GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

GROUNDWATER SCENARIO

SIROHI DISTRICT
RAJASTHAN

Paintings of Sirohi

Western Region

Jaipur

2013

DISTRICT AT A GLANCE – SIROHI, RAJASTHAN

S. No.	Item			Statistics		
1	GENERAL INFORMATION					
	Geographical area (sq km)			5162.17		
	Administrative Division					
	Number of Tehsils			05		
	Number of Blocks(Panchayat Samiti)			05		
	Number of Villages			467		
	Population (As per 2011 Provisional Census)			1036346		
	Urban	Rural	%Decadal growth(Total)	208654	827692	21.86%
	Average Annual Rainfall (1991-2011) in mm			760.09		
2	GEOMORPHOLOGY					
	Major Physiographic Units			Pediment, Buried pediment, alluvial plain, Eolian plain		
	Major Drainage			Luni, West Banas, Jawai,Sukli Bandi, Sagi, Krishanavati, Khari, Kapalganga.		
3	LAND USE (Hect.)As on 2010-11, (Source: Dte. of Economics & Statistics, Ministry of Agriculture,GOI)					
	Forest Area			155467		
	Net Sown Area			167928		
	Not available for cultivation			100106		
	Other uncultivated land excluding fallow land			43173		
	Fallow land			51273		
	Cultivable Area			240555		
	Area sown more than once			72627		
4	MAJOR SOIL TYPE			Loam, sandy clay, saline soil & Kankars		
5	AREA UNDER PRINCIPAL CROPS (As on 2010-11)	Crops		Area in ha	Crops	Area in ha
	(Source: Dte. of Economics & Statistics, Ministry of Agriculture, GOI)	Maize		28948	Other cereals & millets	3278

S. No.	Item		Statistics		
		Pulses	17690	Condiments & spices	7281
		Wheat	39045	Oil seeds	87860
		Jowar	5622	Fruits and vegetables	2186
		Bajra	24198	Fibres	853
		Barley	1203		
6	IRRIGATION BY DIFFERENT SOURCES, As on 2010-11 (Source: Dte. of Economics & Statistics, Ministry of Agriculture, GOI)				
	Source		Area in ha		
	Other wells		71123		
	Tube wells/Bore wells		4816		
	Tanks/Ponds		4801		
	Canals		1258		
	Net Irrigated Area (ha)		81998		
	Gross irrigated area (ha)		105068		
7	NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on November 2012)				
	Number of Dug wells		12		
	Number of Piezometers		04		
8	PREDOMINANT GEOLOGICAL FORMATIONS		Malani Rhyolite, Erinpura/ Sendra/Ambaji granite and gneisses. Kumbhalgarh,Sirohi and Sindreth group of Delhi Super group		
9	HYDROGEOLOGY				
	Major Water bearing formation		Alluvium,Granite,Gneiss, Rhyolite and Metasediments.		
	Depth to water level (Pre-monsoon, 2011) (mbgl)		4.13 (Ambeshwarji) to 34.10 (Posaliya)		
	Depth to water level mbgl(Post-monsoon, 2012)		0.55(Pindwara)-20.97(Barloot)		
	Long term rise/decline water level trend (2001-2011) in m/yr		+1.61 to -0.27		
10	GROUNDWATER EXPLORATION BY CGWB (As on 31.3.2012)				
	Number of wells drilled (EW, OW, Pz Total)		EW-21 OW-01,Pz-01 Total-23		

S. No.	Item	Statistics
	Depth Range (m)	93-173
	Discharge (liter per minute)	Meagre -2000
11	GROUND WATER QUALITY	
	Presence of chemical constituents more than permissible limit (EC in µS/cm at 25^0 C, F in mg/l, Nitrate in mg/l)	EC:-420-4620 F :-0.25 - 4.00 Nitrate:– 20 – 400.
12	DYNAMIC GROUND WATER RESOURCES (March, 2009) in MCM	
	Annually Replenishable Ground Water Resources	300.9981
	Net Annual Ground Water Resources Availability	274.2240
	Net Annual Ground Water Draft	299.9916
	Net G.W. Availability for future Irrigation Development.	12.3924
	Stage of Ground Water Development	109.40%
13	Awareness and training Activity (Water Management Training Programme)	08.03.2006 Place: Sirohi
14	Groundwater control and Regulation	No. of OE blocks:02 No. of block notified: Nil
15	MAJOR GROUND WATER PROBLEMS AND ISSUES	Low Yield of Wells, Quality problems and declining water levels at some places

Ground Water Information
Sirohi District
Contents

1.0 Introduction 1
2.0 Rainfall & Climate 3
3.0 Geomorphology & Drainage 3
3.1 Drainage 3
4.0 Soils & Irrigation Practices 3
4.1 Irrigation 4
5.0 Ground Water Scenario 4
5.1 Geological Framework 4
5.2 Hydrogeological Condition 4
5.3 Depth to Water Level 6
5.4 Water Level Fluctuation 7
6.0 Ground Water Quality 9
6.1 Water Quality in Shallow Aquifer 9
6.2 Water quality in Deep Aquifer 12
7.0 Ground Water Resources 12
8.0 Status of Ground Water Development 13
9.0 Awareness & Training Activity 13
10.0 Ground Water Related Issues & Problems 14
11.0 Ground Water Development Strategy 14
11.1 Ground Water Development 14
11.2 Ground Water Management 15
12.0 Recommendations 16

List of Figures

1. Index map of Sirohi district
2. Hydrogeological map of Sirohi district
3. Depth to Water Level Map (May, 2011)
4. Depth to Water Level Map (November, 2011)
5. Seasonal Water Level Fluctuation Map (May-November, 2011)
6. Decadal Premonsoon Water Level Trend Map (May, 2002- May,2011)
7. Iso Electrical Conductivity Map of Sirohi district (May, 2011)
8. Iso Fluoride Map of Sirohi district (May, 2011)
9. Nitrate Distribution Map of Sirohi district (May, 2011)
10. Iso-Iron Map of Sirohi district (May, 2011)
11. Net Annual Ground Water Availability Vs Draft for all uses

List of Tables

1. Studies undertaken by CGWB
2. Salient features of Ground Water Exploration
3. Tehsil wise distribution of basin area in Sirohi district.
4. Area irrigated by different sources in Sirohi district.
5. Pre & Post-monsoon water level fluctuation (2011)
6. Long term Pre-monsoon water level fluctuation (2002-2011)
7. Ranges of various chemical constituents in ground water in Sirohi district
8. Block wise ground water resources of Sirohi district
9. Recommendations for future ground water development in Sirohi district.

GROUND WATER SCENARIO
DISTRICT -SIROHI, RAJASTHAN

1.0 Introduction

Sirohi district is located between 24° 15' and 25° 17' latitude and 72°16' and 73°11' longitude covering an area of 5136 sq.km. The district, named after Sirohi town, is a part of Jodhpur Division and is divided into three sub-divisions namely Sirohi, Reodar and Mt.Abu. Administratively, the district is divided into five tehsils and five development blocks. As of 2011, it is the third least populous district of Rajasthan after Jaisalmer and Pratapgarh. Total population of the district is 1036346 and Rural and Urban population of the district is 827692 and 208654 respectively. Total number of villages in the district is 467 and it also has 05 urban towns. Index map of Sirohi district is given in Fig. 1.

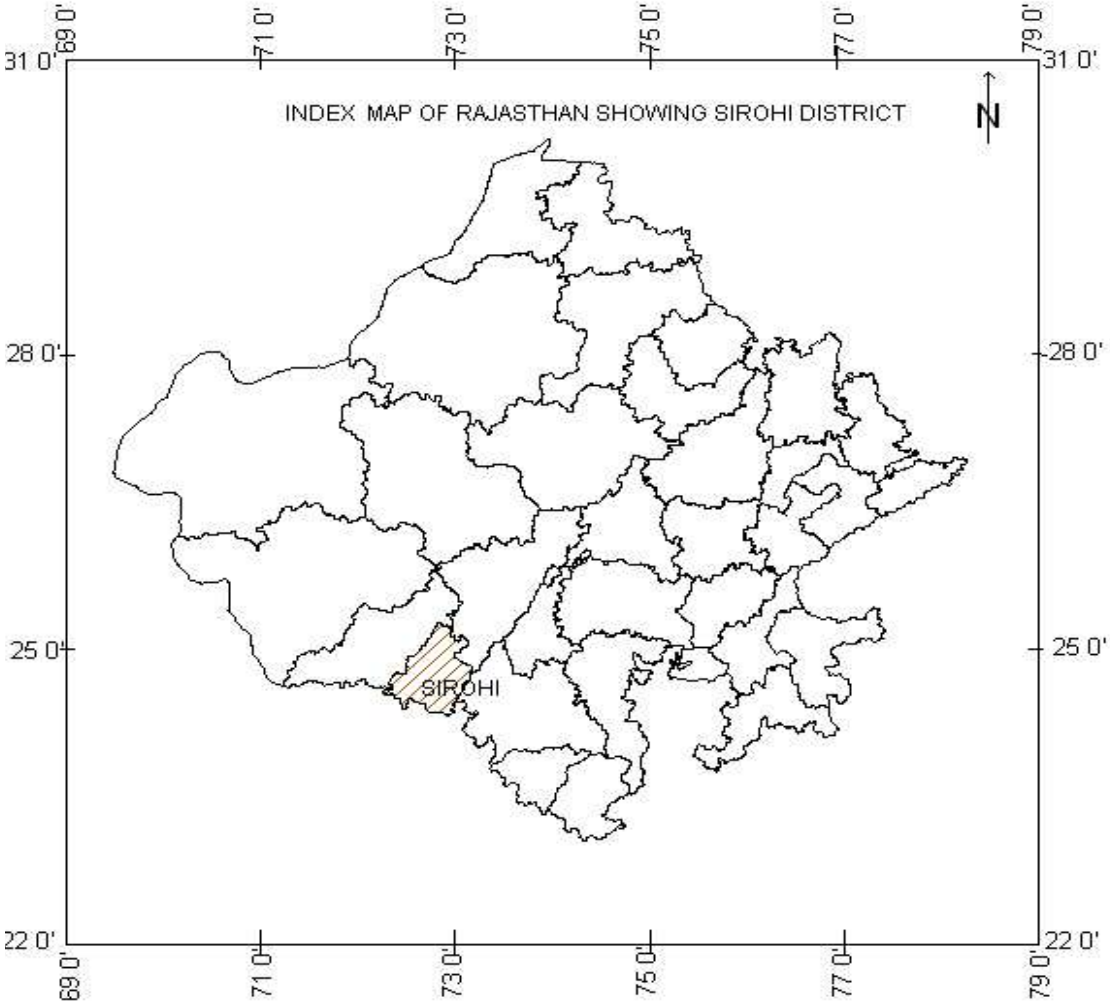

Fig. 1: Index map of Sirohi district

Geological Survey of India had first carried out investigations regarding occurrence of fluoride in well water and water supply to the villages affected by fluorosis in Sheoganj Tehsil between 1969-70 and 1970-71. Systematic hydrogeological surveys in the district were initially carried out by the Geological Survey of India during 1969-70 and 1971-72. The Systematic surveys were continued by Central Ground Water Board after its establishment in 1972. Various scientific studies carried out by Central Ground Water Board are listed in Table 1.

Table 1: Studies undertaken by CGWB.

S. No.	Officer	AAP	Type of Survey/Study
1.	B.P. Verma	1976-77	Systematic Hydrogeological Investigation in tribal areas of Abu Road tehsil, Sirohi district.
2.	Bhatia, A.K. & Subhash Datta	1979	Reappraisal Study of Ground Water Resources of a part of Jawai Basin, Barmer, Jalore and Sirohi Districts of Rajasthan (Manuscript report of CGWB)
3.	N.H. Reddy	1980-81	Systematic Hydrogeological Survey in parts of Sirohi and Pali districts
4.	Khan, Dr. M. N.	2000	Reappraisal Hydrogeological Survey in parts of Jawai sub basin of Luni River Catchment. (in parts of Jalore and Sirohi District) (Un-published report)
5.	Sujeet Kumar	2007	Groundwater Development and Management Studies in Sirohi district & parts of Udaipur district (Rajasthan) with special reference to recharge studies.

Besides the above scientific activities, report on ground water resources and development potential of the district has been brought out in the years 1983 and 1991. Ground water regime in the district is monitored through a network of 20 observation wells. Ground water exploration has been carried out to decipher aquifer geometry and ascertain potentiality and water quality parameters. A total of 20 EW, 1 OW, and 1 piezometer have been constructed so far. Salient features of ground water exploration in Sirohi district are given in Table 2.

Table 2: Salient Features of Ground Water Exploration

Type of well	No.	Depth drilled (m)	SWL (m)	T (m^2/day)	Discharge (lpm)	EC (µS/cm) at 25°C
EW	20	93.1 – 173	0.55-18.6	295	36-2000	245-3965
OW	1	112	6.7		1000	
PZ	1	150	9.87		30	2340

2.0 Rainfall & Climate

Average annual rainfall (1991-2011) of the district is 760.02 mm. However, normal rainfall for the period 1901 to 1970 is 606.3mm. The annual rainfall gradually decreases from southern part to northern part. The maximum average rainfall is 1488.6mm at Mt.Abu and minimum average rainfall is 542.2 mm at Sheoganj.

The district experiences either mild or normal drought once in two years. Severe type of droughts have been recorded very rarely. The most severe type of drought had occurred in the district at Pindwara (2000) and Reodar (1987).

3.0 Geomorphology & Drainage

The district is characterized by undulating topography. A large part of the district is vast semi-desert plain marked by isolated hillocks and chain of hills forming eastern fringe of Thar Desert. Abu-Sirohi range divides the district into two parts. Mt. Abu is situated at about 1219 m amsl and is an irregular plateau which is surrounded by several projecting peaks and ridges. Gurusikhar is the highest peak in Aravalli range touching 1722 m amsl.

3.1 Drainage

Sirohi district falls in parts of Luni (41.2 %),W. Banas (35.5 %), Sukli (18.7%), Other nallah(3.2%) and Sabarmati(1.3%)basins. Tehsil wise distribution of basin area is given below in Table 3.

Table 3: Tehsil wise distribution of basin area in Sirohi district

S.No	Name of Tehsil	Area in Sq. Km.				
		Luni	West Banas	Sukli	Sabarmati	Other nallah
1	Sirohi	910.9	141.6	63.8	-	-
2	Pindwara	45.5	781.3	-	-	163
3	Reodar	31.3	223.5	88.3	-	-
4	Abu Road	0.4	647.4	-	-	-
5	Sheoganj	1094.4	1.7	-	-	-

The drainage system is well developed in the district. Jawai is the main river of north-west part. This river eventually meets Luni river. West Banas is the most important river. Other rivers which flow in the district are Khari, Sukli, Bandi, Kapalganga and Krishnavati. There are no natural lakes in the district. Artificial Lake named Nakki lake in Mt.Abu is picturesque and has become place of pride.

4.0 Soils & Irrigation Practices

The soils of the district fall under the following broad categories:

Mattiyar (Stiff Clay):- Black coloured soil found in Pindwara and parts of Sheoganj blocks. This soil is more suitable for growing Wheat, Barley and Cotton.

Gorat or Bhuri (Sandy):- Light brown coloured soil found in Reodar, some parts of Sirohi and Sheoganj tehsils. It is fertile and suitable for growing Bajra.

Reti(sand):- It occurs in river beds and is suitable for growing Tomatoes and watermelon.

Kankari (hard and stony mixed with sand):- It occurs around the base of the hills.

Khari(saline soil):- Unsuitable for crops occurring in western parts of the district.

4.1 Irrigation

The principal means of irrigation in the district are wells/tube wells, though some areas are irrigated by canals, etc. Groundwater is the main source of irrigation and is utilized through dug wells, DCB's, and tube wells. Canal irrigates only a small area. Important irrigation projects are West Banas, Sukli Selwar, Angore, Kameri, Swaroopsagar, Kailashnagar, Mandar Nallah etc. Details of the area irrigated by different sources are furnished in Table 4.

Table 4: Irrigated area by different sources (Area in Ha)

S. No.	Net irrigated Area				Gross irrigated Area			
	Tube wells	Tanks	Canals	Others	Tube wells	Tanks	Canal	Others
1	4816	4801	1258	71123	5858	4801	1305	93104
TOTAL	**81998**				**105068**			

5.0 Ground Water Scenario

5.1 Geological Framework

Geological formations exposed in the district range in age from Proterozoic to Recent. Oldest rock are Calc. Schist, and Calc. Gneiss belonging to Kumbhalgarh group of Delhi Super Group of Proterozoic age, while the youngest formation is Alluvium belonging to Quaternary age. Rocks of Delhi Supergroup are exposed in the southeastern and central parts of the district. Post Delhi intrusives include Erinpura, Sendra and Ambaji granite/ granitic gneiss, which are exposed in the northeastern, southwestern and southeastern parts of the district. Malani rhyolites are exposed in the southern and northern parts of the district around Abu Road and Sheoganj blocks. Northwestern and southwestern parts of the district are covered by unconsolidated sediments comprising of alluvium and windblown sand.

5.2 Hydrogeological Condition

Hydrogeological map of the district is presented in Fig. 2. Ground water occurs under water table conditions both in unconsolidated and consolidated formations. Its occurrence is controlled by topography, physiography and structural features of the geological formations. The movement of ground water in hard rock areas is governed by size, openness, interconnection and continuity of structurally weak planes while in unconsolidated rocks, ground water movement takes place through pore spaces between grains. Water bearing properties of different aquifers are described below.

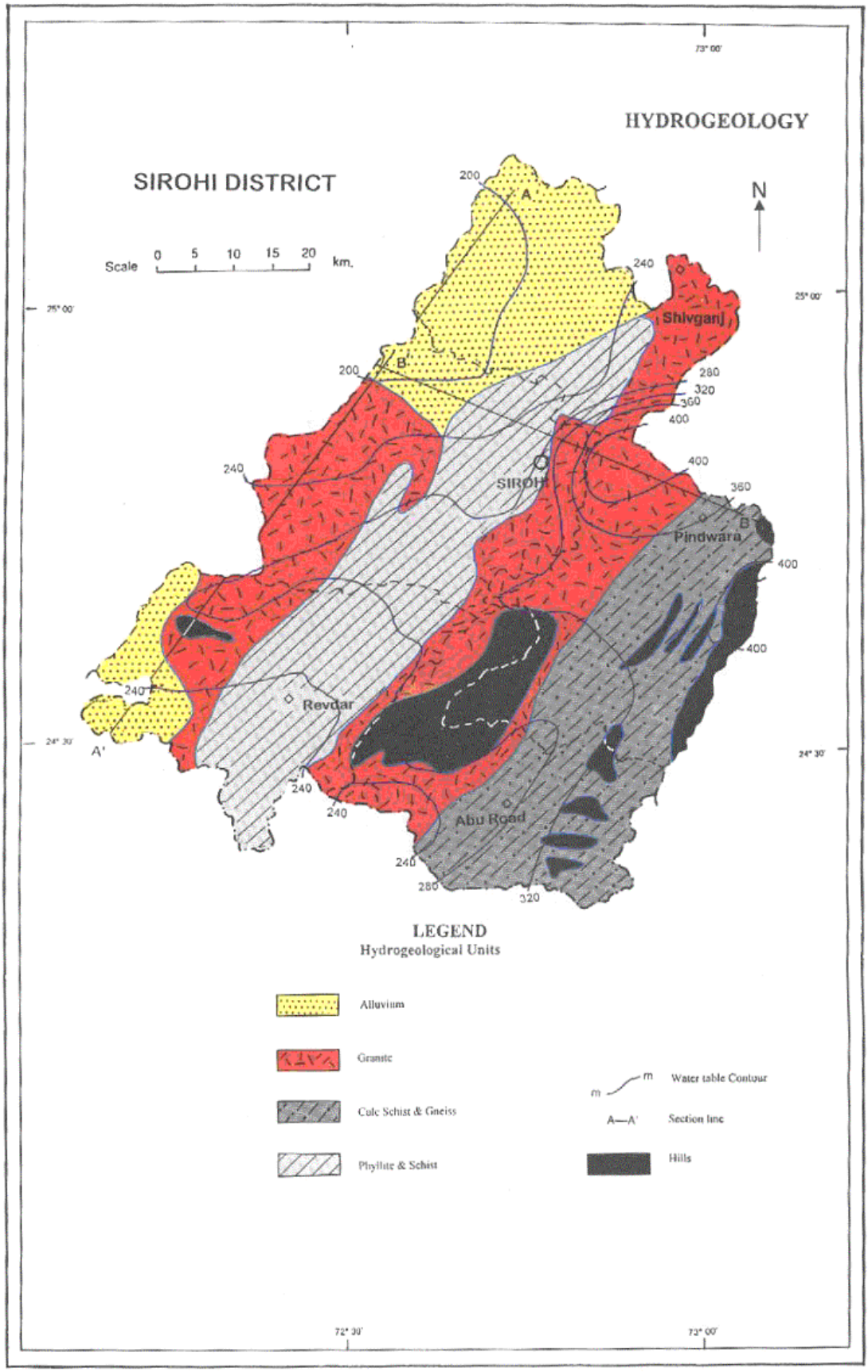

Fig.2: Hydrogeological map of Sirohi district

5.2.1 Ground Water in Delhi Super Group

Phylites and Schists

These aquifers occur predominantly in Abu Road, Pindwara and central part of Sirohi tehsil. A few intrusives are also found which have low permeability. Ground water is retained in weathered zones, fractures, joints etc. Depth of open wells tapping these aquifers ranges from 25 to 40 m. Yield of wells varies from 30 to 250 m^3/day. The depth to water level in the area tapping these aquifers ranges from 20 m to 40m in the northern part and 10m to 20m in the western part.

5.2.2 Ground Water in Post Delhi Group of Formations

Rhyolite and granite (Malani igneous suite) and Erinpura granite & gneiss

Over a large part of the area, Erinpura granite forms the principal aquifer but to a small extent. Malani rhyolite and granite form aquifers especially in the northern and western parts of the district. Idar granite also exists in the central part of the district. This aquifer is tapped by open wells ranging in depth from 20 to 50m. The depth to water level varies from 20 to 40 mbgl in the northern part and 10 to 20 mbgl in the western part of the district. Yield of wells ranges from meager to 250 m^3/day.

5.2.3 Ground Water in Unconsolidated Sediments

Alluvium

Alluvium overlies the weathered hard rock formation in the northern and western parts of the district. It has limited thickness and areal extent. It is confined to catchments of Jawai, Sukli and Khari rivers. The depth to water level is less than 10 mbgl near river courses but exceeds 35m in other areas. Depth of wells ranges from 25m to 40m.Yield of wells ranges from 150 to 1000 m^3/day.

5.3 Depth to Water Level

The depth to water level varies widely depending upon topography, drainage, bedrock geology etc. During Pre-monsoon (May, 2011), depth to water varied from 4.13 to 34.1 mbgl (Fig. 3). In major part if the district depth to water level ranges between 10 and 20 mbgl. Depth to water level less than 10 mbgl was observed in eastern and southeastern parts of the district and a small pocket in the western part. Deep water levels (20-40 mbgl) were observed in the northwestern and southwestern parts of the district.

During Post-monsoon (November, 2011), the depth to water level varied from 0.55 to 20.97 mbgl (Fig. 4). Shallow water level less than 2 mbgl was observed in major part of Pindwara block and eastern part of Sirohi block. In the remaining parts of the district, depth to water level varied from 2 to 20 m except northern part of Sirohi and western part of Sheoganj block, where deeper water levels ranging from 20-40 mbgl were observed.

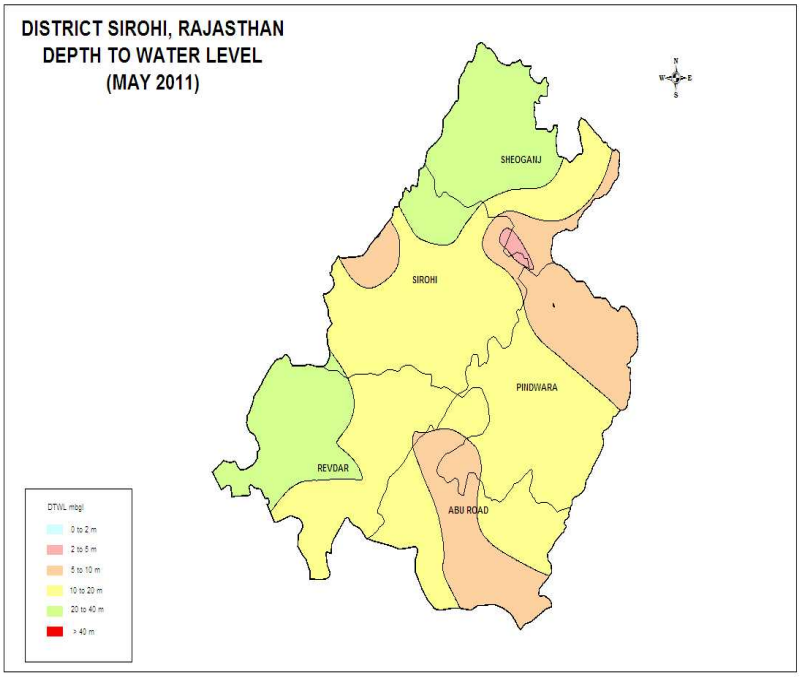

Fig. 3: Depth to Water Level Map (May, 2011)

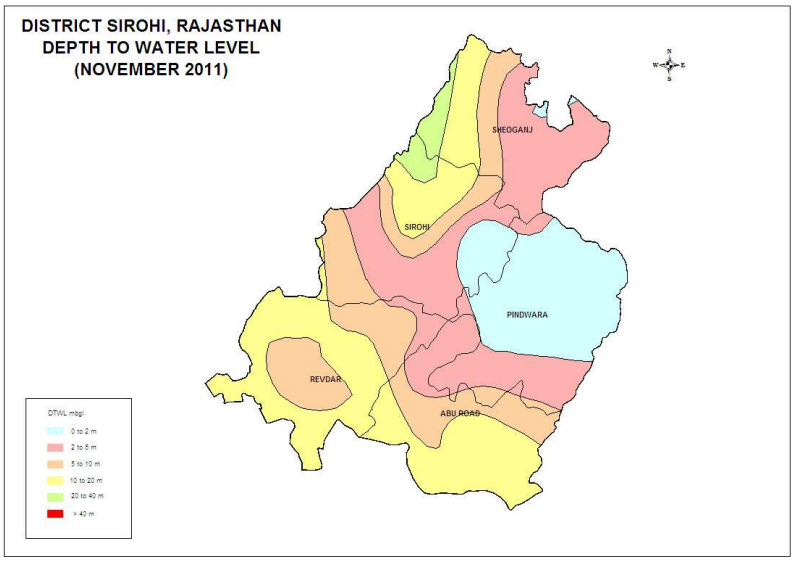

Fig. 4: Depth to Water Level Map (November, 2011)

5.4 Water Level Fluctuation

Analysis of Pre- and Post-monsoon water level data (May - November, 2011) indicates that there has been rise in water level over a major part of the district (Fig. 5). Perusal of fluctuation data indicates that major part of the district has recorded rise in water level of more than 10 m (Table 5). Decline in water has been observed in some of the wells in the district in parts of Abu Road, Sirohi and Sheoganj blocks.

Table 5: Pre & Post-monsoon water level fluctuation (2011)

Block	Range of fluctuation(m)				
	No. of wells	Rise		Fall	
		Minimum	Maximum	Minimum	Maximum
Abu Road	3	3.36	3.60	8.25	8.25
Pindwara	3	3.20	16.85	-	-
Reodar	4	4.90	15.07	-	-
Sheoganj	2	16.60	32.15	-	-
Sirohi	5	6.64	13.35	0.91	1.15

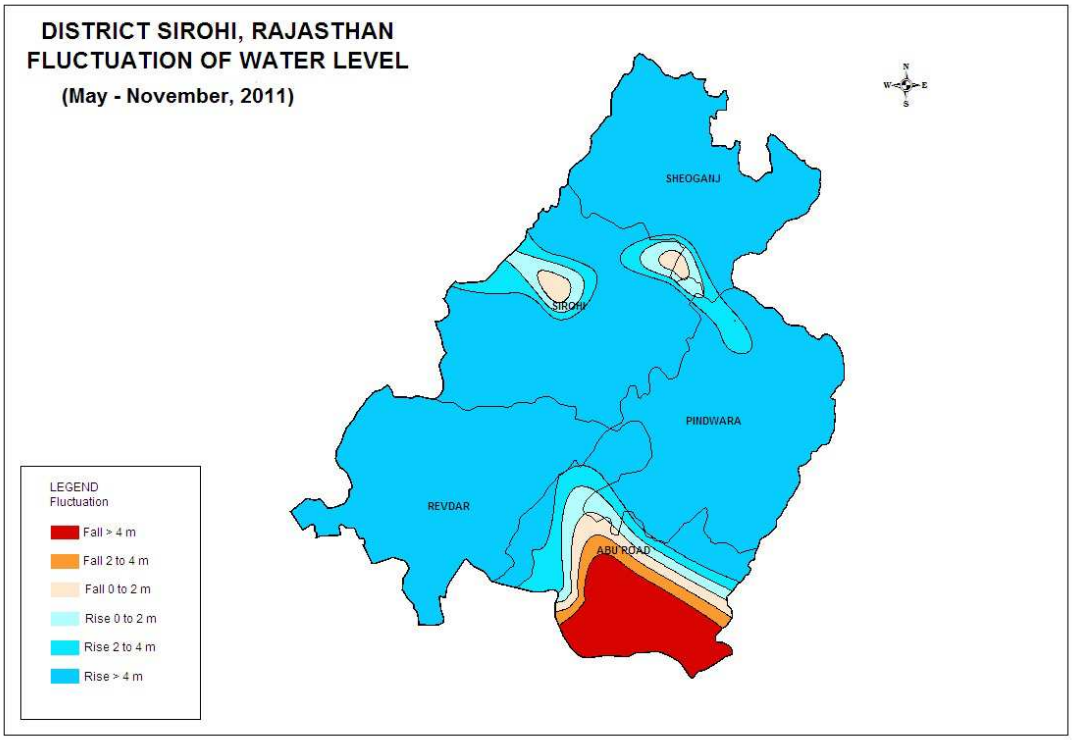

Fig.5: Seasonal Water Level Fluctuation Map (May – November, 2011)

Analysis of long term water level data of Pre-monsoon (2002-2011) indicates that majority of monitoring stations have registered rise in water levels (Table 6). Rising trend ranges from 0.28 m/yr to 1.61 m/yr during pre-monsoon (Fig. 6). Declining trend in water level has been observed in some parts of Sheoganj, Sirohi and Reodar blocks.

Table 6: Long Term Pre-monsoon water level fluctuation (2002-2011)

Block	Range of fluctuation (m)				
	No. of wells	Rise		Fall	
		Minimum	Maximum	Minimum	Maximum
Abu Road	3	1.94	0.94	1.73	1.73
Pindwara	4	8.76	2.59	0.78	0.78
Reodar	4	0.91	0.71	0.13	1.20
Sheoganj	1	-	-	6.18	6.18
Sirohi	5	4.27	0.19	1.36	4.70

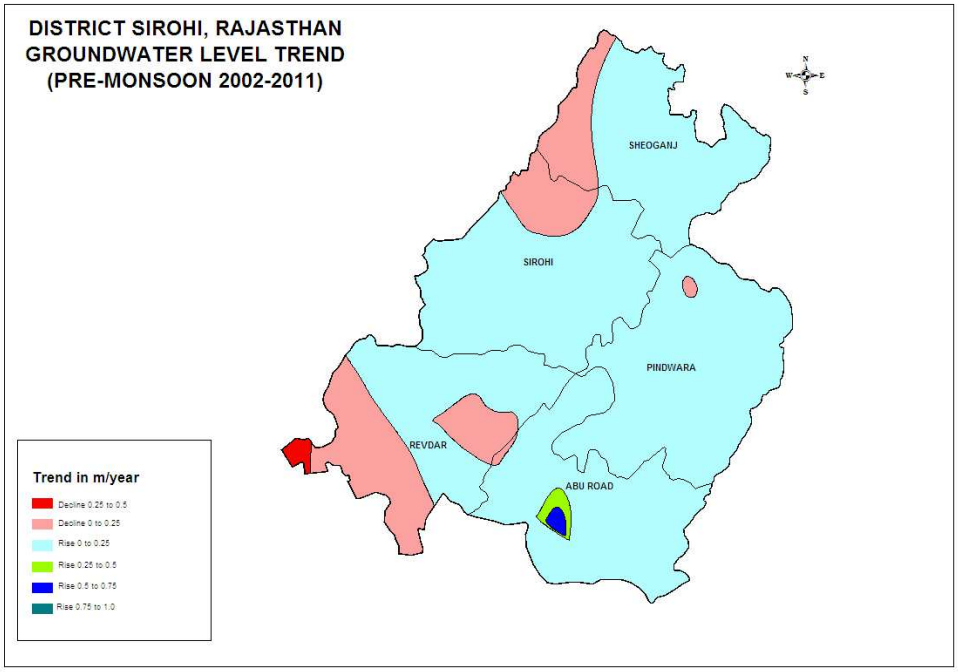

Fig. 6: Pre-monsoon Decadal Water Level Trend Map (May, 2002 - May, 2011)

6.0 Ground Water Quality

6.1 Water Quality in Shallow Aquifer

The range of various chemical constituents of ground water in Sirohi district during premonsoon 2011 is indicated in Table 7.

Table 7: Ranges of various chemical constituents in ground water in Sirohi district (May 2011)

S.No.	Chemical constituent	Range
1	pH	7.2 - 8.35
2	Chloride	30 - 1400 mg/l
3	Specific conductivity at 25°C	420-4620 µS/cm at 25^0C
4	Total hardness as $CaCo_3$	200 - 980 mg/l
5	Calcium	20 - 150 mg/l
6	Magnesium	02 - 165 mg/l
7	Iron	0.12 - 5.40 mg/l
8	NO_3	20 - 400 mg/l
9	F	0.25 - 4.00 mg/l

Shallow ground water of dug well zone is alkaline in nature with pH ranging from 7.2 to 8.35.

Chemical analysis data of samples collected during May, 2011 shows that EC in ground water varies from 420 - 4620 micrmhos/cm at 25 ^{o}C. Over a large part of the district, electrical conductivity is below 2000 mmhos/cm at 25^{o}C. In the southeastern and northwestern parts of the district, ground water is slightly brackish, where EC ranges from 2000-3000 mmhos/cm at 25^{o}C.In and around Pindwara and Sirohi town ground water is saline but higher values are recorded in very small pocket. The iso electrical conductivity map is presented in Fig. 7. Chloride content varies from 30 mg/l to 1400 mg/l.

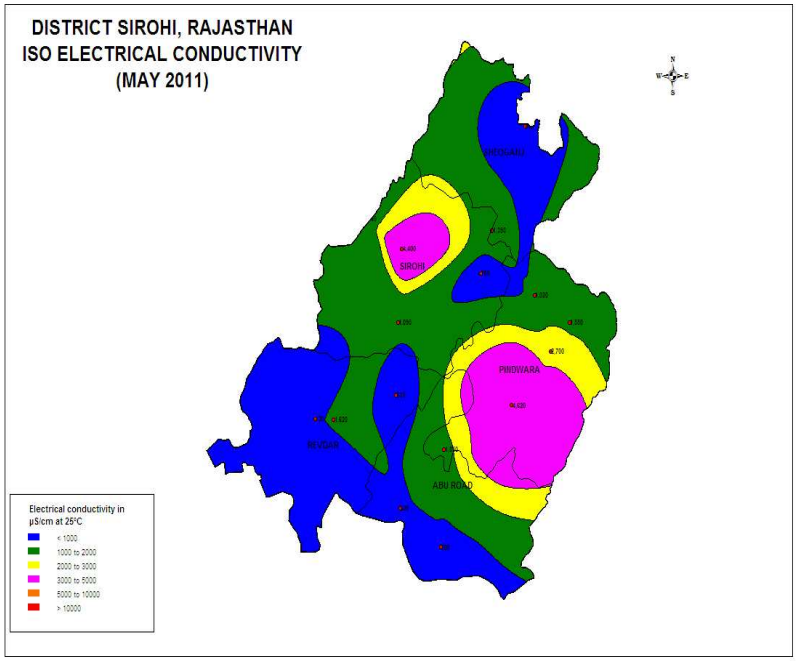

Fig-7: Iso Electrical Conductivity Map of Sirohi district (May, 2011)

Fluoride content in ground water is within the permissible limit of 1.5 mg/lit in major part of the district. Higher concentration (>1.5mg/lit) is found in central and southwestern parts of the district covering parts of Sheoganj, Sirohi and Reodar blocks. The Iso Fluoride map is presented in Fig. 8.

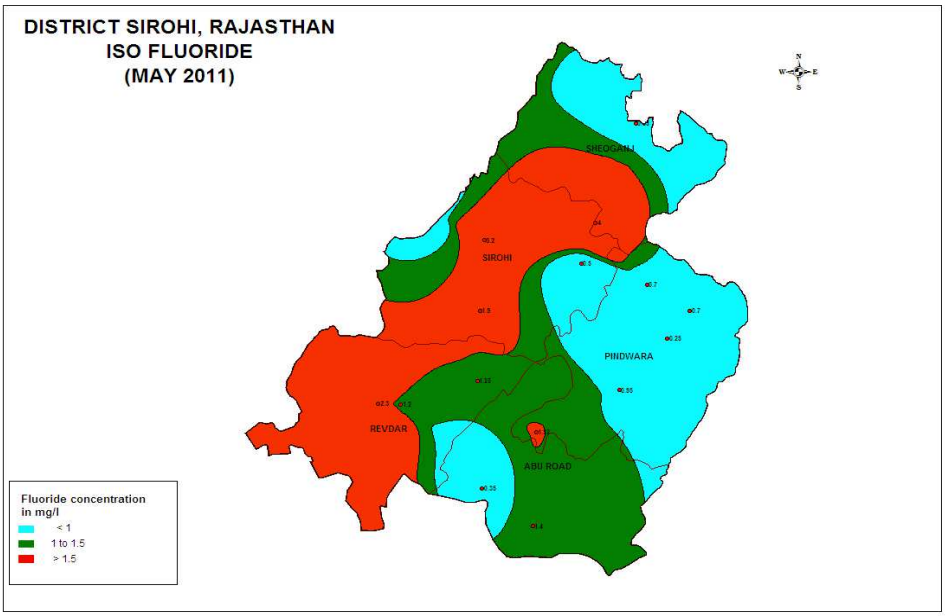

Fig. 8: Iso Fluoride Map of Sirohi district (May, 2011)

The concentration of Nitrate ranges from 20 ppm to 400 ppm. Nitrate values in major part of the district are within 45 ppm. Higher values of nitrate occur in southern part of the district in Pindwara, Abu Road and Reodar blocks. The Nitrate distribution map is presented in Fig. 9.

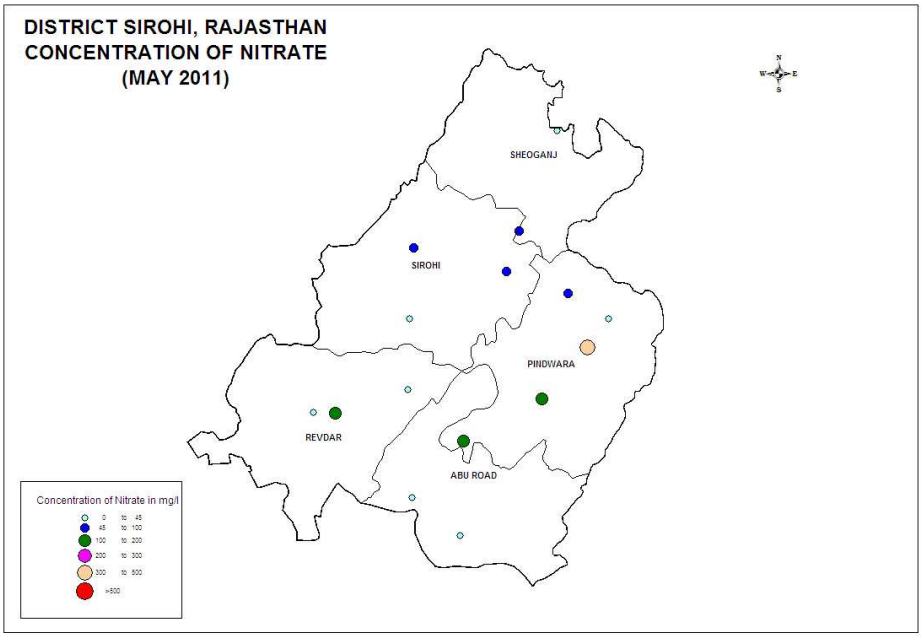

Fig.9: Nitrate Distribution Map of Sirohi district (May,2011)

Concentration of iron varies from negligible to 0.12 to 5.40 mg/l. It is within the permissible limit of 1.0 mg/l over a major part of the district except in the southern part of Sirohi block, eastern part of Reodar block, northwestern part of Abu Road block, and eastern parts of Sheoganj and Pindwara blocks, iron concentration in ground water exceeds 1.00 mg/l. The Iron distribution map is presented in Fig. 10.

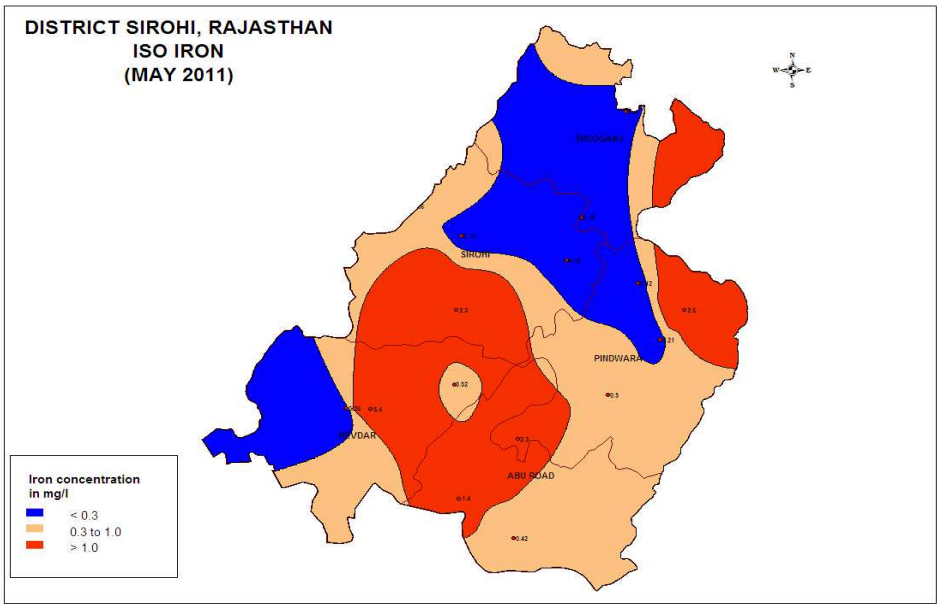

Fig.10: Iso Iron Map of Sirohi district (May,2011)

6.2 Water quality in Deep Aquifer

Chemical analysis of ground water samples collected from tubewells shows that ground water quality in deeper aquifers is generally fresh and potable. The EC is generally less than 600 µS/cm at 25^{o}C to 3500 µS/cm at 25 ^{o}C. Cconcentration of Chloride varies from 28 mg/l to 1000 mg/l. Cconcentration of Fluoride is less than 1.0 mg/l and is well within the permissible limit.

7.0 Ground Water Resources

Ground water resources have been jointly estimated by Central Ground Water Board and Ground Water Department, Government of Rajasthan (As on 31.03.2009) as per the norms recommended by GEC 97. While assessing the ground water resources, saline and hilly areas have not been considered. Annually replenishable ground water resources of the district have been estimated to be 300.9981 MCM. Net annual ground water availability is estimated to be 274.224 MCM. Total annual ground water withdrawal for all uses has been estimated to be 299.9916 MCM with stage of development at 109.40 %.

Summarized block wise ground water resources of Sirohi district are given below in Table 8 and bar chart diagram of Annual Replenishable Ground Water Resource Vs Annual Draft for all uses is presented in Fig. 11.

Table 8: Block wise ground water resources of Sirohi district

(MCM)

S. No.	Assessment Unit	Annually Replenishable Ground Water Resource	Net Annual Ground Water Availability	Gross Ground Water Draft for All uses	Stage of Ground Water Development (%)	Category
1	Aburoad	28.4195	26.5459	25.8975	97.56	S.Critical
2	Pindwara	61.8987	55.8964	55.7683	99.77	S.Critical
3	Reodar	71.6449	65.1419	85.4448	131.17	OE
4	Sheoganj	67.8477	61.0629	67.718	110.9	S.Critical
5	Sirohi	71.1873	65.5769	65.163	99.37	OE
	Total	300.9981	274.224	299.9916	109.4	OE

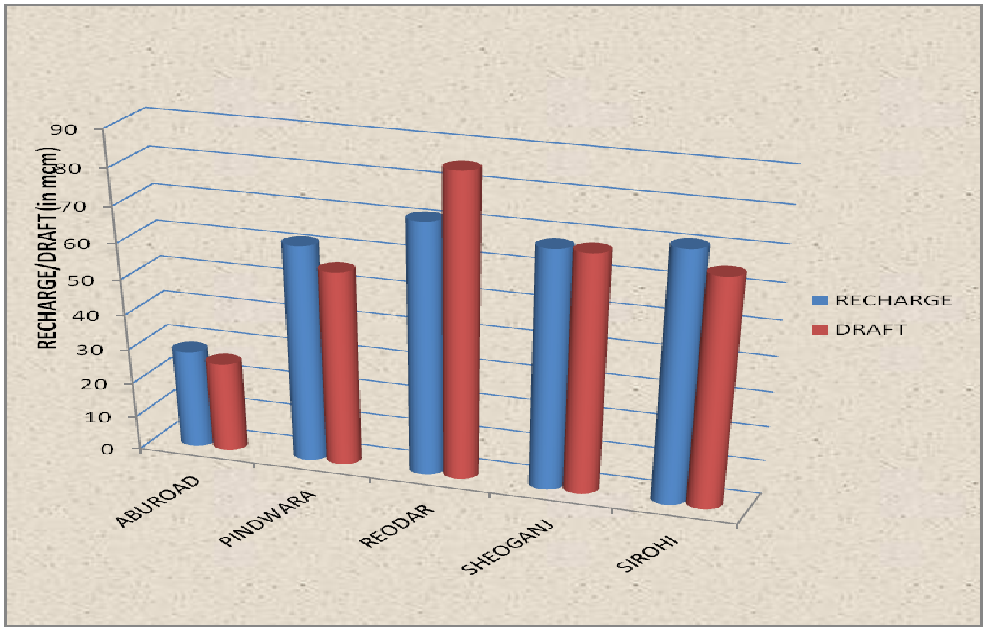

Fig. 11: Annual Replenishable Ground Water Resource Vs. Annual draft for all uses

8.0 Status of Ground Water Development

Phyllite, granite, schist and alluvium form the aquifer in different parts of the district. Alluvial area is restricted to river beds. Ground water occurs under unconfined to semi-confined condition. Depth and diameter of the dug well and bore well depends on formation and geomorphology. However, general depth of dug well and bore well ranges from 9 to 50 m and 100 to 120 m respectively.

9.0 Awareness & Training Activity

Central Ground Water Board organises Water Management Training Programmes with the objective of capacity building in the States on the need and techniques of water conservation and rain water harvesting. One such programme was organised in Sirohi town during March, 2006.

10.0 Ground Water Related Issues & Problems

Almost the entire district is facing problem of ground water scarcity. However, there are some areas vulnerable for pollution and depleted water table. Major issues in the district are as follows:

In the block, fluoride (>1.5 mg/lit) is found in more than 40% villages and habitations. Fluoride hazard is mainly in central and western parts of the district. The total salt concentration more than 2000 mg/l is observed in 20% villages. Salinity is scattered in central and eastern parts of the district.

11.0 Ground Water Development Strategy

11.1 Ground Water Development

Stage of ground water development in the district is 109.4 %. The scope for ground water development is almost exhausted in 2 blocks where ground water development has already exceeded 100% and the blocks have been categorized as “Over-exploited”. Remaining blocks fall under “Semi Critical” category where ground water development is approaching 100%. There is very little scope left for further development in such blocks for irrigation or industrial use. However, exploratory drilling can be taken up in unexplored area for estimation of aquifer parameters. Recommendations for future ground water development in Sirohi district are given below in Table 9.

Table 9: Recommendations for future ground water development in Sirohi district

S. No.	Block	Potential zone area (sq.km.)	Aquifer	Depth to water (m)	Recommendation for D/W & T/W	Proposed depth (m)	Expected discharge (lpd)	Electrical conductivity (µS/ cm)
1	Abu Road	60.50	Alluvium	9 - 21	Large dia D/W	25-30	90,000-120,000	Below 2000
		142.34	Phyllite/ Schist	4 - 18	D.C.B.	30+H.B	60,000-80,000	Below 2000
		128.22	Granite	5 - 18	TW	100-120	40,000-70,000	Below 2000
2	Pindwara	525.38	Schist/ Gneiss	8 - 25	Large dia D/W	25-30	90,000-110,000	Below 2000
		66.37	Granite	6 - 15	D.C.B.	30+H.B	70,000-80,000	Below 2000
		291.15	Granite	5 - 17	TW	100-120	40,000-70,000	Below 2000
3	Reodar	185.93	Alluvium	7 - 23	Large dia D/W	30-35	80,000-120000	Below 2000
		553.00	Phyllite/ Schist	8 - 28	D.C.B.	30+HB	60,000-80,000	Below 2000
		246.87	Granite	9 - 28	TW	100-120	40,000-70,000	Below 2000
4	Sheoganj	526.03	Alluvium	11 -49	Large dia D/W	30-40	60,000-120,000	2000-6000
		60.15	Phyllite/ Schist	18 - 41	D.C.B.	30+HB	40000-80000	Below 4000
		186.71	Granite	14 - 29	TW	100-120	40,000-70,000	Below 4000

S. No.	Block	Potential zone area (sq.km.)	Aquifer	Depth to water (m)	Recommendation for D/W & T/W	Proposed depth (m)	Expected discharge (lpd)	Electrical conductivity (µS/ cm)
5	Sirohi	209.37	Alluvium	13 - 37	Large dia D/W	30-40	80,000-120,000	Below 4000
		262.53	Phyllite/ Schist	12 - 25	D.C.B.	30+HB	60,000-80,000	Below 4000
		67.18	Granite	8 - 25	TW	120-150	60,000-80,000	Below 4000
		564.00	Granite	8 - 23	TW		60,000-80,000	Below 4000

11.2 Ground Water Management

11.2.1 Regulation of Ground Water Development

Out of 5 blocks in the district, 2 blocks viz. are Over-exploited. There is need to regulate ground water withdrawals in such areas. The remaining 3 blocks are semi critical, caution has to be exercised while planning development of ground water. Ground water resources need to be used judiciously.

11.2.2 Water Conservation and Artificial Recharge

As many areas in the district face problem of ground water over-exploitation, further exploitation of this precious resource must be checked. Artificial recharge is a difficult task in the district as the country rock is composed exclusively of hard rocks, water level gradient is steep and storage capacity is low. Under such conditions, there is likelihood that recharged water will reappear as base flow. Any induced water application will create localized mound with no change in trend of declining water level in adjacent areas.

For sustainable utilization of water resources, conjunctive use of surface and ground water is inevitable. Water harvesting through construction of bunds, anicuts, and roof top rain water 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, sites of these structures should be selected carefully.

Irrigation, Watershed Development & Soil Conservation Department have constructed sub-surface barriers and anicuts under Integrated Mission on Sustainable Development Project to harvest rainwater, reduce soil erosion and check runoff velocity. So far large number of water harvesting structures (WHS) have been constructed in the district

Impact assessment of water harvesting structures has revealed that there has been increase in cropping area, cropping intensity, crop production and labour employment observed in the project area. Erosion from nalla 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 water harvesting programmes may be promoted in the district for further development of surface water and ground water resources to enhance agricultural production.

12.0 Recommendations

- Ground water draft is fairly high in the entire district. Stage of ground water development in the District has reached 109.4% due to indiscriminate use. It is high time to control development of ground water in such areas.
- Yield of wells in the district can be improved by connecting fracture zones through construction of adits or by constructing infiltration galleries or even by adopting latest fracturing techniques.
- Revival of traditional ground water storage system i.e. Baori, open wells, Tanka etc. for rain water conservation for use in day to day life will reduce ground water draft.
- Awareness programmes and trainings on rainwater harvesting will be beneficial to check decline in water level and justified use.
- Taking advantage of uneven topography of the area, small water harvesting structures or earthen dams, upstream of irrigation commands, at suitable sites, may be constructed to store rainwater. This will increase recharge to ground water and will ultimately result in increase of yield of wells.
- 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 achieve this.
- Alluvial tracts along river channels of Krishanavati, Khari and Kapalganga are the most feasible locations where shallow wells can be constructed to harness the shallow water table aquifers being potentially recharged by the flash floods 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.
- Sowing of high water requirement crops should be discouraged. Proper agriculture extension services should be provided to the farmers so that they can go for alternate low water requirement economical crops