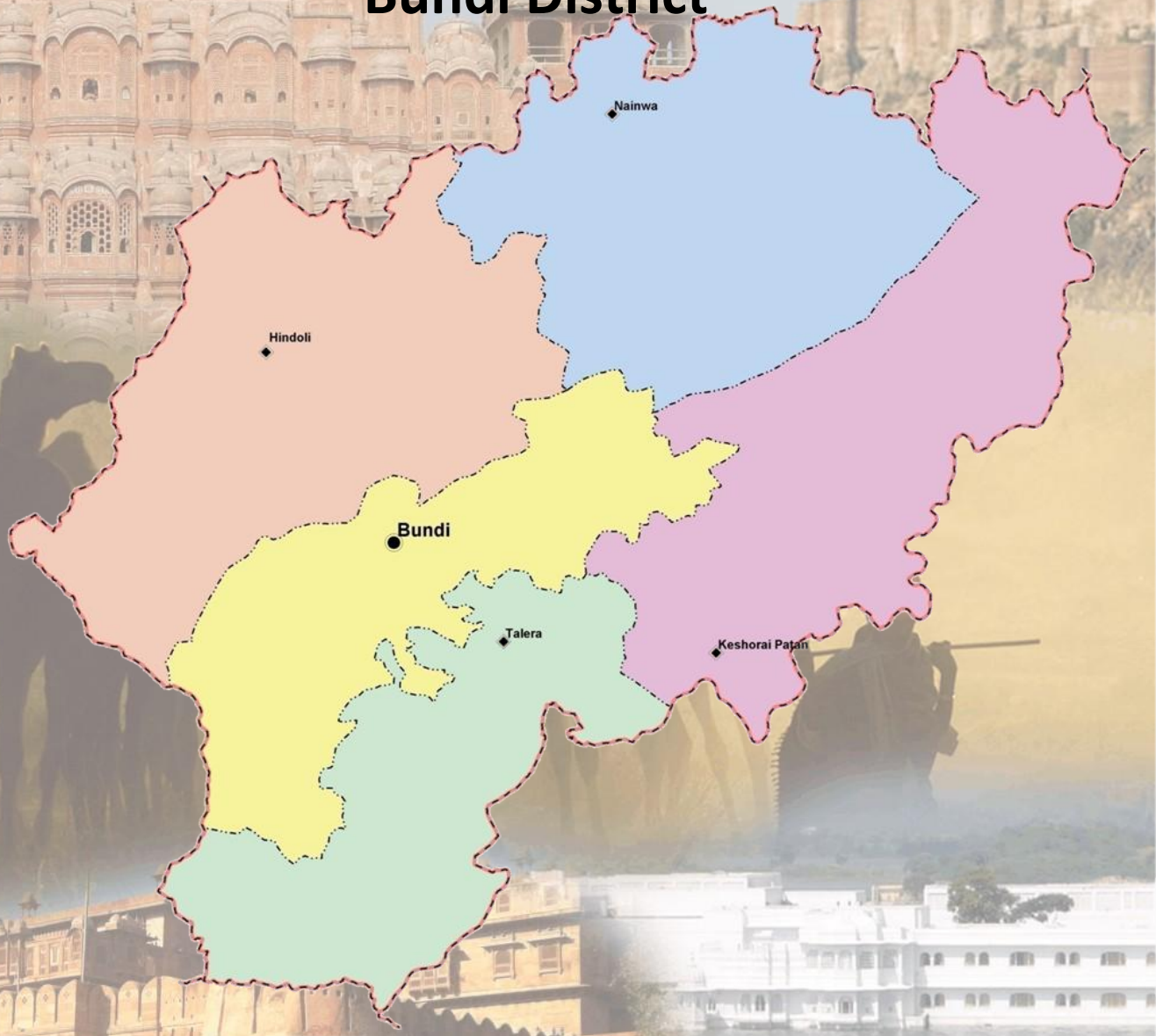
Ground Water Department,
Rajasthan

Hydrogeological Atlas of Rajasthan
Bundi District

European Union
State Partnership Programme

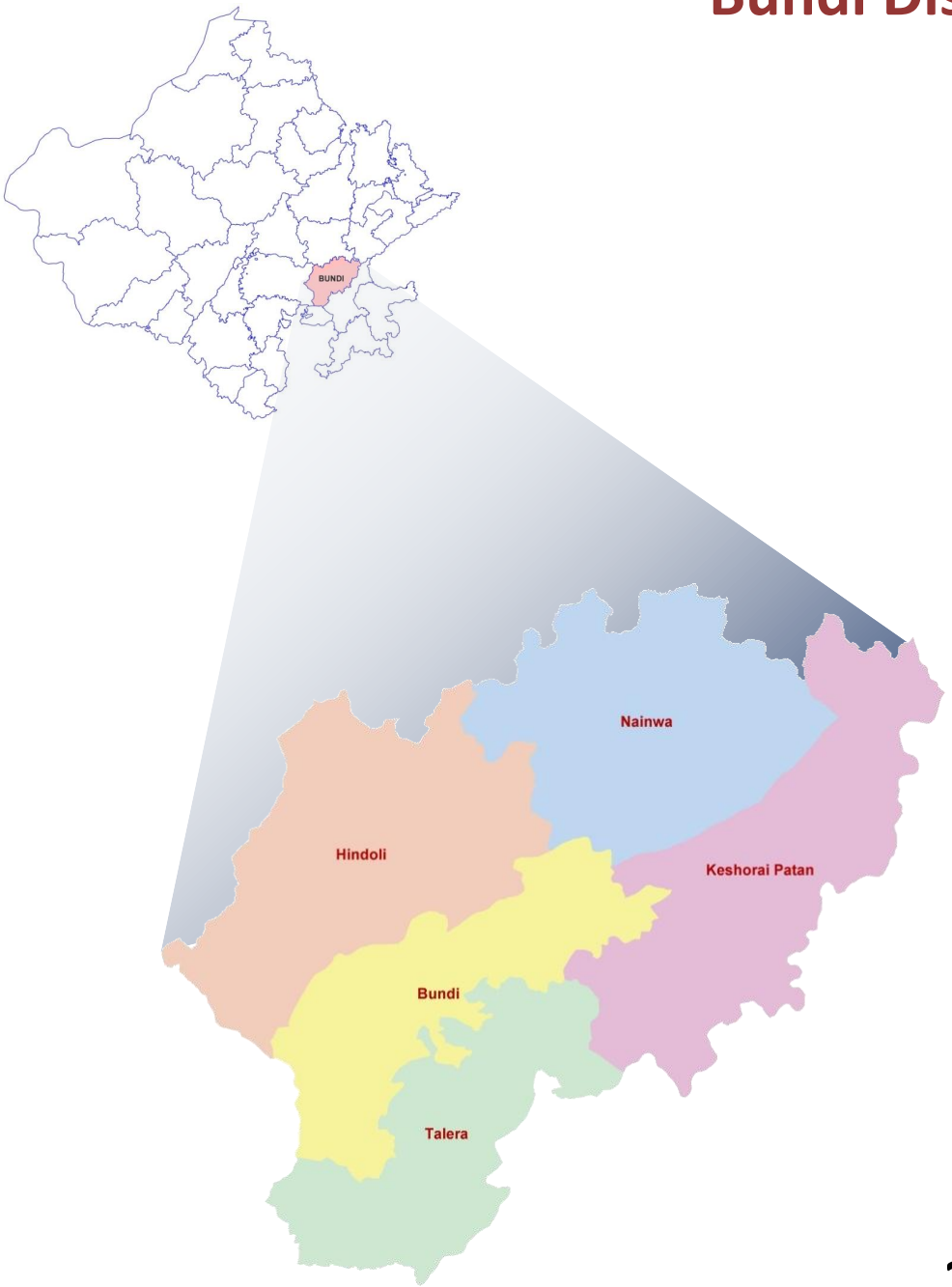


2013

ROLTA
Rolta India Limited

Hydrogeological Atlas of Rajasthan

Bundi District



Contents:

2013

ADMINISTRATIVE SETUP

DISTRICT – BUNDI

Location:

Bundi district is located in the southeastern part of Rajasthan. It is bounded in the north by Tonk district; in the northeast by Sawai Madhopur district; east to southeast by Kota district; south by Chittaurgarh and in the west by Bhilwara district. It stretches between 24° 59' 22.09" to 25° 53' 03.41" north latitude and 75° 15' 35.63'' to 76° 21' 32.20'' east longitude covering area of 5.776.5 sq km. The district has a systematic drainage system, and most part of the district is drained by the southwest to northeast flowing Chambal River and its tributaries. Small part of the district in the north is drained by tributaries of Banas River.

Administrative Set-up:

Bundi district is administratively divided into five Blocks. The following table summarizes the basic statistics of the district at block level.

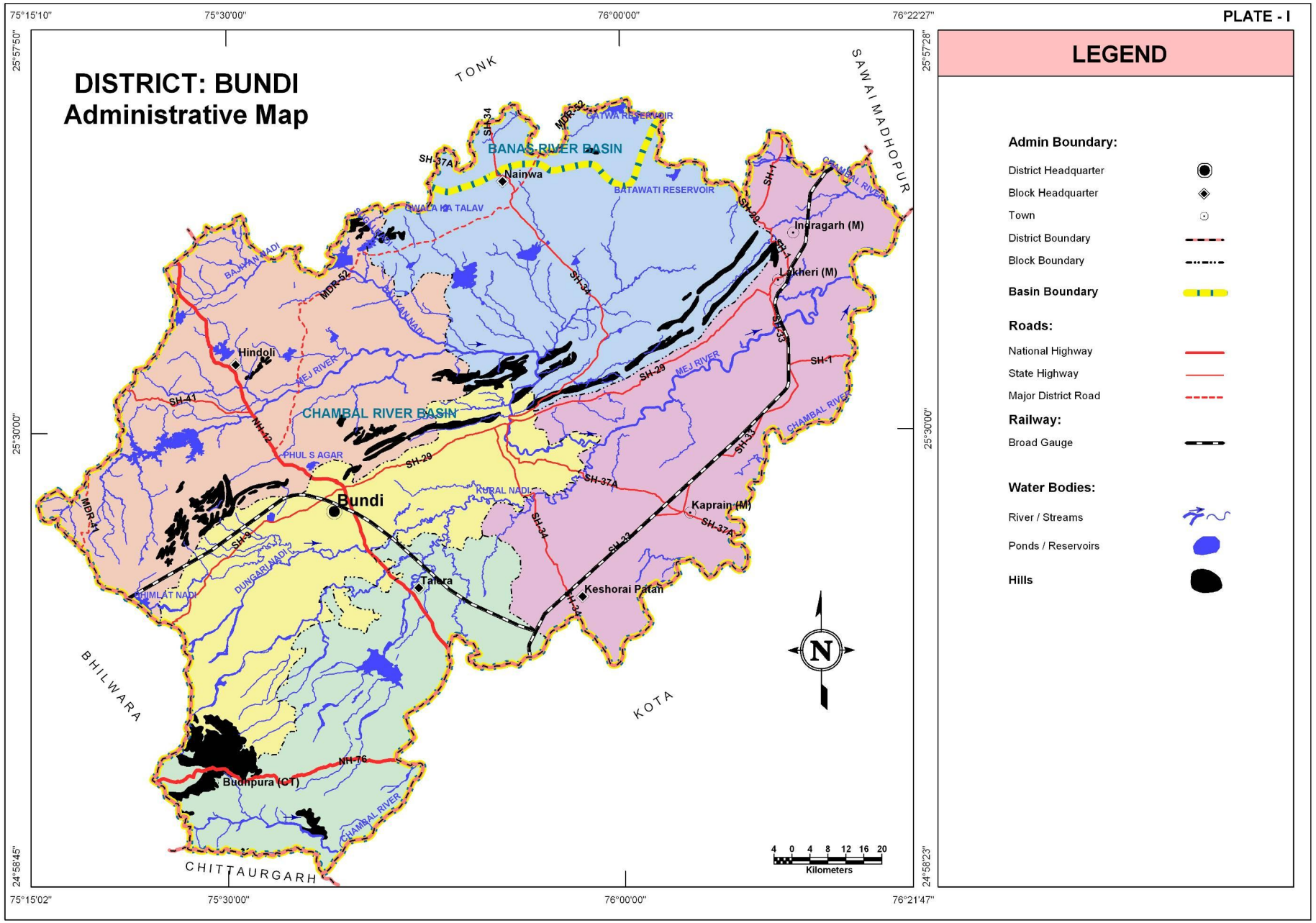
S. No.	Block Name	Population (Based on 2001 census)	Area (sq km)	% of District Area	Total Number of Towns and Villages
1	Bundi	2,15,821	938.4	16.2	163
2	Hindoli	1,89,290	1,354.3	23.4	174
3	Keshorai Patan	2,49,755	1,341.3	23.3	231
4	Nainwa	1,71,401	1,230.6	21.3	182
5	Talera	1,36,353	911.9	15.8	106
Total		**9,62,620**	**5,776.5**	**100.0**	**856**

Bundi district has 856 towns and villages, out of which five are block headquarters as well.

Climate:

Summer season in Bundi district of Rajasthan extends from the month of March to the month of May. Summer season records very high temperatures often reaching 46°C or above. The winter season starts from the month of November and lasts till February, and during this time the minimum temperature recorded is very low often around 3-4°C. Monsoon season is start from July and end in early September. Average annual rainfall in district is about 585.0mm.

PLATE - I



LEGEND

Admin Boundary:

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

Roads:

- National Highway
- State Highway
- Major District Road

Railway:

- Broad Gauge

Water Bodies:

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

TOPOGRAPHY

DISTRICT – BUNDI

Topography of the district is characterized by flat to undulating terrain with small isolated mounds. It is divided in almost two equal parts by NE-SW trending Vindhyan Range. The general topographic gradient is from southwest to northeast in the southern part of the Range whereas to the northern part of the ridge the gradient is generally from west to east. High elevation hills are found southern part of the district around Budhpura and to the west of Bundi city. Chambal is the most prominent River in the district and there are some important tributaries like Dungari, Bhimlat, Mej, Bajian, Sugll and Kupal etc. The general topographic elevation in the district is between 250 m to 300 m above mean sea level. Elevation ranges from a minimum of 200 m above mean sea level in Keshorai Patan block in the southeastern part of the district and maximum of 547.1 m above mean sea level In Talera block in southern part of the district.

Table: Block wise minimum and maximum elevation

S. No.	Block Name	Minimum Elevation (m amsl)	Maximum Elevation (m amsl)
1	Bundi	215.0	539.8
2	Hindoli	242.3	538.6
3	Keshorai Patan	200.0	484.2
4	Nainwa	225.1	504.3
5	Talera	227.6	547.1

RAINFALL

The rainfall received by the district is fairly good. The general distribution of rainfall across can be visualized from total annual rainfall isohyet map presented in the Plate – III, which reveals a high rainfall area (900 – 100 mm) in the northeast and southwestern parts of the district whereas the minimum rainfall area was in the northwestern part of the district. Apart from these high and low areas, most part of the district has shown a general rainfall range of 700 mm to 800 mm. The annual average rainfall was 716.4 mm based on the data of available blocks. Keshorai Patan block received maximum annual rainfall (914.6 mm) whereas minimum was in Nainwa block (570.4 mm). Highest average annual rainfall recorded in Hindoli block about 740.6 mm.

Table: Block wise annual rainfall statistics (derived from year 2010 meteorological station data)

Block Name	Minimum Annual Rainfall (mm)	Maximum Annual Rainfall (mm)	Average Annual Rainfall (mm)
Bundi	671.9	795.7	729.4
Hindoli	638.4	789.3	740.6
Keshorai Patan	653.8	914.6	729.2
Nainwa	570.4	803.2	673.5
Talera	633.9	857.2	709.4

PLATE - II

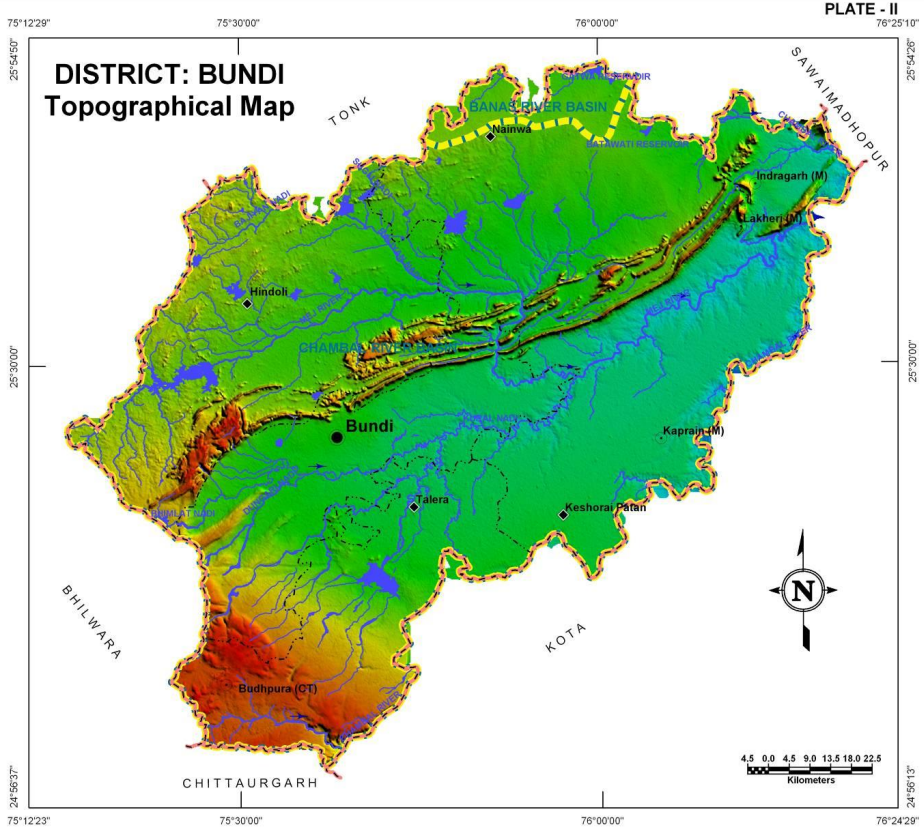
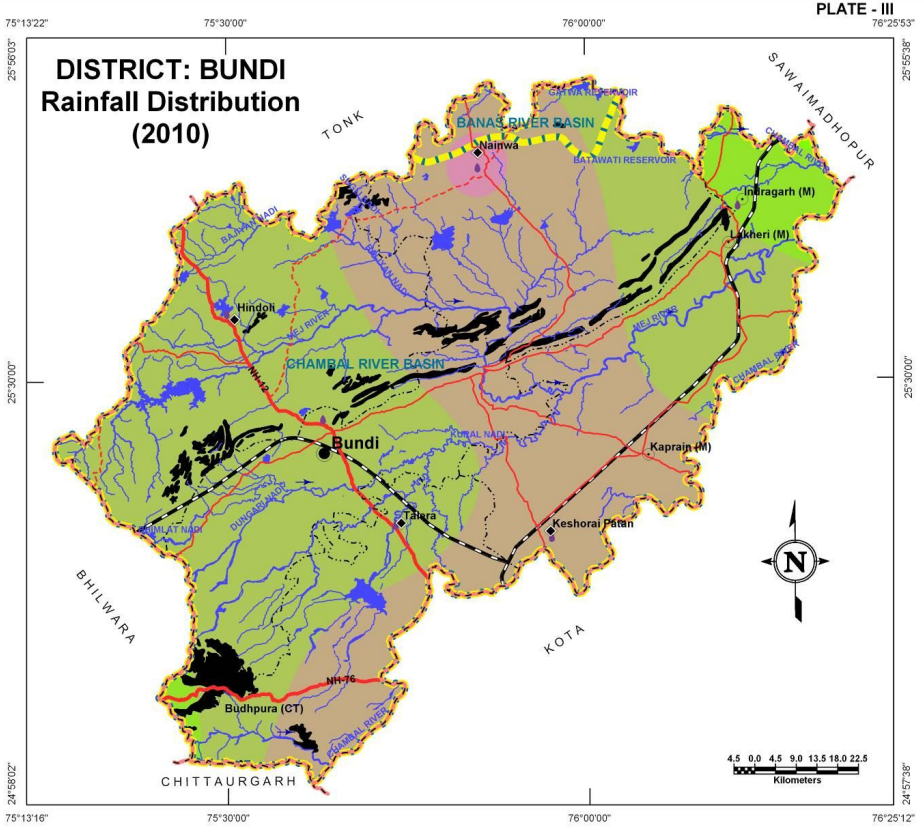


PLATE - III



LEGEND

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

Basin Boundary

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Elevation (m amsl):

547 500 450 400 350 300 250 200 186

Source : SRTM DEM

LEGEND

Admin Boundary:
- District Headquarter
- Block Headquarter
- Town
- Raingauge Stations
- District Boundary
- Block Boundary

Basin Boundary

Roads:
- National Highway
- State Highway
- Major District Road

Railway:
- Broad Gauge

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Hills

Isohyets (mm):
- 500-600
- 600-700
- 700-800
- 800-900
- 900-1000

GEOLOGY

DISTRICT – BUNDI

Geologically, the upper part of the district i.e. NE-SW exposed by rock formation belonging to Bhilwara Super Group and lower part of the district belonging to the Vindhyan Super Group. In Bhilwara Super Group rocks of Hindoli, Mangalwar & Jahajpur Groups are exposed. Vindhyan sedimentary sequences have occupied northeastern to southern part of the district. These are grouped as upper Vindhyan Super Group (100-600 m.y.) and separated from Bhilwara Super Group by a major reverse fault known as Great Boundary Fault. The Groups of Vindhyan Super Group i.e. Kaimur, Rewa & Bhander and their formations are well exposed in the district.

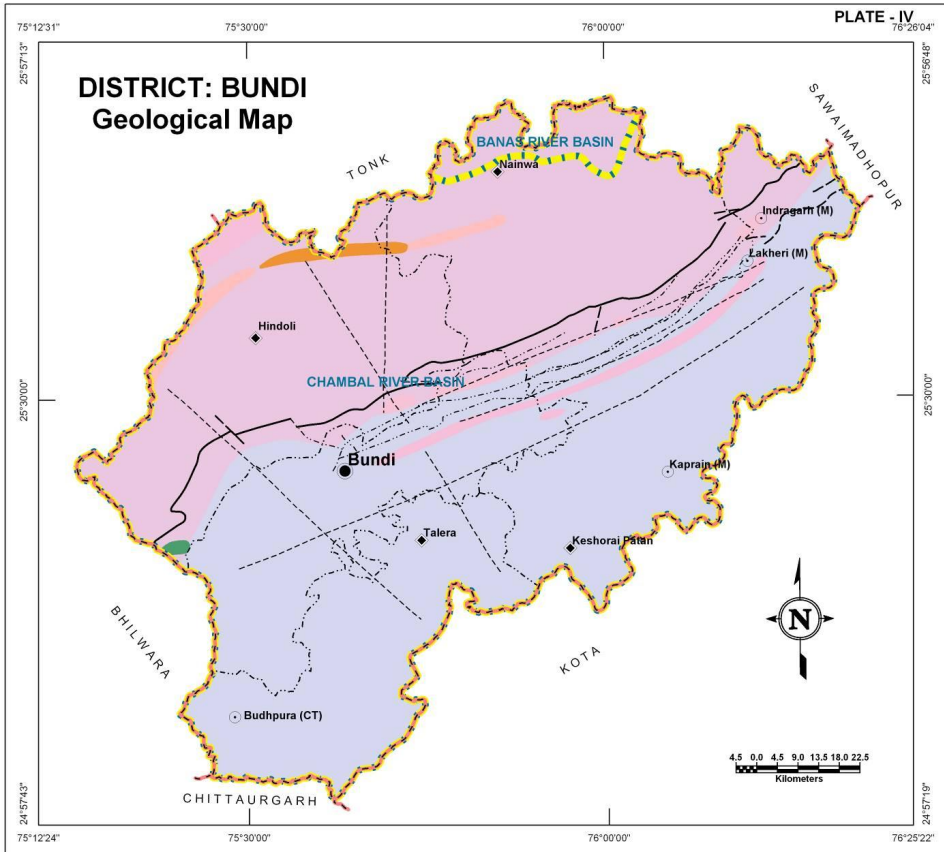
Super Group	Group	Formation
Recent to sub-Recent		Soil Alluvium
Vindhyan	Upper Bhander	Upper Bhander shale, Balwan Limestone, Maihar Sandstone
	Lower Bhander	Sirbu shale, Lower Bhander sandstone, Samaria shale, Lower Bhander limestone, Ganugarh shale
	Rewa	Govindgarh sandstone, Jhiri shale, Indergarh sandstone, Panna shale
	Kaimur	Kaimur sandstone, Badanpur conglomerate
X--------X--------X--------X--------X--------X--------X--------X---Unconformity---X--------X--------X-------X-------X-------X-------X-------X-------X		
		Acid & Basic intrusives
Bhilwara	Jhazpur	Dolomite, ferruginous, chert, carbonaceous, phyllite, ferruginous phyllites with thin band of conglomerate, gritty quartzite & quartzite
	Hindoli & Mangalwar complex	Shale, phyllite, mica schist, quartzite, dolomites, limestone, amphibolites, calc-silicates & quartzite

GEOMORPHOLOGY

Table: Geomorphologic units, their description and distribution

Origin	Landform Unit	Description
Denudational	Buried Pediment	Pediment covers essentially with relatively thicker alluvial, colluvial or weathered materials.
	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 Fan	A fan shaped mass of sediment deposit at a point along a Nallah, river where there is a decrease in gradient.
	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.
	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.
Structural	Plateau	Formed over varying lithology with extensive, flat, landscapes, bordered by escarpment on all sides. Essentially formed horizontally layered rocky marked by extensive flat top and steep slopes. It may be criss crossed by lineament.
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.

PLATE - IV



LEGEND

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

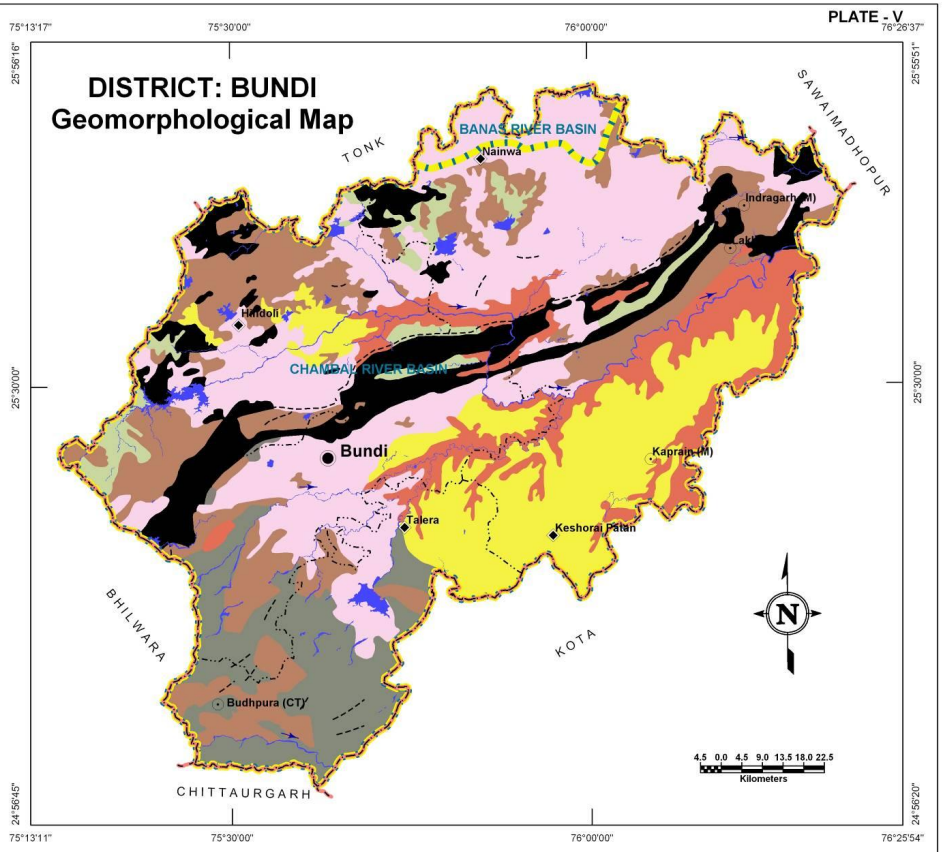
Basin Boundary

Structural Features:
- Fault
- Great Boundary Fault
- Lineament
- Thrust

Geology:
- Jahazpur Group
- Hindoli Group
- Mangalwar Complex
- Bhander Group
- Rewa Group
- Kaimur Group
- Jahazpur Granite
- Dolerite sills & dykes

Source: District Resource Map of Rajasthan - GSI

PLATE - V



LEGEND

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

Basin Boundary

Water Bodies
- River/Ponds/Reservoirs

Structural Features:
- Fault/Fractures/Lineament

Hills:
- Structural/Denudational/Linear Ridge

Landform Units:

Fluvial Origin:
- Alluvial Plain
- Valley Fill
- Alluvial Fan
- Ravine

Denudational Origin:
- Pediment
- Burried Pediment

Structural Origin:
- Plateau

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

AQUIFERS

DISTRICT – BUNDI

Aquifers area formed in the district within Alluvium, Shale, Sandstone, Limestone and Phyllite. GBF plays important role in separating the aquifers formed in sedimentary rocks of Vindhyans with Bhilwara Super Groups. South of GBF, alluvium is the most prominent aquifer occupying about 22% of the spatial coverage of aquifers while shale, sandstone and limestone aquifers occupy 17.6%, 15.6% and 4.8% of the total aquifer area in the district. North of the GBF, phyllites are the only rocks that form aquifers. The primary openings in sandstones and secondary openings in other hard rock formation facilitate storage of underground water. Sand, silt gravels and pebbles within thick alluvial cover over the bedrocks constitute aquifers in alluvium.

Table: Aquifer potential zones their area and their description

Aquifer in Potential Zone	Area (sq km)	% age of district	Description of the unit/Occurrence
Younger Alluvium	1,269.9	22.0	It is largely constituted of Aeolian and Fluvial sand, silt, clay, gravel and pebbles in varying proportions.
Limestone	276.8	4.8	In general, it is fine to medium grained, grey, red yellowish, pink or buff in colour.
Sandstone	898.4	15.6	Fine to medium grained, red colour and compact and at places.
Phyllite	2,129.1	36.9	These include meta sediments and represented by carbonaceous phyllite.
Shale	1,016.7	17.6	Grey, light green and purple in colour and mostly splintery in nature.
Hills	185.6	3.1	-
Total	**5,776.5**	**100.0**	

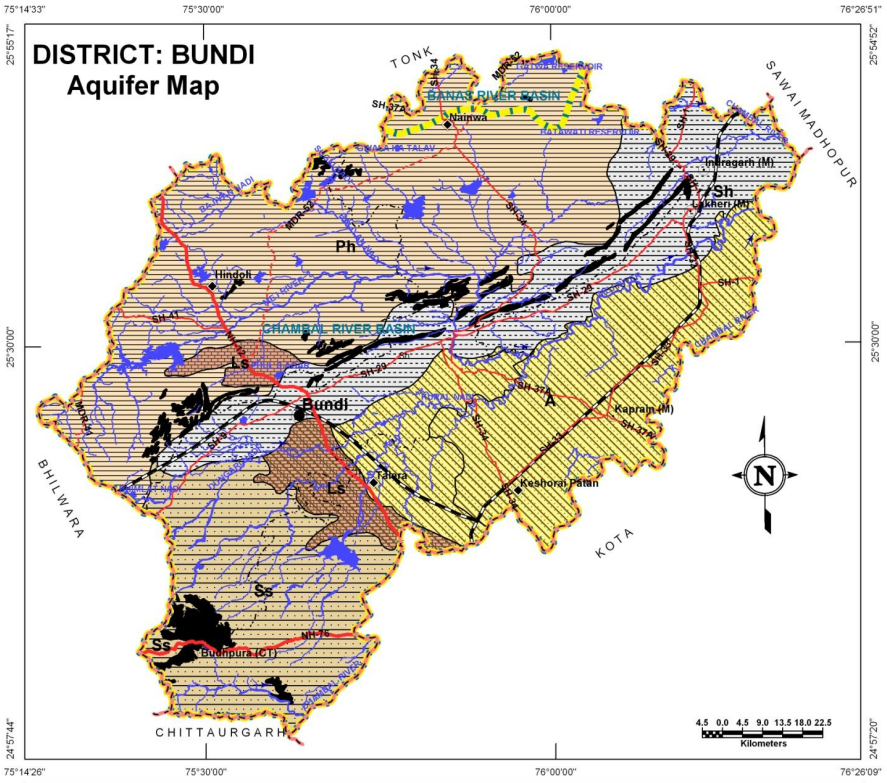
STAGE OF GROUND WATER DEVELOPMENT

The Keshorai Patan block in the eastern part of the Bundi district falls into 'Semi Critical' category from ground water development stage assessment.The spatial coverage of this block largely corresponds to alluvial aquifer area in the district. The remaining four blocks are 'Over Exploited' as development of ground water exceeds the recharge in the area and therefore needs attention to control the over usage of ground water.

Categorization on the basis of stage of development of ground water	Block Name
Semi-Critical	Keshorai Patan
Over Exploited	Hindoli, Bundi, Talera, Nainwa

Basis for categorization: Ground water development <= 70 – 90% Semi critical and >100% - Over-Exploited

PLATE - VI



LEGEND

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

Roads:
- National Highway
- State Highway
- Major District Road

Railway:
- Broad Gauge

Water Bodies:
- River / Streams
- Ponds / Reservoirs

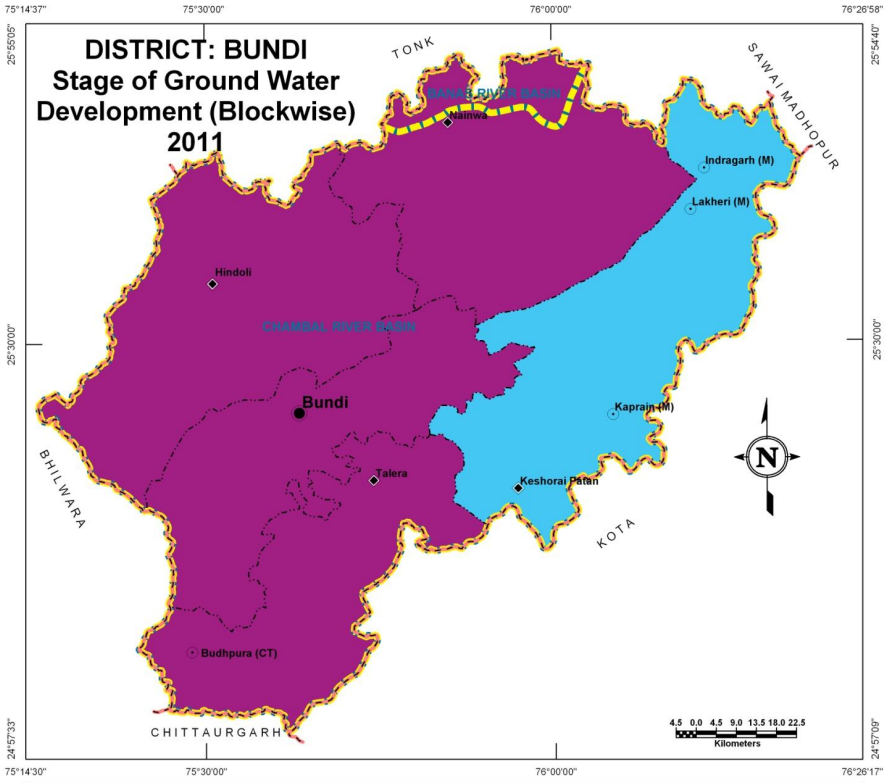
Hills

Command Area

Aquifer:
- Younger Alluvium
- Limestone
- Sandstone
- Phyllite
- Shale

Source: Ground Water Potential Zone Map - GWD, Rajasthan

PLATE - VII



LEGEND

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

Stage of Ground Water Development:
- Semi-Critical
- Over-Exploited

Source: Ground Water Department, Rajasthan

LOCATION OF EXPLORATORY AND GROUND WATER MONITORING WELLS DISTRICT – BUNDI

Bundi district has well distributed network of large number of exploratory wells (87) and ground water monitoring stations (236) in the district owned by RGWD (60 and 218 respectively) and CGWB (27 and 18 respectively). The exploratory wells have formed the basis for delineation of subsurface aquifer distribution scenario in three dimensions. Benchmarking and optimization studies suggest that ground water level monitoring network is sufficiently dense and distributed whereas 3 additional wells to be added to water quality monitoring network to optimize it.

Table: Block wise count of wells (existing and recommended)

Block Name	Exploratory Wells			Ground Water Monitoring Stations			Recommended additional wells for optimization of monitoring network	
	CGWB	RGWD	Total	CGWB	RGWD	Total	Water Level	Water Quality
Bundi	1	6	**7**	4	26	**30**	-	1
Hindoli	5	17	**22**	3	57	**60**	-	2
Keshorai Patan	8	14	**22**	8	54	**62**	-	-
Nainwa	6	18	**24**	3	60	**63**	-	-
Talera	7	5	**12**	-	21	**21**	-	-
Total	**27**	**60**	**87**	**18**	**218**	**236**	**-**	**3**

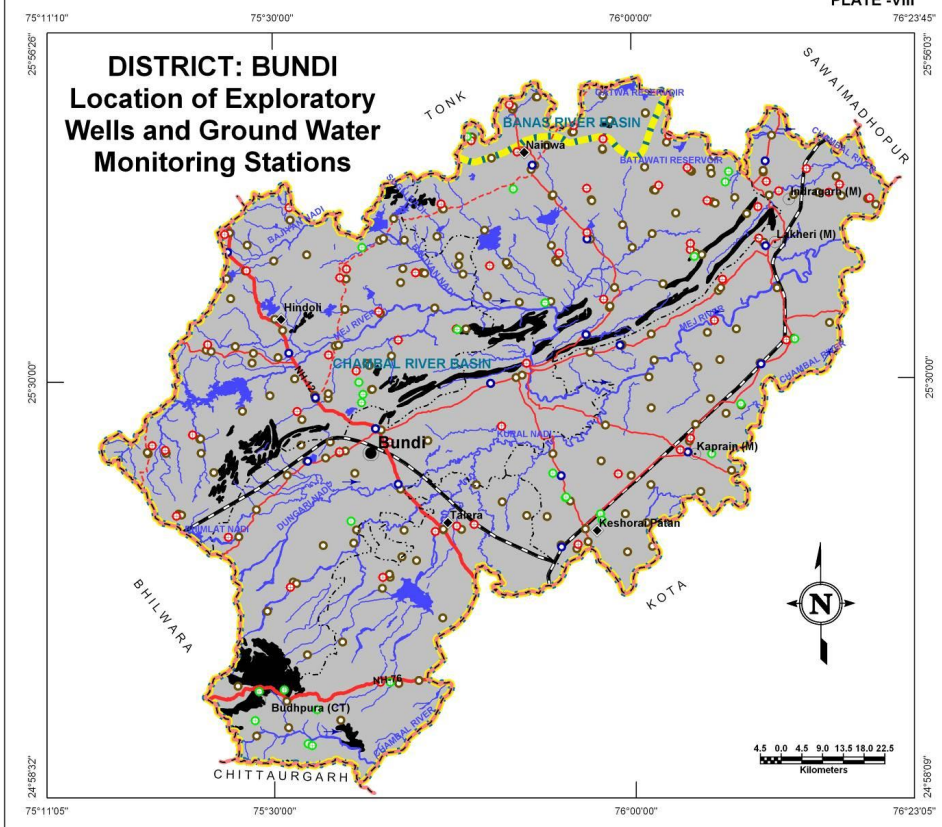
DEPTH TO WATER LEVEL (PRE MONSOON – 2010)

Depth to water level shows variation from less than 10m below ground level to about 40m below ground level. More than half area of the district has shown a generally moderate depth to ground water occurrence ranging between 10m and 20m of depth whereas the isolated patches have shown deeper water levels reaching upto 40m below ground level. The deepest water level recorded in the east of Lakheri. The shallow occurrence of ground water (<10m bgl)is seen in south and south eastern parts of the district.

Depth to water level (m bgl)	Block wise area coverage (sq km) *					Total Area (sq km)
	Bundi	Hindoli	Keshorai Patan	Nainwa	Talera	
<10	253.7	0.3	536.4	-	667.6	**1,458.0**
10-20	611.3	1,014.0	622.2	931.1	188.1	**3,366.7**
20-30	52.1	287.4	179.8	244.9	-	**764.2**
>30	-	-	2.0	-	-	**2.0**
Total	**917.1**	**1,301.7**	**1,340.4**	**1,176.0**	**855.7**	**5,590.9**

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

PLATE -VIII



LEGEND

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

Roads:
- National Highway
- State Highway
- Major District Road

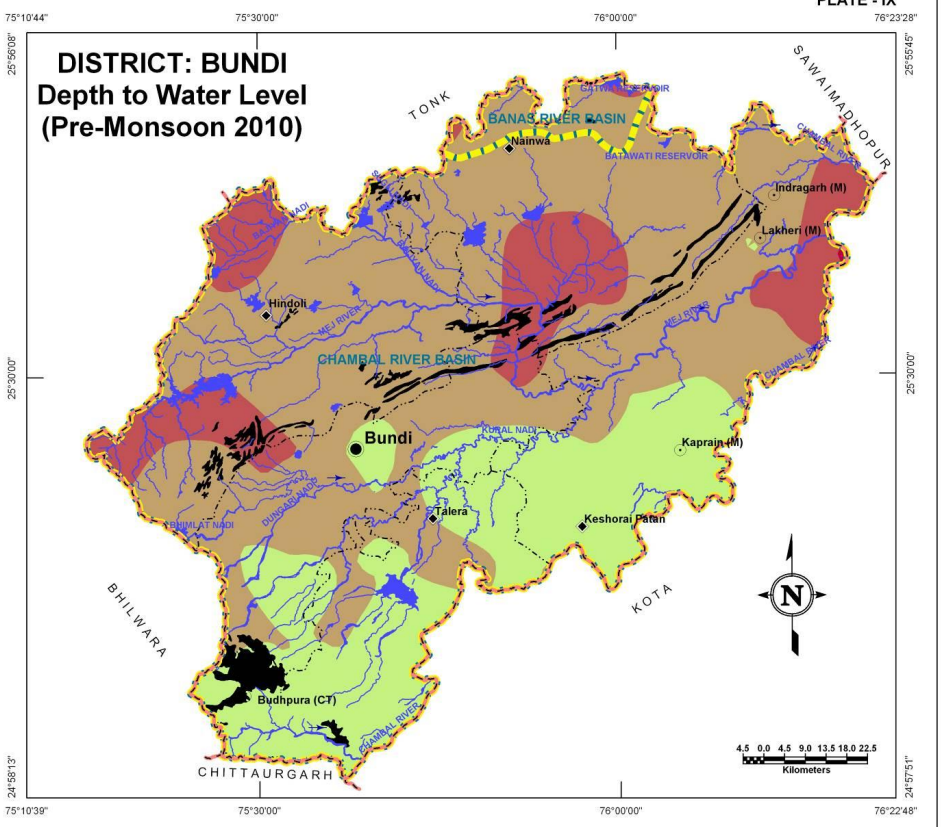
Railway:
- Broad Gauge

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

Exploratory Wells:
- CGWB
- RGWD

Ground Water Monitoring Stations:
- CGWB
- RGWD

PLATE - IX



LEGEND

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

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

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

WATER TABLE ELEVATION (PRE MONSOON – 2010) DISTRICT – BUNDI

There is large variation in water table elevation in the district. General flow direction of ground water is from southwest to northeast within major part of the district. Highest water table elevation (up to >480m amsl) is recorded in the southwestern part (Talera Block) of the district. The water table gradually lowers towards northeast reaching a minimum elevation (<180m amsl) in the Keshorai Patan block. The flow gradients are steeper in the southwestern part in the vicinity of hills whereas it assumes a flatter gradient in the plain areas with occasional localized flow reversals as well.

Table: Block wise area covered in each water table elevation range

Block Name	Block wise area (sq km) within water table elevation (m amsl) range															Total Area (sq km)
	< 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 - 480	> 480	
Bundi	-	-	37.4	310.1	291.6	66.7	34.2	31.4	28.8	22.8	26.1	27.6	38.8	1.6	-	**917.1**
Hindoli	-	-	-	18.8	225.8	331.1	365.4	308.0	43.0	9.6	-	-	-	-	-	**1,301.7**
Keshorai Patan	-	11.3	255.7	863.8	209.6	-	-	-	-	-	-	-	-	-	-	**1,340.4**
Nainwa	-	-	-	7.5	930.0	194.9	43.6	-	-	-	-	-	-	-	-	**1,176.0**
Talera	-	-	-	77.5	199.4	65.6	42.5	36.4	36.8	39.3	41.6	53.6	129.6	121.3	12.1	**855.7**
Total	**-**	**11.3**	**293.1**	**1,277.7**	**1,856.4**	**658.3**	**485.7**	**375.8**	**108.6**	**71.7**	**67.7**	**81.2**	**168.4**	**122.9**	**12.1**	**5,590.9**

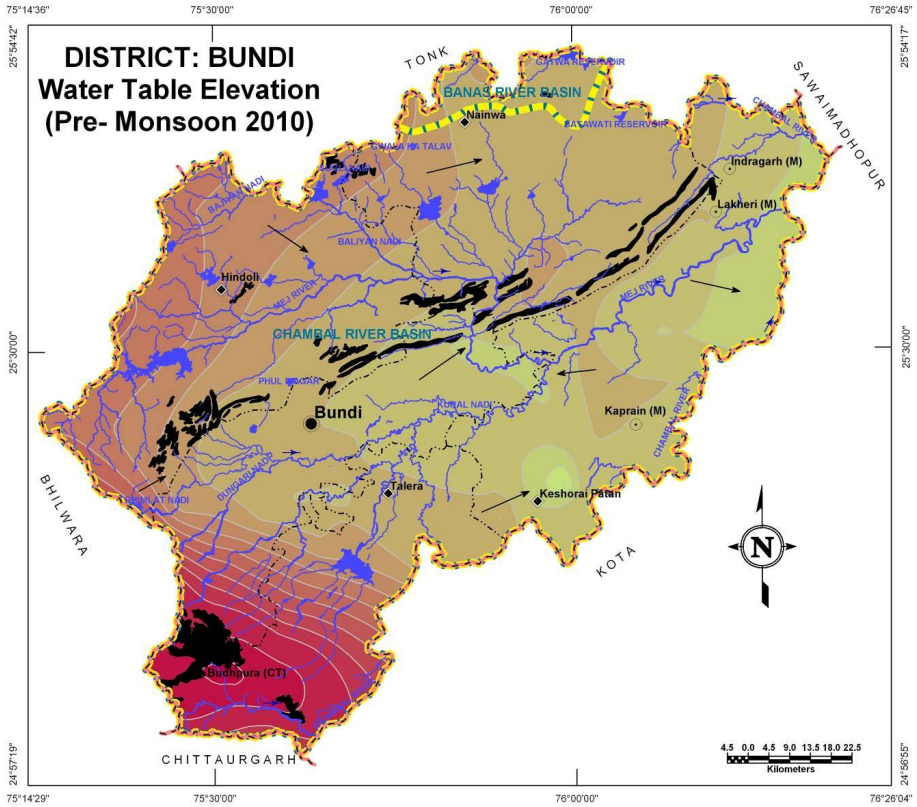
WATER LEVEL FLUCTUATION (PRE TO POST MONSOON 2010)

A 2m contour interval adopted to visualize the ground water level fluctuation reveals a fall of 2 m in one area to rise in other areas reaching upto 18m, as seen in Plate XI. The negative fluctuation areas (indicated by pink and red regions) are the areas where overexploitation is taking place and even after monsoon recharge water level has not risen and has actually gone down with respect to pre-monsoon levels. Such large ground water depletion areas are located in the southeastern part of Talera block and eastern part of Keshorai Patan block. Rest of the district has shown a general to significant rise in ground water level in the post monsoon season with respect to pre monsoon season. Maximum rise of more than 18m is noticed in the western part of the district (in the northern part of Hindoli block).

Table: Block wise area covered in each water fluctuation zone

Block Name	Water level fluctuation range (m)												Total Area (sq km)
	<-2	-2 – 0	0 – 2	2 – 4	4 – 6	6 – 8	8 – 10	10 – 12	12 – 14	14 – 16	16 – 18	>18	
Bundi	1.4	49.1	98.0	166.7	350.7	185.1	27.0	11.6	9.5	7.9	6.8	3.3	**917.1**
Hindoli	-	-	1.8	15.7	38.0	223.7	368.2	225.5	171.9	136.1	109.8	11.0	**1,301.7**
Keshorai Patan	41.1	339.8	320.5	366.6	256.9	15.5	-	-	-	-	-	-	**1,340.4**
Nainwa	-	1.0	15.9	66.6	257.7	459.0	355.9	19.9	-	-	-	-	**1,176.0**
Talera	15.4	58.1	128.8	187.7	311.7	143.8	10.2	-	-	-	-	-	**855.7**
Total	**57.9**	**448.0**	**565.0**	**803.3**	**1,215.0**	**1,027.1**	**761.3**	**257.0**	**181.4**	**144.0**	**116.6**	**14.3**	**5,590.9**

PLATE - X



LEGEND

Admin Boundary:

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

Basin Boundary

Water Bodies:

- River / Streams
- Ponds / Reservoirs

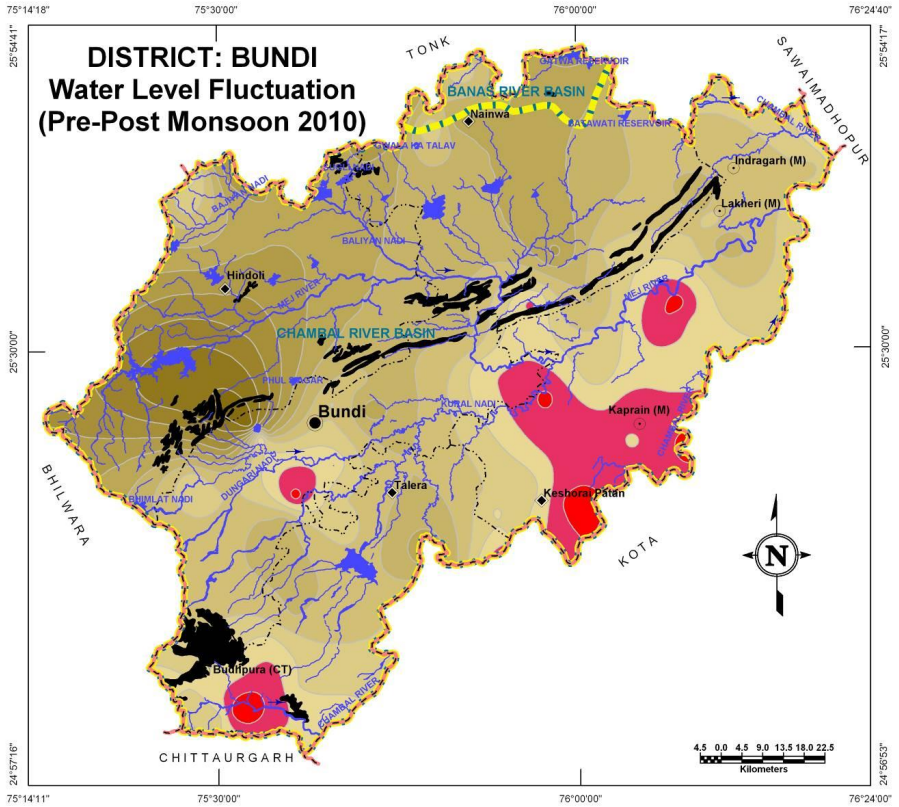
Hills

Water Table Elevation

Water Table Elevation(m amsl):

<180	320 - 340
180 - 200	340 - 360
200 - 220	360 - 380
220 - 240	380 - 400
240 - 260	400 - 440
260 - 280	440 - 480
280 - 300	>480
300 - 320	

PLATE - XI



LEGEND

Admin Boundary:

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

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 to 8
- 8 to 10
- 10 to 12
- 12 to 14
- 14 to 16
- 16 to 18
- >18

GROUND WATER ELECTRICAL CONDUCTIVITY DISTRIBUTION DISTRICT – BUNDI

The Electrical conductivity (at 25°C) distribution map is presented in Plate – XII. The areas with low EC values in ground water (<2000 µS/cm) are shown in yellow color which occupy almost 91% of the district area indicating that, by and large the ground water in this district is suitable for domestic purpose. The areas with moderately high EC values (2000 - 4000 µS/cm) are shown in green color and occupy 9% of the district area, largely eastern part of the district. No areas have shown very high EC values.

Table: Block wise area of Electrical conductivity distribution

Electrical Conductivity Ranges (µS/cm at 25°C) (Ave. of years 2005-09)	Block wise area coverage (sq km)										Total Area (sq km)
	Bundi		Hindoli		Keshorai Patan		Nainwa		Talera		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
<2000	880.0	96.0	1,301.7	100.0	898.7	67.0	1,175.4	99.9	824.4	96.3	**5,080.2**
2000-4000	37.1	4.0	-	-	441.7	33.0	0.6	0.1	31.3	3.7	**510.7**
>4000	-	-	-	-	-	-	-	-	-	-	**-**
Total	**917.1**	**100.0**	**1,301.7**	**100.0**	**1,340.4**	**100.0**	**1,176.0**	**100.0**	**855.7**	**100.0**	**5,590.9**

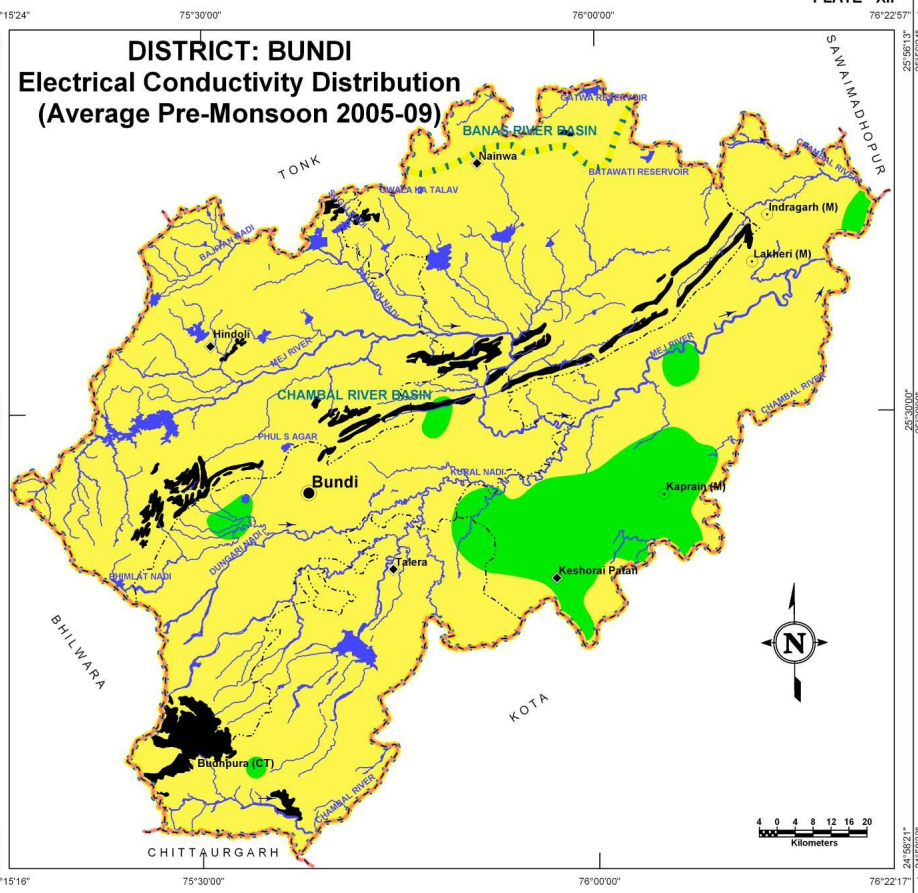
GROUND WATER CHLORIDE DISTRIBUTION

The yellow colored regions in Plate – XIII are such areas where chloride concentration is low (<250 mg/l) which occupy approximately 92% of the district. The ground water in this region is suitable for domestic purpose. The areas with moderately high chloride concentration (250-1000mg/l) are shown in green color and occupy approximately 8% of the district area scattered, largely middle part of the district. No area has shown high chloride concentration ground water.

Table: Block wise area of Chloride distribution

Chloride Concentration Range (mg/l) (Ave. of years 2005-09)	Block wise area coverage (sq km)										Total Area (sq km)
	Bundi		Hindoli		Keshorai Patan		Nainwa		Talera		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
<250	715.0	78.0	1,244.7	96.0	1,165.6	87.0	1,135.4	97.0	855.7	100.0	**5,116.4**
250-1000	202.1	22.0	57.0	4.0	174.8	13.0	40.6	3.0	-	-	**474.5**
>1000	-	-	-	-	-	-	-	-	-	-	**-**
Total	**917.1**	**100.0**	**1,301.7**	**100.0**	**1,340.4**	**100.0**	**1,176.0**	**100.0**	**855.7**	**100.0**	**5,590.9**

PLATE - XII



LEGEND

Admin Boundary:

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

Basin Boundary

Water Bodies:

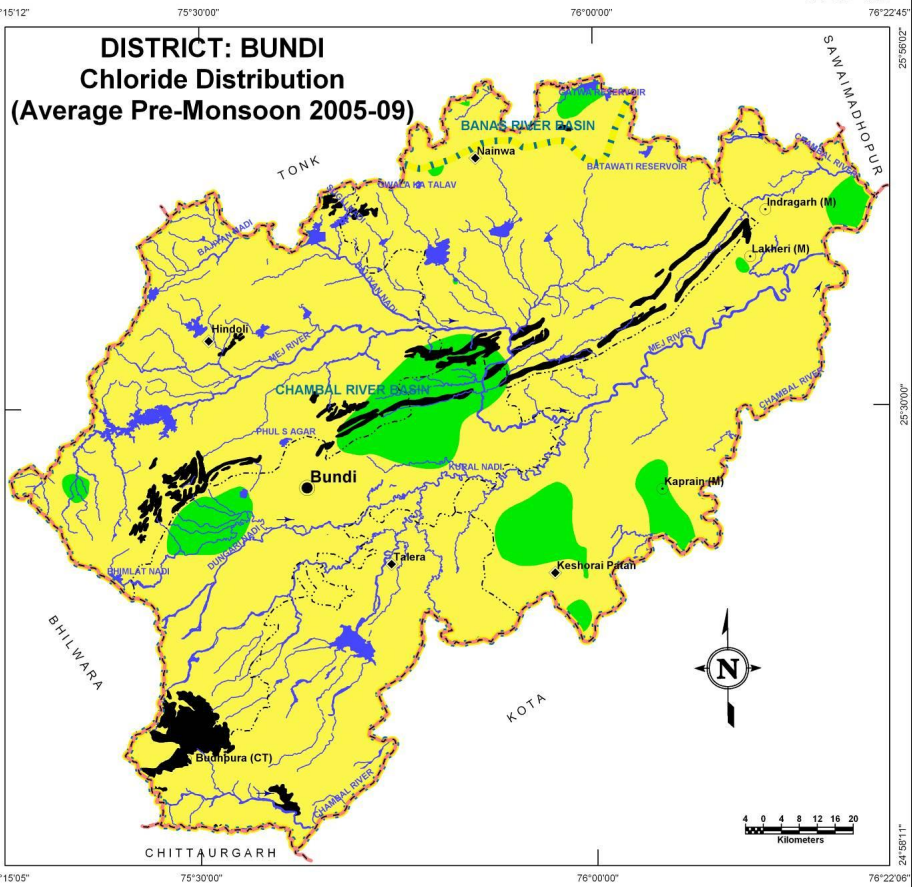
- River / Streams
- Ponds / Reservoirs

Hills

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

- < 2000
- 2000-4000

PLATE - XIII



LEGEND

Admin Boundary:

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

Basin Boundary

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Hills

Chloride Concentration (mg/l):

- < 250
- 250 - 1000

GROUND WATER FLUORIDE DISTRIBUTION DISTRICT – BUNDI

The Fluoride concentration map is presented in Plate XIV.High fluoride concentration areas are not present within the district which makes the ground water by and large suitable for domestic purposes however; some scattered areas have shown moderately high concentration of fluoride in ground water. The areas with low concentration (i.e.,>1.5 mg/l) are shown in yellow color which occupy almost 92% of the district area indicating that it is suitable for domestic purpose. The areas with moderately high concentration (1.5 – 3.0 mg/l) are shown in green color patches which are seen to have scattered in eastern and western part of the district, largely around Keshorai Patan.

Table: Block wise area of Fluoride distribution

Fluoride concentration range (mg/l) (Ave. of years 2005-09)	Block wise area coverage (sq km)										Total Area (sq km)
	Bundi		Hindoli		Keshorai Patan		Nainwa		Talera		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
<1.5	854.6	93.2	1,250.0	96.0	1,072.3	80.0	1,175.8	100.0	809.3	94.6	**5,162.0**
1.5-3.0	62.5	6.8	51.7	4.0	268.1	20.0	0.2	-	46.4	5.4	**428.9**
>3.0	-	-	-	-	-	-	-	-	-	-	**-**
Total	**917.1**	**100.0**	**1,301.7**	**100.0**	**1,340.4**	**100.0**	**1,176.0**	**100.0**	**855.7**	**100.0**	**5,590.9**

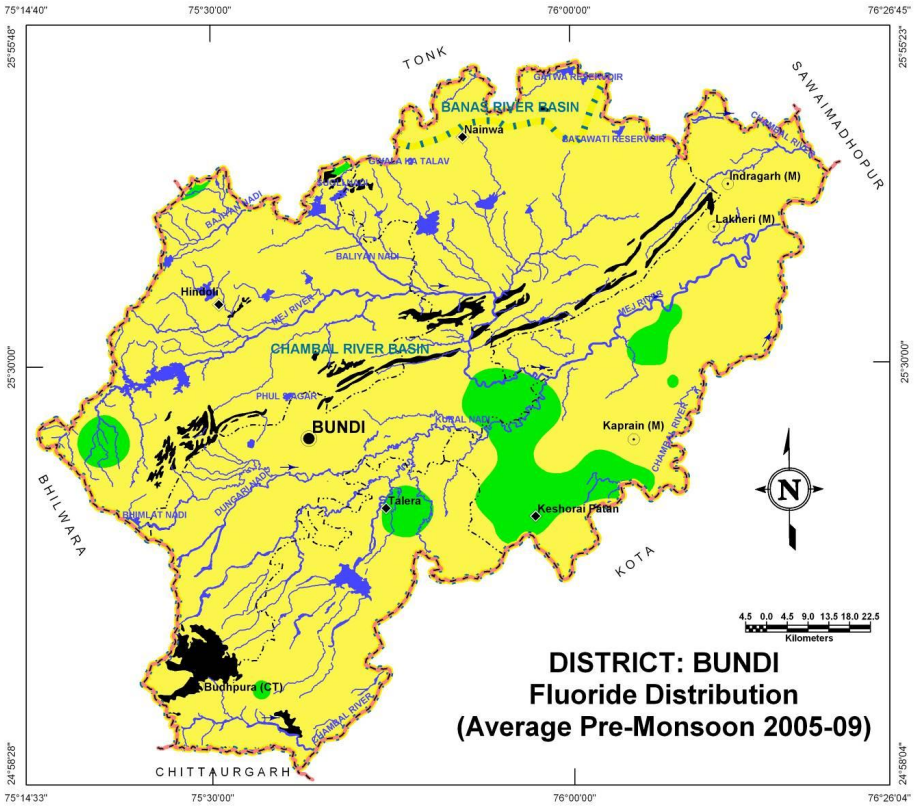
GROUND WATER NITRATE DISTRIBUTION

High nitrate concentration in ground water renders it unsuitable for agriculture purposes. Plate XV shows distribution of Nitrate in ground water. Low nitrate concentration area (<50 mg/l) is seen in yellow color and occupies approximately 80% of the district area which is suitable for agriculture purpose. The areas with moderately high nitrate concentration (50-100 mg/l) are shown in green color occupy approximately 17% of the district area, largely northwestern part of the district within phyllite aquifers. Remaining part of the district area is covered with high nitrate concentration (>100 mg/l) which is shown in red colored patches, also seen within phyllite aquifers north of GBF and in these areas the ground water is not suitable for agriculture purpose.

Table: Block wise area of Nitrate distribution

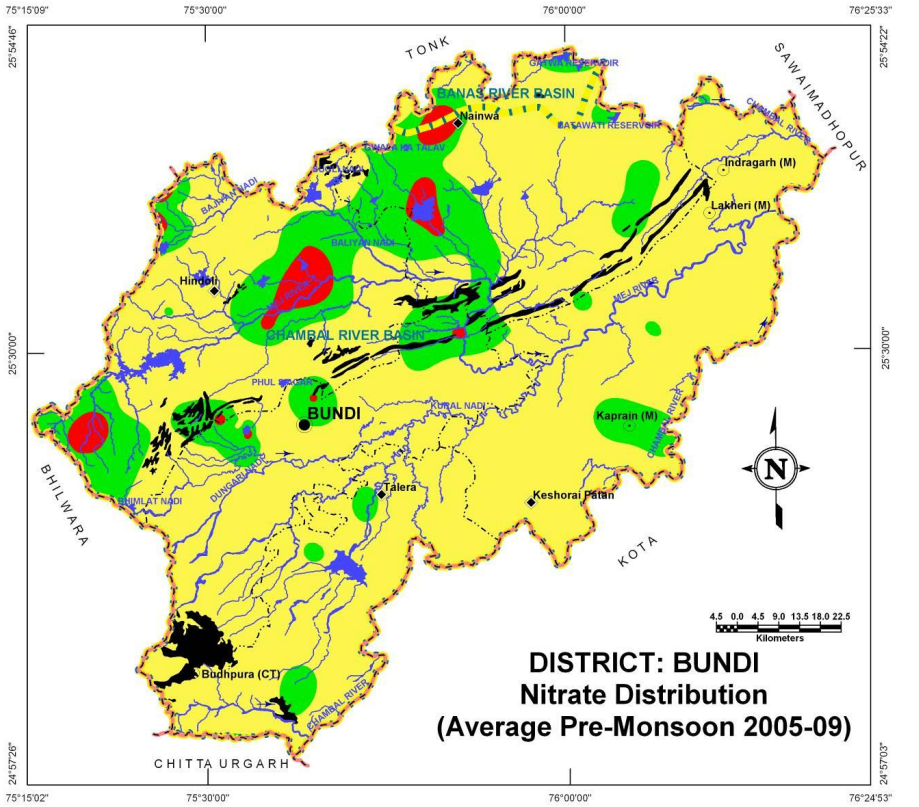
Nitrate concentration range (mg/l) (Ave. of years 2005-09)	Block wise area coverage (sq km)										Total Area (sq km)
	Bundi		Hindoli		Keshorai Patan		Nainwa		Talera		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
<50	774.4	84.4	821.2	63.1	1,262.2	94.2	810.4	68.9	807.6	94.4	**4,475.8**
50-100	138.0	15.0	389.9	30.0	78.2	5.8	314.5	26.7	48.1	5.6	**968.7**
>100	4.7	0.5	90.6	7.0	-	-	51.1	4.3	-	-	**146.4**
Total	**917.1**	**100.0**	**1,301.7**	**100.0**	**1,340.4**	**100.0**	**1,176.0**	**100.0**	**855.7**	**100.0**	**5,590.9**

PLATE - XIV



DISTRICT: BUNDI
Fluoride Distribution
(Average Pre-Monsoon 2005-09)

PLATE - XV



DISTRICT: BUNDI
Nitrate Distribution
(Average Pre-Monsoon 2005-09)

LEGEND

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

Basin Boundary

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Hills

Fluoride Concentration (mg/l):
- < 1.5
- 1.5-3.0

LEGEND

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

Basin Boundary

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Hills

Nitrate Concentration (mg/l):
- < 50
- 50-100
- > 100

DEPTH TO BEDROCK

DISTRICT – BUNDI

The thick alluvial deposits are underlain by bedrock of different lithology and age. Plate XVI depicts the bedrock depth from ground level in Bundi district. Since weathered and fractured bedrock is also significant from hydrogeologic view point, the beginning of massive bedrock (end of weathered and fractured zone or alluvial material) has been considered for defining top of bedrock depth. Depth variation in Bundi district does not appear to vary significantly since it does not go deeper than 40m bgl within the district. The major rocks types constituting the bedrock are limestone, sandstone, phyllites and schist. Central part of the district i.e., in Bundi, Hindoli, Keshorai Patan and Talera blocks and northern part of Nainwa bedrock depth is less than 20m bgl. Deepest bedrock has been encountered NearIndragarh town and Nainwa blockwhere it reaches to more than 40m deep.

Depth to bedrock (m bgl)	Block wise area coverage (sq km)										Total Area (sq km)
	Bundi		Hindoli		Keshorai Patan		Nainwa		Talera		
	Area	%age	Area	%age	Area	%age	Area	%age	Area	%age	
<20	913.1	99.6	751.3	57.7	397.7	29.7	438.8	37.3	855.7	100.0	**3,356.6**
20-40	4.0	0.4	550.4	42.3	794.8	59.3	721.7	61.4	-	-	**2,070.9**
>40	-	-	-	-	147.9	11.0	15.5	1.3	-	-	**163.4**
Total	**917.1**	**100.0**	**1,301.7**	**100.0**	**1,340.4**	**100.0**	**1,176.0**	**100.0**	**855.7**	**100.0**	**5,590.9**

UNCONFINED AQUIFER

Alluvial material forms aquifers in most of eastern half of the district. The thickness of unconfined aquifer varies from less than 10 m south of Lakheri to more than about 20m to the east of Keshorai Patan block. Small portion of the area are covered with alluvial aquifer in Bundi and Telera blocks. Weathered, fractured and jointed rock formations occurring at shallower depths constitute good unconfined aquifers. Such aquifers under unconfined conditions are spread almost in the entire district excluding eastern parts of the district. This productive zone attains very high thickness of more than 50m to the north of Ninwa and western fringe of Hindoli. However, the major part of the district has less than 20m thickness in the district.

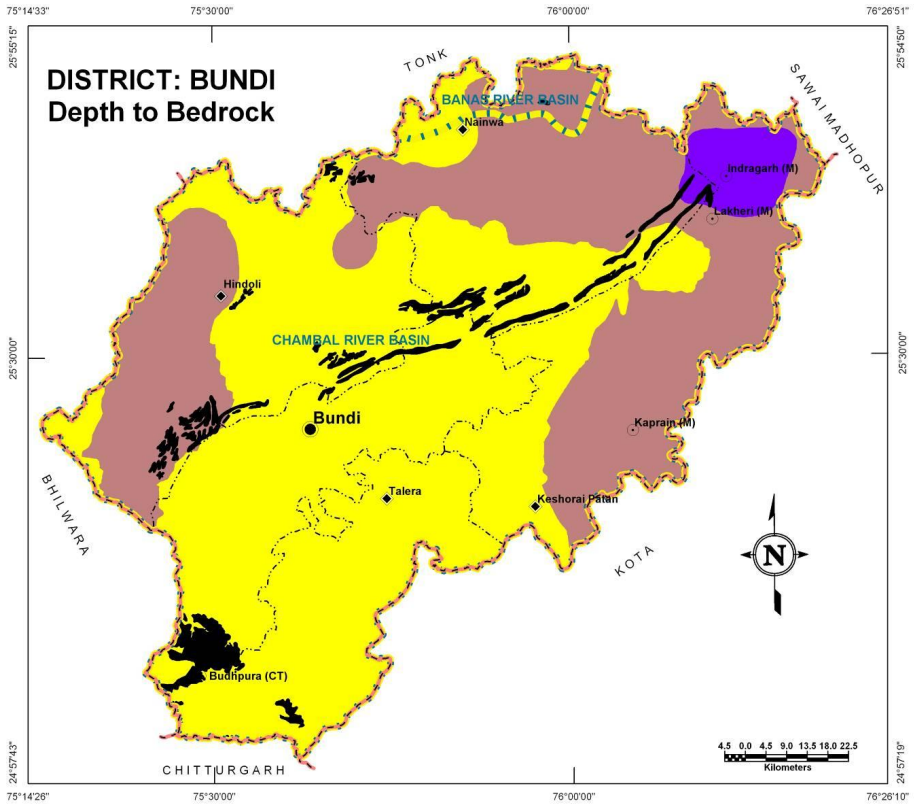
Alluvial areas

Unconfined aquifer Thickness (m)	Block wise area coverage (sq km)					Total Area (sq km)
	Bundi	Hindoli	Keshorai Patan	Nainwa	Talera	
< 10	162.5	-	508.7	-	76.2	**747.4**
> 10	8.4	-	402.3	-	105.7	**516.4**
Total	**170.9**	**-**	**911.0**	**-**	**181.9**	**1,263.8**

Hardrock areas

Unconfined aquifer Thickness (m)	Block wise area coverage (sq km)					Total Area (sq km)
	Bundi	Hindoli	Keshorai Patan	Nainwa	Talera	
< 10	624.4	707.9	411.3	736.1	634.5	**3,114.2**
10-20	121.8	302.6	18.1	345.7	39.3	**827.5**
20-30	-	196.2	-	68.6	-	**264.8**
30-40	-	79.6	-	19.0	-	**98.6**
40-50	-	15.4	-	5.8	-	**21.2**
> 50	-	-	-	0.8	-	**0.8**
Total	**746.2**	**1,301.7**	**429.4**	**1,176.0**	**673.8**	**4,327.1**

PLATE - XVI



LEGEND

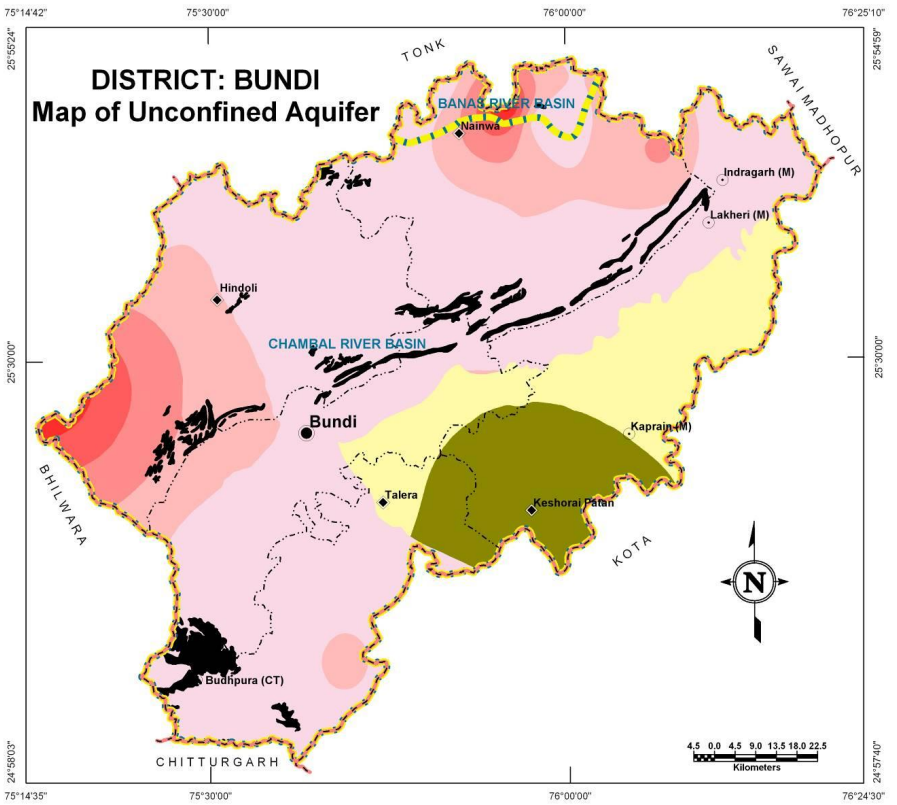
Admin Boundary:

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

Depth to Bedrock (m bgl):

- < 20
- 20-40
- > 40

PLATE - XVII



LEGEND

Admin Boundary:

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

Aquifer Thickness(m):

Alluvial Area

- <10
- >10

Weathered & Fractured Zone in Hardrock Area

- <10
- 10-20
- 20-30
- 30-40
- 40-50
- >50

Glossary of terms

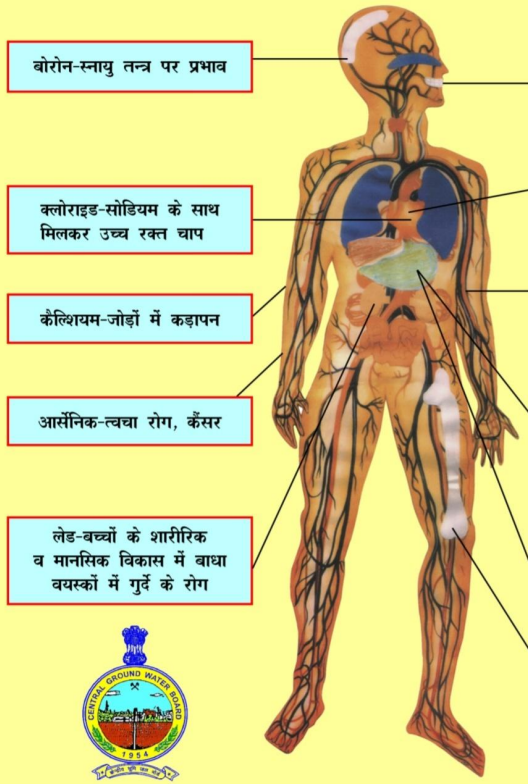
S. No.	Technical Terms	Definition
1	AQUIFER	A saturated geological formation which has good permeability to supply sufficient quantity of water to a Tube well, well or spring.
2	ARID CLIMATE	Climate characterized by high evaporation and low precipitation.
3	ARTIFICIAL RECHARGE	Addition of water to a 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 it's complete saturation.
28	TOTAL DISSOLVED SOLIDS	Total weight of dissolved mineral constituents in water per unit volume (or weight) of water in the sample.
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

(Contd…)

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

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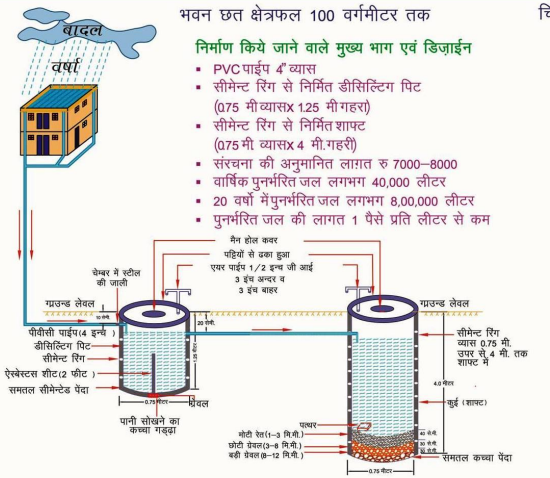
भूजल अमूल्य है इसे प्रदूषित न करें।

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

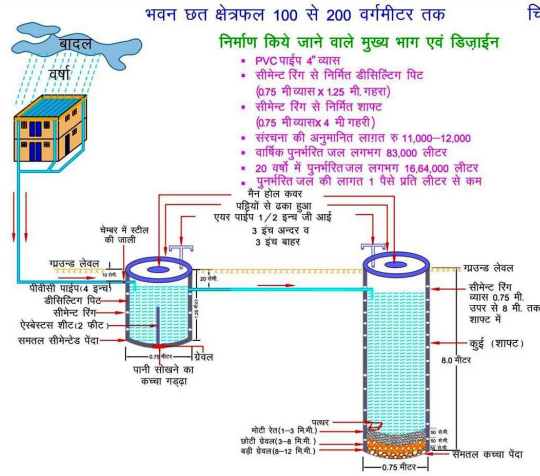


चित्र–2

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

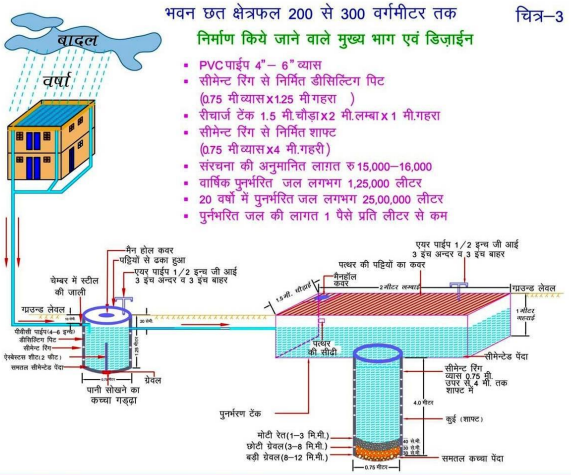


चित्र–3

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
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम

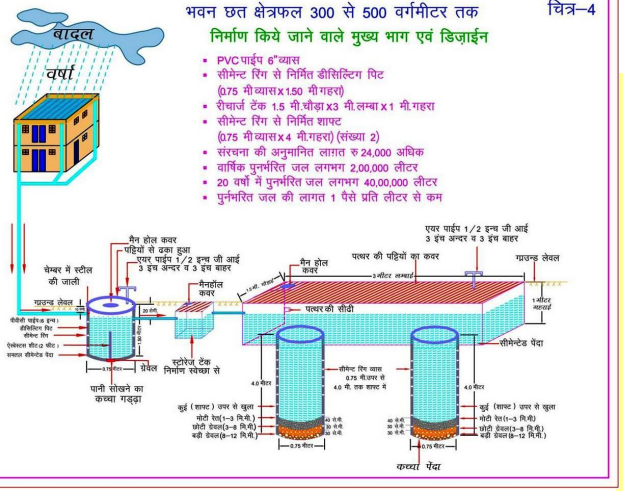


चित्र–4

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
- पुनर्भरित 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 • an underground lake • a net work of underground rivers • 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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