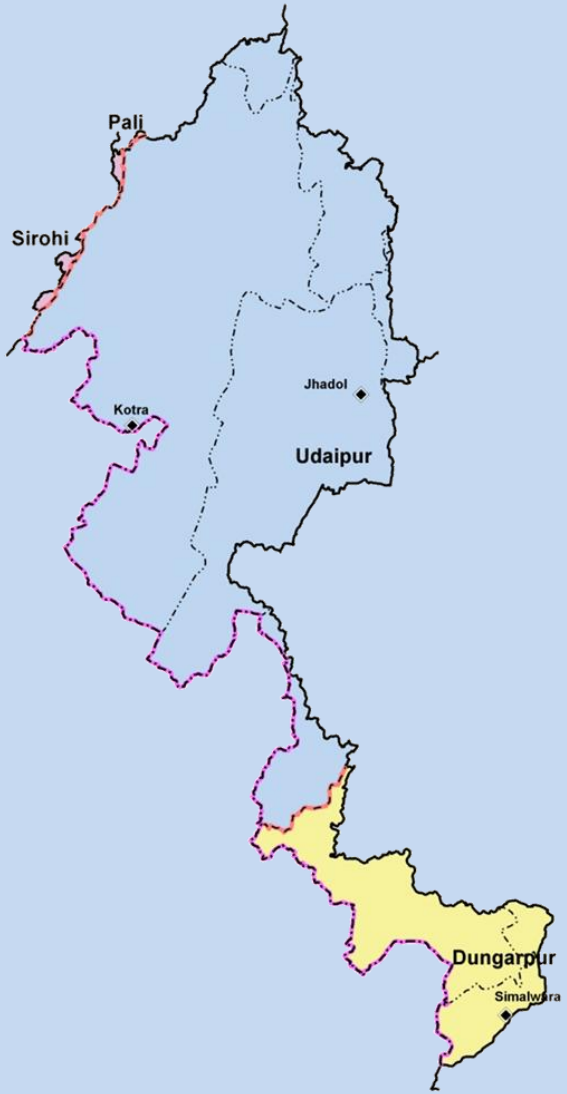
Ground Water Department,
Rajasthan

European Union
State Partnership Programme

Hydrogeological Atlas of Rajasthan

Sabarmati River Basin



2013

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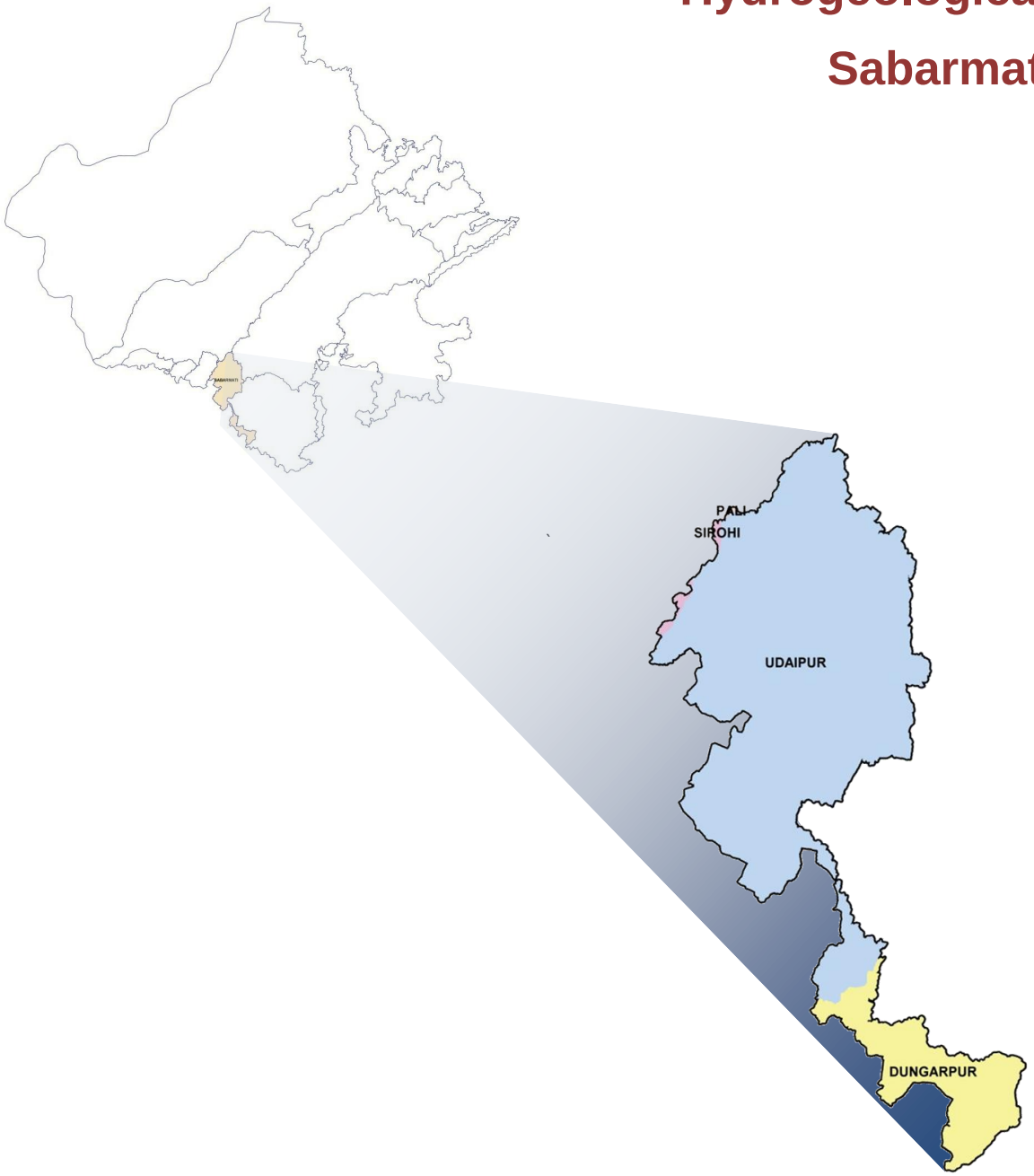
Hydrogeological Atlas of Rajasthan

Sabarmati River Basin



Contents:

2013

ADMINISTRATIVE SETUP

SABARMATI RIVER BASIN

Location:

Sabarmati River Basin is located in mid south-western Rajasthan. It stretches between 23° 28' 25.18" to 24° 55' 14.72" North latitude and 72° 59' 38.90'' to 73° 48' 29.62'' East longitudes. In the northwest the boundary of Sabarmati river basin is shared with West Banas and Luni rivers, eastern boundary is formed by Banas and Mahi rivers. The southwestern boundary is an administrative border with Gujarat State. The basin extends over parts of Dungarpur, Pali, Sirohi and Udaipur Districts. The total catchment area of the Basin is 4,095.6 km^2.

Sabarmati River originates in the Aravali hills in Mount Abu area, and flows in a southwesterly direction. The main tributaries of the Sabarmati river are Wakal river and the Sel Nadi, which also originate in the same Aravali hill range west of Udaipur city and flow south-westwards in courses generally parallel to the Sabarmati river, up to their confluence with the river (in Gujarat).

Administrative Set-up:

Administratively, Sabarmati River Basin extends over parts of Dungarpur, Pali, Sirohi and Udaipur Districts encompassing 12 Blocks and 757 towns and villages.

S. No.	District Name	Area (sq km)	% of Basin Area	Total Number of Blocks	Total Number of Towns and Villages
1	Dungarpur	606.0	14.8	3	**137**
2	Pali	1.4	-	1	**-**
3	Sirohi	23.0	0.6	2	**1**
4	Udaipur	3,465.2	84.6	6	**619**
Total		**4,095.6**	**100.0**	**12**	**757**

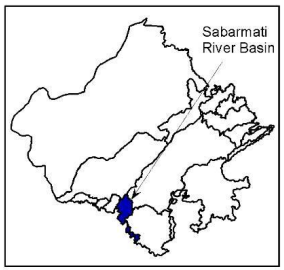
Climate:

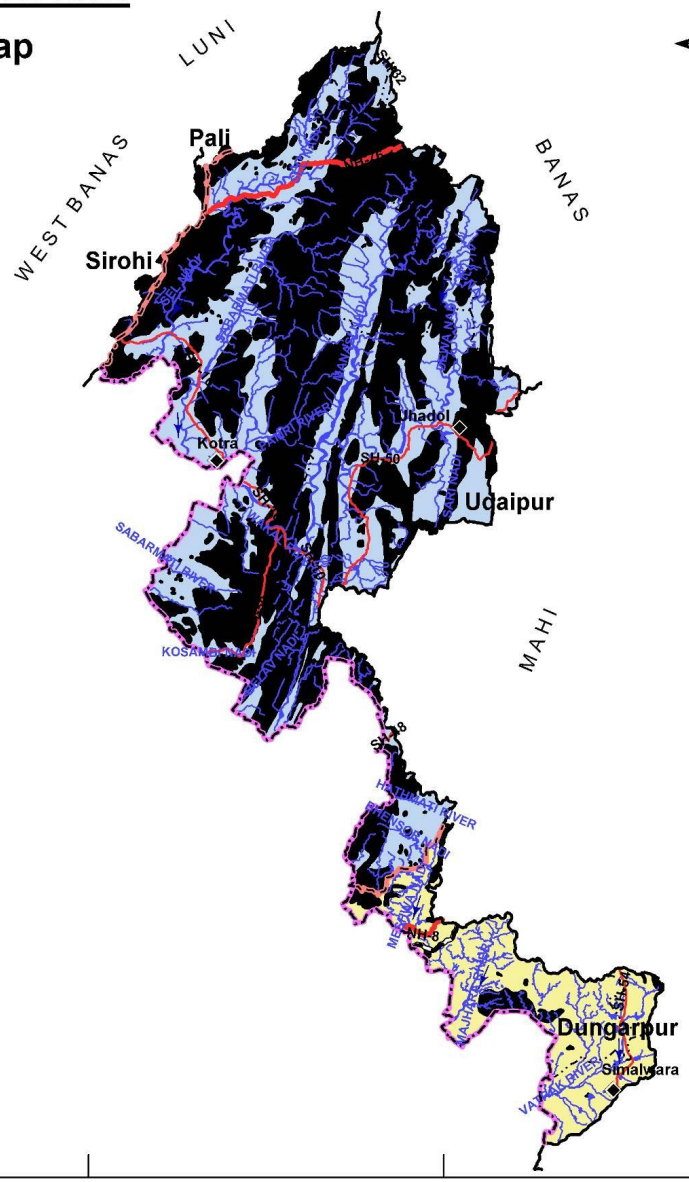
The Rajasthan part of Sabarmati River basin primarily falls within hilly areas of Aravalli Range and has a humid to sub-humid. It is extremely cold from October to February while turning hot from March to September. Overall, it receives good rainfall during monsoon period that extends during the four Monsoon months (June-September). The annual mean rainfall over the Sabarmati Basin was computed as 575 mm, of which about 96% falls during these four months as non-monsoon rainfall is negligible.

PLATE - I

SABARMATI RIVER BASIN

Administrative Map





LEGEND

Admin Boundary:

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

River Basin Boundary

Roads:

- National Highway
- State Highway

Railway:

- Broad Gauge

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Hills

TOPOGRAPHY

The major part of the Basin is marked by hilly terrain belonging to the Aravali chain marked by steep slopes and narrow valleys. The hills trend in northeast-southwest direction. The elevation variation within the part of basin is very high (to the extent of about 1000m). The higher elevations (about 1168m) have been observed in the northeastern portion and lower elevations (about 175m) are observed in the southern part of the basin indicating general sloping downwards towards south to southwestern direction. The river and its tributaries either flow parallel to the ridges in NW-SE direction or cut across them in a SE-NW or E-W directions.

Table: District wise minimum and maximum elevation

S. No.	District Name	Min Elevation (m amsl)	Max. Elevation (m amsl)
1	Dungarpur	174.6	496.9
2	Pali	683.8	952.2
3	Sirohi	434.3	901.7
4	Udaipur	242.1	1,167.0

RAINFALL

The area of the basin being small, hill and less inhabited, has very few rain gauge stations. The rainfall distribution map (Plate – III) reveals high rainfall areas being located in the hilly areas in Udaipur district and reduces further southeastwards reaching minimum in Dungarpur area. The total average rainfall in the year 2010 had been around 1000mm.

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	Jhadol	1,081.0	84.0	1,165.0
2	Kotra	782.0	114.0	896.0

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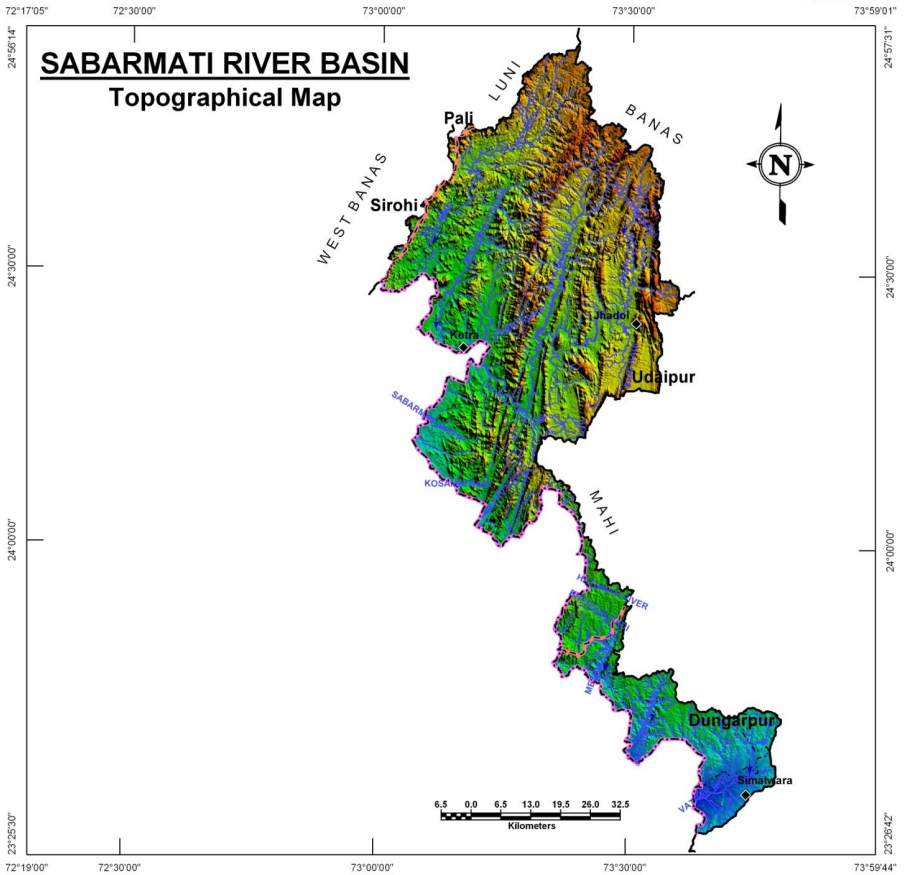
PLATE - II



LEGEND

Admin Boundary:

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

River Basin Boundary

Water Bodies:

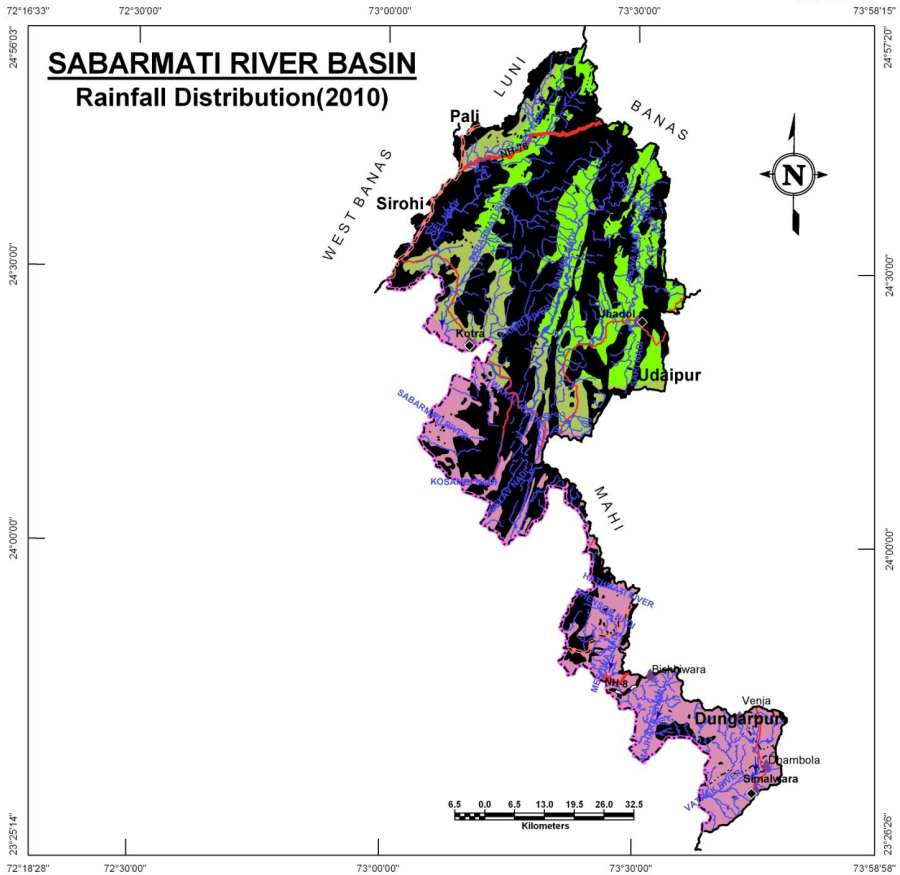
- River / Streams
- Ponds / Reservoirs

Elevation(m amsl):

1168 m
1125 m
1000 m
875 m
750 m
625 m
500 m
375 m
280 m
175 m

Source : SRTM DEM

PLATE - III



LEGEND

Admin Boundary:

- Block Headquarter
- Raingauge Station
- State Boundary
- District Boundary
- Block Boundary

River Basin Boundary

Roads:

- National Highway
- State Highway

Railway:

- Broad Gauge

Water Bodies:

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

Isohyets(mm):

- 800-900
- 900-1000
- > 1000

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GEOLOGY

SABARMATI RIVER BASIN

The Sabarmati River Basin is covered mainly by rocks belonging to the Pre-Cambrian rocks (Delhi Super-Group and Aravalli Super - Group). Very limited area, i.e., valleys intervening hills has deposits of eolian and fluvial origin of Recent to Sub-Recent age.

Age	Super-Group	Group/Formation	Rock Types
Sub-Recent To Recent	Alluvium (and Colluvium)	--	Pebbles, gravel. Sand, silt, clay
----------x----------x---------- Unconformity ----------x----------x----------			
Lower Precambrian To Upper Precambrian	Delhi	Kumbhalgarh (with Sandra Ambaji Intrusives)	Calc-schists and gneisses, marble, mica-schists and Quartzites with Synorogenic Granites, gneisses, migmatites
		Gogunda	Quartzites, biotite- Schists, calc-schists, Horneblende schists, Calc-silicates
Lower Precambrian (Algonkian)	Aravalli	Champaner	Phyllites, meta proto Quartzites, meta Greywackes, Metaconglomerates, Dolomites, Mica-schists, etc.
		Lunavada	Phyllites, meta Siltstone, meta Quartzites, meta-sub Greywackes, Garnetiferous Mica-schists, meta Conglomerates, Dolomites
		Jharol	Chlorite phyllites, Quartzites, mica Schists, biolite Schists, etc.

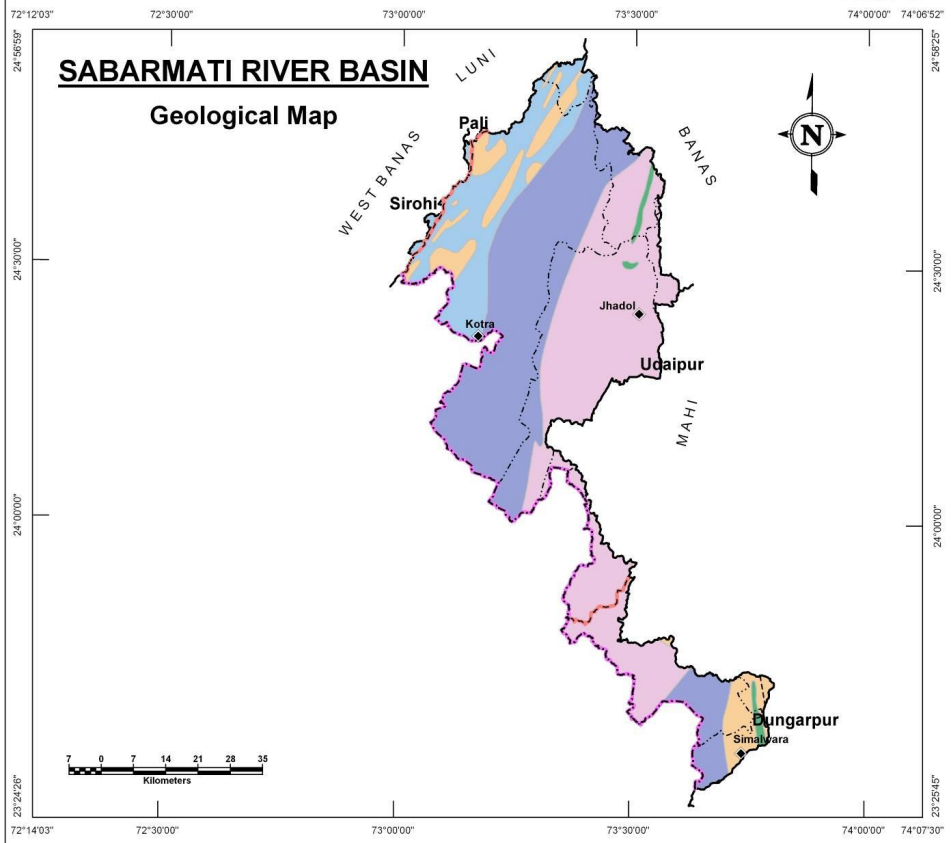
GEOMORPHOLOGY

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.
	Pediplain	Coalescence and extensive occurrence of pediment.
Fluvial	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.
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

SABARMATI RIVER BASIN

Geological Map



LEGEND

Admin Boundary:

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

River Basin Boundary

Structural Features:

- Fault
- Lineament

Geology:

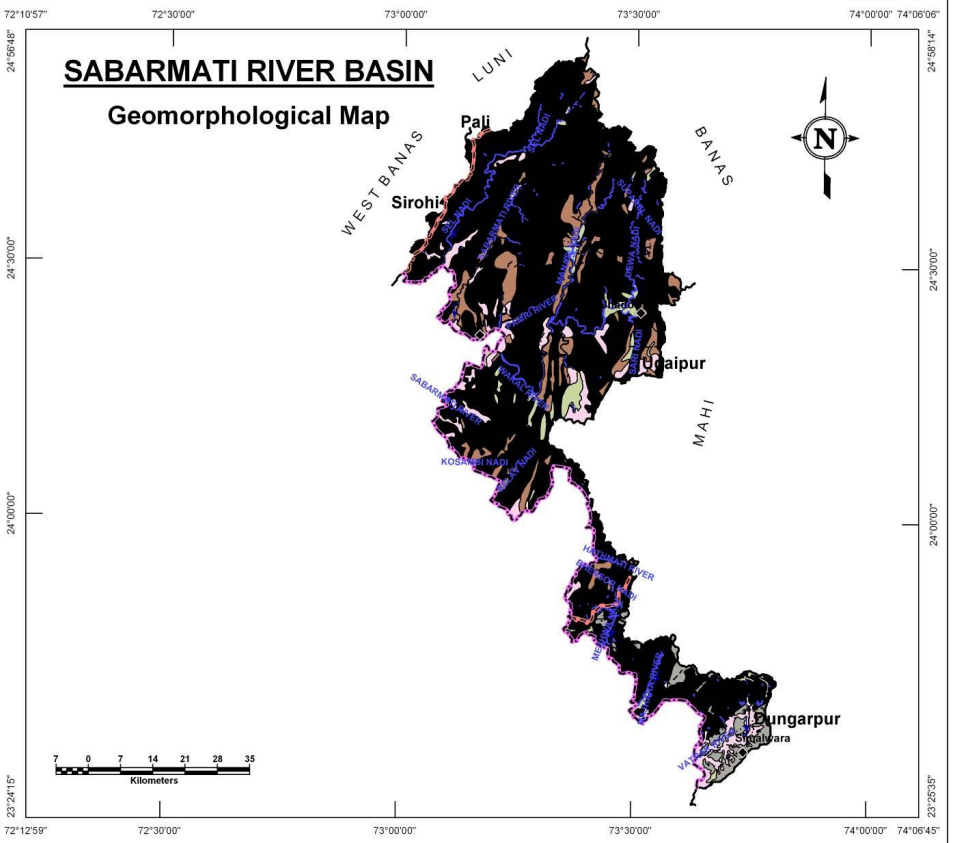
- Kumbhalgarh Group
- Gogunda Group
- Lunavada Group
- Jharol Group
- Barilake Group
- Udaipur Group
- Sendra-Ambaji Granite & Gneiss
- Rakhabdev Ultramafic Suite

Source : District Resource Map of Rajasthan - GSI

PLATE - V

SABARMATI RIVER BASIN

Geomorphological Map



LEGEND

Admin Boundary:

- Block Headquarter
- 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:

- Valley Fill

Denudational Origin:

- Pediplain
- Pediment
- Burried Pediment

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

AQUIFERS

Phyllites constitute the predominant aquifer type as can be seen in Plate – VI, which occupy close to 30% of the basin area. This is followed by Schist aquifers (about 9% of area) and then by Granites and Quartzites. Weathering and fracturing of rocks within each lithologic type results into formation of aquifers within the massive hard rocks. It can be seen both from map and statistical table below which indicates the predominance of hilly area within the basin that occupy more than half of the basin area.

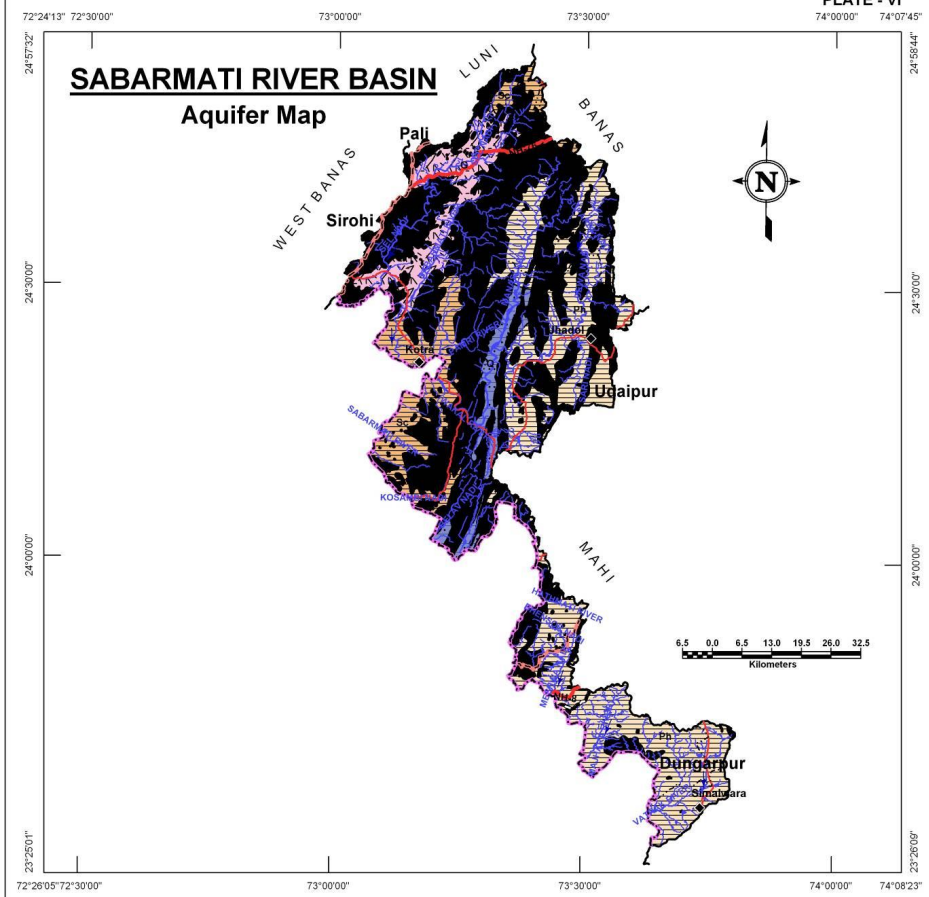
Aquifer in Potential Zone	Area (sq km)	% of Basin Area	Description of the unit/Occurrence
Phyllite	1,225.3	29.9	These include meta sediments and represented by carbonaceous phyllite.
Schist	354.4	8.7	Medium to fine grained compact rock. The ltho units are soft, friable and have closely spaced cleavage.
Quartzite	140.3	3.4	Medium to coarse grained and varies from feldspathic grit to sericitic quartzite.
Granite	297.9	7.3	Light gey to pink colour, medium to coarse grained, and characteristically have porphyritic texture.
Non Potential Zone	2,077.7	50.7	Hills
Total	**4,095.6**	**100.0**	

LOCATION OF GROUND WATER MONITORING WELLS

The basin has a fairly well distributed network of ground water monitoring stations (103) in the basin owned by RGWD (93) and CGWB (10); and an additional one well has been recommended to be added to the water quality monitoring network to add more effectiveness to it while the existing wells are sufficient to monitor water level in the basin.

District Name	CGWB	RGWD	Total	Recommended additional wells for optimization of monitoring network	
				Water Level	Water Quality
Dungarpur	2	33	35	-	**1**
Pali	-	-	-	-	**-**
Sirohi	-	-	-	-	**-**
Udaipur	8	60	68	-	**1**
Total	**10**	**93**	**103**	**0**	**1**

PLATE - VI



LEGEND

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

River Basin Boundary

Roads:
- National Highway
- State Highway

Railway:
- Broad Gauge

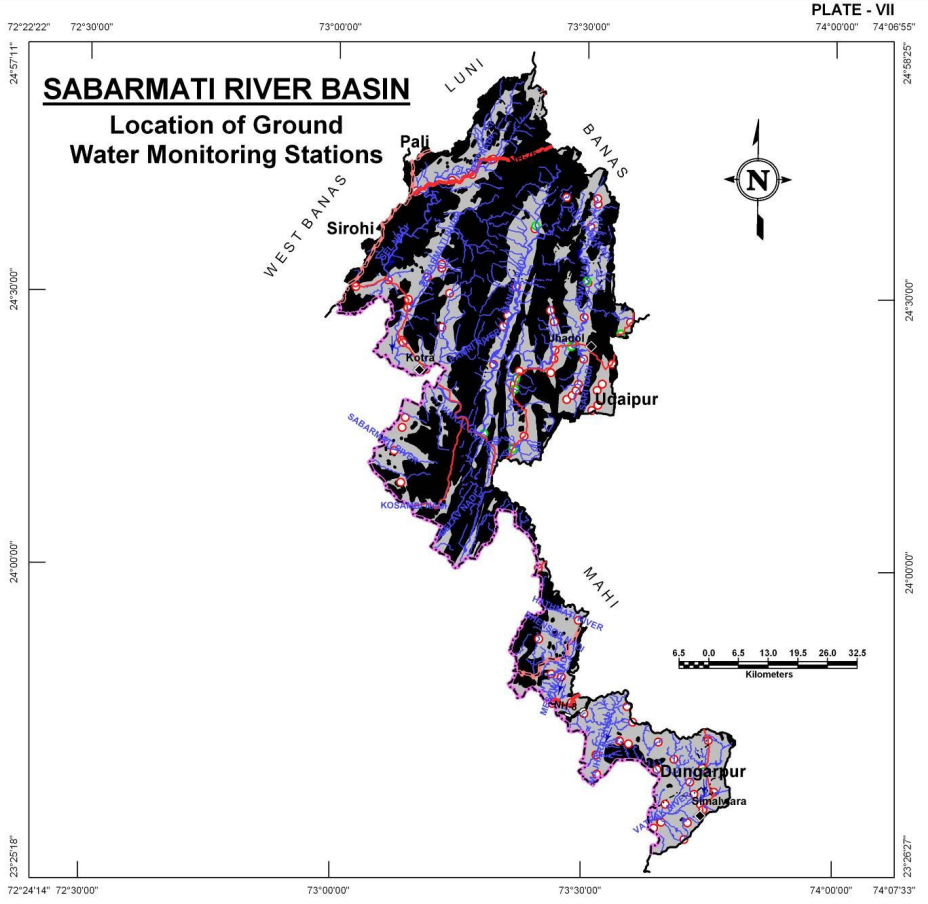
Water Bodies:
- River / Streams
- Ponds / Reservoirs

Hills

Aquifer:
- Phyllite
- Schist
- Quartzite
- Granite

Source: Ground Water Potential Zone Map - GWD,Rajasthan

PLATE - VII



LEGEND

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

River Basin Boundary

Roads:
- National Highway
- State Highway

Railway:
- Broad Gauge

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Hills

Ground Water Monitoring Stations:
- CGWB
- RGWD

LOCATION OF EXPLORATORY WELLS

SABARMATI RIVER BASIN

In all, there are 36 exploratory wells present in the basin drilled in the past by RGWD (26) and CGWB (10) that form basis for delineation of sub-surface aquifers. Large part of the area being hilly terrain and by and large excluded from detailed exploration, the density of exploratory wells in rest of the area from ground water exploration perspective, is good.

District Name	CGWB	RGWD	Total
Dungarpur	8	13	**21**
Pali	-	-	**-**
Sirohi	-	-	**-**
Udaipur	2	13	**15**
Total	**10**	**26**	**36**

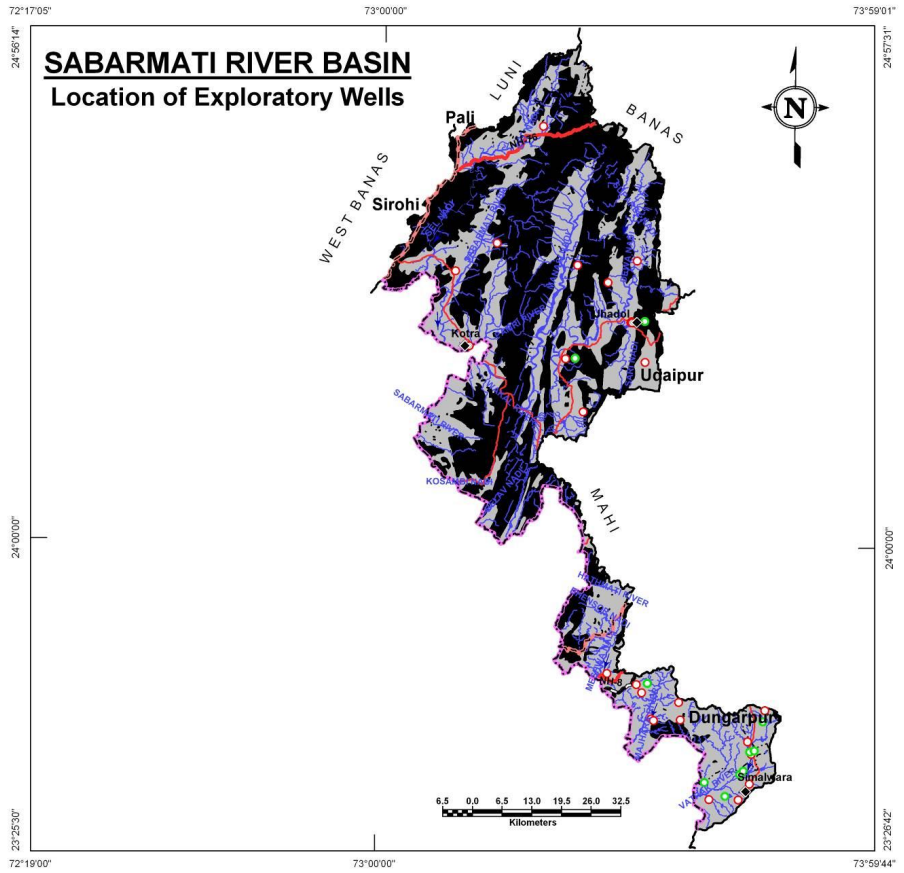
DEPTH TO WATER LEVEL (PRE MONSOON – 2010)

The general depth to water level in the basin ranges from 10 to 30 meters below ground level, as seen on northeastern, central, western and southwestern parts of the basin. These two interval ranges (10-20m and 20-30m bgl) together occupy more than 84% of the non-hilly basin area. Ground water at very shallow depths (<10m bgl) also occurs in large parts in Udaipur and Dungarpur districts covering an area of about 284 sq kms.

Depth to water level (m bgl) Pre Monsoon - 2010	District wise area coverage (sq km)*				Total Area (sq km)
	Dungarpur	Pali	Sirohi	Udaipur	
< 10	43.2	-	-	240.8	**284.0**
10 - 20	269.1	-	-	615.6	**884.7**
20 - 30	240.5	-	-	572.4	**812.9**
30 - 40	-	-	-	29.7	**29.7**
> 40	-	-	-	6.6	**6.6**
Total	**552.8**	**-**	**-**	**1,465.1**	**2,017.9**

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

River Basin Boundary

Railway:
- Broad Gauge

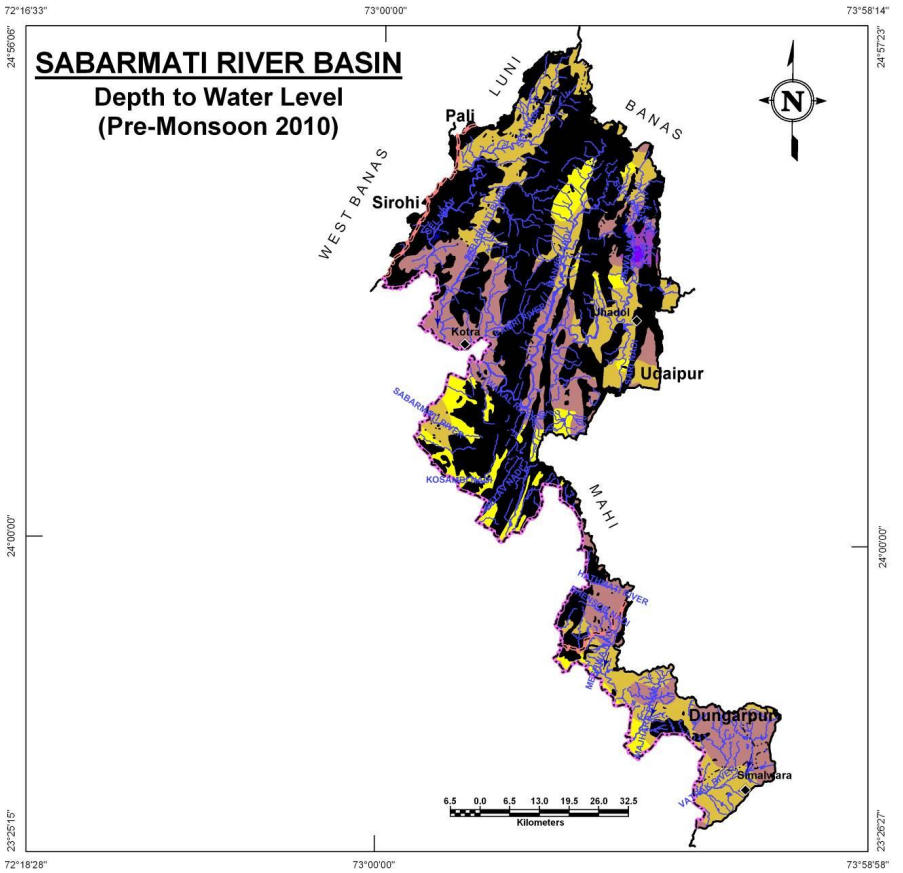
Roads:
- National Highway
- State Highway

Water Bodies:
- River / Streams
- Ponds / Reservoirs

Hills

Exploratory Wells:
- CGWB
- RGWD

PLATE - IX



LEGEND

Admin Boundary:
- Block Headquarter
- 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) SABARMATI RIVER BASIN

Water table elevation shows large variation since the topography in the basin reaches a high of about >1200m amsl and low of about 175m amsl. A perusal of Plate X reveals steep ground water flow gradients in the hilly areas of Udaipur district where the elevation ranges from about 840m amsl to about 400m amsl at the marginal areas of hills in the western part. The initial flow direction is from northeast to southwest till it reaches the plain areas west of Aravallis. The nearly isolated basin part of Dungarpur district shows a relatively lower water table elevation ranges below 400m amsl to the lowest of the basin of about 180m amsl coupled with lower flow gradients.

Water Table Elevation (m amsl) Pre Monsoon - 2010	District wise area coverage (sq km)				Total Area (sq km)
	Dungarpur	Pali	Sirohi	Udaipur	
< 180	0.6	-	-	-	**0.6**
180 - 200	80.9	-	-	-	**80.9**
200 - 220	114.7	-	-	-	**114.7**
220 - 240	79.5	-	-	2.0	**81.5**
240 - 260	65.9	-	-	4.9	**70.8**
260 - 280	66.5	-	-	21.5	**88.0**
280 - 300	39.6	-	-	74.3	**113.9**
300 - 320	51.6	-	-	100.1	**151.7**
320 - 340	52.9	-	-	93.9	**146.8**
340 - 360	0.6	-	-	106.6	**107.2**
360 - 380	-	-	-	58.4	**58.4**
380 - 400	-	-	-	42.8	**42.8**
400 - 440	-	-	-	108.5	**108.5**
440 - 480	-	-	-	116.2	**116.2**
480 - 520	-	-	-	191.5	**191.5**
520 - 560	-	-	-	179.5	**179.5**
560 - 600	-	-	-	136.3	**136.3**
600 - 640	-	-	-	94.0	**94.0**
640 - 680	-	-	-	27.2	**27.2**
680 - 720	-	-	-	33.5	**33.5**
720 - 760	-	-	-	34.0	**34.0**
760 - 800	-	-	-	20.2	**20.2**
800 - 840	-	-	-	18.0	**18.0**
> 840	-	-	-	1.7	**1.7**
Total	**552.8**	**-**	**-**	**1,465.1**	**2,017.9**

WATER LEVEL FLUCTUATION (PRE TO POST MONSOON 2010)

The Basin has predominantly hardrock aquifers constituting most of the non-hilly parts. Therefore, wide fluctuations in water levels are seen to rise by very high numbers to the extent of 14m in post-monsoon period with respect to pre-monsoon water levels. Apart from very high fluctuation areas that are limited in spatial distribution, the general variation is observed in the range of 2m to 10m.

District Name	District wise area coverage (sq km) within fluctuation range								Total Area (sq km)
	< 2	2 to 4	4 to 6	6 to 8	8 to 10	10 to 12	12 to 14	> 14	
Dungarpur	17.6	167.3	165.7	85.8	84.5	21.5	7.1	3.3	**552.8**
Pali	-	-	-	-	-	-	-	-	**-**
Sirohi	-	-	-	-	-	-	-	-	**-**
Udaipur	15.6	411.4	435.2	397.1	179.1	24.0	2.7	-	**1,465.1**
Total	**33.2**	**578.7**	**600.9**	**482.9**	**263.6**	**45.5**	**9.8**	**3.3**	**2,017.9**

PLATE - X

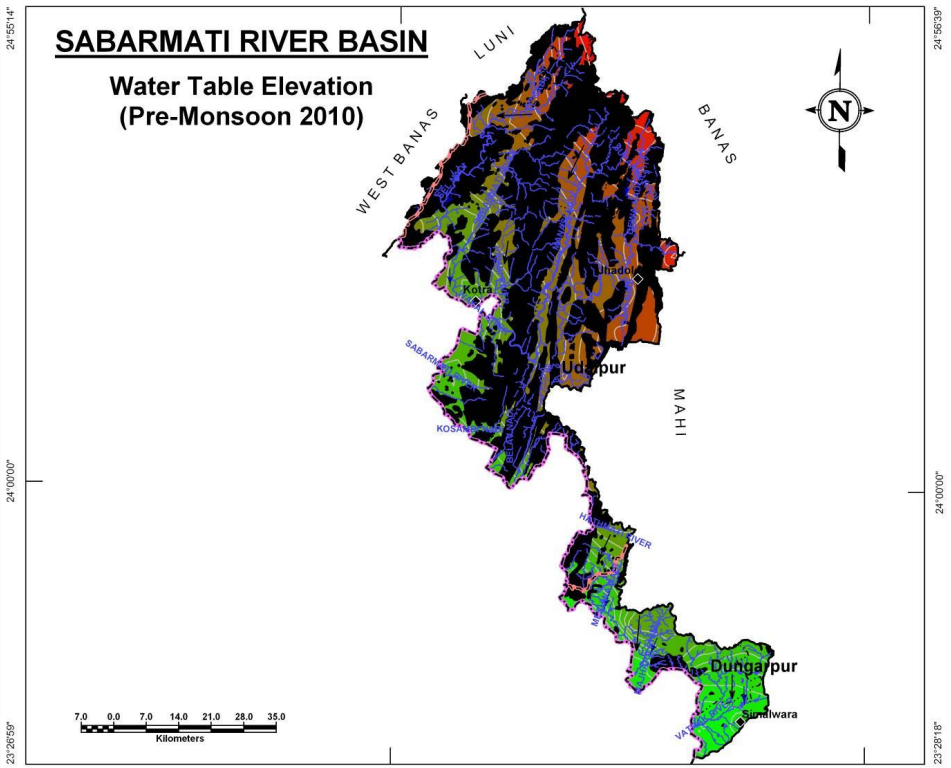
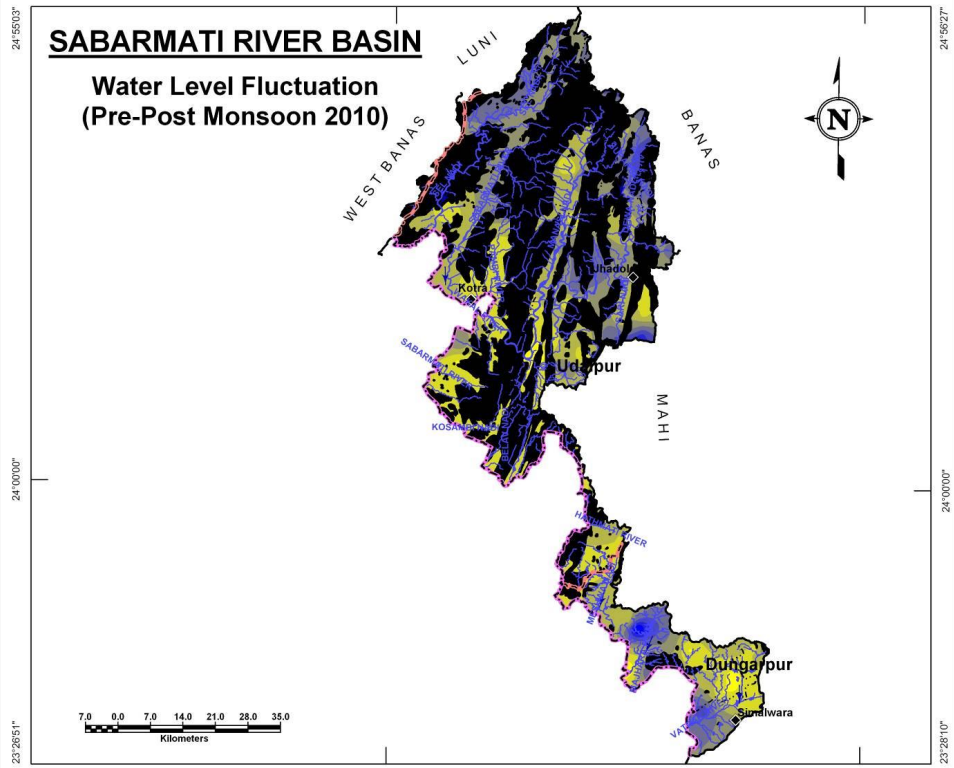


PLATE - XI



LEGEND

Admin Boundary:

- Block Headquarter
- State Boundary
- District Boundary
- Block Boundary
- **RiverBasin Boundary**
- **Water Bodies:**
- River / Streams
- Ponds / Reservoirs
- **Hills**
- **Water Table Elevation**

Water Table Elevation(m amsl):

<180	400 - 440
180 - 200	440 - 480
200 - 220	480 - 520
220 - 240	520 - 560
240 - 260	560 - 600
260 - 280	600 - 640
280 - 300	640 - 680
300 - 320	680 - 720
320 - 340	720 - 760
340 - 360	760 - 800
360 - 380	800 - 840
380 - 400	>840

LEGEND

Admin Boundary:

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

Water Level Fluctuation(m):

- < 2
- 2 to 4
- 4 to 6
- 6 to 8
- 8 to 10
- 10 to 12
- 12 to 14
- >14

ELECTRICAL CONDUCTIVITY DISTRIBUTION SABARMATI RIVER BASIN

The Electrical Conductivity (at 25°C) distribution map is presented in Plate XII reveals that almost the entire basin has good quality of water suitable for domestic and other purposes. Approximately 99.5% of the non-hilly basin area has shown low EC values i.e., falling within the < 2000 µS/cm range. Very small area (0.5% of the basin) around Jhadol in Udaipur district has shown EC values in the range of 2000-4000 µS/cm. There is no area that has high EC values of more than 4000 µS/cm.

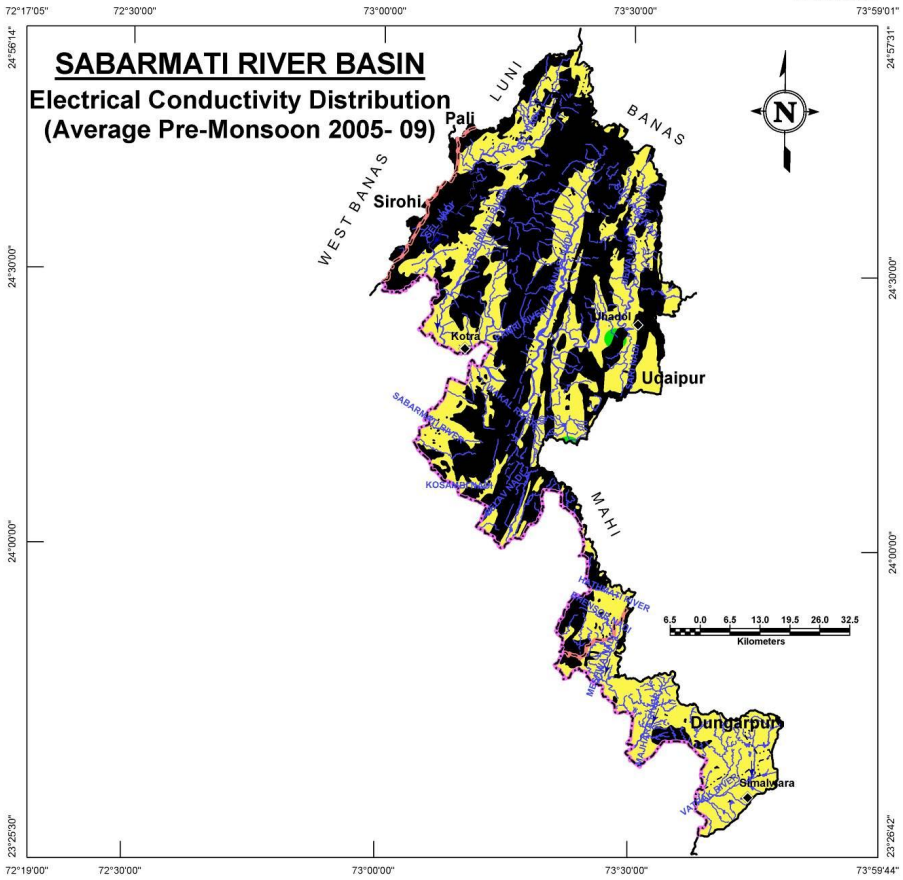
Electrical Conductivity Ranges (µS/cm at 25°C) (Ave. of years 2005-09)	District wise area coverage (sq km)								Total Area (sq km)
	Dungarpur		Pali		Sirohi		Udaipur		
	Area	% age	Area	% age	Area	% age	Area	% age	
< 2000	552.8	100.0	-	-	-	-	1,454.8	99.3	**2,007.6**
2000-4000	-	-	-	-	-	-	10.3	0.7	**10.3**
Total	**552.8**	**100.0**	**-**	**-**	**-**	**-**	**1,465.1**	**100.0**	**2,017.9**

CHLORIDE DISTRIBUTION

Chloride concentration distribution map in Plate XIII indicates that most of the Sabarmati river basin falls within the < 250 mg/l category that renders the ground water suitable for domestic and other purposes. About 93% of the basin area is covered by Yellow coloured region that leaves only 7% area with Green colour where the ground water falls within the 250-1000 mg/l category which still is within tolerable limits for domestic use. No area has shown very high chloride concentration (i.e., >1000mg/l).

Chloride Ranges (mg/l) (Ave. of years 2005-09)	District wise area coverage (sq km)								Total Area (sq km)
	Dungarpur		Pali		Sirohi		Udaipur		
	Area	% age	Area	% age	Area	% age	Area	% age	
< 250	551.5	99.8	-	-	-	-	1,318.7	90.0	**1,870.2**
250 - 1000	1.3	0.2	-	-	-	-	146.4	10.0	**147.7**
Total	**552.8**	**100.0**	**-**	**-**	**-**	**-**	**1,465.1**	**100.0**	**2,017.9**

PLATE - XII



LEGEND

Admin Boundary:

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

River Basin Boundary

Water Bodies:

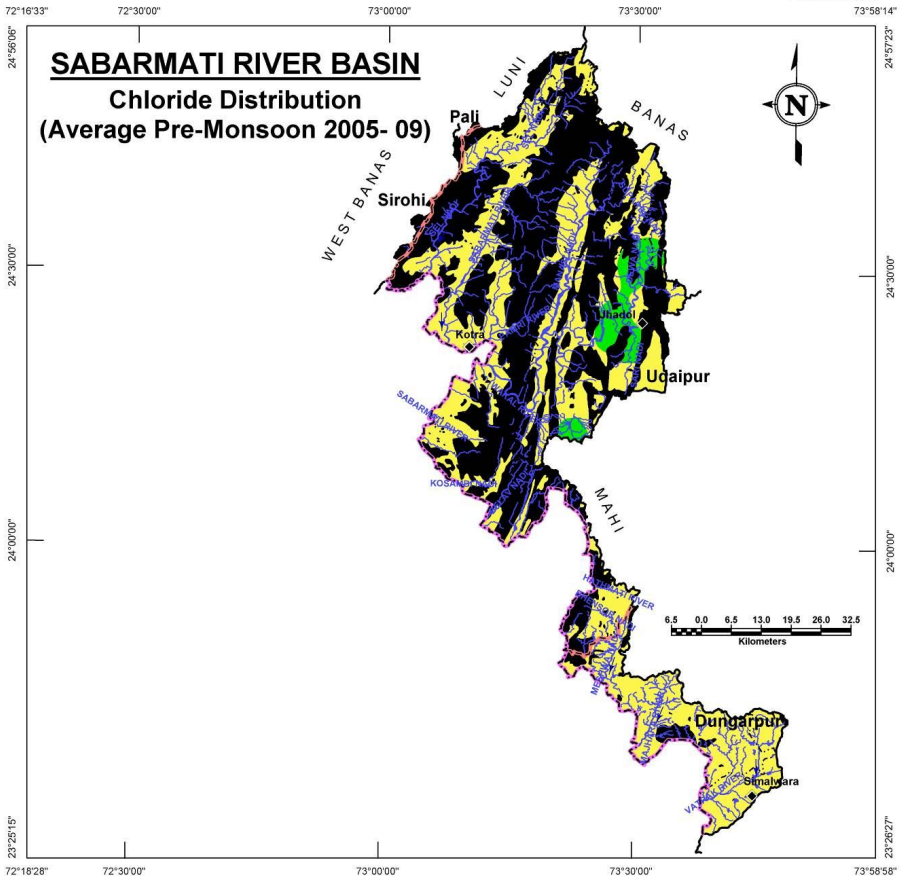
- River / Streams
- Ponds / Reservoirs

Hills

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

- < 2000
- 2000-4000

PLATE - XIII



LEGEND

Admin Boundary:

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

River Basin Boundary

Water Bodies:

- River / Streams
- Ponds / Reservoirs

Hills

Chloride Concentration (mg/l):

- < 250
- 250-1000

FLUORIDE DISTRIBUTION

SABARMATI RIVER BASIN

The Fluoride distribution map is presented in Plate XIV shows a very small patch (<2% of the basin area) in the northwestern part of the basin within Udaipur district near the Pali district border that has moderately high Fluoride concentration (1.5 – 3.0 mg/l). Remaining part of the basin which is approximately 98% of the basin area (excluding hilly area), falls within low fluoride concentration region which is suitable for domestic and other purposes.

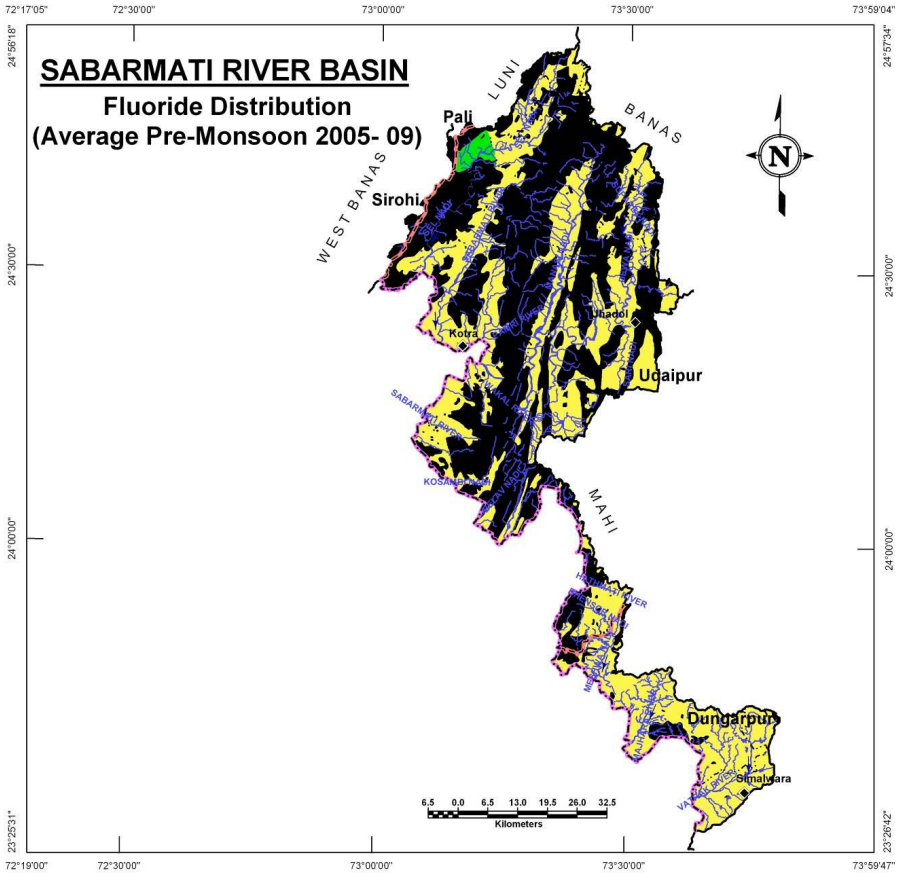
Fluoride Ranges (mg/l) (Ave. of years 2005-09)	District wise area coverage (sq km)								Total Area (sq km)
	Dungarpur		Pali		Sirohi		Udaipur		
	Area	% age	Area	% age	Area	% age	Area	% age	
< 1.5	552.8	100.0	-	-	-	-	1,427.6	97.4	**1,980.4**
1.5-3.0	-	-	-	-	-	-	37.5	2.6	**37.5**
Total	**552.8**	**100.0**	**-**	**-**	**-**	**-**	**1,465.1**	**100.0**	**2,017.9**

NITRATE DISTRIBUTION

High nitrate concentration in ground water renders it unsuitable for agriculture purposes. Plate XV shows distribution of Nitrate in ground water. There are some isolated patches in the central and northern part of the basin that have shown high concentration of Nitrate in ground water (>100mg/l) and together these account for hardly 3% of the basin area, all within Udaipur district. Surrounding these high Nitrate concentration areas are moderate concentration areas (50-100 mg/l) covering about 21% of basin area. The rest of the basin area (excluding hilly areas) falls within low Nitrate concentration area where the ground water is suitable for agriculture.

Nitrate Ranges (mg/l) (Ave. of years 2005-09)	District wise area coverage (sq km)								Total Area (sq km)
	Dungarpur		Pali		Sirohi		Udaipur		
	Area	% age	Area	% age	Area	% age	Area	% age	
< 50	545.9	98.7	-	-	-	-	978.4	66.8	**1,524.3**
50-100	6.9	1.3	-	-	-	-	426.1	29.1	**433.0**
> 100	-	-	-	-	-	-	60.6	4.1	**60.6**
Total	**552.8**	**100.0**	**-**	**-**	**-**	**-**	**1,465.1**	**100.0**	**2,017.9**

PLATE - XIV



LEGEND

Admin Boundary:

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

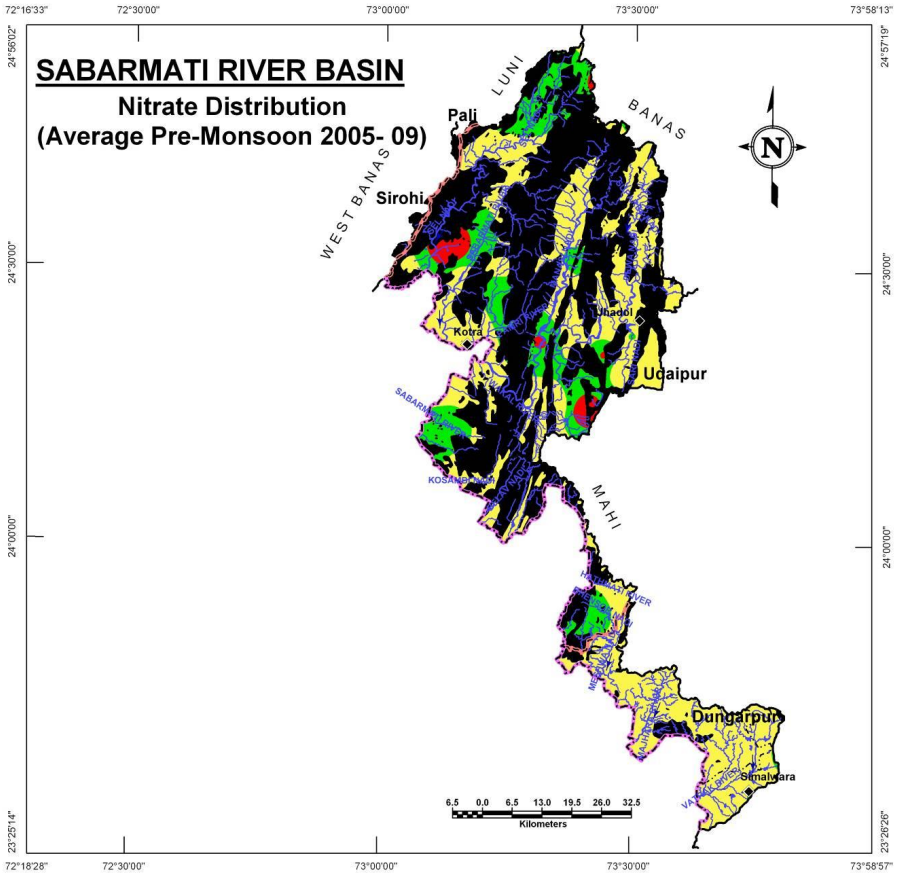
Water Bodies:

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

Fluoride Concentration (mg/l):

- < 1.5
- 1.5-3.0

PLATE - XV



LEGEND

Admin Boundary:

- Block Headquarter
- 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

SABARMATI RIVER BASIN

The entire area of the Sabarmati River basin is underlined by the hard rocks at different depths. The major rocks types occurring are Siltstone, shale, greywackes in sedimentary rock type, Schist, Gneiss, Quartzite, Slate, Phyllite in Metamorphic rock and migmatites in igneous rocks. These rocks are overlain by thin alluvial sands of rivers and streams and residual soils from the weathering of hard rocks. The depth to bed rock defines the sub surface topography of the occurrence of massive hard rock beneath alluvial deposits and weathered and fractured zone in hard rocks.

Perusal of the map (Plate – XVI) of depth to bed rock in meters above ground level reveals that the depth to bed rock is at shallow levels in northern part of the river basin which gradually deepens in south and southern part. The depth to bedrock in the river basin varies from 40-60 m bgl in the south, to less than 20m bgl in the northern parts. The general depth to bedrock has been in the 20-40m bgl range as about 62% of the basin area falls within this category.

Depth to Bedrock (m bgl)	District wise area coverage (sq km)				Total Area (sq km)
	Dungarpur	Pali	Sirohi	Udaipur	
< 20	-	-	-	299.4	**299.4**
20-40	265.2	-	-	989.2	**1,254.4**
40-60	283.9	-	-	120.8	**404.7**
> 60	3.7	-	-	55.7	**59.4**
Total	**552.8**	**-**	**-**	**1,465.1**	**2,017.9**

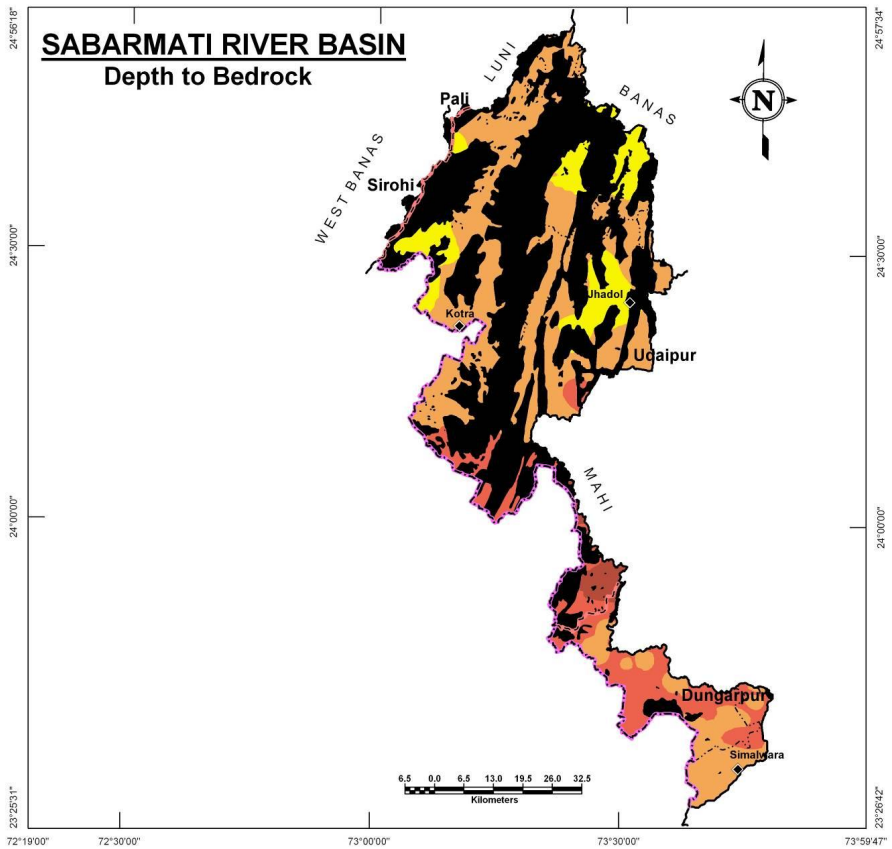
UNCONFINED AQUIFER

Hardrock areas:

Weathered, fractured and jointed secondary openings within hardrock formations constitute aquifer within them in the basin. Perusal of Plate – XVII reveals that the 10m to 30m thickness zones occupies significant parts of the basin amounting to approximately 75% of the potential zone. The thicker aquifer (>30m) are mostly present in Udaipur district and at some places even reaching >50m but the latter however is very limited in extent. About 13% of the potential zones has very thin (<10m) horizon of aquifer.

Unconfined aquifer Thickness (m)	District wise area coverage (sq km)				Total Area (sq km)
	Dungarpur	Pali	Sirohi	Udaipur	
<10	70.5	-	-	183.0	**253.5**
10-20	269.1	-	-	554.1	**823.2**
20-30	190.7	-	-	486.8	**677.5**
30-40	20.0	-	-	199.7	**219.7**
40-50	2.5	-	-	41.3	**43.8**
> 50	-	-	-	0.2	**0.2**
Total	**552.8**	**-**	**-**	**1,465.1**	**2,017.9**

PLATE - XVI



LEGEND

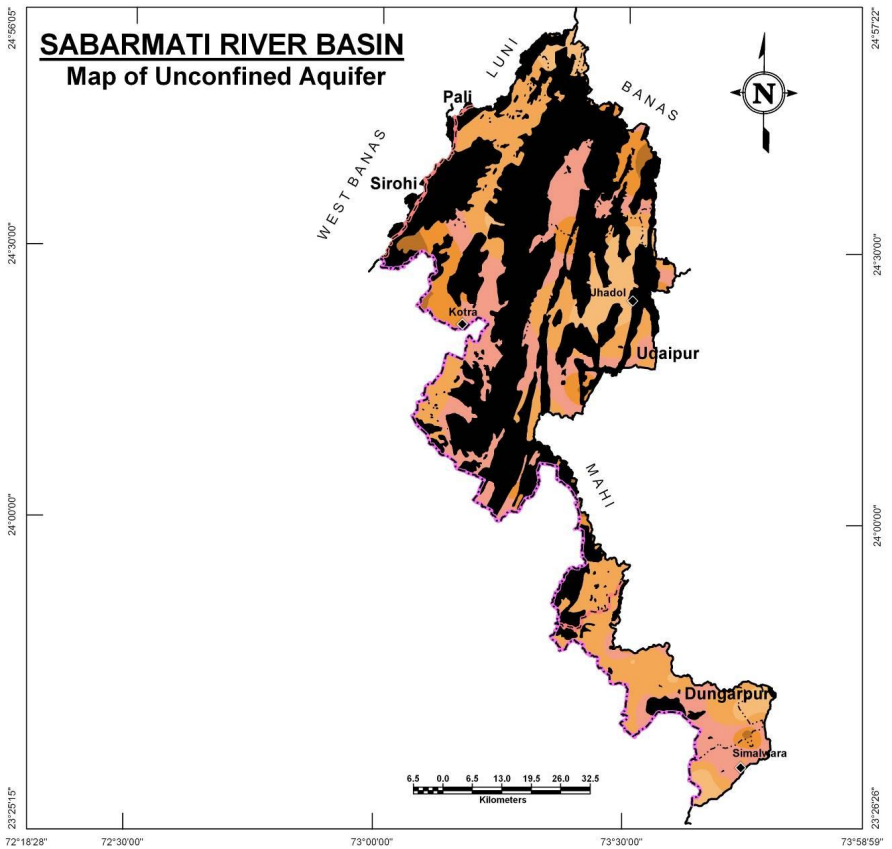
Admin Boundary:

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

Depth to Bedrock (m bgl):

- < 20
- 20-40
- 40-60
- >60

PLATE - XVII



LEGEND

Admin Boundary:

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

Aquifer Thickness (m):

Weathered & Fractured Zone in Hardrock Area :

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

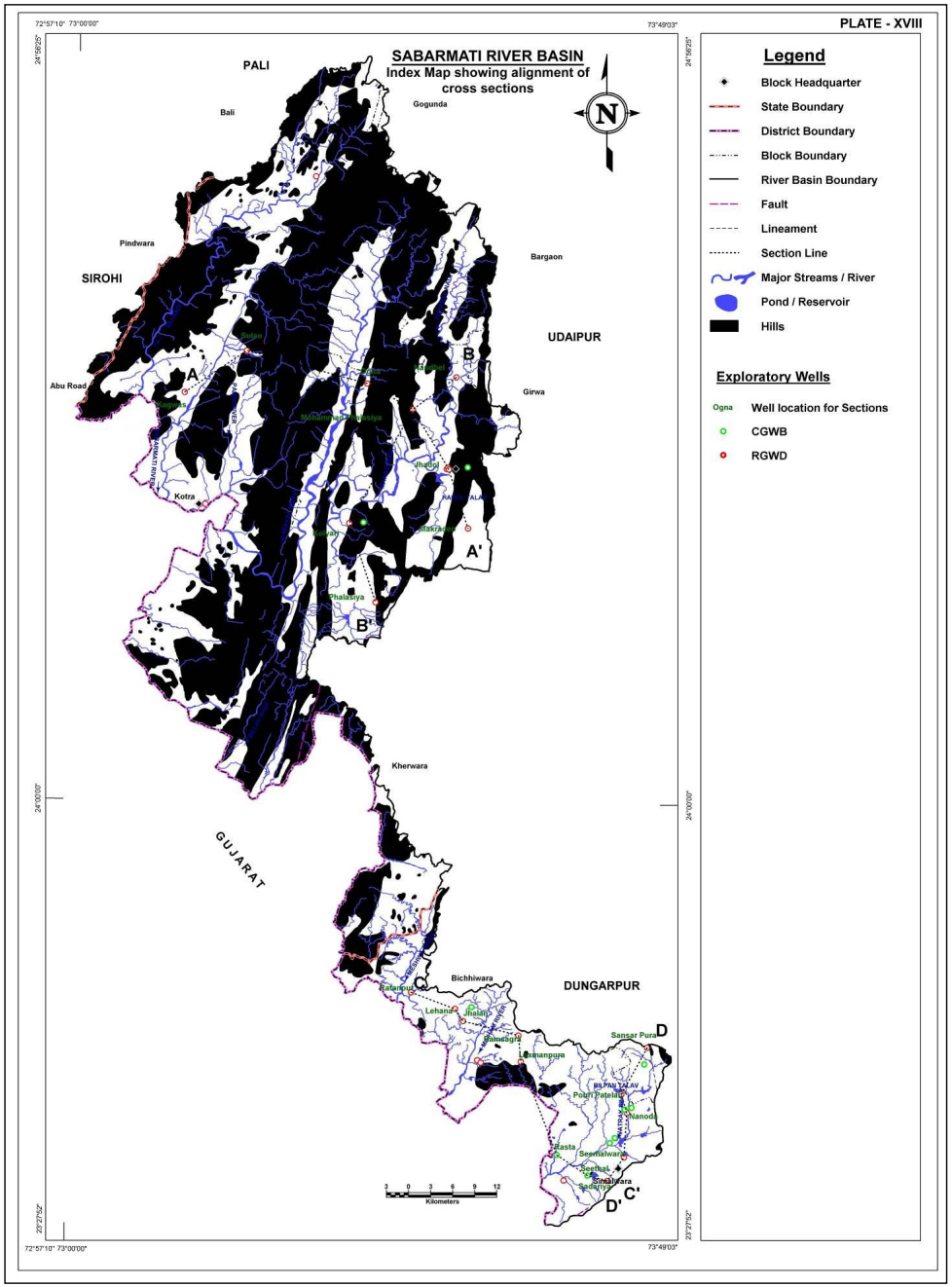
CROSS SECTIONS

SABARMATI RIVER BASIN

Several hydrogeological 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 effect 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’	W – E – SE
Section BB’	SW – NE
Section CC’	NW – SE
Section DD’	N – S

PLATE - XVIII



Rolta India Limited

Section A-A':

The A-A' section (Plate – XIX) trends in W-E-SE direction extending to a distance of about 52.5km across the Sabarmati, Wakal and Manasi Rivers in the basin. The section depicts the disposition of different layers of gneiss, schist and phyllite overlain by top soil. The lithologs of 5 boreholes along with surrounding well information is taken while preparing the section. At a distance of about 20 km of 'A', there is a fault close to Manasi River where Gneisses (in the west) are juxtaposed against Schists (in the east)

The water level varies from 375 m amsl to 640 m amsl following the surface topography. The gradient is very steep in the eastern part which flattens out in the middle of the section and again becoming steep towards west.

Section B-B':

The section B-B' (Plate – XX) is trending SW – NE direction and covers an approximate length of 37.5 km, roughly parallel to Manasi River. The lithologs of 4 boreholes along with surrounding well information has been considered while preparing the section. The section reveals a predominantly schistose lithology throughout, except for a small patch of Phyllite in the southwestern part. Topography is high in the two ends of the section and low but wide in the centre.

Ground water level varies from 590 m amsl to 790 m amsl in this profile, parallel to surface topography.

PLATE - XIX

SABARMATI RIVER BASIN

Cross section Along A-A'

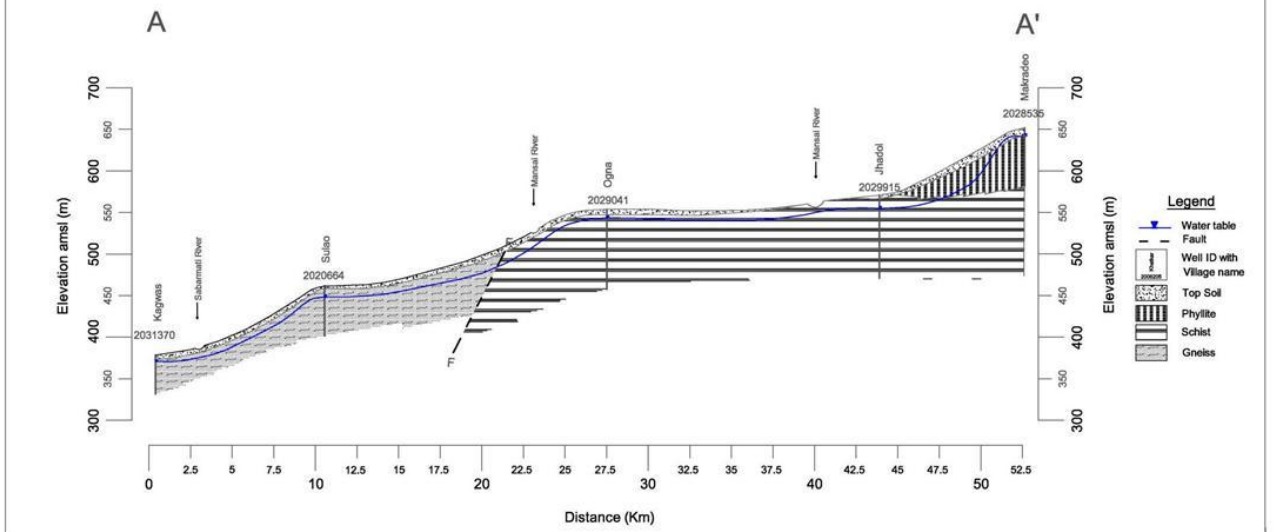
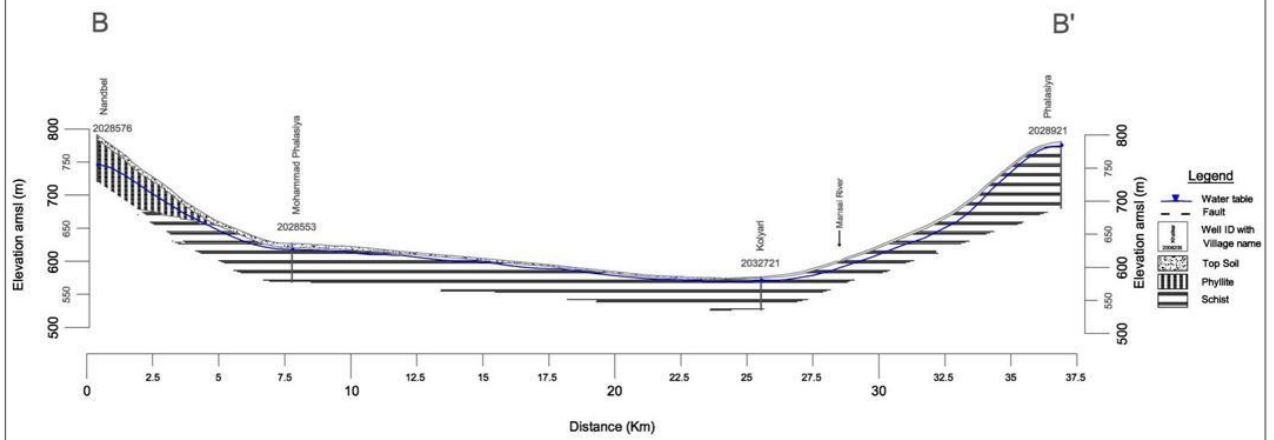


PLATE - XX

SABARMATI RIVER BASIN

Cross section Along B-B'



Section C-C':

The C-C' (Plate – XXI) section has been plotted across the southeastern isolated part of the basin trending NW-SE, covering a distance of about 42.5 km, broadly perpendicular to the Majhara and Vatrak Rivers. The lithologs of 8 boreholes along with surrounding well information has been considered while preparing the section. Except for a thin band of Quartzite in the northwestern part of the section, Phyllite is the only lithology present in the section and this is overlain by top soil throughout the section.

The water level in this section varies from 190 m amsl to 340 m amsl, parallel to surface topography.

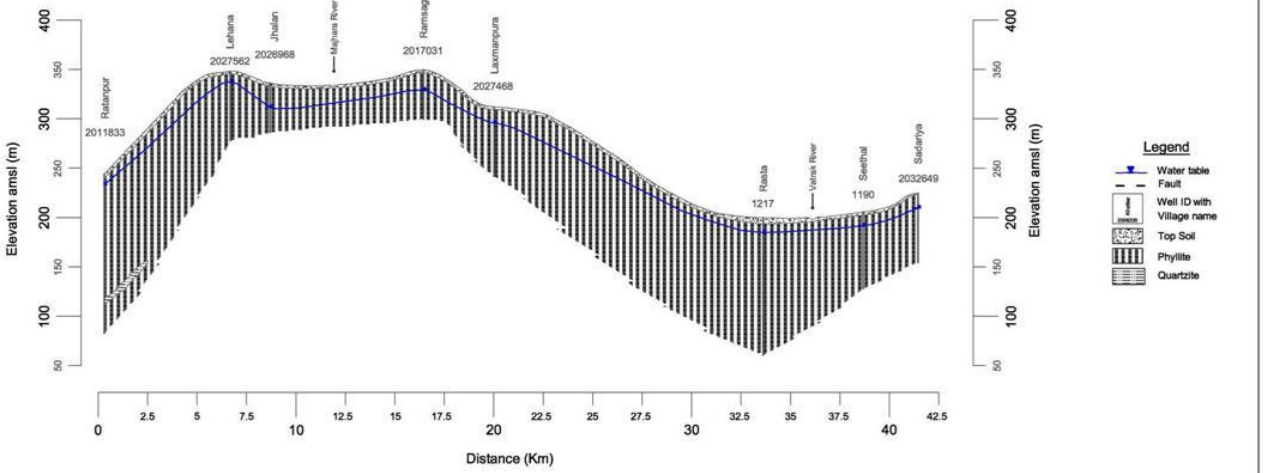
Section D-D':

The D-D' (Plate – XXII) section is 22.5 km long trending in N-S direction, in the southern part of the basin. The lithologs of 5 boreholes along with surrounding well information is taken into consideration while preparing the section. The section reveals a monotonously single lithology i.e., Phyllite in all the wells that is overlain by top soil throughout the basin.

Ground water level varies from 210 m amsl to 300 m amsl, following the topography that slopes from north to south.

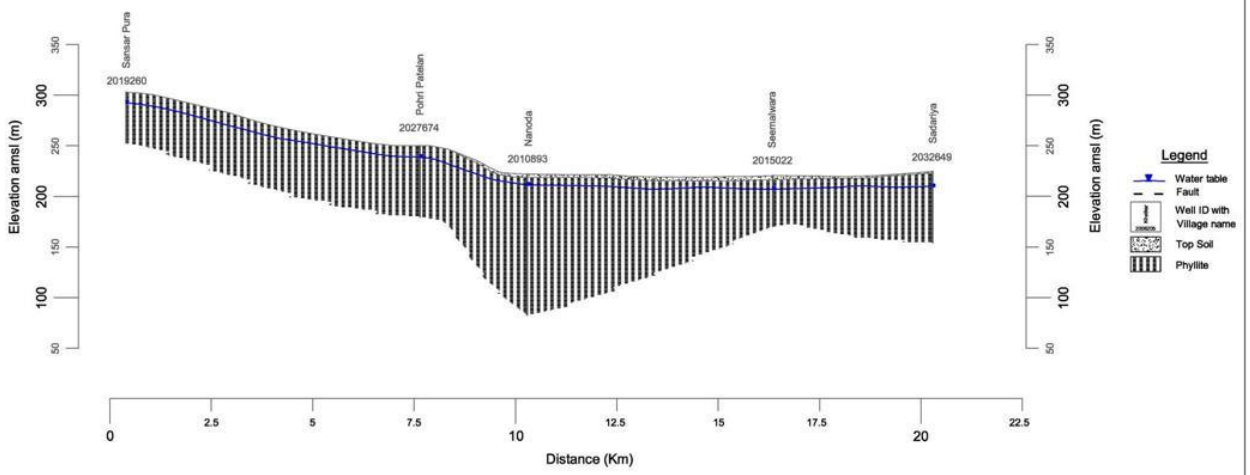
PLATE - XXI

SABARMATI RIVER BASIN
Cross section Along C-C'



SABARMATI RIVER BASIN
Cross section Along D-D'

PLATE - XXII



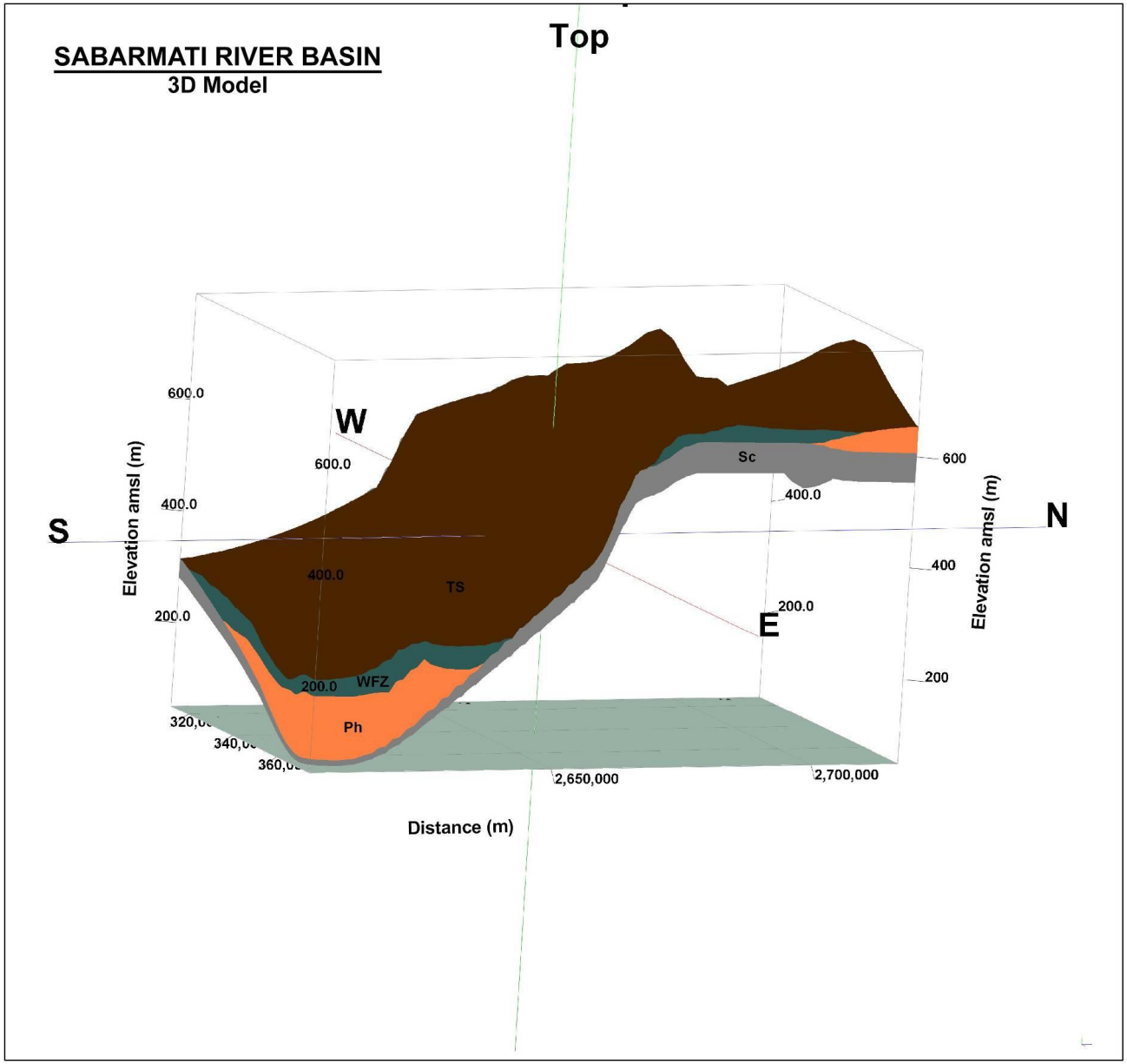
3D MODEL OF AQUIFERS

SABARMATI RIVER BASIN

The continuous litho-stratigraphic model has been developed for the Sabarmati 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.

With this model it is apparent that beneath the top soil there is a persistent weathered and fractured zone of hard rock acting as unconfined aquifers, in south east and southeastern part of the basin. Predominantly, massive Phyllites and Schists are underlying the weathered and fractured zone in the area. Thickness of schist is high in north as compared to other area of the basin.

PLATE - XXIII



Legend

TS	Top Soil
WFZ	Weathered & Fractured Zone
Ph	Phyllite
Sc	Schist
G	Granite

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.

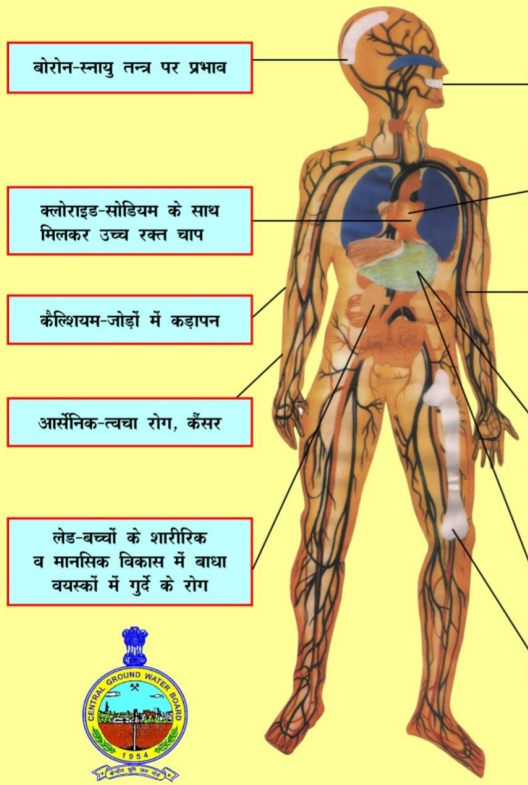
(Contd…)

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

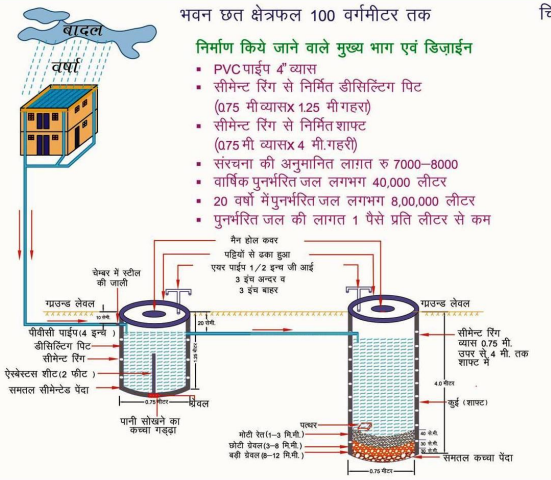
भूजल अमूल्य है इसे प्रदूषित न करें।

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 लागत रु 7000–8000
- वार्षिक पुनर्भरित जल लगभग 40,000 लीटर
- 20 वर्षों में पुनर्भरित जल लगभग 8,00,000 लीटर
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम

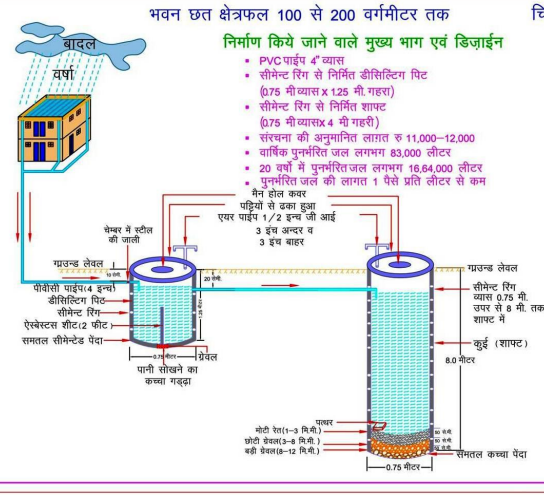


चित्र–2

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 लागत रु 11,000–12,000
- वार्षिक पुनर्भरित जल लगभग 83,000 लीटर
- 20 वर्षों में पुनर्भरित जल लगभग 16,64,000 लीटर
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम

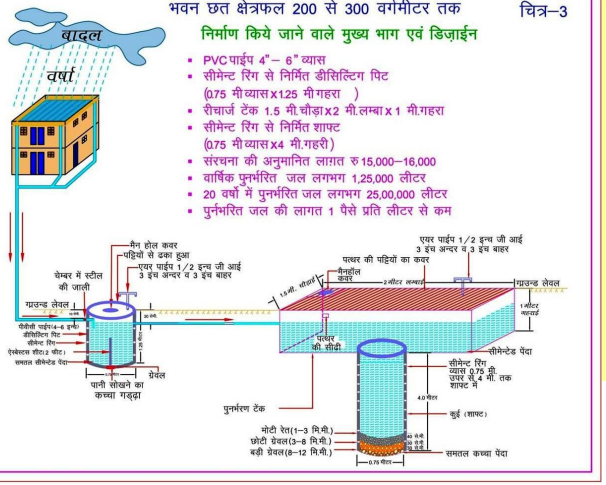


चित्र–3

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 लागत रु 15,000–16,000
- वार्षिक पुनर्भरित जल लगभग 1,25,000 लीटर
- 20 वर्षों में पुनर्भरित जल लगभग 25,00,000 लीटर
- पुनर्भरित जल की लागत 1 पैसे प्रति लीटर से कम

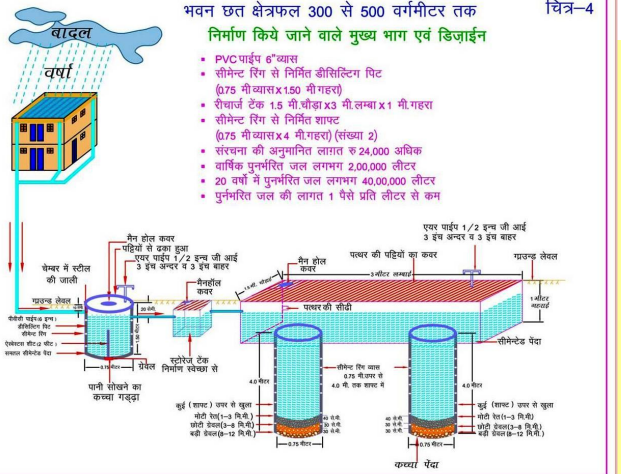


चित्र–4

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 लागत रु 24,000 अधिक
- वार्षिक पुनर्भरित जल लगभग 2,00,000 लीटर
- 20 वर्षों 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 • 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

ROLTA

Rolta India Limited

Central & Registered Office
Rolta Tower A,
Rolta Technology Park,
MIDC, Andheri (East),
Mumbai - 400 093
Tel : +91 (22) 2926 6666, 3087 6543
Fax : +91 (22) 2836 5992
Email : indsales@rolta.com

www.rolta.com