CENTRAL GROUND WATER BOARD

MINISTRY OF WATER RESOURCES,
RIVER DEVELOPMENT AND GANGA REJUVENATION
GOVERNMENT OF INDIA

GROUNDWATER BROCHURE
KARAULI DISTRICT

RAJASTHAN

WESTERN REGION
JAIPUR
March 2018

GROUND WATER BROCHURE, KARAULI DISTRICT
AT A GLANCE

1	GENERAL INFORMATION		
i	**Geographical area (sq.km.)**		5038.60
ii	**Administrative Divisions**		2 (Hindaun & Karauli)
	No. of Blocks		5 (Hindaun, Karauli, Nadauti, Sopotara & Todabhim blocks)
	No. of Villages		878 (inhabited-836 +uninhabited-42)
	No. of Towns		3 (Hindaun, Todabhim & Karauli)
	Number of Municipalities (Nagar Palikas)		3 (Hindaun Todabhim & Karauli))
iii	**Population(as per 2011 census)**		1,458,248
iv	**Population Density (persons/sq.km. of area)**		264
v	**Literacy Rate**		66.22%
vi	**Normal annual rainfall(mm)**		559
vii	**Maximum/Minimum temperature(^oC)**		49/2
2	GEOMORPHOLOGY		
i	**Major physiographical units**	i	Hilly terrain in south, south eastern part and extreme north western part.
		ii	Isolated hills in alluvial plain in central part.
		iii	Alluvial part in northern part.
ii	**Major Drainage**		Chambal - Perennial Gambhir & Morel - Seasonal
3	MAJOR SOIL TYPES	i	Older Alluvium (2.88% of the area)
		ii	Lithosols and Regosols of hills (46.82% of the area)
		iii	Recent Alluvium (50.30% of the area)
4	NUMBER OF GROUND WATER MONITORING STATIONS OF **CGWB (As on March, 2018)**		
i	**No. of dug wells**		17
Ii	**No. of piezometers**		9
5	PREDOMINANT GEOLOGICAL FORMATIONS		• Alluvium • Formations of Delhi and Vindhyan Super Groups
6	HYDROGEOLOGY		
i	**Principal Water Bearing Formations**		Quaternary Alluvium and Talus & Scree (covering - 49% of district area)
			Vindhyan Sandstone and Shale (covering -51% of district area)
ii	**Pre-monsoon depth to water level during 2016 (mbgl)**		0.18-34.06
iii	**Post-monsoon depth to water level during 2016 (mbgl)**		1.33-34.06
iv	**Long term water level trend in last 10 years (2007-2017) m/year**		0.01 (decline) to -0.14 (rise)
7	GROUND WATER EXPLORATION BY CGWB (as on 31.03.2018)		

i	**No. of wells drilled**	**Type of wells**	**Formation**		**Total**
			Alluvium	**Hard rock**	
		EW	10	23	33
		SH	3	-	3
		PZ	8	4	12
			Alluvium		**Hard rock** (Vindhyan sandstone and shale)
ii	**Depth Range (m)**		31-157		100-203
iii	**Discharge (lpm)**		< 50-860		< 50-300
iv	**Transmissivity (m^2 /day)**		75 - 413		-
v	**Storativity**		1.06×10^{-1}– 3.55×10^{-4}		-
8	GROUND WATER QUALITY				
i	**Presence of chemical constituents more than permissible limit**	**EC: >3000 µmhos/cm at 25^0 C**	Constituted by 22% of samples		
		F:>1.5 mg/l	Constituted by 11% of samples		
		NO_3: >45mg/l	Constituted by 50% of samples		
Ii	**Type of water**		Alkaline		
9	DYNAMIC GROUND WATER RESOURCES (as on 31.03.2013) (Figures in mcm)				
i	**Net annual GW availability**		324.05		
Ii	**Existing Gross GW draft for all uses**		474.02		
Iii	**Projected demand for domestic and industrial uses up to 2025**		53.3746		
Iv	**Stage of ground water development (%)**		154.17		
10	AWARENESS AND TRAINING ACTIVITIES				
	Mass awareness programme organized		Nil		
ii	**Water management training programmes organized**		Nil		
11	EFFORTS OF ARTIFICIAL RECHARGE AND RAINWATER HARVESTING				
i	**Projects completed by CGWB (numbers and amount spent)**		Scheme on artificial recharge to ground water through dug wells in the district including entire Rajasthan State implemented by Ministry of Water Resources, Govt. of India during XI plan.		

		Six recharge structures completed/constructed.
12	GROUND WATER CONTROL AND REGULATION	
I	**Number of OE blocks**	4 (Hindaun,Sapotra,karauli & Todabhim)
Ii	**Number of safe blocks**	1(Nadauti)
13	**NOTIFICATION OF BLOCK**	Todabhim notified on 13.08.2011
		Hindaun Block proposed for notification vide Public Notice dated 11.01.2014
14	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	
i	**Over-draft of ground water**	Reduction in yields of wells
ii	**Declining water level**	
iii	**Ground water salinity**	Salinity, high fluoride and nitrate hazards have rendered ground water as unfit for various consumptions viz. drinking, irrigation, industrial etc. in isolated pockets of district
Iv	**High fluoride hazards**	
V	**High nitrate hazards**	

DISTRICT GROUND WATER BROCHURE
KARAULI DISTRICT

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GROUND WATER BROCHURE
KARAULI DISTRICT

1.0 INTRODUCTION

Karauli district is located in the eastern part of the Rajasthan State and lies between 26°02'00" and 27°00'00" North Latitudes and between 76°28'30" and 77°23'30" East

Longitudes covering geographical area of 5038.60 sq.km (Fig.1). Administratively the Karauli district is divided into two sub-divisions viz. Hindaun and Karauli. It has five blocks viz. Hindaun, Todabhim, Nadauti, Karauli and Sapotra. The total population of the district is 1,458,248 (Census 2011). Out of this, 14.96% of total population lives in towns and 85.04% in rural areas. The population density is 264 persons per sq. km of area.

The drainage system of the district is well developed. Main rivers in the district are Chambal, Gambhir & Morel and their tributaries. Chambal is the only perennial river and flows in north-easterly direction along interstate border of the district with Madhya Pradesh. Banas river making short boundary touches the Sawai Madhopur district boundary at Hadoti and joins. Morel river enters district 3 km south of Khera (in Sapotra block) and flows for a short distance in south direction and joins Banas river at Hadoti. Gambhir river originates from the hills near Karauli and follows a northernly course till Lapavali from where it takes turn and flows in the easterly direction. Near village Pali, it leaves the district and enters Bharatpur district.

Drainage in the rocky terrain is sub-parallel type, while in plain area, it is dendritic type. The drainage density in the district increases gradually towards south (Fig.2). Between Todabhim and Nadauti, it is less than 0.30 km/sq.km. The drainage density around Nayagaon, Begrama and west of Nadauti, is between 0.30 and 0.50 km/sq.km. Around Karauli, north of Sapotra , Hindaun and entire norht-eastern part of district, it ranges from 0.5 to 0.70 km/sq.km. In the southern part of district, the drainage density is more than 0.70 km/sq.km. This part is covered with Vindhyan and high drainage density indicates substantial run off. Agriculture activity is spread over both for kharif and rabi cultivation. Kharif cultivation is rainfed and rabi cultivation is mostly based on ground water. The main kharif crops grown in the area are Bajra, Guar, Cow pea (Chola), Moong, Moth where as principal rabi crops are Wheat, Gram, Mustard etc.

1.1 Previous work: Systematic hydrogeological surveys were carried out by the officers of Geological Survey of India during 1965-66 and by Central Ground Water Board during1976-77, 1977-78,1978-80,1979-80,1981-82 and 1979-80. Geophysical surveys (Resistivity survey) were carried out by Central Ground Water Board during 1979 and 1980. Reappraisal ground water survey were carried during 1995-96 and 1994-95. On the basis of hydrogeological studies, exploratory drilling programme was undertaken by Central Ground Water Board in parts of Banganga river basin during 1976-79 (drilled one exploratory well); in Morel river basin during 1979-82 (drilled 5 EW and 2 slim holes); in Gambhir river basin during 1983-85 (drilled 2 exploratory well, one slim hole and one piezometer). Later piezometers were constructed during 1993-94 (two), 1994-95 (three) and during 1997-98 (two). During 2012-13, 4 Exploratory well and 4 piezometers were constructed in hard formation.

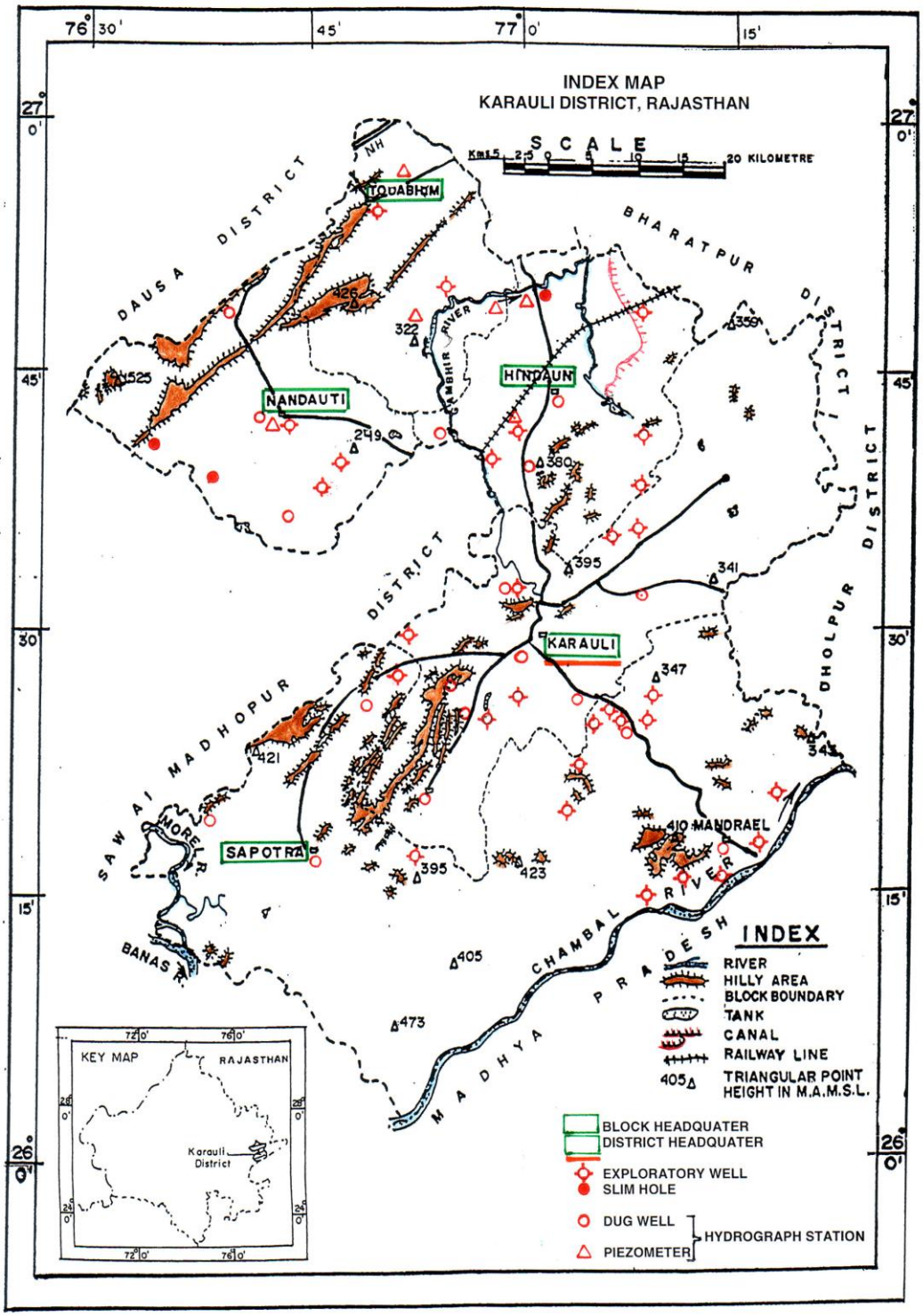

Figure1: Index map of Karauli District

Monitoring of National Hydrograph Stations established in the district is being carried out 4 times in a year by Central Ground Water Board.

Initially, the comprehensive report of Sawai Madhopur district (inclusive part of present Karauli district) was written in 1982 entitled “Ground Water Resources and Development Potential of Sawai Madhopur District”. In this series, it was revised during 1988.

Karauli district report was compiled. After that it was updated with information of Hydrogeological Framework and Development Prospects and issued in 2002. Ground water profile of Karauli district was issues in Jan, 2009.

2.0 RAINFALL AND CLIMATE

The climate of the district can be classified as semi-arid. It is characterized by very hot summers and very cold winters with poor rainfall during south-west monsoon period. In May and June, the maximum temperature may sometimes goes up to 48ºC. The potential evapotranspiration rates are quite high, especially during May and June. The total annual potential evapotranspiration is 1502.6mm. The normal rainfall of district is 559 mm with 67.12% of humidity. The height of mean sea level for the district varies from 400 to 600 m amsl.

3.0 GEOMORPHOLOGY AND SOIL TYPES

The surface elevation of the district ranges from 223 to 525 m above mean sea level. The south and south eastern part of the district comprises hilly terrain. Hills have generally NE-SW trend. Along the north-western border of the district between Todabhim and Raisana, a series of hill ranges belonging to Pre-Aravalli and Delhi Super Groups of rocks exist. These are also trending in NE-SW direction. Physiographically, the district is divided into three main parts as given below. The general elevation of these hill lie between 384 and 525 m above mean sea level.

Type	Description
Hilly terrain in south, south eastern part and extreme north-western part.	Hilly terrains are mainly confined to Karauli and Sapotra blocks. The highest elevation is 525 m amsl about 2.5 km. west of Chirawanda (in Nadauti block
Isolated hills in alluvium plain in central part	Major portion of district lying in northern, central and north-western part, comprises alluvial plains with isolated hills. Development of ravines is seen in area along Chambal river and its tributaries
Alluvial plain in the northern part.	Hindaun, Nadauti, and Todabhim form mainly plain terrain. The general elevation lies between 226 and 262 m amsl.

The soil types in Karauli district have been presented in table given below.

Soil	Area (sq. km)	%	Distribution
Older alluvium	145	2.88	Lies in parts of Todabhim and Nadauti blocks. These are derived from alluvium. They are non-calcareous, semi consolidated to unconsolidated brown soils, loamy sand to sandy loam in texture. They are well drained and occupy gently sloping terrains.
Lithosols and Regosols of Hills	2359	46.82	Occupies the parts of Nadauti, Karauli, Sapotra and Todabhim blocks. These are formed on the Bhilwara hills, and hill slopes. These soils are shallow with gravels very near the surface, light textured, fairly drained, reddish brown in colour. Cultivation is restricted because of a limited root zone.

Soil	Area (sq. km)	%	Distribution
Recent Alluvium	2535	50.30	Rests in parts of Nadauti, Hindaun, Todabhim, Sapotra and Karauli blocks. These are found along the flood plains of Chambal and Gambhir rivers and are developed on alluvium and covers about 2535 sq. km of district. The soil are deep, well drained, sandy loam to loam in texture and non-calcareous.

The area is drained by Chambal perennial river and Gambhir & Morel ephemeral rivers and their tributaries. Important water bodies are Pachna, Kolisil, Beshan Sagar, Nag Talai, Mohanpura and Talaka. The following irrigation projects exist in the district.

Type	Total nos.	Name of Project
Major	1	Pachna (Karauli block) Capacity – 10069 CCA in hec.
Medium	1	Kolisil (Sapotra block) Capacity – 4739 CCA in hec.
	2	Beshan Sagar (Todabhim block) Capacity – 2775 CCA in hec.
Minor	5	In Karauli block
	6	In Todabhim block
	5	In Sapotra block
	10	In Nadauti block

4.0 GEOLOGY

Quaternary alluvium occupies a large area of about 2453 sq. km. It is composed of silt, sand, clay, kankar and gravel and is deposited by major rivers and streams. It occupies the major part of Todabhim, Nadauti, Hindaun blocks underlained by Bhilwara Super Group of rocks (comprising of interbedded sequence of shale slate schist quartzite phyllite and limestone) separated with Vindhyan Super Group of formations (represented by Semri, Rewa, Bhander Groups consisting mainly of various types of Shales, Sandstones and Limestones) in entire east, south eastern part by the Great Boundary Fault. The extreme north-western stretch in small area is underlain by Delhi Super Group of rocks. The Delhi Super Group of rocks are found unconformably overlying the mica schist and gneisses of Bhilwara Super Group. The Alwar Group of rocks are folded forming the strike ridges. Conglomerates and conglomeratic quartzites are exposed as narrow outcrop to the south of Todabhim.Talus and Scree are found in local patches near hilly catchments having width from a few tens of metres to 500 metres and thickness from 40 to 55 m. Exploratory drilling has indicated a wide variation in thickness of alluvium ranging from 10 m in west to 65 m in eastern part.

5.0 GROUND WATER SCENARIO

5.1 Aquifer System

The ground water occurs both in unconsolidated and consolidated formations of the district (Fig.2).

A) Consolidated Formation

Consolidated formation covers about 2495 sq. km (49.52%) of district and forms the principal aquifer in the district. It covers the southern, eastern and extreme north western strip of the district. The consolidated formations include sandstone and shale of Vindhyan Super Group and quartzites and schists of Delhi Super Group. The ground water occurs under unconfined condition in weathered and fractures portion of consolidated formations. These form generally poorer aquifer than alluvium and are tapped by open wells, dug cum borewells and bore wells.The ground water condition in various formations is described as below:

i. Vindhyan Sandstone and Shale

It encompasses about 2280 sq. km area and lies in southern and entire eastern part of the district. It forms the most prominent aquifer after alluvium in areal extent. The quartzitic sandstone occurring around Sapotra, Ramsar Bad and Khiskar in southern part of district are fine grained, compact and massive. These are highly resistant to weathering. Ground water occurs under unconfined conditions in fractures and jointed space. This forms poor aquifer and many wells in these got dry during summers. These Sandstones are horizontal to sub-horizontal and more or less tectonically undisturbed, as a result, vertical joints are very rare.

Bhander sandstone occur as aquifer in southern and eastern part of the district around Bhankri, Machilpur and Langra. This is also resistant to weathering and has two sets of joints. Ground water in these occurs under phreatic conditions.

The aquifer is tapped by open wells, dug cum borewells and tubewells/ borewells. In general, the diameter and depth of open wells varies from 2.5 to 3.5 m and 12 m to 30 m, respectively whereas depth of bore wells lies between 50 m and 210 m.

The yield of open wells/ dug cum bore wells in majority of cases ranges from 20 to 70 m^3/day, whereas discharge of borewells from 4.5 m^3/hr to 22.50 m^3/hr.

ii. Quartzites and schists

Quartzites and Schists of Delhi Super Group constitute poor aquifer and occur in a limited area in extreme north western strip of district (forming western part of Nadauti block) and covers an area of about 215 sq.km. Ground water occurs under unconfined conditions in weathered portion of rock units and in joints, fractures and other structural weaker zones. The extent of weathering is low and varies from 2 to 10 m in thickness. Yield of open wells depends on extent of weathering and the diameter of wells.

Generally the yield of dug wells tapping these formation ranges from 30 to 70 m^3/day

B) Unconsolidated Formation

The ground water occurs under unconfined to confined conditions in the unconsolidated formation (alluvium of Quaternary age) which is tapped through various ground water abstraction structures viz. dug well, dug cum borewell and tubewell.

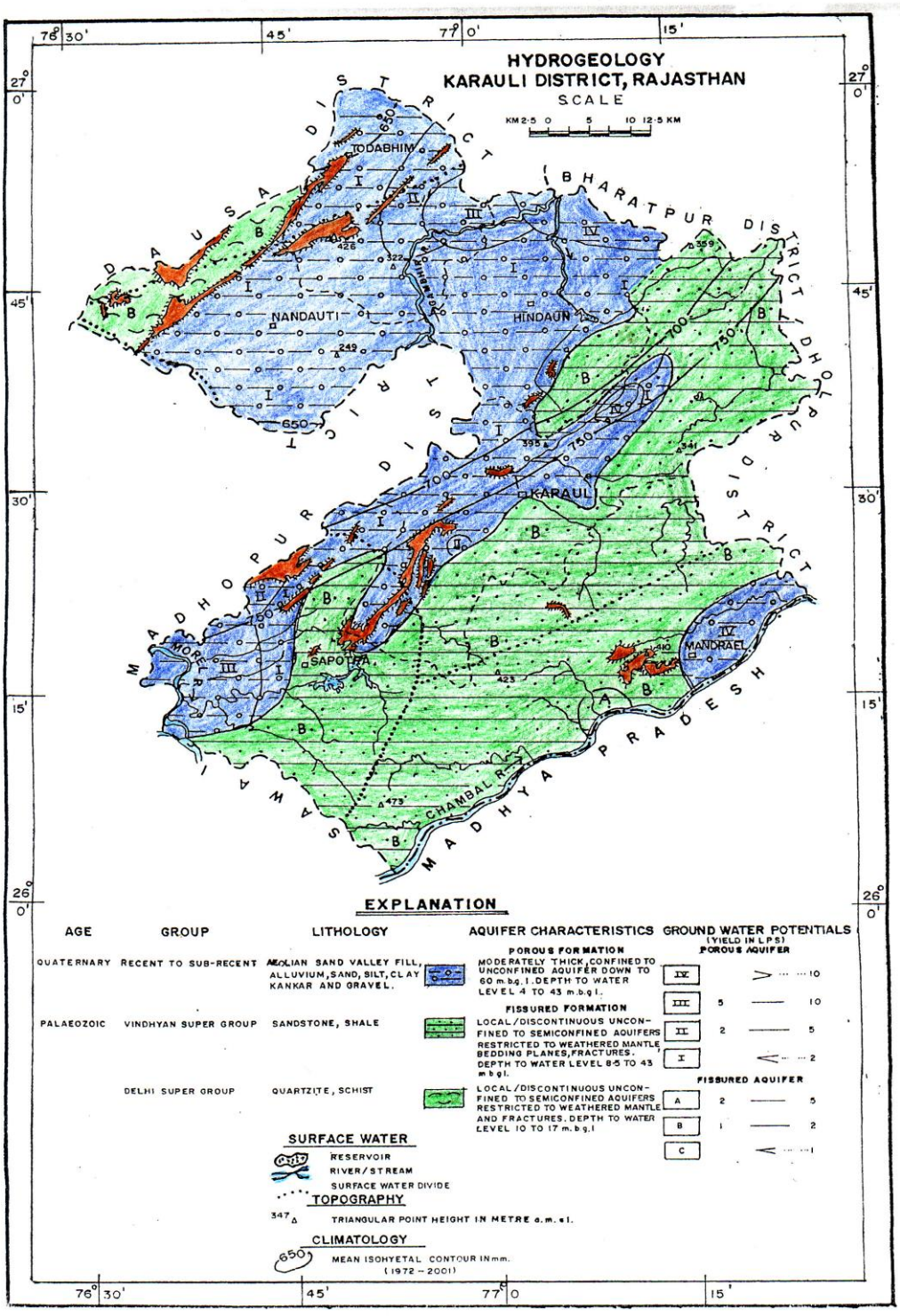

Figure 2: Hydrogeological map of Karauli district

i. Alluvium

Quaternary alluvium occupying an area of about 2453 sq. km., forms aquifer in large part. It lies in central, northern, western parts of the district and in extreme south-eastern patch along Chambal river. It consists of silt, sand, clay, kankar and gravel. Out of these sandy clay and silty clay with kankar forms the most dominating constituent which generally occur in upper zone and is being tapped by dug wells. Gravel generally occurs at depth near the basement and these too generally do not form continuous layer. Quaternary alluvium forms most important aquifer which is being tapped by dug wells, dug cm borewells and tubewells.

The ground water occurs under unconfined, semi-confined and confined conditions in these formation. Eleven exploratory wells, five slim holes and eight piezometers have been drilled as on March, 2014. The boreholes data revealed that the thickness of alluvium in major part of alluvial area varies from 10 m in western part to 65 m in eastern part. However, at Soroth thickness of alluvium reaches up to 91 m.

The yield of dug wells in majority of cases varies from 40 to 150 m^3/day. Higher yield is found where gravel bed is encountered. A few pumping tests have been conducted on open wells tapping alluvium. The data revealed that discharge of open wells lies between 9.06 m^3/hr and 31.6 m^3/hr. The draw down varies from 0.88 m to 3.76 m on 45 to 180 minutes of pumping. The time required for complete recuperation ranges from 150 to 240 minutes. The specific capacity ranges from 0.030 to 0.255 m^3/min/m of draw down and optimum yield from 0.050 to 0.64 m^3/min.

The yield of open wells and dug cum borewells tapping alluvial formation varies from 175 to 900 lpm having drawdown from 0.609 to 12.17 m depending upon the locations. The specific capacity of wells ranges from 0.0383 to 0.1131 m^3/m/m. The optimum yield (Karanjack's method) of wells varies from 106 to 374 lpm. The permeability of wells tapping quartzite ranges from 0.016 to 0.045 m/hr and maximum water inflow capacity from 8.61 to 32.99 m^3/hr.

ii. Talus and Scree

The Talus and Scree forms important aquifer in the district. These generally occur along fault zone in foot hill regions. These occur in flanks of high hills mainly Delhi Quartzites ranges lying in north-western part of district in Nadauti and Todabhim blocks and in central western part of district in Sapotra and Karauli blocks. The width of the talus and scree zone varies from a few tens of metres to 500 metres. These are composed to fine to coarse sand with angular fragments of rocks together with loess. Exploratory drilling at Todabhim and Patoli indicated that the thickness of talus and scree deposit varies from 40 to 55 m. Yield of dug wells tapping this formation ranges from 100 to 1000 m^3/day.

The talus and scree forms aquifer around Gidani, Chirawada, Chainpura, Timawa and Pal in Nadauti Block; around Todabhim, Patoli, Bhandari and Parli in Todabhim Block and also to south west of Sapotra in Sapotra Block.

5.2 Aquifer Parameters

The specific capacity of wells ranges from 0.11 m^3/min/m (at Katkar in Hindaun block) to 0.916 m^3/min/m (at Mahu in Hindaun block). Wells tapping talus and scree gave specific capacity values varying from 0.028 m^3/min/m (at Khora in Todabhim block) to 0.33 m^3/min/m (at Mohanpur in Karauli block). In Vindhyan sandstone it was 0.0715 m^3/min/m at Karauli.

The aquifer characteristics of deeper aquifers have been revealed by the pumping test done on exploratory well drilled by Central Ground Water Board in Banganga, Morel and Gambhir river basins. In part of Banganga basin falling in Karauli district, the confined aquifer occurs at Todabhim and has transmissivity of 413 m^2/day value and stortivity is of order of 2.40×10^{-2}. In Morel river basin slug test was conducted on a few exploratory wells where yield was very poor. The value of transmissivity ranges from 0.104 to 0.1053 m^2/day. The low transmissivity values indicate clayey and silty nature of formation. In the Gambhir river basin, the values of transmissivity computed were 28.12, 75.22, 220 and 288 m^2/day in exploratory wells at Hindaun, Sanet, Sri Mahaveerji and Suroth, respectively. The storage coefficient of formation was found varying between 1.50×10^{-3} to 0.355×10^{-3}.

5.3 Ground Water Level

The total number of hydrograph stations in the district is 26 including 17 dug wells and 9 piezometers.

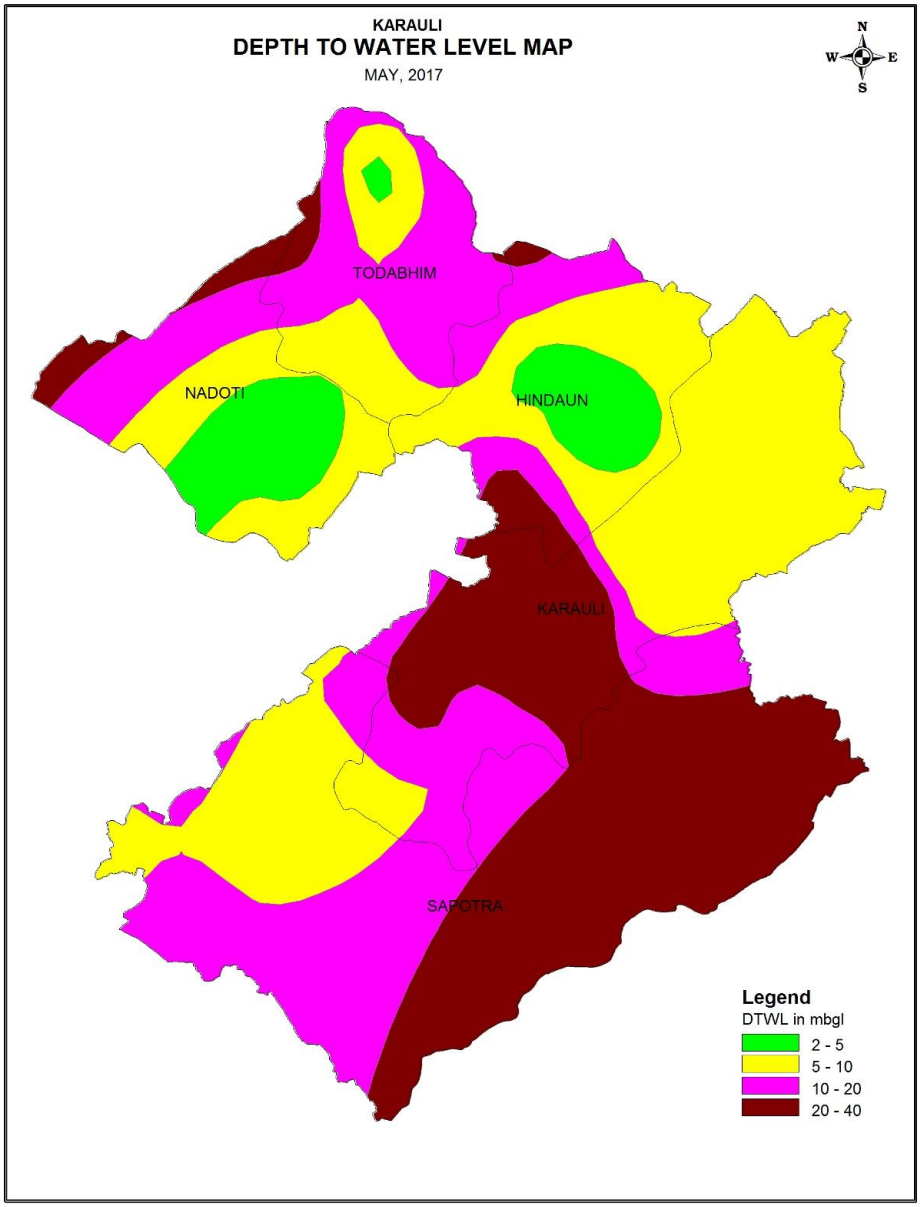

Figure 3: Depth to Water Level Map (May 2017)

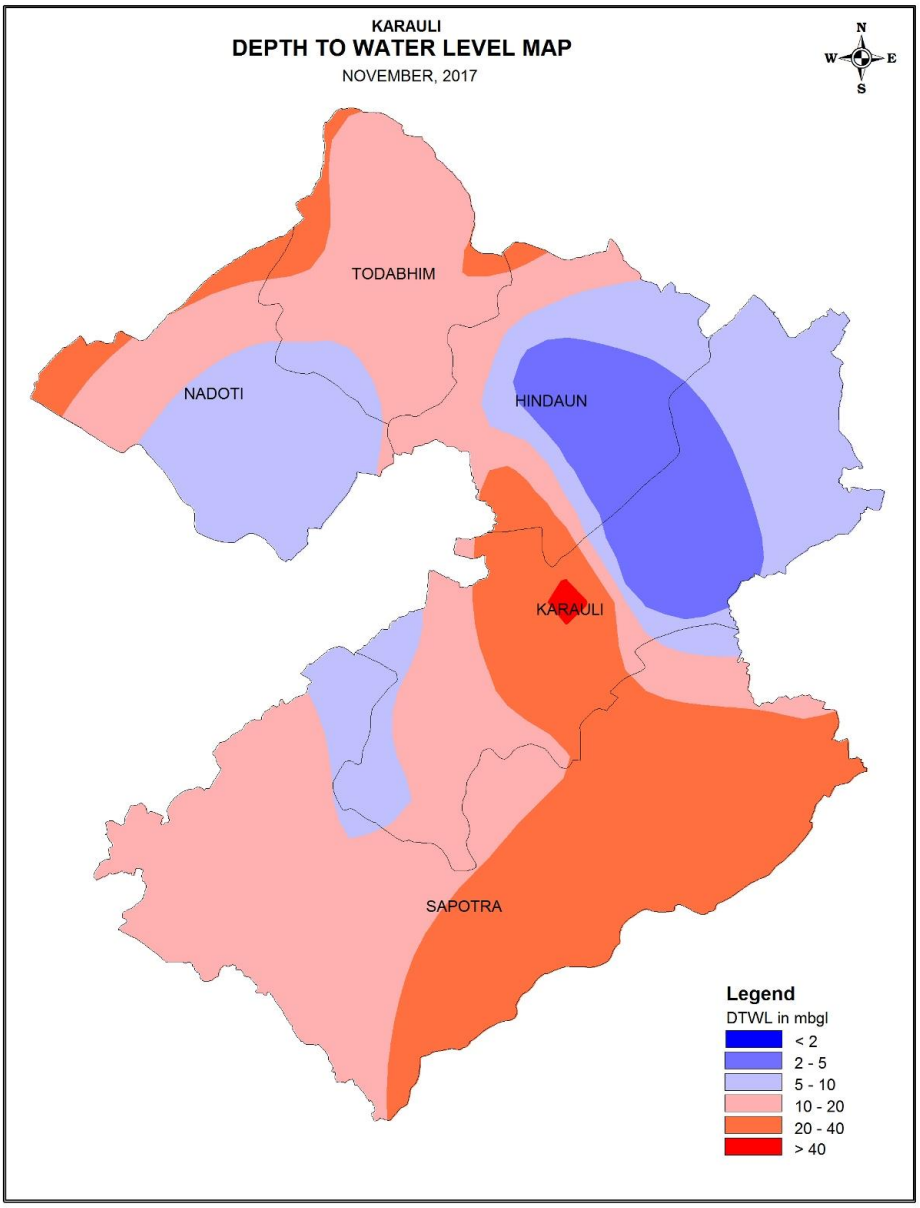

Figure 4: Depth to Water Level Map (November 2017)

Analysis of long term water level data of selected hydrograph stations for the last ten years (2007-2017) indicates that most of the selected representative wells from each block have shown rising water levels. The Badh Kamla station of Hindaun Block, Keladevi station of Karauli Block and Langra station of Sapotra Block have shown water level rises of 0.14, 0.06, 0.07 m/year, respectively. A very small water level falls have been seen at Karanpura station of Todabhim Block and Nadauti station of Nadauti Block during this period. The long term trends of selected stations are given below and hydrographs for these are given in Annexure I

Name of Station	Block	Trend (m/year)

Badh Kamla	Hindaun	-0.14
Karanpura1	Todabhim	0.04
Keladevi	Karauli	-0.06
Langra	Sapotra	-0.07
Nadauti	Nadauti	0.01

The status of bore holes (as on 31.03.2018) drilled by Board is as given in table below. In alluvium, the depth of drilling ranges from 31.0 to 162 m having depth of wells from 31.0 to 157 m. The discharge of well in general varies from less than 50 to 1300 lpm with drawdown ranging from 6.60 to 24.37m. 23 borewells and 4 piezometers have been drilled in Vindhyan Sandstone, Shale & Limestone and Delhi quartzite forming part of hard rock. The depth of borewells ranges from 101.54 to 203 m having discharge from less than 50 to 1320 lpm with moderate drawdown.

Type of wells	**Formation**		**Total**
	Alluvium	**Hard rock**	
Exploratory well (EW)	10	23	33
Slim Hole (SH)	3	0	3
Piezometer (PZ)	8	4	12

High yielding borewells have been drilled at Garhi Ka Gaon (440lpm), Rodhai (480 lpm), Ond (550 lpm), Atewa (600 lpm), Karauli (600lpm), Gothra (470 lpm), Mohanpurs (1320lpm) tapping Vindhyan and at Karauli (600lpm) tapping Delhi quartzite.

The discharge of exploratory wells statistically analysed is furnished below.

Discharge Range(lpm)		**Soft Formation**		**Hard Formation**	
		No. of well	**%**	**No. of well**	**%**
Less than 100		8	44	8	31
100	300	3	16.5	9	35
300	500	3	16.5	4	15
500	700	1	5	3	11
700	1000	2	11	1	4
More than 1000		1	5	1	4
Total		**18**		**26**	

5.4 Ground Water Quality

The ground water is alkaline type having pH value more than 7. According to ground water chemical quality data for Premonsoon 2016, the electrical conductivity value ranges from 550 μmhos/cm at 25°C (at Mamachari in Karauli Block) to a maximum of 6999 μmhos/cm at 25°C (at Sahar in Nadauti Block). However, in general it varies from 500 to 5000 μmhos/cm at 25°C (Fig.5). In major part of all the blocks, the electrical conductivity between 750 and 1500 μmhos/cm at 25°C is found. And in another larger part, it varies between 1500 to 3000 μmhos/cm at 25°C except few

western areas the block. EC value ranging between 2000 and 3000 is constituted by 11% of the samples and 20% of stations rest beyond 3000 μmhos/cm at 25°C occupying the south western part of Hindaun Block, southern part of Nandauti Block, some western part of Karauli Block and northern part of Sapotra Block.

Fluoride content ranges from 0.36 (at Hindaun station in Hindaun Block) to a maximum of 2.2 mg/l (at Islampur station in Hindaun Block). Out of total stations, 11% of stations have Fluoride concentration more than permissible limit of 1.5 mg/l (Fig.6). Nitrate concentration falls within permissible limit of 45 mg/l at 50% of stations (Fig.7). The minimum value of Nitrate is observed at Mamachari in Karauli Block (4 mg/l) and maximum at Sahar in Nadauti Block (600 mg/l).

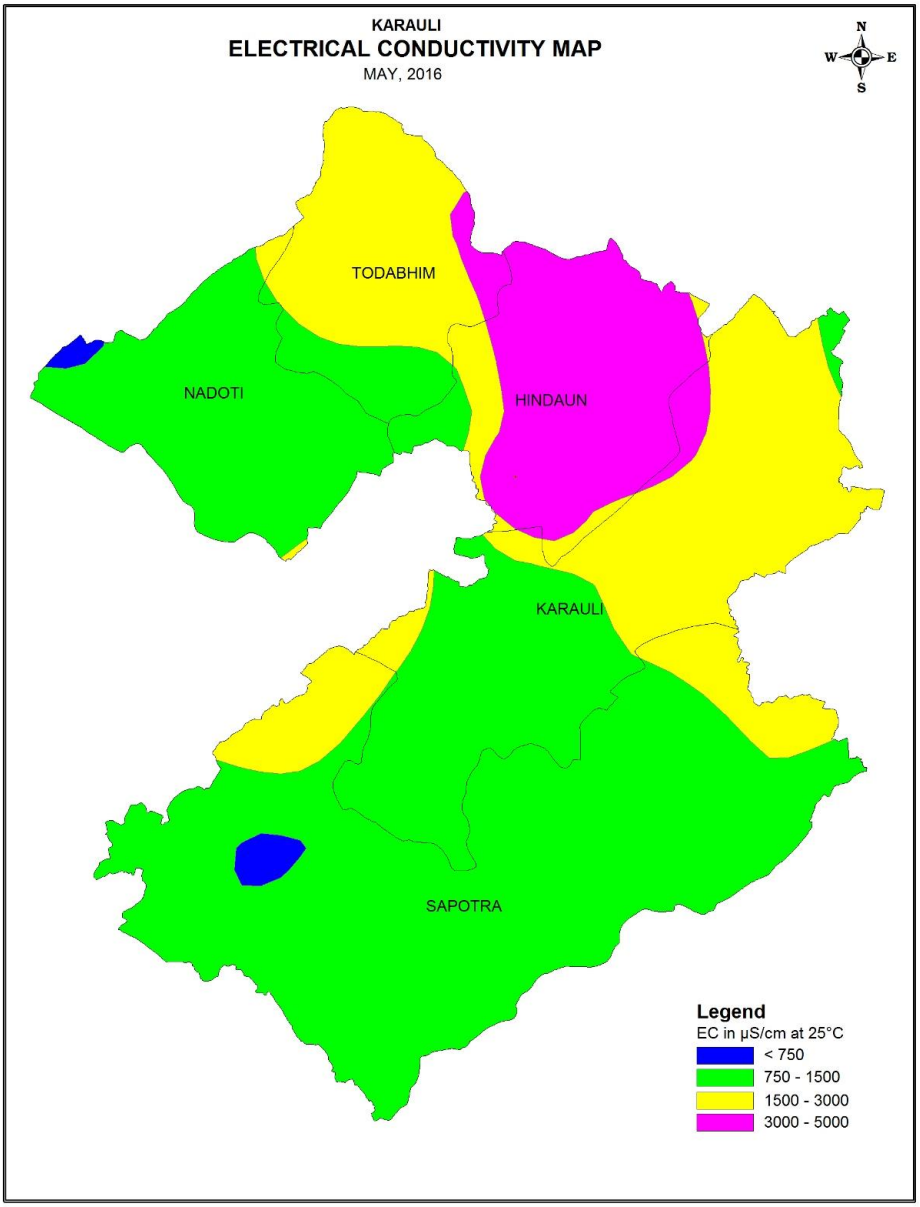

Fig 5: Iso Electrical Conductivity Map (May 2016)

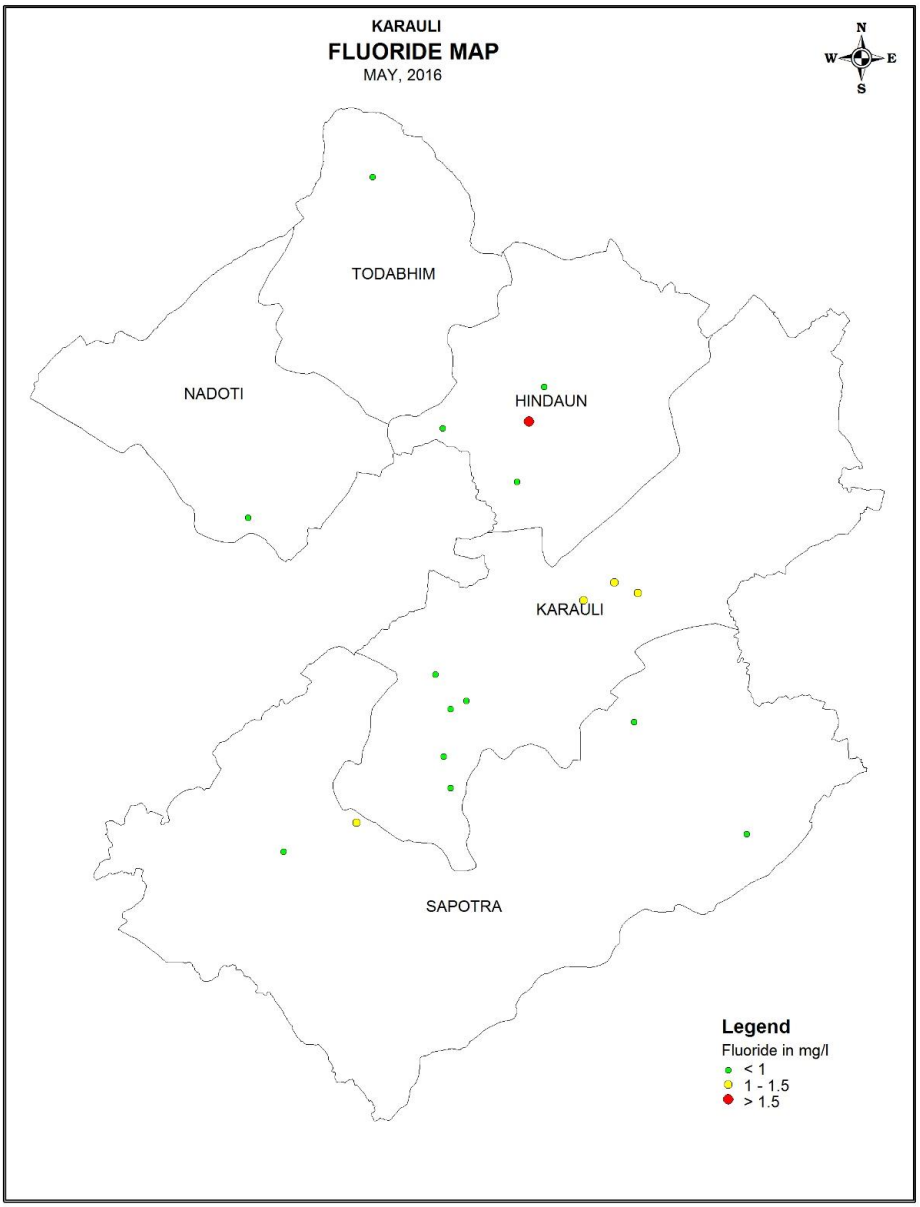

Fig 6: Fluoride Distribution Map (May 2016)

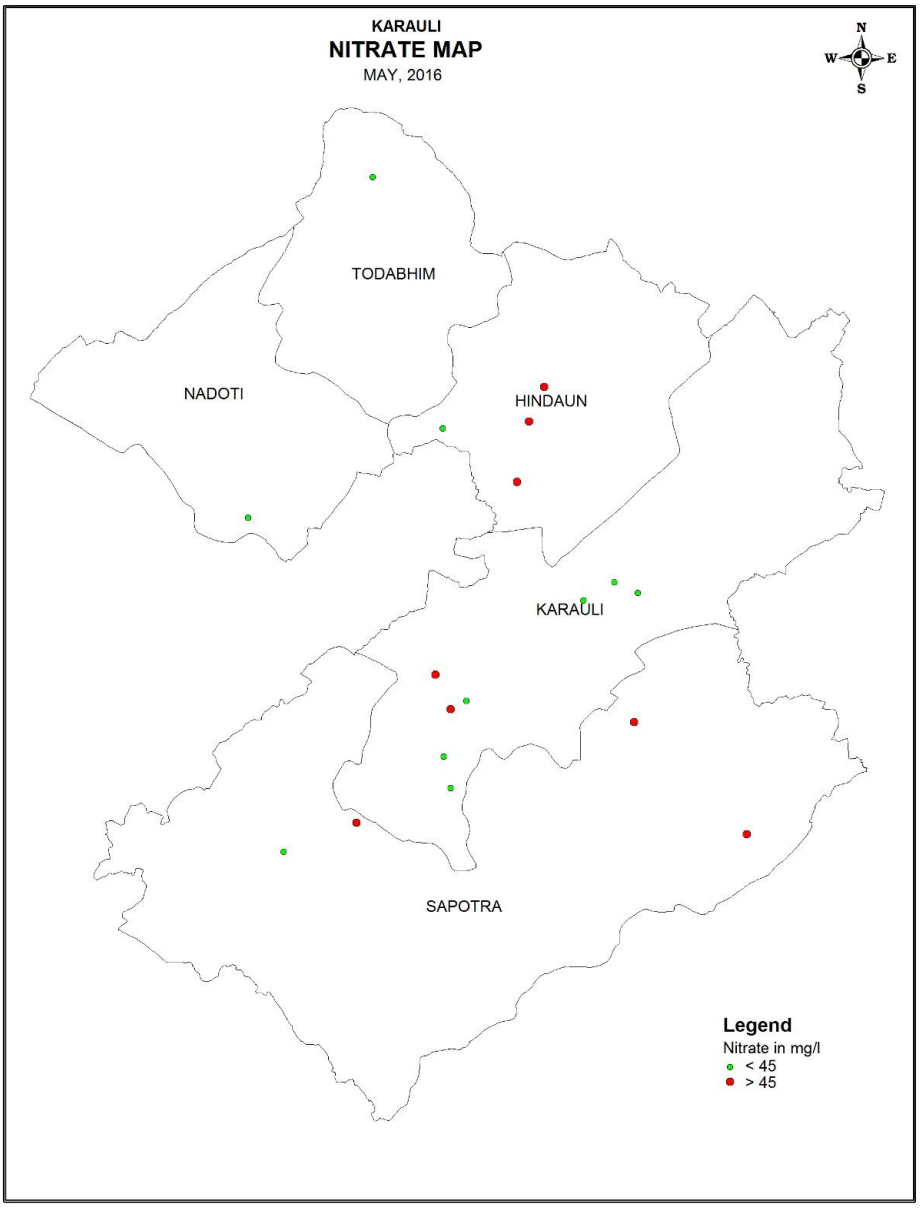

Fig 7: Nitrate Distribution Map (May 2016)

Ground water quality in shallow aquifer (Exploration Data)

The ground water in shallow aquifers is alkaline type having pH value more than 7. The electrical conductivity value ranges from 280 µmhos/cm at 25°C (at Atewa in Karauli Block) to a maximum of 8400 µmhos/cm at 25°C (Bardala in Nadauti Block). However, in general it varies from 500 to 5000 µmhos/cm at 25°C. In major part of all the blocks, the electrical conductivity between 750 and 3000 µmhos/ cm at 25°C is found. Electrical conductivity less than 750 µmhos/ cm at 25°C is found in major part of Nadauti block and locally in Todabhim, Hindaun, Karauli and Sapotra blocks.The isolated patches falling in Nadauti, Todabhim and Hindaun blocks, have been noticed between 3000 and 5000 µmhos/ cm at 25°C electrical conductivity values. Electrical conductivity more than 5000 µmhos/ cm at 25°C is observed in isolated pockets lying in southern part

of Nadauti block (Figure 8). EC more than 3000 µmhos/cm at 25°C is constituted by 12% of ground water samples analyzed.

The Nitrate content ranges from 2 ppm (minimum at Sai Markarpura in Karauli Block) to 571 ppm (miximum at Sahar in Nadauti Block). However, in general it lies between 10 ppm and 268 ppm. The analysis of data reveals that 66% of water samples analyzed fall within acceptable limit i.e. 45 ppm of drinking water standards and 34% beyond the limit which is not relaxable. The nitrate concentration is noticed within permissible limit of 45 ppm in major part of all the blocks. However, isolated pockets in Nadauti, Todabhim, Hindaun, Karauli and Sapotra Blocks, Nitrate concentration beyond acceptable limit of 45 ppm is observed (Fig.9).

The Fluoride content mostly fall within permissible limit of 1.5 mg/l. However, it ranges in the district from traces to 6.45 mg/l (maximum at Gudachanderji in Nadauti Block). However, in general it falls between traces and 2.60 mg/l (Fig.9).

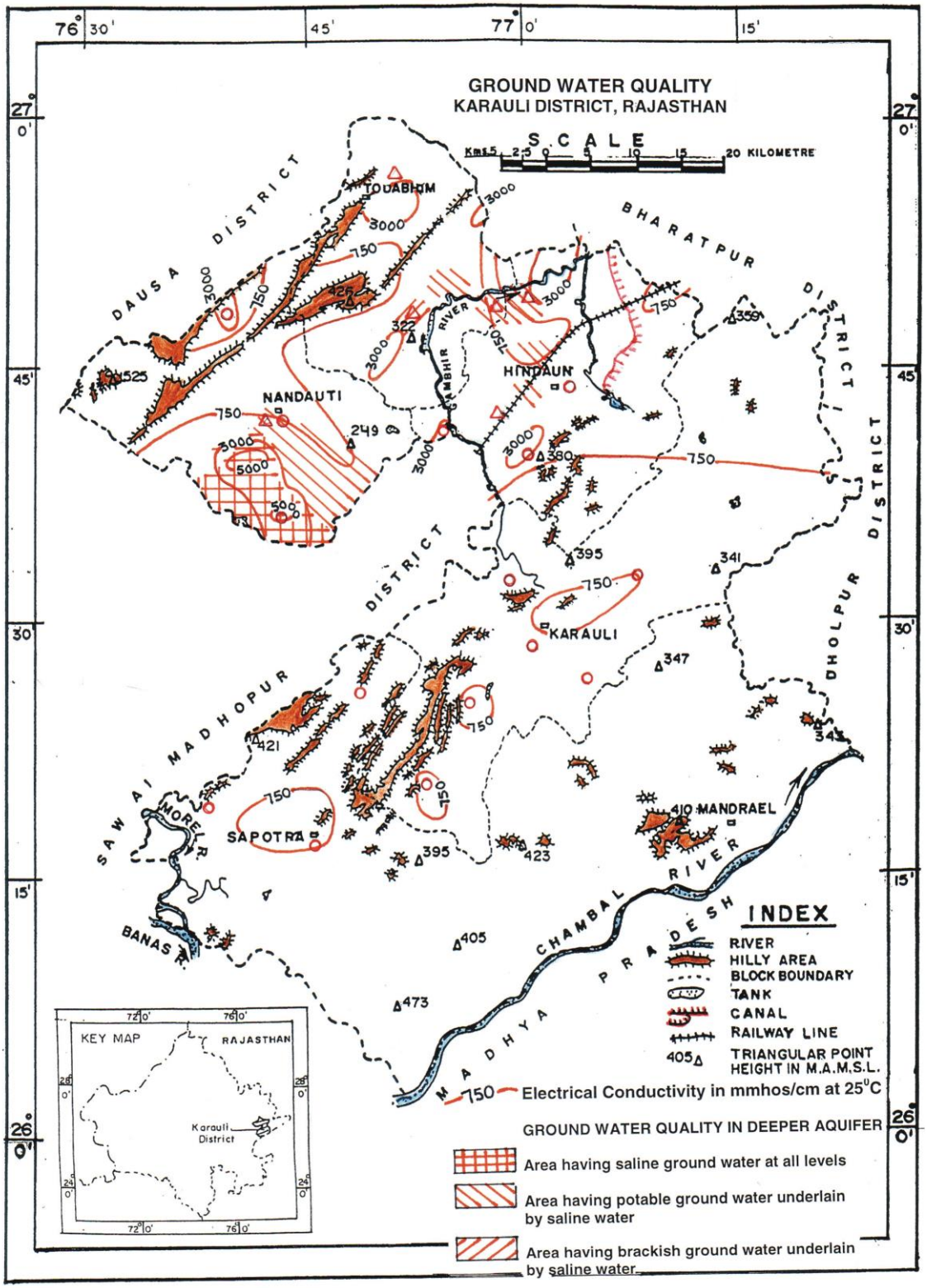

Figure 8: Electrical Conductivity Map (Exploration Data)

The statistical analysis of data indicates that 82.03% of samples have Fluoride concentration within permissible limit i.e. 1.5 mg/l of drinking water standards and 18% beyond the limit. The Fluoride concentration less than 1.5 mg/l (permissible limit as per drinking water standards) is observed in major part of all the blocks in the district. However, isolated patches having Fluoride content more than 1.5 mg/l have been observed in northern part of Nadauti Block and in extreme part of Hindaun Block.

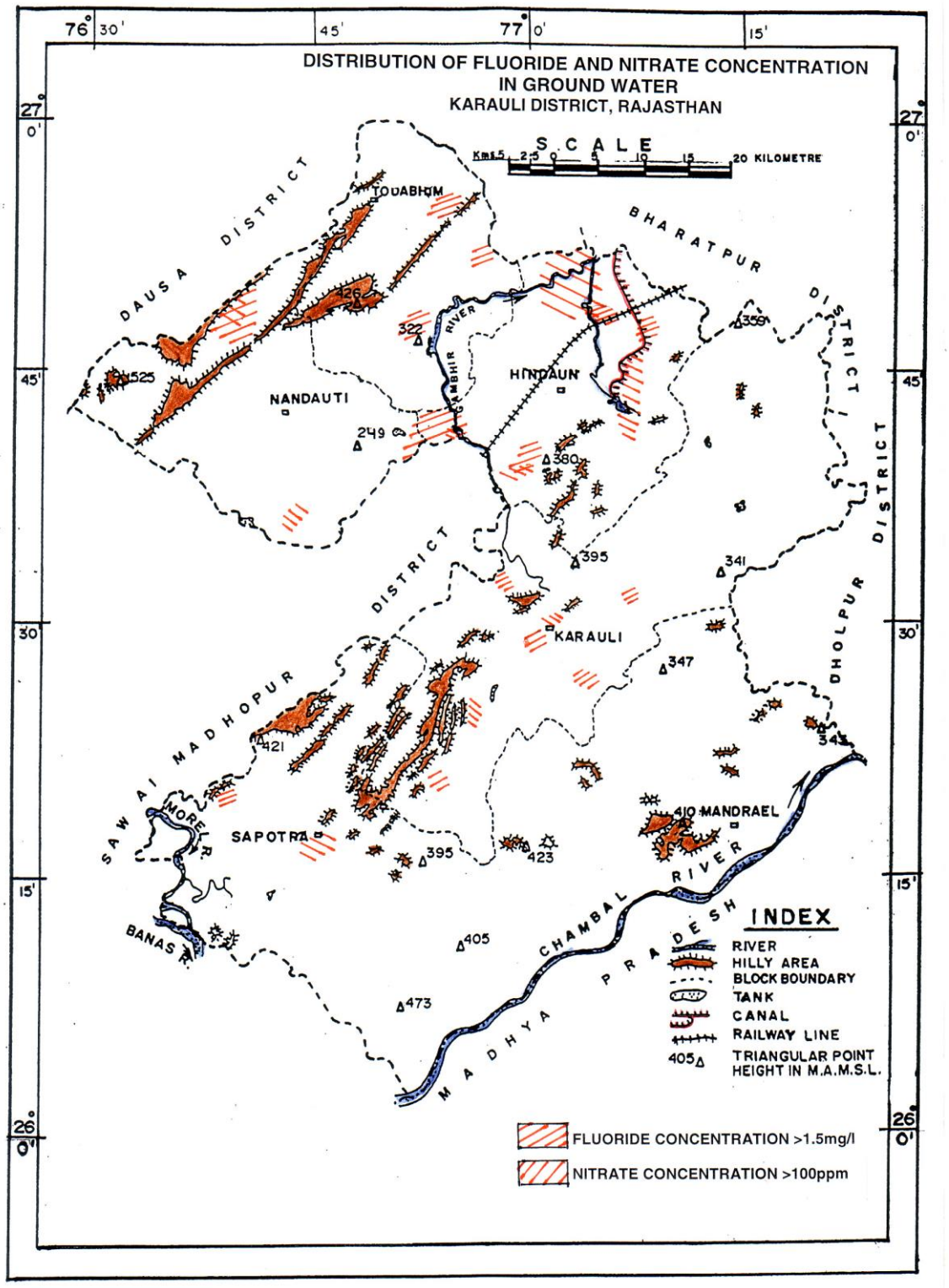

Figure 9: Fluoride and Nitrate Distribution Map (Exploration Data)

Ground water quality in deeper aquifer (Exploration Data)

The electrical conductivity value ranges from 500 (minimum at Ratanpura in Sapotra block) to 16500 (maximum at Nagal Pahari in Todabhim block) mmhos/cm at 25°C. The electrical conductivity value more than 3000 mmhos/cm at 25°C is constituted by 27.05% of stations. The minimum & maximum values of Electrical Conductivity values in deeper aquifers are on higher side. The Nitrate concentration in deeper formation ranges from

6 ppm (at Banki in Hindaun Block) to 306 ppm (at Mandryel in Sapotra Bblock). The nitrate content more than 45ppm (which is acceptable limit and no relaxation beyond this) is constituted by 67% of stations. The Fluoride concentration varies form 0.26 mg/l (at Kurgaon EW in Sapotra Block) to 4.0 mg/l (at Nadauti Pz in Nadauti Block). The Fluoride concentration more than 1.50 mg/l is constituted by 22% of stations.

Depth wise salinity variation

The depth wise salinity variation of ground water is indicated by analytical results of water samples collected from exploratory wells, slim holes and piezometers falling in the study area and also from geophysical analysis/ interpretation results of these bore holes. The depth wise ground water quality variation scenario is described in the following paragraph and depicted in Fig.8.

a. Saline ground water at all level

The saline ground water at all level has been noticed around Bamori, Bardala, north of Gandal Sagar, Bagar Shahar and south of Gothra ka Pura areas falling in southern part of Nadauti Block.

b. Potable ground water underlain by saline ground water

Such areas around Nadauti and complete south-eastern part of Nadauti upto the Sawai Madhopur district (around Gothra Kapura, Sop, Khedla Khedi, Badagaon, Kalma Kemri, Lanwad) boundary in Nadauti Block; around Mundia, Karanpura (Todabhim Block), Tibara, Mandawar, Sikranda Meena in Hindaun Block) have been noticed.

c. Brackish ground water underlain by saline water

Such areas have been observed around Nangal Pahari in Todabhim block

Ground Water Quality in Karauli Urban Area

The ground water quality in Karauli urban agglomerate is fresh, potable and suitable for domestic, agricultural and industrial purposes. The electrical conductivity of ground water is generally within 2000 µmhos/ cm at 25°C and Chloride content within 500 ppm. The Fluoride concentration in general lies within permissible limit of 1.5 mg/l. The Nitrate content in major part of area lies within permissible limit however, higher concentration i.e. >100 ppm is noticed at som places.

5.5 Ground Water Resources

The dynamic ground water resources as per ground water estimation as on 31.03.2013 are furnished below.

Block	Area of Block (Sq.Km.)	Potential Zone Area (Sqkm)	Net Annual G W Availabi- lity (mcm)	Existing Gross Ground Water Draft for Irrigation (mcm)	Existing Gross Ground Water Draft for Dom.& Industrial Use (mcm)	Existing Gross Ground Water Draft for All Uses (mcm)	Net G.W. Availabi-lity for future Irrigation Develop-ment (mcm)	Stage of Ground Water Develop-ment (%)	Category
1	2	3	4	5	6	7	8	9	10
Hindaun	637.70	575.20	58.04	118.24	9.70	127.95	0.0000	220.42	OE
Karauli	1262.09	1084.46	85.03	85.87	9.64	95.51	0.0	112.33	OE
Nadauti	650.50	571.06	35.45	23.33	5.57	28.91	8.09	81.54	SAFE
Sapotra	1958.81	1219.49	99.63	97.43	10.07	107.5	0.47	107.9	OE
Todabhim	529.50	452.21	45.90	96.98	17.17	114.15	0.0000	248.66	OE

Out of total 3902.42 sqkm of potential zone area, 3607.87 sq.km.(92.45%) area falls under non-command and 294.55 sq.km.(7.55%) fall under canal command area. Out of 5 blocks, 4 blocks (Hindaun, Sapotra,karauli and Todabhim) fall under over-exploited category and 1 block Nadauti under safe category.

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

6.1. Declining ground water level

Long term water level data (2007 -2017) has indicated declining water level trends at many stations of district. As a result of which, three blocks viz. Hindaun, Sapotra and Todabhim have entered into over-exploited category which is needed to be controlled through notifying the blocks and further imposing ban on the construction of ground water abstraction structures except drinking use.

6.2 Ground water salinity

The electrical conductivity more than 3000 µmhos/cm at 25°C is represented by 20% of stations only. The isolated patches falling in Nadauti, Todabhim and Hindaun blocks, have been noticed between Electrical Cobnductivity values of 3000 and 5000 µmhos/cm at 25°C. Electrical conductivity more than 5000 µmhos/cm at 25°C is observed in isolated pockets lying in southern part of Nadauti Block and western part of Karauli Block.

6.3 Fluoride hazard

The Fluoride content more than 1.5mg/l is constituted by 11% of stations which has been observed in isolated pockets in Hindaun and Karauli Blocks.

6.4 Nitrate hazard

The Nitrate content more than 45 ppm is constituted by 50% of stations which has been observed in isolated pockets in Nadauti, Hindaun, Karauli and Sapotra blocks.

7.0 GROUND WATER DEVELOPMENT AND MANAGEMENT STRATEGY

7.1 Ground Water Development

The stage of ground water development (as on 2013) for the district is 154.17%. Out of total 5 blocks, FOUR blocks viz. Hindaun,Sapotra and Todabhim ,karauli have more than 100% stage of ground water development ranging from minimum 107.90% in Sapotra block to a maximum of 248.66% in Todabhim block and have been categorized under over-exploited category. Remaining block viz. nadauti have 81.54% stage of ground water development, and have been categorized under safe category.

7.2 Ground Water Management

- As the district has 154.17% stage of ground water development, no recommendation is extended in Hindaun,Karauli, Sapotra and Todabhim blocks which are over-exploited and hence thereby leaving little scope of further ground water development for irrigation except for drinking purpose. Remaining Nadauti block fall under safe category and have very limited scope for future GW development for irrigation. If at all required, GW development may be taken up only in very restricted and planned way to avoid becoming further over-exploited.
- Ground water should be used judiciously taking in to account of modern agriculture water management techniques by cultivating crops requiring less watering and use of sprinkler system and drip irrigation should be encouraged.
- A modern agriculture management has to be taken into account for effective water management techniques involving economic distribution of water maintaining minimum pumping hours and also be selecting most suitable cost effective crops pattern i.e. for getting maximum agriculture production through minimum withdrawal. Adopting proper soil and water management even the ground water with some what dissolved solids(TDS) may also be suitable for irrigation for salt tolerant crops in the area having high salinity.
- Desalination and de-flurosis plants may be installed in the areas/villages facing ground water salinity and fluoride hazards.
- As the area is underlain by unsaturated moderate thickness of alluvium which provides sufficient scope of artificially augmentation to the ground water body as alluvial formation has very good storage and transmission capacity. In the district, there is rainfall of about 2816.58 mcm considering the area and average annual rainfall.. The above data indicate the availability of surplus water which can be used for artificial recharge through the various techniques feasible in alluvial and hard rock terrain. In alluvial area, following ways of recharge techniques may be adopted.
  - i) Roof top/paved area rain water harvesting for recharge to ground water in urban and industrial area.
  - ii) Village water runoff/roof top rain water harvesting by dug wells/percolation tanks in rural area.

iii) Construction of recharge shafts with gabion structures in nalas.
iv) Recharge by dug well/percolation pit in agriculture farm.

In hard rock terrain nala bunding, anicuts, dug wells, percolation tanks etc. are feasible structures which may be used to recharge the ground water body. These will certainly enhance the recharge to ground water body resulting in rise in water level.Technical guidance is provided by CGWB to various organizations as and when approached.

- Mass awareness programmes should be arranged at local level to make common mass aware of importance of ground water resources, its better practices of use in domestic, irrigation and industrial fronts, present status of ground water scenario, its conservation etc.
- Training programmes should be arranged at local level to teach the common mass of various techniques of artificial augmentation to ground water resources.

8.0 NOTIFICATION OF BLOCK

The stage of ground water development of the district is 154.17.23% which reflects excessive withdrawal of ground water in comparison to recharge, resulting in depletion of ground water levels and reduction in yield of wells. In view of this, one block i.e. Todabhim in Karauli district has already been notified by Central Ground Water Authority, New Delhi on 13.08.2011 for regulation and control of ground water development. In such notified block, permission to abstract ground water through any energized means is not accorded for any purpose other than drinking.

Hindaun Block of the district is also proposed for notification vide Public Notice dated 11.01.2014 for regulation and control of ground water development.

9.0 AWARENESS AND TRAINING ACTIVITIES

Awareness programme for conservation & judicious use of water and training programme for rain water harvesting in the district particularly in notified block of Todabhim and in the Hindaun Block (proposed for notification) are to be planned and executed.