GOAL SIERRA LEONE

BOREHOLE GEOPHYSICAL SITING AT AT SELECTED DISTRICTS IN SIERRA LEONE –BO DISTRICT

SITING REPORT

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Dynamic Integrated Geohydro Environmental Services cc

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I confirm (by initialing) that the items above have been reviewed for Quality Control, and this document is ready for release.

Signed: _____ Date: _____

Project Manager 10/11/2015

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SUMMARY

Resistivity profiles and Resistivity soundings were performed at Kaganthama, Mahera and Barbara CHCs in Port Loko District form the 17th of October 2015 to the 20th of October 2015. The profiles were at three different depth of investigations i.e. 15m, 25m and 40m, while the soundings were performed at maximum depths of approximately 100m.

Two drilling points are recommended for each CHC i.e. the priority drilling site and a backup site.

We recommend a revisit of Jembe CHC if the yields obtained are not sustainable. The revisit will be done with magnetic survey plus resistivity, the VES spots will be chosen from low magnetic anomalies which will represent faults.

Table 10 lists the drilling sites and provides the detailed rationale for the selection of the site and the proposed drilling depths.

At Kagbanthama the ground geophysical survey was done along profile line (PL001P1) of 140m as there was no other available space to extend it or locate another second profile. Three VES soundings were performed from which two drilling sites were recommended at 0756014E; 0991296N and 0755988E; 0991281N.

At Mahera no profiling was done as there was no survey space available, hence investigations were conducted through three VES which were conducted at spots available. Drilling is recommended at points 0698199E, 0951501N and 0698199E, 0951501N

At Barbara ground geophysical survey done along one profile line (PL003P1) which was 60m long, as there was no other available space to extend it or locate another second profile. The profile was surveyed with resistivity investigating at two different depths of investigations of 25m and 40m. Three soundings were done on the site, two of these on the profile line and one on outside the profile line. Drilling at Barbara is recommended at points 0705477E, 0976500N and 0705472E, 0976516N.

1 INTRODUCTION

Universal GeoScience Solutions in Joint Venture with Dynamic Integrated Geo-Hydro Environmental Services have been commissioned by GOAL SIERRA LEONE to train and supervise Department of Water Resources (DWR) personnel to carry out groundwater borehole siting for the implementation of Water, Sanitation and Hygiene activities in District Hospitals and Community Health Centers (CHC, s) in specific districts of Sierra Leone. GOAL has contracted the Department of Water Resources to undertake the siting of the boreholes on selected Hospitals and Community Health Centres under GOAL's remit, (3 in Port Loko District; 2 in Western District; 3 in Bo District; 2 in Kenema District and 2 in Western District).

This report discusses the geophysical surveys which were undertaken in Bo District (Njala Komboya, Sahn and Jembe) and recommends sites for drilling of planned 1 borehole for each of these CHC. The main objective of this project is to identify and develop additional groundwater abstraction points with sufficient volumes of potable water and within acceptable distance to the CHC to supplement the existing water sources and to meet the projected water demand.

There is currently no existing water source at Njala Komboya, the nearest water source is approximately 300m from the facility and is a mechanically drilled well, which is non seasonal. The borehole does not dry up during the dry season. No records of drilling information about the well was obtained at the time of visit, though some CHCs indicated that the bore is about 60m deep. A dry well was dug to 16.6m deep about 100m to the North-West of the facility in the Catholic Church compound, the well was dug through overburden and terminated in competent rock.

A well was mechanically drilled Jembe, however no records of the drilling could be obtained. The borehole does dries up during the dry season.

There is currently no functional water source at Sahn, the nearest water point is a hand dug well at the school which was recently drilled. The well is less than one year old, therefore one cannot determine its seasonality.

In view of the current supply situation and in particular that concerning water quality, it became necessary to identify additional water sources around the CHCs but unfortunately there isn't enough available area to implement enough geophysical borehole siting studies. One profile line was identified for Kgabathanthama CHC during the Inception and Reconnaissance Phase where the three (3) VES locations were chosen. Two drilling sites were identified based on the ground geophysical surveys.

2 BACKGROUND

Considering the unavailability of information regarding results of drilled and hand dug wells in the vicinity of this community, the expected success rate for drilling boreholes with sufficient quantities of water require more geophysical techniques so as to map a number of different aquifer systems which includes weathered basement; fractured basement rocks and faulting zones. Considering the past experiences of the consultant, minimum requirements to facilitate improved groundwater borehole yields will aim at junctions of faults; thick weathered basement which is fractured underneath the weathered zone. Consequently the consultant recommended the use of profiling techniques using Magnetic Method and/or Horizontal Loop Electromagnetic Survey (HLEM) on every line to be surveyed with Resistivity

profiling technique to aid better location of best points to be further investigated with VES technique (GOAL Final Geophysical Siting Report, November 2015). However the contractor is not in a position to source the equipment for Magnetic or HLEM surveys.

3 LOCATION

Bo District is a district in the Southern Province of Sierra Leone. It is the second most populous District in Sierra Leone. Its capital and largest city is the city of Bo, which is the second largest city in Sierra Leone. Three CHCs targeted in this project (Njala Komboya, Jembe and Shahn are shown in Figure 1.

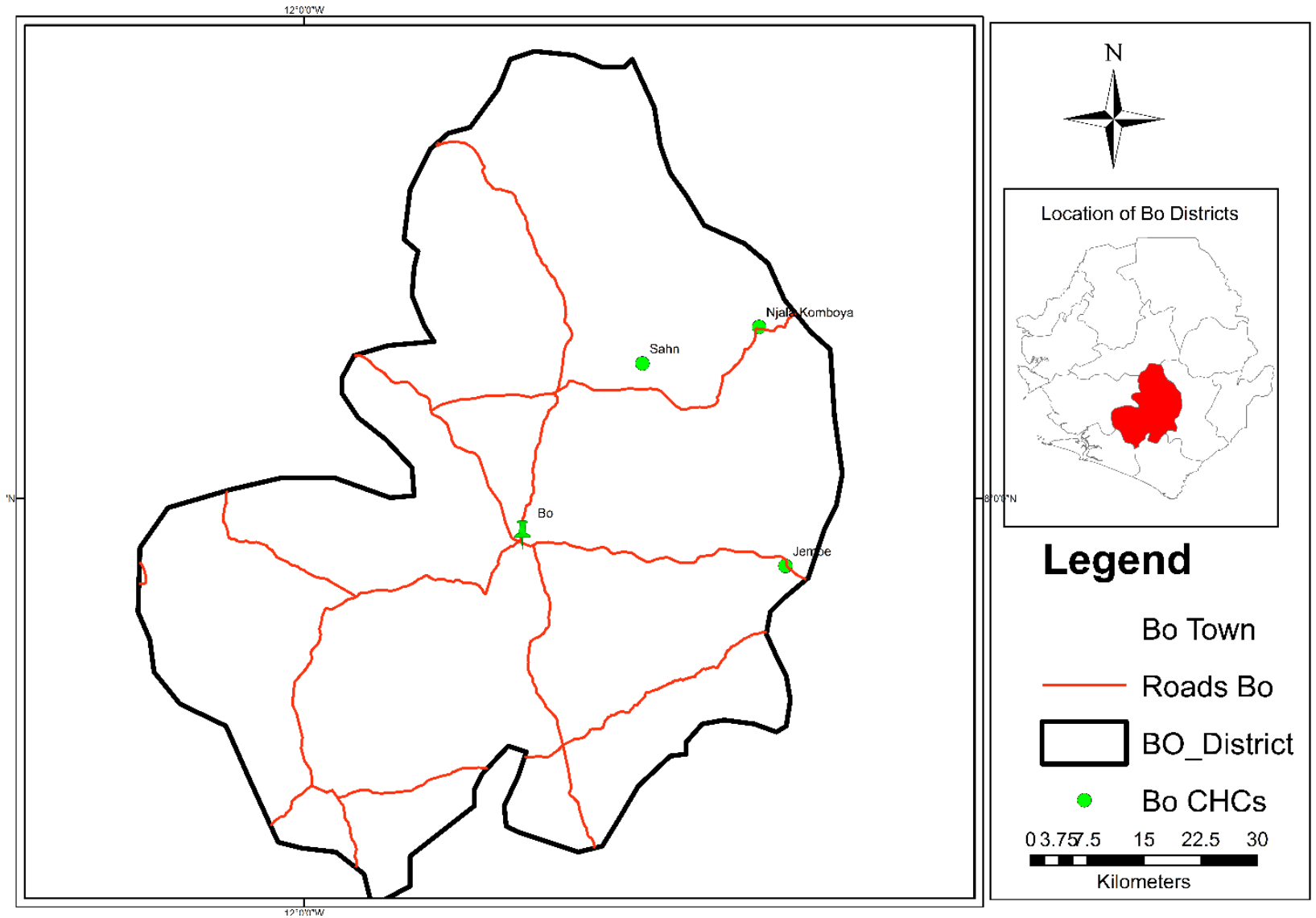

Figure 1: Location of the Target Community Health Centres in Bo District.

4 REGIONAL SETTING

4.1 Geology

The regional geology of the area comprises of rocks of the Archean basement complex. Around the Tungie CHC area the geology is, banded gneiss and granitoids. Inferred regional and local geologic lineaments around Tungie strike in NNW-SSE direction. However no structures have been mapped around the area.

Structurally the area comprises of a set of dolerite dyke intrusions that trend in a roughly WWN- EES direction. It is anticipated that these dykes manifest at the target area, however the technique employed has limited capabilities of picking these dykes. Also of structural significance is a set of faults that trend in NNW-SSE direction. The geology of the target areas is shown in **Error! Reference source not found.**.

4.2 Hydrogeological Setting

Groundwater in this area generally occurs in the fractured rocks and frequently at the base of the top weathered rock or alluvium (overburden). Consequently, two different types of aquifer may be expected in the area. These are the Basement aquifer and sandstone and sand/gravel aquifer. Due to the varying nature of these two aquifers and their potentially different groundwater potential they will be discussed separately. The Precambrian Basement Complex consisting of ancient crystalline granitic gneiss with supracrustal volcanic and sedimentary belts is described as having metasediments, volcanic basement granites, gneisses and migmatites and amphibolites. The aquifers expected in this area are characterized by fractured contacts at the base of the relatively thick weathered zones, fractured contacts between gneiss and dolerite or amphibolites, fractured geological contacts and faults which are trending NW-SE. We also target thick weathered zones of the basement rock. These can be very important if they occur on fractured basins of the basement rock, (Goal Inception Report, October 2015)

4.2.1 Basement aquifers

This unit may be divided into weathered and fractured aquifers. The weathered Basement aquifer often has high transmissivity and storage values to provide some yield, but such aquifers are severely affected by recharge and size of the catchment area. The higher yielding aquifers are found in areas where the contact zone between the weathered overburden and fresh rock is deeply fractured, but it is very sensitive to the amount of the recharge received. The highest yielding Basement aquifers are found in the fractured bedrock, which possesses high transmissivity and at locations where deeply weathered overburden provides some storage. Such fractured aquifers are often recharged through a system of interconnected fractures and fissures. Therefore, when siting high yielding boreholes, it is important to consider the distance to the prospective direct recharge area (current drainage system).

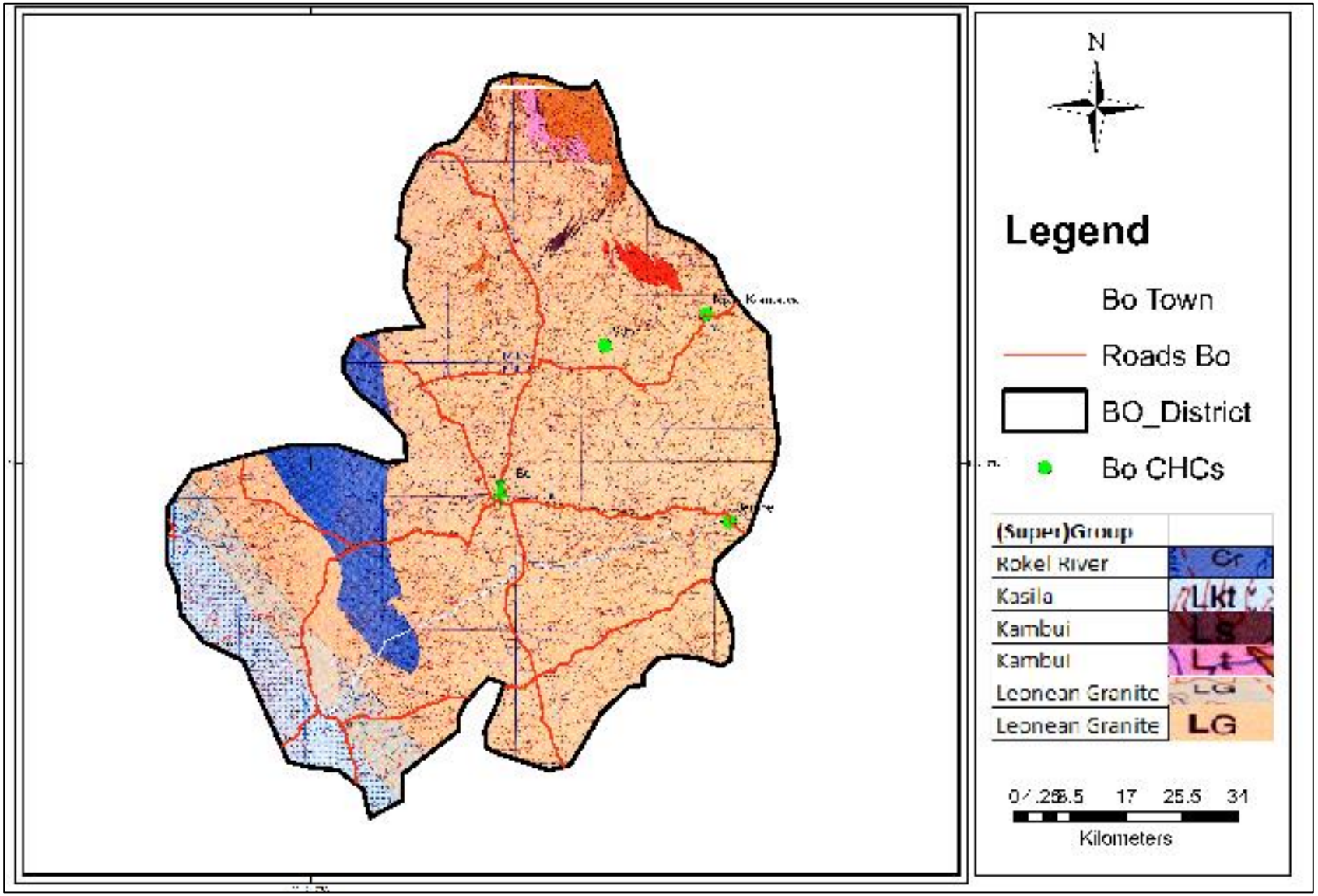

Figure 2 Geology map of Port Loko District with Community Health Centres in the district.

Typical aquifers found in the Basement areas are:

- fractured contacts at the base of the relatively thick weathered zones,
- fractured contacts between gneiss and dolerite or amphibolites,
- fractured geological contacts and faults which are trending NW-SE in the project area.
- thick weathered zones of the basement rock. These can be very important if they occur on fractured basins of the basement rock, (Goal, Inception Report, and October 2015).

All the above targets can be readily mapped by means of geophysical techniques such as the applied Horizontal-Loop frequency domain ElectroMagnetic (HLEM) commonly done with MaxMin instrument and EM34 system, Resistivity profiling, Vertical Electric Soundings (VES) and Magnetic profiling. The EM system maps the variation in the overburden thickness and any subvertical conductive fractures, faults or contacts. The magnetic technique allows mapping any intrusions of dolerites, faults or contacts between lithologies, if such possess varying magnetic susceptibilities (readiness to magnetise in the Earth's magnetic field). Resistivity profiling will map the areas with thick weathered zones, finally VES is a direct way to map the thickness and composition of the overburden and to assess the fracturing at its base. Such a comprehensive suite of geophysical techniques is likely to provide a highly effective siting strategy.

5 GEOPHYSICAL SURVEY

5.1 Exploration Strategy

As discussed previously that underlying thick weathered, thick sediments and fractured bedrocks form the main aquifer units in this district. Deep weathered and fractured zones in the bedrock underlying thick sedimentary beds were considered as the main target feature for groundwater development and thus for geophysical surveys. Such features allow tapping thicker aquifer zones and are generally associated with geological lineaments, faults and lithological contacts. In the Inception phase these features were interpreted from geology only as there was no other variety of data sets including airborne magnetic data, ortho-photographs and Landsat imagery was available (Goal, Inception Report, October 2015). Details of the profile lines are summarized Tables 1 to 3

5.2 Siting Criteria

In the inception report, the criterion for siting boreholes at the given Community Health Centres was highlighted. In order of priority these are:

1) The site should be chosen principally on hydrogeological and related geophysical grounds so that the greatest chance of obtaining an adequate yield was achieved.
2) The site should be free from potential pollution by latrines, waste and animals.
3) The site should be within 400m of the community and preferably less than very close to the Health Centre.
4) The site should be either free from risk of flooding or capable of being protected from flooding by suitably designed headworks (i.e. a raised concrete).
5) The site should be one which was not a risk from erosion due to usage by animals.

Clearly it is not always possible to achieve all these criteria at all sites since the overriding criterion that of finding water, is often in conflict with one or more of the others. In most cases however, it was possible to achieve a reasonable compromise.

5.3 Survey Techniques and Equipments

Resistivity plus magnetic profiling followed by VES of Schlumberger array were considered to be the minimum geophysical techniques for this type of survey in this district. Resistivity profiling followed by VES techniques were the only available methods to consider for delineation of weathered and fractured zones in the project area. Magnetic profiling is an effective technique in delineating dolerite intrusions, lithological contacts and faults, while HLEM profiling is effective in delineating vertical and sub-vertical fractures zones but these were not available as the contractor couldn't source the equipment. Integrated use of both profiling techniques is very effective in areas like this, where significant resistivity conductivity contrast is expected in the bedrock geology such as highly resistive granites and less resistive weathered granites and gneiss rocks. Following profiling, potential anomalies were identified for further assessment using VES. VES provides depth and thickness estimates of weathered and fractured zones based on the resistivity values. Weathered and fractured bedrocks are generally represented by low resistivity values compared with massive bedrocks.

Geophysical techniques applied include resistivity profiling at a station spacing of 10 m. Where the survey space permits, two resistivity profiles of minimum 100m in Schlumberger array configuration were carried out at three different levels of investigation being 15m; 25m and 40m. Vertical Electrical Soundings (VES) were carried out at low resistivity anomalies picked by the profiling method. This was surveyed to a stretch of AB/2 equal to 100 m. The geophysical survey techniques, instruments, survey parameters and total input for district are provided in **Tables below.**

Table 1: Summary of Geophysical Survey, Jembe CHC

Community Health Centre, CHC	Geophysical Method	Survey Parameters, Direction	Name	Location			
				Start		End	
				Easting (m)	Northing (m)	Easting (m)	Northing (m)
Jembe CHC	Resistivity Profiling	Station spacing = 10m AB/2 = 15; 25; 40m MN/2 = 1	Profile 1	00232272	0876190	0232247	0876233
			Profile 2				
	Vertical Electrical Sounding	Schlumberger; Max AB/2 = 100m	BO003S1	0232251	0876230		
			BO003S2	0232259	0876216		
			BO003	0232268	0876200		

Table 2: Summary of Geophysical Survey, Njala Komboya CHC

Community Health Centre, CHC	Geophysical Method	Survey Parameters	Name	Location			
				Start		End	
				Easting (m)	Northing (m)	Easting (m)	Northing (m)
Njala Combuya	Resistivity Profiling	Station spacing = 10m AB/2 = 15; 25; 40m MN/2 = 1	Profile 1	0228996	0907323		
			Profile 2	0228988	0907323	0229029	0907259
	Vertical Electrical Sounding	Schlumberger; Max AB/2 = 100m	BO001S1	0228958	0907254		
			BO001S2	Pumping Borehole			
			BO001S3	0228986	0907308		
			BO001S4	0229058	0907369		

Table 3: Summary of Geophysical Survey at Sahn CHC

Community Health Centre, CHC	Geophysical Method	Survey Parameters	Name	Location			
				Start		End	
				Easting (m)	Northing (m)	Easting (m)	Northing (m)
Sahn CHC	Resistivity Profiling	Station spacing = 10m AB/2 = 15; 25; 40m MN/2 = 1	Profile 1	0213737	0902732	0213728	0902725
	Vertical Electrical Sounding	Schlumberger; Max AB/2 = 100m	BO002S1	0224059E	0931165N		
			BO002S2	02224046E	0931144N		
			BO002S3	0224044E	0931137N		

6 SURVEY RESULTS AND DISCUSSION

The objectives of ground geophysical survey in this area were to delineate fractured/weathered zones associated with geological interpreted lineaments. These were interpreted as important structural features for groundwater development but unfortunately there was virtually no space to undertake profiling. The resistivity profiling data were plotted using Microsoft Excel and interpreted qualitatively to locate the best positions for carrying out depth investigations (VES). Vertical Electrical Soundings (VES) were carried out at low resistivity anomalies. The soundings were surveyed to a stretch of AB/2 equal to 100 m which gives a theoretical investigation depth of 100m.

The VES were processed and interpreted with the Interpex forward and inverse modeling software RESIXIP. Discussion of the survey results in each CHC area is as follows:

6.1 Njala Kombuya CHC – BO001

The ground geophysical survey was planned along two lines perpendicular to each other (BO001P1) and (BO001P2), of lengths 90m and 50m respectively. These profiles were anticipated to cut across the geological trends of the faults and dykes which are seen on the geological map. There was no enough space to do any length more than those reported on this target area. The profiles were surveyed with resistivity investigating at three different depths of investigation of 15m, 25m and 40m. The most important being the deep zones which were picked at 25m and 40m deep. The profile results are as plotted and presented in. Following the interpretation of profiling data, 3 VES were conducted over low resistivity points which were considered as best groundwater potential anomalies. VES data plots with geo-electric model are also presented in Appendix 1. The discussion of the survey results along the profile line in the area is as follows:

Table 4: **Summary Resistivity Profiling for line BO001P1**

Profile Line	Resistivity	Comment
KM001P1	Low resistivity contrast at stations 20m and 30m	VES 3 was done on this line at station 20m.

Table 5: Summary Resistivity Profiling for line BO001P2

Profile Line	Resistivity	Comment
KM001P2	Low resistivity contacts at stations 20m and 60m	VES1 and VES 2 at 20m, and 50m respectively.

Table 5: Summary of Vertical Electrical Soundings

	Coordinates	Layer	Resistivity (Ohm-m)	Depth (m)	Comments
VES 1 – BO001S1	0228958E 0907254N	1	400	1	
		2	1530	24	
		3	2930		
VES 2 – BO001S2		1	130	1	This is the Well supplying water at the moment
		2	250	4	
		3	70	10	
		4	4590		
VES 3 – BO001S3	0228986 0907308	1	1800	1	Priority site A There is thick overburden with a thicker weathered zone. Most like fractured around 35m.
		2	850	3	
		3	1990	4	
		4	800	28	
		5	1040		
VES 4 – BO001S4	0229058E 09073697N	1	1100	1	Priority site B There is thick overburden with a thicker weathered zone.
		2	3920	3	
		3	1320	24	
		4	8610		

6.2 Sahn CHC

Two profiles were done on this target site. BO002P1 is of length 90m whilst BO002P2 is of length 40m. VES points were chosen at relatively low resistivity stations. The area confirms thick overburdens of sediments. VES data plots with geo-electric model and the profiles are presented in

APPENDIX 2: Sahn GEOPHYSICAL RESULTS

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Table 6: Summary of Vertical Electrical Soundings

	Coordinates	Layer	Resistivity (Ohm-m)	Depth (m)	Comments
VES 1 – BO002S1	0213726E 0902715N	1	325	2	Priority site B Thick overburden and resistivity relatively lower than that for VES 2.
		2	1300	13	
		3	6520		
VES 2 – BO002S2	0213726E 0902715N	1	400	1	
		2	1725	16	
		3	7220		
VES 3 – BO002S3	0213724E 0902757N	1	270	1	Priority site A There is moderately thick overburden with a conductive layer at after 15m. Most like fractured after 40m.
		2	130	3	
		3	21000	9	
		4	1022		

6.3 Jembe CHC – BO003

The ground geophysical survey was planned along one profile line (BO003P1) across the anticipated geological trends expected in the area. The line was done of 50m long from which VES were chosen. The profile was surveyed with resistivity investigating at three different depths of investigation of 15m, 25m and 40m. The profile results are as plotted and presented in Appendix 3. Following the interpretation of profiling data, 3 VES were conducted over low resistivity points which were considered as being possible groundwater potential anomalies. VES data plots with geo-electric model are also presented in Appendix 3. The discussion of the survey results along the profile line in the area is as follows:

Table 7: **Summary Resistivity Profiling for line BO003P1**

Profile Line	Resistivity	Comment
PL003P1	Generally the resistivities in this area are high, there are lots of dykes and faults in this area, it would have been best if magnetic method was deployed here, but we have relative Low resistivity at stations 50m and 70m.	VES 10 at 20; VES 3 at a spot place

Table 8: **Summary Resistivity Profiling for line BO0003P2**

Profile Line	Resistivity	Comment
BO003P1	Generally the resistivities in this area are high but we have relative Low resistivity at stations 50m and 70m.	VES 1 at station 10m.

Table 9: **Summary of Vertical Electrical Soundings**

	Coordinates	Layer	Resistivity (Ohm-m)	Depth (m)	Comments
VES 1 – BO003S1	0232251E 0876230N	1	516	1	
		2	1570	5	
		3	2800		
VES 2 – BO003S2	0232259E 0876216N	1	280	1	Backup Site B - The site has very high resistivities and the weathered layer is not big.
		2	1580	1.5	
		3	1150	9	
			2890	18	
			1220		
VES 3 – BO003S3		1	50	1	Priority site A – There is a weathered layer after 5 m to a depth of 11m. We anticipate fracturing above deeper than 30m.
		2	8550	5	
		3	530	11	
		4	15976	32	
		5	2450		

7. RECOMMENDATIONS FOR DRILLING

7.1. Recommended Drilling Sites

A total of three drilling sites and their three backup sites have been recommended for drilling. The list of sites with selection criteria and recommended drilling depths are provided in **Table 9**. There is need to verify and evaluation of incoming drilling results from these sites in for correlation with the geophysical data.

We recommend a revisit of Jembe CHC if the yields obtained are not sustainable. The revisit will be done with magnetic survey plus resistivity, the VES spots will be chosen from low magnetic anomalies which will represent faults.

Table 10: List of Recommended Drilling Sites

Site	Site Reference	Coordinates	Site Selection Criteria	Maximum Drilling Depth (m)
BO001DS1 – Priority site A Njala Kumbuya CHC	VES 3 – BO001S3	0228986E 0907308N	– There is thick overburden with a thicker weathered zone. Most like fractured around 35m.	70 m
BO001DS2 Backup Drill Site Njala Kumbuya CHC	VES 4 – BO001S4	0229058E 09073697N	There is thick overburden with a thicker weathered zone.	70 m
BO002DS1 – Priority Site A Sahn CHC	VES 3 – BO002S3	0213724E 0902757N	- There is moderately thick overburden with a conductive layer at after 15m. Most like fractured after 40m.	70m
BO002DS2 - Sahn CHC	VES 1 – BO002S1	0213726E 0902715N	Thick overburden and resistivity relatively lower than that for VES 2..	70m
BO003DS1 - Gura Mamende Tungie CHC	VES 3 – BO003S3	0232268E 0876200N	- There is a weathered layer after 5 m to a depth of 11m. We anticipate fracturing above deeper than 30m.	70m
BO003DS2 Gura Mamende Tungie CHC	VES 2 – BO003S2	0232259E 0876216N	The site has very high resistivities and the weathered layer is not big.	70m

7.2. Drilling, Borehole Construction, Development and Testing

7.2.1. Drilling

- It is proposed to use 40m as normal minimum drilling depth and 70 m as a normal maximum drilling depth which shall only be exceeded under typical circumstances and when drilling takes place in rock under the sediments found in Kissy and Port Loko targets. In the extreme situations, the drill depth may go to a maximum of 100m.
- It is proposed to use 15 m as the normal minimum depth to the top screen in order to avoid contamination of boreholes.
- It was observed during the hydrogeological reconnaissance survey that many boreholes in the area have failed due to siltation, which is the result of improper well design or construction. The well design and construction is of particular importance due to abundant fine grained material in the aquifer. It will thus be crucial that gravel pack of suitable grain size is placed against the screens and that correct gravel pack installation is done. It is there by recommended that Goal follow this up in order to achieve high quality borehole construction.
- It is recommended that a sump of minimum 6 m shall be installed below the screen for boreholes in unconsolidated formations. For boreholes in consolidated formations, the sump shall be of minimum 3 m
- Yield should be measured at least every six meters, and recorded after the first water strike, such information is critical in determining when to terminate the bore.
- It is highly recommended that drill chips are logged by a qualified geologist before installation of casing, and that such installation is supervised by a qualified hydrogeologist.

7.2.2. Borehole Development

- We recommend Air lifting and jetting methods using a single pipe system as the most effective borehole development method to be employed.

7.2.3. Test Pumping

- It is recommended that test pumping shall comprise of a 4 stage steps test of minimum 2 hours (120 minutes) each step with measurement of yield, drawdown and recovery.
- We also recommend a Constant Rate Test (CRT) for a minimum of 24 hours.
- The above is followed by a Recovery test, which will consists of measurement of residual drawdown after constant rate test until static water level is achieved.

7.2.4. Groundwater Sampling and Hydro-chemical Analysis

- We recommend that water samples for chemical analysis of major ions, selected metals and bacteriological contamination be taken at the end of borehole development and at the end of CRT.

- Field water quality parameters should be measured during drilling and test pumping. Typical water quality meters will measure TDS, EC, pH and Temperature. Measuring these field water

quality parameters serves to provide an early indication of deteriorating water quality. This is important in cases where saline water intrusion might be expected.

7.2.5. Disinfection

- It is recommended that disinfection could be carried out immediately after pump installation, using chlorine granules. This would make disinfection of the pump parts unnecessary. The drilling contractor will accordingly be given a choice between disinfecting after test pumping, and disinfecting after pump installation.

7.2.6. Criteria for Successful Boreholes

- The criteria for declaring boreholes successful may have to be flexible considering borehole yield, water quality and distance of existing water source in the dry season. The Consultants will liaise with the Client in cases where such a flexible approach appears relevant. The consultant will immediately report cases where WHO water quality limits are exceeded so that a decision to stop superstructure construction or pump installation can be made if needed.

8. REFERENCES

The following reports provide more information on the geology and hydrogeology of Sierra Leone. Some, and others, can be accessed through the Africa Groundwater Literature Archive

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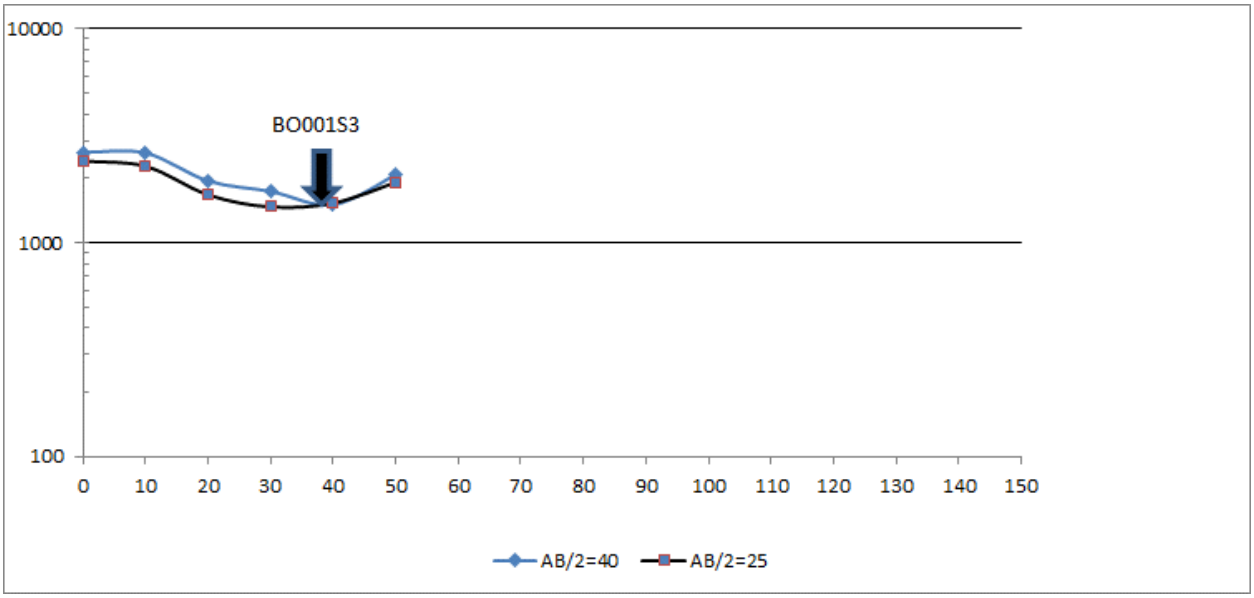
APPENDICES

Appendix 1: NJALA KOMBOYA GEOPHYSICAL RESULTS

BOO1P1



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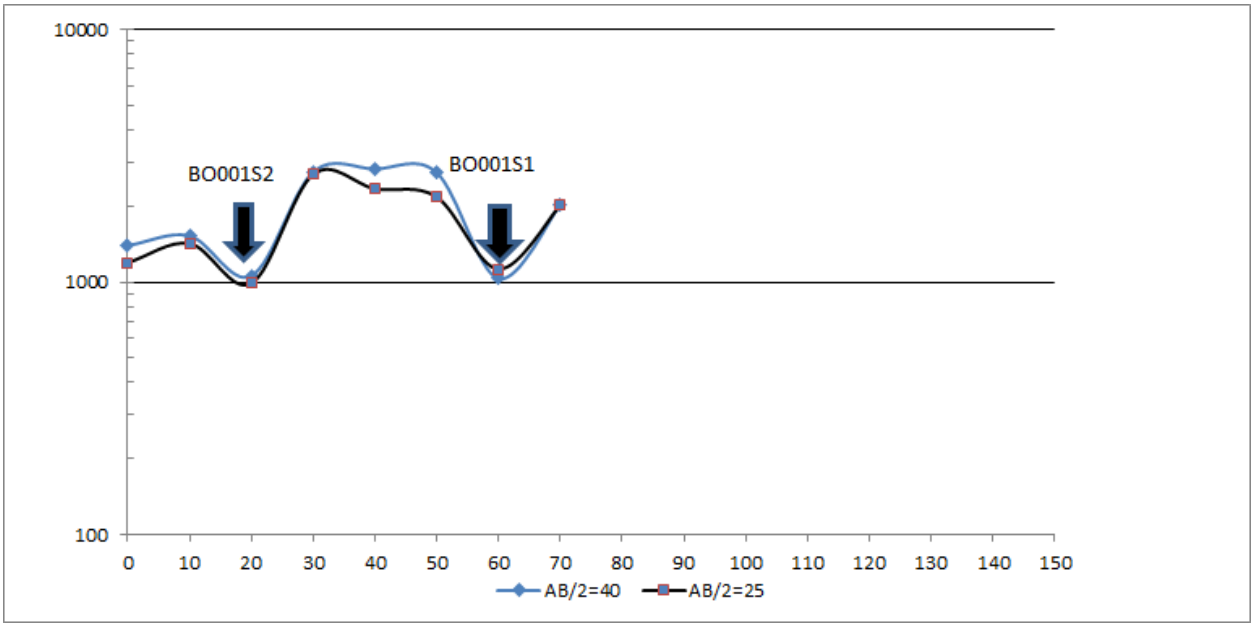

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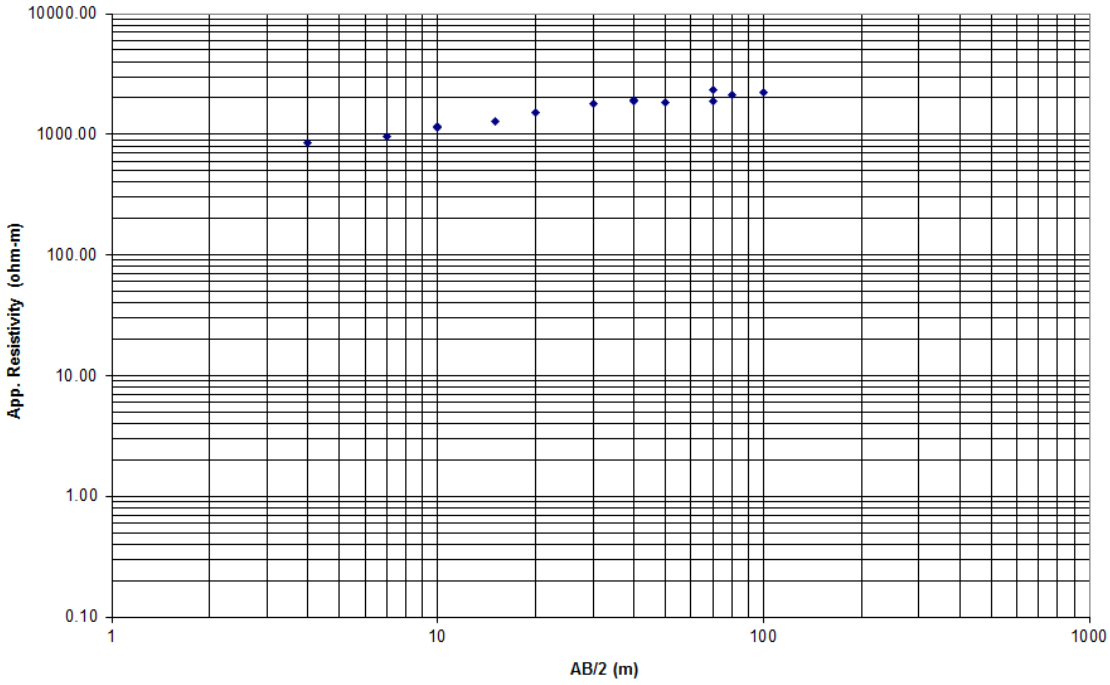
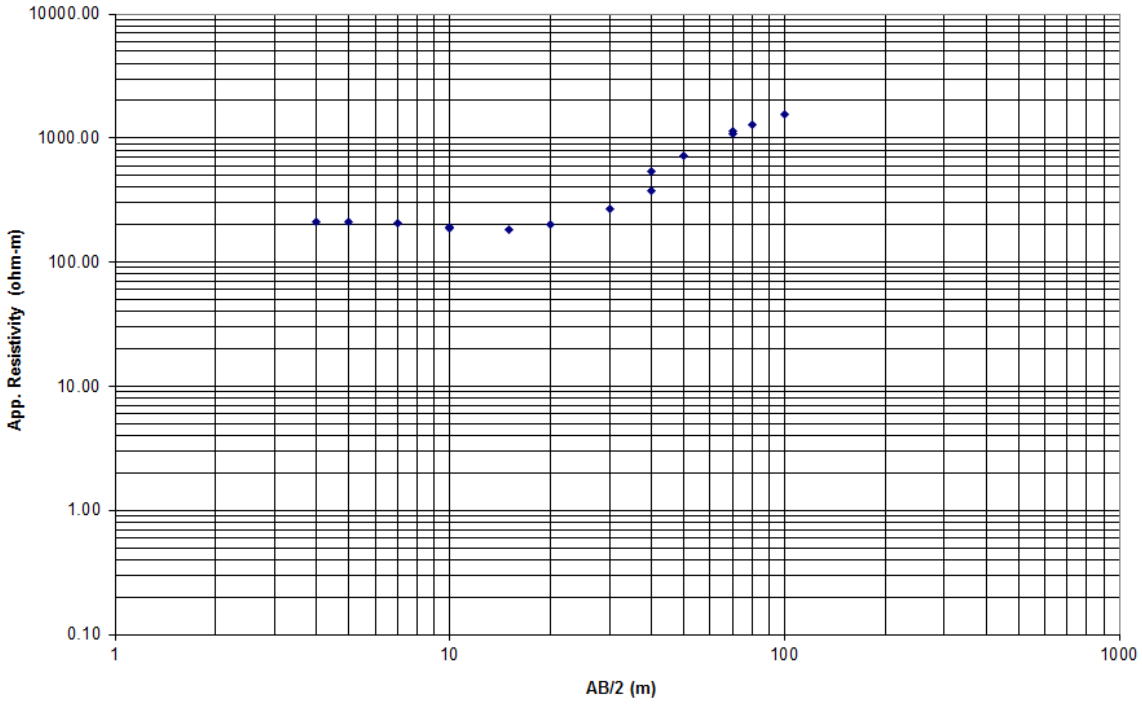
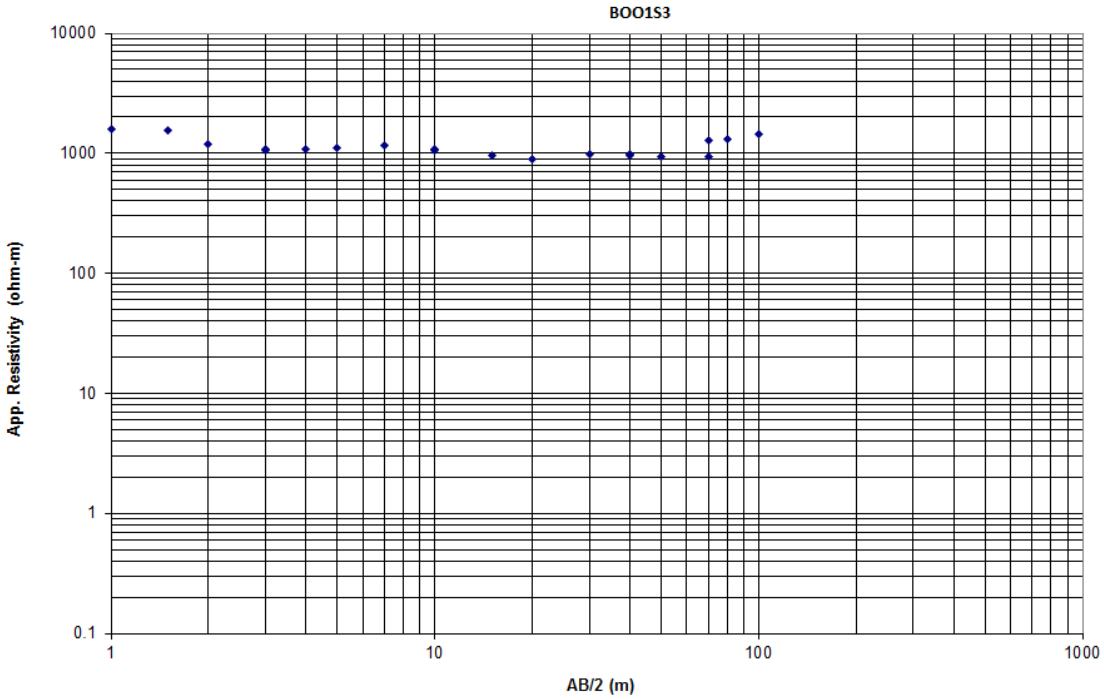
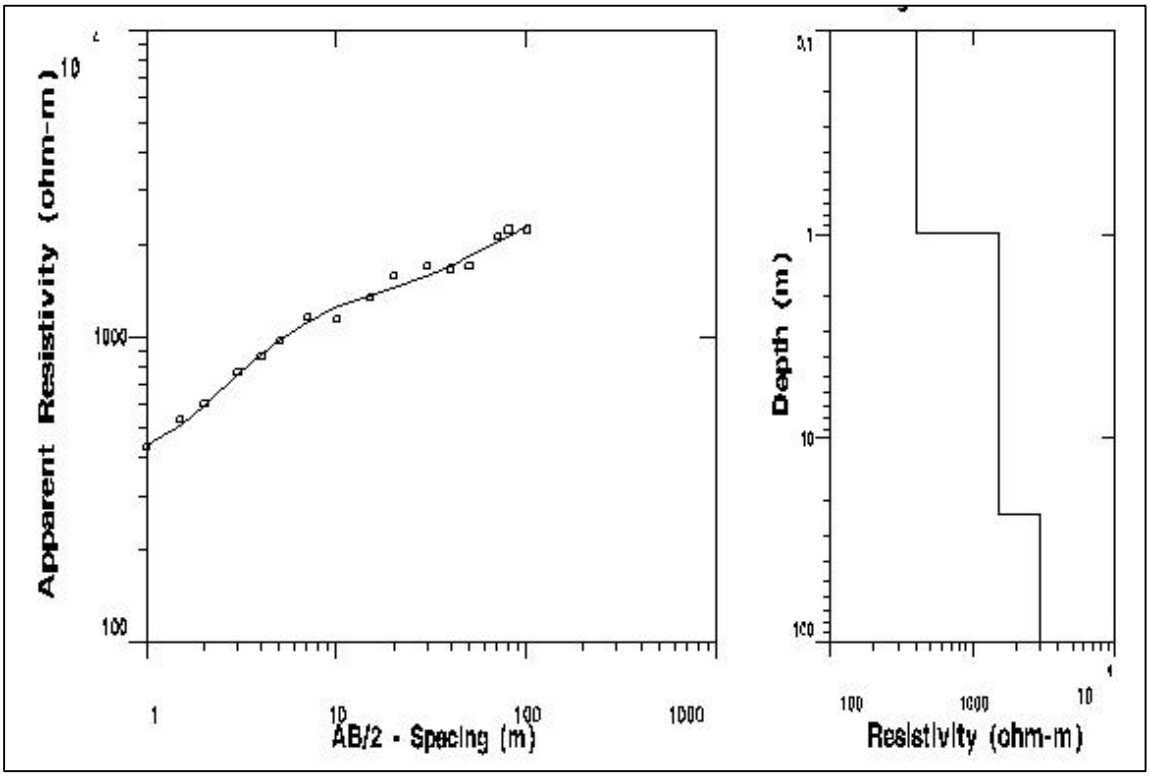


App. Resistivity Vs AB/2 BOO1S2

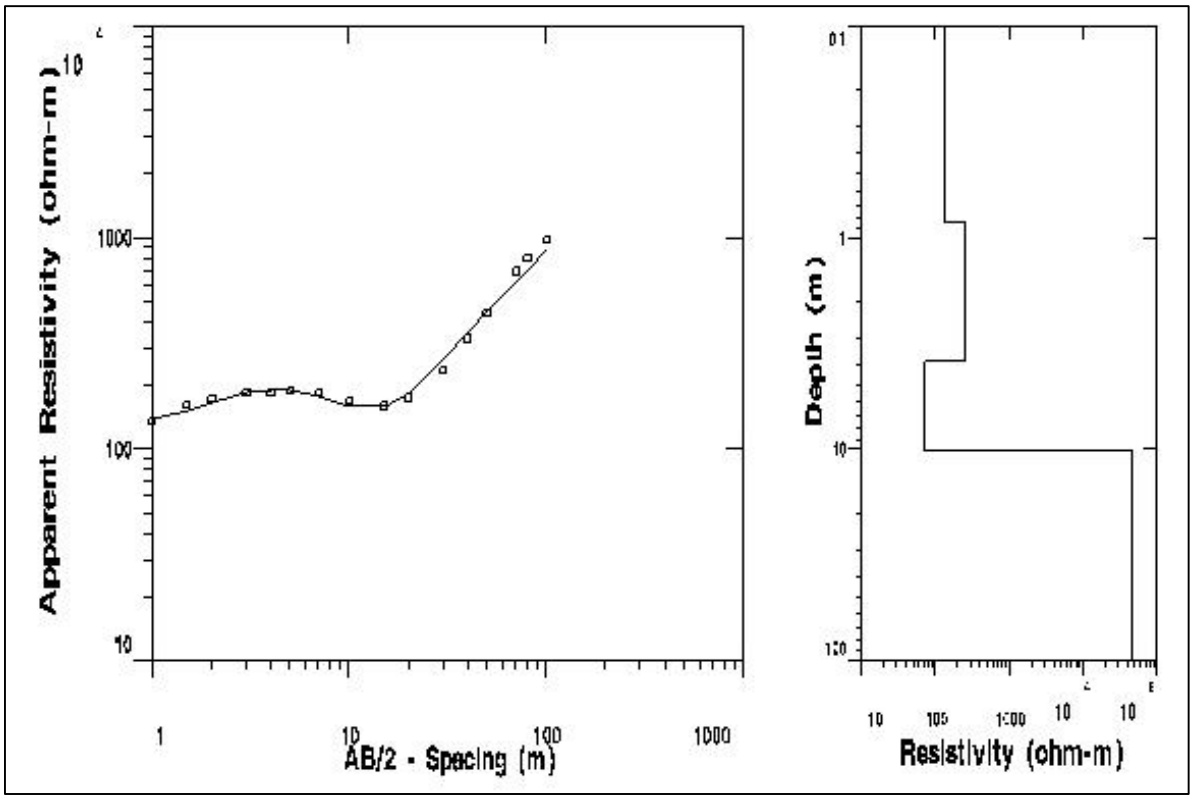



BOO1S3
App. Resistivity (ohm-m)
10000
1000
100
10
1
0.1
1
10
100
1000
AB/2 (m)

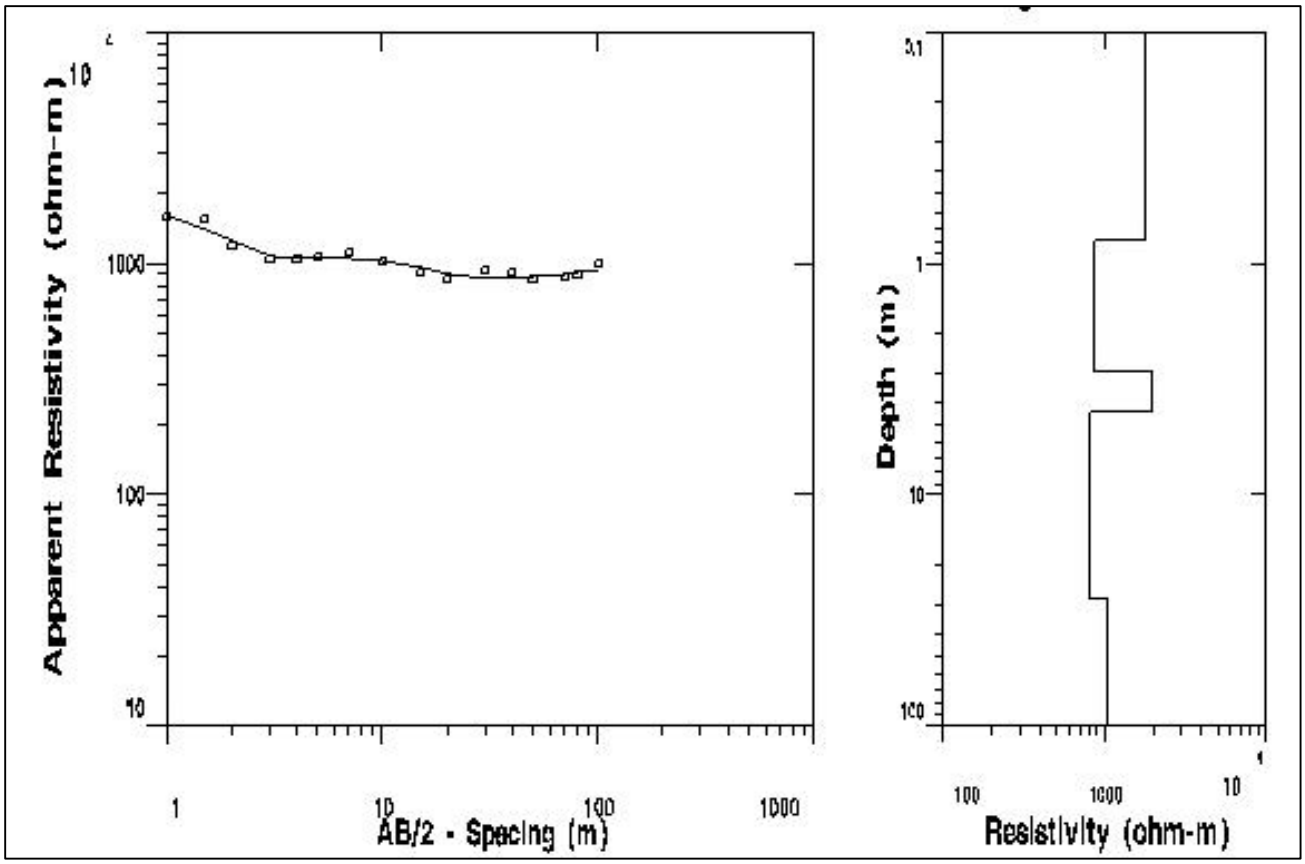
BOO1S1



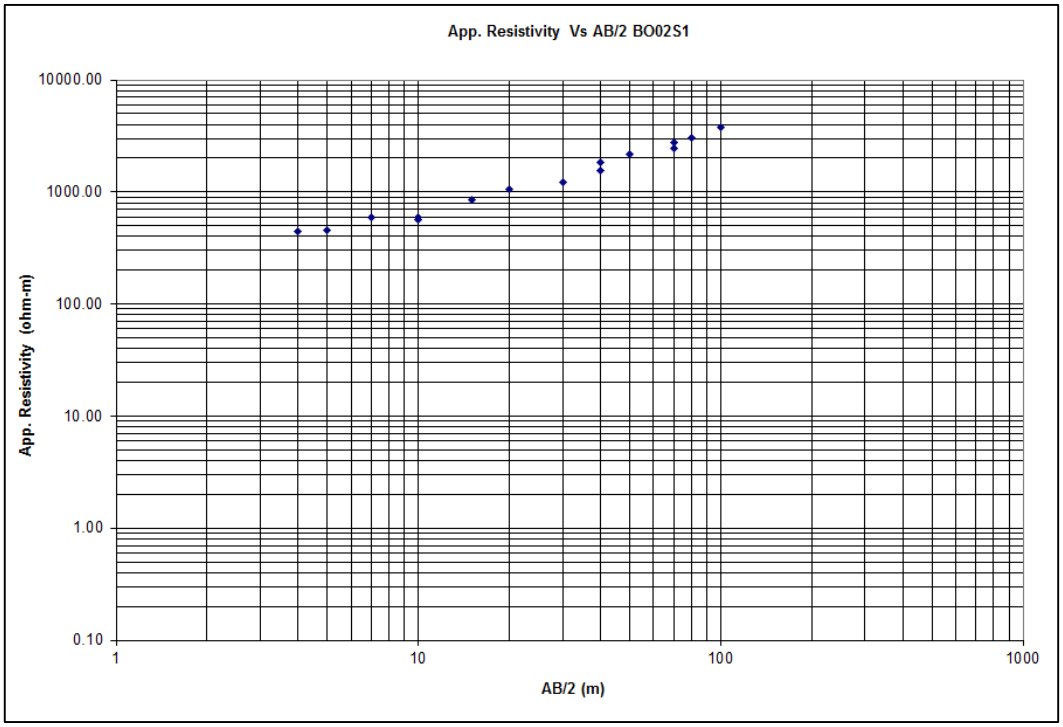
B001S2

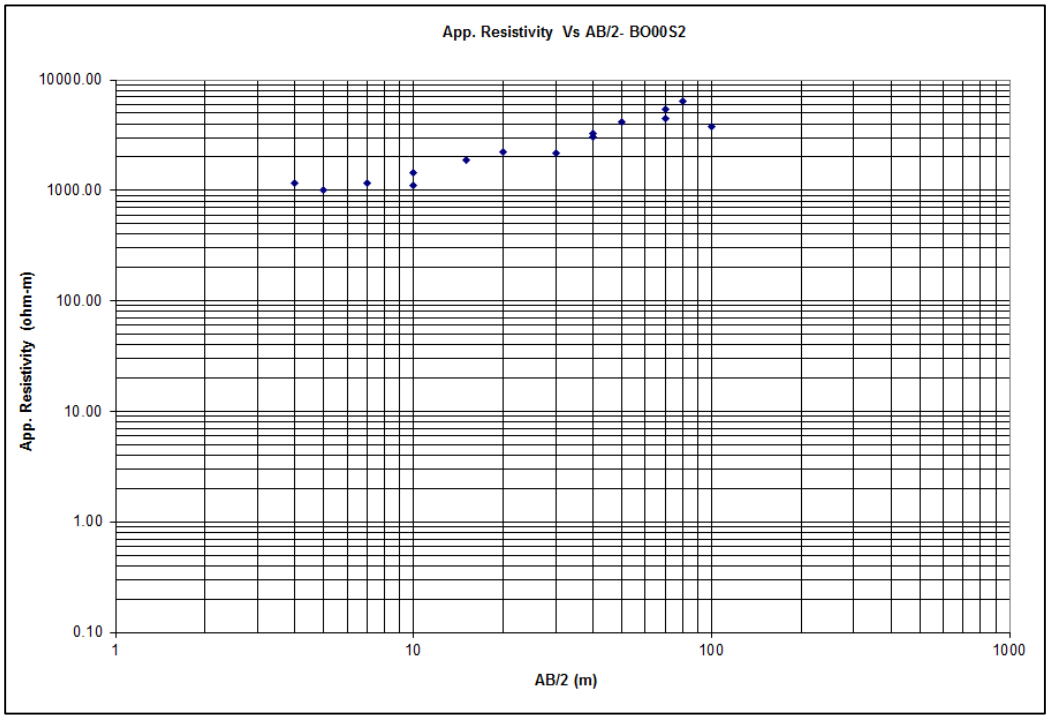


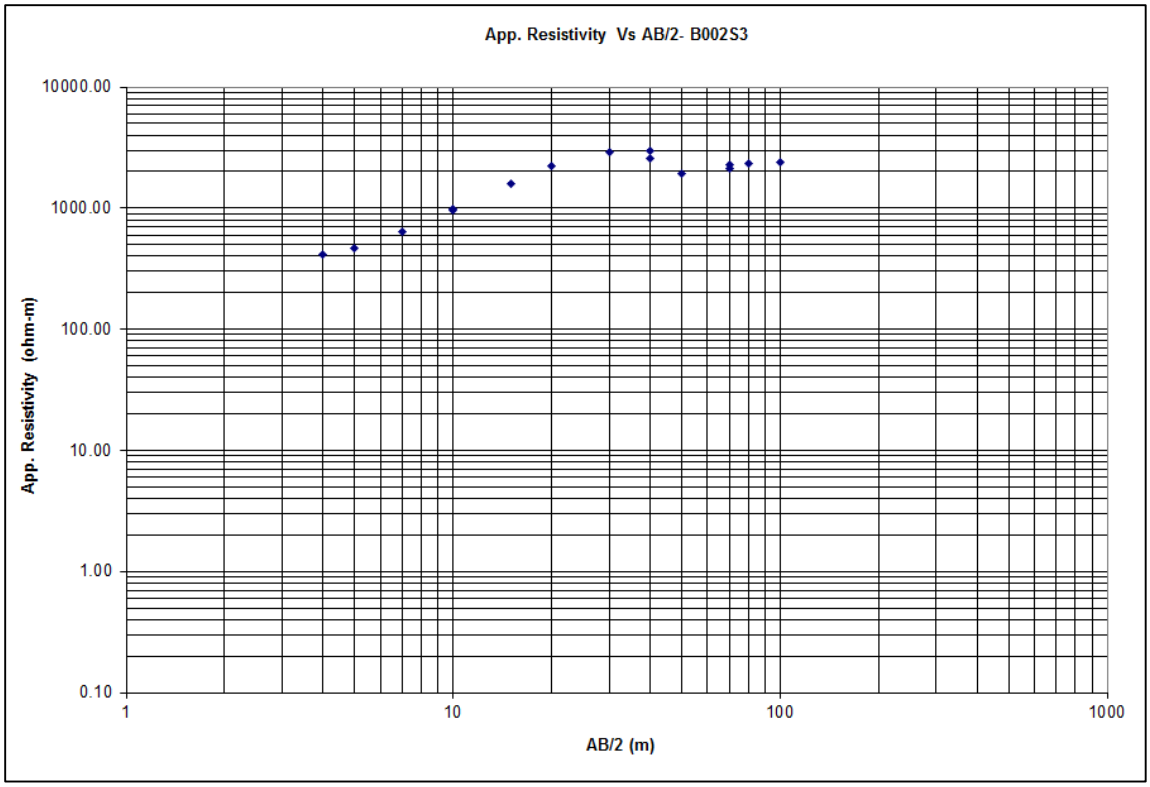
BOO1S3


Apparent Resistivity (ohm-m)
10
1000
100
10
1
10
100
1000
AB/2 - Spacing (m)
Depth (m)
1
10
100
100
1000
10
Resistivity (ohm-m)

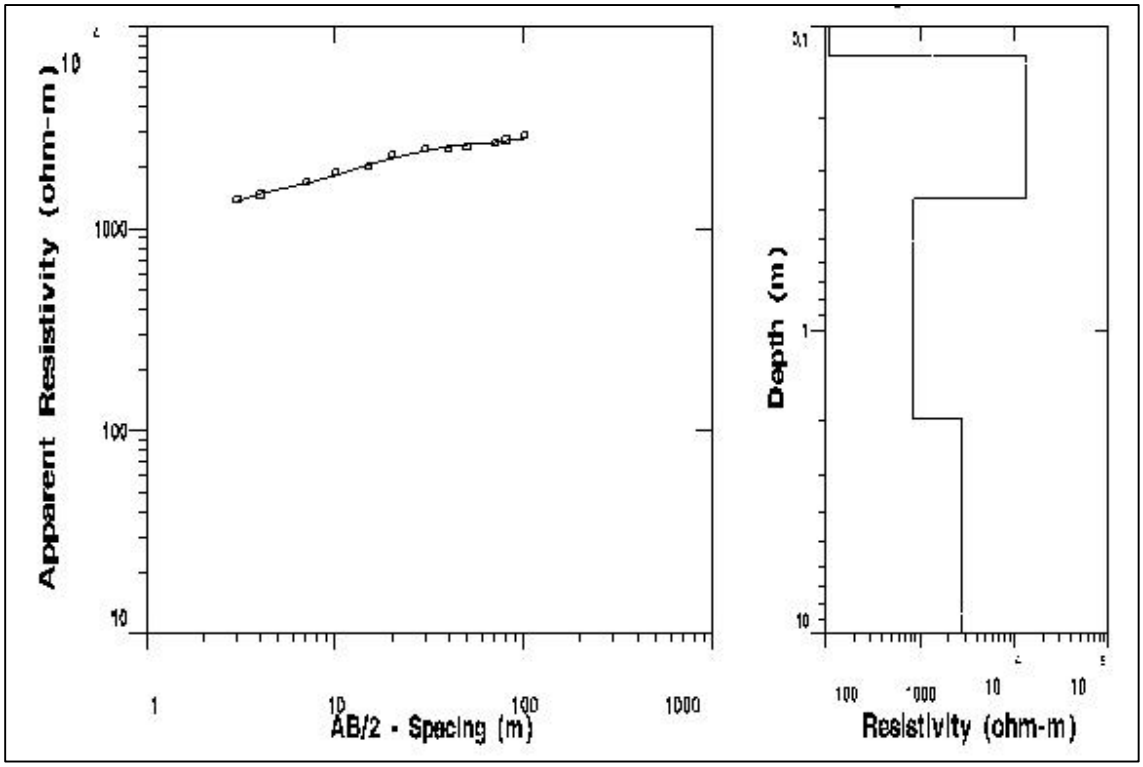
APPENDIX 2: Sahn GEOPHYSICAL RESULTS



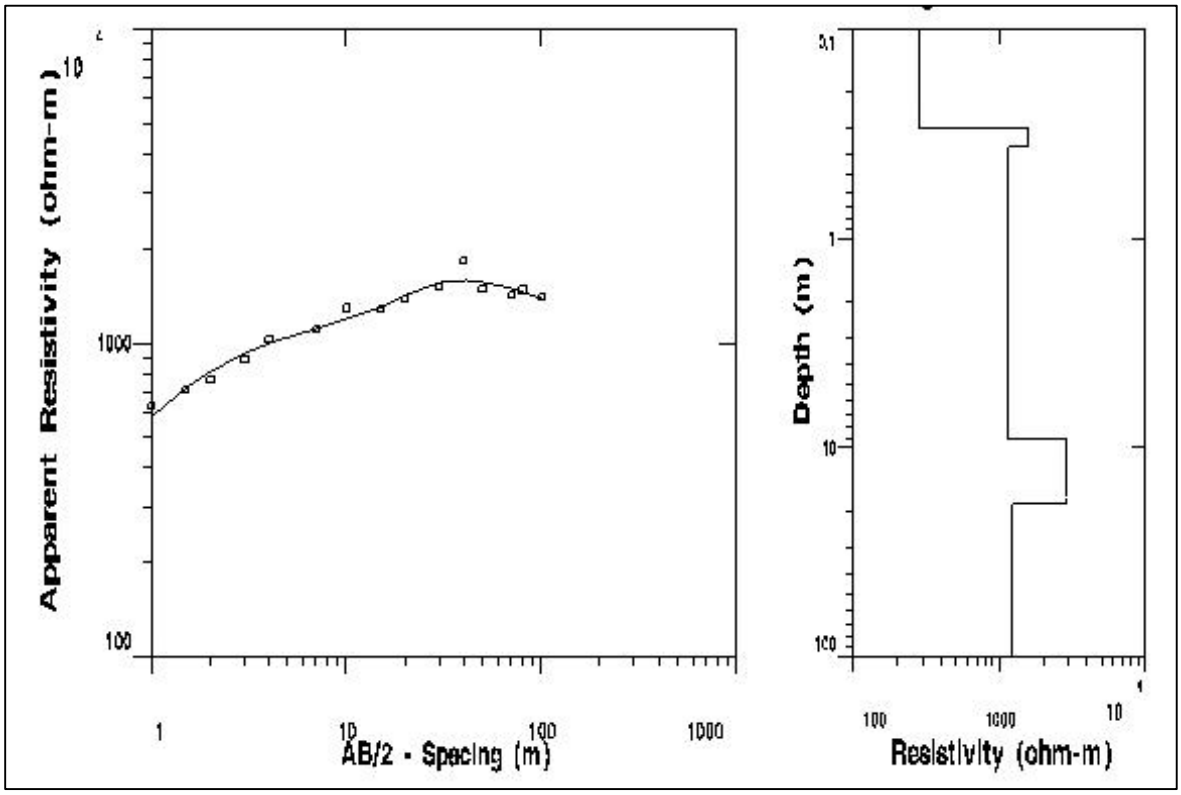



App. Resistivity Vs AB/2- B002S3
App. Resistivity (ohm-m)
10000.00
1000.00
100.00
10.00
1.00
0.10
1
10
100
1000
AB/2 (m)

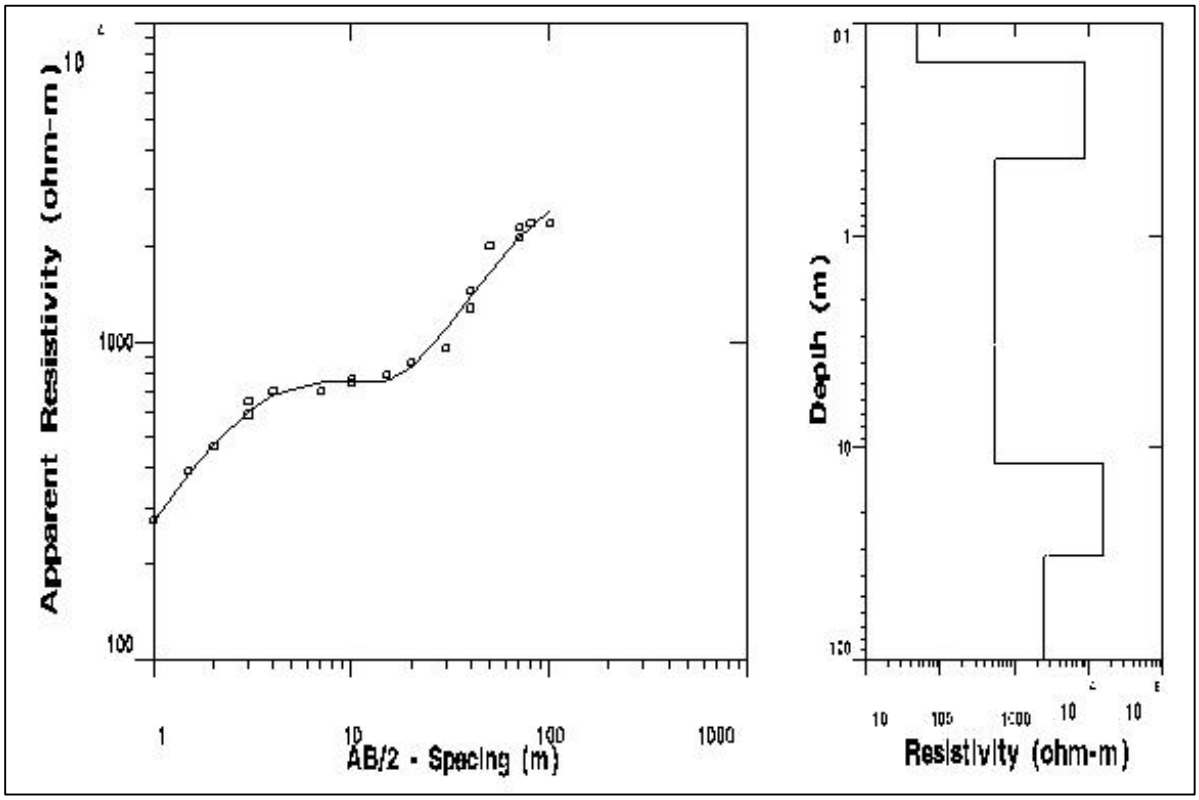
BO001S1


Apparent Resistivity (ohm-m)
1000
100
10
1
10
100
1000
AB/2 - Spacing (m)
Depth (m)
1
10
100
1000
10
Resistivity (ohm-m)

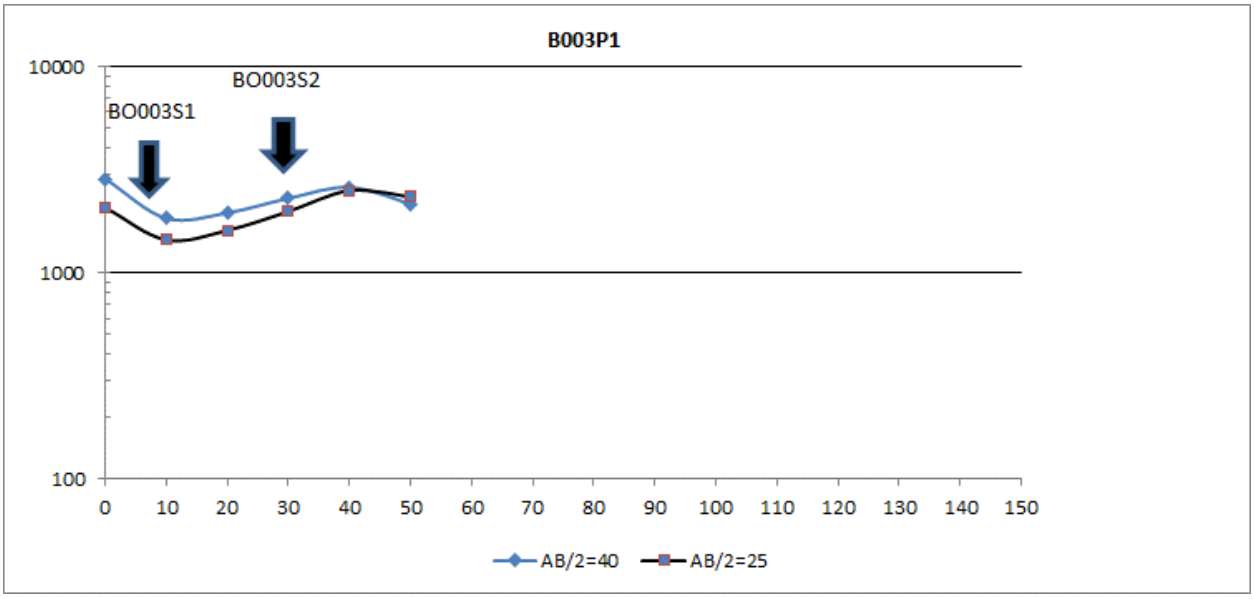
BO001S2

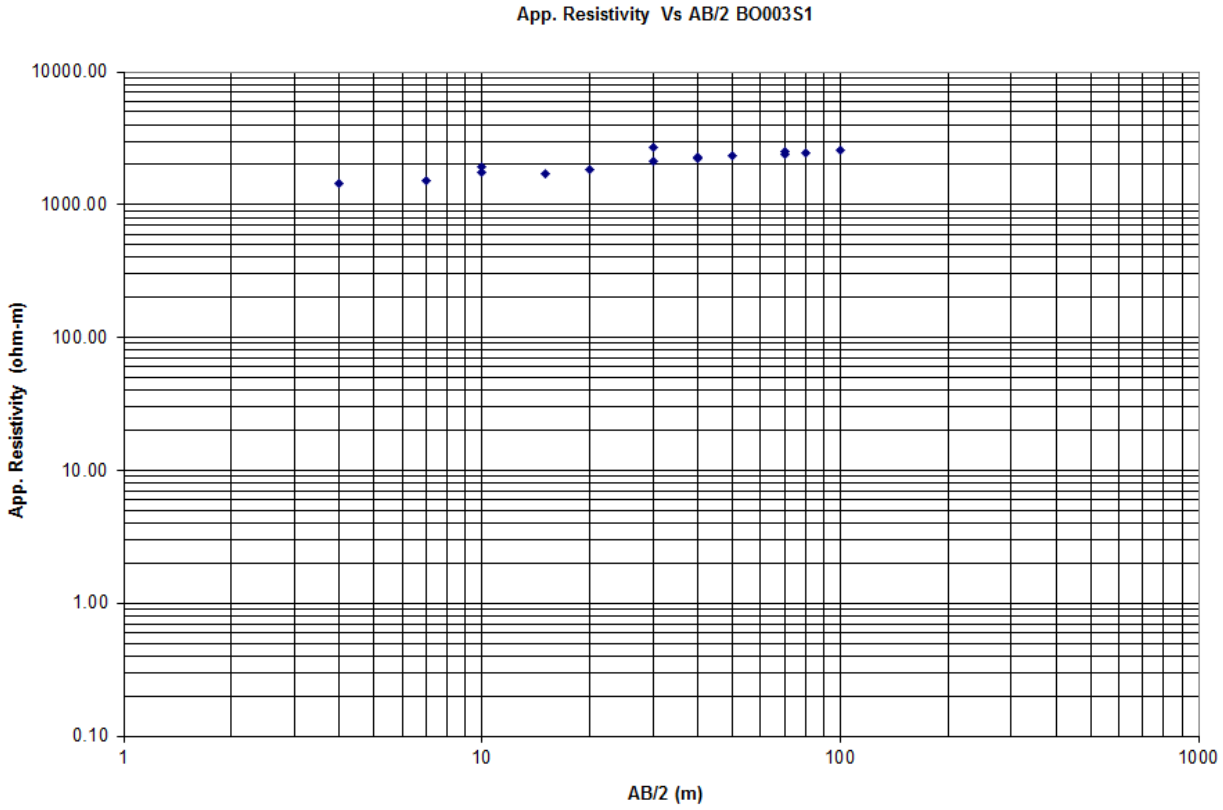


BO001S2

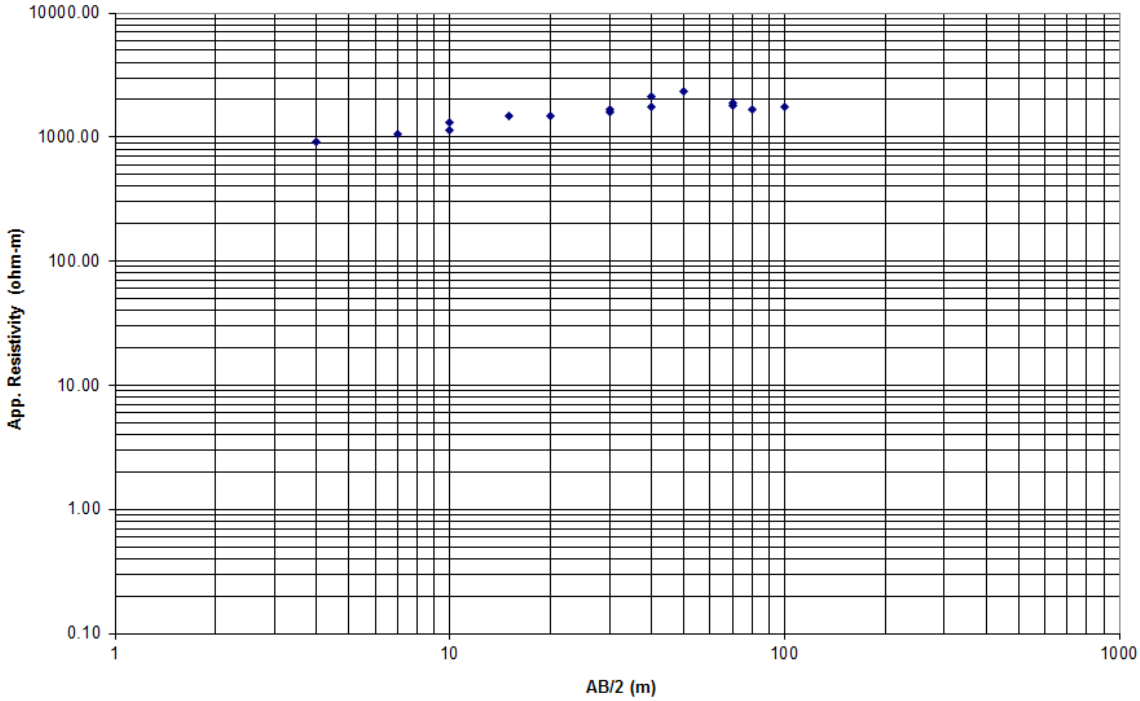


Appendix 3: Jembe GEOPHYSICAL RESULTS

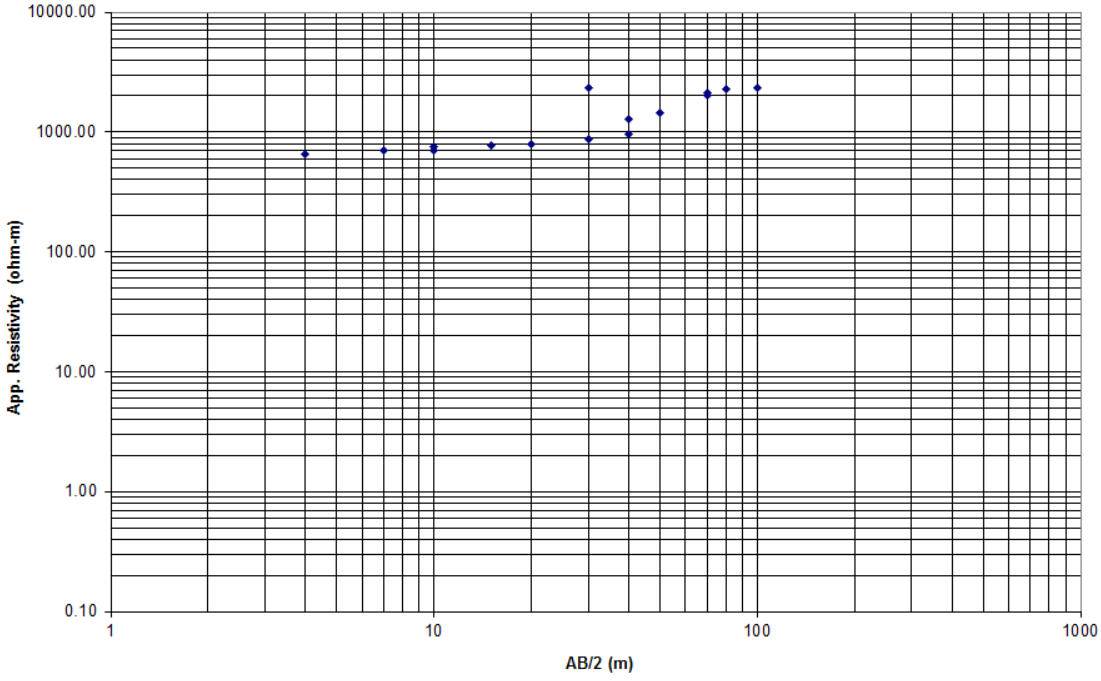




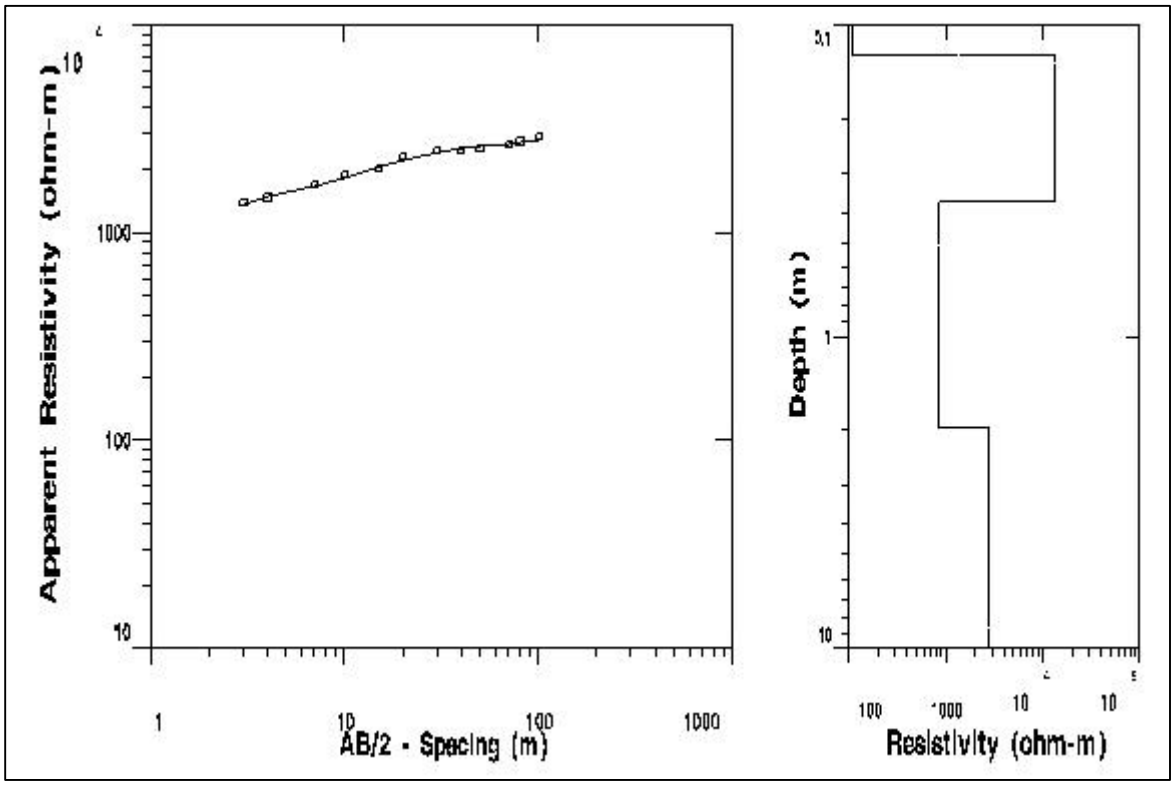
App. Resistivity Vs AB/2 BO003S2



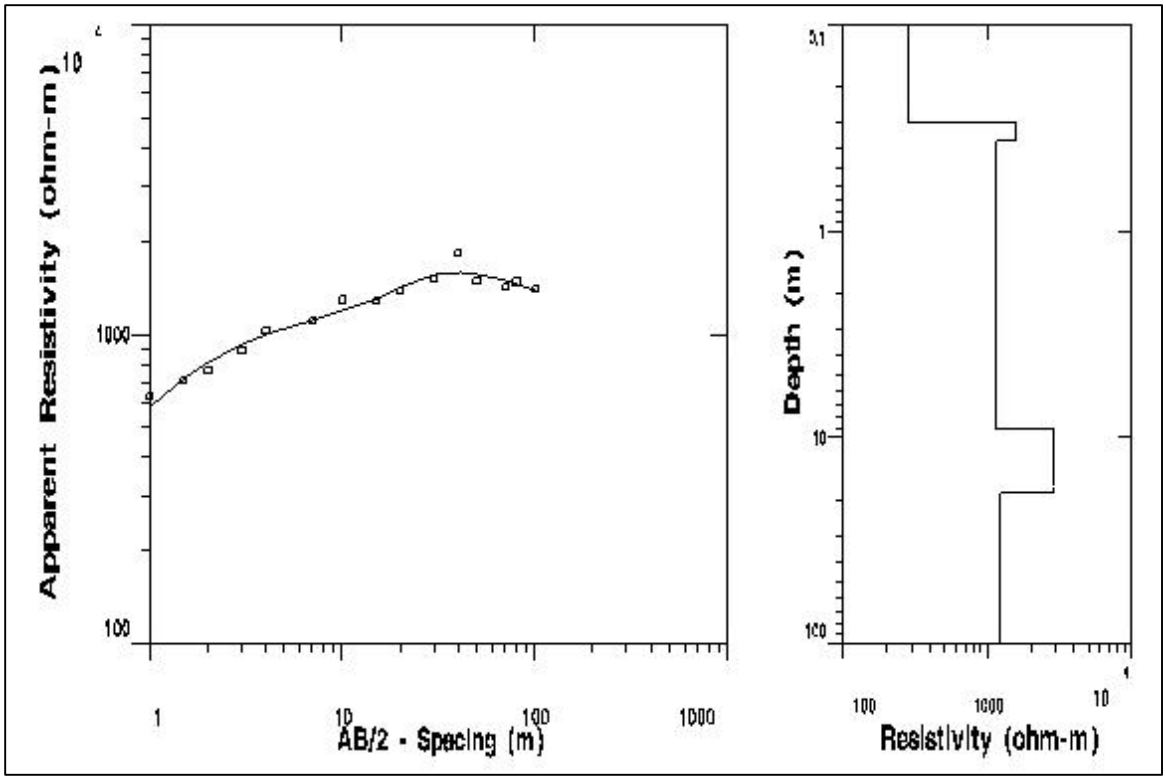
App. Resistivity Vs AB/2- BO003S3

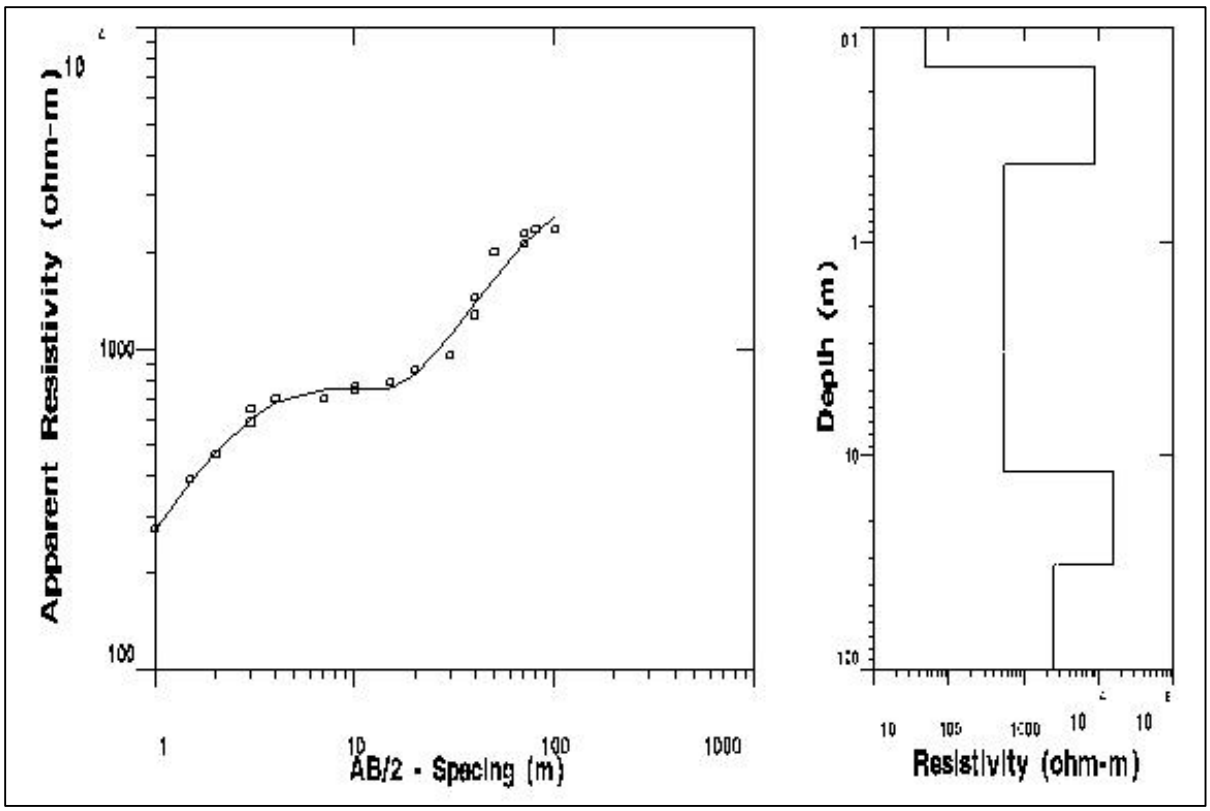


BO003S1



BO003S2


Apparent Resistivity (ohm-m)
10
1000
100
1
10
100
1000
AB/2 - Spacing (m)
0.1
1
10
100
Depth (m)
100
1000
10
Resistivity (ohm-m)


Apparent Resistivity (ohm-m)
10
1000
100
1
10
100
1000
AB/2 - Spacing (m)
0.1
1
10
100
Depth (m)
10
105
1000
10
10
Resistivity (ohm-m)