

## BARWANI DISTRICT AT A GLANCE

| S.No. | ITEMS   | Statistics  |
|-------|---|---|
| 1.    | GENERAL INFORMATION   |   |
|       | i) Geographical area (sq. km)   | 3,664.68  |
|       | ii) Administrative Divisions (As on 2003)<br>Number of Tehsil/Blocks<br>Number of Panchayats/Villages | 6 / 7<br>383 / 714  |
|       | iii) Population   | 10,81,039   |
|       | iv) Average Annual Rainfall (mm)  | 738.6   |
| 2.    | GEOMORPHOLOGY   |   |
|       | i) Major Physiographic Units  | a) Narmada Valley<br>b) Satpura Range<br>c) Vindhyan Range                                  |
|       | ii) Major Drainage  | a) Narmada<br>b) Goi<br>c) Kharka<br>d) Deb<br>e) Tapti                                     |
| 3.    | LAND USE (sq km)  |   |
|       | i) Forest area  | 244.09  |
|       | ii) Net area sown   | 2325.82   |
|       | iii) Cultivable area  | 2630.72   |
| 4.    | MAJOR SOIL TYPES  | Medium Black Cotton Soil<br>Alluvial type of soil along<br>the drainage.                    |
| 5.    | AREA UNDER PRINCIPAL CROPS sq. km   | Jowar – 505.67<br>Corn – 340.77<br>Soyabean – 208.52<br>Peanuts – 172.54<br>Cotton – 507.85 |
| 6.    | IRRIGATION BY DIFFERENT SOURCES<br>(Area and Number of Structures)                                    | Area in Sq. Km /<br>no. of Structures   |
|       | Dugwells  | 216.86 / 24297  |
|       | Tube wells/Bore wells   | 119.42 / 4856   |
|       | Tanks/Ponds   | 385.11 / 93   |
|       | Canals  | 44.95 / 150   |
|       | Other Sources   | 213.01  |
|       | Net Irrigated Area  | 655.38  |
|       | Gross Irrigated Area  | 779.93  |
|       |   |   |

|     |   |  |
|-----|---|--|
| 7.  | NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on 31.3.2007)<br>No. of Dug Wells<br>No. of Piezometers   | 8<br>04  |
| 8   | PREDOMINANT GEOLOGICAL FORMATIONS   | Alluvium<br>Laterite<br>Deccan Trap  |
| 9   | HYDROGEOLOGY<br>Major Water Bearing Formation<br>Pre-monsoon depth to water level during 2007<br>Post-monsoon depth to water level during 2007<br>Long Term water level trend in 10 years (1998-2007) in m/yr | Alluvium & Deccan Trap<br>6 - 9 mbgl<br><br>6 - 9 mbgl<br><br>Declining Trend<br>(0 - 2mbgl) |
| 10. | GROUND WATER EXPLORATION BY CGWB (As on 31.3.2007)  |  |
|     | No of wells drilled (EW,OW,PZ,SH, Total)  | EW=3, Pz=4, Total=7  |
|     | Depth Range (m)   | 41 - 129   |
|     | Discharge (litres per second)   | 0.5 - 5  |
|     | Storativity (S)   | $1.84 \times 10^{-4}$ - $4.1 \times 10^{-4}$   |
|     | Transmissivity ( $m^2$ /day)  | 7-32.30  |
| 11. | GROUND WATER QUALITY  |  |
|     | Presence of Chemical constituents more than permissible limit (eg EC, F, As,Fe)   | Nil  |
|     | Type of Water   | Alkaline   |
| 12  | DYNAMIC GROUND WATER RESOURCES (2004) in MCM  |  |
|     | Annual Replenishable Ground Water Resources   | 40.78  |
|     | Net Annual Ground Water Draft   | 26.98  |
|     | Projected Demand for Domestic and Industrial Uses upto 2025   | 3.41   |
|     | Stage of Ground Water Development   | 66%  |
| 13. | AWARENESS AND TRAINING ACTIVITY   |  |
|     | Mass Awareness Programmes Organised<br>Date<br>Place<br>No. of Participants   | Nil  |
|     | Water Management Training Programmes Organised<br>Date<br>Place<br>No. of Participants  | Nil  |

|     |   |     |
|-----|---|-----|
| 14  | EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING |     |
|     | Projects completed by CGWB (No. & Amount Spent)       | Nil |
|     | Projects under technical guidance of CGWB (Numbers)   | Nil |
| 15. | GROUND WATER CONTROL AND REGULATION                   |     |
|     | Number of OE Blocks                                   | 1   |
|     | Number of Semi-Critical Blocks                        | 1   |
|     | Number of Blocks notified                             | Nil |
| 16  | MAJOR GROUND WATER PROBLEMS AND ISSUES                |     |

## **1.0 INTRODUCTION**

Barwani district is located in the south western part of Madhya Pradesh, occupying an area of 3664.8 sq.km. The district is bounded on the north by Dhar district, on the south and west by Dhule district of Maharashtra State and in the east by Khargone district. The district extends between the parallels of latitude 21° 22' and 22° 22' north and the meridian of longitude 74° 27' and 75° 30' east and falls in Survey of India toposheet Nos. 46J, 46K, 46N and 46O. The district is divided into six tehsils and seven Development Blocks.

### **1.1 Drainage**

About 88% of the district lies in Narmada Basin and 12% in Tapti Basin. The major tributaries of Narmada are Deb and Goi. No major tributary of Tapti flows in the district. The surface water availability at 75% dependability for both the Basins is 966.70 MCM of which 921.95 MCM is from Narmada Basin and 44.75 MCM from Tapti Basin. The district area is drained mainly by the Narmada river and its tributaries like Goi and Deb. All of these tributaries flow from south to north and join Narmada. Similarly, tributaries like Tori, Churi, Dudhikheda etc. flow from north to south. Major rivers are perennial to semi-perennial.

### **1.2 Irrigation**

The total area irrigated by canals is 4.95 sq km of the total area sown 2325.82 sq. km .The total area irrigated by tubewells is 119.42 sq. km., by open wells 216.86 sq. km and by ponds & Tanks 385.11 sq. km. The total area under assured irrigation from various sources is 655.38 sq. km. This was only 28.17% of the net sown area .Thus almost 72% of the sown area in the district is dependent on rain-fed irrigation.

### **1.3 Studies carried out by CGWB**

Systematic Hydrogeological Survey was carried out by Sh. G.M.Reddy, in the year 1982-83 in parts of toposheets 46O/9, 13, 14, 46N/16, in the year 1985-86 by Sh.A.K.Mishra, Jr. Hg in toposheets 46K/13, 46O/1,5, in the year 1986-87 by Sh. K.Srinivasan, A.Hg in parts of toposheet 46J/3,4,8 & 46 K/1, 5(Pt), 9, 14(Pt). Reappraisal survey was carried out by Sh.Sourabh Gupta, Sc. 'B' and Sh.Babu Nair, Sc. 'B' in the year 1992-93. Exploratory drilling in the district was taken up in the district under Narmada Sagar Command area in 1983-84.

## **2.0 RAINFALL AND CLIMATE**

The climate of the district on the whole is tropical and dry, except during south west monsoon season (middle of June to September). Winter Season is between November to February. Summer season starts from March and ends by June.

### **2.1 Rainfall**

The district is influenced by South-West Monsoon which extends from June to September. The mean annual rainfall is 738.64 mm There is very little rainfall in the winter season. The monsoon rainfall accounts for 80% - 85% of the annual rainfall.

### **2.2 Temperature & Humidity**

May is the hottest month of the year when general temperature goes upto 42° C, occasionally, it goes upto 47° C. December is the coldest month of the year when the mean daily temperature comes down to about 11° C.

The humidity is maximum in the monsoon season and is very low in dry months. It is as low as 10% in dry months and as high as 94% in the monsoon season.

## **3.0 GEOMORPHOLOGY & SOIL TYPES**

### **3.1 Geomorphology**

Physically, the district comprises of three distinct natural divisions viz. Narmada valley in the northern part, uplands along southern and western margins (Satpura Range and highly dissected Deccan Plateau) and Narrow belt of scarp ridges (Vindhyan Hill Range). The area of the district displays undulatory topography which includes highly dissected plateau, linear ridges, residual hills and low lying plains. The highest elevation in the district is 1033 m amsl south of Ramgarh fort in Sendhwa Block. The lowest point is at elevation 149 m amsl near Talwda Deb in Rajpur Block.

### **3.2 Soil Types**

Generally, five types of soils are found in the district namely Kali-I, Kali-II, Kali-III, Halki Khadri and Bardi. The soils of Barwani district are classified as

medium black cotton soils containing nearly 50% silt and clay together. Mostly the soils are lighter, open and drained.

Alluvial type of soil is found on both the sides of the river Narmada and in some patches on the banks of its tributaries like Goi, Deb & Bour. This type of soil is deep fertile & well drained. The soils of the rest of the district are mostly shallow & poor in fertility.

## **4.0 GROUND WATER SCENARIO**

### **4.1 Hydrogeology**

The occurrence and movement of ground water is governed and conditioned by geomorphic configuration of the place and water bearing properties of the lithounits like porosity, permeability etc. The description of the hydrogeologic units is as follows.

#### **4.1.1 Deccan Traps**

These are basaltic lava flows and form the most predominant and widespread hydrogeological formations in the district. The top weathered mantle where thickness and presence of secondary porosity change according to geomorphic situation offer ground water occurrence under unconfined condition. However, fractures, joints are the pre-dominant features to form the occurrence of water under semi-confined conditions. The weathered, jointed, fractured and vesicular units of basalts form moderately potential aquifers. The zeolitic basalt, in fractured form also makes good aquifers. The red bole bed which is predominantly clay. This formation has highly variable yields, being higher in dug wells.

In the unconfined pheratic basaltic aquifer, the ground water is extracted by open wells (depth range 5 –16m) whose diameter varies from 2-9 m. Depending upon the type of ground water extraction device, the ground water yields varies between 10 cu. M/day to 432 cu. M/day.

#### **4.1.2 Alluvium**

The alluvial deposits are confined mainly to Narmada & Goi rivers and are not very extensive in thickness. The thickness of alluvium in the piezometer at Anjad has been found to be 10 m. The ground water in alluvium occurs under pheratic conditions. The specific capacity of the wells located in pheratic zone is about 490 lpm/meter of drawdown.

### 4.1.3 **Aquifer Parameters**

#### 4.1.3.1 **Pheratic Aquifer**

Controlled pumping tests results on number of dug wells in the district shows that the yield of wells tapping vesicular basalts and massive traps ranges from 24 to about 70 cu.m/day. The specific capacity of wells varies from 25 lpm/m of drawdown to 285 lpm/m of drawdown in weathered vesicular basalt. The specific capacity of wells in alluvial aquifer is about 490 lpm/m of drawdown.

#### 4.1.3.2 **Confined Aquifer**

Depending upon the intensity of fractures and its areal extent, the basaltic aquifers are found to be yielding as low as 5 lpm to as high as 300 lpm in the district. The transmissivity characteristics of confined aquifer ranges from 2 m<sup>2</sup> /day to as high as 312 m<sup>2</sup> /day.

### 4.1.4 **Ground Water Levels**

#### 4.1.4.1 **Pre-monsoon Ground Water Level**

A perusal of the pre-monsoon ground water (2007) reveals that in a major part of the district, the ground water levels are between 6-9 mbgl. Deeper Ground water levels of 9-12 m bgl are found in parts of Barwani, Rajpur and Thikri Blocks. A substantial part of Thikri Block has water level in excess of 12 m bgl as does a small part of Barwani Block. Shallower water levels of 3-6 mbgl are found in isolated patches of Thikri (in the proximity of Narmada river) and in Rajpur Block.

#### 4.1.4.2 **Post –monsoon Ground Water Level**

During the post monsoon period (2007), ground water levels, in a major part of the district are between 6-9 m bgl. Shallower water levels of 3-6 m bgl are observed in parts of Pati, Barwani, Rajpur and Thikri Blocks. Deeper water levels of 9-12 m bgl are observed in Pansemal, Niwali and Thikri Blocks. Isolated patches of 0-3 m bgl are observed in Rajpur Blocks.

#### 4.1.4.3 **Long Term Water Level Trend**

The long term water level trend (pre monsoon 1998-2007) indicates that 57.10% of the wells are showing a decline of 0-2 m. 28.60% are showing a rise of 0-2 m & 14.30% are showing a rise of 2-4 m.

## 4.2 Ground Water Resources

The ground water resources of the district are shown in the **table No-**. The district has no command area or poor ground water quality area. The district has one Over-Exploited Block (Pansemal) and one semi-critical Block (Rajpur). The overall stage of ground water development in the district is 66%.

## 4.3 Ground Water Quality

The ground water in the area is generally alkaline in nature and the pH values are within acceptable limits. The Chloride concentration in the area is below 250 mg/l. The higher chloride values generally coincide with areas having high EC thus indicating that the salinity in ground water is mainly due to chloride. Concentration of magnesium and calcium in Barwani district are within permissible limits. The nitrate concentration in the district ranges between 0 – 127 mg/l with only Thikri having a value of 127 mg/l. This appears to be a localized phenomena. The fluoride concentration in the district ranges between 0.20 to 1.30 mg/l. The total hardness in the district ranges between 60 to 625 mg/l falling within permissible limit. The plot of the Piper diagram indicates that alkaline water is found at Baruphatak, Julwania, Niwali and Rajpur. At Sendhwa, the water is of alkaline earth sulphate and chlorite type, having permanent hardness, which can be removed by ion-exchange method. At Palsud, the water is alkali sulphate and chloride type.

The Wilcox diagram of Barwani district indicates that the ground water has low sodium hazard and medium to high salinity hazard. Thus, the ground water of Barwani district is chemically fit for drinking as well as agriculture purposes.

## 4.4 Status of Ground Water Development

Ground water is the main source of irrigation and drinking water in Barwani district. Out of a total sown area of 2325.82 sq km, only 779.93 sq km area is under assured irrigation. The total number of dug wells and tube wells in the district, in the year 2003, was 24297 and 4856 respectively. There has been a steady rise in the development of ground water. The stage of ground water development in the district is 66% (Base year 2004). There are 5 urban areas in the district viz. Barwani, Thikri, Rajpur, Pansemal and Sendhwa which have population growth rate of 28.34%, 17.84%, 24.43%, 13.90% and 34.34% respectively. Among the above-mentioned urban areas, only two towns have organized surface and ground water drinking water supply and the rest are dependent on ground water only. Barwani has designated capacity of 1.80 mgd (million gallons per day) with a per capita supply of 65 liters/day, while Sendhwa has designed capacity of 0.90 mgd with a per capita supply of 32 liters/day.

## **5.0 GROUND WATER MANAGEMENT STRATEGY**

### **5.1 Ground Water Development**

The development of ground water resources of Barwani district is increasing every year. The development, so far, has been mostly through dug wells. However, in recent years, the number of tube wells is also increasing. The availability of ground water for irrigation in the district is 14079.04 Ham and the stage of ground water development in the district is 60.44%. However, this rate is bound to increase in the future and may lead to a situation wherein the annual withdrawal of ground water may exceed the natural recharge in a normal monsoon year. This may happen since the cropping intensity and hence the number of ground water abstraction structures are likely to increase. This, coupled with increased drinking water requirement would create a stress on the existing ground water resources. It is thus essential that the available resources are utilised judiciously.

Based on the availability of ground water for future irrigation, feasible ground water abstraction structures have been worked out as 4693 additional dug wells and 2347 additional tube wells. Pansemal Block has not been taken into account as it is an over –exploited Block. The dug wells should be of depth 10-20 m and of diameter 4-8 m, whereas the tube wells should be depth 30-100 m.

### **5.2 Water Conservation and Artificial Recharge**

The main problem in Barwani district is not so much due to non availability of ground water, but lack of natural replenishment to ground water. The annual rainfall and its yearly variation has been leading to severe drought conditions over the past few years.

Deccan Traps in Barwani district constitute aquifers mainly with low to moderate permeabilities.

On account of extreme temperature and climatic variations, weathering in shallow zones is quite intense, creating an overburden with moderate to high infiltration rates. Although the weathered zones are not present over the entire aerial extent of Trap, yet fracture porosity of the rocks also gets increased due to weathering action.

Such locales with fractures and high weathered overburden having moderate to high infiltration rates are ideally suitable for construction of injection wells and percolation tanks.

Streams that generally flow on weak surface zones having high permeability also constitute good recharge zone. Numerous volcanic dykes cutting across surface drainage are seen in the district. The sub surface continuation of these dykes is generally impermeable, resulting in impounding of some water in the stream channel on the upstream side.

There is ample scope for increasing the potential of these zones by grouting leaks, if any, in the dykes or by constructing a small anicut or check dam over these dykes for impounding surface water for recharge.

The weathered and fractured zone overlying the fresh rock constitute a profitable zone for development. The thickness of weathered zone varies from negligible to a maximum of about 20 meters.

All the major streams and rivers in the district are gaining in nature i.e. the ground water flow is contributing to the base flow. This flow, if arrested, could increase the storage potential of the weathered and fractured portion of the aquifer. This can be achieved by constructing sub-surface dykes in the weathered portion, resting on the fresh rock.

The alignment of the dyke should be perpendicular to the ground water flow direction. This would have the effect of creating a sub-surface dam and thus arresting the flow from the area. The area upstream of this dyke can then be exploited through tube wells or large diameter dug wells depending upon the site-specific conditions.

Although, Central Ground Water Board has not financed any artificial recharge scheme in the district, the State Government, under the 'Jal Abhishek Abhiyan', has sanctioned the construction of 1023 artificial recharge structures out of which 210 had been completed till 2007-08.

## 6.0 RECOMMENDATIONS

- (i) In view of the limited regional extent and poor potential of the deeper aquifers in the district, it is recommended that the ground water exploitation from the deeper aquifer should be restrained and limited to drinking water supply only.
- (ii) For construction of shallower tube wells, hydraulic troughs and areas upstream of dykes, especially at the intersection of dykes with the drainage should be selected. As regards semi-confined aquifer, it is essential to locate minor vertical or steeply dipping shear zones by aerial photo and geophysical studies.
- (iii) It is recommended that additional 4693 dug wells and 2347 tube wells should be constructed at favourable locations in a phased manner over a period of 10 years in Pati, Barwani, Rajpur, Sendhwa & Niwali Blocks.
- (iv) Open wells should have diameter in the range of 4-6 m and depth of about 12-16 m. The dug cum bore wells should have a 150 mm bore of 20 m depth from the bottom of the dug well. Shallow bored wells of 150 mm diameter could be drilled upto 150 m depth. 3-5 HP Centrifugal pump are adequate for dug wells.
- (v) Actual spacing norms may not be strictly applicable for open wells yielding less than 20 lpm but a spacing of 150-200 m should be observed for wells yielding more than 20 lpm.
- (vi) Artificial recharge to ground water in areas by creating storage of fresh water through rain water harvesting in an integrated water shed scheme and maintain the impounded head of water in small reservoir for as long as possible to promote induced infiltration. Structures like Check Dams, Sub-surface dykes, percolation tanks, recharge wells should be constructed through public participation.