Research Article *ISSN: 2319-507X*
Khadri SFR, IJPRET, 2013; Volume 1(8): 283-301 *IJPRET*

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

GROUNDWATER REGIME OF POHRA REGION, AMRAVATI DISTRICT, MAHARASHTRA WITH REFERENCE TO WATER RESOURCE MANAGEMENT

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Accepted Date:

27/02/2013

Publish Date:

01/04/2013

Keywords

Fluorides,

Drinking water,

Fluorosis,

Groundwater,

Sustainable development

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Abstract

New concept of drainage deepening and widening for groundwater recharge is emerging today as the useful techniques for geo-environmental studies. This new concept has been applied to Pohra village in the Amravati district where the drainage channels near the public water supply well behind cement bandhara has been deepened by 3 meter, width 25 meters and length 150 meters. During this process silt and clay has been removed for ground water recharge purpose. Litho logically this area is overlain by shallow alluvium up to 5 meter depth. Below 5 meters vesicular basalt is present. Both alluvium and vesicular basalt are acting as potential aquifer in this region. The Pohra village was facing acute shortage of drinking water since long time. After water budgeting, it is observed that the shortage of water reaches about 120.50 ham. After taking the structure of drainage deepening and widening adequate drinking water is available to public water supply well of Pohra village. This new concept of drainage deepening and widening can proved to be successful where weathered strata and clay over burden is present which restricts the groundwater percolation. Hypsometric analysis of the drainage basin was carried out to decipher the stages of landform evolution, and to assess the influence of geologic and tectonic factors on topography and its modifications. It was concluded that the area of the sub-catchments controls the aspect ratios of the basin because of lateral drainage branching and network bifurcation. Two landform evolution models were generated on the basis of variations in the coordinates of the slope inflection points on the hypsometric curves in terms of relative height and plain area. The landform of the drainage basin had approached almost steady state equilibrium stage. An empirical relationship between terrain uplift and hypsometric parameters was derived. It was suggested that the SW part of the drainage basin, covering parts of the Satpuda hill range, which has been uplifted more than its NE segment. Geologic features, especially the dislocation and fault zones, indicated that the drainage basin had a protracted geological evolution that led to the development of various types of bed-rocks and different structural zones, some of which were still active, controlling the geomorphic features and tectonic topography. The soils hardly showed well defined profile development and contained a large component of Aeolian sands in stabilized and old dune fields. Thus the inter stream area has registered higher concentration of various chemical constituents in the groundwater. The groundwater is Mg - Ca - HCO3 – Cl type as indicated in the hydro-chemical piper plots of groundwater samples in the district. The groundwater quality in the Wilcox diagram shows that most of the samples are under C2S1 and C3S1 category. The weak correlations of chromium with rest of elements indicate that there could very low chromium pollution in the area.

Introduction:

Ground water is one of the most important components of the hydrologic cycle in nature. The occurrence of groundwater is wide spread but uneven. In some rocks it occurs in small quantity, whereas some other rocks contain enormous groundwater that can be used for major purposes of agriculture, drinking and industries. For the estimation of aquifer parameters, understanding the geological frame work in which groundwater occurrences is necessary. The less important non-commercial minor occurrences of groundwater is also of great importance, as it provide a key to ground water exploration purposes. (Dhokarikar, 1987). The hazardous growth and concentration of population and industries in urban areas in recent years has caused many serious problems. One of the major problem is the scarcity in groundwater occurrence. Groundwater is the natural gift to the living beings which is most precious and widely distributed resource on the earth, Groundwater is the renewable resource but its renewability is not infinite. So the groundwater management and development has to be planned in scientific way. So that the adverse effect of over development could be avoided. Reliable estimation of groundwater resources applying suitable methodology is a prime necessity. (Bagade, 1999; Vyas, 1999).

The Maharashtra state is mostly covered by the Deccan trap basalt showing irregular levels in groundwater occurrence. This diversity of Deccan Trap basalt with reference to groundwater occurrence varies with change in topography, geomorphologic and local environmental conditions. Hence to locate a suitable site for groundwater exploration is very difficult task in this region. The flows of Deccan trap basalt vary in thickness from few meters to hundreds of meters. These flows or litho units behave differently in ground water occurrence due to change in their chemistry, compactness, presence of amygdales, vesicles, fractures etc. In Deccan trap, groundwater occurs mostly due to its secondary porosity and the presence of joints, fractures, vesicles, amygdales etc.

Methods of Study

 ISSN: 2319-507X
IJPRET

The Deccan trap basaltic terrain of Pohra area, Amravati district, [lat. 20°.55' -20°.58' and Long. 77°.45' - 77°.55'] falling in survey of India toposheet No. 55H/13 is studied with reference to resistivity survey, pumping test, hydrogeomorphological condition, geophysical, remote sensing and lineament aspects. Remote sensing technique, hydrogeomorphological maps, resistivity survey results are also helpful in identifying different basaltic layers present underground and their possible correlation (Fig.1. and 2).

Fig. 1: Map of Amravati district showing location of the study area

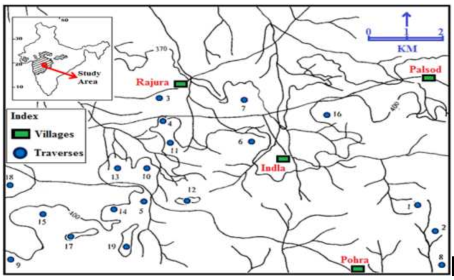

Figure 2: Physiographic map of Pohra area showing field traverses 1 to 19.

Resistivity Survey:

In Deccan volcanic province, prospecting for groundwater is a challenging task. Remote sensing study is important for locating the potential zones of groundwater by demarcating the lineaments, various geomorphic units and lithology of the Deccan traps. (Adyalkar, 1984). Attempt has been made by Thigale (1979) to establish relationship of plants with the occurrence of groundwater. The various methods and techniques have certain limitations in groundwater exploration. The resistivity survey is found to be useful to detect the aquifers in Deccan traps. Balkrishna and Ramanujachary (1978) have analyzed the results of resistivity survey in Malwa plateau, Deccan plateau and the flanks of the Sahyadri ranges. Sathyamurthy et.al. (1979) studied the result of electrical resistivity surveys for groundwater in Deccan traps of Maharashtra.

Geophysical method provide indirect but most reliable picture of sub surface formations by measuring various physical parameters like density, magnetic susceptibility, electrical conductivity etc.

Electrical resistivity survey is the most suitable method for groundwater exploration. The vertical electrical sounding (VES) gives most accurate information about the strata present below. In hard rock terrain like Deccan Traps, where various layers of the lava flows are present, this method is proved to be useful. There is a difference in geochemical, petrographic, jointing pattern, and vesicles etc. of the Deccan trap which ultimately reflect in the difference in resistivity values of these flows. The true resistivity values and thickness of the layers are obtained by interpretation of the sounding curves. (Parikh, 1989).

In this study, an attempt has been made to explore the ground water bearing formations by Schlumberger vertical electrical resistivity sounding method at 12 important locations at Pohra area with AB/2 = 120m and Mn/2 = 10m The curves obtained by plotting resistivity Vs AB/2 interpreted by using the curve matching technique (Fig. 1) of Orellana and Mooney (1966). This study has laid to the identification of groundwater regime of the region by indicating the general slope of the groundwater movement toward the west. The first and uppermost layer represents moderately to highly fractured basalt covered by thin top soil. Whereas the second layer is characterized by hard, compact, massive basalt (Fig. 2). The permeability of this second layer is very less, which is reflected in the low values of storativity, transmissivity and storage coefficient of this area, as compare to the standard values of these parameters for Deccan trap. The Pohra area is characterized by three main lithological units which include weathered basalt with top soil, hard, compact, massive basalt and vesicular basalt. In this study, an attempt has been made to understand the ground water potential and watershed management of the region. (Table. 1) This survey also proved to be useful for identifying various basaltic layers present underground and their possible correlation (Fig. 2).

Pumping Test:

The total eleven wells selected for pumping text are located in a jointed, fractured and weathered basalt. This is a lower dissected plateau of the Deccan trap province which is situated at the western foot hill zone of the Pohra hill ranges. On the eastern side of the study area, the hills form the plateau region which act as a recharge site and the area under study can be considered as a discharge site. The common practice is that the well selected for pumping test should be below the water.

Results and Discussion

The Piper diagram (Piper, 1944) is useful for evaluating the geochemical evolution of the groundwater under study. Results are plotted on a Piper diagram in Figure 7 a & b. Two triangular fields, plotted separately, form the percentage epm (equivalent per million) values of the cations Ca++ and Mg++ (alkaline earths) and Na+ (alkali), and the anions HCO3- (weak acid) and SO4-- and Cl- (strong acid). The general characteristics of the water are represented by the projections of these points in the triangular fields in a central diamond-shaped field. Groundwater in the region is significantly dominated by the alkaline earths (Ca++ and Mg++) over the alkalies (Na+ and K+). An examination of the central diamond-shaped field shows that most of the samples are in the upper left half of the figure. The strong acids (SO4-- & Cl-) exceed the weak acids (represented by $HCO3^-$). The Piper Trilinear diagrams of the groundwater samples of the study area reveals that the water samples fall in the area of 1,4 and 6 fields suggesting the alkaline earths exceeded alkalis and strong acid exceeds week acid respectively (Fig. 3 a & b). The suitability of water for irrigation purpose can be classified on the basis of sodium percentage, electrical conductivity and sodium absorption ratio.. The values of sodium percentage and electrical conductivity (after Wilcox, 1948) demonstrates that a majority of samples have been classifies as “good to permissible” for irrigation purpose and the remaining samples have been classified as “permissible to doubtful” for irrigation purposes as its sodium absorption ratio is 24 to 58.The isocon maps showing the variations of electrical conductivity in various alluvial and Deccan Trap regions exposed in the study area indicate the presence of three distinct zones namely good (i) where the electrical conductivity

(EC) values range between 250-750, (ii) permissible, where the EC values are between 750-2000 and (iii) doubtful, where the EC values are between 2000-3000. The results demonstrate the alluvial zone shows doubtful quality of groundwater, which is not suitable for drinking purposes in the northern most part of the study area with the gradual reduction of EC values towards south. It is interesting to note that none of the samples analyzed shows EC values > 3000 which indicates that the rate of salinity is not very high in this region. This proves that the salinity of the alluvial zone of the Uma river basin is in the lower range which can be removed by employing suitable recharge methods and also by pumping the saline water into the Purna river during rainy season when most of the water goes as runoff. The correlation coefficient matrix for various hydro geochemical variables along with Ec, pH and water level (bgl) are given in Table 1. It is observed from the matrix that Mg, Cl, Na and CO_3 show strong correlation with each other whereas; K, pH and SO_3show a less pronounced correlation. The dominant variables of each factor are given in table 10 in the decreasing order of dominance along with percentage of variance and eigen value for each factor. The special distribution of electrical conductivity (Ec) of groundwater during pre and post monsoon periods of 2004 and 2005 were shown in Fig. 6. The results indicate that the range of Ec in the study area lies between 312 to 1500 and 321 to 1790 for pre and post monsoon periods during 2004 where as it varies between 311 to 1587 and 348 to 1724 for pre and post monsoon periods during 2005. In general the Ec of groundwater in alluvial unconfined aquifers is 311 to 1790. In the study area high Ec is found in northwestern part and low Ec is found in central and southern parts due to the presence of basaltic aquifers, which are recharged regularly by rainfall as compared to alluvium.

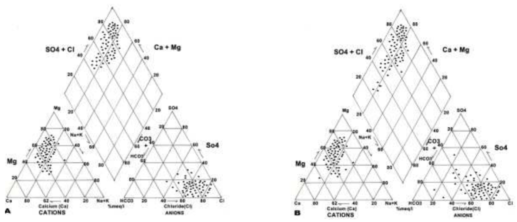

Fig.3 A &B Piper Trilinear Diagram showing groundwater quality in the

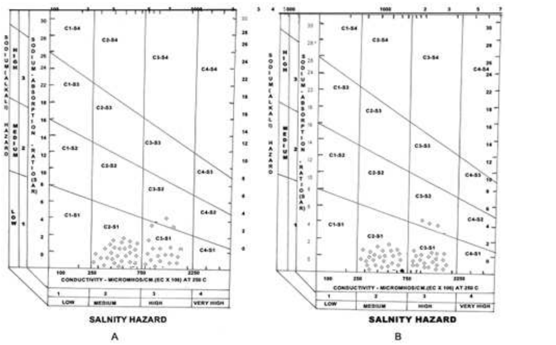

Fig.4A&B Rating of water samples in relation to salinity and sodium hazard of Karam River basin (After USS Lab, 1954), A: Pre-Monsoon, June,2008; B: Post-Monsoon, December 2008

Based on groundwater hardness, the study area can be divided into six categories namely A1-A3 indicating the permanent hardness and B1-B3 indicating the temporary hardness. A2 and A3 types occur in the southwestern part whereas, the southern part contain the saline belt, which form a part of the Purna Saline tract. The TDS plots in the study area shows fresh water in the Murtizapur area with < 1000 TDS whereas, towards the NE and SE parts show brackish water and towards south eastern extreme, the saline zone has been identified.

The SAR quality has demonstrated the water quality of the Karam river basin, which supports the earlier values of EC. The results indicate the presence of four distinct zones in the study area which are (I) excellent, where the SAR ratio is <10, (ii) good, where it is 10-18, (iii) fair, where it is 18-26 and (iv) poor, where the SAR ratio is >26. It is interesting to note that alluvial zone belonging to Purna Saline tract shows poor quality of water which is not suitable for drinking and irrigation purpose with small pocket of fair quality zone in between the saline tract. Whereas, the Deccan Trap region show fair to excellent quality of groundwater as indicated by its SAR values.

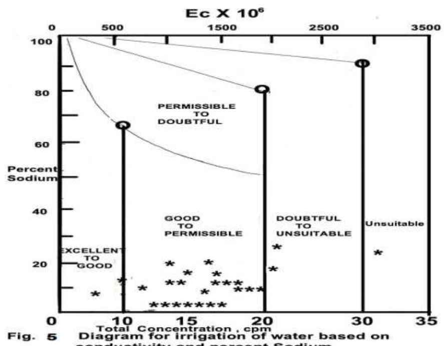

Fig. 5 Diagram for irrigation of water based on conductivity and percent Sodium

Water level Fluctuations

General behavior of groundwater is studied from water level data. In winter, water level is 12.02 m and the minimum is 6.54 m in the extreme west and central parts of the area. The water level during southwest monsoon shows that the maximum is

10.9 m and the minimum is 4.52 m, with respect to ground level. Likewise, the summer water level also shows that the maximum is 20.52 m and the minimum is 5.39 m. The water level during the northeast monsoon shows that the maximum is 10.29 m and the minimum is 4.16 m. The groundwater level varies greatly and not follows any rhythmic pattern. The water level fluctuations in the area are calculated at a maximum of 3.52 m and a minimum of 1.44 m, respectively. The fluctuation of water level is high in these villages.

Groundwater flow

From static water level data for 20 years (from 1990 – 2010) within a basin, an annual average water level map is constructed with respect to the above mean sea level. The flow system of these basins have revealed that the east – west movement, since it has a well defined relief, recharge area at the topographic high and adjacent discharge area. Further, the topographic elevation and groundwater level gradient decrease from west to east gradually and thus confirms the flow pattern. Further, it is observed that the central and eastern part of the area has more favorable permeability (low gradient of water level) than the other areas. Similarly, the areas of west, west – central and NW and SW corners have lower recharge (high gradient of water level) than discharge. The convex trend of flow indicates the presence of abduction zone in the western part of the study area

Summary and Conclusions

Laterites and basalts are the main litho types found in the study area. The laterites are derived from the residual weathering or lateralization of basalts (Radhakrishna & Vaidyanadhan 1994). The basalts exposed on the surface belong to upper cretaceous age (southern flank of Deccan traps). Well-developed laterites are found overlying basalts in the central part of the Asirgarh, while the basalts outcrop in the northern and southern part of the are shown in Figure 1. The weathering of laterites gives rise to red soil whereas basalts to black soil. The laterites possess interconnected primary openings and also secondary fractures. The basalts are devoid of primary openings but possess secondary openings in the form of fractures and joints. These features help in easy infiltration of surface water. The pores & fractures in laterites and fractures & joints in basalts act as reservoirs of groundwater. Thus, in the study area groundwater occurs under phreatic (unconfined) condition in laterites and basalts that are outcropping at surface. The groundwater found in the basalts below laterites occur under semi-confined to confined conditions. The groundwater is exploited by either dug well or bore well in the study area (Sarwade 2004). Dug wells are more popular in lateritic horizon, due to shallow water table (depth: 2.0-15.0 m) cost effectiveness, simplicity in construction and operation. The bore wells are drilled in laterites and basalts where the water level varies from 35.0 to 45.0 m. So, all dug wells are replenished by shallow aquifers (laterites) and bore wells from deep aquifers (basalts).

Water resource management

In Pohra area, moderately dissected plateau occurs at an average elevation of more than 420 meters forming major physiographic break. This unit is covered with thin soil cover with weathered mantle which act as a typical recharge zone (Fig. 6). Other geomorphic units like plateau top, denudational hill and denudational slope are very poor as far as ground water prospectus are concerned. On the other hand, lower dissected plateau unit is present at the foot hill region of this area with thick soil cover and weathered mantle has excellent ground water prospectus. In the study area, the recharge of groundwater is controlled by topography; thickness of weathered zone, and infiltration capacity of soil and subsoil strata within the zone of aeration. The area exposes seven lava flows, which are separated, by these horizons of red boles. Each part of the flow forms a separate unit, which differs from the other, based on variation in porosity and permeability of the flow units. The water bearing capacity of various lava flows depends on the flow nature and geomorphic expression. The massive portions are devoid of any openings due to low porosity and hence unproductive for groundwater. Whereas, the vesicular and amygdaloidal horizons of lava flows show interconnected and uniformly distributed vesicles contributing to their groundwater potential due to high degree of porosity and permeability, which further intensifies due to differential weathering.

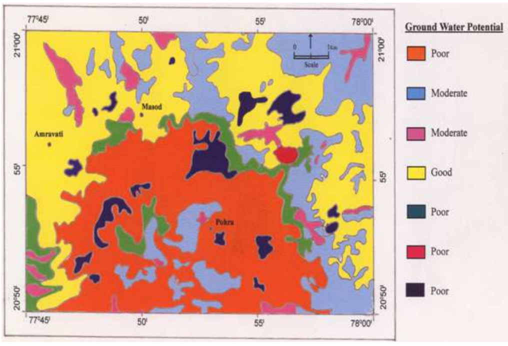

Fig: 6 Groundwater potential zones interpreted through GIS techniques

In order to estimate the yield of wells in the shallow aquifers in the study area, 15 pumping tests were conducted at selected locations consisting of jointed, fractured and weathered basalt (Table 2,). The results indicate that the transmissivity and permeability values are more or less similar to one another indicating free movement of groundwater with in the basin limits with the presence of permeability barrier towards "High" where the values reduces drastically. The transmissivity values for the well no. 1,4,9 and 10 are found to be 22.91 sq.m/day, 58.12 sq.m/day, 22.88 sq.m/day, 24.68 sq.m/day respectively. The standard value for Deccan Traps is 30 – 100 sq.m/day, indicating that the obtained values are in accordance with the standards. Occasionally, the closely spaced interconnecting joints present in between the massive horizons may contribute towards the formational porosity can form productive zone. The size and number of vesicles, degree of weathering and jointing pattern mainly control the water productivity and yielding strength of aquifers in basaltic terrain. Hence, highly weathered zones of vesicular and amygdaloidal basalts are good producer of groundwater.

The area of investigation is characterized by the presence of multiple aquifer system showing productive and unproductive zones due to the presence of alternating massive and vesicular units with lateral variation. The depth to water level studies indicate four distinct zones which include shallow water level (1 -5m), moderately deep water level (5-8m), deep water level (8-15m) and very deep water level (>15m). The shallow water level is influenced by the surface irrigation methods showing recharge of groundwater table. The groundwater level fluctuation mainly depends on the difference in water levels of pre-monsoon and post monsoon periods, which can be directly linked, to recharge and discharge of groundwater. The results indicate three distinct zones namely low water level fluctuations (1-2m), moderate water level fluctuations (2-3m) and high water level fluctuations (>3m). The low water level fluctuations are more prominent in the region, which is controlled by the recharge of groundwater by surface irrigation, and low frequency of dug wells causing less groundwater withdrawal. Whereas, the high water level mining of groundwater during non-monsoon seasons for irrigation purposes causes fluctuations. The spatial distribution of Ec in Karam river basin during pre and post monsoon periods indicate the identification of various zones reflecting its water potentiality

Table 1 Physico-chemical characteristics of Maru river basin

S No	Well no	Geomorphic unit	well Type	Physical parameters			**Chemical parameters**				Hard-ness	Acidity
				T	C	pH	**Ca Cl Mg HCO_3 TH Acidity**					
1	P-1	H D P (A)	B.W.	25.4	0.363	6.64	42.226	28.76	18.62	352	143	21
2	P -2	H D P (B)	B.W.	24.6	0.343	6.18	78.176	25.56	0.1	462	186	26
3	P-3	H D P (A)	D.W.	27.3	0.424	5.81	98.252	53.96	26.21	1243	356	78
4	P -4	M D P (B)	D.W.	28.4	0.363	6.41	66.432	22.72	8.77	642	152	20
5	P -5	H D P (B)	D.W.	24.2	0.381	5.74	83.366	17.04	3.89	500	224	20
6	P -6	P.T.	D.W.	22.3	0.261	6.24	82.176	22.72	12.65	200	132	12
7	P -7	P.T.	D.C.B	20.5	0.405	6.46	76.192	48.28	12.98	500	220	12
8	P -8	P.T.	D.W.	20.1	0.563	5.78	82.176	31.24	22.36	800	320	80
9	P -9	P.T.	D.W.	18.8	0.359	6.82	86.163	14.22	14.56	600	294	16

10	P -10	P.T.	D.W.	22.3	0.383	5.08	78.144	45.44	7.79	320	212	36
11	P -11	P.T.	D.W.	24.3	0.324	6.51	58.096	19.88	1.95	320	128	12
12	P -12	M D P (B)	D.W.	22.2	0.318	6.43	88.096	14.20	18.51	400	196	16
13	P -13	M D P (B)	D.W.	26.5	0.209	6.54	62.064	19.88	3.89	140	96	10
14	P -14	M D P (B)	D.W.	24.6	0.382	6.65	112.54	14.29	6.32	500	160	12
15	P -15	H D P (A)	D.W.	28.7	0.224	5.72	51.324	14.28	1.94	340	136	52
16	P -16	H D P (A)	D.W.	25.2	0.277	6.43	54.508	11.36	9.74	440	176	20
17	P -17	H D P (B)	D.W.	24.6	0.321	6.24	152.34	19.88	9.42	500	192	12
18	P -18	H D P (B)	D.W.	29.3	0.365	7.82	56.112	28.46	17.54	340	212	32
19	P -19	H D P (B)	D.W.	24.6	0.238	6.37	76.956	14.22	2.92	360	152	12
20	P -20	H D P (B)	D.W.	25.2	0.306	7.44	104.28	17.04	2.41	380	204	16
21	P -20	H D P (B)	D.W.	28.2	0.309	7.04	83.366	19.88	0.14	420	212	12
22	P -22	M D P (A)	D.C.B	27.7	0.557	6.32	56.112	22.72	36.05	720	288	14
23	P -23	M D P (A)	D.W.	26.4	0.534	6.35	125.24	17.04	6.43	1000	236	24
24	P -24	M D P (B)	D.W.	27.5	0.688	7.52	152.34	34.08	9.02	920	376	14
25	P -25	M D P (B)	B.W.	30.1	0.325	5.54	72.144	28.44	19.49	780	260	16
26	P -26	M D P (A)	D.C.B	27.9	0.506	6.65	96.19	19.88	11.67	880	288	28
27	P-27	M D P (A)	D.C.B	26.0	0.324	7.28	128.25	14.23	7.54	760	268	44
28	P -28	M D P (A)	D.W.	27.2	0.565	8.12	120.24	31.24	2.98	800	312	20
29	P -29	H D P (A)	D.W.	26.7	0.282	6.54	98.004	19.88	6.82	420	172	20
30	P-30	M D P (A)	D.W.	27.2	0.334	7.85	96.192	14.26	8.25	580	208	32
31	P -31	M D P (A)	D.W.	26.9	0.468	7.85	212.54	34.08	5.12	560	308	20
32	P -32	M D P (A)	D.W.	27.1	0.356	8.86	68.937	17.04	6.82	580	200	20
33	P -33	M D P (A)	D.W.	26.3	0.432	6.46	96.192	25.56	6.41	640	256	28
34	P -34	M D P (A)	D.W.	26.2	0.405	6.77	123.44	56.88	8.04	640	240	24

35	P -35	M D P (B)	D.W.	26.9	0.666	8.04	160.32	53.96	6.89	1628	380	28
36	P-36	M D P (A)	D.W.	27.5	0.578	8.45	152.30	25.56	1.54	1842	332	24
37	P -37	M D P (A)	D.W.	27.3	0.389	8.68	115.34	17.04	3.21	2146	228	32
38	P-38	M D P (A)	B.W.	26.9	0.208	7.89	80.263	22.72	7.56	400	60	28
39	P -39	M D P (B)	D.W.	26.5	0.565	7.51	152.30	71.45	9.32	640	280	18
40	P -40	M D P (A)	D.W.	26.8	0.485	6.75	112.22	14.28	4.12	780	292	16
41	P -41	M D P (B)	D.W.	27.5	0.433	6.53	107.41	17.04	5.87	700	248	28
42	P -42	M D P (A)	D.W.	27.2	0.418	7.62	123.46	19.88	9.32	680	260	14
43	P -43	M D P (A)	D.W.	25.9	0.479	6.44	113.82	19.88	6.43	740	280	16
44	P -44	M D P (A)	D.W.	27.5	0.534	7.59	131.41	14.22	6.41	900	340	12
45	P -45	M D P (A)	D.W.	26.1	0.544	6.67	142.68	25.56	10.43	900	308	20
46	P -46	M D P (A)	D.W.	27.5	0.527	6.48	112.22	19.88	5.12	830	336	20
47	P -47	M D P (A)	D.W.	26.4	0.524	8.43	115.43	22.72	8.77	682	286	21
48	P -48	M D P (B)	D.W.	27.1	0.506	6.87	160.32	19.88	6.98	740	340	24
49	P -49	A. P.	D.W.	26.2	0.547	6.75	107.41	28.48	15.59	648	332	24

(A) Table. 2 Hydro-geomorphologic units of the study area

Origin	Geomorphic unit/ Landform	Description	Groundwater potential
Fluvial	Alluvial plain (A.P.)	Thick unconsolidated alluvial material consisting of sand, silt and clay	**Very Good**
Fluvial	Bajada zone (B.Z.)	Unconsolidated alluvial material consisting of rock boulders, cobbles, pebbles, sand and silt	**Good**
Structural	Moderately dissected plateau - A	Basaltic plateau, moderately dissected, with high drainage density with thin	**Poor**

		soil cover	
Structural	Moderately dissected plateau - B	Basaltic plateau, moderately dissected, with high drainage density and thick soil cover	**Moderate**
Structural	Highly dissected plateau -A	Moderate to steeply sloping basaltic plateau margins with high drainage density and negligible soil cover	**Poor**
Structural	Highly dissected plateau - B	Moderately slopping basaltic plateau margins with high drainage density and thin weathered mantle and soil cover	**Poor**
Structural	Plateau top	Isolated basaltic plateau with steep side slopes with moderate soil cover	**Poor**
Structural	Structural ridge	Narrow aligned ridges	**Poor**
Denudation	Denudation hillock	Basaltic hills with steep sided slopes	**Poor**

Table 3. RTable 3 Result of pumping tests results of the Pohra region

Well No	**Safe Yield (Qs) Lts./day**	**Specific Capacity (C) Lts/min/m of D/D**	**Transmissivity (T)**	**Storativity (S)**
1	1,45,143	183	154 sq.mt./day	**0.421**
2	16.543	62	98 sq.mt./day	**0.336**
3	1,62,000	95	78 sq.mt./day	**0.259**
4	68.460	41	69 sq.mt./day	**0.186**

5	72,800	34.46	58 sq.mt./day	**0.892**
6	1,66,2461	98	54 sq.mt./day	**0.454**
7	52,720	21	242 sq.mt./day	**1.982**
8	43,652	26	181 sq.mt./day	**0.665**
9	96,200	31	226 sq.mt./day	**2.421**
10	2,48000	86	56 sq.mt./day	**0.657**
1	43,720	27	204 sq.mt./day	**1.322**
12	61,400	32.26	56 sq.mt./day	**0.863**
13	1,54,000	86	54 sq.mt./day	**0.898**
14	36,720	24	178 sq.mt./day	**1.312**
15	55,400	28.46	75 sq.mt./day	**0.894**
16	1,36,000	78	68 sq.mt./day	**0.593**
17	54,720,	43	189 sq.mt./day	**1.382**
18	63,4000	18.46	64 sq.mt./day	**0.896**
19	1,24,000	106	46 sq.mt./day	**0.392**
20	**48,720**	**68**	**164 sq.mt./day**	**1.324**

*Fracture zone encountered in a well attributes high transmissivity value

Recommendations:

Well No	**Recommendations**
1	**Deepening of well by 6mts. can increase the well yield by 25%-30%**
2	**Fractured and Weathered zone encountered up to the depth of 15 m ts.b.g.l**

3	Fractured and Weathered zone encountered up to the depth of 24 mts.b.g.l
4	Fractured and Weathered zone encountered up to the depth of 16mts.b.g.l
5	Fractured and Weathered zone encountered up to the depth of 14 mts.b.g.l
6	Weathered zone not extending below 15mts
7	Weathered zone not extending below 12mts
8	Weathered zone not extending below 25mts
9	Fractured and Weathered zone encountered up to the depth of 28 mts.b.g.l
10	Feasible for Bore well of depth 220fts. And also for Bore well of depth of 30mts
11	Not feasible
12	Feasible for open well of depth 15mts. And also for Bore well of depth of 195mts
13	Not feasible
14	Fractured and Weathered zone encountered up to the depth of 38 mts.b.g.l
15	Fractured and Weathered zone encountered up to the depth of 26 mts.b.g.l
16	Fractured and Weathered zone encountered up to the depth of 32 mts.b.g.l
17	Weathered zone not extending below 14mts
18	Weathered zone not extending below 12mts
19	Weathered zone not extending below 15mts
20	Feasible for Bore well of depth 164mts. And also for Bore well of depth of 58mts

Table 4. Pumping test results obtained at the Pohra Region

Well	Depth of	Diamet er	Water	Q	DD	Max. DD	REC recorde	% of REC

					recorded		d	
no.	well (m)	(m)	Level(m)	(m^3/d)	(in min)	observed	(in min)	observed
1	23.45	2.32	3.89	25.07	138	1.41	160	78.72
2	31.98	1.35	5.23	21.21	179	0.55	268	62.54
3	20.23	1.07	7.64	13.77	150	0.53	180	94.23
4	19.14	1.28	4.57	21.00	210	0.55	250	101.24
5	25.85	1.98	5.88	307.13	60	3.19	120	56.23
6	16.76	1.12	6.25	21.85	182	0.39	180	95.42
7	12.19	1.26	7.03	26.71	154	1.46	240	73.55
8	15.24	1.73	8.95	42.39	186	0.33	92	103.05
9	22.25	1.14	14.07	12.74	160	0.60	240	83.00
10	18.29	1.60	15.15	22.69	170	0.58	300	96.28
11	20.76	2.59	6.38	91.76	150	0.49	300	101.78
12	19.64	1.52	6.25	24.83	120	0.45	248	84.00
13	15.85	1.98	4.88	307.13	80	3.19	140	51.23
14	16.76	1.82	6.89	21.85	190	0.39	190	98.44
15	12.19	1.76	5.82	26.71	130	1.48	220	72.55
16	16.24	1.78	6.98	42.39	164	0.33	98	100.22
17	20.65	1.44	12.05	12.74	182	0.66	240	84.00
18	18.23	1.86	14.12	22.69	186	0.52	321	96.28
19	19.76	2.24	6. 86	91.76	148	0.59	306	100.52
20	18.84	1.82	6.85	24.83	134	0.44	242	96.00

Well no. & location: 1.; 2.; 3.; 4., 5. 6.; 7. ,; 8. 9., ..; 10.; 11. 12.; Q = discharge rate (in m^3/day); DD = Drawdown (in m); REC = Recovery.

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