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Groundwater Prospecting And Identification Of Artificial Recharge Sites Using Electrical Resistivity Technique

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ABSTRACT
Water is an important natural resource, which is available both on surface as well as in recharge zone of weathered layer and in various other suitable water reservoir formations/structures below the surface. As the availability of surface water is erratic and irregular one needs to study and map the underground water reservoirs. Therefore, in view of the upcoming requirement of water in the region there is need to exploit groundwater resource, which is limited and confined to fractured and weathered zones.The occurrence and movement of groundwater especially in fractured bedrock aquifers in a given area is governed by many factors viz., topography, lithology, geological structures, fracture density, aperture and connectivity, secondary porosity. Therefore, it is necessary to explore and study the ground water resources effectively using suitable techniques. The study is an attempt to delineate groundwater potential zones, in addition with discovery of positions of aquifer in campus of **NDMVPS KBT COE NASHIK**. The study area is mainly underlain by basalt type of rock formation. Vertical Electrical Sounding data will be collected from various locations to obtain layered resistivity parameters and potential fractured zones in the deep aquifer.
KEYWORDS— electrical resistivity, ground profile and formation, aquifer, delineation, ground recharge

I INTRODUCTION

Groundwater is a dynamic and replenish-able natural resource. In general, the occurrence and movement of groundwater, especially in fractured bedrock aquifers, in a given area is governed by factors such as topography, lithology, geological structures, geomorphology, slope, drainage pattern and climatic conditions. The sustainability and yield of the wells are mainly controlled by fracture density, Therefore, exploration and exploitation of ground water resources require thorough understanding of geology, hydrogeology and geomorphology of the area. Integration of various data and thematic maps, such as terrain features derived from remote sensing images, hydrogeomorphical details, depth to groundwater table and geophysical resistivity sounding data help in generation of ground water potential zone maps which when supplemented with geophysical data. There are several methods employed for delineating groundwater potential zones such as geological, hydrological, geophysical and remote sensing techniques. Integration of various data and thematic maps, such as terrain features derived from remote sensing images, hydrogeomorphical details, depth to groundwater table and geophysical resistivity sounding data help in generation of groundwater potential zone maps which when supplemented with geophysical data i.e. VES data in GIS environment, facilitates effective evaluation of groundwater potential zones.

Vertical electrical resistivity method can provide depth of occurrence of groundwater zone, thickness of the aquifer system and the probable location for well sites. Lineaments and its intersections reflect rock structures through which water can percolate and travel up to several kilometers within. To predict ground control problems in underground structures, lineament is strongly related to discontinuities such as joints, faults, and folds.

There are several methods employed for delineating groundwater potential zones such as geological, hydrological, geophysical and remote sensing techniques. Integration of various data and thematic maps, such as terrain features derived from remote sensing images, hydrogeomorphical details, depth to groundwater table and geophysical resistivity sounding data help in generation of groundwater potential zone maps which when supplemented with geophysical data i.e. VES data in GIS environment, facilitates effective evaluation of groundwater potential zones (Singh et al., 1997; Yadav et al., 2007). Vertical electrical resistivity method can provide depth of occurrence of groundwater zone, thickness of the aquifer system and the probable location for well sites (Srivastava and Bhattacharya, 2006; Israil et al., 2006). Lineaments and its

intersections reflect rock structures through which water can percolate and travel up to several kilometers
within. To predict ground control problems in underground structures (Kane et al., 1996), lineament is strongly related to discontinuities such as joints, faults, and folds. For these reasons, lineament was used for structural analysis, analysis of the relationship with lithology, and assessment of groundwater productivity. Integrated studies using remote sensing, GIS and VES approaches has been applied successfully for delineation of ground water potential zones by various researchers (Srinivasa Rao et al., 2000; 2006; Srivastava and Bhattacharya, 2006; Balakrishna et al., 2014; Venkateswaran et al., 2014; Srivastava, Giri, Bhattacharya 2012; S. Venkateswaran 2014.

The study is an attempt to delineate groundwater potential zones in Udoji Maratha Boarding Campus, Nashik. It also aims to understand the lineament pattern and fracture geometry of hard rock aquifers. The study area has geological position (20^0 00' 50"N - 20^0 1' 02.2"N latitude and 73^0 45' 39.5"E - 73^0 45' 55.3"E longitude)

The groundwater potential varies from place to place, sometimes within a few meters and even within the same geological formation. In hard rock terrain availability of groundwater is limited and is essentially confined to fractured and weathered zones.

II METHODOLOGY

Geophysical study mainly include to find out characteristics of various rock type in lithosphere .for that we are using electric resistivity method using electric resistivity meter SSR1. Electrical resistivity depends on many factors like mineral content, texture, moisture content, salinity, fissures and fractures of geological formations. In Electrical Resistivity method(Wenner method for the measurement of Vertical Electrical Sounding (VES)for this ground survey), the electrical resistance is measured by applying an electric current between a pair of outer electrodes and measuring the apparent potential difference between a pair of inner electrodes. Depth of current penetration is proportional to the spacing between the electrodes in homogeneous ground and varying the electrode separation provides information about the stratification of the ground.

In water bearing rocks there is also an indirect relationship between resistivity and lithology or geologic age, since these two factors tend to control the porosity and water storage capacity of rocks. The magnitude of rock resistivities has a wide range from a fraction of ohm-m to several thousands of ohm-m. The rocks containing high concentration of metallic minerals and saline water may show resistivities less than 1 ohm-m to a few ohm-m

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The clays and marls show one to a few tens of ohm-m. Sands and sand stones show from ten to a few hundreds of ohm-m.. The resistivity of a given formation also changes depending on the degree of weathering and number of fractures.

2.1 Study Area

The study area has geological position (20^0 00' 50" - 20^0 1' 02.2"N latitude and 73^0 45' 39.5" - 73^0 45' 55.3"E longitude).

Fig 1. Geological Position Of Study Area

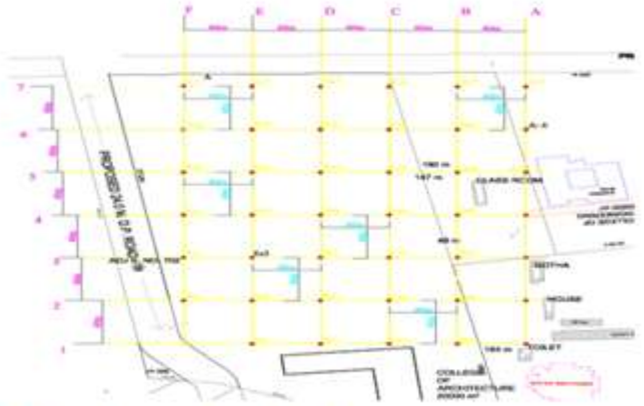

Fig.2. study area and grid pattern for surveying.

2.1.1. Features of study area-

(i) Study area affect more one section of recharge site.
(ii) Site should be such that it allow gravitational flow towards recharge pit.
(iii) Open area on which we can locate recharge site only that much of area are selected for resistivity survey
(iv) Total area : 213304sq.mt
(v) Area Covered by building-29607 Sq.m
(vi) Open area-111864 Sq.m
(vii) Area of farm-32870
(Area consider for resistivity survey-72700 sq.m)

The study area includes the campus of NDMVPS KBT COE, campus of CMCS college, . campus of Agricultural college, which in total comprises of 56 acres situated at Gangapur Road in Nasik city in Maharashtra state, India.

In this study area, we are going to carry out ground survey using electrical resistivity method.VES using electrical resistivity method ,is carried out at various loactions in the open spaces of study area.

III ANALYSIS AND DISCUSSION

It is possible to solve the field equation directly to get the resistivities and thicknesses of the subsurface layers from the field data. The field data obtained
from electrical resitivity meter from ground survey ,data collected is tabulated form. Sample calculation of spot E7 in grid pattern

Spot E7				
Spacing	R	1/R	2aΠ	2aΠR
1	3.569877	0.280122	6.28	22.41883
2	3.7531	0.266446	12.56	47.13894
3	2.26833	0.440853	18.84	42.73534
4	1.87461	0.533444	25.12	47.0902
5	1.7789	0.562145	31.4	55.85746
6	1.4019	0.713318	37.68	52.82359
8	1.01876	0.981585	50.24	51.1825
10	0.9667	1.034447	62.8	60.70876
12	0.91277	1.095566	75.36	68.78635
14	0.975641	1.024967	87.92	85.77836
16	0.94193	1.06165	100.48	94.64513
18	0.9214	1.085305	113.04	104.1551
20	0.91871	1.088483	125.6	115.39
22	0.90178	1.108918	138.16	124.5899
24	0.8981	1.113462	150.72	135.3616
26	0.87911	1.137514	163.28	143.5411
28	0.85461	1.170124	175.84	150.2746
30	0.82416	1.213357	188.4	155.2717

Table 1. Apparent resistivity value calculation

Spot no E7					
Sr. no	Layer no	Thickness	Depth	Apperent resistivity	Type of rock
1	1	2	2	-.314.15	up to 0.5m-soil,from 0.5to1m-murum, below 1m- Highly fractured basalt
2	2	2	4	48.33	Broadly spaced fractured basalt
3	3	1	5	241.66	Highly compact basalt
4	4	3	8	42.83	Broadly spaced fractured basalt
5	5	4	12	209.43	Highly compact basalt
6	6	2	14	-161.10	Highly fractured basalt/cavity/gap
7	7	12	26	685.43	Highly compact basalt
8	8	4	30	299.190	Highly compact basalt

Table 2. Detailing of type of rock

- **Discussion about spot E7 :**

(i) According to resistivity value at spot E7 available soil cover is 0.5 meter
(ii) Mainly found rock type at E7 are : Weathered amygdaloidal basalt, Highly compact basalt, Highly fractured basalt/cavity/gap, Broadly spaced fractured basalt etc
(iii) Rain water can be stored in weathered/highly fractured rock, such rock is found at depth 14 meter from ground surface with layer thickness of 2 meter approximately.
(iv) So suitable depth to discharge rain water for E7 is 14 meter approximately.
(v) At spot E7 compact basalt is available at depth 5 meter with layer thickness of 1 meter
(vi) On this spot ground water potential zone i.e. aquifer i.s observed at 14 meter depth , which is an confined aquifer First,

3.1. Selection Of Recharge Site

(i) Rain water can observe more in agricultural farm and it may destroy crop due to flooding
(ii) So we cant provide the recharge site middle in the farm
(iii) According to subsurface geological setup and topographical condition of study area, there are at least four suitable locations for recharge sites are selected as shown in fig.
(iv) The selected site is such a that, easier to collect water flowing form roof of the building and play ground.
(v) Separate recharge site is provided for engineering building + ITI collage, hostel building and surrounded area which is near engineering building
(vi) An another recharge site near to architectural building which collect water from architecture building, CMCS collage and surrounding area
(vii) Location 1 and 2 are optional to each other because they collecting water from same area
(viii) But the locationno.2 i.e.location near to the building is more efficient because they have helps to recharge the existing bore.
(ix) At location 2 fractured rock is found at depth of 15 meter , and horizontal extent of that rock is also sufficient to store water , and that location is near to building so this is an ideal location to recharge an ground water.
(x) Location 3 is near to architectural building , fractured rock is found at depth of 8 meter having thickness of 5meter and horizontal extent of 120 meter, rater can be recharge at this location economically.
(xi) Location no 4 is at spot E7 , which is helpful to recharge the existing open well. By observing the contour map of study are it is assured that ground slop is toward NE corner of field so spot e7 is selected for recharging the open well . At that location it is easier to collect the due to available ground slop.
(xii) For location no4 recharge structure can provide at depth of 5 meter since fractured rock is encountered at that depth.

3.2. Selected Location For Bore Well

(i) Bore well should be taken at a location such that there is maximum possibility of availability of ground water
(ii) Site where confined aquifer are available, that is considered to have good ground water potential
(iii) Ground water potential of each spot is as stated earlier, all the spot are divided in three group according to their ground water potential in table
(iv) Spot in category poor are those at which mostly compact basalt rock is encountered up to greater depth
(v) At spot in category good ground water potential unconfined aquifer is located that's why it is an temporary source of water.
(vi) At spot in category of very good ground water potential multi aquifer is encountered , so boar well at this location get supply of water from more than one source. It is also observed that aquifer is dipping towards that point so that also increase the ground water potential of that spot.
(vii) By keeping all the above point in the mind we conclude that E4, C4, C7, F4, E4, E5 are the best possible position from ground water potential point of view.

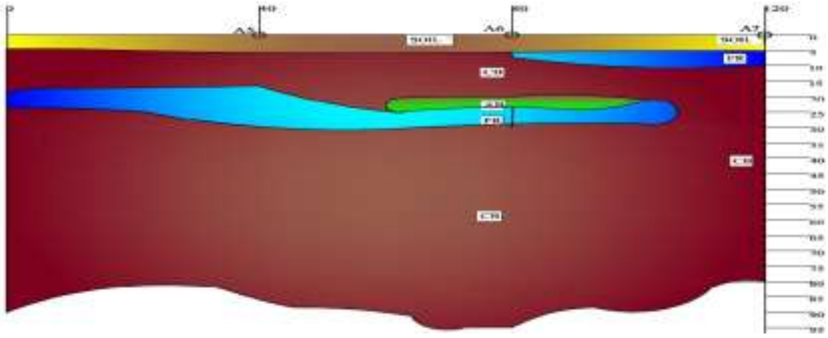

Fig.3 Section showing type of rock layer

IV RESULTS

From our experimental work we listed out some results, which satisfactorily fulfill the requirement of our project. They are as listed below

(i) Water can be stored in the rock which is porous or highly fractured. Water may percolate through fracture and cavity, such rock is available in our study area.

(ii) From the sub-surface geological arrangement, we conclude that groundwater recharge zone is available at a depth 15m for location 2, and at a depth of 8 m for location 3, and at 5 meter depth for location 4.

(iii) An aquifer is available at a depth of 20 meter in our study area.

(iv) Main rock type found are weathered amygdaloidal basalt, highly compact basalt, highly fractured basalt/cavity/gap, zeoletic basalt mixed with red bole. etc.

(v) Mainly compact basalt rock and weathered amygdaloidal basalt are found.

(vi) In our work, we did not find any past dumping pit underground.

(vii) Rock formation of study area are found very good and sound from foundation point of view. Sufficiently hard and sound rock is found at an average depth of 1.5 m.

(viii) On site soil cover of 0.5 to 1 m is available.

(ix) At spot where multi aquifer is encountered, bore well at this location gets supply of water from more than one source. It is also observed that if aquifer is dipping towards a point, that also increases the ground water potential of that spot.

(x) By keeping all the above point in mind we conclude that E4, C4, C7, F4, E4, E5 are the best possible positions from ground water potential point of view.

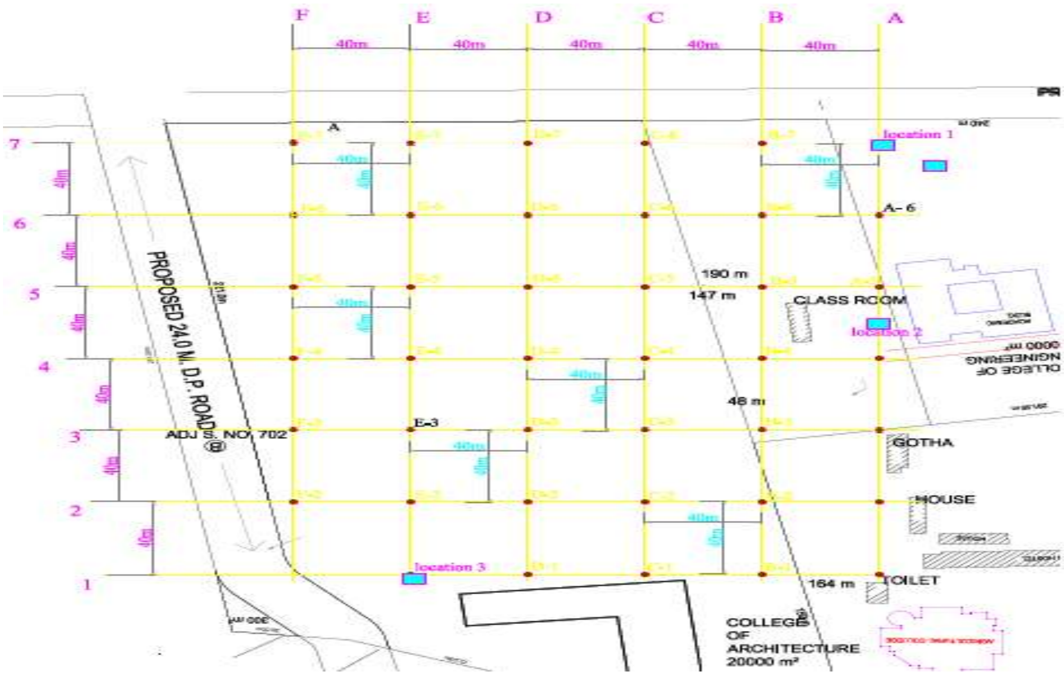

Fig.4 location of three possible recharge site

V CONCLUSION

As we discussed in introduction, preservation of ground water is very important for effective use of available water and to avoid wastage of water. It can be done by recharging ground water in the available underground aquifer. In Udoji Maratha boarding campus ample amount of rain water is collected.

Electrical resistivity method has proved to be effective for vertical sounding of ground. By using this method we successfully found out the type of underground rock layer. Main rock types found are weathered amygdaloidal basalt, highly compact basalt, highly fractured basalt/cavity/gap, red bole mixed with zeoletic basalt, murum etc. Mainly basaltic rock type are found. As we know water can be stored in fractured or porous rock. In our study area weathered amygdaloidal basalt and fractured compact basalt are found. Such aquifer are encountered at depth of 20 meter. By studying the underground rock formation we have selected two locations for recharging available aquifer by collected rain water, at which we can economically recharge the water at depth of 15 meter for location no-2 and at depth 8 meter for location no-3.

Rock formation of study area also found sound from foundation point of view , rock having significant bearing strength are found at an average depth of 1.5 to 1 meter, hence building foundation will not lead to any costly earthwork . Above that rock layer there is soil cover with varying thickness from 0.5 to 1 meter.

At spot where multi aquifer is encountered, borewell at this location get supply of water from more than one source. It is also observed that if aquifer is dipping towards a point, that also increases the ground water potential of that spot. By keeping all the above point in the mind we conclude that E4, C4, C7, F4, E4, E5 are the best possible position from ground water potential point of view.

So we successfully completed the aims and objectives of our project, from the work we carried out.

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