For official use

Technical Report Series

GROUND WATER BROCHURE GANDHINAGAR DISTRICT GUJARAT

Compiled by
R.K.Verma
Assistant Hydrogeologist

Government of India
Central Ground Water Board
West Central Region
Ahmedabad

March 2014

For official use

Technical Report Series

GROUND WATER BROCHURE GANDHINAGAR DISTRICT GUJARAT

Compiled by
R.K.Verma
Assistant Hydrogeologist

Government of India
Central Ground Water Board
West Central Region
Ahmedabad

March 2014

GANDHINAGAR DISTRICT AT A GLANCE

SL No.	Items	Statistics
1	**General Information**	
	i) Geographical Area (Sq. Km)	**2137.62**
	ii) Administrative Divisions (As on 2011) Number of Taluka Number of Villages	 **4** **252**
	iii) Populations (As per 2011 census)	**13,87,478**
	iv) Average Annual Rainfall (mm)	**823**
2.	**GEOMORPHOLOGY**	
	Major Physiographic Units	**Alluvial plain**
	Major Drainages	**Sabarmati**
3.	**LAND USE (Sq. Km)**	
	a) Forest area b) Net area sown c) Cultivable area	**21.00** **1613** **1933**
4.	**MAJOR SOIL TYPES**	**Sandy Loam**
5.	**AREA UNDER PRINCIPALFOODGRAIN CROPS** Rice (140 Sq Km), Bajra (310 Sq Km), Wheat (210 Sq Km), Cereals (670 Sq Km) , Other Pulses (70 Sq Km), Total Pulses (70 Sq Km), Total food grains (740 sq km), Ground Nut (30 Sq Km), Sesamum (30 Sq Km), rapes and Mustard (70 Sq Km), total oil seeds (380 Sq. Km)	
6.	**IRRIGATION BY DIFFERENT SOURCES (Areas and numbers of structures) in Sq Km**	
	Dugwells	91/2203
	Tube wells/Bore wells	829/5571
	Tanks/Ponds/Water conservation structures	1
	Canals	1
	Other Sources	3
	Net Irrigated area (sq. km.) (2004-05)	925
	Gross Irrigated area (sq. km.) (2004-05)	1238
7.	**NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB (As on 31-03-2012)** No of Dug Wells No of Piezometers	**33** 03 30
8.	**PREDOMINANT GEOLOGICAL FORMATIONS**	
	Alluvium/ Tertiaries	

9. HYDROGEOLOGY

- Major Water Bearing Formation: Quaternary alluvium

Depth to water level during 2009-10

	Phreatic aquifer (DTW)		Semiconfined and Confined aquifer (Pz head)	
	Min.	**Max.**	**Min.**	**Max.**
Pre-monsoon	10.05 (Dahegam-II)	25.20 (Adalaj PZ-III)	56.42 (Kalol Pz-II)	118.95 (Mansa)
Post-monsoon	6.63 (Dahegam-II)	23.78 (Adalaj PZ-III)	55.16 (Kalol Pz-II)	178.12 (Charada-I)

Long Term (10 Years) Water Level Trend (2001 to 2010)		
Trend	**Pre-Monsoon**	**Post- Monsoon**
Rise (m/Yr)	Nil	Nil
Fall (m/Yr)	0.30 (Dahegam) to 1.87 (Gandhinagar)	0.71 (Dahegam) to 2.24 (Mansa)

10. GROUND WATER EXPLORATION BY CGWB (As on 31 -03 -2011)

No of wells drilled (EW, OW, Pz, SH, Total)

EW= 21	OW = 6	Pz= 29	SH= 01	Total =57

Depth Range(m)	**20- 534**
Discharge (Litres per second)	**6- 20 lps**
Transmissivity (m^2/day)	**350-1100**

11 GROUND WATER QUALITY

Presence of chemical constituents more than permissible limit)	**Fluoride : 140 Villages** **Salinity : 7 villages** **Nitrate : 30 villages**
Type of water	**Overall Fresh**

DYNAMIC GROUND WATER RESOURCES (2011)

Annual Replenishable Ground Water Resources (MCM)	543.84
Net Ground water Availability (MCM)	453.00
Projected Demand for Domestic and industrial Uses up to 2025 (MCM)	42.57
Stage of Ground Water Development (%)	120.05

DISTRICT GROUND WATER BROCHURE
GANDHINAGAR

1. Introduction

Gandhinagar District is an administrative division of Gujarat, India, whose headquarters are at Gandhinagar, the state capital. It was organized in 1964.

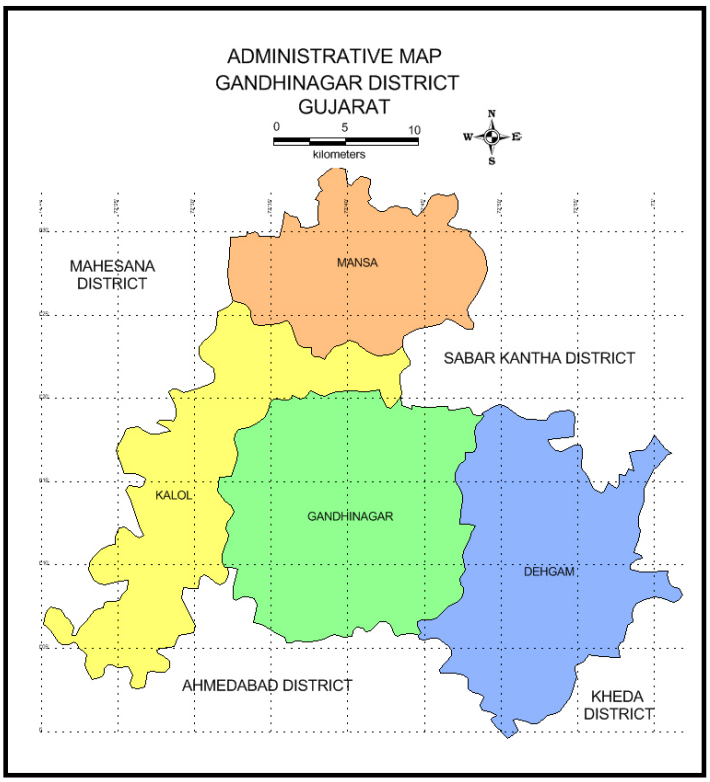
It has an area of 649 km², and a population of 1,334,455 of which 35.02% were urban (2001 census). The district includes Gandhinagar with three Suburbs - Chandkheda, Motera, Adalaj. The four tehsils are - Gandhinagar, Kalol INA, Dahegam and Mansa - and 216 villages.

Gandhinagar district is bounded by the districts of Sabarkantha and Aravalli to the northeast, Kheda to the southeast, Ahmedabad to the southwest, and Mehsana to the northwest.

1.1 Administrative Details

The district comprises of four talukas namely, Gandhinagar, Dahegam, Kalol and Mansa. It has 291 numbers of villages, and nine urban areas. Total area of the district is 2137.62 sq. km. It is situated between latitude 22°56' and 23°36' and longitude 72°23' to 73°05'.

According to the 2011 census Gandhinagar district has a population of 1,387,478. The district has a population density of 660 inhabitants per square kilometer (1,700 /sq mi) . Its population growth rate over the decade 2001-2011 was 12.15%. Gandhinagar has a sex ratio of 920 females for every 1000 males,[3] and a literacy rate of 85.78%.



1.2 Basin/ Sub-basin

Major portion of the district falls under Sabarmati basin.

1.3 Drainage

The entire district is a part of North Gujarat Alluvial plain with neither hill features nor any prominent natural water bodies.

The Sabarmati, the Khari and the Meshwo are important rivers of the district. One of the most important feature of the drainage of the district is lack of any definite drainage system in the western part and other is artificial drainage i.e. The Narmada Canal System.

The Sabarmati River, which flows through the district in north- south direction, is the principal river of the district. The Sabarmati flows through the central part of Gandhinagar taluka. The Sabarmati was once a perennial river, however, after construction of dam near Dharoi, it is generally dry during lean periods except for a small channel of flow due to water released from Dharoi dam. Recently water from Narmada canal is being fed to the river and the river retains water downstream of Narmada canal.

1.4 Irrigation Practices

Table: 3- Area irrigated under the major crops in Gandhinagar District

Area in '00 Hect.				
Rice (Paddy)	**Jowar**	**Bajra**	**Maize**	**Wheat**
31	8	29	1	28

Table: 4- Major source of irrigation in Gandhinagar District

S.No.	Taluka	Ground Water			Surface Water	Total
		Dug Wells	Tube Wells	Total	Surface Flow	
1.	Dahegam	2000	1315	3315	1	3316
2.	Gandhinagar	56	1610	1666	0	1666
3.	Mansa	15	1321	1336	0	1336
4.	Kalol	100	1200	1300	0	1300
	Total	2171	5446	7617	1	7618

1.5 Studies /Activities carried out by CGWB

1.5.1 Systematic hydrogeological studies

Systematic hydrogeological studies carried out by Central Ground Water Board are as given in table 5 below.

Table: 5- Systematic hydrogeological studies

Name	Taluka	Year
Sh. M.M.Oza (GSI)	Parts of Gandhinagar District	1962-67
UNDP project study of CGWB	Parts of Gandhinagar District	1971-74

1.5.2 Reappraisal hydrogeological survey

Reappraisal hydrogeological survey of the entire district was carried out by following officers of CGWB.

Table: 6- Reappraisal hydrogeological survey

Name	Area covered (Talukas)	Year
J.N. Bhagat, A.K. Jain & A.B.Kawade	Parts of Gandhinagar district	**1993-94**
B.Mohapatra	Gandhinagar District	**2005-06**

1.5.3 Ground Water Exploration

The Ground Water Exploration was first taken up during 1971-74 under UNDP project and thereafter under various programmes of Central Ground Water Board. During UNDP Project two boreholes were drilled at Sardhav (Sardhao) in the north-western part of the district. These were converted into piezometers. Subsequently, during 1985-86, three piezometers, tapping different aquifers zones were constructed in the Sachivalay complex by CGWB under its Piezometer Construction Programme. Two Deposit wells, down to 200 m depth, were also constructed at Palej Agriculture Farm during 1981. Under Hydrology project five Piezometers one each at Nardipur and Mansa and three at Kalol were constructed. One artificial recharge well and one recharge well cum piezometer was constructed at IFFCO Kalol. Hydrogeological details of the wells are given in table 7 below.

Table: 7- Ground Water Exploration

Salient Features	EW	OW	Pz	Slim Hole	Total
Total Nos.	21	06	29	1	57
Drill Depth range (mbgl)	48-611				
Depth Constructed range (mbgl)	20-534				
Static Water Level (mbgl)	24.65-				
Discharge (LPS)	6-20				
Transmissivity (m^2 / day)	350-1100				

2. Rainfall and climate

The district experiences semi-arid type of climate. The rainy season lasts from June to September and coincides with south-west monsoon. Winter season last from November to February and summer season from March to June. About 95% of the annual rainfall is received during south-west monsoon season (June to Sept.), July being the heavy rainfall month. There is no climatological station in Gandhinagar, however, the IMD Station located at Ahmedabad Airport is quite close to Gandhinagar and is representative for the district. The annual normal rainfall (1930-60) for the Ahmedabad IMD Station is about 823 mm The climatological data for Ahmedabad IMD Station is given in table and figure respectively.

The general temperature in Gandhinagar district increases rapidly from February to May, the later being the hottest month with mean daily maximum and minimum temperature as 41° and 26°C respectively. The district is sometimes affected by cold waves due to western disturbances that pass across north India causing minimum temperature to drop the freezing point.

In the monsoon months, the relative humidity is generally 65% or more. However, the rest of the year is comparatively dry. March and April are the driest months where the humidity in less than 45% dropping to 20% or less in the afternoons.

Winds are generally light except in the late summer and in early part of southwest monsoon period when they are moderate to stormy especially in the southwest direction (about 10 km/h).

Climatological data of Ahmedabad IMD station which is nearest is given in the table 8.

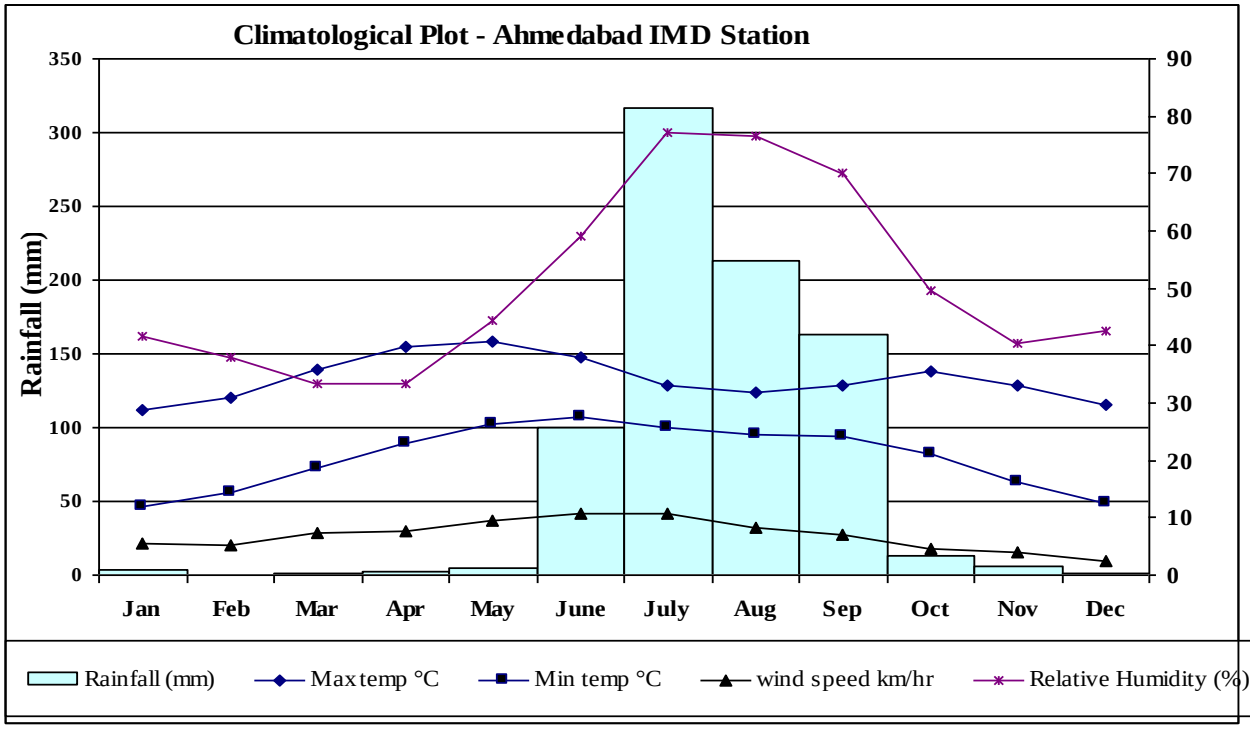


Table: 8- Ahmedabad IMD Station - Climatological Data (1931-60)

Month	Temp		Relative Humidity	Vapour Pressure	Wind Speed	Rainfall
	Max	Min				
	°C	°C	%		Km/hr	mm
Jan	28.70	11.90	41.50	9.35	5.4	3.9
Feb	31.00	14.50	38.00	10.05	5.1	0.3
Mar	35.70	18.60	33.50	12.00	7.3	0.9
Apr	39.70	23.00	33.50	14.85	7.8	1.9
May	40.70	26.30	44.50	22.45	9.5	4.5
June	38.00	27.40	59.00	28.90	10.8	100.0
July	33.20	25.70	77.00	30.85	10.8	316.3
Aug	31.80	24.60	76.50	29.65	8.3	213.3
Sep	33.10	24.20	70.00	27.60	7.0	162.8
Oct	35.60	21.20	49.50	19.10	4.6	13.1
Nov	33.00	16.10	40.50	12.75	4.1	5.4
Dec	29.60	12.60	42.50	10.65	2.6	0.7
Mean	34.18	20.51	50.50	19.02	6.94	68.59
Mean Winter	30.58	13.78	40.63	10.70	4.30	2.58
Mean Summer	38.53	23.83	42.63	19.55	8.85	26.83
Mean Monsoon	33.43	23.93	68.25	26.80	7.68	176.38

3. Geomorphology and Soil Type

3.1 Geomorphology

Geomorphologically the district as whole has a flat planar topography.

3.2 Soils

The soils in the district are generally sandy loam type with grey to brown colour. As per the studies carried out during UNDP project, they are generally deep and have moderate to good permeability and drainability. In the western part of the district the soils are alkali type and saline. They are typically deep, grey, calcareous sandy loam of very low permeability.

4. Ground Water Scenario

4.1 Hydrogeology

The district forms a part of Cambay basin and is occupied by quaternary alluvium comprising mainly of sand, gravel, silt clay and Kankar etc. The Hydrogeological map of the district is presented as figure- .

The ONGC has established that the thickness of alluvium in the North Gujarat is about 700 m. However. As per the studies carried out by CGWB under UNDP Project the Miocene formations were encountered within 611 m at the deepest borehole drilled in the district at Sardhao. There is a sequence pf alternating layers of granular sandy and clayey horizons, the uppermost granular zone varies in thickness from 5 to 65 m. it is underlain by a thick clay bed followed by alternating sequence of arenaceous and argillaceous horizons. The granular horizons occurring at various depths forms potential aquifers. The aquifer system of the district is described below.

Aquifer System

Geological survey of India during its studies had identified three confined aquifers within a depth of 600 m in the adjoining Mahesana district. These were designated as “A”, “B” and “C” aquifers. Subsequently, the studies carried out by CGWB under UNDP project, which also covered the northern part of Gandhinagar district, a multi-aquifer system was established. A total of 7 aquifers zones, each separated by aquiclude of varying thickness, were identified as “A”, “B”, “C”, “D”, “E”, “F” and “G”. Of these first five i.e. “A to E” represents Quaternary alluvium, whereas, last two i.e. “F & G” represents Miocene sediments. A brief discussion of these aquifers is given in table.

The thickness of quaternary alluvium is limited in the eastern part and all the aquifers are not developed in this part. Moreover, identification of different aquifers also becomes very difficult in the eastern part due to limited thickness of aquiclude. However, the aquifer system is well developed in the western part. The aquifers in the entire district are the southward and eastward extension of those identified in the UNDP Project area.

The aquifer “A” in the district occurs as phreatic and semi-confined aquifer. The thickness varies from less than 25 m in the east to more than 80 m in the

western part. Most of the dug wells and shallow tubewells tap this aquifer. However, over the years it has gone dry and at present occurs as saturated zone only in the vicinity of Sabarmati River and in the eastern parts of Dahegam & Gandhinagar Talukas.

The aquifer “B” and “C” which occurs within a depth of about 225 m, are the most exploited aquifer in the district and most of the tubewells constructed tap these aquifers. Aquifer “D” is also being developed in some parts of the district particularly in Mansa and Kalol Talukas.

The deeper aquifers, i.e., “E”, “F” and “G” are required to be properly explored and tested for future use.

The depth of most prolific and most exploited aquifers in the district range from about 50 m to more than 300 m. The depth of tubewells gradually increases from east to west. The Dug-cum-bore wells and shallow tubewells (<100m) are feasible in the eastern part. However, in the western part only deep tubewells are feasible. The feasible depth of tube wells ranges from less then 100 m in the eastern part to more than 300 m in parts of Mansa Taluka.

The tubewells tap all potential zones upto the depth constructed. The aquifers being tapped are “B and/or C” in major part of the district. However, aquifer “A” and “D” are also being developed either in isolation or in combination of other aquifers in the eastern and western parts respectively.

Table: 2 Hydrogeological Characteristics of the Aquifers.

Strati-graphy	Aquifer Nomen-clature	Lithological Characteristics	Depth to top of aquifer	Thickness		Nature of aquifer	Remarks
				Range	Average		
			(mbgl)	(m)	(m)		
RECENT TO MIOCENE	Aquifer A	Coarse sand, gravel, pebbles, medium and fine sands & Clayey Sand.	5 - 71	35-125	62	Phreatic & semi confined.	Variable Water Quality.
	Aquitard I	Clay interbeded with sand and sandy clay.		13-88	39		
	Aquifer B	Medium to coarse sand and gravel interbeded with sandy clay	78 - 162	10-80	45	Confined	Generaly Good Water Quality
	Aquitard II	Clay interbeded with sand and sandy clay		13-80	37		
	Aquifer C	Fine to medium sand interbeded with clay, sandy clay	154 - 274	13-62	34	Confined	Generally Good Water Quality
	Aquitard III	Clay interbeded with sand and sandy clay.		19-172	73		
	Aquifer D	Medium sand interbeded with sandy clay	229 - 402	11-105	52	Confined	Variable Water Quality
	Aquitard IV	Clay interbeded with sandy clay.		11-76	44		
	Aquifer E	Fine to medium sand with sandy clay	300 - 342	11-57	24	Confined	Generally Good Water Quality
MIOCENE	Aquiclude V	Grey clay and clay stone.		13-148	41		
	Aquifer F	Fine to medium sand, sand stone interbedded with siltstone	200-574	7-68	39	Confined	Variable Water Quality
	Aquiclude VI	Clay & Clay stone		34-49	40		
	Aquifer G	Fine to medium sand, sandstone interbeded with siltstone	200 - 574	7-68	39	Confined	Variable Water Quality
PALAE OCENE	-	Basalt			267		
CRETACEOUS	Aquifer H	Himmatnagar Sandstone	214 - 547	98-145	121		Variable Water Quality

4.2 Ground Water Regime Monitoring

Ground Water Regime monitoring is being carried out four times in a year during May, August, November and January. In all 33 Hydrograph stations (3 Open Wells and 30 Purpose built Piezometers)spread over the entire district are being monitored during 2012-13.

Premonsoon (May 2012)

The ground water level during the premonsoon period (May 2012) ranged from 7.55 to 59.40 mbgl. The shallowest Water level of 7.55 mbgl was recorded at Dahegam and the deepest water level of 59.4 m was recorded at Amrapur. The range of ground water level in the district is given as below.

Table: 11- Range of Ground Water Level during Pre Monsoon (May 2012)

No of well analysed	DTWL mbgl		No of well in different Depth Ranges					
	Min	Max	0 to 2 (m)	2 to 5 (m)	5 to 10 (m)	10 to 20 (m)	20 to 40 (m)	>40(m)
6	7.55	59.4	0 0.00%	0 0.00%	1 16.67%	3 50.00%	1 16.67%	1 16.67%

Postmonsoon (November 2012)

The ground water level during the postmonsoon period (November 2012) ranged from 6.27 to 59.17 mbgl. The shallowest Water level of 6.27 mbgl was recorded at Dahegam and the deepest water level of 59.17 m was recorded at Amrapur. The range of ground water level in the district is given as below.

Table: 12-Range of Ground Water Level during Post Monsoon (Nov-2012)

No of well analysed	DTWL mbgl		No of well in different Depth Ranges					
	Min	Max	0 to 2 (m)	2 to 5 (m)	5 to 10 (m)	10 to 20 (m)	20 to 40 (m)	>40(m)
6	6.27	59.17	0 0.00%	0 0.00%	1 16.67%	3 50.00%	1 16.67%	1 16.67%

83.33 % of the wells in the district showed rise in the ground water level between May to November 2012. Rise in the district ranged form 0.23 to 6.18m. 66.67% of the wells showed rise between 0 to 2 m and 16.67 % of the wells showed rise > 4 m.

16.67 % of the wells in the district showed fall in the ground water level between May to November 2012. Fall in the district was observed at one well i.e. Serthapara (0.19 m.)

Table: 13- Range of Fluctuation

No of well analy sed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
	Rise		Fall		Rise			Fall				
	Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
6	0.23	6.18	0.19	0.19	4 66.67 %	0 0 %	1 16.67 %	1 16.67 %	0 0 %	0 0 %	5	1

4.2.1.1 Long Term Fluctuations

Long Term Fluctuations- May (2002 to 2011)

A comparison of the water level observed in May 2011 with the average water level observed in the month of May during last one decade (2002-2011) reveals that rise in water level ranged from 0.12 to 3.11 mbgl and fall ranged from 0.75 to 5.38 mbgl. 50% of the wells had shown rise in the ground water level whereas 50% of the wells have shown fall in the water level.

Table: 14- Categorisation of Changes In Water Level During May 2012 with respect to Decadal Average of May (2002 to 2011)

No of well analyse d	Range of Fluctuation (m)				No. of Wells Showing Fluctuation						Total No. of Wells	
	Rise		Fall		Rise			Fall				
	Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4	Rise	Fall
6	0.12	3.11	0.75	5.38	2 33.33 %	1 16.67 %	0 0%	2 33.33 %	0 0 %	1 16.67 %	3	3

Long Term Fluctuations- November (2002 to 2011)

A comparison of the water level observed in November 2012 with the average water level observed in the month of November during last one decade (2002-2011) reveals that none of the stations have rise in water level. All the four stations have fall in water level. The fall ranged from 0.37 to 1.69 mbgl. 100% of the wells have shown fall in the ground water level.

Table: 15- Categorisation of Changes In Water Level During November 2012 with respect to Decadal Average of November (2002 to 2011)

No of well analysed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation			Total No. of Wells	
	Rise		Fall		Fall				
	Min	Max	Min	Max	0 to 2	2 to 4	>4	Rise	Fall
4	0	0	0.37	1.69	4 100%	0 0%	0 0 %	0	4

4.3 Ground Water Resources

The ground water resources of the district were calculated as on March 2011 in collaboration with the Government of Gujarat using the methodology suggested by Ground Water Resource Estimation Committee (GEC-97). These resources were computed after reorganisation of the districts.

4.3.1 Ground Water Recharge

The Annual Ground Water Recharge varies from 9836.37 ha.m (Mansa taluka) to 14114.01 ha.m (Dehgam Taluka). The Gross Annual Ground Water Recharge in the district is 48837.83 ha.m. The net available recharge after leaving natural discharge from monsoon period varies from 8852.73 ha.m (Mansa Taluka) to 13408.31 ha.m (Dehgam Taluka). The net available recharge in the district is 45300.05 ha.m.

4.3.2 Ground Water Draft

The ground water draft from irrigation and Domestic /Industrial sources is presented in Table:16. The Existing Gross Ground Water Draft for all uses varies from 13142.70 ha.m (Mansa taluka) to 14077.80 ha.m (Gandhinagar Taluka). The Gross Ground Water Draft for All uses in the district is 54384.00 ha.m.

4.3.3 Ground Water Balance for Irrigation

The irrigation potential available for future use of ground water has been computed leaving the ground water projected for allocation for the domestic and industrial requirements (for Next 25 Years) for all the talukas. It is 0 ha.m in all the four talukas. The total irrigation potential available for future use of ground water in the district is 0 ha.m.

Table: 16- Ground Water Resource Potential (GWRE-2011) (in ha m)

Sr. No.	Assessment Unit/ District	Total Annual Ground Water Recharge	Natural Discharge during non-monsoon season	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic & industrial water supply	Existing Gross Ground Water Draft for All uses
1	Dahegam	14114.01	705.70	13408.31	13043.50	757.00	13800.50
2	Gandhinagar	12806.03	640.30	12165.73	13250.80	827.00	14077.80
3	Kalol	12081.43	1208.14	10873.29	12424.00	939.00	13363.00
4	Mansa	9836.37	983.64	8852.73	12553.70	589.00	13142.70
TOTAL		**48837.83**	**3537.78**	**45300.05**	**51272.00**	**3112.00**	**54384.00**

4.3.4 Level of Ground Water Development & Stage

The level of Ground Water Development varies between 102.93 % (Dehgam Taluka) and 148.46 % (Mansa Taluka). The overall development in the district is 120.05 %. All the four talukas are categorised as Over Exploited.

Table: 17- Stage of Ground Water Development (GWRE-2011)

(in ha m)

Sr. No.	Assessment Unit/ Taluka	Net Annual Ground Water Avail-ability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for All uses (4+5)	Allocation for domestic and industrial require-ment supply upto next 25 years	Net Ground Water Availabilit y for future irrigation developme nt (3-4-7)	Stage of Ground Water Development {(6/3)*100} (%)	Categorizat ion for future ground water develop-ment
1	2	3	4	6	7	8	9	
1	**Dahegam**	13408.31	13043.50	13800.50	1015.00	0	102.93	Over Exploited
2	**Gandhinagar**	12165.73	13250.80	14077.80	1159.00	0	115.72	Over Exploited
3	**Kalol**	10873.29	12424.00	13363.00	1258.00	0	122.90	Over Exploited
4	**Mansa**	8852.73	12553.70	13142.70	825.00	0	148.46	Over Exploited
TOTAL		**45300.05**	**51272.00**	**54384.00**	**4257.00**	**0**	**120.05**	**Over Exploited**

4.4 Ground Water quality

4.4.1 Unconfined aquifer (Phreatic)

Groundwater in the district is in general potable and fresh, both in phreatic and confined aquifers within 200 m depth. However, as reported earlier the phreatic aquifer exists only in the eastern parts of the districts.

4.4.2 Confined aquifers

The Gujarat Water resources and Development Corporation (GWRDC) Ltd., Govt. of Gujarat is monitoring ground water quality of tube wells. The ground water quality deteriorates from east to western parts of the district i.e. in the ground water flow direction. The TDS varies from about 500 mg/l to more than 2700 mg/l. However, in major part of the district the ground water quality is potable with less than 2000 TDS. Higher TDS is observed in western part around Chhatral.

Ground water Quality is monitored through Ground water Monitoring stations in the district. Analysis of ground water quality data for May 2012 is presented as below.

Table: 18-Range of Different Chemical Constituents in Ground Water

Chemical constituents	Unit	Minimum	Maximum
TDS		1072 (Gandhinagar)	1090 (Dahegam)
pH		8.10 (Gandhinagar)	8.77 (Dahegam)
Sp. Conductance	**μS/cm at 25^0C**	1600 (Gandhinagar)	1627 (Dahegam)
HCO_3	**mg/l**	317 (Dahegam)	659 (Gandhinagar)
Cl^-	**mg/l**	149 (Gandhinagar)	213 (Dahegam)
NO_3	**mg/l**	95 (Gandhinagar)	125 (Dahegam)
SO_4^-	**mg/l**	2 (Gandhinagar)	91 (Dahegam)
F^-	**mg/l**	1.25 (Dahegam)	2.65 (Gandhinagar)
Ca^{++}	**mg/l**	12 (Dahegam)	96 (Gandhinagar)
Mg^{++}	**mg/l**	46(Gandhinagar)	125 (Dahegam)
Fe	**mg/l**	0.16 (Dahegam)	1.90 (Gandhinagar)
TH	**mg/l**	430 (Gandhinagar)	550 (Dahegam)
Na^+	**mg/l**	188 (Gandhinagar)	190 (Dahegam)
K^+	**mg/l**	0.4 (Dahegam)	21.0 (Gandhinagar)

4.4.3 Type of pumps and water lifting devices for Irrigation dugwells, shallow tubewells and deep tubewells.

Table: 21-No. of Water Lifting Devices for Irrigation Schemes

Taluka	Ground Water				Surface Water			Total
	Dugwell	Shallow Tube Wells	Deep Tube Wells	Total	S. Flow	S. Lift	Total	
Dahegam	3	660	2167	2830	0	0	0	**2830**
Gandhinagar	32	0	2990	3022	0	0	0	**3022**
Kalol	0	0	1365	1365	2	0	2	**1367**
Mansa	0	0	1468	1468	0	0	0	**1468**
Total	**35**	**660**	**7990**	**8685**	**2**	**0**	**2**	**8687**

Table: 21-Dugwells

Taluka	Electric pumps	Diesel pumps	Wind mills	Solar pumps	Man/Ani. Operated	Others	Total
Dahegam	0	0	3	0	0	0	**3**
Gandhinagar	0	32	0	0	0	0	**32**
Kalol	0	0	0	0	0	0	**0**
Mansa	0	0	0	0	0	0	**0**
Total	**0**	**32**	**3**	**0**	**0**	**0**	**35**

Table: 22- Shallow Tubewells

Taluka	Electric pumps	Diesel pumps	Wind mills	Solar pumps	Man/Ani. Operated	Others	Total
Dahegam	660	0	0	0	0	0	**660**
Gandhinagar	0	0	0	0	0	0	**0**
Kalol	0	0	0	0	0	0	**0**
Mansa	0	0	0	0	0	0	**0**
Total	**660**	**0**	**0**	**0**	**0**	**0**	**660**

Table: 23- Deep Tubewells

Taluka	Submersible pumps	Turbine pumps	Others	Total
Dahegam	2151	0	16	**2167**
Gandhinagar	2989	1	0	**2990**
Kalol	1364	1	0	**1365**
Mansa	1467	1	0	**1468**
Total	**7971**	**3**	**16**	**7990**

4.4.4 Irrigation scenario from ground water sources

4.4.4.1.1 Dugwells

As per MI census 2000-01 there are 35 dugwells out of which none are in use. Irrigation potential created through these dugwells is 0 ha. and potential utilized is 0 ha. area.

4.4.4.1.2 Shallow tubewells

As per MI Census 2000-01 there are 660 shallow tubewells out which 660 are in use. The irrigation potential created is 8712 ha. and utilized is 8372 ha.area.

4.4.4.1.3 Deep Tubewells

As per MI census 2000-01 there are 7990 deep tubewells in the district out of which 7927 are in use. The irrigation potential created is 127330 ha. and potential utilized is 115575 ha. area.

Following is the talukawise detail of irrigation potential for ground water sources

Table: 24- Talukawise detail of irrigation potential for ground water sources

ha.

Taluka	Dugwells		Shallow tubewells		Deep tubewells		Total	
	Potential created	Potential utilized	Potential created	Potential created	Potential utilized	Potential utilized	Potential created	Potential utilized
Dahegam	0	0	8712	8372	34511	30059	43223	38431
Gandhinagar	0	0	0	0	40705	38242	40705	38242
Kalol	0	0	0	0	27384	25102	27384	25102
Mansa	0	0	0	0	24730	22172	24730	22172
Total	**0**	**0**	**8712**	**8372**	**127330**	**115575**	**136042**	**123947**

5. Ground Water Management Strategy

5.1 Ground Water Development

As per the GWRE, 2011 report, all the Four Talukas of the district are Over Exploited. The level of Ground Water Development varies from 102.93 % (Dehgam Taluka) to 148.46 % (Mansa Taluka). The overall development in the district is 120.05 %, and as a whole the Gandhinagar district is Over Expoited. Though, Improvement in Groundwater development is observed as a perusal of GWRE 2004, 2009 and 2011, but there is no scope for further development of groundwater resources in the district. Great need of artificial recharge and rainwater harvesting is required for efficient management of groundwater resources in the district.

5.2 Water Conservation and Artificial Recharge

The Ground Water development is about 120.05% in the district. All the four talukas are overexploited with the level of ground water development ranging from about 102.93% to about 148.46%. The drinking water supply as well as irrigation is mostly ground water based. The irrigation potential has not only been created to its capacity but has already exceeded.

The dependence on ground water has created stress on the resources and the resources are shrinking as the mining continues. The affect of overexploitation is manifested in the form of continuous declines in the water levels/ piezometric heads and deterioration in the ground water quality. However, the Narmada Canal based water supply will have its effect on ground water regime.

For sustainable development of resources on equitable basis and its management it is essential to educate the masses and practice water conservation techniques, rainwater harvesting and artificial recharge in the district.

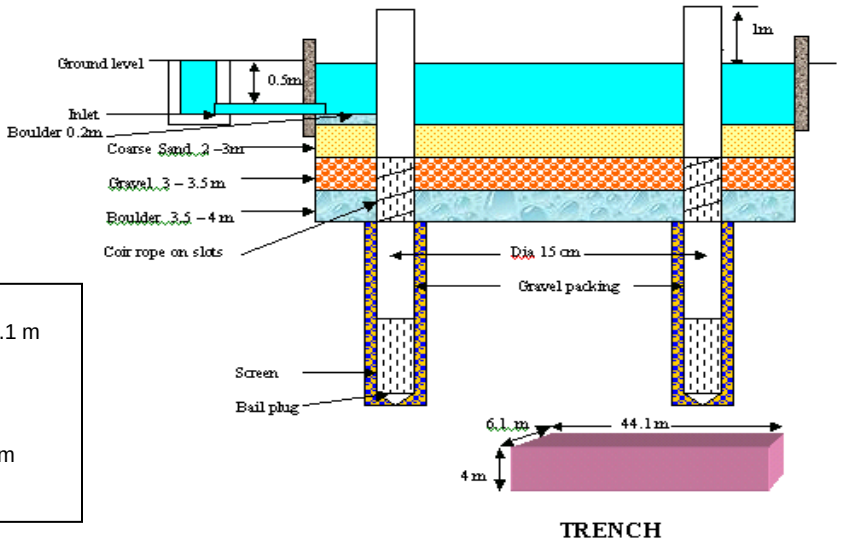
Rainwater harvesting and artificial recharge activities taken up by Govt. Agencies , NGOs etc. are as below.

1. Central Ground Water Board in the early eighties has carried out pilot for technical feasibility and economic viability of artificial recharge of groundwater studies in North Gujarat alluvial plains (UNDP/CGWB-1986)
2. Under the aegis of Central Ground Water Board, IFFCO has implemented Rain water harvesting by constructing RechargeTrench along with two recharge wells at Kasturinagar colony, , village Sertha, taluka Kalol. 29376 m^3/yr of rainwater is expected to recharge the groundwater. The design of the recharge structure is as below.

Design of Recharge Trench and Recharge Wells, Jasturinagar, IFFCO, Kalol.

TRENCH
Dimension: Length – 44.1 m
Width -- 6.1 m
Depth -- 4 m

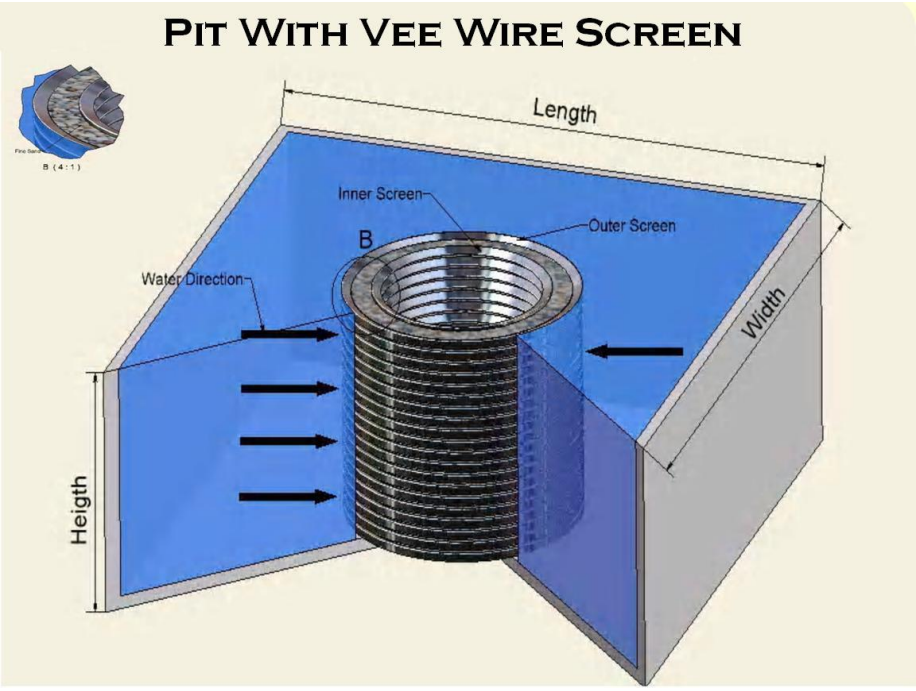
INJECTION WELL
Dimension: Depth - 47 m
Dia - 15 cm
Screen length –22m



TRENCH

3. The Gujarat Water Supply and Sewerage Board (GWSSB), Govt. of Gujarat converted one failed tubewell at village Tara na Chhapra in Dahegam taluka into recharge well by suitably modifying its design. The design modification includes fixing double screens (Johnson) at the surface and providing filter media between the screens. It provides for backwashing of filter media and the recharging water can be seen form the top. During the experiment 22000 Ltrs of water was recharged in 20 minutes. A recharge rate of 20 lps is estimated. It is reported by the local public that during monsoon lot of water was recharged through this well. The design of recharge well is given as below as fig.

Figure. Recharge well at Tara na Chhapara, taluka Dehgam.



4. GWSSB, Govt of Gujarat has taken up Artificial recharge on 15 failed tubewells in Dahegam taluka. Constructed 15 new recharge tubewells in ponds in Gandhinagar taluka.
5. Capital project has constructed 175 recharge wells of 40/ 60 m depth in the Gandhinagar city.
6. A new check dam on river Sabarmati is under construction near Gandhinagar.
7. At village Sargasan in Gandhinagar taluka VIKSAT has constructed percolation well in the village pond.

Various rainwater harvesting schemes depending on the suitable hydrogeological conditions have been constructed in the district viz. Recharge tube wells , deepening the of the village ponds etc and have shown good impact on the groundwater scenario.

Table: 25- Taluka wise Suitable Artificial Recharge Structures

Taluka	Formation /Aquifer	Suitable Artificial Recharge Structures
Dahegam	Soft Rock	Percolation Tanks/ Ponds, Recharge Wells, Recharge Shafts
Gandhinagar		
Kalol		
Mansa		

6. Mass awareness and Training Activity, Workshops etc.

6.1 Mass awareness Programmes

Till now one mass awareness programme has been conducted in the district at Village Shertha.

Table: 26 Mass Awareness Programmes

S.No	Taluka	Place	Date	No. of Participants
1.	Gandhinagar	Shertha	31-3-2000	1000

6.2 Water Management Training Programmes

Till now Water management training programme have been conducted in the district by CGWB.

Table: 27 Water Management Training Programmes

S.No	Taluka	Place	Date	No. of Participants (App.)
1.	Gandhinagar	Gandhinagar	16-17 March 2004	20
2.	Gandhinagar	Gandhinagar	26 March 2009	40

6.3 Workshops

Till now Four Workshops have been organised in the district by CGWB.

Table: 27 Workshops

S.No	Taluka	Place	Date	No. of Participants (App.)	Theme
1.	Gandhinagar	Infocity Club Resort, Gandhinagar	19-01-2010	100	Capacity Building for Stakeholders in Water Resources Management in Gujarat and UT of Daman & Diu
2.	Gandhinagar	Cambay Spa and Golf Resort, Gandhinagar	22-02-2010	100	Dug Well Recharge :Efficiency and Eficacy
3.	Gandhinagar	Fortune Havelli Inn, Gandhinagar	25-03-2010	85	Ground Water Management in Costal Areas on occasion of World Water Day
4.	Gandhinagar	Cambay Spa and Golf Resort, Gandhinagar	28-03-2011	100	Rain Water Harvesting And Ground Water Recharge

6.4 Tier-II Training Programme on Aquifer Management and Plan.

Till now Two Tier-II Training Programms on Aquifer Management and Plan have been organised in the district by CGWB.

Table: 27 Tier-II Training Programme on Aquifer Management and Plan

S.No	Taluka	Place	Date
1.	Gandhinagar	GJTI, GWS&SB, Govt. of Gujarat	7-11 January 2013
2.	Gandhinagar	GJTI, GWS&SB, Govt. of Gujarat	16-20 December 2013

7. Areas Notified by CGWA/SGWA

Central Ground Water Authority constituted under section 3(3) of Environment (Protection) Act, 1986 in exercise of its powers and functions provided under section 5 of the Environment (Protection) Act, 1986 (No. 29 of 1986) issue directions in writing to any person, officer or any authority and such person, officer or Authority shall be bound to comply with such directions, for regulation and control of groundwater development and management in whole of India.

CGWA has notified three talukas of the Gandhinagar district vide its Public Notice with details as below.

Sr. No.	Area Notified	Public Notice No.	Date	Subject	Directions
1.	**Gandhinagar Taluka**	**Public Notice No. 7 / 2000**	**02.09.2000**	Declaration of Ground Water Aquifers below 200M. Depth as "Protected Aquifers" exclusively for drinking & Domestic water use in Gandhinagar Taluka	The Aquifers located below 200 m depth are declared as "Protected Aquifers" and shall be used for construction of tubewells for drinking and domestic and water supply only. No well shall be constructed by any person /agency tapping the aquifer zones located below 200 m depth without prior specific approval of the Authority.
2.	**Kalol Taluka**	**Public Notice No.1 / 2012**	**27-11-2012**	Declaration of the Areas as "Notified Area" for regulation of Groundwater Abstraction/ Development	1. No person/agency organisation/industry will construct /install any new structure for extraction of ground water resources without prior specific approval of the Authorized Officer i.e. Chief Officer –in-charge of Revenue District (whether called district Collector, Deputy Commissioner or by any other name) of the district and subject to the guidelines/safeguards envisaged from time to time in this connection by the Authority for ground water extraction and rainwater harvesting /recharge etc. 2. The authorized officer shall ensure that no person /organisation/industry/builder/ developer shall undertake the operation of drilling, construction, installation of new abstraction structure and any scheme /project for ground water development and management in the notified area without his prior specific approval after the publication of this Public Notice.
3.	**Mansa Taluka**				

8. Ground Water Related Issues and Problems

Looking at the fact the groundwater development has already reached at the over exploited and the piezometric heads are declining at a rapid rate it is necessary that a cautious approach be adopted for developing the groundwater resources. Further the ground water quality is also deteriorating in some areas and according to GWSSB the number of villages/ hamlets with poor water quality are increasing every year. It is necessary that immediate measures for augmenting the groundwater through artificial recharge may be taken up. Also, a closely knit monitoring system for monitoring water levels and quality in different aquifer horizons may be initiated by constructing a suitable number of piezometers.

Taluka wise problems in ground water development are discussed hereunder:

Gandhinagar: In Gandhinagar taluka the ground water development is almost 115.72%. In eastern part of the taluka the ground water quality deteriorates at depth. The fluoride content of groundwater in the proximity of river Sabarmati is more than 1.5 PPM. The fluoride content is more than permissible limit in 74 villages/ hamlets, whereas, in 10 villages/ hamlets the Nitrate is more than the permissible limit.

Kalol : The level of ground water development in Kalol taluka is 122.90%. The quality of ground water in the shallow aquifer is poor in the south western part. The fluoride content is more than permissible limit in six villages/ hamlets, whereas, in 13 villages/ hamlets the Nitrate is more the permissible limit.

Mansa : In Mansa taluka the ground water development is almost 148.46%. The quality of ground water deteriorates at depth, whereas, at shallow depth the concentration of Fluoride is more. The fluoride content of groundwater in the proximity of river Sabarmati is more than 1.5 PPM. The fluoride content is more than permissible limit in 13 villages/ hamlets, whereas, in two villages/ hamlets the Nitrate is more, in two villages/ hamlets both are more than permissible limits.

Few special problems of the taluka are as follows:

1. Deformation of wells is reported i Lodhra-Galdhara area of the talukain depth range of 140-180 m bgl.
2. Higher drawdowns are reported in Ajol – Patanpura area.
3. Encrustation problem is reported around Charada village.

Dahegam: In Dahegam taluka the ground water development is almost 102.93%. The fluoride content is more than permissible limit in 35 villages/ hamlets, whereas, in onevillages/ hamlets the Nitrate is more. In the eastern and north eastern part the blue clay is encountered between 40 and 100 mbgl, the depth of tube wells in this area is limited and due to over exploitation the yield of tubewells has reduced. In the eastern part the ground water quality deteriorates at depth.

- Over exploitation of ground water is a major issue in some parts of the district resulting in the fast depletion of this resource. Piezometric heads of deep confined aquifer has also declined sharply owing to the huge withdrawal. In some parts of the district phreatic aquifers are desaturated needing urgent attention.
- Replacement wells, increase in well depth, prime mover, declining well yields are also the major issues.
- Although ground water quality for irrigation practice is within the limit in most parts of the district but many parts of the district are having high fluoride (>1.5 ppm) content (140 villages) (Source: GWSSB)
- Awareness among the people regarding rainwater harvesting and artificial recharge.

9. Conclusions and Recommendations

9.1 Conclusions

The Gandhinagar district was one of the **smallest districts** in Gujarat.

The district has **four talukas** namely, the Gandhinagar, Kalol, Mansa and Dahegam Talukas.

The district has a monotonous **flat topography** with Sabarmati, Meshwo and Khari rivers draining the district.

The **climate** of the district is semi-arid with annual normal rainfall of 823 mm.

Geologically the area is part of Cambay basin and is occupied by the quaternary alluvium comprising silt and sand.

The depth of tubewells range from about 50m in eastern part to more than 300m in parts of Mansa taluka.

The potentiometric heads of first confined aquifer ranges between 50 mamsl to less than 50 mbmsl, whereas, second confined aquifer ranges from approximately 10 mamsl to 60 mbmsl. The potentiometric head of user aquifer ranges from about 40 mamsl to less than 70 mbmsl, however, in major part of the district it is below mean sea level.

The **general slope** of the piezometric surface is towards west and southwest.

Central Ground Water Authority, MOWR, Govt. of India, has **notified** three talukas viz. Gandhinagar, Mansa and Kalol..

The **ground water quality** deteriorates from east to west i.e. in the ground water flow direction. In major part of the district the ground water quality of user aquifer is potable.

The **ground water recharge** have been taken up by Capital Project in the Gandhinagar city, state agencies and by NGOs.

The Narmada canal based water supply will reduce dependability on ground water for drinking purposes and will improve water supply. It will also have salutary effect on ground water regime.

9.2 Recommendations

The groundwater is the main source of water supply in the district, both for domestic and irrigation, however, Narmada Canal based water supply will help ease stress on this precious resource. The Govt. agencies and NGOs have taken steps in rainwater harvesting and artificial recharge, however, sustained efforts by all concerned needs to be taken to augment the groundwater resources. Further, it is also necessary that deeper aquifers may be explored further and more monitoring stations be established.

There is a great need for management of resources for sustainable development. Conservation and augmentation measures of the groundwater resources. The declining trend of the groundwater level over the years has resulted to near complete desaturation of the aquifers in certain parts of the region.

As a conservation measure, farmers should be encouraged and educated to adopt modern irrigation techniques like drip, sprinkler irrigation etc. to effect minimum withdrawal and maximum utilisation of groundwater. Suitable cropping pattern can also be conceived and implemented that require lesser water-consumption.

The district bears a multi-layered aquifer systems. Development is taking place at considerable rate without proper assessment of parameters of individual aquifer systems. Precise data of individual aquifer groups are to be collected for proper assessment and management of the same.

The aquifers of the deeper Miocene formations identified at some deep exploratory boreholes, needs further detailed study in the area.

The fluoride occurrence in the ground water in the district is of considerable amount at many places. A detailed study has to be made so that necessary measures can be taken up in the proposed water supply scheme.

Special study including exploratory drilling may be taken up to study reason of specific problems (scaling and squeezing of pipes) in Mansa taluka.

More piezometers, tapping different aquifer horizons may be constructed. The frequency of monitoring may be increased by installing DWLRs at 4 places preferably one Peizometer nest in each taluka..

An awareness programme should be started to educate the masses, regarding the situation prevailing.

The management of water resources should shift from demand oriented. Less water intensive crops, better irrigation practices etc. should be promoted. Technology should be used to minimise wastage of water even at households.

The technology of water conservation, rainwater harvesting and artificial recharge should be simple and should be transferred to the users. The site/area specific techniques should be made available to users.

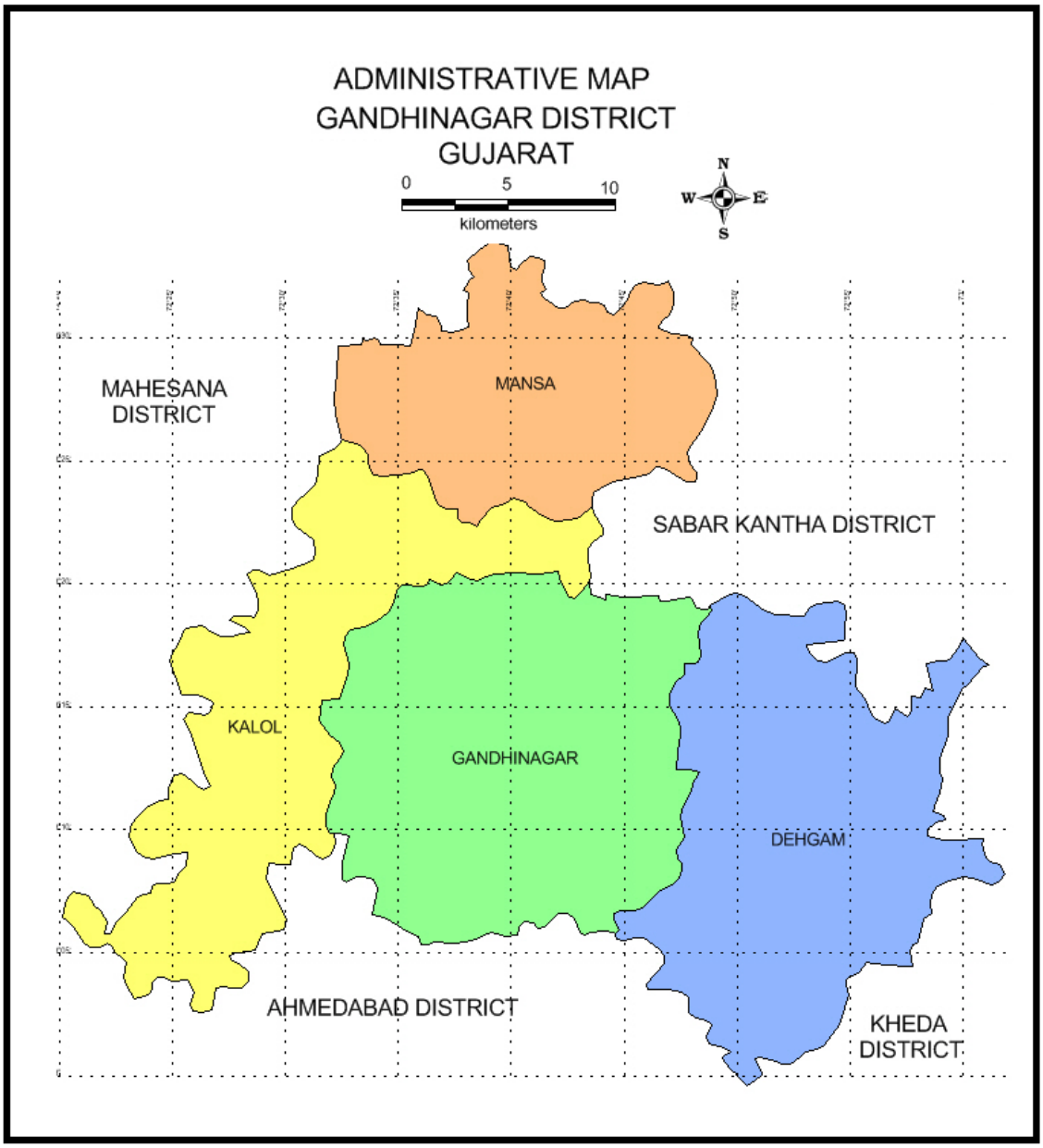
Field studies may be carried out to take up artificial recharge of groundwater by constructing injection wells/ connector wells in the Sabarmati River bed. Areas suitable for different types of recharge structures should be identified.

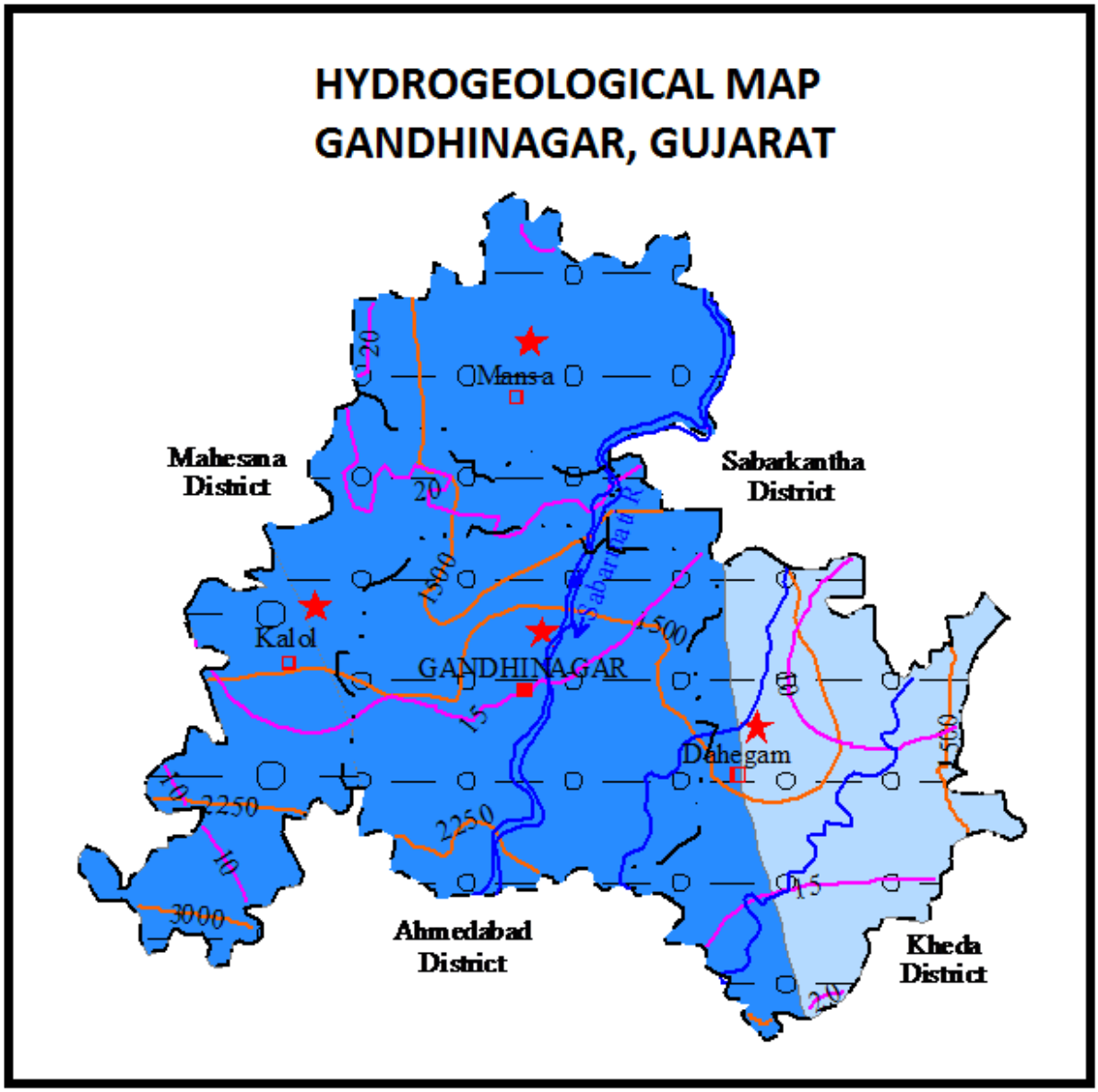
The artificial recharge directly into the aquifer by injection/ recharge wells should not be practiced without proper technical/ scientific knowledge. It may happen that in the zeal of recharging more water, we are polluting the aquifer.

Water conservation, harvesting and artificial recharge should be promoted like a mission. Every household should be advised to practice it.

Water intensive industries like water park etc. should not be permitted in the district.

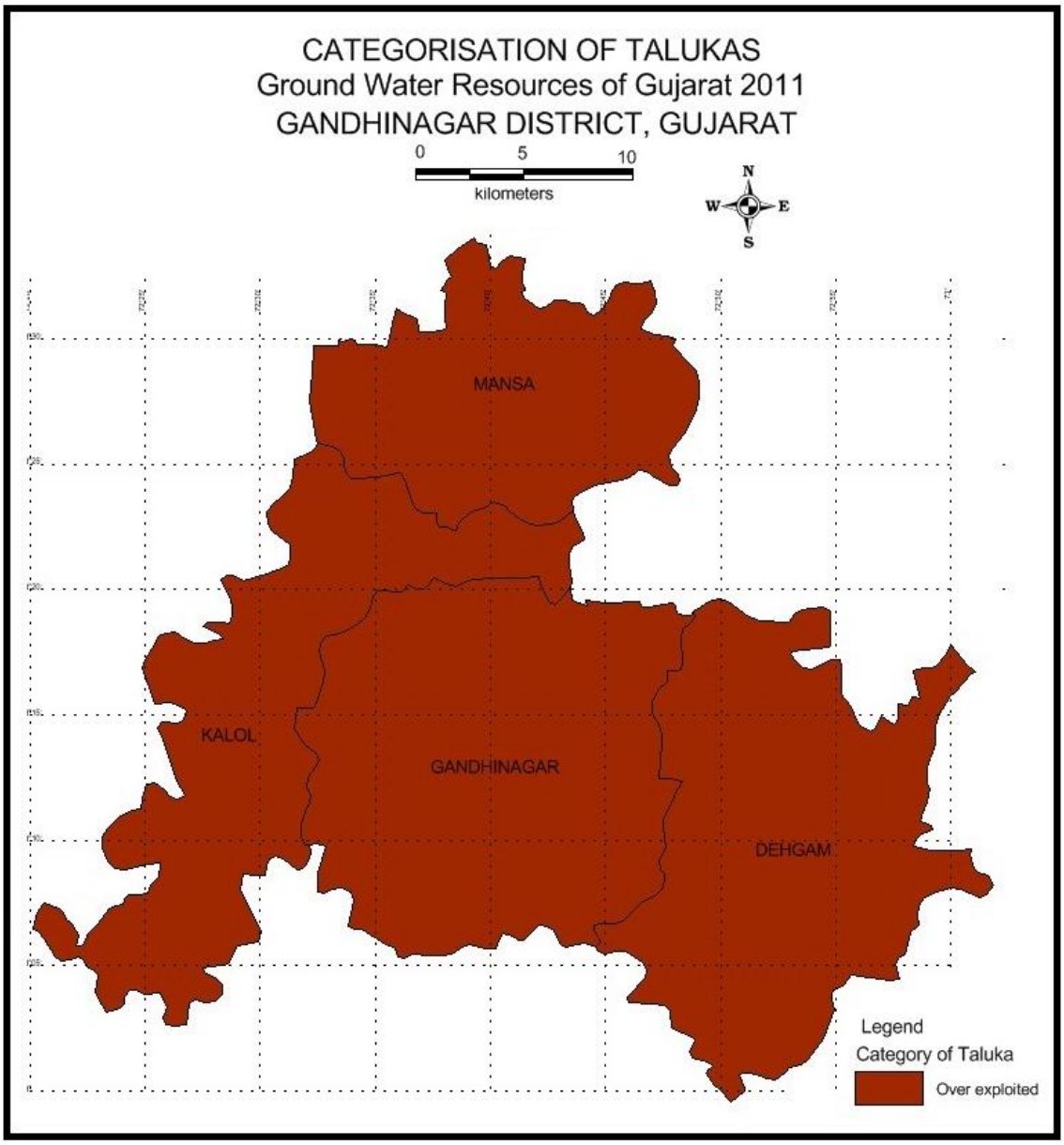
The directives of the Central Ground Water Authority and State Ground Water Authority should be implemented strictly.

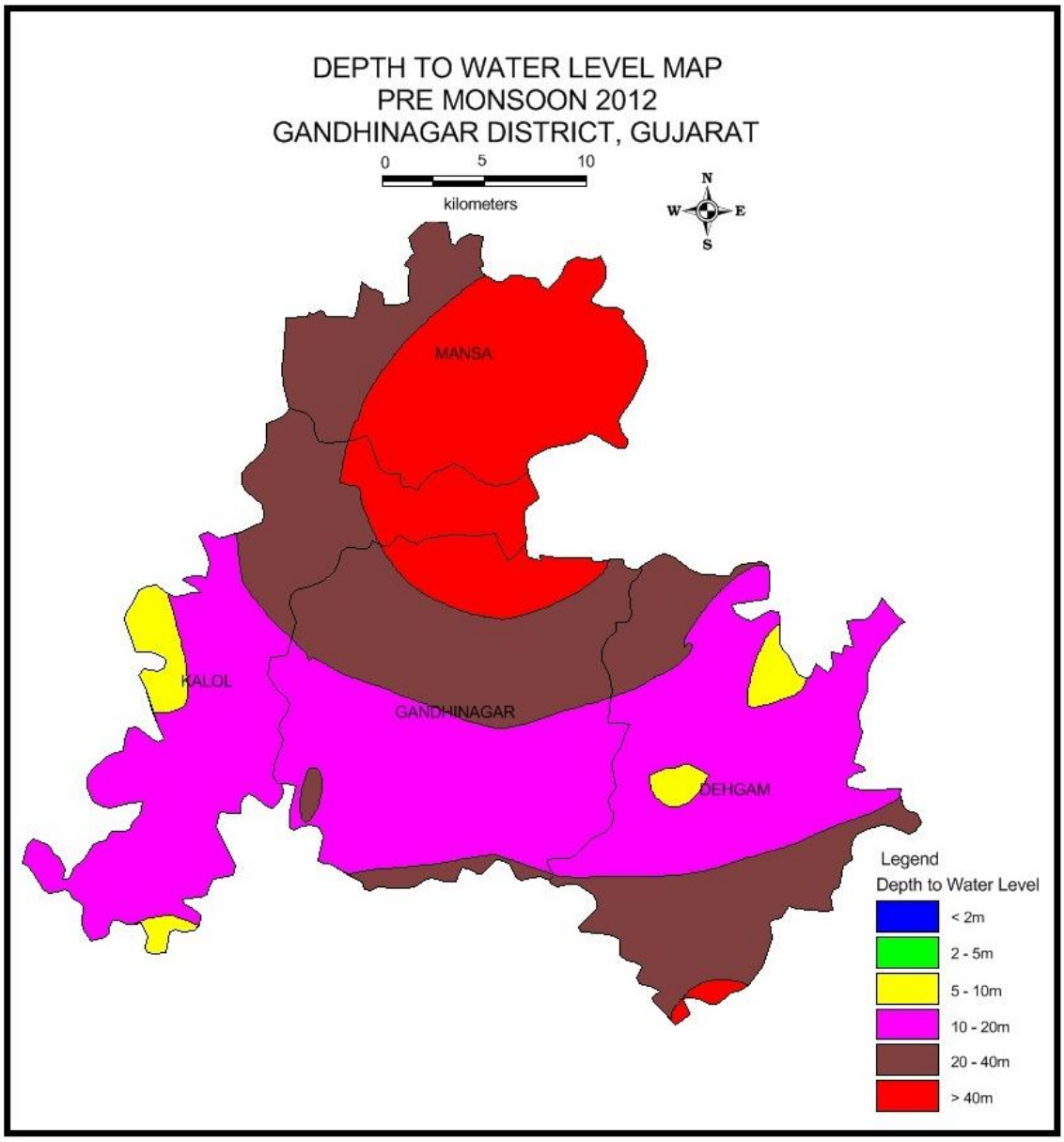

ADMINISTRATIVE MAP
GANDHINAGAR DISTRICT
GUJARAT
0
5
10
kilometers
N
W
E
S
MAHESANA DISTRICT
MANSA
SABAR KANTHA DISTRICT
KALOL
GANDHINAGAR
DEHGAM
AHMEDABAD DISTRICT
KHEDA DISTRICT

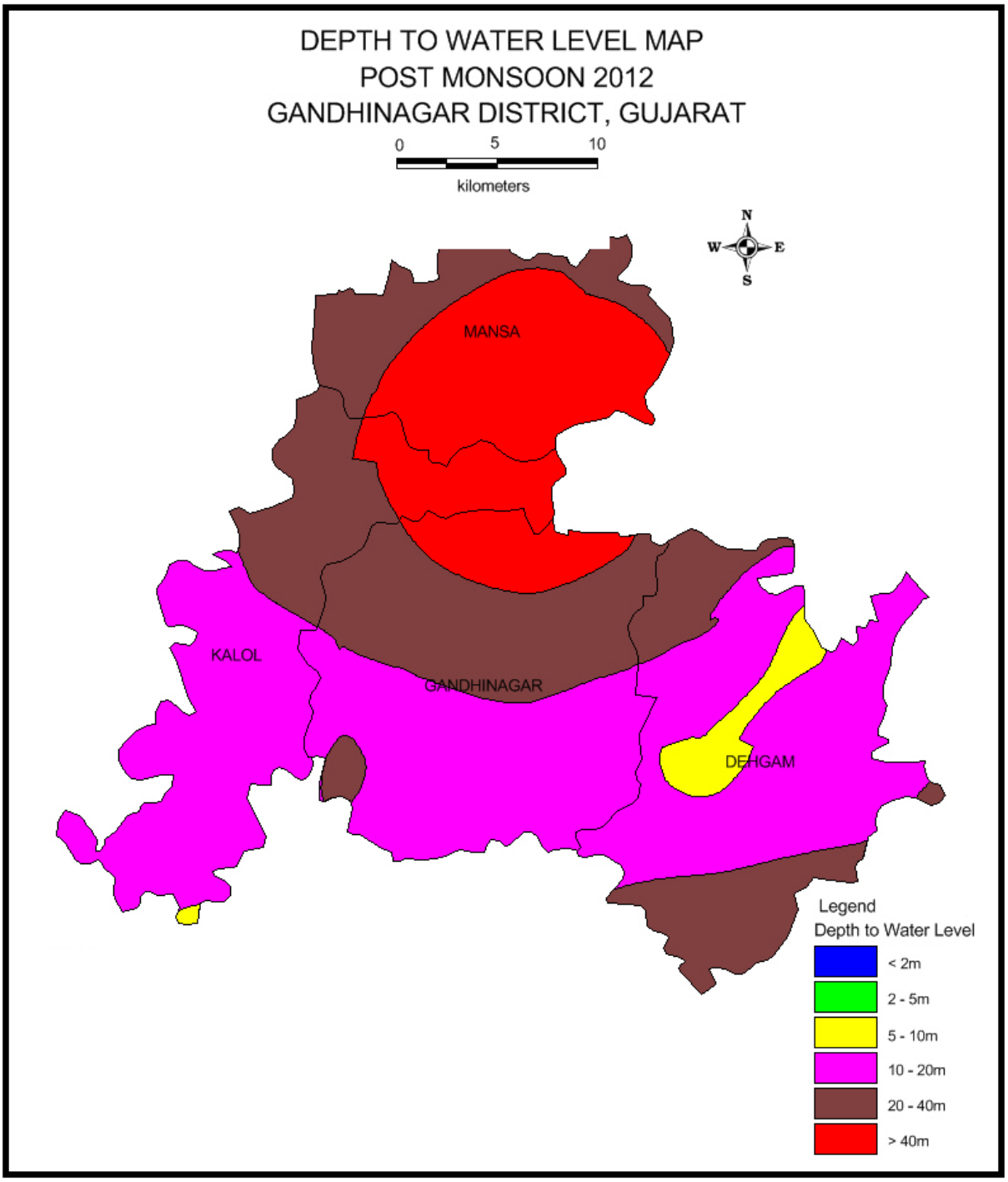


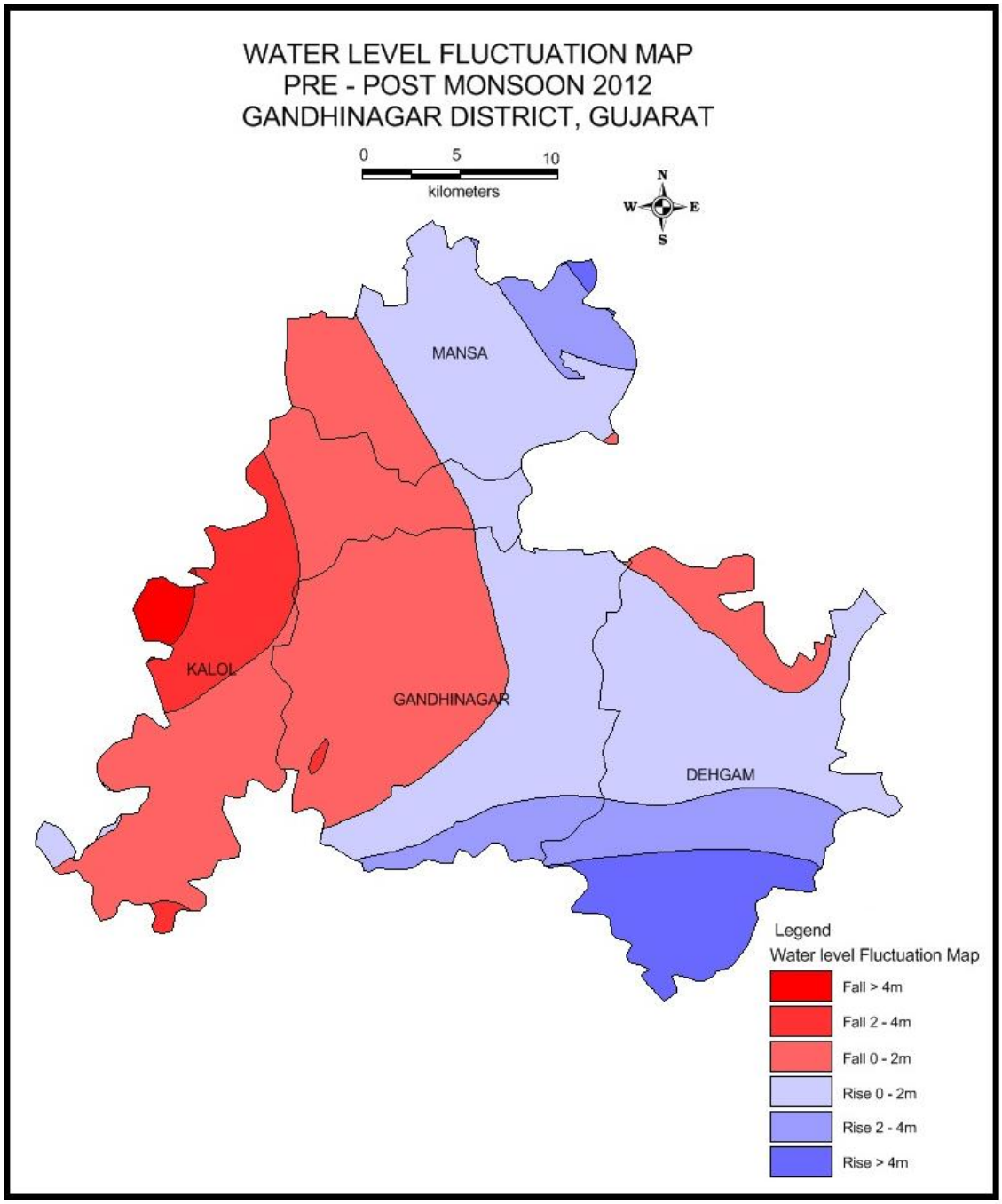
LEGEND

	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	200-300 600-800	Percolation Tanks/ Ponds, Recharge Wells,
Soft Rock Aquifer	Tubewell	Direct Rotary Reverse Rotary	100-300	600-1200	Percolation Tanks/ Ponds, Recharge Wells, Recharge Shaft
20	Pre-monsoon Decadal mean (1993-2000) Depth to Water Level (mbgl)		2000	Electrical Conductivity (µS/cm at 25° C)	
	Over Exploited Taluka				
	Drainage		✉/☎	District/Taluka HQ	


CATEGORISATION OF TALUKAS
Ground Water Resources of Gujarat 2011
GANDHINAGAR DISTRICT, GUJARAT
0
5
10
kilometers
N
W
E
S
MANSA
KALOL
GANDHINAGAR
DEHGAM
Legend
Category of Taluka
Over exploited


DEPTH TO WATER LEVEL MAP
PRE MONSOON 2012
GANDHINAGAR DISTRICT, GUJARAT
0
5
10
kilometers
N
W
E
S
MANSA
KALOL
GANDHINAGAR
DEHGAM
Legend
Depth to Water Level
< 2m
2 - 5m
5 - 10m
10 - 20m
20 - 40m
> 40m


DEPTH TO WATER LEVEL MAP
POST MONSOON 2012
GANDHINAGAR DISTRICT, GUJARAT
0
5
10
kilometers
N
W
E
S
MANSA
KALOL
GANDHINAGAR
DEHGAM
Legend
Depth to Water Level
< 2m
2 - 5m
5 - 10m
10 - 20m
20 - 40m
> 40m


WATER LEVEL FLUCTUATION MAP
PRE - POST MONSOON 2012
GANDHINAGAR DISTRICT, GUJARAT
0
5
10
kilometers
N
W
E
S
MANSA
KALOL
GANDHINAGAR
DEHGAM
Legend
Water level Fluctuation Map
Fall > 4m
Fall 2 - 4m
Fall 0 - 2m
Rise 0 - 2m
Rise 2 - 4m
Rise > 4m