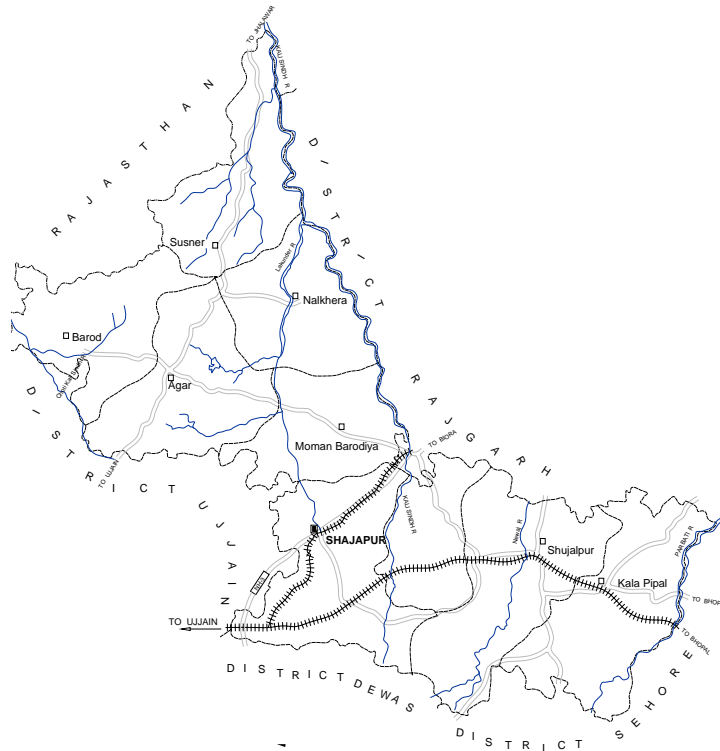


DISTRICT GROUND WATER INFORMATION BOOKLET



SHAJAPUR DISTRICT MADHYA PRADESH



**Ministry of Water Resources
Central Ground Water Board
North Central Region
Government of India**

MAY, 2009

SHAJAPUR DISTRICT AT A GLANCE

S. No.	Items	Statistics	
1	General Information		
	(i) Geological Area (ii) Administrative Division (As on 2006) Number of Tehsils Number of Blocks Number of Panchayat Number of Janpad Panchayat Number of villages (iii) Population (iv) Average Annual Rainfall (mm)	6196.00 sq. km 8 8 554 08 1068 1290230 1047.9 mm	
2	Geomorphology		
	Major Physiographic Units	Western, southern, south eastern part are highly undulating with broad flat topped hills and isolated hills. North eastern part flat land mass small mounds and hillocks Central plain with scattered hillocks.	
	Major Drainages	Kali Sindh, Lakhundar Nevaj, Parbati River Chambal and Ganga basin.	
3	Land Use (2004-05)		
	(a) Forest Area (In Ha) (b) Net area sown (In Ha) (c) Cultivable area (In Ha)	6011 499349 12932	
4	Major Soil Types	Black Cotton soil, lateritic soil, alluvium mixed silt + clay	
5	Area Under Principal Crops (As on 2006)	499349	
6	Irrigation by Different Sources	Irrigated Area (Ha)	No. of Structures
	Dug wells Tube well/Bore wells Canals Tanks/Ponds Net area irrigated Gross irrigated area	83041 57309 2946 4567 163773 163779	66025 12270 67 106 - -
7	Number of Ground Water Monitoring Wells of CGWB. (As on 31.3.2007)		
	No. of Dug Wells No. of Piezometers	21 09	

8	Predominant Geological Formations :	Recent alluvium, laterite and Deccan traps
9	Hydrogeology	
	Major Water Bearing Formation	Alluvium, laterite, weathered vesicular and fractured basalts.
	Pre-Monsoon Depth to water level during 2007	6.68-23.4 m
	Post-Monsoon Depth to water level during 2007	3.55-13.2 m
	Long Term water level trend in 10 years (1998-2007)	0.05-0.67 m/year (post monsoon) 0.08-1.37m/year (pre monsoon)
10	Ground Water Exploration by CGWB (As on 31.3.2007)	
	No. of wells drilled EW OW, PZ, Total	Exploratory well 36 Observation well 18 Piezometers (H.P.) 09
	Depth range (m)	59.98 – 203.35 m
	Discharge (lps)	0.8 – 15 lps
	Storativity (s)	-
	Transmissivity (m ² /day)	-
11	Ground Water Quality	
	Presence of chemical constituents more than permissible limit. (e.g. EC, F, As, Fe)	Electrical conductivity varies between 583 to 2700 μ S/cm at 25°C high nitrate and salinity and excess fluoride at places 2.45 to 3.3 mg/l
	Type of Water	C ₂ S ₁ & C ₃ S ₁ type suitable for irrigation
12.	Dynamic Ground Water Resources (2004) in MCM	
	Annual Replenish able Ground Water Resources	523.20
	Net Annual Ground Water Draft	594.39
	Projected Demand for Domestic and Industrial uses up to 2025	35.78
	Stage of Ground Water Development	114%
13	Awareness and Training Activity	Nil
14	Efforts for Artificial Recharge & Rainwater Harvesting – Nil	
15	Ground Water Control and Regulation	
	No. of Over Exploited Blocks	Kalapipal, Mohan Barodia, Nalkheda,
	No. of Critical Blocks	Shujalpur and Susner
	No. of Blocks notified	Barod
	Number of notified blocks	Agar, Shajapur Nil
16	Major ground water problems and issues	1. Depletion of ground water level. 2. Drought due to ground water, over exploitation 3. Salinity problems at places.

1.0 Introduction

Shajapur district is situated in north- western part of Madhya Pradesh. It is part of Malwa plateau spanning over an area of 6,196 km. The district is bounded by Rajgarh District on the west , Ratlam district on the north , Jhalawad district of Rajasthan state and by Dewas and Sehore district in the south. The district are extends between the parallel of latitude 23⁰ 06' and 77⁰ 19' north and between meridians of longitude of 75⁰ 41' and 77⁰ 02'' Falling in survey of India toposheet No. 46M, 54D. Eastern boundaries of the district having natural division and bounded by rivers Parwti, Kali sindh and Chhoti Kali Sindh respectively.

Shajapur which is district head quarter formed in 1901 is located on national highway No. 3 Agra – Bombay road, the district has a good netweel of roads and rail communication. The district head quarter is 211 km from Bhopal. Shajapur district is maily agriculture based district and its main crop wheat, Jawar, Soyabean are common crops Maize gram Rice, Bajra, Sugarcane, Groundnut are the less important crops.

The total geographical area of the district is 6196 sq. kms and has been divided in 08 Tehsil 8 blocks with a population of 12,90,230 according to census 2001. Fig-1. The details of administrative units are given below in table No. 1.

Table-1 : Administrative Division, Shajapur, District M.P.

S.No.	Blocks	Area in Sq. Km	No. of villages	No of Village Panchayat	No. of Janpad Panchayat
1	Shajapur	882.84	171	93	01
2	Mohan Barodiya	904.05	167	83	01
3	Sujalpur	786.31	130	71	01
4	Kalapipal	815.67	119	77	01
5	Agar	720.64	137	59	01
6	Barod	735.75	140	65	01
7	Susner	642.90	111	55	01
8	Nalkheda	561.61	93	48	01

Drainage :

Entire Shajapur district lies within Yamuna basin, Chambal sub basin and is drained by Prominently northerly flowing rivers like Chhoti Kalisindh, Kali Sindh, Lakhunder Newaj and Parvati. These rivers and their streams given dendritic drainage. The district area is located between surface elevation 335 and 608 msl. The drainage system of Ujjain district has been depicted in the fig-2.

Irrigation :

The Irrigation facilities in Shajapur district are moderate and 32.08% (2005-06) of net sown area is irrigated and rest of the area is rain-fed. Surface water irrigation in the district is largely through tanks and their canals. Total 41 minor, 4 medium, 6 lift, irrigation scheme is working in entire district ground water is the main sources of irrigation in the district. Out of total 1637.73 sq. km irrigated land, 1403.94 sq. km is irrigated from ground water sources which is about 86.07% of total irrigation in the district. There are 1,22,701 bore wells and 60,025 dug wells in the district for irrigation.

Central Ground Water Board (CGWB) Activities :

- Systematic hydrogeology survey were carried out by the central ground water board, north central region Bhopal during 1988-89
- Hydrogeological investigation for source finding in hard core problem villages referred by public health engineering department during the year (1988-89).
- Reappraisal Hydrogeological investigation were taken up by central ground water board, NCR, Bhopal covering the entire district during 1994-95.
- Reappraisal hydrogeological investigation were taken up by Central Ground Water Board, North Central Region Bhopal covering entire district 2004-05.
- Under accelerated exploratory drilling program 35 number of exploratory wells were drilled in entire Shajapur district for water supply during 2003-04.
- Under the world bank assisted hydrogeology project 09 shallow and deep Piezometers had been constructed in Shajapur district.

2.0 Rainfall and Climate

The climate of Shajapur district MP characterized by hot summer and general dryness except during the south west monsoon season. The year may divided into four seasons. The cold season, December to February is followed by the hot season from March to about the middle of June. The period from the middle of June to September is the south west monsoon season. October and November form the post monsoon or transition period.

The normal annual rainfall of Shajapur District is 104.79 mm Shajapur district receives maximum rainfall during south – west monsoon period i.e. June to September. About 92.3% of the annual rainfall received during monsoon season. Only 7.7% of the annual rainfall takes place between October to May period. Thus surplus water for ground water recharge is available only during the south – west monsoon period. The maximum rainfall received at Shajapur is 987.3 mm and minimum at Susnet 865.4 mm.

The normal maximum temperature received during the month of May is 39.9⁰ C and minimum during the month of January 9.6⁰ C. The normal annual means maximum and minimum temperature of Shajapur district is 31.3⁰ C & 35.5⁰ C respectively.

During the south- west monsoon season the relative humidity generally exceeds 88% (July / August month). The rest of the year is drier. The driest part of the year is the summer season, when relative humidity is less than 33%. April is the driest month of the year.

The wind velocity is higher during the pre monsoon period as compared to post monsoon period. The maximum wind velocity is 27.0 km / hr. observed during the month of June and minimum 7.1 km/hr during the month of November. The average normal annual wind velocity of Shajapur district is 15.9 km / hr. Normal climatologically parameter of indore and rainfall data of Shajapur District is given in attached Annexure.

Table-2: Normal Climatological Parameters for Shajapur District

S.No.	Parameters	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	Maximum Temp (°C)	26.1	28.9	33.7	37.7	39.9	35.7	29.5	28.2	29.3	31.1	28.8	26.7	31.3
2	Minimum Temp (°C)	9.6	11.0	15.3	20.4	24.8	24.4	22.6	22.0	21.0	17.2	12.1	9.9	17.5
3	Relative Humidity (%)	63	47	31	30	44	73	88	88	85	60	54	57	60
4	Wind Velocity (Km/hr.)	9.9	10.8	13.0	15.5	24.4	27.0	26.2	21.7	18.5	9.8	7.5	7.1	15.9
5	Rainfall (m.m.)	9.9	2.5	6.3	3.3	8.6	137.4	350.5	326.4	152.1	23.9	20.6	6.1	1047.9

Geomorphology and Soil Types

3.01 Geomorphology

The district lies on a part of Malwa plateau at a general elevation between 335 and 608m amsl with an elevation of about 275m. The entire district is characterized by a typical Trappean geomorphology comprising extensive plain, low lying hills and hills clusters with gentle northerly slope. Western, south, south-eastern parts are highly undulated with broad flat topped hills, cluster terraces and isolated hills. A number of hills capped by laterite are noticed in the north-western, western part. The central area is plain with scattered hillocks. The highest point 608m amsl occurs a few kilometers south-west of Shajapur and the lowest part is about 335m in the Kali Sind and Newaj river valleys. Bad land topography along small nalah courses and scarp development upto maximum of 20m are quite common along the rivers. The general slopes is from south to north marked by a number of small rivers which later join the Kali Sind river.

3.02 Soils

The soil in Shajapur district are of mixed type and there is no distinct boundary in between any two type of soils. There are three categories of soils ,identified in the district area-

(a) Black cotton Soil

These soils are dark grey to black in color, composed of clay and are plastic & sticky in nature. These soils are fertile in nature and derived from decomposition of trappean rocks having thickness of 15 cm to 2m . These soils cover major part of the district.

(b) Lateritic soil

These soils consist of sandy loam to clayey loam and brick red to red in colour. These soils are derived from weathered ferruginous basalt and are found around Agar and Barod blocks.

(c) Alluvium soil

The alluvium is of mixed origin & comprises of silt & clay and admixtures of these in varying properties. The occurrence of alluvium is confined to the bank of stream and rivers and usually 3 to 4m un thickness.

4.0 Ground Water Scenario

4.1 Hydrogeology

Decan Trap basaltic rock occupies the entire Shajapur district. The different flows of basaltic rock are mostly of “Aa” type but ”Pahoehoes” and intermediate type are also present. A typical flow unit consist of a lower dense massive, horizon passing upwards into a vesicular, amygdaloidal or jointed basalt. At places, top of individual flows are marked by reddish brown clayey material(Red bole) of few cm to 5 m thickness. Usually the red- bole and vesicular basalt are prone to weathering and give rise extensive black cotton soil. There are sixteen basaltic flows which were identified by Geological Survey of India in a vertical column of 275m 9(between altitude of 335 to 610 m amsl) in entire Shajapur district. The various flows of basalts are at times inter-bedded and fossiliferous inter trappen. The description of various lava flows are presented in the table below-

Table-3: Type : Thickness of Basaltic Lava Flows in Shajapur District

Flow Nos	Thickness	Formation & Description	Age
11 to 16	100m (Elevation above 500m)	Indore Formation six, fine grained Sparsely porphyritic Aa type flows	Upper cretaceous to lower Eocene
07-10	60M (Elevation 460 m)	Kankariya Purukheri formation four Aa is Pahoehoe type flows (Fossiliferous inter trappean)	
02-06	100 m (Elevation upper contact at 440-443m)	Kalisindh formation Five fine grained sparsely to moderately porphyritic Aa flows	
00-01	15 M (Elevation 340 m)	Mandleshwar formation fine to medium grained sparely to moderate porphyric Aa flows	

4.2 Occurrence of Ground Water :

Ground Water occurs in different lava flows having distinctive feature like significant primary porosity in the form of vesicles lava tubes formed due to emanations of gases in weathered lava flows along with fractures, variation vesicles and its vide spatial and temporal up with minerals considerable reduced by filling up with minerals like zeolites, calcite, and silica to form amygdale. Alternating sequence of pervious and compact horizon function as a multi aquifer system.

Shallow ground water occurs in the weathered vesicular, jointed fractured zones of basaltic flows generally under unconfined conditions at some places under semi confined to confined condition due to the presence of thickly silty clays overlying the jointed rocks in the cases of deepr aquifer. Shallow aquifer also noticed in alluvium occurs along Lakhunda , Kalisindh , Newaj and Parvati river courses laterite development on basalt is not extensive except at and around Agar town where the traps have undergone maximum degree of leaching. The hydrogeology of the Shajapur district has been depicted in fig. 2

4.3 Ground Water Levels

Variation of ground water levels in a area is an important component of Hydrological cycle because of its is a physical reflection of aquifer system. As the change in ground water level is directly related to ground water balance and its continuous records provide direct information of sub surface geo environmental changes due to withdrawal of ground water. To monitor the seasonal & annual fluctuation, change in quantity and quality of ground water, CGWB has established. Ground water monitoring wells and piezometers in entire Shajapur district. The monitoring of ground water levels in these wells is being carried out by CGWB during the month of May, August, November and January. High frequency ground water level monitoring is being carried out at many places deep piezometers using automatic water level records. To study ground water regime of the area pre monsoon and post monsoon maps of the Shajapur district has been prepared (fig. 3 and 4).

4.3.1. Pre Monsoon (May 2006.)

In pre monsoon period, May 2006 (fig.3) depth to water level ranges between 6.68 mbgl at Shajapur to 23.40 mbgl at Agar. The most part of the district have water level in the range of 8.0 to 12.0 m bgl during the pre monsoon water level more than 12.0 mbgl recorded at Matkotra, Agar, Maksi Panwadi, Shajapur and Susner ground water monitoring wells.

4.3.2. Post Monsoon (November 2007)

During Post monsoon period November 2007 (fig. 4) the water level ranges from 3.55 m bgl at Sujlapur to 13.2 mbgl at Susner. It is observed that in most part of the district the water level lies between 3.5 m to 8.00 mbgl. During post monsoon period water level more than 8.00 m has been recorded at Agar, Matkotra, Choma, Panwadi, Soyat & Susner ground water monitoring wells.

4.3.3. Water Level Fluctuation (May 2007 to Nov 2007)

A comparisons of pre monsoon water level data with the post monsoon water level data reveals that there is rise of water in entire district. The rise of 2 m to 5 m has been observed in Many ground water monitoring well of the district rise in water level more than 5 m has been recorded at Tanodiya, Salsalai and Shujalpur ground water monitoring well minimize rise in water levels has been recorded as 0.69 m at Matkotra and maximum rise in water levels recorded as 15-37 m bgl at Sujalpur ground water monitoring wells.

4.3.4. Ground Water Level Trend (May 1998 to May 2007)

Analysis of ground water level data of pre monsoon period indicate that there is decline trend in water level in entire district except ground water monitoring well of Amla, Nandni, Akodia. In general 0.01 to 0.05 m/year water level declines has been observed in the district. The maximum decline in water levels 0.67 m/year has been observed at Akodia.

4.3.5. Ground Water Level Trend (Nov 1998 to Nov 2007)

Analysis of ground water level data of post monsoon period indicate that there is decline trend in water level in entire district except at Nalkheda and Akodia ground water monitoring wells. In general 0.08 to 0.56 m/year water level declines has been observed in district. The maximum decline in water levels 1.16 m/year has been observed at Agar ground water monitoring well.

4.4 Aquifer Parameters

Central ground water board has drilled only one exploratory well at Agar in Shajapur district which was abandoned due to meager discharge , 35 exploratory wells were drilled in Shajapur district through out sourcing under accelerated exploration program. Under the world bank assisted hydrology project 09 Piezometers have been drilled for monitoring of ground water levels in entire district. It is inferred from the exploratory data that the yield of deccan trap basalt, along the Kalisindh river, deeper aquifer are promising and yield ranges from 8 to 15 lps as compared to 5 to 15 lps in the district (0.5 lps at Jokhar, Jaikhi and 14.5 lps at Dhudhana village) The draw down ranges between 0.5 m at Dhudhana to 40.06 m at Shajapur. The static water level is generally deep and varying from 2.44 mbgl at Shajapur to 102.0 m at Manglaj.

4.5 Ground Water Resources

Ground Water Resources estimation of Shajapur district has been computed for base year 2004 on block wise basis. Out of eight blocks only two blocks namely Agar and Shajapur are falling under semi critical category. Only one block namely barod is falling under critical category. Remaining five blocks namely. Kalapipal. Mohanbarodia, Nalkheda, Shujalpur and Susner blocks falling under the category of Over exploited. There are 11 minor and one major irrigation project namely Ranjeet Sagar in the district. The over all stage of ground water development of the district is 114%.

As per ground water resource estimation figures. Net ground water availability in Shajapur district is 523.20 MCM and ground water draft for all uses is 594.39 MCM. Remaining stage of ground water development 114% as a whole for the district. Allocation of future domestic and industrial supply of ground water is negative figure because as a whole the district is over exploited. The net annual ground water available in the Shajpur district and ground water draft from all uses for all blocks is shown in table and is also presented in fig. 5

4.6 Ground Water Quality

4.6.1 Ground Water Quality for Drinking

Ground Water Quality in Shajapur district is assessed annually by CGWB on the basis of water samples collected from 16 nos. of hydrographs stations in the district. Ground water inn the district is generally medium to high saline as electric conductivity values between 583 – 2700 $\mu\text{S}/\text{cm}$. High EC of more than 1500 $\mu\text{S}/\text{cm}$ were found in dug well of Kalapipal (1710 $\mu\text{S}/\text{cm}$), Barod (1717 $\mu\text{S}/\text{cm}$), Choma(2060 $\mu\text{S}/\text{cm}$) and Soyat (2700 $\mu\text{S}/\text{cm}$) villages.

Constituents like Sulphate, Calcium and Magnesium were within the safe limit for drinking water as per BIS standards. Nitrate in the ground water of Shajapur is varying between 5 – 169 mg/l. Nitrate of more than 100 mg/l was found in two villages namely, Agar(128 mg/l) and Kalapipal(169 mg/l). High nitrate in the village area is appears due to excessive use of fertilizers and agricultural waste. The total hardness of ground water in the district is under safe limit except Kalapipal (707 mg/l) and Soyat (610 mg/l) villages, which are beyond 600mg/l as per BIS standards. High chloride of more than 250 mg/l in the ground water was also found in Kalapipal(280 mg/l), Barod(518 mg/l), Choma (489 mg/l) and Soyat (805 mg/l) villages. Ground water in the district at many places is saline and due care id needed before its use.

4.6.2 Ground Water Quality for Irrigation

High SAR is not good for irrigation as it lead to Sodium hazards. Water samples in the district generally fall in C_2S_1 , C_3S_1 and C_4S_1 classes of US Salinity diagram. However, ground water in the district is generally safe for irrigation but proper drainage system is required where EC is more than 1500 $\mu\text{S/cm}$.

4.6.3 Geogenic problems

Fluoride in the district is generally below 1.50 mg/l except Amla (2.45 mg/l), Barod(2.55 mg/l), Nalkheda (2.79 mg/l), Susner (3.30 mg/l) and Akodia (7.81 mg/l). More than 1.50 mg/l is responsible for bone deformation. Due care is needed to use ground water for drinking where, fluoride concentration is more than 1.50 mg/l. No Arsenic has been detected in the district.

Table-4: Classification of Ground Water for Irrigation purpose.

C_1S_1 $C_1 = 100-250 \mu\text{S/cm}$ $S_1 = <10$	C_1S_2 $S_2 = 10-18$	C_1S_3 $S_3 = 18-26$	C_1S_4 $S_4 = >26$
C_2S_1 $C_2 = 250-750 \mu\text{S/cm}$	C_2S_2	C_2S_3	C_2S_4
C_3S_1 $C_3 = 750-2250 \mu\text{S/cm}$	C_3S_2	C_3S_3	C_3S_4
C_4S_1 $C_4 = 2250-5000 \mu\text{S/cm}$	C_4S_2	C_4S_3	C_4S_4

C Stands for Salinity (TDS or EC)

S Stands for alkalinity (Sodium Absorption Ratio)

C_1 = Excellent

C_2 = Excellent

C_3 = Good

C_4 = Bad

$> C_4$ = Worst

S_1 = Good to Satisfactory

S_2 = Satisfactory

S_3 = Bad

S_4 = Worst

4.7 Status of Ground Water Development

Ground Water is the main source for drinking and irrigation in the Shajapur district. About 85.72% irrigation in the district is from ground water sources, though the level of ground water development is about 114%. There are 12270 tube wells and 60025 dug wells in Shajapur district. The depths of tube wells range between 8.0 m to 24.0 m and yields of tube wells range between 8 to 15 lps depending on hydrogeological situation in the area. High yielding tube wells are at Passukhedi, Tilawad Maina, Kishoni, Sujalpur, Nalkheda, Manglaj, Ukawat & Dudhana (14.5 lps).

Apart from private sources, hand pumps are the main source of rural water supply in the district. There are 1068 villages having tube wells and hand pumps and 627 villages with pipe water supply facilities for drinking water.

GROUNDWATER RESOURCE POTENTIAL OF SHAJAPUR DISTRICT, M.P.

S. N.	Assessment Unit/ Block	Command/ non-Command/ Total	Net Annual Ground water Availability (In MCM)	Existing Gross Groundwater Draft for Irrigation (In MCM)	Existing Gross Groundwater Draft for Domestic & Industrial water Supply (In MCM)	Existing Gross Ground water Draft for All uses (In MCM)	Allocation for domestic & industrial requirement supply upto next 25 years (In MCM)	Net Groundwater Availability for future irrigation development (In MCM)	Stage of Groundwater Development $\{(13/10)*100\}$ (%)
1	2	3	4	5	6	7	8	9	10
	Shajapur								
	Agar	Command	20.22	1.65	0.57	2.21	0.76	17.81	11
		Non-Command	13.51	41.68	2.26	43.95	3.80	-31.97	325
		Block Total	33.73	43.33	2.83	46.16	4.56	-14.16	137
	Barod	Command							
		Non-Command	61.74	55.65	2.36	58.01	3.21	2.88	94
		Block Total	61.74	55.65	2.36	58.01	3.21	2.88	94
	Kalapipal	Command							
		Non-Command	82.17	86.56	3.40	89.96	4.43	-8.82	109
		Block Total	82.17	86.56	3.40	89.96	4.43	-8.82	109
	Mohan Berodia	Command							
		Non-Command	79.39	98.68	3.64	102.32	4.79	-24.07	129
		Block Total	79.39	98.68	3.64	102.32	4.79	-24.07	129
	Nalkhera	Command							
		Non-Command	46.93	46.72	2.14	48.86	2.83	-2.62	104
		Block Total	46.93	46.72	2.14	48.86	2.83	-2.62	104
	Shajapur	Command	11.17	2.26	0.63	2.89	1.33	7.59	26
		Non-Command	76.47	58.53	3.56	62.09	4.71	13.23	81
		Block Total	87.65	60.79	4.19	64.97	6.04	20.82	74
	Shujalpur	Command							
		Non-Command	78.95	109.88	4.18	114.05	5.85	-36.77	144
		Block Total	78.95	109.88	4.18	114.05	5.85	-36.77	144
	Susner	Command							
		Non-Command	52.64	67.47	2.59	70.06	4.08	-18.91	133
		Block Total	52.64	67.47	2.59	70.06	4.08	-18.91	133
		District Total	523.20	569.08	25.32	594.39	35.78	-81.65	114

Table 10 – Analysis of Ground Water Samples of Shajapur District for the year 2008.

S. No	District	Village	pH	EC	CO ₃	HCO ₃	Cl	SO ₄	NO ₃	F	TH	Ca	Mg	Na	K
					ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
1	Shajapur	Barod	7.17	941	0	366	71	58	10	0.35	400	120	24	16	28.0
2	Shajapur	Matkotra	7.13	1903	0	537	284	15	116	0.87	365	124	135	40	0.2
3	Shajapur	Tanodiya	7.25	1160	0	610	21	8	49	0.79	485	76	72	44	0.2
4	Shajapur	Soyat	7.29	1664	0	439	248	50	85	0.47	575	156	69	72	0.5
5	Shajapur	Guradi bangle	7.19	5005	0	952	876	150	404	0.71	.890	254	305	279	2.0
6	Shajapur	Susner	7.16	1388	0	537	113	15	90	0.5	510	154	55	38	0.2
7	Shajapur	Amla	7.43	757	0	189	121	35	19	0.88	175	48	13	94	0.5
8	Shajapur	Nalkhera	7.28	1353	0	348	117	65	195	0.4	•315	204	26	28	2.0
- 9	Shajapur	Agar	7.13	1453	0	354	199	55	121	0.43	540	202	33	40	0.7
10	Shajapur	Choma	7.24	989	0	409	74	10	53	0.59	375	106	27	55	0.1
11	Shajapur	M.barodia	7.43	2966	0	49	926	125	2	1.76	440	130	28	478	3.5
12	Shajapur	Panwadi	7.16	2370	0	573	294	115	220	0.73	890	240	71	135	1.7
13	Shajapur	Shajapur	7.28	1638	0	464	209	85	63	0.88	535	94	73	130	0.8
14	Shajapur	Tilawad gokind			0										
15	Shajapur	Salsalai	7.02	1059	0	317	82	90	40	0.67	335	104	18	77	0.6
16	Shajapur	Shujalpur	7.93	660	0	73	174	20	2	1.89	45	12	4	132	0.5
17	Shajapur	Akodia	7.23	1441	0	451	195	63	12	0.67	265	72	21	210	0.9
18	Shajapur	Kalapipal	7.05	1960	0	451	220	150	176	0.33	790	184	80	86	2.8
19	Shajapur	Nandni	.7.34	713	0	256	25	5	130	0.55	295	46	44	28	0.9
20	Shajapur	Arandia	7.38	514	0	177	64	15	3	1.52	105	22	12	70	0.2
21	Shajapur	Makshi	7.10	571	0	153	53	75	7	0.3	230	64	17	24	2.8

5.0 Ground Water Issues and Management Strategy

It is felt that the over exploitation, indiscriminate development of ground water industrial, development, anthropogenic and irrigation practice have lead to many ground water related problems, which needs proper management of ground water resources these problems are being discussed below :

5.1. Ground Water Depletion

As per ground water resources estimated of Shajapur district for the year 2004 the available ground water resources 523.20 MCM and gross annual ground water development for the entire district has been reached to 114% thus there is no scope for future development of ground water resources in the district. Out of eight blocks of district Agar and Shajapur blocks comes under semi critical category, Barod block comes under critical category, while rest of the five blocks are over-exploited.

5.2. Ground Water Conservation and Artificial Recharges

Considering stage of ground water development hydrogeological situation of the area, decline trend of ground water level and occasional scanty rainfall followed by deviation in the incidence of average annual rainfall there is need to implement artificial recharge to replenish the over exploited aquifer and to store surplus water during the monsoon season for use, during the dry season. Among the requisite for artificial recharge of ground water is moderate permeability and the host rock (deccan trap basalts/ water bearing strata) on the one hand and high permeability of over burden on the other hand.

In view of the fact that these requirement are available in the district to a large extent the feasibility of the artificial recharge to ground water becomes valid.

The degree & extent of weathering shallow depth is quite intense and the zone that favors higher infiltration rate is inferred. However the temporal and spatial extent of such weathered rock is to be systematically mapped.

Similarly the stream, which follows weak surface zone which can also constitute favorable areas for ground water recharge. Plan may be adopted using hill to valley approach in watershed. At origin of streams gully plug & contour trenches- may be constructed to arrest surface water run off. Gabion structures may be constructed at the down stream of these structures, across.

The stream to check the velocity of the following water percolation tanks are most important from ground water recharge point of view and these are recommended in second and third order stream on porous and permeable formations.

It overcome the silting problems, due to which percolation of water at sub surface may reduce, recharge shaft may be constructed inside the percolation tanks recharge shaft may also be constructed at those places where impervious formation are at surface and at shallow depth porous and permeable rocks are found.

Properly designed tube well also act as recharge shaft, if recharge water is needed in deeper aquifer overlain by imperious rocks. Sub surface dykes are water conservation structure constructed at suitable locations across the river beds at end of watershed to check sub surface flow of water along stream beds.

Dug well recharge is also applicable in rural area, in this the water from field is diverted in to recharge well through de-siltation chamber and filter media in well through delivery pipe.

In urban areas roof top rain water harvesting technique can be adopted. Municipal sewage and rejected waste water from industries units in town and cities should be treated on large and such treated water could be used for irrigation gardening, horticulture etc.

6.0 Ground Water Related issues and problems

Long term water level trend analysis shows that majority of ground water monitoring wells are showing decline trend. This is due to heavy exploitation of ground water for agriculture and industrial user resulting in the 114% stage of ground water development as a whole the district may be treated as over exploited. The salinity problem (generally medium to high saline) as electrical conductivity varies from 583 to 2700 $\mu\text{S}/\text{cm}$ reported at Kalapipal, barod, Choma & Soyat.

The successive drought due to scanty rainfall in the district has severely affected the agriculture activity resulting in the district falling under semi arid. The crises of drinking water are also worsted under such situations.

7.0 Awareness and Training Programme

Central Ground Water Board, North Central Region, has not organized any mass awareness programme water management training programme Mela, fair etc. expect Artificial recharge through open dug wells in over exploited blocks of Shajapur district.

8.0 Area Notified by CGWA/SGWA

The over exploited blocks of Shajapur district namely, Kalapipla Mohan Barodia, Nalkheda Sujalpr and Susner has not been notified till date.

9.0 Recommendation

- The Stage of ground water development of Shajapur district as a whole is 114% which reveals that there is very less scope for future development of G. W. as balance of ground water for future irrigation is showing negative firm of -81.65 MCM and depletion of ground water levels is recorded almost in all parts of the district due to the fact that withdrawal of ground water is exceeding the recharge and successive deficit in monsoon rainfall.
- Mass awareness programme and training programme by the scientist of Central Ground Water Board on ground water conservation and artificial recharge techniques should be conducted to aware the peoples and user agencies.
- It has been mandatory to implant the suitable rainwater harvesting techniques on the detailed hydrogeological and scientific basis delineating the productive and promising flow of Deccan traps by the use of satellite imagery and aerial photographs to locate worthy area for artificial recharge.
- Conjunctive area of surface water and ground water is recommended in the entire district.
- Roof Top Rain Water Harvesting project should be implemented in urban areas of Shajapur district.
- Cultivation in the district depends mostly on precipitation irrigation from ground water contributes upto 86.07% of the total area. This heavy dependence on ground water resources the existing medium and minor irrigation project should be utilized for assured irrigation.
- Municipal sewage and rejected waste water from industries units in town and cities should be treated and such treated water could be used for irrigation in gardening and horticulture etc.
- De-siltation of existing Ponds and Tanks structures / should be carried out every year to improve the ground water recharge through them.