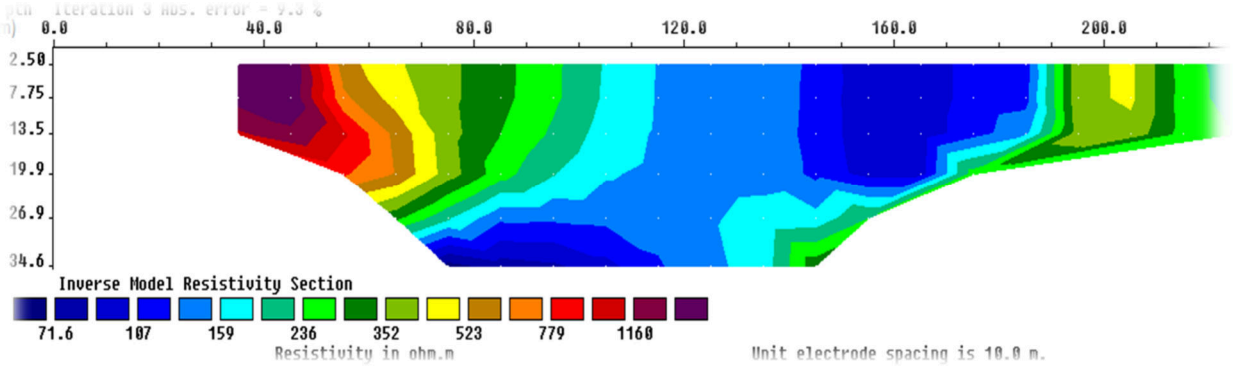
Geophysical Survey in Kochi Abad Village
Bagrami District, Kabul Province



Prepared by:
M. Hassan Saffi, Senior Hydro-geologist
Ahmad Jawid Hydro-geologist

Reviewed by: Betman Bhandari, WASH Adviser

December, 2013

Paikob-e-Naswar, Wazirabad, PO Box 208, Kabul, Afghanistan
Phone: (+93) (020) 220 17 50 Mobile (+93) (0)70 28 82 32
E-mail: dacaar@dacaar.org Website: www.dacaar.org

Table of Contents

Table of Figure

Table of Table

List of abbreviations and technical terminologies

S_p	Self Potential (mV)
Roh	Apparent Resistivity (ohm/m)
V_P	Voltage Potential (mV)
I_n	Current (mA)
VES	Vertical Electrical Sounding
DACAAR	Danish Committee for Aid to Afghan Refugees
WASH	Water, Sanitation and Hygiene

1. Introduction

DACAAR is a humanitarian organization working in Afghanistan since 1984 on water and sanitation sector to enhance the quality of Afghan rural people health. DACAAR has many years of experience in the WASH sector and has installed more than 41,000 water points in Afghanistan. To implement WASH activities, DACAAR's Programme Department employs a team of highly experienced and qualified managers, engineers, geologists, hydro-geologist, technicians, trainers and hygiene education specialists. We have a provision to carry out detailed geo-physical survey before the implementation of water supply project. The geo-physical survey in Kochi Abad Village, Bagrami District, Kabul Province was carried out on Sep 5, 2013 which was supported by ROI program.

Kochi Abad village is located 25 km in the east western of capital Kabul. Twenty two hundreds population are settled in the village and agriculture and livestock is the main occupation for livelihoods of Kochi Abad people.
The location of Kochi Abad village is shown in the figure 1

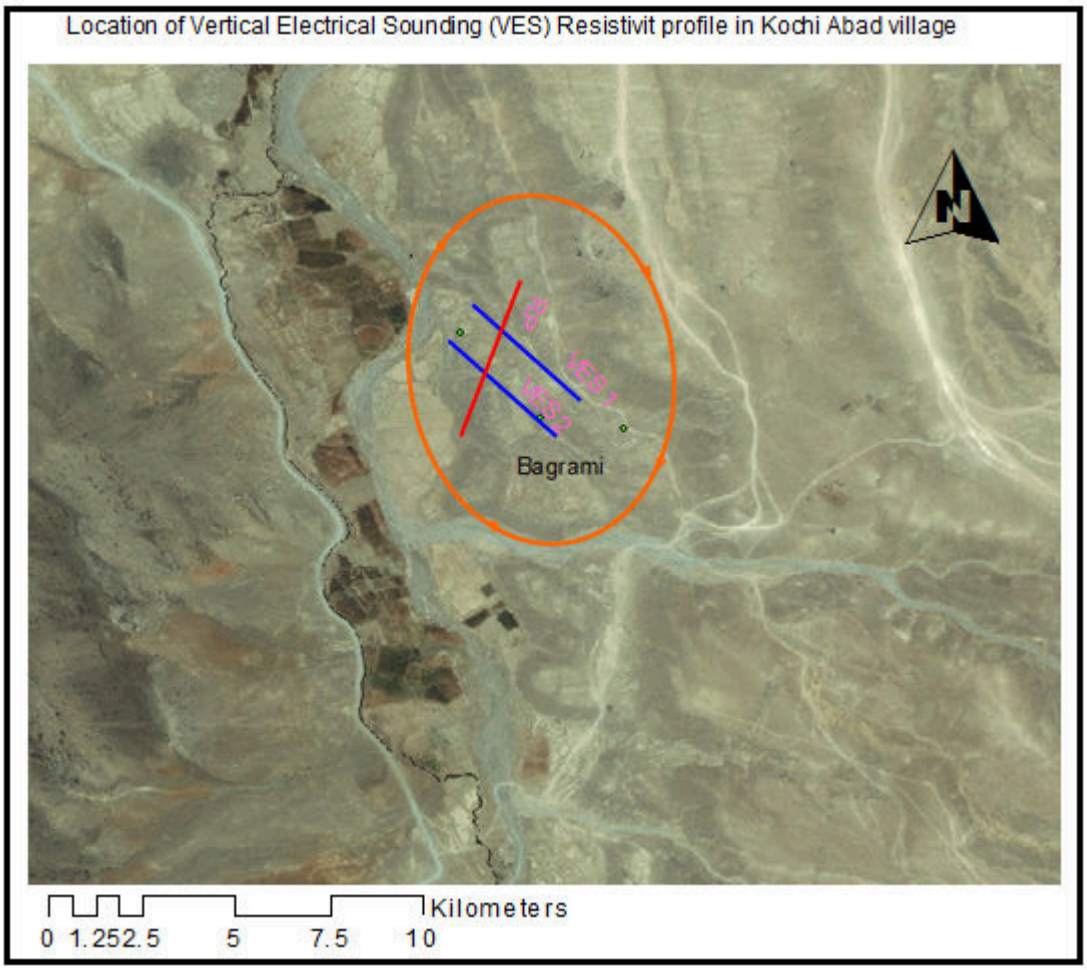


Figure 1.Location of Kochi Abad village

On September 5, 2013, DACAAR were performed Profiling and Vertical Electrical Sounding (VES) survey in the village for provision of drinking water by using Shlumberger electrodes

arrangement (Figure 1). SYSCAL Pro resistivity meter measured the field data (Figure 2) and the data 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 geo-physical situation of the study area.
- Identify the depth of aquifer and fundamental rock.
- Identify the depth of groundwater table of the area.
- Provide recommendation on the feasibility of drilled well in the study area.

3. Rationale to carry out survey

More than 500 households of Kochi Abad village are using dug wells without hand pumps and ditches for drinking water which is located 1.5 km from their home. The most of dug well dried up during dry season and the people cannot dig the well due hard strata. The people are using the stream and ditches water which are having high turbidity and facal coli form bacteria.
The people of this area have drinking water problems in terms of quality and quantity. Therefore there is needed to provide safe drinking water through drilling of tube well and construction of water supply system.

4. Methodology and materials

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

Figure 2.Measured field data by SYSCAL Pro resistivity meter

Our survey team identified the following geological conditions of the surface area:

- Recent Quaternary: Gravel, sand, clay and clay sand.
- Middle Quaternary: Gravel, sand, clay, clay sand and loam.
- Late Quaternary: Gravel, sand, clay clay sand and loess.
- Late Permian: Limestone, dolomite, marl conglomerate, sandstone and siltstone.
- Early Triassic-Middle Triassic: Limestone, dolomite and marl.
- Middle Triassic-Late Triassic: Sandstone, siltstone, mudstone, carbonaceous shale a limestone, marl and conglomerate.
- Vendian –Cambrian: Limestone marble, quartzite and mica schist
- Early Proterozoic: Biotite, gneiss, marble plagiogneiss and quartzite

The geological condition of the area is shown in the figure 3.

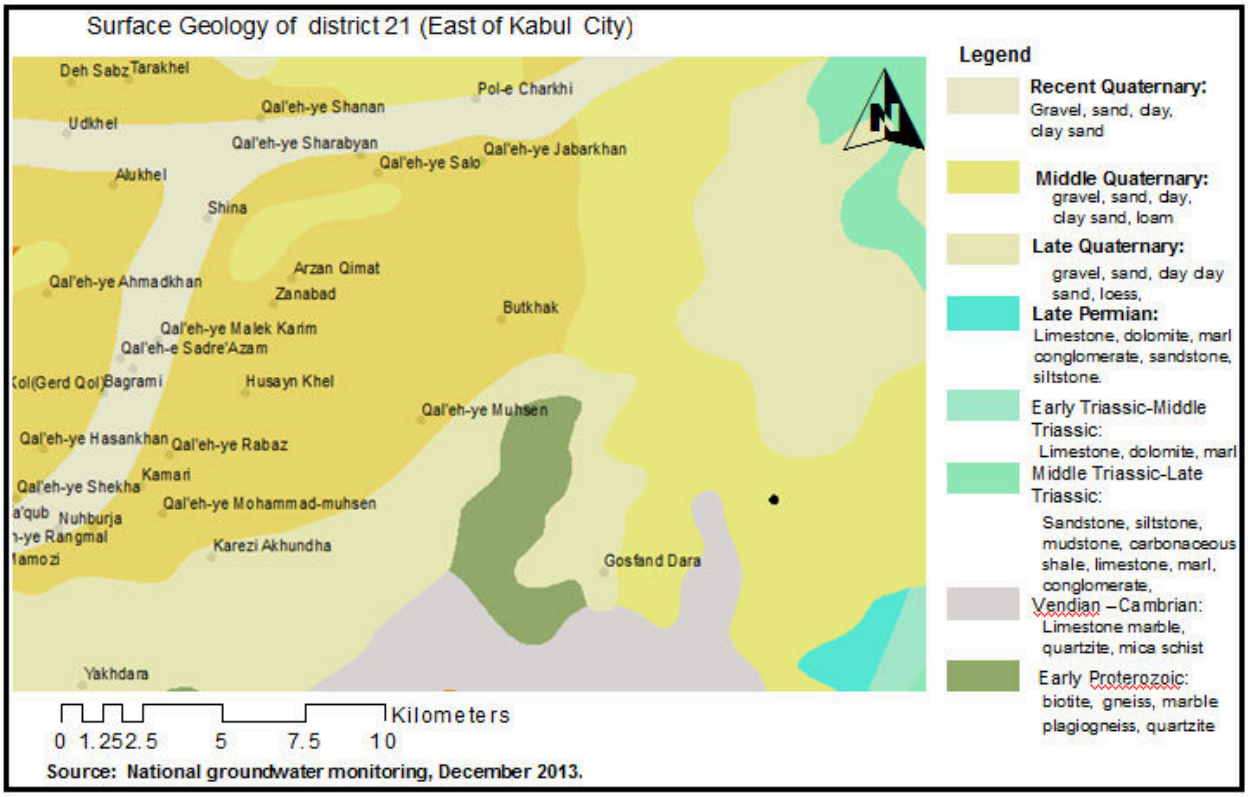


Figure 3.Surface geological setting of the Kochi Abad area

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.

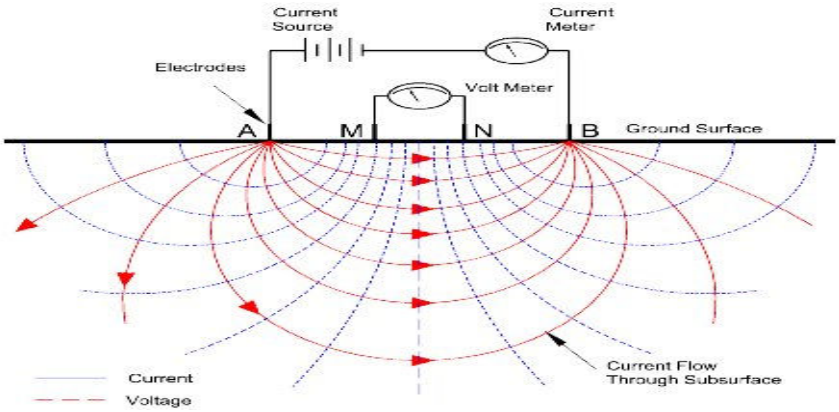


Figure 4.Schlumberger applied techniques method

Apparent resistivity value is calculated:

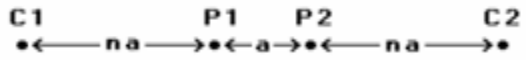
$$Pa = \frac{KV}{I}$$

Where:

Pa 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.

$$K = \prod n(n = 1)a$$



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

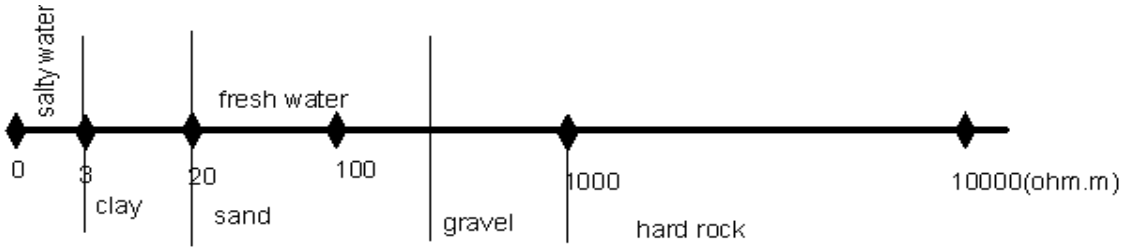


Figure 5.Resistivity scale for water and rocks

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.

5. Finding of the survey

The survey was carried out in the inside of Haji Auob garden. The locations and lenth of VES and profil(resistivity traversing) is shown in the table 1

No.	Location Name	VES and Profiles	LAT.	LON.	Elevation (m)	VES length (m)
1	Kohi Abad	Profile-1	34.47322	69.40685	1814	145
1	Kochi Abad	VES-1	34.47060	69.40531	1812	300
2	Kochi Abad	VES-2	34.47044	69.40667	1815	200

Table 1.The locations and lengths of VES and profile

Profiling#1 Lat: 34.47322 Lon: 69.40685

Distance (m)	Distance between each reading (m)		Resistivity Ohm (m)
35.00	10.00	3	671.349
45.00	10.00	3	731.056
55.00	10.00	3	359.795
65.00	10.00	3	354.537
75.00	10.00	3	426.881
85.00	10.00	3	558.861
95.00	10.00	3	251.129
105.00	10.00	3	197.283
115.00	10.00	3	155.117
125.00	10.00	3	155.741
135.00	10.00	3	139.692
145.00	10.00	3	152.208
155.00	10.00	3	137.273
165.00	10.00	3	136.226
175.00	10.00	3	149.333
185.00	10.00	3	124.089
195.00	10.00	7	368.814
205.00	10.00	7	441.528
215.00	10.00	7	203.983
225.00	10.00	7	165.394
275.00	10.00	7	129.978
85.00	10.00	7	135.817
95.00	10.00	7	171.721
105.00	10.00	7	165.73
115.00	10.00	7	189.907
125.00	10.00	7	206.639
135.00	10.00	7	270.958
145.00	10.00	7	146.034

Table 2.Measured Profiling Field Data

Table 3, Vertical Electrical Sounding (VES-1) field measurement data

VES No1
Lat: 34.47060 **Lon: 69.40531**

AB/2	MN/2	Rho	Vp	In	K
1.5	0.5	305.405	614.585	12.644	13.7
2	0.5	308.55	-235.83	0.9	24.7
3	0.5	323.54	-185.32	1.57	56.2
4	0.5	338.07	-69.57	1.01	100
5	0.5	329.6	-53.88	1.27	157
6	0.5	323.67	-22.81	0.79	226
8	0.5	325.24	-86.08	1.24	402
8	2	304.22	-31.92	0.79	99
10	2	295.49	-29.75	1.31	156
12	2	290.32	-30.94	1.36	225
15	2	284.71	-31.03	1.89	352
20	2	292.8	-7.89	0.83	627
20	5	283.27	-21.63	0.89	247
25	5	309.69	-22.64	1.37	389
30	5	334.71	-21.27	1.74	562
40	5	325.22	-15.18	2.31	1001
50	5	319.3	-12.33	3	1567
50	10	320.77	-26.01	3.05	778
60	10	332.58	-11.75	1.94	1123
80	10	319.26	-6.97	2.16	2003
100	10	304.26	-4.17	2.13	3134
120	10	272.25	-6	4.95	4516
120	25	241.34	-14.04	5.03	1790
150	25	205.33	-13.85	9.27	2808
200	25	124.27	-2.14	4.26	5007
250	25	62.37	-0.38	2.42	7834
300	25	38.77	-0.44	6.4	11290

Table 3.Vertical Electrical Sounding (VES-1) field measurement data

VES No2
Lat: 34.47044 **Lon:**69.40667

AB/2	MN/2	Rho	Vp	In	K
1.5	0.5	563.69	-5438.12	6.06	13.7
2	0.5	322.71	-1492.26	5.44	24.7
3	0.5	162.38	-429.28	7.26	56.2
4	0.5	106.44	-183.21	8.51	100
5	0.5	79.65	-74.4	7.26	157
6	0.5	80.89	-79.19	10.99	226

8	0.5	101.67	-70.08	13.8	402
8	2	107.63	-387.26	16.95	99
10	2	133.6	-650.18	36.69	156
12	2	163.43	-368.76	24.8	225
15	2	193.04	-54.97	4.94	352
20	2	232.54	-47.12	6.3	627
20	5	219.62	-126.87	6.8	247
25	5	195.49	-69.7	6.72	389
30	5	204.49	-42.54	5.71	562
40	5	187.27	-4.97	1.31	1001
50	5	135.27	-20.48	11.77	1567
50	10	115.06	-38.31	12.55	778
60	10	95.17	-11	6.35	1123
80	10	79.6	-13.6	16.9	2003
100	10	80.71	-0.97	1.87	3134
120	10	75.66	-2.86	8.5	4516
120	25	103.14	-9.96	8.36	1790
150	25	92.33	-4.01	5.98	2808
200	25	55.47	-5.61	25.04	5007

Table 4.Vertical Electrical Sounding (VES-2) field measurement data

6. Interpretation of the field data

6.1 Resistivity Profile (traversing)

The distance versus apparent resistivity graph(Figure 6) indacates that the depth of 40-60m has relatively a good pasibility for groundwater development.

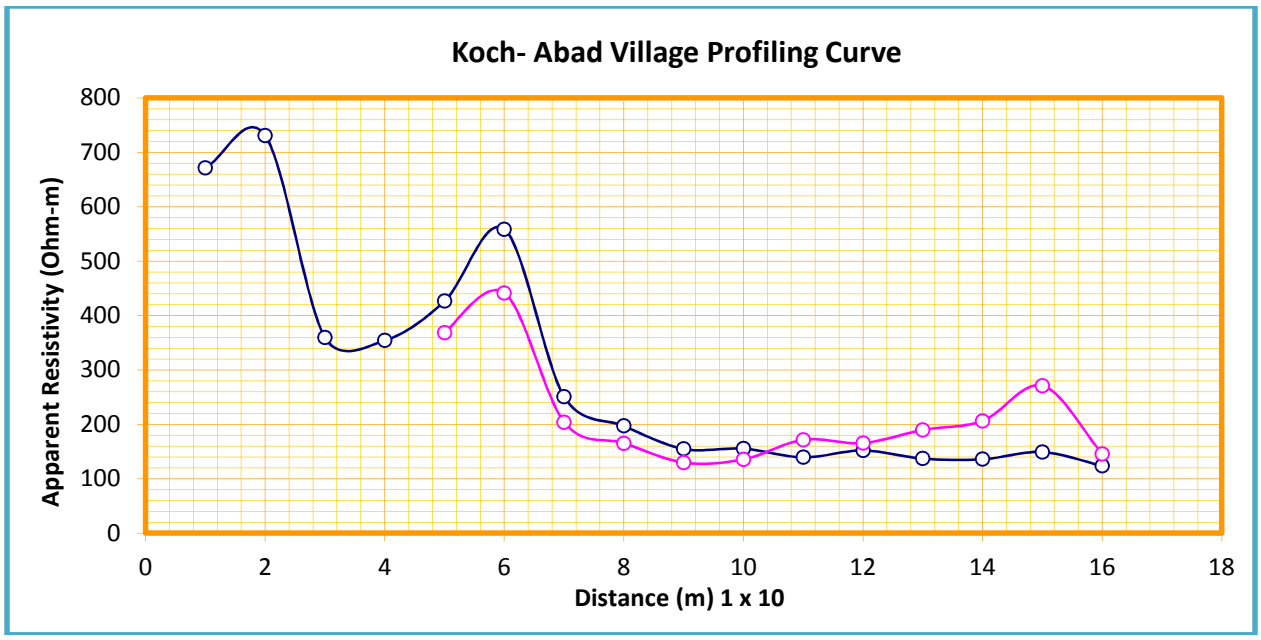


Figure 6.Kochi Abad village profiling resistivity curve

The profilling resitivity image interpreteted by Res2dinvx32 softwares and profilling resitivity image is indacated in the figure 7

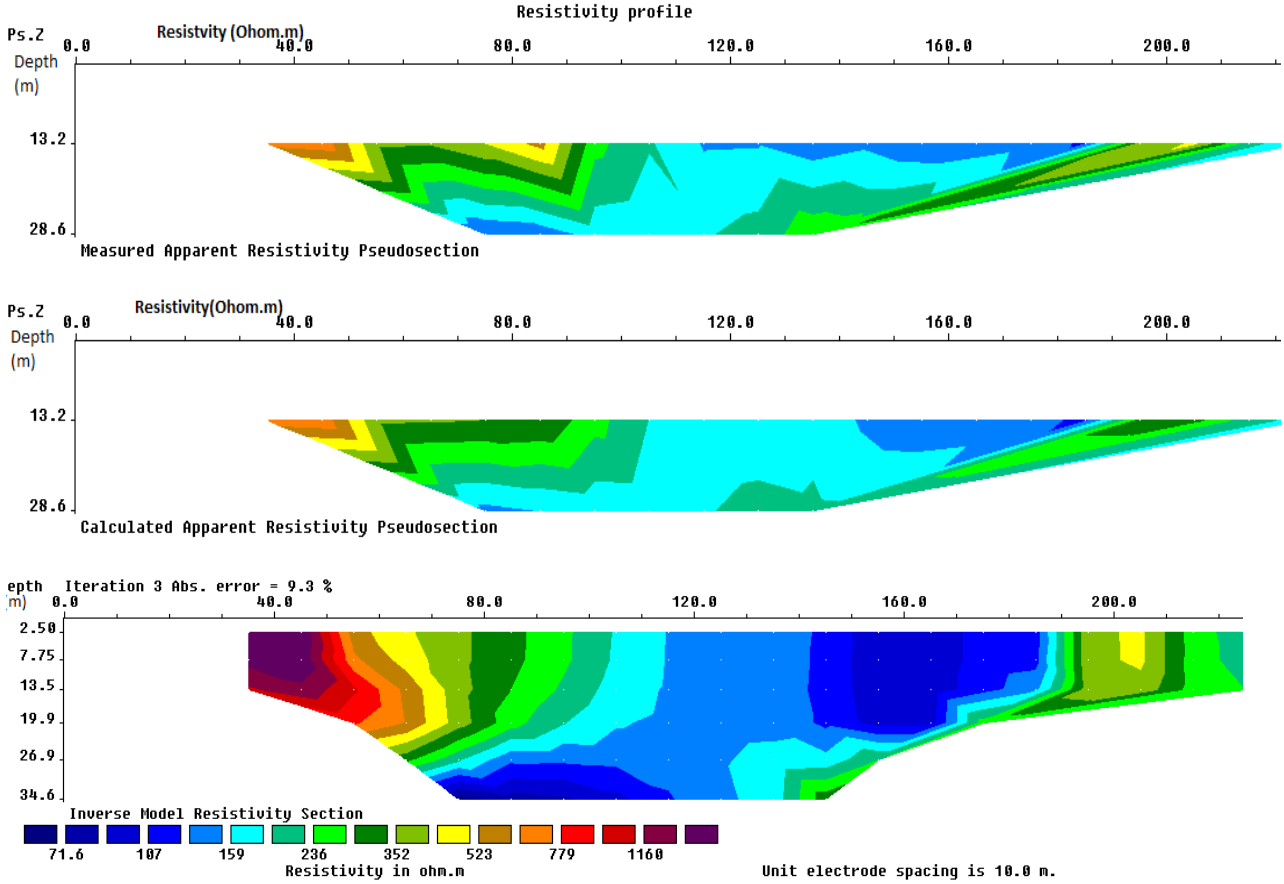


Figure 7.Kochi Abad village profiling resistivity image

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.

No	VES	Apparent Resistivity (Ohom.m)	Layers	Thickness (m)	Depth(m)	Expected litho- logy of layers
1	VES-1	322	1	6.89	6.89	Mixed sediment (gravel, sand, clay and silt)
		133	2	2.44	9.33	Mixed sediment (cobble, gravel, sand and clay
		401	3	70.5	79.8	Gravel mixed with sand, clay and silt
		1.76	4	> 70.5	> 79.8	clay
2	VES-2	925	1	0.869	0.869	Mixed sediment (pebble, gravel, sand and clay)
		46.2	2	2.4	3.27	Sand and gravel, silt
		1248	3	3.84	7.11	conglomerate
		12.6	4	10.1	12.2	Mixed sediment (gravel, sand,

						clay and silt)
		123	5	> 10.1	>17.2	Gravel mixed with sand, clay and silt)

Table 5.Interpreted Data, Layers, Thickness and Depth

6.3 Graphic Interpretation of Vertical Electrical Sounding Data

The VES -1 and VES-2 field data (apparent resistivity versus electrodes distance) were interpreted by IPI2 win software. The boundaries, thickness and depth of rocks layers were determined according to the measured and computed apparent resistivity and geo-electrical model (Table 5). The rock types were specified according to the computed apparent resistivity based on the geophysical interpretation principles. The Apparent resistivity versus Electrodes distance curve for VES -1 and VES-2 are shown in the Figure 6 ,7 and Figure 9.

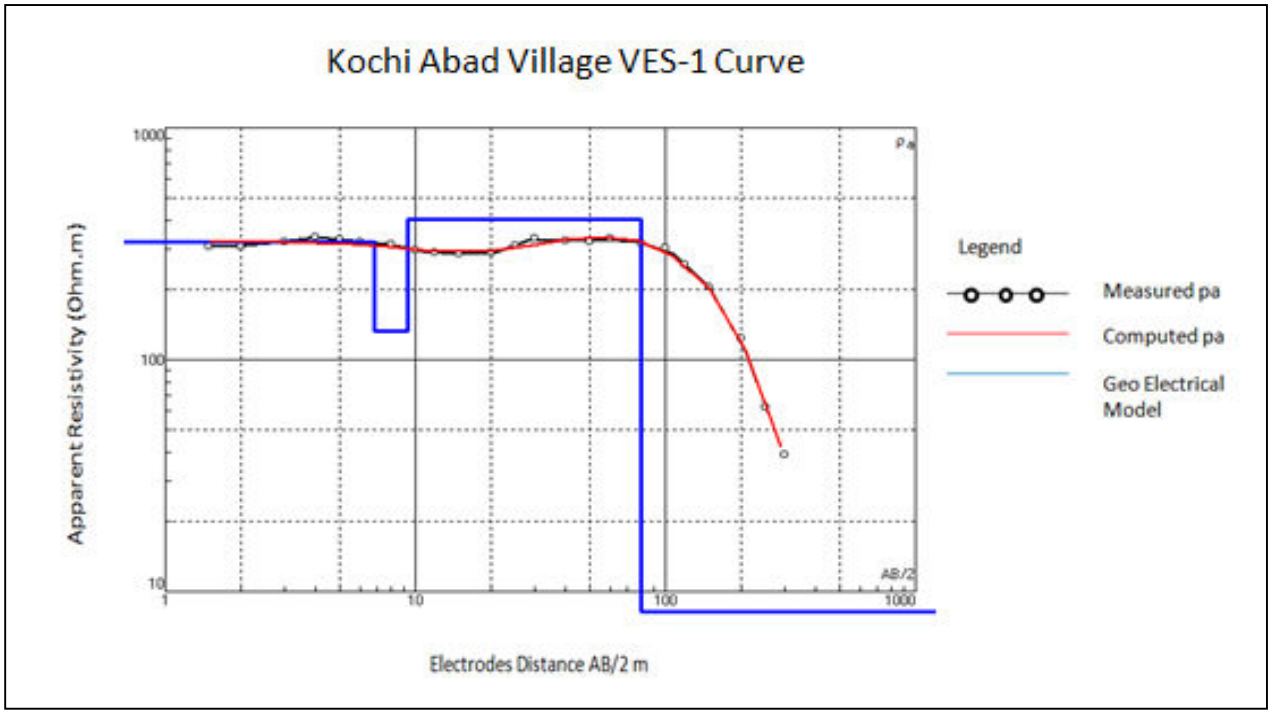


Figure 8.Vertical Electrical Sounding Data Graphic Interpretation

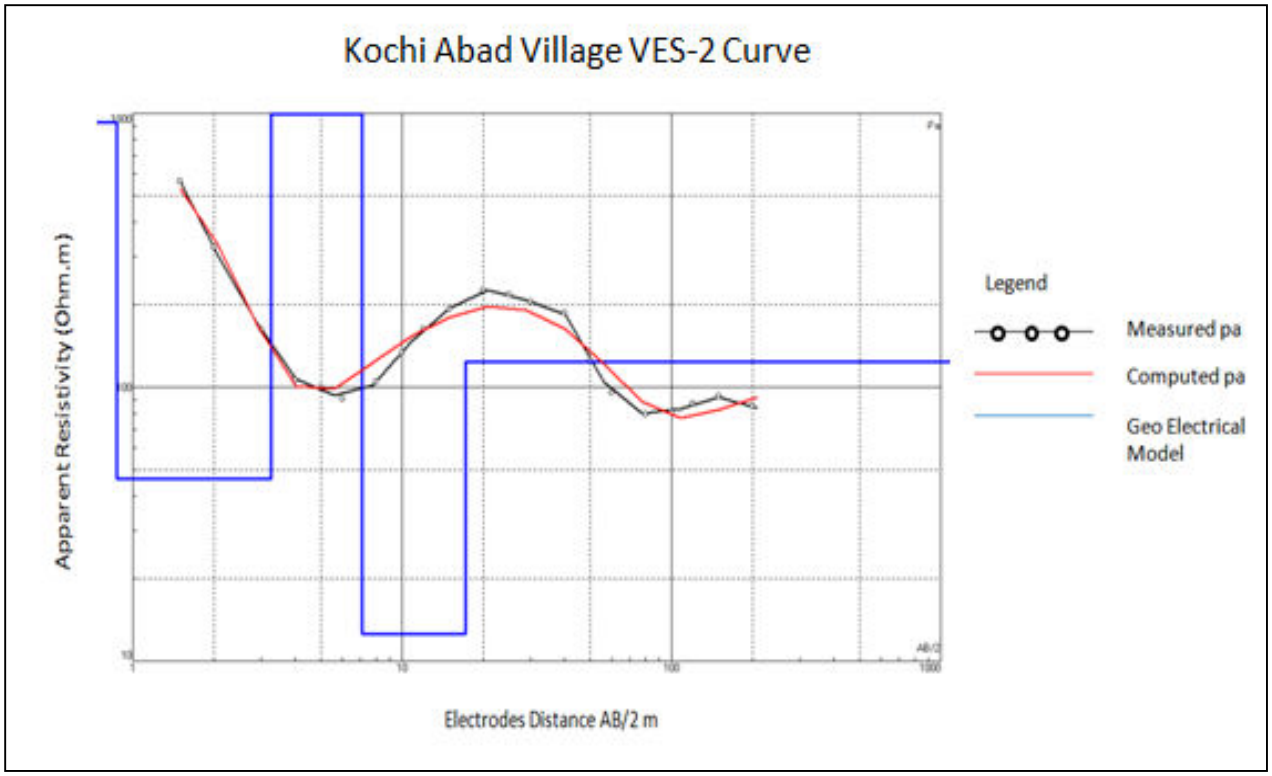


Figure 9.Vertical Electrical Sounding Data Graphic Interpretation

7. Conclusions

The VES1 and VES2 measured apparent resistivity, computed resistivity and geo electrical model data interpretation show:

- The water table ranges from 17 m to 22 m.
- The aquifer consists of gravel mixed with sand, sand clay and silt.
- The aquifer has fresh water. The groundwater can be developed for drinking water.
- Results show that the target area is feasible for the groundwater development.
- The discharge of groundwater is a beyond the scope of this study.

8. Recommendations

- The Kochi Abad village area is feasible for groundwater development.
- The ground water table ranges from 17 m to 22 m.
- The depth of bedrock(fundamental rock) ranges between ? m.
- The well should be drilled to the depth of 70 by Percussion or Rotary Drilling Rig.
- Recommended to carry out pumping test to determine the yield of discharge of well.