CHAPTER 6

GROUNDWATER LEVEL VARIATIONS AND AQUIFER PARAMETERS
6.1 GROUNDWATER LEVEL AND ITS VARIATION

It is well observed phenomenon in northern part of India that the water reaches to its shallowest level due to the maximum rainfall recharge in the month of November and it recedes to deeper water level conditions in the month of June.

Groundwater level in an unconfined aquifer is much sensitive to fluctuation. This may be because of pumping influence in near by area, river stage and also because of groundwater movements. The data collected from observation wells were used in interpretation of depth to water, movement and fluctuation of water level.

6.1.1 Depth to Water Table

In an unconfined aquifer the water table is the upper surface of the zones of saturation where hydrostatic pressure is equal to atmospheric pressure and may be defined as the water column which stands in well penetrating the aquifer. The water level standing in the dug wells are considered accurate enough to represent the water level in the area (Fetter, 1988). The depths to water table maps depict the regional variations of the water level with respect to land surface all over the area and are useful in deciphering the area of recharge and discharge. Recharge areas are characterized by deeper water table while shallow water table below the land surface indicates discharge area (Fetter, 1988).

The depth to water table map of the area has been prepared using water level data collected from a network of evenly spaced observation wells (Appendix III B, C, D, and E). Water level maps for pre- and post-monsoon periods were prepared for the years 2006 and 2007 (Figures 6.1a, 6.1b and 6.2a, 6.2b).

In pre-monsoon seasons, i.e. June 2006 and 2007, the depth to water level ranges from 9.87 to 27.78 m and 9.76 to 29.44 m below ground level, respectively. The deepest water levels viz. 27.78 m in June 2006 and 29.44 m in June 2007 were recorded at the location Lank. The shallowest water level, i.e. 9.87 and 9.76 m bgl was observed at Qutubpur Datana (Appendix IIIB and IIID).
Figure- 6.1a Pre-monsoon depth to water level map (June 2006)
Figure- 6.1b Pre-monsoon depth to water level map (June 2007)
The area has been divided into 10 depth to water level zones varying from (1) <10 - 12, (2) 12 - 14, (3) 14 - 16, (4) 16 - 18, (5) 18 - 20, (6) 20 - 22, (7) 22 - 24, (8) 24 - 26, (9) 26 - 28, and (10) > 28 m bgl.

A perusal of the maps show that water levels are shallow along Hindon river which ranges from 9.87 to 15.18 m bgl and 9.76 to 15.76 m bgl during June 2006 and June 2007 at Qutubpur Datana and Budhana, respectively. The deep water table conditions occur in the central tract of the study area. Moreover, during field surveys in pre-monsoon season both the rivers and canals were found partially dried and only stagnant patches of water were noticed.

A comparative study of pre-monsoon depth to water maps of 2006 and 2007 reveals that the water level in most of the observation wells shows declining trend with time. The maximum decline of water level occurs at locations Kharar, Daha and Lank, i.e. 2.32, 2.05 and 1.66 m, respectively.

In post-monsoon season, i.e. November 2006 and November 2007, the depth to water level ranges from 8.9 - 27.46 and 9.67 - 29.28 m bgl at location Qutubpur Datana and Lank, respectively (Appendix III C and III E). A perusal of November 2006 depth to water level map (Figure 6.2a) shows that the shallow water level zone is confined to the vicinity of Hindon river which gradually deepens due west, i.e. in the central part of the study area. Likewise, in November (2007) depth to water level map (Figure 6.2b) shallow water table is found to occur along Hindon river which gradually deepens towards west i.e. in the central part of the study area.

6.1.2 Water level Fluctuation

The difference between successive rise and fall in the water level in observation wells during a year is called fluctuation, where rise is due to the recharge and fall because of the discharge.

The measurement of water level fluctuations in observation wells is an important facet of groundwater studies (Freeze and Cherry, 1979). Differences in the quantities of groundwater supply and disposal in specific time interval results in changes in storage and fluctuations of groundwater levels. A rise in water level indicates that accretion to groundwater storage is taking place. Similarly, a decline in the water level indicates that the groundwater in storage is being depleted (Karanth, 1987).
Figure- 6.2a Post-monsoon depth to water level map (November 2006)
Figure- 6.2b Post-monsoon depth to water level map (November 2007)
Water level fluctuations can result from a wide variety of hydrological phenomena, both natural and anthropogenic. In many cases there may be more than one mechanisms operating simultaneously and if measurements are to be correctly interpreted, the mechanisms involved are to be understood properly. These may be rainfall infiltration to the water table, air entrapment during groundwater recharge, bank storage effects near streams, atmospheric pressure effects, groundwater pumpage, seepage through canal beds and agricultural irrigation and drainage (Freeze and Cherry, 1979). Near streams, the water level fluctuations are in response to changes in the river stage. The magnitude and extent of these fluctuations depend on the relative head differences between groundwater and surface water levels, slope of the water table, permeability and specific yield of the materials.

The magnitude of water level fluctuation also depends on climatic factors, drainage, topography and geologic conditions. Water level fluctuation in response to precipitation is comparatively greater in the uplands, corresponding to recharge areas than in lowlands and valley bottoms, corresponding to discharge areas.

The fluctuations are represented by way of contours of water level differences in pre and post monsoon. Water levels for the period of June and November 2006 and 2007, respectively (Figures 6.3 and 6.4). The difference of groundwater level shows a seasonal pattern of fluctuations. The water level fluctuation in the study area is of both the types, i.e. positive and negative showing rise and fall in water level, respectively. These fluctuations pertain to conditions where in recharge exceeds the discharge and vice versa.

A perusal of fluctuation map for the year 2006 (Figure 6.3), shows that the area is demarcated by three fluctuation zones with an interval of 0.5 m, i.e. (1) -0.5 to 0 m, (2) 0 to 0.5 m, and (3) 0.5 to 1.0 m. In general, the fluctuations range between 0 to 1 m. A major portion of the area is represented by 0 to 0.5 m fluctuation zone. The maximum fluctuation, i.e. 0.97 m is recorded at Qutubpur Datana in the southeastern part of the area. A fluctuation of >0.5 m was observed all along river Hindon from Jasoi to Qutubpur and is due to combined effects of recharge from rainfall and inflow from the river.

The water level fluctuation map of year 2007 (Figure 6.4), shows that the area can be divided into five zones with an interval of 0.5 m, i.e. (1) -1.5 to -1.0 m, (2) -1.0 to -0.5 m, (3) -0.5 to 0 m, (4) 0 to 0.5 m, and (5) 0.5 to 1.0 m. Positive fluctuation is
Figure 6.3 Water level fluctuation map for the year 2006
Figure 6.4 Water level fluctuation map for the year 2007
observed all along river Hindon and at the down reaches of Krishni river which may be attributed to some local factors like recharge by river water. Most of the central part has fluctuations ranging from -0.5 to 0 m. The maximum negative fluctuation zone, i.e. -1.5 to -1.0 m is restricted to a smaller part in the vicinity of Krishni at Chajpur and Kharar. The statistical analysis of water level fluctuation (2007) data is shown in Table 6.1.

Table 6.1: Statistical analysis of water level fluctuation in 2007

<table>
<thead>
<tr>
<th>Fluctuation range (m)</th>
<th>Numbers of observation well</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.5 to -1.0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>-1.0 to -0.5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>-0.5 to 0</td>
<td>13</td>
<td>33</td>
</tr>
<tr>
<td>0 to 0.5</td>
<td>18</td>
<td>46</td>
</tr>
<tr>
<td>0.5 to 1.0</td>
<td>03</td>
<td>8</td>
</tr>
</tbody>
</table>

The above Table shows that the positive groundwater fluctuation is characterized by 54% of the total number of wells, i.e. 21 wells, 33% of the wells fall in -0.5 to 0 m zone. Zone with fluctuation from -1.0 to -0.5 m is characterized by a meager 8% wells. The zone of maximum negative values is characterized by 2 wells corresponding to 5% of the total wells. This negative fluctuation is explained by the fact that the area is receiving below average rainfall since last five years. However, the abstraction scenario is same or slightly higher than the previous years. This has pushed the study area in to a complicated and alarming situation where in the discharge is exceeding the groundwater recharge.

6.2 WATER TABLE CONTOURS AND GROUNDWATER MOVEMENT

Water level data of wells collected during pre monsoon and post monsoon for the year 2006 and 2007 were analyzed and altitude of water level with reference to the mean sea level (msl) was worked out. Reduced levels of water table with reference to msl were plotted and water table contour maps were generated with contour interval of 2 m. These maps are very useful in deciphering the groundwater flow direction, gradient and areas of recharge and discharge. Convex contours indicate area
Figure- 6.5a Pre-monsoon water table contour map for June 2006
Figure- 6.5b Pre-monsoon water table contour map for June 2007
of groundwater recharge while concave contours show tract of groundwater discharge (Todd, 1980). Further, the divergence of flow lines indicates a recharge area whereas the convergence of flow lines depict the discharge area (Fetter, 1988).

6.2.1. Groundwater Conditions during Pre-monsoon Seasons

The elevation of water table ranges from 230 m in the NE at Budhina Kalan to 200 m in the SW at Rahatna (Figure 6.5a and 6.5b). The general direction of the flow is north to south. However, locally some different flow directions are also witnessed which in all likelihood are due to over abstraction of groundwater.

In general, the gradient varies from 3.3 m/km in the NE to 0.82 m/km in the SW during the premonsoon period of 2006. In the central part of the area, there are two significant groundwater trough observed at Mohammadpur Raising and Lank. The possible reason for these troughs is indiscriminate pumping of groundwater for agricultural uses. Evidently, due to excessive withdrawal the flow direction of groundwater movement has been disturbed locally. The groundwater trough at Mohammadpur Raising is much prominent than that of Lank. The hydraulic gradient is 2.4 m/km at Mohammadpur Raising and 1.7 m/km at Lank.

At Mohammadpur Raising in the NE and Barnawa in the south, hydraulic gradient is steep, i.e. 3.3 m/km and 2.4 m/km, respectively. Such a steep gradient is generally considered a result of either heavy withdrawal of groundwater or lower permeability in the aquifer material. It has been observed in the field that the area is excessively pumped. Thus, it may be inferred that the steep gradient in these areas is due to excessive abstraction rather than low permeability conditions. Krishni seems to be influent through out its course. Hindon river is also influent, in general.

The heavy groundwater withdrawal in the vicinity of river has strong bearing on determining the nature of river-aquifer interaction. Since, the groundwater draft is, more or less, uniform throughout the year, the contour pattern depicted seems to be permanent in nature. The average annual decline of water level from pre-monsoon 2006 to pre-monsoon 2007 is 0.94 m.

6.2.2 Groundwater condition during post-monsoon seasons

The elevation of water table contours range from 231 m in the NE to 201 m in the SW (Figures 6.6a and 6.6b). Post-monsoon contours remain more or less same as those of pre monsoon period. The only difference is that although the two troughs that
Figure- 6.6a Post-monsoon water level contour map for November 2006
Figure- 6.6b Post-monsoon water level contour map for November 2007
developed in the pre monsoon period (2006) persist, the one in the NW becomes smaller. The troughs at Mohammadpur Raising and Lank, therefore, seem to be permanent features of the groundwater regime of the area. General groundwater flow is north to south with some minor variations in the southern part of the area. These may be attributed to local factors, such as, pumping and other anthropogenic influences.

In general the gradient varies from 0.75 m/km in SW to 4.2 m/km in NE. Steep gradient is indicated from Bhurakalan to Mohammadpur Raising in the northeastern part and from Barnawa to Shajahanpur in the region also where Krishni and Hindon join one another.

6.3 LONG TERM BEHAVIOR OF WATER LEVELS - HYDROGRAPHS
Water level data provide records of short term changes and long term trends of fluctuations of storage within groundwater reservoirs. Data on groundwater levels may be used for various objectives, such as (Walton, 1970):

(1) Identifying areas of detrimentally low or high water levels
(2) Facilitating prediction of groundwater supply outlook for the future by showing the time-rate of change in groundwater storage
(3) Appraising the relationship between water level fluctuations and pumping, precipitation, and other factors
(4) Indicating the status of groundwater in transit
(5) In aiding the base flow of streams
(6) In furnishing information for use in research

Historical water level data of 5 permanent hydrograph stations were collected from Central Ground Water Board (CGWB) and State Groundwater Department (UPSGWD). The data were utilized to prepare hydrographs with a view to study their behaviour with respect to time and space and their dependence on natural phenomenon.

Water levels in water table aquifers are affected by direct recharge from precipitation, evapotranspiration, withdrawals from the wells and discharge to streams, and sometimes changes in atmospheric pressure. The water level, therefore, has a rising and declining trend with respect to time and a function which causes such rises in water levels, i.e. availability of rainfall (Walton 1970).
Perusals of hydrographs indicate that the water level variation is cyclic and sinusoidal as a function of time and space. For a year, the water level is deepest during the month of June and shallowest during the month of November. It is observed that the water level starts rising by the last week of June and attains shallowest level in November. In overdeveloped areas a downward trend of water levels may continue for many years because of continual increases in pumpage or withdrawals in excess of recharge, or both.

Hydrographs of five permanent stations were plotted which show progressive declining trend in the study area which is is pronounced and persistent (Figures 6.7a, 6.7b and 6.7c). A trend line was fitted on all the graphs. Using 't' statistics for testing the significance of the observed regression coefficient, the values of $R^2$ and $R$ for the given data set are 0.83, 0.81, 0.94, 0.23, 0.91 and 0.91, 0.97, 0.48, 0.95 for Phusar, Daha, Budhana, Barnawa, and Shamli stations, respectively. The significance level of all the values varies between 0.01 and 0.001, which is quite good fitting with 99% of confidence. The average annual decline of groundwater in area is given in Table 6.2.

Table 6.2: Average annual declines in the area

<table>
<thead>
<tr>
<th>Hydrograph station</th>
<th>Average annual decline (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phusar</td>
<td>1.03</td>
</tr>
<tr>
<td>Daha</td>
<td>0.98</td>
</tr>
<tr>
<td>Budhana</td>
<td>0.31</td>
</tr>
<tr>
<td>Barnawa</td>
<td>0.07</td>
</tr>
<tr>
<td>Shamli</td>
<td>1.10</td>
</tr>
</tbody>
</table>
Figure 6.7a Long term water level fluctuation trends at Phusar and Daha

Figure 6.7b Long term water level fluctuation trends at Budhana and Barnawa

Figure 6.7c Long term water level fluctuation trends at Shamli
6.4 TEMPORAL VARIATION IN WATER TABLE AND MONTHLY RAINFALL

The monthly rainfall data has been collected from Shamli and Budhana raingauge stations. Graphs of monthly rainfall and water level were prepared to see the impact of rainfall on water table. The close analysis of the graphs shows that rainfall is a major source of groundwater recharge. This is depicted in the rise of water level at the end of the monsoon period. Groundwater recharge is maximum in monsoon months and minimum in non-monsoon time period.

Extended dry periods have pronounced adverse effects on water levels; groundwater storage is considerably reduced during these periods. In areas of heavy pumping, the hydrograph often show the seasonal and secular fluctuation not because of natural phenomena but also because of seasonal fluctuation in pumping rates.

The scanty and below average rainfall in the last nine years at Shamli has affected the groundwater regime in the area and is clearly depicted in Figure 6.8a. The rainfall in the year 2007 is decreased by 16% of the average at the Shamli raingauge station. This has given rise to almost flat trend of water level which was earlier characterized by sharp rise in the month of November and decline in June.

The long term water level data of Budhana and Daha (Figures 6.8b and 6.8c) show that the intensity and magnitude of rainfall has decreased considerably which has resulted in sharp decline in water levels. A critical study of hydrographs indicates that the ascent of level is also affected by the intensity and distribution of rainfall.

6.5 AQUIFER PARAMETERS

The aquifer parameters discussed here include isopermeability and hydraulic conductivity as determined in laboratory. In addition, there is a discussion on parameters assessed using the pump test.
Figure 6.8a Temporal variation of rainfall and water level at Shamli

Figure 6.8b Temporal variation of rainfall and water level at Budhana

Figure 6.8c Temporal variation of rainfall and water level at Budhana – Daha
6.5.1 Isopermeability

Logan (1964) reasoned that if a well is pumped for such a long period that the flow is in steady state, then an approximate estimation of the order of magnitude of the transmissivity can be made using the Theims formula for a confined aquifer which can be written as:

\[
T = \frac{2.3 Q \log \left( \frac{r_{\text{max}}}{r_w} \right)}{2 \pi S_{\text{mw}}} 
\]  

\[ \quad \ldots (1) \]

Where,

- \( R \) = radius of pumped well in m
- \( r_{\text{max}} \) = radius of influence in m
- \( S_{\text{mw}} \) = maximum drawdown in the pumped well in m

Logan further stated that the accuracy of the calculation depends only on the accuracy of measurement of \( S_{\text{mw}} \) (on which well losses may have substantial influence and on the accuracy of the ratio \( r_{\text{max}}/r_w \). As \( r_{\text{max}}/r_w \) cannot be accurately determined generally, Logan opined that although the variation in \( r_{\text{max}} \) and \( r_w \) may be substantial, the variation in the logarithm of their ratio is much smaller. Hence, assuming average conditions of the ratio, he suggested a value of 3.33, for log ratio which may be taken as rough approximation.

Substituting the value given above in the equation (1), we get the Logan’s formula,

\[
T = \frac{1.22 Q}{S_{\text{mw}}} 
\]  

\[ \quad \ldots (2) \]

Where, \( S_{\text{mw}} \) is the maximum drawdown in a pumped well.

According to Krusemen and de Rider (1970) Logan’s formula in the above form gives erroneous results of the order of 50% or more. However, based on Logan’s approach, an isopermeability map of the area was prepared (Figure 6.9). For the purpose, specific capacity and drawdown data of various tube wells were collected and utilised for the determination of transmissivity and permeability by
Figure- 6.9 Logan’s Isopermeability map
Logan’s formula. A perusal of the isopermeability map of the area shows that there are five isopermeability zones, viz. (1) 10-20, (2) 20-30, (3) 30-40, (4) 40-50, and (5) >50 (the unit being m/day). The permeability range of 20 to 30 m/day covers the major portion of the study area, which gradually increases towards southeast of Hindon river.

The maximum value is 54 and 51 m/day at Babri and Barnawa, respectively, in the norther and southern parts of the study area. Here sand percent values are also more, i.e. 50 and 58%, respectively. The area in the middle of Krishni- Hindon Interfluve, particularly around villages Bhaju, Bhanaura Khurd and Jaula, have low permeability values, i.e. 10-20 m/day and these locations are characterized by lower sand percent, i.e. <44%. Some areas show very high sand percent (54 to >69%) but the permeability values recorded are low (30-40 m/day). This may possibly be attributed to subtle variation in grain size, sorting characteristics and grain packing, representing microscopic inhomogeneities that control permeability and thus the fluid flow characteristics. In general the permeability values decreases from north to south but the southern part of the area shows again an increasing trend up to the meeting point of the two rivers.

6.5.2 Laboratory Estimation of Hydraulic Conductivity

Hydraulic conductivity $K$ of an aquifer is known to depend both upon the fluid properties and properties of transmitting medium. For the present study, 6 aquifer material samples (sand) were collected from drilling sites and their permeability was determined using constant head permeameter. Permeability can be obtained using the Darcy’s Law by measuring the volume of water ($V$) percolated through the sample of cross-sectional area ($A$) and length ($L$) in given time ($t$) under a constant head ($h$) at laboratory (constant) temperature. The equation used is:

$$K = \frac{VL}{hAt}$$

The hydraulic conductivity obtained by permeameter ranges from 1.07 to 3.84 m/day, which correspond to typical conductivity value for fine grained size material (Todd, 1980). These values are an order of magnitude lower than those estimated by pumping tests in adjacent area by Bhatnagar et al., (1982). The permeability values obtained by permeameter represent the sample from shallow depth. The size of sand tested varies from very fine to fine. Therefore, the values obtained are at lower side.
Moreover, natural set-up is also altered because of compaction of the sand grains in confined environment.

The estimated permeability of various aquifer materials is tabulated below in Table 6.3.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Location</th>
<th>Depth (m)</th>
<th>K(m/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fatehpur</td>
<td>43</td>
<td>1.07</td>
</tr>
<tr>
<td>2</td>
<td>Fatehpur</td>
<td>60</td>
<td>3.84</td>
</tr>
<tr>
<td>3</td>
<td>Sarai</td>
<td>50</td>
<td>2.65</td>
</tr>
<tr>
<td>4</td>
<td>Bhaju</td>
<td>66</td>
<td>1.801</td>
</tr>
<tr>
<td>5</td>
<td>Jaula</td>
<td>33</td>
<td>2.56</td>
</tr>
<tr>
<td>6</td>
<td>Jaula</td>
<td>66</td>
<td>3.56</td>
</tr>
</tbody>
</table>

6.5.3 Pump Test

Gupta et al., (1985) conducted 9 pump tests in Krishni-Hindon inter-strem region. The reported transmissivity value ‘t’ calculated from pump test data in the area of study ranges from 720 to 1820 m²/day and are given in Table 6.4.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Transmissivity (m²/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29° 17' 30&quot;</td>
<td>77° 22'</td>
<td>720</td>
</tr>
<tr>
<td>2</td>
<td>29° 16'</td>
<td>77° 24' 30&quot;</td>
<td>1060</td>
</tr>
<tr>
<td>3</td>
<td>29° 16'</td>
<td>77° 28'</td>
<td>1100</td>
</tr>
<tr>
<td>4</td>
<td>29° 15'</td>
<td>77° 28'</td>
<td>1100</td>
</tr>
<tr>
<td>5</td>
<td>29° 13' 30&quot;</td>
<td>77° 27'</td>
<td>1120</td>
</tr>
<tr>
<td>6</td>
<td>29° 14'</td>
<td>77° 29'</td>
<td>1180</td>
</tr>
<tr>
<td>7</td>
<td>29° 13' 20&quot;</td>
<td>77° 23' 25&quot;</td>
<td>1200</td>
</tr>
<tr>
<td>8</td>
<td>29° 11'</td>
<td>77° 26' 45&quot;</td>
<td>1820</td>
</tr>
<tr>
<td>9</td>
<td>29° 10'</td>
<td>77° 24' 40&quot;</td>
<td>1390</td>
</tr>
</tbody>
</table>

6.6 INFERENCE

Depths to water table during pre- and post-monsoon range between 9.87 to 27.78 m bgl and 8.9 to 27.46 m bgl, respectively, in 2006. In 2007, the water level varies...
between 9.76 to 29.44 m bg! and 9.67 to 29.28 m bgl, respectively. The shallowest occurrence is recorded at Qutubpur Datana while the water table is deepest at Lank.

In one year period, i.e. June 2006 and June 2007, there had been lowering of water table by up to 2.32 m. Similar observations were made during November in the corresponding years. In general, water table is relatively shallow along river Hindon and deeper in the central part.

The water level fluctuation ranges from -0.49 to 1.0 m and -1.5 to 1.0 m in 2006 and 2007, respectively. The water level fluctuation during 2007 is insignificant due to below average rainfall.

Water table contour maps have revealed that the movement of groundwater is, in general, from north to south. Hydraulic gradient during pre- and post-monsoon periods has been estimated at 0.82 – 3.3 and 0.75 – 4.2 m/km, respectively.

At places the gradient is rather steep. For example, it is 2.4 to 3.3 between Mohammadpur Raising and Barnawa. This seems to be related to excessive pumping.

Two significant groundwater troughs have been observed in the middle of the area at Mohammadpur Raising and Lank. Evidently, these are persistent features and could have developed as a result of excessive and indiscriminate pumping.

Historical water level data of 5 permanent monitoring wells were analysed. These hydrographs show declining trend. The average annual decline of groundwater is from 0.073 to 1.1 m.

An isopermeability map has been prepared using Logan (1964) approximation. The permeability ranges from 12 to 54 m/day. The bulk of the area is represented 20-30 m/day permeability zone.

The hydraulic conductivity of aquifer materials were also determined by constant head Permeameter, and the values obtained by Permeameter ranges from 1.07 to 3.84 m/day which correspond to typical conductivity value of fine grained size. These values are lower than the pumping test values. The possible reason for low values are that the sand samples are fine grained. Moreover, the natural setup is also altered because of compaction of the sand grains in confined environment whereas transmissivity of aquifer evaluated by pumping test in previous studies ranges between 720 and 1820 m²/day.