GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

GROUNDWATER SCENARIO

BHILWARA DISTRICT, RAJASTHAN

Meja Dam,Bhilwara

Western Region
Jaipur
2013

DISTRICT AT A GLANCE – BHILWARA DISTRICT, RAJASTHAN

S No	Item	Statistics	
1	**GENERAL INFORMATION**		
	(i) Geographical area (sq km)	10,455	
	(ii) Administrative Division (As on 31.3.2007)		
	Number of Tehsils	12	
	Number of Blocks	11	
	Number of Villages (Census 2011)	1834	
	(iii) Population (As per provisional 2011 Census)	24, 08,523	
	Growth rate 2001-2011 (%)	19.27%	
	Density of population(Person per sq.km)	230	
	(iv) Average Annual Rainfall (1971-2012) in mm	635.1	
2	**GEOMORPHOLOGY**		
	Major Physiographic Units	Pediment, Buried, Intermontane Valley, Pediment, Plateau, Sandy Plain	
	Major Drainage	Banas River	
3	**LAND USE (ha)**		
	(a) Forest Area	75623	
	(b) Net Sown Area	443433	
	(c) Total Cropped Area	732965	
4	MAJOR SOIL TYPE	Loam, Clay loam, sand and sandy loam, pebbly & stony loam	
5	**AREA UNDER PRINCIPAL CROPS** *(As on 2010-11)*	Crops	Area in ha
		Maize	202328
		Oil Seeds	153286
		Wheat	118780
		Pulses	114567
		Jowar	54236
		Barley	29884
		Fibres	12956
		Spices	3189
		Bajra	5105
		Fruits & Vegetables	2114
6	**IRRIGATION BY DIFFERENT SOURCES** (As on 2010-11)		
	Source	Net Irrigated Area (ha)	Gross Irrigated Area in ha
	Tubewells	15487	17338
	Other wells	139326	150790
	Tanks	9908	10209
	Canal	13791	13791
	Other Sources	3080	3185
	Total	181592	195313

7	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB** (As on March 2012)	
	Number of Dug wells	38
	Number of Piezometers	4
8	**PREDOMINANT GEOLOGICAL FORMATIONS**	Rock types belonging to Bhilwara Supergroup, Aravallis & Vindhyan Supergoup
9	**HYDROGEOLOGY**	
	Major Water bearing formation	Gneiss, Schist/phyllite, Sandstone, Limestone
	Depth to water level (Pre-monsoon, 2011) (mbgl)	3 –23
	Depth to water level (Post-monsoon, 2011) (mbgl)	1 – 16.5
	Long term water level trend (2001-2011) in cm/yr	Fall< 60 Rise<80
10	**GROUNDWATER EXPLORATION BY CGWB** (As on 31.3.2012)	
	Number of wells drilled (EW, OW, PZ, SH, Total)	EW - 34 & SH -1
	Depth Range (m)	13 – 203
	Discharge (liter per second)	Negligible – 31
	Storativity	-
	Transmissivity (m^2/day)	8 – 230 (Hard Rock) 200 – 3000 (Alluvium)
11	**GROUND WATER QUALITY**	
	Range of presence of chemical constituents	EC:-840-8450 m. mhos / cm at 25^0C Cl:-35-2453 mg/l F:- 0.24 -7.24mg/l NO_3:– 5.2 – 749 mg/l
	Type of water	Chloride type
12	**DYNAMIC GROUND WATER RESOURCES (March, 2009) in mcm**	
	Annual Replenishable Ground Water Resources	428.1800
	Net Annual Ground Water Availability	386.5900
	Net Annual Ground Water Draft	524.0040
	Projected Demand for Domestic and Industrial Uses.	28.9695
	Stage of Ground Water Development	135.55%
13	**GROUND WATER CONTROL AND REGULATION**	
	Number of Over-exploited blocks	11 (Entire District)
14	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Scarcity of water

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GROUND WATER SCENARIO
BHILWARA DISTRICT, RAJASTHAN

1.0 Introduction

The district is situated between $25^0$01' & $25^0$58' North latitude and $74^0$01' & $75^0$28' East longitude covering geographical area of 10,455 sq km (Fig-1). Bhilwara district is part of Ajmer Division. The district is divided into 4 sub-divisions namely Bhilwara, Gulabpura, Mandalgarh & Shahpura and comprises of 12 tehsils & 11 blocks. Total number of villages in the district is 1834. Rural & Urban population of the district is 18,95,869 and 5,12,654 respectively. Decennial population growth rate of the district is 19.27% since 2001. The district is known for its textile industries and mineral wealth. Sex ratio (No. of females per 1000 males) is 966 and population density per sq km is 230. Index map of Bhilwara district is shown n Fig. 1.

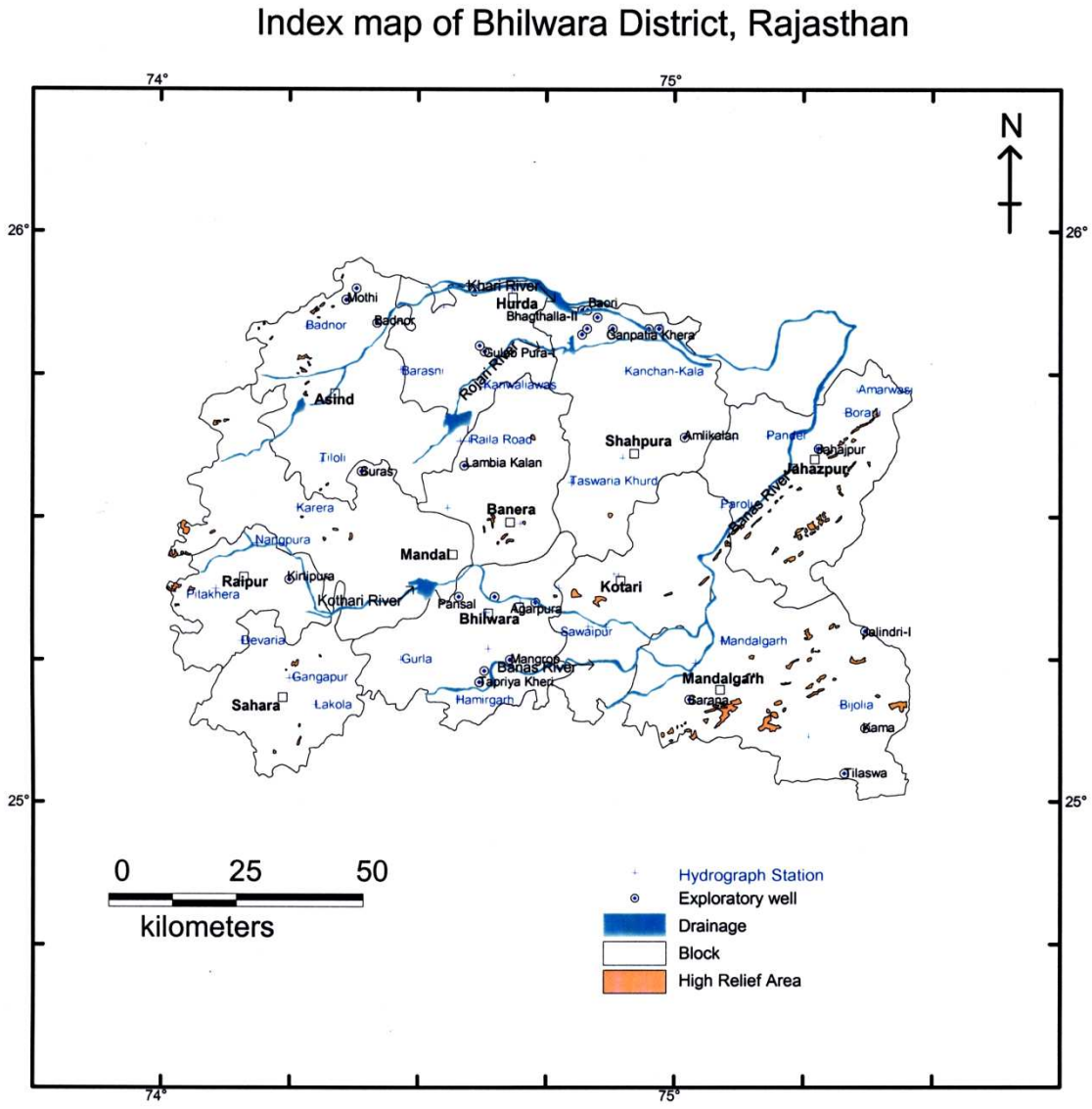

Fig. 1: Admnistrative Divisions

Details of various scientific studies carried out by Central Ground Water Board in Bhilwara district are given in Table 1.

Table -1: Studies undertaken by CGWB.

S. No.	Office/Officer	AAP	Type of Survey/Study
1	GSI	1962-64	Systematic Hydrogeological Survey
2	Dr. A.N. Lal	1978- 79	Systematic Hydrogeological Survey
3	Tariq Shafiq	1981-82	Systematic Hydrogeological Survey
4	CGWB	1981-84	Hydrogeological investigation along with Exploratory drilling for water supply to Rampura - Agucha mines of Hindustan Zinc Limited.
5	CGWB	1989	Hydrogeological investigation of Banas River.
6	Dr.S.C.Dhiman	1990	Hydrogeological Frame work and ground Water Development Potentialities of Bhilwara District.
7	CGWB	2000-01	Reappraisal hydroeological survey of entire District.
8	Dr. Rakesh Kushwaha	2010-11	Ground Water Development and Management Studies in parts of Bhilwara District

Under Ground Water Exploration Programme, 34 exploratory boreholes and 1 slim hole have been drilled. Salient features of ground water exploration in the district are given in Table 2. Since 1973, monitoring of water levels is being carried out four times a year from 42 National Hydrograph Network Stations.

Table- 2: Salient Features of Ground Water Exploration in Bhilwara district

S. No.	Location	Type of well	Year of cons.	Depth drilled (m)	Depth constr (m)	Zones tapped (mbgl) From	To	Formation Tapped	SWL (m)	Disc. (lpm)	DD (m)	Trans. m^2/day
1	Bhagthalla-I	EW	81-84	26.20	26.20	10 19	16 26	Allu	-	-	-	-
2	Bhagthalla-II	EW	81-84	13.00	12.75	19	26	Allu	5.65	250	2.44	845
3	Baori	EW	81-84	14.50	14.00	7	11	Allu	5.32	400	3.80	499
4	Sanoaria	EW	81-84	25.14	20.00	9	18	Allu	3.23	1001	1.36	2533
5	Shibji Ka Baag	EW	81-84	14.69	14.75	6	14	Allu	7.90	1372	1.43	2581
6	Ganpatia Khera	EW	81-84	13.00	13.00	7	12	Allu	3.89	554	0.70	3108
7	Phulia	EW	81-84	16.50	16.00	6	14	Allu	2.28	1872	2.24	1585
8	Rampura	EW	81-84	21.00	20.50	11	18	Allu	8.10	1142	1.21	2507
9	Jalindri-I	EW	98-99	14.00	14.00	Naked		Qzite	6.20	465	-	-
10	Jalindri-II	EW	98-99	58.00	58.00	Naked		Shale & Qzite	5.51	1223	6.79	230
11	Kama	EW	98-99	178.0	178.0	Naked		Sst & Shale	8.64	Negl.	-	-
12	Tilaswa	EW	98-99	124.0	124.0	Naked		Sst	4.16	1222	6.33	229
13	Sarana	EW	98-99	153.2	153.2	Naked		Qzite & Phyllite	4.14	660	23.87	50
14	V.S.P.N. Bhilwara	EW	98-99	132.0	132.0	Naked		Schist	10.95	484	26.55	15.61

S. No.	Location	Type of well	Year of cons.	Depth drilled (m)	Depth constr (m)	Zones tapped (mbgl) From	To	Formation Tapped	SWL (m)	Disc. (lpm)	DD (m)	Trans. m^2/day
15	Agarpura	EW	98-99	179.0	179.0	Naked		Schist Abolite	14.25	183	28.65	8.08
16	Pansal	EW	98-99	178.5	178.5	Naked		Schist	16.87	Dry	-	-
17	Suras	EW	98-99	178.5	178.5	Naked		Calc. Sil.	32.00	Negl.	-	-
18	Kirtipura	EW	98-99	172.3	172.3	Naked		-do-	2.15	200	19.12	-
19	Tapriya Khera	EW	98-99	174.0	174.0	Naked		Schist	5.55	60 PYT	50.44	-
20	Belia Kalan	EW	1999-2000	134.0	134.0	Naked		Schist gneiss	5.92	60 PYT	41.00	-
21	Gulab Pura-I	EW	2000-01	200.4	200.4	Naked		Gneiss	14.20	20 PYT	>40	-
22	Khari Kalamba	EW	-do-	117.5	117.5	Naked		Gneiss	4.99	315 PYT	41.16	-
23	Gulab Pura – II	EW	-do-	202.9	202.9	Naked		Gneiss	-	Dry	-	-
24	Lambia Kalan	EW	-do-	172.0	172.0	13 130 142	15 135 148	Gneiss	7.45	82 PYT	36.60	-
25	Mangrop	EW	-do-	200.85	200.85	20 189	25 195	Gneiss	14.05	65 PYT	27.40	-
26	Amarpura	EW	2001-02	65.60	65.60	Naked		Dlmite	17.93	830	6.35	-
27	Kanti I	EW	2001-02	25.90		Naked		Dlmite				-
28	Kanti II	EW	2001-02	187.60	187.60	Naked		Dlmite	23.00	meagre		-
29	Kheri	EW	2001-02	115.40	115.40	Naked		Schist	26.90	meagre		-
30	Pancha Ka Bara	EW	2001-02	41.20	41.20	Naked		Schist	12.94	20	13.96	-
31	Pander	EW	2001-02	163.20	163.20	Naked		Schist	11.00	50		-
32	Amalda	EW	2001-02	22.90		Naked		Qzite				-
33	Gadoli	EW	2001-02	196.70	196.70	Naked		Schist	2.49	220	34.37	-
34	Sarsiya	EW	2001-02	144.40	144.40	Naked		Schist	7.71	120		-
35	Dhanao	SH	81-84	13.64		-	-	Allu	-	-	-	-

Abbreviations used: Qzite – Quartzite, Dlmite – Dolomite, Allu – Alluvium, Abolite – Amphibolite, Calc. Sil. – Calc. Silicate, Sst - Sandstone

2.0 Rainfall and Climate

Mean annual rainfall (1971-2012) of the district is 635.1 mm whereas normal rainfall (1901-70) is lower than average rainfall and placed at 603.3. Almost 95% of the total annual rainfall is received during the southwest monsoon, which enters the district in the last week of June and withdraws in the middle of September. Probability of average annual rainfall exceeding 900 mm is only 10%. However, there is 90% probability that the average rainfall will be more than 400 mm. The probability of occurrence of mean annual rainfall is 45%. Drought analysis based on agriculture criteria indicates that the district is prone to mild and normal types of droughts. Occurrence of severe and very severe types of droughts is very rare. Average annual rainfall for last 10 years in the district is shown in Table 3.

January is the coldest month with mean maximum and minimum temperatures being lowest at 22.2^0C & 7.3^0C. Temperature in summer month of June reaches up to 46^0C. There is drop in temperature due to onset of monsoon and rises again in the month of September.

Atmosphere is generally dry except during the monsoon period. The humidity is highest in August with mean daily relative humidity at 80%. The annual

potential evapotranspiration in the district is 1495 mm and is the highest in the month of May (228 mm).

Table -3: Average annual rainfall for last 10 years.

YEAR	Bhilwara	Asind	Banera	Hurda	Jahajpur	Kotri	Mandal	Mandal-garh	Raipur	Sahada	Shahpura	Bijolia
2001	684.0	645.0	710.0	556.0	833.0	780.0	670.0	683.0	583.0	674.0	618.0	1012.0
2002	317.0	232.0	297.0	214.0	312.0	398.0	268.0	411.0	291.0	262.0	283.0	490.0
2003	493.5	321.0	448.0	624.0	720.0	512.0	535.0	914.0	506.0	574.0	575.0	796.0
2004	922.0	475.0	1179.0	548.0	852.0	1331.0	841.0	875.0	525.2	643.0	1044.0	1168.0
2005	450.0	531.0	505.0	461.0	550.0	521.0	390.0	594.0	712.5	767.0	556.0	602.0
2006	1120.0	451.0	953.0	740.0	873.0	674.0	902.0	904.0	937.0	763.0	681.0	1027.0
2007	492	463	460.00	581.0	753.0	598	439	885	373	564	593	474
2008	737	327	460	581	753	598	439	885	373	564	593	474
2011	730	568	681	676	1004	903	632	880	722	570	677	767
2012	630	462	616	450	543	640	671	638	726	557	575	650
Aver-age	**664.42**	**445.43**	**682.0**	**523.83**	**690**	**687.71**	**601.00**	**730.17**	**592.45**	**613.83**	**626.17**	**849.17**

3.0 Geomorphology, Drainage, Soil, Land Use & Irrigation Practices

Bhilwara district consists of fairly open plains in the north and southeast with a few hillocks and undulating plains & hills in the south and northeastern part. Occasional inselberg, low-lying hillocks and chains of ridges break the monotony of peneplained tract. The area of the district generally slopes gently except in western & northwestern part where slope is high. Geomorphological divisions of the district are given in Table -4.

Table -4: Geomorphic units in Bhilwara district

Origin	Landform Unit	Occurrence
Fluvial	Alluvial Plain	Along rivers- Khari, Masi, Banas, Kothari
	Valley Fill	Small scattered patches in east & west
	Ravine	Along Berach River in south
Denudational	Pediment	Scattered in entire district, mainly in east & west
	Buried Pediment	Almost entire district except in east, southeast & north
	Intermontane Valley	Scattered in east & southeast
Aeolian	Sandy Plain	North
Structural	Plateau	Southeast
Hills	Linear Ridges	Near Jahazpur town
	Structural Hill	In northwest & eastern part of the district and Bhilwara town

Bhilwara district falls in the Banas (9157.2 sq km), Chambal (1164.9 sq km) & Luni basins (133.0 sq km). Breakup of the basin area falling in various blocks is given in Table-5.

Table-5: Block wise area falling in Banas, Chambal and Luni basins

S No	Block	Area in sq km		
		Banas Basin	Chambal Basin	Luni Basin
1	Asind	1161.3	0	133.0
2	Banera	725.3	0	0
3	Suwana	674.8	0	0
4	Hurda	962.2	0	0
5	Jahazpur	779.8	468.8	0
6	Kotri	686.8	0	0
7	Mandal	1156.5	0	0
8	Mandalgarh	668.4	696.1	0
9	Raipur	533.5	0	0
10	Sahara	494.9	0	0
11	Shahpura	1313.6	0	0
Total		9157.1	1164.9	133.0

Major River of the district is Banas, which flows in northeast to easterly direction. It enters near village Doodiya in Bhilwara tehsil in the west flowing towards east and takes an abrupt turn towards north-northeastern direction near Bigod downstream of the confluence with Berach River and again takes an easterly turn near Kanti and finally flows towards northeast till it enters Tonk district. Total length of the Banas River is 142 km in Bhilwara district. Channel pattern of Banas is sinuous and changes to more or less straight between Bigod and Rajamahal indicating structural control on the drainage pattern. Important tributaries are Berach, Kothari, Unli, Mendi, Nakadi, Chandrabhaga and Khari River. All these are ephemeral.

3.1 Soils

Soils of the district are classified as follows:

Clay loam or medium black: This type of soil is found in the hilly areas in the central parts of the district.

Loam: This type of soil is found in the entire district.

Sand and sandy loam: This type of soil is found mostly near the banks of rivers and nallahs.

Loam pebbly & stony: These types of soils are met within the hilly areas of the eastern blocks of the district.

4.0 Ground Water Scenario

4.1 Hydrogeology

Major water bearing formations are gneiss and schist (Bhilwara Supergroup); gneiss, schist, phyllite, slate and limestone (Aravalli Supergroup); sandstone, shale and limestone (Vindhyan Supergroup) and alluvium. Ground water occurs under unconfined to semi-confined condition. Weathered zone below the water table acts as a good storage. The joints, fissures and other plains of structural weakness as well as their extent, size, opening and inter-connection control occurrence & movement of ground water. Hydrogeology of Bhilwara district is depicted in Fig.2.

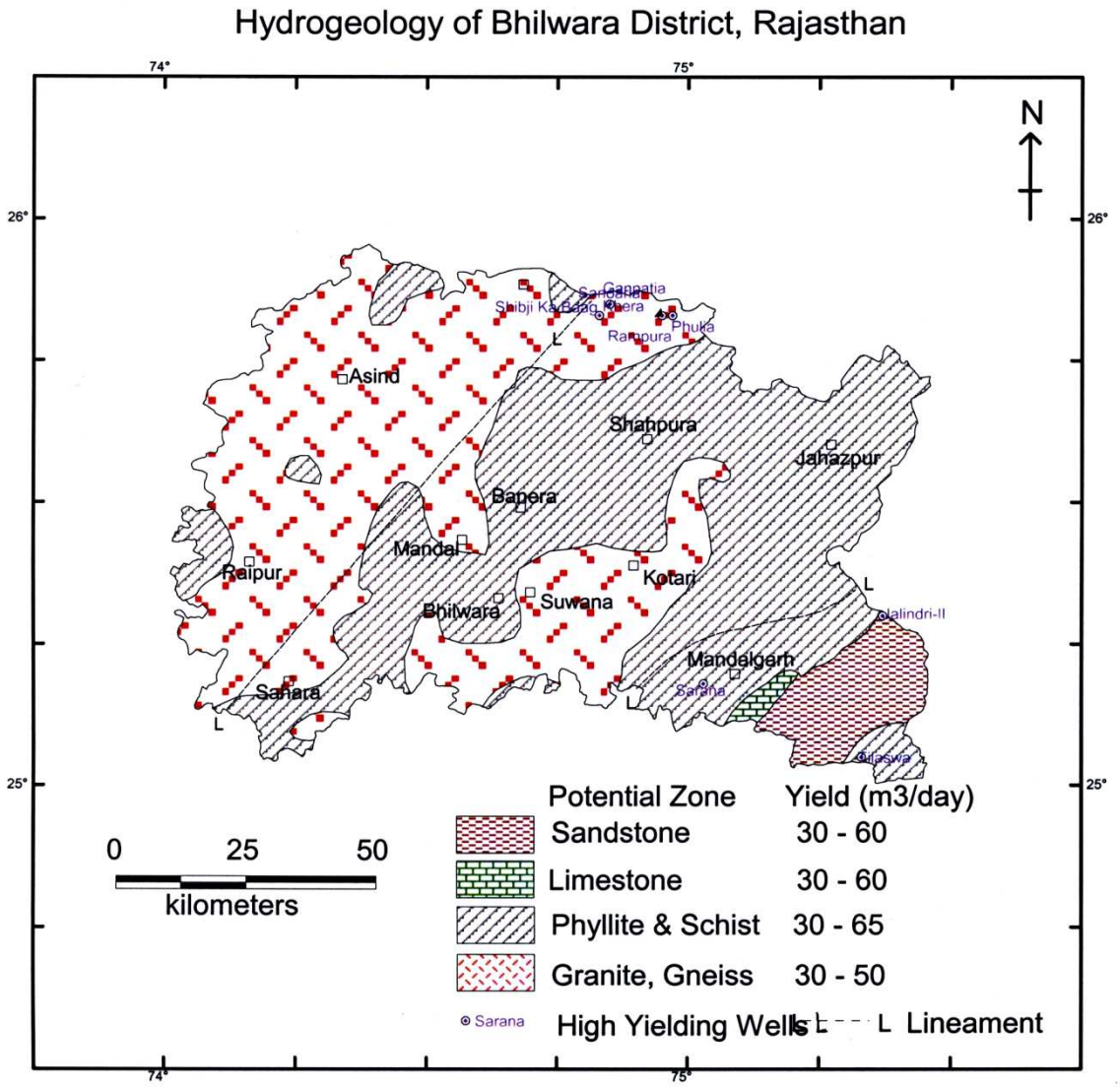

Fig. 2: Hydrogeology

Weathered gneiss forms upper part of the bedrock in central part. Weathered gneiss with schist occupy most of the northern part under thin cover of alluvium. In schists, phyllites and slates, weathered zone extends to depth greater than in granites and gneisses. Muscovite schist often grades into gneiss. These have well-developed foliation and irregular joints and are intruded by granite, pegmatite and quartz veins. The contact between these intrusives and schists provides good channel for ground water circulation. Dug

wells in Gangapur and Bhilwara area tapping gneiss and mica schist yield between 25 & 50 m^3/day. Joints are well developed in amphibolites and in some porphyritic granites. Dug wells tapping amphibolite yield more (average yield 30 m^3/day) as compared to wells in granitic gneiss.

Phyllites and schists are predominating in the eastern parts of the district near Shakargarh, Amalda and Kachola towards north of Great Boundary Fault. These formations are intercalated with dolomitic limestone, quartzite and basic intrusive. Depth of wells tapping these formations varies from 15 to 50 m. Yield of wells varies from 30 to 45 m^3/day.

Dolomitic limestone is grey to light brown and compact at the surface. It forms aquifer in intercalations with slates and phyllites around Bagota, Laxmipura, Rampura, Amargarh, Dolpura, Kishangarh, Bakli, Bhajgarh, west of Banakhera, Mal Ka Khera, northeast of Mohanpura, Ladpura and Ratiya Khera. Depth of wells ranges from 15 to 35 m with yield from 50 to 60 m^3/day.

Quartzites are generally intercalated with phyllites and slates. These are brown coloured, hard and jointed. Thickness of weathered and fractured zone ranges from 10 to 30 m. Depth of dug wells is generally more than 20m. Yield of dug wells varies from 15 to 25 m^3/day. Specific yield of schist/phyllite, gneiss, sandstone and limestone is 1.75%, 1.5%, 1.0% and 2.5% respectively. The transmissivity of aquifer tapping alluvium confined to Banas River varies from 499 to 3108 m^2/day whereas in hard rock areas in the district, it varies from 8.08 & 230 m^2/day

Sandstone and shale are confined to Mandalgarh block. Dug wells are 3 to 30 m deep and yield water between 40 & 50 m^3/day.

Quaternary alluvium is confined to narrow valleys along the river and stream courses. The alluvium is generally shallow but whenever saturated forms good aquifer. Yield of the wells in alluvium ranges from 75 to 100 m^3/day.

4.2 Depth to water level and water level fluctuations

Depth to water level as recorded in 42 NHS during 2011 ranges from 3.00 to 23.00 and 1.00 to 16.00mbgl during pre-monsoon and post monsoon respectively. Block wise depth to water level in the district during pre-monsoon as well as post-monsoon is given in Table 6.

During Pre-monsoon period, depth to water level in major part of the district varies from 10 to 20 mbgl. Depth to water level in the range of 20 to 40 mbgl has been observed in a few wells in Raipur, Mandal, Asind and Harda blocks

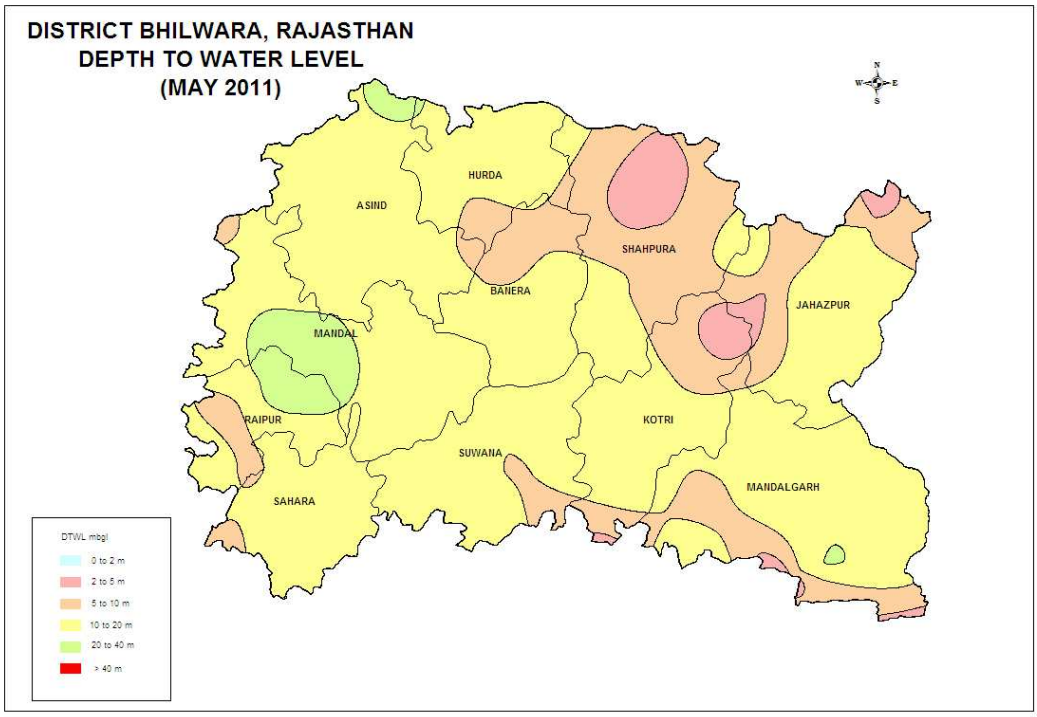

Fig. 3: Depth to Water Level (May 2011)

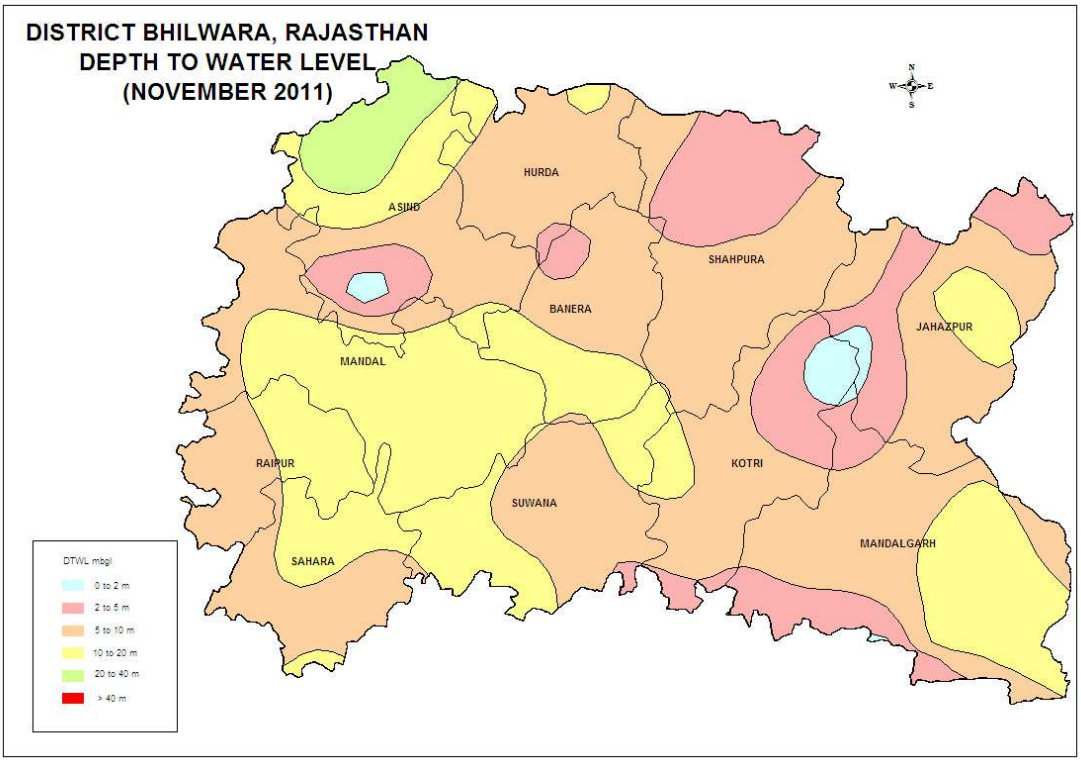

Fig.4: Depth to water Level (Nov. 2011)

During Post-monsoon (November, 2011), ground water level in major part of the district was registered in the range of 5 to 10 m. Water level in the range of 10-20 m was observed in northwestern, southwestern, central and eastern

parts of the district (Fig. 4). Water levels above 20 m have been recorded in part of Asind block. Shallower water levels upto 5 m have also been recorded in northern, western and southern parts of the district.

Table 6: Pre -monsoon water level (2011)

Pre-monsoon water level (2011)

Block	Depth to Water Level(m)		
	No. of wells	Minimum	Maximum
ASIND	4	10.35	27.30
BANERA	3	8.97	18.68
HURDA	2	10.88	15.15
JAHAZPUR	5	4.59	17.67
KOTRI	4	3.12	19.22
MANDAL	2	22.25	28.50
MANDALGARH	4	8.05	20.36
RAIPUR	3	9.06	23.08
SAHADA	2	15.40	17.88
SHAHPURA	3	3.25	12.70
SUWANA	2	9.00	18.49

Post-monsoon water level (2011)

Block	Depth to Water Level(m)		
	No. of wells	Minimum	Maximum
ASIND	5	1.05	27.68
BANERA	3	5.05	13.14
HURDA	2	8.77	10.31
JAHAZPUR	5	2.22	11.66
KOTRI	4	1.06	13.53
MANDAL	2	16.50	20.27
MANDALGARH	3	6.92	14.53
RAIPUR	2	7.44	13.98
SAHADA	2	7.00	11.48
SHAHPURA	3	2.12	9.78
SUWANA	2	5.10	12.39

Broadly, water table slopes follow drainage direction. Nature of Banas River is effluent. Water table elevation & gradient range from 360 to 260 meter above mean sea level (mamsl) & 2.5 to 3.02m/km respectively in the eastern part, Jahazpur block and northern part of Mandalgarh block. In the rest of Mandalgarh block water table elevation ranges from 540 to 340 mamsl.

Analysis of water level data of Pre- and Post-monsoon periods (May – November, 2011) shows that there has been rise in water levels in the district except central part of Shahpura block, where decline of 44 cm has been recorded (Table 7, Fig. 5). Rise in water level ranges from 1.13 m in Shahpura and Mandalgarh blocks to 9.69 in Kotri block.

Table-7: Seasonal water level fluctuation(2011)

Block	Rise			Fall	
	No. of wells	Minimum	Maximum	Minimum	Maximum
ASIND	4	2.64	9.30	-	-
BANERA	3	2.49	8.18	-	-
HURDA	2	2.11	4.84	-	-
JAHAZPUR	5	2.37	6.01	-	-
KOTRI	3	2.06	9.69	-	-
MANDAL	2	5.75	8.23	-	-
MANDALGARH	3	1.13	7.65	-	-
RAIPUR	2	1.62	9.10	-	-
SAHADA	2	6.40	8.40	-	-
SHAHPURA	3	1.13	3.84	0.44	0.44
SUWANA	2	4.80	6.10	-	-

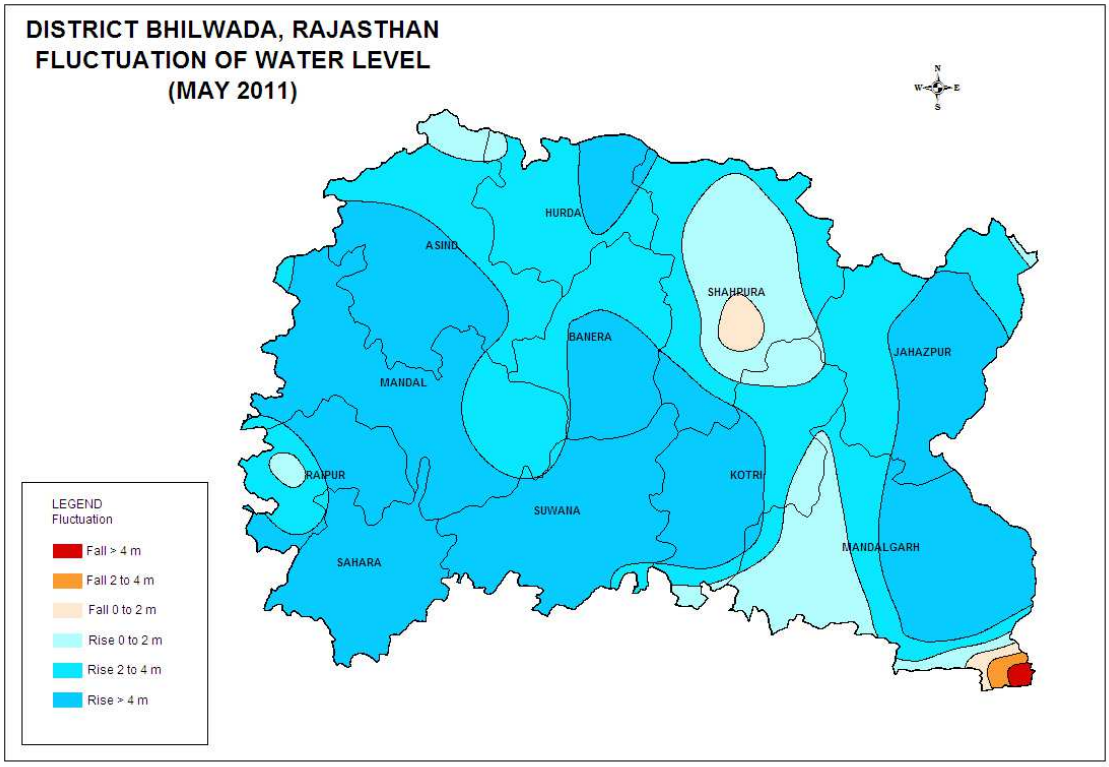

Fig 5: Seasonal fluctuation pre to post Monsoon, 2011

Analysis of long term Pre-monsoon (2002-2011) water level data indicates declining trend of upto 25cm/year in major parts of Asind, Shahpura, Mandal, Jahazpur and Mandalgarh and some parts of Hurda, Kotri, Suwana, Sahara and Raipur blocks. Remaining areas have registered rising trend of upto 25 cm/year. Pre monsoon decadal trend map is presented in Fig. 6.

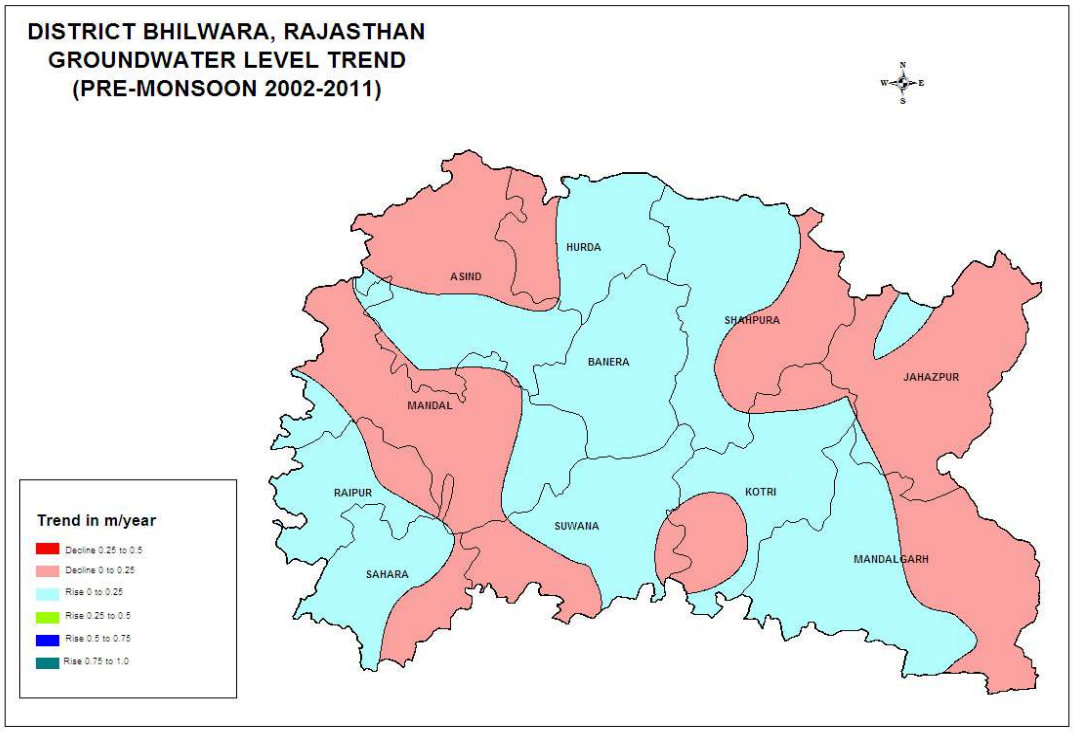

Fig. 6: Decadal premonsoon fluctuation (2002-2011)

4.3 Ground Water Resources

Ground water resources have been reassessed jointly by Central Ground water Board and Ground Water Department, Rajasthan as on 31.3.2009 based on Ground Water Estimation Committee (1997). Total annually replenishable ground water resource of the district has been assessed as 428.18 mcm and net annual ground water availability has been estimated as 386.59. Net annual ground water withdrawal for all uses has been estimated to be 524 mcm with stage of ground water development at 135.55%. All the blocks in the district are 'Over-exploited'. Block wise details of ground water resources and withdrawal are given in Table 8.

Table 8: Block wise details of Ground Water Recharge, Draft and Category.

Block	Type of Area	Annual Replenishable Ground Water Resource (mcm)	Net Annual Ground Water Availability (mcm)	Existing Gross Ground Water Draft for Irrigation (mcm)	Existing Gross G.W. Draft for Dom. & Ind. Use (mcm)	Existing Gross Ground Water Draft for all uses (mcm)	Stage of G.W. Develop-ment. (%)	Category
Asind	C and NC	**33.606**	**30.245**	**47.886**	**2.6882**	**50.5742**	**167.21**	OE
Banera	C and NC	**31.9545**	**28.843**	**36.076**	**2.2733**	**38.3489**	**132.96**	OE
Hurda	C and NC	**21.8926**	**19.703**	**23.371**	**1.9872**	**25.3584**	**128.70**	OE
Jahazpur	C and NC	**46.58442**	**41.926**	**59.886**	**2.1353**	**62.0213**	**147.93**	OE
Kotri	C and NC	**43.2048**	**39.4453**	**45.7824**	**1.3374**	**47.1198**	**119.46**	OE
Mandal	C and NC	**44.61**	**40.149**	**40.61**	**3.5348**	**44.1452**	**109.95**	OE

Block	Type of Area	Annual Replenishable Ground Water Resource (mcm)	Net Annual Ground Water Availability (mcm)	Existing Gross Ground Water Draft for Irrigation (mcm)	Existing Gross G.W. Draft for Dom. & Ind. Use (mcm)	Existing Gross Ground Water Draft for all uses (mcm)	Stage of G.W. Develop-ment. (%)	Category
Mandalgarh	C and NC	**69.0157**	**62.1141**	**86.484**	**4.0357**	**90.5197**	**145.73**	OE
Raipur	C and NC	**21.505**	**19.354**	**30.745**	**1.7666**	**32.5118**	**167.98**	OE
Sahada	C and NC	**21.6204**	**19.529**	**146.98**	**1.9079**	**26.8367**	**137.42**	OE
Shahpura	C and NC	**48.9306**	**44.5497**	**44.4405**	**2.2608**	**46.7013**	**104.83**	OE
Suwana	C and NC	**45.256**	**40.7304**	**55.8765**	**3.99021**	**59.86671**	**24.929**	OE
TOTAL OF DISTRICT		**428.1800**	**386.59**	**496.09**	**27.9174**	**524.00**	**135.55**	**OE**

4.4 Ground Water Quality

In the district, 33 water samples were collected during May 2011. The classification of ground water samples was carried out based on the desirable and maximum permissible limits for the parameters viz., TDS, TH, Ca, Mg, Cl, SO_4 and NO_3 prescribed in the standards and is given in table 9.

Table 9--Classification of Ground Water Samples based on BIS Drinking Water Standards (IS-10500-91, Revised 2003)

Parameters	DL	MPL	Samples with conc. < DL	Samples with conc. in DL-MPL	Samples with conc. >MPL
TDS	500	2000	0	22	11
Chloride	250	1000	13	15	5
Sulphate	200	400 (if Mg does not exceed 30ppm)	18	10	5
Nitrate	45	-	18	15	
Fluoride	1	1.5	12	7	14
Calcium	75	200	19	13	1
Magnesium	30	100	13	15	5
Iron	0.3	1.0	18	13	2
TH	300	>600	12	12	9

(Here, DL- Desirable Limit, MPL- Maximum Permissible Limit)

In greater part of the district covering mainly the southern & eastern part, ground water quality in shallow aquifer is fresh with electrical conductance less than 2000 mmhos/cm at 25^0C (Fig. 7). Ground water of high electrical conductance occurs in small isolated patches. In the northern parts, i.e. parts of Hurda, Shahpura, Asind and Jahajpur blocks and part of Mandal block, groundwater is comparatively more saline with electrical conductivity 2000 to 3000 mmhos/cm at 25^0C or higher. Variation in conductivity is confirmed by presence of chloride. Electrical conductivity at small patches of Suwana, Jahajpur, Asind and Shahpura blocks has been recorded more than 10000 µS/cm at 25^0 C. Borewells drilled at Vijay Singh Pathik Nagar (Bhilwara City), Gulabpura and Mangrop show EC values 5640, 5430 & 36280 µS/cm at 25^0 C respectively. Groundwater is brackish (more than 3000 to 18030) at Bhilwara – Ajmer border along the Khari River. High conductivity in groundwater makes the area unfit for non-salt tolerance crops. Salt tolerant crops are suggested in these areas.

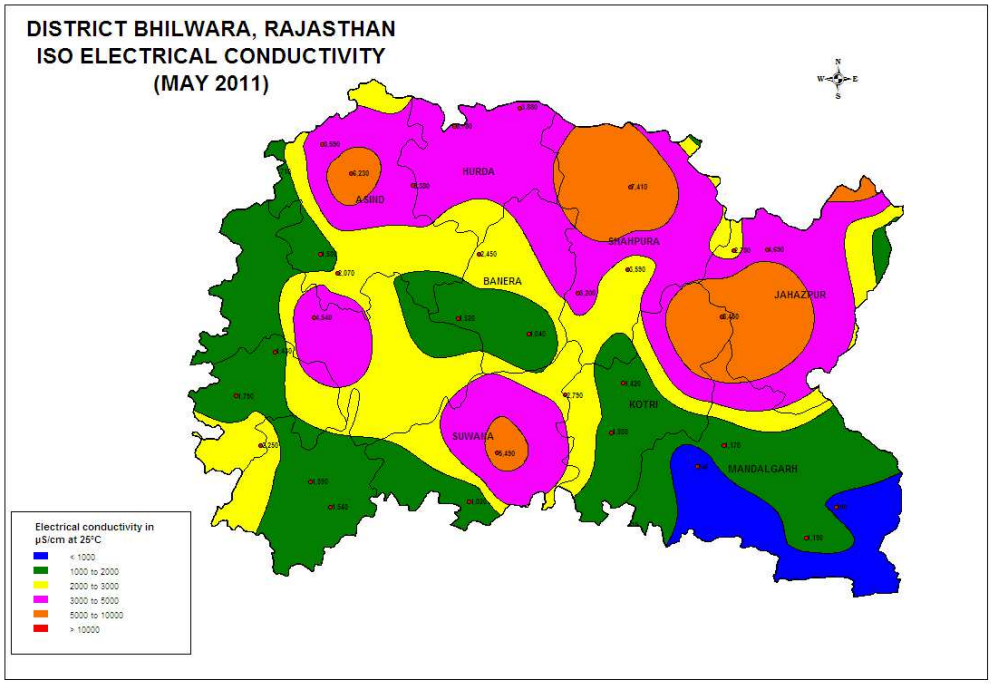

Fig 7: Distribution of Electrical Conductivity

Fluoride concentration in groundwater exceeding permissible limit (1.5 mg/l) has been reported from Hurda, Asind, Shahpura and Suwana blocks. Iso Fluoride Map of Bhilawara district is presented in Fig. 8.

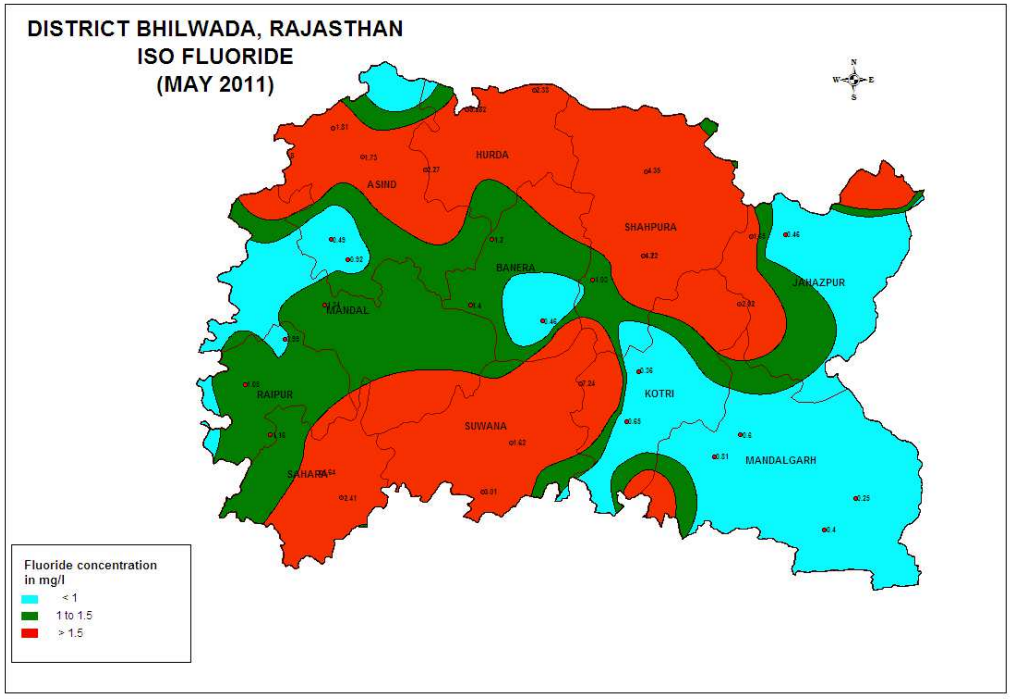

Fig. 8: Distribution of Fluoride.

Nitrate distribution in the district varies from 2 to 200 mg/l. Out of 29 samples collected during premonsoon 2012, 17 sample(60%) had nitrate within permissible limit (<45 mg/l). Higher values of nitrate were observed in Mandal, Kotri, Banera and Asind blocks. Distribution of Nitrate in the district is shown in Fig. 9.

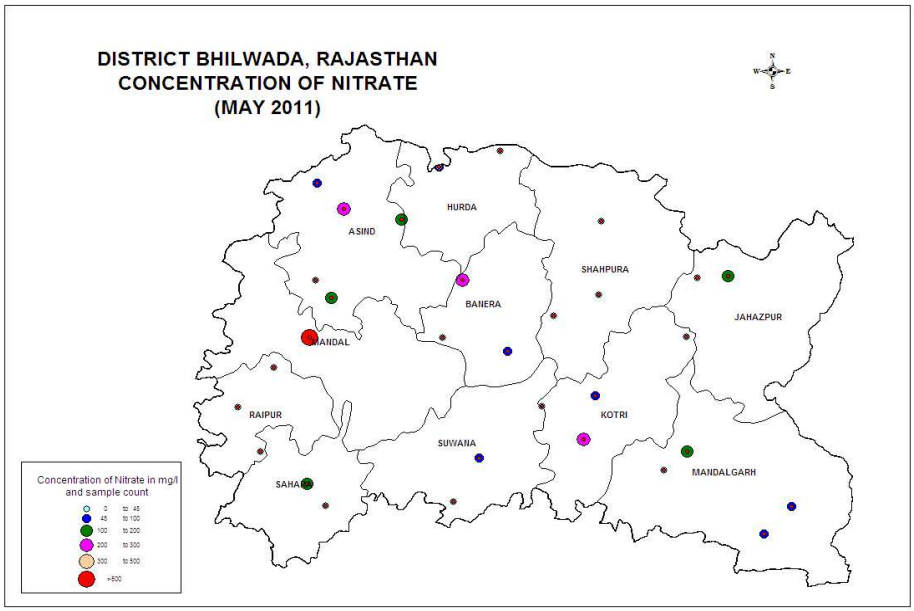

Fig. 9: Distribution of Nitrate

Iron content in ground water in the district varies from 0.3 to 6.9 mg/l. Iron concentration in 50% parts of district has been found to be less than the desirable limit of 0.3 mg/l. Around 40% area of district has been found to be

contain iron content in ground water within the permissible limit of 0.3 - 1 mg/l. Iron distribution in ground water is shown in Fig.10.

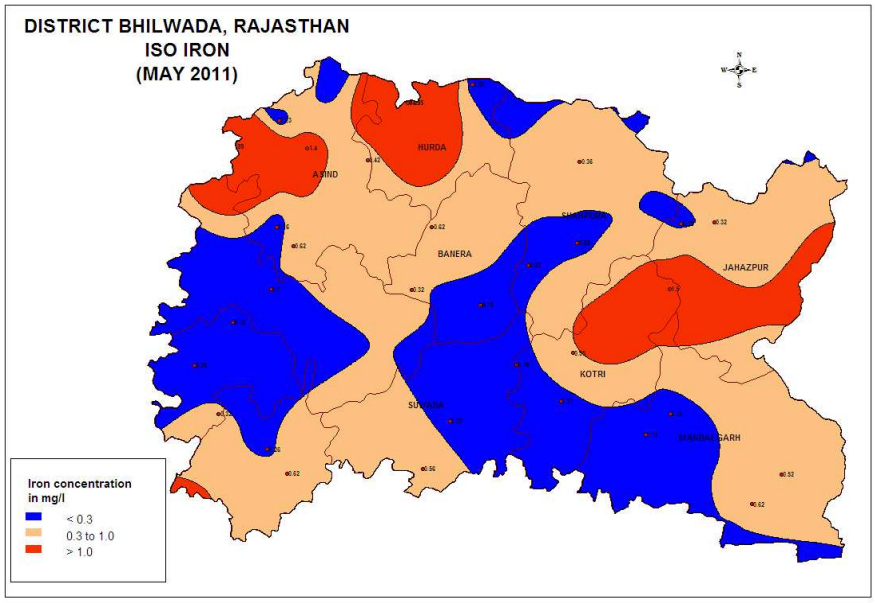

Fig.10: Distribution of Iron

5.0 Status of Ground Water Development

Ground water development in the district is being done by dug wells, bore wells and dug cum bore wells. Dug wells with horizontal boring are also common. Diameter of dug well varies from 1 m to 6 m with depth ranging from 3 m to 40 m.

Gneiss, schist, phyllite, slate, dolomitic limestone, sandstone, shale and alluvium form the aquifers in different parts of the district. Alluvial area is restricted to riverbeds. Ground water occurs under unconfined to semi-confined conditions. Depth and diameter of the dug wells and bore wells depend on formation and geomorphology. However, general depth of dug well and bore wells ranges from 10 to 30m and 150m respectively except in alluvial aquifer where depth of dug well ranges from 15 to 20 m. Details of groundwater abstraction structures are furnished in Table 10.

Table-10 : Details of groundwater abstraction structures in Bhilwara

Formation	Yield of Dug well (m^3/day)	Discharge of Bore well (lpm)	Depth (m)		Diameter		Type of pump/Water lifting devices
			Dug well	Bore well	Dug well (m)	Bore well (mm)	
Alluvium (Tube well)	45-55	250-1500	20-25	15-20	4-5	200	Submersible /Centrifugal pump/ Bullock
Granite Gneiss	30-40	60-100	40-55	150-175	4-5	200	
Phyllite/ Schist	30-45	20-450	15-50	150	4-5	200	

Dolomitic Limestone	50-60	20-500	15-25	150	4-5	200	
Quartzite	15-25	20-600	10-30	150	4-5	200	
Sandstone Shale	40-50	20-500	3-30	150	4-5	200	

5.1 Ground Water Management Strategy

Ground Water Development

Stage of ground water development in the district is 135.55%, which indicates that the scope of ground water development is already exhausted. All the blocks are "Over-exploited". Most of the boreholes have been drilled in the northern part of district falling in Shahpura, Hurda, Asind blocks and southern part in Suwana block. There is no scope for further development in the district for irrigation or industrial use. However, exploratory drilling can be taken up in unexplored area for estimation of aquifer parameters.

5.2 Water Conservation and Artificial Recharge

In view of over development, further exploitation of precious resource needs to be checked. For sustainable development of ground water, artificial recharge measures need to be adopted to augment ground water and surface water resources. M/s Hindustan Zinc Limited (HZL) has constructed collector well in Banas River, in the downstream side of Ghewaria mines, which is being recharged after dewatering of soapstone mine at Ghewaria, whenever the dewatering stops, discharge of collector well reduces drastically. Exploratory drilling results have shown potential zone having inferior quality water, which can be blended with fresh water for irrigation use.

Artificial recharge is the only solution to augment ground water through construction of bunds, anicuts, and rooftop harvesting structures. The area has undergone polyphase deformation in geological past, which has resulted in a complex structure (folded, faulted and jointed) that may not be conducive for such structures. Therefore, site of these structures should be selected carefully.

Watershed Development & Soil Conservation Department has constructed permanent (masonry) check dams under Irrigated Watershed Development Project to harvest rainwater, reduce soil erosion and check runoff velocity. In the district 285 check dams covering an area of 108962 ha have been constructed.

Impact assessment of check dams has revealed increase in water level, cropping area, cropping intensity, crop production and labor employment in the project area. Erosion from nallah bank has minimized. Cropping pattern and cropping intensity have changed. Harvested water provides supplementary irrigation during long dry spell. In view of the above, such artificial recharge programmes may be taken up in the district to ensure availability of water on sustainable basis to enhance agricultural production.

6.0 Ground Water Related Issues and Problems

Almost entire district is facing problem of ground water scarcity. Over the greater part of the district occupied by hard rock formation, the well yields are very poor. As such the depth of weathered zone is generally restricted up to 30m, which control the occurrence and movement of groundwater. Deep-seated fractures below 100m are very rare. This causes reduction in the well yield drastically during the summers creating acute water shortage of domestic water supply. However, in selective areas located on structurally weak planes connected to some recharge source, wells continue to yield moderate quantity of water. Deeper levels are either devoid of water or of poor quality of ground water (brackish to saline). Alluvium occurs at limited places along the major drainage/ valley fills but has very shallow thickness. The well yield varies considerably year to year in different parts of the district and over the season. Thus the availability of surface as well as ground water is very scarce in low rainfall years & especially in summer months.

7.0 Recommendations

- Ground water draft is very high in almost all the blocks. Exploitation of ground water has to be controlled by preventing further development.
- Revival of traditional ground water storage system i.e. *Baori*, open wells, *Tanka* etc. for rainwater conservation for use in day to day life will reduce ground water draft.
- There are 352 textile related industries located in Bhilwara and Gulabpura town. These industries consume huge quantity of water resulting in drinking water problem. Effluent is left untreated and allowed to mingle with ground water. Regular monitoring is required and check on disposal of untreated wastes can prevent ground water from getting polluted.
- Awareness programmes and training on rainwater harvesting will be beneficial to check the decline in water level and justified use.
- Taking advantage of uneven topography of the area, small check dams or earthen dams, upstream of irrigation commands, at suitable sites, may be constructed to store rainwater. This will increase recharge to ground water which would ultimately result in increase of yield of wells.
- An area of 794.18 sq km is occupied by forest. To protect the area from environmental degradation, extensive programme of afforestation and soil conservation measures needs to be taken up.
- Modern agricultural management techniques have to be adopted for effective and optimum utilization of the water resources. Maintaining irrigation through minimum pumping hours as per minimum requirement of water by the crop and also selecting most suitable cost effective cropping pattern can help in water conservation.
- Alluvial tracts along river channels of Banas, Kothari, Khari, Manusi and Chandrabhaga are most feasible locations where shallow wells can be constructed to harness the shallow water table aquifers being

potentially recharged by the flash flood and surface runoff. These wells can be used for water supply, wherever feasible.

- Surface runoff can be harnessed by constructing tanks at feasible sites in the area occupied by the hard rock terrain for supplementing irrigation potential to increase the agricultural production.
- High water requirement crops are discouraged. Proper agriculture extension services should be provided to the farmers so that they can go for alternate low water requirement economical crops.