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HYDROGEOLOGICAL STUDY AT INTERNATIONAL CITY (INFORMATION CENTRE) MATRI MANDIR AUROVILLE

12th October 2016

FINAL REPORT

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EXECUTIVE SUMMARY

The report documents the comprehensive hydrogeological study carried out at International City (Information Centre), Matri Mandir located in Auroville. The objective of the study was to assess the ground water potential at the site and identify ideal locations for sinking wells to meet their future water requirement. EGSS collated all available data from the client, governmental agencies and collected inventory data in and around the site. Sedimentary deposits ranging from alluvium, clay, Sand and sandstone and shale deposits of Tertiary era occurs at the site at various depths. Following data review EGSS mobilized to field to conduct field survey involving Global Positioning Systems Survey (GPS Survey), Geophysical Resistivity survey, etc. All data was interpreted in conjunction with the regional geological data. EGSS concludes that moderate to poor yielding aquifers belonging to Tertiary Period exists within the site. Of the three soundings VES 3 has better aquifer conditions than VES 1 and VES 2.

EGSS recommends one Tubewell location at VES 3 (170 metres depth) to meet the future water requirements.

SECTION

1

1 INTRODUCTION

The report documents the comprehensive hydrogeological study carried out at International City (Information Centre), Matri Mandir in Auroville area. The objective of the study was to assess the ground water potential at the site and identify ideal locations for sinking wells to meet their future water requirement. The study is to assess the ground water potential in the site and identify locations that will facilitate sustained yield from borewells drilled in the site.

Auroville is a universal township in the making for a population of up to 50,000 people from around the world (Source: www.auroville.org). Started during 1968 the present population in Auroville is reported to be 2,160. Auroville is growing at a rapid pace and so its demand on water supply resulting in exploitation of groundwater resources through shallow and deep borewells.

Auroville is located at a distance of about 160 Km South of Chennai city and falls in both Tamil Nadu State and Pondicherry Union Territory. It is located at a distance of about 10 Km North of Pondicherry Town. The township area falls in the Survey of India Topographic sheet 57 P/16. It is at a distance of about 4 Km from the Coromandel Coast and at an elevation of around 50m above mean sea level. It is an elevated terrain exhibiting a dome like structure, sloping in all directions.

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1.1 Objectives

The objective of the study is to assess the ground water potential in the three sites and locate the best location for drilling a borewell.

1.2 Scope of Work

The project scope is to conduct a comprehensive review of the hydrogeological conditions at three select locations of the area and select the best location for recommending a borewell.

Task 1 Data collection and review followed by field work, conduct field work to assess the site aquifer conditions by:

a. Site Walk though, GPS mapping of the location to be surveyed
b. Conducting resistivity survey at 3 locations to map the subsurface features like thickness and extension of sand, clay shale, sandstone if existing at the site.

Task 2 Prepare Final Report

Prepare a final report that includes resistivity survey data, interpretation of data and the subsurface strata disposition, potential ground water locations, drilling methodology, depth and type of well, expected yield from wells.

1.3 Report Structure

The report is presented in one Volume.

- Section 1, Introduction provides a short description of the site and surroundings, the scope and objectives of the study.
- Section 2 provides review of background data and available literature, summary of geology and hydrogeology, site history
- Section 3 provides details of field work methodology etc.

- Section 4 provides detailed site assessment and observations during field program, discussion of results of the investigation, site assessment and observations during field program, and interpretation of field results
- Section 5 provides the conclusions and recommendations on future course of action.

FIGURES 1 and 2

Appendix A Geophysical Survey Outputs.

SECTION

2

2 LITERATURE REVIEW & PROJECT INCEPTION

EGSS collected available data on site from site and surroundings; conducted a reconnaissance survey to study the existing operations around the site; the explicit details of individual sub-tasks carried out are detailed below.

2.1 Desk Top Review

EGSS collated the following data for carrying out this study and collected the same from different agencies. The list of documents collected and the respective sources are listed below:

1. Groundwater Perspectives Report of Villupuram district from Public Works Department, Tamilnadu 2000

2.2 Geology and Hydrogeology

The study area is underlain by Quaternary formation which includes the recent alluvium, followed by Tertiary group of formations which includes

1) Cuddalore formation

2) Manaveli formation and

3) Kadaperikuppam Formation.

The Tertiaries are underlain by Cretaceous group of formations which consists of 1) Turuvai Limestone 2) Ottai Claystone 3) Vanur Sandstone and 4) Ramanthapuram Formation. Perusal of

the Central Groundwater Board data highlights the lithology of the above mentioned formations and is given below:

Ramanathapuram Formation: Consists of alternating layers of sands, sandstone and carbonaceous claystone with thin seams of lignite.

Vanur Sandstones: Consists of coarse grained, friable grayish white, pebbly sandstones, with intercalations of shale.

Ottai Claystone: Consists of Black to greenish black claystone with bands of limestone, silt and siltstone.

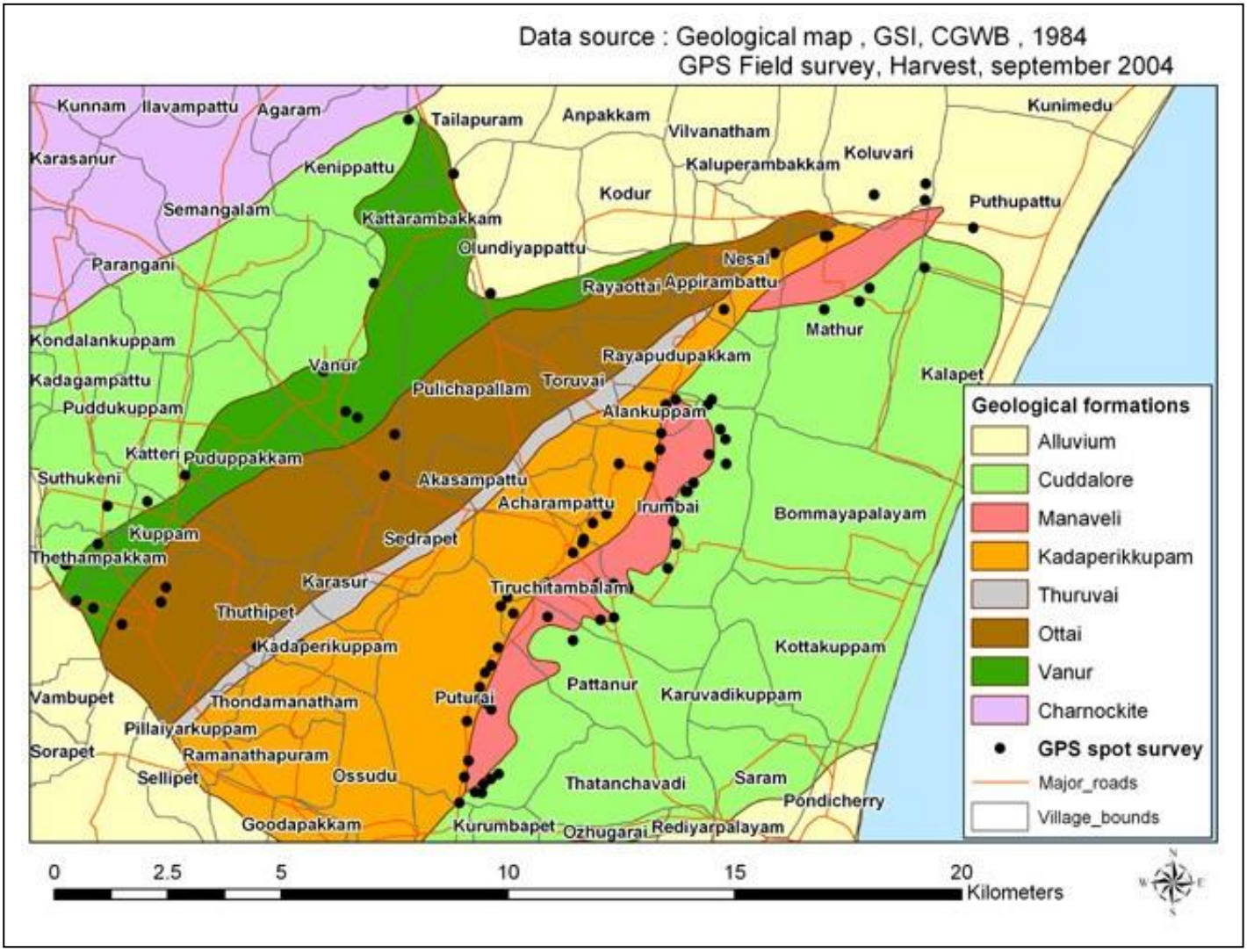
Turuvai Limestone: Consists mainly of fossiliferous grey limestone with bands of sandstone.

Kadapperikuppam Formation: Consists mainly of calcareous sandstones, yellowish to grey in colour with thin lenses of clay and shale and bands of shell limestone.

From the point of occurrence and movement of groundwater, the sand, sandstone and limestone act as major water bearing formation. The presence of clay, claystone, and shale hinders the movement of groundwater and hence are not considered as good water bearing formations. While comparing the formations present in the study area in terms of groundwater potential, by far the best is the cuddalore formation as it consists of sand and sandstone; because of its very high groundwater potential, the cuddalore formation is also a highly exploited formation in the region through deep borewells.

The Geological Map is shown in Figure 1.

Figure 1 Geology Map of the Area



SECTION

3

3 MOBILIZATION & FIELD WORKS

EGSS mobilized and commenced field works on 8th October 2016 and concluded field work on 8th October 2016. Field work included Geophysical resistivity survey, GPS survey and site assessment.

3.1 Site Reconnaissance

EGSS team conducted comprehensive site surveys that included the following

1. Collection of information from site focal points

3.2 Geophysical Resistivity Survey

In order to supplement the hydro geological data and to assess the possibilities of the occurrence of water at different depths and at different locations, geophysical surveys were carried out, using a digital Resistivity meter with constant current facility. EGSS utilized computerised resistivity meter to conduct the resistivity survey.

The Resistivity Meter is a specialized version of IGIS resistivity meters designed for use in resistivity surveys upto about 200 m depth. It utilizes rechargeable batteries as power source to energize the ground. The equipment, powered by a 24V rechargeable battery can send highly stabilized currents upto 400mA and read the resulting potential with a 100 micro volts resolution or ground resistance directly with 50 micro ohms resolution. Housed in sturdy briefcase, the instrument provides highly reliable digital outputs of ground resistance during

field surveys and finds extensive use in ground water exploration, dam site investigation, delineation of geological structural features and in several other related problems.

After site walkthroughs, three (3) detailed Vertical Electrical Soundings (VES) were taken to 170 m depth. Apparent Resistivity is obtained for the different current electrode separation. EGSS utilized schlumberger method of survey for assessing the subsurface lithology. Survey was also carried in existing wells around the site to serve as calibration for the area.

The resistivity methods are based on the measurement of resistance of various portions of the ground after passing electric current in to the earth. Usually the ground is constituted of various materials and the resistivity determined is the apparent resistivity. In Vertical Electric Sounding (VES) the observation point remains fixed and the current electrodes are expanded to obtain deeper penetration of current. This enables us to study the geological section of the subsurface. The location of the geophysical survey points (VES) is shown in **Figure 1.**

At the site all these survey points are identified GPS coordinates. The apparent Resistivity obtained is plotted against current electrode separation on a log-log scale. These curves are studied and interpreted for the different hydrogeological units. The survey data is presented and discussed in Section 4.

3.3 Global Positioning Systems (GPS) Survey

GPS survey was conducted to record the coordinates of locations of resistivity survey points and shown in Table 1

Table 1 GPS coordinates of VES locations

Sl no	VES ID	Easting	Northing
1	VES 1	369196	1327311
2	VES 2	369144	1327401
3	VES 3	369132	1327357

Easting and Northing values are in meters, UTM Zone 44 N WGS 84

Figure 2 VES Location Map in Google Earth

SECTION

4

4 INTERPRETATION OF TEST RESULTS

4.1 REVIEW OF AVAILABLE DATA

As mentioned in previous chapters EGSS reviewed the following reports/ / data relevant to this site assessment's objectives.

1. Geological maps

2. Available report from State and Central Ground Water board, Chennai

4.2 INTERPRETATION OF FIELD RESULTS

4.2.1 Geophysical Resistivity Survey Results

The water level in the area is around 20 metres and below ground.
Perusal of the geophysical survey data and the interpretation of the graphs show the following:

1. The shallow layers indicate predominance of fine to medium sand in VES 1, 2 and VES 3 to 30 m below ground level indicated gradual rise in resistivity with values in the range of 8 to 11 ohm m. Alternating rise and fall in resistivity values from 9 to 12 ohm Between 30m to 120 indicate clay/ shale alternating with minor siltstone and sandstone

2. In the area, the apparent Resistivity values range between 6 to 8 ohm m beyond 120 m with gradual falling trends at depths ranging from 120 m – 170 m indicates the presence of shale with alternating medium saturated sandstone. Falling curve trends with low resistivity values indicate presence of intercalations of clay, silty fine sandstone and shale. The area is likely to have moderate to poor aquifers. These locations are likely to exhibit lower yield.

The general stratigraphy of the three locations interpreted based on resistivity survey and well inventory at the site

VES - 1:

0 to 12m: Top soil, clayey sand.
12 to 30m: Sand with minor clay.
30 to 100m: Mainly Clay/ silt stone/ Shale intercalated with sandstone.
110 to 170m: Shale with minor sandstone
Expected Yield: 5,000 to 7000 LPH - (90 meter to 120 meter)
Expected Yield: 7000 to 10000 Litres Per Hour - (120 meter to 170 meter)**

VES - 2:
0 to 20m: Top soil, sand and sandstone with minor clay.
20 to 40m: clay beds with siltstone.
40 to 50m: sandstone.
50 to 100m: Sandstone alternating with shale
100 to 120m: shale layers with intercalated sandstone/ limestone
120 to 140m: Sandstone predominant with minor shale
140 to 170 m – shale with minor sandstone
Expected Yield: 7000 to 10000 Litres Per Hour - (90 meter to 120 meter)**
Expected Yield: 10000 to 12000 LPH - (120 meter to 170 meter)

VES - 3:

0 to 12m: Top soil, sand and clay.

12 to 45m: Predominant sand, sandstone with minor shale

45 to 70m: Shale intercalated with sandstone.

70 to 90m: shale with minor sandstone

90 to 100m: sandstone with minor shale

100 to 120m: shale with minor sandstone

120 to 140 Predominant sand stone

140 to 170 Predominant shale with minor sand stone

Expected Yield: 8,000 to 12000 Litres Per Hour 90 meter to 120.**

Expected Yield: 15,000 to 18000 Litres Per Hour 120 meter to 170.**

** The yield estimate provided is indicative and there is no guarantee for yield.

Of the three points VES locations **VES 3** exhibits the best favourable curve trends and indicate predominant presence of fine to medium saturated sandstone formations at depths of 20m to 120 m below ground level and minor sandstone formations intercalated with shale between 120 m to 170m depth. The location of VES soundings are shown in Figure 2 and the VES data, interpretation graphs are shown in Appendix A.

SECTION

5

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

EGSS completed a comprehensive evaluation of the site after conducting field studies, data review and interpretation of field results. Based on the results of the field investigation and data evaluation, EGSS presents the following conclusions and recommendations:

From the field study and Analysis EGSS concludes the following:

Ground Water Potential of the site

1. The site and the surroundings receive moderate rainfall in the range of 100 to 120 cm annually.
2. The area has very good potential for adequate recharge from rainfall and from surface water bodies around the area.
3. In the site recent alluvial deposits occur up to 30 metres depth. Medium sand/sandstone aquifers are likely between 20 to 50 m depth and fine sandstones/shale extend to depths of 170 metres below ground level. Moderate to poor ground water potential occurs at 110 to 170 m depth.
4. Of the three soundings conducted, location VES 3 exhibits favorable curve trends that indicates the maximum yield potential and the yield is expected to be in the range of 15000 to 18000 litres per hour.

5.2 Recommendations

From the above the EGSS recommends the following.

1. One pilot boreholes may be drilled to a depth of 170 m at VES 3. The specification of borewells are explained below

The borewells may also be drilled through conventional rotary drilling method.

The borewell diameter may be enlarged to 14 to 16 inches (350 to 400 mm). The lithology and yielding zones can be accurately monitored. The length of plain and slotted pipes should be decided based on the nature of the drill cuttings coming out of the borewell and the study of drill time log. The annular space between the pipe assembly and the borewell should be filled with clean, washed and well rounded Quartz gravel. The borewell should be thoroughly washed with clean water and chemical to clear the borewell off the drilling mud. The borewell should be developed atleast for 16 hours till the water is clear without any sand or suspended particles. The discharge should be measured with a 90° 'V' notch plate. Based on the results of development, decision on the type of pump and depth of installation of submersible pump should be decided

The schedule of work is shown in Table 2.

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Table 2: schedule of work for drilling and construction of a borewell.

Sl.No	Details of work	Quantity
1	Mobilization of Truck mounted straight rotary mud drilling rig to the site and preparation of site.	LS
2.	Drilling of 300mm (12 inches) dia. bore hole using Rotary rig	170m
3	Reaming to 400 inches using Rotary rig	170m
3.	8 inch 200 mm dia. PVC threaded pipe assembly of 10kg/cm^2 pressure consisting of the following a) Plain pipe b) Slotted pipe – Machine cut slot c) Bottom cap	 70m 100 m 1 No
4.	shrouding charges of sub-rounded to rounded clean quartz gravel.	170 m
5.	Cleaning and washing of borewell with clean water and chemical	8 hours if drilled through Rotary rig.
6.	Development of the borewell with air compressor till the water becomes clear.	8 hrs

Based on drilling log the slots may be modified accordingly

Signature

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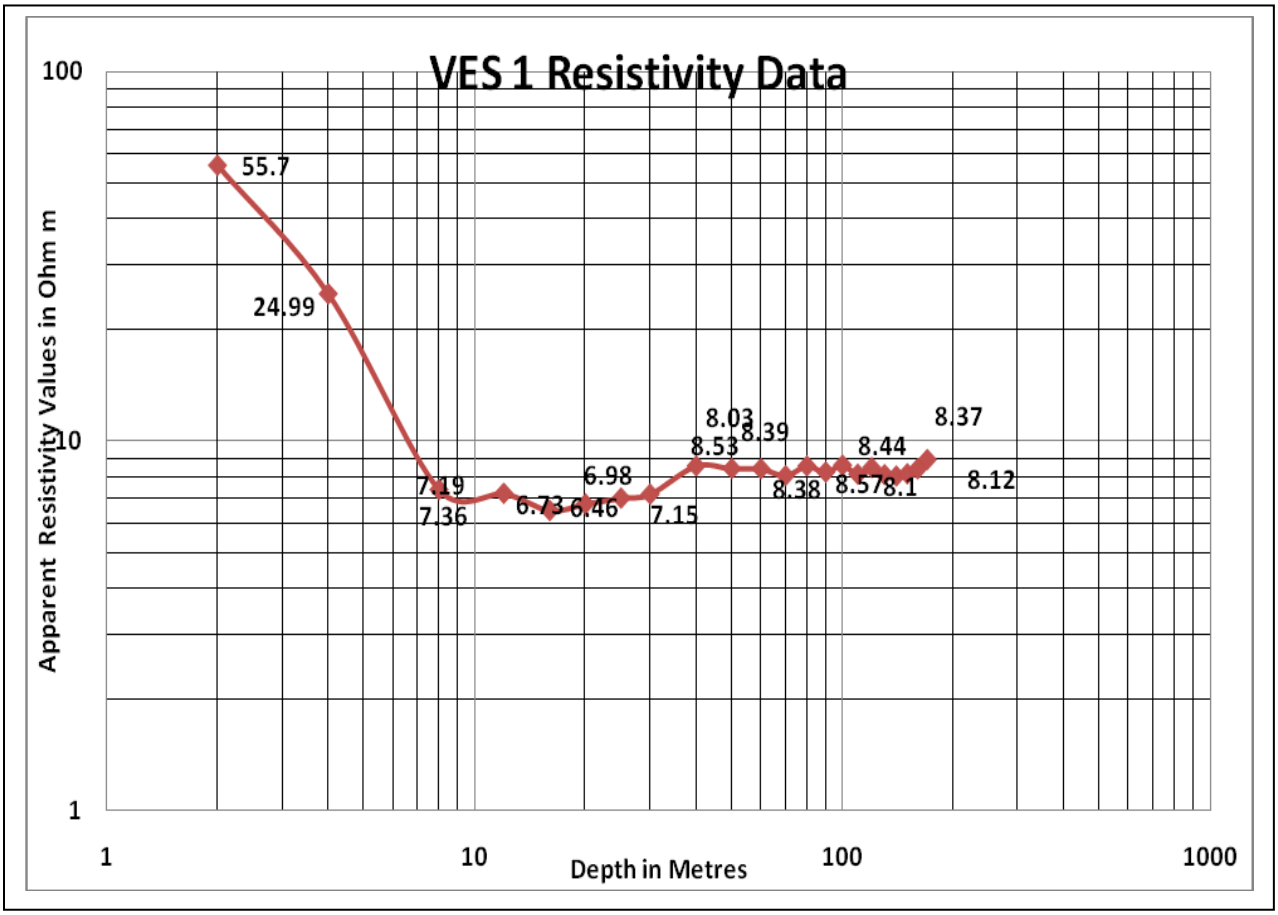
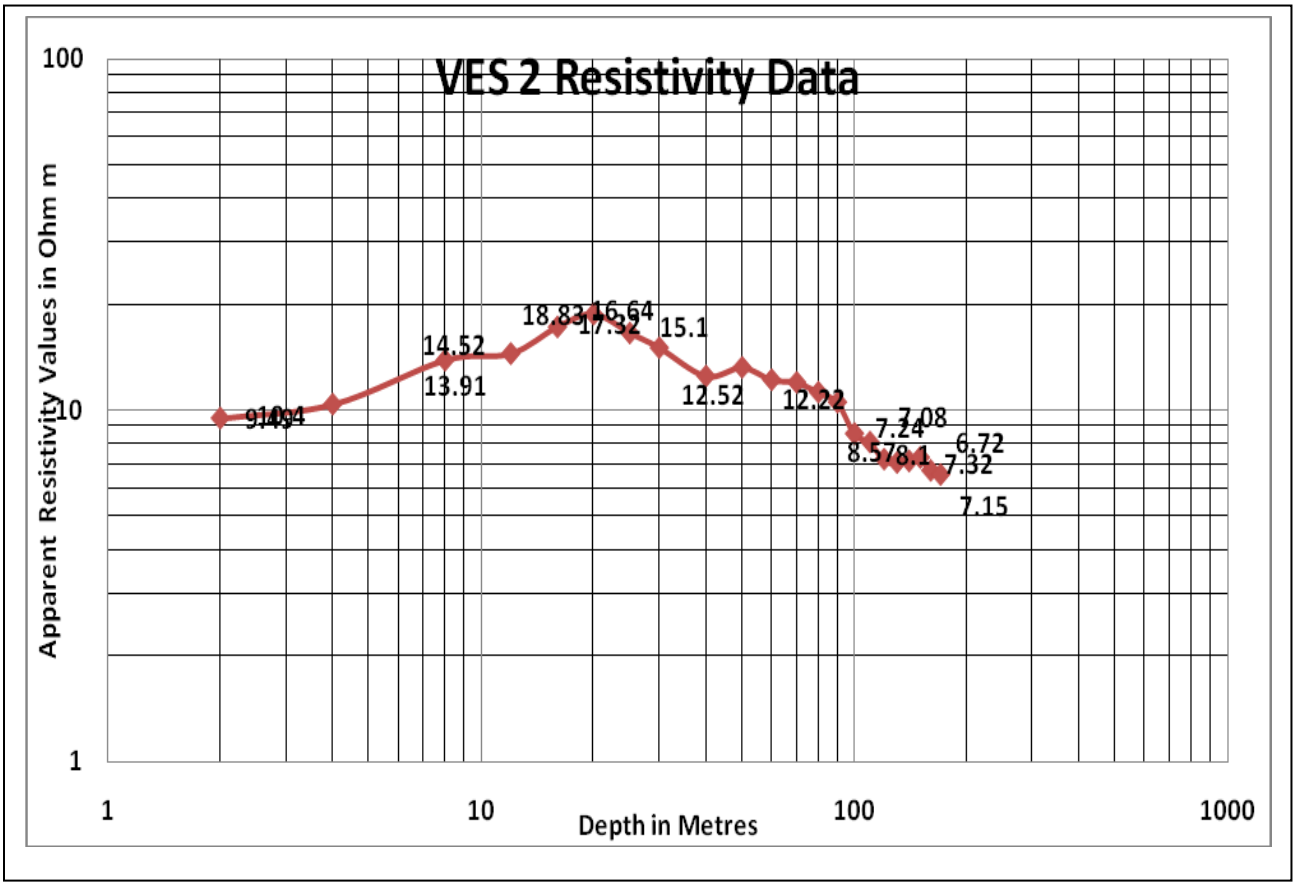
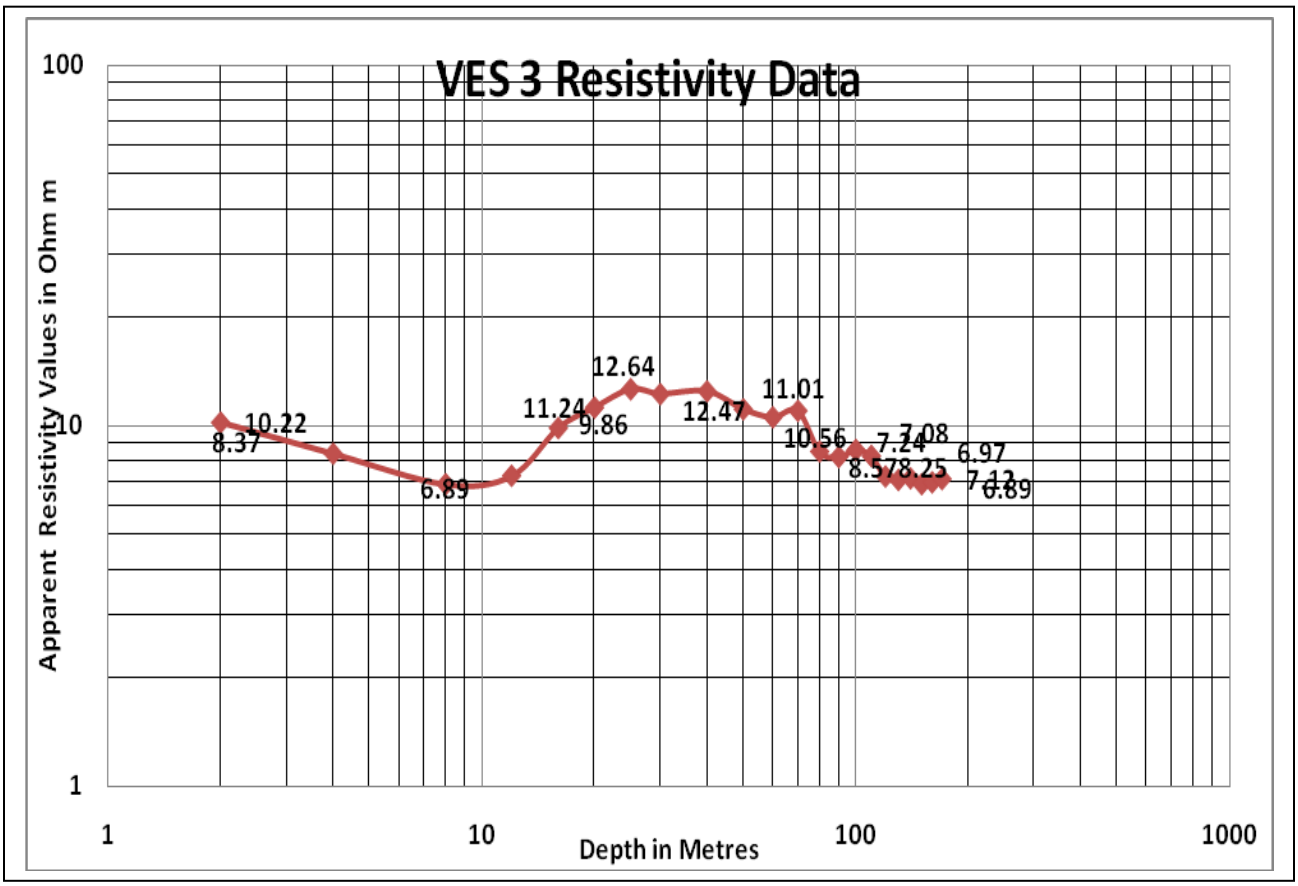
Appendix A VES Data and Graphs

RESISTIVITY GRAPHS PONDICHERRY SITE

ab/2	VES 1	VES 2	VES 3
2	55.7	9.49	10.22
4	24.99	10.4	8.37
8	7.36	13.91	6.89
12	7.19	14.52	7.27
16	6.46	17.32	9.86
20	6.73	18.83	11.24
25	6.98	16.64	12.64
30	7.15	15.1	12.26
40	8.53	12.52	12.47
50	8.39	13.26	11.12
60	8.38	12.22	10.56
70	8.03	12.01	11.01
80	8.53	11.26	8.49
90	8.21	10.54	8.2
100	8.57	8.57	8.57
110	8.1	8.1	8.25
120	8.44	7.24	7.24
130	8.08	7.08	7.08
140	8.01	7.15	7.15
150	8.12	7.32	6.89
160	8.37	6.72	6.97
170	8.88	6.54	7.12


VES 1 Resistivity Data
Apparent Resistivity Values in Ohm m
100
10
1
1
10
100
1000
Depth in Metres
55.7
24.99
7.19
7.36
6.73
6.46
6.98
7.15
8.53
8.03
8.39
8.38
8.44
8.57
8.1
8.37
8.12


VES 2 Resistivity Data
Apparent Resistivity Values in Ohm m
100
10
1
1
10
100
1000
Depth in Metres
14.52
13.91
18.83
16.64
17.32
15.1
12.52
12.22
7.24
7.08
6.72
7.32
7.15


VES 3 Resistivity Data
Apparent Resistivity Values in Ohm m
100
10
1
1
10
100
1000
Depth in Metres
8.37
10.22
6.89
11.24
9.86
12.64
12.47
11.01
10.56
8.57
7.24
7.08
8.25
6.97
7.12
6.89