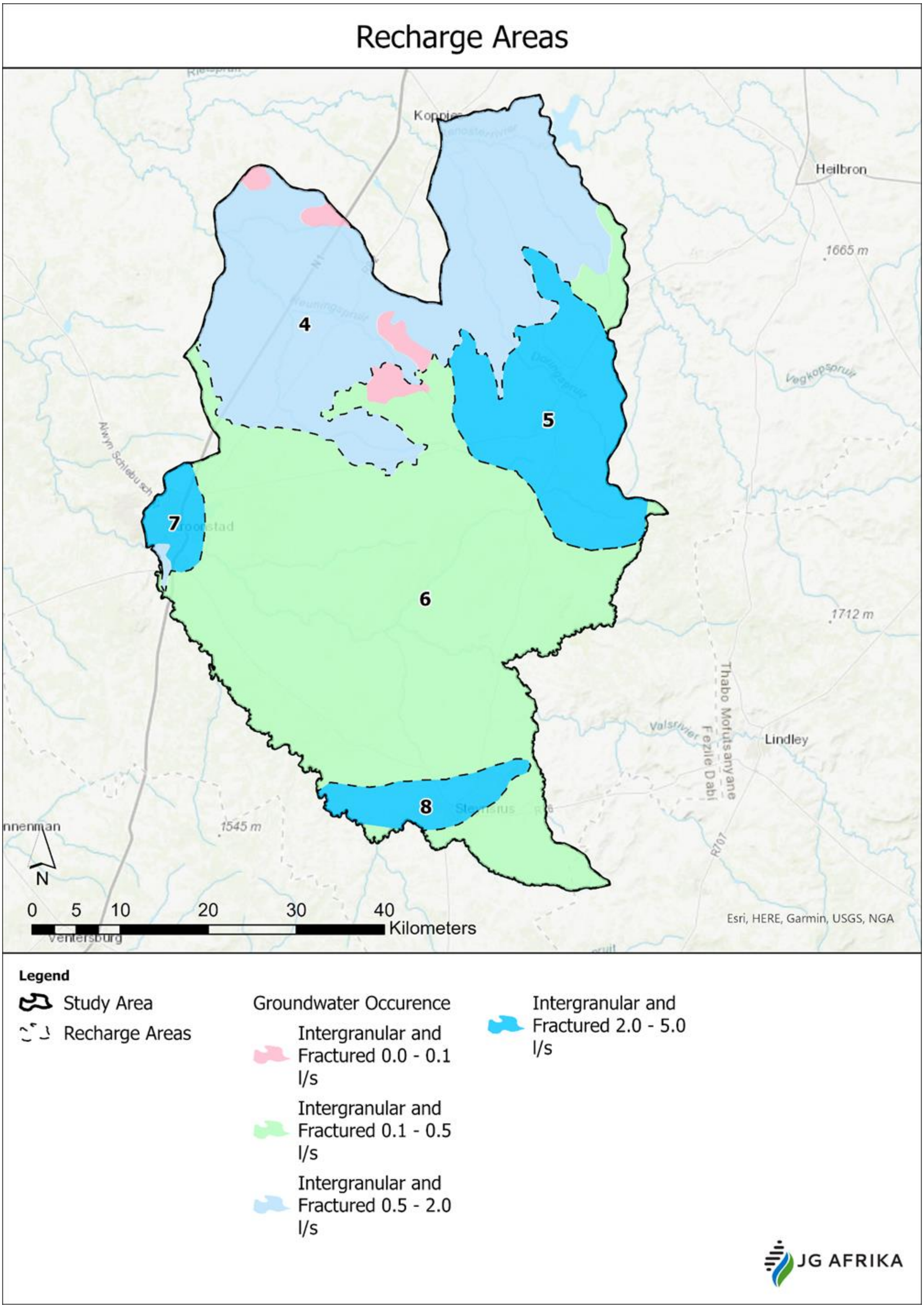



*Figure 15: Recharge Zone Numbers*

#### 6.5.2 Hydraulic Conductivities

Since no aquifer tests were available, the hydraulic conductivities were determined through the calibration process by keeping the recharge values within a tight range around values obtained from the GRAII database.

The horizontal hydraulic conductivities are related to the groundwater occurrence units, therefore each unit in each layer was calibrated with a hydraulic conductivity. Calibration is non-unique, therefore aquifer tests would be required to obtain a better hydraulic conductivity range to calibrate against. The geometric mean of the horizontal hydraulic conductivities of selected layers are presented in Table 9, and a vertical anisotropy factor of 10 was used throughout the model.

*Table 9: Summary of Hydraulic Conductivities for Model Layers*

| Layer No | Layer | Hydraulic Conductivity (m/d) |
|---|---|---|
| Layer 1 | Sandstone | 0.094614 |
| Layer 2 | Shale | 0.203044 |
| Layer 3 | Sandstone | 0.071675 |

### 6.6 Initial Conditions

The model was initialized with parameter values as presented above. Initial water levels were required to solve the steady-state equation. The regional borehole water levels were discussed in Section 4. As a high correlation between the average water levels and topography was observed, the Bayesian interpolation method to generate water levels across the entire domain is well suited. The Bayesian method employs Bayes' probability theorem that describes the probability of an observation, based on prior knowledge of conditions that might be related to the observation. The main advantage of using the Bayesian interpolation is that water levels can also be extrapolated to areas where no water level information exists. Using known elevation data, the probability calculation can be used to estimate the water levels. The resultant water level map for the project area representing the initial model water levels is presented in Figure 16.

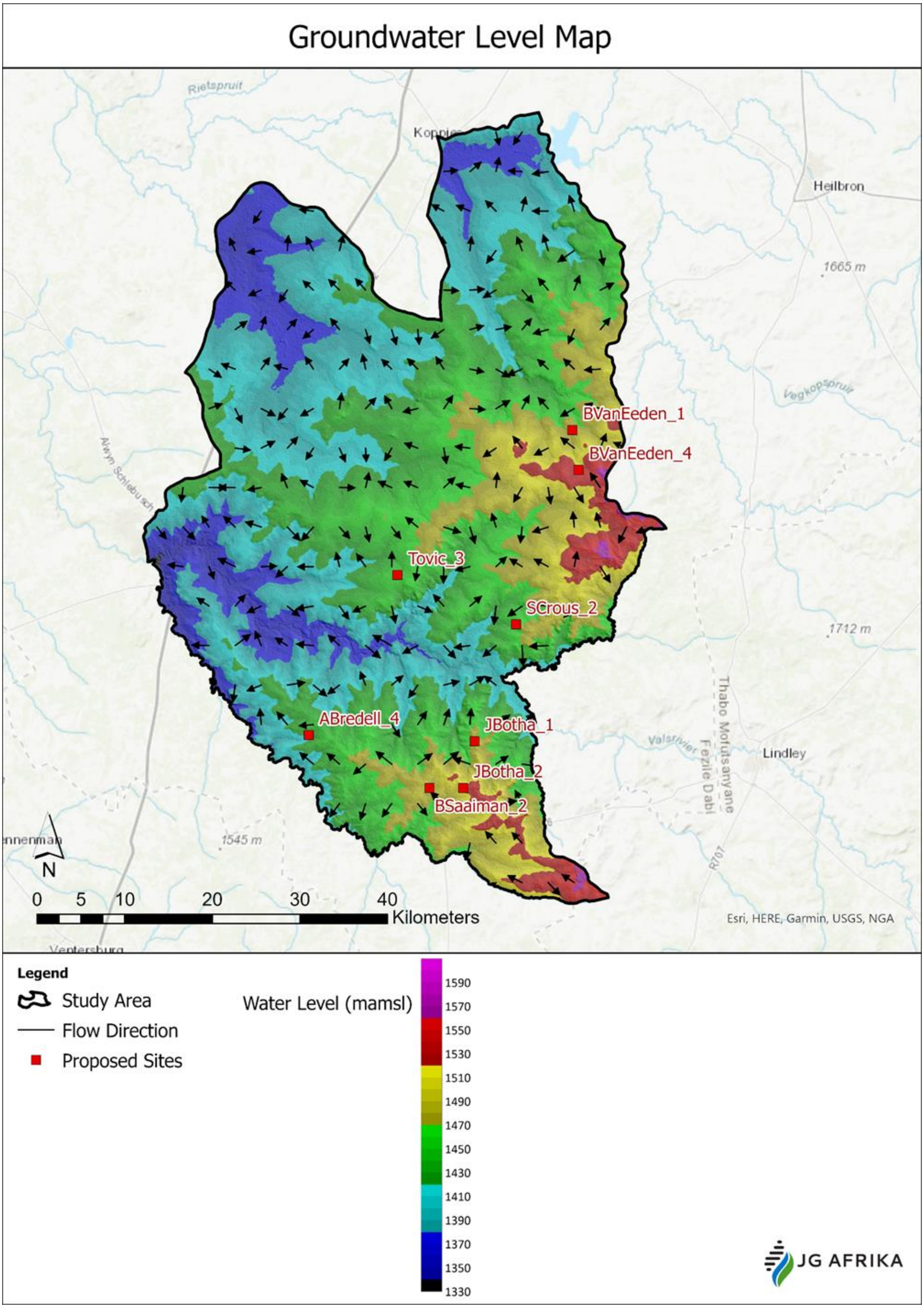



*Figure 16: Initial Model Water Levels*

## 7 MODEL CALIBRATION

The steady state head distribution is dependent upon the recharge, hydraulic conductivity, sources, sinks, and boundary conditions specified. For a given recharge component and set of boundary conditions, the head distribution across the aquifer under steady-state conditions can be obtained for a specific hydraulic conductivity value. The simulated head distribution can then be compared to the measured head distribution and the hydraulic conductivity or recharge values can be altered until an acceptable correlation between measured and simulated heads is obtained. The advantage of a steady state model is that the parameter for storage coefficient is not required to solve the groundwater flow equation, therefore there are fewer unknown parameters to determine.

The calibration process was done by changing the model parameters for hydraulic conductivity and keeping the recharge within a tight range of the obtained values. Borehole water levels were used to calibrate the steady state groundwater flow model until an acceptable correlation was obtained. The spatial distribution of these boreholes and calibration state is presented in Figure 17. The error bars indicate a ±5 m variation and all green boreholes lie within this range when comparing observed and simulated water levels.

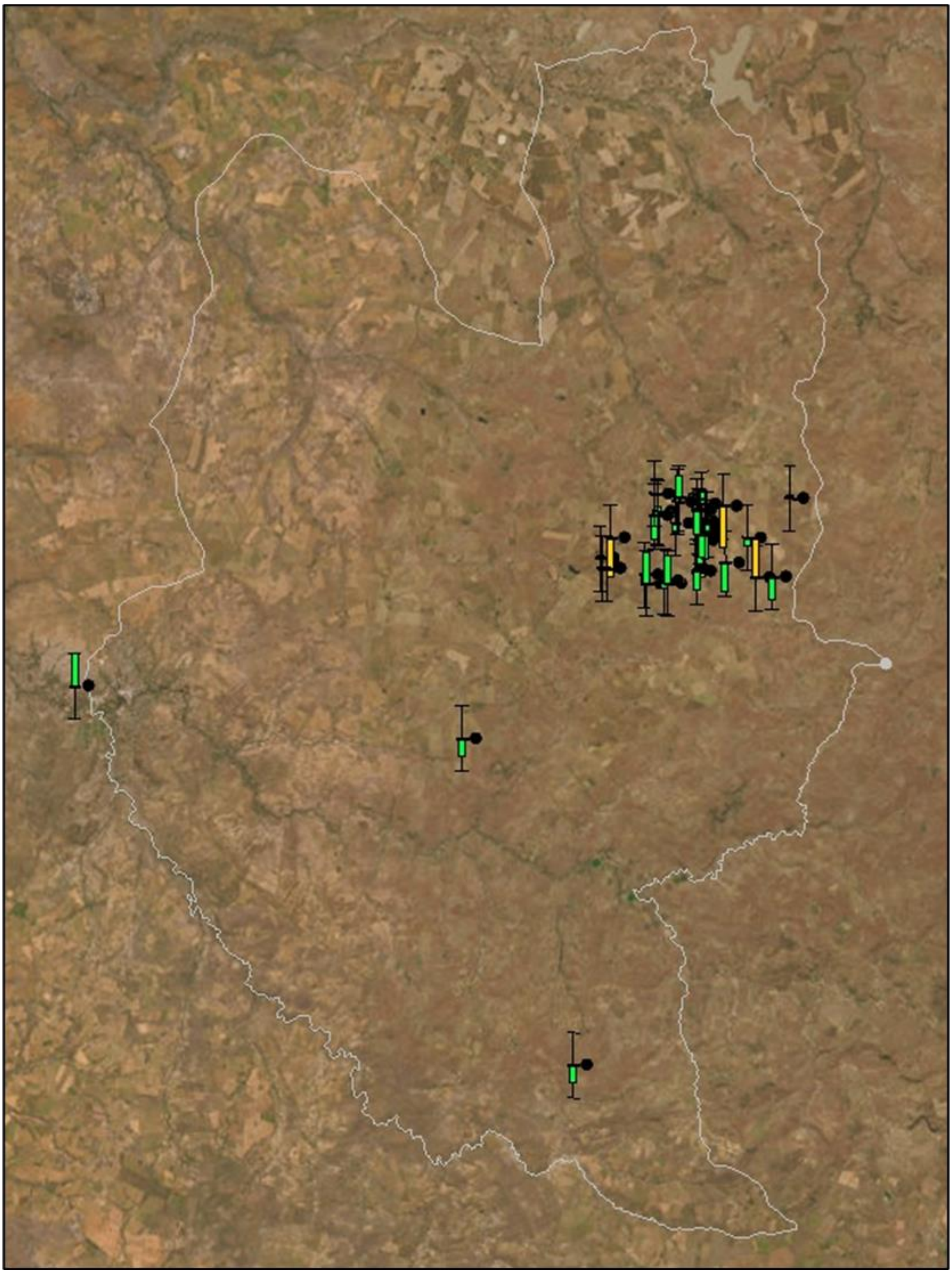


*Figure 17: Calibration State of Boreholes*

The observed versus simulated water levels for each calibration borehole is presented in Figure 18 This shows a high correlation over the project area.

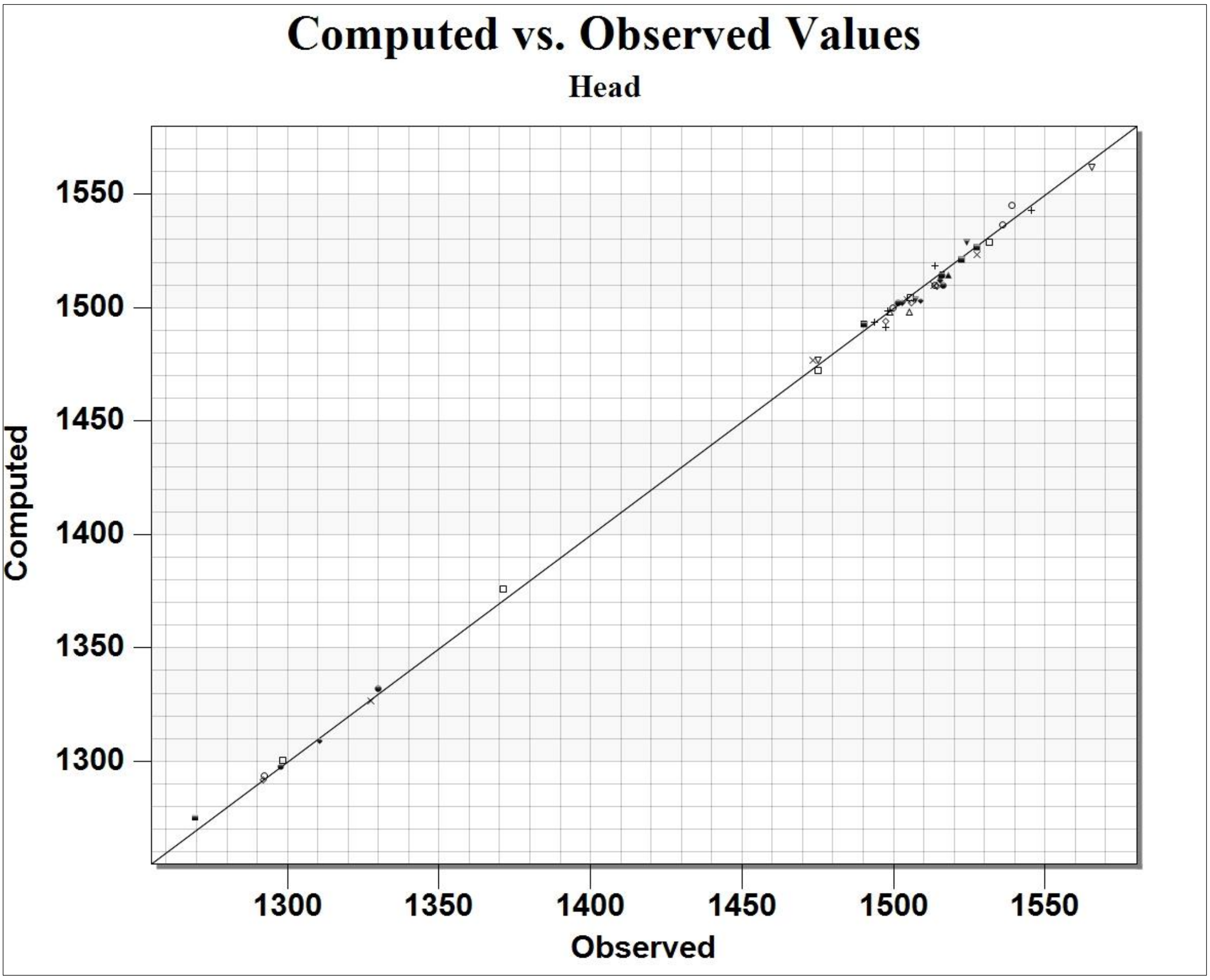



*Figure 18: Correlation Between Observed and Simulated Water Levels*

Not all observation boreholes were used in the calibration process due to contrasting water levels of some boreholes in close proximity to each other. Possible reasons for water level anomalies could be one of the following:

- Water levels measured at different periods in time which are subject to different rainfall and site conditions. Only water levels measured between 2000 and 2023 were considered to reduce the temporal window, but at the same time, get a good spatial distribution of water levels over the area
- Some boreholes intersect different aquifer systems or geological features like faults or dykes. To account for these types of borehole responses, substantial monitoring data is required to understand the water level behaviour. Furthermore, borehole construction could also play an important role in water level response.

# 8 MODEL SCENARIOS

## 8.1 Introduction

The generic scenario considered for each of the proposed sites was the well casing integrity is hypothetically deteriorated to the extent that some pollutant could enter any of the three layers of the model. A percentage model is used to determine the pollution plume footprint. The percentage model assumes conservative mass transport, therefore if the source concentration is known, the plume concentration is obtained my multiplying the source concentration with the plume percentage.

## 8.2 Methodology

The calibrated numerical groundwater flow model was used and pumping boreholes were introduced into the model, as the change in hydraulic gradients could influence the direction of the plume migration. During the hydrocensus, it was not possible to establish the abstraction rates of existing boreholes, so an estimate was made based on the inferred type of use. Estimated abstraction rates are presented in Table 10.

*Table 10: Estimated Abstraction at Field Verified Sites*

| ID | Equipment | Comment (condition, observed use, etc) | Estimated Abstraction |
|---|---|---|---|
| S12 | windmill | livestock watering | 5 |
| S13 | windmill | livestock water, piped underground | 5 |
| S14 | submersible | livestock water, solar installation | 5 |
| S15 | submersible | livestock watering, solar installation, borehole in | 2 |
| S16 | windmill | livestock watering | 5 |
| S17 | submersible | domestic use | 1 |

In addition to the field verified boreholes, registered use resources were obtained from the WARMS database, and these boreholes were also introduced as pumping boreholes at the rates specified. The WARMS boreholes are presented in Table 11. Pumping boreholes introduced into the model for scenario modelling are presented in Figure 19.

*Table 11: WARMS Borehole Pumping Rates*

| Registration ID | Longitude | Latitude | Use (L/s) |
|---|---|---|---|
| 23014060 | 27.63564 | -27.95593 | 0.01 |
| 23002698 | 27.54044 | -27.58133 | 48.40 |
| 23015960 | 27.27952 | -27.65038 | 0.48 |
| 23002625 | 27.55925 | -27.95315 | 0.28 |
| 23002625 | 27.55925 | -27.95315 | 0.84 |
| 23002625 | 27.55925 | -27.95315 | 7.81 |
| 23002625 | 27.54397 | -27.96701 | 1.27 |
| 23002625 | 27.55925 | -27.96148 | 0.28 |
| 23002625 | 27.58842 | -27.93926 | 1.11 |
| 23002625 | 27.55925 | -27.95315 | 0.37 |
| 23002625 | 27.55925 | -27.95315 | 0.56 |
| 23002625 | 27.55925 | -27.95315 | 0.37 |
| 23087419 | 27.68505 | -27.50442 | 0.17 |
| 23002643 | 27.69121 | -27.56428 | 5.79 |
| 23000529 | 27.59121 | -27.52678 | 0.09 |
| 23020286 | 27.33425 | -27.34484 | 0.34 |
| 23086125 | 27.33136 | -27.35375 | 0.90 |
| 23018967 | 27.48009 | -27.57483 | 0.29 |
| 23018967 | 27.46620 | -27.56845 | 0.58 |
| 23018967 | 27.48009 | -27.57483 | 0.69 |

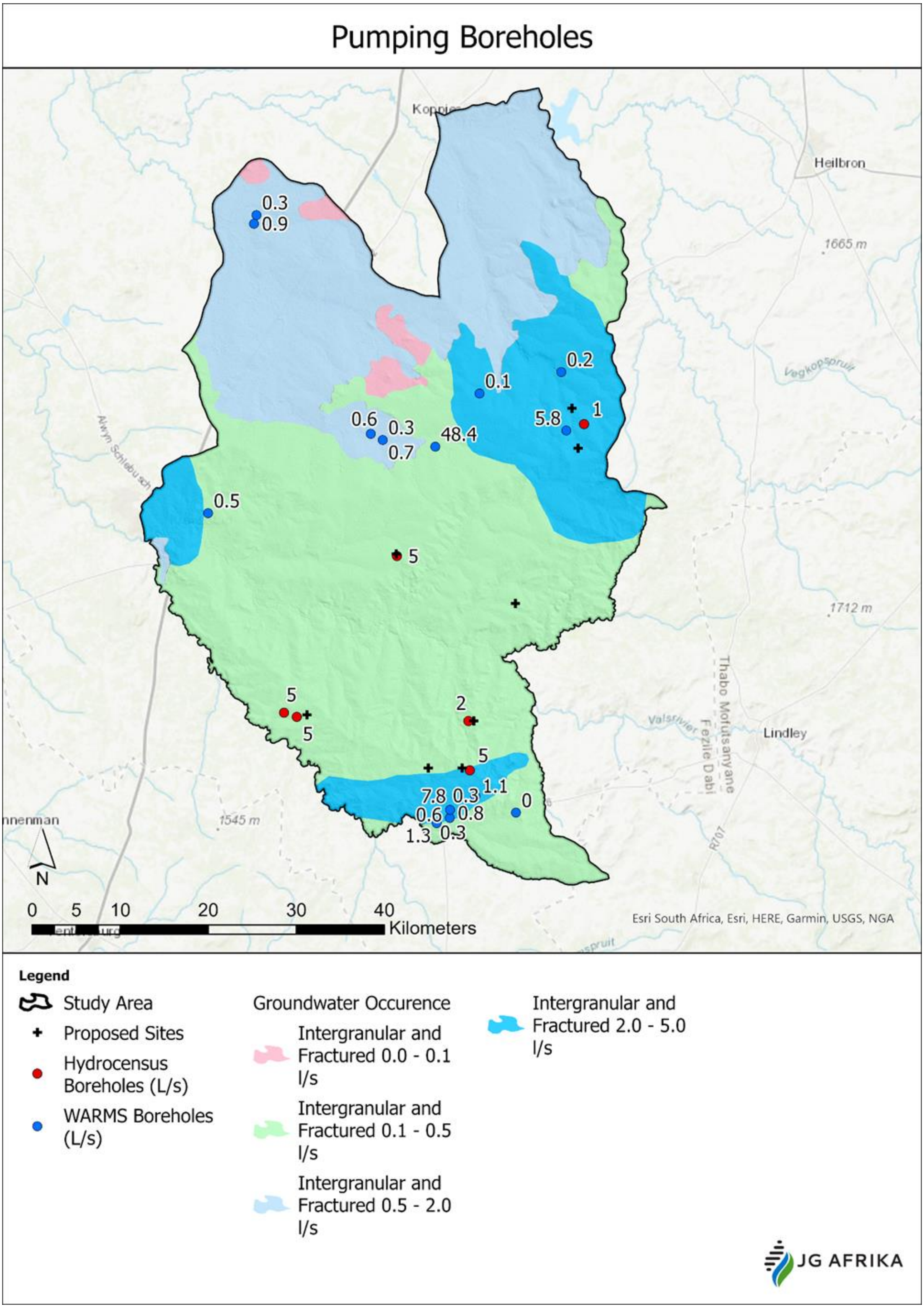



*Figure 19: Pumping Boreholes*

# 9 MODEL RESULTS (STEADY STATE)

Evaluating the general response of the expected plume movements, the following can be said for the majority of the sites:

- The plume movement over 100 years does not extend far (Max 680 m). This is based on estimated aquifer parameters and not field verified aquifer test data
- In areas where a wetland or pan is in close proximity to the proposed site, the plume moves in the direction of the wetland or pan, as this is modelled as a groundwater discharge zone.
- The shallow groundwater conditions (<200m depth) were considered most relevant for development of model scenarios as these aquifers are the source of many water supply boreholes in the project area, and present the greatest risk. Deeper aquifers, as per those being targeted by the Rhino exploration programme are lower risk, and modelled plumes will have less lateral extent in the deeper aquifers.

The graphical plume outputs are presented in Figure 21 to Figure 24.

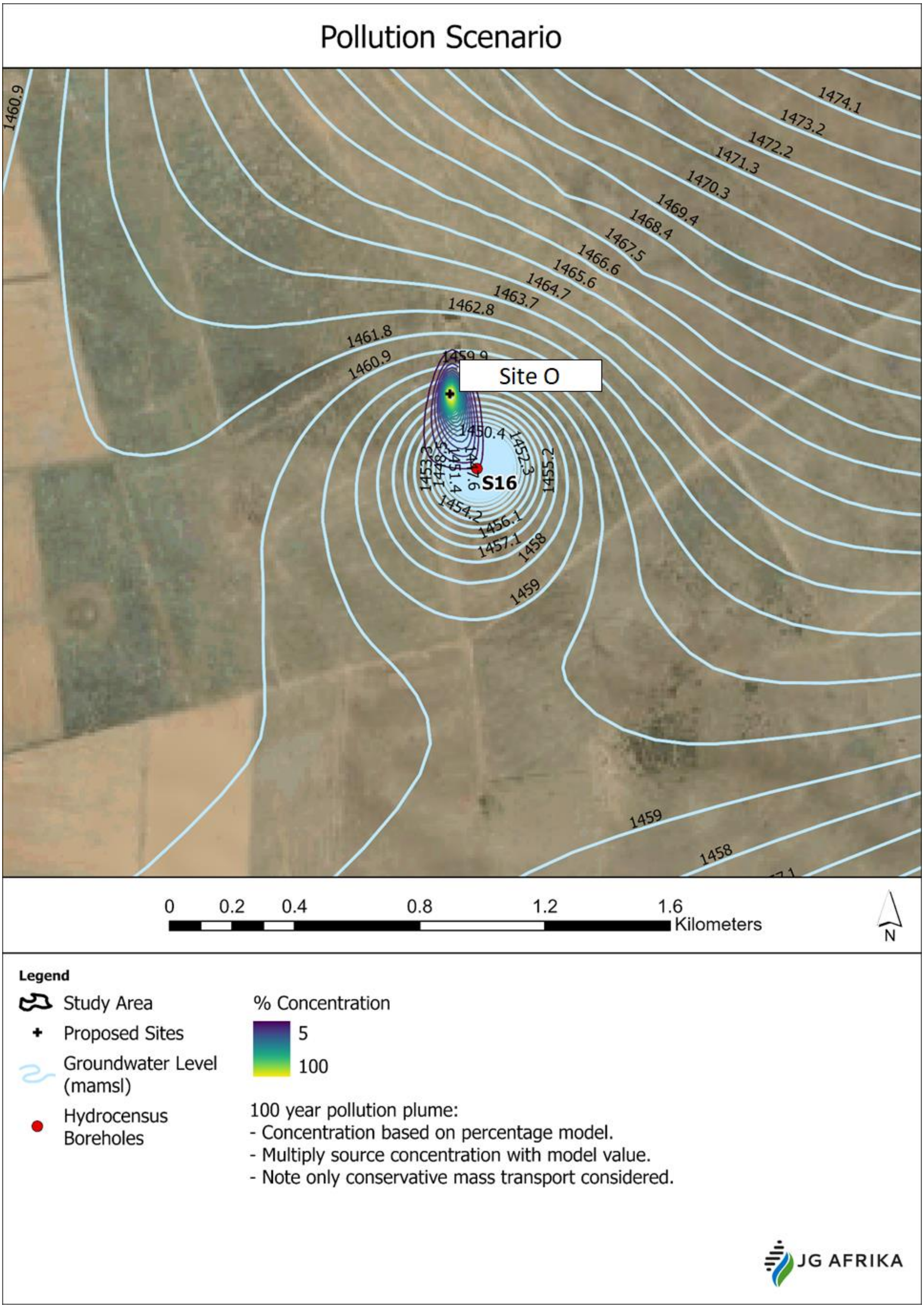



*Figure 20: Modelled Plume - Site O*

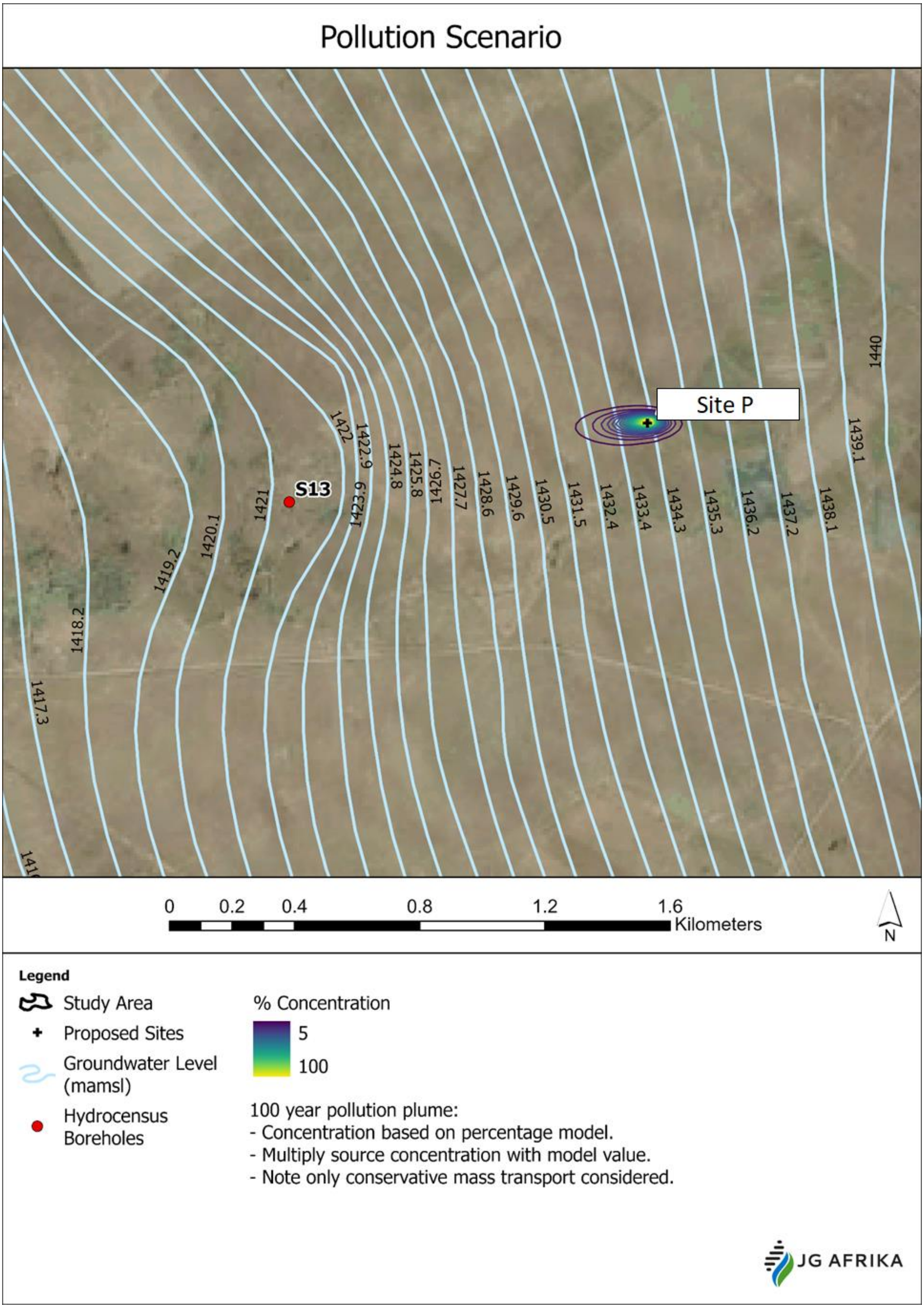



*Figure 21: Modelled Plume - Site P*

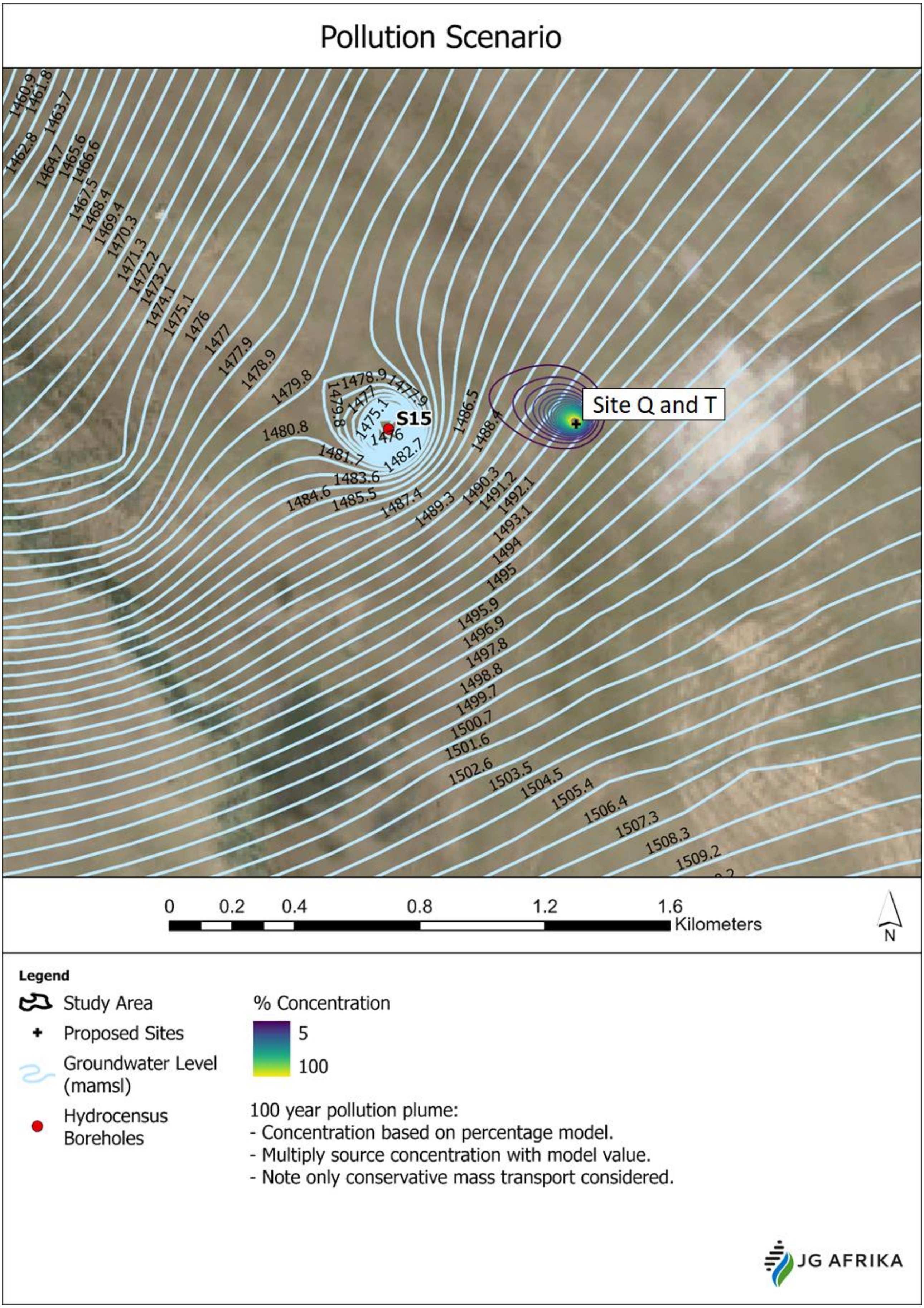



*Figure 22: Modelled Plume - Site Q and T*

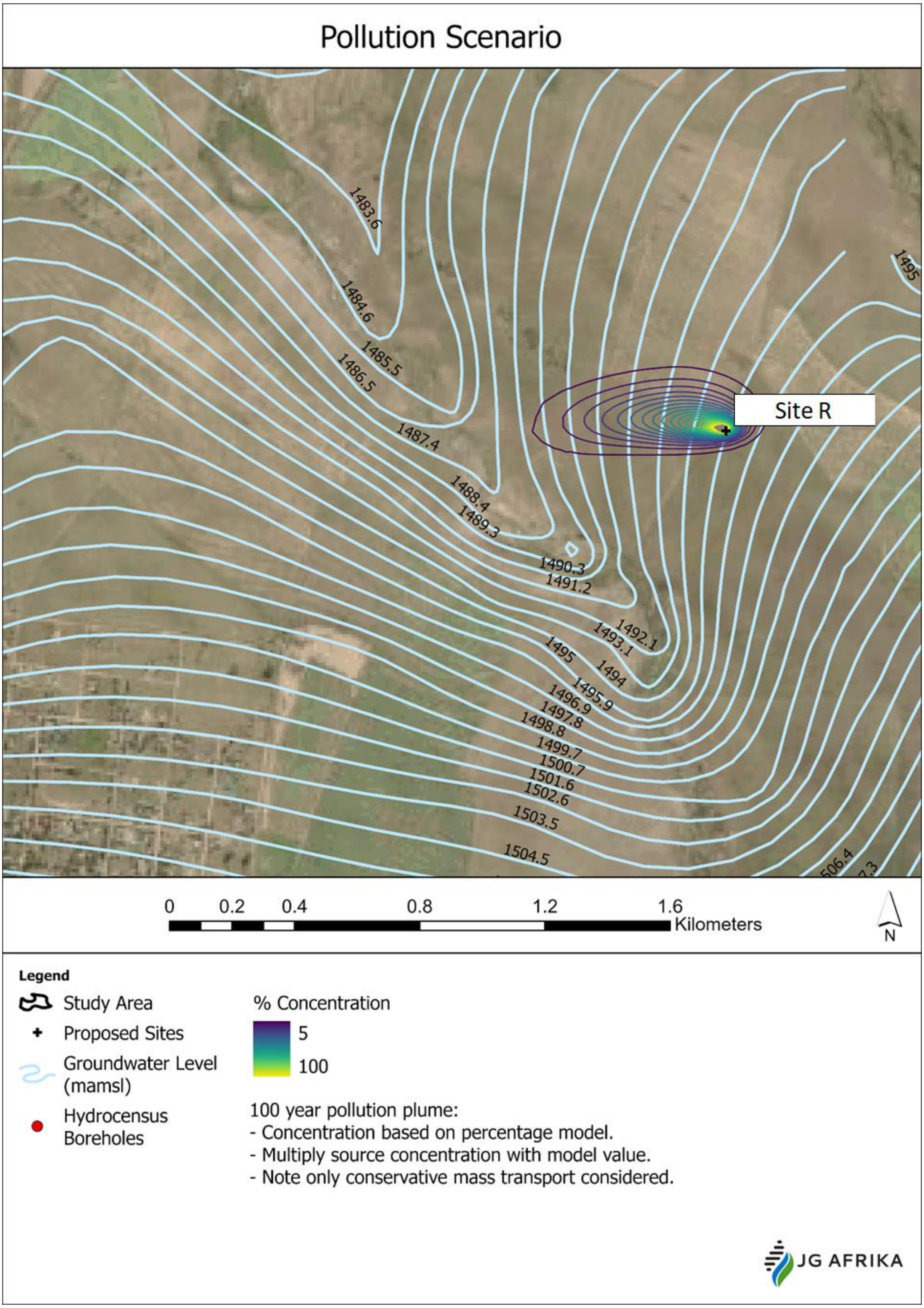



*Figure 23: Modelled Plume - Site R*

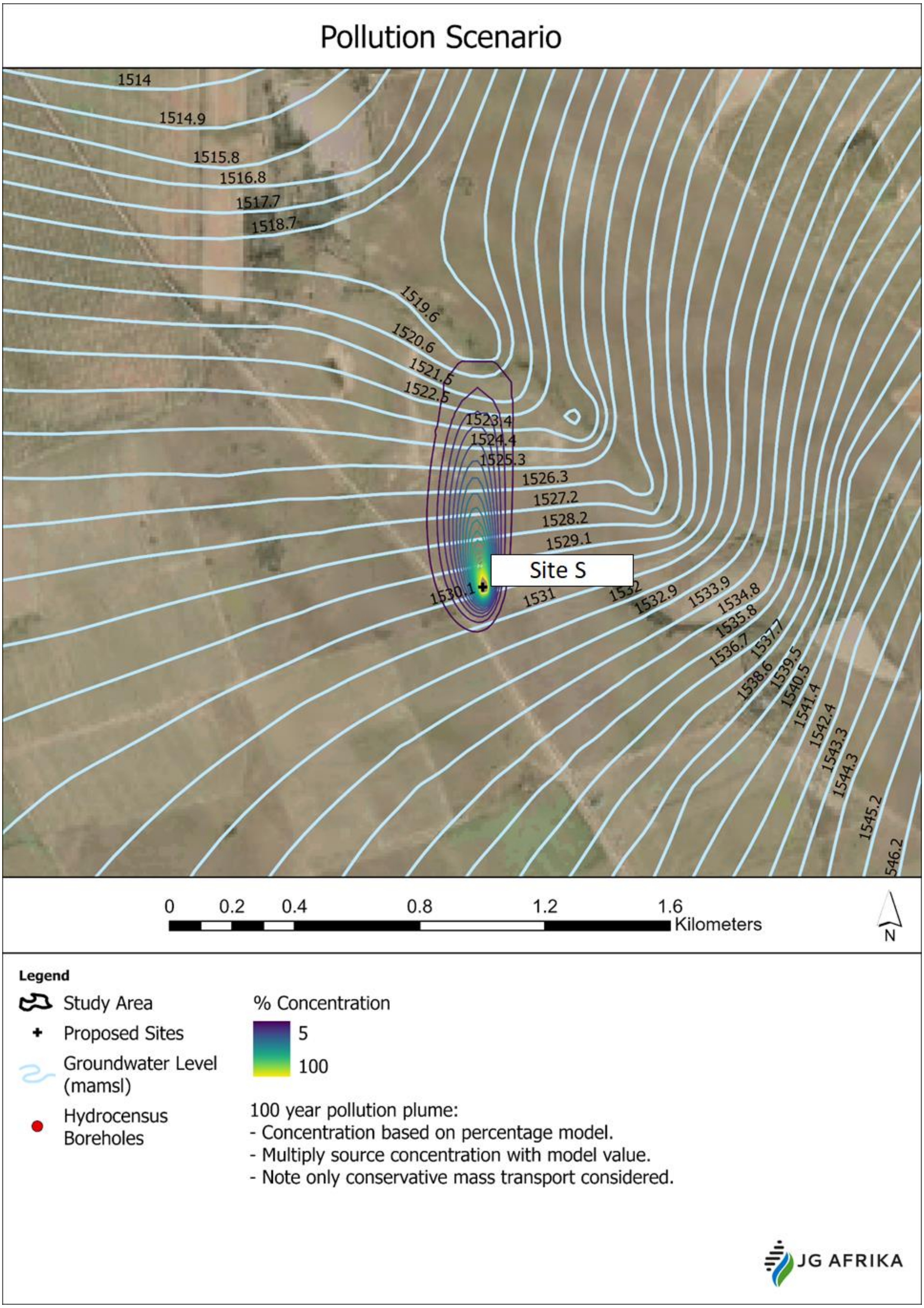



*Figure 24: Modelled Plume - Site S*

# 10 GEOHYDROLOGICAL RISK AND IMPACT

## 10.1 Geohydrological Potential

The project area is underlain by mudstone and sandstone which has been intruded by dolerite in isolated areas. The geohydrology is a medium to low yielding intergranular fractured rock aquifer. The project area falls within two (2 No.) aquifer class units which are classified as Minor.

## 10.2 Vulnerability

Vulnerability is considered *Low to Medium*. Factors considered in the vulnerability rating include depth to groundwater and contaminant loading. The depth to groundwater is expected to be variable in the range 0 to 35 mbgl. The cover sands are inferred to be relatively thick at most sites, which will provide some filtration to underlying rock aquifers. The associated Parsons Groundwater Quality Management System gives the site a Low Level of Protection index when comparing vulnerability as the second variable.

| TABLE A and B: Ratings for the Groundwater Quality Management classification system. | | | |
|---|---|---|---|
| AQUIFER SYSTEM MANAGEMENT CLASSIFICATION | | SECOND VARIABLE CLASSIFICATION | |
| | | AQUIFER VULNERABILITY CLASSIFICATION | |
| Class | Points | Class | Points |
| Sole Source Aquifer System | 6 | High | 3 |
| Major Aquifer System | 4 | Medium | 2 |
| Minor Aquifer System | 2 | Low | 1 |
| Non-aquifer System | 0 | | |
| Special Aquifer System | 0 - 6 | | |

| TABLE C: Appropriate level of groundwater protection required, based on the Groundwater Quality Management classification | |
|---|---|
| GQM INDEX | LEVEL OF PROTECTION |
| < 1 | Limited protection |
| 01-03 | Low level protection |
| 03-06 | Medium level protection |
| 06-10 | High level protection |
| > 10 | Strictly non-degradation |

| Variable 1 | Variable 2 |
|---|---|
| Aquifer System | Second Variable Description |
| Minor Aquifer System | Vulnerability |
| | Low Medium |
| 2 | 1.5 |
| GQM Index | Level of Protection |
| 3.0 | Low level protection |

## 10.3 Strategic Value

The strategic value is considered *Medium to High.* The strategic value of groundwater is based on existing groundwater use. Use of the groundwater resource was identified near many of the sites. The primary use for the groundwater is for domestic and agricultural applications. The associated Parsons Groundwater Quality Management System gives the site a *Medium Level of Protection* index when comparing strategic value as the second variable.

| TABLE A and B: Ratings for the Groundwater Quality Management classification system. | | | |
|---|---|---|---|
| AQUIFER SYSTEM MANAGEMENT CLASSIFICATION | | SECOND VARIABLE CLASSIFICATION | |
| | | AQUIFER VULNERABILITY CLASSIFICATION | |
| Class | Points | Class | Points |
| Sole Source Aquifer System | 6 | High | 3 |
| Major Aquifer System | 4 | Medium | 2 |
| Minor Aquifer System | 2 | Low | 1 |
| Non-aquifer System | 0 | | |
| Special Aquifer System | 0 - 6 | | |

| TABLE C: Appropriate level of groundwater protection required, based on the Groundwater Quality Management classification | |
|---|---|
| GQM INDEX | LEVEL OF PROTECTION |
| < 1 | Limited protection |
| 01-03 | Low level protection |
| 03-06 | Medium level protection |
| 06-10 | High level protection |
| > 10 | Strictly non-degradation |

| Variable 1 | Variable 2 |
|---|---|
| Aquifer System | Second Variable Description |
| Minor Aquifer System | Strategic Value |
| | Medium High |
| 2 | 2.5 |
| GQM Index | Level of Protection |
| 5.0 | Medium level protection |

Other contaminant sources in the project area are typically associated with agricultural practices, including livestock activities, crop management through fertilizers, and on site sanitation facilities of communities. These activities are already impacting on water quality in the area.

### 10.4 Quantitative Environmental Risk Assessment and Mitigation

The quantitative environmental risk assessment (ERA) is presented in Annexure E. The ERA identifies general and construction phase activities that may impact on the groundwater receiving environments. The Significance Points (SP) score is calculated from the following equation using ranking scales:

$$SP = probability \times (duration + scale + magnitude)$$

The ERA for the groundwater receiving environment is summarised in Table 12. All activities identified scored *LOW* for the pre mitigation ratings. Most scores can be reduced further with the introduction of mitigation measures include in Table 12.

*Table 12: Summary Risk Assessment Scoring*

| Significance / Consequence | Activity Description | Probability | Duration | Scale | Magnitude | Significance | PRE MITIGATION SP SCORE and RATING | >60 indicates high environmental significance <30 indicates low environmental significance | Mitigation | POST MITIGATION SP SCORE and RATING | >60 indicates high environmental significance <30 indicates low environmental significance | SP Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **General Site Activities** | | | | | | | | | | | | |
| Quality | Contamination of soils and groundwater from sanitation infrastructure;<br>1. leaks and/or loss of containment from portable toilets<br>2. low permeability soils<br>3. shallow bedrock | improbable to low | immediate | site | minor | low negative | 1.5(1+1+2) = 6 | LOW | Approved disposal contractor per implementation of the EMP, with routine management | 1(1+1+2) = 4 | LOW | -2 |
| | Contamination of soils and groundwater from hydrocarbon and hazardous sources;<br>1. leaks from standing plant and equipment at off site holding and on site<br>2. spills from refuelling of plant on site and fuel storage systems<br>3. spills from maintenance of plant on site<br>4. washing of plant and equipment at off site holding and on site<br>5. hazardous storage areas | medium | short to medium | site to local | moderate | medium high negative | 3(2.5+1.5+6) = 30 | LOW | Drip trays, spill response per implementation of the EMP, brown fields storage, appropriate compaction layer | 2.5(2.5+1.5+5) = 23 | LOW | -8 |
| | General geohydrological setting considerations<br>1. Future decant of contaminated waters from bores from exploratory drilling<br>2. deterioration of groundwater quality from abstraction from bores<br>3. Recharge of groundwater systems<br>4 increased impacts from shallow groundwater systems | improbable | immediate | site | minor | low negative | 1(1+1+2) = 4 | LOW | Unlikely | 1(1+1+2) = 4 | LOW | 0 |
| | Contamination of groundwater systems through exploratory drilling and creating of conduits to deeper aquifers | medium to high | immediate | site | moderate | medium high negative | 3.5(1+1+6) = 28 | LOW | Casing and grouting per implementation of the method statement, approved and experienced contractor, decommission bores if compromised | 3(1+1+5) = 21 | LOW | -7 |
| | Impacts on downstream groundwater users | low to medium | permanent | site | moderate | medium high negative | 2.5(5+1+6) = 30 | LOW | Set buffer zones around sites based on model results and inform landowners, construct sanitary seals at existing resources if necessary, conduct routine water quality monitoring of nearby resources, decommission compromised resources and provide alternative supplies | 2(5+1+5) = 22 | LOW | -8 |
| Quantity | Impacts on groundwater quantity | low | short | site | minor | low negative | 2(2+1+2) = 10 | LOW | Specify source of industrial water for drilling operations if not from a groundwater resource. Expected quantities will be low | 2(2+1+2) = 10 | LOW | 0 |
| **Construction and Drilling Activities** | | | | | | | | | | | | |
| Quality | Contamination of soils and groundwater from site excavation areas;<br>1. increased turbidity loading and microbiological loading<br>2. mobilisation of existing elevated compounds in the soil matrix | low to medium | immediate | site | minor to low | low medium negative | 2.5(1+1+3) = 13 | LOW | Limit excavations and footprint, stormwater management, implement the EMP | 2(1+1+3) = 10 | LOW | -3 |
| | Contamination of soils and groundwater from drilling activities/techniques including;<br>1. from return water sumps during drilling (mud rotary) with seepage or major loss of containment<br>2. from surface returning drill chips (air percussion) and temporary surface storage<br>3. from surface returning contaminated groundwater and temporary surface storage | high | immediate | site | low to moderate | medium high negative | 4(1+1+5) = 28 | LOW | Per implantation of the method statement and EMP; routine sludge removal and appropriate disposal, reuse, recycling, rapid response, backup storage tanks and pumps | 3.5(1+1+4) = 21 | LOW | -7 |
| | Contamination of soils and groundwater from drilling activities/techniques including;<br>1. compromised construction and installation of casing and seals<br>2. use of hazardous drill additives<br>3. concrete batching | medium to high | immediate | site | moderate | medium high negative | 3.5(1+1+6) = 28 | LOW | Use alternate non hazardous drill additives, per the implementation of the method statement; use approved and experienced contractor, consider sanitary seals for headworks construction, carry out on site testing and decommission comprised holes | 2(1+1+5) = 14 | LOW | -14 |
| | Contamination of groundwater from compromised decommissioned bores | low to medium | permanent | site | moderate | medium high negative | 2.5(5+1+6) = 30 | LOW | Casing and grouting per specifications and implementation of the method statement, approved and experienced contractor, apply tremie system when installing seals and grout, post decommission inspections and monitoring | 2(5+1+4) = 20 | LOW | -10 |
| | Impacts on downstream groundwater users | low to medium | permanent | site | moderate | medium high negative | 2.5(5+1+6) = 30 | LOW | Set buffer zones around sites based on model results and inform landowners, construct sanitary seals at existing resources if necessary, conduct routine water quality monitoring of nearby resources, decommission compromised resources and provide alternative supplies | 2(5+1+5) = 22 | LOW | -8 |
| Quantity | Impacts on groundwater quantity | low | short | site | minor | low negative | 2(2+1+2) = 10 | LOW | Specify source of industrial water for drilling operations if not from a groundwater resource. Expected quantities will be low | 2(2+1+2) = 10 | LOW | 0 |

### 10.5 Mitigation Measures

Significance scores can in most instances be reduced by applying suggested mitigation measures as presented in Table 12 . The mitigations measures for activities suggested in Table 12 are not exhaustive. It must be noted that risk and mitigation has been heavily considered in the development of the Project Description and Method Statement[3]. Implementation of this plan will ensure the mitigations are in place.

## 11 CONCLUSIONS

This report presents the results of a geohydrological assessment carried out for exploration right ER294 for Rhino Oil and Gas near Welkom and Kroonstad in the Free State. The geohydrological report has been prepared as a specialist study in support of the environmental authorisation process. The aim of the assessment was to characterise the geohydrological setting, and to determine the risk of potential impacts by the activities on the receiving groundwater environment.

The project area is underlain by an intergranular and fractured aquifer that is medium to low yielding and medium yielding in selected areas. The underlying aquifer class units are classified as *Minor*. The observed depth to groundwater was typically recorded in the range 0 to 35 mbgl. The aquifer vulnerability is low to medium. The Parsons Groundwater Quality Management System gives the site a Low Level of Protection index for the second variable vulnerability. The strategic value is medium to high. The Parsons Groundwater Quality Management System gives the site a Medium Level of Protection index for the second variable strategic value.

The risk and impact of the activities was reviewed by means of a quantitative environmental risk assessment (ERA) as developed for by the Operational Guideline: Integrated Water and Waste Management Plan. The ERA identified all listed activities to score LOW. Many activity scores can be further reduced with the application of appropriate mitigation measures, by focusing on the probability and magnitude factors. All mitigation measures (Table 12) should be considered to reduce potential impacts and risk.

[3] Report reference 720.18034.00020 of SLR Consulting (South Africa) (Pty) Ltd, titled ” Rhino Oil and Gas - Project Description”, draft report No.1, January 2023

# *Annexure A: Declaration of Specialist*

## DECLARATION OF THE SPECIALIST

I ROBERT SCHAPERS, as the appointed Specialist hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that:

- In terms of the general requirement to be independent:
  - other than fair remuneration for work performed in terms of this application, have no business, financial, personal or other interest in the development proposal or application and that there are no circumstances that may compromise my objectivity; or
  - ~~am not independent, but another specialist (the "Review Specialist") that meets the general requirements set out in Regulation 13 of the NEMA EIA Regulations has been appointed to review my work (Note: a declaration by the review specialist must be submitted);~~
- I have disclosed to ~~the applicant~~, the EAP, ~~the Review EAP (if applicable), the Department and I&APs~~ all material information that has or may have the potential to influence the decision of the Department or the objectivity of any Report, plan or document prepared or to be prepared as part of the application; and
- I am aware that a false declaration is an offence in terms of Regulation 48 of the EIA Regulations.

17 April 2023

Signature of the Specialist: Date:

**JG AFRIKA (PTY) LTD**

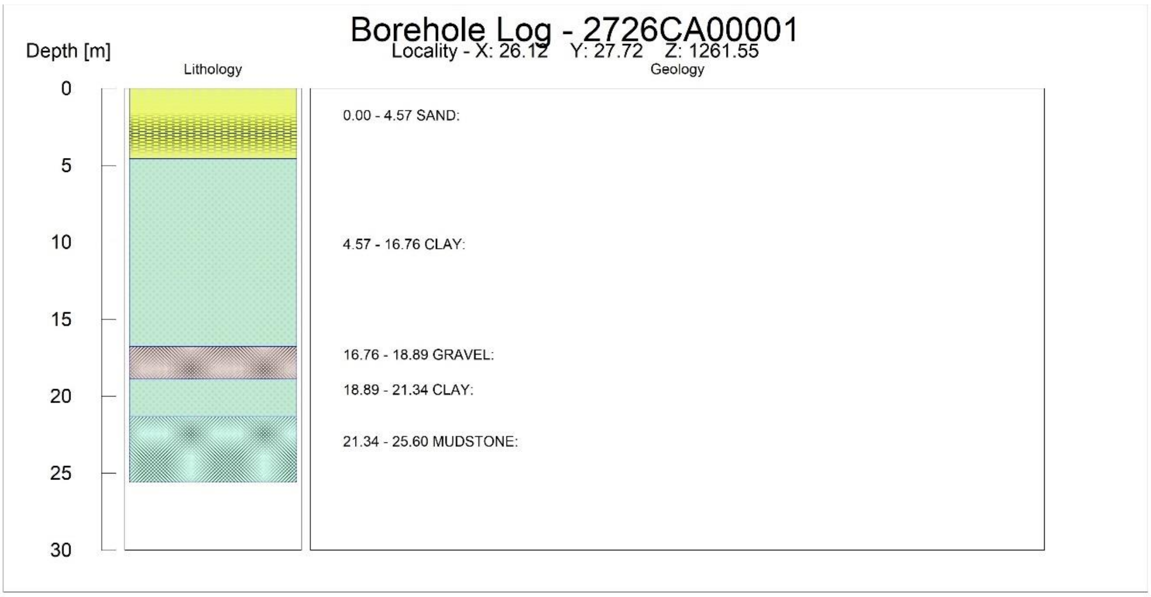
Name of company (if applicable):

# *Annexure B: NGA Borehole Logs*


Borehole Log - 2726DA00003
Depth [m]
Locality - X: 26.54 Y: 27.53 Z: 1302.00
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
0.00 - 43.00 SAND:

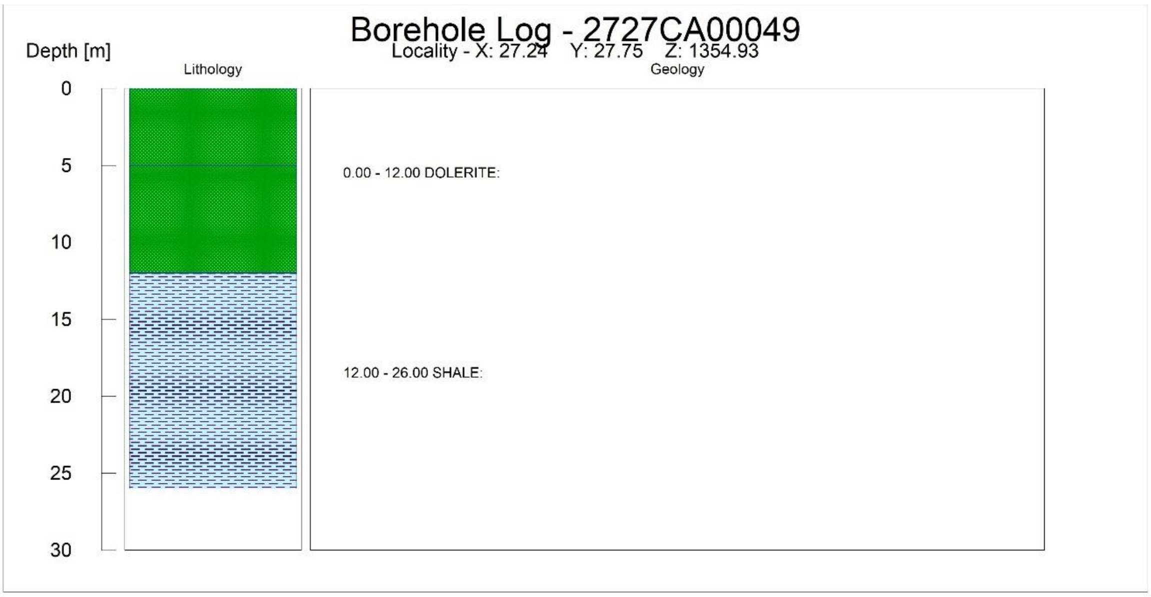

Borehole Log - 2727AD00008
Depth [m]
Locality - X: 27.42 Y: 27.45 Z: 1392.97
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
50
0.00 - 12.19 SHALE:
12.19 - 36.57 DOLERITE:
36.57 - 46.93 SHALE:

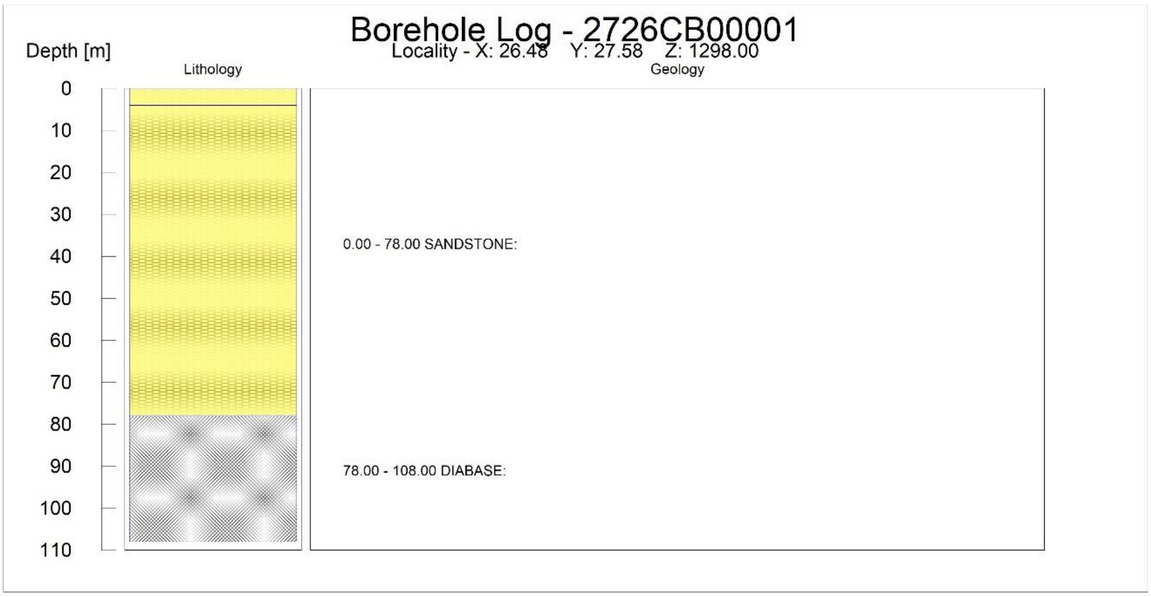

Borehole Log - 2726BC00001
Locality - X: 26.55 Y: 27.49 Z: 1317.95
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
0.00 - 12.00 CLAY:
12.00 - 70.00 SANDSTONE:


Borehole Log - 2726CA00001
Locality - X: 26.12 Y: 27.72 Z: 1261.55
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
0.00 - 4.57 SAND:
4.57 - 16.76 CLAY:
16.76 - 18.89 GRAVEL:
18.89 - 21.34 CLAY:
21.34 - 25.60 MUDSTONE:

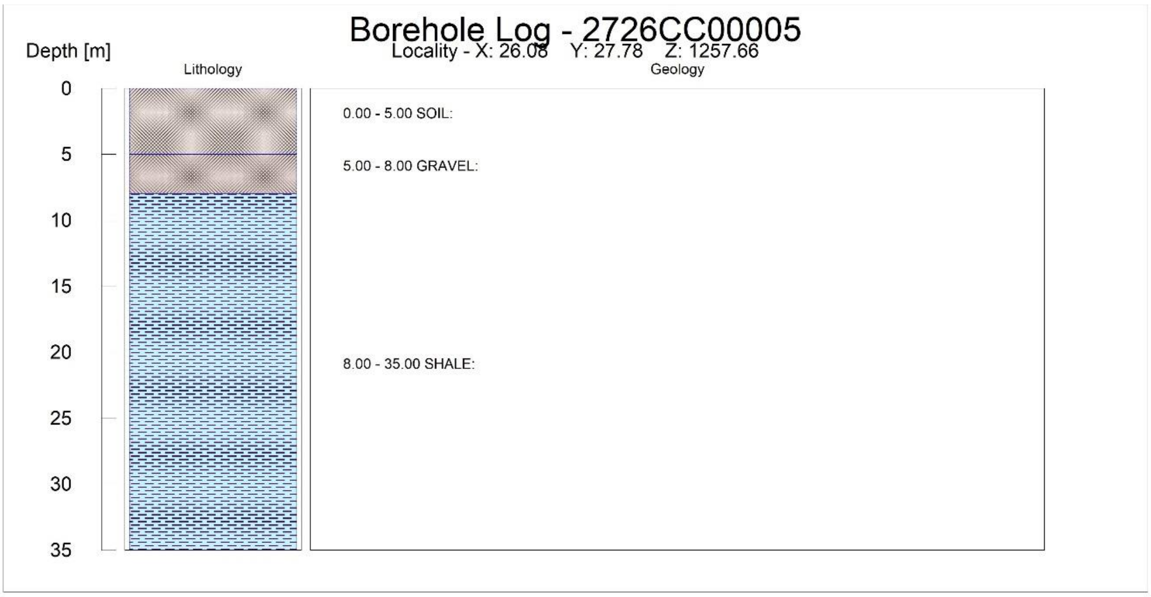

Borehole Log - 2726CA00002
Locality - X: 26.13 Y: 27.60 Z: 1268.20
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
0.00 - 7.00 SOIL:
7.00 - 45.00 SANDSTONE:

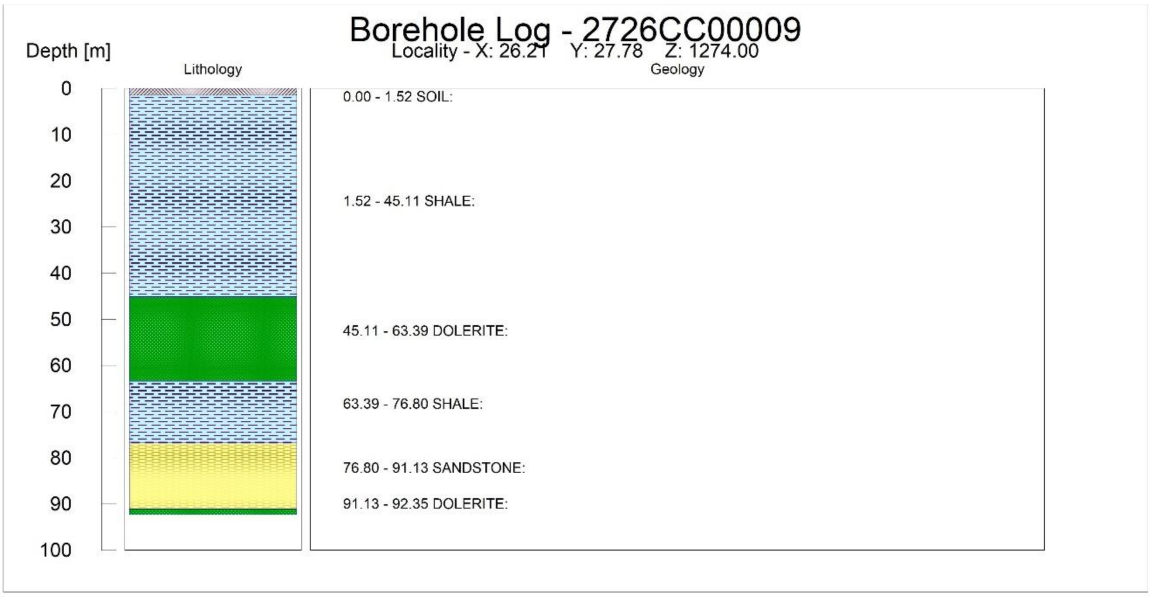

Borehole Log - 2726CA00047
Locality - X: 26.24 Y: 27.70 Z: 1284.00
Depth [m]
Lithology
Geology
0
5
10
15
20
25
0.00 - 0.91 SOIL:
0.91 - 20.11 DOLERITE:
20.11 - 20.42 SANDSTONE:
20.42 - 21.03 DOLERITE:

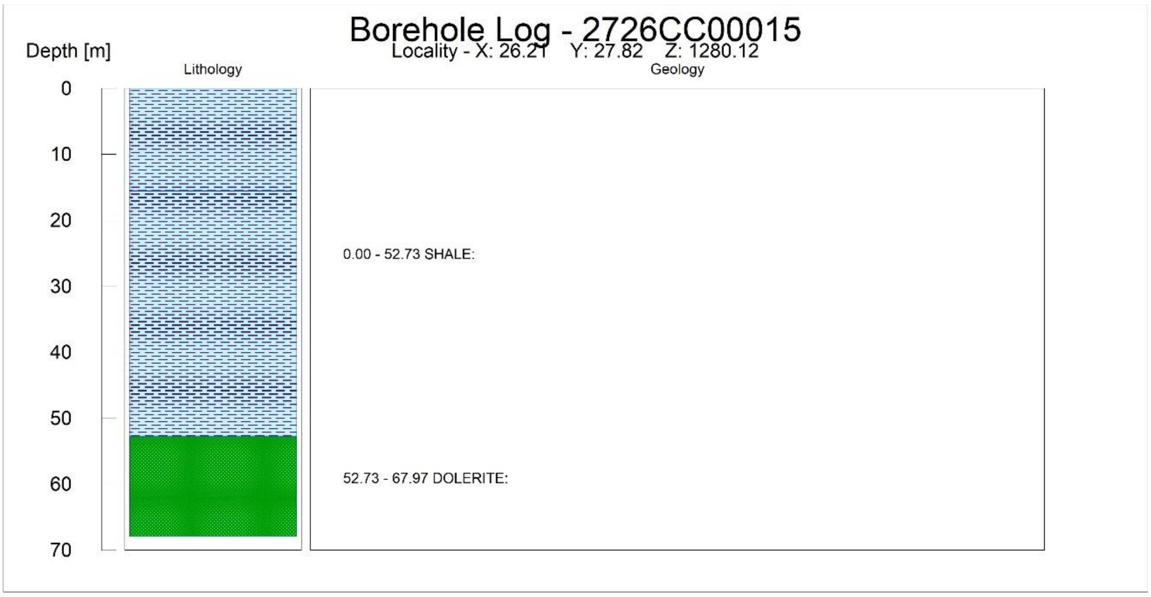

Borehole Log - 2727CA00049
Locality - X: 27.24 Y: 27.75 Z: 1354.93
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
0.00 - 12.00 DOLERITE:
12.00 - 26.00 SHALE:

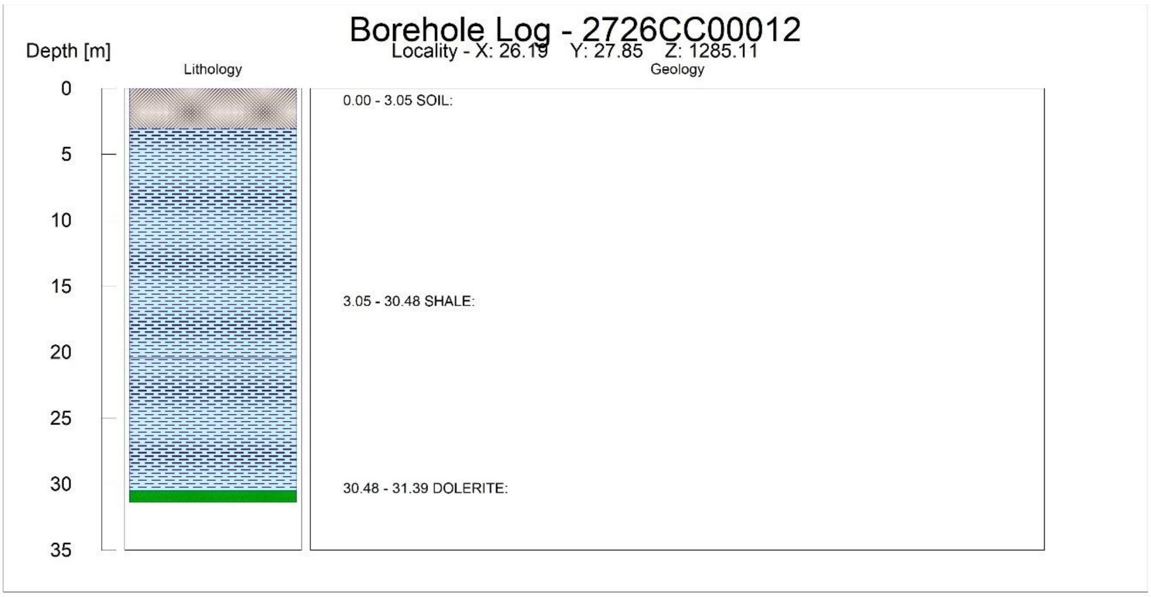

Borehole Log - 2726CB00001
Locality - X: 26.48 Y: 27.58 Z: 1298.00
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
100
110
0.00 - 78.00 SANDSTONE:
78.00 - 108.00 DIABASE:

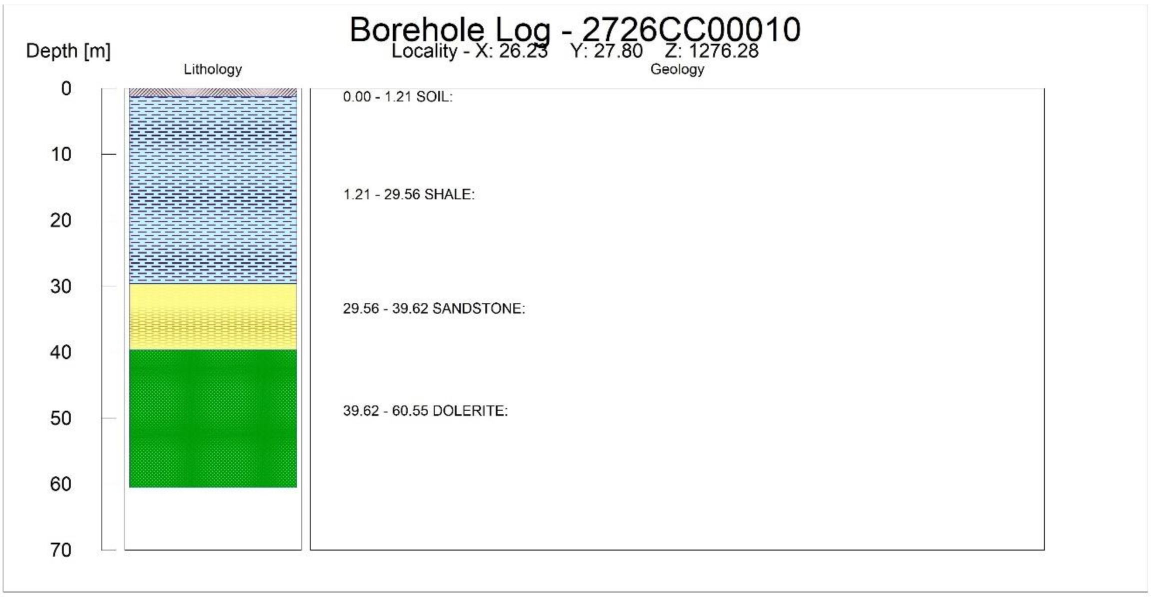

Borehole Log - 2726CB00002
Locality - X: 26.48 Y: 27.72 Z: 1310.99
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 20.00 GRAVEL:
20.00 - 60.00 SHALE:

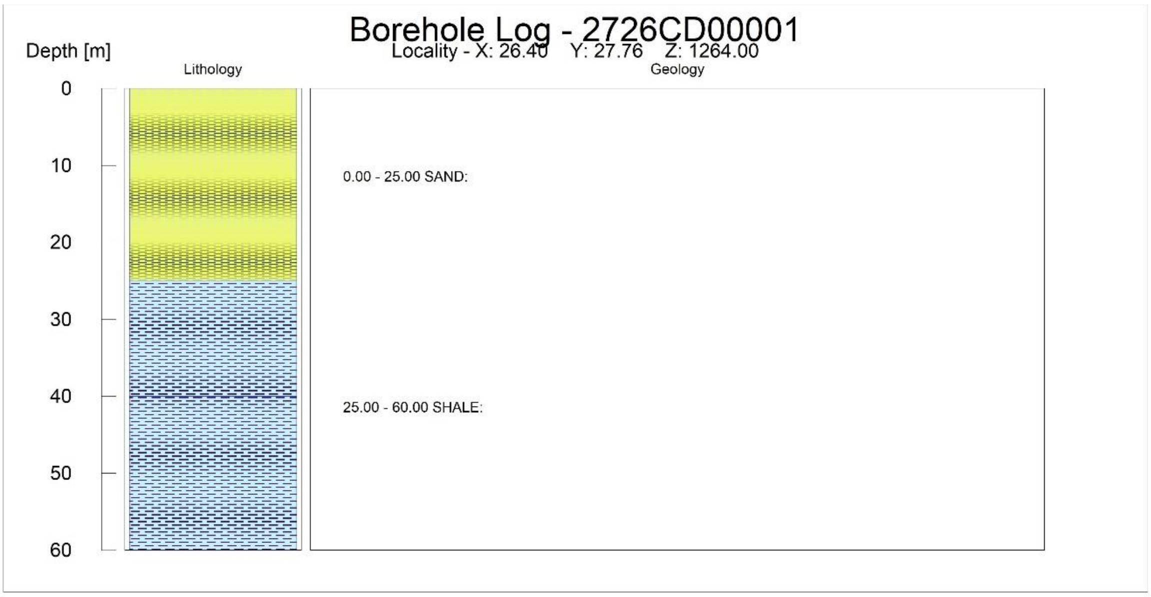

Borehole Log - 2726CC00005
Locality - X: 26.08 Y: 27.78 Z: 1257.66
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
0.00 - 5.00 SOIL:
5.00 - 8.00 GRAVEL:
8.00 - 35.00 SHALE:

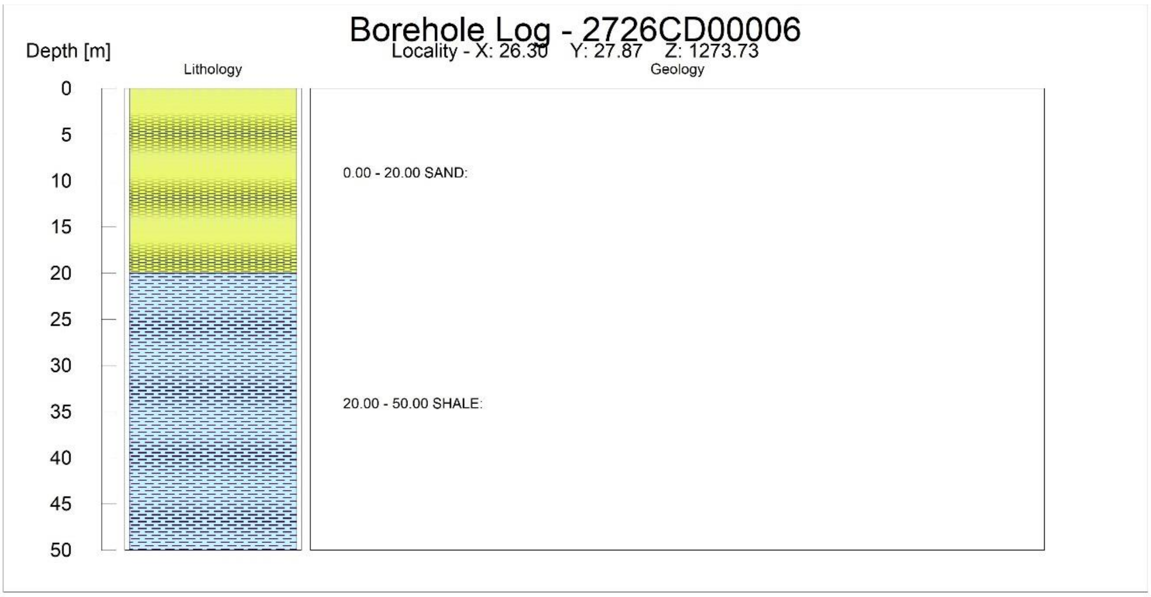

Borehole Log - 2726CC00009
Locality - X: 26.21 Y: 27.78 Z: 1274.00
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
100
0.00 - 1.52 SOIL:
1.52 - 45.11 SHALE:
45.11 - 63.39 DOLERITE:
63.39 - 76.80 SHALE:
76.80 - 91.13 SANDSTONE:
91.13 - 92.35 DOLERITE:

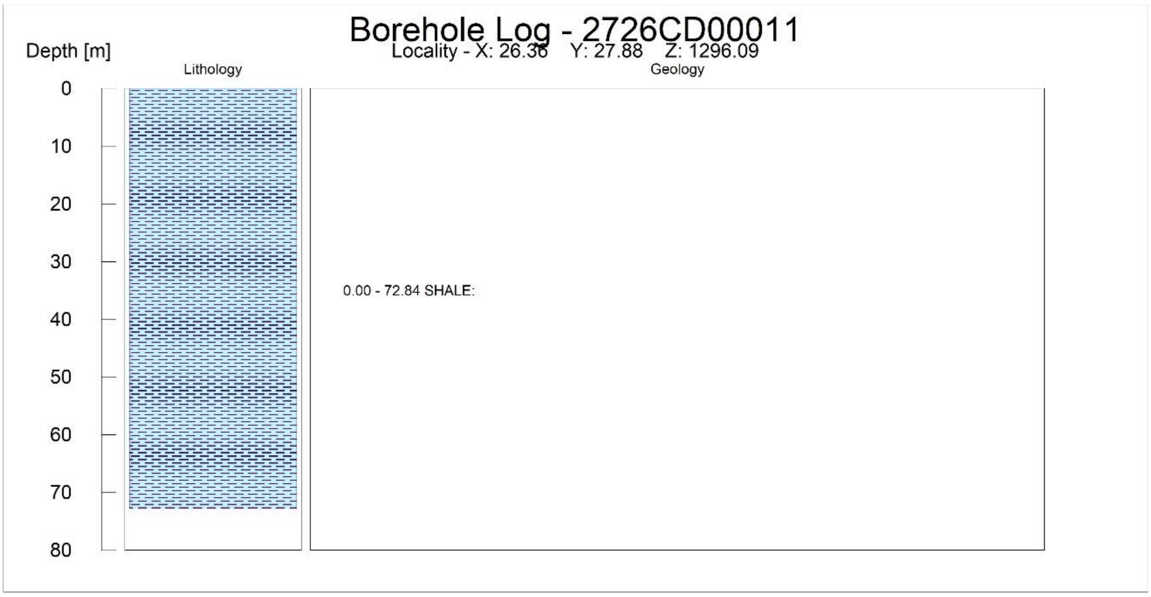

Borehole Log - 2726CC00015
Locality - X: 26.21 Y: 27.82 Z: 1280.12
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
0.00 - 52.73 SHALE:
52.73 - 67.97 DOLERITE:

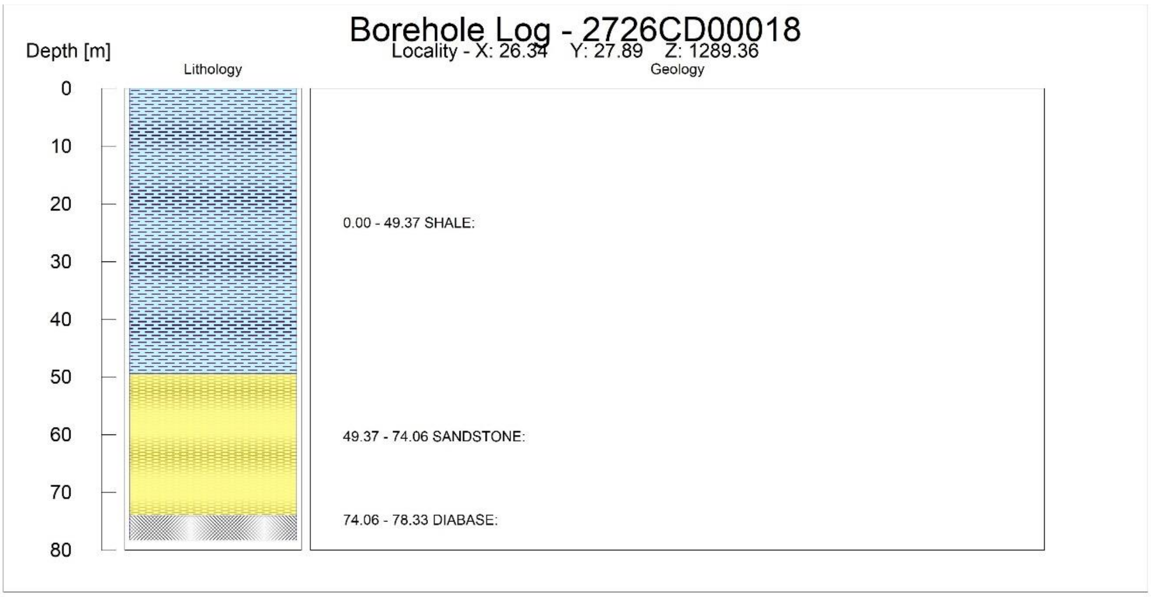

Borehole Log - 2726CC00012
Locality - X: 26.19 Y: 27.85 Z: 1285.11
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
0.00 - 3.05 SOIL:
3.05 - 30.48 SHALE:
30.48 - 31.39 DOLERITE:

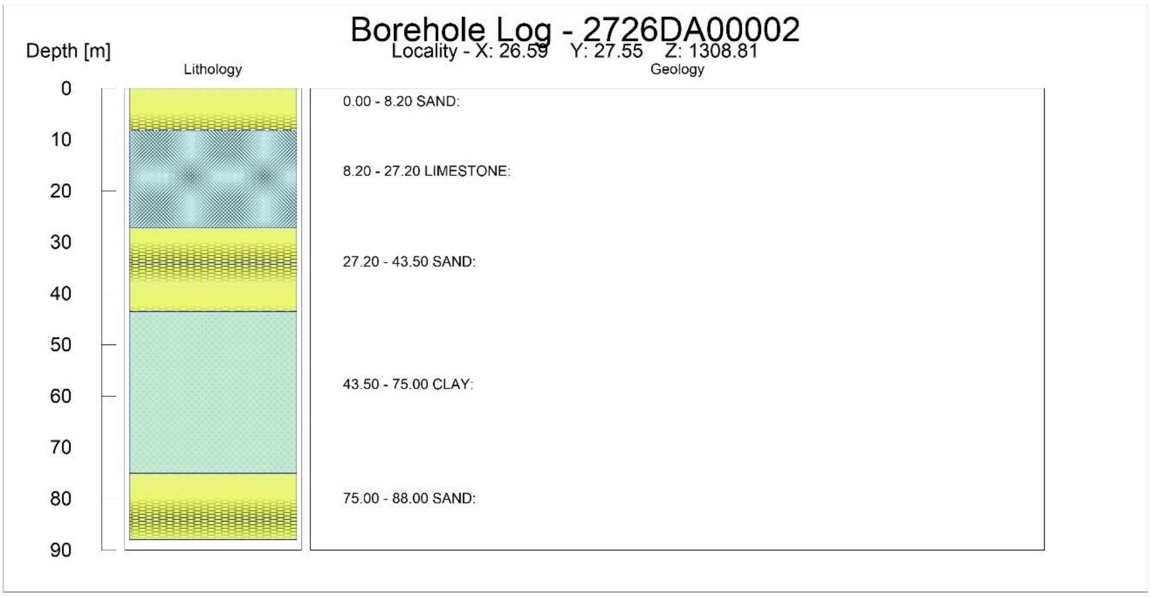

Borehole Log - 2726CC00010
Locality - X: 26.23 Y: 27.80 Z: 1276.28
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
0.00 - 1.21 SOIL:
1.21 - 29.56 SHALE:
29.56 - 39.62 SANDSTONE:
39.62 - 60.55 DOLERITE:


Borehole Log - 2726CD00001
Locality - X: 26.40 Y: 27.76 Z: 1264.00
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 25.00 SAND:
25.00 - 60.00 SHALE:


Borehole Log - 2726CD00006
Locality - X: 26.30 Y: 27.87 Z: 1273.73
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
50
0.00 - 20.00 SAND:
20.00 - 50.00 SHALE:


Borehole Log - 2726CD00011
Locality - X: 26.36 Y: 27.88 Z: 1296.09
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
0.00 - 72.84 SHALE:

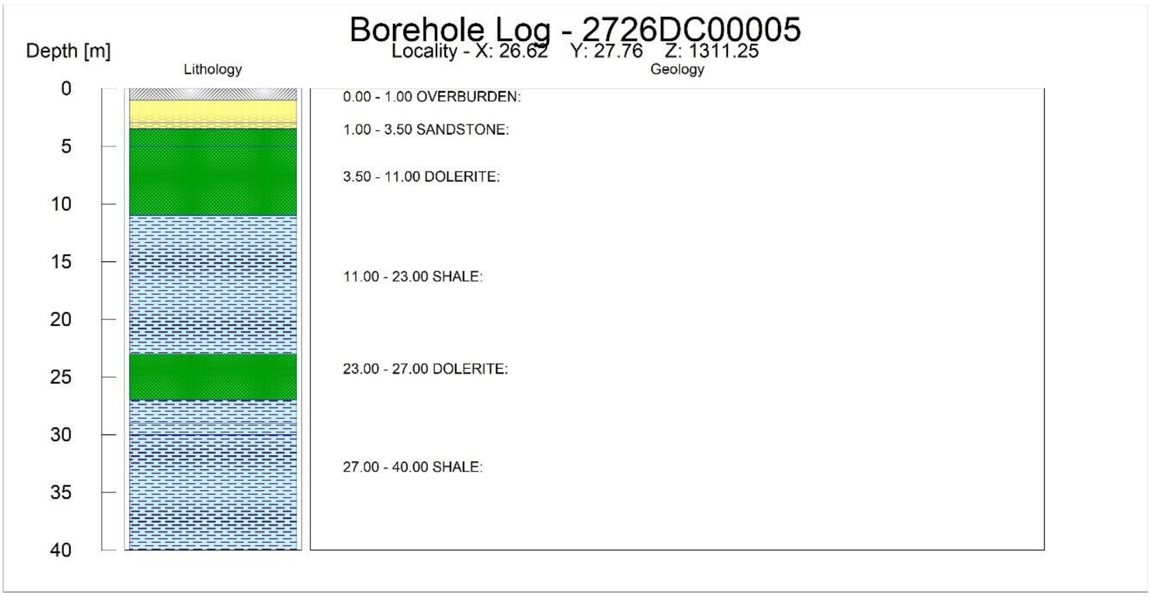

Borehole Log - 2726CD00018
Locality - X: 26.34 Y: 27.89 Z: 1289.36
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
0.00 - 49.37 SHALE:
49.37 - 74.06 SANDSTONE:
74.06 - 78.33 DIABASE:

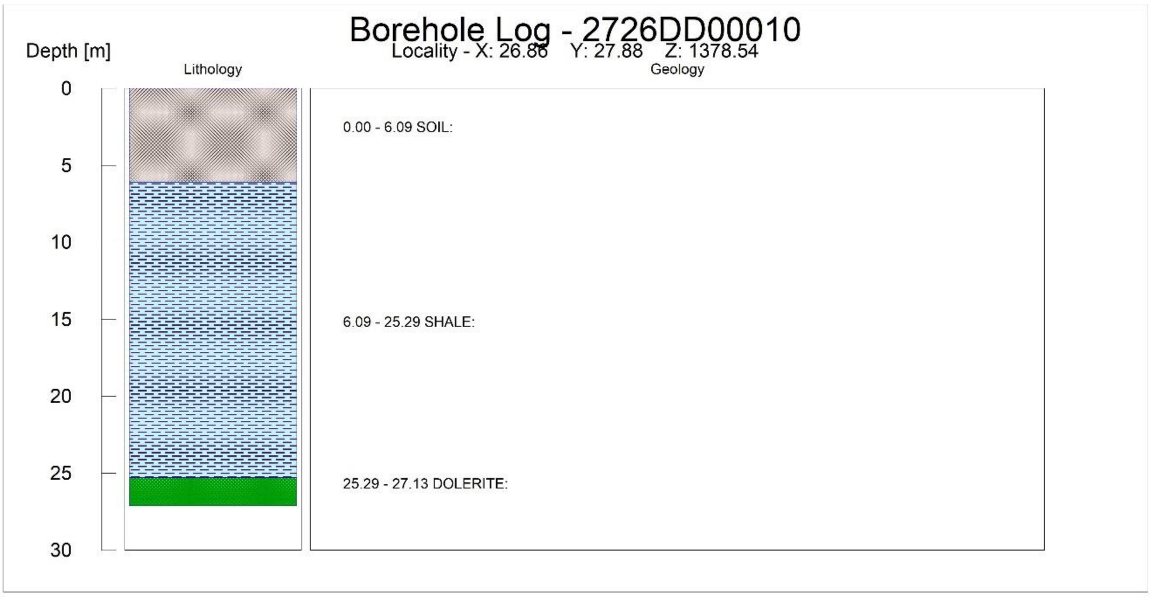

Borehole Log - 2726DA00002
Locality - X: 26.59 Y: 27.55 Z: 1308.81
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
0.00 - 8.20 SAND:
8.20 - 27.20 LIMESTONE:
27.20 - 43.50 SAND:
43.50 - 75.00 CLAY:
75.00 - 88.00 SAND:

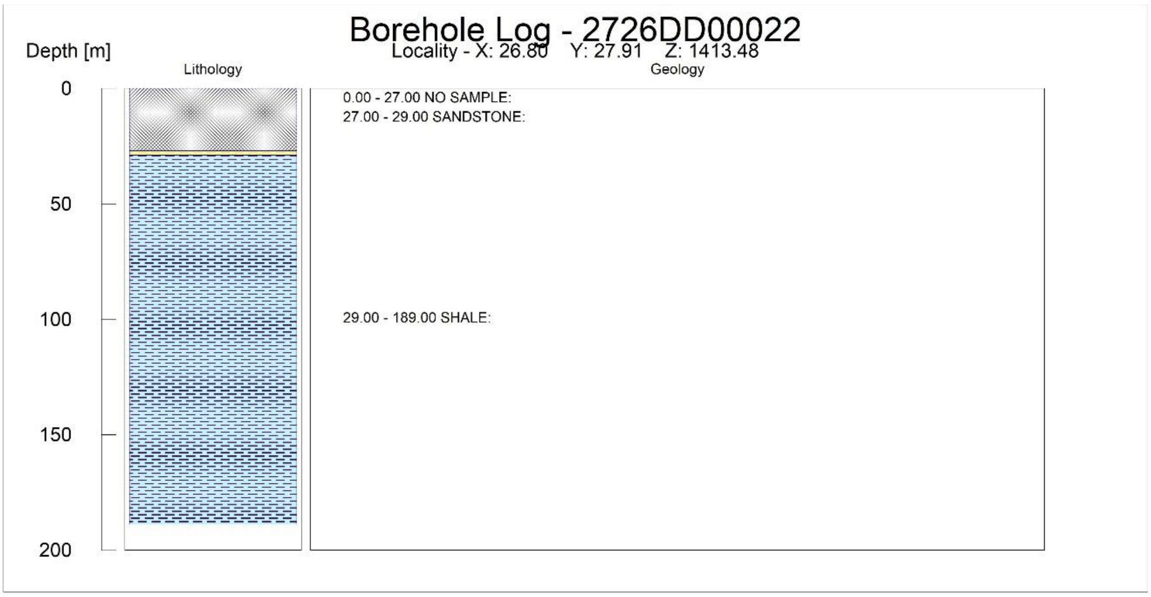

Borehole Log - 2726DA00003
Locality - X: 26.54 Y: 27.53 Z: 1302.00
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
0.00 - 43.00 SAND:


Borehole Log - 2726DA00004
Locality - X: 26.52 Y: 27.55 Z: 1301.43
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
0.00 - 43.00 SAND:

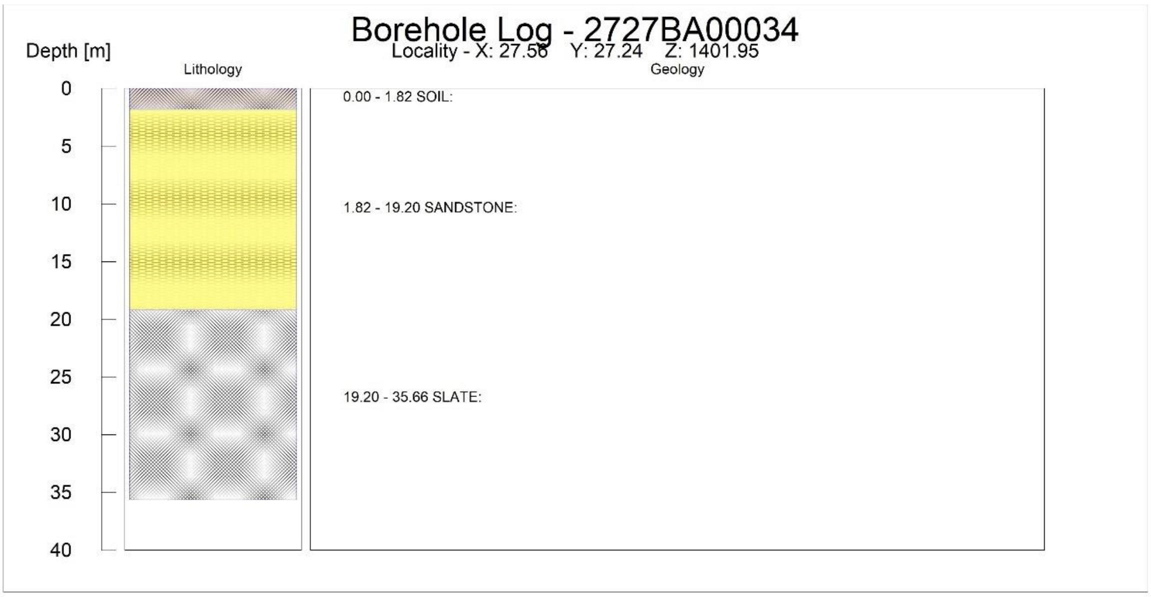

Borehole Log - 2726DC00002
Locality - X: 26.66 Y: 27.86 Z: 1328.42
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
0.00 - 35.00 SHALE:

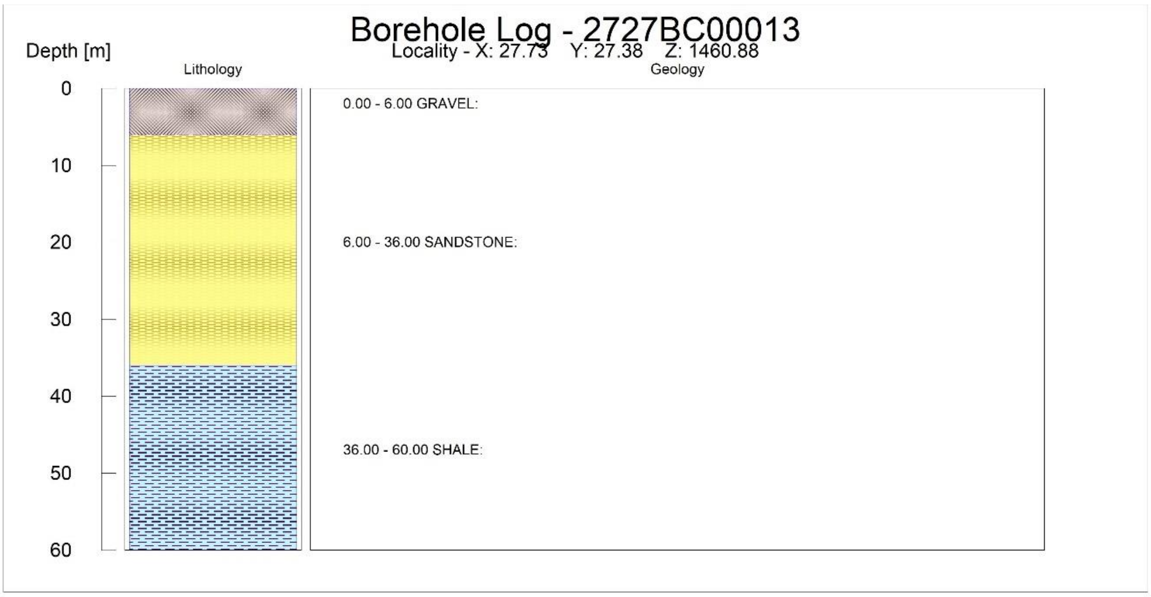

Borehole Log - 2726DC00005
Locality - X: 26.62 Y: 27.76 Z: 1311.25
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
0.00 - 1.00 OVERBURDEN:
1.00 - 3.50 SANDSTONE:
3.50 - 11.00 DOLERITE:
11.00 - 23.00 SHALE:
23.00 - 27.00 DOLERITE:
27.00 - 40.00 SHALE:

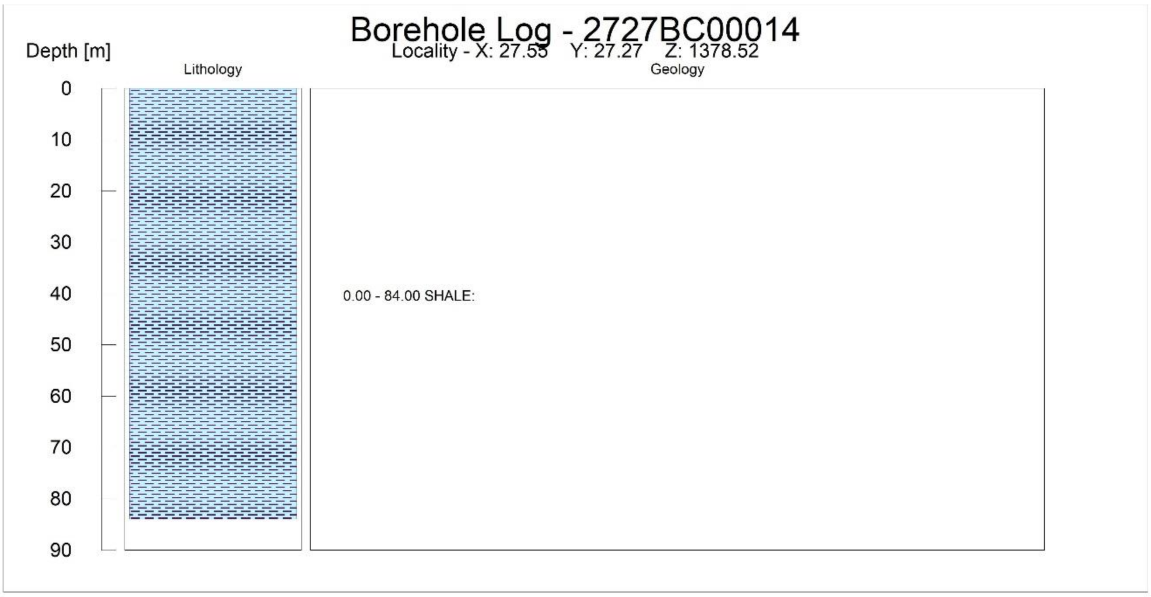

Borehole Log - 2726DD00010
Locality - X: 26.86 Y: 27.88 Z: 1378.54
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
0.00 - 6.09 SOIL:
6.09 - 25.29 SHALE:
25.29 - 27.13 DOLERITE:

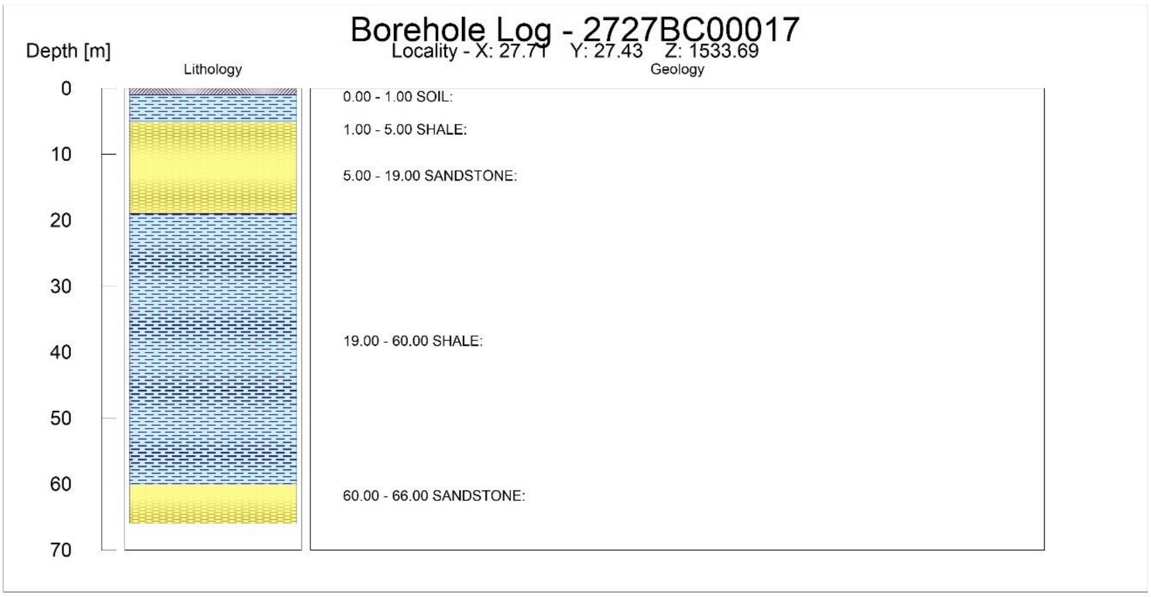

Borehole Log - 2726DD00022
Locality - X: 26.80 Y: 27.91 Z: 1413.48
Depth [m]
Lithology
Geology
0
50
100
150
200
0.00 - 27.00 NO SAMPLE:
27.00 - 29.00 SANDSTONE:
29.00 - 189.00 SHALE:


Borehole Log - 2727AD00012
Locality - X: 27.49 Y: 27.48 Z: 1421.64
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
0.00 - 10.00 SOIL:
10.00 - 66.00 SHALE:


Borehole Log - 2727BA00034
Locality - X: 27.56 Y: 27.24 Z: 1401.95
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
0.00 - 1.82 SOIL:
1.82 - 19.20 SANDSTONE:
19.20 - 35.66 SLATE:

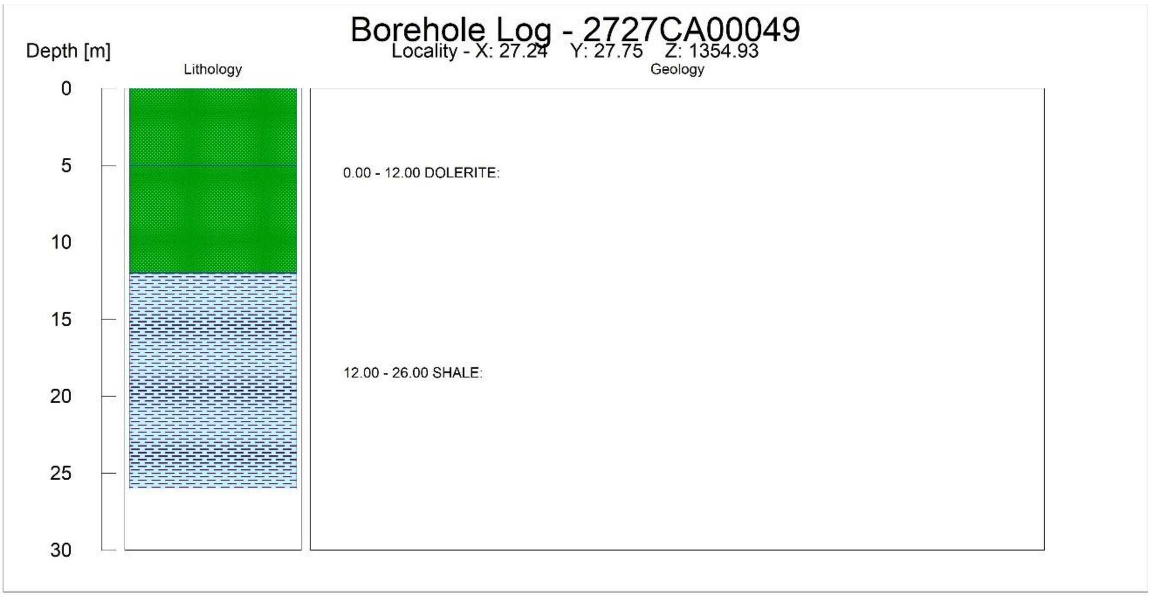

Borehole Log - 2727BC00013
Locality - X: 27.73 Y: 27.38 Z: 1460.88
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 6.00 GRAVEL:
6.00 - 36.00 SANDSTONE:
36.00 - 60.00 SHALE:

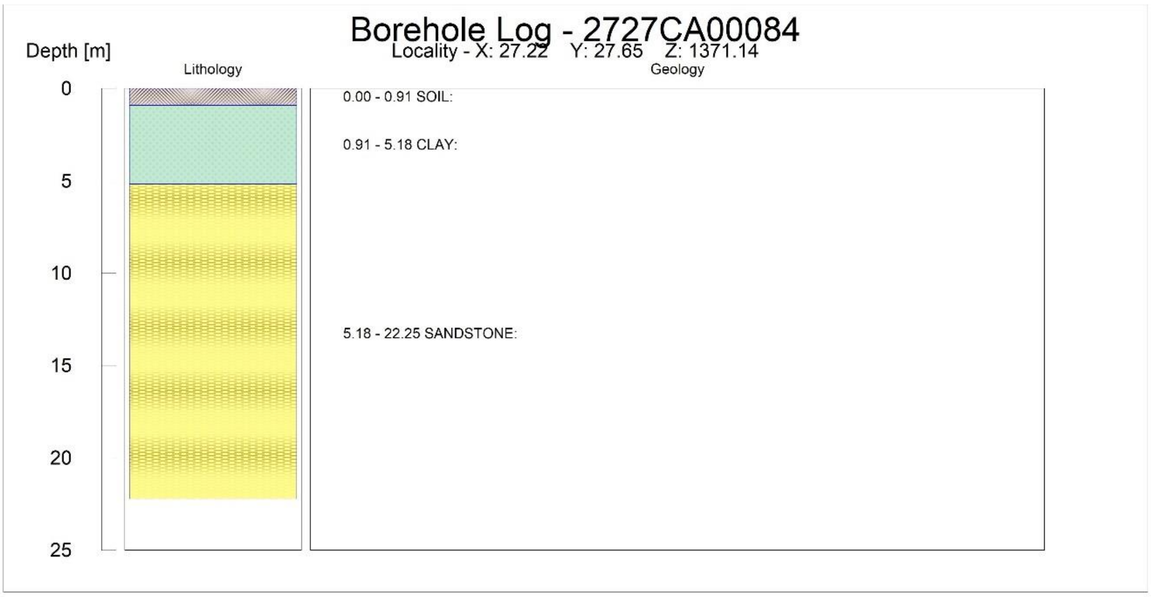

Borehole Log - 2727BC00014
Locality - X: 27.55 Y: 27.27 Z: 1378.52
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
0.00 - 84.00 SHALE:

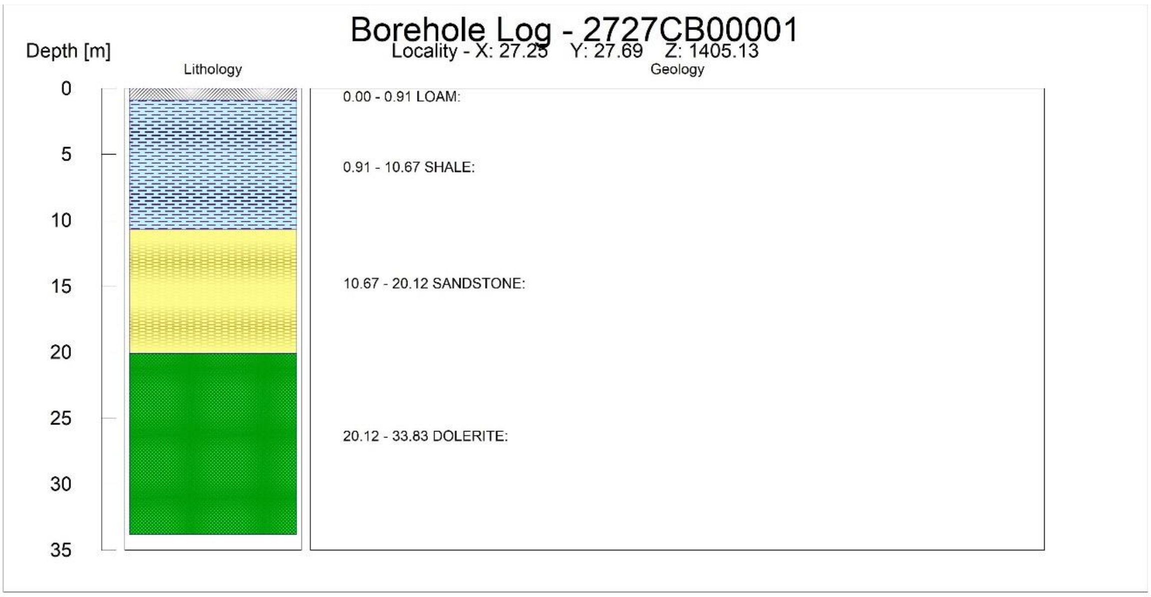

Borehole Log - 2727BC00017
Locality - X: 27.71 Y: 27.43 Z: 1533.69
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
0.00 - 1.00 SOIL:
1.00 - 5.00 SHALE:
5.00 - 19.00 SANDSTONE:
19.00 - 60.00 SHALE:
60.00 - 66.00 SANDSTONE:

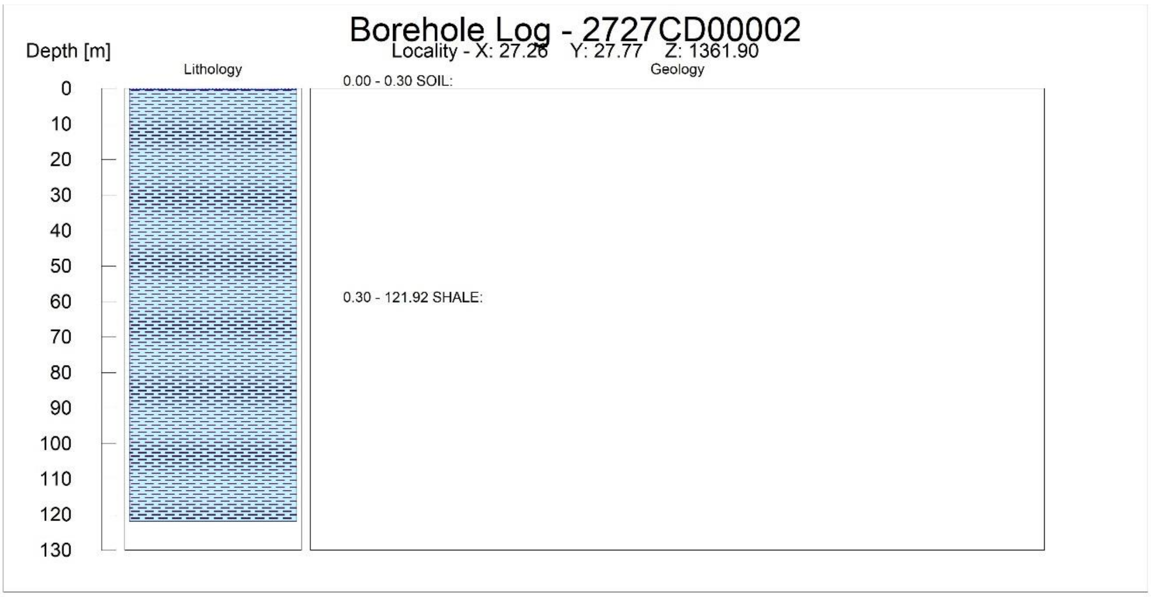

Borehole Log - 2727BC00020
Locality - X: 27.67 Y: 27.26 Z: 1396.99
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
0.00 - 25.00 DOLERITE:
25.00 - 38.00 SANDSTONE:
38.00 - 105.00 SHALE:
105.00 - 109.00 SANDSTONE:
109.00 - 139.00 SHALE:
139.00 - 144.00 SANDSTONE:


Borehole Log - 2727CA00016
Locality - X: 27.23 Y: 27.62 Z: 1430.34
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
0.00 - 0.91 CLAY:
0.91 - 1.52 SANDSTONE:
1.52 - 27.43 DOLERITE:
27.43 - 60.96 SHALE:


Borehole Log - 2727CA00049
Locality - X: 27.24 Y: 27.75 Z: 1354.93
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
0.00 - 12.00 DOLERITE:
12.00 - 26.00 SHALE:

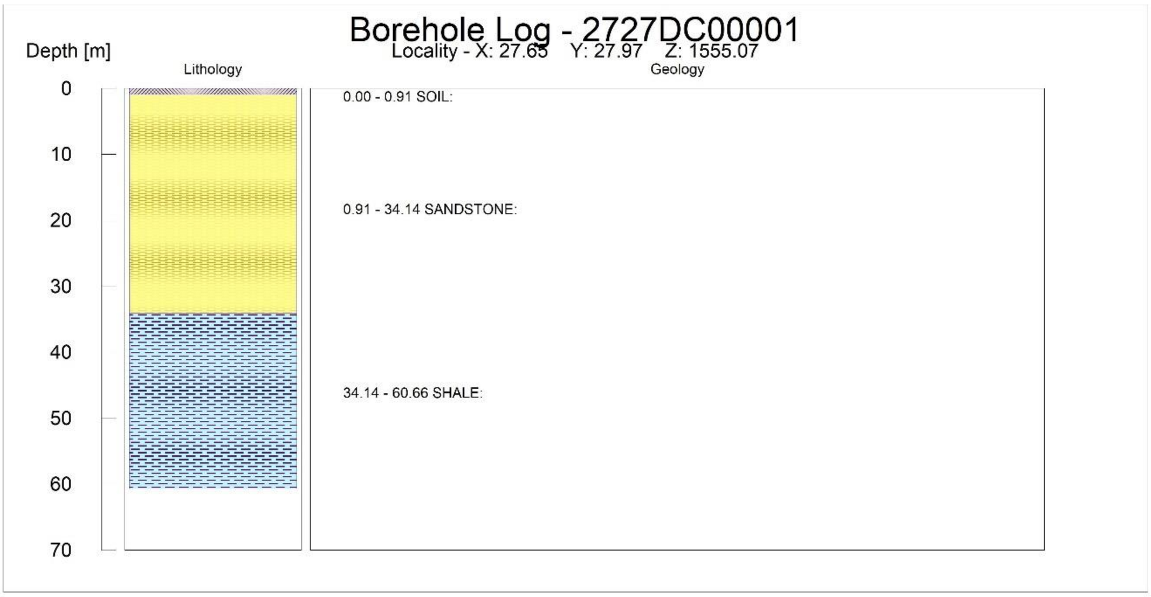

Borehole Log - 2727CA00084
Locality - X: 27.22 Y: 27.65 Z: 1371.14
Depth [m]
Lithology
Geology
0
5
10
15
20
25
0.00 - 0.91 SOIL:
0.91 - 5.18 CLAY:
5.18 - 22.25 SANDSTONE:

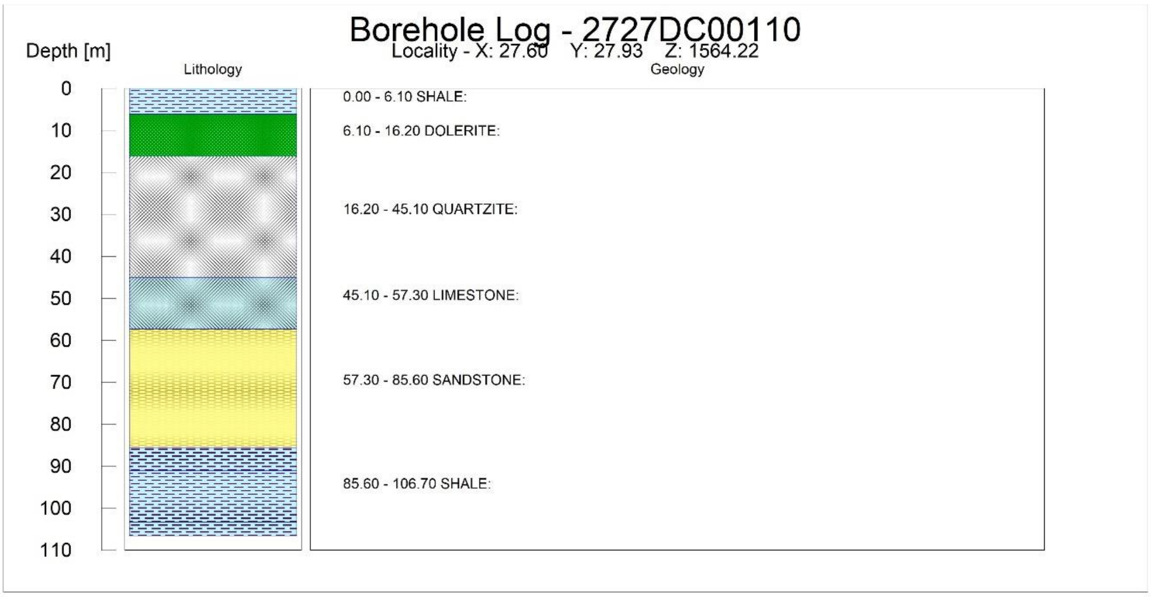

Borehole Log - 2727CB00001
Locality - X: 27.25 Y: 27.69 Z: 1405.13
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
0.00 - 0.91 LOAM:
0.91 - 10.67 SHALE:
10.67 - 20.12 SANDSTONE:
20.12 - 33.83 DOLERITE:

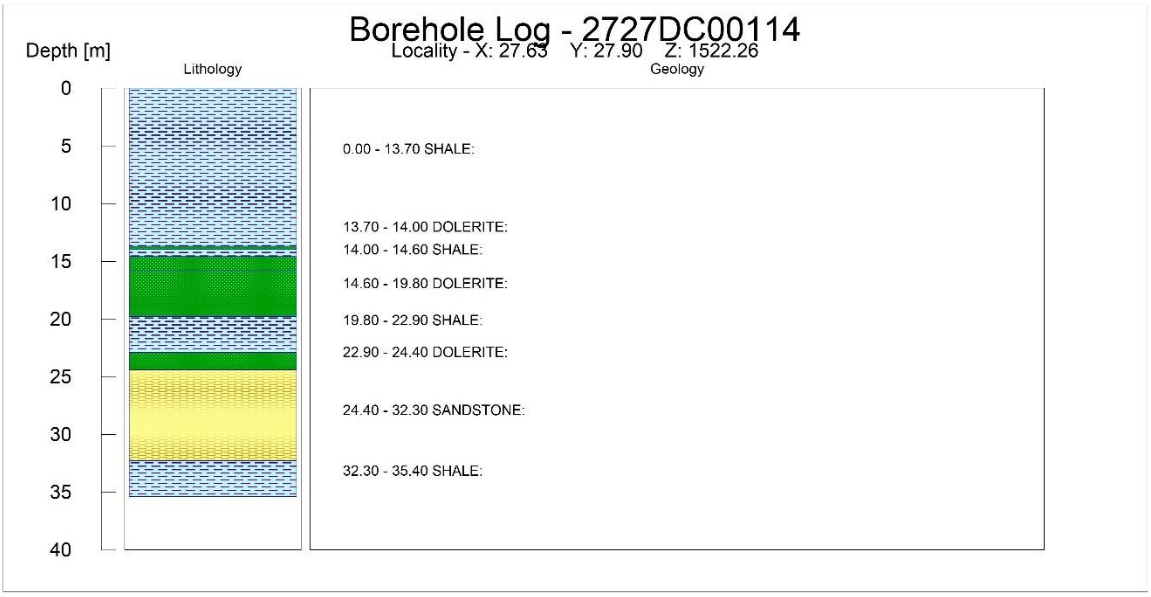

Borehole Log - 2727CD00002
Locality - X: 27.26 Y: 27.77 Z: 1361.90
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
100
110
120
130
0.00 - 0.30 SOIL:
0.30 - 121.92 SHALE:

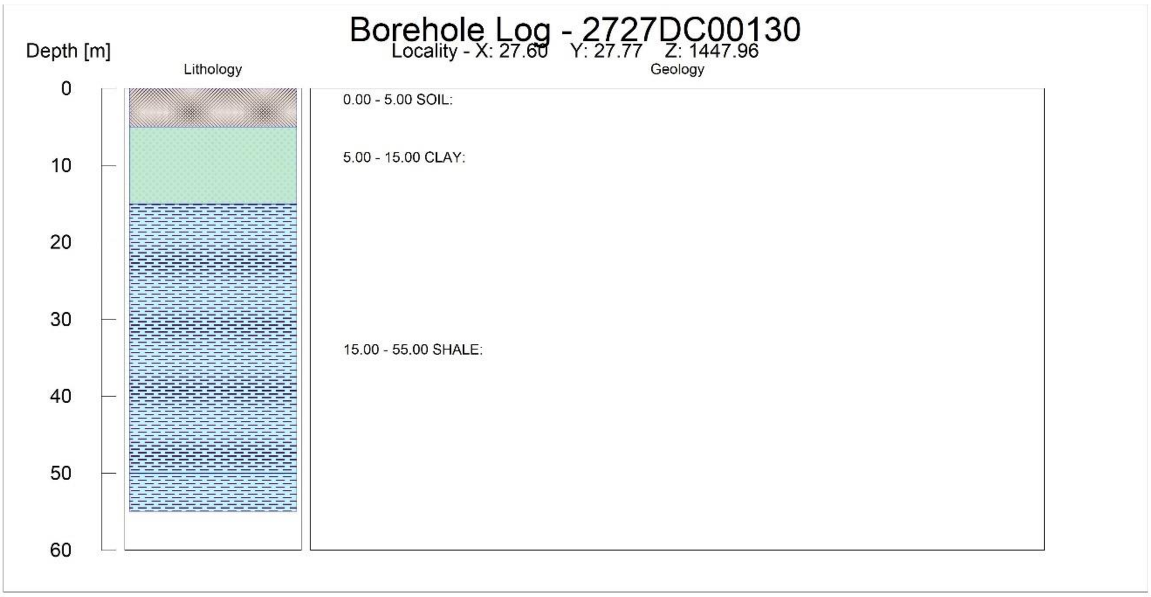
Borehole Log - 2727CD00005
Locality - X: 27.41 Y: 27.93 Z: 1426.09
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
50
0.00 - 0.91 SOIL:
0.91 - 9.14 CLAY:
9.14 - 18.59 SHALE:
18.59 - 46.94 SANDSTONE:

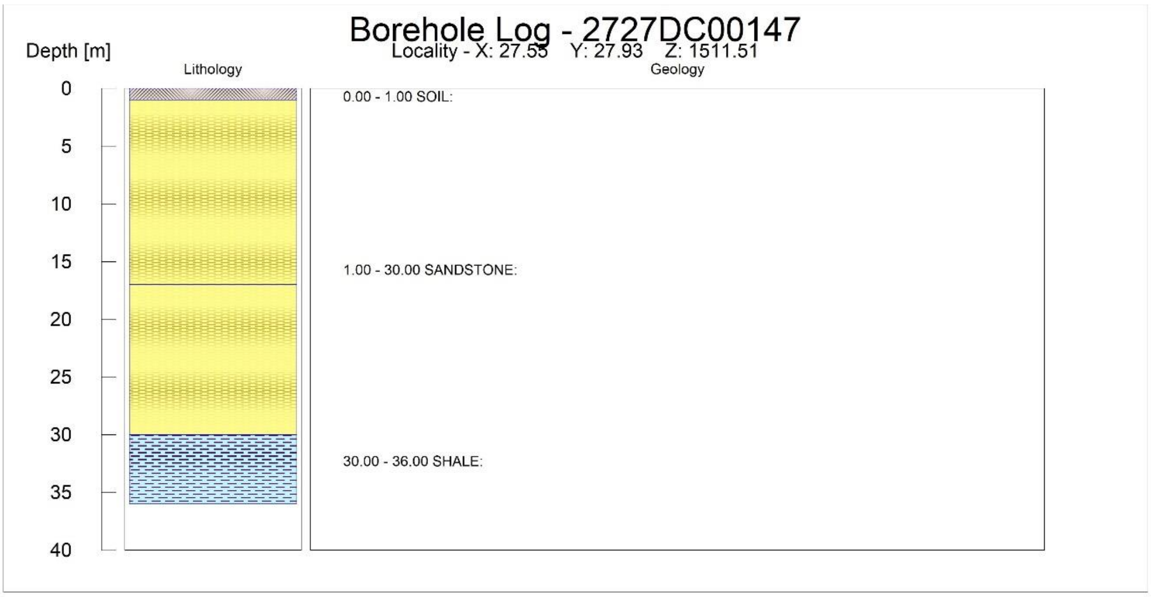

Borehole Log - 2727DA00213
Locality - X: 27.73 Y: 27.68 Z: 1561.48
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
0.00 - 3.00 SHALE:
3.00 - 4.00 GRAVEL:
4.00 - 54.00 DOLERITE:
54.00 - 66.00 SANDSTONE:
66.00 - 76.00 SHALE:


Borehole Log - 2727DC00001
Locality - X: 27.65 Y: 27.97 Z: 1555.07
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
0.00 - 0.91 SOIL:
0.91 - 34.14 SANDSTONE:
34.14 - 60.66 SHALE:

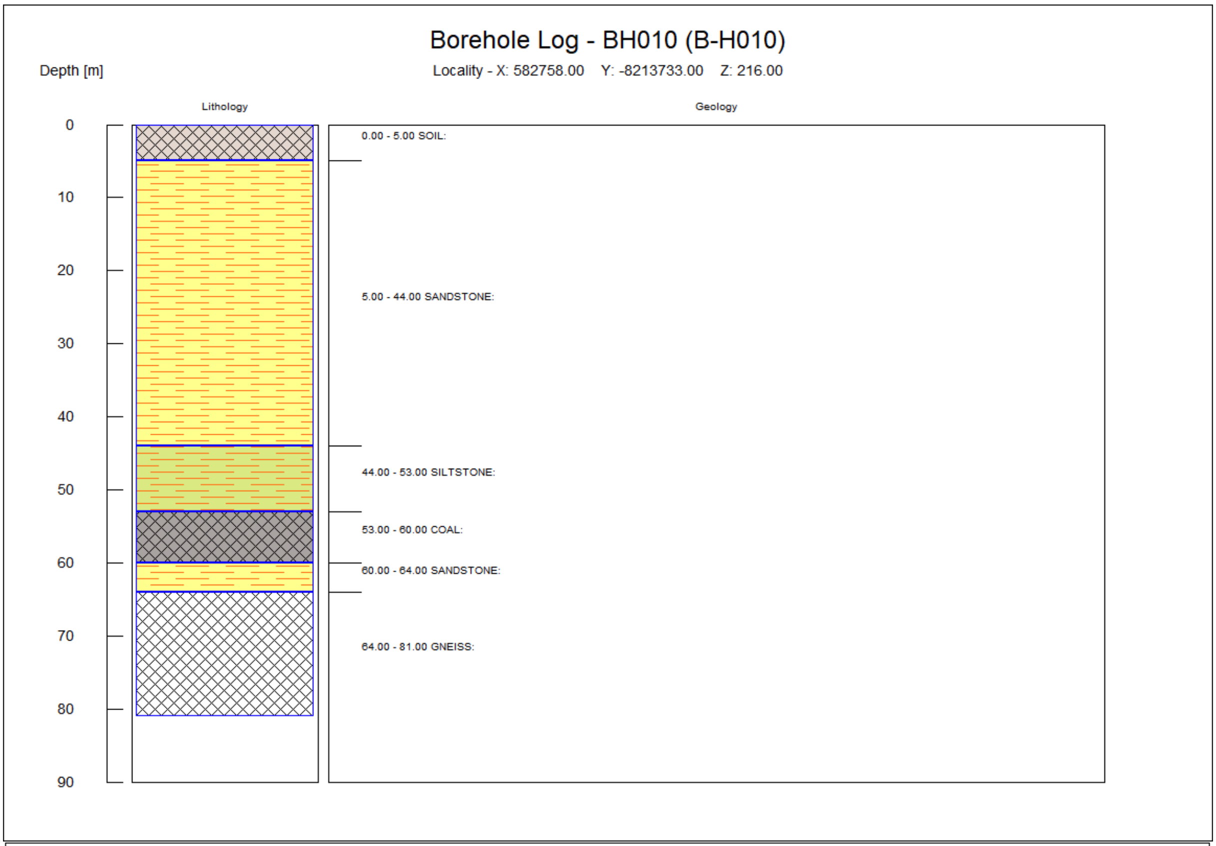

Borehole Log - 2727DC00110
Locality - X: 27.60 Y: 27.93 Z: 1564.22
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
100
110
0.00 - 6.10 SHALE:
6.10 - 16.20 DOLERITE:
16.20 - 45.10 QUARTZITE:
45.10 - 57.30 LIMESTONE:
57.30 - 85.60 SANDSTONE:
85.60 - 106.70 SHALE:

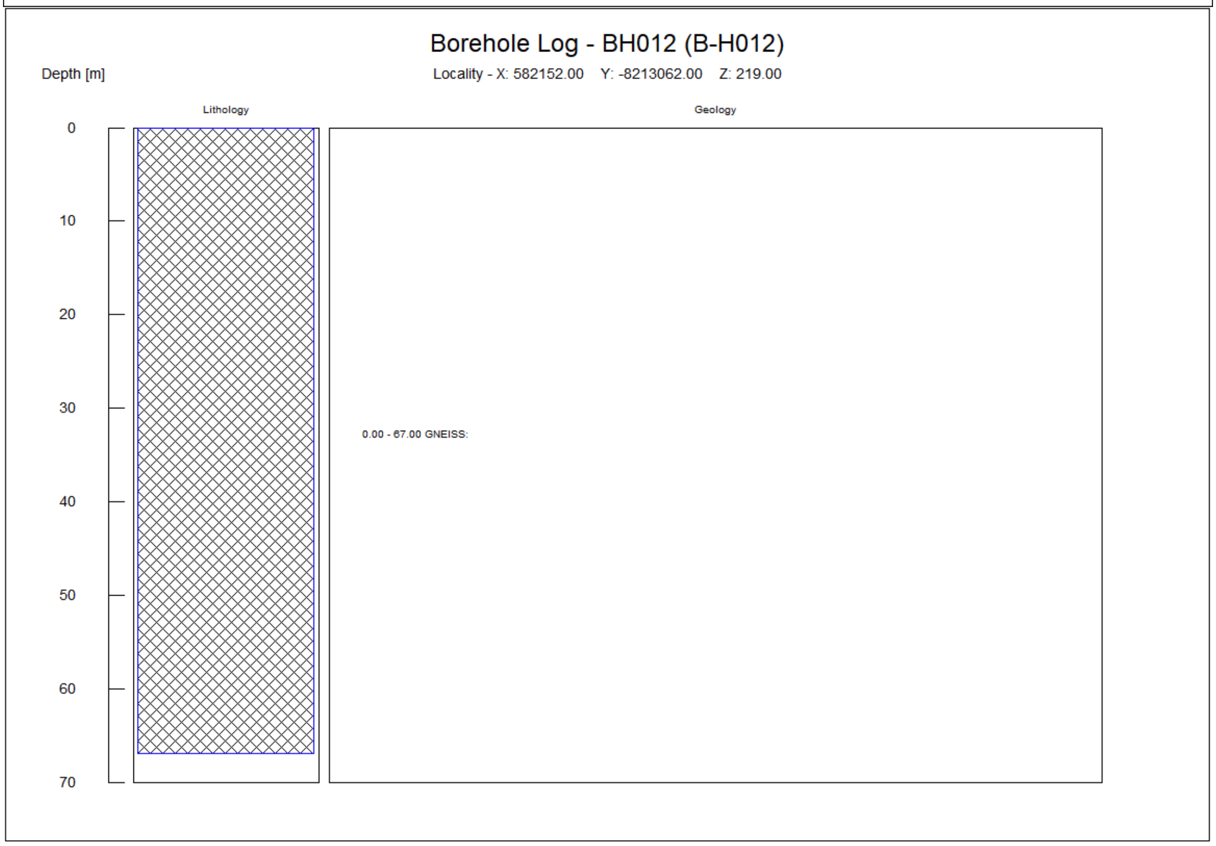

Borehole Log - 2727DC00114
Locality - X: 27.63 Y: 27.90 Z: 1522.26
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
0.00 - 13.70 SHALE:
13.70 - 14.00 DOLERITE:
14.00 - 14.60 SHALE:
14.60 - 19.80 DOLERITE:
19.80 - 22.90 SHALE:
22.90 - 24.40 DOLERITE:
24.40 - 32.30 SANDSTONE:
32.30 - 35.40 SHALE:

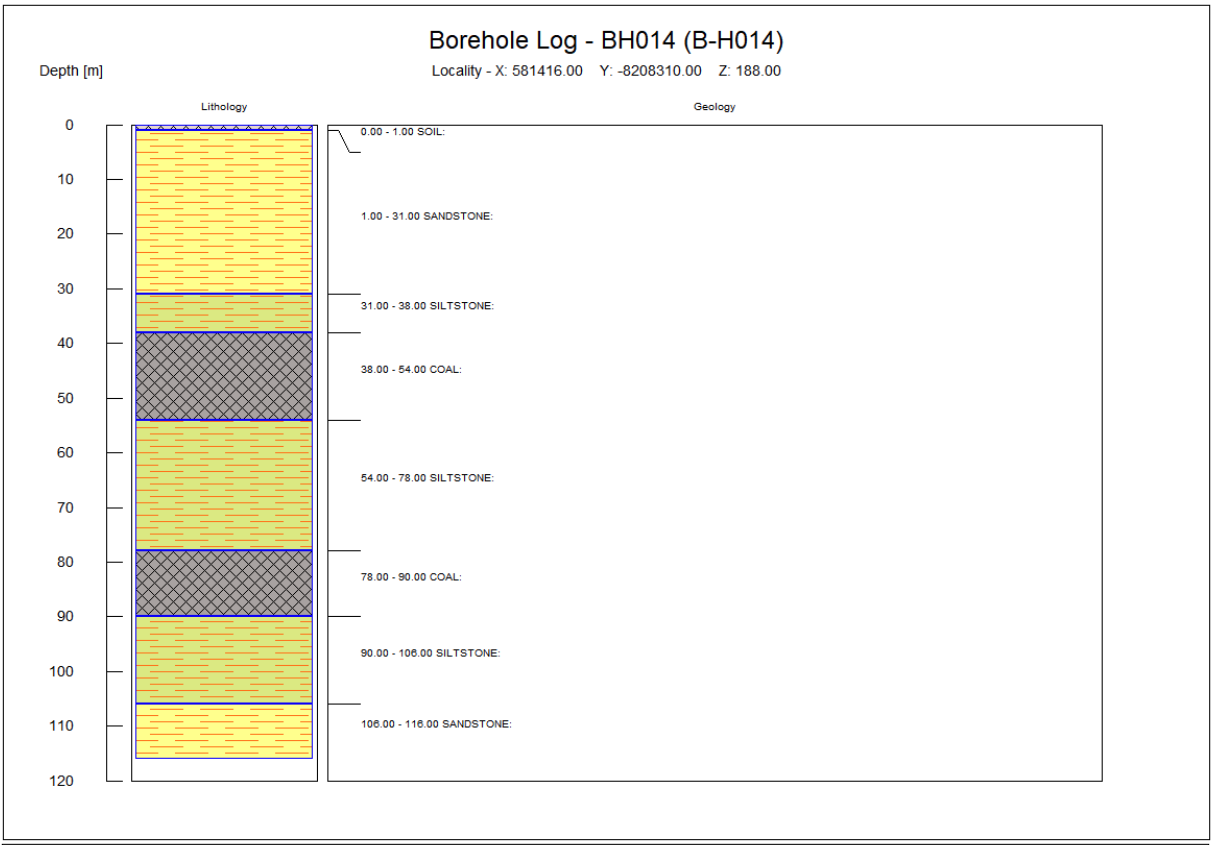

Borehole Log - 2727DC00130
Locality - X: 27.60 Y: 27.77 Z: 1447.96
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 5.00 SOIL:
5.00 - 15.00 CLAY:
15.00 - 55.00 SHALE:

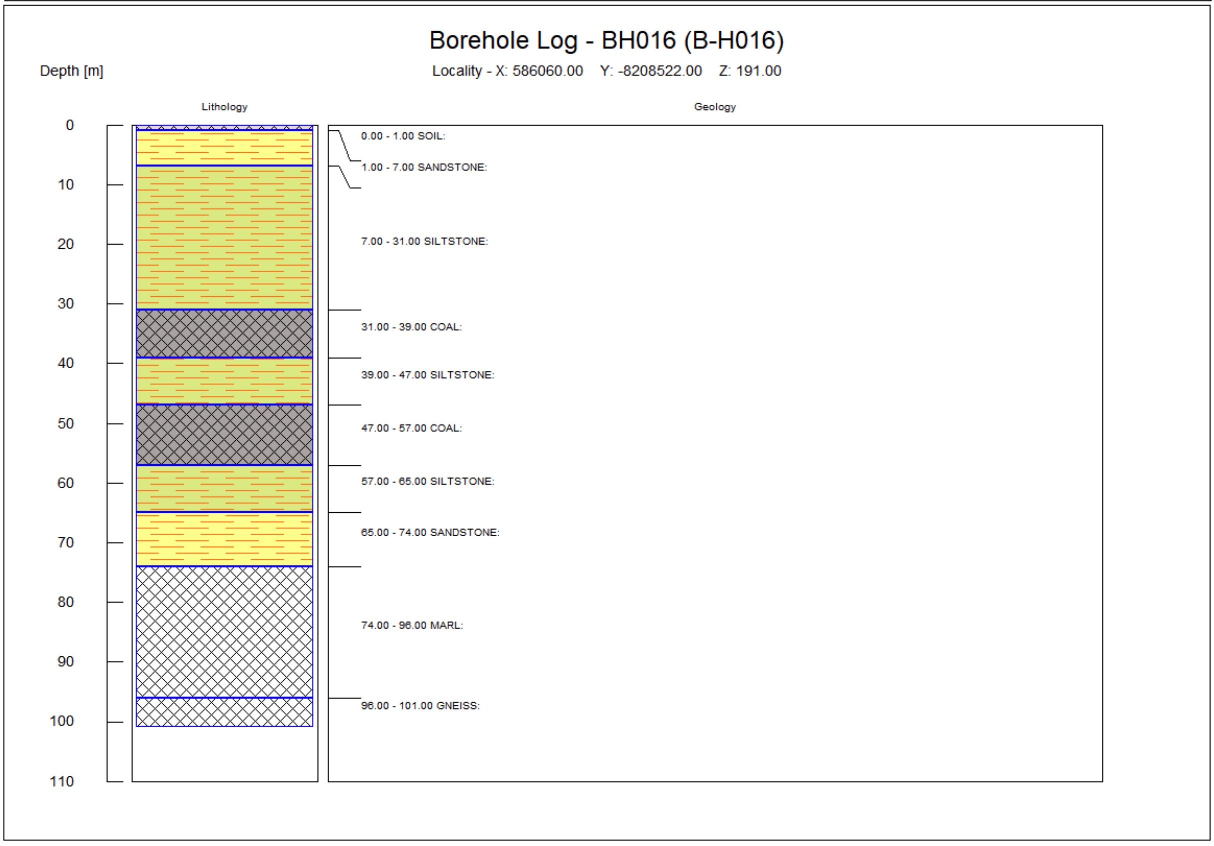


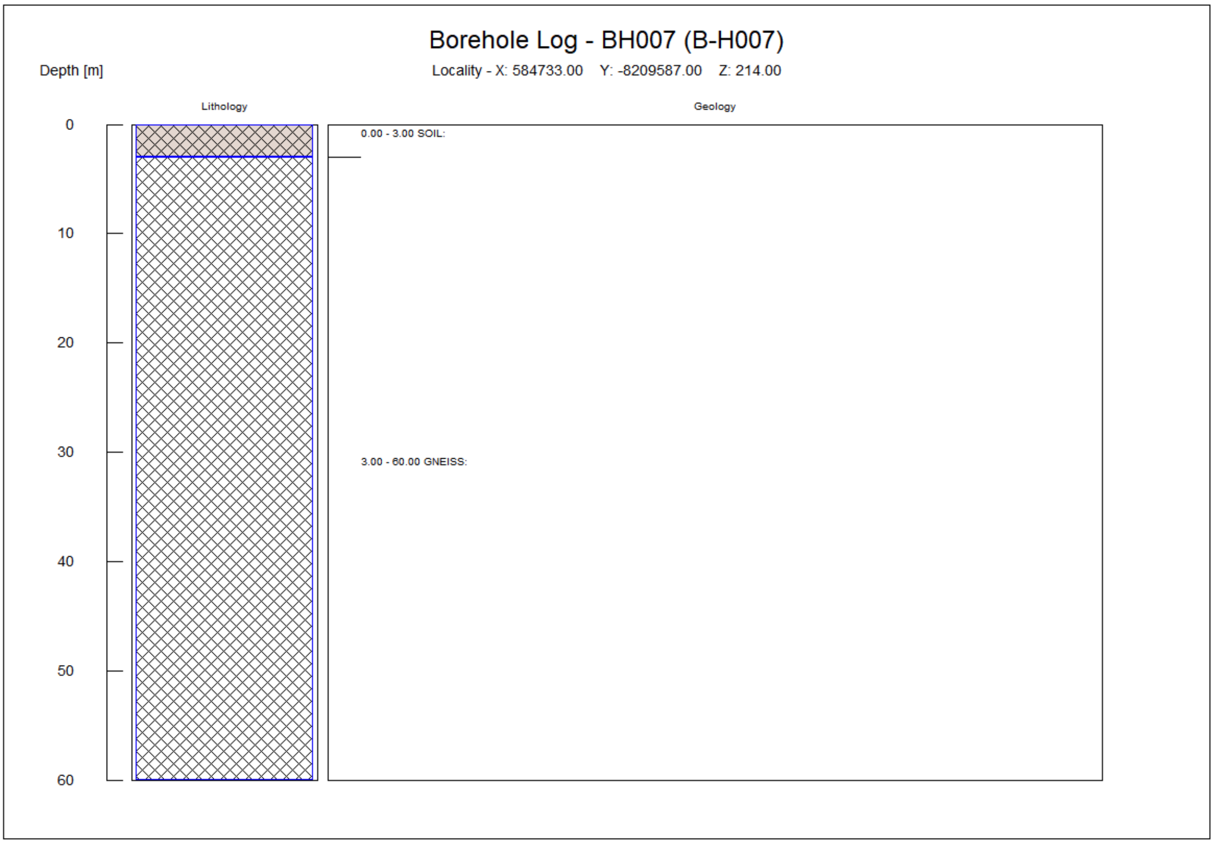
Borehole Log - 2727DC00147
Locality - X: 27.55 Y: 27.93 Z: 1511.51
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
0.00 - 1.00 SOIL:
1.00 - 30.00 SANDSTONE:
30.00 - 36.00 SHALE:

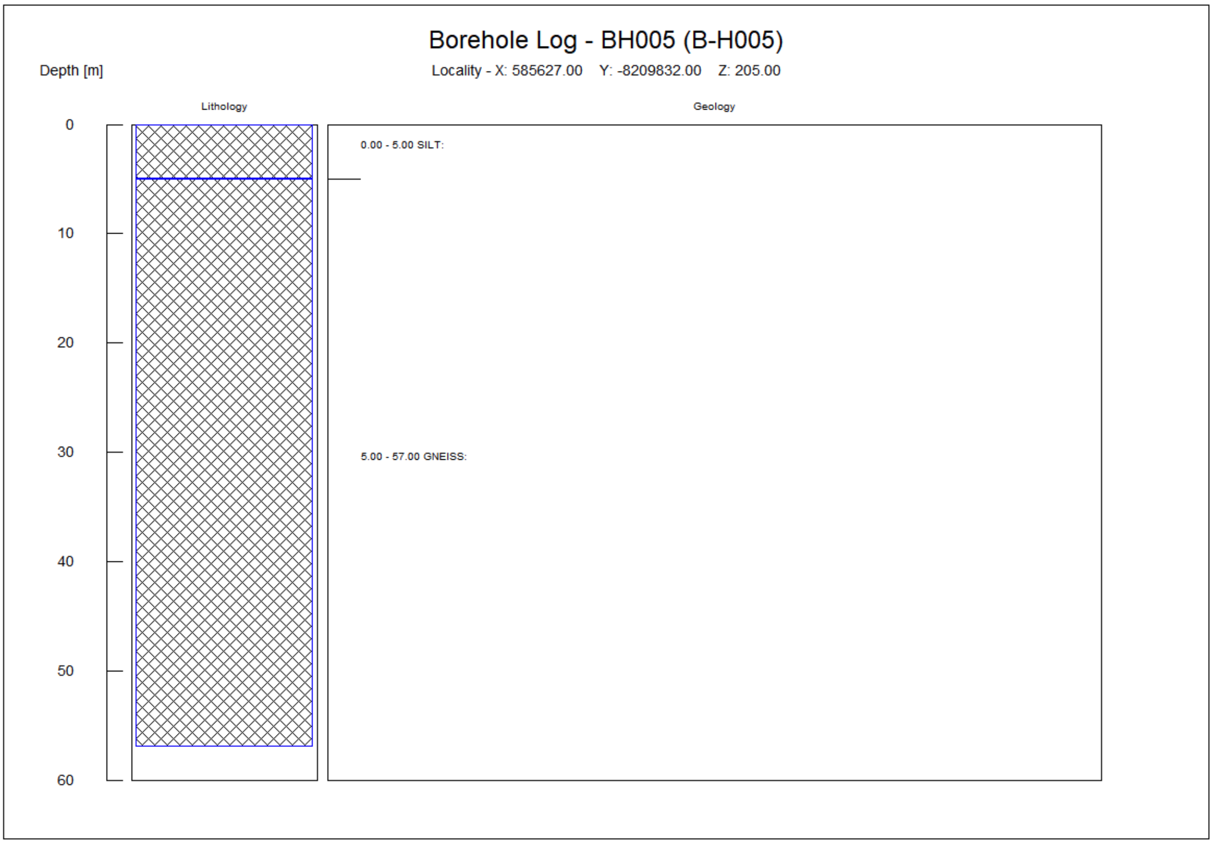

Borehole Log - BH010 (B-H010)
Depth [m]
Locality - X: 582758.00 Y: -8213733.00 Z: 216.00
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
0.00 - 5.00 SOIL:
5.00 - 44.00 SANDSTONE:
44.00 - 53.00 SILTSTONE:
53.00 - 60.00 COAL:
60.00 - 64.00 SANDSTONE:
64.00 - 81.00 GNEISS:

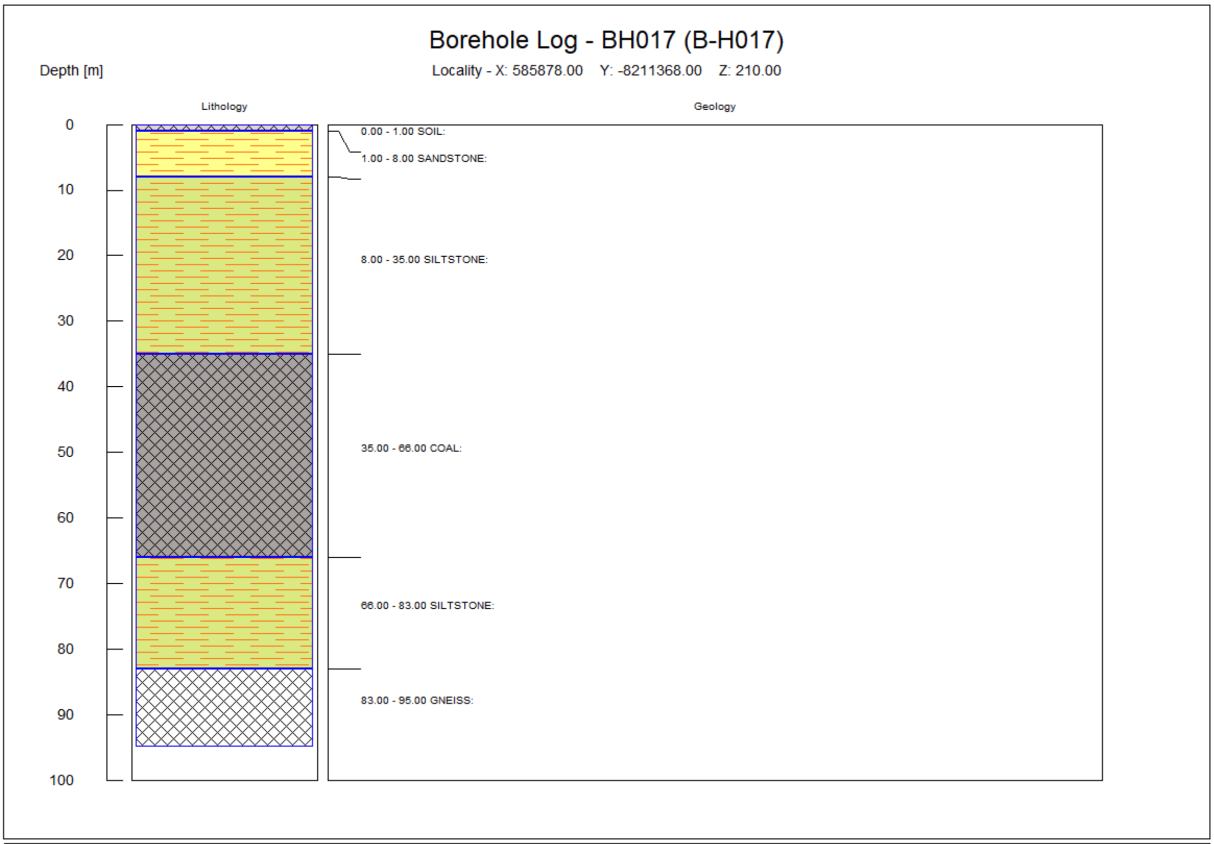

Borehole Log - BH012 (B-H012)
Depth [m]
Locality - X: 582152.00 Y: -8213062.00 Z: 219.00
Lithology
Geology
0
10
20
30
40
50
60
70
0.00 - 67.00 GNEISS:

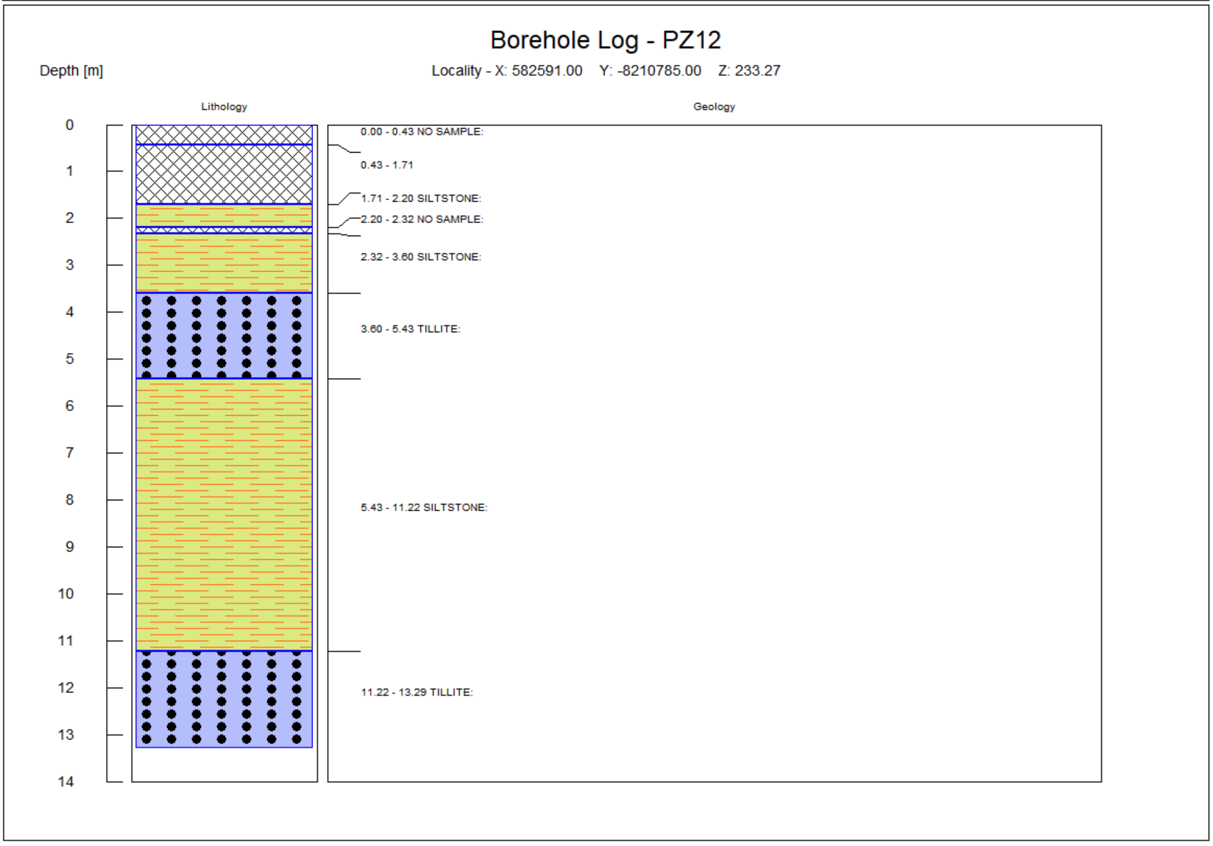

Borehole Log - BH014 (B-H014)
Depth [m]
Locality - X: 581416.00 Y: -8208310.00 Z: 188.00
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
100
110
120
0.00 - 1.00 SOIL:
1.00 - 31.00 SANDSTONE:
31.00 - 38.00 SILTSTONE:
38.00 - 54.00 COAL:
54.00 - 78.00 SILTSTONE:
78.00 - 90.00 COAL:
90.00 - 106.00 SILTSTONE:
106.00 - 116.00 SANDSTONE:

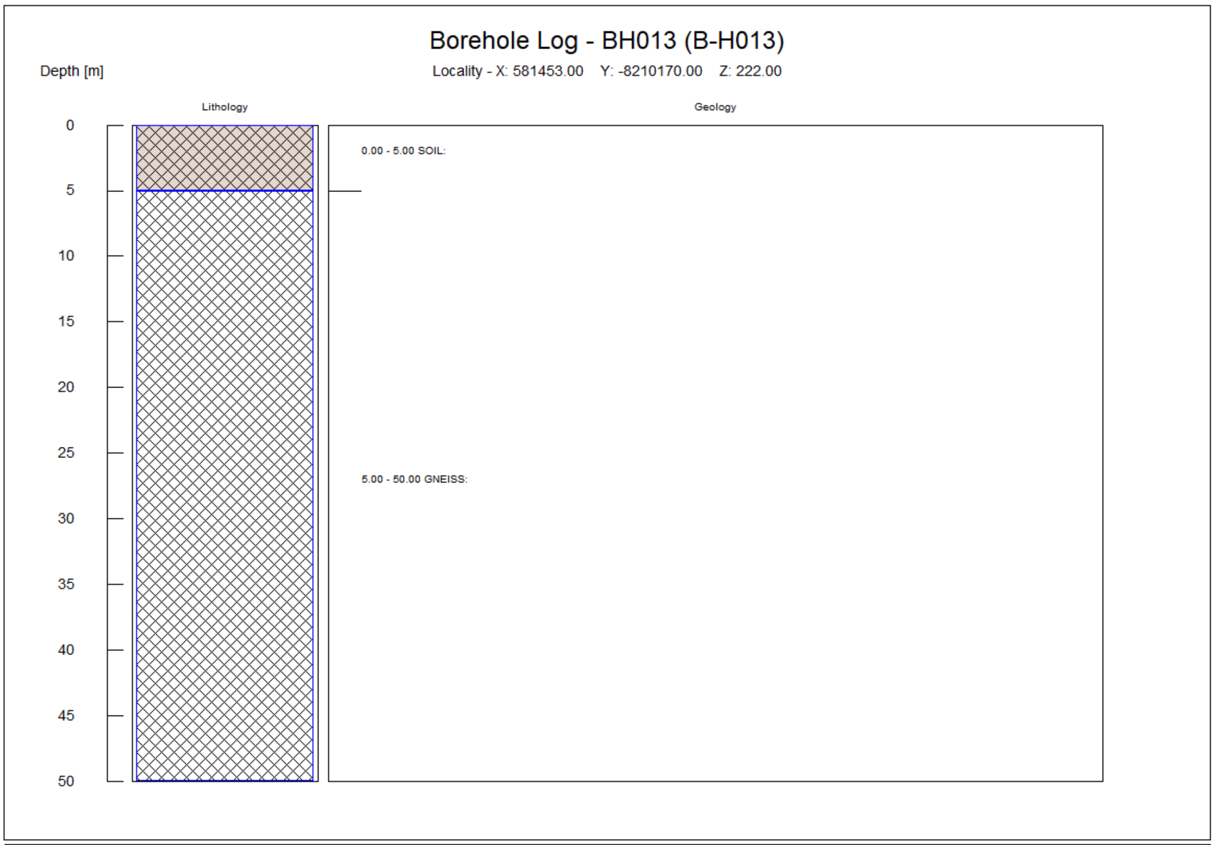

Borehole Log - BH016 (B-H016)
Depth [m]
Locality - X: 586060.00 Y: -8208522.00 Z: 191.00
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
100
110
0.00 - 1.00 SOIL:
1.00 - 7.00 SANDSTONE:
7.00 - 31.00 SILTSTONE:
31.00 - 39.00 COAL:
39.00 - 47.00 SILTSTONE:
47.00 - 57.00 COAL:
57.00 - 65.00 SILTSTONE:
65.00 - 74.00 SANDSTONE:
74.00 - 96.00 MARL:
96.00 - 101.00 GNEISS:

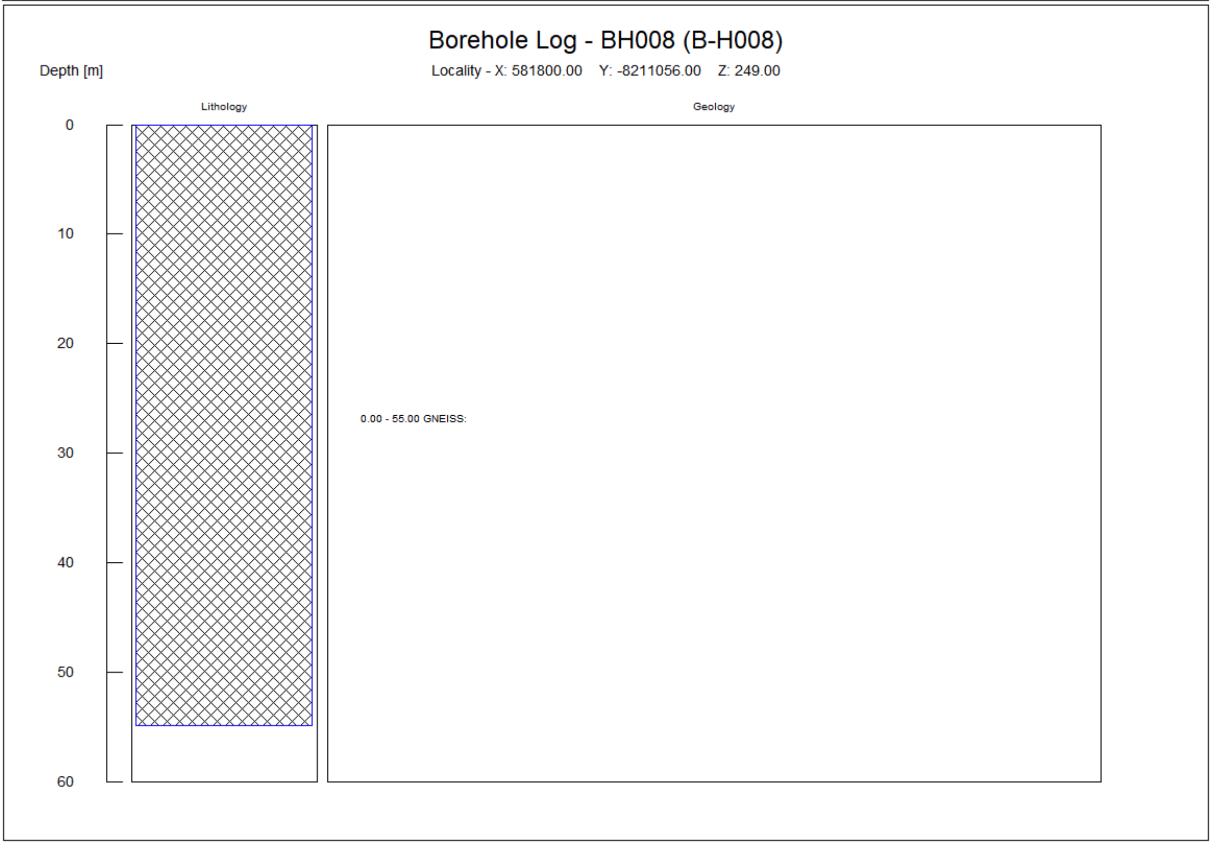

Borehole Log - BH007 (B-H007)
Locality - X: 584733.00 Y: -8209587.00 Z: 214.00
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 3.00 SOIL:
3.00 - 60.00 GNEISS:

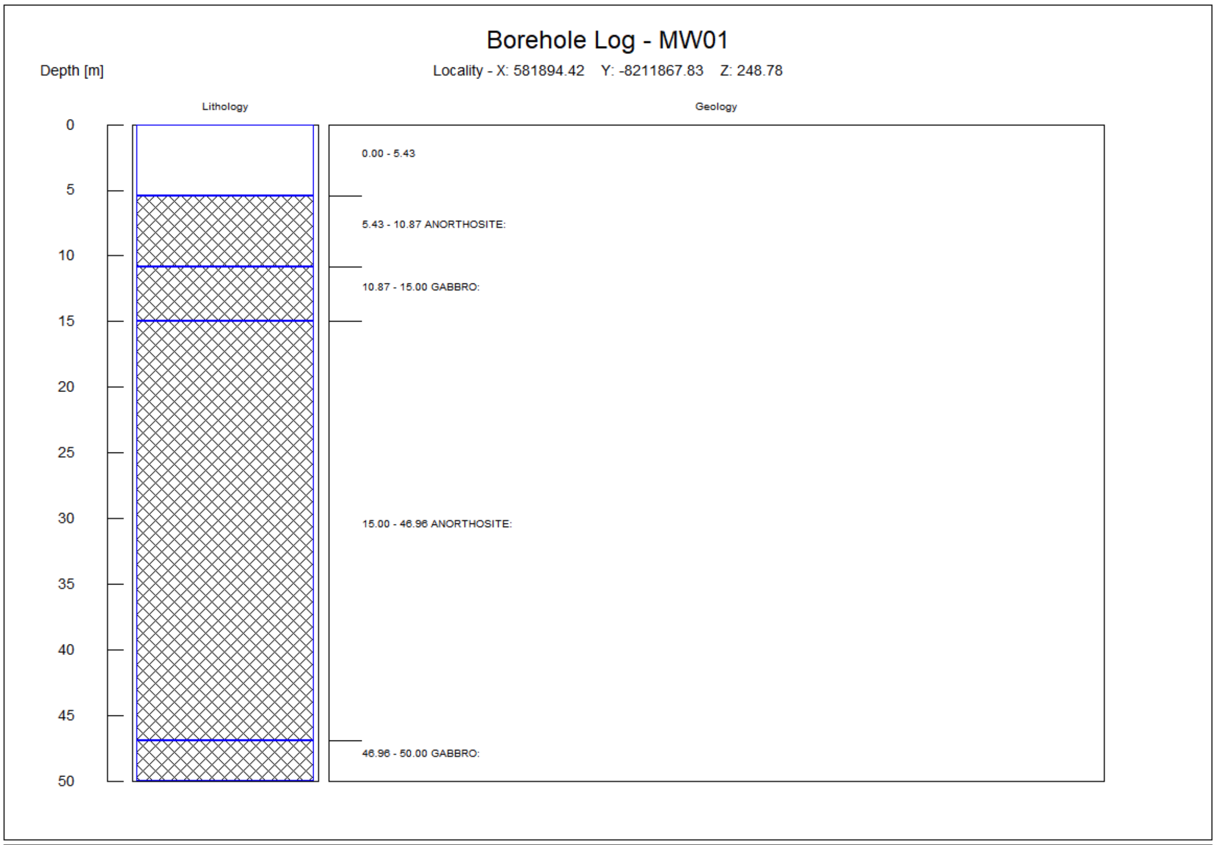

Borehole Log - BH005 (B-H005)
Locality - X: 585627.00 Y: -8209832.00 Z: 205.00
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 5.00 SILT:
5.00 - 57.00 GNEISS:

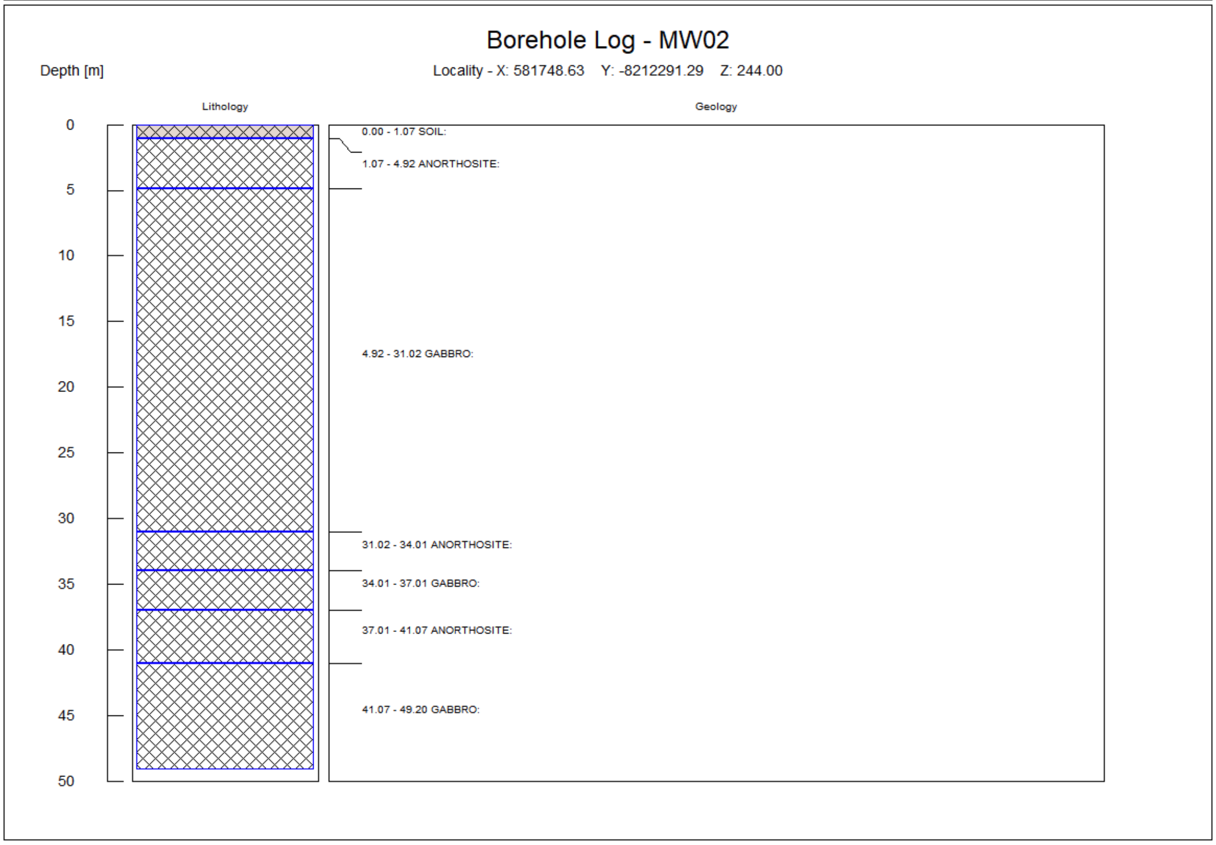

Borehole Log - BH017 (B-H017)
Depth [m]
Locality - X: 585878.00 Y: -8211368.00 Z: 210.00
Lithology
Geology
0
10
20
30
40
50
60
70
80
90
100
0.00 - 1.00 SOIL:
1.00 - 8.00 SANDSTONE:
8.00 - 35.00 SILTSTONE:
35.00 - 66.00 COAL:
66.00 - 83.00 SILTSTONE:
83.00 - 95.00 GNEISS:

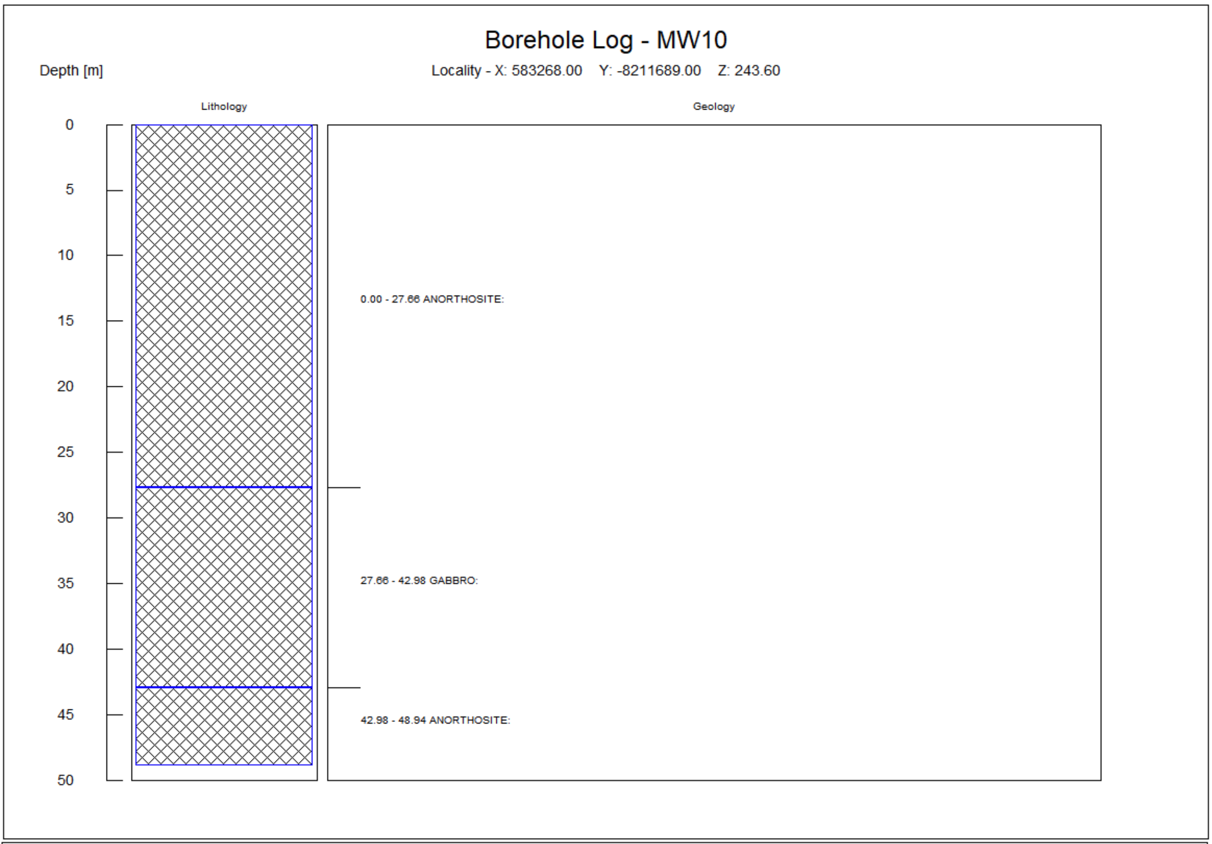

Borehole Log - PZ12
Depth [m]
Locality - X: 582591.00 Y: -8210785.00 Z: 233.27
Lithology
Geology
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
0.00 - 0.43 NO SAMPLE:
0.43 - 1.71
1.71 - 2.20 SILTSTONE:
2.20 - 2.32 NO SAMPLE:
2.32 - 3.60 SILTSTONE:
3.60 - 5.43 TILLITE:
5.43 - 11.22 SILTSTONE:
11.22 - 13.29 TILLITE:

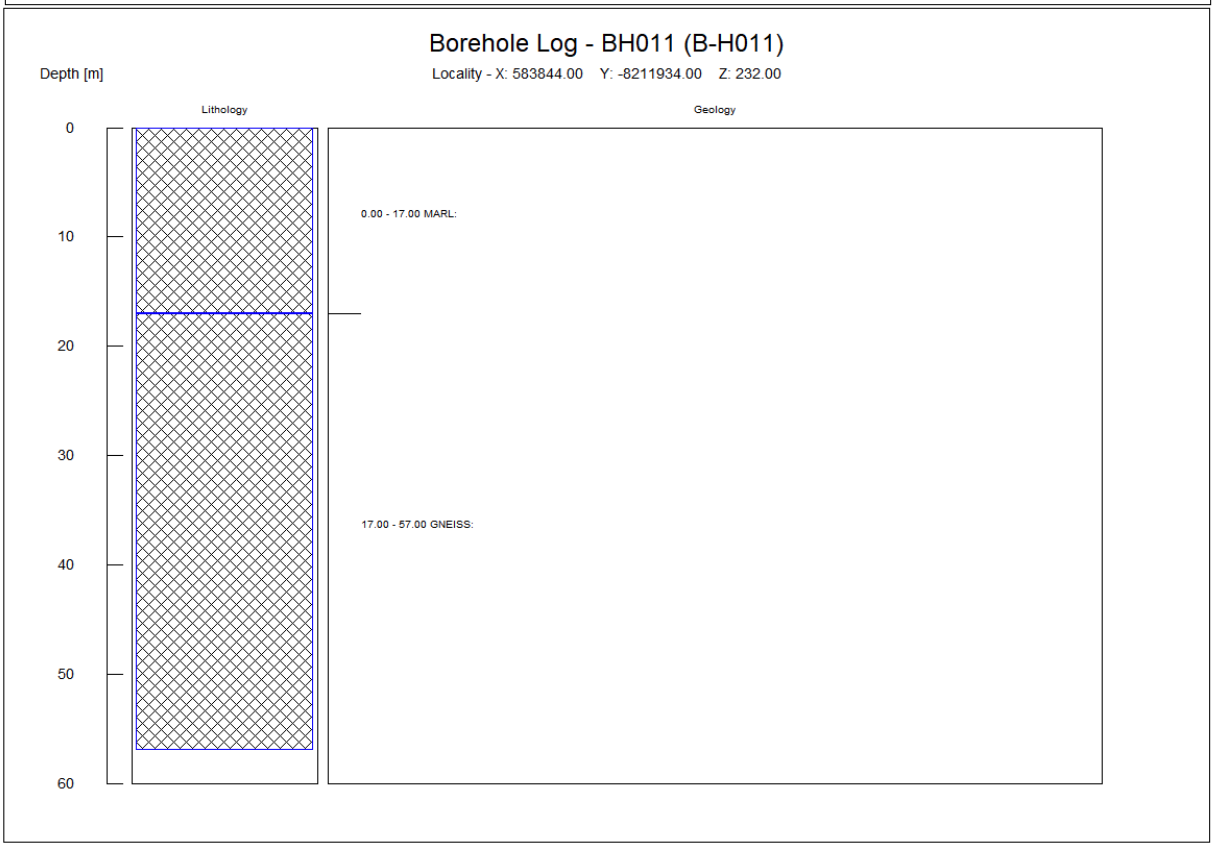

Borehole Log - BH013 (B-H013)
Depth [m]
Locality - X: 581453.00 Y: -8210170.00 Z: 222.00
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
50
0.00 - 5.00 SOIL:
5.00 - 50.00 GNEISS:

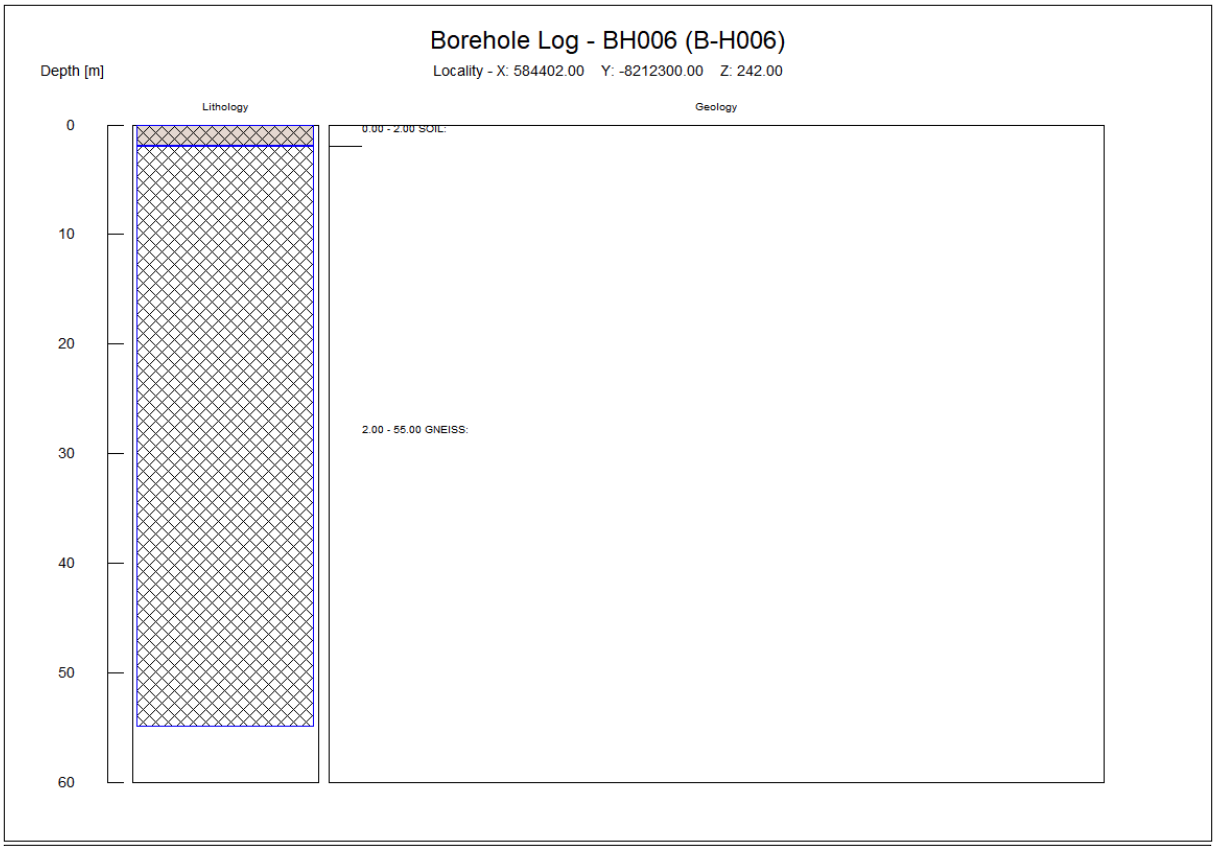

Borehole Log - BH008 (B-H008)
Depth [m]
Locality - X: 581800.00 Y: -8211056.00 Z: 249.00
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 55.00 GNEISS:

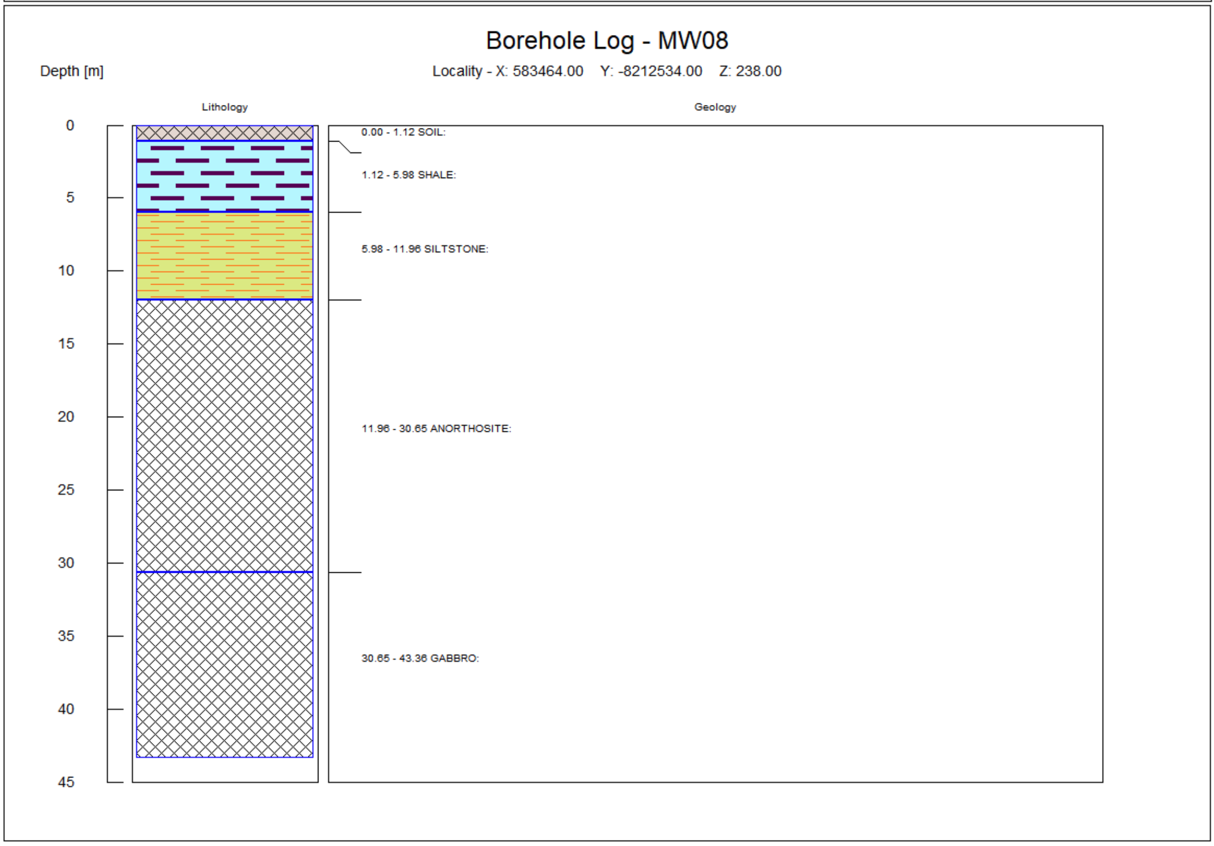

Borehole Log - MW01
Depth [m]
Locality - X: 581894.42 Y: -8211867.83 Z: 248.78
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
50
0.00 - 5.43
5.43 - 10.87 ANORTHOSITE:
10.87 - 15.00 GABBRO:
15.00 - 46.96 ANORTHOSITE:
46.96 - 50.00 GABBRO:

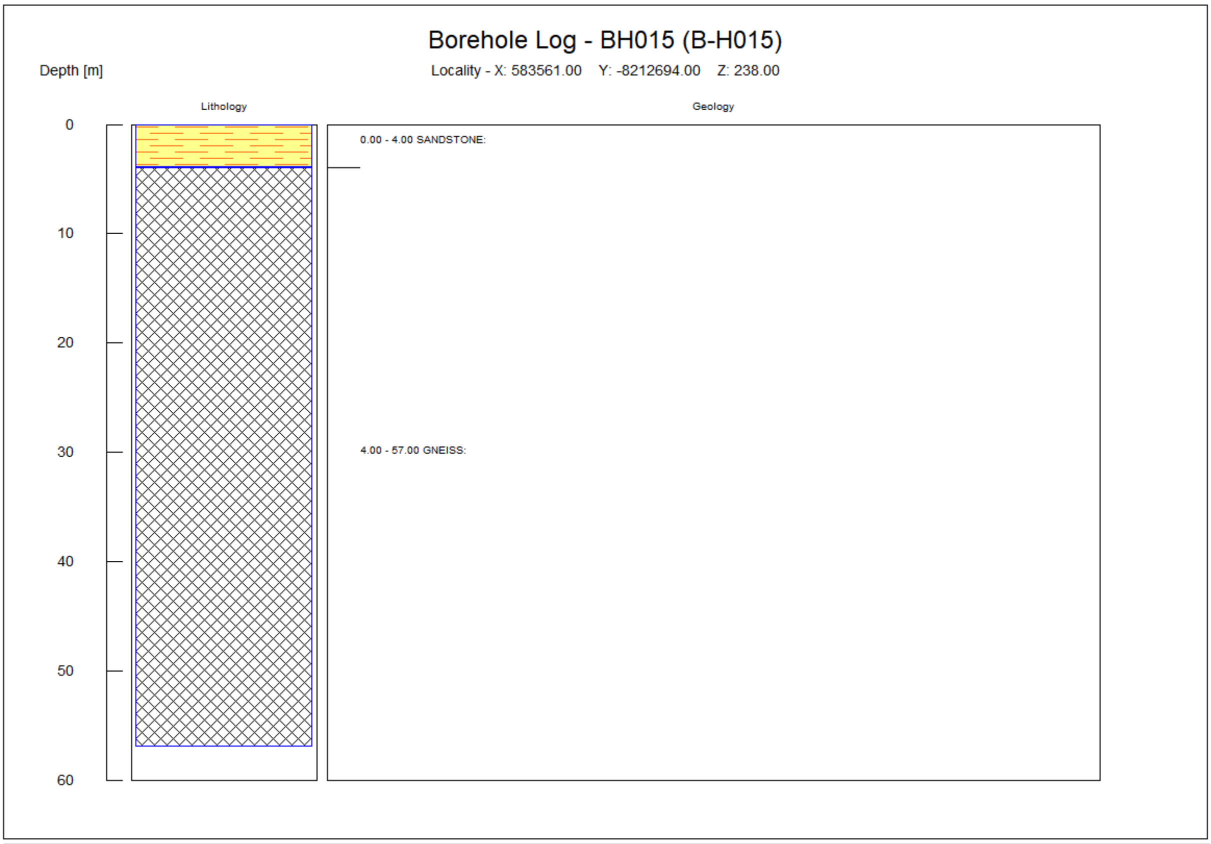

Borehole Log - MW02
Depth [m]
Locality - X: 581748.63 Y: -8212291.29 Z: 244.00
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
50
0.00 - 1.07 SOIL:
1.07 - 4.92 ANORTHOSITE:
4.92 - 31.02 GABBRO:
31.02 - 34.01 ANORTHOSITE:
34.01 - 37.01 GABBRO:
37.01 - 41.07 ANORTHOSITE:
41.07 - 49.20 GABBRO:

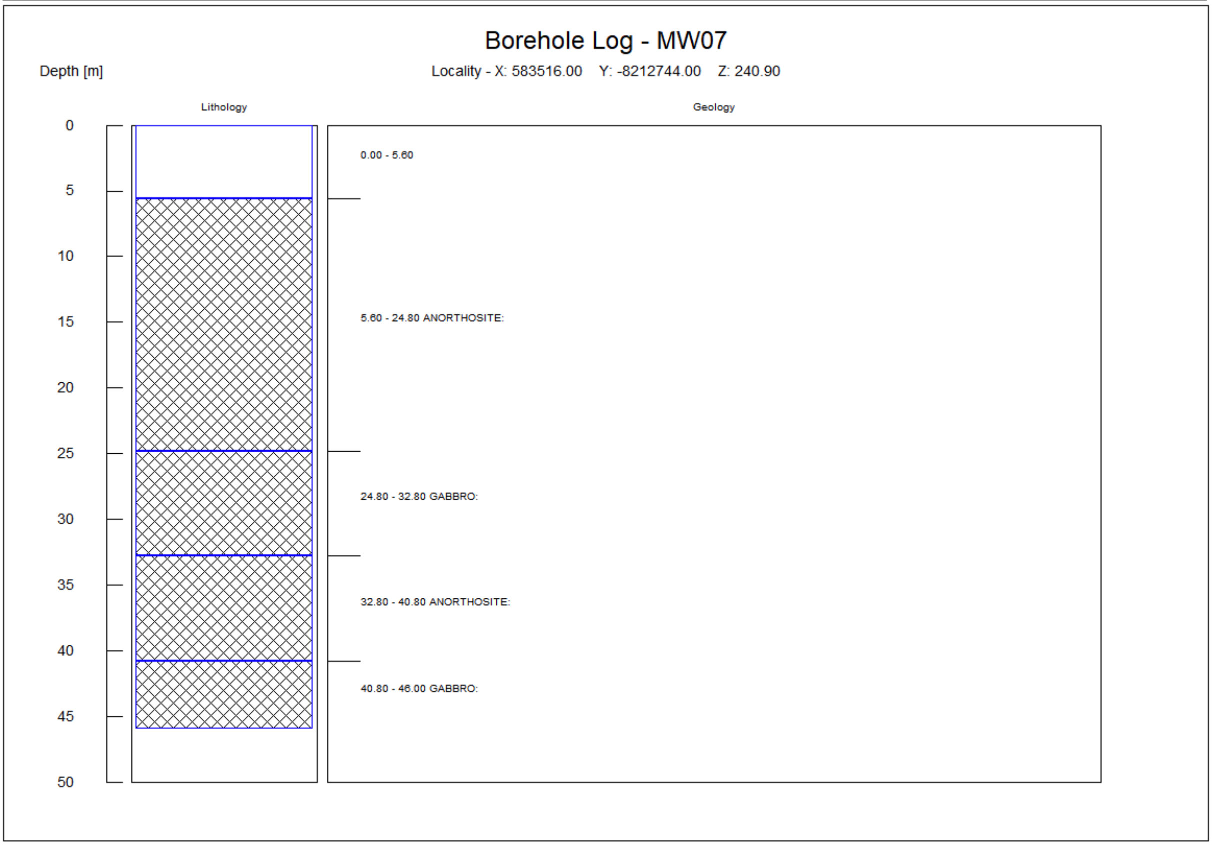

Borehole Log - MW10
Depth [m]
Locality - X: 583268.00 Y: -8211689.00 Z: 243.60
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
50
0.00 - 27.66 ANORTHOSITE:
27.66 - 42.98 GABBRO:
42.98 - 48.94 ANORTHOSITE:

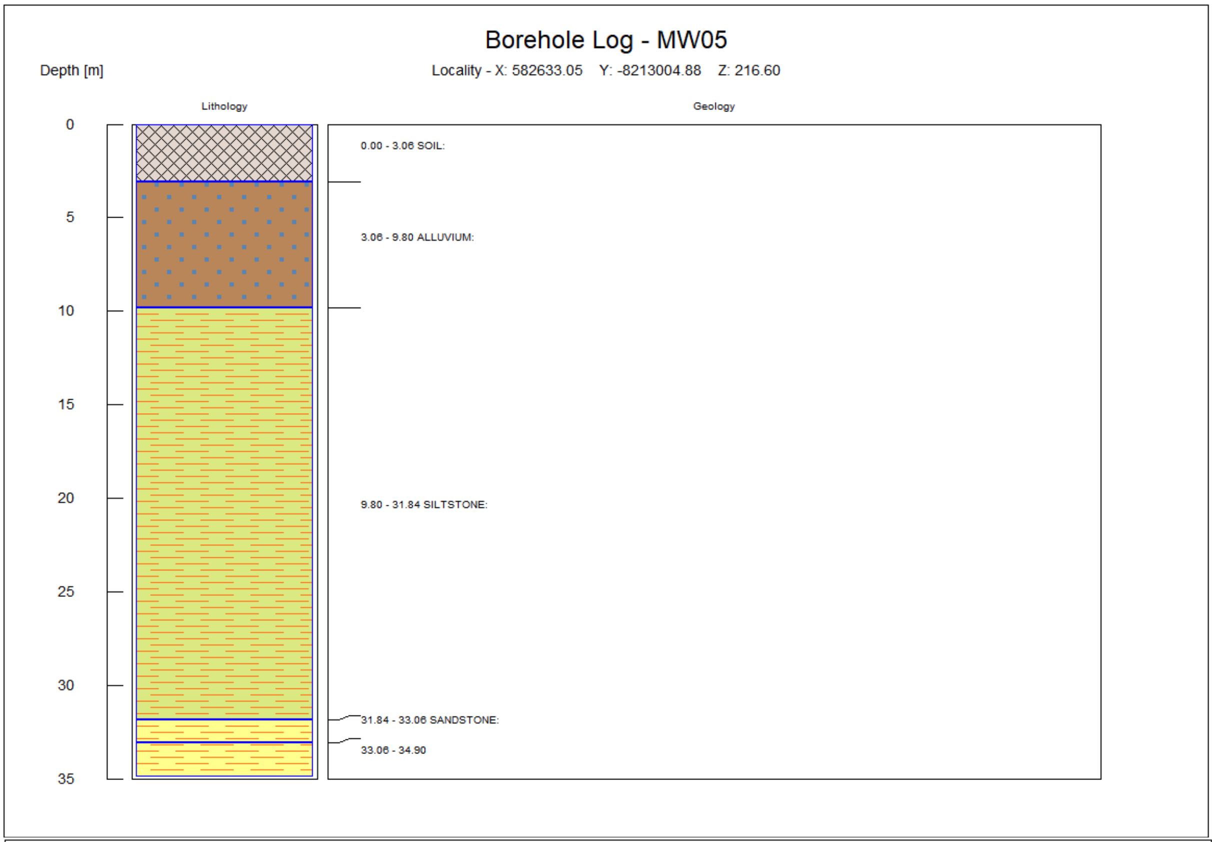

Borehole Log - BH011 (B-H011)
Depth [m]
Locality - X: 583844.00 Y: -8211934.00 Z: 232.00
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 17.00 MARL:
17.00 - 57.00 GNEISS:

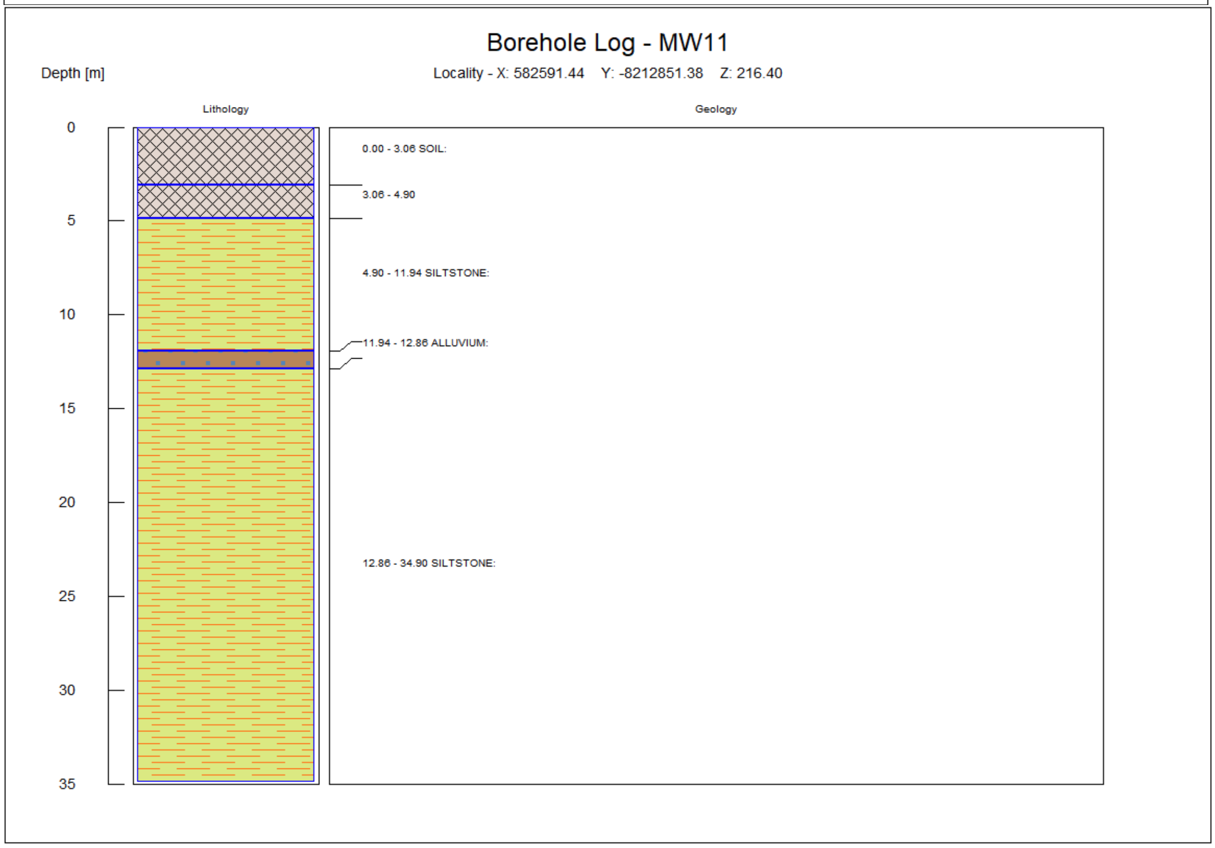

Borehole Log - BH006 (B-H006)
Locality - X: 584402.00 Y: -8212300.00 Z: 242.00
Depth [m]
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 2.00 SOIL:
2.00 - 55.00 GNEISS:

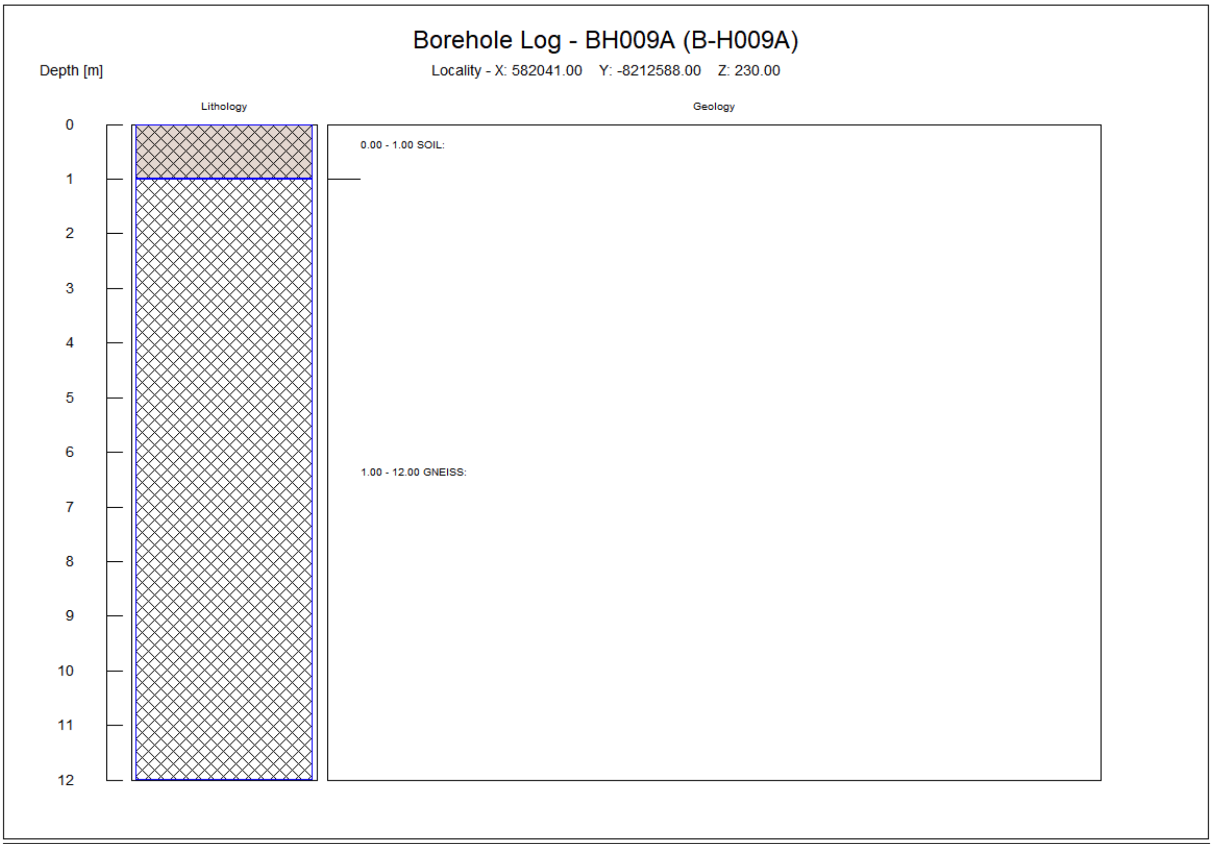

Borehole Log - MW08
Locality - X: 583464.00 Y: -8212534.00 Z: 238.00
Depth [m]
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
0.00 - 1.12 SOIL:
1.12 - 5.98 SHALE:
5.98 - 11.96 SILTSTONE:
11.96 - 30.65 ANORTHOSITE:
30.65 - 43.36 GABBRO:

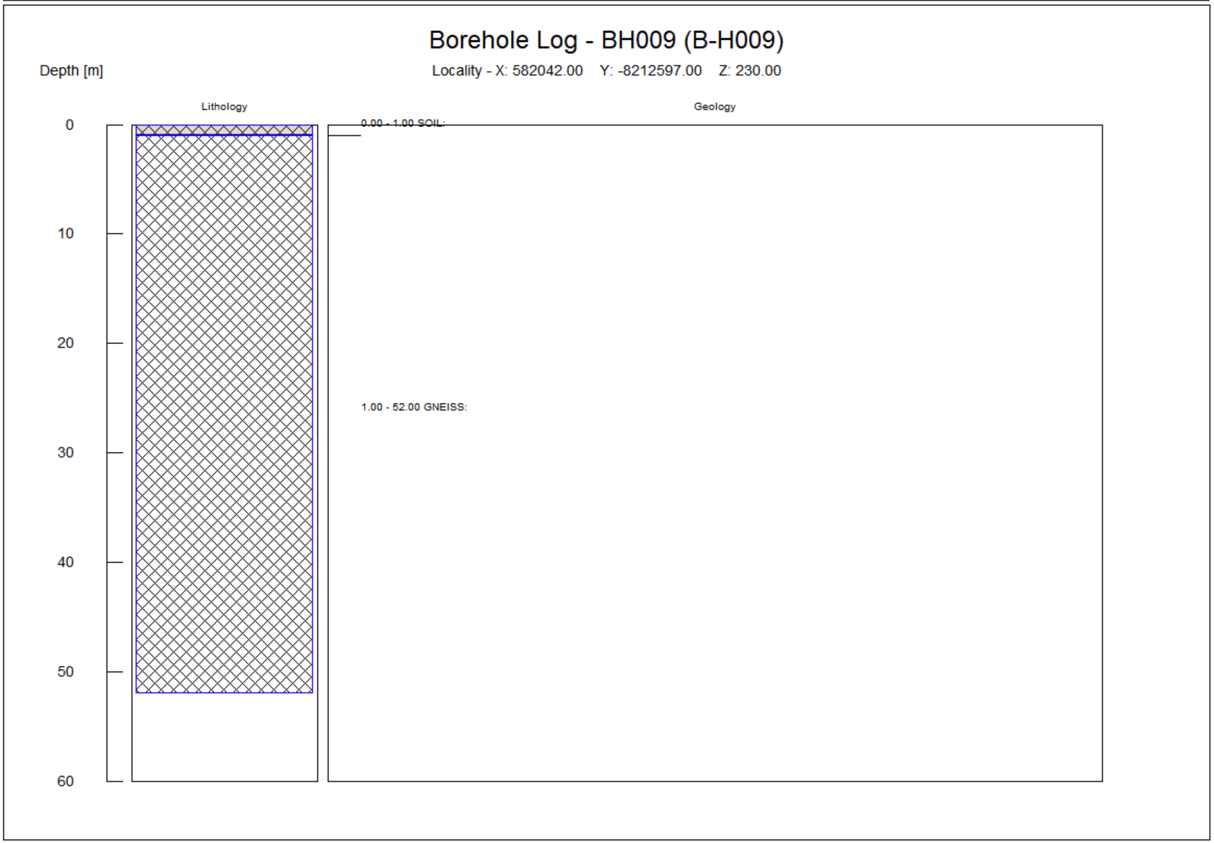

Borehole Log - BH015 (B-H015)
Depth [m]
Locality - X: 583561.00 Y: -8212694.00 Z: 238.00
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 4.00 SANDSTONE:
4.00 - 57.00 GNEISS:

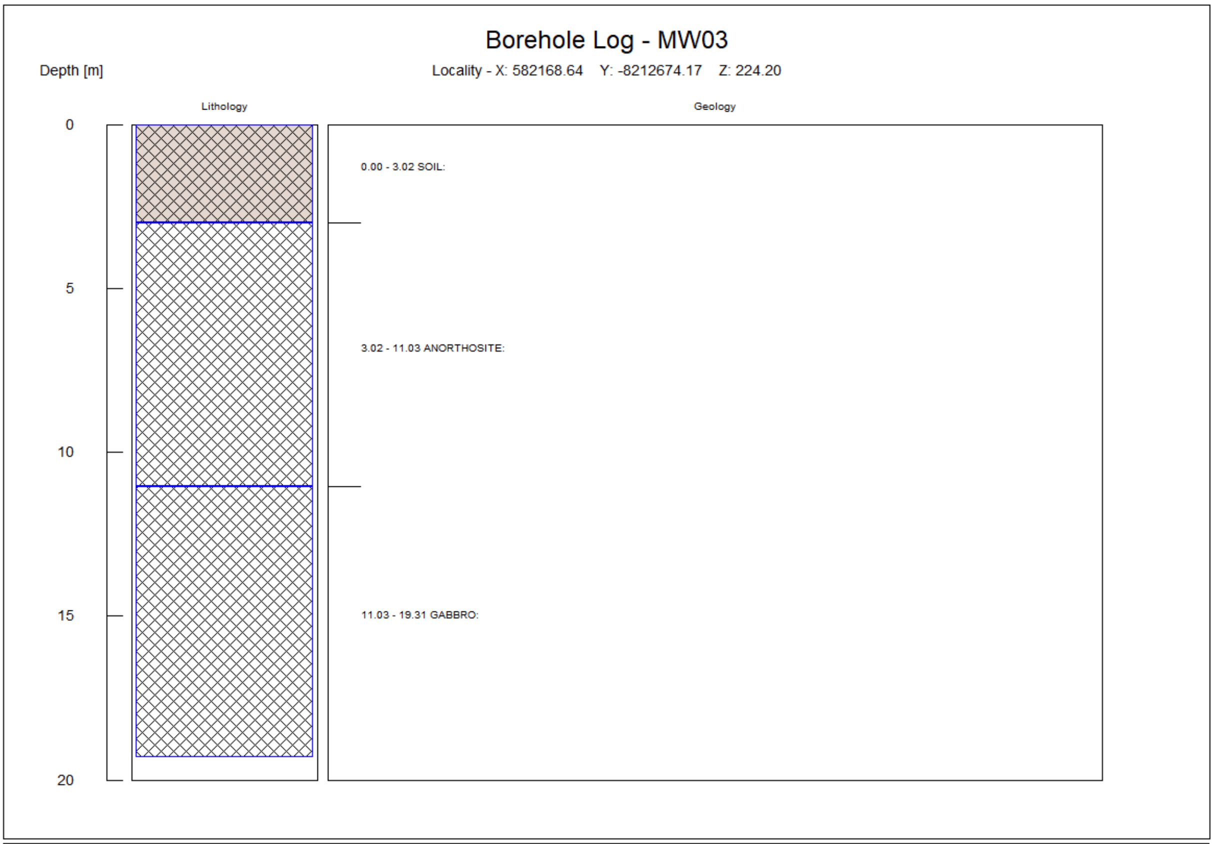

Borehole Log - MW07
Depth [m]
Locality - X: 583516.00 Y: -8212744.00 Z: 240.90
Lithology
Geology
0
5
10
15
20
25
30
35
40
45
50
0.00 - 5.60
5.60 - 24.80 ANORTHOSITE:
24.80 - 32.80 GABBRO:
32.80 - 40.80 ANORTHOSITE:
40.80 - 46.00 GABBRO:

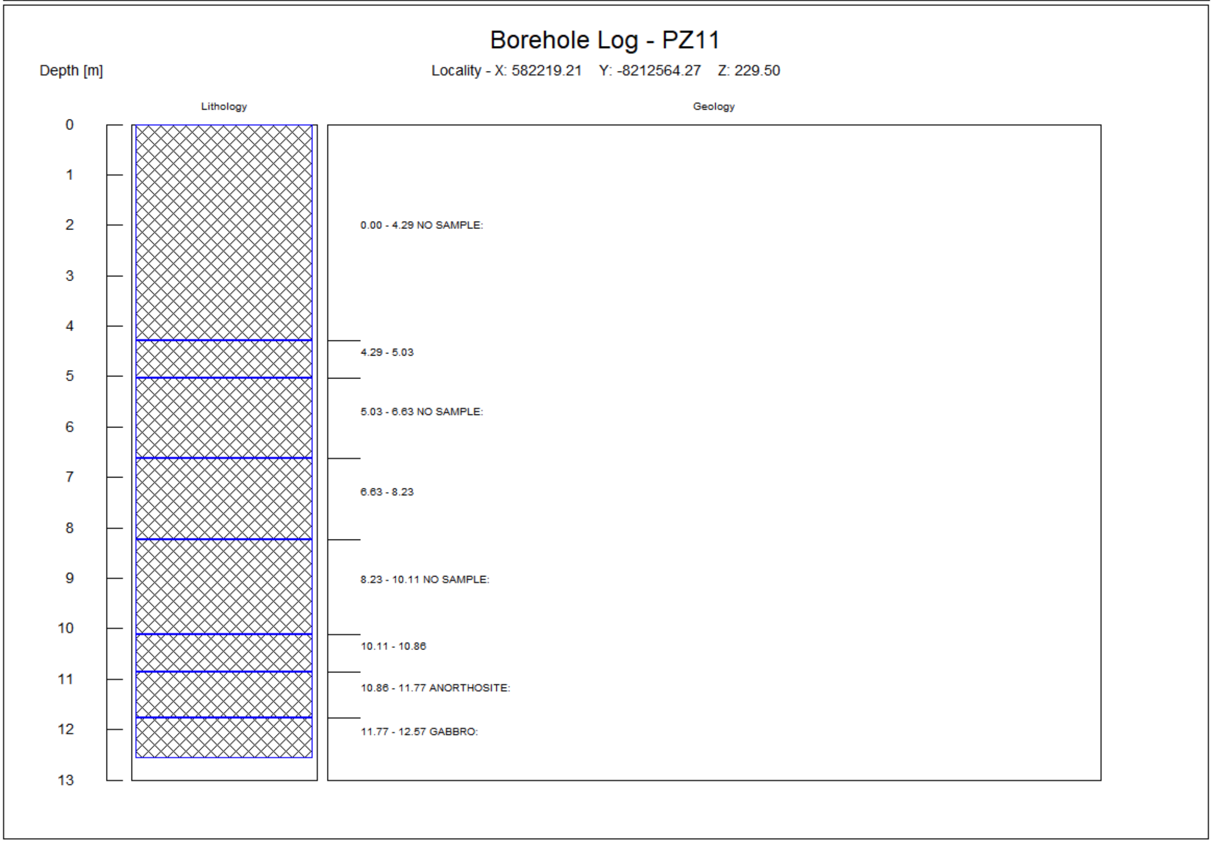

Borehole Log - MW05
Depth [m]
Locality - X: 582633.05 Y: -8213004.88 Z: 216.60
Lithology
Geology
0
5
10
15
20
25
30
35
0.00 - 3.06 SOIL:
3.06 - 9.80 ALLUVIUM:
9.80 - 31.84 SILTSTONE:
31.84 - 33.06 SANDSTONE:
33.06 - 34.90

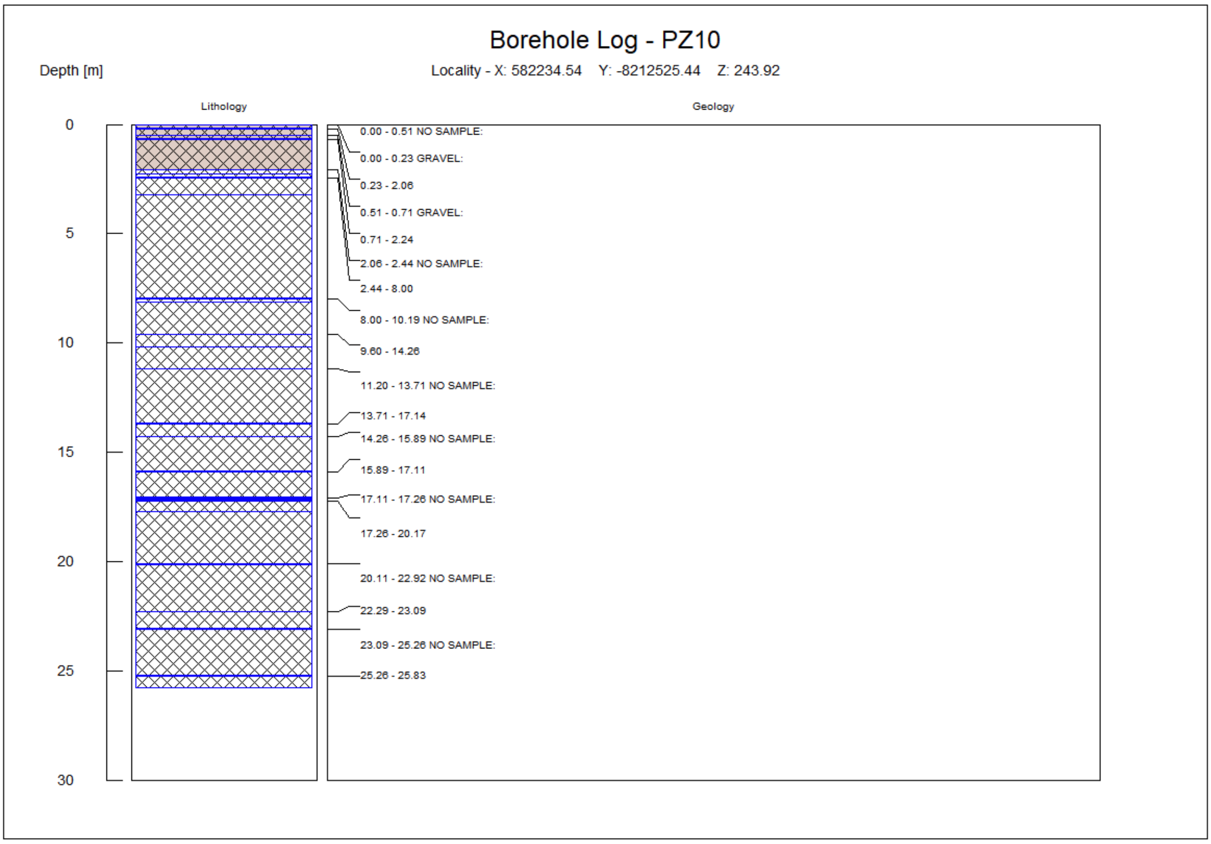

Borehole Log - MW11
Depth [m]
Locality - X: 582591.44 Y: -8212851.38 Z: 216.40
Lithology
Geology
0
5
10
15
20
25
30
35
0.00 - 3.06 SOIL:
3.06 - 4.90
4.90 - 11.94 SILTSTONE:
11.94 - 12.86 ALLUVIUM:
12.86 - 34.90 SILTSTONE:

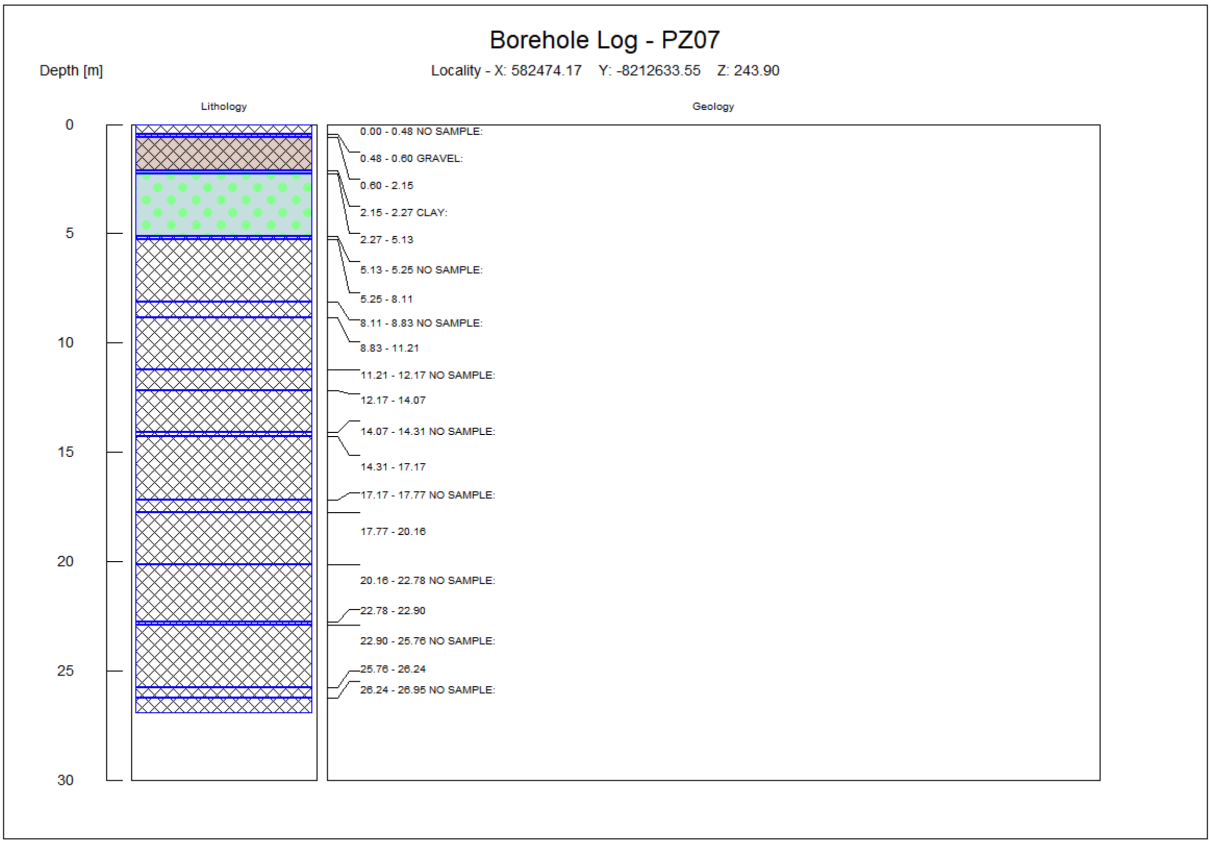

Borehole Log - BH009A (B-H009A)
Depth [m]
Locality - X: 582041.00 Y: -8212588.00 Z: 230.00
Lithology
Geology
0
1
2
3
4
5
6
7
8
9
10
11
12
0.00 - 1.00 SOIL:
1.00 - 12.00 GNEISS:

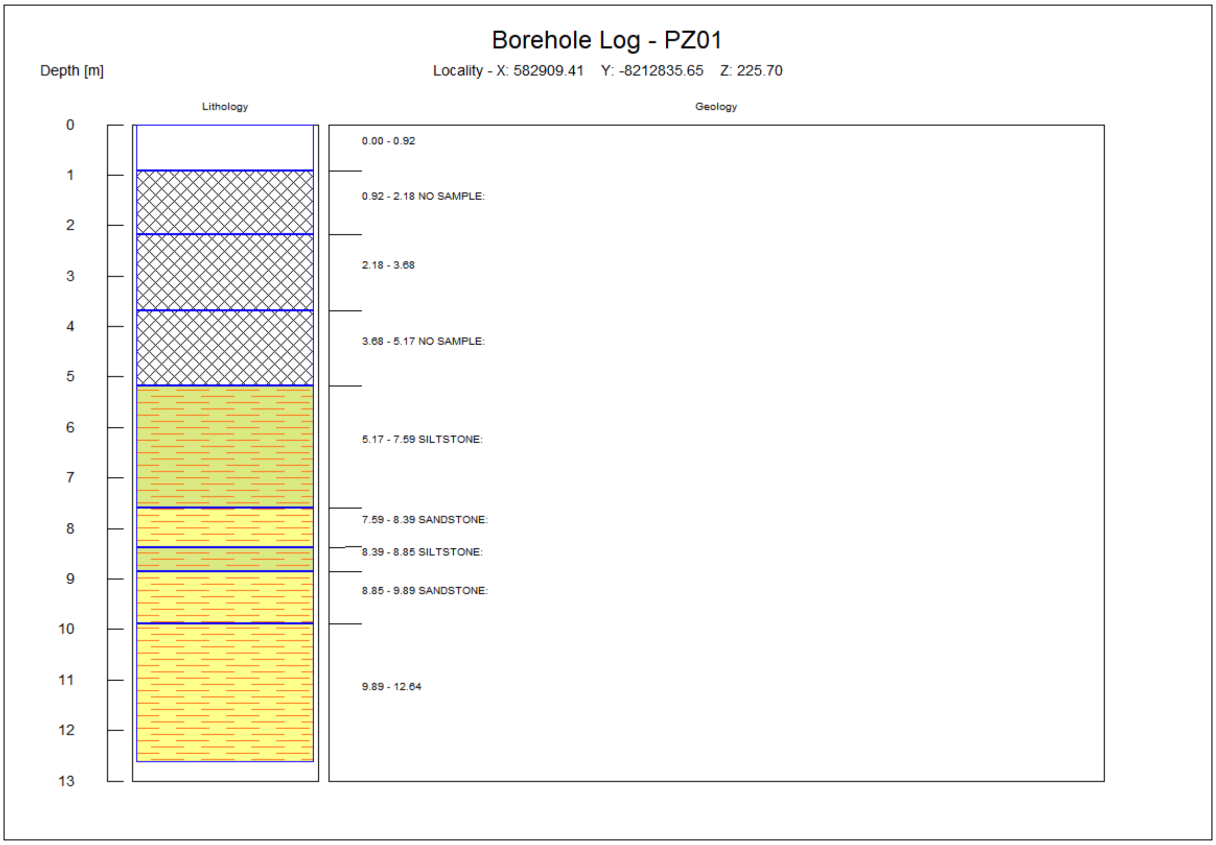

Borehole Log - BH009 (B-H009)
Depth [m]
Locality - X: 582042.00 Y: -8212597.00 Z: 230.00
Lithology
Geology
0
10
20
30
40
50
60
0.00 - 1.00 SOIL:
1.00 - 52.00 GNEISS:


Borehole Log - MW03
Depth [m]
Locality - X: 582168.64 Y: -8212674.17 Z: 224.20
Lithology
Geology
0
5
10
15
20
0.00 - 3.02 SOIL:
3.02 - 11.03 ANORTHOSITE:
11.03 - 19.31 GABBRO:


Borehole Log - PZ11
Depth [m]
Locality - X: 582219.21 Y: -8212564.27 Z: 229.50
Lithology
Geology
0
1
2
3
4
5
6
7
8
9
10
11
12
13
0.00 - 4.29 NO SAMPLE:
4.29 - 5.03
5.03 - 6.63 NO SAMPLE:
6.63 - 8.23
8.23 - 10.11 NO SAMPLE:
10.11 - 10.86
10.86 - 11.77 ANORTHOSITE:
11.77 - 12.57 GABBRO:


Borehole Log - PZ10
Depth [m]
Locality - X: 582234.54 Y: -8212525.44 Z: 243.92
Lithology
Geology
0
5
10
15
20
25
30
0.00 - 0.51 NO SAMPLE:
0.00 - 0.23 GRAVEL:
0.23 - 2.06
0.51 - 0.71 GRAVEL:
0.71 - 2.24
2.06 - 2.44 NO SAMPLE:
2.44 - 8.00
8.00 - 10.19 NO SAMPLE:
9.60 - 14.26
11.20 - 13.71 NO SAMPLE:
13.71 - 17.14
14.26 - 15.89 NO SAMPLE:
15.89 - 17.11
17.11 - 17.26 NO SAMPLE:
17.26 - 20.17
20.11 - 22.92 NO SAMPLE:
22.29 - 23.09
23.09 - 25.26 NO SAMPLE:
25.26 - 25.83


Borehole Log - PZ07
Depth [m]
Locality - X: 582474.17 Y: -8212633.55 Z: 243.90
Lithology
Geology
0
5
10
15
20
25
30
0.00 - 0.48 NO SAMPLE:
0.48 - 0.60 GRAVEL:
0.60 - 2.15
2.15 - 2.27 CLAY:
2.27 - 5.13
5.13 - 5.25 NO SAMPLE:
5.25 - 8.11
8.11 - 8.83 NO SAMPLE:
8.83 - 11.21
11.21 - 12.17 NO SAMPLE:
12.17 - 14.07
14.07 - 14.31 NO SAMPLE:
14.31 - 17.17
17.17 - 17.77 NO SAMPLE:
17.77 - 20.16
20.16 - 22.78 NO SAMPLE:
22.78 - 22.90
22.90 - 25.76 NO SAMPLE:
25.76 - 26.24
26.24 - 26.95 NO SAMPLE:


Borehole Log - PZ01
Depth [m]
Locality - X: 582909.41 Y: -8212835.65 Z: 225.70
Lithology
Geology
0
1
2
3
4
5
6
7
8
9
10
11
12
13
0.00 - 0.92
0.92 - 2.18 NO SAMPLE:
2.18 - 3.68
3.68 - 5.17 NO SAMPLE:
5.17 - 7.59 SILTSTONE:
7.59 - 8.39 SANDSTONE:
8.39 - 8.85 SILTSTONE:
8.85 - 9.89 SANDSTONE:
9.89 - 12.64

UTM 36S Projected Data

| Borehole Name | X (m) | Y (m) | Z (mamsl) | Water Level (mamsl) | Water Level (mbgl) | Depth (mbgl) |
|---|---|---|---|---|---|---|
| MW05 | 582633.1 | 8213004.9 | 216.6 | 215.1 | 1.5 | 35 |
| MW11 | 582591.4 | 8212851.4 | 216.4 | 214.5 | 1.9 | 35 |
| PZ09 | 582433.5 | 8212729.0 | 216.8 | 214.9 | 1.9 | 6.8 |
| S4-Hnew05 | 577335.0 | 8216549.0 | 173.45 | 171.3 | 2.15 | 106 |
| A-HA008 | 569835.0 | 8218383.0 | 130.14 | 127.2 | 2.94 | 36 |
| A-HA008A | 569819.0 | 8218348.0 | 130.95 | 127.8 | 3.15 | 38 |
| S6-H003B | 581168.0 | 8216083.0 | 187.81 | 184.4 | 3.41 | 25 |
| S5-HA003 | 576492.0 | 8222867.0 | 135.25 | 131.8 | 3.45 | 22.5 |
| S6-H008B | 580785.0 | 8217681.0 | 164.42 | 160.9 | 3.52 | 17 |
| S6-H003 | 581220.0 | 8216098.0 | 187.56 | 184 | 3.56 | 88 |
| S6-H002 | 581806.0 | 8218480.0 | 205.93 | 202.3 | 3.63 | 103 |
| S6-H008 | 580808.0 | 8217719.0 | 165.03 | 161.3 | 3.73 | 186 |
| S5-HA004 | 576528.0 | 8222849.0 | 135.42 | 131.6 | 3.82 | 24 |
| A-HA009F | 569356.1 | 8216622.1 | 131.77 | 127.7 | 4.07 | |
| PZ01 | 582909.4 | 8212835.7 | 225.7 | 221.6 | 4.1 | 12.7 |
| MW03 | 582168.6 | 8212674.2 | 224.2 | 220 | 4.2 | 19.2 |
| S5-HA006 | 576409.0 | 8222402.0 | 135.74 | 131.5 | 4.24 | 28 |
| S6-H006 | 582698.0 | 8217105.0 | 216.96 | 212.7 | 4.26 | 40 |
| S6-H008A | 580805.0 | 8217695.0 | 164.81 | 160.4 | 4.41 | 18 |
| S5-HA001 | 576588.0 | 8223277.0 | 136.2 | 131.6 | 4.6 | 23 |
| A-HA009A | 569128.0 | 8216840.0 | 132.04 | 127.3 | 4.74 | 41 |
| S6-H003A | 581171.0 | 8216079.0 | 187.56 | 182.8 | 4.76 | 82 |
| S5-HA001A | 576602.0 | 8223263.0 | 137.27 | 132.5 | 4.77 | 7.5 |
| S5-HA007 | 576452.0 | 8222369.0 | 136.33 | 131.5 | 4.83 | 22 |
| S4-H004 | 577904.0 | 8216544.0 | 179.55 | 174.7 | 4.85 | 157 |
| S5-HA005 | 576570.0 | 8222839.0 | 136.71 | 131.7 | 5.01 | 26 |
| A-HA009 | 569138.0 | 8216791.0 | 133.7 | 128.6 | 5.1 | 41 |
| S5-HA002 | 576617.0 | 8223248.0 | 137.76 | 132.5 | 5.26 | 7 |
| S4-H005 | 578227.0 | 8215018.0 | 188.13 | 182.4 | 5.73 | 102 |
| S1-H002B | 582808.0 | 8215242.0 | 197.37 | 191.6 | 5.77 | 30 |
| S5-H003B | 577822.0 | 8220024.0 | 151.42 | 145.4 | 6.02 | 25 |
| S1-H002 | 582802.0 | 8215186.0 | 197.51 | 191.4 | 6.11 | 127 |
| S3-H003A | 573516.0 | 8217337.0 | 149.85 | 143.7 | 6.15 | 81 |
| S3-H003 | 573511.0 | 8217417.0 | 149.49 | 143.3 | 6.19 | 117 |
| PS2ANA003 | 586142.3 | 8209877.5 | 201.61 | 195.4 | 6.21 | 16.48 |
| S5-H003 | 577803.0 | 8220017.0 | 151.15 | 144.7 | 6.45 | 27 |
| PZ12 | 582591.0 | 8210785.0 | 233.27 | 226.8 | 6.47 | 13.27 |
| S6-183 | 581135.0 | 8216976.0 | 181.7 | 175.2 | 6.5 | 47.8 |
| S1-329 | 582629.0 | 8215330.0 | 197 | 190.5 | 6.5 | 10 |
| S6-180 | 581091.0 | 8216952.0 | 182.2 | 175.6 | 6.6 | 8.5 |
| B-H016A | 586062.0 | 8208539.0 | 191 | 184.4 | 6.6 | 14 |
| PS2ANA008 | 587031.7 | 8210166.0 | 209.06 | 202.4 | 6.66 | 31.13 |
| S6-182 | 581179.0 | 8217000.0 | 181.7 | 174.9 | 6.8 | 9 |
| B-H016 | 586060.0 | 8208522.0 | 191 | 184.2 | 6.8 | 106 |
| S3-H001 | 573023.0 | 8216990.0 | 151.12 | 144.3 | 6.82 | 140 |
| S1-327 | 582617.0 | 8215075.0 | 197.6 | 190.7 | 6.9 | 13 |
| S5-H001 | 576607.0 | 8222290.0 | 138.33 | 131.4 | 6.93 | 24 |
| PS5NA006 | 576451.9 | 8222368.9 | 135.9 | 128.9 | 7 | 12.23 |
| PZ11 | 582219.2 | 8212564.3 | 229.5 | 222.4 | 7.1 | 12.5 |
| S5-H003A | 577850.0 | 8220069.0 | 152.71 | 145.6 | 7.11 | 30 |
| S3-H001A | 573027.0 | 8216913.0 | 149.54 | 142.4 | 7.14 | 100 |
| INS2ANA001 | 585526.8 | 8212851.2 | 220.3 | 213.1 | 7.2 | 21.51 |
| S1-328 | 582524.0 | 8215518.0 | 197.9 | 190.6 | 7.3 | 71 |
| APP01 | 569302.2 | 8217269.6 | 132.72 | 125.4 | 7.32 | |

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|---|---|---|---|---|---|---|
| Geotech-01 | 589060.0 | 8209514.0 | 202.97 | 195.6 | 7.37 | 125.08 |
| APP02 | 569304.8 | 8217129.3 | 132.76 | 125.2 | 7.56 | 29 |
| S2-H003A | 586879.0 | 8212587.0 | 225.89 | 218.3 | 7.59 | 42 |
| APP05 | 569215.3 | 8216176.0 | 132.72 | 125.1 | 7.62 | 30 |
| INS2ANA002 | 585236.6 | 8213485.5 | 221.43 | 213.8 | 7.63 | 20.58 |
| APP03 | 569301.5 | 8216969.4 | 132.86 | 125.2 | 7.66 | 29.5 |
| APP04 | 569199.7 | 8216050.3 | 132.68 | 125 | 7.68 | 27 |
| S2-H004B | 587502.0 | 8211265.0 | 216.75 | 208.7 | 8.05 | 30 |
| S2-H003 | 586859.0 | 8212567.0 | 225.91 | 217.8 | 8.11 | 222 |
| S2-H006 | 587438.0 | 8211880.0 | 222.56 | 214.4 | 8.16 | 120 |
| B-H017 | 585878.0 | 8211368.0 | 210 | 201.8 | 8.2 | 95 |
| S6-162 | 581805.0 | 8215662.0 | 192.9 | 184.6 | 8.3 | 11 |
| INS2ANA003 | 585712.0 | 8212500.7 | 218.82 | 210.4 | 8.42 | 21.17 |
| S6-222 | 581111.0 | 8217190.0 | 181.9 | 173.3 | 8.6 | 94 |
| S6-H004C | 581754.0 | 8217116.0 | 187.92 | 179.3 | 8.62 | 109 |
| S1-H004 | 583459.0 | 8215160.0 | 199.25 | 190.4 | 8.85 | 121 |
| B-H018 | 586345.0 | 8210511.0 | 208 | 199.1 | 8.9 | 101.4 |
| MW08 | 583464.0 | 8212534.0 | 238 | 229.1 | 8.9 | 43 |
| S2-H001 | 588332.0 | 8210575.0 | 218.75 | 209.8 | 8.95 | 150 |
| B-H018A | 586358.0 | 8210506.0 | 208 | 199 | 9 | 15.5 |
| PS2ANA007 | 588013.5 | 8208127.6 | 193.48 | 184.2 | 9.28 | 18.9 |
| S4-H006 | 575376.0 | 8216847.0 | 167.39 | 157.8 | 9.59 | 312 |
| Geotech-02 | 589579.0 | 8210688.0 | 226.35 | 216.6 | 9.75 | 71.12 |
| S4-H006A | 575347.0 | 8216866.0 | 165.97 | 156.2 | 9.77 | 30 |
| S6-H004A | 581770.0 | 8217141.0 | 184.92 | 175.1 | 9.82 | 108 |
| S6-177 | 582015.0 | 8215634.0 | 195 | 185 | 10 | 16 |
| B-H005A | 585625.0 | 8209858.0 | 204 | 193.8 | 10.2 | 14 |
| B-H005 | 585627.0 | 8209832.0 | 205 | 194.8 | 10.2 | 57 |
| S1-H001 | 581679.0 | 8213857.0 | 207.5 | 197.2 | 10.3 | 117 |
| S1-H001A | 581777.0 | 8213921.0 | 206.46 | 196 | 10.46 | 110 |
| ROVINA003 | 569280.2 | 8215998.2 | 129.39 | 118.9 | 10.49 | 28 |
| UGW20 | 580575.0 | 8217470.0 | 167.1 | 156.6 | 10.5 | 15 |
| B-H011A | 583861.0 | 8211939.0 | 232 | 221.4 | 10.6 | 15 |
| S2-H004 | 587496.0 | 8211281.0 | 215.78 | 205 | 10.78 | 132 |
| S6-178 | 582037.0 | 8215639.0 | 194.9 | 184.1 | 10.8 | 51 |
| ROVINA001 | 569563.0 | 8217688.3 | 130.51 | 119.6 | 10.91 | 30 |
| B-H014 | 581416.0 | 8208310.0 | 188 | 177 | 11 | 118 |
| UGW5 | 582353.9 | 8215627.0 | 200 | 188.9 | 11.1 | 68 |
| Chipanga-7A | 578156.0 | 8219004.0 | 158.2 | 146.9 | 11.3 | |
| S1-H005 | 581315.0 | 8213844.0 | 211.34 | 200 | 11.34 | 45.5 |
| S6-H001 | 582503.0 | 8215684.0 | 202.36 | 191 | 11.36 | 42 |
| S6-H006A | 582695.0 | 8217104.0 | 216.77 | 205.4 | 11.37 | 100 |
| UGW19 | 580560.0 | 8217461.0 | 173.7 | 162.3 | 11.4 | 15 |
| S6-161 | 581827.0 | 8215674.0 | 195.5 | 184.1 | 11.4 | 21 |
| S6-H004B | 581773.0 | 8217134.0 | 184.94 | 173.5 | 11.44 | 40 |
| S4-Hnew02 | 578757.0 | 8216340.0 | 193.27 | 181.5 | 11.77 | 80 |
| S1-Hnew01 | 583477.0 | 8216000.0 | 202.87 | 191.1 | 11.77 | 50 |
| S2-H005 | 588470.0 | 8211206.0 | 224.3 | 212.5 | 11.8 | 144 |
| B-H014A | 581409.0 | 8208296.0 | 188 | 176 | 12 | 16 |
| B-H010 | 582758.0 | 8213733.0 | 216 | 204 | 12 | 81 |
| S4-Hnew01 | 578773.0 | 8216321.0 | 194.95 | 182.8 | 12.15 | 60 |
| S6-194 | 581678.0 | 8216016.0 | 196.2 | 183.8 | 12.4 | 40 |
| S6-197 | 582185.0 | 8216096.0 | 196.1 | 183.7 | 12.4 | 84 |
| S6-175 | 581972.0 | 8215624.0 | 196.4 | 183.9 | 12.5 | 36 |
| S6-168 | 581503.0 | 8216096.0 | 196.7 | 184.2 | 12.5 | 13.5 |
| ROVINA002 | 569304.6 | 8216781.3 | 130.08 | 117.4 | 12.68 | 36 |
| B-H011 | 583844.0 | 8211934.0 | 232 | 219.3 | 12.7 | 57 |

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|---|---|---|---|---|---|---|
| S6-206 | 581575.0 | 8216793.0 | 189.1 | 176.3 | 12.8 | 51 |
| S6-208 | 581756.0 | 8217065.0 | 189.3 | 176.4 | 12.9 | 45 |
| S2-H004A | 587493.0 | 8211302.0 | 217.87 | 204.9 | 12.97 | 129 |
| B-H012A | 582155.0 | 8213071.0 | 219 | 206 | 13 | 13 |
| S6-214 | 581531.0 | 8216769.0 | 189.2 | 175.9 | 13.3 | 38.5 |
| MW10 | 583268.0 | 8211689.0 | 243.6 | 230.3 | 13.3 | 48.6 |
| S6-166 | 581937.0 | 8215733.0 | 196.7 | 183.2 | 13.5 | 15 |
| S1-Hnew03-Obs | 583515.0 | 8215968.0 | 204.84 | 191.2 | 13.64 | 50 |
| S6-215 | 581509.0 | 8216757.0 | 190.2 | 176.5 | 13.7 | 35 |
| S6-169 | 581611.0 | 8216158.0 | 198 | 184.3 | 13.7 | 45.5 |
| S6-218 | 581487.0 | 8216745.0 | 190.1 | 176 | 14.1 | 25 |
| S6-216 | 582223.0 | 8217214.0 | 190.3 | 176.1 | 14.2 | 30 |
| S2-H007 | 588122.0 | 8211944.0 | 242.47 | 228.2 | 14.27 | 97 |
| S6-219 | 581465.0 | 8216733.0 | 190.6 | 176.2 | 14.4 | 20.5 |
| S6-210 | 581640.0 | 8216829.0 | 190.9 | 176.4 | 14.5 | 49 |
| S6-204 | 581421.0 | 8216709.0 | 193.1 | 178.2 | 14.9 | 80 |
| S6-172 | 581697.0 | 8216209.0 | 198.7 | 183.6 | 15.1 | 19.5 |
| S6-171 | 581719.0 | 8216221.0 | 199 | 183.6 | 15.4 | 20.5 |
| S4-Hnew03 | 578802.0 | 8216293.0 | 199.79 | 184.3 | 15.49 | 60 |
| Geotech-05 | 578699.0 | 8215998.0 | 201.79 | 186.3 | 15.49 | 40.12 |
| S6-220 | 581443.0 | 8216721.0 | 192.2 | 176.5 | 15.7 | 25 |
| S6-191 | 581748.0 | 8215840.0 | 200.2 | 184.5 | 15.7 | 18 |
| MW07 | 583516.0 | 8212744.0 | 240.9 | 225.1 | 15.8 | 45.9 |
| MW09 | 583240.0 | 8211904.0 | 243.5 | 227.6 | 15.9 | 48.5 |
| S4-H002A | 578688.0 | 8215695.0 | 197.05 | 180.7 | 16.35 | 75 |
| S4-H002 | 578700.0 | 8215717.0 | 197.18 | 180.8 | 16.38 | 141 |
| Geotech-04 | 589316.0 | 8209629.0 | 208 | 191.6 | 16.4 | 53.06 |
| S6-211 | 581662.0 | 8216841.0 | 193.5 | 176.5 | 17 | 70 |
| S1-Hnew02-Obs | 583602.0 | 8216060.0 | 211.19 | 194.1 | 17.09 | 60 |
| B-H003 | 585952.0 | 8214153.0 | 243.09 | 225.7 | 17.39 | 98 |
| S6-213 | 581553.0 | 8216781.0 | 193.9 | 176.5 | 17.4 | 71 |
| S6-212 | 581684.0 | 8216853.0 | 194.1 | 176.5 | 17.6 | 70 |
| S6-221 | 581284.0 | 8217174.0 | 177.7 | 160 | 17.7 | 19 |
| PZ04 | 582654.4 | 8212715.2 | 243.8 | 224.5 | 19.3 | 25.8 |
| S4-Hnew04 | 578751.0 | 8215766.0 | 200.15 | 180.6 | 19.55 | 100 |
| PZ10 | 582234.5 | 8212525.4 | 243.92 | 223.3 | 20.62 | 22.92 |
| S5-H004A | 576661.0 | 8220388.0 | 156.19 | 135.3 | 20.89 | 57 |
| S5-H004B | 576614.0 | 8220538.0 | 156.96 | 135.8 | 21.16 | 100 |
| RG04NA001 | 588210.1 | 8207236.6 | 181.85 | 159.9 | 21.95 | 21.9 |
| B-H010A | 582744.0 | 8213732.0 | 215 | 193 | 22 | 22 |
| B-H012 | 582152.0 | 8213062.0 | 219 | 197 | 22 | 67 |
| PS4NA001 | 575927.0 | 8216221.0 | 174.32 | 152 | 22.32 | 22.72 |
| S5-H004 | 576626.0 | 8220443.0 | 155.72 | 133.2 | 22.52 | 54 |
| S4-H002B | 578696.0 | 8215694.0 | 197.15 | 174.6 | 22.55 | 30 |
| B-H006 | 584402.0 | 8212300.0 | 242 | 219.4 | 22.6 | 55 |
| PS1NA002 | 581037.8 | 8211999.1 | 239.9 | 217.1 | 22.8 | 21.4 |
| PZ07 | 582474.2 | 8212633.6 | 243.9 | 220.7 | 23.2 | 26.9 |
| PS4NA004 | 578766.4 | 8216322.4 | 194.91 | 171.4 | 23.51 | 60 |
| B-H009 | 582042.0 | 8212597.0 | 230 | 206.4 | 23.6 | 52 |
| B-H015 | 583561.0 | 8212694.0 | 238 | 214 | 24 | 57 |
| PS2ANA006 | 583794.7 | 8212633.8 | 241.74 | 217.6 | 24.14 | 30.65 |
| S6-201 | 581064.0 | 8217322.0 | 184.8 | 160.6 | 24.2 | 36 |
| Geotech-03 | 578753.0 | 8215968.0 | 206.92 | 182 | 24.92 | 137.05 |
| PS2ANA001 | 588466.2 | 8211202.7 | 223.88 | 198.9 | 24.98 | 15.4 |
| S6-199 | 581086.0 | 8217334.0 | 185.4 | 160.2 | 25.2 | 42.5 |
| B-H001A | 576684.0 | 8214928.0 | 206.43 | 180.2 | 26.23 | 50 |

| | | | | | | |
|---|---|---|---|---|---|---|
| B-H001 | 576676.0 | 8214940.0 | 206.6 | 179.8 | 26.8 | 102 |
| MW02 | 581748.6 | 8212291.3 | 244 | 217.2 | 26.8 | 49 |
| PS1NA001 | 581025.5 | 8214035.0 | 223.7 | 196.7 | 27 | 30 |
| PS2ANA005 | 583190.3 | 8209880.7 | 240.86 | 211.5 | 29.36 | 30.61 |
| | | | | | | |
| MW01 | 581894.4 | 8211867.8 | 248.78 | 218.1 | 30.68 | 49.8 |
| PS2ANA002 | 590380.7 | 8208943.9 | 211.38 | 178.5 | 32.88 | 150.2 |
| PS2ANA004 | 585102.3 | 8208050.7 | 205.36 | 168.4 | 36.96 | 33 |
| WDS2ANA003 | 587107.5 | 8208653.4 | 241.12 | 200.8 | 40.32 | |
| B-H007 | 584733.0 | 8209587.0 | 214 | 168.8 | 45.2 | 60 |
| PN001NA002 | 586379.7 | 8211993.4 | 250.71 | 205.3 | 45.41 | |
| PS4NA003 | 578746.1 | 8215972.5 | 206.31 | 159.9 | 46.41 | 90 |
| WDS2ANA004 | 587107.5 | 8208653.4 | 241.12 | 193.3 | 47.82 | |
| PN001NA001 | 586379.7 | 8211993.4 | 250.71 | 177.5 | 73.21 | |

# *Annexure C: NGA and WARMS Resource Summary Information*

| ER | ID | LONGITUDE | LATITUDE | ELEV | DEPTH |
|---|---|---|---|---|---|
| 294 | 026098D | 27.56198 | -27.94686 | 1520 | 43.4 |
| 294 | 026098E | 27.56174 | -27.94453 | 1513 | 31.7 |
| 294 | 026247D | 27.57855 | -27.93979 | 1530 | 37.8 |
| 294 | 026247E | 27.57857 | -27.93977 | 1530 | 31.7 |
| 294 | 026248D | 27.57404 | -27.93925 | 1524 | 18.2 |
| 294 | 026248E | 27.58023 | -27.94070 | 1531 | 46.0 |
| 294 | 026251D | 27.57975 | -27.94001 | 1531 | 19.5 |
| 294 | 026251E | 27.57936 | -27.93953 | 1532 | 37.8 |
| 294 | 20360 | 27.23298 | -27.61741 | 1430 | |
| 294 | 2429DD00139 | 27.67521 | -27.55945 | 1521 | 80.0 |
| 294 | 2429DD00140 | 27.67521 | -27.55945 | 1521 | 80.0 |
| 294 | 2429DD00143 | 27.67532 | -27.55936 | 1521 | 80.0 |
| 294 | 26096 | 27.55533 | -27.94854 | 1520 | |
| 294 | 26096A | 27.55555 | -27.94693 | 1515 | |
| 294 | 26097B | 27.54145 | -27.94799 | 1495 | |
| 294 | 26097C | 27.54145 | -27.94830 | 1493 | |
| 294 | 26098A | 27.56162 | -27.94439 | 1515 | |
| 294 | 26098B | 27.56174 | -27.94465 | 1512 | |
| 294 | 26098C | 27.56191 | -27.94515 | 1514 | |
| 294 | 26099 | 27.56853 | -27.94153 | 1520 | |
| 294 | 26099A | 27.56855 | -27.94177 | 1521 | |
| 294 | 26099B | 27.57237 | -27.94139 | 1527 | |
| 294 | 26203 | 27.67521 | -27.55949 | 1521 | |
| 294 | 26204 | 27.67521 | -27.55953 | 1521 | |
| 294 | 26205 | 27.67537 | -27.55936 | 1522 | |
| 294 | 26206 | 27.67521 | -27.55951 | 1521 | |
| 294 | 26207 | 27.67536 | -27.55936 | 1522 | |
| 294 | 26208 | 27.67521 | -27.55950 | 1521 | |
| 294 | 26209 | 27.67535 | -27.55936 | 1522 | |
| 294 | 26209A | 27.67521 | -27.55948 | 1521 | |
| 294 | 26209B | 27.67533 | -27.55936 | 1522 | |
| 294 | 26209C | 27.67521 | -27.55944 | 1521 | |
| 294 | 26210 | 27.67531 | -27.55936 | 1521 | |
| 294 | 26210A | 27.67534 | -27.55936 | 1522 | |
| 294 | 26211 | 27.67521 | -27.55946 | 1521 | |
| 294 | 26212A | 27.67521 | -27.55947 | 1521 | |
| 294 | 26213 | 27.67530 | -27.55936 | 1521 | |
| 294 | 26244 | 27.57427 | -27.93976 | 1528 | |
| 294 | 26245 | 27.57843 | -27.94118 | 1533 | |
| 294 | 26245A | 27.57832 | -27.94199 | 1536 | |
| 294 | 26246 | 27.54915 | -27.94956 | 1504 | |
| 294 | 26247 | 27.57855 | -27.93977 | 1530 | |
| 294 | 26247A | 27.57855 | -27.93978 | 1530 | |
| 294 | 26247B | 27.57853 | -27.93980 | 1530 | |
| 294 | 26247C | 27.57856 | -27.93977 | 1530 | |

| | | | | | |
|---|---|---|---|---|---|
| 294 | 26247F | 27.57855 | -27.93980 | 1530 | |
| 294 | 26248 | 27.57854 | -27.94003 | 1529 | |
| 294 | 26248A | 27.57854 | -27.94015 | 1529 | |
| 294 | 26248B | 27.57413 | -27.93945 | 1525 | |
| 294 | 26248C | 27.57867 | -27.94026 | 1530 | |
| 294 | 26248F | 27.57919 | -27.94048 | 1530 | |
| 294 | 26249 | 27.52426 | -27.94501 | 1477 | |
| 294 | 26249A | 27.52454 | -27.94615 | 1480 | |
| 294 | 26250 | 27.57940 | -27.94438 | 1547 | |
| 294 | 26250A | 27.57837 | -27.94451 | 1546 | |
| 294 | 26251 | 27.57937 | -27.93996 | 1530 | |
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| 294 | 2727DA00111 | 27.60173 | -27.56038 | 1510 | 24.4 |
| 294 | 2727DA00112 | 27.60354 | -27.56130 | 1510 | 16.5 |
| 294 | 2727DA00113 | 27.60185 | -27.56244 | 1508 | 21.3 |
| 294 | 2727DA00114 | 27.71311 | -27.60162 | 1538 | 23.7 |
| 294 | 2727DA00115 | 27.70858 | -27.60572 | 1534 | |
| 294 | 2727DA00116 | 27.69109 | -27.59502 | 1563 | |
| 294 | 2727DA00117 | 27.70635 | -27.58548 | 1546 | |
| 294 | 2727DA00118 | 27.57967 | -27.54567 | 1499 | 27.4 |
| 294 | 2727DA00119 | 27.67220 | -27.55309 | 1507 | 15.5 |
| 294 | 2727DA00120 | 27.67220 | -27.55310 | 1507 | |
| 294 | 2727DA00121 | 27.67221 | -27.55309 | 1507 | |
| 294 | 2727DA00122 | 27.67220 | -27.55311 | 1507 | |
| 294 | 2727DA00123 | 27.67222 | -27.55309 | 1507 | |
| 294 | 2727DA00124 | 27.67220 | -27.55312 | 1507 | 51.0 |
| 294 | 2727DA00125 | 27.67223 | -27.55309 | 1507 | 30.0 |
| 294 | 2727DA00126 | 27.67220 | -27.55313 | 1507 | 30.0 |
| 294 | 2727DA00127 | 27.67224 | -27.55309 | 1507 | 30.0 |
| 294 | 2727DA00128 | 27.67220 | -27.55314 | 1507 | 50.0 |
| 294 | 2727DA00129 | 27.67220 | -27.55669 | 1508 | |
| 294 | 2727DA00130 | 27.67575 | -27.55669 | 1519 | |
| 294 | 2727DA00131 | 27.67575 | -27.55670 | 1519 | 30.0 |
| 294 | 2727DA00132 | 27.67576 | -27.55669 | 1519 | |
| 294 | 2727DA00133 | 27.67575 | -27.55671 | 1519 | |
| 294 | 2727DA00134 | 27.67225 | -27.55309 | 1507 | 39.0 |
| 294 | 2727DA00135 | 27.67599 | -27.54798 | 1509 | |
| 294 | 2727DA00136 | 27.67599 | -27.54799 | 1509 | 30.0 |
| 294 | 2727DA00137 | 27.67600 | -27.54798 | 1509 | |
| 294 | 2727DA00138 | 27.67462 | -27.55450 | 1516 | |
| 294 | 2727DA00139 | 27.67630 | -27.55349 | 1519 | 150.0 |
| 294 | 2727DA00140 | 27.67630 | -27.55350 | 1519 | 90.0 |
| 294 | 2727DA00141 | 27.67631 | -27.55349 | 1519 | 75.0 |
| 294 | 2727DA00142 | 27.67462 | -27.55451 | 1516 | |

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|---|---|---|---|---|---|
| 294 | 2727DA00143 | 27.67463 | -27.55450 | 1516 | |
| 294 | 2727DA00144 | 27.67462 | -27.55452 | 1516 | |
| 294 | 2727DA00145 | 27.67577 | -27.55669 | 1519 | 108.0 |
| 294 | 2727DA00146 | 27.67630 | -27.55351 | 1519 | 34.0 |
| 294 | 2727DA00147 | 27.67632 | -27.55349 | 1519 | 32.0 |
| 294 | 2727DA00148 | 27.67630 | -27.55352 | 1519 | 79.0 |
| 294 | 2727DA00149 | 27.67599 | -27.54800 | 1509 | 34.7 |
| 294 | 2727DA00150 | 27.67575 | -27.55672 | 1519 | |
| 294 | 2727DA00151 | 27.67578 | -27.55669 | 1519 | |
| 294 | 2727DA00152 | 27.67575 | -27.55673 | 1519 | |
| 294 | 2727DA00153 | 27.67579 | -27.55669 | 1519 | 24.0 |
| 294 | 2727DA00154 | 27.67575 | -27.55674 | 1519 | |
| 294 | 2727DA00155 | 27.67580 | -27.55669 | 1519 | 36.0 |
| 294 | 2727DA00156 | 27.67575 | -27.55675 | 1519 | 36.0 |
| 294 | 2727DA00157 | 27.67581 | -27.55669 | 1519 | 40.0 |
| 294 | 2727DA00158 | 27.67575 | -27.55676 | 1519 | 34.0 |
| 294 | 2727DA00159 | 27.67963 | -27.55398 | 1518 | |
| 294 | 2727DA00160 | 27.67963 | -27.55399 | 1518 | 66.0 |
| 294 | 2727DA00161 | 27.67633 | -27.55349 | 1519 | |
| 294 | 2727DA00162 | 27.67630 | -27.55353 | 1519 | |
| 294 | 2727DA00163 | 27.67634 | -27.55349 | 1519 | |
| 294 | 2727DA00164 | 27.67630 | -27.55354 | 1519 | |
| 294 | 2727DA00165 | 27.67794 | -27.55580 | 1520 | |
| 294 | 2727DA00166 | 27.67795 | -27.55580 | 1520 | |
| 294 | 2727DA00167 | 27.67794 | -27.55581 | 1520 | |
| 294 | 2727DA00168 | 27.67964 | -27.55398 | 1518 | 30.0 |
| 294 | 2727DA00169 | 27.67796 | -27.55580 | 1520 | |
| 294 | 2727DA00170 | 27.67794 | -27.55582 | 1520 | |
| 294 | 2727DA00171 | 27.67797 | -27.55580 | 1520 | |
| 294 | 2727DA00172 | 27.67794 | -27.55377 | 1519 | |
| 294 | 2727DA00173 | 27.68124 | -27.54873 | 1508 | 31.4 |
| 294 | 2727DA00174 | 27.68124 | -27.54874 | 1508 | 31.5 |
| 294 | 2727DA00175 | 27.68125 | -27.54873 | 1508 | |
| 294 | 2727DA00176 | 27.68124 | -27.54875 | 1508 | |
| 294 | 2727DA00177 | 27.68126 | -27.54873 | 1508 | |
| 294 | 2727DA00178 | 27.67963 | -27.55400 | 1518 | |
| 294 | 2727DA00179 | 27.67965 | -27.55398 | 1518 | 76.0 |
| 294 | 2727DA00180 | 27.67963 | -27.55401 | 1518 | 120.0 |
| 294 | 2727DA00181 | 27.67966 | -27.55398 | 1519 | |
| 294 | 2727DA00182 | 27.67963 | -27.55402 | 1518 | |
| 294 | 2727DA00183 | 27.67967 | -27.55398 | 1519 | 36.0 |
| 294 | 2727DA00184 | 27.67794 | -27.55583 | 1520 | 48.0 |
| 294 | 2727DA00185 | 27.67798 | -27.55580 | 1520 | |
| 294 | 2727DA00186 | 27.67794 | -27.55584 | 1520 | |
| 294 | 2727DA00187 | 27.67963 | -27.55403 | 1518 | |
| 294 | 2727DA00188 | 27.67968 | -27.55398 | 1519 | 30.0 |

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|---|---|---|---|---|---|
| 294 | 2727DA00189 | 27.67963 | -27.55404 | 1518 | 36.0 |
| 294 | 2727DA00190 | 27.67969 | -27.55398 | 1519 | 37.0 |
| 294 | 2727DA00191 | 27.67799 | -27.55580 | 1520 | |
| 294 | 2727DA00192 | 27.66677 | -27.55536 | 1497 | 30.6 |
| 294 | 2727DA00193 | 27.66728 | -27.55525 | 1497 | 31.3 |
| 294 | 2727DA00194 | 27.66703 | -27.55503 | 1496 | 33.0 |
| 294 | 2727DA00195 | 27.66704 | -27.55480 | 1497 | 33.0 |
| 294 | 2727DA00196 | 27.66665 | -27.55480 | 1495 | 33.0 |
| 294 | 2727DA00197 | 27.66614 | -27.55490 | 1498 | 33.6 |
| 294 | 2727DA00198 | 27.66700 | -27.54288 | 1486 | 30.0 |
| 294 | 2727DA00199 | 27.67043 | -27.56163 | 1501 | 99.0 |
| 294 | 2727DA00200 | 27.67170 | -27.56379 | 1509 | 73.0 |
| 294 | 2727DA00201 | 27.67181 | -27.56606 | 1511 | 21.9 |
| 294 | 2727DA00202 | 27.67916 | -27.55998 | 1526 | 79.0 |
| 294 | 2727DA00203 | 27.67504 | -27.54645 | 1508 | |
| 294 | 2727DA00204 | 27.66564 | -27.55343 | 1496 | 24.0 |
| 294 | 2727DA00205 | 27.69517 | -27.57461 | 1530 | 55.0 |
| 294 | 2727DA00206 | 27.65770 | -27.55349 | 1503 | 15.0 |
| 294 | 2727DA00207 | 27.66004 | -27.54976 | 1500 | 30.0 |
| 294 | 2727DA00208 | 27.65710 | -27.54815 | 1509 | |
| 294 | 2727DA00209 | 27.67021 | -27.56158 | 1500 | 50.0 |
| 294 | 2727DA00210 | 27.67048 | -27.56130 | 1501 | 50.0 |
| 294 | 2727DA00211 | 27.67521 | -27.55936 | 1521 | 54.9 |
| 294 | 2727DA00212 | 27.67522 | -27.55936 | 1521 | 70.1 |
| 294 | 2727DA00213 | 27.73298 | -27.68380 | 1561 | 76.0 |
| 294 | 2727DA00214 | 27.73299 | -27.68380 | 1561 | 38.0 |
| 294 | 2727DA00215 | 27.73298 | -27.65936 | 1572 | 39.0 |
| 294 | 2727DA00216 | 27.73299 | -27.65936 | 1572 | 38.0 |
| 294 | 2727DA00217 | 27.73298 | -27.65937 | 1572 | 42.0 |
| 294 | 2727DA00218 | 27.69965 | -27.66714 | 1539 | 45.0 |
| 294 | 2727DA00219 | 27.69965 | -27.66715 | 1539 | 30.0 |
| 294 | 2727DA00220 | 27.69966 | -27.66714 | 1539 | 42.0 |
| 294 | 2727DA00251 | 27.67532 | -27.55936 | 1521 | 22.0 |
| 294 | 2727DA00255 | 27.67534 | -27.55936 | 1522 | 37.8 |
| 294 | 2727DA00262 | 27.67521 | -27.55952 | 1521 | 19.5 |
| 294 | 2727DB00024 | 27.76632 | -27.66714 | 1554 | 20.0 |
| 294 | 2727DC00001 | 27.64965 | -27.96714 | 1555 | 60.7 |
| 294 | 2727DC00002 | 27.64966 | -27.96714 | 1555 | 65.5 |
| 294 | 2727DC00003 | 27.64965 | -27.96715 | 1555 | 39.3 |
| 294 | 2727DC00004 | 27.54144 | -27.94773 | 1496 | 37.8 |
| 294 | 2727DC00008 | 27.56169 | -27.94450 | 1514 | 34.8 |
| 294 | 2727DC00049 | 27.54145 | -27.94743 | 1497 | 61.0 |
| 294 | 2727DC00050 | 27.56632 | -27.95047 | 1545 | 43.8 |
| 294 | 2727DC00051 | 27.56633 | -27.95047 | 1545 | 37.8 |
| 294 | 2727DC00052 | 27.56632 | -27.95048 | 1545 | 31.7 |
| 294 | 2727DC00053 | 27.56634 | -27.95047 | 1545 | 22.5 |

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|---|---|---|---|---|---|
| 294 | 2727DC00054 | 27.56632 | -27.95049 | 1545 | 31.7 |
| 294 | 2727DC00055 | 27.56635 | -27.95047 | 1545 | 43.8 |
| 294 | 2727DC00056 | 27.56632 | -27.95050 | 1544 | 56.1 |
| 294 | 2727DC00057 | 27.56636 | -27.95047 | 1545 | 40.0 |
| 294 | 2727DC00058 | 27.56632 | -27.95051 | 1544 | 43.9 |
| 294 | 2727DC00059 | 27.56637 | -27.95047 | 1545 | 25.6 |
| 294 | 2727DC00060 | 27.56632 | -27.95052 | 1544 | 31.7 |
| 294 | 2727DC00061 | 27.56638 | -27.95047 | 1545 | 43.9 |
| 294 | 2727DC00062 | 27.56632 | -27.95053 | 1544 | 31.7 |
| 294 | 2727DC00063 | 27.56639 | -27.95047 | 1545 | 43.0 |
| 294 | 2727DC00064 | 27.56632 | -27.95054 | 1544 | 31.7 |
| 294 | 2727DC00065 | 27.56640 | -27.95047 | 1545 | 62.2 |
| 294 | 2727DC00066 | 27.56632 | -27.95055 | 1544 | 37.8 |
| 294 | 2727DC00067 | 27.56641 | -27.95047 | 1545 | 37.8 |
| 294 | 2727DC00068 | 27.56632 | -27.95056 | 1544 | 19.5 |
| 294 | 2727DC00069 | 27.56642 | -27.95047 | 1545 | 31.7 |
| 294 | 2727DC00070 | 27.56632 | -27.95057 | 1544 | 43.9 |
| 294 | 2727DC00071 | 27.56643 | -27.95047 | 1545 | 13.4 |
| 294 | 2727DC00072 | 27.56632 | -27.95058 | 1544 | 30.5 |
| 294 | 2727DC00073 | 27.56644 | -27.95047 | 1545 | 13.4 |
| 294 | 2727DC00074 | 27.56632 | -27.95059 | 1544 | 31.7 |
| 294 | 2727DC00075 | 27.56645 | -27.95047 | 1545 | 16.4 |
| 294 | 2727DC00076 | 27.56632 | -27.95060 | 1544 | 22.8 |
| 294 | 2727DC00077 | 27.56646 | -27.95047 | 1545 | 18.2 |
| 294 | 2727DC00078 | 27.56632 | -27.95061 | 1544 | 51.8 |
| 294 | 2727DC00079 | 27.56647 | -27.95047 | 1544 | 25.6 |
| 294 | 2727DC00080 | 27.56632 | -27.95062 | 1544 | 46.0 |
| 294 | 2727DC00082 | 27.56632 | -27.95063 | 1544 | 54.8 |
| 294 | 2727DC00083 | 27.56649 | -27.95047 | 1544 | 56.0 |
| 294 | 2727DC00084 | 27.56632 | -27.95064 | 1544 | 19.5 |
| 294 | 2727DC00085 | 27.56650 | -27.95047 | 1544 | 43.4 |
| 294 | 2727DC00086 | 27.56632 | -27.95065 | 1544 | 19.5 |
| 294 | 2727DC00087 | 27.56651 | -27.95047 | 1544 | 19.5 |
| 294 | 2727DC00088 | 27.56632 | -27.95066 | 1544 | 50.0 |
| 294 | 2727DC00089 | 27.56652 | -27.95047 | 1544 | 31.7 |
| 294 | 2727DC00092 | 27.56632 | -27.80325 | 1409 | 6.0 |
| 294 | 2727DC00093 | 27.56632 | -27.95068 | 1544 | 36.0 |
| 294 | 2727DC00094 | 27.56654 | -27.95047 | 1544 | 31.0 |
| 294 | 2727DC00095 | 27.58298 | -27.93377 | 1547 | 37.2 |
| 294 | 2727DC00096 | 27.63298 | -27.76714 | 1478 | 24.4 |
| 294 | 2727DC00097 | 27.63298 | -27.76717 | 1477 | 32.3 |
| 294 | 2727DC00098 | 27.63299 | -27.76714 | 1478 | 39.0 |
| 294 | 2727DC00099 | 27.63298 | -27.76715 | 1478 | 32.0 |
| 294 | 2727DC00100 | 27.58298 | -27.94269 | 1542 | 22.3 |
| 294 | 2727DC00101 | 27.58299 | -27.94269 | 1542 | 10.4 |
| 294 | 2727DC00102 | 27.58298 | -27.94270 | 1542 | 35.2 |

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|---|---|---|---|---|---|
| 294 | 2727DC00103 | 27.58300 | -27.94269 | 1543 | 32.2 |
| 294 | 2727DC00104 | 27.51632 | -27.92603 | 1519 | 77.1 |
| 294 | 2727DC00105 | 27.51633 | -27.92603 | 1519 | 39.6 |
| 294 | 2727DC00106 | 27.51632 | -27.92604 | 1519 | 31.1 |
| 294 | 2727DC00108 | 27.51634 | -27.92603 | 1519 | 77.1 |
| 294 | 2727DC00109 | 27.51632 | -27.92605 | 1519 | 21.3 |
| 294 | 2727DC00110 | 27.59965 | -27.93380 | 1564 | 106.7 |
| 294 | 2727DC00111 | 27.51632 | -27.95047 | 1481 | 23.8 |
| 294 | 2727DC00112 | 27.51633 | -27.95047 | 1481 | 53.6 |
| 294 | 2727DC00113 | 27.51632 | -27.95048 | 1481 | 30.5 |
| 294 | 2727DC00114 | 27.63298 | -27.90047 | 1522 | 35.4 |
| 294 | 2727DC00115 | 27.63298 | -27.90048 | 1522 | 22.3 |
| 294 | 2727DC00116 | 27.63299 | -27.90047 | 1522 | 15.2 |
| 294 | 2727DC00117 | 27.63298 | -27.90049 | 1522 | 13.4 |
| 294 | 2727DC00130 | 27.59965 | -27.76714 | 1448 | 55.0 |
| 294 | 2727DC00131 | 27.59965 | -27.76715 | 1448 | 75.0 |
| 294 | 2727DC00136 | 27.56632 | -27.95069 | 1544 | 26.8 |
| 294 | 2727DC00137 | 27.56655 | -27.95047 | 1544 | 66.8 |
| 294 | 2727DC00138 | 27.56632 | -27.95070 | 1544 | 64.0 |
| 294 | 2727DC00139 | 27.56656 | -27.95047 | 1544 | 86.3 |
| 294 | 2727DC00140 | 27.56632 | -27.95071 | 1544 | 74.7 |
| 294 | 2727DC00141 | 27.56636 | -27.95047 | 1545 | 61.0 |
| 294 | 2727DC00142 | 27.56633 | -27.80325 | 1409 | 6.0 |
| 294 | 2727DC00147 | 27.54965 | -27.93103 | 1512 | 18.0 |
| 294 | 2727DC00148 | 27.58043 | -27.93964 | 1533 | 31.7 |
| 294 | 2727DC00149 | 27.57993 | -27.93936 | 1534 | 80.0 |
| 294 | 2727DC00150 | 27.57993 | -27.93936 | 1534 | 80.0 |
| 294 | 2827BA00034 | 27.66631 | -28.00931 | 1602 | 0.0 |
| 294 | 38668 | 27.20715 | -27.65797 | 1380 | |
| 294 | 41503 | 27.66965 | -27.25853 | 1397 | |
| 294 | FS01114 | 27.65939 | -27.55397 | 1501 | |
| 294 | ZQMAGP3 | 27.66678 | -27.55528 | 1497 | |

| ER | WARMS Registration ID | Longitude | Latitude | Use (L/s) |
|---|---|---|---|---|
| 294 | 23014060 | 27.63564 | -27.95593 | 0.01 |
| 294 | 23002698 | 27.54044 | -27.58133 | 48.40 |
| 294 | 23015960 | 27.27952 | -27.65038 | 0.48 |
| 294 | 23002625 | 27.55925 | -27.95315 | 0.28 |
| 294 | 23002625 | 27.55925 | -27.95315 | 0.84 |
| 294 | 23002625 | 27.55925 | -27.95315 | 7.81 |
| 294 | 23002625 | 27.54397 | -27.96701 | 1.27 |
| 294 | 23002625 | 27.55925 | -27.96148 | 0.28 |

| | | | | |
|---|---|---|---|---|
| 294 | 23002625 | 27.58842 | -27.93926 | 1.11 |
| 294 | 23002625 | 27.55925 | -27.95315 | 0.37 |
| 294 | 23002625 | 27.55925 | -27.95315 | 0.56 |
| 294 | 23002625 | 27.55925 | -27.95315 | 0.37 |
| 294 | 23087419 | 27.68505 | -27.50442 | 0.17 |
| 294 | 23002643 | 27.69121 | -27.56428 | 5.79 |
| 294 | 23000529 | 27.59121 | -27.52678 | 0.09 |
| 294 | 23020286 | 27.33425 | -27.34484 | 0.34 |
| 294 | 23086125 | 27.33136 | -27.35375 | 0.90 |
| 294 | 23018967 | 27.48009 | -27.57483 | 0.29 |
| 294 | 23018967 | 27.46620 | -27.56845 | 0.58 |
| 294 | 23018967 | 27.48009 | -27.57483 | 0.69 |

# *Annexure D: Laboratory Certificates of Analysis*

EPL
ENVIRONMENTAL POLLUTION LABORATORY

sanas Testing Laboratory

# TEST REPORT
# 41076A

**Client and Project Information**

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | JG Afrika | | | | |
| **Address:** | 1ste Floor, Block C Westville | **Attention:** | Robert Schapers | **Project number:** | 5759 |
| | Durban | **Tel:** | (031) 275 5502 | **Project name:** | ROG |
| | 3629 | **Email:** | schapersr@jgafrika.com | | |

**Sample Information**

| | | | | | |
|---|---|---|---|---|---|
| | | | | **Date Received:** | 2022/12/05 |
| **Sample ID:** | **S12** | **Matrix:** | Water | **Date Analysed:** | 2022/12/05 |
| **Units:** | mg/l [ppm] (unless stated elsewhere) | **Container:** | Plastic | **Date Issued:** | 2022/12/21 |

## Cations and Metals

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Al** | 0.17 | **Cd** | <0.003 | **K** | 4.59 | **Pb** | <0.01 | **U*** | <0.03 |
| **As** | <0.01 | **Co** | <0.05 | **Mg** | 22.44 | **Sb** | <0.01 | | |
| **B** | <0.5 | **Cr** | <0.05 | **Mn** | 0.11 | **Se** | <0.01 | | |
| **Ba** | <0.05 | **Cu** | 0.10 | **Na** | 249.10 | **V** | <0.05 | | |
| **Ca** | 57.19 | **Fe** | 0.08 | **Ni** | <0.05 | **Zn** | 0.13 | | |

## Anions (Discrete Analyser)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Cl** | 71.57 | **NO2 as N** | <0.13 | **SO4** | 329.20 | **NO3 + NO2 as N** | <0.5 |
| **F** | 1.43 | **NO3 as N** | <0.5 | | | | |

## Other Parameters

| | | | | | |
|---|---|---|---|---|---|
| **pH** | 8.09 | **Turbidity (NTU)*** | 1.09 | **E.coli (colonies/100ml)*** | 0 |
| **EC (µs/cm)** | 1590 | **NH3 as N*** | 0.04 | **Total Coliforms (colonies/100ml)*** | 400 |
| **TDS** | 1092 | **Total Phenol*** | <0.01 | **Total Plate Count (colonies/ml)*** | 32 |
| **TOC*** | <10 | **Colour (hazen)*** | <10 | | |
| **Free CN*** | <0.002 | **Hg*** | <0.005 | | |

**Disclaimers**

1) The results only relate to the test items provided, in the condition as received.
2) This report may not be reproduced, except in full, without the prior written approval of the laboratory.
3) Parameters marked " * " are not included in the SANAS Schedule of Accreditation for this laboratory.
4) A = Concentration outside calibration range, ** = Outsourced analysis, UTD = Unable to Determine, RTF = Results To Follow, NR = Not Requested.
5) Methods: EPL-WL-001 (Conductivity), EPL-WL-002 (Alkalinity), EPL-WL-003 (pH), EPL-WL-004 (TDS), EPL-WL-005 (Anions by IC), EPL-WL-006 (Cations by IC), EPL-WL-007 (Metals), EPL-WL-008 (Cr(VI)), EPL-WL-009 (TOC), EPL-WL-010 (Hg by DMA), EPL-WL-011 (Anions by Discrete Analyser), EPL-HPLC-001 (Formaldehyde).
6) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

**Miche Kannemeyer**
Authorised Signatory

**Page 12 of 17**

www.epl.co.za 13 Sovereign Drive Route21 Corporate Park Irene South Africa Tel: +27 12 345 1004 info@epl.co.za

EPL
ENVIRONMENTAL POLLUTION LABORATORY

sanas

# TEST REPORT
## 41076A

**Client and Project Information**

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | JG Afrika | | | | |
| **Address:** | 1ste Floor, Block C Westville | **Attention:** | Robert Schapers | **Project number:** | 5759 |
| | Durban | **Tel:** | (031) 275 5502 | **Project name:** | ROG |
| | 3629 | **Email:** | schapersr@jgafrika.com | | |

**Sample Information**

| | | | | | |
|---|---|---|---|---|---|
| | | | | **Date Received:** | 2022/12/05 |
| **Sample ID:** | **S13** | **Matrix:** | Water | **Date Analysed:** | 2022/12/05 |
| **Units:** | mg/l [ppm] (unless stated elsewhere) | **Container:** | Plastic | **Date Issued:** | 2022/12/21 |

### Cations and Metals

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Al** | 0.12 | **Cd** | <0.003 | **K** | 14.04 | **Pb** | <0.01 | **U*** | <0.03 |
| **As** | <0.01 | **Co** | <0.05 | **Mg** | 47.83 | **Sb** | <0.01 | | |
| **B** | <0.5 | **Cr** | <0.05 | **Mn** | <0.05 | **Se** | 0.01 | | |
| **Ba** | <0.05 | **Cu** | 0.06 | **Na** | 197.30 | **V** | <0.05 | | |
| **Ca** | 128.20 | **Fe** | 0.64 | **Ni** | <0.05 | **Zn** | 0.10 | | |

### Anions (Discrete Analyser)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Cl** | 49.16 | **NO2 as N** | <0.13 | **SO4** | 340.30 | **NO3 + NO2 as N** | 4.86 |
| **F** | 0.62 | **NO3 as N** | 4.86 | | | | |

### Other Parameters

| | | | | | |
|---|---|---|---|---|---|
| **pH** | 7.51 | **Turbidity (NTU)*** | 39.49 | **E.coli (colonies/100ml)*** | 0 |
| **EC (µs/cm)** | 1712 | **NH3 as N*** | <0.02 | **Total Coliforms (colonies/100ml)*** | 100 |
| **TDS** | 1078 | **Total Phenol*** | <0.01 | **Total Plate Count (colonies/ml)*** | 151 |
| **TOC*** | <10 | **Colour (hazen)*** | <10 | | |
| **Free CN*** | <0.002 | **Hg*** | <0.005 | | |

**Disclaimers**

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5) Methods: EPL-WL-001 (Conductivity), EPL-WL-002 (Alkalinity), EPL-WL-003 (pH), EPL-WL-004 (TDS), EPL-WL-005 (Anions by IC), EPL-WL-006 (Cations by IC), EPL-WL-007 (Metals), EPL-WL-008 (Cr(VI)), EPL-WL-009 (TOC), EPL-WL-010 (Hg by DMA), EPL-WL-011 (Anions by Discrete Analyser), EPL-HPLC-001 (Formaldehyde).
6) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

**Miche Kannemeyer**
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EPL
ENVIRONMENTAL POLLUTION LABORATORY

sanas Testing Laboratory

# TEST REPORT
# 41076A

**Client and Project Information**

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | JG Afrika | | | | |
| **Address:** | 1ste Floor, Block C Westville | **Attention:** | Robert Schapers | **Project number:** | 5759 |
| | Durban | **Tel:** | (031) 275 5502 | **Project name:** | ROG |
| | 3629 | **Email:** | schapersr@jgafrika.com | | |

**Sample Information**

| | | | | | |
|---|---|---|---|---|---|
| | | | | **Date Received:** | 2022/12/05 |
| **Sample ID:** | **S14** | **Matrix:** | Water | **Date Analysed:** | 2022/12/05 |
| **Units:** | mg/l [ppm] (unless stated elsewhere) | **Container:** | Plastic | **Date Issued:** | 2022/12/21 |

## Cations and Metals

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Al** | 0.14 | **Cd** | <0.003 | **K** | 0.99 | **Pb** | <0.01 | **U*** | <0.03 |
| **As** | 0.01 | **Co** | <0.05 | **Mg** | 26.38 | **Sb** | <0.01 | | |
| **B** | <0.5 | **Cr** | <0.05 | **Mn** | <0.05 | **Se** | <0.01 | | |
| **Ba** | 0.12 | **Cu** | 0.07 | **Na** | 38.83 | **V** | <0.05 | | |
| **Ca** | 50.42 | **Fe** | 0.08 | **Ni** | <0.05 | **Zn** | <0.05 | | |

## Anions (Discrete Analyser)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Cl** | 25.18 | **NO2 as N** | <0.13 | **SO4** | 41.92 | **NO3 + NO2 as N** | <0.5 |
| **F** | 0.10 | **NO3 as N** | <0.5 | | | | |

## Other Parameters

| | | | | | |
|---|---|---|---|---|---|
| **pH** | 7.84 | **Turbidity (NTU)*** | 0.11 | **E.coli (colonies/100ml)*** | 0 |
| **EC (µs/cm)** | 667 | **NH3 as N*** | <0.02 | **Total Coliforms (colonies/100ml)*** | 0 |
| **TDS** | 443 | **Total Phenol*** | <0.01 | **Total Plate Count (colonies/ml)*** | 4 |
| **TOC*** | <10 | **Colour (hazen)*** | <10 | | |
| **Free CN*** | 0.008 | **Hg*** | <0.005 | | |

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5) Methods: EPL-WL-001 (Conductivity), EPL-WL-002 (Alkalinity), EPL-WL-003 (pH), EPL-WL-004 (TDS), EPL-WL-005 (Anions by IC), EPL-WL-006 (Cations by IC), EPL-WL-007 (Metals), EPL-WL-008 (Cr(VI)), EPL-WL-009 (TOC), EPL-WL-010 (Hg by DMA), EPL-WL-011 (Anions by Discrete Analyser), EPL-HPLC-001 (Formaldehyde).
6) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

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ENVIRONMENTAL POLLUTION LABORATORY

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# TEST REPORT 41076A

**Client and Project Information**

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | JG Afrika | | | | |
| **Address:** | 1ste Floor, Block C Westville | **Attention:** | Robert Schapers | **Project number:** | 5759 |
| | Durban | **Tel:** | (031) 275 5502 | **Project name:** | ROG |
| | 3629 | **Email:** | schapersr@jgafrika.com | | |

**Sample Information**

| | | | | | |
|---|---|---|---|---|---|
| | | | | **Date Received:** | 2022/12/05 |
| **Sample ID:** | **S15** | **Matrix:** | Water | **Date Analysed:** | 2022/12/05 |
| **Units:** | mg/l [ppm] (unless stated elsewhere) | **Container:** | Plastic | **Date Issued:** | 2022/12/21 |

## Cations and Metals

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Al** | 0.21 | **Cd** | <0.003 | **K** | 1.36 | **Pb** | <0.01 | **U*** | <0.03 |
| **As** | <0.01 | **Co** | <0.05 | **Mg** | 18.11 | **Sb** | <0.01 | | |
| **B** | <0.5 | **Cr** | <0.05 | **Mn** | <0.05 | **Se** | <0.01 | | |
| **Ba** | 0.19 | **Cu** | 0.08 | **Na** | 47.02 | **V** | <0.05 | | |
| **Ca** | 37.72 | **Fe** | 0.76 | **Ni** | <0.05 | **Zn** | 0.05 | | |

## Anions (Discrete Analyser)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Cl** | 10.53 | **NO2 as N** | <0.13 | **SO4** | 32.55 | **NO3 + NO2 as N** | <0.5 |
| **F** | 0.27 | **NO3 as N** | <0.5 | | | | |

## Other Parameters

| | | | | | |
|---|---|---|---|---|---|
| **pH** | 7.97 | **Turbidity (NTU)*** | 51.59 | **E.coli (colonies/100ml)*** | 0 |
| **EC (µs/cm)** | 568 | **NH3 as N*** | <0.02 | **Total Coliforms (colonies/100ml)*** | 0 |
| **TDS** | 399 | **Total Phenol*** | <0.01 | **Total Plate Count (colonies/ml)*** | 39 |
| **TOC*** | <10 | **Colour (hazen)*** | 26.80 | | |
| **Free CN*** | 0.006 | **Hg*** | <0.005 | | |

**Disclaimers**

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6) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

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# TEST REPORT
## 41076A

**Client and Project Information**

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | JG Afrika | | | | |
| **Address:** | 1ste Floor, Block C Westville | **Attention:** | Robert Schapers | **Project number:** | 5759 |
| | Durban | **Tel:** | (031) 275 5502 | **Project name:** | ROG |
| | 3629 | **Email:** | schapersr@jgafrika.com | | |

**Sample Information**

| | | | | | |
|---|---|---|---|---|---|
| | | | | **Date Received:** | 2022/12/05 |
| **Sample ID:** | **S16** | **Matrix:** | Water | **Date Analysed:** | 2022/12/05 |
| **Units:** | mg/l [ppm] (unless stated elsewhere) | **Container:** | Plastic | **Date Issued:** | 2022/12/21 |

### Cations and Metals

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Al** | 0.15 | **Cd** | <0.003 | **K** | 28.24 | **Pb** | <0.01 | **U*** | <0.03 |
| **As** | <0.01 | **Co** | <0.05 | **Mg** | 17.34 | **Sb** | <0.01 | | |
| **B** | <0.5 | **Cr** | <0.05 | **Mn** | <0.05 | **Se** | <0.01 | | |
| **Ba** | <0.05 | **Cu** | 0.16 | **Na** | 75.99 | **V** | <0.05 | | |
| **Ca** | 10.45 | **Fe** | 0.28 | **Ni** | <0.05 | **Zn** | 0.05 | | |

### Anions (Discrete Analyser)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Cl** | 19.06 | **NO2 as N** | <0.13 | **SO4** | 23.81 | **NO3 + NO2 as N** | <0.5 |
| **F** | 0.28 | **NO3 as N** | <0.5 | | | | |

### Other Parameters

| | | | | | |
|---|---|---|---|---|---|
| **pH** | 8.74 | **Turbidity (NTU)*** | 4.09 | **E.coli (colonies/100ml)*** | 200 |
| **EC (µs/cm)** | 584 | **NH3 as N*** | 0.15 | **Total Coliforms (colonies/100ml)*** | 11700 |
| **TDS** | 628 | **Total Phenol*** | <0.01 | **Total Plate Count (colonies/ml)*** | 156 |
| **TOC*** | 12.52 | **Colour (hazen)*** | 122.00 | | |
| **Free CN*** | <0.002 | **Hg*** | <0.005 | | |

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# TEST REPORT 41076A

**Client and Project Information**

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | JG Afrika | | | | |
| **Address:** | 1ste Floor, Block C Westville Durban 3629 | **Attention:** | Robert Schapers | **Project number:** | 5759 |
| | | **Tel:** | (031) 275 5502 | **Project name:** | ROG |
| | | **Email:** | schapersr@jgafrika.com | | |

**Sample Information**

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | **S17** | **Matrix:** | Water | **Date Received:** | 2022/12/05 |
| **Units:** | mg/l [ppm] (unless stated elsewhere) | **Container:** | Plastic | **Date Analysed:** | 2022/12/05 |
| | | | | **Date Issued:** | 2022/12/21 |

## Cations and Metals

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Al** | 0.24 | **Cd** | <0.003 | **K** | 19.69 | **Pb** | <0.01 | **U*** | <0.03 |
| **As** | <0.01 | **Co** | <0.05 | **Mg** | 39.25 | **Sb** | <0.01 | | |
| **B** | <0.5 | **Cr** | <0.05 | **Mn** | <0.05 | **Se** | <0.01 | | |
| **Ba** | 0.07 | **Cu** | 0.15 | **Na** | 108.90 | **V** | <0.05 | | |
| **Ca** | 96.29 | **Fe** | 0.08 | **Ni** | <0.05 | **Zn** | 0.05 | | |

## Anions (Discrete Analyser)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Cl** | 112.70 | **NO2 as N** | <0.13 | **SO4** | 66.52 | **NO3 + NO2 as N** | 11.10 |
| **F** | 0.77 | **NO3 as N** | 11.10 | | | | |

## Other Parameters

| | | | | | |
|---|---|---|---|---|---|
| **pH** | 8.15 | **Turbidity (NTU)*** | 2.74 | **E.coli (colonies/100ml)*** | 0 |
| **EC (µs/cm)** | 1222 | **NH3 as N*** | <0.02 | **Total Coliforms (colonies/100ml)*** | 400 |
| **TDS** | 701 | **Total Phenol*** | <0.01 | **Total Plate Count (colonies/ml)*** | 12 |
| **TOC*** | <10 | **Colour (hazen)*** | <10 | | |
| **Free CN*** | 0.003 | **Hg*** | <0.005 | | |

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5) Methods: EPL-WL-001 (Conductivity), EPL-WL-002 (Alkalinity), EPL-WL-003 (pH), EPL-WL-004 (TDS), EPL-WL-005 (Anions by IC), EPL-WL-006 (Cations by IC), EPL-WL-007 (Metals), EPL-WL-008 (Cr(VI)), EPL-WL-009 (TOC), EPL-WL-010 (Hg by DMA), EPL-WL-011 (Anions by Discrete Analyser), EPL-HPLC-001 (Formaldehyde).
6) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

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National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

Environmental Isotope Laboratory

*Postal address: Private Bag 11, Wits, 2050, South Africa.*
*Physical Address: Empire Road (between Jan Smuts Avenue and Yale Road)*
*Tel ++27 11 351 7000/1 (switchboard/secretary), Fax ++27 11 351 7053*

Report
Reference: JGA001

**Date:** 25th January 2023

**Environmental isotope analysis on seventeen (17) water samples**

**submitted by Robert Schapers**

**JG Afrika**

— —

M.J. Butler, M. Mabitsela

**confidential**

## 1. General

Seventeen water samples were submitted by Mr R. Schapers of JG Afrika for D/H ($^{2}H/^{1}H$) and $^{18}O/^{16}O$ analysis. The samples were received on the 5th of December 2022.

## 2. Stable Isotope Analysis

Water D/H ($^{2}H/^{1}H$) and $^{18}O/^{16}O$ ratios were analysed in the laboratory of the Environmental Isotope Laboratory (EIL) of iThemba LABS, Johannesburg.

The equipment used for stable isotope analysis consists of a Los Gatos Research (LGR) Liquid Water Isotope Analyser. Laboratory standards, calibrated against international reference materials, are analysed with each batch of samples. The analytical precision is estimated at 0.5‰ for O and 1.5‰ for H.

Analytical results are presented in the common delta-notation:

$$\delta^{18}O(‰) = \left[ \frac{(^{18}O/^{16}O)_{sample}}{(^{18}O/^{16}O)_{standard}} - 1 \right] \times 1000$$

which applies to D/H ($^{2}H/^{1}H$), accordingly. These delta values are expressed as per mil deviation relative to a known standard, in this case standard mean ocean water (SMOW) for $\delta^{18}O$ and $\delta D$.

## 3. Results

The analytical results are presented in Tables 1 and 2 and partially illustrated in Figure 1.

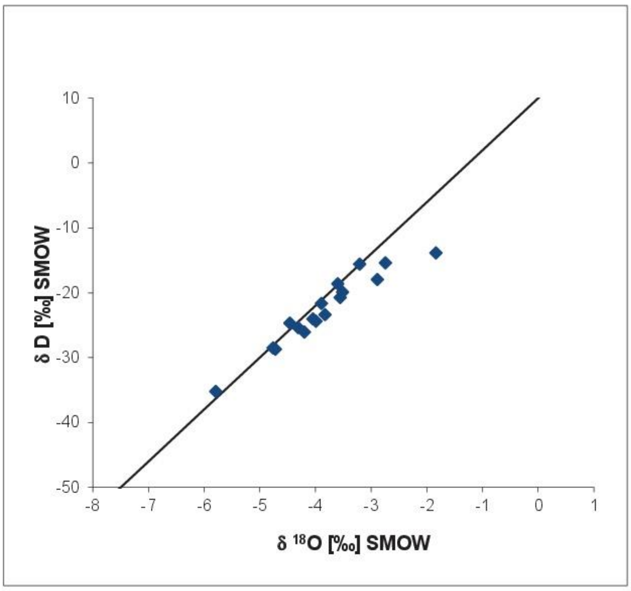


**Figure 1**: Stable isotope data relative to Global Meteoric Water Line (Craig, 1961).

The stable isotope analyses for all samples data could be well reproduced within the expected analytical error limits. Figure 1 shows these data in a $\delta^{18}O$ vs. $\delta D$ space relative to the Global Meteoric Water Line (GMWL, Craig, 1961).

## 4. References

**Craig, H.** (1961). Isotopic variations in meteoric waters. *Science*, **133**, 1702–1703.

**Table 1: Analytical Results**

| | | | Deuterium | Oxygen-18 |
|---|---|---|---|---|
| Lab No | Field Name | Description | δD‰ SMOW | δ18O‰ SMOW |
| JGA 001 | S01 | 2022/11/29 | -18.0 | -2.89 |
| JGA 002 | S02 | 2022/11/29 | -24.7 | -4.46 |
| JGA 003 | S03 | 2022/11/29 | -18.6 | -3.60 |
| JGA 004 | S04 | 2022/11/29 | -15.6 | -3.21 |
| JGA 005 | S05 | 2022/11/29 | -24.0 | -4.05 |
| JGA 006 | S06 | 2022/11/30 | -15.4 | -2.74 |
| JGA 007 | S07 | 2022/11/30 | -24.4 | -3.99 |
| JGA 008 | S08 | 2022/11/30 | -19.9 | -3.52 |
| JGA 009 | S09 | 2022/12/01 | -25.4 | -4.31 |
| JGA 010 | S10 | 2022/12/01 | -23.4 | -3.83 |
| JGA 011 | S11 | 2022/12/01 | -26.1 | -4.20 |
| JGA 012 | S12 | 2022/12/02 | -28.7 | -4.72 |
| JGA 013 | S13 | 2022/12/02 | -28.5 | -4.76 |
| JGA 014 | S14 | 2022/12/02 | -21.7 | -3.89 |
| JGA 015 | S15 | 2022/12/02 | -20.8 | -3.56 |
| JGA 016 | S16 | 2022/12/02 | -13.9 | -1.84 |
| JGA 017 | S17 | 2022/12/03 | -35.2 | -5.79 |

**Table 2: Stable isotope aliquot determinations**

| | | | Deuterium | | | Oxygen-18 | | |
|---|---|---|---|---|---|---|---|---|
| Lab No. | Field Name: | Description | analysis | Batch | δD‰ SMOW | analysis | Batch | δ18O‰ SMOW |
| JGA 001 | S01 | 2022/11/29 | a | 2023/01/23 | -17.9 | a | 2023/01/23 | -2.86 |
| | | | b | | -18.0 | b | | -2.92 |
| | | | | **avg.:** | **-18.0** | | **avg.:** | **-2.89** |
| | | | | *diff.:* | *0.1* | | *diff.:* | *0.07* |
| JGA 002 | S02 | 2022/11/29 | a | 2023/01/19 | -24.3 | a | 2023/01/19 | -4.49 |
| | | | b | | -25.1 | b | | -4.43 |
| | | | | **avg.:** | **-24.7** | | **avg.:** | **-4.46** |
| | | | | *diff.:* | *0.8* | | *diff.:* | *0.07* |
| JGA 003 | S03 | 2022/11/29 | a | 2023/01/19 | -18.9 | a | 2023/01/19 | -3.56 |
| | | | b | | -18.3 | b | | -3.64 |
| | | | | **avg.:** | **-18.6** | | **avg.:** | **-3.60** |
| | | | | *diff.:* | *0.6* | | *diff.:* | *0.08* |
| JGA 004 | S04 | 2022/11/29 | a | 2023/01/19 | -15.3 | a | 2023/01/19 | -3.27 |
| | | | b | | -15.9 | b | | -3.15 |
| | | | | **avg.:** | **-15.6** | | **avg.:** | **-3.21** |
| | | | | *diff.:* | *0.5* | | *diff.:* | *0.13* |
| JGA 005 | S05 | 2022/11/29 | a | 2023/01/20 | -23.6 | a | 2023/01/20 | -4.00 |
| | | | b | | -24.4 | b | | -4.09 |
| | | | | **avg.:** | **-24.0** | | **avg.:** | **-4.05** |
| | | | | *diff.:* | *0.8* | | *diff.:* | *0.09* |
| JGA 006 | S06 | 2022/11/30 | a | 2023/01/23 | -15.5 | a | 2023/01/23 | -2.75 |
| | | | b | | -15.3 | b | | -2.74 |
| | | | | **avg.:** | **-15.4** | | **avg.:** | **-2.74** |
| | | | | *diff.:* | *0.1* | | *diff.:* | *0.01* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| JGA 007 | S07 | 2022/11/30 | a | 2023/01/19 | -24.6 | a | 2023/01/19 | -3.96 |
| | | | b | | -24.2 | b | | -4.03 |
| | | | | **avg.:** | **-24.4** | | **avg.:** | **-3.99** |
| | | | | *diff.:* | *0.5* | | *diff.:* | *0.08* |
| JGA 008 | S08 | 2022/11/30 | a | 2023/01/19 | -19.6 | a | 2023/01/19 | -3.51 |
| | | | b | | -20.2 | b | | -3.52 |
| | | | | **avg.:** | **-19.9** | | **avg.:** | **-3.52** |
| | | | | *diff.:* | *0.6* | | *diff.:* | *0.01* |
| JGA 009 | S09 | 2022/12/01 | a | 2023/01/20 | -25.5 | a | 2023/01/20 | -4.33 |
| | | | b | | -25.3 | b | | -4.29 |
| | | | | **avg.:** | **-25.4** | | **avg.:** | **-4.31** |
| | | | | *diff.:* | *0.2* | | *diff.:* | *0.04* |
| JGA 010 | S10 | 2022/12/01 | a | 2023/01/19 | -23.4 | a | 2023/01/19 | -3.82 |
| | | | b | | -23.4 | b | | -3.84 |
| | | | | **avg.:** | **-23.4** | | **avg.:** | **-3.83** |
| | | | | *diff.:* | *0.0* | | *diff.:* | *0.03* |
| JGA 011 | S11 | 2022/12/01 | a | 2023/01/19 | -25.8 | a | 2023/01/19 | -4.19 |
| | | | b | | -26.4 | b | | -4.21 |
| | | | | **avg.:** | **-26.1** | | **avg.:** | **-4.20** |
| | | | | *diff.:* | *0.5* | | *diff.:* | *0.02* |
| JGA 012 | S12 | 2022/12/02 | a | 2023/01/19 | -28.9 | a | 2023/01/19 | -4.70 |
| | | | b | | -28.5 | b | | -4.73 |
| | | | | **avg.:** | **-28.7** | | **avg.:** | **-4.72** |
| | | | | *diff.:* | *0.4* | | *diff.:* | *0.03* |
| JGA 013 | S13 | 2022/12/02 | a | 2023/01/19 | -28.3 | a | 2023/01/19 | -4.73 |
| | | | b | | -28.8 | b | | -4.80 |
| | | | | **avg.:** | **-28.5** | | **avg.:** | **-4.76** |
| | | | | *diff.:* | *0.5* | | *diff.:* | *0.07* |
| JGA 014 | S14 | 2022/12/02 | a | 2023/01/19 | -21.7 | a | 2023/01/19 | -3.87 |
| | | | b | | -21.7 | b | | -3.92 |
| | | | | **avg.:** | **-21.7** | | **avg.:** | **-3.89** |
| | | | | *diff.:* | *0.0* | | *diff.:* | *0.04* |
| JGA 015 | S15 | 2022/12/02 | a | 2023/01/19 | -20.7 | a | 2023/01/19 | -3.56 |
| | | | b | | -20.8 | b | | -3.56 |
| | | | | **avg.:** | **-20.8** | | **avg.:** | **-3.56** |
| | | | | *diff.:* | *0.0* | | *diff.:* | *0.00* |
| JGA 016 | S16 | 2022/12/02 | a | 2023/01/23 | -13.9 | a | 2023/01/23 | -1.78 |
| | | | b | | -13.9 | b | | -1.89 |
| | | | | **avg.:** | **-13.9** | | **avg.:** | **-1.84** |
| | | | | *diff.:* | *0.0* | | *diff.:* | *0.11* |
| JGA 017 | S17 | 2022/12/03 | a | 2023/01/20 | -35.2 | a | 2023/01/20 | -5.81 |
| | | | b | | -35.2 | b | | -5.77 |
| | | | | **avg.:** | **-35.2** | | **avg.:** | **-5.79** |
| | | | | *diff.:* | *0.0* | | *diff.:* | *0.04* |

# *Annexure E: Quantitative Environmental Risk Assessment (ERA) Guideline*

***Ref: Department of Water Affairs*** ***February 2010***
***Operational Guideline: Integrated Water and Waste Management Plan***

In terms of a quantitative environmental risk assessment (ERA), the assessment will be based on:

- Probability of occurrence which describes the likelihood of the impact actually occurring and is indicated as:-
  - Improbable, where the likelihood of the impact is very low;
  - Probable, where there is a distinct possibility of the impact to occur;
  - Highly probable, where it very likely that the impact will occur;
  - Definite, where the impact will occur regardless any management measure.
- Consequence of occurrence in terms of:
  - Nature of the impact;
  - Extent of the impact, either local, regional, national or across international borders;
  - Duration of the impact, either short term (0-5 years), medium term (6-15 years) or long-term (the impact will cease after the operational life of the activity) or permanent, where mitigation measures by natural processes or human intervention will not occur;
  - Intensity of the impact, either being low, medium or high effect on the natural, cultural and social functions and processes.
- Significance level of the risk posed by the water use, which is determined through a synthesis of the probability of occurrence and consequence of occurrence.

The applicant will have to rank the risks based on the quantitative assessment as described above into high, medium, or low risks. Management measures need to be identified to mitigate, prevent and /or reduce the risk. These measures will primarily be focussed on the risks identified as high in the ranking matrix, but will also include measures for medium and low risks. The management measures will be taken forward in the IWMP as part of the water use authorisation process.

In order to assess each of the factors for each impact the ranking scales as contained in Table 7-1 could be used. Once the factors had been ranked for each impact, the environmental significance of each impact could be assessed by applying the following formula:

**SP = (magnitude + duration + scale) x probability**

where SP is defined as significance points.

Table 7-1: Ranking Scales for ERA

| | |
|---|---|
| **PROBABILITY** = P<br>5 – Definite / don't know<br>4 – High probable<br>3 – Medium probability<br>2 – low [probability<br>1 – Improbable<br>0 - None | **DURATION** = D<br>5 – Permanent<br>4 – Long-term ceases with operational life)<br>3 – Medium-term (5 – 15 years)<br>2 – Short-term (0-5 years)<br>1 - Immediate |
| **SCALE** = S<br>5 – International<br>4 – National<br>3 – Regional<br>2 – Local<br>1 – Site<br>0 – None | **MAGNITUDE** = M<br>10 – Very high / Don't know<br>8 – High<br>6 – Moderate<br>4 – Low<br>2 – Minor |

The maximum value of significance points (SP) is 100. Environmental effects could therefore be rated as either high (H), moderate (M), or low (L) significance on the following basis:

- More than 60 points indicates high (H) environmental significance
- Between 30 – 60 points indicate moderate (M) environmental significance
- Less than 30 points indicates low (L) environmental significance.