HYDROGEOPHYSICAL INVESTIGATION FOR BOREHOLE DEVELOPMENT AT FUTA, AKURE, ONDO STATE.

CLIENT: NAME WITHELD FOR PRIVACY

CONSULTANT: MUKOLAK GEOCONSULT NIG. LTD.

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EXECUTIVE SUMMARY

A pre-drilling geophysical investigation was conducted at the Federal University of Technology, Akure (FUTA), Ondo State for groundwater development. The survey engaged the Electrical Resistivity Geophysical Method by utilizing both the Horizontal profiling technique as well as the Schlumberger depth sounding technique. On the long traverse established in a near east - west direction at the back of the building, horizontal profiling (HP) technique carried out revealed relatively lower resistivity values at some points along the traverse, suggesting that prospective Vertical electrical sounding (VES) locations can be harnessed at these points. Hence, VES points 1, 2 and 3 were acquired at locations 50m, 60m and 80m westward from station 0 on the long profile at the back of the building whereas VES point 4 was located at station 0 on the profile at the front of the building. The interpretation of the VES data showed that, curve types HA was delineated for the four VES locations implying that 4 geoelectric layers can be inferred for the four locations.

Further interpretation revealed that the area is underlain by Top Soil, Weathered Layer, Partially Weathered Layer, and Fresh Basement at the three locations. In addition, at the VES locations, at the VES locations, the top soil has a resistivity value range (103 – 335 ohm-m) with thickness (0.7 – 1.5 m), the weathered layer has a resistivity value range (41 – 84 ohm-m) with thickness (2.9 – 10.2 m). Also, the partially weathered layer has a resistivity value range of (204 – 533 ohm-m) with thickness (10.7 – 15.5m) and the fresh basement has a resistivity value range (793 – 1786 ohm-m) with infinite thickness**. The geoelectric parameters from the VES data suggest that at the four VES locations, the weathered layer is clayish in nature and judging from the relatively lower permeability nature of clay, the weathered layer is therefore unsuitable for groundwater abstraction. However, at VES location 4, the weathered layer resistivity value shows a relatively less clayey nature and therefore it might offer prominence for seasonal and moderate yield hand dug well as a means of groundwater abstraction judging from its shallow depth but appreciable thickness. Also, the partially weathered layer at the VES locations do not offer prominence for groundwater abstraction since the resistivity value at this layer is suspected to be incompatible with groundwater saturation. Therefore, it is recommended that groundwater abstraction through borehole development is not feasible at any of the four VES locations. Regardless, a shallow hand dug well to a depth of about 10m – 12m (33ft – 40ft) is suggested at VES 4 but such well will be largely seasonal and of moderate yield.**

It should however be pointed out that the electrical resistivity survey simply identifies physical structures like (fractured layer) within a rock body but does not guarantee the occurrence of water in it as it could be filled with ore body for example (Like electrical conductivity material) or may be a dry fracture. However, the electrical method has an excellent track record when it comes to finding useful quantities of water in hard rock. It should also be stated here that the quantity of water depends solely on the rock materials in which the water interacts over the years. A geophysicist is therefore not liable to either quantify and /or describe the quality of the groundwater obtained at a VES location as they are absolutely a function of nature.

1.0 INTRODUCTION

The use of surface geophysics in evaluating the groundwater condition of an area is important not only in reducing the wild cat search through drilling but in locating the best probable point in an area thereby allowing for comparison and scientific guidance to control the choice of location. Therefore, the geophysical investigation is employed to highlight the following objectives:

(i) **the geoelectric sequence/subsurface geology of the area**

(ii) **the geoelectric parameters of the area**

(iii) **the probable aquiferous units and the nature/characteristics of the aquifer**

(iii) **the depth to the aquifer**

This will assist greatly in borehole design, drilling and development of the well.

2.0 SITE DESCRIPTION

The study area is within the Federal University of Technology Akure (FUTA), Ondo State. The use of groundwater is desirable for the domestic use of people due to its portability and sustainability. Within the study area, there is an existing hand dug well already dug at the side of the building suggesting that the, if the geology is right, there may be a tendency of seeing prominent borehole or hand dug well point in the study area. Thus the data acquisition process was done to first assess the suitability of the geology along the traverse established at the back of the building and oriented in an approximately East - West direction to which horizontal profiling (HP) technique was carried out to locate zones of anomalously lower resistivity values along the traverse which further investigation involving VES data acquisition can be acquired on them. Thus, VES 1 was located at 50m on the traverse, VES 2 was located at 65m and VES 3 was located at 85m westward from point 0 and VES 4 was located at point 0 on the traverse at the front of the building (Figure 1).

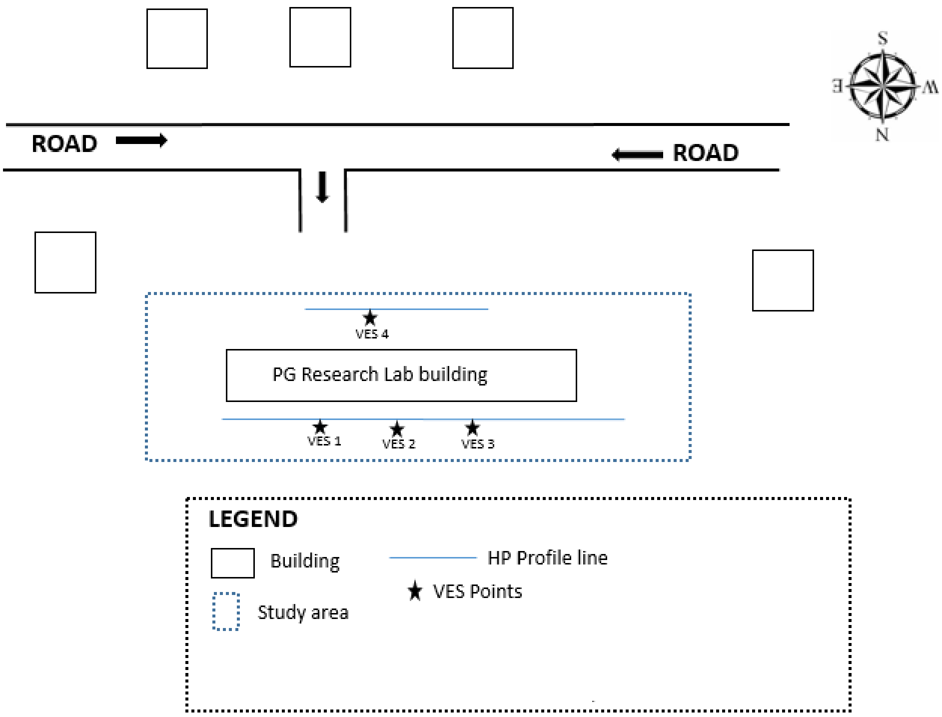

Fig. 1: Layout map of the study area

3.0 GEOLOGY AND GEOMORPHOLOGY

Mainly, Precambrian basement complex rocks such as Granite have underlain the study area (FUTA). The study area is situated on a flat terrain (370-380m) above the sea level with the topography being gentle. There is no visible presence of outcrops in the study area. Also, there is presence of vegetation along the traverse line.

4.0 GEOPHYSICAL INVESTIGATION

The geophysical investigation employed both the horizontal profiling (HP) using Wenner array as well as the Vertical Electrical Sounding (VES) technique employing the normal Schlumberger array (Fig. 2). In the HP technique employing wenner array, the two potential electrodes were located within the two current electrodes and an electrode spacing of 20m was adopted. Measurement were taken at each station positions which were 5m apart from each other until the whole station were exhausted within the established traverse. In the VES approach employing Schlumberger configuration, with the potential electrodes located within the current electrodes, the half current electrode (AB/2) spreading starting from 1m and reaching a maximum spread of 100m was adopted. The R-50 earth resistivity meter was used as the geophysical measuring equipment and the whole processes adopted were geared towards good and accurate data acquisition.

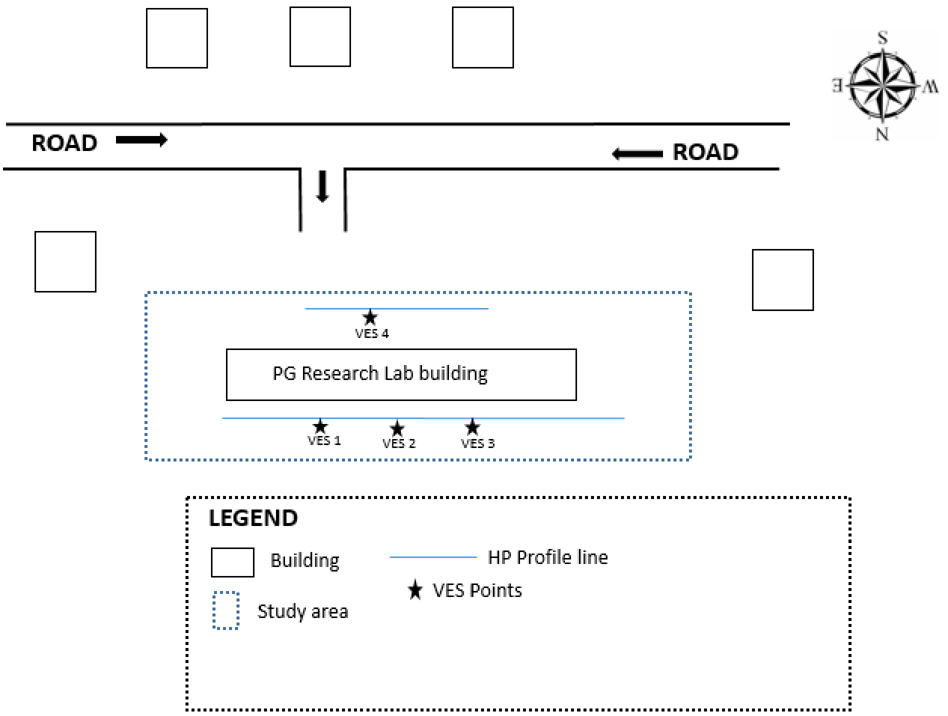

Fig. 2: Data acquisition map of the study area

5.0 DATA PRESENTATION AND INTERPRETATION

Geophysical data can be presented in the form of depth sounding curves, profiles, maps, sections and tables. For this study, the use of profile, depth sounding curves and tables in discussing and establishing the relevant subsurface layers and basement structures for the target were adopted. Table 1a and b shows the horizontal profiling data along the traverses at the back and front of the building respectively.

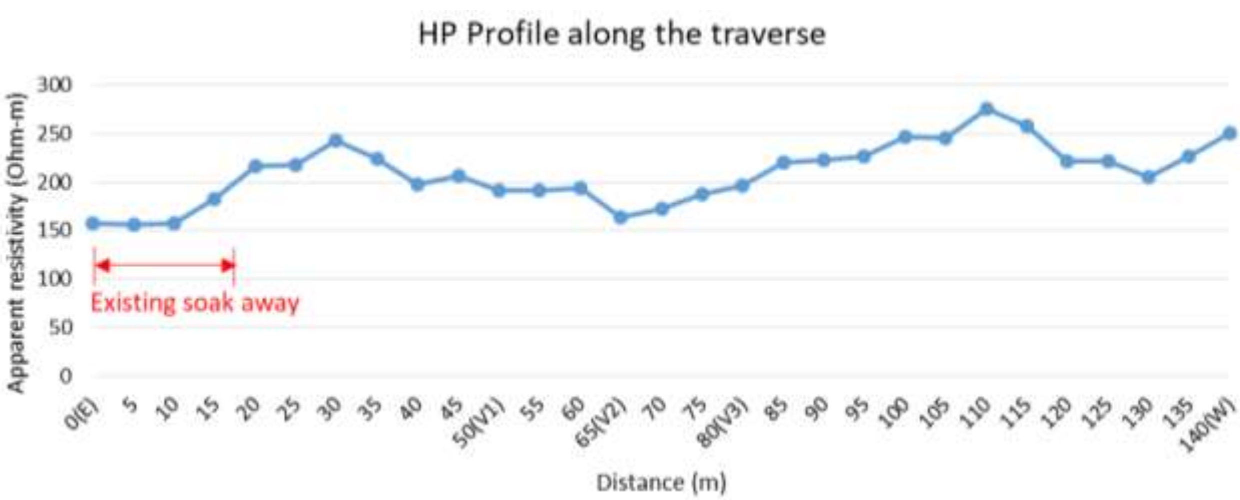

Fig. 3a: Horizontal profile along the traverse at the back of the building

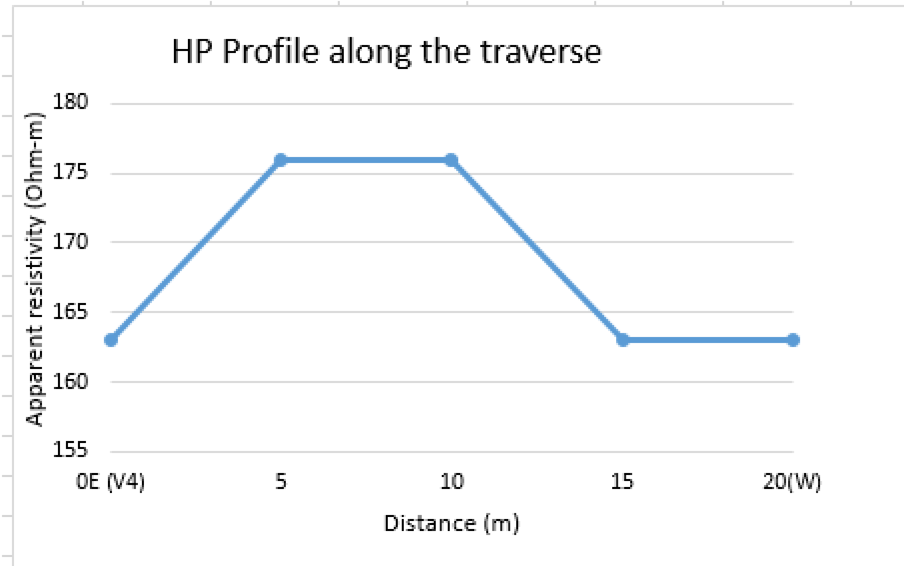

Fig. 3b: Horizontal profile along the traverse at the front of the building

Figure 3a shows the horizontal profile (HP) along the traverse at the back of the building which was established in a near E-W direction. The result of the profile showed relatively lower resistivities at some points along the established traverse which could be diagnostic that conductive zones relevant for groundwater abstraction could fall at these points. The most relevant conductive zones with good subsurface impression diagnostic of groundwater were subsequently picked from the HP profile using the vertical electrical sounding (VES). These points located at 50m, 60m and 85m westward from point 0 were subsequently probed and were regarded as VES1, VES 2 and VES 3 respectively. In addition, Fig. 3b also depicts the horizontal profile established at the front of the building and the relatively lower resistivity at location 0 was probed in a depth sounding manner and regarded as VES 4. The typical VES field data are shown in Tables 2a, b, c and d. The sounding data are plotted and presented as sounding curves (Fig.4a, b, c and d) and are interpreted quantitatively. The results of the VES quantitative interpretation are shown in Tables 3a, 3b, 3c and 3d as geoelectric parameters.

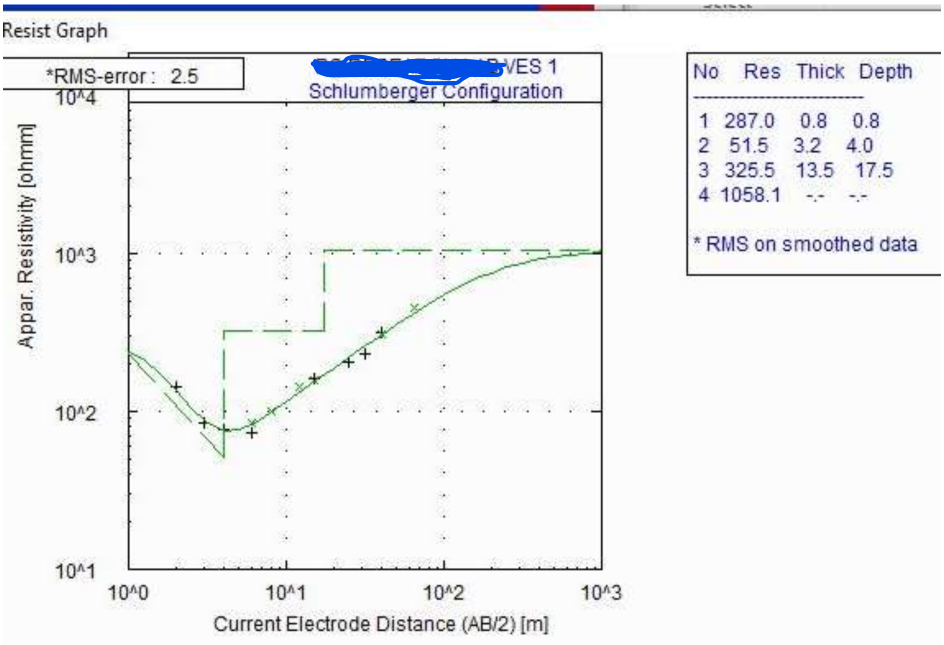

Fig. 4a: Depth sounding curve for VES 1

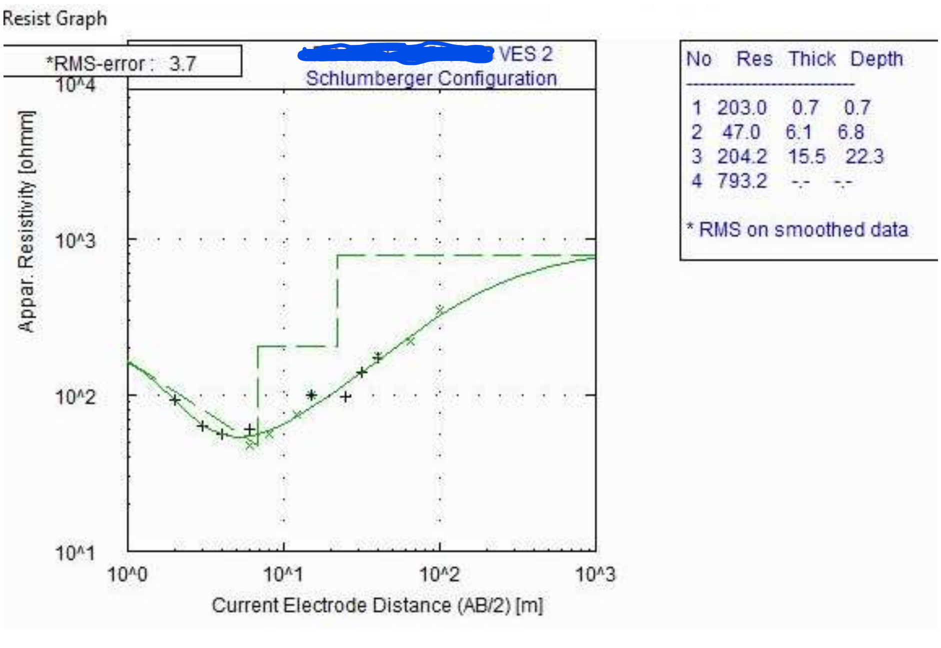

Fig. 4b: Depth sounding curve for VES 2

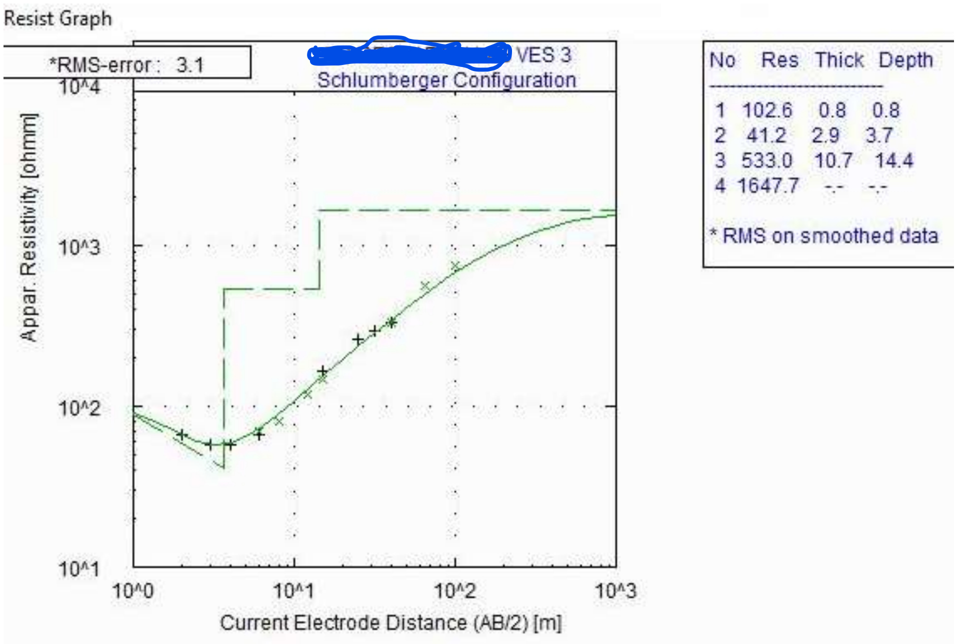

Fig. 4c: Depth sounding curve for VES 3

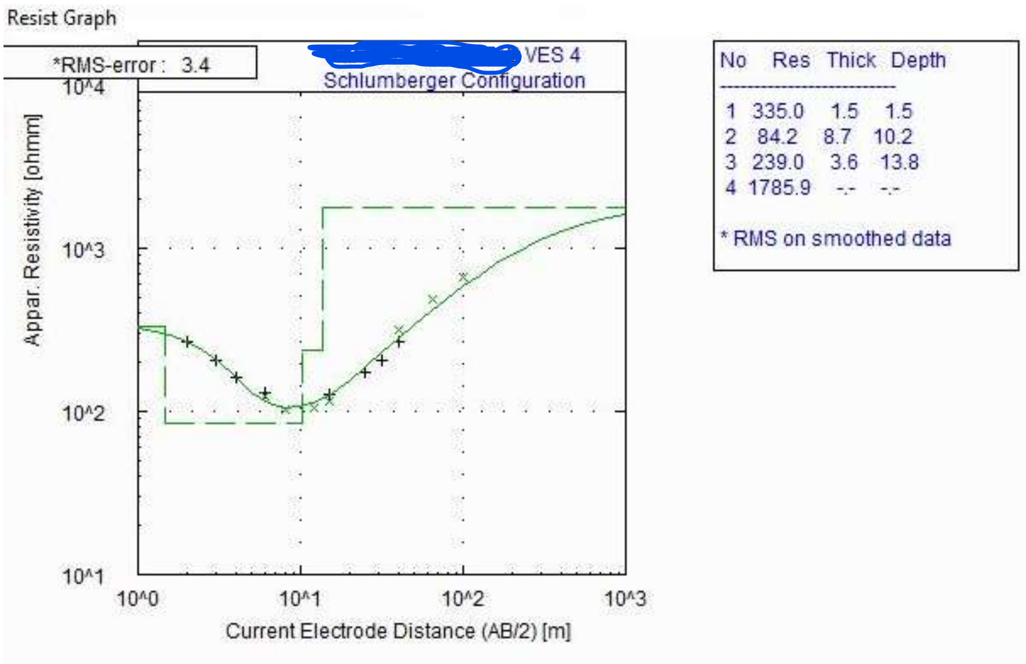

Fig. 4d: Depth sounding curve for VES 4

Table 3a: VES Interpreted Results (V_1)

S/N	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithologic Equivalence
1	287	0.8	0.8	Topsoil
2	52	3.2	4.0	Weathered layer
3	326	13.5	17.5	Partially Weathered Layer
4	1058	-	-	Fresh Basement

Table 3b: VES Interpreted Results (V_2)

S/N	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithologic Equivalence
1	203	0.7	0.7	Topsoil
2	47	6.1	6.1	Weathered Layer
3	204	15.5	15.5	Partially Weathered Layer
4	793	-	-	Fresh Basement

Table 3c: VES Interpreted Results (V_3)

S/N	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithologic Equivalence
1	103	0.8	0.8	Topsoil
2	41	2.9	3.7	Weathered Layer
3	533	10.7	14.4	Partially Weathered Layer
4	1648	-	-	Fresh Basement

Table 3d: VES Interpreted Results (V_4)

S/N	Resistivity (Ωm)	Thickness (m)	Depth (m)	Lithologic Equivalence
1	335	1.5	1.5	Topsoil
2	84	8.7	10.2	Weathered Layer
3	239	3.6	13.8	Partially Weathered Layer
4	1786	-	-	Fresh Basement

From Tables 3a, b, c and d, the geo-electric parameters obtained from depth sounding at the four VES locations V1, V2, V3 and V4 classified the area into four geo-electric layers. The interpretation of these layers revealed that the area is underlain by Top Soil, Weathered Layer, Partially Weathered Layer and Fresh Basement at the four locations. In addition, at the VES locations, the top soil has a resistivity value range (103 – 335 ohm-m) with thickness (0.7 – 1.5 m), the weathered layer has a resistivity value range (41 – 84 ohm-m) with thickness (2.9 – 10.2 m). Also, at the VES locations, the partially weathered layer has a resistivity value range of (204 – 533 ohm-m) with thickness (10.7 – 15.5m) and the fresh basement has a resistivity value range (793 – 1786 ohm-m) with infinite thickness. **The geoelectric parameters from the VES data suggest that at the four VES locations, the Weathered layer is clayish in nature and judging from the relatively lower permeability nature of clay, the weathered layer is therefore unsuitable for groundwater abstraction. However, at VES location 4, the weathered layer resistivity value shows a relatively less clayey nature and therefore it might offer prominence for seasonal and moderate yield hand dug well as a means of groundwater abstraction judging from its shallow depth but appreciable thickness. Also, the partially weathered layer at the VES locations do not offer prominence for groundwater abstraction since the resistivity value at this layer is suspected to be incompatible with groundwater saturation.**

GROUNDWATER POTENTIAL EVALUATION

In a typical basement terrain, the groundwater prospect is hinged on a fairly thick overburden and weathered layer with resistivity parameters compatible with groundwater saturation. The weathered layer in the study area is clayish in nature and due to the relatively lower permeability nature of clay, it is unsuitable for groundwater abstraction. Also, which could have offered some opportunity for groundwater abstraction also possesses relatively high resistivity value suspected to be incompatible with groundwater saturation. **In view of this, the four VES locations VES 1, VES 2, VES3 and VES4 are therefore unsuitable for groundwater abstraction through borehole development but hand dug well can be acquired only at VES4.**

CONCLUSION

The most promising lithologic unit for groundwater occurrence within the study area would have been the weathered layer supposed it is not clayish in nature which forfeited it to be suitable for groundwater abstraction. In addition, the partially weathered layer also possess relatively high resistivity value suspected to be unsuitable for groundwater saturation which also added to the unsuitability of the three VES locations for groundwater abstraction. Therefore, such locations do not offer prospect in terms of abstraction for groundwater either through hand dug well or borehole development.

RECOMMENDATION

It is therefore recommended that groundwater abstraction through borehole development is not feasible at any of the four VES locations. However, a shallow hand dug well to a depth of about 10m – 12m (33ft – 40ft) is suggested at VES 4 but such well will be largely seasonal and of moderate yield.