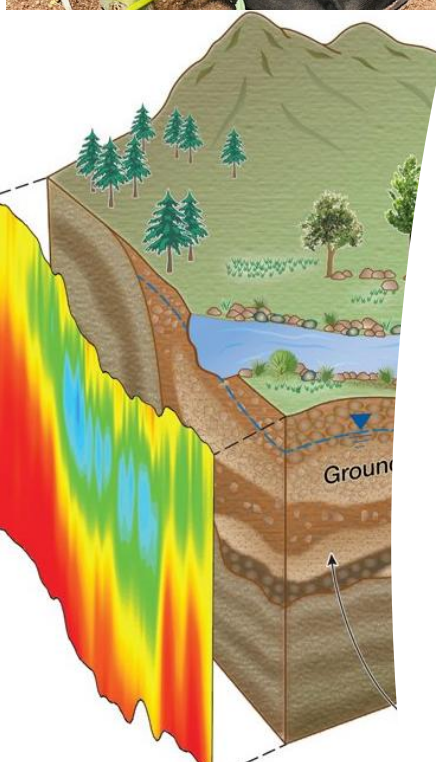




Hydrogeological Investigation Report for One Borehole

In Kyakakwanzi village, Kyegegwa District

August 2026

Hydrogeological Survey Report for One Production Borehole in Kyakakwanzi Village, Kyegegwa District

Contractor



Aqua Borehole Solution & Engineering

New Mutasa complex, Room NR 1977, Kasangati Uganda

+256 0777 422 400 | +256 778 372 208

info@aquaboreholesolutions.ug

Client:

.....

Kyakakwanzi Kibuye Kyegegwa

+256 760954016 | +256 788850406

[Email:](#)

Site:

Project ID: 202654

Prepared by: Festo B.N.

MWE Reg No.: J34/2026/RR

+256 (0) 788632408

TABLE OF CONTENTS

LIST OF ACRONYMS	v
INTRODUCTION	1
METHODOLOGY	3
SITE DESCRIPTION	7
RESULTS OF THE STUDY	14
INTERPRETATION AND DISCUSSION	18
CONCLUSIONS AND RECOMMENDATION.....	20
APPENDICES	22
GLOSSARY OF TERMS	24

TABLE OF FIGURES

Figure 1: Kyegegwa district.....	2
Figure 2:Sting R1 & ADMT – 300 ZN.....	5
Figure 3: Surveyed points	6
Figure 4: General geology of Uganda.....	7
Figure 5: Presence of aquifers in weathered and fractured zones in basement rocks.....	8
Figure 6: Lithology of the project area	8
Figure 7: Occurrence of groundwater	9
Figure 8: Aquifer types and productivity.....	10
Figure 9: Boreholes data (2015 data).....	12
Figure 10: Topographic map of site.....	13
Figure 11: Isoline graph of Profile 1.....	14
Figure 12: Isoline graph of Profile 5.....	15
Figure 13: Isoline graph of Profile 6.....	15
Figure 14: Graph of the VESs.....	17

LIST OF TABLES

Table 1: Location of the project.....	1
Table 2: Activity schedule	3
Table 3: Threats to the borehole	3
Table 4: Characteristics of the different aquifers.....	11
Table 5: Borehole data in Kyegegwa in 5.5km radius underlain by same geology.....	12
Table 6: Resistivity values	16
Table 7: Drilling point selection	18
Table 8: Analysis of the data	20

LIST OF ACRONYMS

agl	Above ground level
bgl	Below ground level
d	Day
SWL	Static Water Level
FWS	First Water strike
MWS	Main water strike
CAL	Calibration
WBZ	Water Bearing Zone
hr.	Hour
l	Liters
VES	Vertical Electrical Sounding
DTB	Depth to Bedrock
RDD	Recommended Drilling Depth
DD	Drilled depth
Ωm	ohm.m (Unit for Apparent resistivity)
UBOS	Uganda Bureau of Statistics
Km	Kilometer
MWE	Ministry of water and environment
DWD	Directorate of water development
IGIS-SSR	Integrated Geo Instruments & Services Private Limited
GPS	Global Positioning System
m ³ /hr.	Cubic meters per hour
BH	Borehole
HP	Hand pump

INTRODUCTION

Background

Hydrogeological and siting survey services were sourced at a farm in Kyakakwanzi village, Kyegegwa district.

In order to achieve the project target, one team was deployed to carry out a reconnaissance survey. The results of the desk study and the reconnaissance survey were used to select the areas where detailed geophysical surveys were carried out to identify potential borehole drilling sites. The collected data was analyzed together with the desk study information and formed the basis for the selection of the recommended drilling points.

Purpose of the survey

To identify suitable sites for drilling of a borehole that shall yield water of good quantity for domestic and production use at the farm.

Specific objectives

- a) Identify drilling points
- b) Assess groundwater potential
- c) Outline drilling guidelines.

Scope of work

Siting of production a borehole in Kyegegwa consisted of three main phases:

1. A desk study was done on the potential sites provided by the client. Then a reconnaissance visit around the sites in the project area was undertaken. During this phase, data on elevation, geology and lineaments was gathered and existing siting information studied.
2. Geophysical survey (profiling and VESs) was carried out in the second phase in the project area to get a better understanding of the hydrogeological build up and to identify possible drilling locations.
3. The results of the geophysical survey were analyzed and compiled in the current report during the third phase

Location of the projects

Table 1: Location of the project

District	Sub county	Parish	Village	Location	Latitudes	Longitudes
Kyegegwa	Kyegegwa	Kibuye	Kyakakwanzi	Farm	0.484729°	31.091907°

Kyegegwa District has a total area of 1,747 km² (675 sq. mi), the district is located on the main highway between Mubende and Fort Portal Tourism City, approximately 110 kilometres (68 mi) by road East of Fort Portal. It neighbors Mubende District in the West, Kiruhura in the South, Kibaale in the North, Kyenjojo in the North-West and Kamwenge in the South West.

The District Headquarters is in Kyegegwa Town Council just 500meters from the highway, Kyegegwa Town Council serves as an administrative and commercial centre for Kyegegwa District. Other urban centers include: Mpara, Kakabara, Hapuuyo, Kazinga and Kasule.

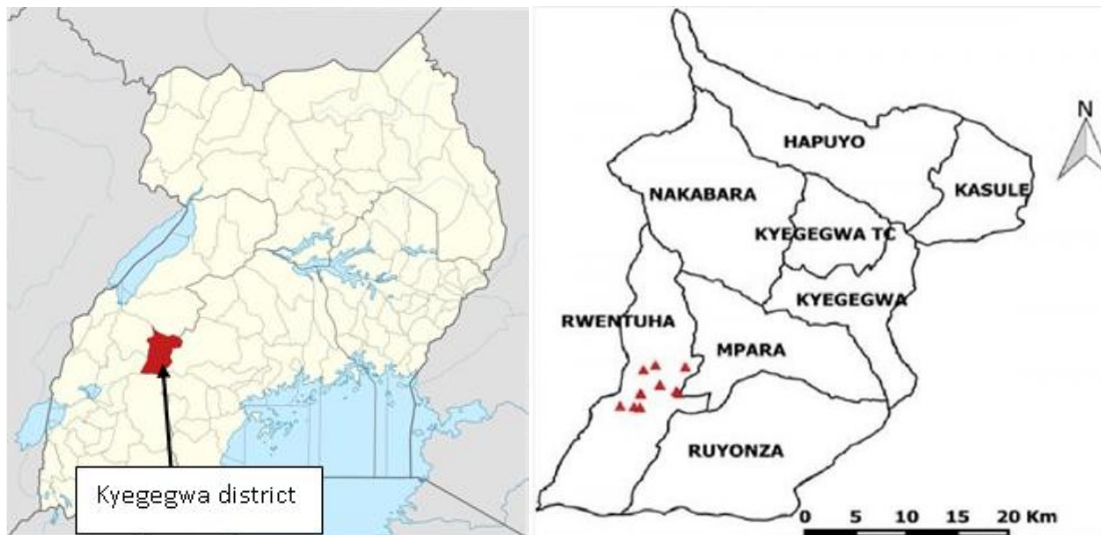


Figure 1: Kyegegwa district

METHODOLOGY

Activity schedule

The time and activity schedule are given in Table 2.

Table 2: Activity schedule

Activity	From	To	Days	Staff
Desk study	28 th /08/2026	28 th /08/2026	1	Festo B.N.
Reconnaissance	29 th /08/2026	29 th /08/2026	1	Festo B.N.
Geophysical fieldwork	29 th /08/2026	29 th /08/2026	1	Festo B.N.
Analysis and reporting	30 th /08/2026	30 th /08/2026	1	Festo B.N.

Desk study

This consisted of review of existing geological maps, hydrogeological maps, satellite imagery, aerial photographs, and previous borehole records in the vicinity. It also involved analysis of rainfall data and hydrological information. The aim of the information analysis is to get a better understanding of the hydrogeology of the area.

Field reconnaissance

This involved visual inspection of the site or area of interest to compile data about topography, drainage patterns, existing water sources (springs, rivers, wells), vegetation, any visible geological features (outcrops, faults), ensuring that the potential sites are free from any threats to the borehole, and easily accessible to the community and drill rig

The following minimum distances from threats to borehole/points were considered during survey.

Table 3: Threats to the borehole

Sn	Existing structure	Minimum distance from point (m)
1	Existing production well	500
2	Existing hand pumps	100
3	Latrine, septic tanks and soak ways	30
4	Streams, canals, irrigation ditches	50
5	Buildings	10
6	Solid dumps and burial grounds/graveyard	500
7	Main and municipal roads	20
8	Lakes and rivers	100

However, these are broad estimates; specific minimum distances vary with the knowledge of the geology of the project area

The survey target sites were selected based on the following criteria:

- Lineaments, fractured zones in the granulite and gneiss rocks formation identified through analysis of topographical and geological maps.
- Topographically low-lying areas.
- Areas within the client's boundaries

Geophysical survey

Basic principles

The electrical properties of rocks in the upper part of the earth's crust are dependent upon the lithology, porosity and the degree of pore space saturation and the salinity of the pore water. Saturated rocks have lower resistivity than unsaturated and dry rocks. The higher the porosity of the saturated rock, or the higher the salinity of the saturating fluids, the lower the resistivity value. The presence of clays and conductive minerals also reduces the resistivity of the rock. The resistivity of earth materials can be studied by measuring the electrical potential distribution produced at the earth's surface by an electric current that is passed through the earth.

The resistance R of a certain material is directly proportional to its length L and cross-sectional area A , expressed as:

$R = R_s * L/A$ (in Ohm) Where R_s , is known as the specific resistivity, characteristic of the material and independent of its shape or size.

With Ohm's Law,

$R = dV/I$ (Ohm) Where, dV is the potential difference across the resistor and I is the electric current through the resistor.

The specific resistivity may be determined by:

$R_s = (A/L) * (dV/I)$ (in Ohm m).

Material used

- Sting R1 resistivity meter
- ADMT-300ZN water detector
- Tape measure
- GPS

- Pen and book



Figure 2: Sting R1 & ADMT – 300 ZN

One siting team was deployed, headed by a hydrogeologist who was assisted by geophysical field assistant. One casual laborer was recruited from the project areas to support the hydrogeologist with the physical work (hammering electrodes, carrying equipment, vegetation clearing etc.). Measurements were carried out at the sites agreed upon by the client comprised of resistivity profiles and Vertical Electrical Soundings (VES) at promising anomalies of the profiles.

Detailed geophysical measurements were carried out by means of an ADMT-300ZN water detector. Maximum Depth of 200m was used with polar and point distances of 5m and 2.5m. A maximum AB/2 of 83m was used with the potential electrodes MN/2 placed at 5m during VESing using Sting R1. The changes in apparent resistivity values with depth, in the direction of the longest dimension of the anomalous volume under investigation, gave a geophysical signature which was analyzed with guideline positive VES signatures. Six profiles of about 130m total and three VESs were done around the site.

No calibration was also carried out.

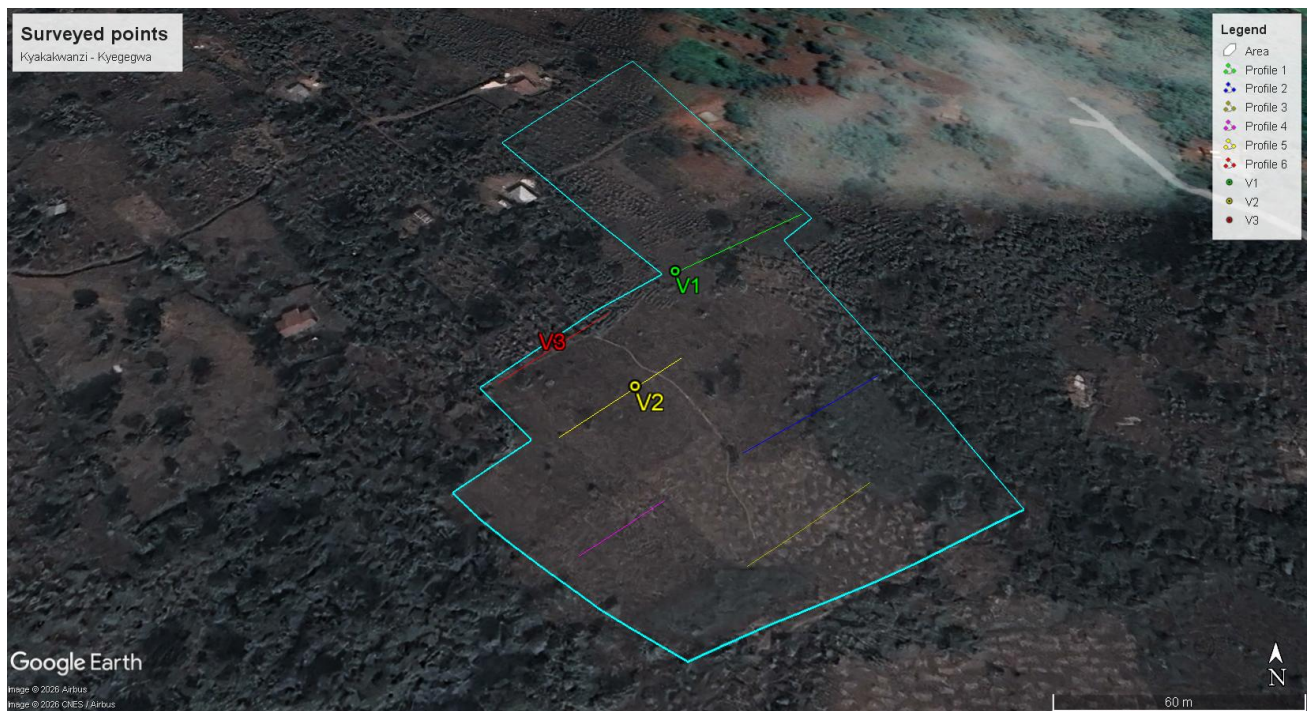


Figure 3: Surveyed points

The data captured by ADMT-300ZN was modelled and analyzed using SURFER software to get an insight into the depth and type of the overburden and the bedrock. The vertical electrical soundings by Sting R1 terameter data was interpreted and modelled using specialized software which include Winsev™, EarthIMAGER-1D™ and VES™ software

Three points were pegged.

SITE DESCRIPTION

Geology

Lithology, fractures, faults, dykes, weathering etc. affect groundwater availability and recharge. Geological data of Uganda provided information on the geology of the area of interest, lithological mannerisms which consequently have an impact on groundwater.

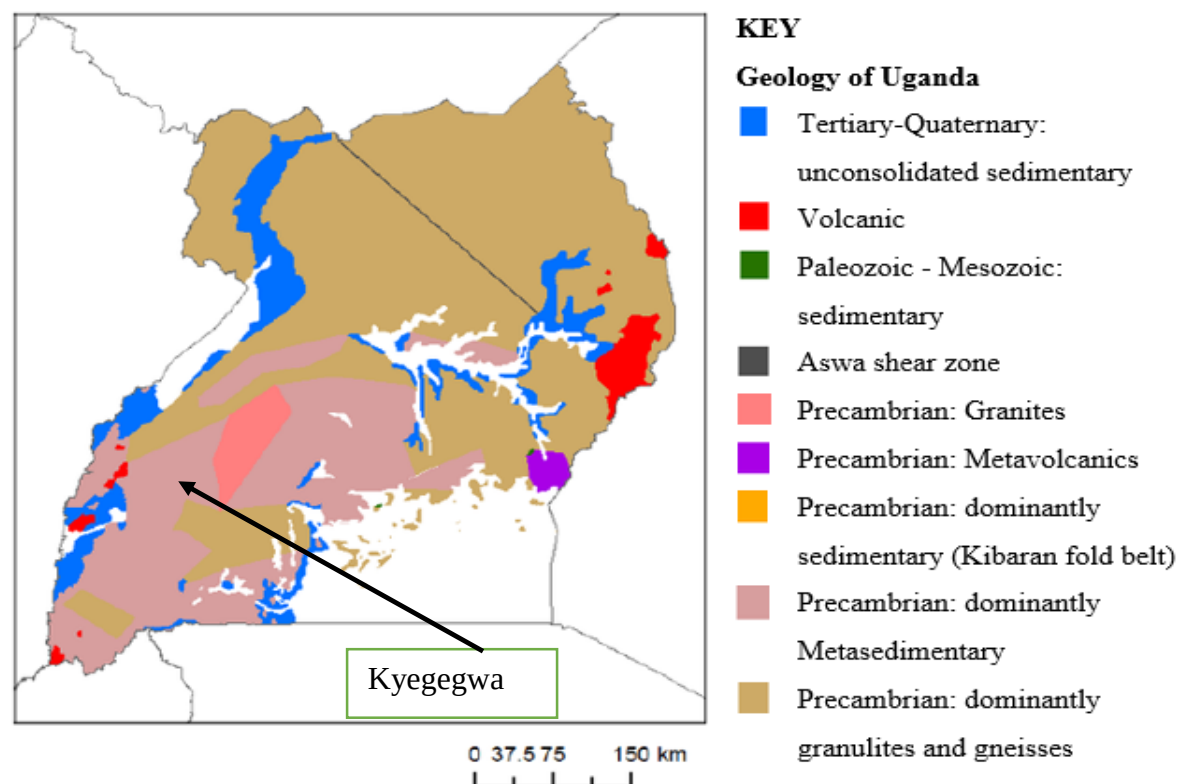


Figure 4: General geology of Uganda

Uganda's geology is predominantly underlain by Precambrian rocks, which form part of the African Craton, but also features younger sedimentary basins and volcanic activity.

The landscape of Uganda is shaped by its geology, featuring high plateaus, rolling hills, the dramatic rift valley escarpments, and volcanic cones. The highest point is Margherita Peak in the Rwenzori Mountains (a horst block within the rift system), and the lowest points are within the rift valley lakes.

Kyegegwa District is entirely underlain by Precambrian crystalline basement and metamorphic strata - primarily comprising granites, gneisses, and fine-grained ancient sedimentary rocks - which heavily dictate its hydrogeology and groundwater availability. Groundwater storage primarily occurs within two distinct zones of these basement formations: a shallow weathered mantle (saprolite) and deeper structural fractures within the hard bedrock. In the northern parts of the district, productive aquifers are generally shallow and within reach of handpumps and shallow wells. In contrast, southern sections rely more on tapping deeper fractures within hard crystalline rock. Limited pockets of Holocene-era

sediments, alluvium, and swamp deposits exist along local river valleys and low-relief wetlands linked to the Katonga basin, providing localized shallow phreatic water.

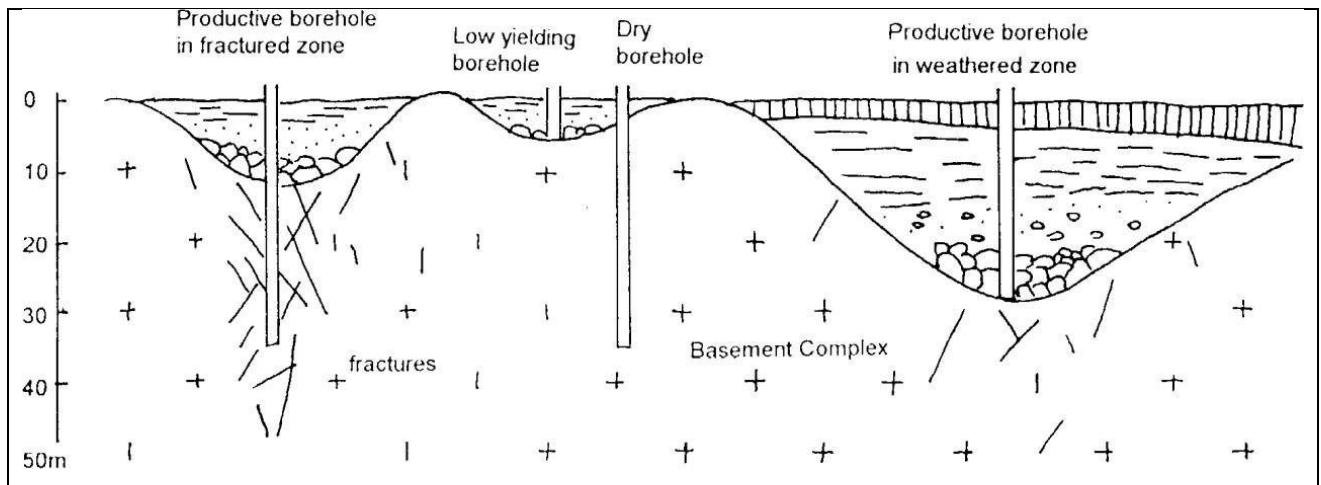


Figure 5: Presence of aquifers in weathered and fractured zones in basement rocks

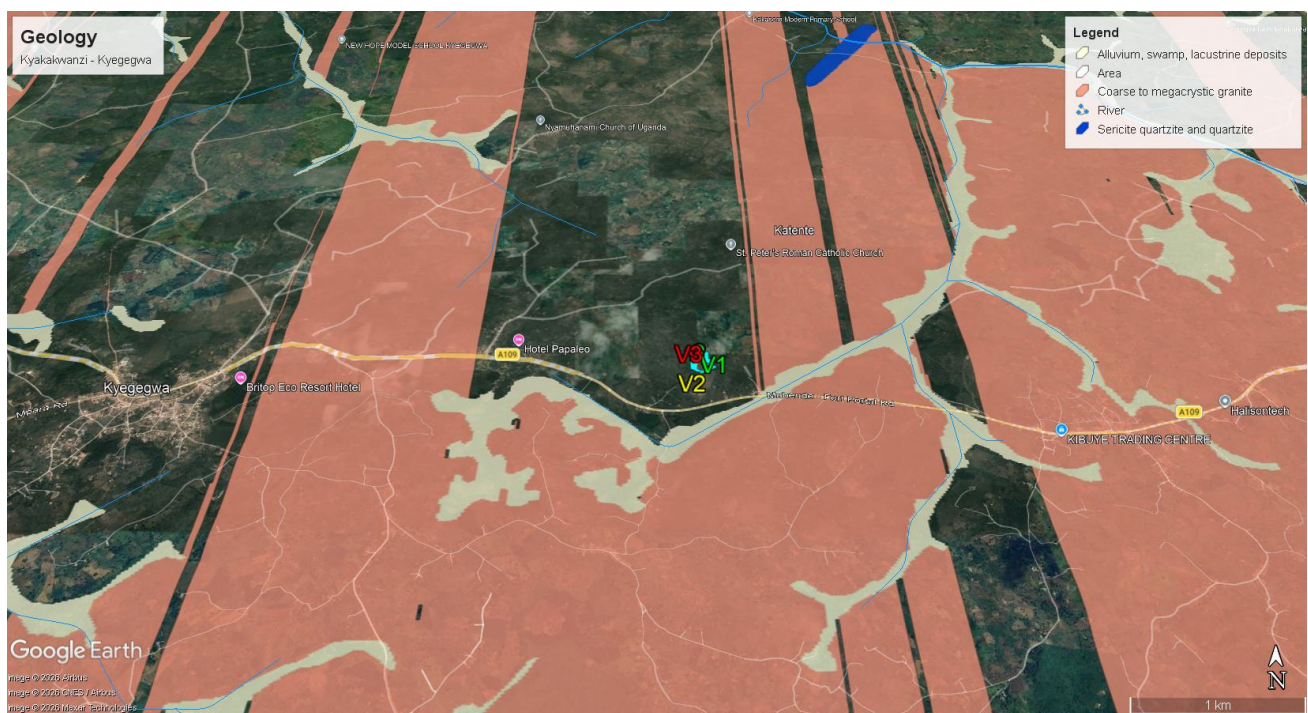


Figure 6: Lithology of the project area

The project area is underlain by **Coarse to megacrystic granite** lithology.

The **coarse to megacrystic granite** found in Kyegegwa District constitutes a significant portion of the Mubende granite batholith. Because this specific intrusive rock features exceptionally large mineral crystals (phenocrysts up to 10 cm) embedded within a coarse groundmass, its physical properties create distinct conditions for local groundwater storage, movement, and extraction. Like all crystalline igneous rocks, the interlocking matrix of megacrystic granite has virtually no native pore spaces to hold water. Groundwater storage depends entirely on secondary porosity created by tectonic joints,

faults, and cooling fractures. However, because this granite is highly massive, localized zones with minimal jointing exist, severely limiting water movement. The coarse nature of the granite alters how it weathers. Mechanical breaking and chemical alteration of the massive feldspar megacrysts form a thick, gritty, and sandy weathered layer (saprolite/regolith). At the base of this weathered profile sits a transitional "saprock" layer. This zone features blocks of fresh granite separated by highly permeable, grit-filled cracks that serve as the main reservoir storing localized groundwater. Borehole yields within this megacrystic granite are highly variable and discontinuous. If a well hits a localized network of open fractures or thick, coarse saprock, it can support a sustainable handpump or small-scale solar pump. Water-rock interactions with the felsic minerals (quartz and potassium feldspar) in the granite, combined with tropical rainwater recharge, yield groundwater that is typically soft, poorly buffered, and slightly acidic. **dissolved iron (Fe)** and manganese into the water table, sometimes causing an unpalatable taste or staining.

Hydrogeology

Groundwater originates for all purposes from infiltration of rainfall below the root zone, either directly on the soil or in ponds, lakes and river beds. Thereafter, the water of the saturated zone in the aquifers can be found between the pores of the grains of the formations and soil particles (voids/primary porosity/unconsolidated) or between the discontinuities in hard rocks (consolidated formation/secondary porosity). This is the amount of water that we can pump and exploit in order to meet our demands.

Groundwater may be classified as being either internal or external.

- Interior includes juvenile water.
- Exterior includes; connate water, absorbed water and meteoric water.

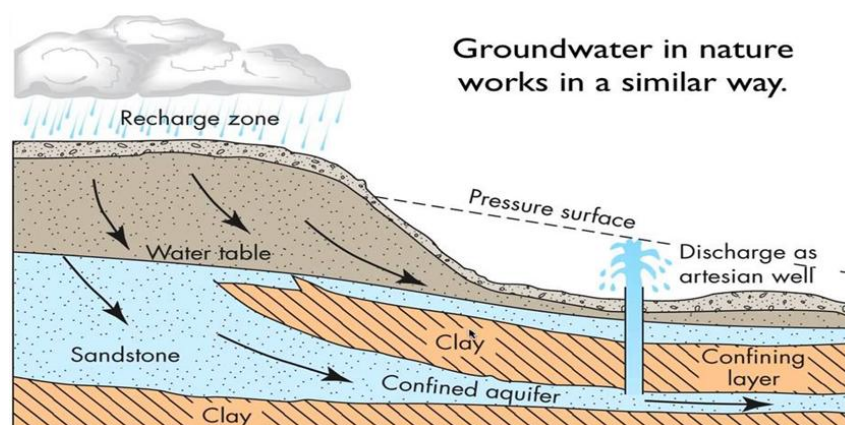


Figure 7: Occurrence of groundwater

Recharge to the groundwater system primarily occurs through direct infiltration of rainfall, especially in areas with permeable soils and vegetation. The weathered zone plays a crucial role in storing this infiltrated water and slowly releasing it to deeper fractures. Recharge assessments have been carried out in Apac in northern Uganda, Mbarara in Western Uganda, Wobulenzi in Central Uganda, Nkokonjeru in Eastern Uganda and Hoima in Central Uganda. The recharge assessment methods used have ranged from soil moisture balance using spreadsheet and the model, EARTH to water level fluctuation, isotope techniques and hydrograph separation. Groundwater recharge estimates obtained using the various methods range between 90 and 220 mm per annum and this accounts for between 7 and 20% of the average annual precipitation in Uganda.

Aquifers

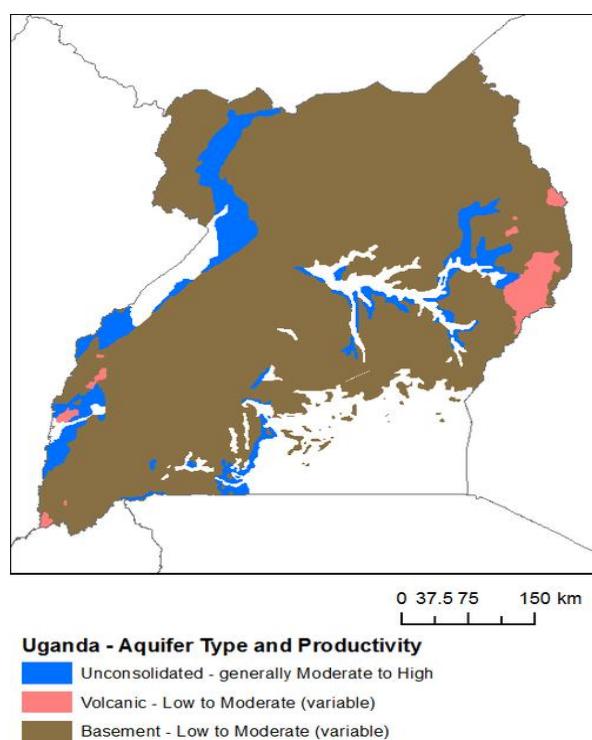


Figure 8: Aquifer types and productivity

The main aquifer used in Uganda is Weathered and/or Fractured Precambrian crystalline basement rocks. These aquifers generally have low permeability and low storage. Their physical aquifer properties are largely a function of tectonic history and long-term cycles of weathering and erosion. Most boreholes in the country tap groundwater from basement aquifers. The Kyegegwa site is under the Basement aquifer type.

Table 4: Characteristics of the different aquifers

AQUIFER TYPE	Unconsolidated & Sedimentary	Volcanic	Basement
Location	Along rivers, lakes, Albertine & Cenozoic	Around volcanic mountains	In relatively flat lands and Precambrian crystalline rocks
Occurrence	Unconfined or semi-confined		Unconsolidated weathered regolith (saprolite) or fissured/fractured bedrock (saprock)
Yield (m ³ /hr.)	1-50 possible		0.5-12
Aquifer depth	10->100m		5-30m (weathered), >100m (fractured)
Drilling depth (m)	Variable up to 100		45-70
Static water level	Variable to 20m		1-45 (typically 5-20) m
Avg. transmissivity (m ² /day)	34		14 in bedrock, 0.1-20 (average 16) in weathered zone
Hydraulic conductivity(m/day)	0.02-15		
Average storage	0.1		0.014 (maybe as low as 10 ⁻⁴) in bedrock,
Coefficient			0.21 in weathered zone
Recharge rate	Rainfall		Rainfall (12-200 mm/yr.)
Water quality	Low TDS, highly vulnerable to pollution		Highly variable, no inorganic chemicals, iron and manganese common, occasional high salinity, vulnerable to pollution

Boreholes or groundwater abstraction points

This consists of borehole databases (from the ministry of Water and Environment and from contractor), national reports on the (hydro)geology of Uganda and data from the respective district. An extensive dataset of existing boreholes in the area is used to create an image of the favorability of the area in terms of groundwater. Figure below shows an overview of the boreholes that are used for this analysis. It should be noted that the geological map, on which the classification is based, is a simplification of

reality. Therefore, the data contains a certain degree of uncertainty, however it provides useful insight in the situation.

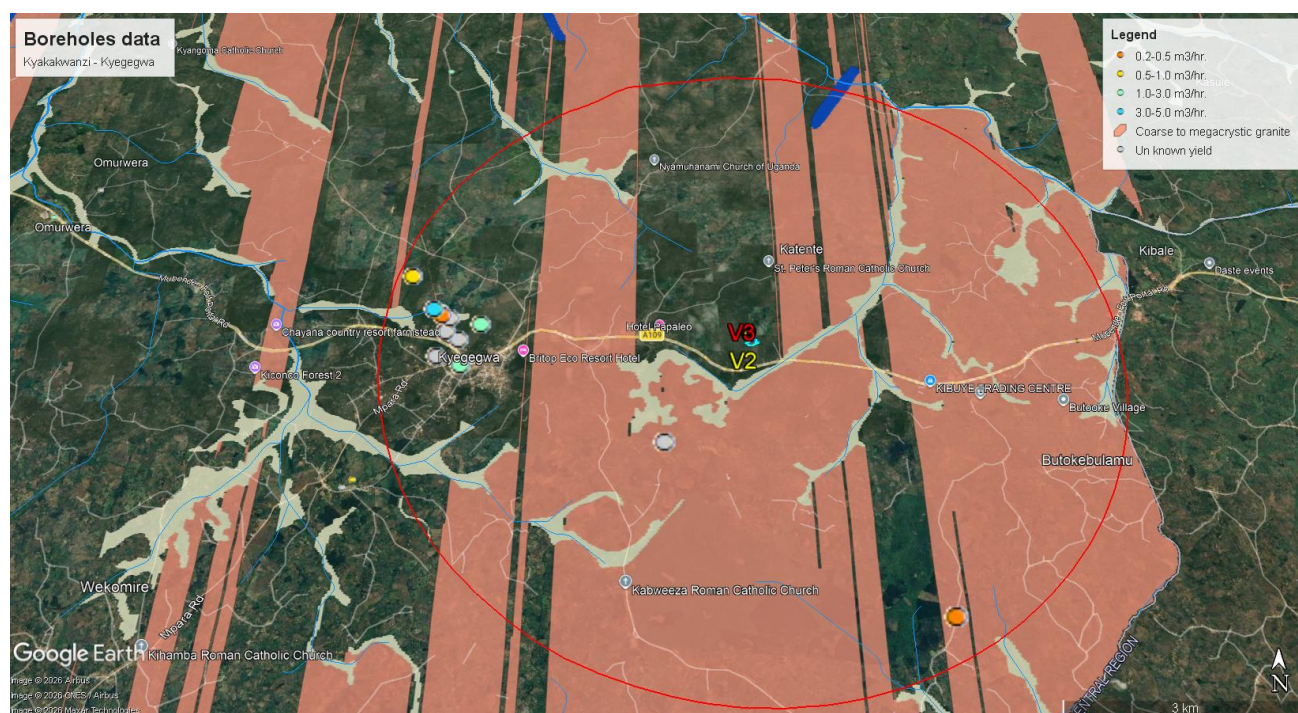


Figure 9: Boreholes data (2015 data)

Table 5 containing Administrative units, Source ID, Drilled Depth (DD), Depth to Bedrock (DBR), First Water Strike (FWS), Main Water Strike (MWS), Yield (Q), shows the data of boreholes in Coarse to megacrystic granite lithology.

Table 5: Borehole data in Kyegegwa in 5.5km radius underlain by same geology.

Village	Source ID	DD (m)	DBR (m)	FWS (m)	MWS (m)	Q (m³/hr.)
Buteera	DWD27537	124	60	17	-	-
Kyegegwa	CD3020	56	45	45	45	2.2
Kyegegwa	DWD27153	71	27	31	31	2.6
Kyegegwa	GS1085	152	29	48	-	-
Kyegegwa H/C	DWD14256	80	42	80	80	0.8
Humura P/S	DS1305	154	-	41	-	-
Kyegegwa T/C	DWD24564B	77	49	77	77	0.5
Kyegegwa	DWD27152	71	48	14	70	3.5
Kyegegwa 1	36303	119	-	-	-	-
Nkaaka	DWD27150	99	36	42	42	1
	Minimum	56	27	14	31	0.5
	Average	100	42	44	58	1.8
	Maximum	154	60	80	80	3.5

- Drilled depths range between 56m and 154m but averagely 100m.

- Estimated depth to the bedrock is between 27 and 60m.
- Water strikes are from 14 to 80m.
- Yields range between 0.5 and 3.5 m³/hr. but averagely 1.8 m³/hr.

Topography and drainage

The topography of Kyegegwa District is characterized by a gently rolling plateau landscape dominated by flat-topped hills, shallow valleys, and vast low-relief plains. Its landforms are heavily tied to the ancient, highly weathered African surface typical of central and western Uganda.

As is common elsewhere in general, wells drilled in valleys would have greater groundwater potential, reported yields and specific capacities than wells drilled in the same unit on slopes or hilltops. Points or areas at the lower elevation were therefore considered first during hydrogeological surveys.

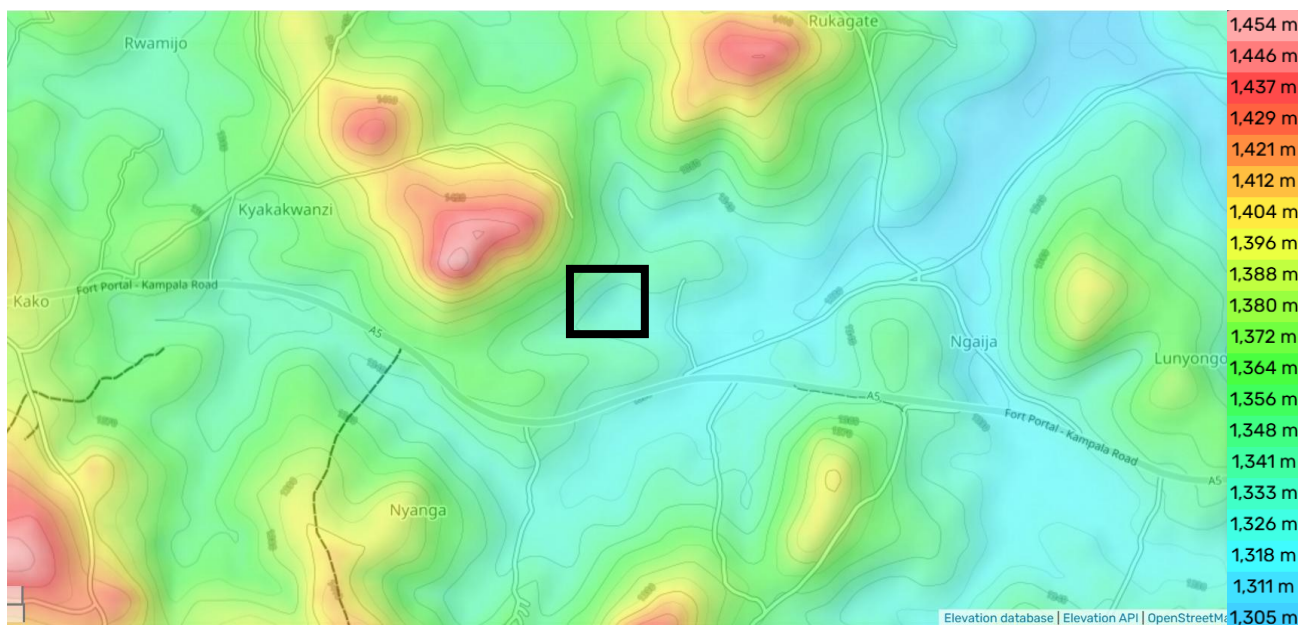


Figure 10: Topographic map of site

RESULTS OF THE STUDY

The final output of the ADMT is in form of colored 2D graphs called ISOLINES showing Depth on vertical scale in 10m interval and Profile Length or distance on Horizontal scale.

- Pink, purple and dark blue representing less resistive formations or substances (assumed as water).
- Sky blue and green representing relatively resistive formations or substances (assumed as moist sand, and clay).
- Yellow and red colors representing highly resistive formations or substances (assumed as rocks or dry hard substances).

Profile 1

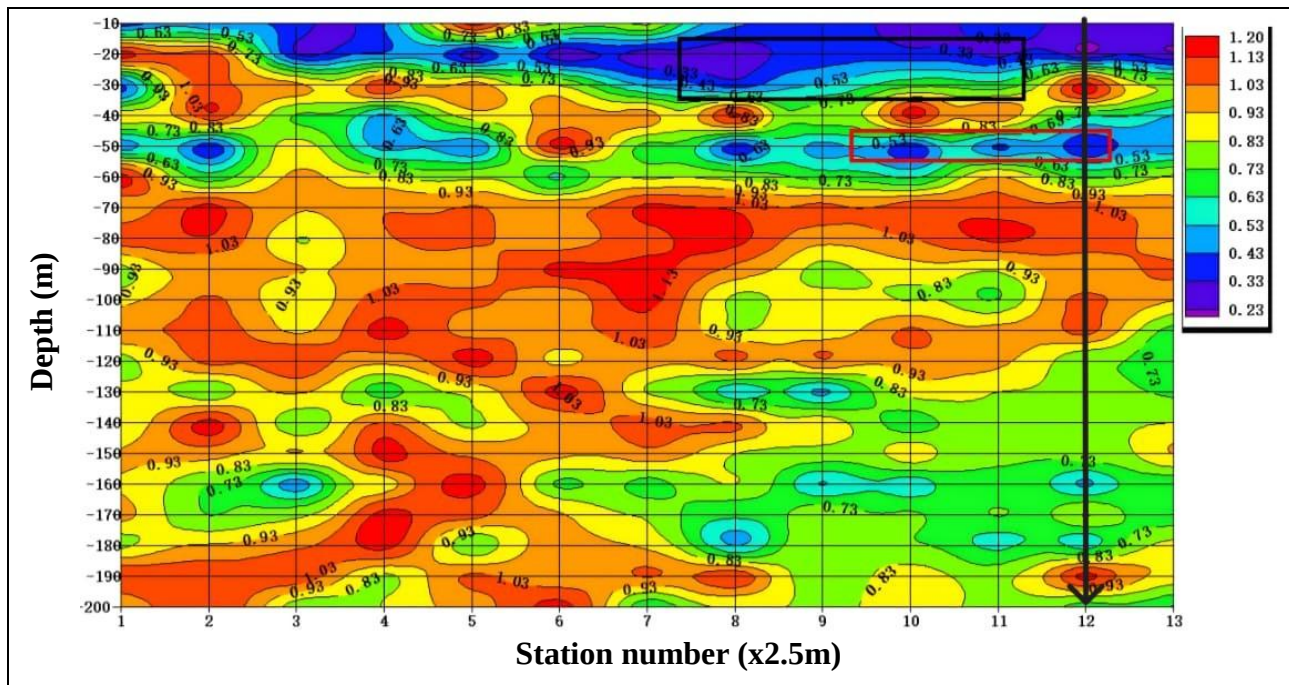


Figure 11: Isoline graph of Profile 1

Profile 01 was surveyed in the central part from East to West. It has apparent resistivity ranging from 0.23 to 1.2 ohm.m. At a depth of 10 to 25, and 35 to 70m, anomalies were detected in the area. These signify conducting zones which are assumed to be good saturated or weathered and fractured layers (aquifers). Station number 12 was VESed as VES 1.

Profile 5

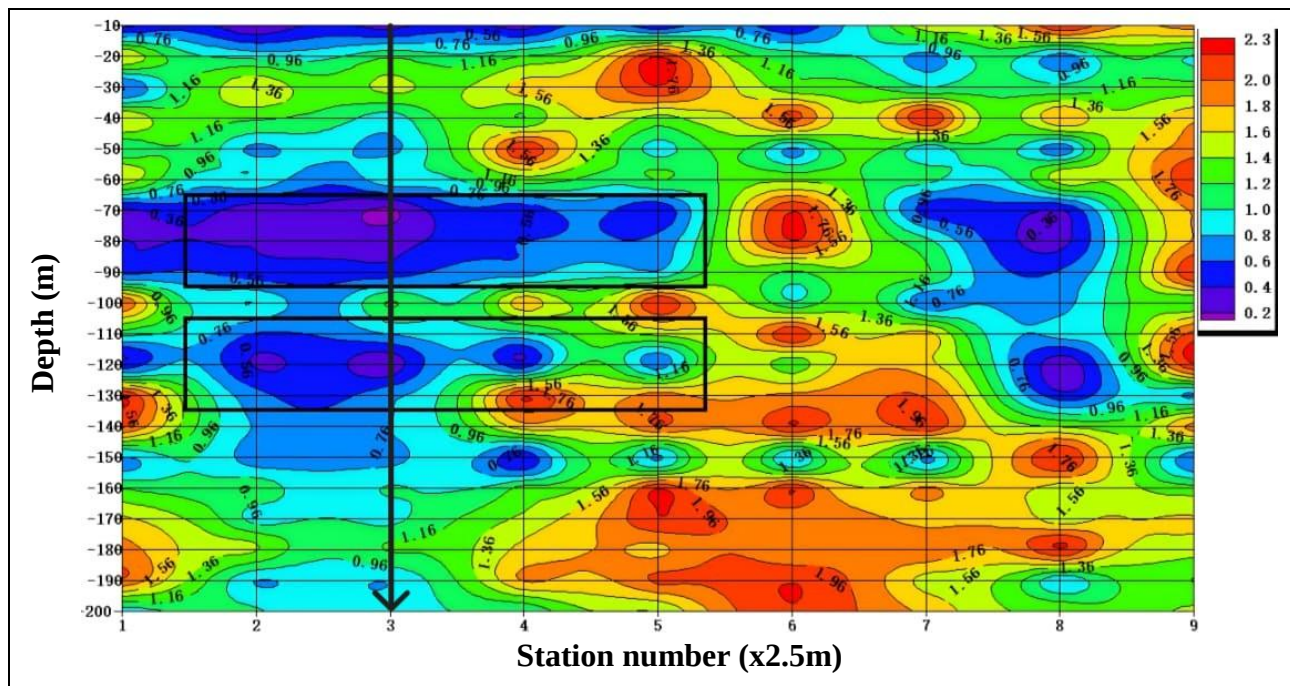


Figure 12: Isoline graph of Profile 5

Profile 05 was surveyed in the Western part from East to West. It has apparent resistivity ranging from 0.2 to 2.3 ohm.m. At a depth of 40 to 95, and 110 to 130m, anomalies were detected in the area. These signify conducting zones which are assumed to be good saturated or weathered and fractured layers (aquifers). Station number 03 was VESed as VES 2.

Profile 6

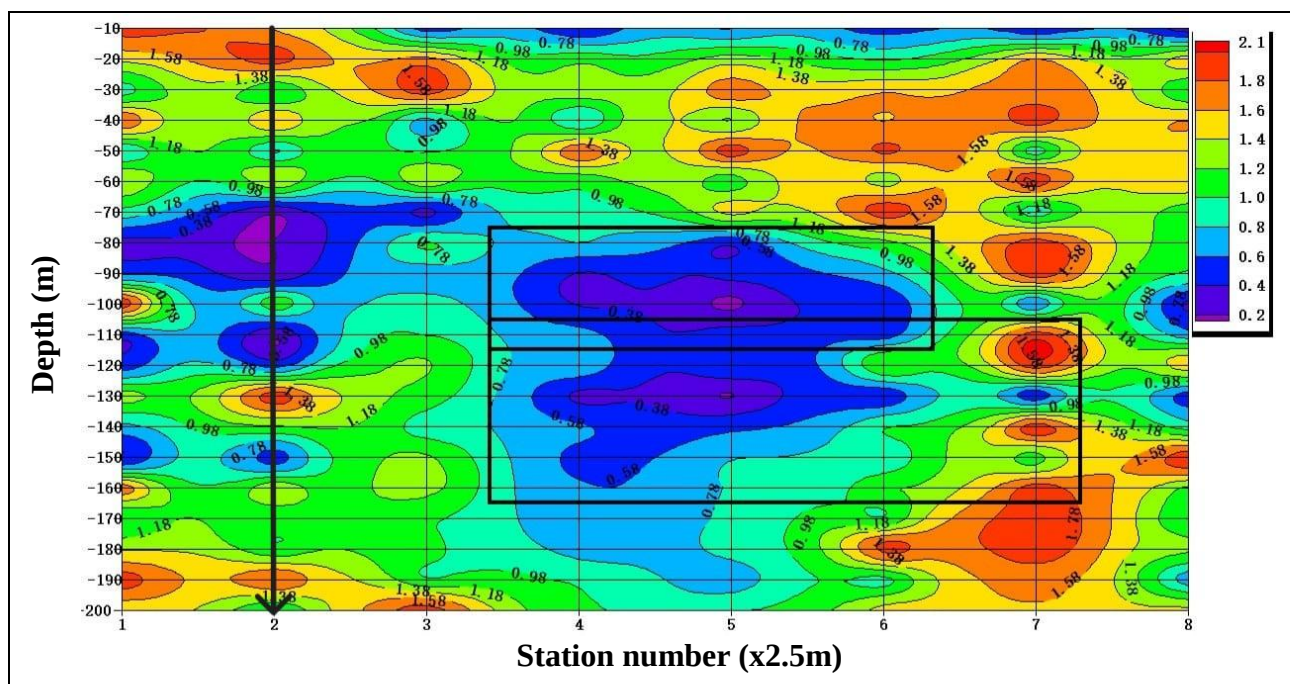


Figure 13: Isoline graph of Profile 6

Profile 06 was surveyed in the Western part from East to West. It has apparent resistivity ranging from 0.2 to 2.1 ohm.m. At a depth of 60 to 100m, and 110 to 120m, anomalies were detected in the area. These signify conducting zones which are assumed to be good saturated or weathered and fractured layers (aquifers). Station number 2 was VESed as VES 3.

The interpretation of the sounding curves was undertaken by using fixed resistivity values of the bedrock and the pre-bedrock layer of 5000 ohm.m and 150 ohm.m, respectively. In addition, a layer with a resistivity value of about 10 to 20 ohm.m (clay) was interpreted in most cases, except if this layer would be negligibly thin.

Table 6: Resistivity values

STN	CalR	Cal	R1	V1	R2	V2	R3	V3
13.2		0.0	10.43	489.2	2.456	115.2	6.274	294.3
19		0.0	3.671	389.1	0.879	93.2	2.533	268.5
27.5		0.0	1.486	341.8	0.2619	60.2	0.8866	203.9
40		0.0	0.638	315.8	0.1277	63.2	0.3387	167.7
58		0.0	0.3005	315.2	0.09339	98.0	0.1812	190.1
83		0.0	0.1996	430.3	0.07693	165.9	0.1292	278.6
120		0.0		0.0		0.0		0.0

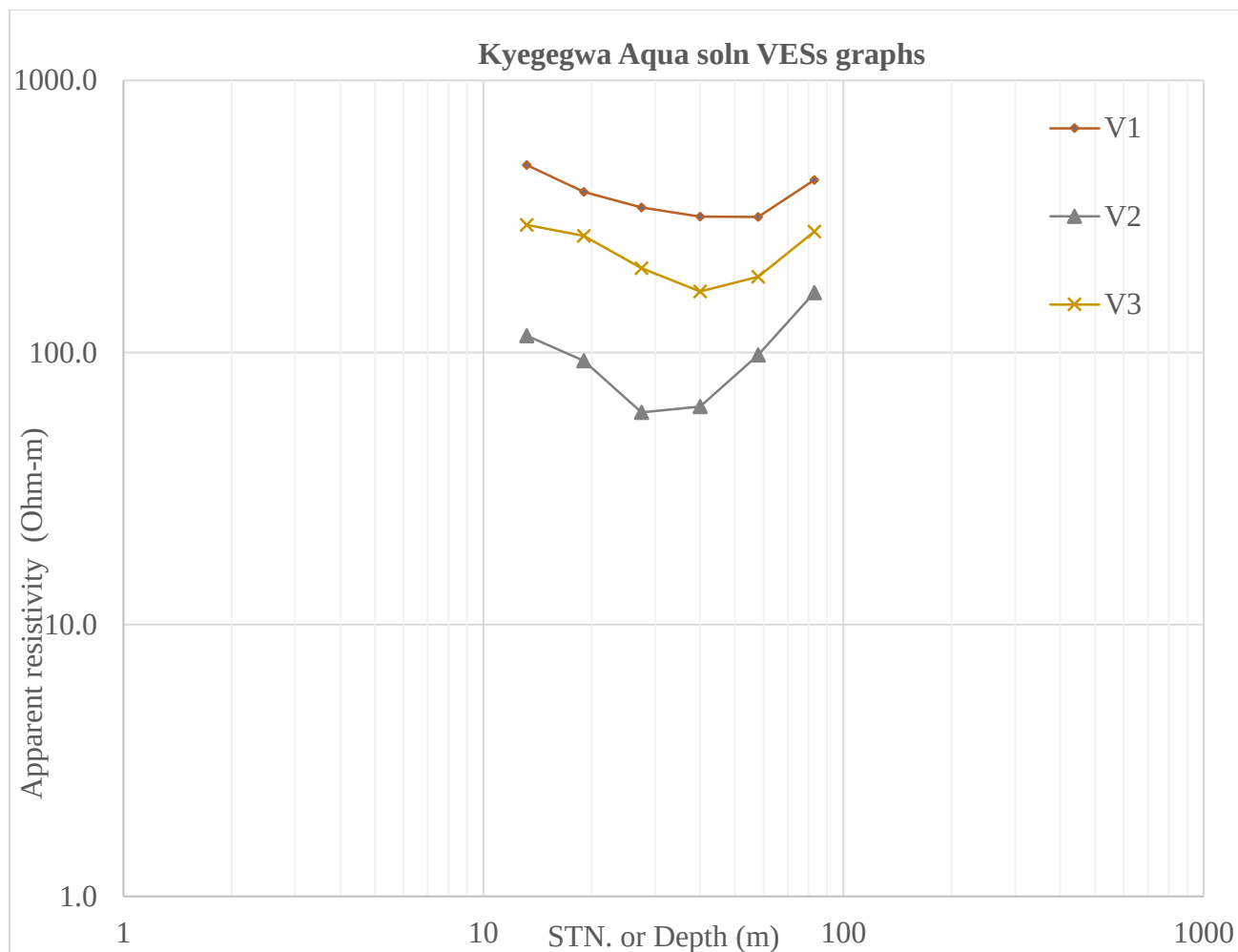


Figure 14: Graph of the VESs

All three VES curves show a classic **H-type or HA-type curve** characteristic, where resistivity drops in the middle layers (weathered zone) and rises steeply at greater depths due to the high-resistivity granite bedrock (5,000 ohm.m).

V1 (High Resistivity): Shows high values throughout (315.8 to 489.2 ohm.m). The minimum is 315.2 ohm.m at 58m. This indicates a thin, poorly weathered overburden with low water-bearing potential.

V2 (Lowest Resistivity): Outlines the most promising profile. Resistivity drops to a minimum of 60.2 ohm.m at 27.5m and stays low up to 58m. This signifies a deep, heavily weathered/fractured zone mixed with some clay contents.

V3 (Moderate Resistivity): Reaches a clear minimum of 167.7 ohm.m at 40m. This value aligns closely with the target pre-bedrock layer profile (150 ohm.m) indicating an optimal fractured aquifer zone.

INTERPRETATION AND DISCUSSION

Drilling points selection

The investigated sites are evaluated in order to select the most promising sites for a high yielding borehole. This evaluation is primarily done based on a scoring system. This classifies the sites in a technical and quantitative way, based on shape and location of anomaly and Vertical Electrical Sounding, topographical and geological setting and hydrogeological experience of the consultant. Furthermore, the sites are compared with geophysical data of boreholes in the area, to assess how much the newly surveyed sites resemble the calibration measurements.

The final recommendations will be based on the scoring, comparison with existing borehole data and the experience of the hydrogeologist

The decisive factors in prioritizing the proposed water supply option in terms of its rating were;

- VES curve characteristics (Shape/breaks and size of the anomaly) (10 points)
- Relation to calibration data (10 points)
- Resistivity of the VES or profile (8 points)
- Relation to nearby wells (8 points)
- Accessibility of the point (6 points)
- Topographic setting and nature of the surrounding vegetation (6 points)
- Client's preference (2 point)

Table 7: Drilling point selection

Point	Characteristics (0-10)	Relation to calibration (0-10)	Resistivity (0-8)	Relation to boreholes data (0-8)	Accessibility (0-6)	Topography (0-6)	Clients' preference (0-2)	Total points (50)
01	6	-	6	6	4	5	2	29
02	8	-	8	7	4	6	2	35
03	9	-	7	8	4	5	2	35

Correlation with Regional Borehole Data (Table 5)

Depth to Bedrock (DBR): Table 5 shows an average DBR of **42m** The upward turn of curves V2 and V3 after 40-58m matches this transition into solid granite bedrock perfectly.

Water Strike Depth: The average Main Water Strike (MWS) in the area is 58m. The low-resistivity troughs for V2 and V3 occur between 27m and 58m, confirming that groundwater is stored directly above or within the fractured pre-bedrock boundary.

Yield Expectations: High-yielding local boreholes (like DWD27152 with 3.5 m³/hr. tap into deeper weathered pockets (DBR = 48m) V2 and V3 mimic these successful configurations, whereas V1 mirrors dry/low-yield holes (like GS1085).

V3 displays a well-defined fractured layer (167.7 ohm.m) at the ideal regional depth thus, is recommended as first priority. V2 offers the lowest-resistivity weathered zone thus, is second priority.

Potential challenges

- Moderate groundwater potential or yield (0.5-3.5 m³/hr.).
- Thick overburden (45m).
- Poor accessibility (narrow roads)

CONCLUSIONS AND RECOMMENDATION

Conclusion

Table 8: Analysis of the data

Priority	Recommended	Alternative
Point	V3	V2
Coordinates & Elevation	0.484729, 31.091907 & 1349m	0.484579, 31.092121 & 1345m
Maximum drilling depth (m)	120	100
Expected depth to bedrock (m)	60	45
Expected Water strikes (m)	20-90, 100-120	20-90
Estimated yield (m ³ /hr.)	-	-
Expected formation	Top soil + Clay + Regolith (0 - 60), Granite (60 - 120)	
Accessibility	Fair	Fair
Possible threat	Moderate yield, Poor accessibility, Thick Regolith	
Likely water quality elements	Iron , Manganese	
Contact person	Marvin: +256788850406	

1. It should be noted that the interpretations are simplifications of the collected data, the actual depth to bedrock and final decision on when to stop drilling should be made on site by the supervisor/hydrogeologist in consultation with the driller.
2. Pegs were used to mark the drilling points.
3. In all cases, drilling will aim at tapping water available in both the overburden and bedrock.
4. The results are based on the client's area of interest and boundaries.
5. The estimated yield is not a guarantee as the actual yield could be less or more than the estimated.

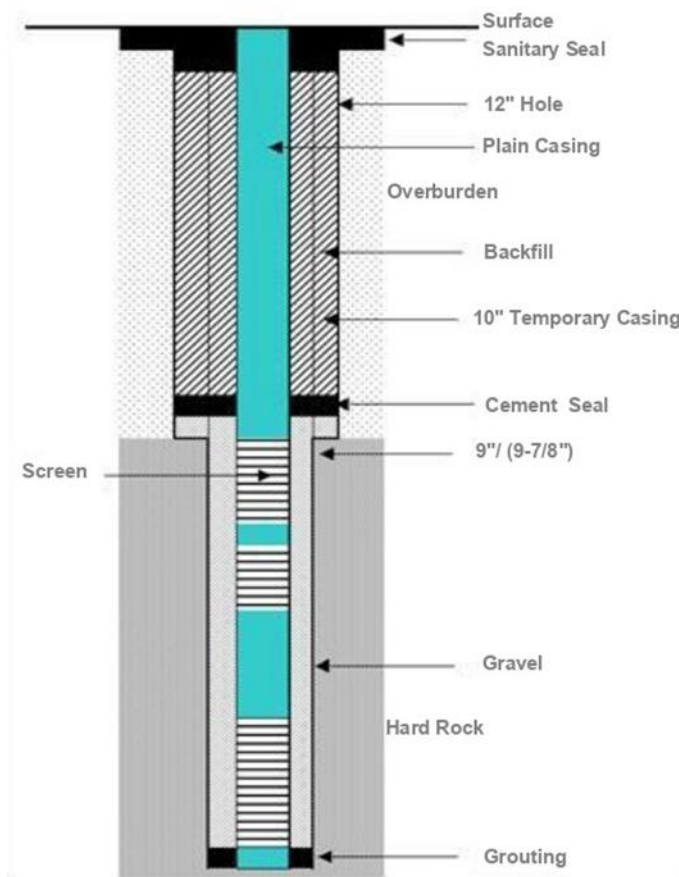
Recommendation

Drilling

- i. **VES 03 is the recommended drilling point** whereas VES 02 is the alternative.
- ii. **Recommended drilling depth is 120m.** However, drilling can stop once sufficient water is achieved or as reasonably deemed fit by the supervising hydrogeologist.
- iii. The rig should be suitable for drilling through both unconsolidated (collapsing) material and hard basement rock.
- iv. Widen the roads to improve accessibility.
- v. Drilling (rig operation) should be done by a highly experienced driller.

- vi. Mud drilling method should be used in thick overburden and air rotary (DTH) in competent rock with diameter of not less than 5 inches to the recommended depth. The driller should have temporary steel casings to at least 60m to prevent collapsing during drilling.
- vii. Geologic rock samples should be collected every 2 meters' interval or when change in lithology is observed. Struck and rest water levels should be carefully recorded, as well as water quality and estimates of the yield of individual aquifers encountered.

Design



- a) The design is to be determined by the supervising hydrogeologist in consultation with the driller on site basing on the type and competence of the formation or rock. Design A (Full casing), shallow well design with 5-inch permanent casings should be adopted on sites with loose formations while Design B (Open Hole) can be used for sites with very competent hard rock formation or drilled to more than 120m.
- b) The water strike zones should be cased with screens and gravel packed.
- c) Clay or cement (2m) seal and 3m grout should be put at the bottom and on top to prevent contamination. The well should be backfilled outside the casings.
- d) Development should be done using air or water jetting, air-lifting or mechanical plunging (not over pumping) to repair damaged aquifers and remove clay for a minimum of one (01) hour.

Pumping and Recovery test

- Test pumping should be done continuously for at least twelve (12) hours after drilling and development. Recovery test should be done after constant rate test until 95% of the water is recovered in the well.

APPENDICES



Appendix 1: V2 (Alternative)



Appendix 2: V3 (Recommended)

GLOSSARY OF TERMS

- Alluvium:** General Term for detrital material deposited by flowing water.
- Aquifer:** A Geological formation or structure, which stores and transmits water to wells, boreholes or springs.
- Colluvium:** General term for detrital material deposited by hill slope gravitational processes with or without water as an agent. Usually of mixed Texture.
- Conductivity:** Transmissivity, T per unit length (m/day).
- Confined aquifer:** A formation in which the groundwater is isolated from the atmosphere by impermeable geologic formations. Confined water is generally at greater pressure than atmospheric, and will therefore rise above the struck level in a borehole.
- Development:** In borehole engineering, this is the general term for procedures applied to repair the damage done to the formation during drilling. Often the borehole walls are partially clogged by an impermeable “wall cake”, consisting of fine debris crushed during drilling, and clays from the penetrated formations. Well development removes these clayey cakes, and increases the porosity and permeability of the materials around the intake portion of the well as a result, a higher sustainable yield can be achieved.
- Evaporation:** Loss of water from a land area through transpiration from plants and evaporation from the surface.
- Fault:** A larger fracture surface along which appreciable displacement has taken place.
- Gneiss:** Irregularly banded rock, with predominant quartz, feldspar and micaceous minerals. A product of regional metamorphism, especially of a higher grade
- Gradient:** The rate of change in total head per unit of distance, which causes flow in the direction of the lowest head.
- Granulate:** Even-grained metamorphic rock of coarse grain composed mainly of hornblende and plagioclase minerals. A product of regional metamorphism of the highest grade
- Heterogeneous:** Not uniform in structure or composition.
- Hydraulic head:** Energy contained in water mass-produced by elevation, pressure or velocity.
- Hydrogeological:** Those factors that deal with subsurface waters and related geological aspects of surface waters.

Infiltration:	Process of water entering the soil through the ground surface.
Joint:	Fractures along which no significant displacement has taken place.
Metamorphic:	Referring to rocks that have been changed in structure and mineralogy by a combination of high pressure, high temperature, and/or chemical factors often linked to major regional tectonic events. Examples are gneisses, schist's, granulites, etc.
Percolation:	Process of water seeping through the unsaturated zone, generally from a surface source to the saturated zone.
Perched aquifer:	Unconfined groundwater separated from an underlying main aquifer by an unsaturated zone. Downward percolation hindered by an impermeable layer.
Peneplain:	A levelled surface, which has lost nearly all its relief by passing through a complete cycle of erosion (also used in a wider sense to describe a flat erosion surface in general).
Permeability:	The capacity of a porous medium to transmit fluids.
Piezometric level:	An imaginary water table, representing the total head in a confined aquifer, and is defined by the level to which water would rise in a well.
Porosity:	The portion of bulk volume in a rock or sediment that is occupied by openings, either isolated or connected.
Test pumping:	A test that is conducted to determine aquifer and/or well characteristics.
Recharge:	General term applied to the passage of water from surface or subsurface sources (e.g. rivers, rainfall, lateral groundwater flow) to the aquifer zones.
Regolith:	The mantle of loose or semi-consolidated material (soils, sediments and broken rock) overlying the bedrock.
Saprolite:	Weathered residual rock in place.
Static water level:	The level of water in a well that is not being affected by pumping. Also known as “rest water level”
Transmissivity, T:	A measure for the capacity of an aquifer to conduct water through its saturated thickness (m ² /day).
Unconfined:	Referring to an aquifer situation whereby the water table is exposed to the atmosphere through openings in the overlying materials (as opposed to confined conditions).
Yield:	Volume of water discharged from a well in a unit time.