

**REPORT ON GEOELECTRIC RESISTIVITY
SURVEY TO DECIPHER AVAILABILITY OF
GROUND WATER NEAR VILLAGE BHADLA,
TEHSIL PHALODI, DISTRICT JODHPUR
(RAJASTHAN)**

CUSTOMER

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INTRODUCTION

This report deals with the geoelectric resistivity survey carried out to decipher availability of groundwater situated near village Bhadla, District Jodhpur.

The investigation was carried out on 5th to 9th April 2012 at ten locations. This report includes methodology, results obtained and recommendations of geoelectric resistivity survey.

HYDROGEOLOGY

OCCURRENCE OF GROUNDWATER

The ground water in the area occurs under semi-confined to confined conditions in the pore spaces of fine to coarse grained, gritty poorly consolidated well sorted sandstones. The occurrence and movement of groundwater is controlled porosity and permeability of various admixtures of sandstone and claystone. The average yield of the tubewells tapping sandstone as an aquifer varies from 12 m³/hr to 25 m³/day with a drawdown less than 10 meters occurring after 8 to 10 hours of continuous pumping.

The depth to water table varies from 46 m bgl to more than 50 m bgl., in borewells.

GEOELECTRIC RESISTIVITY INVESTIGATION

The geoelectric resistivity methods have been in use for structural investigations such as location of geological contacts and fault planes, basement highs, salt domes, determination of thickness of overburden. It is used widely for investigation of groundwater in locating aquifer and determining the groundwater table etc.

The resistivity of a rock formation is mainly governed by its moisture content, the latter again being dependent on porosity of rock and the percent volume of pores filled with water and its salinity. To a lesser extent, other factors such as grain size, arrangement of the pores, temperature etc, also affect the resistivity value of the rock formation.

The geophysical resistivity survey was carried out in the area under study to know the response of subsurface geological formations and aquifer to the electrical currents injected.

METHODOLOGY

The geoelectric resistivity survey was carried out with the help of Aqua meter CRM 500 using Schlumberger's configuration in which the distance between potential electrodes is far less than the current electrodes. The resistance for different electrode spacings was recorded and converted into apparent resistivity using geometrical factor. Thereafter, true resistivity was obtained with the help of inverse slope technique and interpretations about the lithology and saturated zones were made.

In this system, electric currents are injected into the ground and resistance offered by water bearing formations and dry zones are recorded from digital display. The resistivity values are obtained by inverse slope technique. In this technique straight lines are obtained by plotting reciprocal of resistance on the ordinate and the electrode spacing on the abscissa. The slopes of straight lines are computed with the help of the computer determining absolute resistivity of various underground formations at varying depth directly from the resistance recorded in the field.

In the geo-electric resistivity method of survey for ascertaining subsurface occurrence of groundwater, the resistivity response depend primarily on the amount of impregnating water, the conductivity of water and the manner in which the water is distributed. The first two factors have a nearly linear relation with the resistivity while the influence of third factor is more complicated and depends on the nature of aquifer material.

The dry rocks, weather porous or non-porous are practically poor conductors and hence the resistivity increases, but the resistivity of these rocks decreases with the increasing amount of saturation in openings likewise, for alluvium the resistivity decreases with increasing amount of pore water.

The resistivity method for groundwater is based on resistivity contrast rather than on absolute values in principle. The contrast of resistivity values were used to demarcate the boundaries of saturated and unsaturated zones by comparing and analyzing the resistivity response obtained from various sites, where geo-electric probes were taken.

INTERPRETED RESULTS ABOUT AVAILABILITY OF GROUNDWATER

The geoelectric resistivity survey sites were scanned by Aqua meter CRM 500. The data thus obtained were analyzed the results of which have been described under:-

Subsurface Interpreted Litho logy at Investigated Sites Based on Geoelectric Resistivity Survey

VES :1 (Ibrahim Khan ki Dhani)					
Date:		06.04.2012	Height above msl (approx.)		203 m
Coordinate:		N 27° 28' 41.508"		E 71° 54' 18.978"	
Depth (m)		Description	Yield Potential	Quality	
from	to				
0	3	Mainly Aeolian Sand	-	-	
3	12	Predominantly gravels with Silty Sand	-	-	
12	53	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	-	-	
53	140	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	Moderate	Marginal to potable	
140	160	Mainly sandstone; argillaceous at some few horizons and intermittent intercalations of clay/claystone	Low to moderate	Marginal to potable	
160	200	Mainly clay/claystone with intermittent intercalations of siltstone	Low	Marginal to potable	

VES :2 (Kamaal ki Dhani)					
Date:		06.04.2012	Height above msl (approx.)		193 m
Coordinate:		N 27° 29' 23.012"		E 71° 57' 32.854"	
Depth (m)		Description	Yield Potential	Quality	
from	to				
0	3	Mainly Aeolian Sand	-	-	
3	20	Predominantly Gravels with Silty Sand	-	-	
20	53	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	-	-	
53	133	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	Moderate	Marginal to potable	
133	160	Mainly sandstone; argillaceous at some few horizons and intermittent intercalations of clay/claystone	Low to moderate	Marginal to potable	
160	200	Mainly clay/claystone with intermittent intercalations of siltstone	Low	Marginal to potable	

VES :3 (Sago Khan ki Dhani)						
Date:		:	06.04.2012	Height above msl (approx.)	:	187 m
Coordinate:		:	N 27° 28' 45.152"		E 71° 58' 29.512"	
Depth (m)		Description			Yield Potential	Quality
from	to					
0	2	Mainly Aeolian Sand			-	-
2	17	Predominantly gravelswith some clays			-	-
17	47	Sandstone; friable with intercalations of argillaceous sandstone & siltstone			-	-
47	140	Sandstone; friable with intercalations of argillaceous sandstone & siltstone			Moderate	Marginal to potable
140	173	Mainly sandstone; argillaceous at some few horizons and intermittent intercalations of clay/claystone			Low to moderate	Marginal to potable
173	200	Mainly clay/claystone with intermittent intercalations of siltstone			Low	Marginal to potable

VES :4 (Fakir Mohmmad ki Dhani)						
Date:		:	06.04.2012	Height above msl (approx.)	:	190 m
Coordinate:		:	N 27° 28' 29.114"		E 72° 2' 7.446"	
Depth (m)		Description			Yield Potential	Quality
from	to					
0	5	Mainly Aeolian Sand			-	-
5	20	Predominantly gravelswith Silty Sand			-	-
20	59	Sandstone; friable with intercalations of argillaceous sandstone & siltstone			-	-
59	147	Sandstone; friable with intercalations of argillaceous sandstone & siltstone			Moderate	Marginal to potable
147	180	Mainly sandstone; argillaceous at some few horizons and intermittent intercalations of clay/claystone			Low to moderate	Marginal to potable
180	200	Mainly clay/claystone with intermittent intercalations of siltstone			Low	Marginal to potable

VES :5 (Allah Baks ki Dhani)						
Date:		:	07.04.2012	Height above msl (approx.)	:	191 m
Coordinate:		:	N 27° 27' 49.069"		E 72° 1' 6.290"	
Depth (m)		Description			Yield Potential	Quality
from	to					
0	3	Mainly Aeolian Sand			-	-
3	13	Predominantly Gravels with Silty Sand			-	-
13	53	Sandstone; friable with intercalations of argillaceous sandstone & siltstone			-	-
53	166	Sandstone; friable with intercalations of argillaceous sandstone & siltstone			Moderate	Marginal to potable
166	200	Mainly sandstone; argillaceous at some few horizons and intermittent intercalations of clay/claystone			Low to moderate	Marginal to potable

VES :6 (Sikandar ki Dhani)						
Date:		:	07.04.2012	Height above msl (approx.)	:	203 m
Coordinate:		:	N 27° 30' 00.29"		E 71° 55' 7.852"	
Depth (m)		Description			Yield Potential	Quality
from	to					
0	3	Mainly Aeolian Sand			-	-
3	17	Predominantly Gravels with Silty Sand			-	-
17	57	Sandstone; friable with intercalations of argillaceous Sandstone & Siltstone			-	-
57	140	Sandstone; friable with intercalations of argillaceous Sandstone & Siltstone			Moderate	Marginal to potable
140	167	Mainly sandstone; argillaceous at some few horizons and intermittent intercalations of clay/claystone			Low to moderate	Marginal to potable
167	200	Mainly clay/claystone with intermittent intercalations of siltstone			Low	Marginal to potable

VES :7 (Ibrahim Khan ki Dhani)					
Date:	:	08.04.2012	Height above msl (approx.)	:	203 m
Coordinate:	:	N 27° 29' 15.017"		:	E 71° 55' 51.551"
Depth (m)		Description	Yield Potential	Quality	
from	to				
0	3	Mainly Aeolian Sand	-	-	
3	10	Predominantly Gravels with Silty Sand	-	-	
10	63	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	-	-	
63	127	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	Moderate	Marginal to potable	
127	200	Mainly clay/claystone with intermittent intercalations of siltstone	Low	Marginal to potable	

VES :8 (Sheju Khan ka Tubewell)					
Date:	:	08.04.2012	Height above msl (approx.)	:	203 m
Coordinate:	:	N 27° 29' 48.754"		:	E 71° 55' 37.057"
Depth (m)		Description	Yield Potential	Quality	
from	to				
0	3	Mainly Aeolian Sand	-	-	
3	16	Predominantly Gravels with Silty Sand	-	-	
16	56	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	-	-	
56	115	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	Moderate	Marginal to potable	
115	167	Mainly sandstone; argillaceous at some few horizons and intermittent intercalations of clay/claystone	Low to moderate	Marginal to potable	
167	200	Mainly clay/claystone with intermittent intercalations of siltstone	Low	Marginal to potable	

VES :9 (Usman ki Dhani)					
Date:	:	09.04.2012	Height above msl (approx.)	:	203 m
Coordinate:	:	N 27° 29' 26.891"		:	E 71° 56' 48.022"
Depth (m)		Description	Yield Potential	Quality	
from	to				
0	5	Mainly Aeolian Sand	-	-	
5	20	Predominantly Gravels with Silty Sand	-	-	
20	56	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	-	-	
56	125	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	Moderate	Marginal to potable	

125	153	Mainly sandstone; argillaceous at some few horizons and intermittent intercalations of clay/claystone	Low to moderate	Marginal to potable
153	200	Mainly clay/claystone with intermittent intercalations of siltstone	Low	Marginal to potable

VES :10 (Baniya Tubewell)				
Date:		: 09.04.2012	Height above msl (approx.)	: 203 m
Coordinate:		: N 27° 28' 33.279"		E 72° 0' 4.889"
Depth (m)		Description	Yield Potential	Quality
from	to			
0	3	Mainly Aeolian Sand	-	-
3	17	Predominantly Gravels with Silty Sand	-	-
17	52	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	-	-
52	126	Sandstone; friable with intercalations of argillaceous sandstone & siltstone	Moderate	Marginal to potable
126	170	Mainly sandstone; argillaceous at some few horizons and intermittent intercalations of clay/claystone	Low to moderate	Marginal to potable
170	200	Mainly clay/claystone with intermittent intercalations of siltstone	Low	Marginal to potable

CONCLUSIONS

The objective of the present investigation was to study the availability of groundwater. The geophysical study of the aquifer system and inferences thereon show availability of groundwater to the extent of approximately < 2000 to 3000 liters per hour at investigated sites.

The investigations show that the aquifers have low capacity to transmit water. The quality of water is indicated to be good.

Location of site	Depth upto which potential aquifers are likely to occur	Expected Capacity of tubewell (litres per hours)	Quality	Drilling method used in present strata	Dia
S ₁	160 m	14000 - 16000	Marginal to Potable	Combination	16"/8"
S ₂	160 m	15000 - 17000			
S ₃	173 m	14000 - 16000			
S ₄	180 m	17000 - 18000			
S ₅	200 m	16000 - 17000			
S ₆	167 m	17000 - 18000			
S ₇	127 m	13000 - 15000			
S ₈	167 m	16000 - 18000			
S ₉	153 m	16000 - 18000			
S ₁₀	170 m	18000 - 20000			

RECOMMENDATIONS

Technical Specification of Proposed Tubewell

- (a) Drilling shall be done by the rotary rig down to the depths suggested under conclusions, for each location recommended.
- (b) The diameter of the boreholes shall be 16" (406.4 mm) or as required from ground level to the bottom.
- (c) Samples of drill cuttings shall be collected at regular depth intervals of three meters or whenever there is a change in the strata is encountered. The samples shall be dried, labeled and preserved for study and preparation of lithological log.
- (d) The aquifer zones to be tapped in the tubewells shall be decided on the basis of lithological log.
- (e) It is recommended to lower 8" dia well assembly consisting of blank and slotted pipes.
- (f) The annular space between the borehole and tubewell assembly should be packed with well-graded pea gravel of good quality.
- (g) The tubewells should be systematically developed with the help of an air compressor till the water becomes clear and sand free at the maximum discharge.
- (h) The tubewells are likely to yield quantity of water suggested under conclusions.

The recommendations made in this report about quantitative and qualitative aspects of ground water are based on hydro geological conditions, which existed in the surveyed area during the period of investigation, under limitations of geophysical system of exploration. Deviation in the quantitative and qualitative assessment can not be ruled out due to inherent limitations of the system.

For CEG Test House And Research Centre Pvt. Ltd.

(Dr. Anil Dixit)
Executive Director

Annexure - A

GEOELECTRIC RESISTIVITY SURVEY DATA SHEET
Schlumberger Electrode Configuration

AB/2	MN/2	Geometrical Factor (K)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)	Resistance (Ohm)
			Bhadla 1	Bhadla 2	Bhadla 3	Bhadla 4	Bhadla 5
1.5	0.5	6.28	119.9	141	135.7	124.2	127.6
2	0.5	11.775	58	64	61.5	59.7	57.1
3	0.5	27.475	20.5	24.1	22.3	21.4	19.5
4	0.5	49.455	8.81	11.56	11.2	9.25	8.22
4	1	23.55	-	26.4	23.8	-	-
5	0.5	77.715	4.5	-	-	6.95	7.41
5	1	37.68	9.21	17.5	13.5	14.7	15.3
6	1	54.95	4.76	10.96	8.84	9.35	8.86
8	1	98.91	1.43	4.84	4.41	4.19	3.71
10	1	155.43	0.532	2.53	2.07	1.95	1.68
10	2	75.36	1.2	5.09	4.22	4.01	3.36
15	2	173.485	0.225	1.45	1.29	1.06	0.992
20	2	310.86	0.088	0.505	0.413	0.47	0.38
20	5	117.75	0.266	1.34	1.06	1.26	1.02
25	5	188.4	0.134	0.52	0.481	0.432	0.417
30	5	274.75	0.082	0.224	0.203	0.191	0.183
35	5	376.8	0.056	0.113	0.11	0.087	0.085
40	5	494.55	0.045	0.067	0.062	0.049	0.046
45	5	628	0.033	0.041	0.038	0.038	0.037
50	5	777.15	0.028	0.029	0.031	0.027	0.028
50	10	376.8	0.053	0.065	0.06	0.056	0.059
60	10	549.5	0.034	0.034	0.037	0.035	0.038
70	10	753.6	0.024	0.022	0.029	0.024	0.027
80	10	989.1	0.017	0.015	0.021	0.019	0.022

90	10	1256	0.014	0.012	0.015	0.015	0.017
100	10	1554.3	0.01	0.008	0.012	0.011	0.012
100	20	753.6	0.023	0.019	0.025	0.023	0.025
110	20	918.45	0.0175	0.012	0.019	0.018	0.021
120	20	1099	0.0143	0.01	0.014	0.015	0.017
130	20	1295.25	0.0114	0.009	0.011	0.013	0.014
140	20	1507.2	0.00875	0.008	0.009	0.01	0.011
150	20	1734.85	0.0072	0.007	0.0075	0.0085	0.0095
160	20	1978.2	0.00675	0.006	0.0065	0.007	0.008
170	20	2237.25	0.0058	0.005	0.0055	0.0065	0.007
180	20	2512	0.005	0.005	0.0048	0.0056	0.0061
190	20	2802.45	0.0046	0.004	0.0042	0.005	0.0052
200	20	3108.6	0.00425	0.0035	0.0035	0.0045	0.0045
200	40	1507.2	0.0092	0.0074	0.0075	0.0095	0.0095
210	40	1668.125	0.008	0.0065	0.0065	0.0085	0.0085
220	40	1836.9	0.0065	0.0058	0.0055	0.0075	0.0075
230	40	2013.525	0.00575	0.005	0.0045	0.0065	0.0067
240	40	2198	0.00495	0.0044	0.0038	0.0055	0.006
250	40	2390.325	0.00415	0.0037	0.0033	0.005	0.0055
260	40	2590.5	0.0037	0.003	0.003	0.0045	0.005
270	40	2798.525	0.00325	0.0025	0.0027	0.0045	0.0045
280	40	3014.4	0.0028	0.0021	0.0024	0.004	0.004
290	40	3238.125	0.0024	0.0018	0.0021	0.0035	0.0035
300	40	3469.7	0.00195	0.0016	0.002	0.003	0.003

GEOELECTRIC RESISTIVITY SURVEY DATA SHEET
Schlumberger Electrode Configuration

AB/2	MN/2	Geometrical Factor (K)	Resistance (Ohm)		Resistance (Ohm)		Resistance (Ohm)	
			Bhadla 6	Bhadla 7	Bhadla 8	Bhadla 9	Bhadla 10	
1.5	0.5	6.28	106.4	123.5	156.3	133.2	146.3	
2	0.5	11.775	52.3	62.8	68.5	59.1	71.4	
3	0.5	27.475	17.1	23.5	25.3	23.1	25.1	
4	0.5	49.455	7.56	9.23	9.58	12.33	12.2	
4	1	23.55	-	-	-	-	-	
5	0.5	77.715	4.12	5.12	5.17	7.35	7.15	
5	1	37.68	8.46	10.45	10.46	15.1	14.5	
6	1	54.95	5.65	5.34	6.69	8.91	8.67	
8	1	98.91	3.01	1.93	3.21	3.86	3.94	
10	1	155.43	1.66	0.532	1.7	2.13	1.95	
10	2	75.36	3.38	1.08	3.45	4.33	3.94	
15	2	173.485	1.02	0.328	1.13	1.63	1.26	
20	2	310.86	0.395	0.125	0.425	0.722	0.496	
20	5	117.75	1.04	0.325	1.12	1.88	1.28	
25	5	188.4	0.456	0.174	0.585	0.688	0.538	
30	5	274.75	0.211	0.108	0.243	0.312	0.244	
35	5	376.8	0.098	0.069	0.107	0.124	0.125	
40	5	494.55	0.051	0.048	0.058	0.065	0.076	
45	5	628	0.038	0.036	0.042	0.046	0.047	
50	5	777.15	0.029	0.028	0.033	0.033	0.031	
50	10	376.8	0.059	0.058	0.067	0.067	0.064	
60	10	549.5	0.039	0.038	0.045	0.045	0.042	
70	10	753.6	0.028	0.027	0.032	0.03	0.03	
80	10	989.1	0.021	0.02	0.023	0.022	0.022	
90	10	1256	0.016	0.015	0.01755	0.017	0.016	
100	10	1554.3	0.012	0.01165	0.014	0.0135	0.01225	

100	20	753.6	0.025	0.024	0.029	0.028	0.025
110	20	918.45	0.02	0.0185	0.023	0.022	0.0202
120	20	1099	0.0165	0.0147	0.018	0.018	0.0165
130	20	1295.25	0.0135	0.0121	0.0145	0.0145	0.0135
140	20	1507.2	0.011	0.00985	0.012	0.012	0.01125
150	20	1734.85	0.0094	0.00835	0.01	0.01	0.00925
160	20	1978.2	0.00815	0.0071	0.00855	0.0085	0.00775
170	20	2237.25	0.00705	0.0061	0.00745	0.00725	0.00665
180	20	2512	0.00605	0.00525	0.00635	0.00625	0.00575
190	20	2802.45	0.00515	0.0046	0.00545	0.00545	0.0052
200	20	3108.6	0.00455	0.00385	0.00475	0.00475	0.00445
200	40	1507.2	0.00955	0.0079	0.0095	0.00965	0.00905
210	40	1668.125	0.0085	0.0069	0.00845	0.00855	0.00795
220	40	1836.9	0.00752	0.0062	0.00725	0.0075	0.007
230	40	2013.525	0.00665	0.0056	0.00645	0.0067	0.00625
240	40	2198	0.00585	0.005	0.00575	0.00575	0.00555
250	40	2390.325	0.00535	0.0043	0.00525	0.00515	0.005
260	40	2590.5	0.00485	0.0038	0.00465	0.00465	0.0044
270	40	2798.525	0.00435	0.00345	0.00425	0.00425	0.004
280	40	3014.4	0.004	0.00305	0.00375	0.00385	0.00355
290	40	3238.125	0.00355	0.0027	0.00325	0.0035	0.00325
300	40	3469.7	0.00325	0.0024	0.00295	0.003	0.003