Groundwater Research and Development Potential in Auchi Polytechnic-Philipa Idogho Campus

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Abstract
The immediate need of water is very vital to every organism therefore its availability and provision becomes very essential to life. As a result this study focused on the provision of quality ground water for sustainability of staff and students of Auchi polytechnic and its environs. It carried out conduction of resistivity sounding at the site and interpretation of the field Vertical Electrical Sounding (VES) data to obtain geo-electric parameters. Determination of the hydrogeological characteristics of the subsurface at the site based on geo-electric and available geologic information reveal the possible of water availability. It recommended that a suitable drilling rig that can effectively drill to the required specifications and depth should be mobilized to site for subsequent projects.
Keywords: Lithology, Depth, Geological survey, Ground water, ETF, Campus

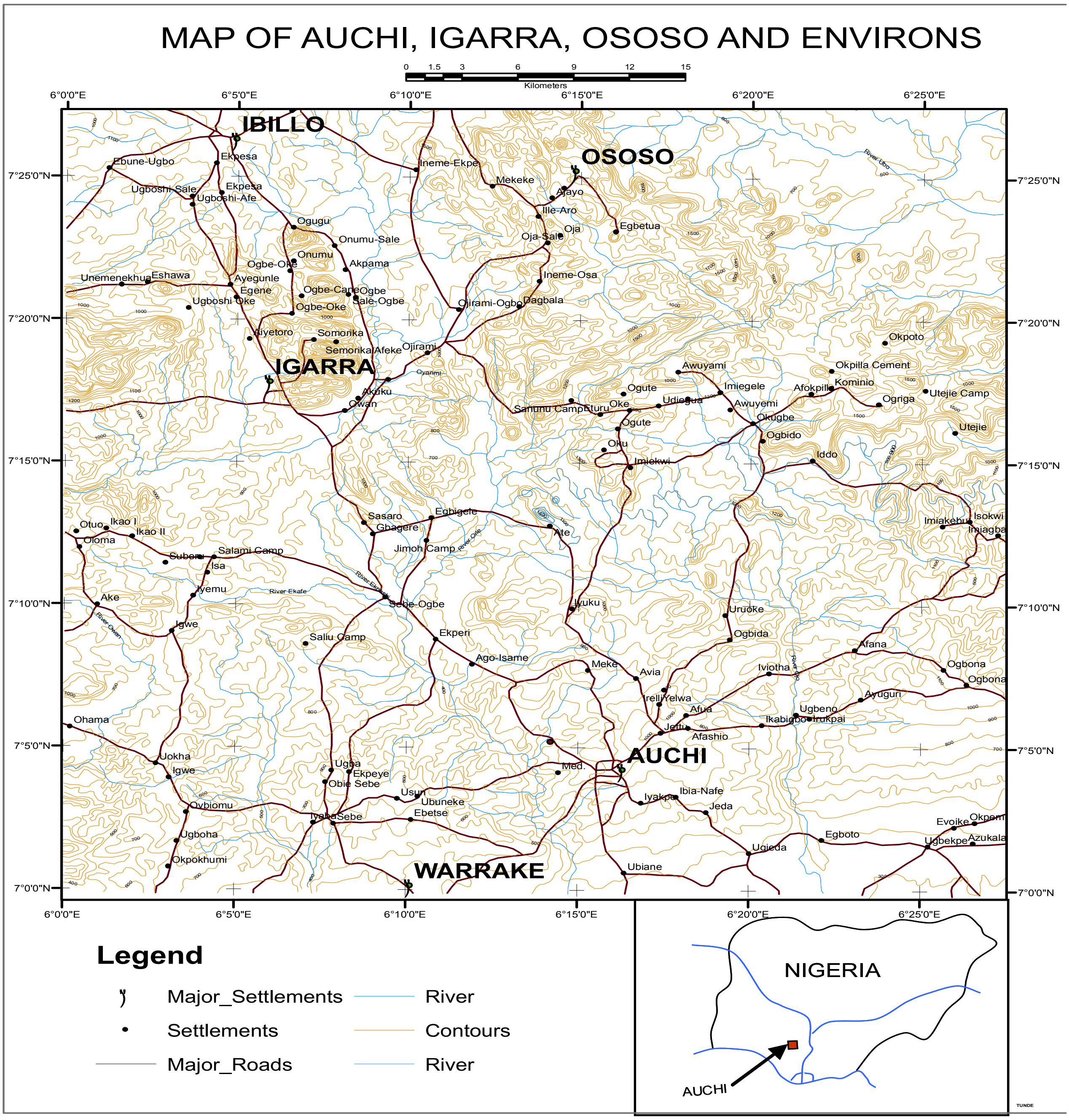
1. Heading 1 Introduction
The basic need and sustenance of man is water. As a result of its immediate needs to animal, plant and others, water availability and provision becomes very essential to life. According to Mulla, Syed, Abed and Pardhan (2011) observed that water is essential for life on the earth and any other planet and further explained that it is the fundamental right to get pollution free water to the every individual. The pollution of surface water can be treated with different techniques. It is very difficult to get purified ground water. In the Marathwada region from ancient times the people were using ground water for day-to-day use and drinking purpose. Groundwater resource development is a very viable means of meeting the ever increasing needs of our teeming population for potable water. Groundwater abstraction is more commonly done through borehole drilling. The amazing rates of failure recorded in the past drilling works have necessitated the absolute need for pre-drilling investigations (Fasunwon, Ayeni and Lawal, 2010). Geophysical methods have been very useful in determining the geological sequence and structure of the subsurface rocks by the measurement of their physical properties. Although there are varieties of geophysical techniques, which could be used in groundwater exploration, electrical resistivity method has proved reliable in delineating zones of relatively low resistivity signatory of saturated strata in various geologic terrains (Odejobi, 1999). Some chemical constituents are expected of ground water. For instance in the study of Majolagbe, Kasali and Ghaniyu (2011), the following chemical observations were recorded and helped to shape the study in Lagos suburban for ground water project. The chemicals are Cd, Fe, Cu Zn Mg and Na which were determined using Flame Atomic Absorption Spectrophotometer (Buck scientific 210VGP model). The study confirmed that concentration of Pb, Fe and Cd found in Isolo study area were higher than WHO health based guideline values, indicating possible impact of landfill on the groundwater quality. This raises the question of toxicities of these elements, hence pose potential threat to man. Most of the nutritive metals analysed (Na, Zn, and Cu) in Isolo samples maintained strong positive correlation with r values ≥ 0.8 showing possible common source, unlike Ifo water samples that had all the metals analysed found within the WHO standards for drinking water. Ifo groundwater is soft with pH within the WHO acceptable range for drinking water while Isolo water is moderately hard, acidic in nature; hence require further treatment for it to be potable.
In the ground water study of the Auchi Polytechnic presents a different view point based on the location, depth, geophysical analysis and Lethological laboratory test conducted before embarking on the project in the survey site. In addition, the total field operations and data acquisition at the site lasted for two days and follow the execution of the ground water project.
1.1Research Objective
The primary objective of this investigation focuses on the followings:

- Conduction of Resistivity sounding at the site and interpretation of the field Vertical Electrical Sounding (VES) data to obtain geo-electric parameters.

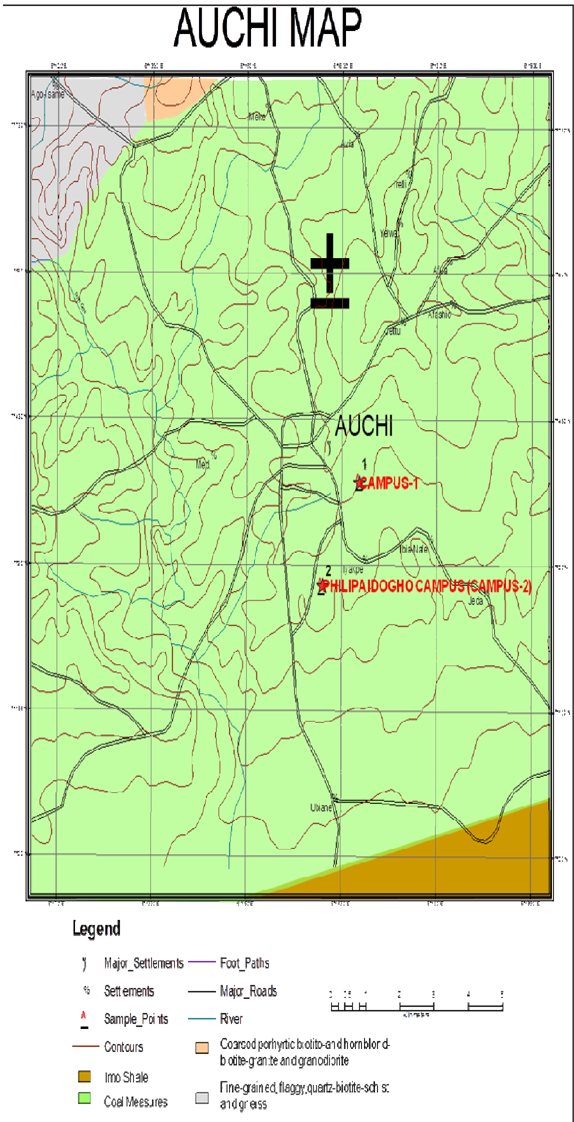
- Determination of the hydrogeological characteristics of the subsurface at the site based on geo-electric and available geologic information.
- Making an appropriate recommendations for the planning and execution of a viable groundwater abstraction project (at the site) through borehole drilling
- Production of groundwater and quality distribution in the study area.
- Installation of a treatment plant unit.

1.2 Study Area: Site location and description

The geophysical exploration was carried out within Auchi Polytechnic, Auchi, Edo State, Nigeria. VES 1 is approximately defined by the geographical coordinates of latitude N070 02'44.4" and Longitude E0060 16'11.8". The observed elevation above the mean sea level is 213 m.



Source: Authors' Extract of Auchi and its environments, 2012.



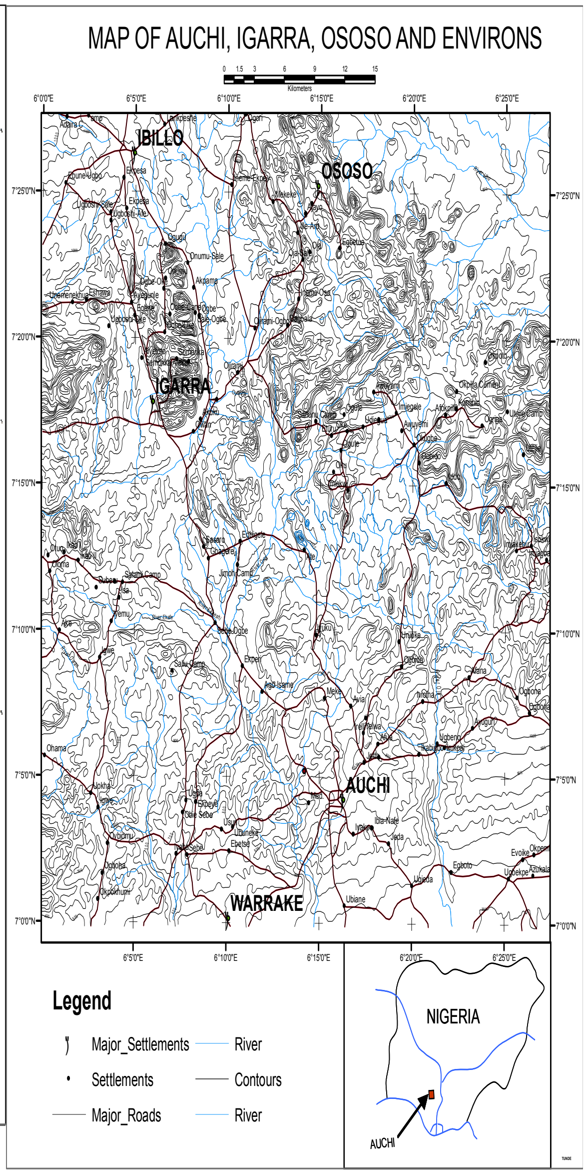


Fig. 1: Geological map of Auchi and Environs

Source: Authors' Geological Map of Auchi and its environments, 2012.

2. Material and Method of Study

In this project, most materials employ involve geophysical survey, site clearing, mud pit construction, mobilization of equipment/personnel, drilling operation, excavation for tank foundation, chain design for tank foundation, casing of the borehole, gravel packing of the borehole, pump installation/pump testing, fabrication of the tank/stanchion , excavation for pipe laying, distribution points/reticulation, fetching points, treatment unit, painting of the stanchion/Tank, fencing of borehole perimeter, diagrams/pictures, financial breakdown, geophysical results, Some of our challenges/constrains. For illustrative purpose see the features below:

The Physical diagram of the project execution

Figure 2 a and b Terrameter and reels

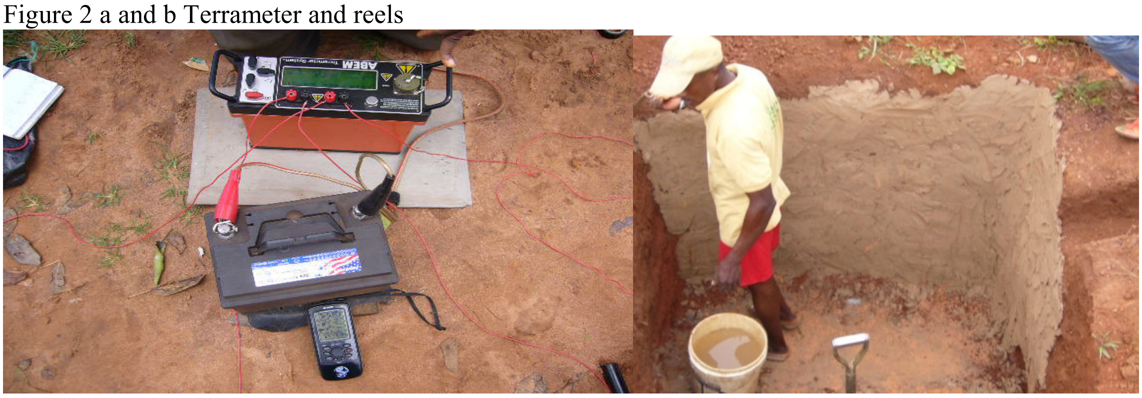


Figure 2 a and b Terrameter and mud pit

2.1 Field procedure

The groundwater exploration carried out at the site was done using electrical resistivity sounding techniques (VES). This was achieved with the aid of ABEM AC Terrameter and other field accessories. Geographical coordinates and elevations were obtained from the GARMIN GPS map 76CSx' set.

Three Vertical electrical sounding (VES) were done at the site using Schlumberger array. The total spread length (i.e. AB/2) attained for the three VES points within the limit of the available space were 500m, 350m, and 150m. However, the artificially generated electrical signal can hardly go beyond AB>2Km. This is why resistivity sounding is best suited for groundwater and not petroleum exploration (Kearey and Brooks, 1988).

The Physical diagram of the project execution

Figure 2 a and b drilling rig and chemical mixture of drilling mud

Figure 2 a and b stanchion stands and overhead tank under construction

Figure 2 a and b pump testing of borehole water

3. Geology and Hydrogeology

Desktop study and field observations show that the geologic material underlying the site belongs to the Ajali formation. The formation hitherto known as upper coal measure is made up of false-bedded sandstone, thin lenticular shales, coal and pebbly gravel. The texture is variable but generally speaking, it is coarse. Hydrogeological formation is a good prospect and it is often associated with fairly deep water table conditions.

4. Data Presentation

The quantitative interpretations of the resistivity sounding curves were done to obtain the geoelectric parameters (i.e. layer thicknesses and resistivities) with the aid computer assisted iteration techniques.

Table 1: Geographical Coordinates and Elevations of Sampled Points

S/N	Description	Position		Elevation (m)
		Latitude [N]	Longitude [E]	
1	VES1	07^{O}02'44.4"	006^{O}16'11.8"	213
2	VES 2	07^{0}02'50.9"	006^{0}16'03.3"	218
3	VES 3	07^{0}02'49.1"	006^{0}16'07.0"	216

Source: Laboratory analytical results, 2011

Table 2: Geoelecric Parameters and Inferred Lithology [VES1]

Layer no	App Res [ohm-m]	Thickness [m]	Lithology
1	1762	0.875	Lateritic/ Topsoil
2	110	1.13	Sub topsoil
3	1341	19.78	sandy horizon
4	10546	29.64	Resistive sandy/sandstone/clayey layer
5	198	65.71	Saturated sandy/partly clayey horizon
6	2061	52.88	Saturated sandy/sandstone/partly clayey layer
7	69766	-	Dry /resistive sandstone layer

Source: Laboratory analytical results, 2011 lithological interpretation of VES1

Table 3: Geoelecric Parameters and Inferred Lithology [VES2]

Layer no	App res [ohm-m]	Thickness [m]	Lithology
1	720	0.89	Lateritic/ Topsoil
2	5315	3.26	Sub topsoil
3	522	12.93	Clayey unit
4	9047	16.32	sandy horizon
5	736 77	56.27	Dry sandy/sandstone/Sandy/clayey layer
6	1767	55.85	Saturated sandy/sandstone/partly clayey layer
7	6054	-	Resistive sandstone layer

Source: Laboratory analytical results, 2011 lithological interpretation of VES2

Table 4: Geoelecric Parameters and Inferred Lithology [VES3]

Layer no	App res [ohm-m]	Thickness [m]	Lithology
1	1207	1.9	Lateritic/ Topsoil
2	2448	6.77	Sub topsoil
3	1296	5.82	Sandy/Clayey unit
4	8342	39.48	Dry sandy/sandstone-/clayey layer
5	815	-	Saturated sandy/sandstone/partly clayey layer

Source: Laboratory analytical results, 2011 lithological interpretation of VES3

Table 5:

VES-1 Depth (m) ⇩

-0.89	A	Top Soil
-4.18	B	Subsoil
-17.08	C	Clayey Layer
-33.41	D	Sandy Layer
-90.08	E	Dry Sandy/SSt
-145.9	F	Saturated Sandy
∞	G	Resistive SSt

VES-2 Depth (m) ⇩

-0.875	A	Top Soil
-2.01	B	Subsoil
-21.79	C	Sandy Layer
-51.44	D	Resistive Layer
-117.1	E	Saturated Sandy
-170.0	F	Saturated SSt
∞	G	Resistive SSt

VES-3 Depth (m) ⇩

-1.9	A	Top Soil
-8.67	B	Subsoil
-14.5	C	Sandy/Clayey Layer
-53.98	D	Dry Sandy/SSt
∞	E	Saturated Layer

Source: Field analytical results, 2011.

Table 6: Physical Characteristic Combined Standards Results of Chemical Analysis

S/N	Parameter	Philipa Idogho Campus Borehole	NAFDAC Maximum Allowed Limits	SON Standard	WHO Standard	
					Highest Desirable	Maximum Permissible
1	Colour	2.0 TCU	3.0 TCU	3.0 TCU	3.0 TCU	15.0 TCU
2	Odour	NS-Bent	N.S	N.S	N.S	N.S
3	Taste	tasteless	N.S	N.S	N.S	N.S
4	PH at 20^0C	6.7	6.50-8.5	6.50-8.5	7.0-8.9	6.90-9.50
5	Turbidity	ND	5.0 NTU	5.0 NTU	5.0 NTU	5.0 NTU
6	Conductivity	43.3(μS/cm)	1000(μS/cm)	1000(μS/cm)	100(μS/cm)	1200(μS/cm)
7	Total Solid	20.5mg/l	500mg/l	500mg/l	500mg/l	1500mg/l
8	Total Alkalinity	8.2mg/l	100mg/l	100mg/l	100mg/l	100mg/l
9	Phenolphthalein Alkalinity	-	100mg/l	100mg/l	100mg/l	100mg/l
10	Chloride	53.1mg/l	100mg/l	100mg/l	200mg/l	250mg/l
11	Fluoride	-	1.0mg/l	1.0mg/l	1.0mg/l	1.5mg/l
12	Copper	ND	1.0mg/l	1.0mg/l	0.5mg/l	2.0mg/l
13	Iron	0.25mg/l	0.3mg/l	0.3mg/l	1mg/l	3mg/l
14	Nitrate (NO3)	0.45mg/l	10mg/l	10mg/l	10mg/l	50mg/l
15	Nitrate (NO2)	0.15mg/l	0.02mg/l	0.02mg/l	0.2mg/l	3mg/l
16	Manganese	0.06mg/l	2.0mg/l	0.05mg/l	0.1mg/l	1.0mg/l
17	Magnesium	0.02mg/l	20mg/l	0.20mg/l	20mg/l	20mg/l
18	Zinc	0.01mg/l	5.0mg/l	5.0mg/l	0.01mg/l	3.0mg/l

19	Selenium	-	0.0mg/l	N/S	0.01mg/l	0.01mg/l
20	Silver	-	-	-	N/S	N/S
21	Cyanide	ND	0.01mg/l	0.01mg/l	0.01mg/l	0.07mg/l
22	Sulphate	1.54mg/l	100mg/l	100mg/l	250mg/l	500mg/l
23	Calcium	0.88mg/l	75mg/l	75mg/l	N/S	N/S
24	Aluminium	ND	0.5mg/l	N/S	0.2mg/l	0.2mg/l
25	Potassium	0.09mg/l	10.0mg/l	10.0mg/l	N/S	N/S
26	Lead	ND	0.01mg/l	0.01mg/l	0.01mg/l	0.01mg/l
27	Chromium	ND	0.05mg/l	0.05mg/l	0.05mg/l	0.05mg/l
28	Cadmium	0.01mg/l	0.003mg/l	0.003mg/l	0.003mg/l	0.003mg/l
29	Arsenic	-	0.01mg/l	0.01mg/l	0.01mg/l	0.01mg/l
30	Barium	-	0.05mg/l	0.05mg/l	0.05mg/l	0.07mg/l
31	Mercury	-	0.001mg/l	0.001mg/l	0.001mg/l	0.001mg/l
32	Antimony	-	N/S	N/S	-	0.02mg/l
33	Tin	-	-	-	-	1.2µg/l
34	Nickel	ND	-	-	-	0.02mg/l
35	Total Hardness($CaCO_3$)		100mg/l	100mg/l	100mg/l	500mg/l
36	Vinyl Chloride	-	0mg/l	0mg/l	0mg/l	0mg/l

Source: Martlet Environmental Research Laboratory Limited Results of Chemical Analysis

5. Results and discussion

The interpreted result is presented as sounding curves and descriptive geo-electric logs/Section. Seven geo-electric layers were resolved for VES1. Layer 1 and 2 stand for lateritic topsoil and subsoil with thicknesses 0.875m and 1.13m and Layers 3 is the sandy horizon. Layer 4 is designated as the resistive sandy/sandstone/clayey layer. The fifth layer is the saturated sandy/ partly clayey horizon. Layer 6 is also saturated sandy/sandstone/partly clayey unit. The seventh layer of unknown thickness is designated as the dry/resistive sandstone horizon. VES 2 and 3 are of the same trend.

Two distinct saturated layers (i.e. Aquifers) were identified from the interpreted VES results. The first is layer 5 while the second is layer 6. The calculated thicknesses of layers 5 and 6 are 65.71m and 52.88m respectively. Furthermore the depth to the to the base of layer 6 is 170m (561ft)

The apparent resistivity values for the saturated layers are fairly low, indicating good aquifers. In view of the above hydrogeological and hydro-geophysical analysis, it can be deduced that groundwater resource development through borehole drilling at the site is feasible.

Therefore the borehole at the site, a maximum drilled depth of 197m (650ft) is recommended and VES 1 is the recommended drilling point. It is advised that the terminal drilled depth of the borehole at the site should be left at the discretion of the site geologist and hydro-geologist, who should document and supervise the borehole construction work in it's entirely.

6. Conclusion and Recommendation

The on-going research work is currently on phase IV with a successful completion of phase I – III. The result of the pre-drilling geophysical investigations for groundwater resource development (through borehole construction) carried out within Auchi Polytechnic campus, Auchi Edo State is presented in this report. Hydrogeological and hydro-geophysical deductions made from the interpreted VES data establish the feasibility of a viable groundwater abstraction project at the site. A total drilled depth of 197m (650ft) is recommended. In addition, a suitable drilling rig that can effectively drill to the required specifications and depth should be mobilized to the

site for the project. The entire (On-the-site) drilling process should be supervised and documented by a competent and professional geologist and hydro-geologist who should also determine the final/terminal depth of the borehole at the site.
Well design and completion processes should be anchored on the downhole lithological assessment of cuttings. To establish water quality and portability, a full analysis of the water sample from the developed borehole should be done at a reputable laboratory for physio-geo-chemical and biological analysis, in order to ascertain the hydro-geochemical impurity determination of the groundwater, so as to pin-point the exalt type of water treatment plant-unit to be installed. In addition to the pump testing a 5.5HP submersible pump was installed.

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