CHAPTER – III

HYDROGEOLOGY

3.1 INTRODUCTION

River basins are the traditional agricultural land because of their highly favourable geomorphic terrain, productive soil cover and abundant water supply. These basins with rich alluvial soil, which gets enriched annually, and good irrigation network of canals and tube wells, support multiple cropping patterns and provide relatively high crop yield. Over the years, changing trend in land use pattern is noticed in river basins and the reasons could be due to changing farming techniques, aquaculture, population growth and advances in biotechnology (Vaidhyanadhan, 1964). Tamil Nadu state having a geographical area of 1,30,058 Km² is endowed with a diversified hydrogeological regime. It is drained by a number of major and minor rivers of ephemeral nature. The excess stress on groundwater resource development has critically damaged the environment and resulting in manifestation of problems viz, progressive lowering of water levels and consequent decline in the yield and productivity of the wells, ingress of sea water along the coast etc. thus causing a serious damage to the socio-economic conditions (Chakkarapani et al., 1996). The intensive urbanization coupled with uncontrolled population explosion increases the demand for water day by day. The gap between demand and supply by Government agencies widens rapidly, forcing individuals and private agencies to create their own sources, mainly from groundwater.
3.2 HYDROMETEOLOGY

The science of hydrogeology is primarily concerned with the evaluation of occurrence, availability and quality of groundwater (Lohman, 1979). Evaluation of aquifer parameters is an important aspect of all groundwater resource assessment. Groundwater is basically a dynamic resource, which may be expressed as the quantity of water measured by the difference between optimum and minimum water table within the aquifer. This annual periodic fluctuation of water table results from the natural annual hydrological cycle where groundwater-yielding aquifer is principally recharging through rainwater (Satyajit Biswas, 2003). Recharging also depends on the other factors such as climate, geomorphology, topography, soil and most importantly sub surface geology. More than 50 % percent of rainfall of Tamil Nadu is contributed by the northeast monsoon, which occurs during the months of October, November and December. One or two cyclone crosses the area during this season with heavy rain. This state is also receiving rain through southwest monsoon and non-monsoon rain.

To have a better understanding in the field of hydrogeology, a periodical hydrometeorological monitoring is needed. Some of the important hydrometeorological parameters are rainfall, temperature, evaporation, evapotranspiration, humidity, soil moisture and wind velocity.

3.2.1 CLIMATE

The study area enjoys tropical climate and falls in a semi arid region. The area of study includes highly elevated region, gentle slope
and low-lying coastal plain. There are four rain gauge stations situated in this area namely, Tiruchuli, Kamudhi, Mudukulathur and Kadaladi. Long-term rainfall data have been collected from various Central and State Government organizations. From these data (1992 – 2001), after the computation of average annual rainfall, an isohyetal map has been prepared (Fig. 3.1). The area receives rainfall mostly by the influence of the two monsoons, viz: Northeast Monsoon and Southwest Monsoon. Occasionally, non-monsoon rainfall also contributes sufficient amount of precipitation. The average annual rainfall of the study area is 700 mm and state average annual rainfall is 1030 mm (Ram Mohan, 1984). The average annual rainfall for 10 years period (1992 – 2001) of the study area is given in table 3.1.

3.2.2 Temperature

The area experiences the tropical climate, which has mean maximum temperature of 35° C in the summer to mean minimum temperature above 24° C; rarely the temperature exceeds the maximum. The highest temperature is recorded during the months of May and June while the minimum is encountered during the end of November, December and January. The general hydrometeorological data collected for the year 2001 from the Public Works Department is enlisted in table 3.2. The mean maximum temperature for the year 2001 is recorded in the month of April and May (41° C and 40° C respectively) and the minimum is observed in the month of January (28° C) (Table 3.2). The hottest days fall in the months of April and May while coldest days is felt in December and January. The temperature starts to rise from mid February and reach the maximum during April. By the influence of southwest monsoon, the temperature is brought down to a little from June and after
<table>
<thead>
<tr>
<th>Rain Gauge Station</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>NE Monsoon</th>
<th>SW Monsoon</th>
<th>Non Monsoon Rainfall</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td>Tiruchuli</td>
<td>6.1</td>
<td>19.6</td>
<td>4</td>
<td>16.2</td>
<td>30.5</td>
<td>24.3</td>
<td>23.4</td>
<td>31.5</td>
<td>85</td>
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<td>262.1</td>
<td>164.2</td>
<td>76.4</td>
<td>502.7</td>
</tr>
<tr>
<td>Kamudhi</td>
<td>37.9</td>
<td>13.2</td>
<td>24.4</td>
<td>55.6</td>
<td>42.4</td>
<td>12.5</td>
<td>26.4</td>
<td>49</td>
<td>56.1</td>
<td>151.4</td>
<td>152.9</td>
<td>59.2</td>
<td>363.5</td>
<td>144</td>
<td>131.1</td>
<td>661</td>
</tr>
<tr>
<td>Mudukutthur</td>
<td>48.9</td>
<td>19.2</td>
<td>26.9</td>
<td>45.4</td>
<td>35.8</td>
<td>8.4</td>
<td>27.4</td>
<td>56.8</td>
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<td>176.2</td>
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<td>98</td>
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<td>20</td>
<td>15</td>
<td>10</td>
<td>14</td>
<td>10</td>
<td>74</td>
<td>121</td>
<td>180</td>
<td>255</td>
<td>556</td>
<td>108</td>
<td>239</td>
<td>905</td>
</tr>
</tbody>
</table>

**Table 3.1 Average Annual Rainfall in Lower Gundar Basin (1992 – 2001) (mm)**
<table>
<thead>
<tr>
<th>Month</th>
<th>Average Temperature (°C)</th>
<th>Maximum Temperature (°C)</th>
<th>Minimum Temperature (°C)</th>
<th>Average Humidity (%)</th>
<th>Average Evaporation (mm/day)</th>
<th>Average Soil Moisture (%)</th>
<th>Average Wind Velocity (Km/hr)</th>
<th>Average Sun Shine (hrs/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>33.00</td>
<td>30.5</td>
<td>28.00</td>
<td>73</td>
<td>137.00</td>
<td>5.97</td>
<td>8.91</td>
<td>8.27</td>
</tr>
<tr>
<td>February</td>
<td>34.00</td>
<td>31.5</td>
<td>30.00</td>
<td>67</td>
<td>138.20</td>
<td>8.36</td>
<td>9.24</td>
<td>8.36</td>
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<tr>
<td>March</td>
<td>39.50</td>
<td>36.75</td>
<td>34.00</td>
<td>66.5</td>
<td>222.00</td>
<td>6.56</td>
<td>6.96</td>
<td>6.56</td>
</tr>
<tr>
<td>April</td>
<td>41.00</td>
<td>36.75</td>
<td>32.50</td>
<td>63</td>
<td>236.60</td>
<td>6.96</td>
<td>6.19</td>
<td>7.17</td>
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<tr>
<td>May</td>
<td>40.00</td>
<td>37.5</td>
<td>35.00</td>
<td>63</td>
<td>234.80</td>
<td>6.86</td>
<td>6.94</td>
<td>7.95</td>
</tr>
<tr>
<td>June</td>
<td>39.50</td>
<td>37.25</td>
<td>35.00</td>
<td>64</td>
<td>241.50</td>
<td>6.55</td>
<td>6.85</td>
<td>8.36</td>
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<tr>
<td>July</td>
<td>39.50</td>
<td>36.75</td>
<td>35.00</td>
<td>65</td>
<td>267.90</td>
<td>18.57</td>
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<td>7.35</td>
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<td>August</td>
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<td>36.75</td>
<td>35.00</td>
<td>58</td>
<td>235.70</td>
<td>15.41</td>
<td>14.58</td>
<td>7.60</td>
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<tr>
<td>September</td>
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<td>36.75</td>
<td>32.00</td>
<td>72</td>
<td>231.20</td>
<td>14.38</td>
<td>17.96</td>
<td>8.30</td>
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<tr>
<td>October</td>
<td>34.00</td>
<td>31.5</td>
<td>29.00</td>
<td>71</td>
<td>108.90</td>
<td>7.01</td>
<td>7.06</td>
<td>6.26</td>
</tr>
<tr>
<td>November</td>
<td>33.00</td>
<td>31.5</td>
<td>29.00</td>
<td>71.5</td>
<td>114.90</td>
<td>5.64</td>
<td>5.43</td>
<td>7.51</td>
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<tr>
<td>December</td>
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<td>30.25</td>
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<td>68.5</td>
<td>131.10</td>
<td>5.49</td>
<td>5.49</td>
<td>8.15</td>
</tr>
</tbody>
</table>
onset of northeast monsoon, a considerable lowering of temperature is noticed.

3.2.3 Humidity

The absolute humidity of a given air mass is the number of grains of water present per cubic metre of air. At any given temperature, air can hold a maximum amount of moisture, i.e. the saturation humidity. This is proportional to the temperature of the air. The relative humidity for an air mass is the percentage ratio of the absolute humidity to the saturation humidity. As the relative humidity approaches 100% evaporation ceases. The average annual humidity for the year 2001 is 66.10%. Maximum humidity reaches in the months of November and December while minimum is from March to August in the year 2001 (Table 3.2).

3.2.4 Soil Moisture

Soil moisture is high during the month of December (26.59%) and low during the month of February (8.36%) (Table 3.2).

3.2.5 Evaporation

The highest evaporation is recorded during the month of July (267 mm) for the study area indicating highest temperature and radiation. The lowest is recorded during the month of October (108.90 mm) (Table 3.2).
3.2.6 Evapotranspiration

Evapotranspiration is a concomitant occurrence of both evaporation and transpiration from a bare soil or soil with vegetation. Hydrological studies utilize the concept of potential evapotranspiration (PET), which is defined as the amount of water that would be removed from a land surface by evaporation and transpiration if sufficient water was available in the soil to meet the demand.

Actual evapotranspiration is the proportion of potential evapotranspiration that is actually evapotranspired under existing soil moisture and supply is dependent on the unsaturated soil moisture storage capacity. It is affected by vegetative factors such as plant types and stage of growth (Freeze & Cherry, 1979).

In Lower Gundar basin, soil is wet only for a limited period because of the scanty rainfall and less supply of water for evapotranspiration. During the dry months, soil moisture storage is depleted. Actual evapotranspiration falls below potential evapotranspiration and water deficit occurs after entire available water in the soil is evaporated. The evapotranspiration recorded in the study area for the year 2001 is given in the table 3.2.

3.3 Groundwater Level

The depth to the water level is closely related to topography, influence of surface water bodies extraction and rainfall. From the prevailing rainy seasons, September and January has been chosen for monitoring pre monsoon and post monsoon water levels respectively.
Variation in the groundwater level reflects primarily the mass balance between recharge and discharge and secondarily by the influence of local transmissivity and storativity.

The long-term water level data of this area, for the period between 1992 and 2001 have been collected from Tamil Nadu Water Supply and Drainage Board (TWAD) and Groundwater division of PWID and average annual water levels and fluctuation have been computed. From this computation water level, contour maps have been prepared for both pre- and post monsoon seasons (Figs. 3.2 & 3.3). The depth to the water level varies from 3.5 m to 23.7 m (bgl) during pre monsoon period and 2.9 m to 23.10 m (bgl) in post monsoon (Table 3.3). The water level is deeper in topographically elevated regions and shallower in sand dunes area. From the water level maps, it is inferred the groundwater flow direction is northwest to southeast.

3.4 WATER LEVEL FLUCTUATION

Generally water levels, in phreatic aquifers have fluctuation often due to various reasons. The difference in water levels from pre monsoon to post monsoon seasons, illustrate the fluctuation of any region. Davis and Dewiest (1966) identified some causes for water level fluctuation in the aquifers.

- Changes in atmospheric pressure
- Changes in Ground water storage
- Deformation of aquifer
- Disturbances with in the wells, and
- Chemical or thermal changes in and around the wells
In Lower Gundar basin fluctuation ranges from 0.21 m around Mudukulathur to 3.2 m near Periya Kattangudi (Table 3.3). A thematic map displaying water level fluctuation of this area has been prepared (Fig.3.4). Fluctuation is very high in the central and northwest regions, which are thickly populated places around Kamudhi and Tiruchuli.

### Table 3.3 Average Seasonal Water Level and Fluctuation of Lower Gundar Basin

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Location Name</th>
<th>Pre Monsoon Water Level (m) (bgf)</th>
<th>Post Monsoon Water Level (m) (bgf)</th>
<th>Fluctuation in water level (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sakkarakottai</td>
<td>3.99</td>
<td>3.14</td>
<td>0.85</td>
</tr>
<tr>
<td>2</td>
<td>Pacheri</td>
<td>4.64</td>
<td>4.23</td>
<td>0.41</td>
</tr>
<tr>
<td>3</td>
<td>Chettikulam</td>
<td>4.55</td>
<td>4.31</td>
<td>0.24</td>
</tr>
<tr>
<td>4</td>
<td>Murugaiyapuram</td>
<td>4.5</td>
<td>4.11</td>
<td>0.39</td>
</tr>
<tr>
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<td>Puliyangulam</td>
<td>3.5</td>
<td>3.2</td>
<td>0.3</td>
</tr>
<tr>
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<td>7.2</td>
<td>4.05</td>
<td>3.2</td>
</tr>
<tr>
<td>7</td>
<td>Tiruchuli</td>
<td>5.4</td>
<td>3.7</td>
<td>1.7</td>
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<td>8</td>
<td>Kongalakudi</td>
<td>5.22</td>
<td>3.76</td>
<td>1.46</td>
</tr>
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<td>9</td>
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<td>13.7</td>
<td>11.32</td>
<td>2.38</td>
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<td>10</td>
<td>Sethupuram</td>
<td>4.8</td>
<td>3.7</td>
<td>1.1</td>
</tr>
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<td>11</td>
<td>Kil Taraikudi</td>
<td>10.07</td>
<td>8.64</td>
<td>1.43</td>
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<td>3.7</td>
<td>3.1</td>
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<td>Abiramam</td>
<td>23.7</td>
<td>23.1</td>
<td>0.6</td>
</tr>
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<td>14</td>
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<td>9.22</td>
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<td>15</td>
<td>Marudanganalur</td>
<td>5.46</td>
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<td>1.75</td>
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<td>16</td>
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<td>8.2</td>
<td>6.04</td>
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<td>0.21</td>
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<td>7.2</td>
<td>2.6</td>
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<td>19</td>
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<td>21</td>
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<td>2.9</td>
<td>2.2</td>
</tr>
<tr>
<td>22</td>
<td>Terkukadukusanthai</td>
<td>3.56</td>
<td>3.01</td>
<td>0.55</td>
</tr>
</tbody>
</table>
LOWER GUNDAR BASIN
Average Annual Water Level (1992 - 2001) (m) (bgl) Pre Monsoon

LEGEND
- Below - 4
- 4 - 6
- 6 - 12
- 12 - 18
- Above - 18

Fig. 3.2
LOWER GUNDAR BASIN
Average Annual Water Level (1992 - 2001)
(m) (bgl) Post Monsoon

LEGEND

- Below - 4
- 4 - 6
- 6 - 12
- 12 - 18
- Above - 18

Fig. 3.3
As the annual replenishment of the aquifer primarily depends on the rainfall, study of annual rainfall for the considered period is imperative in analyzing the water level trend and fluctuation (Satyajit Biswas, 2003). In this area, water level changes in response to the monsoon rainfall have been observed. Correlations between average annual rainfall and average annual water level (1992 – 2001) for the four rain gauge stations have been analyzed (Figs.3.5, 3.6, 3.7 & 3.8). From this analysis, it is inferred that the water level rises during October, November and December, by the influence of northeast monsoon. Decline in water level is observed during July, August and September.

3.5 Occurrence of Groundwater in Lower Gundar Basin

Groundwater occur both in crystalline and sedimentary formations of lower Gundar basin under water table condition.

3.5.1 Groundwater in Crystalline rocks

Groundwater occurs in crystalline rocks and consolidated sediments to a limited extent. The loose unconsolidated sediments are the only water bearing zones at shallow depth. In and around Kamudhi, crystalline basement occur at shallow depths, which are highly weathered. The groundwater exists under water table condition in the weathered crystalline rock. The depth to water level varies from 3 to 12 m bgl. The depth of dug wells range from 6 to 14 m bgl and bore wells are drilled up to a depth of 50 m (bgl) in the fractured crystalline zone (IWS, 1998). The pediment and buried pediment of this region, posses moderate groundwater potential.
Fig. 3.5 Average Annual Rainfall Vs Average Annual Water Levels (1992 – 2001) Tiruchuli

Fig. 3.6 Average Annual Rainfall Vs Average Annual Water Levels (1992 – 2001) Kamudhi
**Fig. 3.7 Average Annual Rainfall Vs Average Annual Water Levels (1992 – 2001) Mudukulathur**

**Fig. 3.8 Average Annual Rainfall Vs Average Annual Water Levels (1992 – 2001) Kadaladi**
3.5.2 Groundwater in Tertiary and Cretaceous Sediments

Groundwater occurs under water table and semi confined conditions in Tertiary and Cretaceous formations, consisting of friable sandstones and compact clay that are exposed in north, northwestern and central parts of the study area. Thickness of sediment increases towards the coast. The depth to water table is shallow. Depth of dug wells range upto 10 m (bgl). Depth of the bore wells is in the Tertiary and Cretaceous formations range from 40 m to 100 m.

3.5.3 Groundwater in Alluvium of Recent and sub Recent Sediments

Alluvium consisting of sands, clays and gravels are widely present near the coastal region. Water table is very shallow and dug well depth ranges from 3 m onwards.

3.6 Coastal Hydrology

Coastal aquifers are important sources of groundwater for domestic and agricultural activities in the coastal domain. Coastal hydrogeological conditions can be represented by unconfined, semi-confined or confined aquifers.

In coastal zones, fresh water overlies the saltwater as the density of freshwater, (1 g /ml) is less than that of saltwater (1.022 to 1.031 g /ml). The boundary surface between the two types of water is known as the saltwater – fresh water interface or the interface. The hydrodynamic balance of the fluids governs the shape and movement of the interface.
3.6.1 Basic Principles

Ghyben (1889) developed an analytical expression for the location of the sharp interface and Herzberg (1901) arrived independently at the same conclusion. Their formula relates the elevation of water table in an unconfined aquifer to the elevation of the interface between salt and fresh water (Fig3.9). It is known as the static equilibrium principle and is written as

$$Z = \frac{\rho_f}{\rho_s - \rho_f} h$$  \hspace{1cm} 3.1

where,
\(\rho_f\) is the density of fresh water.
\(\rho_s\) is the density of saltwater
\(Z\) is the depth below sea level to a point on the interface and
\(h\) is the water table elevation above sea level at that point.

![Diagram of the Ghyben-Herzberg Interface Model](image)

Fig. 3.9 THE GHYBEN - HERZBERG INTERFACE MODEL

(\(h_f\) = Fresh water head, \(h_s\) = Depth to interface below sea level)
3.6.2 Saltwater Sources

In any coastal area, seawater forms the main source for saltwater encroachment and the other sources of water are:

1. Seawater that might have entered during sediment deposition or during a high stands of the sea in the geologic past.
2. Concentrated salt beds of various types in geologic formations.
3. Saline water concentrated by evaporation, and
4. Man's domestic industrial and agricultural wastes.

3.6.3 Saltwater Upconing

The change in the normal salinity distribution in coastal aquifers due to discharge is described as an "upconing" of the interface between saline and fresh groundwater. The dispersion of salinity in the aquifer affects the upconing process (Fig.3.10).

![Diagram](image)

Where

$Q$ is Rate of Pumping, $L$ is Depth of the interface below well screen, $K$ is Permeability, and $Z$ is Rise of salt water interface

Fig. 3.10 UPCONING IN SALT WATER
3.6.4 Study Area Detail

In southern coastal region of the study area, encounters shallow fresh water and deeper saline zones, which has been confirmed by geophysical investigations (vide Sub title 5.5.3). Similarly, high salinity exists in few locations in inland, which could only be explained through salt-water upconing that could be due to over exploitation (vide sub title 4.8).

3.7 AQUIFER PARAMETER EVALUATION

Pumping test is conducted to determine (i) the performance characteristic of a well (ii) the hydraulic parameters of the aquifer. For well performance test, yield and drawdown are recorded so that the specific capacity can be calculated. The second purpose of pumping test is to provide data from which the principal factors of aquifer performance – transmissivity and storage coefficient can be calculated, which can be also known as aquifer test. Aquifer test predicts the effect of new withdrawal on the existing well, drawdowns at future times and different discharges and the radius of the cone of influence for individual are multiple wells (Driscoll 1986).

An aquifer test consists of pumping a well at a constant rate and recording the drawdown in and nearby observation wells at specific times. There are two primary types of aquifer tests: constant rate tests and step drawdown tests. In the constant rate test, the well is pumped for a significant length of time same rate whereas in step drawdown test, the well is pumped at successively greater discharge for relatively short period.
For accurate data, the pumping tests are to be carried out systematically. Utmost care is to be taken while recording the time, discharge and depth measurements. The following are the important criteria to be followed during pumping test:

- The maximum anticipated drawdown.
- Volume water pumped and drawdown, and
- Whether observation well are located so that they exhibit drawdown.

The accuracy of drawdown data taken during a pumping test depends on the following:

- Maintaining a constant yield during the test
- Measuring the drawdown carefully in the pumping well and in one or two properly placed observation wells.
- Taking drawdown reading at appropriate time intervals
- Determining how changes in barometric pressure, stream levels and tidal oscillations affect drawdown data.
- Comparing recovery data with drawdown data taken during the pumping portion of the test.

3.7.1 Important Parameters in Aquifer Evaluation

The Static Water Level (SWL), Pumping Water Level (PWL), Draw down (D), Residual Drawdown (RD), Types of tests, Pumping rate (Discharge), Specific capacity (C), Transmissivity (T) and Storage coefficient (S) are the important parameters in aquifer evaluation.
3.7.1.a Static Water Level (SWL)

The water level in a well below ground level with no water being discharged from it either by pumping or by free flow is called static water level. It is generally expressed as the depth from ground surface or from a measuring point above the ground surface to the water level in a well. Saturated thickness can be measured, if the total depth of the well and static water level are known.

3.7.1.b Pumping Water Level (PWL)

The level at which water stands in a well when pumping is in progress is called Pumping Water Level or Dynamic Water Level. To find out this, water level is measured at small intervals during the pumping test. During the course of pumping, the PWL will be changing until the pumping is stopped.

3.7.1.c Draw Down (D)

Draw down in a well is the extent to which the water level is lowered when pumping is in progress. Draw down is the difference between the static water level and pumping water level. This represents the head that causes the water to flow through aquifer material towards the well. Draw down is measured at constant interval. This is measured in each well for a specific duration ranging from 100 minutes to 1,350 minutes. Exploitation of ground water in any region leads to the declining of water level thereby limiting the yield from the aquifers. Hence, the prediction of draw down in an aquifer is important in ground water evaluation while taking up domestic or irrigation project.
3.7.1.d Residual Draw Down (RDD)

After pumping is stopped, water level rises and approaches the initial water level. During such a recovery period, the depth at which the water level is found below the initial static water level is called the residual drawdown. In other words, it is the difference between initial water level and recovered water level.

3.7.1.e Types of Tests

There are two types of tests to determine the safe pumping rate:

(i) Constant discharge test
(ii) Step draw down test

❖ CONSTANT DISCHARGE TEST

This test involves pumping a well at a constant discharge rate and measuring the varying drawdown throughout the test.

❖ STEP DRAW DOWN TEST

This test involves pumping a well at variable discharge rates in controlled stages. The discharge could be increased or decreased. The advantage of this test is that the relationship between drawdown, laminar flow and turbulent flow can be
determined accurately. And indicates whether the tube well has been constructed properly or not.

3.7.1.f Pumping Rate (Discharge)

This is the volume of water per unit of time discharged from a well either by pumping or by free flow. It is measured in litres per minute (lpm) or cubic meter per hour (m³/hr) or cubic meter per day (m³/day).

3.7.1.g Specific Capacity

Specific capacity of a well is the ratio of discharge to draw down (Summers, 1972). It is usually expressed as litres per minute of draw down. Dividing the yield by draw down, each measured at the same times gives the value of the specific capacity. It is a measure of the effectiveness of the well (Todd, 1980). It is not a constant because draw down varies with a number of factors, including length of time since pumping began, rate of pumping, well construction, boundary condition within the aquifer and influence of pumping wells nearby. Slitcher (1906) gave the formula for computing the specific capacity for dug wells is shown below.

$$C = 2.303 \times \left( \frac{A}{t} \right) \times \log \left( \frac{s}{s''} \right) \tag{3.1}$$

where

- $C$ is Specific capacity of the well, lpm / mdd,
- $A$ is Area of the cross section of the well, m²
- $t$ is Time since pumping stopped, min.,
- $s$ is Draw down (m) just before pumping stopped and
- $s''$ is Residual draw down (m) at any time $t$ after pumping stopped
The measured specific capacity is often a rough index of the formation encountered. It has no theoretical validity in terms of flow to well or potentiometric surface of aquifer. Slitcher's equation is however useful in the case of detecting the ground water flow.

Specific capacity is the property of the well and it is less considered here, as the objective of this study emphasizes more on the property of the aquifer rather than the well. Hence, $T$ and $S$ are dealt with in order to understand the aquifer as they throw light on the potential of the aquifer for ground water as well as recharge.

3.7.1.h Transmissivity ($T$)

The Transmissivity or coefficient of transmissivity is defined as the rate of flow of water in litres per day, through a vertical strip of aquifer one meter wide and extending to the full-saturated thickness of the aquifer under a hydraulic gradient of 100 percent at a temperature $15.5^\circ$C (Ramakrishnan, 1998). It has the dimensions of $L^2$, $T$ and is usually expressed as $m^2$/day.

The transmissivity of lower Gundar basin ranges from 0.636 $m^2$/day in Mudukulathur (Loc. No. 8) to 548.30 $m^2$/day at Tiurchuli (Loc. No. 2) (Table – 3.4). A transmissivity contour map has been prepared for the study area (Fig. 3.11).
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Location</th>
<th>Transmissivity (m²/d)</th>
<th>Specific Capacity Lpm/mdd</th>
<th>Aquifer Thickness (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pupupatti</td>
<td>198</td>
<td>52.05</td>
<td>11.0</td>
</tr>
<tr>
<td>2.</td>
<td>Tiruchuli</td>
<td>548.3</td>
<td>56.43</td>
<td>14.0</td>
</tr>
<tr>
<td>3.</td>
<td>Mandalamanickam</td>
<td>424.6</td>
<td>43.5</td>
<td>7.4</td>
</tr>
<tr>
<td>4.</td>
<td>Abiramam</td>
<td>386.745</td>
<td>2.85</td>
<td>14.4</td>
</tr>
<tr>
<td>5.</td>
<td>Kamudhi</td>
<td>0.908</td>
<td>2.73</td>
<td>54.7</td>
</tr>
<tr>
<td>6.</td>
<td>Marudangnalur</td>
<td>112.339</td>
<td>23.46</td>
<td>16.6</td>
</tr>
<tr>
<td>7.</td>
<td>Mudainadu</td>
<td>54.076</td>
<td>0.056</td>
<td>67.0</td>
</tr>
<tr>
<td>8.</td>
<td>Mudukulathur</td>
<td>0.636</td>
<td>2.12</td>
<td>44.5</td>
</tr>
<tr>
<td>10.</td>
<td>Kadaladi</td>
<td>165.620</td>
<td>1.504</td>
<td>7.4</td>
</tr>
<tr>
<td>11.</td>
<td>Sayalkudi</td>
<td>4.390</td>
<td>1.110</td>
<td>80.8</td>
</tr>
</tbody>
</table>

High transmissivity zone in north could be due to highly weathered crystalline rocks that exist in this region. Thick pile of clay that occurs in shallow horizon of the entire south may be the cause for low transmissivity.

3.7.1.i Storage Coefficient / Storativity

The Storage coefficient (S) is the other character, which reflects the storage coefficient of aquifer. Storage coefficient of an aquifer is the volume of water released from the storage or taken into storage, per unit surface area of the aquifer, per unit change in head. In water table aquifer / unconfined aquifer, S is the result of two elastic effects: the compression of the aquifer, and the expansion of the confined water, when the head or
LOWER GUNDAR BASIN
Aquifer Transmissivity (m²/d)

LEGEND

▲ Pump Test Location

- Below - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- Above - 500

Fig. 3.11
the pressure is reduced during pumping. Storage coefficient is dimensionless and varies from 0.01 to 0.30 for water table aquifers and 0.00001 to 0.001 for confined aquifers (Karanth, 1987). The lower Gundar basin aquifers have S ranging between 0.05 and 0.17.

3.8 SIGNIFICANCE

The study area falls in semi arid region and enjoys tropical climate. The average annual rainfall is 700 mm. Comparatively southern coastal zone experience higher rainfall (> 900 mm) than the inland regions. April and May are the hottest period while end of November, December and January being the coldest season of a year.

Water level fluctuation is high in two thickly populated locations, one in north (Periya Kattangudi) and the other in central region (Muthuramalingapuram). Rainfall versus water level study indicates the water level responds to monsoon rainfall to a smaller extent. The flow direction of groundwater is northwest to southeast.

Groundwater exists under water table condition in weathered rocks, pediments and buried pediments in north. Groundwater occurs both in water table and semi confined condition in sedimentary formations in central and southern coastal region. The depth to the water levels is shallow to moderate in north and relatively shallow in southern coastal regions.

Saline water upconing is experienced in inland regions, which may be due to over exploitation of groundwater in these locations (vide sub title 4.8). The sizes of saline upconing vary with reference to seasons,
indicating the movement of salt water / fresh water interface that has been confirmed through geophysical investigations too (vide Fig. 4.16 & 4.17)

High transmissivity zone in north indicate a highly weathered porous medium exist in the region. The low transmissivity along the south may be due to presence of thick pile of clay.