REPORT ON

HYDROGEOLOGICAL STUDIES AND GEOPHYSICAL INVESTIGATIONS OF SITING 1No. BOREHOLE FOR MECHANISATION

AT

NASSIT COMMERCIAL SITE, MAKAMA-MAKENI

Regimannuel Gray Construction
c/o Mr. Ngayenga

Prepared by:

EDAL DRILLING COMPANY

49 WATERLOO STREET

FREETOWN

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TEL: 033993727

OCTOBR, 2010

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1. INTRODUCTION

National Social Security and Insurance Trust (NASSIT) Commercial site is located at Makama-Makeni. The authorities in charge of the Site want to explore the possibility of getting good source of groundwater for both commercial and domestic use.

In the quest to search for a groundwater, the authorities of the site contracted Regimanuel Gray who then engaged Edal Drilling Company Limited to undertake Hydrogeological Studies and geophysical investigations together with drilling of 1No. borehole at the site.

The studies were, among others, to provide enough data and information to be used in assessing the possibility of striking fresh underground water in the alternative of a borehole at the site. This report documents the work carried out at the site on October 10, 2010.

2. BACKGROUND OF THE STUDY AREA

Background information was obtained by means of a study consisting of the acquisition of previous work (Geophysics, Drilling logs, Geo-electrical logs of the area) carried out in and around the study area, geological and Topographical Maps of the area. Based on that, a siting strategy was deployed.

Geologically, the area is composed of the Granitic Basement which is crystalline granite, quartz and haematitic granulites and gneiss of Archean age.

Hydrogeologically, yield prospectivity is considered poor to very poor except in structurally affected areas where yield can be significantly higher.

3. FIELD WORK

3.1 Field Reconnaissance Survey

The aim of the reconnaissance survey was to select target areas for geophysical survey. The field reconnaissance survey was undertaken on October 10, 2010 and the activities that were carried out involved;

- Geomorphologic survey of areas not identified during desk study but could be significant in hydrogeological studies; and
- Demarcation of area for traverse lines for geophysical survey.

3.1.1 Selection of Traverse Lines

Traverse line was run on the basis of geomorphologic and physical features such as vegetation, stream direction as well as any significant hydrogeological features encountered in the premises. The traverse line was perpendicular to the major strike direction of the geological formation of the area.

One traverse line was run in the NE-SW direction. The rationale behind the selection of this traversing trend was to intercept the major trend of NW-SE fractures in the area.

3.2 Geophysical Survey

The Geophysical survey consisted mainly of Electrical Resistivity Profiling and Vertical Electrical Sounding (VES) using SAS 1000/4000 DZD 6A Multifunction Electrical meter.

3.2.1 Resistivity Profiling

Resistivity Profiling was carried out along the traverse line using the recommended Schlumbeger configuration. Two depths of 19m and 40m were investigated, using the electrode separations of (L/2, a/2) given by 19m, 0.5m and (40m, 5.0m). The electrode separations (19m, 0.5m) and (40m, 5.0m) were assumed to probe the weathered layer and Bed rock respectively (WRRI, 1994).

3.2.2 Selection of VES Points

The profiling results were plotted on a linear scale, and preliminary interpretation was done on the field to select the best anomalous points for Vertical Electrical Sounding (VES). The VES point was restricted to areas where relatively lower apparent resistivities were recorded on the horizontal profile.

One (1) very good point was gotten VES on the entire profile line A. The VES point was marked with inscription on the wall at the site.

3.2.3 Vertical Electrical Sounding (VES)

Vertical Electrical Sounding (VES) was carried out with the aim of determining the formation resistivities and the depth to bedrock, as well as finding the possibility of obtaining fracture at depth the sounding points.

The Schlumberger electrode configuration and the expanding procedure were used for the VES. Data control was ensured by plotting the VES results on the field as VES measurements were in progress. Unreasonable values that registered high standard deviation (sd) greater than unity were rejected and sounding repeated at the same spot several times until reasonable values were recorded. Changing the position of the electrodes and varying the current input ensured this.

4. DATA ANALYSIS AND INTERPRETATION

4.1 Geophysical Survey

The electrical resistivity profiling result and its corresponding response curves is presented in Fig 1A, whiles the Vertical Electrical Sounding results and corresponding curves are presented in fig 2A.

4.1.1 Resistivity Profiling

The interesting feature of resistivity profiling interpretation is the identification and selection of anomalous points or zones. These anomalous points or zones in this area are generally resistivity values below the average resistivity values along a given profile line.

On the average, the measured apparent resistivity values for the (19m, 0.5m) and (40m, 5.0m) were medium-high. Values ranging between 444 ohm-m and 3651ohm-m, and averaging 20171ohm-m were recorded.

The general medium-high resistivity values recorded in the area could indicate shallow overburden thickness and slight weathering as well as fracture development conditions in the area. The groundwater potential in this area could be variable ranging between medium and high.

The measured apparent resistivity values range between 444 ohm-m and 1324 ohm-m with a mean of 827 ohm-m for the (19m, 0.5m) separation. For the (40m, 5.0m) separation, the measured apparent resistivity values were in the range of 1280 ohm-m and 3651ohm-m with a mean of 2438ohm-m. In general, high resistivity values were recorded with the (40m, 5.0m) than the (19m, 0.5m) separation along the traverse. Well-defined anomalous points of low resistivity values were selected for Vertical Electrical Sounding.

4.1.2 Vertical Electrical Sounding (VES)

Based on the results of the resistivity profiling, the point A45m was selected for VES. The VES results and response curves at the point A45/S1 is presented in Fig 2A. The interpretation was carried out using the RESIST software.

4.2 Selection of Promising Points

The selected point for test drilling at NASSIT Commercial Site, Makama been done by considering the thickness of the various layers of the subsurface structure and their corresponding apparent resistivity from the analyses of VES results as well as the behaviour of the anomalous point during the profiling.

Table 1: The VES the point A45 and its interpretation for test drilling

VES POINT	LAYER	DEPTH (m)	THICK-NESS (m)	APPARENT RESISTIVITY (Ohm-m)	POSSIBLE WATER ZONES (m)	MAX DRILLING DEPTH (m)
A45/S1	1 2 3 4 5	3 4 11 13.5 -	3 1 7 2.5 -	855 80 1200 115 2250	**10 --20** **35 --45**	**60**

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on the analyses of the entire results, and in line with the aims of the study, the drawn conclusions are:

- the study area is composed of the Granitic Basement
- the formation has undergone slight degree of weathering which control groundwater occurrence and accumulation.
- Groundwater potential could be medium - high.

5.2 Recommendation

In this regard, it is recommended that,

- test drilling could be carried out at **A45/S1** to confirm the existence of aquifer system.
- the **maximum drilling depth** at this site should be **60m** below ground level. However, the supervisor may exceed this or go below this depth based on the field conditions.
- both physico-chemical and bacteriological test should be carried out on the borehole water samples from completed well.

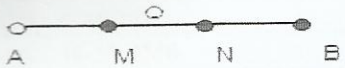
FIG 1A: Resistivity Profiling results and corresponding responds curves along Profile A

RESISTIVITY PROFILING DATA SHEET- SCHLUMBERGER METHOD

Project: Private
Date: 10-10-2010
Operator: Obeng
District: Bombali

Profile #: A
Station interval (m): 5
Region:
COMMUNITY: Makama -Makeni

Length (m): 75
Bearing: 65



$$K = \frac{AM*AN}{MN} * 3.142 \qquad \rho = K * \frac{\Delta V}{1}$$

Station No.	Electrode Seperation AB/2=19m, K=1133, MN/2= 0.5m			Electrode Seperation AB/2=40m, K=495, MN/2= 5.0m		
	ΔV 1	(ohm-m)	Remarks	ΔV 1	(ohm-m)	Remarks
0	2.355	2668.22		7.494	3709.53	
5	1.526	1728.96		6.9033	3417.13	LIMITED
10	1.1072	1254.46		6.7285	3330.61	
20	1.082	1225.91		4.1141	2036.48	
25	0.8791	996.02		2.6003	1287.15	
30	1.2296	1393.14		2.3813	1178.74	
35	0.831	941.52		2.0928	1035.94	
40	0.7381	836.27		1.6686	825.96	
45	0.392	444.1		1.5218	753.29	VES
50	0.4601	521.3		1.6101	797.00	
55	0.495	560.84		1.8215	901.64	
60	0.6263	709.6		1.8441	912.83	LIMITED
75	0.8818	999.1		2.4911	1233.09	

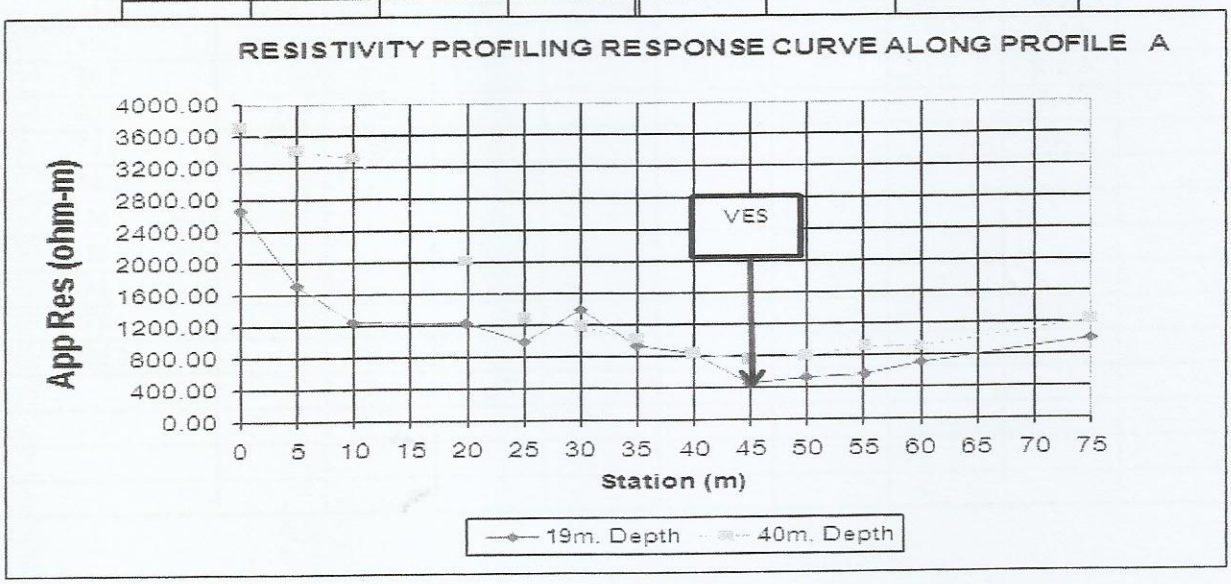


FIG 2A: SCHLUMBERGER VES & MODEL AT A45/S1

NASSIT COMM.SITE, Makama-Makeni - A45/S1

Client :	Community : NASSIT COMM.SITE, Makama
Project : Private	Sounding Number : A45/S1
District : Bombali	Coordinates East : 08 243 39
Date : 10-10-2010	Coordinates North : 09 823 46
Field Operator : Obeng	GPS Datum : GPS datum
Interpreted by : Obeng	Azimuth : 65

Schlumberger Array VES Field Data

AB/2 (m)	MN(m) 1.0 (MN-1)	MN(m) 10 (MN-2)	MN(m) 30 (MN-3)	ΔV/I (MN-1)	ΔV/I (MN-2)	ΔV/I (MN-3)	ρ (ohm-m) (MN-1)	ρ (ohm-m) (MN-2)	ρ (ohm-m) (MN-3)
1.0	2.4			333.3100			785.3		
2.0	11.8			77.9770			918.8		
3.0	27.5			30.4190			836.2		
4.0	49.5			14.0980			697.8		
5.0	77.8			7.4589			580.0		
6.0	112			4.3135			484.5		
8.0	200			2.9131			583.4		
10.0	313			1.9259			603.6		
15.0	706	63		0.8110	11.8270		572.6	742.1	
20.0	1,256	118		0.3920	5.7217		492.3	674.1	
25.0	1,963	188		0.3310	3.4536		649.7	651.0	
30.0	2,827	275		0.1580	2.3810		446.6	649.0	
35.0	3,848	377		0.1290	1.8315		496.3	690.5	
40.0		495			1.5982			790.8	
50.0		778			1.1810			918.3	
60.0		1,123			0.9301			1044.6	
70.0		1,532			0.7741			1185.8	
80.0									
100.0									
125.0									
150.0									
175.0									
200.0									

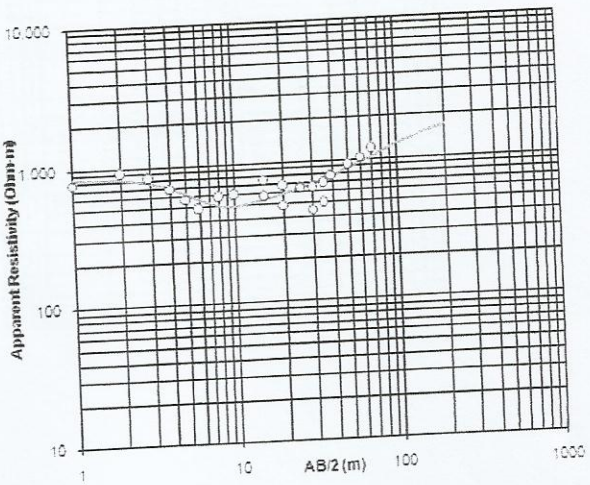
Client :
Project : Private
District : Bombali
Date : 10-10-2010
Field Operator : Obeng
Interpreted by : Obeng

Community : NASSIT COMM.SITE, Makama-
Sounding Number : A45/S1
Coordinates East : 08 243 39
Coordinates North : 09 823 46
GPS Datum : GPS datum
Azimuth : 65

NASSIT COMM.SITE, Makama-Makeni - A45/S1

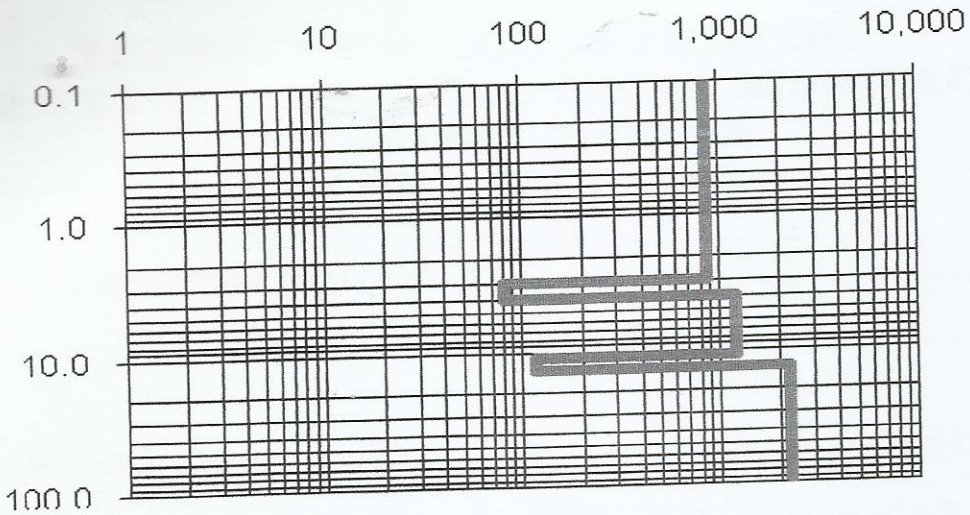
GeoVES 1.3
MS Excel based modelling of Vertical Electrical Soundings in the Schlumberger Array using Gosh linear filters

Data		Model		
AB/2 (m)	Measured Apparent Resistivity (Ohm-m)	Modelled Apparent Resistivity (Ohm-m)	Model Error	Included in Model (1=yes)
1.0	785.3	951	4.281	1
2.0	918.6	924	0.525	1
3.0	808.2	772	4.101	1
4.0	757.5	700	8	1
5.0	530.0	629	2.490	1
6.0	494.5	572	7.650	1
8.0	583.1	508	5.706	1
10.0	606.5	494	12.099	1
15.0	572.8	599	1.156	1
20.0	498.3	597	10.879	1
25.0	849.7	845	21	1
30.0	845.8	888	88.499	1
35.0	498.5	791	54.944	1
15.0	723.1	539	41.813	1
20.0	674.1	597	8.002	1
25.0	851.8	845	35	1
30.0	849.8	888	1.551	1
35.0	850.5	791	1.323	1
40.0	750.5	772	285	1
50.0	918.3	882	3.156	1
60.0	1044.8	950	8.905	1
70.0	1165.2	1.035	22.732	1



Model Parameters						
Model Layer	Resistivity (Ohm-m)	Resistivity Range	Thickness (m)	Thickness Range	Depth (m)	Depth Range
1	955		3		3	
2	80		1		4	
3	1200		7		11	
4	115		2.5		13.5	
5	2250					
6						
7						
8						

Geoelectrical Model



NATIONAL WATER QUALITY LABORATORY
TOWER HILL
FREETOWN

TEL: 076-504-278/076-752-120
MINISTRY OF ENERGY AND WATER RESOURCES
WATER SUPPLY DIVISION
TOWER HILL, FREETOWN

Water Quality monitoring Report Sheet

Water Authority:.....EDAL DRILLING COMPANY..... .....
.....

District:...W/Area .....Chiefdom:.....Town: Makeni ... ...Date: 19/10/10.....

Sample No.:...NASSIT Commercial ...Location: Makama... Type of Source: B/Hole... .
Time:...

	Parameters	Measured Values	WHO recommended Permissible Limits
1.	Water Temperature (°C)	27.2	No. Value
2.	PH	6.0	6.5 – 8.5
3.	Turbidity (NTU)	2.4	<5.0
4.	Conductivity (µS/cm)	159	<450
5.	TDS (mg/l)	79.4	<248
6.	Salinity (ppt)	0.0	<0.4
7.	Residual Chlorine (mg/l)	0.01	0.3-0.5 after 30min. disinfections
8.	Aluminium (mg/l)	0.02	<0.2
9.	Ammonia (mg/l)	0.00	No. Value
10.	Bromine (mg/l)	-	No. Value
11.	Calcium Hardness $CaCO_3$ (mg/l)	31	<500
12.	Copper (mg/l)	0.18	<2.0
13.	Fluoride (mg/l)	1.12	<1.5
14.	Iron (mg/l)	0.3	<0.3
15.	Magnesium (mg/l)	21	<200
16.	Manganese (mg/l)	0.1	<0.4
17.	Molybdenum (mg/l)	-	0.25
18.	Nitrite (mg/l)	0.00	3.0
19.	Nitrate – Nitrogen (mg/l)*HR*	6.4	<10
20.	Potassium (mg/l)	4.2	<6.0
21.	Phosphate (mg/l) *LR*	0.65	<20
22.	Silica (mg/l)	-	<15
23.	Sulphate (mg/l)	2	<400
24.	Sulphide (mg/l)	0.01	<0.5
25.	Sulphite (mg/l)	-	No. Value

26.	Chloride (mg/l)	-	<250
27	Arsenic – (p)	0.0	0.01
28	Chromium – (p)	0.01	0.05
29.	Bicarbonate (mg/l)	25	
30.	Zinc (mg/l)	0.00	<5.0
31.	E. Coli	0.0	Zero
32.	Faecal Coliforms	10	Zero
33.	Non-Faecal Coliforms	15	<10
34.	Vibro-parahaemolyticus	-	Zero
35.	Salmonella sp.	-	Zero

RECOMMENDATION/COMMENTS:- Physico/chemical analysis result indicates that parameters are within the WHO recommended standard for drinking water, except for PH, which is below its limits of 6.5 see result.

The source is polluted with faecal bacteria. Chlorination to be done, with a o.3mg/l – 0.5mg/l of free chlorine, which is the WHO recommended standard for potable water.

Signed:.....
(Technician)

WATER QUALITY ANALYSIS LABORATORY SIGN. DATE

.....
(Supervisor)

Date:..... 21/10/10