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SUB SURFACE INVESTIGATION USING ELECTRICAL RESISTIVITY METHOD – A CASE STUDY FROM SRM INSTITUTION, RAMAPURAM, CHENNAI (T.N), INDIA

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ABSTRACT

The geophysical investigation is a fundamental study to illustrate the physical characteristics of the sub surface within the chosen sites. The study includes sub surface investigation using vertical electrical sounding (VES) by Schlumberger configuration in SRM Institution, Ramapuram, Chennai. The significance of the study is to assess the thickness of the aquifer and sub surface layers to evaluate their hydraulic characteristics. The study area is located at Chennai, Tamilnadu, India. The total extent of the campus is about 16 acres. It is located between North Latitudes 13° 02' 03.66"N and 13° 01' 53.89"N and between East Longitudes 80° 10' 37.22" E and 80° 10' 53.84" E. The objective of the investigation is to identify the sub surface layers for further study of finding suitable locations of groundwater potential for pumping and recharge.

Keywords: Geophysical, sub surface, vertical electrical sounding (VES), Schlumberger configuration

1. INTRODUCTION

Resistivity survey was carried out in SRM Ramapuram campus to demarcate the vertical layers of sub surface. The electrical resistivity survey is one of the geophysical investigations for the determination of resistivity of the subsurface formation by sending an electric current into the ground and measuring the potential field generated by the current. (Nicholas O. Mariita, 1986 and Ashvin Kumar Meena 2011). In this study, vertical electrical soundings were conducted using an Aquameter-CRM 500 model with Schlumberger array configuration (Verma et al., 1980 and Oseji et.al., 2005). By pinning two electrodes into the ground and inducing an electric current through the ground, a potential field is created. Schlumberger array configuration is as shown in Diagram 1 explains that a direct current is introduced into the ground through two current electrodes A and B. The potential

electrodes M and N are inserted in the ground between the outer current electrodes A and B, where the potential difference is measured across these two potential electrodes and apparent resistivity is computed as $\rho = K (V/I)$, where K is the geometric factor of the electrode arrangement. By repeating the entire setup moved one step to the side, resistivity along a profile is measured.

2. STUDY AREA

The study area, SRM Institution is located at Chennai, Tamilnadu, India. The total extent of the campus is about 16 acres. It is located between North Latitudes 13° 02' 03.66"N and 13° 01' 53.89"N and between East Longitudes 80° 10' 37.22" E and 80° 10' 53.84" E. The institution which is located within Chennai limits comes under tropical climate. The period from April to June is generally hot and from December to February is pleasant. The mean annual temperature is 24.3° C (Min) to 32.9° C (Max). The extreme temperatures recorded are 13.9° C and 45° C. The humidity is generally high and the percentage of humidity ranges between 58 and 84. The normal annual rainfall recorded in the Meenambakkam meteorological station is 1323.7 mm and in the Nungambakkam meteorological station is 1285.6 mm. About 62% of the annual rainfall is contributed from North East monsoon, 31% from South West monsoon and the balance of around 7% is contributed from winter and summer rainfall. Chennai district is underlain by various geological formations from ancient Archaean to the Recent Alluvium. The geological formations of the district can be grouped into three units, namely i) the Archaean crystalline rocks ii) consolidated Gondwana and Tertiary sediments and iii) the Recent Alluvium. The Archaean crystalline rocks of the district comprise chiefly of charnockites, gneisses and the associated basic and ultra basic intrusive (Balakrishnan.T 2008). The study area comes under the formation of alluvium laterites at the top of the aquifer and Tertiary sandstones Gondwanas (Sandstone, Gravels) at the bottom 1 to 50 m bgl (CGWB, 2017).

3. GEOPHYSICAL INVESTIGATION

Geophysical investigation using electrical resistivity method were conducted at 16 locations in the campus such as in Tennis court, In between PG block and TRP auditorium, Main Block, Opposite to admin structure Block, Sivasakthi hostel, Main block Opposite, Central block opposite, Central block Backside, Opposite to Heat power Laboratory, Admin block backside, OP hostel backside, In front of PG block, In front of SRM Dental college, Backside of Mechanical Block, Admin and Dean office Opposite, TRP Auditorium Backside. The measurements were obtained by moving the current electrodes between 2 m and 40 m. The observed resistivity values corresponding to AB/2 and MN/2, geometric constant K and apparent resistivity values are tabulated as shown in Table 1.The type curves were obtained by plotting apparent resistivity values against half current electrode separation (AB/2) in double log graph.

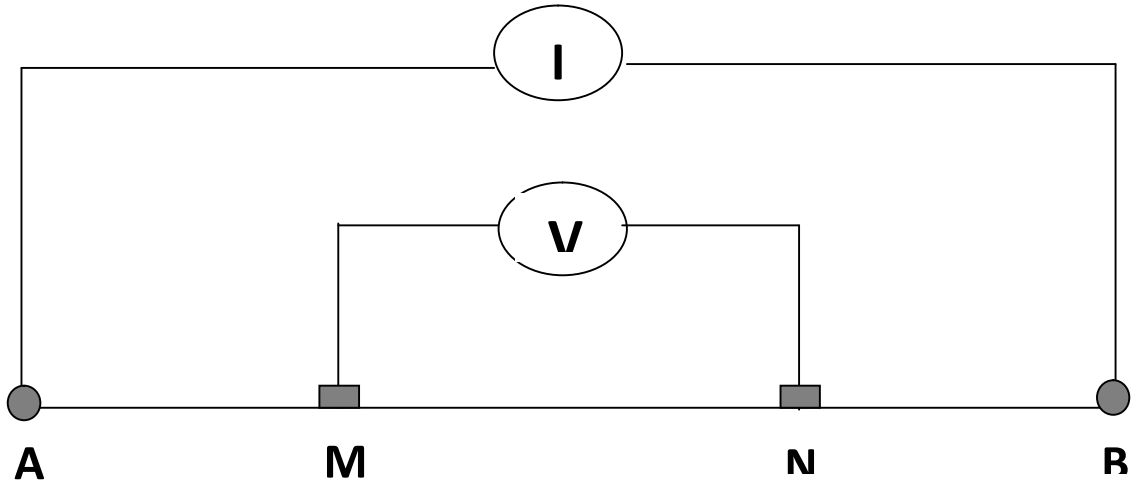


Diagram 1: Schlumberger Electrical Profile Configuration

Table 1: Vertical Electrical Sounding Data

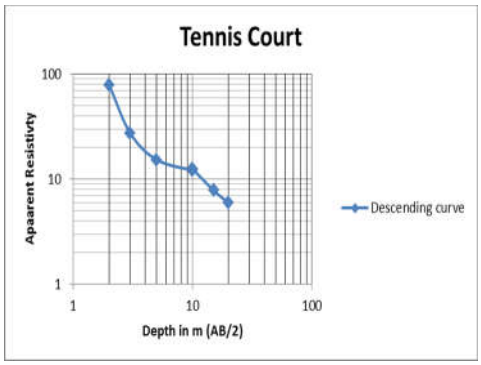
Location	AB/2 in m	MN/2 in m	Geometric Constant K	Resistance Ohm-m	Apparent resistivity Ohm-m
Tennis court	2	1	8.96	16.6989	78.723
	3		11.58	2.1776	27.373
	5		12.14	0.405	15.296
	10		37.06	0.078	12.194
	10	5	11.47	0.529	12.4851
	15		57.60	0.1242	7.8097
	20		46.43	0.0504	5.950
In between PG block and TRP auditorium	2	1	632.50	5.318	25.074
	3		444	1.5729	19.774
	5		388	0.519	19.601
	10		482	0.071	11.060
	10	5	484	0.443	10.452
	15		221.70	0.113	7.1442
	20		144	0.055	6.563
	25		194	0.036	6.967
Main Block	2	1	835	3.739	17.630
	3		930	1.351	16.9841
	5		792	0.340	12.823
	10		762	0.056	8.835
	10	5	767	0.4069	9.592
	15		549	0.086	5.424
	20		755	0.024	2.884
Opposite to Admin Structure Block(Bike Parking)	2	1	517	5.399	25.456
	5		398	0.228	8.633
	10		329	0.048	7.520
	10	5	329	0.355	8.368
	15		487	0.116	7.293
	20		311	0.066	7.825
	25		182	0.045	8.625
	30		404	0.029	8.122
	30	15	807	0.081	5.776
Sivasakthi	2	1	690	7.886	37.178

hostel	3		380	2.168	27.261
	5		679	0.483	18.235
	15	5	169	0.106	6.672
	20		389	0.04	5.290
Main Block Opposite	2	1	399	5.489	25.877
	3		433	0.948	11.920
	5		374	0.230	8.697
	10		592	0.037	5.764
	10	5	592	0.218	5.155
	15		336	0.073	4.647
	20		332	0.041	4.865
	25		316	0.023	4.515
Central Block Opposite	2	1	362	13.747	64.809
	5		198	0.466	17.612
	10	5	275	0.171	7.753
	15		198	0.115	7.232
	20		226	0.055	10.55
	25		133	0.033	6.30
Central Block Opposite(bike Parking)	2	1	197	13.514	63.709
	3		163	2.613	32.853
	5		192	0.421	15.913
	10		207	0.051	7.984
	10	5	206	0.381	9.003
	15		358	0.101	6.378
	15	10	360	0.413	8.126
	20		341	0.130	6.146
	25		408	0.070	5.852
	30		279	0.046	5.904
Opposite to Heat Power Laboratory (Basketball Court)	2	1	61	9.875	46.557
	3		68	1.615	20.3134
	5		52	0.353	31.335
	10		63	0.063	9.792
	10	5	52	0.393	9.2783
	15		156	0.118	7.452
	20	10	130	0.055	6.518
	20		140	0.156	7.359
	25		94	0.08	7.292
	30		160	0.061	7.721

Admin block Backside	2	1	138	10.059	47.424
	3		210	1.208	12.933
	5		172	0.353	13.344
	10		317	0.102	15.9716
	10	3	316	0.501	11.83
	15		54	0.169	10.64
	20		180	0.069	8.179
	25		148	0.040	7.6130
Admin and dean office opposite	2	1	97.94	7.646	36.049
	3		119	1.250	15.719
	5		155	0.154	5.842
	10		102	0.097	15.190
	10	5	102	0.670	15.814
	15		86	0.481	30.248
	20		41	0.216	25.48
	25		112	0.124	23.542
OP hospital backside	2	1	315	24.992	117.822
	3		306	5.485	68.962
	5		337	0.843	31.794
	10		256	0.0418	6.51103
	10	3	358	0.0414	9.776
	17		71	0.1210	10.040
	25		243	0.049	9.381
In front of PG Block(Car parking)	2	1	587	6.362	29.996
	3		589	1.944	24.510
	5		353	0.693	26.142
	10		478	0.089	13.8152
	10	5	479	0.0690	16.2803
	15		383	0.151	9.553
	20		118	0.049	5.819
	20	10	117	0.149	7.031
	25		212	0.050	4.186
	30		282	0.023	3.011
In front of SRM Dental college	2	1	106	7.871	36.855
	3		267	0.718	9.028
	5		60	0.300	11.341
	10		12.82	0.061	9.625
	10	5	13.56	0.162	4.041

	15		116	0.108	6.798
	20		519	0.048	5.761
	25		56.7	0.011	2.101
Backside of Mechanical Block	2	1	128.69	8.8189	41.575
	3		105	2.615	33.507
	5		95	0.817	30.706
	10		117	0.114	17.802
	10	5	111	0.767	18.083
	17		210	0.063	5.271
	20		169	0.042	5.048
	20	10	112	0.118	5.591
	26		91	0.054	4.952
	30		178	0.034	4.377
TRP Auditorium Backside	2	1	475	1.475	6.957
	3		308	0.968	12.171
	5		290	0.148	5.608
	10		193	0.230	35.82
	10	5	605	0.388	9.162
	15		261	0.097	6.105
	20		126	0.036	4.309
	25		141	0.023	4.384

The results of vertical electrical soundings for 16 locations are shown in figures 1 to 16 below.



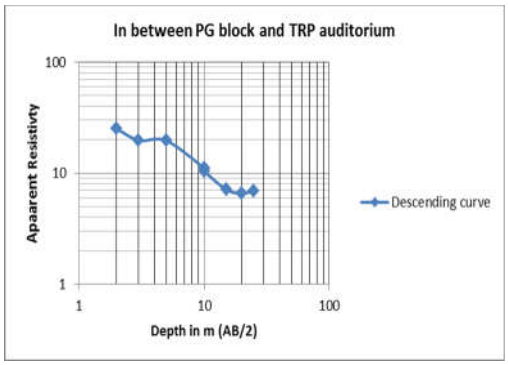
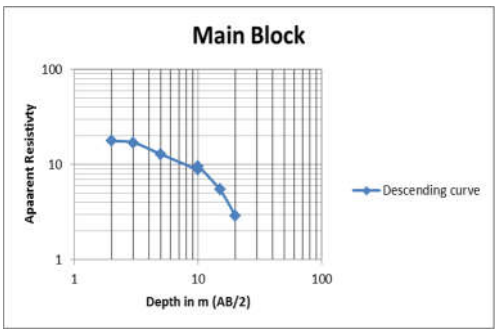


Fig. 1 **Fig. 2**



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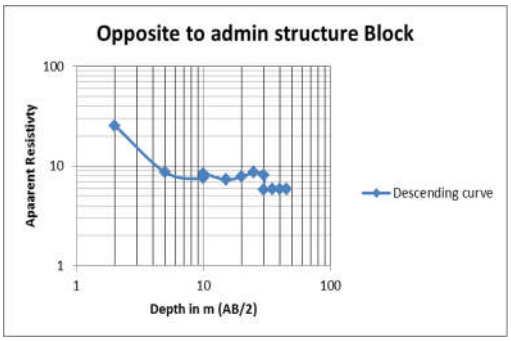

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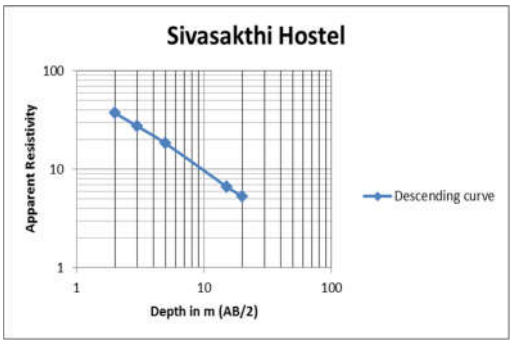

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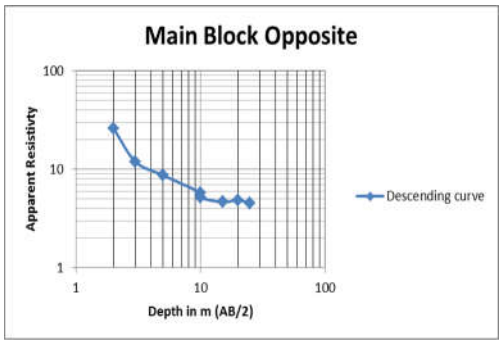
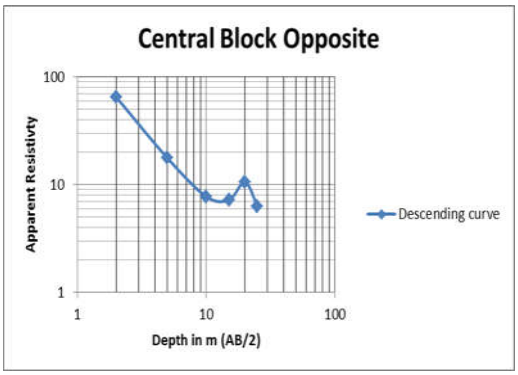


Fig. 6



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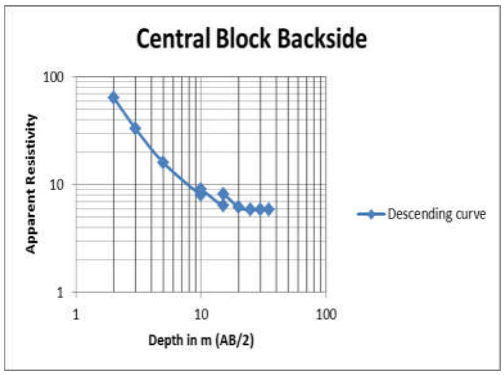
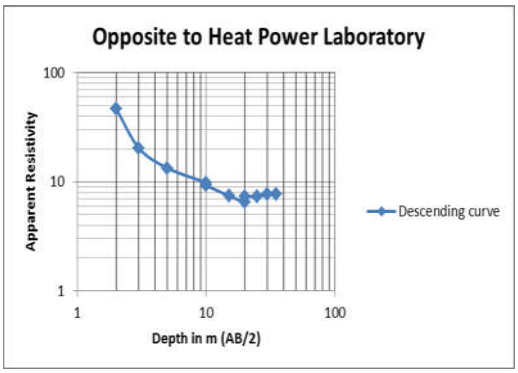


Fig. 8



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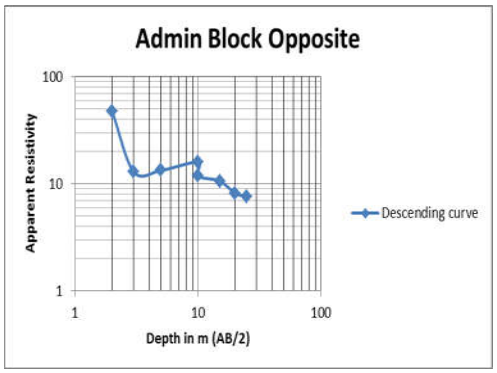


Fig. 10

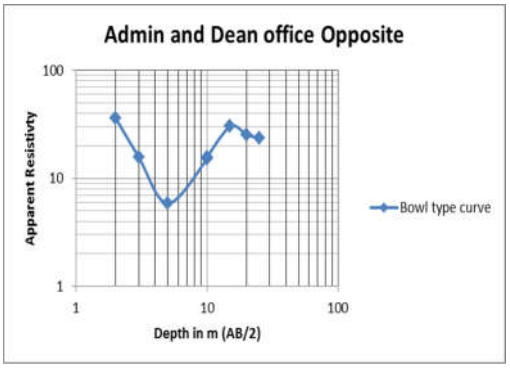


Fig. 11

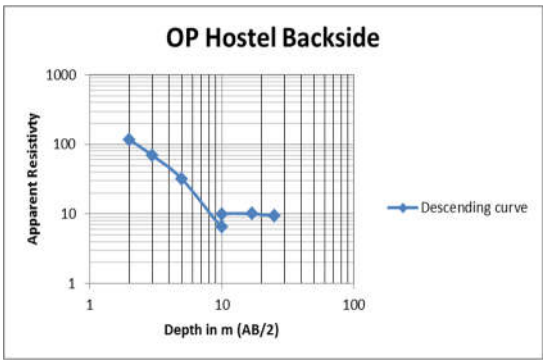


Fig. 12

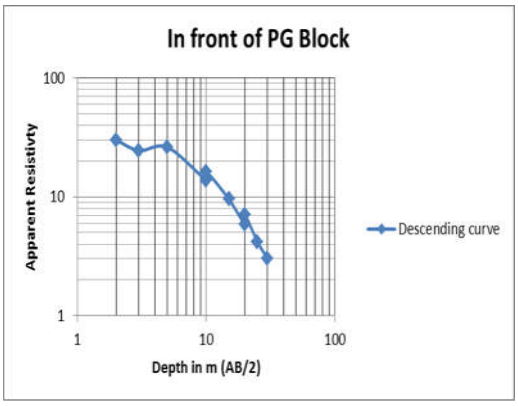


Fig. 13

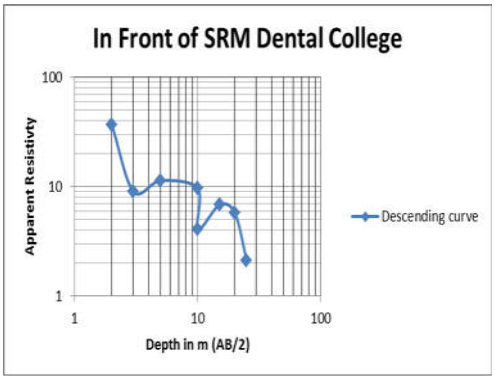
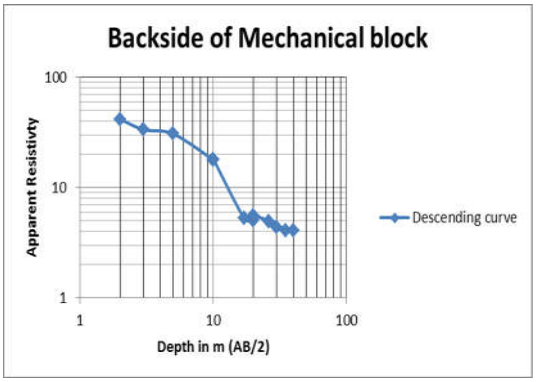


Fig. 14



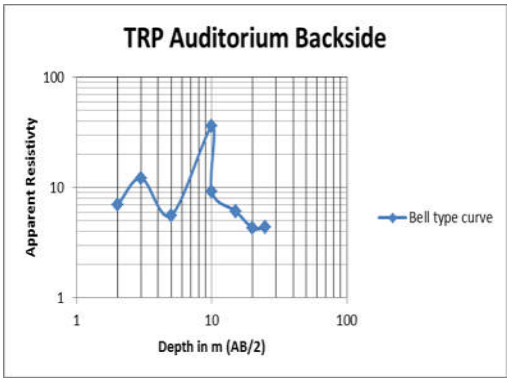


Fig. 15 **Fig. 16**

4. RESULTS AND DISCUSSION

Geophysical investigation is conducted at 16 locations which reveal that there are three possible type curves such as descending type (Q type curve), bowl type (H type curve) and bell type (K type curve) curves (Singh & Tripathi 2009). Descending curves are obtained for the locations Tennis court, in between PG block and TRP auditorium, Main Block, Opposite to admin structure Block, Sivasakthi hostel, Main block Opposite, Central block opposite, Central block Backside, Opposite to Heat power Laboratory, Admin block backside, OP hostel backside, In front of PG block, in front of SRM Dental college and Backside of Mechanical Block. Bowl type curve is obtained for the location Admin and Dean Office Opposite. Bell type curve is obtained for the place TRP Auditorium Backside which belongs to. The sub surface of 25 to 35 mbgl of entire campus shows the presence of low resistivity material with the resistivity values of less than 100 ohm.m. Based on resistivity data, the demarcation of sub surface layers are arrived and are shown in Table 2.

Table 2: Subsurface layers demarcation

S. No	Location	Subsurface Demarcation
1	Tennis court	0 to 3m : Top soil and sandy clay 3 to 10m : Sandy clay 10 to 20m : Clay mainly with minor sand
2	In between PG block and TRP auditorium	0 to 5m : Top soil and Clayey sand 5 to 15m : Sandy Clay 15 to 25m : Sand with clay intercalation followed by sandstone
3	Main Block	0 to 10m : Top soil and sandy clay 10 to 20m : Clay mainly with minor silt
4	Opposite to Admin Structure Block(Bike Parking)	0 to 5m : Top soil and sandy clay 5 to 25m : Sand mainly with clay intercalation 25 to 45m : Shale with minor Siltstone
5	Sivasakthi hostel	1 to 10m : Top soil and sandy clay 10 to 20m : Clay mainly with minor silt
6	Main Block Opposite	0 to 5m : Top soil and sandy clay 5 to 25m : Sandy clay with intermittent sand intercalation 25 to 35m : Shale with minor Siltstone
7	Central Block Opposite	0 to 10m : Top soil and sandy clay

		10 to 15m : Sand mainly 15 to 25m : Sand followed by shale and siltstone
8	Central Block Opposite(bike Parking)	0 to 10m : Top soil and sandy clay 10 to 15m : Sand mainly 15 to 20m : Sand followed by shale and siltstone 20 to 35m : Shale with intermittent Sandstone
9	Opposite to Heat Power Laboratory (Basketball Court)	0 to 10m : Top soil and Clayey sand 10 to 15m : Sand mainly 15 to 20m : Sand followed by shale and siltstone 20 to 35m : Sandstone with intermittent Shale and shale
10	Admin block Backside	0 to 4m : Top soil and Clayey sand 4 to 10m : Sand mainly 10 to 20m : Sand followed by shale and siltstone 20 to 25m : Sandstone with intermittent Shale
11	Admin and dean office opposite	0 to 5m : Top soil and Clayey sand 4 to 15m : Sand mainly 15 to 25m : Sand followed by shale and siltstone
12	OP hospital backside	0 to 10m : Top soil and Clayey sand 10 to 25m : Sand followed by shale and siltstone
13	In front of PG Block(Car parking)	0 to 5m : Top soil and Clayey sand 5 to 15m : Sandy clay with sand intercalation 15 to 30m : Sand followed by clay and shale mainly
14	In front of SRM Dental college	0 to 5m : Top soil and Clayey sand 5 to 10m : Sand with minor clay intercalation 10 to 20m : Sand clay 20 to 25m : Clay followed by Shale
15	Backside of Mechanical Block	0 to 5m : Top soil and Clayey sand 5 to 10m : Sand with minor clay intercalation 10 to 18m : Sand clay 18 to 40m : Clay followed by Shale
16	TRP Auditorium Backside	0 to 5m : Top soil and Clayey sand 5 to 10m : Sand with minor clay intercalation 10 to 20m : Sand clay 20 to 25m : Clay followed by Shale

5. CONCLUSION

The results of geophysical investigation indicate that the entire geological formation of the campus is unconfined aquifer with thickness of 25 m to 30 m from ground surface and below that shows the confined layer of hard rock formation. The nature of sub surface is alluvium which consists of sand, clay and silt. The formation of layers with sand and sandstone are having good groundwater bearing capacity. The layers of shale and clay have poor groundwater potential. With the help of sub surface investigation, the pumping and recharge wells can be proposed within the campus.

REFERENCES

1. Nicholas O. Mariita,(1986), Schlumberger Vertical Soundings, Techniques and interpretation with examples from Krisuvik and Gnerardalur,Iceland and Olkaria,Kenya,pg. 7-44.
2. Ashvin Kumar Meena (2011), Exploration of Groundwater Using Electrical Resistivity Method, National Institute of Technology, Rourkela.

3. Oseji J O, Atakpo E A and Okolie E C (2005), Geoelectric investigation of the aquifer characteristics and groundwater potential in Kwale, Delta state, Nigeria', J. Appl. Sci. Environ. Mgt., Vol. 9 (1) 157 – 160.
4. Verma R.K, Rao M.K and Rao C.V (1980), Resistivity investigations for ground water in metamorphic areas near Dhanbad, India, Groundwater, Vol. 18, Issue 1, pp .46-55.
5. Balakrishnan.T(2008), District Groundwater Brochure Chennai District, Tamil Nadu, South Eastern Coastal Region Chennai, Central Ground Water Board, Ministry of Water Resources Government of India.
6. Report on Aquifer Mapping And Aquifer Management Plan For The Chennai Aquifer System, Tamilnadu South Eastern Coastal Region Chennai, Central Ground Water Board, River Development & Ganga Rejuvenation, Ministry of Water Resources Government of India, 2017.
7. Singh, V.B. & Tripathi, J.N. (2009). An investigation of groundwater condition using geoelectrical resistivity method: A case study from some parts of Kaushambi district (U.P.) India. Journal of Spatial Hydrology. 9. 20-28.