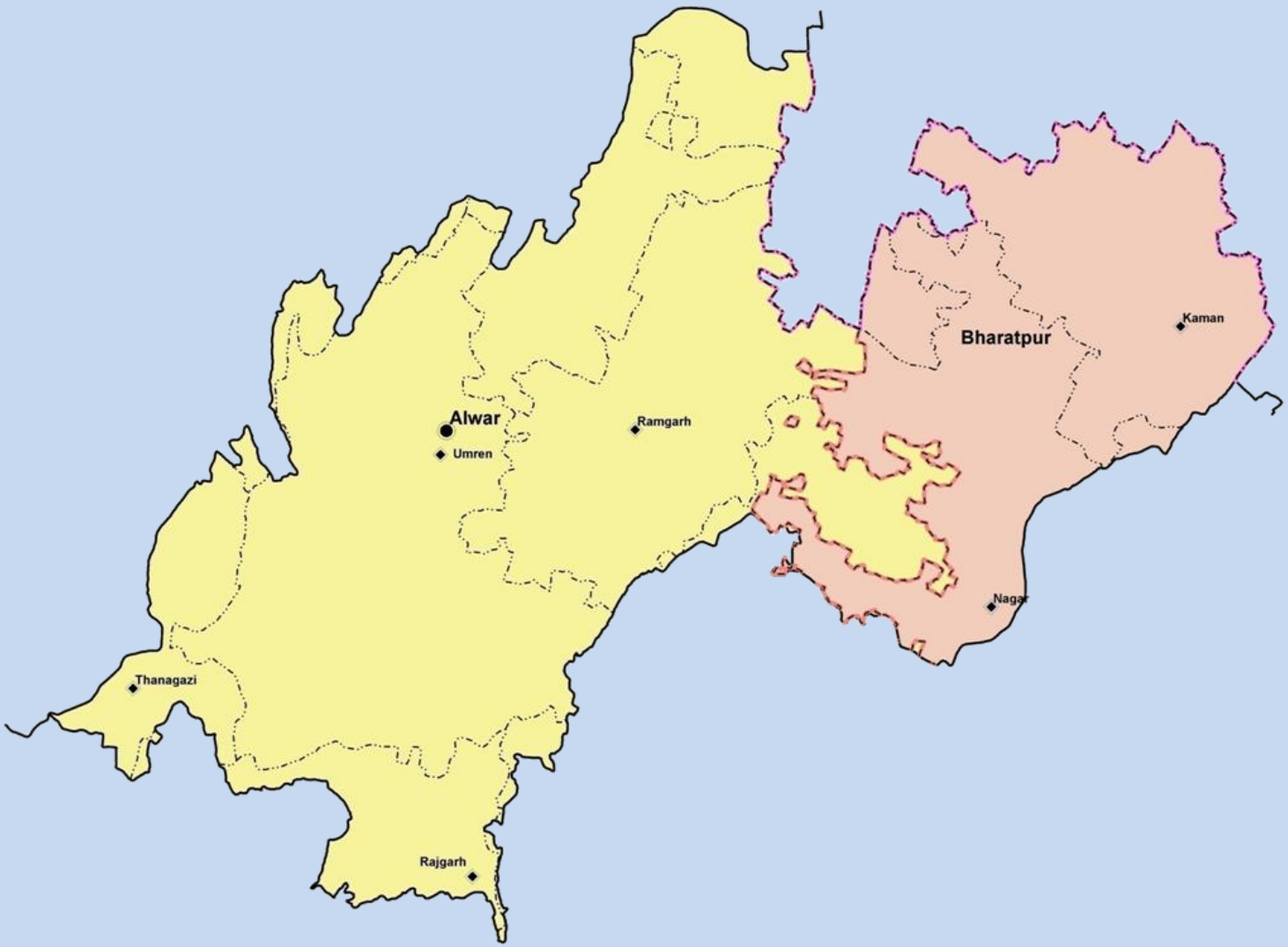
Ground Water Department,
Rajasthan

European Union
State Partnership Programme

# Hydrogeological Atlas of Rajasthan

## Ruparail River Basin

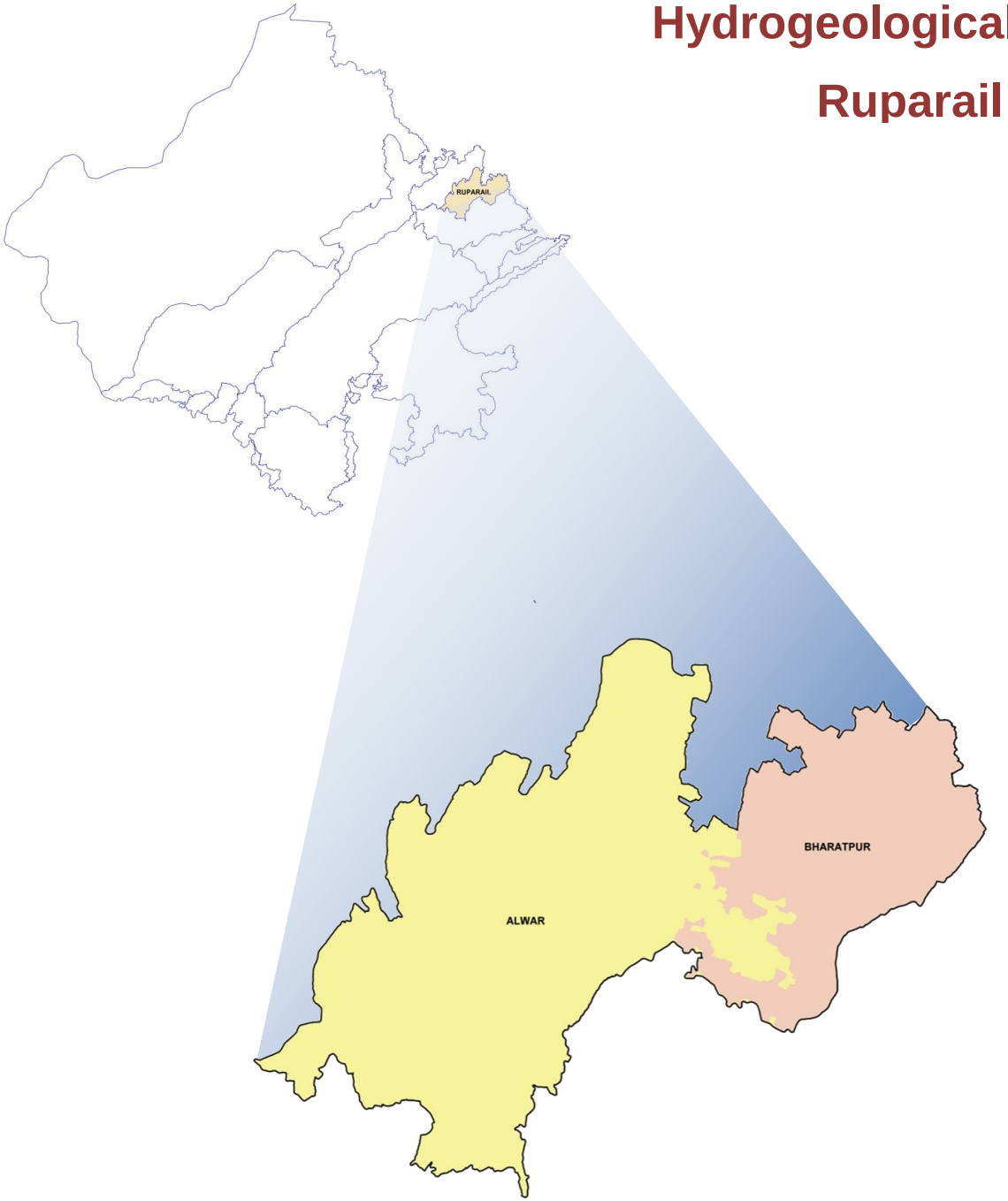



2013

ROLTA
Rolta India Limited

# Hydrogeological Atlas of Rajasthan

# Ruparail River Basin




## Contents:



**2013**

# ADMINISTRATIVE SETUP

# RUPARAIL RIVER BASIN

## Location:

The Ruparail River Basin is located in the northeastern part of Rajasthan. It stretches between 27° 09' 22.24" to 27° 55' 10.35" North latitude and 76° 14' 42.36'' to 77° 21' 34.47'' East longitudes. The basin extends in a broadly W-E direction and is bounded by the Sabi River Basins in the northwest side and the Banganga River Basin in the southeast. The northern border is shared with Haryana State. The basin extends over parts of Bharatpur and Alwar Districts. The total catchment area of the Basin is very small and extends over an approximate area of 3,809.6 $km^2$.

River Ruparail, also known as Barah, rises in the Udainath hills of Thanagazi Reserved Forest (RF), Alwar District. It traverses these hills northwards, turning towards the east and northeast before disappearing in Bharatpur District. It flows first through hills and subsequently through plains nearly up to Kusalpur in Bharatpur district. It has a total length of about 104 km. A number of smaller streams rise from the various sub-ranges of the above-mentioned RF hills, e.g. the Narainpur, Golari, Sukri, Shanganga and Nalakroti Rivers and contribute to Ruparail flow.

## Administrative Set-up:

Administratively, Ruparail River Basin extends over parts of Bharatpur and Alwar districts encompassing 15 Blocks divided into 984 towns and villages. Major part of the river flows through Alwar district where its catchment is about 71% of basin area whereas the rest falls within the Bharatpur district.

| S. No. | District Name | Area (sq km) | % of Basin Area | Total Number of Blocks | Total Number of Towns and Villages |
|---|---|---|---|---|---|
| 1 | Alwar | 2,694.5 | 70.7 | 12 | 582 |
| 2 | Bharatpur | 1,115.1 | 29.3 | 3 | 402 |
| **Total** | | **3,809.6** | **100.0** | **15** | **984** |

## Climate:

The basin is located on the northeastern part of Rajasthan sharing its boundary with Haryana. It falls within the semi-arid to sub-humid regions but witnesses extreme temperatures during the hottest months which are May and June. Coldest months are December and January where temperatures sometimes reach near-zero levels. Incidentally, India's highest ever recorded temperature of 50.6 °C was measured at Alwar on 10 May 1956. The rain are mostly received during monsoon season i.e., from July through September, and mean annual rainfall over the basin was computed as 576mm.

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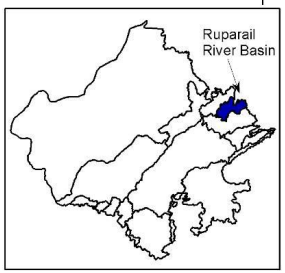
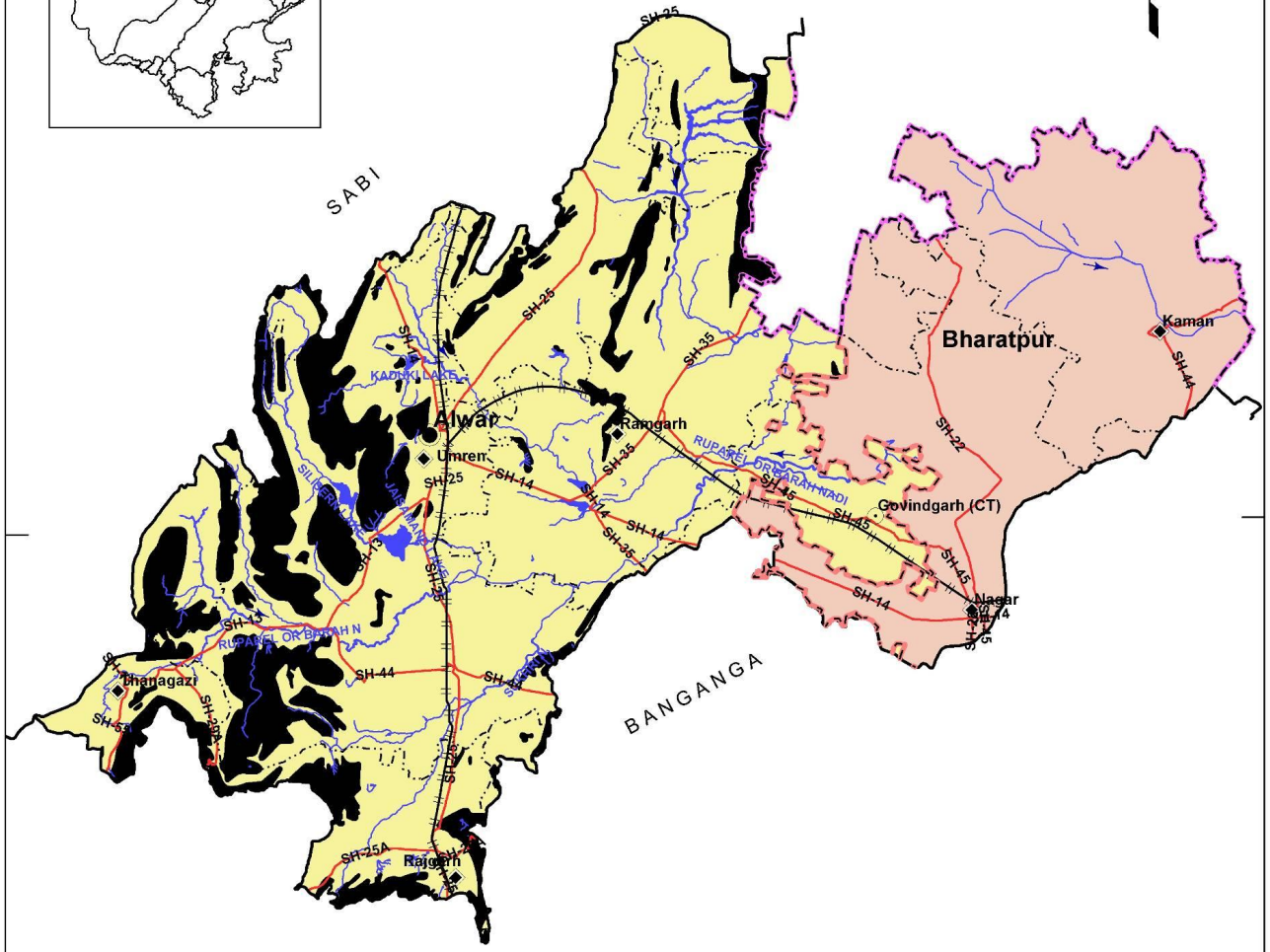
PLATE - I

# RUPARAIL RIVER BASIN

## Administrative Map




## LEGEND

**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- River Basin Boundary

**Roads:**

- State Highway

**Railway:**

- Metre Gauge

**Water Bodies:**

- River / Streams
- Ponds / Reservoirs

**Hills**

ROLTA

## TOPOGRAPHY



The western part is hilly where the river originates, and then the terrain slopes towards east and then to northeast. The hills mostly belong to the Aravali ridges are locally curvilinear representing dome and basin structures but follow a broad southwest – northeast trend. The river has an inland drainage system and ends up in the depression around Bharatpur city. The elevation ranges from a minimum of 179m in Bharatpur district to a maximum of about 716m in Alwar district. Ghana bird sanctuary area is actually a regional depression with no exit that leads to retention of surface water flows.

**Table: District wise minimum and maximum elevation**

| S. No. | District Name | Min Elevation (m amsl) | Max. Elevation (m amsl) |
|---|---|---|---|
| 1 | Alwar | 204.0 | 716.4 |
| 2 | Bharatpur | 179.4 | 366.2 |

## RAINFALL

The general distribution of rainfall across the Ruparail River Basin can be visualized from isohyets presented in the Plate – III where the basin seems to have received good rainfall in the year 2010. The total annual rainfall was in excess of 1200mm in basin as recorded by the Govindgarh met station followed by Kaman. The lowest total annual rainfall in the basin was recorded at the Pahari station which accounted for 669mm. The average annual rainfall computed based on available station data is about 871 mm. The rainfall data for available rain gauge stations is presented below.

**Table: District wise total annual rainfall (based on year 2010 meteorological station recordings (http://waterresources.rajasthan.gov.in)**

| S. No. | Rain gauge Stations | Total Monsoon Rainfall (mm) | Total Non-Monsoon Rainfall (mm) | Total Annual Rainfall (mm) |
|---|---|---|---|---|
| 1 | Alwar | 781.0 | 76.0 | 857.0 |
| 2 | Govindgarh | 1,239.0 | 25.0 | 1,264.0 |
| 3 | Kaman | 965.0 | 57.0 | 1,022.0 |
| 4 | Malakhera | 767.0 | 59.0 | 826.0 |
| 5 | Nagar | 687.0 | 57.0 | 744.0 |
| 6 | Pahari | 603.0 | 66.0 | 669.0 |
| 7 | Rajgarh | 634.0 | 80.0 | 714.0 |
| 8 | Ramgarh | 806.7 | 67.0 | 873.7 |

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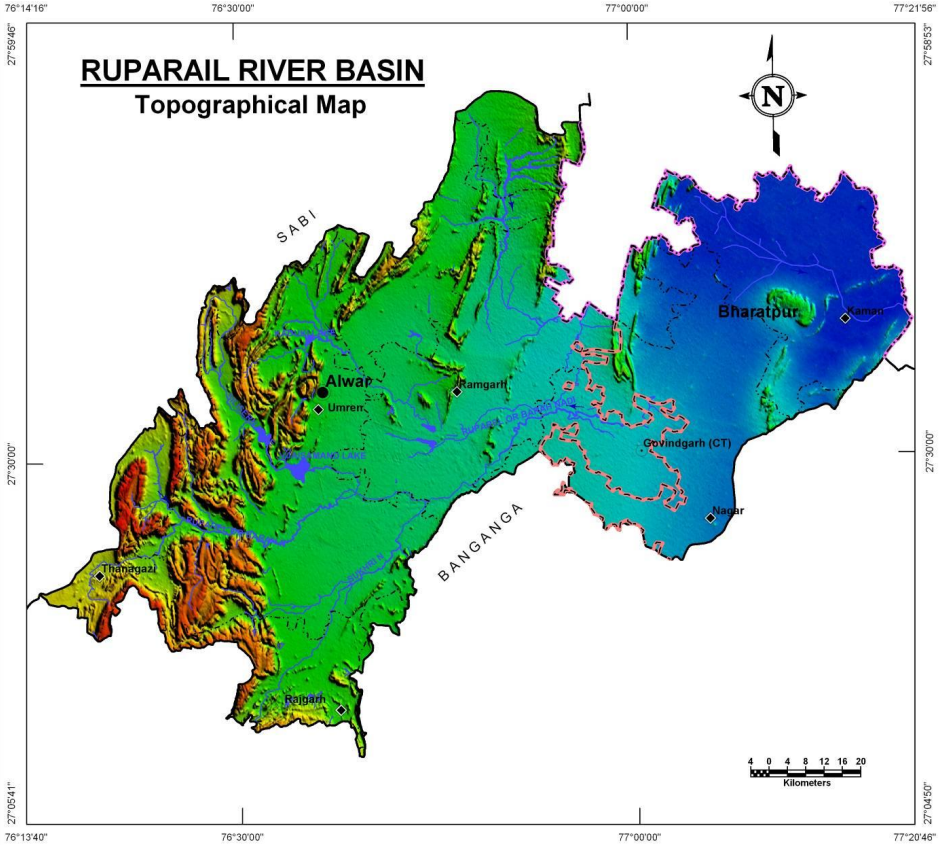
PLATE - II




## LEGEND

**Admin Boundary:**
- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary

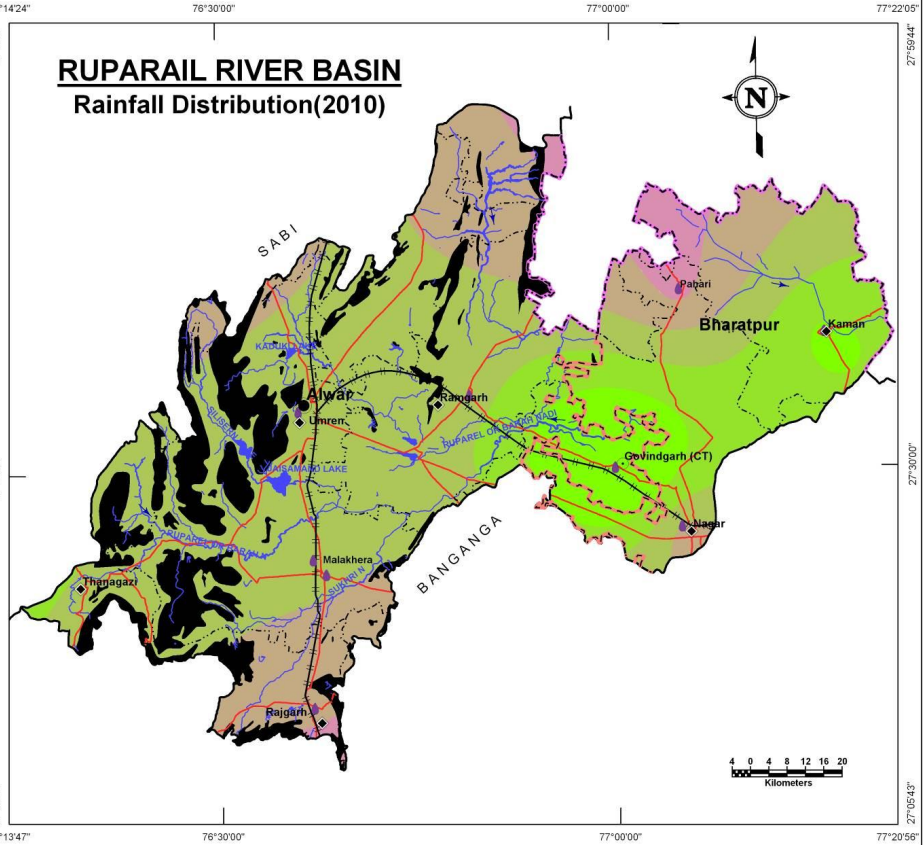
**River Basin Boundary**

**Water Bodies:**
- River / Streams
- Ponds / Reservoirs

Source : SRTM DEM

**Elevation(m amsl):**
716 m
625 m
500 m
375 m
260 m
179 m

PLATE - III




## LEGEND

**Admin Boundary:**
- District Headquarter
- Block Headquarter
- Town
- Raingauge Station
- State Boundary
- District Boundary
- Block Boundary

**River Basin Boundary**

**Roads:**
- State Highway

**Railway:**
- Metre Gauge

**Water Bodies:**
- River / Streams
- Ponds / Reservoirs

**Hills**

**Isohyets(mm):**
- 600-700
- 700-800
- 800-900
- 900-1000
- > 1000

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# GEOLOGY

# RUPARAIL RIVER BASIN

The area covered by the basin is very small (about 3800 sq km) so geologic variation in the basin is also very limited. The alluvium (sand, clay, kankar and coarse colluvial material) and wind-blown sand occupies significant area in the central and eastern part of the basin whereas Delhi Super Group rocks occupy the rest of the area in the west and also appearing sporadically in the alluvial terrain along with Raialo Group of rocks represented by dolomites, quartzites etc.

| Age | Super-Group | Group/ Formation | Rock Types |
|---|---|---|---|
| Sub-Recent To Recent | Alluvium | Alluvium | Alluvial sand, Clay, Kankar with subordinate colluvial gravel, Pebbles, cobbles etc., and wind-blown sand or Dune sand |
| ----------x----------x----------Unconformity----------x----------x----------x------- | | | |
| Upper Precambrian To lower Cambrian | Delhi | Ajabgarh | Schists, phyllites, Quartzite and dolomites |
| | | Alwar | Quartzite, Conglomerates, grits With subordinate shale and calcareous bands, Meta dolerites, epidiorites |
| | | Raialo | Dolomites, Limestone Sandstones/ quartzite |

# GEOMORPHOLOGY

| Origin | Landform Unit | Description |
|---|---|---|
| Aeolian | Sandy Plain | Formed of aeolian activity, wind-blown sand with gentle sloping to undulating plain, comprising of coarse sand, fine sand, silt and clay. |
| Denudational | Intermontane Valley | Depression between mountains, generally broad & linear, filled with colluvial deposits. |
| | Pediment | Broad gently sloping rock flooring, erosional surface of low relief between hill and plain, comprised of varied lithology, criss-crossed by fractures and faults. |
| Fluvial | Alluvial Plain | Mainly undulating landscape formed due to fluvial activity, comprising of gravels, sand, silt and clay. Terrain mainly undulating, produced by extensive deposition of alluvium. |
| | Alluvial Plain (Sandy) | Flat to gentle undulating plain formed due to fluvial activity, mainly consists of gravels, sand, silt and clay with unconsolidated material of varying lithology, predominantly sand along river. |
| | Valley Fill | Formed by fluvial activity, usually at lower topographic locations, comprising of boulders, cobbles, pebbles, gravels, sand, silt and clay. The unit has consolidated sediment deposits. |
| | Ravine | Small, narrow, deep, depression, smaller than gorges, larger than gulley, usually carved by running water. |
| | Water logged/ Wetland | Area submerged in water or area having very shallow water table. So that it submerges in water during rainy season. |
| Hills | Denudational, Structural Hill, Linear Ridge | Steep sided, relict hills undergone denudation, comprising of varying lithology with joints, fractures and lineaments. Linear to arcuate hills showing definite trend-lines with varying lithology associated with folding, faulting etc. Long narrow low-lying ridge usually barren, having high run off may form over varying lithology with controlled strike. |

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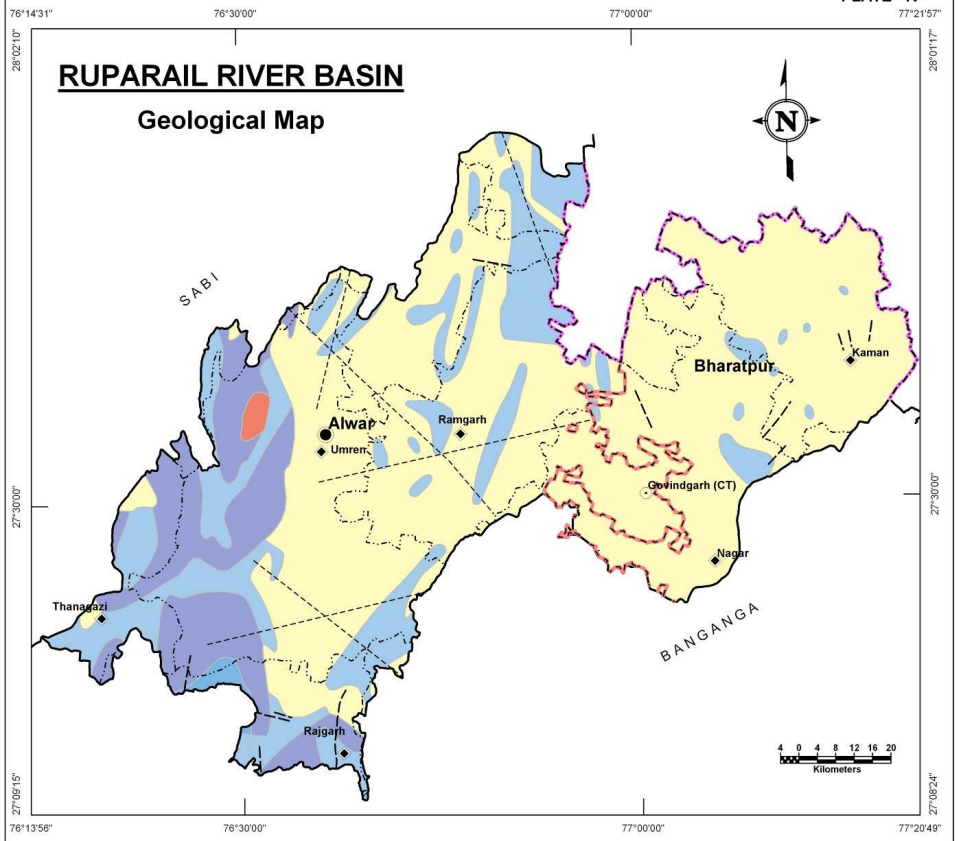
PLATE - IV

# RUPARAIL RIVER BASIN

## Geological Map




## LEGEND

**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary

**River Basin Boundary**

**Structural Features:**

- Fault
- Great Boundary Fault
- Lineament

**Geology:**

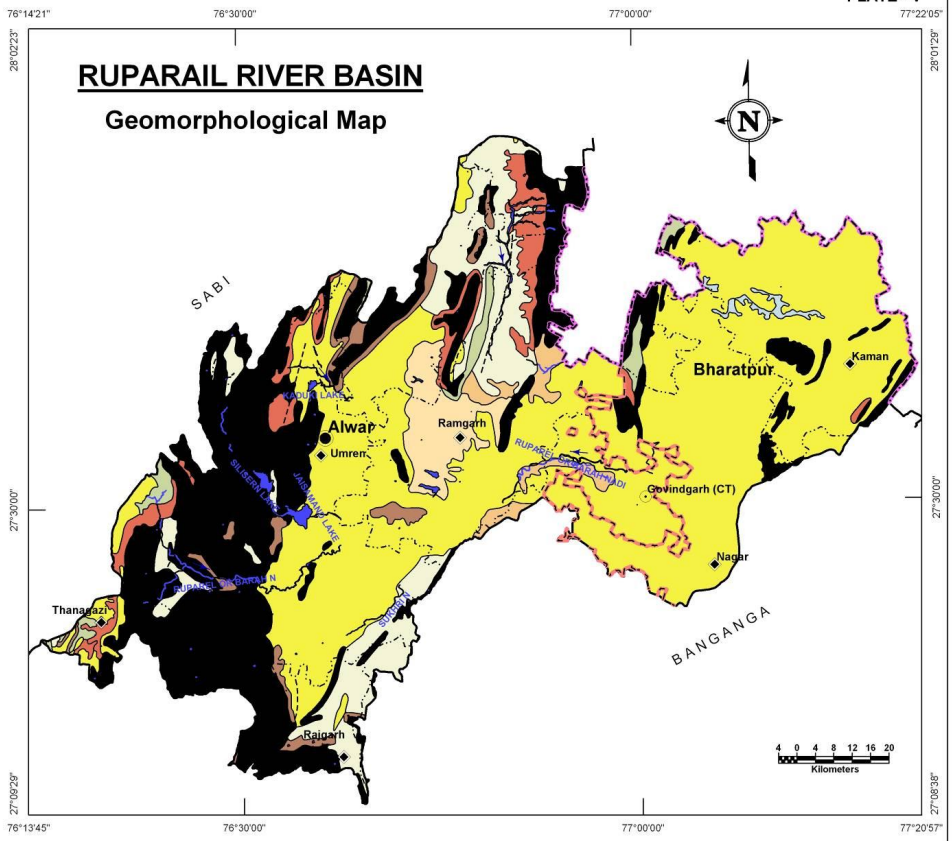
- Alluvium and Wind blown sand
- Ajabgarh Group
- Alwar Group
- Raialo Group
- Bairath/Dadikar/Harsora/Chapoli/Ajitgarh/Ajmer Granite etc.

Source : District Resource Map of Rajasthan - GSI

PLATE - V

# RUPARAIL RIVER BASIN

## Geomorphological Map




## LEGEND

**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary

**River Basin Boundary**

**Water Bodies:**

- River/Ponds / Reservoirs

**Structural Features:**

- Fault/Fractures/Lineament

**Hills:**

- Structural/Denudational/ Linear Ridge

**Landform Units:**

**Fluvial Origin:**

- Alluvial Plain
- Alluvial Plain (Sandy)
- Ravine
- Valley Fill
- Waterlogged Area

**Denudational Origin:**

- Pediment
- Intermontane Valley

**Aeolian Origin:**

- Sandy Plain

Source : Ground Water Atlas of Rajasthan - SRSAC & GWD, Rajasthan

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# AQUIFERS

# RUPARAIL RIVER BASIN

Weathered and fractured quartzites and alluvium constitute principal aquifers in the basin. Older alluvium occupies about 70% of the basin area forming it the most important aquifer, however, the quality of water in some parts of the aquifer is not of potable quality. The quartzite aquifers are seen in hilly region and its vicinity which generally contains fresh water occupies about 16% of the basin area.

| Aquifer in Potential Zone | Area (sq km) | % of Basin Area | Description of the unit/Occurrence |
|---|---|---|---|
| Older Alluvium | 2,696.1 | 70.7 | This litho unit comprises of mixture of heterogeneous fine to medium grained sand, silt and kankar. |
| Quartzite | 615.7 | 16.2 | Medium to coarse grained and varies from feldspathic grit to sericitic quartzite. |
| Non Potential Zone | 497.8 | 13.1 | Hills and reserve forests. |
| **Total** | **3,809.6** | **100.0** | |

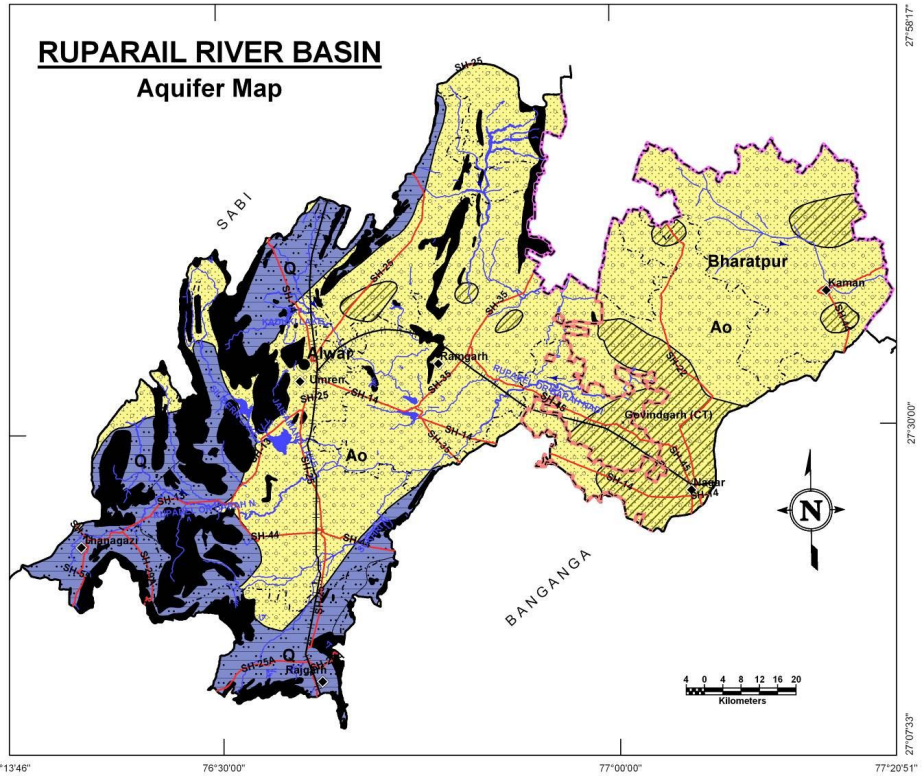
## LOCATION OF GROUND WATER MONITORING WELLS

The basin has a well distributed network of large number of ground water monitoring stations (104) in the basin owned by RGWD (76) and CGWB (28); and an additional 116 wells have been recommended to be added to network to effectively monitor ground water quality (97 additional wells) and water level (19 additional wells) in the basin.

| District Name | CGWB | RGWD | Total | Recommended additional wells for optimization of monitoring network | |
|---|---|---|---|---|---|
| | | | | Water Level | Water Quality |
| Alwar | 15 | 31 | 46 | 19 | 63 |
| Bharatpur | 13 | 45 | 58 | - | 34 |
| **Total** | **28** | **76** | **104** | **19** | **97** |

PLATE - VI

# RUPARAIL RIVER BASIN
## Aquifer Map




## LEGEND

**Admin Boundary:**
- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**
- **Roads:**
- State Highway
- **Railway:**
- Metre Gauge

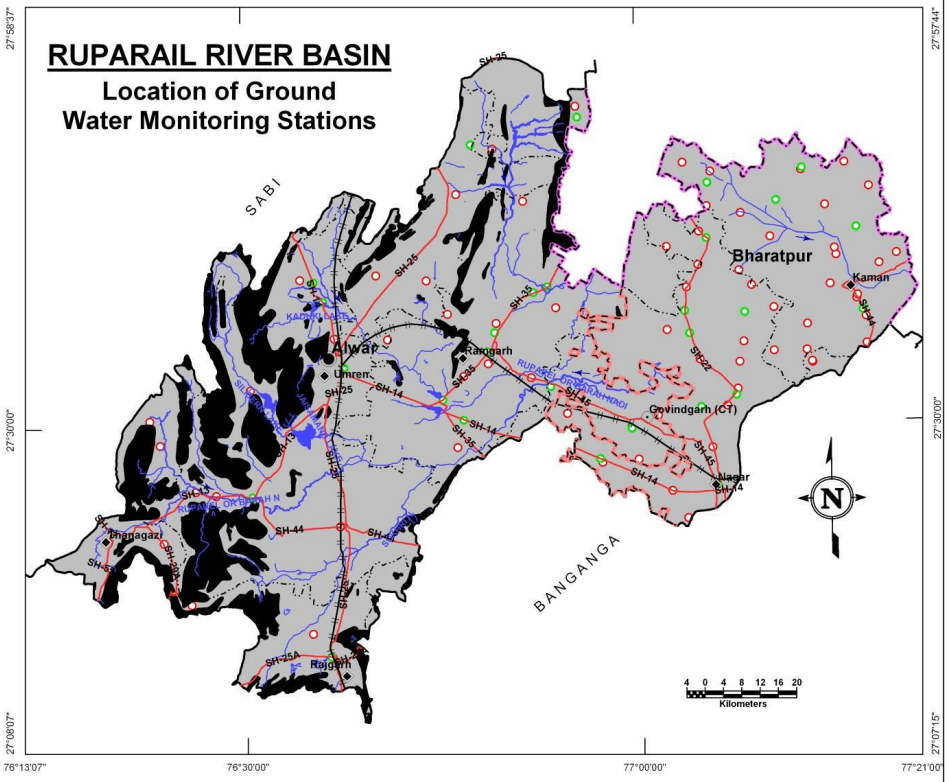
**Water Bodies:**
- River / Streams
- Ponds / Reservoirs
- **Hills**
- **Saline Area**

**Aquifer:**
- Older Alluvium
- Quartzite

Source: Ground Water Potential Zone Map - GWD,Rajasthan

PLATE - VII

# RUPARAIL RIVER BASIN
## Location of Ground Water Monitoring Stations




## LEGEND

**Admin Boundary:**
- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**
- **Roads:**
- State Highway
- **Railway:**
- Metre Gauge

**Water Bodies:**
- River / Streams
- Ponds / Reservoirs
- **Hills**

**Ground Water Monitoring Stations:**
- CGWB
- RGWD

## LOCATION OF EXPLORATORY WELLS



In all there are 162 exploratory wells present in the basin drilled in the past by RGWD (152) and CGWB (10) that form the basis for delineation of sub-surface aquifer system. A perusal of Plate – VII reveals that the density of wells is more in alluvial areas than in hilly hardrock areas. Large number of exploratory wells are seen around Alwar city.

| District Name | CGWB | RGWD | Total |
|---|---|---|---|
| Alwar | 4 | 117 | 121 |
| Bharatpur | 6 | 35 | 41 |
| **Total** | **10** | **152** | **162** |

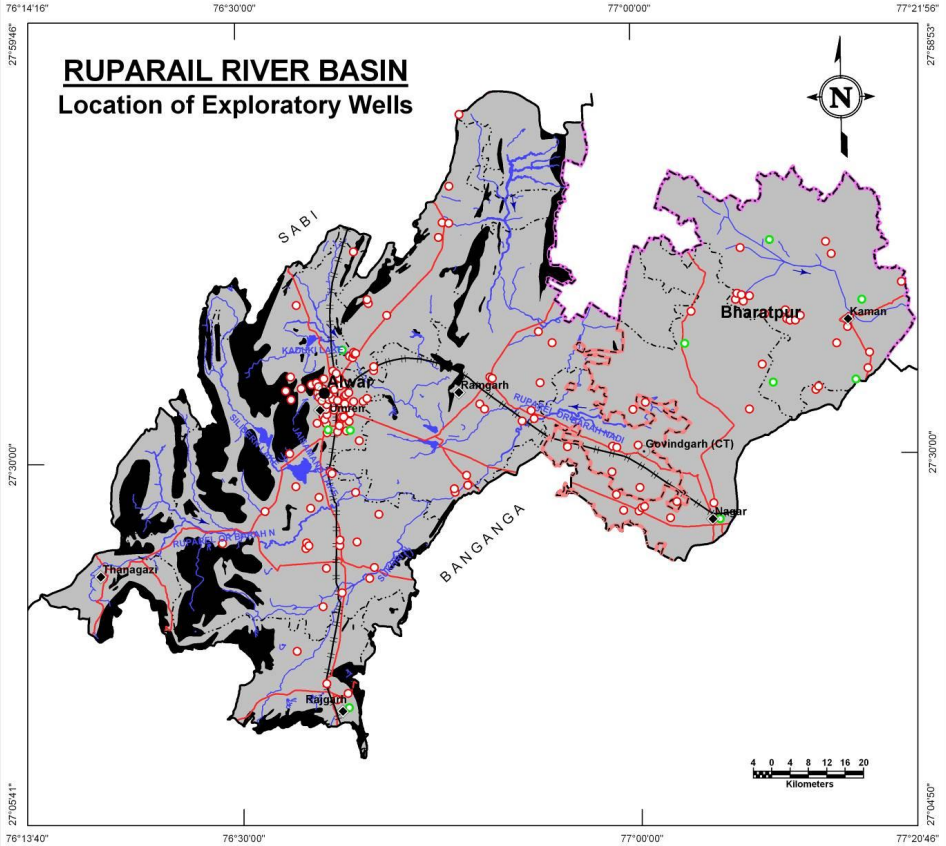
## DEPTH TO WATER LEVEL (PRE MONSOON – 2010)

The general depth to water level in the basin is less than 30 meters below ground level, as seen in most of the eastern and western parts of the basin. There is a significant deepening of water levels in the central part around Alwar city and further southwards as indicated by >30m bgl water level contours reaching depths of more than 40m bgl. The shallow depth to ground water levels is seen in the eastern most part around Kaman and Bharatpur where the water occurs at depths of less than 10m bgl.

| Depth to water level (m bgl) Pre Monsoon - 2010 | District wise area coverage (sq km)* | | Total Area (sq km) |
|---|---|---|---|
| | Alwar | Bharatpur | |
| <10 | 12.5 | 441.2 | **453.7** |
| 10-20 | 738.7 | 624.1 | **1,362.8** |
| 20-30 | 601.8 | 49.9 | **651.7** |
| 30-40 | 536.2 | - | **536.2** |
| >40 | 307.4 | - | **307.4** |
| **Total** | **2,196.6** | **1,115.2** | **3,311.8** |

* The area covered in the derived maps is less than the total basin area since the hills have been excluded from interpolation/contouring.

PLATE - VIII




## LEGEND

**Admin Boundary:**
- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- River Basin Boundary

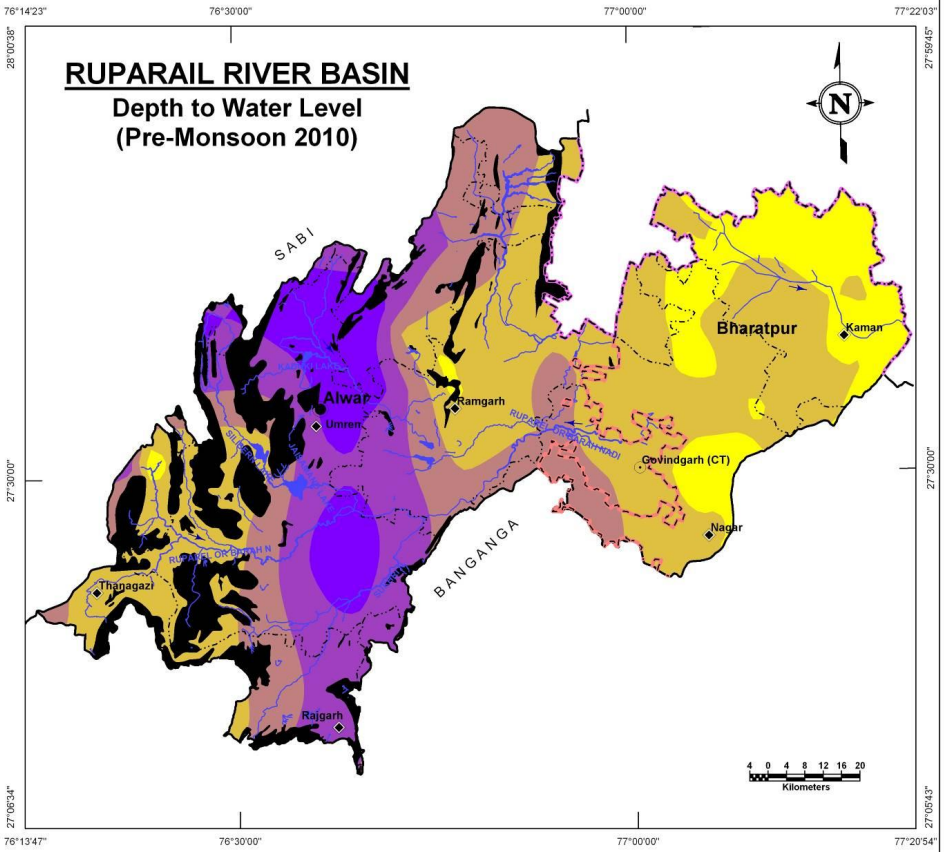
**Railway:**
- Metre Gauge

**Roads:**
- State Highway

**Water Bodies:**
- River / Streams
- Ponds / Reservoirs
- Hills

**Exploratory Wells:**
- CGWB
- RGWD

PLATE - IX




## LEGEND

**Admin Boundary:**
- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- River Basin Boundary

**Water Bodies:**
- River / Streams
- Ponds / Reservoirs
- Hills

**Depth to Water Level (m bgl):**
- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- > 40

# WATER TABLE ELEVATION (PRE MONSOON 2010) RUPARAIL RIVER BASIN

The flow directions marked on water table elevation contour map (Plate – X) indicate an initial southwest to northeast flow and another regional sub-surface flow from north to south. These two flow directions meet in the centre of the basin and ultimately follow an eastwards flow towards Bharatpur. The water table elevations show very steep gradients in the western hilly part which more gradual and sluggish towards east. The variation between minimum and maximum water table elevations is quite large, being about 180m amsl to about 440m amsl resulting into a net head difference of 260m. For major part of the basin, the water table elevation varies in the general range of 180m amsl to 240m amsl.

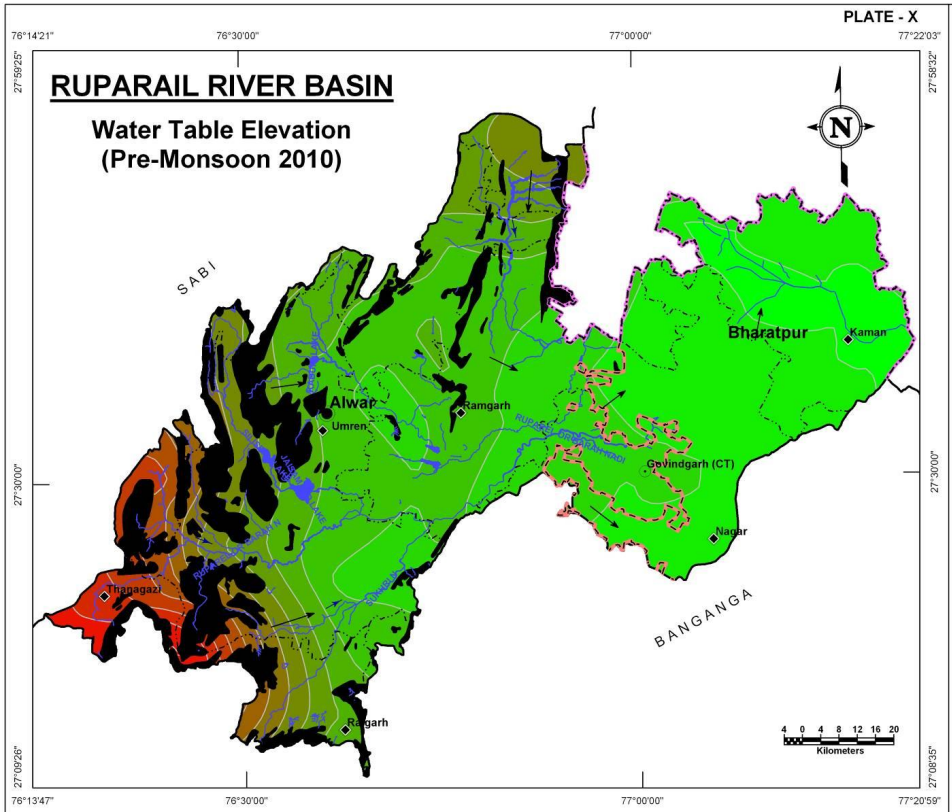
| Water Table Elevation (m amsl) Pre Monsoon - 2010 | District wise area coverage (sq km) | | Total Area (sq km) |
|---|---|---|---|
| | Alwar | Bharatpur | |
| < 180 | - | 223.6 | **223.6** |
| 180 - 200 | 47.8 | 809.3 | **857.1** |
| 200 - 220 | 465.0 | 82.3 | **547.3** |
| 220 - 240 | 690.4 | - | **690.4** |
| 240 - 260 | 331.4 | - | **331.4** |
| 260 - 280 | 204.4 | - | **204.4** |
| 280 - 300 | 186.3 | - | **186.3** |
| 300 - 320 | 55.0 | - | **55.0** |
| 320 - 340 | 55.4 | - | **55.4** |
| 340 - 360 | 50.8 | - | **50.8** |
| 360 - 380 | 51.8 | - | **51.8** |
| 380 - 400 | 33.3 | - | **33.3** |
| 400 - 440 | 24.6 | - | **24.6** |
| > 440 | 0.4 | - | **0.4** |
| **Total** | **2,196.6** | **1,115.2** | **3,311.8** |

# WATER LEVEL FLUCTUATION (PRE TO POST MONSOON 2010)

Water level fluctuation map is presented in Plate – XI. Perusal of the map reveals that the hilly areas in the western part of the basin show greater rise in the water table in post-monsoon season as compared to pre-monsoon water levels, whereas the flatter alluvial areas show lesser fluctuation. The hilly areas with hardrock aquifers had shown a general rise of 2-6m and in the western extremity reaching a high of 6m. There is an unusually high of 6m west of Kaman. The alluvial areas have shown a general fluctuation range of 0-4m and on some occasions showed a fall in water level (in post monsoon period) by more than 2m as seen around Kaman and especially around Alwar, possibly because of ground water extraction exceeding monsoon recharge.

| District Name | District wise area coverage (sq km) within fluctuation range (m) | | | | | | Total Area (sq km) |
|---|---|---|---|---|---|---|---|
| | < -2 | -2 to 0 | 0 to 2 | 2 to 4 | 4 to 6 | > 6 | |
| Alwar | 0.4 | 88.5 | 824.4 | 1,061.4 | 213.2 | 8.6 | **2,196.5** |
| Bharatpur | - | 12.1 | 539.3 | 441.9 | 113.1 | 8.8 | **1,115.2** |
| **Total** | **0.4** | **100.6** | **1,363.7** | **1,503.3** | **326.3** | **17.4** | **3,311.7** |

PLATE - X




## LEGEND

**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**

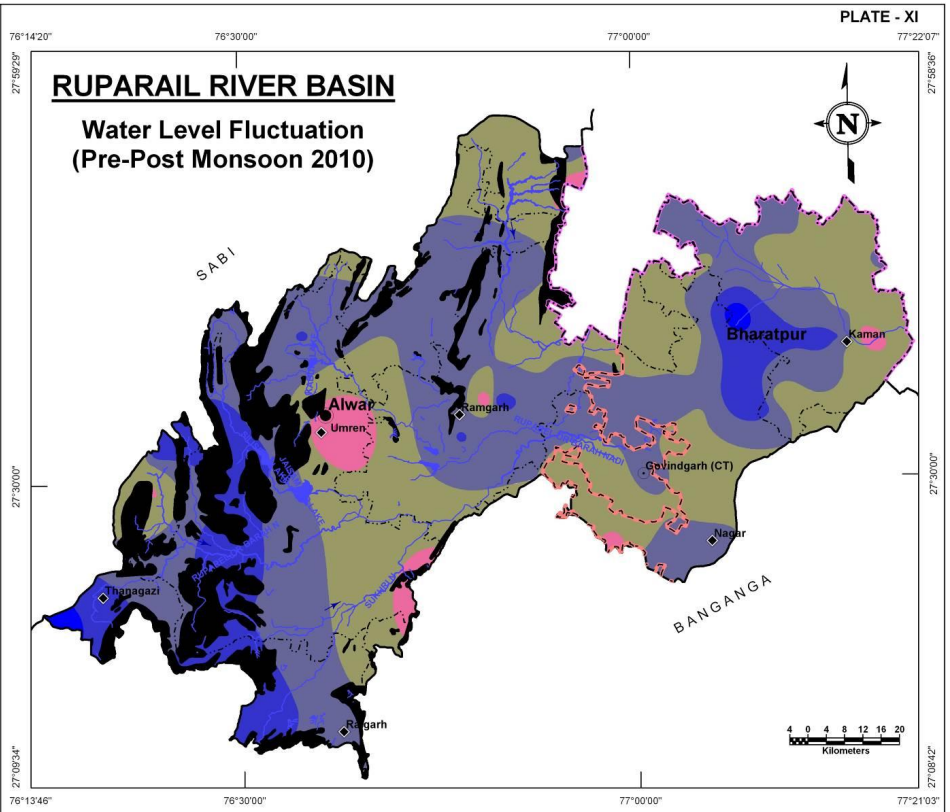
**Water Bodies:**

- River / Streams
- Ponds / Reservoirs
- **Hills**
- **Water Table Elevation**

**Water Table Elevation(m amsl):**

- <180
- 180 - 200
- 200 - 220
- 220 - 240
- 240 - 260
- 260 - 280
- 280 - 300
- 300 - 320
- 320 - 340
- 340 - 360
- 360 - 380
- 380 - 400
- 400 - 440
- >440

PLATE - XI




## LEGEND

**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**

**Water Bodies:**

- River / Streams
- Ponds / Reservoirs
- **Hills**

**Water Level Fluctuation(m):**

- < -2
- -2 to 0
- 0 to 2
- 2 to 4
- 4 to 6
- >6

# ELECTRICAL CONDUCTIVITY DISTRIBUTION RUPARAIL RIVER BASIN

The Electrical Conductivity (at 25°C) distribution map is presented in Plate – XII reveals an in general low values (EC <2000 µS/cm) in the western part of the basin which makes it suitable for domestic purposes. From the central part of the basin (east of Alwar city) till the edge of the basin in the east the EC values gradually show a rise and large patches of high salinity could be seen in Bharatpur district. Interestingly, the low EC areas largely correspond to hardrock aquifer areas and the high salinity (EC >4000 µS/cm) is seen in alluvial aquifers especially the areas where the Ruparail river disappears in the topographic low around Bharatpur. The low, moderate and high EC areas occupy 55.4%, 26.7% and 17.9 % of the basin areas respectively.

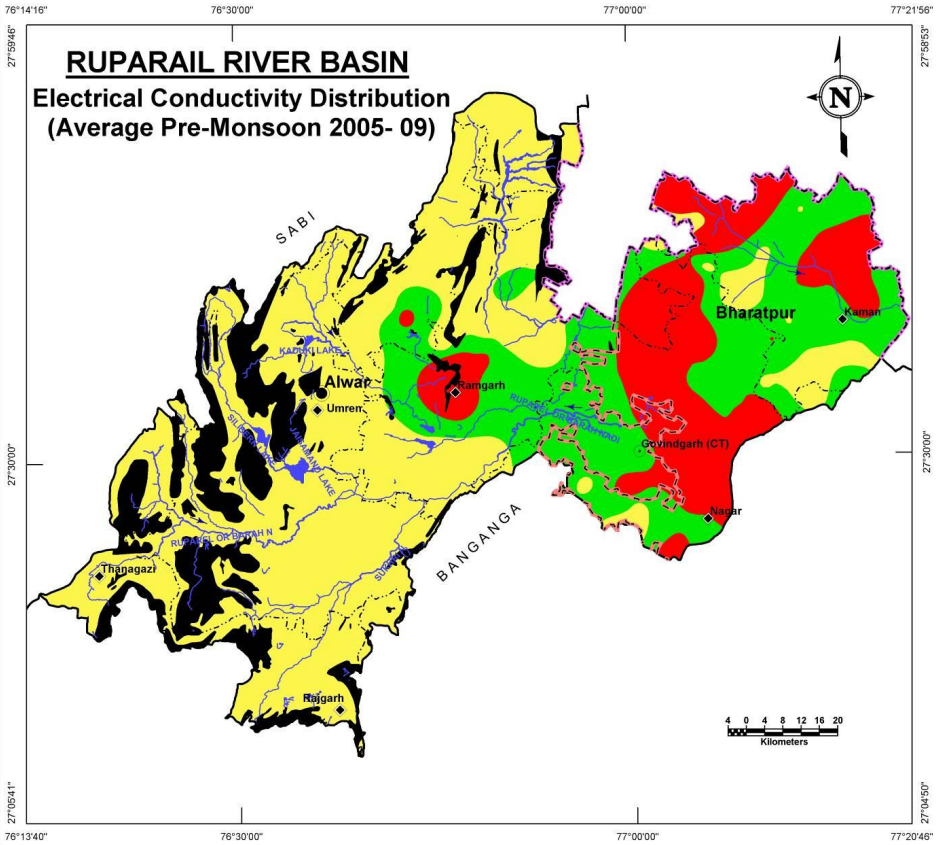
| Electrical Conductivity Ranges (µS/cm at 25°C) (Ave. of years 2005-09) | District wise area coverage (sq km) | | | | Total Area (sq km) |
|---|---|---|---|---|---|
| | Alwar | | Bharatpur | | |
| | Area | % age | Area | % age | |
| < 2000 | 1,724.7 | 78.5 | 109.1 | 9.8 | **1,833.8** |
| 2000-4000 | 374.6 | 17.1 | 510.1 | 45.7 | **884.7** |
| > 4000 | 97.2 | 4.4 | 496.0 | 44.5 | **593.2** |
| **Total** | **2,196.5** | **100.0** | **1,115.2** | **100.0** | **3,311.7** |

# CHLORIDE DISTRIBUTION

High chloride concentration in ground water also renders it unsuitable for domestic and other purposes. The chloride concentration map (Plate – XIII) exhibits a similar distribution pattern as to that of Electrical Conductivity. A predominantly yellow colour (<250 mg/l) in the map suggests that from chloride perspective, the ground water is suitable for all purposes and together with moderately high concentration (250 – 1000 mg/l), these areas occupy about 84% of basin area and the rest of the area (about 16%) has high chloride concentration (>1000 mg/l) in ground water. The hilly aquifers areas formed in quartzites broadly correspond to low chloride concentration areas whereas the alluvial aquifers seem to have, in general, higher chloride concentration in ground water.

| Chloride Ranges (mg/l) (Ave. of years 2005-09) | District wise area coverage (sq km) | | | | Total Area (sq km) |
|---|---|---|---|---|---|
| | Alwar | | Bharatpur | | |
| | Area | % age | Area | % age | |
| < 250 | 1,543.6 | 70.2 | 28.2 | 2.5 | **1,571.8** |
| 250 – 1000 | 572.7 | 26.1 | 634.0 | 56.9 | **1,206.7** |
| > 1000 | 80.2 | 3.7 | 453.0 | 40.6 | **533.2** |
| **Total** | **2,196.5** | **100.0** | **1,115.2** | **100.0** | **3,311.7** |

PLATE - XII




## LEGEND

**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**

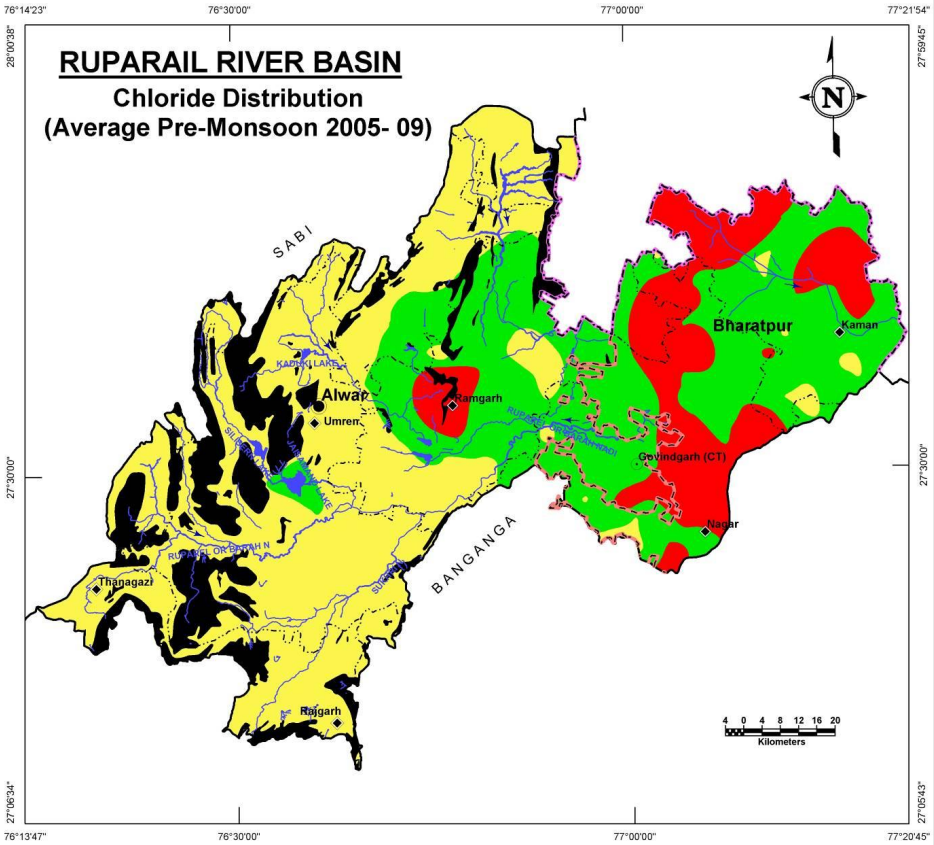
**Water Bodies:**

- River / Streams
- Ponds / Reservoirs
- **Hills**

**Electrical Conductivity (µS/cm at 25°C):**

- < 2000
- 2000-4000
- > 4000

PLATE - XIII




## LEGEND

**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**

**Water Bodies:**

- River / Streams
- Ponds / Reservoirs
- **Hills**

**Chloride Concentration (mg/l):**

- < 250
- 250 - 1000
- > 1000

# FLUORIDE DISTRIBUTION

# RUPARAIL RIVER BASIN

The Fluoride concentration map for Ruparail River Basin (Plate XIV) shows some scattered patches where very high Fluoride concentration (>3 mg/l) was recorded and these occupy an area of approximately 5.4% area of Alwar district in its easternmost part adjoining Bharatpur, whereas the high fluoride patch in Bharatpur district is present in its northern part. Overall, the high fluoride areas occupy about 5% of the basin area. Moderate Fluoride concentration (1.5 – 3.0 mg/l) areas surround the high fluoride areas and together in both districts occupy about 25% area. The rest of the area (approximately 70%) has shown very low concentration of fluoride in ground water samples which makes it suitable for all purposes.

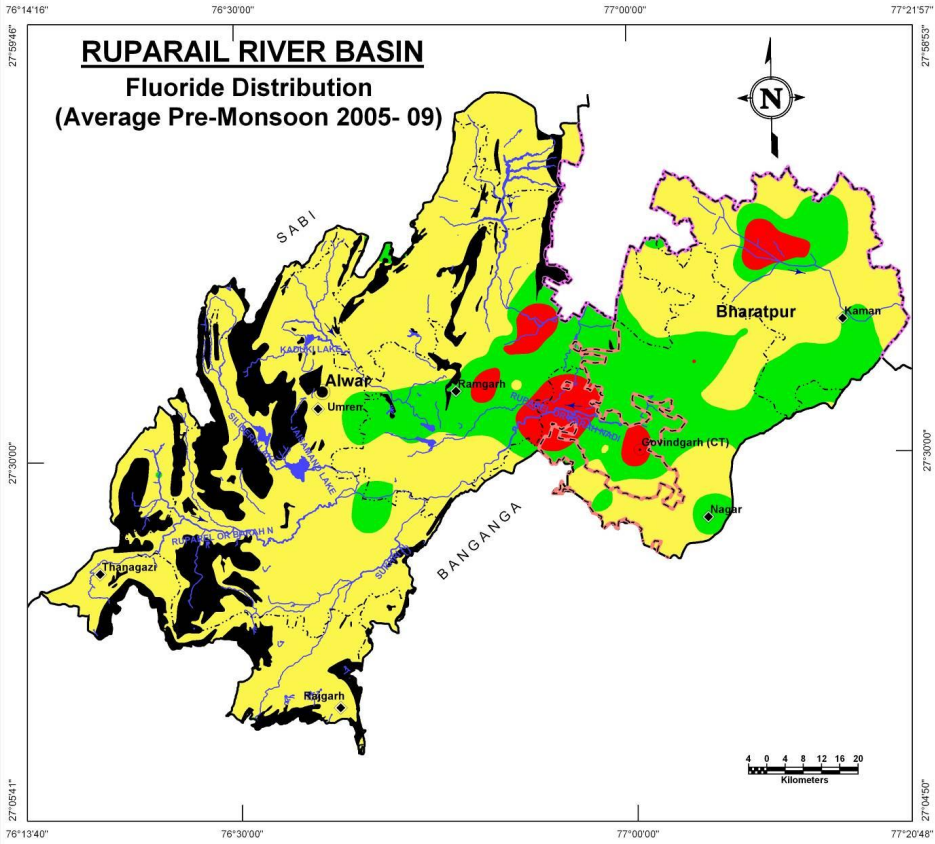
| Fluoride Ranges (mg/l) (Ave. of years 2005-09) | District wise area coverage (sq km) | | | | Total Area (sq km) |
|---|---|---|---|---|---|
| | Alwar | | Bharatpur | | |
| | Area | % age | Area | % age | |
| <1.5 | 1,726.5 | 78.6 | 603.5 | 54.1 | **2,330.0** |
| 1.5-3.0 | 350.5 | 16.0 | 462.4 | 41.5 | **812.9** |
| >3.0 | 119.5 | 5.4 | 49.3 | 4.4 | **168.8** |
| **Total** | **2,196.5** | **100.0** | **1,115.2** | **100.0** | **3,311.7** |

# NITRATE DISTRIBUTION

Plate XV shows distribution of Nitrate in ground water which is important to assess the ground water's suitability for agriculture. The distribution pattern does not show any direct relation to aquifers since several isolated high Nitrate concentration (>100 mg/l) patches are seen distributed over the area in the northern hilly areas of Alwar district as well as central and eastern parts within alluvial areas of the basin. Overall, 16.6% of the basin area is unsuitable for agriculture, however some part of this high Nitrate concentration areas fall within hilly (non-agriculture) areas also. This leaves about 83.4% of the basin area falling within low to moderate (i.e., <100 mg/l).

| Nitrate Ranges (mg/l) (Ave. of years 2005-09) | District wise area coverage (sq km) | | | | Total Area (sq km) |
|---|---|---|---|---|---|
| | Alwar | | Bharatpur | | |
| | Area | % age | Area | % age | |
| < 50 | 1,427.6 | 65.0 | 465.3 | 41.7 | **1,892.9** |
| 50-100 | 451.7 | 20.6 | 416.5 | 37.4 | **868.2** |
| > 100 | 317.2 | 14.4 | 233.4 | 20.9 | **550.6** |
| **Total** | **2,196.5** | **100.0** | **1,115.2** | **100.0** | **3,311.7** |

PLATE - XIV




## LEGEND

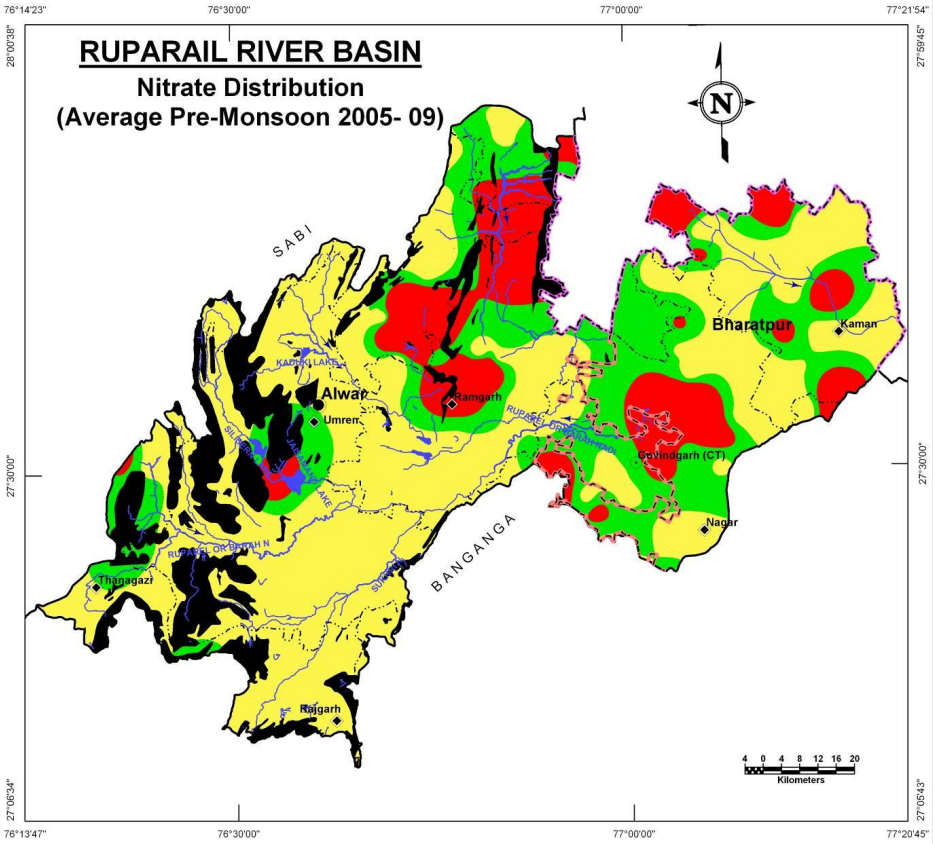
**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**
- **Water Bodies:**
- River / Streams
- Ponds / Reservoirs
- **Hills**

**Fluoride Concentration (mg/l):**

- < 1.5
- 1.5-3.0
- >3.0

PLATE - XV




## LEGEND

**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**
- **Water Bodies:**
- River / Streams
- Ponds / Reservoirs
- **Hills**

**Nitrate Concentration (mg/l):**

- < 50
- 50-100
- >100

# DEPTH TO BEDROCK

# RUPARAIL RIVER BASIN

The entire area of the Ruparail River basin is underlined by the hard rocks at different depths. The major rocks types occurring are Slate and Quartzite. These rocks are overlain by alluvial deposits of sand, clay, silt, kankar with subordinate colluvial, gravels, pebbles, cobbles and windblown sand and dune sand. The depth to bed rock defines the sub surface topography of the occurrence of massive hard rock beneath alluvial deposits and weathered and fractured hard rocks that are significant from aquifer mapping perspective.

On perusal of the map (Plate – XVI) of depth to bedrock (in meters above ground level) it is apparent that the bedrock is at deeper levels in eastern part of the river basin which gradually occurs at shallower depths in the western part and finally exposed as hills, further west and north. In the western part the hills apparently have steeply dipping slopes because the bedrock encountered in the adjacent areas also is deep, ranging between 60 to 80m below ground level. In the eastern part of Alwar district and in most part of Bharatpur district, the depth to bedrock gradually increases towards east attaining depths of more than 140m bgl.

| Depth to Bedrock (m bgl) | District wise area coverage (sq km) | | Total Area (sq km) |
|---|---|---|---|
| | Alwar | Bharatpur | |
| < 60 | 370.0 | - | **370.0** |
| 60-80 | 1,310.2 | - | **1,310.2** |
| 80-100 | 387.2 | 250.6 | **637.8** |
| 100-120 | 127.0 | 632.1 | **759.1** |
| 120-140 | 2.1 | 206.0 | **208.1** |
| > 140 | - | 26.5 | **26.5** |
| **Total** | **2,196.5** | **1,115.2** | **3,311.7** |

# UNCONFINED AQUIFER

Hydrogeological properties are different for alluvial and hard rock aquifers and therefore, this aquifer has been mapped as two separate regions viz, unconfined aquifers in alluvial and in hard rock areas.

Except for hardrock exposure areas, this aquifer is present all over the basin with thickness varying from less than 10 meter in the vicinity of hilly areas to more than about 30m, in general. Occasionally, it gains more than 30m thickness, locally as seen around Ramgarh in Alwar district. In the western part of the river basin hill outcrops are present and surrounding to these outcrops; weathered and fractured zone of hard rock acts as aquifer, varying in thickness from less than 2 meter to more than 6 meter falling within <10m thickness category. West of Alwar and around Rajgarh in Alwar district, the thickness of weathered and fractured zone reaches thickness of about 20m.

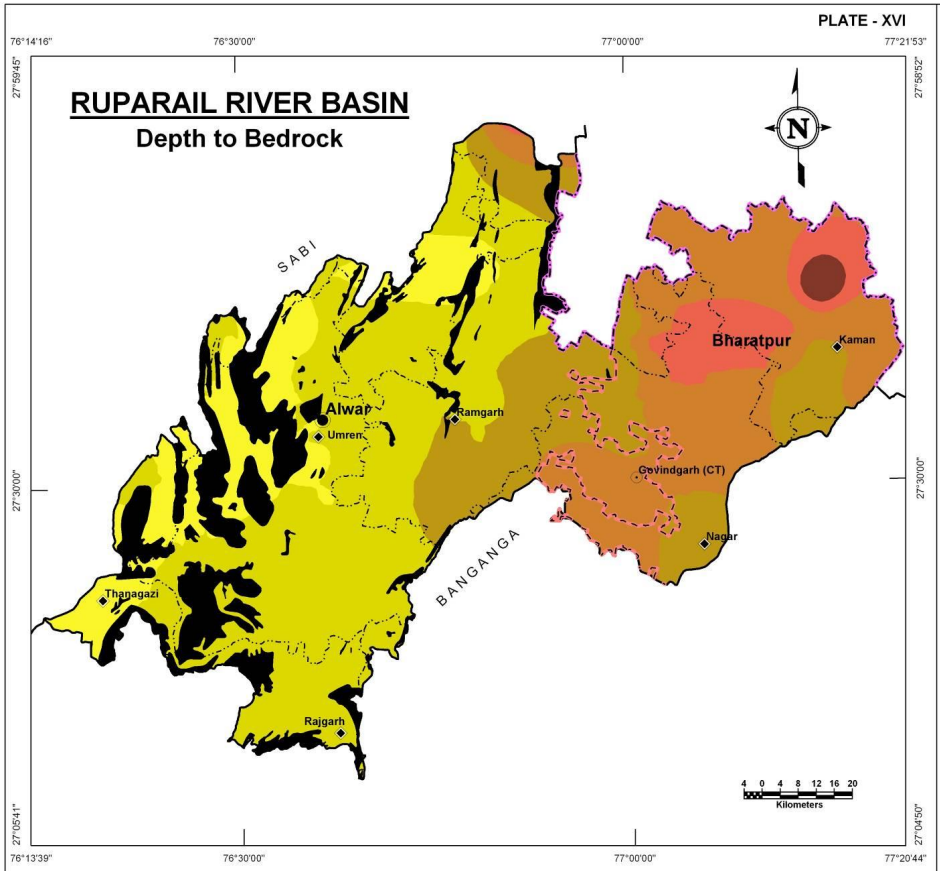
**Alluvial areas**

| Unconfined aquifer Thickness (m) | District wise area coverage (sq km) | | Total Area (sq km) |
|---|---|---|---|
| | Alwar | Bharatpur | |
| < 10 | 818.3 | 340.4 | **1,158.7** |
| 10-20 | 656.1 | 611.8 | **1,267.9** |
| 20-30 | 150.5 | 160.1 | **310.6** |
| > 30 | 49.3 | 2.9 | **52.2** |
| **Total** | **1,674.2** | **1,115.2** | **2,789.4** |

**Hardrock areas:**

| Unconfined aquifer Thickness (m) | District wise area coverage (sq km) | | Total Area (sq km) |
|---|---|---|---|
| | Alwar | Bharatpur | |
| <10 | 262.5 | - | **262.5** |
| 10-20 | 257.3 | - | **257.3** |
| > 20 | 2.5 | - | **2.5** |
| **Total** | **522.3** | **-** | **522.3** |

PLATE - XVI




## LEGEND

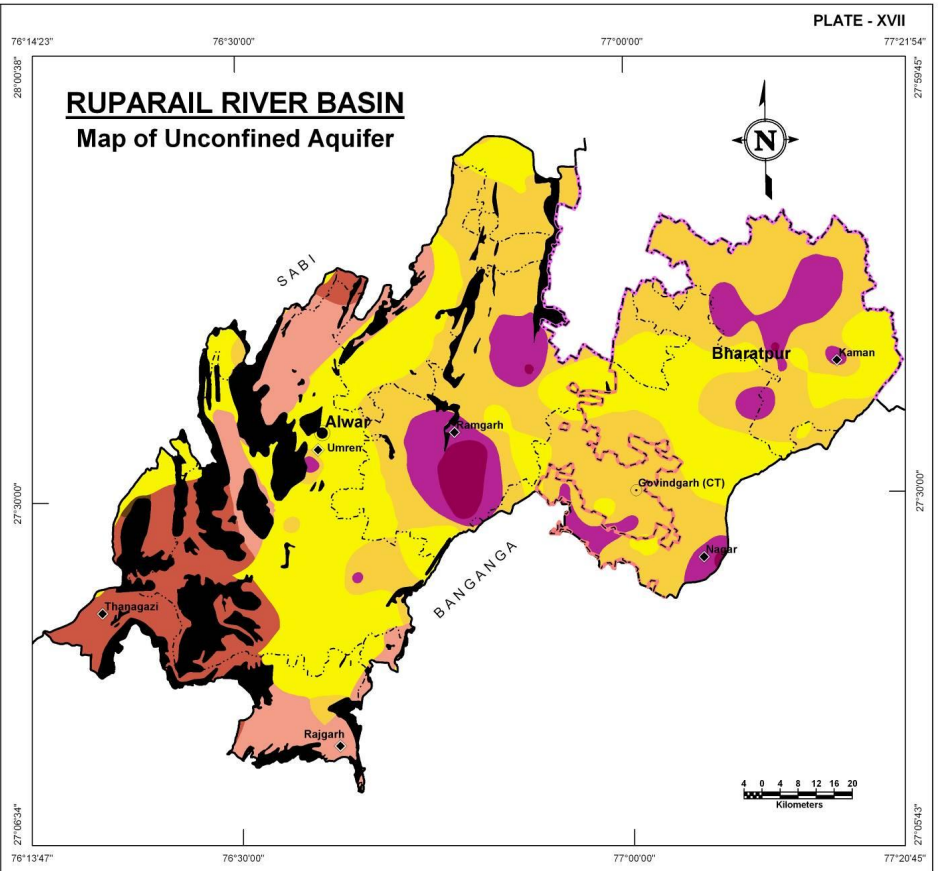
**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**
- **Hills**

**Depth to Bedrock (m bgl):**

- <60
- 60-80
- 80-100
- 100-120
- 120-140
- >140

PLATE - XVII




## LEGEND

**Admin Boundary:**

- District Headquarter
- Block Headquarter
- Town
- State Boundary
- District Boundary
- Block Boundary
- **River Basin Boundary**
- **Hills**

**Aquifer Thickness (m):**

**Alluvial Area:**

- < 10
- 10-20
- 20-30
- >30

**Weathered & Fractured Zone in Hardrock Area :**

- <10
- 10-20
- >20

# CROSS SECTIONS

# RUPARAIL RIVER BASIN

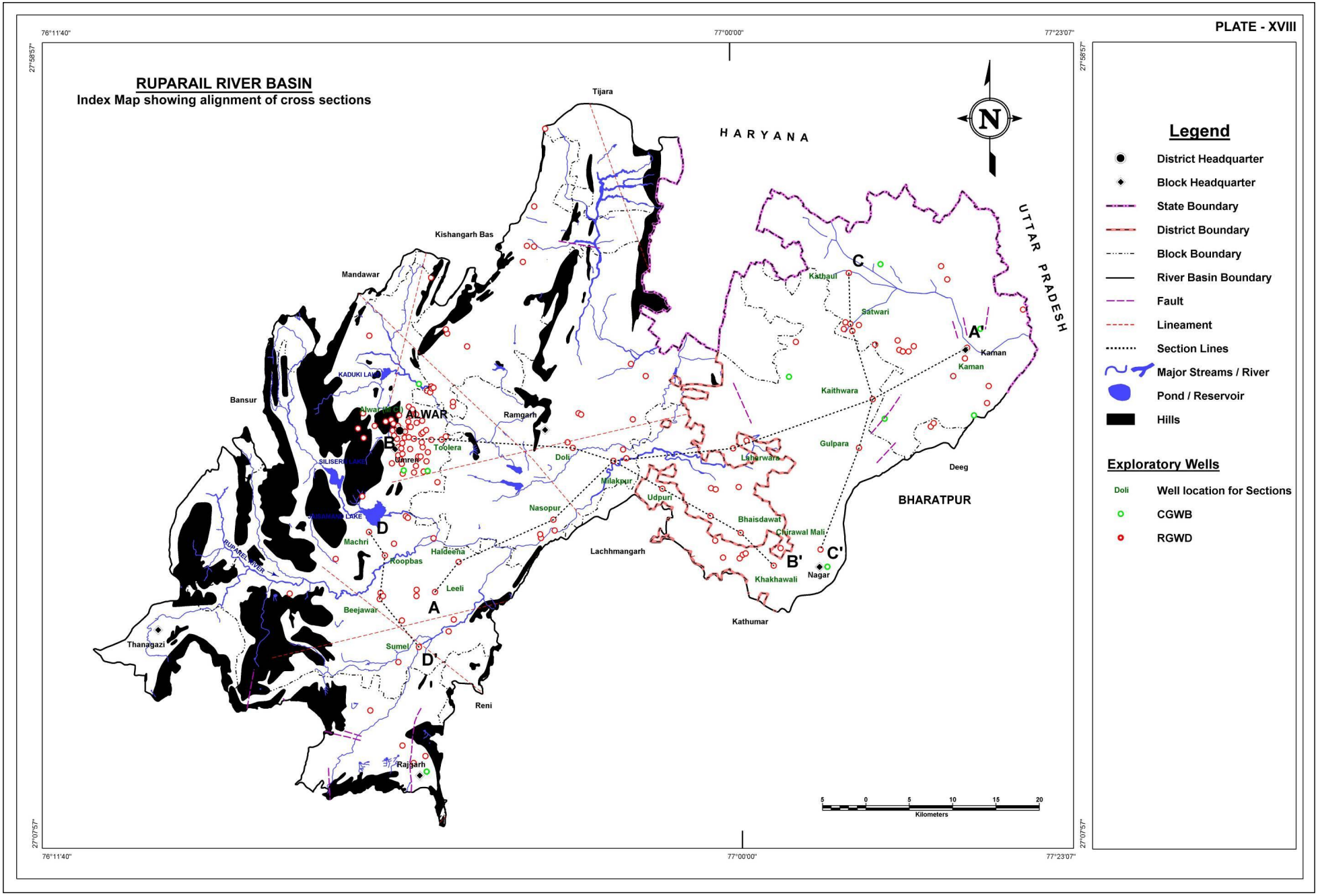
Several hydrogeologic cross sections have been drawn to better depict the sub-surface distribution of lithology. These sections have been overlaid with geological maps and structural faults if there are any have been transferred for verification of their impact on sub-surface material disposition. The alignment of the cross sections is shown in Plate – XVIII and corresponding sections are presented in Plates – XIX to XXII. The broad alignment of the sections is as given below:

| Name of Section Line | Orientation |
|---|---|
| Section AA’ | SW – NE |
| Section BB’ | W – E |
| Section CC’ | N – S |
| Section DD’ | NW – SE |

PLATE - XVIII

# RUPARAIL RIVER BASIN

## Index Map showing alignment of cross sections




## Legend

- District Headquarter
- Block Headquarter
- State Boundary
- District Boundary
- Block Boundary
- River Basin Boundary
- Fault
- Lineament
- Section Lines
- Major Streams / River
- Pond / Reservoir
- Hills

## Exploratory Wells

- Doli — Well location for Sections
- CGWB
- RGWD

# CROSS SECTIONS



## Section A-A':

Section A-A' (Plate – XIX) is taken in an approximate SW-NE direction covering length of about 70km. The lithologs of 7 boreholes along with surrounding well information is taken while preparing the section. Quartzite and Slate constitute continuous bedrock over which 60-70m of alluvial material is deposited. The alluvium is formed of clay and sand. In most part of the section clay constitutes the lower layer and sand is deposited over it. A thin soil cover is persistently present over the alluvium.

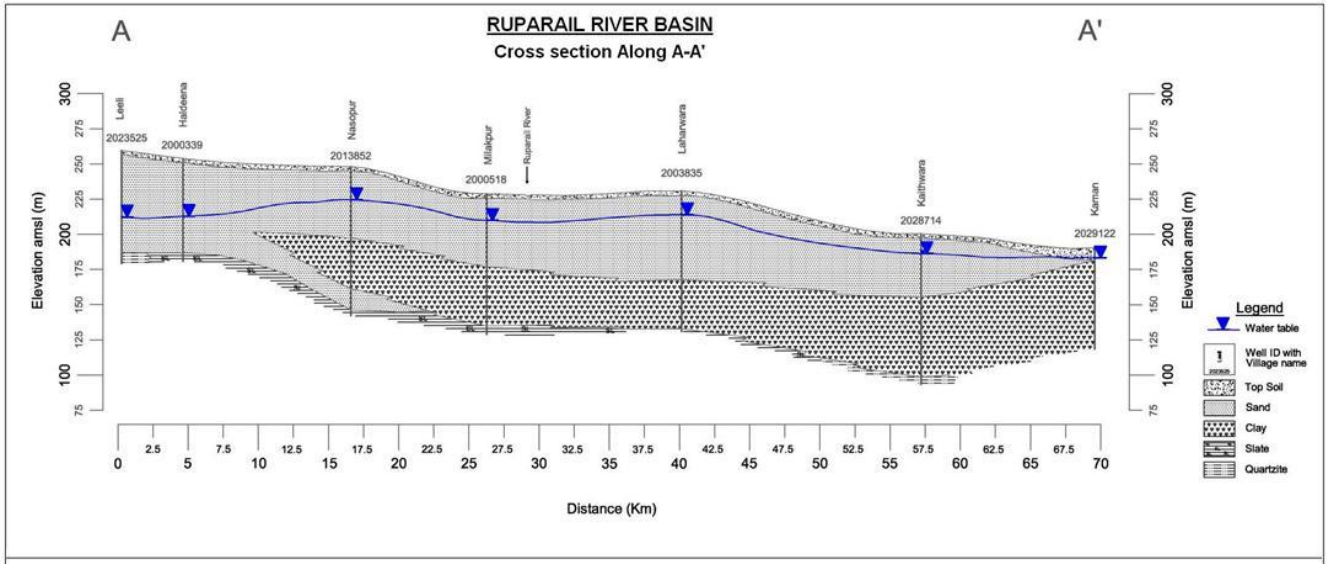
Depth to water level ranges from 180 meter amsl to 215 meter amsl maintaining good parallelism to topography, except in 0-10 km stretch where it is deeper.

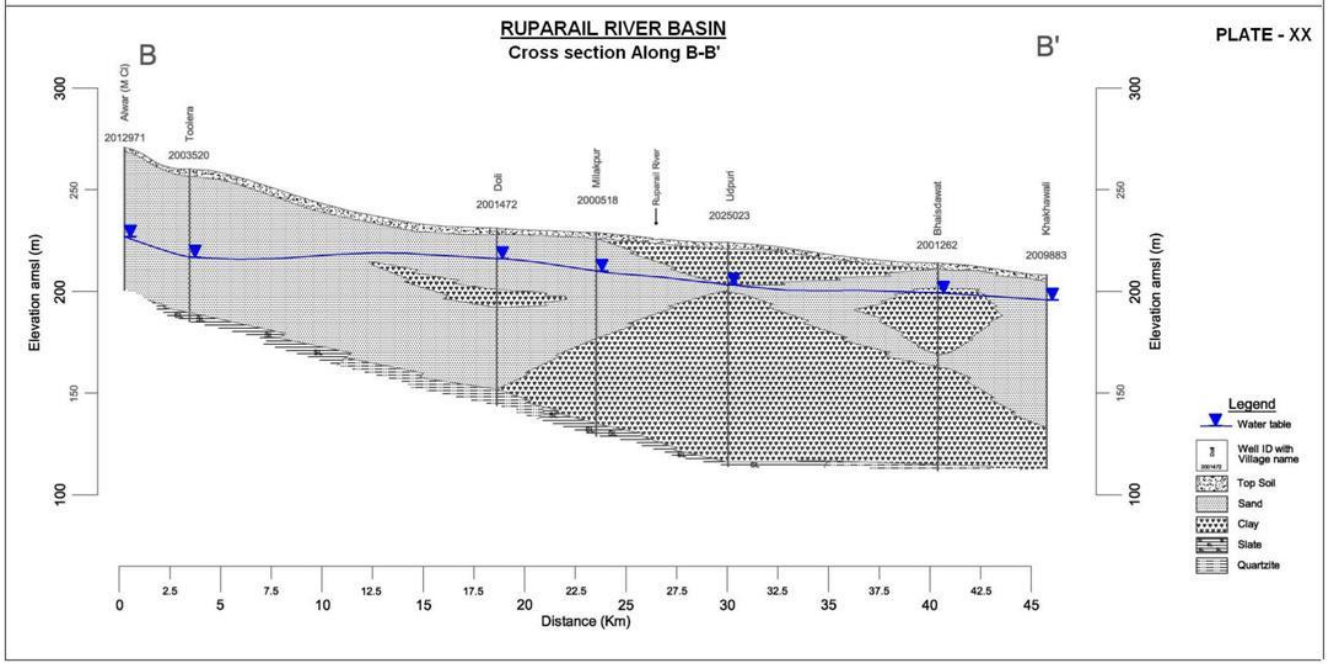
## Section B-B':

The section BB' (Plate – XX) is considered from W to E direction covering to a distance of 45 km. The lithologs of 7 boreholes are incorporated in this section along with surrounding data. In this section too, the quartzites and slates form the bedrock base over which 80-100m thick alluvial material is deposited. The western part is predominantly sandy with small clay lens within but the eastern half of the section is primarily clayey with very limited sand thickness which however again increases further eastwards. A thin soil cover is persistently present.

Depth to water level ranges from 195 meter amsl to 225 meter amsl in the section which is deeper in western part and shallower in eastern part of the section.

PLATE - XIX


RUPARAIL RIVER BASIN
Cross section Along A-A'
A
A'
Leeli
Haldeena
Nasopur
Milakpur
Ruparail River
Lahanwara
Kaithwara
Kaman
2023525
2000339
2013852
2000518
2003835
2028714
2029122
Elevation amsl (m)
Distance (Km)
Legend
Water table
Well ID with Village name
Top Soil
Sand
Clay
Slate
Quartzite


RUPARAIL RIVER BASIN
Cross section Along B-B'
PLATE - XX
B
B'
Alwar (M.Cl)
Todera
Dolli
Milakpur
Ruparail River
Lidpuri
Bhaisawat
Khakhawali
2012971
2003520
2001472
2000518
2025023
2001262
2009883
Elevation amsl (m)
Distance (Km)
Legend
Water table
Well ID with Village name
Top Soil
Sand
Clay
Slate
Quartzite

**Section C-C':**

Section C-C' (Plate – XXI) is prepared trending N-S direction in the western part of the river basin covering a length of about 35kms. The lithologs of 5 boreholes are incorporated in the section along with surrounding data. Here also, the lowermost horizon in the section is quartzite and slaty with quartzite appearing prominently in northern part and slate in southern. The section can be described as predominantly clayey in nature with only 25-30m thick sandy beds below or above the clay layer which forms aquifers in the area. Thin soil cover constitutes the top layer.

Depth to water level ranges from 180 meter amsl to 190 meter amsl in the section.

**Section D-D':**

Section D-D' (Plate – XXII) is taken along NW-SE direction in the eastern part of the basin covering a length of about 16km only. The data from 4 boreholes has been utilized, with surrounding well information to decipher the sub-surface information. This section also reveals a thick horizon of alluvial material. The bedrock formed of slate occurs at a very shallow depth of about 35m below ground level which gradually steepens to about 75m bgl made up of quartzite in the next well just 3kms southwards. Quartzite again appears in the southernmost well as bedrock. The alluvial material is predominantly clayey but sand does form good aquifers in the eastern and western parts of the section.

Depth to water level ranges from 225 meter amsl to 250 meter amsl in the section and follows parallelism to topography.

PLATE - XXI

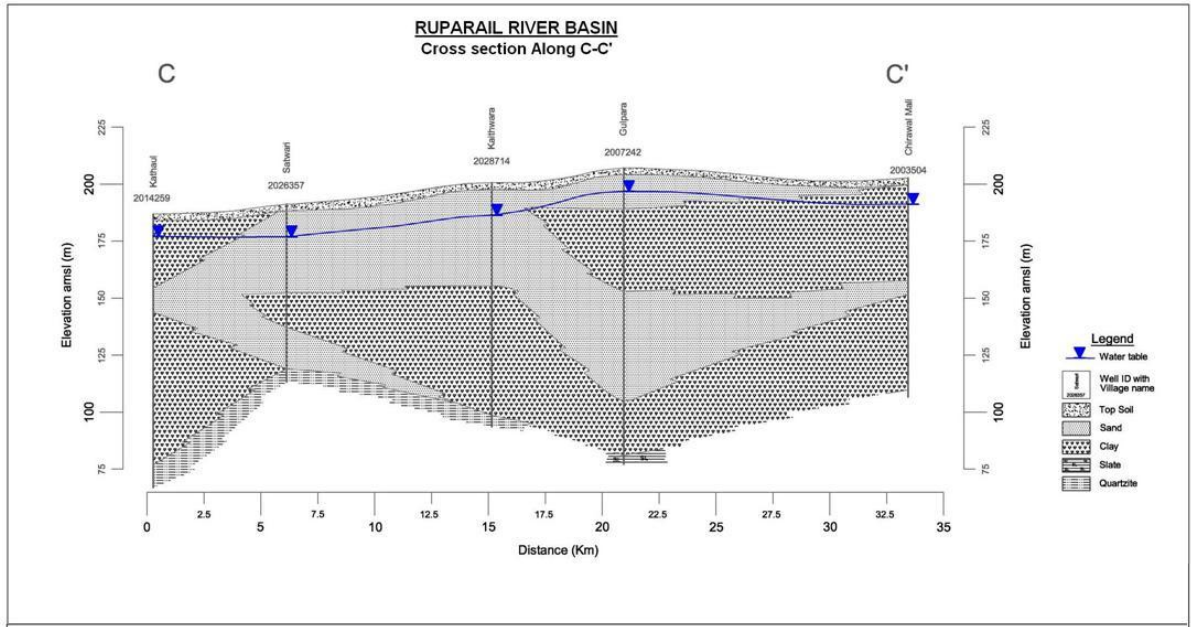
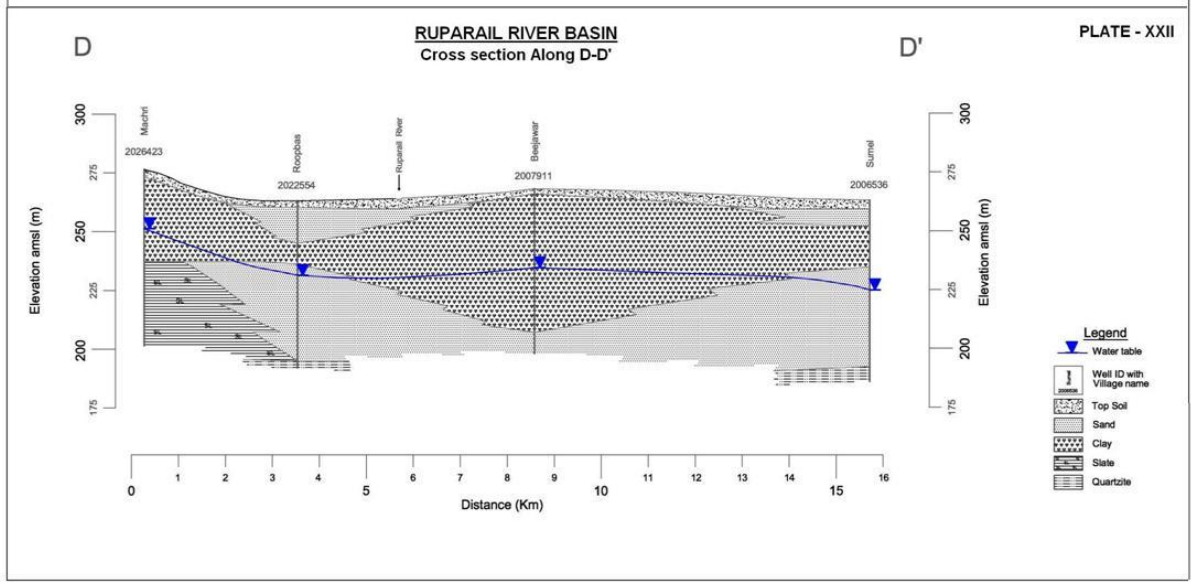



PLATE - XXII



# 3D MODEL OF AQUIFERS

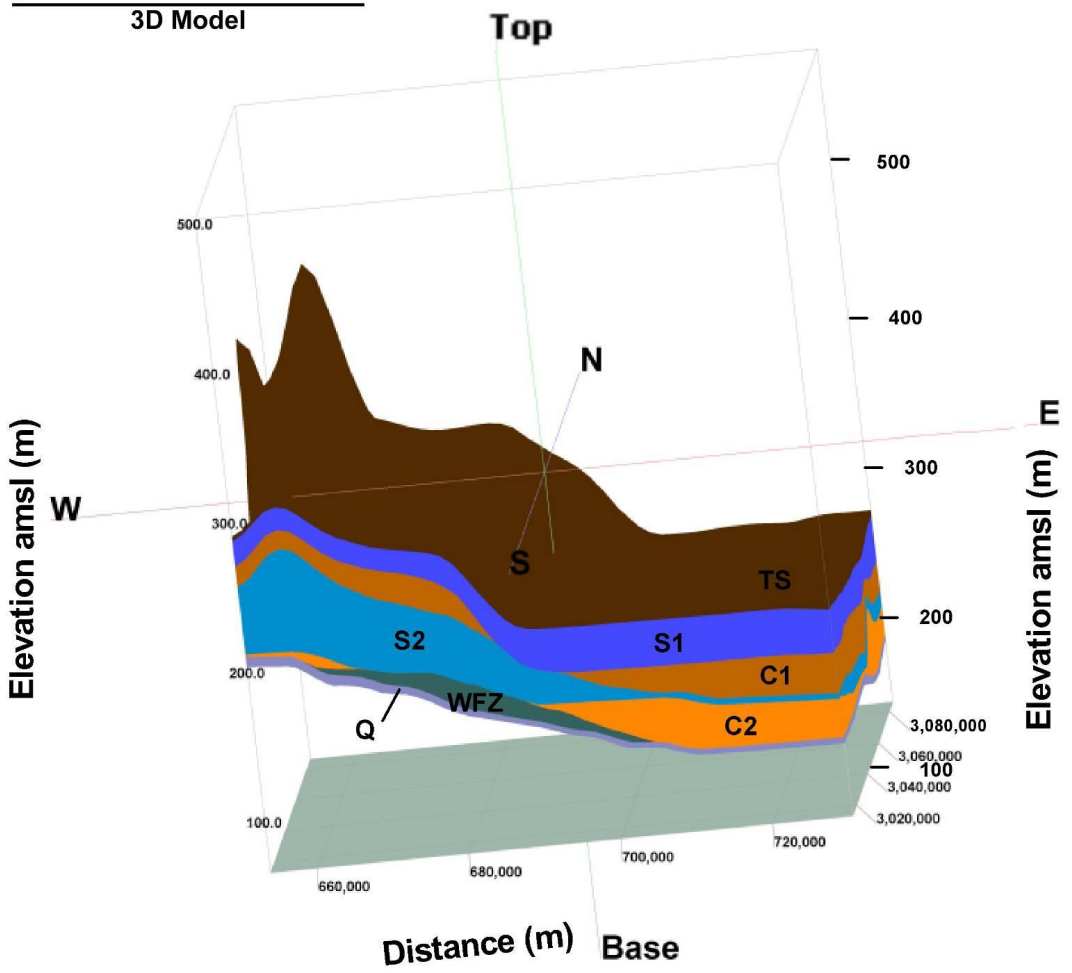
# RUPARAIL RIVER BASIN

The continuous litho-stratigraphic model has been developed for the Ruparail River Basin using the data of scattered wells as input. 3D model depicts the sub-surface aquifer disposition of litho-stratigraphic units forming aquifers, aquicludes and aquitards in the area.

Plate – XXIII presents 3D model depicting the various litho-stratigraphic units in the entire river basin. From this model it is apparent that older alluvium consisting of sand and clay is underlying the top soil throughout the basin area as multiple intercalated layers. Alluvium is underlain by quartzite in the area. Significant weathered and fractured hard rock zone is present in the southern part of the area.

PLATE - XXIII

## RUPARAIL RIVER BASIN
3D Model




### Legend

| | |
|---|---|
| TS | Top Soil |
| S1 | Sand |
| C1 | Clay |
| S2 | Sand |
| C2 | Clay |
| WFZ | Weathered & Fractured Zone |
| Q | Quartzite |

# Glossary of terms

| S. No. | Technical Terms | Definition |
|---|---|---|
| 1 | AQUIFER | A saturated geological formation which has good permeability to supply sufficient quantity of water to a Tube well, well or spring. |
| 2 | ARID CLIMATE | Climate characterized by high evaporation and low precipitation. |
| 3 | ARTIFICIAL RECHARGE | Addition of water to a ground water reservoir by man-made activity |
| 4 | CLIMATE | The sum total of all atmospheric or meteorological influences principally temperature, moisture, wind, pressure and evaporation of a region. |
| 5 | CONFINED AQUIFER | A water bearing strata having confined impermeable overburden. In this aquifer, water level represents the piezometric head. |
| 6 | CONTAMINATION | Introduction of undesirable substance, normally not found in water, which renders the water unfit for its intended use. |
| 7 | DRAWDOWN | The drawdown is the depth by which water level is lowered. |
| 8 | FRESH WATER | Water suitable for drinking purpose. |
| 9 | GROUND WATER | Water found below the land surface. |
| 10 | GROUND WATER BASIN | A hydro-geologic unit containing one large aquifer or several connected and interrelated aquifers. |
| 11 | GROUND WATER RECHARGE | The natural infiltration of surface water into the ground. |
| 12 | HARD WATER | The water which does not produce sufficient foam with soap. |
| 13 | HYDRAULIC CONDUCTIVITY | A constant that serves as a measure of permeability of porous medium. |
| 14 | HYDROGEOLOGY | The science related with the ground water. |
| 15 | HUMID CLIMATE | The area having high moisture content. |
| 16 | ISOHYET | A line of equal amount of rainfall. |
| 17 | METEOROLOGY | Science of the atmosphere. |
| 18 | PERCOLATION | It is flow through a porous substance. |
| 19 | PERMEABILITY | The property or capacity of a soil or rock for transmitting water. |
| 20 | pH | Value of hydrogen-ion concentration in water. Used as an indicator of acidity (pH < 7) or alkalinity (pH > 7). |
| 21 | PIEZOMETRIC HEAD | Elevation to which water will rise in a piezometers. |
| 22 | RECHARGE | It is a natural or artificial process by which water is added from outside to the aquifer. |
| 23 | SAFE YIELD | Amount of water which can be extracted from ground water without producing undesirable effect. |
| 24 | SALINITY | Concentration of dissolved salts. |
| 25 | SEMI-ARID | An area is considered semiarid having annual rainfall between 10-20 inches. |
| 26 | SEMI-CONFINED AQUIFER | Aquifer overlain and/or underlain by a relatively thin semi-pervious layer. |
| 27 | SPECIFIC YIELD | Quantity of water which is released by a formation after its complete saturation. |
| 28 | TOTAL DISSOLVED SOLIDS | Total weight of dissolved mineral constituents in water per unit volume (or weight) of water in the sample. |

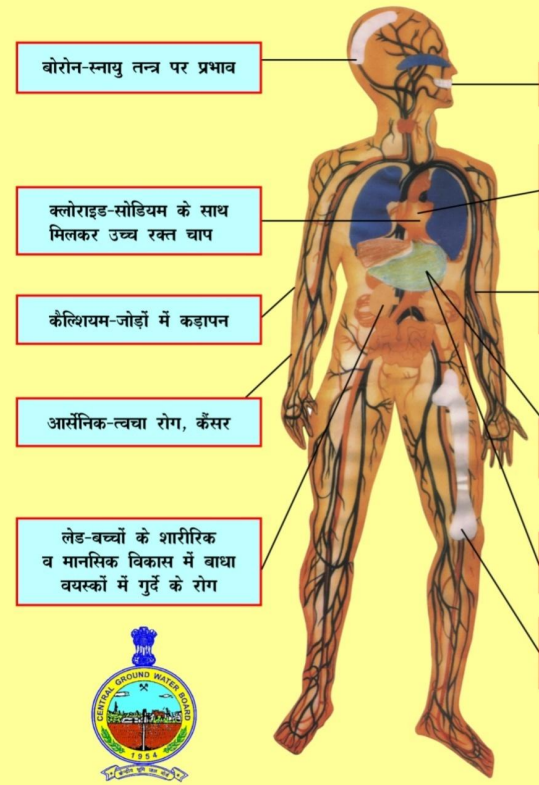
(Contd…)

| S. No. | Technical Terms | Definition |
|---|---|---|
| 29 | TRANSMISSIBILITY | It is defined as the rate of flow through an aquifer of unit width and total saturation depth under unit hydraulic gradient. It is equal to product of full saturation depth of aquifer and its coefficient of permeability. |
| 30 | UNCONFINED AQUIFER | A water bearing formation having permeable overburden. The water table forms the upper boundary of the aquifer. |
| 31 | UNSATURATED ZONE | The zone below the land surface in which pore space contains both water and air. |
| 32 | WATER CONSERVATION | Optimal use and proper storage of water. |
| 33 | WATER RESOURCES | Availability of surface and ground water. |
| 34 | WATER RESOURCES MANAGEMENT | Planned development, distribution and use of water resources. |
| 35 | WATER TABLE | Water table is the upper surface of the zone of saturation at atmospheric pressure. |
| 36 | ZONE OF SATURATION | The ground in which all pores are completely filled with water. |
| 37 | ELECTRICAL CONDUCTIVITY | Flow of free ions in the water at 25C mu/cm. |
| 38 | CROSS SECTION | A Vertical Projection showing sub-surface formations encountered in a specific plane. |
| 39 | 3-D PICTURE | A structure showing all three dimensions i.e. length, width and depth. |
| 40 | GWD | Ground Water Department |
| 41 | CGWB | Central Ground Water Board |
| 42 | CGWA | Central Ground Water Authority |
| 43 | SWRPD | State Water Resources Planning Department |
| 44 | EU-SPP | European Union State Partnership Programme |
| 45 | TOPOGRAPHY | Details of drainage lines and physical features of land surface on a map. |
| 46 | GEOLOGY | The science related with the Earth. |
| 47 | GEOMORPHOLOGY | The description and interpretation of land forms. |
| 48 | PRE MONSOON SURVEY | Monitoring of Ground Water level from the selected DKW/Piezometer before Monsoon (carried out between 15th May to 15th June) |
| 49 | POST-MONSOON SURVEY | Monitoring of Ground Water level from the selected DKW/Piezometer after Monsoon (carried out between 15th October to 15th November) |
| 50 | PIEZOMETER | A non-pumping small diameter bore hole used for monitoring of static water level. |
| 51 | GROUND WATER FLUCTUATION | Change in static water level below ground level. |
| 52 | WATER TABLE | The static water level found in unconfined aquifer. |
| 53 | DEPTH OF BED ROCK | Hard & compact rock encountered below land Surface. |
| 54 | G.W. MONITORING STATION | Dug wells selected on grid basis for monitoring of state water level. |
| 55 | EOLIAN DEPOSITS | Wind-blown sand deposits |

Ground Water Department,
Rajasthan

European Union
State Partnership Programme

# भूजल में घुले मुख्य तत्वों की अधिकता का मानव शरीर पर दुष्प्रभाव



- बोरोन-स्नायु तन्त्र पर प्रभाव
- क्लोराइड-सोडियम के साथ मिलकर उच्च रक्त चाप
- कैल्शियम-जोड़ों में कड़ापन
- आर्सेनिक-त्वचा रोग, कैंसर
- लेड-बच्चों के शारीरिक व मानसिक विकास में बाधा वयस्कों में गुर्दे के रोग
- फ्लोराइड - दंत क्षरण
- सोडियम-हृदय, गुर्दा व रक्त परिसंचरण रोगों से ग्रसित लोगों को हानिकारक
- नाइट्रेट-नवजात शिशुओं में ब्लू बेबी बीमारी (मेथमोग्लोबिनिमिया)
- सल्फेट-अधिकता में मैग्नेशियम के साथ मिलकर दस्तावर
- आयरन-आयरन जीवाणु से आमाशय संबंधी रोग
- फ्लोराइड-जोड़ों में अकड़न, हड्डियों में मुड़ाव

केन्द्रीय भूमि जल बोर्ड,
पश्चिमी क्षेत्र, जयपुर
जल संसाधन मंत्रालय
भारत सरकार
e-mail:cgwbwr@sancharnet.in

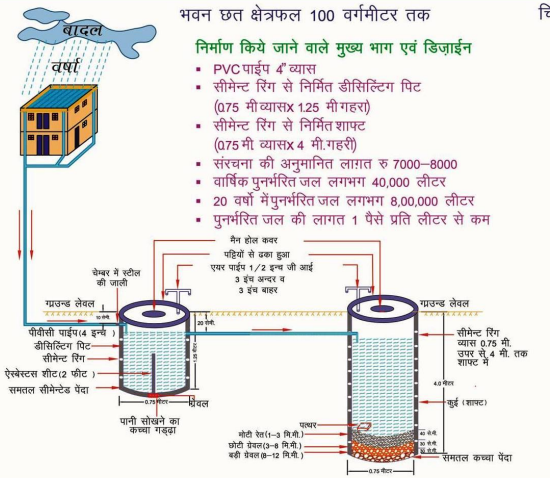
**भूजल अमूल्य है इसे प्रदूषित न करें।**

## चित्र–1

### भवन छत क्षेत्रफल 100 वर्गमीटर तक

**निर्माण किये जाने वाले मुख्य भाग एवं डिज़ाईन**

- PVC पाईप 4" व्यास
- सीमेन्ट रिंग से निर्मित डीसिल्टिंग पिट (0.75 मी.व्यास x 1.25 मी.गहरा)
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी व्यास x 4 मी.गहरी)
- संरचना की अनुमानित लाग़त रु 7000–8000
- वार्षिक पुनर्भरित जल लगभग 40,000 लीटर
- 20 वर्षो में पुनर्भरित जल लगभग 8,00,000 लीटर
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम

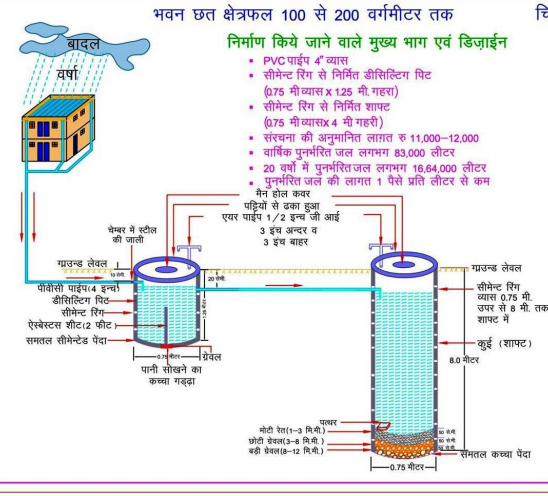



## चित्र–2

### भवन छत क्षेत्रफल 100 से 200 वर्गमीटर तक

**निर्माण किये जाने वाले मुख्य भाग एवं डिज़ाईन**

- PVC पाईप 4" व्यास
- सीमेन्ट रिंग से निर्मित डीसिल्टिंग पिट (0.75 मी.व्यास x 1.25 मी. गहरा)
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी व्यास x 4 मी गहरी)
- संरचना की अनुमानित लाग़त रु 11,000–12,000
- वार्षिक पुनर्भरित जल लगभग 83,000 लीटर
- 20 वर्षो में पुनर्भरित जल लगभग 16,64,000 लीटर
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम

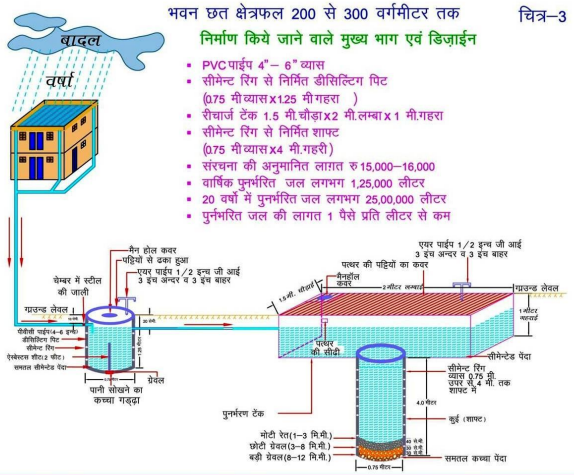



## चित्र–3

### भवन छत क्षेत्रफल 200 से 300 वर्गमीटर तक

**निर्माण किये जाने वाले मुख्य भाग एवं डिज़ाईन**

- PVC पाईप 4"– 6" व्यास
- सीमेन्ट रिंग से निर्मित डीसिल्टिंग पिट (0.75 मी.व्यास x 1.25 मी.गहरा )
- रीचार्ज टेंक 1.5 मी.चौड़ा x 2 मी.लम्बा x 1 मी.गहरा
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी व्यास x 4 मी.गहरी)
- संरचना की अनुमानित लाग़त रु 15,000–16,000
- वार्षिक पुनर्भरित जल लगभग 1,25,000 लीटर
- 20 वर्षो में पुनर्भरित जल लगभग 25,00,000 लीटर
- पुर्नभरित जल की लागत 1 पैसे प्रति लीटर से कम

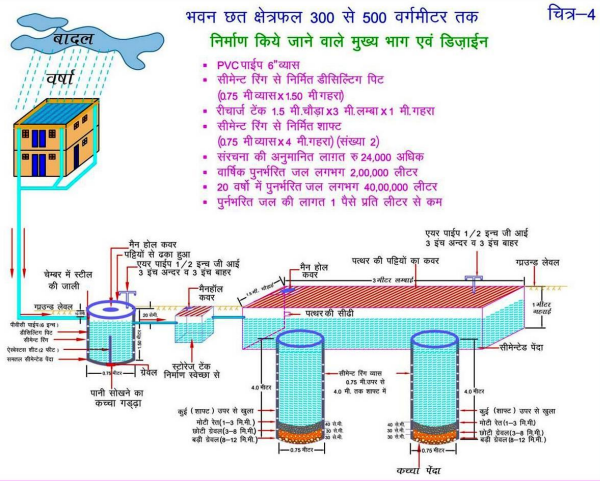



## चित्र–4

### भवन छत क्षेत्रफल 300 से 500 वर्गमीटर तक

**निर्माण किये जाने वाले मुख्य भाग एवं डिज़ाईन**

- PVC पाईप 6" व्यास
- सीमेन्ट रिंग से निर्मित डीसिल्टिंग पिट (0.75 मी.व्यास x 1.50 मी गहरा)
- रीचार्ज टेंक 1.5 मी.चौड़ा x 3 मी.लम्बा x 1 मी.गहरा
- सीमेन्ट रिंग से निर्मित शाफ्ट (0.75 मी.व्यास x 4 मी.गहरा) (संख्या 2)
- संरचना की अनुमानित लाग़त रु 24,000 अधिक
- वार्षिक पुनर्भरित जल लगभग 2,00,000 लीटर
- 20 वर्षो में पुनर्भरित जल लगभग 40,00,000 लीटर
- पुर्नभरित जल की लागत 1 पैसे प्रति लीटर से कम

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## Myths and Facts about Ground Water

| S No | Myths | Facts |
|---|---|---|
| 1 | What is Ground Water<br>• an underground lake<br>• a net work of underground rivers<br>• a bowl filled with water | Water which occurs below the land in geological formations/rocks is Ground water |
| 2 | Ground Water occurs everywhere beneath the Land Surface | Not really, it depends on the nature of rock formation |
| 3 | There is a relationship between ground water and surface water | Not all the places. Near streams/rivers there is relation |
| 4 | Groundwater is not renewable resource | It is renewable source and every year it is being recharged through rain/applied irrigation etc |
| 5 | Ground water is unlimited and deeper you drill more discharge | It is limited to annual recharge from rain/applied irrigation. The discharge may not increase if you go deeper |
| 6 | Ground Water moves rapidly | The movement of ground water is very slow |
| 7 | Ground water pumped from wells is thousands of years old | Generally the ground water being tapped through wells is a few years old |
| 8 | If water taste good—it is safe to drink | It may have other chemicals e.g. fluoride, nitrates etc which are harmful |
| 9 | Water from free flowing tube wells is very pure | This water can also be contaminated so test before use |
| 10 | If I recharge my TW/DW/HP it will not benefit me | It will also benefit you and also adjoing wells |
| 11 | There is no static ground water resources in Rajasthan | Rajasthan is also having Static GW resources, and being tapped in most of areas as GW annual withdrawal is more than annual recharge |
| 12 | I cannot meet annual cooking and drinking water requirement by rain water harvesting | The water requirement for drinking and cooking is only 8 lit/day. You can harvest this water for family of 5 persons from roof top or paved area of 75 Sq m to meet annual requirement |
| 13 | You can increase ground water recharge | This can be done by harvesting the rain water and storing in sub surface reservoir (GW) by constructing the recharge structures |
| 14 | You cannot use abandoned TW/HP/DW for ground water recharge | These should be used as recharge structures as harvested rain water is directly put into GW reservoir |
| 15 | Putting waste near HP/TW will not cause any problem | Such actions will pollute wells and water |


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