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## **Geophysical Survey at Qezel Kand Village, Sholgara District, Balkh Province**

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## List of Abbreviation and Technical Terms

Roh:	Apparent Resistivity (Ohm.m)
Sp:	Self Potential (mV)
Vp:	Voltage Potential (mV)
In:	Current (m A)
VES:	Vertical Electrical Sounding
DACAAR:	Danish Committee for Aid to Afghan Refugee
WASH:	Water, Sanitation and Hygiene

## 1. Introduction

DACAAR is a humanitarian organization working in Afghanistan since 1984 on water sanitation and hygiene sector to enhance the quality of Afghan peri urban and rural people health. DACAAR has many years of experience in the WASH sector and has installed more than 43,000 water points in Afghanistan DACAAR's Programme has highly experienced and competent engineers, geologists, hydro-geologist, technicians, trainers and hygiene education specialists to implement the project effective and efficient. DACAAR has a provision to carry out detailed geo-physical survey before the implementation of water supply project. The geo-physical survey in Qezel Kand Village, Sholgara District, Balkh Province was carried out on November 21, 2013 which was supported by ROI program.

Qezel Kand Village, is located about 8 Km south east of Sholgara District Center. Fives hundreds population are settled in the village and agriculture and livestock are the main occupation for livelihoods. People of this village have safe drinking water problems due to deep water table and muddy surface water.

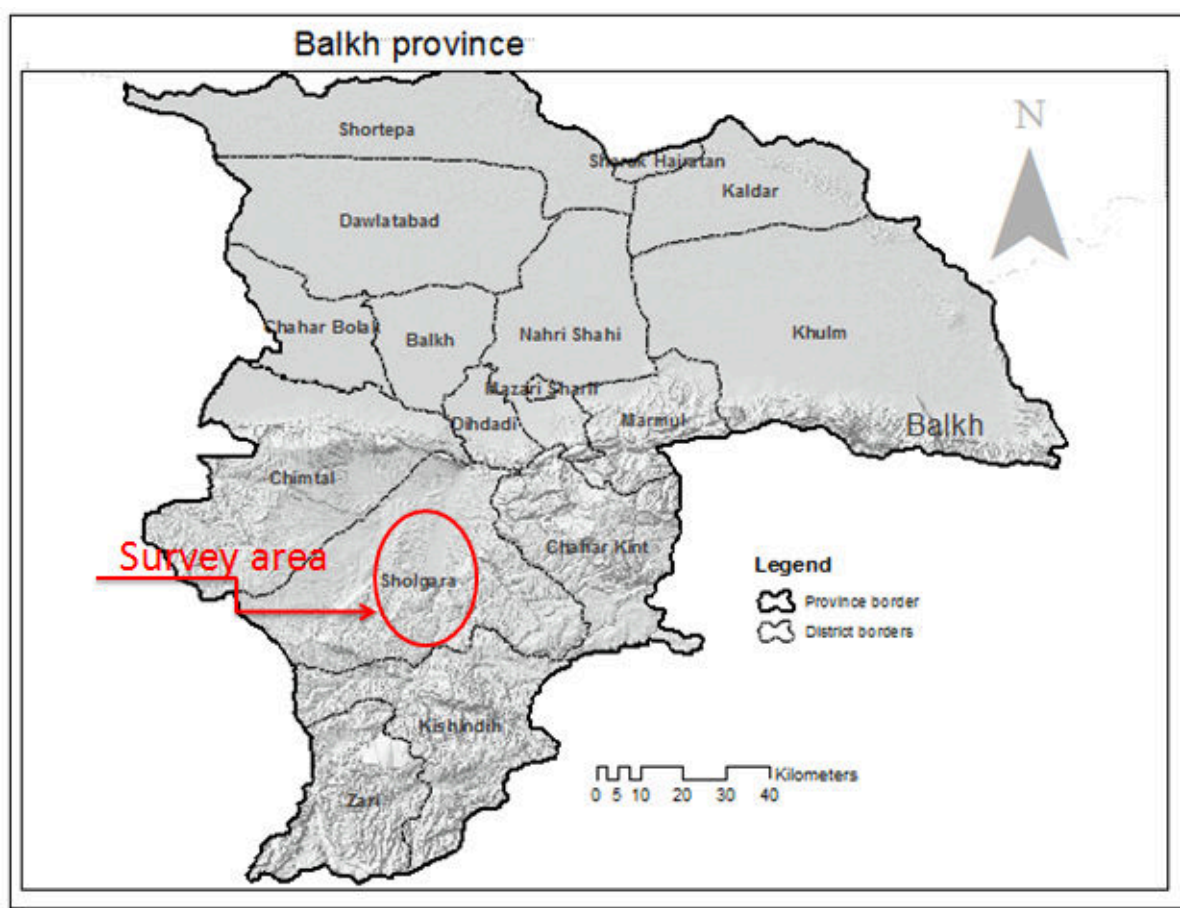


Figure 1 The location of Qezel Kand village in Sholgara district of Balkh province

DACAAR performed Vertical Electrical Sounding (VES) Survey in Qezel Kand Village for provision of drinking water by using Shlumberger electrodes arrangement on Novem-

ber 21, 2013, (Figure 1). SYSCAL Pro resistivity meter measured the field data (Figure 2) which was interpreted by IPI2 win software.

## 2. Objectives of the survey

The overall objective of this survey is to assess the feasibility of drilled well in the target area. The following are the specific objectives of the survey:

- Explore to get understanding on the geologic formation (rock and soil) of the subsurface.
- Identify the depth of aquifer and fundamental rock.
- Identify the depth of groundwater table of the area.
- Provide recommendations on the feasibility of drilled well in the study area.

## 3. Rationale to carry out survey

More than 200 households of Qezel Kand are using the ditches water which (origin from Balkhab River) are having high turbidity and fecal coliform bacteria (DACAAR Lab result, 2013). There is no any improved Handpumped wells and water supply pipe scheme due to embedded hard strata and deep aquifer.

The people of this area have drinking water problems in terms of quality and quantity. Village people complaints that frequent diarrhea incident will be happening due to contaminated water. Therefore, there is needed to provide safe drinking water through drilling of tube well and construction of water supply system.

## 4. Surface geological setting of area

The surface geological formation of the survey area is:

- Recent Quaternary: Shingly and detritus sediments (gravel, sand, clay, sand, loess)
- Middle Quaternary: Shingly and detritus sediments (gravel, sand, clay, sand, loess, loam, and travertine)
- Early Miocene: Red clay, sandstone, siltstone, conglomerate, and limestone
- Paleocene: Limestone, marl, dolomite, sandstone, siltstone and conglomerate

The Geological setting of the area is shown in the figure 2.

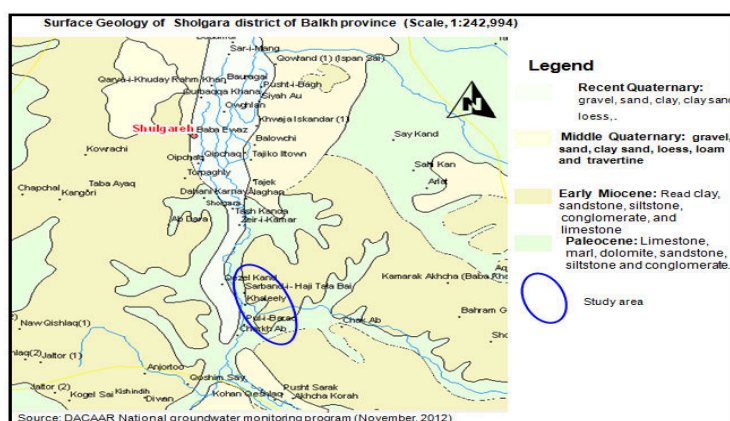


Figure 2: Surface geological setting of the survey area (Qezel Kand Area)

## 5. Methodology and materials

DACAAR performed a geophysical survey by using SYSCAL Pro resistivity meter.



Figure 3: Measured field data by SYSCAL Pro resistivity meter

Vertical electrical sounding methodology was also applied to find out the geo-physical information of the ground. The Applied Schlumberger Techniques was also used by transmitting electrical current into the ground from DC (direct current) or low frequency sources by two electrodes (A and B). The potential difference between a second pair of electrodes (M and N) was measured.

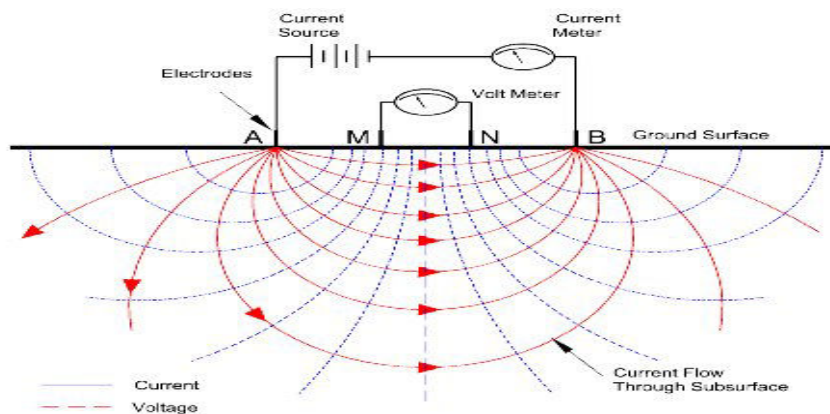


Figure 4. Schlumberger applied techniques method

Apparent resistivity value is calculated:

$$\rho_a = KV / I$$

Where:

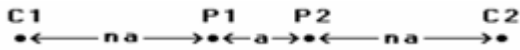
$\rho_a$  is the apparent resistivity

**K** is the geometric factor,

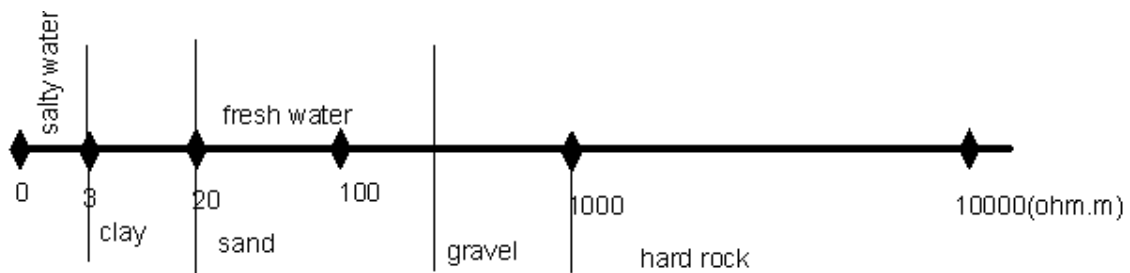
**V** is a voltage or potential difference between a second pair of electrodes in volts

**I** is the current from DC or low frequency sources by two electrodes in ampere.

$$K = \frac{\pi}{n(n+1)} a$$



The field data interrelated according to the following resistivity scale for water and rocks.



**Figure 5 Resistivity scale for water and rocks**

All information and data were interpreted by using IPI2 wins software. The interpreted data were used to calculate apparent resistivity, thickness, depth and boundaries of layers.

## 6. Finding of the survey

The survey was carried out in Qezel Kand Village. The locations and length of VES and profil(resistivity traversing) is shown in the table 1

**Table 1 Location of VES profiles**

NO	Village	VES Profiles	Latitude	Longi-tude	Eleva-tion (m)	VES Distance (m)
1	Qezel Kand Village	VES-1	36.23613	66.89246	?	600
2	Qezel Kand Village	VES-2	36.23494	66.89153	646	600
3	Qezel Kand Village	VES-3	36.23443	66.89417	643	600



Figure 6 Location and length of VES profiles in Qezel Kand Village.

### 6.1 Measured VES field data

The field data were measured by SYSCAL Pro resistivity meter and the measured data are shown in Table 2 and Table 3.

Table 2 VES#1 Measured Field Data

VES # 01					
Latitude: 36.23613		Longitude: 66.89246		Elevation (m): 643	
AB/2	MN/2	$\rho_a$ ( $\Omega m$ )	$\Delta V$ (mV)	I (mA)	K
1	1	83.4769	1389.589	39.119	2.35
2	1	55.4316	158.276	33.693	11.8
3	1	55.007	93.498	46.743	27.5
4	1	57.1318	54.666	47.358	49.5
5	1	59.6179	18.678	24.343	77.7
6	1	61.82028	19.294	34.955	112
8	1	67.1214	9.396	27.997	200
10	1	72.4564	9.411	40.654	313
15	1	94.715	2.858	21.265	705
15	10	86.0596	29.134	21.262	1250
20	10	115.25	41.223	42.203	1960
20	1	123.47	4.168	42.194	62.8
25	1	142.95	2.679	36.732	118
25	10	135.77	26.434	36.601	188
30	10	157.35	14.274	24.946	275



35	10	176.55	16.021	34.209	377
40	10	196.117	25.353	63.991	495
50	10	230.73	9.64	32.588	780
60	10	259.1	2.886	12.475	1120
70	10	293.74	2.564	13.355	1530
80	10	332.68	2.464	14.813	2000
80	60	263.099	13.493	14.77	3130
100	60	296.102	16.866	27.056	4900
100	10	363.42	3.187	27.448	288
125	10	419.083	1.137	13.294	475
125	60	350.66	5.994	13.164	770
150	60	390.996	2.865	8.28	1130
175	60	415.21	3.186	11.97	1560
200	60	426.74	3.903	18.658	2040
250	60	446.231	1.573	11.386	3230
300	60	430.07	1.033	11.193	4660

**Table 3VES#2 Measured Field Data**

VES # 02					
Latitude: 36.23494    Longitude:66.89153    Elevation (m):646					
AB/2	MN/2	$\rho_a$ ( $\Omega$ m)	$\Delta V$ (mV)	I (mA)	K
1	1	304.455	623.939	4.816	2.35
2	1	222.443	156.257	8.289	11.8
3	1	146.611	17.604	3.302	27.5
4	1	108.6682	11.251	5.125	49.5
5	1	84.34576	6.365	5.242	77.7
6	1	87.148.3	7.806	10.032	112
8	1	85.37498	9.13	21.388	200
10	1	95.22	3.65	11.998	313
15	1	112.101	6.234	39.204	705
15	10	109.48	68.346	39.203	1250
20	10	135.907	16.644	14.451	1960
20	1	135.011	4.813	44.561	62.8
25	1	156.27	2.825	35.431	118
25	10	158.024	29.886	35.555	188
30	10	179.0258	5.486	8.427	275
35	10	195.318	9.081	17.528	377
40	10	206.8685	3.317	7.937	495
50	10	231.576	6.746	22.722	780
60	10	245.929	1.893	8.621	1120
70	10	263.235	3.303	19.198	1530
80	10	264.8	3.789	28.617	2000
80	60	247.83	24.966	29.012	3130
100	60	230.07	42.276	87.282	4900
100	10	241.05	6.696	86.945	288
125	10	236.531	3.23	66.913	475
125	60	227.71	20.024	20.024	770
150	60	225.67	6.89	34.5	1130
175	60	254.529	4.412	27.041	1560
200	60	273.91	3.796	28.271	2040
250	60	236.55	3.882	53.006	3230
300	60	250.95	15.283	283.792	4660

**Table 4VES#3 Measured Field Data**

ES # 03 Latitude: 36.23443    Longitude:66.89417    Elevation (m):643						
AB/2	MN	$\rho_a$ ( $\Omega$ m)	$\Delta V$ (mV)	I (mA)	K	
1	1	201.45	4843.389	56.498	2.35	
2	1	240.34	1114.223	54.704	11.8	
3	1	233.17	438.505	51.715	27.5	
4	1	156.89	121.357	38.288	49.5	
5	1	112.45	58.204	40.215	77.7	
6	1	86.159	39.555	51.418	112	
8	1	64.011	13.973	43.658	200	
10	1	59.379	5.694	30.014	313	
15	1	83.918	0.985	8.275	705	
15	10	83.915	8.465	6.335	1250	
20	10	118.369	7.685	7.661	1960	
20	1	112.898	0.695	7.695	62.8	
25	1	138.68	1.054	14.896	118	
25	10	145.97	11.466	14.767	188	
30	10	168.64	10.822	17.647	275	
35	10	191.32	10.019	19.742	377	
40	10	216.91	5.78	13.19	495	
50	10	256.01	6.861	20.903	780	
60	10	300.714	3.524	13.125	1120	
70	10	327.898	0.394	1.843	1530	
80	10	368.968	1.296	7.025	2000	
80	60	351.969	8.831	7.226	3130	
100	60	416.069	15.914	18.168	4900	
100	10	424.06	2.457	18.135	288	
125	10	443.1153	2.981	30.874	475	
125	60	472.8989	9.754	15.882	770	
150	60	488.59	21.731	50.258	1130	
175	60	504.696	26.757	82.705	1560	
200	60	484.6	4.331	18.232	2040	
250	60	441.739	4	29.248	3230	
300	60	357.05	6.052	78.987	4660	

**6.2 Vertical electrical sounding**

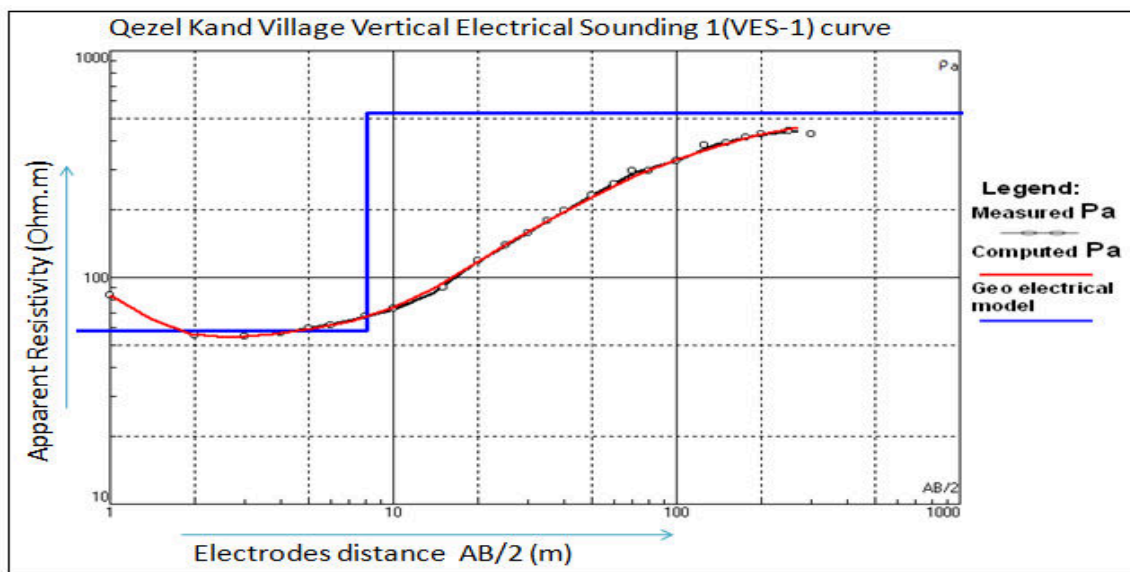
The interpreted data were used to calculate apparent resistivity, thickness, depth and boundaries of layers. The interpreted data are shown in Table 5.

**Table 5 VES#1, VES#2 and VES#3 Interpreted Data**

No	VES Profiles	Vertical Electrical Sounding data interpretation results				% Error	Expected lithology of layers
		App-Resistivity (Ohm-m)	Layer	Thick-ness (m)	Depth (m)		
1	VES-1	133.8	1	0.5	0.5	2	Clay with sand and gravel (dry)
	LAT: 36.22387	16.3	2	0.17	0.676		Clay, silt clay (dry)
	LON: 66.91016	58.41	3	7.403	8.07		Dry sand and gravel
		529.5	4	?	?		Limestone with fracture water
2	VES-2	327	1	1.27	1.27	2.291	Gravel, sand with clay (dry)
	LAT: 36.22739	28.9	2	0.815	2.09		Clay with sand(dry)
	LON: 66.90565	90.1	3	10.1	12.2		Gravel and sand (dry)
		531	?	?	?		Limestone and Shale with fracture water
3	VES-3	200	1	0.975	0.975	4.2	Clay with gravel sand and silt
	LAT: 36.22927	413	2	0.797	1.77		Shale and limestone without fracture water
	LON: 66.90630	14.4	3	2.27	4.04		Clay with sand and gravel (dry)
		8732	4	7.8	11.8		clay
		284	5	?	?		Shale and limestone without fracture water

**6.3 Vertical Electrical sounding data Graphic interpretation**

The VES -1, VES-2 and VES-3 field data (Apparent resistivity versus Electrodes distance) were interpreted by IPI2 win software as well as manually. The boundaries, thickness and depth of rocks layers were determined according to the measured and computed apparent resistivity and geo electrical model (Table 4). The rock types were specified according to the computed apparent resistivity based on the geophysical interpretation principles (Figure 5). The Apparent resistivity versus Electrodes distance curve for VES -1, VES-2 and VES-3 are shown in the Figure 7, Figure 8 and Figure 9.



**Figure 7: VES#1 Curve**

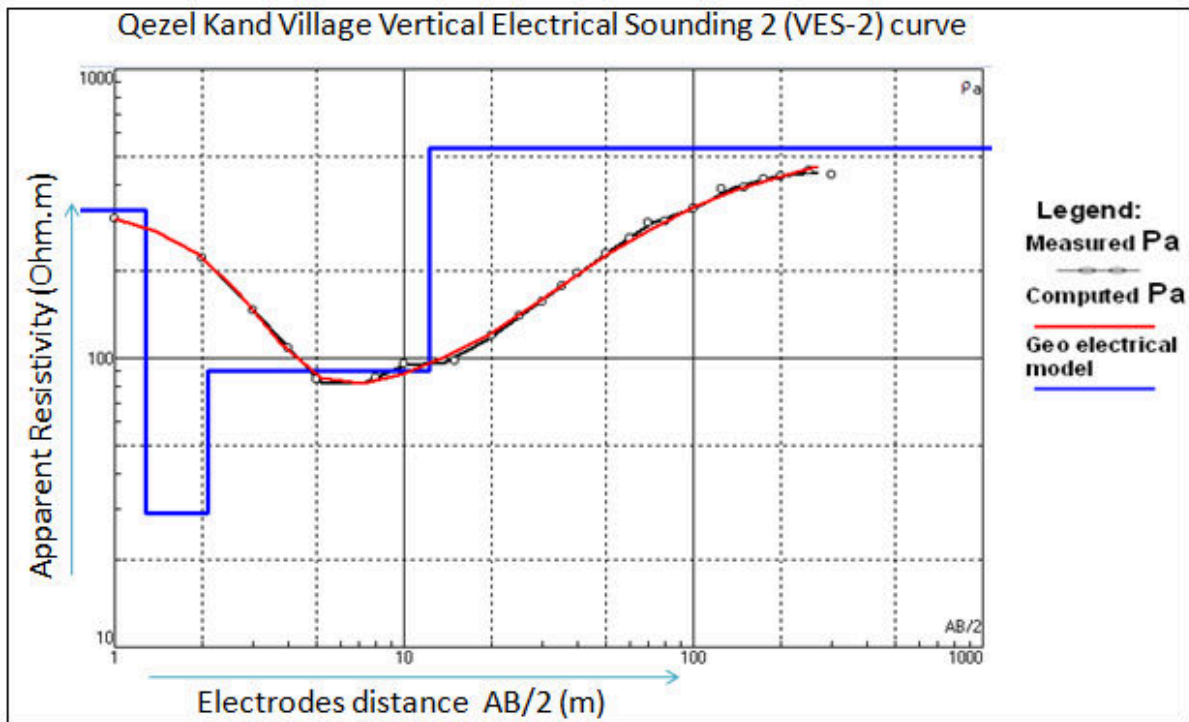


Figure 8: VES#3 Curves

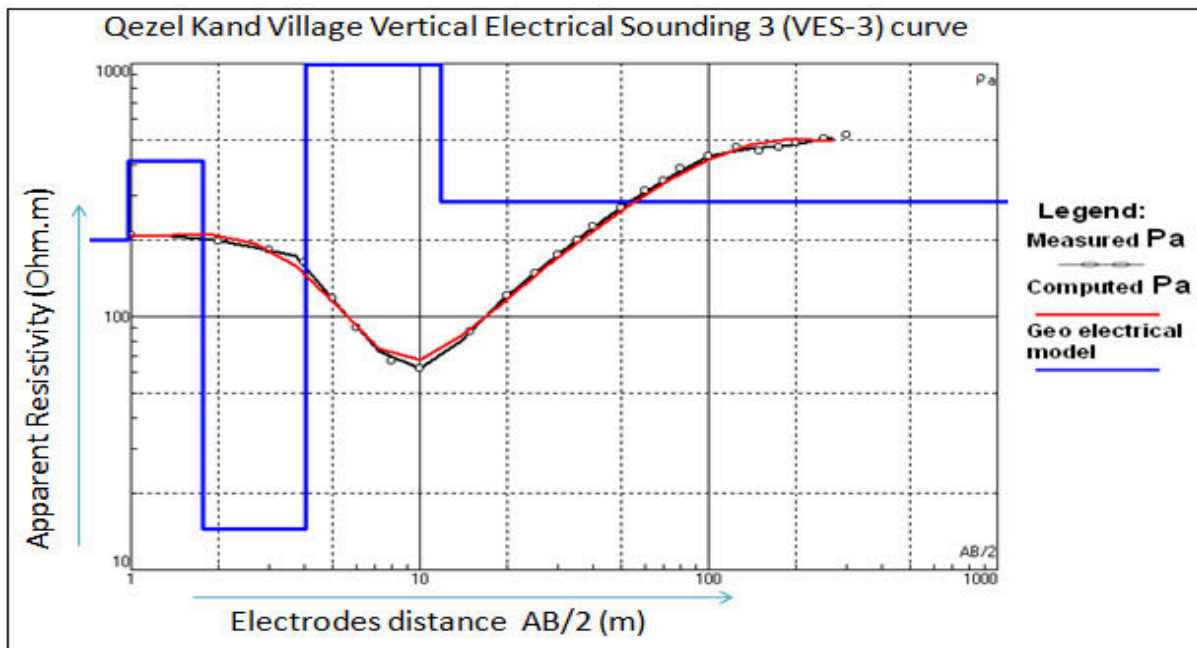


Figure 8: VES#3 Curves

### 7. Conclusion

The measured, computed apparent resistivity and geo-electrical curves show:

- The field data graphic interpretation of profiles VES-1, VES-2 and VES-3 show that the marl and limestone formation has fracture water. The water table ranges between 85 - 90 m. The water is fresh for the drinking (table 4).
- The VES-1, VES-2 and VES-3 graphs rectify the same results.

## **8. Recommendation**

- The discharge of well will be determined after performing of pumping test. It is suggested to drill an observation well to the depth of 135m then to make pumping test before installation of pipe and screen, if the well produces enough water for pipe scheme construct the well.