For official use

Technical Report Series

GROUNDWATER BROCHURE

SABARKANTHA DISTRICT

Compiled By

K.M.NAYAK
Asst. Hydrogeologist

Government of India
Ministry of Water Resources
Central Ground Water Board
West Central Region
Ahmedabad

April 2014

PROFILE OF SABARKANTHA DISTRICT

SL No.	Items	Statistics
1	General Information	
	i) Geographical area as per state territory/as per village papers (Sq. Km)	7390
	ii) Administrative Divisions (As on 3/2011) Number of Taluka Number of Village	 13 11389
	iii) Populations (As per 2011 census)	2,42,7346
	iv) Average Annual Rainfall (mm)	810
2.	GEOMORPHOLOGY	
	Major Physiographic Units : Pediments, highly dissected plateau and hills	
	Major Drainages: Sabarmati, Vatrak, Hathmati, Meshvo, Hamav & Khari	
3.	LAND USE (Sq. Km) (2006-07)	
	a) Forest area b) Net area sown c) Cultivable area	1263 4376 5735
4.	MAJOR SOIL TYPES**:** Sandy soils & Loam, Brown to black soils, Black cotton soils	
5.	AREA UNDER PRINCIPAL CROPS (Hectare) (2006-07) Rice - 8, Jowar-1, Bajra-23, Wheat-101, Maize-116,Total cereals-249, Gram -4, other pulses-46, Total pulses-50, Total food crops- 300, Ground nut-59, Seasam -6, Rapes and Mustard-11, Total oil seeds-113, Cotton – 85.	
6.	IRRIGATION BY DIFFERENT SOURCES (Area in Sq Km/ no of structures)	
	Dugwells	1339/79503
	Tube wells/Borewells	499/6256
	Tanks/Ponds/Water conservation structures	7
	Canals	256
	Other Sources	21
	Net Irrigated area (sq. km.) (2006-07)	2122
	Gross Irrigated area (sq. km.) (2006-07)	2845
7.	NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB (As on 31-03-2011) No of Dug Wells No of Piezometers	45 33 12
8.	PREDOMINANT GEOLOGICAL FORMATIONS: Meta-sediments such as Phyllites, quartzites, schist of Aravalli super group and Delhi Super group, Post Delhi Intrusive of Idar granite and gneiss; Infra-trappean of Lameta beds; Himmatnagar sandstones and limestone; Deccan trap basalts and alluvium deposit by river channels and valley fills.	
9.	HYDROGEOLOGY Major Water Bearing Formation**:** Groundwater occur in unconfined to semi-confined condition in phyllite, schist & quartzite, Granite and gneiss, Deccan trap formation in weathered mantle and factures zones. Under unconfined to confined condition in alluvium along river courses, valley fills flood plain & abandoned Palaeochannel deposits.	

Depth to water Level during 2011-12		
Period	Phreatic Aquifer (DTW)	Semi-confined /Confined Aquifer (PZ head)

	Min	Max	Min	Max
Pre Monsoon	**4.68 (Khedbrahma)**	**41.40 (Derol Pz)**	**NA**	**NA**
Post Monsoon	**1.73 (Vijaynagar)**	**41.00 (Derol)**	**NA**	**NA**

Long Term (10 Years) Water Level Trend (2003 to 2012)

Trend	Pre-Monsoon	Post- Monsoon
Rise (m/Yr)	0.0003 (Virpur) to 2.339 (Revas)	0.0092 (Hamirpur) to 2.5008 (Revas)
Fall (m/Yr)	0.007 (Panvath) to 0.4265 (Khedbrahma)	0.007 (Vijaynagar) to 0.5101 (Ratanpur)

10.	GROUND WATER EXPLORATION BY CGWB (As on 31-03-2011)	
	No of wells drilled (EW, OW, Pz, SH, Total) EW: 105,OW: 18, PZ :12, SH:03, Total: 138	
	Depth Range(m)	20.00 m to 500.18
	Discharge (Litres per minute)	12.60 to 720
11	GROUND WATER QUALITY	
	Electrical Conductivity (uS/cm at 25°C)	597 – 5390
	Fluoride (mg/l)	0.0 – 2.0
	NO_3 (mg/l)	3.0 – 590
	Iron (mg/l)	0.0 – 1.53
12.	DYNAMIC GROUND WATER RESOURCES (As on 2011)	
	Annual Replenishable Ground Water Resources (MCM)	1248.83
	Net Ground water Availability (MCM)	1186.39
	Projected Demand for Domestic and industrial Uses upto 2025 (MCM)	77.38
	Stage of Ground Water Development (%)	72.7 (Semi – critical)
13	AWARENESS AND TRAINING ACTIVITY (as on 3/2012)	
	Mass Awareness Programmes organized No of Participants	Nil
	Water Management Training Programmes organized (No of Participants)	Nil
14	EFFORTS OF ARTIFICIAL RECHARGE & RAIN WATER HARVESTING (31-3-2011)	
	Projects completed by CGWB (No & Amount spent)	Nil
	Projects under technical guidance of CGWB (Numbers)	NA
15	GROUND WATER CONTROL AND REGULATION (2011)	
	Number of OE Blocks	Nil
	Number of Critical Blocks	Nil
	Number of Semi Critical Blocks	04
	Number of Safe Blocks	09
	Number of Saline Blocks	Nil
	No. Of Blocks Notified by CGWA	Nil
16	MAJOR GROUND WATER PROBLEMS AND ISSUES	

i) Declining Groundwater levels/ Piezometric heads in user aquifers
ii) Increasing depth of tube wells
iii) Increasing instances of high fluoride
iv) Groundwater contamination due to unplanned construction and poor technical design of tube wells
v) Awareness amongst villagers on water conservation techniques
vi) Demand supply management

Contents

GROUNDWATER BROCHURE OF
SABARKANTHA DISTRICT

1. INTRODUCTION:

The district derives its name from the Sabarmati river that separates Sabarkantha from the neighbouring districts. The district is bounded by the Rajasthan State to the north, Banaskantha and Mehsana districts to the west, Gandhinagar, Kheda, and Panchmahal districts to the south. It is a border district in the eastern part of the Gujarat and is situated between $23^0$03'32" and $24^0$29'40" North latitudes and $72^0$43'34" and $73^0$39'26" East longitudes, covered by toposheets no. 45D, H, 46A and E of Survey of India. The district head quarter at Himmatnagar well connected with road and rail with Ahmedabad and Gandhinagar. Fig. 1 Location Map of Sabarkantha District.
The district consist of 13 talukas namely Bayad, Bhiloda, Dhansura, Himmatnagar, Idar, Khedbrahma, Malpur, Meghraj, Modasa, Prantij, Talod, Vadali, Vijaynagar.

1.1. DEMOGRAPHY

According to the 2011 census, the total population of Sabarkantha district is 24,27,346 persons. Out of this nearly 85% rural population is spread in 1376 villages while 15% of urban population is spread in 15 towns. The density of population is around 328 souls per sq.km. The district had a population of 20,82,531 as of 2001 and 24,27,346 as of 2011 with an decadal growth of 16.56%. The demographic analysis reveals that during last two decade there has been rapid growth in urban population. Sabarkantha has a sex ratio of 950 females for every 1000 males and a literacy rate of 76.60%.

1.2. CLIMATE

Sabarkantha district is located in east of *Gujarat,* comes under normal rainfall areas in Gujarat, having sub-tropical climate with moderately low humidity. The main seasons prevailing in the district are (a) monsoon - mid of June to October, (b) winter - November to February, and (c) summer – March to June.

The maximum daily temperature during the year ranges from 31.0 °C in January to 48.5 °C in May while minimum temperature ranges from 11.5 °C in January to 27.5°C in May. Maximum humidity ranges from 81.0% to 25.5%. The wind speed ranges from 88.0 to 184.9 km/day, where as evapo - transpiration ranges from 3.5 to 7.8 mm/day.

Table 01: Climatological Data of Idar station in Sabarkantha district

Climatological Data								
Station:	Idar				District:	Sabarkantha		
Altitude:	219	m AMSL			HA	10	**0.7479511**	
Latitude:	$23^0$50'	N			Longitude:	$73^0$02'	E	
Month	**Max Temp (Deg.C)**	**Mini Temp (Deg.C)**	**Humidity (%)**	**Wind Spd. Kmpd**	**Sunshine (Hours)**	**Solar Rad. (MJ/m2/d)**	**Eto (mm/d)**	**Rainfall (mm)**
January	33.2	13.1	33.0	127.5	8.9	16.6	3.7	0.0
February	38.4	17.0	28.5	129.2	9.5	19.4	4.5	0.0
March	43.9	21.1	25.5	134.6	10.1	22.8	5.8	0.0
April	46.8	21.8	26.5	140.0	10.8	25.6	7.0	0.0
May	48.5	27.5	37.5	161.6	11.4	27.1	7.8	0.0
June	47.2	23.9	57.0	184.9	8.7	23.1	6.8	8.0
July	39.6	23.3	71.5	136.4	5.3	17.9	4.5	177.9
August	36.4	23.3	81.0	105.9	5.4	17.6	3.9	149.2
September	37.4	22.7	69.5	93.3	7.9	20.2	4.5	551.5
October	40.2	23.4	41.5	88.0	9.6	20.3	4.5	0.0
November	35.8	16.3	33.0	105.9	9.3	17.5	3.9	0.0
December	31.0	11.5	35.0	114.9	8.9	15.8	3.5	0.0
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**886.6**
Average	**39.9**	**20.4**	**45.0**	**126.9**	**8.8**	**20.3**	**5.0**	**73.9**

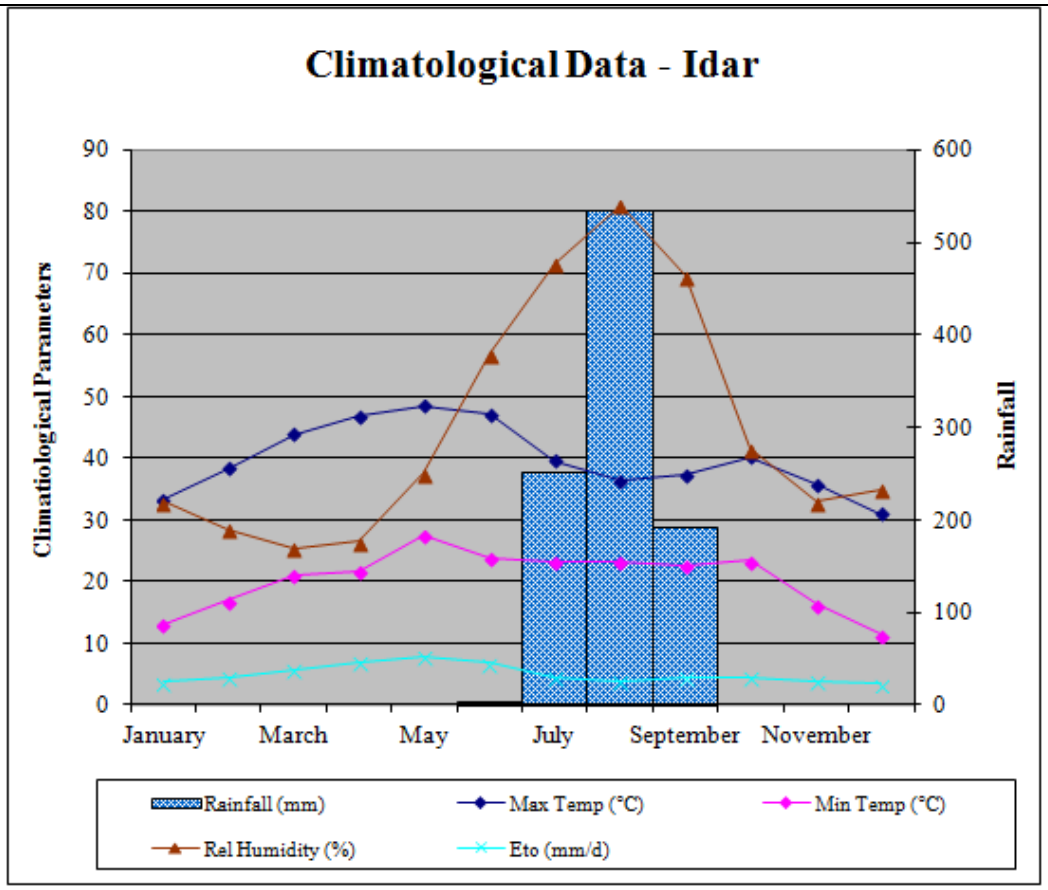

Fig 02: Climatological data analysis of Sabarkantha district

1.3. Rainfall

Sabarkantha district receives much of its rainfall from the south-west monsoon during the period between June & October; its maximum intensity being in the month of July & August. Total rainy days ranges from 20 to 30 days/year. Long term annual rainfall data of 10 rain-gauge stations of the district from year 1981-2012 are statistically analyzed and presented in table No 8. The distribution of mean annual rainfall over the Sabarkantha district.

Table 02 - Statistical Analysis of Rainfall Data Rainfall in mm

Name of the stations	No of Years	Average Annual RF	Standard Deviation	Highest RF - Year		Lowest RF - Year	
Bayad	1981 - 2012	840.3	387.5	1758	2006	367	2000
Bhiloda	1981 - 2010	814.0	317.5	1666	1994	291	1985
Himmatnagar	1981 - 2012	752.8	341.7	1654	2006	106	1987
Idar	1981 - 2012	666.3	271.1	1350	2006	245	1987
Khedbrahma	1981 - 2012	754.4	364.4	1754	1981	127	1987
Malpur	1981 - 2010	774.0	380.6	2057	2006	331	2000
Meghraj	1981 - 2012	803.0	345.0	1853	2006	248	2002
Modasa	1981 - 2010	794.4	357.5	1840	2006	342	1985
Prantij	1981 - 2011	797.0	364.7	1535	1997	220	1985
Vijaynagar	1981 - 2012	749.0	360.6	1951	2006	161	2002

1.4. STUDIES / ACTIVITY BY CGWB

Systematic hydrogeological survey were carried out by Geological Survey Of India between 1965 to 1968 and between 1979 to 1981 by Central Ground Water Board. For systematic hydrogeological Survey, 3500 sq km covered by GSI and 4600 sq km covered by CGWB. Prior to 1969, Exploratory Tubewell Organisation carried out some drilling in the district. From May 1969 to April 1970, GSI drilled five exploratory borehole. Lateron all exploratory drilling work has been carried out by CGWB at different time in different area of the district as part of its AAP work.

Different officers carried out systematic survey work in the district are as follows.

1. J.V.S. Murthy 1965 – 67
2. G.Balsubramaniam 1967 – 68
3. Arun Kumar. 1979 – 80
4. R.N.Meshram 1980 – 81
5. Ashok Kumar. 1997 – 98
6. Ashok Kumar. 1998 – 99
7. D.Gnanasundar 2006 – 07

The findings of the report during these investigations are summarised as follows:

a. Major part of the district is underlain by hard rocks.
b. Mainly the groundwater is developed by dugwells
c. The hard rock formation forms most extensive aquifers in the district.
d. The yield of the wells in the hard rock depends mainly on the thickness of weathered mantle and degree of fracturing.
e. Particularly in the vicinity of the rivers, valley fills, palaeochannel deposits forms potentials aquifers.
f. Groundwater exploration work carried out as part of the AAP during 1969 – 70, 1970 – 71, 1971 – 72, 1990 – 91, 1991 – 92, 1998 – 99, 2000 – 01, 2001 – 02, 2002 – 03, 2006 – 07 and 2007 – 08.

2. Geomorphology

2.1. PHYSIOGRAPHY

Physiographically, the district can be divided in to two zones i.e. the hilly regions and the plains. The hilly ranges cover the northern and eastern part of the district where as the plains, showing the undulating topography, are confined towards west and southwest. Hilly area shown the high relief formed by the long narrow steep sloped and flat topped Aravalli ridges which are intervened by narrow longitudinal valleys. The hilly tract known as Poshina Patti area covers Khedbrahma, Vijaynagar, Meghraj, Malpur and parts of Idar talukas. The highest elevation is about 682.75m amsl towards west of Vijaynagar. The hill ranges are aligned roughly in NE – SW and N – S direction. Near the peripheries of the ridges, there are prominent round hills and mounds of granites between Bhiloda and Idar.Southern and western parts of the district are mostly plain and sandy area covers the Parntij, Himmatnagar, Bayad and parts of Idar and Modasa talukas.

2.2. DRAINAGE

Sabarmati, the major river of the district, flows from north to south, along the western border of the district originating from the hill ranges of the Rajasthan. The area is mainly darined by the southwesterly flowing river, namely the Hathmati, the Khari, the Meshwa, the Majham and the Vatrak.

2.3. SURFACE WATER RESOURCES

There are major surface water irrigation project at Sabarmati, Hathmati, Harnav, Meshvo, Majham, Vatrak and Guhai. Meshvo reservoir is constructed on Meshvo river near village Shamlaji of Bhiloda taluka. The total catchmernt area is 259 sq km. The total canal command area is 34763 ha. Majham reservoir is constructed on the Majham river located near Ambaliyara village in Bayad taluka. The total catchment area is 407.80 sq km. The total canal command area is 6179 Ha. The Vatrak reservoir is constructed on the Vatrak river located near village maydi in Meghraj

taluka. The Sabarmati reservoir is constructed on the Sabarmati river located near dharoi village in Vadali taluka with a total catchment area of 5,540 sq km and 95,222 ha canal command area. Guhai reservoir project is located on the river Guhai in taluka Himmatnagar have a total catchment area of 422.11 sq km covering a canal command area of 11465 ha. Hathmati reservoir project is located on the river Sabarmati in Bhiloda taluka having a total catchment area of 595 sq km covering a total canal command area of 27691 ha.

Table 03: Groundwater prospects of different geomorphic unit

Geomorphic unit	**Groundwater prospects**
Alluvial plain	Excellent
Moderately dissected plateau	Poor to moderate, good along lineament and weathered zone
Eroded land	Moderate
Pediplain	Moderate to poor
Intermontane valley	Good (Depending upon the thickness of the unconsolidated materials)
Dissected granitic hills	Negligible, moderate along features
Dissected meta sedimentary hills	Moderate to good
Hilly terrain (Aravalli range)	Moderate to good along lineament

2.4. SOILS

Sand, goradu and medium black are the three main types of soil found in almost all talukas. Sandy soil is chiefly found in the central part of the district covering mostly Modasa, Meghraj, Malpur, Himmatnagar, Bhiloda and Idar talukas. The goradu soil covers Modasa, Prantij, Himmatnagar, Bhiloda and Malpur talukas and the medium black soil covers Khedbrahma, Vijaynagar, Bayad and Idar talukas.

2.5. LANDUSE PATTERN

The data on land utilisation and irrigated are shows that, the land brought under cultivation and sowing in the Sabarkantha district covers 5737 Ha, where area sown more than once covers 1359 Ha. Forest area covers in the district about 1263 Ha. The details Geographical area covers 7390 sq km where forest area cover 1263 Ha. The Fallow land covers 393 Ha.

3. HYDROGEOLOGY

3.1. GEOLOGY

Geologically, Sabarkantha district is the manifestation of diverse geological extension from Lower Proterozoic to Holocene. The stratigraphy of Sabarkantha district is presented in table 9. The oldest formation in the area is Aravallis Supergroup comprises of various meta-sediments belongs to Lower Proterozoic. The rock types encountered in the area are sedimentary, meta-sedimentary, volcanic and

metamorphic rocks. Among the different rock types, the rocks of Aravallis and Delhi Super group cover a large area in the northern and eastern part of the district. The regional stratigraphic is established by the Geological Survey of India is as follows. (Fig 03: Geological map of Sabarkantha district)

The Aravalli Supergroup

The rocks of the Aravalli Supergroup occupy by mainly the easternpart of the district and are represented by the Goran and the Samlaji Formation of the Jharol Group and Kadana formation of the Lunavada Group. These comprises of highly folded Phyllite, chlorite-mica schist, quartzite, garnetiferous mica schist, calc-amphibolite schist, feldspathic-mica schist and metagraysubwacke.

At places, serpentinite and talc-carbonate rocks of the Rakhabdev Ultramafic suite are seen. Around Vadali, Khedbrahma and Golwada many hills of Calc-gneiesses trend north, north-east to south, south west. These are generally complicated in their formation and bending. General strikes is NNE-SSW and dip is steep. At places, gneisses are intruded by aplite veins. Crystalline dolomites occur as an intercalated sequences within the meta sediments and constitutes an important lithological unit. They have restricted occurrence at Bhanmer, Kendon valley and Jesangpur. Dolomitic limestone occur as a narrow band within mica schist around Bamanwada and Sunak.

The quartzites are fine grained to medium grained and thin bedded. The quartzites occur as scattered isolated outcrops near Meru, Bhanmer and Kheradi. Mica schists, chlorite schist and biotite gneisses are exposed east of Golwada. Phyllites are thinly foliated and hard to friable.

Delhi Supergroup

The northern part of the district is mainly occupied by the rocks belonging to the Kelwara and Antalia Formation of Gogunda group and Todgarh Formation of the Kumbhargarh Group of the Delhi Supergroup. They comprises of quartzite, biotite schist, calc-biotite schist, phyllite, calc-gneiss, calc-schist, marble and biotite gneiss/migmatite.

The rocks belonging to Aravalli and Delhi Super groups are strongly deformed under atleast three phases of deformation. The regional trend of the beds and foliation vary from NNE – SSW to NE – SW with steep dips on either sides. Epidiorite, hornblende schist, amphibolites, pyroxene granulite and gabbro of the Phulad Ophiolite suites are found north of the Songarh. The area in the north is intruded by the Sendra – Ambaji granite. Godhra granite (CA 955 Ma) is exposed in the central part, granite, quartz vein and quartz porphyry, quartz vein and dolerite belonging belonging to the Malani Igneous suite are observed around Idar.

Himmatnagar Formation

Conglomerate, variegated sandstone, shale, clay stone, and chert belonging to the Himmatnagar formation of Mesozoic age are found in and around Himmatnagar. They are exposed up to Arsodia, in south they occur as scattered outcrop, especially near Wantra, Viravada etc on the hill top.

The conglomerate are not always seen at the base of the Himmatnagar formation. It is however well exposed in the river cuttings near Arsodia. The pebbles in the conglomerate are mostly of quartzites pebbles. Near Arsodia, between the basal conglomerate and Himmatnagar sandstone, there are several band of variegated clays.

Sandstones are generally loosely aggregated, but at several places it is also compact. There are several bands of shale with in sandstones.

Lameta formation

Lameta formation, consisting of variegated clay, banded chert and limestone of upper cretaceous age are seen in the southern and southeastern part of the district.

Deccan Traps

Basaltic flows with associated minor inter trappean horizons, grouped under the Deccan traps are limited to the southern and south-western parts in the Meshwo and Mazum river sections. These are of “aa” and pahoe-hoe” type lava flows. Basalts flow also occupy the the area east and north east of Kapadvanj, south of Bayad and north of Dabha and it is also exposed along the Vatrak river section north of Thalpore.

Matanomadh formation, consisting of ferruginous sandy beds, sandstone, clay laterite and conglomerate of Palaeocene age are found exposed in the western part of the district. Laterites have supposed to be originated from the weathering of coarse grained granites and Himmatnagar sandstones. Laterite have varying proportions of limonitic and aluminous ingredients.

Alluvium

Rest of the area occupied by the windblown sands of the Akhaj formation, flood plain and channel fill deposits of Varahi formation of Holocene. Alluvium mainly composed of medium to coarse sand, gravel, cobble and boulders with clay are present in the southern part of the district. Alluvium also found in patches along the Meshwa and Majhan river, north-east of Nawagam, south-west of Bheswara, west of Varngam, south of Khilori and also in patches along the Vatrak river section.

Aeolian sand are brownish yellow, fine to medium grained, sub rounded to rounded and unconsolidated sand occupies the area between the Meshwo and Majham rivers

Table 05: Stratigraphy of Sabarkantha District (After GSI)

Geological Age	Supergroup	Group	Formation	Lithology
Holocene			Varahi Formation	Flood plain and channel fill deposits
			Katpur Formation	Flood plain and channel fill deposits
			Jantral Formation	Sand sheet and sand dune deposits
Palaeocene			Mata no madh Formation	Ferruginous sandy beds, sandstone, clay, laterite and conglomerate.
Cretaceous to Eocene	Deccan Traps		Basalts	Porphyritic and amygdaloidal basalt flow with intertrappean sediments
Upper Cretaceous			Lameta Formation	Varigated clay, banded chert and limestone
Lower Cretaceous			Himmatnagar Formation	Conglomerate, variegated sandstone, shale, claystone and chert
Upper Proterozoic		Malani Igneous Suite		Olivine Dolerite
			Idar Granite	Granite, Quartz porphyry, quartzitic vein
			Godhra Granite	Granite
Middle Proterozoic			Sendra - Ambaji Granite	Granite and leucogranite with quartzo - feldspathic veins
			Phulad Ophiolite Suite	Epidorite, hornblende schist, amphibolite, pyroxene granulite and gabbro
Lower to Middle Proterozoic	Delhi Supergroup	Kumbhalgarh Group	Todgarh Formation	Calc-gneiss, calc-schist, calc-gneiss, impure marble, calcitic marble, biotite schist, calc-biotite schist, biotite gneiss/migmatite
		Gogunda Group	Kelwara Formation	Biotite schist, calc-biotite schist and phyllite
			Antalia Formation	Quartzite and quartz sericite schist, biotite schist and calc-biotite schist
Lower Proterozoic	Aravallies Supergroup	Lunavada Group	Kadana Formation	Mica schist and metasubgraywacke, quartzite
		Intrusive	Rakhabdev Ultramafic suite	Serpentinite and talc-carbonate rock
		Jharol Group	Samlaji Formation	Garnetiferous mica schist, quartzite, calc-amhibolite, feldspathised mica schist
			Goran Formation	Phyllite, chlorite-mica schist, quartzite

and also between the Vatrak and Meshwa river. It also covers the area lying between Varagam and Bheswara around Nanawara, west of Meghraj, east of Majham rivers and to a small extent to the east of Vatrak river. The general range of thickness of Aeolian sand is 5 to 18m but to the south of Balisana, it increases up to 35m.

3.2. OCCURRENCE & DISTRIBUTION OF GROUND WATER

Groundwater occurs both in alluvium and hard rock. Major area of the district is covered by hard rock aquifer, covering a large area in the northern, eastern and southern-western part along with a small patch at central part of the district. Though ground water occurs in all types of formation, but the most productive aquifer are Himmatnagar sandstone, Quarternary sediments (Alluvium) and Deccan traps.

(a) Quartzite, phyllite and schist:

Among the different types of aquifer, quartzite, phyllite and schist occupy the maximum area in the district. In these formations, groundwater occur under unconfined condition in weathered portion and in fissures, joints and other weak planes. The movement of groundwater is controlled by the extent of weathering, fissures, fractures and joints. Large diameter dug wells are existing in these formation. In general, yield of the open wells tapping these formations are poor, except those located near streams and tanks. Yield of the wells ranges from 5 to 350 m^3/day.

(b) Granite and granite gneiss:

Granite and granite gneisses are occur as water bearing formation in the northern part of the district and also in a few scattered areas in the central and southern parts. Groundwater occur under unconfined to semi-confined condition in weathered and fissured zones. Depth of weathered zone is highly variable and extent down to a depth of 30m and at places it has been noticed upto 40m depth. Rarely, the thickness of saturated weathered zones tapped in dugwells exceeds 5m. Depth of dugwells ranges between 8 and 24m while dug cum bore well is around 58m. Yield of wells tapping granite ranges from 5 to 25 m^3/day.

(c) Himmatnagar sandstones:

Himmatnagar sandstone occurs as water bearing formation in the western and south western part of the district. Groundwater occur under unconfined to confined condition. Coarse grained, gritty sandstones occurring in the middle part of the Himmatnagar series form potential aquifer. The complete sequence and the maximum thickness (82m) of Himmatnagar series was encountered in the borehole at Ilol. Here four beds of sandstones have been alternate with shales. The thickness of Himmatnagar seriesvaries from 40m at Timba Kampa

to 82m at Ilol. The yield of the dug well and dug cum bore well varies from 342 to 1752 m^3/day and in tube it ranges from 163 to 864m^3/day.

(d) Deccan Trap:

Deccan Trap occur as water bearing formation in the southern and southern part of the district. In the Deccan traps, groundwater occurs in weathered portion and in weak planes like fissures and joints under unconfined condition. As the weathering thickness extent Deccan trap gives rise to clayey black soil which is impervious and does not yield much water. Weathered zone varies from a few meter to about 20m. As the traps form a gentle mounds, the water table is deeper. Depth of dug well extent up to 30. 10m bgl and dug-cum-borewell extents below to a depth of 60.96 m bgl. The yield of wells tapping Deccan traps ranges from a few cubic meter to 30m3/day. The uppermost trappean flow is highly jointed and brittle. It has been encountered in the boreholes at Mohanpur, Ghari, Fatehpur, Mota and Timba Kampa and the maximum thickness is about 200m as met at Timba Kampa Borehole. The upper part of the flow is potential due to the thick weathered zone and joints, fractures and secondary partings down below.

(e) Sandstone s and Limestones of Bagh beds/ Lameta

Sandstone and limestones of Bagh beds occur in a small area in the southern part of the district. The sandstones are fine grained and compact. So, potentiality are poor. The limestone are massive, compact and poorly jointed and also very poor yielding. Very few dugwells are being constructed tapping these formations. Generally large diameter dug wells are occur tapping these formations and the diameter ranges from 4 to 6 m because of the poor yield of tapped formation.

(f) Alluvium and blown sand aquifer:

Alluvial and blown sand aquifers mainly occur in the south western part of the district and also occur as small scattered patches along different streams. Alluvium is an important formation with regard to the development of ground water in view of occurrence of highly permeable granular beds in some areas. Groundwater occur both under unconfined and confined condition.

Reasonably thick alluvium has been encountered in the boreholes at Derol, Balisana, Nawalpur, Pusri and Nananpur. The thickness of alluvium ranges from 73m (Balisana) to 28.35m (Nananpur). Within alluvium highly permeable, granular beds occur at Derol, Balisana, Nawalpur and Pusri. In the north-eastern and central part the district, small scattered patches of alluvium occur near rivers and streams constituting aquifer of very limited nature which consist of pebbles with little sand up to 10m thick. Yield of dugwell ranges

between 12 to 1062 m^3/day while tube well yield as high as 6720 m^3/day with a low to medium of vary wide range.

Fine to medium grained, unconsolidated sand comprises the aquifer materials in the blown sand and it occurs as water bearing formation in the southern part of the district. The yield of the dug well located in blown sand ranges between 6.4 to 90 m^3/day.

3.3. GROUNDWATER REGIME MONITORING

Ground water regime monitoring is the basic component of groundwater management and it is carried out in parts of Sabarkantha district through National Hydrograph Network Stations (NHNS or NHS). NHSs are observation wells, comprising of dug wells and purpose built bore wells – known as piezometers. There are 33 NHS and 12 piezometers as part of the NHS. Depth to water level map of pre monsoon and post monsoon period and annual fluctuation of water level are prepared with data of NHS for the year 2012. With available data of systematic and reappraisal hydrogeological surveys carried out in the district. The water level of the district is described bellows. Figure 12: Hydrogeological map of Sabarkantha district

Depth to Water Level (May 2012)

The figure 15 shows depth to water level map of Sabarkantha district, prepared on the basis of NHS data of May 2012. In most part of the district, the water level ranged in between 5 to 20m covering almost 75% of the area, northern and northeastern part in isolated patch in Khedbrahma taluka and Vijaynagar and Bhiloda taluka has the water level range in between 2 to 5m. On the western part of the Talod, Prantij, and Himmatnagar taluka, in central part the district near Vadali and Idar taluka ranged in between 20 to 40m. An isolated patches in Prantij and Himmatnagar taluka shown the water level morethan 40m. (Figure 04: DTW May 2012 map of Sabarkantha district.). The minimum water level recorded at Khedbrahma is 4.68 m bgl and maximum water level is 41.40 m bgl at Derol.

Depth to Water Level (Nov 2012)

The figure 05 shows depth to water level map of November 2012. The northern and northeastern part of the district underlain by hard rock formation have water level in range of 0 to 10m bgl. But about 88% of the total area in Sabarkantha district ranged with in 20 m bgl of which 23% represents with 0 to 5 m bgl and 58% ranged within 5 to 20 m bgl of water level. The minimum water level recorded at Vijaynagar is 1.73 m bgl and the maximum water level is 41.00 m bgl recorded at Derol. Areas along western part of the district covering areas of Idar, Himmatnagar, Prantij and talod taluka shows water level of 20 to 40 m bgl and in western part of the Prantij taluka shows morethan 40 m bgl of water level. (Figure 05: DTW November 2012 map of Sabarkantha district.)

Water Level Fluctuation (May - Nov 2012)

The figure 06 shows water level fluctuation map of the district for May- November 2012 period. In the fluctuation map, it shown rise in water level in all parts of the district mainly in the range of morethan 4m shown in eastern and southeastern part of the district. Rest part of the district has a rise in water level ranged within 0 to 2 m and 2 to 4m. Fall in the water level shown in the central part of the district in Bhiloda and Himmatnagar taluka, western part of the Idar taluka, southeastern part of the Prantij and Talod taluka. (Figure 06: Annual water level fluctuation May to November 2012 map of Sabarkantha district.)

Water Level Trend (2003 - 2011)

From the analysis of the water level trend of the Sabarkantha district from 2003 to 2012, it is observed that, during pre-monsoon, the water level has a rise of 0.0003 m/yr (Virpur-Idar) to 2.339 m/yr (Revas) and also has a fall of 0.007 m/yr (Panvath) to 0.4265 m/yr (Khedbrahma). Similarly from the analysis of the post-monsoon data of 2003 to 2012, the rise shown by water level is vary from 0.0092 m/yr (Hamirpur) to 2.5008 m/yr (Revas) and also has a fall of 0.0065 m/yr (Vijaynagar) to 0.5101 m/yr (Ratanpur). Hence, from the analysis it is observed that, at Revas, during both pre-monsoon and post-monsoon has a trend of rising water level.

3.4. GROUNDWATER EXPLORATION

The boreholes drilled by CGWB as a part of Ground Water Exploration work, in various parts of Sabarkantha district have indicate that the sub surface geological formation in the district comprises of phyllite-mica schist, phyllite, quartzite, biotite schist, granite and granite gneiss, sandstone, alluvium and layered sequences of Deccan Trap lava.

The depth range of exploration varies from 20 to 500.18m (Joraji na Muwara, Taluka Prantij; 1970 – 72). The litholog reveals alluvium attains a maximum thickness of 139m and 66m in the boreholes of Balisana and Derol. It gradually thins towards east and increases towards southeastern part at Pusri. Deccan traps attains maximum thickness of 200 m at Timbakampa. The yield of bore wells varies widely from few lps to more than 5 lps. Overall, shallow to medium deep ground water quality is suitable for both irrigation and domestic uses. Map showing location of exploration is shown in figure 02 in Geological map of Sabarkantha district.
The perusals of exploratory drillings data and hydrogeological sections reveal that, Aravalli group of rocks form the basement in the area.

4. HYDROCHEMISTRY

The Sabarkantha district has two main hydrogeological provinces consisting of hard rock types and soft rock. In the hard rock, it is constituted of meta sediments and Deccan traps. In soft rock type, it has alluvium and sandstone. Each terrain has

varied hydro-geochemical regime. Groundwater of the district originates as rainwater that infiltrates through soil into flow system in the underlying geologic material. In Sabarkantha district, higher plateau and hill zones of eastern part constitute as recharge areas, which is underlain by granitic rocks and metasediments. The discharge area constitutes alluvium plain in western and south western part of the district. As groundwater moves along flow lines from recharge areas to discharge areas, the chemistry of groundwater is altered by the effects of variety of geochemical processes. The range analytical result of major ions of representative samples collected during various surveys and exploration works along with NHS data are compiled and the range of major constituents and parameters are given below in table 12.

Table 06: Summarised chemical data of Sabarkantha district

Chemical Parameter	Min	Max	Chemical Parameter	Min	Max
pH	7.56	8.70	F	0.2	2.0
EC	597	5390	Alk	79.8	580.3
TDS	400	3611	Ca	28	320
CO_3	0	12	Mg	17	207
HCO_3	73	708	TH	170	1600
Cl	64	1122	Na	45	530
NO_3	3	590	K	0	13.7
SO_4	5.6	551.0	Fe	0	1.53

*All values are in mg/l except pH and EC in µS/cm at 25°C

4.1. Ground Water Quality

Variation in chemical quality of ground water is due to hydrogeological factors controlled by rock types, depicting aerial distribution of various water quality features. In terms of electrical conductance (EC), measure of total dissolved salts in ground water is varying in between 597 to 5390 µS/cm during May 2012. The chloride content of the district also vary with in 64 to 1122 mg/l. Nitrate content in the district is very high varying within 3 to 590 mg/l. At eight places, Boral (190 mg/l), Choriwad (215 mg/l), Dhansura (125 mg/l), Gadha (120 mg/l), Silwad (125 mg/l), Varvada (105 mg/l), Virpur (590 mg/l) and Seenawad (150 mg/l), where found above 100 mg/l is unsuitable drinking and domestic purpose. Similarly, fluoride content is vary within 0.2 to 2.0 mg/l. At Bhadreswar, Idar taluka (2.0 mg/l) and Poshina (1.50 mg/l) of Khedbrahma taluka are found above the maximum permissible limit and not suitable for the drinking purpose. Iron is the heavy metal that found in the groundwater of the district is varying from 0 to 1.53 mg/l. The maximum value found at Bhadreswar (1.53 mg/l) of Idar taluka and Ratanpur (1.5 mg/l) of Khedbrahma taluka is unsuitable for drinking purpose comparing to BIS 2012: IS10500 as limit set for 0.3 mg/l only. In other chemical ion, total hardness in terms of $CaCO_3$, is found above the BIS

maximum permissible limit of 600 mg/l at 11 places of the district vary within 170 to 1600 mg/l found unsuitable for drinking purpose.

Table 07: Chemical quality of groundwater for drinking and domestic purpose in Sabarkantha district

Sl.No	Chemical Parameter	BIS – 2012 (IS 10500)		Variation of chemical quality during Pre-monsoon season		No of sample exceeding the HDL	No of sample exceeding the MPL
		Highest Desirable Limit	Maximum Permissible Limit	Min	Max		
1	pH	6.5 to 8.5	No Relaxation	7.14	8.6	1	No Relaxation
2	Total Dissolved Solids	500	2000	400	3611	23	2
3	Total Hardness (as CaCO3)	200	600	170	1600	15	11
4	Calcium	75	200	28	320	14	2
5	Magnesium	30	200	17	207	20	1
6	Sodium	-	200	45	530	-	9
7	Potassium	-	12	0	13.7	-	1
8	Bicarbonate	-	-	73	708	-	-
9	Chloride	250	1000	64	1122	8	2
10	Sulphate	200	400	5.6	551.0	3	1
11	Nitrate	45	No Relaxation	3	590	16	No Relaxation
12	Fluoride	1	1.5	0.2	2.0	4	2
13	Alkalinity	200	600	80	580	24	Nil
14	Iron as Fe (mg/l)	0.3	No Relaxation	0	1.53	7	No Relaxation

*Except pH all values are in mg/l (Total no sample analysed=28)

4.2. WATER POLLUTION

Sabarkantha district has a number of medium and small scale industries set up in the south southeastern part of the district in Himmatnagar and Prantij talukas focusing mainly on the Milk powder, wall tiles, denim fabric and ceramics. Major players are Sabar diary, Pathic agrotech, Oracle granite limited, Gujarat Ambuja exports, Eureka tiles and City tiles limited. No major chemical quality problem reported so far, but looking at the quality problems in other parts of the Gujarat due industrial set up, enforcing regulatory measures mandatory before releasing of industrial effluents only after due treatment in ETPs and solid waste disposal at designated sites.

Table 08: Medium and large scale industry in Sabarkantha district

Name of Company	Taluka	Production
Sabar Dairy	Himmatnagar	Milk Powder
Pathik Agrotech	Himmatnagar	Cut flower High-tech Cultivation
Oracle Granite Limited	Himmatnagar	Manufacturing of Wall tiles
Gujarat Ambuja Exports Ltd.	Prantij	Denim Fabric
Eureka Tiles	Prantij	Ceramics
City Tiles Limited	Prantij	Ceramics

Source: Industries Commissionerate, Government of Gujarat, 2007

5. GROUND WATER RESOURCES

Annual ground water recharge of Sabarkantha district, (GWRE 2011), is 1248.83 MCM and after natural discharge of 62.44 MCM due to environmental / runoff purposes, net annual ground water availability is worked out to be of 1186.39 MCM. The gross annual ground water draft in the district is 862.53 MCM out of which 806.39 MCM per year is due to irrigation while remaining 56.14 MCM is accounted for domestic and industrial uses.

The stage of ground water development at year 2011, for all the talukas of the Sabarkantha district computed the range from 53.57% (Malpur taluka) to 88.75% (Idar taluka) and all units of assessment (talukas) have been categorized as *Safe to Semi-critical,* based on the stages of ground water development and the long-term trend of pre and post monsoon ground water levels. Out of 13 talukas, Idar (88.75%), Prantij (82.96%), Talod (81.88%), Vadali (87.57%) are categorized as *semi-critical*. The average stage of groundwater development for the total district is 72.70% and categorized as *semi-critical*. Taluka wise ground water resources and categorization for each assessment unit is presented in table 09.

Table 09: Talukawise groundwater development in Sabarkantha district (2011)

Sl.No	Talukas	Annual Ground Water Recharge	Natural Discharge	Net ground Water Availability	Annual Ground Water Draft			Projected demand for domestic & industrial uses up to 2025	Ground Water Availability for future irrigation	Stage of Ground Water Development	Category
					Irrigation	Domestic & Industrial uses	Total				
1	Bayad	137.83	6.89	130.94	82.16	5.63	87.79	7.56	41.22	67.05%	Safe
2	Bhiloda	113.58	5.68	107.90	68.66	6.24	74.9	8.36	30.88	69.42%	Safe
3	Dhansura	63.29	3.16	60.13	37.04	2.79	39.83	3.91	19.18	66.24%	Safe
4	Himmatnagar	166.3	8.32	157.99	98.54	4.89	103.43	6.55	52.90	65.47%	Safe
5	Idar	133.94	6.70	127.24	105.8	7.13	112.93	9.56	11.88	88.75%	Semi-critical
6	Khedbrahma	61.63	3.08	58.55	33.68	6.76	40.44	9.07	15.80	69.07%	Safe
7	Malpur	69.44	3.47	65.97	32.73	2.61	35.34	3.5	29.74	53.57%	Safe
8	Meghraj	70.47	3.52	66.95	42.24	4.29	46.53	5.75	18.96	69.50%	Safe
9	Modasa	100.08	5.00	95.08	62.73	3.62	66.35	4.86	27.49	69.79%	Safe
10	Prantij	111.13	5.56	105.57	84.81	2.77	87.58	3.71	17.05	82.96%	Semi-critical
11	Talod	86.82	4.34	82.48	63.36	4.17	67.53	7.54	11.58	81.88%	Semi-critical
12	Vadali	80.19	4.01	76.18	64.22	2.49	66.71	3.33	8.63	87.57%	Semi-critical
13	Vijaynagar	54.13	2.71	51.42	30.42	2.75	33.17	3.68	17.32	64.50%	Safe
District Total		1248.83	62.44	1186.39	806.39	56.14	862.53	77.38	302.62	72.70%	Semi-critical

Compute by RIF method

All values are in MCM except stage of GW development

6. Mass Awareness and workshop Programme in Sabarkantha District

One Water Management Training programme and two Mass Awareness Programmes organized in the district to raise the awareness among the people for conservation of water. In the year 2006 – 07, a two days training programme organized at DRDA hall, Himmatnagar from 14th to 15th November 2006 for state groundwater department and NGOs, VOs working in the field of groundwater. Again on 27th December 2006, at Primary school of Therasan, Taluka Vadali, a mass awareness programme organized for local farmer and women including children on water conservation and management. During 2010 – 11, on 22 February 2011, at Vishnu Dham Ashram, Demai of Bayad Taluka, a mass awareness programme on water conservation and management was organized for local farmer and women working in the water sector.

7. CONCLUSION AND RECCOMENDATION

a. The Sabarkantha district having an area of 7390 sq km forms a border district in the eastern part of the Gujarat and comes under the tribal and drought prone area.

b. The district in general poses an undulating topography with an elevation of morethan 600m a msl. The eastern border of the district is marked by hill ranges which strikes NNE – SSW and forms water divide between Sabarmati and Mahi river basin.

c. District receives medium intensity monsoon rainfall of 752 to 840 mm during SW monsoon. It will be good to harness the available monsoon rainfall runoff for artificial recharge to the ground water through construction of check dams, recharge shaft, percolation tanks, site specific recharge bore wells / dug wells, etc., in eastern high land areas and adjoining intermediate plain areas underlain by piedmont zones / weathered hard rock (*goradu*) deposit. All such measures can augment groundwater resources at local levels and can make drinking water supply schemes efficient and sustainable in long term.

d. In Sabarkantha district, the overall stage of groundwater development is semi-critical (72.70%), however, there is constraint of quality in few areas and low yield in inland hard rock areas. Rapid urbanization and concurrent industrial activities are affecting ambient hydrogeological regime lately. With strategy of conjunctive use and by employing multidisciplinary approach for ground water development in eastern hard rock terrain, sustainable development of water source can be accomplished.

e. Major part of the districts is underlain by hard rock formations of Aravalli Super Group and Granite and Gneisses. Small out crops of Deccan trap and Infratrappean are also observed. Hard rock formations in general have vertical to sub-vertical joints. Alluvial deposits occur in the western and south western part of the district.

f. Sustainable groundwater management strategy to conserve existing resources and preventive actions to control contamination of freshwater resources are essential.

g. Strategy for regular monitoring for planned development and pollution control with adequate enforcement directive is essential to prevent occurrence of pollution incident in future.

h. The industrial part of the district needs periodic monitoring of ground water along with quality for post-monsoon and pre-monsoon.

i. Taking into consideration of tribal domination and drought prone area, ‘Mass Awareness Program’ and ‘Water Management Training Program’ programs in regular basis can be arranged in the district for awareness on the depletion of groundwater resources and quality problems.

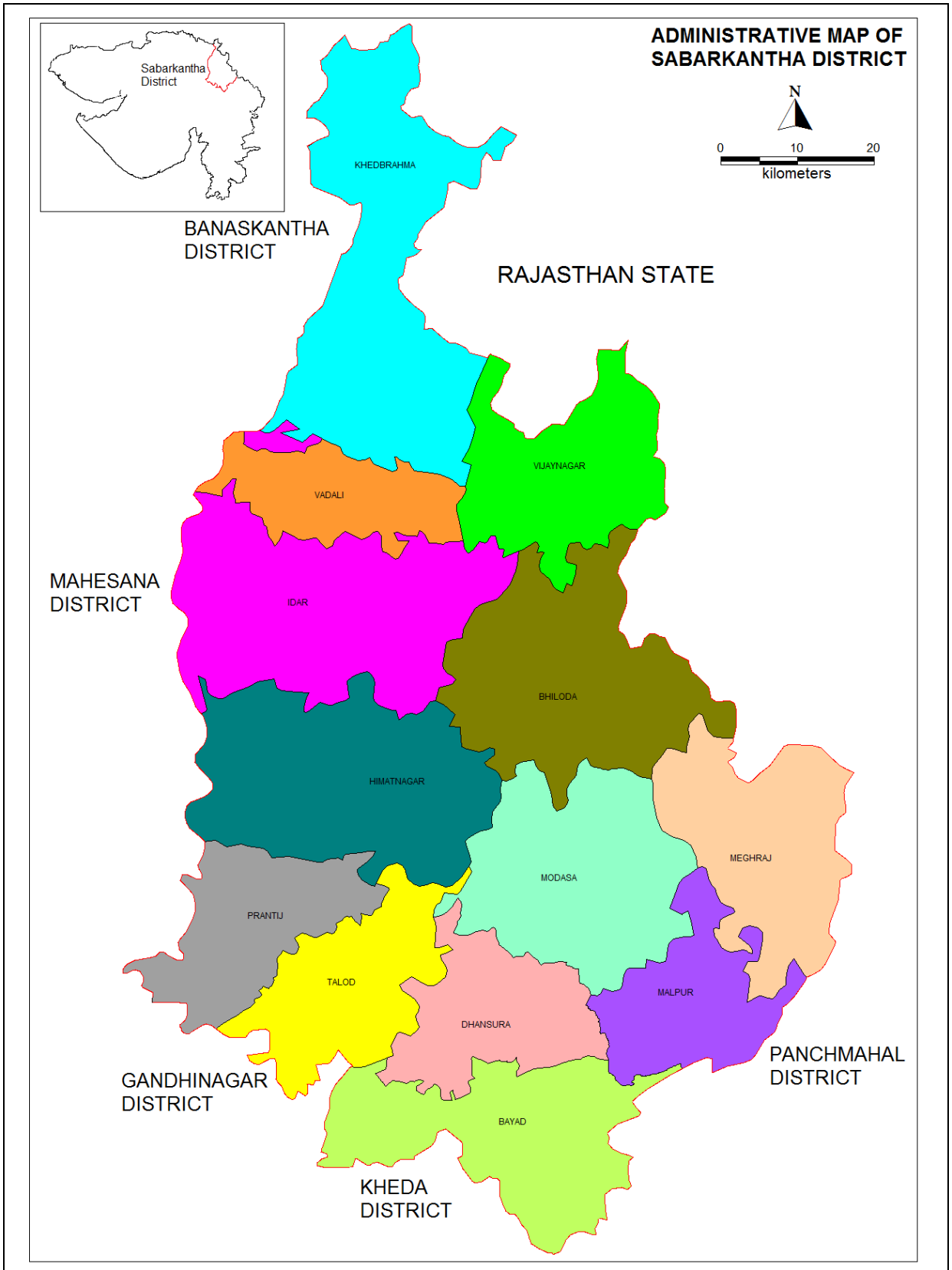

Fig 01: Administrative map of the Sabarkantha district

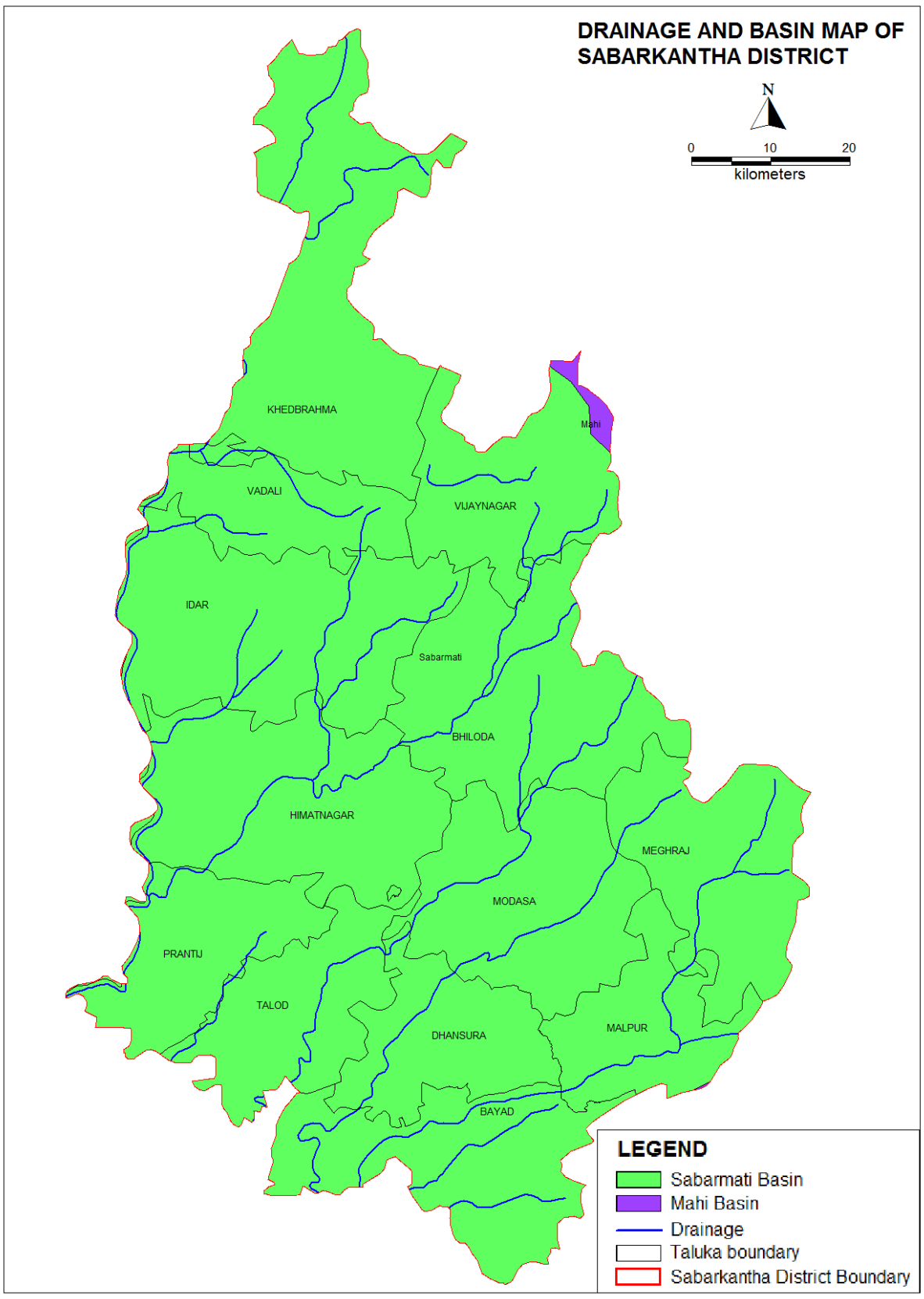

Fig 03: Drainage and Basin map of Sabarkantha district.

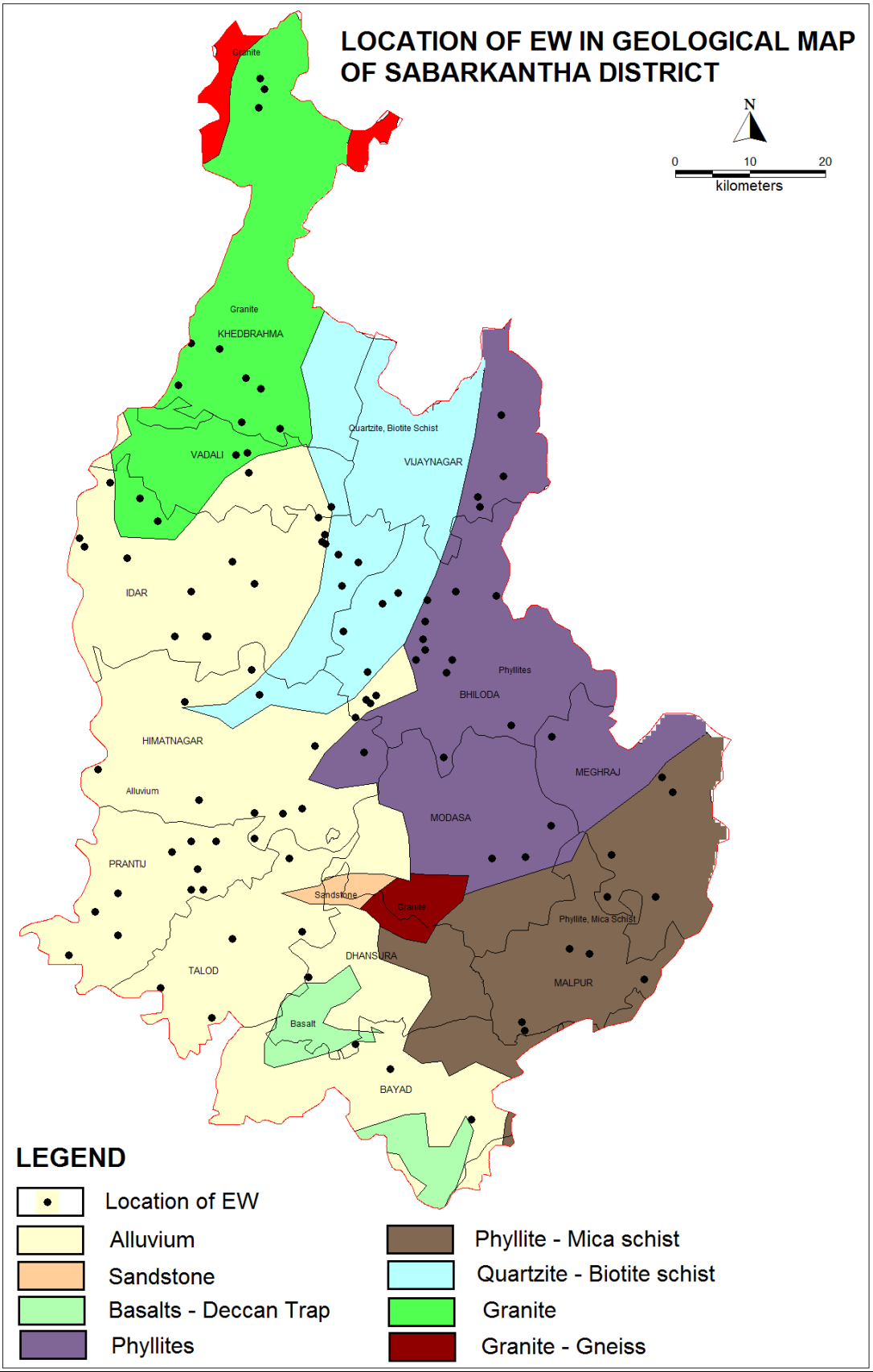

Fig 04: Location of exploratory well in geological map of Sabarkantha district

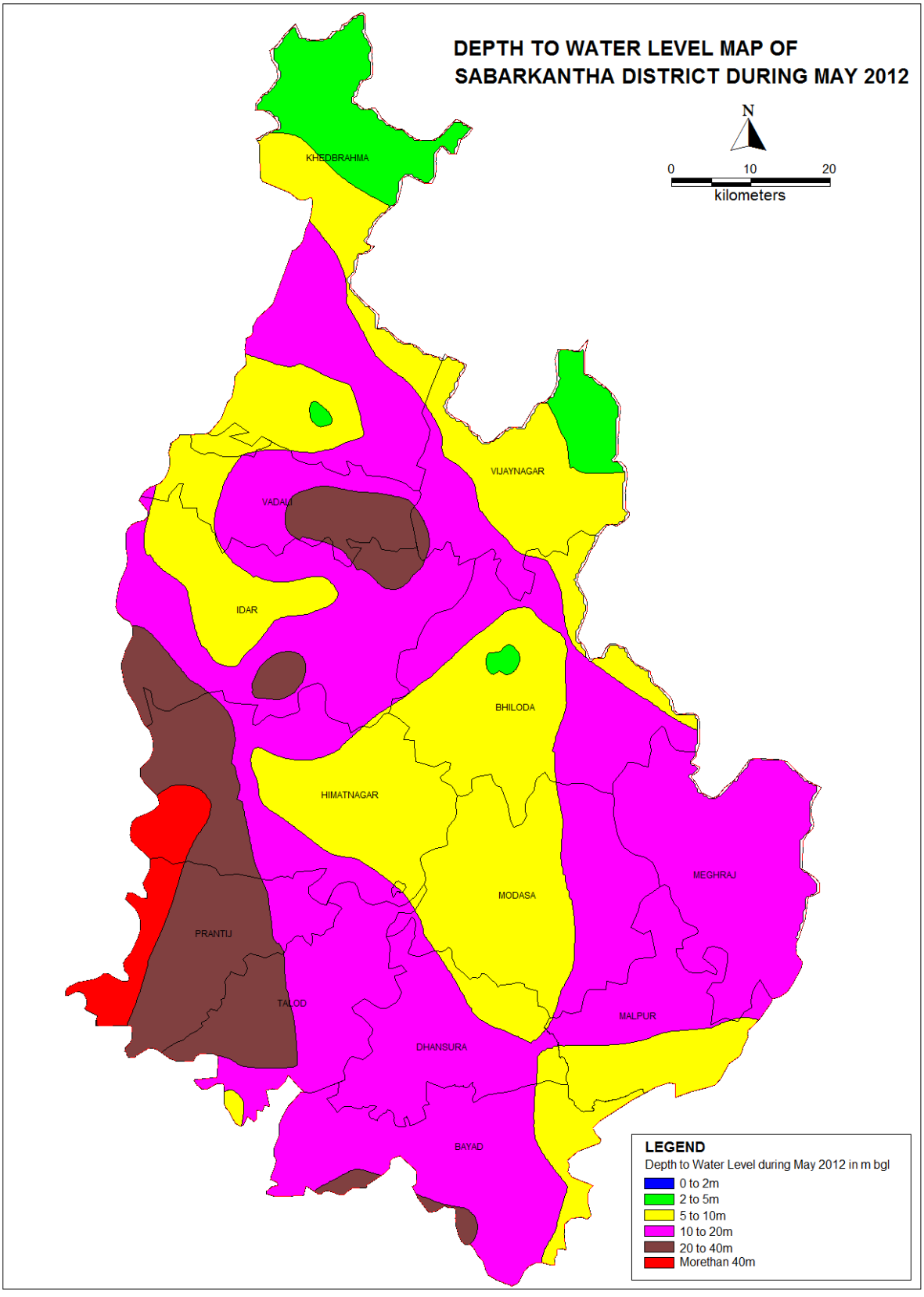

Fig 05: Depth to water level map of Sabarkantha district during May 2012

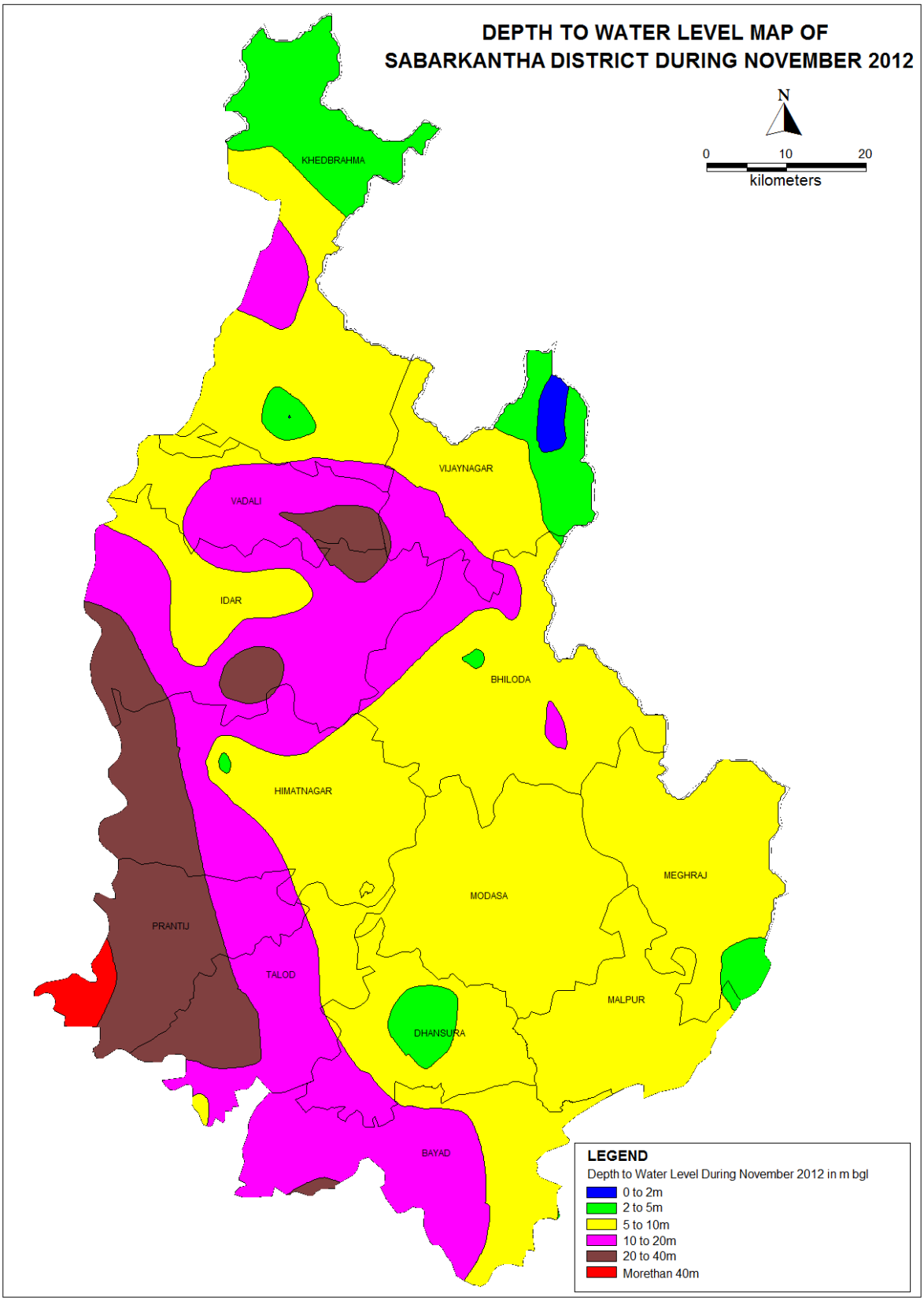

Fig 06: Depth to water level map of Sabarkantha district during Nov 2012

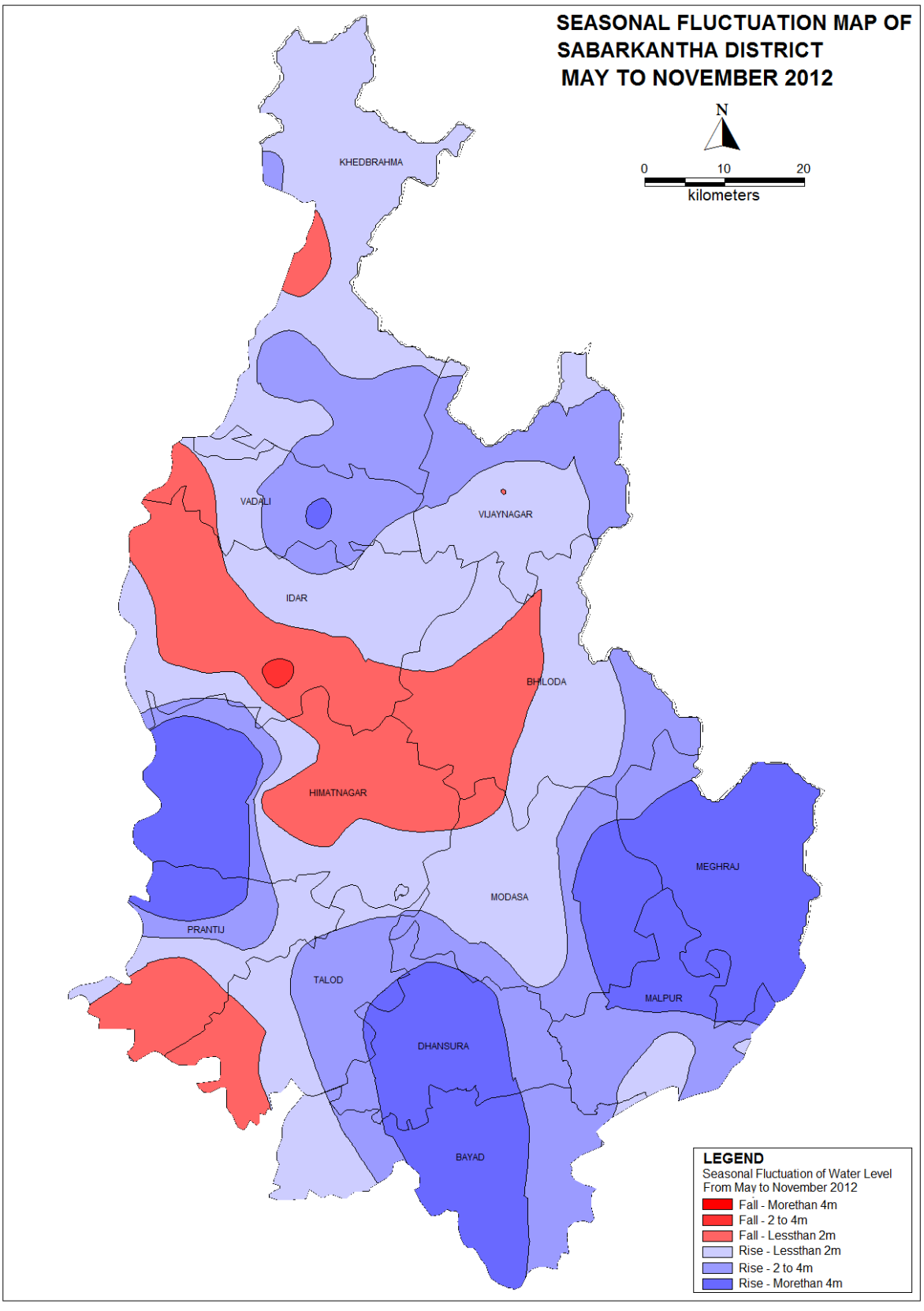

Fig 07: Annual water level fluctuation map of Sabarkantha district during May to Nov 2012

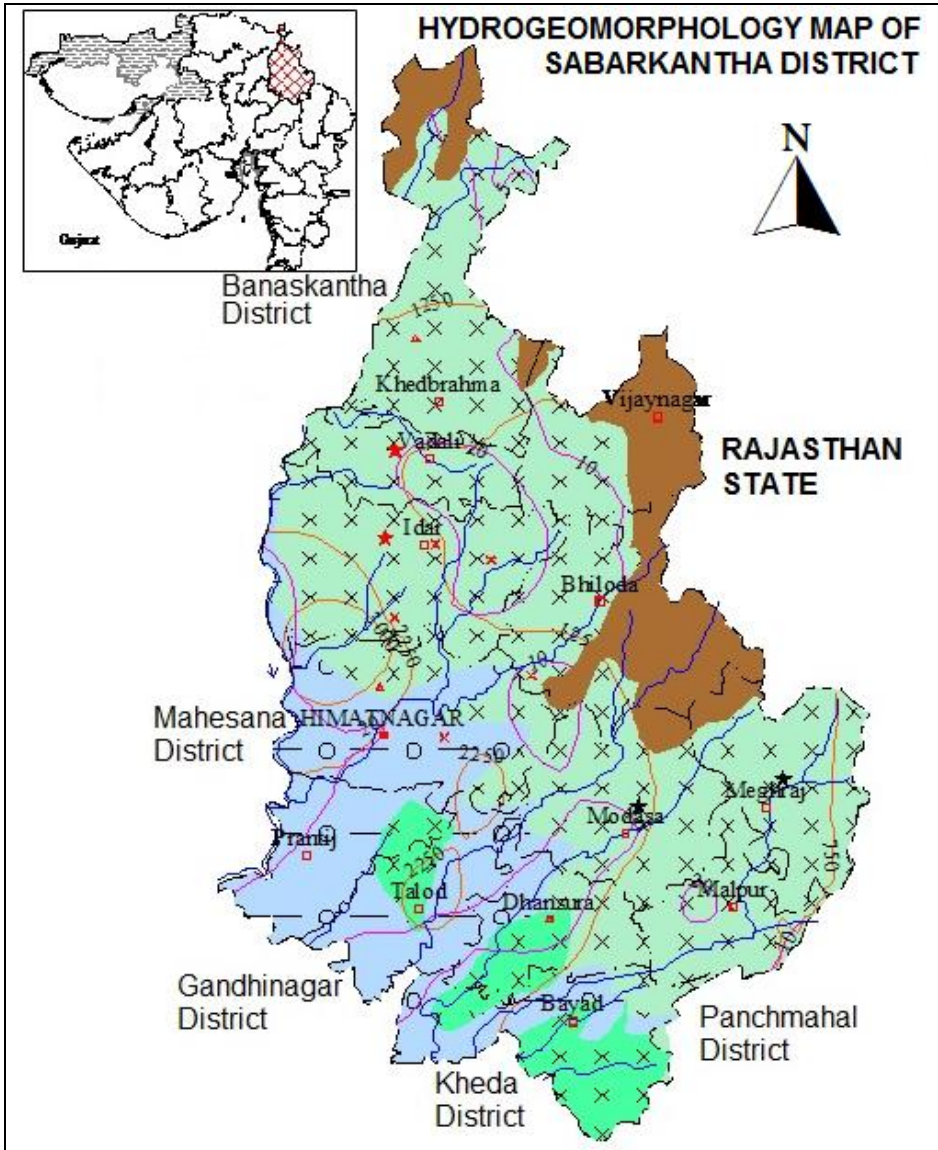

Fig 08: Hydrogeological map of Sabarkantha district.

Legend

Rock type	Wells Feasible	Rigs Suitable	Depth of Well (m)	Discharge (lpm)	Artificial Recharge Structure Suitable
Soft Rock Aquifer	Dug Well Tubewell	Manual Direct Rotary, Reverse Rotary	10-25 50-100	200-300 400-800	Percolation Tanks/ Ponds, Recharge Wells,
Hard Rock Aquifer	Dug Well Borewell	Manual Down the Hole Hammer (DTH)	10-20 50-100	60-200 60-240	Percolation Tanks/ Ponds, Recharge Wells, Check Dams, Nalla Bunds.
Hard Rock Aquifer	Dug Well Borewell	Manual Down the Hole Hammer (DTH)	10-25 100-200	80-150 100-300	Percolation Tanks/ Ponds, Recharge Wells, Check Dams, Nalla Bunds.
Hilly Areas	Not Suitable				Check Dam, Nalla Bund, Gully Plug
20	Pre-monsoon Decadal mean (1993-2000) Depth to Water Level (mbgl)		2000	Electrical Conductivity (µS/cm at 25° C)	
	Fluoride > Maximum Permissible Limit (1.5 mg/l)			Nitrate > Maximum Permissible Limit (100 mg/l)	
	Over Exploited Taluka			Dark Taluka	
	Drainage			District/Taluka HQ	

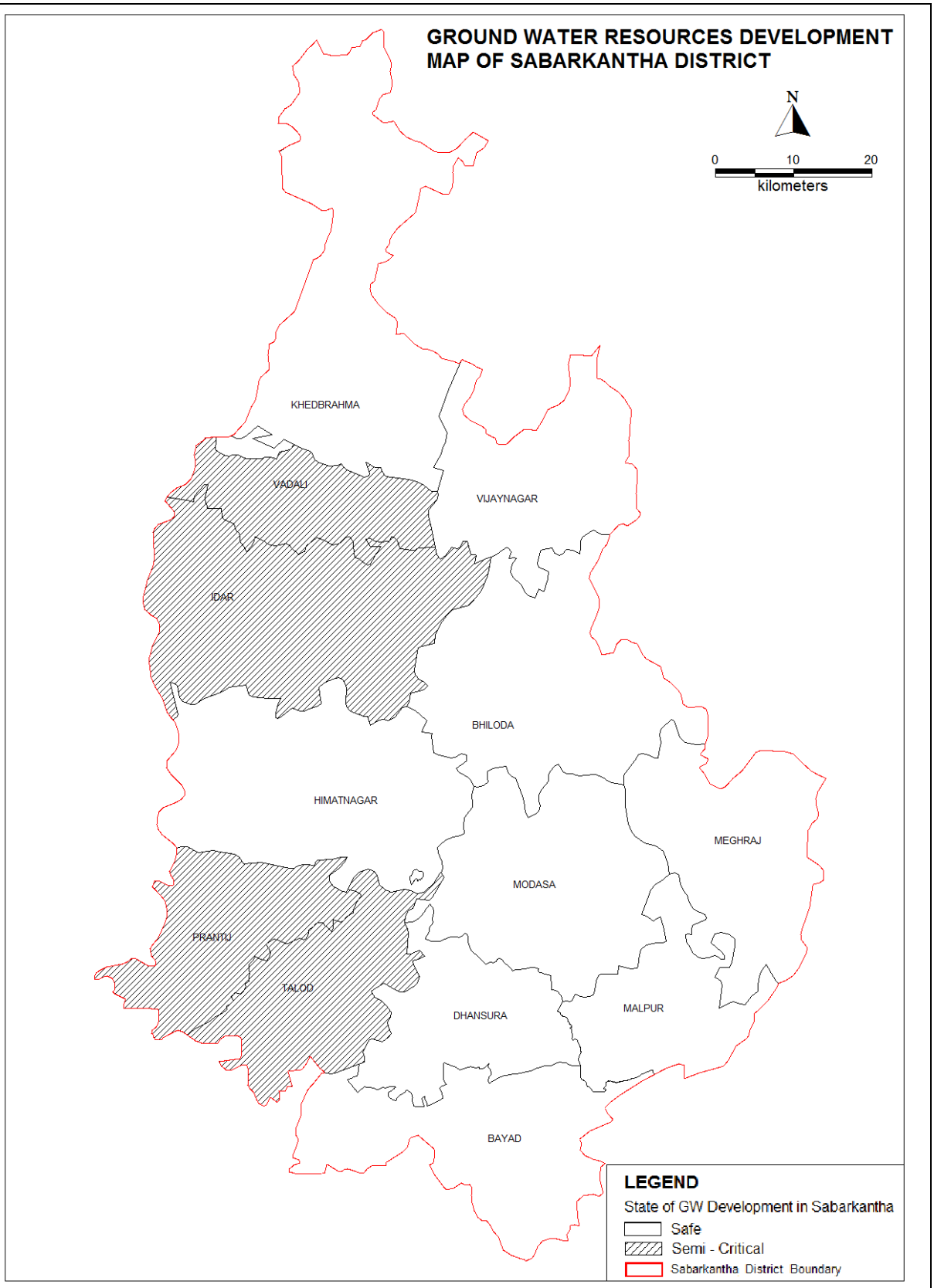

Fig 09: Ground water resources development map of Sabarkantha district

Table 05: Details of the exploratory well of Sabarkantha district									
Sl.No.	**Location**	**Long**	**Latt**	**Taluka**	**Type of Well**	**AAP**	**Depth Drilled (mbgl)**	**Depth Constructed (mbgl)**	**Geology**
1	Ghari SK-2	72°58'00"	23°26'30"	Prantij	EW	1969-70	209	209	SR
2	Mohanpur-SK-1	73°04'45"	23°28'45"	Talod	EW	1969-70	76	76	SR
3	Nawalpur SK-5	73°06'15"	23°20'15"	Dhansura	EW	1969-70	167	167	SR
4	Pusri SK IV	73°05'45"	23°23'30"	Talod	EW	1969-70	170	170	SR
5	Timba Kampa (Harsol)	73°00'15"	23°23'00"	Talod	EW	1969-70	229	229	SR
6	Savela	73°19'00	23°10'00	Bayad	EW	1970-71	23	23	HR
7	Garhi	72°57'00	23°26'30	Prantij	EW	1970-72	213	213	SR
8	Joraji na Muwara	72°58'40"	23°17'20	Prantij	EW	1970-72	500.18	500.18	SR
9	Nananpur	72°57'00"	23°30'00"	Prantij	SH	1970-72	155	155	SR
10	Prantij	72°51'15	23°23'15	Prantij	SH	1970-72	417.04	417.04	SR
11	Sonasan	72°55'30	23°29'15	Prantij	EW	1970-72	192	155.18	SR
12	Waghpur	72°57'30"	23°28'00	Prantij	SH	1971-72	320	320	SR
13	Bamana	73°11'33"	23°40'28"	Bhiloda	EW	1990-91	201.57	201.57	HR
14	Chithoda I	73°19'30"	23°54'45"	Vijaynagar	EW	1990-91	201.57	201.57	HR
15	Chithoda II	73°19'30"	23°54'45"	Vijaynagar	EW	1990-91	177.21	177.21	HR
16	Chunakhan	73°15'35"	23°47'20"	Bhiloda	EW	1990-91	201.57	201.57	HR
17	Goral I	73°07'35"	23°51'20"	Idar	EW 1	1990-91	194.39	194.39	HR
18	Goral II	73°07'35"	23°51'20"	Idar	EW	1990-91	128.49	128.49	HR
19	Gundel I	72°59'15"	24°05'20"	Khedbrahma	EW	1990-91	177.22	177.22	HR
20	Gundel II	72°59'15"	24°05'20"	Khedbrahma	EW	1990-91	157.85	157.85	HR
21	Khumapura	73°15'15"	23°44'30"	Bhiloda	EW	1990-91	189.39	189.39	HR
22	Kushki I	73°22'10"	23°38'20"	Bhiloda	EW	1990-91	201.57	201.57	HR
23	Kushki II	73°22'10"	23°38'20"	Bhiloda	EW	1990-91	201.57	201.57	HR
24	Laxmanpura I	73°08'35"	23°50'35"	Idar	EW	1990-91	201.57	201.57	HR
25	Laxmanpura II	73°08'35"	23°50'35"	Idar	EW 1	1990-91	201.57	201.57	HR
26	Nandoj	73°16'65"	23°42'05"	Bhiloda	EW	1990-91	201.57	201.57	HR
27	Padardi Basat	73°01'20"	24°03'15"	Khedbrahma	EW	1990-91	201.57	201.57	HR

28	Punasan	73°11'05"	23°39'55"	Bhiloda	EW	1990-91	201.57	201.57	HR
29	Vejpur	73°13'15"	23°47'50"	Bhiloda	OW II	1990-91	39.14	39.14	HR
30	Vejpur I	73°13'15"	23°47'50"	Bhiloda	EW I	1990-91	201.57	201.57	HR
31	Vejpur II	73°13'15"	23°47'50"	Bhiloda	EW II	1990-91	39.14	39.14	HR
32	Poshina	73°02'20"	24°22'40"	Khedbrahma	EW	1991-92	201.57	201.57	HR
33	Sankarpura	73°14'40"	23°43'00"	Bhiloda	EW	1991-92	201.57	201.57	HR
34	Bayad	73°12’40”	23°13’40”	Bayad	PZ	1998 - 99	25	25	AL
35	Chandap	72°50’40”	23°55’45”	Idar	PZ	1998 - 99	30	30	Quartzite
36	Khedbrahma	73°02’30”	24°02’30”	Khedbrahma	PZ	1998 - 99	28	28	HR
37	Bhavangadh	72°57'38"	23°32'57"	Himmatnagar	EW	2000-01	200.5	200.5	HR
38	Chadasna	72°58'15"	23°44'42"	Idar	EW	2000-01	200.5	200.5	HR
39	Chanasama	72°58'18"	23°44'42"	Idar	EW	2000-01	200.5	200.5	HR
40	Choriwad	73°08'00"	23°54'02"	Vadali	EW	2000-01	201.6	201.6	HR
41	Dadvav	73°21'33"	22°56'12"	Vijaynagar	EW	2000-01	85.7	85.7	HR
42	Dadvav	73°21'33"	22°56'12"	Vijaynagar	OW I	2000-01	84	84	HR
43	Dadvav	73°21'33"	23°56'12"	Vijaynagar	OW II	2000-01	152.8	152.8	HR
44	Dhamadi	73°01'25"	23°57'55"	Vadali	EW	2000-01	201.6	201.6	HR
45	Dharoi	73°01'25"	23°09'00"	Himmatnagar	EW	2000-01	200.5	200.5	HR
46	Dharoi	73°01'25"	23°09'00"	Himmatnagar	OW I	2000-01	135.5	135.5	HR
47	Dharoi	73°01'25"	23°09'00"	Himmatnagar	OW II	2000-01	62.4	62.4	HR
48	Dharoi I	73°01'25"	23°09'00"	Himmatnagar	EW I	2000-01	200.5	200.5	HR
49	Gadu	73°01'00"	24°00'05"	Khedbrahma	EW	2000-01	201.6	201.6	HR
50	Gadu	73°01'00"	24°00'05"	Khedbrahma	OW	2000-01	200.6	200.6	HR
51	Ghanchali	73°02’25”	24°24’45”	Khedbrahma	EW	2000-01	201.5	201.5	
52	Ghanchali	73°02'25"	24°24'45"	Khedbrahma	OW	2000-01	200	200	HR
53	Govindpura	73°02'00"	23°48'30"	Idar	EW II	2000-01	201.6	201.6	HR
54	Hathrol	73°09'55"	23°15'25"	Dhansura	EW	2000-01	200.5	200.5	HR
55	Jethipura	72°55'45"	23°44'42"	Idar	EW	2000-01	200.5	200.5	HR
56	Kamadia	73°07'30"	23°52'00"	Idar	EW	2000-01	200.6	200.6	HR

57	Kawa I	72°54'24"	23°53'00"	Idar	EW I	2000-01	201.6	201.6	HR
58	Kawa II	72°54'24"	23°53'00"	Idar	EW II	2000-01	201.6	201.6	HR
59	Khoram	72°48'39"	23°51'10"	Idar	EW	2000-01	80.6	80.6	HR
60	Madhari I	73°17'30"	23°43'00"	Bhiloda	EW I	2000-01	67.4	67.4	HR
61	Madhari II	73°17'30"	23°43'00"	Bhiloda	EW II	2000-01	202.5	202.5	HR
62	Mangadh	72°58'12"	23°44'42"	Idar	EW	2000-01	166	166	HR
63	Nikoda	73°02'00"	23°30'12"	Himmatnagar	EW	2000-01	60.2	60.2	HR
64	Parvad I	73°19'41"	23°54'02"	Vijaynagar	EW	2000-01	101	101	HR
65	Parvad II	73°19'41"	23°54'02"	Vijaynagar	EW	2000-01	152	152	HR
66	Phalsana (Khoram)	72°48'39"	23°51'10"	Idar	EW	2000-01	80.5	80.5	HR
67	Pural	73°02'01"	23°32'01"	Himmatnagar	EW	2000-01	108	108	HR
68	Raigadh	73°10'35"	23°36'22"	Himmatnagar	EW	2000-01	200.5	200.5	HR
69	Salera	73°02'48"	24°24'00"	Khedbrahma	EW	2000-01	202.7	202.7	HR
70	Vansdol	73°02'00"	23°48'30"	Idar	EW I	2000-01	152.8	152.8	HR
71	Vansdol	73°02'00"	23°48'30"	Idar	EW II	2000-01	201.6	201.6	HR
72	Vijaynagar	73°21'22"	24°00'35"	Vijaynagar	EW	2000-01	196.6	196.6	HR
73	Abdasan	73°07'19"	23°51'30"	Idar	EW	2001-02	200	200	
74	Adpodara I	73°09'55''	23°38'52'	Himmatnagar	EW I	2001-02	87.1	87.1	SST
75	Adpodara II	73°09'55''	23°38'52'	Himmatnagar	EW II	2001-02	202.6	202.6	SST
76	Ambliya	73°32'36''	23°20'04'	Malpur	EW	2001-02	200	200	AL
77	Amodara	72°59'00''	23°30'00'	Prantij	EW	2001-02	100.9	100.9	SST
78	Amodara	72°59'00''	23°30'00'	Prantij	OW I	2001-02	62.2	62.2	
79	Amodara	72°59'00''	23°30'00'	Prantij	OW II	2001-02	111.2	111.2	
80	Bausar	73°04'15''	23°32'00'	Himmatnagar	EW	2001-02	200.5	200.5	SST
81	Bausar	73°04'15''	23°32'00'	Himmatnagar	OW	2001-02	129.4	129.4	
82	Bhiloda	73°15'22"	23°45'48"	Bhiloda	EW	2001-02	205.8	205.8	
83	Brhamani Nagar	73°25'20''	23°37'30'	Meghraj	EW	2001-02	117.2	117.2	SST
84	Brhamani Nagar	73°25'20''	23°37'30'	Meghraj	OW	2001-02	200.5	200.5	
85	Champlaner I	73°06'45''	23°36'50'	Himmatnagar	EW I	2001-02	20	20	SST

86	Champlaner II	73°06'45"	23°36'50'	Himmatnagar	EW II	2001-02	129.8	129.8	SST
87	Charandwa	73°05'45"	23°32'22"	Himmatnagar	EW	2001-02	120.2	120.2	SST
88	Chotasan	73°07'02"	23°53'15'	Idar	EW	2001-02	200.5	200.5	HR
89	Fatehpura	73°10'52"	23°42'08'	Bhiloda	EW	2001-02	202.6	202.6	SST
90	Ganthi	73°12'04"	23°47'05'	Bhiloda	EW	2001-02	202.6	202.6	SST
91	Gokulpura	73°23'00"	23°17'00'	Malpur	EW	2001-02	166.4	166.4	AL
92	Gokulpura	73°23'00"	23°17'00'	Malpur	OW	2001-02	200.5	200.5	
93	Gota	73°04'00"	23°59'37"	Khedbrahma	EW	2001-02	200	200	
94	Idar	73°00'15"	23°50'05"	Idar	EW	2001-02	205.8	205.8	
95	Jaliya	73°16'52"	23°36'00'	Bhiloda	EW	2001-02	202.6	202.6	SST
96	Kasana	73°34'48"	23°33'30"	Meghraj	EW	2001-02	200	200	
97	Knaniyol	73°02'24"	23°40'30"	Himmatnagar	EW	2001-02	205.8	205.8	
98	Kumapur	73°15'25"	23°43'45"	Kumapur	EW	2001-02	200	200	
99	Likhi	73°01'45"	23°42'19"	Himmatnagar	EW	2001-02	111	111	
100	Mahiyapur I	73°26'45"	23°22'18'	Malpur	EW I	2001-02	202.6	202.6	SST
101	Mahiyapur II	73°26'45"	23°22'18'	Malpur	EW II	2001-02	202.6	202.6	SST
102	Maniyor	72°57'00"	23°47'55"	Idar	EW	2001-02	201.6	201.6	AL
103	Meghraj	73°30'00"	23°29'00'	Meghraj	EW	2001-02	202.6	202.6	SST
104	Morad	73°00'32"	23°57'45'	Vadali	EW	2001-02	129.4	129.4	SST
105	Morad	73°00'32"	23°57'45'	Vadali	OW	2001-02	200.5	200.5	
106	Mudeti	73°10'10"	23°50'00'	Idar	EW	2001-02	207.6	207.6	SST
107	Muloj	73°25'15"	23°31'07"	Meghraj	EW	2001-02	200	200	
108	Munnai	73°09'00"	23°45'04'	Bhiloda	EW	2001-02	79.8	79.8	SST
109	Munnai	73°09'00"	23°45'04'	Bhiloda	OW I	2001-02	178.2	178.2	
110	Munnai	73°09'00"	23°45'04'	Bhiloda	OW II	2001-02	80.6	80.6	
111	Munnai	73°09'00"	23°45'04'	Bhiloda	OW III	2001-02	77.5	77.5	
112	Nava Falasan	72°48'15"	23°51'45'	Idar	EW	2001-02	202.6	202.6	SST
113	Oda	72°52'00"	23°50'20"	Idar	EW	2001-02	147.8	147.8	AL
114	Oda	72°52'00"	23°50'20"	Idar	OW	2001-02	141.6	141.6	

115	Pall	73°21'00"	23°47'36"	Bhiloda	EW	2001-02	200	200	
116	Punasan	73°10'44"	23°40'09"	Bhiloda	EW	2001-02	205.8	205.8	
117	Ramgadhi	73°33'28"	23°26'00'	Meghraj	EW	2001-02	202.6	202.6	SST
118	Sinawada	73°23'15"	23°28'53"	Modasa	EW	2001-02	200	200	
119	Takatuka	73°17'48"	23°47'55'	Bhiloda	EW	2001-02	202.6	202.6	SST
120	Tunadar	73°23'11"	23°16'25'	Malpur	EW	2001-02	202.6	202.6	SST
121	Unchidhanal	72°57'00"	24°05'45"	Khedbrahma	EW	2001-02	202.2	202.2	SST
122	Vadali	73°01'33"	23°56'27'	Vadali	EW	2001-02	200.5	200.5	SST
123	Vadthali	73°34'00"	23°34'36"	Meghraj	EW	2001-02	200	200	
124	Vaktapur	72°56'30"	23°40'00'	Himmatnagar	EW	2001-02	200.5	200.5	SST
125	Verabar	72°53'00"	23°54'36"	Idar	EW	2001-02	200	200	
126	Volva	73°20'38"	23°28'45"	Modasa	EW	2001-02	200	200	
127	Vsai	73°08'52"	23°48'20"	Bhiloda	EW	2001-02	200	200	
128	Eploda	73°29'40"	23°26'00"	Meghraj	EW	2002-03	202.6	202.6	HR
129	Lok	72°56'00"	24°02'45"	Khedbrahma	EW	2002-03	200.5	200.5	HR
130	Lok	72°56'00"	24°02'45"	Khedbrahma	OW	2002-03	202.5	202.5	
131	Majra I	72°47'27"	23°21'50"	Prantij	EW	2002-03	200	143	AL
132	Majra II	72°47'27"	23°21'50"	Prantij	EW	2002-03	200	143	AL
133	Himmatnagar	72°51'15"	23°26'15"	Himmatnagar	PZ	2006 - 07			SST
134	Derol	72°49'42"	23°35'09"	Himmatnagar	PZ I	2006-07	141	141	AL
135	Anwarpura	72°49'28"	23°24'57"	Prantij	PZ	2007-08	200	69	AL
136	Derol	72°27'06"	23°20'42"	Himmatnagar	PZ II	2007-08	70.01	68	AL
137	Malpur	73°28'17"	23°21'55"	Malpur	PZ	2007-08	42.7	42.7	HR
138	Waliampura	72°54'37"	23°19'27"	Talod	PZ	2007-08	148	45	AL