केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण
विभाग, जल शक्ति मंत्रालय
भारत सरकार

Central Ground Water Board
Department of Water Resources, River
Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

Ahmedabad District
Gujarat

पश्चिम मध्य क्षेत्र, अहमदाबाद
West Central Region, Ahmedabad

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TECHNICAL REPORT SERIES.....

भारतसरकार

जल शक्ति मंत्रालय

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केन्द्रीय भूमिजल बोर्ड

GOVERNMENT OF INDIA

MINISTRY JAL SHAKTI

DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT

AND GANGA REJUVENATION

CENTRAL GROUND WATER BOARD

AQUIFER MAP AND MANAGEMENT PLAN, AHMEDABAD DISTRICT, GUJARAT STATE

CENTRAL GROUND WATER BOARD
WEST CENTRAL REGION
GUJARAT
DECEMBER 2021

AQUIFER MAP AND MANAGEMENT PLAN
AHMEDABAD DISTRICT
GUJARAT STATE

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AQUIFER MAP AND MANAGEMENT PLAN
AHMEDABAD DISTRICT
GUJARAT STATE

AHMEDABAD DISTRICT AT A GLANCE

SL No.	Items	Statistics	
1.	General Information		
	i) Geographical Area (Sq. Km)	6585	
	ii) Administrative Divisions (2011) Number of Taluka Number of Villages Panchayat	 9 474	
	iii) Populations (As per 2011 census)	7,045,313	
	iv) Average Annual Rainfall (mm)	658	
2.	GEOMORPHOLOGY		
	Major Physiographic Units	Alluvial plain	
	Major Drainages	Sabarmati	
3.	LAND USE (hec.) (Zilla Ankdakiya Roopreka, 2017-18)		
	a) Forest area b) Net area sown c) Cultivable area	8234 503261 647054	
4.	MAJOR SOIL TYPES	Sandy soil	
5.	AREA UNDER PRINCIPALFOODGRAIN CROPS (hec.)		
	Rice-156340, Bajra-1646, Wheat-137268, Total pulses-44042, Total food crops-52881,Seasam-1464.		
6.	IRRIGATION BY DIFFERENT SOURCES		
	(Areas and numbers of structures)	No.	Area (sq. km.)
	Dugwells	11274	15550
	Tube wells& other wells	7581	1424
	Tanks/Pond/Reservoir/Check Dam	828	45
	Other Sources	-	16
	Gross Irrigated area (sq. km.)	438929	
7.	NUMBERS OF GROUND WATER MONITORING WELLS		
	CGWB (As on 31-3-2019) No of Dug Wells No of Piezometers	35 20 15	
8.	PREDOMINANT GEOLOGICAL FORMATIONS		
	Alluvium& Deccan traps		
9.	GROUND WATER EXPLORATION BY CGWB (As on 31 -03 -2018)		
	No of wells drilled (EW, OW, Pz, SH, Total)		

EW	OW	SH	Pz	Total
35	15	01	80	131

	Depth Range(m)	24- 427
	Discharge (Litres per second)	0.1 – 15 lps
	Transmissivity (m^2/day)	1.78 - 861
10.	GROUND WATER QUALITY(As per chem. Analysis of samples collected during May 2017 NHS monitoring)	
	Presence of chemical constituents more than permissible limit F > 1.5 mg/l NO_3 > 50mg/l	 14 villages 3 villages
	Type of water	Predominant bicarbonate-Chloride type
11.	DYNAMIC GROUND WATER RESOURCES (2017)- in mcm	
	Annual Replenishable Ground Water Resources	578.46
	Net Annual Ground Water Availability	549.54
	Projected Demand for Domestic and industrial Uses up to 2025	24.80
	Stage of Ground Water Development	72.01
12.	AWARENESS/ TRAINING ACTIVITIES Etc. as on 31-03-2018	
	Sl. No. Activity Nos. 1 Mass Awareness Programme 03 2 Water management Training Programme 05 3 Workshops 08 4 State Level painting Competition 04 5 World water Day 2007 01	
13.	GROUND WATER Resource Estimation (GWRE 2017)	
	Number of OE Blocks	Nil
	Number of Critical Blocks	Nil
	Number of Semi Critical Blocks	04 (City Dascroi, Detroj-Rampura , Dholka, Viramgam)
	Number of Safe Blocks	03 (Bavla, Mandal, sanand)
	Number of Saline Blocks	02 (Dhanduka, Dholera)
	No. of Blocks Notified by CGWA	Nil
14.	MAJOR GROUND WATER PROBLEMS AND ISSUES	
	a. Declining Groundwater levels/ Piezometric heads in user aquifers b. Increasing depth of tubewells c. Groundwater contamination due to unplanned construction and poor technical design of tube wells d. Awareness amongst villagers on water conservation techniques	

AQUIFER MAP AND MANAGEMENT PLAN
AHMEDABAD DISTRICT
GUJARAT STATE

1. INTRODUCTION

Aquifer mapping is an attempt to combine a combination of geologic, geophysical, Hydrogeological and chemical data to characterize the quantity, quality and sustainability of ground water in aquifers. India is a country blessed with diverse hydrogeological settings and Groundwater accounts for by far the largest volume of unfrozen fresh water on Earth and thus it is a hugely important as a natural resource. Ground water is the water that seeps through rocks and soil and is stored below the ground. The rocks in which ground water is stored are called aquifers. The movement of groundwater in various aquifer system are highly complex due to occurrence of diverse geological lithological tectonic framework and climatically parameter broadly.

In XII th five year plan, National Aquifer Mapping & Management (NAQUIM) has been introduced to carry out detailed hydrogeological investigation on toposheet wise on a scale of 1:50,000. The proposed activities include micro level hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration, Hydrological and Hydro meteorological studies, Geophysical Surveys, Water Quality Analysis, Specific Yield determination, GIS data integration & analysis, Preparation of Aquifer map, Compilation of Data and Printing of reports etc. The activities under NAQUIM are aimed at identifying the aquifer geometry, aquifer characteristics their yield potential along with the quality of water occurring at various depths. This clear demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. This work will be systematically implemented in the country, by involving state organisations / institutions across India.

The present report deals with the hydrogeological condition in the district. An attempt has been made to understand in depth the detailed scenario of the district in all potential ways.

1.1 Objective: The objective of this study is to prepare Aquifer Map on 1:50,000 scale and prepare management plan for sustainable management of the Groundwater resources.

1.2 Scope of Study: The main scope of study is summarised below.

i. Compilation of existing data (exploration, geophysical, groundwater level and groundwater quality) and data gap analysis.

ii. Periodic long term monitoring of ground water regime (water levels and water quality) for creation of time series data base and ground water resource estimation.

iii. Quantification of groundwater availability and assessing its quality.

iv. Preparation of aquifer maps

v. Preparation of Aquifer Management Plans

vi. Participatory ground water management.

1.3 Location Extent and Accessibility : Ahmedabad district spreading Area of 6585 sq.k.m. is geographically at the centre of Gujarat, situated between 22^0 to $23^0$35' North latitude and $71^0$42'to $72^0$50'East longitude and falls in parts of survey of India degree sheets number 41 N,41 M,46 A and 46B by Mehsana and Gandhinagar districts to the north, Kheda and Anand Districts to the east, the Gulf of Khambhat (Gulf of Cambay), Botad and Bhavnagar districts to the south, and Surendranagar district to the west. Its headquarters is the city of Ahmedabad. 9 talukas of the District include 474 villages, 1 deserted village, 1 corporation, 1 cantonment area and 7 municipalities (Fig. 1 & 2). Ahmedabad also known as Amdavad or Karnavati is an inland city and is the largest city and former capital of Gujarat state. It is the administrative headquarters of the Ahmedabad district and the seat of the Gujarat High Court. The district derives its name from its headquarter city "Ahmedabad".

Fig 1: Location Map of Ahmedabad District in Gujarat State

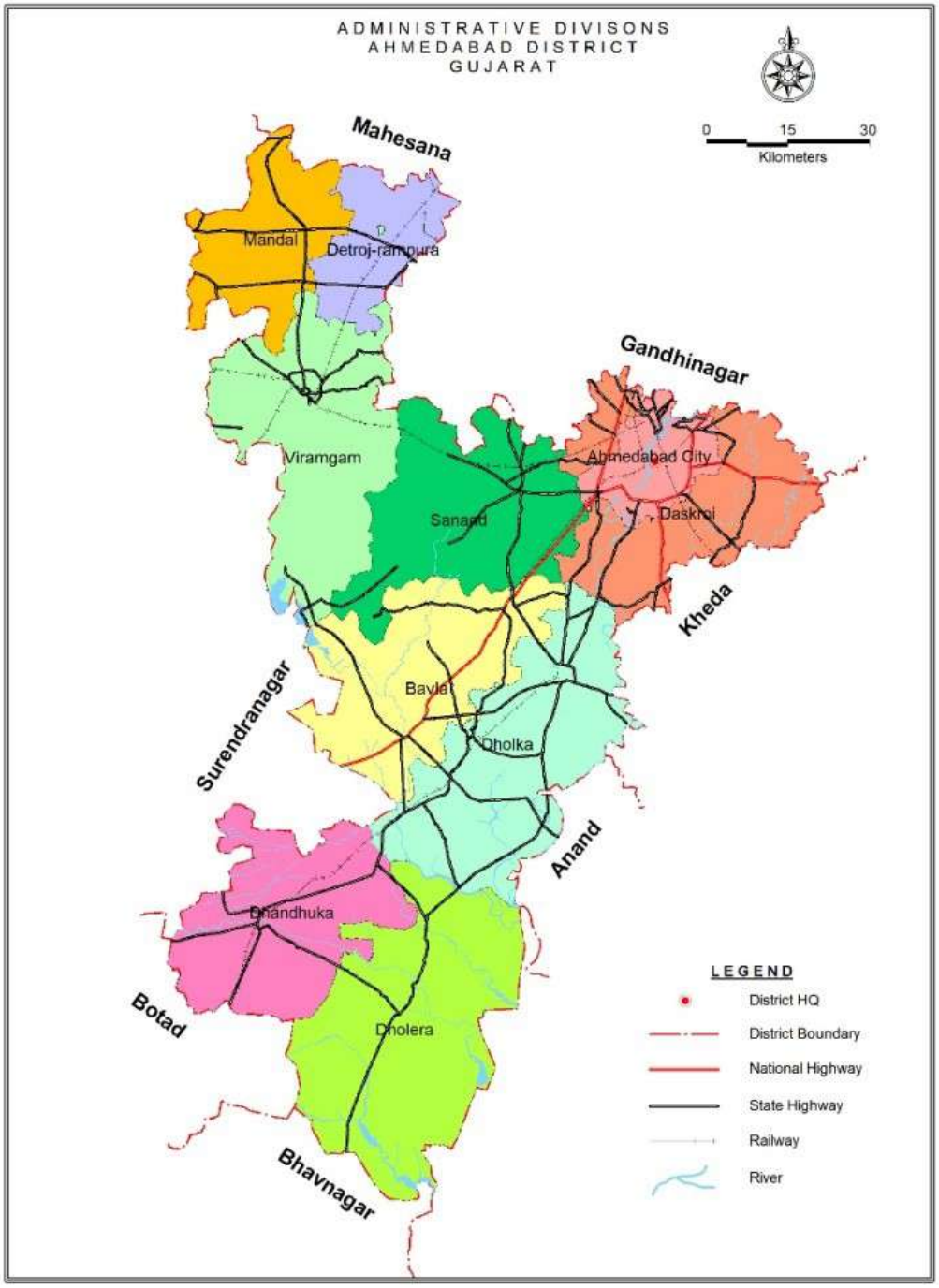


Fig 2: Administrative map

1.4 Previous Work

Following previous work have been carried out in the district.

1.4.1 Systematic hydrogeological studies: Systematic hydrogeological studies carried out by Central Ground Water Board are as given in table 1 below.

Table: 1- Systematic hydrogeological studies

Name	Taluka	Year
R.C.Jain	Dhanduka, Dholka, Sanand, and part of Viramgam, Dascroi& City Talukas	1981-82, 1983-84 and 1986-87.
P.K.Parchure	Part of Viramgam Taluka	1986-87

1.4.2 Reappraisal hydrogeological survey: Reappraisal hydrogeological survey of the entire district was carried out by following officers of CGWB during 1989-90 (Table 2).

Table: 2- Reappraisal hydrogeological survey

Name	Area covered (Talukas)
P.K.Jain	Dhandhuka Taluka
P.R. Gupte	Viramgam, Sanand, City, and Dascroi (Part) Talukas
A.B.Kawde	Dholka, and Dascroi (Part) Talukas

1.4.3 Exploratory Drilling

Ground water exploration by test drilling commenced in the fifties by the erstwhile Exploratory Tubewell Organisation (ETO) and continued later by CGWB. Apart from the exploratory wells, Piezometer of various depths are also constructed in the district for periodic monitoring of the ground water regime in the district and is continued till date. Total 134 wells have been constructed in the district which includes 35 Exploratory wells, 16 Observation Wells, 82 Piezometers and one Slim Hole (Table 3).

Table:3- Details of the wells drilled

Salient Features	EW	OW	Pz	Slim Hole	Total
Total Nos.	35	16	82	1	134
Drill Depth range (mbgl)	25 - 565				
Depth Constructed range (mbgl)	25 - 427				
Static Water Level (mbgl)	9.95 – 100.85				
Discharge (LPS)	0.75 - 10				
Transmissivity (m^2 / day)	1.78 - 861				

1.5 Demography: Ahmedabad district has 9 taluka and 474 village Panchayat. Ahmedabad district is the top most populated district in the State. The population of the district according to the census according to census 2011 is 7,045,313. In Ahmedabad district, Sub-district Ahmedabad has the highest population (5585528) which is also highest in the state whereas sub-district Mandal has the lowest (70346). Its population growth rate over the decade 2001-2011 was 19.78%. Literacy rate in the districts is 85.56%.

1.6 Soil: The soils in the district can broadly be classified as (Fig. 3):

Black Soils: Black soils cover the southern part of Dholka and eastern part of Dhandhuka taluka popularly known as 'Bhal' tract, where cotton is grown in the initial stage of monsoon. It is not very clayey and contains above 20% of clay and about 40 % of sand. Sub-soil invariably contains horizons of lime nodules. This type of soil is highly suitable for cultivation of rabi wheat, which is the main crop raised on this soil. If rains are sufficient in the late monsoon, rabijowar and grams are sown. Medium Black Soils are found in Viramgam, Sanand and Dholka talukas. This soil is suitable for growing bajri, jowar and cotton.

Goradu Soils: Goradu soils vary from fertile brown to sandy loam and is found in City, Dascroi and parts of Sanand, Dholka and Viramgam talukas. This soil is mostly fertile and responds very well to irrigation and manuring. Practically all kinds of crops can grow on this soil.

Kyari: Kyari soils are found in several parts of City, Dascroi, Sanand, Dholka and Viramgam talukas. It is the most fertile soil with very good moisture and retentive capacity. Well known varieties of paddy such as Pankali, kamod, Jirasar, Sukhvel, Sutarsal and Basumati are grown on this soil.

Rocky soils: Rocky soils are found in Dhandhuka taluka and is known as Kaner tract. It is shallow, light in texture and fit for early maturing crops like cotton, Bajri, Jowar and Mat.

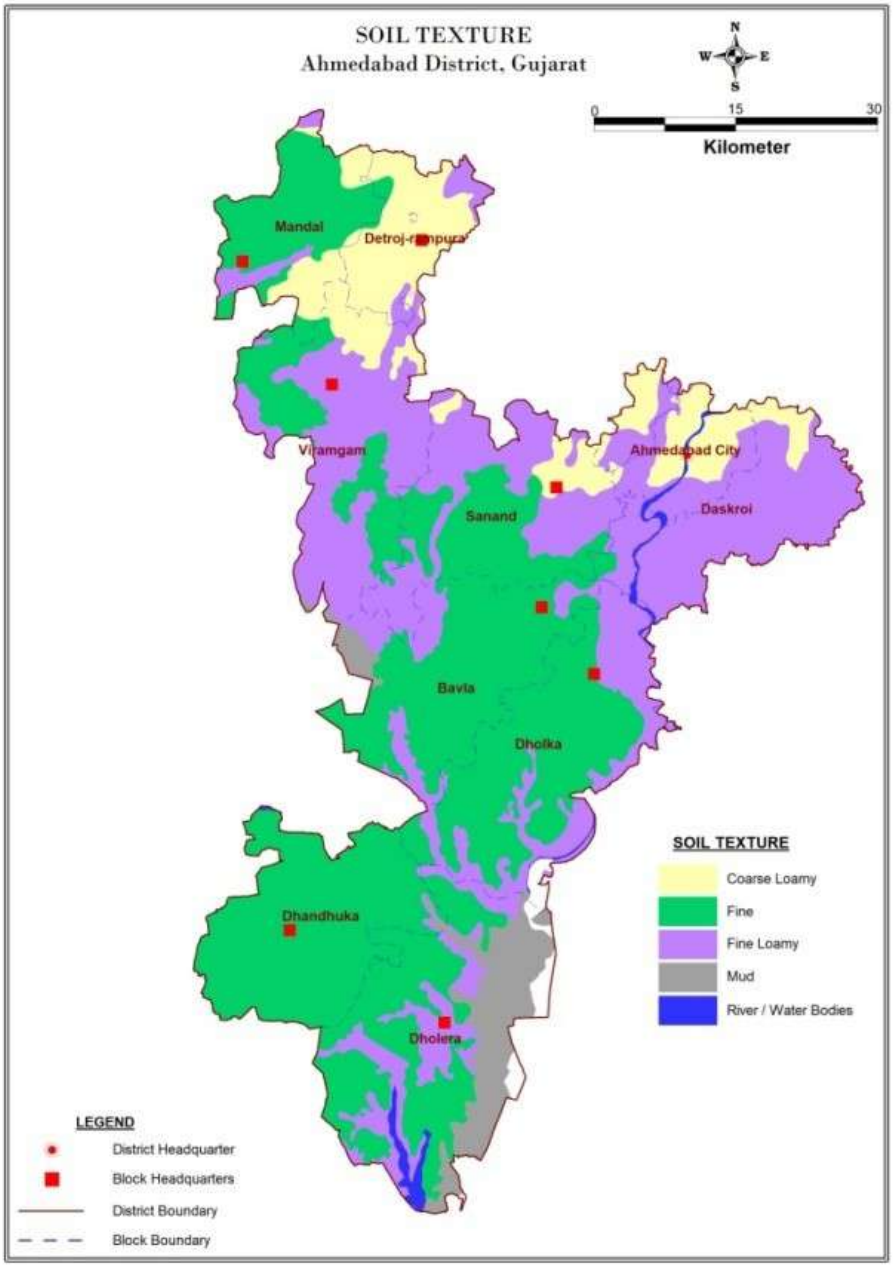


Fig.3 : Soil Texture Map of Ahmedabad District.

1.7 Land Use, Cropping Pattern and Irrigation

1.7.1 Land Use: The Land use pattern of the district is given below in table 4 and is presented in Fig 4:

Table 4: Land Use Pattern in Ahmedabad district

Sr. No.	Taluka Name	Area according to village papers (Ha)	Area under Forest (Ha)	Barren & uncultivable land (Ha)	Land put to non agricultural uses (Ha)	Cultivable waste (Ha)	Permanent pastures & other grazing lands (Ha)	Current fallow (Ha)	Fallow land other than current fallow (Ha)	Net area sown (Ha)	Area sown more than once (Ha)	Gross Cropped area (Ha) (12+13)
1	2	3	4	5	6	7	8	10	11	12	13	14
1	Ahmedabad (city)	-	-	-	-	-	-	-	-	-	-	-
2	Bavla	75853	0	10046	1350	8942	2619	1299	954	50643	21069	71712
3	Daskroi	69887	0	705	8330	950	5638	602	0	53632	9528	63160
4	Detroj-Rampura	33304	0	888	2530	1003	945	109	0	27829	11100	38929
5	Dhandhuka	82786	0	1884	894	5442	1367	1462	759	70978	7523	78501
6	Dholera	118366	8234	26957	10496	9048	7194	987	1226	54224	7348	61572
7	Dholka	96878	0	6354	7666	4840	3220	765	483	73550	29773	103323
8	Mandal	47674	0	2010	3215	850	1610	95	0	38894	8250	47144
9	Sanand	75972	0	2100	5450	2902	1180	296	0	64024	30656	94680
10	Viramgam	84295	0	3200	6588	2145	2550	325	0	69487	18546	88033
11	Total	685015	8234	54144	46519	36122	26323	5940	3422	503261	143793	647054

Source: AnkadiyaRoopRekha 2017-18

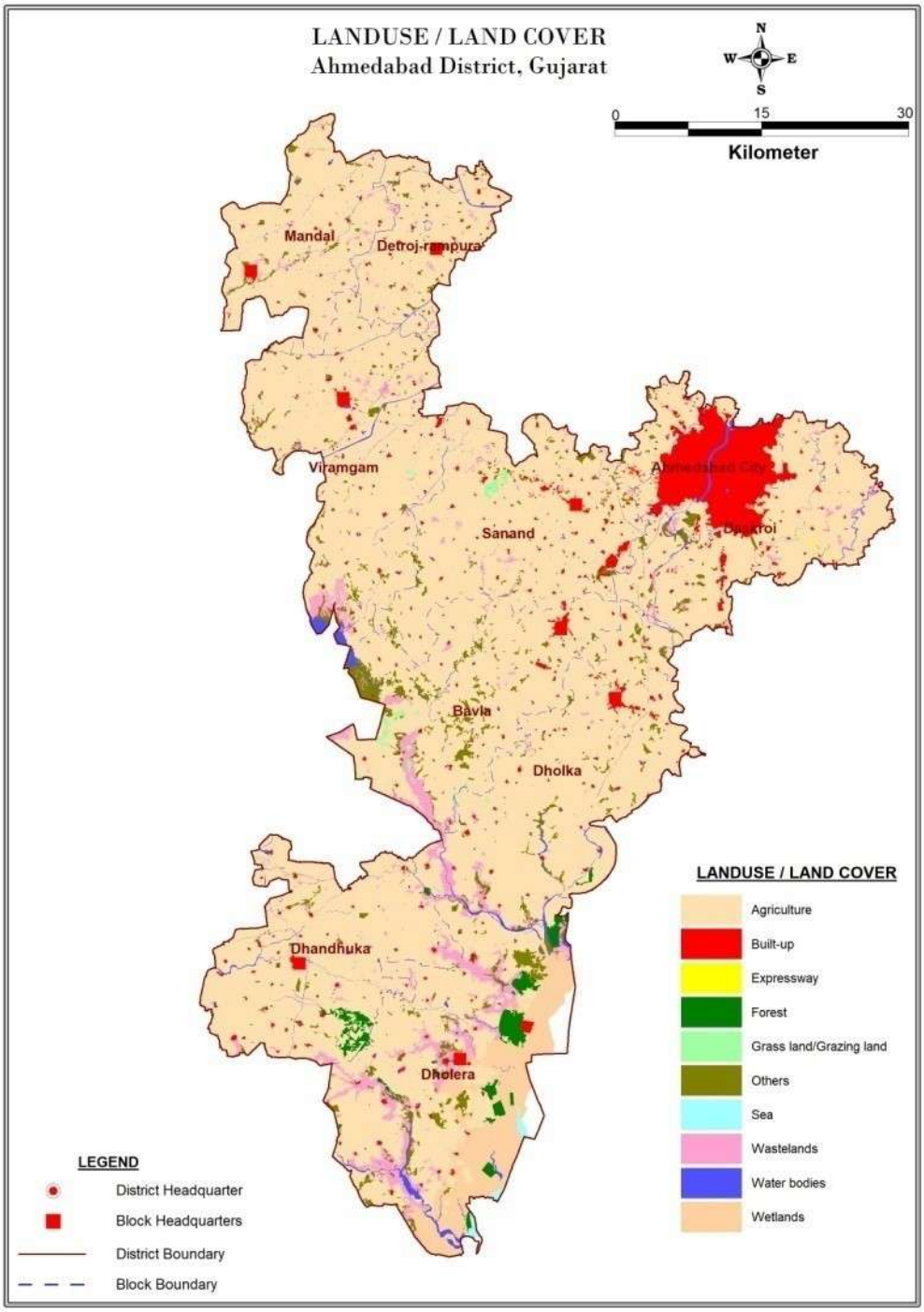


Fig. 4 : Land use Map of Ahmedabad District.

1.7.2 Cropping Pattern: The principal crops of the district are Cotton, Wheat, Paddy, Cumin, Castor, Juwar and Pulses (Table 5). The main crop is Cotton. The district is also selected for cultivation of oil seed crops such as Ground nut, Rap seed, Mustard, Soyabean, Sun flower, Sesamum and Castor under Oil Seeds Production Programme. Castor and Mustard are main oil seed crops in the district. Fruit crops are grown in Dholka taluka. Taluka wise food crop is give in table 6.

The Union Government has launched National Food Security Mission as a10 % centrally sponsored Scheme. The objective is to increase the production of Wheat, Rice & Pulses on as sustainable basis to ensure food security of the country. Ahmedabad district has been included under the said scheme for the production of wheat from the year 2007-08 onwards.

The district is also identified for National Agricultural Development Programme (NADP) from the year 2007-08 with a view to resolve the agricultural development strategies and reoriented to meet the needs of farmers and to evolve a strategies rejuvenating agriculture sector.

It is also selected for the implementation of Agricultural technology Management Agency (ATMA) Project from the year 2006-7 to bring drastic changes in the rural economy of the district. ATMA Project is being implemented in the district through Agriculture University, Anand at Arnej Krushi Sanshodhan Kendra.

Table 5: Crop area in (Hectares) in Year 2016-17

S No.	Crop	Sown Area (Hec)	Irrigation Area(hec)	Production (metric Tonne)	Procution Per Hectare (kg)
1	2	3	4	5	6
1	**Grain**				
	Paddy irrigated	156340	156340	4.8	4800
	Wheat irrigated	103215	103215	2.4	2400
	Wheat Unirrigated	34053	0	0.5	500
	Juwar	0	0	0	0
	Bajri	1646	920	2.5	2500
	Corn	30	30	2.5	2500
	Other Grain Barley	0	0	0	0
	Total Grain	295284	260505	12.7	12700
2	**Pulses**				
	Mung	7153	1833	1	1000
	Tuvar	2346	840	2	2000
	Gram	19625	130	0.08	800

	Other Pulses	14918	648	0.09	900
	Total Pulse	44042	3451	3.17	4700
3	Sugarcane	30	30	0	0
	Spices	16243	16243	164.95	164950
	Fruits	4152	2700	603.62	603620
	Vegetables	32456	32456	5457.24	5458240
	Others	0	0	0	0
	Total	52881	51429	6226.81	6226810
4	**Other NonFood Crop**				
	Cotton Irrigated	30412	30412	2	2000
	Cotton unIrrigated	76585	0	0.6	600
	Other	0	0	0	0
	Total	106997	30412	2.6	2600
5	**Edible Oilcrops**				
	Ground Nuts	78	0	0	0
	Sesame	1464	35	0.9	900
	Other	447	382	0	0
	Total Edible oilcrops	1989	417	0.9	900
6	**Non Edible Oilcrops**				
	Castor	44554	22209	2.5	2500
	Others	2800	135	0	0
	Total	47354	22344	2.5	2500
	Total Nonedible	49343	22761	3.4	3400
7	**Other NonFood Crop**				
	Other Intoxicating crops	525	525	4.75	4750
	Grass	108558	82601	0	0
	Other	0	0	0	0
	Total other Nonfood Crops	0	0	0	0
	Sum of Sown	0	0	0	0
	Total	657630	451684	6253.43	6254960

Source: Ankadiya Roop Rekha 2017-18

Table 6 : Taluka wise food crops

Sl. No.	Taluka Name	Area Under Food Crop	Total Grain	Total Pulses	Total Grain & Pulses	Total Condiments & Spices	Other Food Crops
1	Bavla	58730	54800	3568	58368	85	58730
2	Daskroi	52046	46890	2199	49089	0	52046
3	Detroj-Rampura	17120	5355	10925	16280	360	17120
4	Dhandhuka	26976	10059	16193	26252	596	26976
5	Dholera	15565	14384	1105	15489	76	15565
6	Dholka	78016	73965	1350	75315	250	78016
7	Mandal	12634	4096	3507	7603	4320	12634
8	Sanand	72205	64570	3255	67825	1450	72205
9	Viramgam	30515	21165	1940	23105	5880	30515
	Total	363807	295284	44042	339326	13017	363807

Source: Ankadiya Roop Rekha 2017-18

1.7.3 Irrigation: Area irrigated by different sources is described in table 7.

Table 7 : Source wise Irrigation (Hector)

Sr.No.	Taluka Name	Gross Cropped Area	% Of Gross Irrigated Area Agains Gross Cropped area	Canal	Pond	Dug Well	Other	Area irrigated More than once	Gross Irrigated Area
1	Bavla	36698	64	15462	638	4949	15649	21069	57767
2	Daskroi	28519	52	8035	810	19674	0	26255	54774
3	Detroj-Rampura	0	0	0	0	17205	2100	0	19305
4	Dhandhuka	10413	58	0	0	9268.00	1145	7523	17936
5	Dholera	12896	64	0	500	2142	10254	7348	20244
6	Dholka	55201	65	18194	722	13441.0	22844	29773	84974
7	Mandal	0	0	2600	0	19620	884	0	23104
8	Sanand	86145	100	3000	31500	33000	18645	0	86145
9	Viramgam	56134	75	44000	1500	9350	1284	18546	74680
	Total	286006	65	91291	35670	128649	72805	110514	438929

Source: Ankadiya Roop Rekha 2017-18

1.8 Hydrometeorology : The climate of the district is characterized by hot summer and general dryness except during the southwest monsoon seasons. The year can be divided into four seasons. The period from March to May is the hot season (summer) followed by southwest monsoon from June to September October and November constitute the post-monsoon or retreating monsoon season. The cold season (winter) starts from December and ends in February.

The mean maximum temperature ranges between 28.4ºC during January to 41.8ºC during May and the mean minimum temperatures vary between 11.7ºC during January and 27ºC during June (Fig. 5 & 6). The relative humidity varies between 32 % (March) and 79% (August). The wind velocity varies from 74 km/d (November) and 174.2 km/d (June). The potential Evapo-transpiration varies between 3.2 mm (December) and 7.8 mm/d (June). Long-term average annual rainfall recorded by IMD station at Ahmedabad is 799.6 mm. Most of the rainfall (about 766 mm) is received from south-west monsoon between June to September. Climatological data of Ahmedabad IMD station which is nearest is given in the table 8.

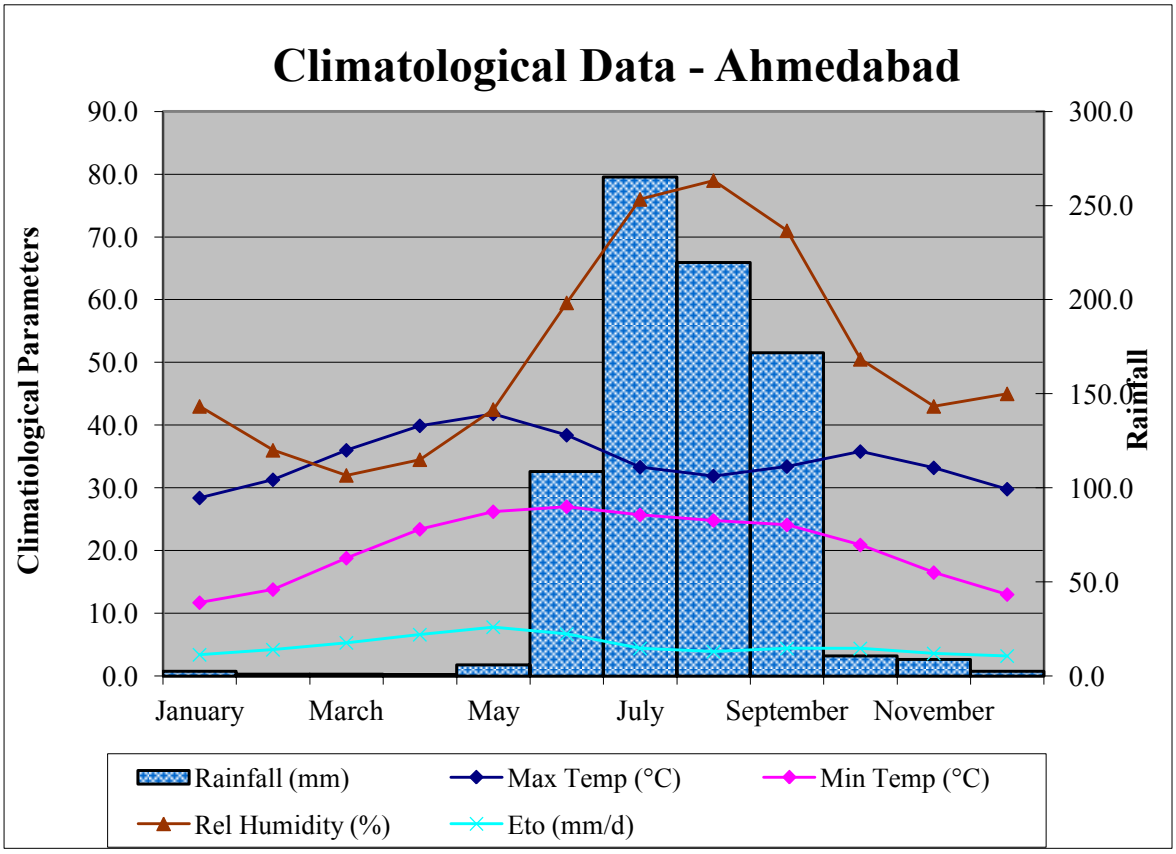


Fig 5: Climatological data of Ahmedabad IMD station.

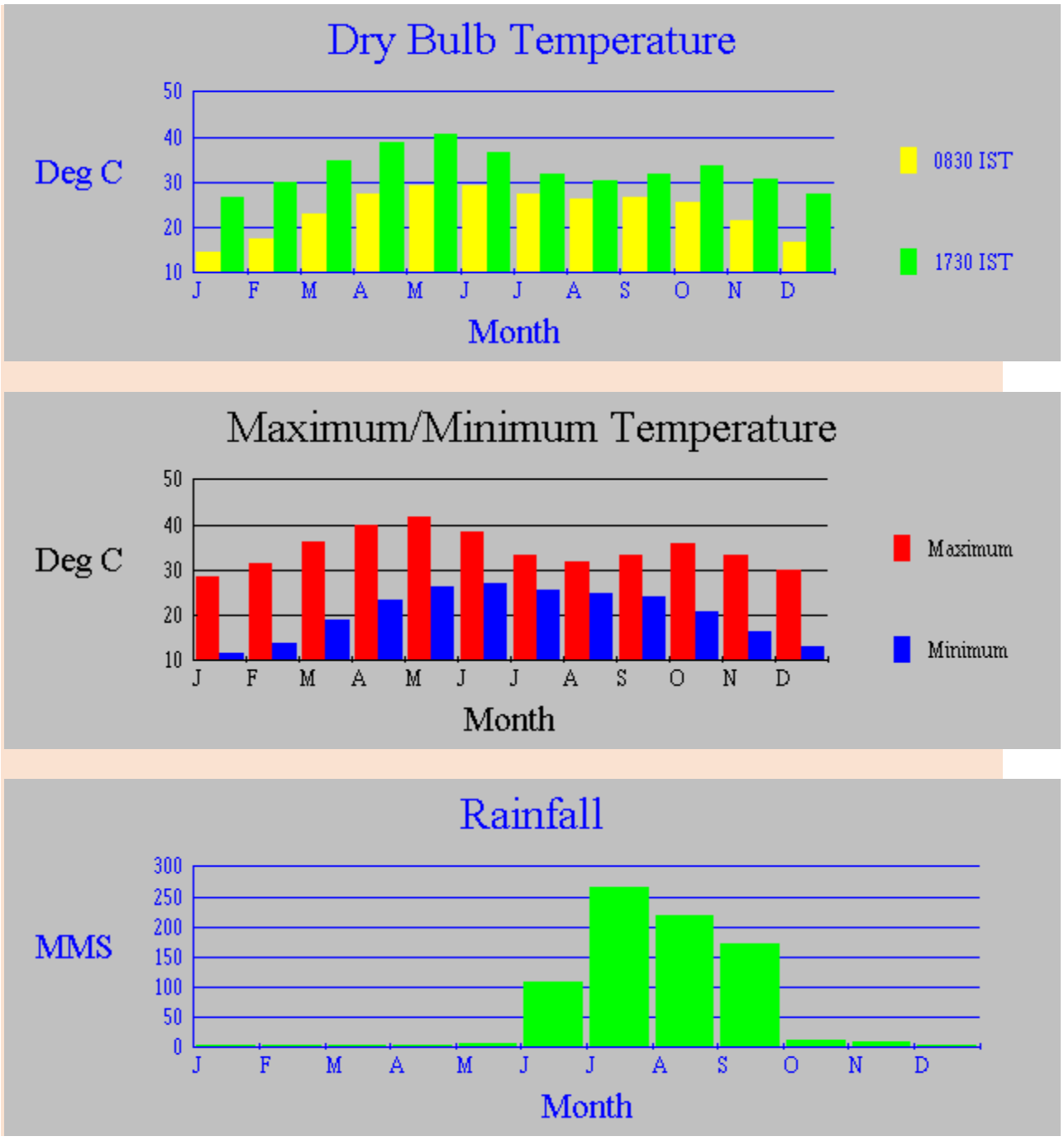


Fig 6 : Temperature and Rainfall chat (Website www.IMD.com)

Table: 8- Climatological data of Ahmedabad IMD station

Month	Max Temp (°C)	Mini Temp (°C)	Humidity (%)	Wind Spd. Kmpd	Sunshine (Hours)	Solar Rad. (MJ/m2/d)	Evapotranspiration (mm/d)	Rainfall (mm)
January	28.4	11.7	43.0	100.1	9.6	17.5	3.4	2.6
February	31.3	13.8	36.0	101.8	10.2	20.5	4.2	1.1
March	36.0	18.8	32.0	108.7	9.3	21.7	5.3	1.0
April	39.9	23.4	34.5	120.8	10.0	24.5	6.6	0.9
May	41.8	26.2	42.5	158.7	10.6	25.9	7.8	6.0
June	38.4	27.0	59.5	174.2	8.8	23.2	6.7	108.7
July	33.3	25.7	76.0	150.1	4.6	16.8	4.4	265.3
August	31.9	24.8	79.0	124.2	4.3	16.0	3.9	219.8
September	33.4	24.1	71.0	103.5	6.7	18.5	4.4	171.9
October	35.8	20.9	50.5	74.2	9.5	20.3	4.4	10.8
November	33.2	16.5	43.0	79.4	9.7	18.1	3.6	8.9
December	29.8	13.0	45.0	91.4	9.5	16.7	3.2	2.6
Total	-	-	-	-	-	-	-	799.6
Average	34.4	20.5	51.0	115.6	8.6	20.0	4.8	-

Rainfall: Meteorological Center and Flood Meteorological office stationed at Ahmedabad collects information regarding meteorological situation of the State (Table9). These Hydro Meteorological data are transmitted by flood meteorological office to the Executive Engineer, Mahi Division, (C.W.C.) at Gandhinagar and Executive Engineer, Tapi Division (C.W.C.) Surat as per their specific requirements.

Table 9: Taluka wise rainfall.

Sl. No.	Taluka Name	2011	2012	2013	2014	2015	2016	2017
1	Ahmedabad (city)	717	674	1158	901	615	574	1049
2	Bavla	491	444	826	1070	382	453	1024
3	Daskroi	450	312	837	480	302	416	647
4	Detroj-Rampura	625	354	980	610	403	337	644
5	Dhandhuka	663	425	1085	675	477	514	728
6	Dholera	0	0	0	0	0	442	555
7	Dholka	573	459	1254	785	310	381	491
8	Mandal	609	436	685	303	358	270	468
9	Sanand	603	586	1265	864	701	524	1007
10	Viramgam	806	440	772	656	518	277	594
Average		615	459	985	705	452	419	721

Source :Ankadiya Roop Rekha 2017-18

1.9 Geomorphology : Geomorphologically the district can be divided into two zones, the major portion of it forms a flat planar topography except for a few rocky features in the extreme southern portion (Fig. 7).

1.9.1 Flat Alluvial Peneplain : It includes the low-lying land of Dholka and Dhandhuka taluka (falling below 20 m) contour characterized by marshy land, which is believed to be under sea in the past. Water logging is common in these tracts at high tides during monsoon. This barren low land is termed as “The Bhal” area and characterized by high coastal salinity. The spreading of alluvial bed of Sabarmati river from end to end of the district is an important natural feature being observed. Below the city, on the left bank of the river and also midway between it and the Khari river are few small rises. But every where else, the surface of the ground is unbroken on every side, except the north, with groves of various trees. Along the Right Bank of Sabarmati river, the prominent characteristics of Dascroi pass into Dholka. However towards west and south-west they pass into fertile but absolutely flat and monotonous black soil of the Bhal. The area from Dholka to Bavliari creek along the coast is characterized by salty and marshy land. Along the western border, the land passes into a reddish form.

1.9.2 Low hills :A series of low hills are present few kilometres west of Rampur in the western Dhandhuka taluka. The hills around Ninana in the most westerly part of Dhandhuka are covered with fragments of quartz and limestone. Some hills are located around Vasai and Miroli in the southern section of the district, also near Thaltej and Gota of Dascroi taluka in the north, and Chandisar in Dholka and Vastrapur in the City Taluka.

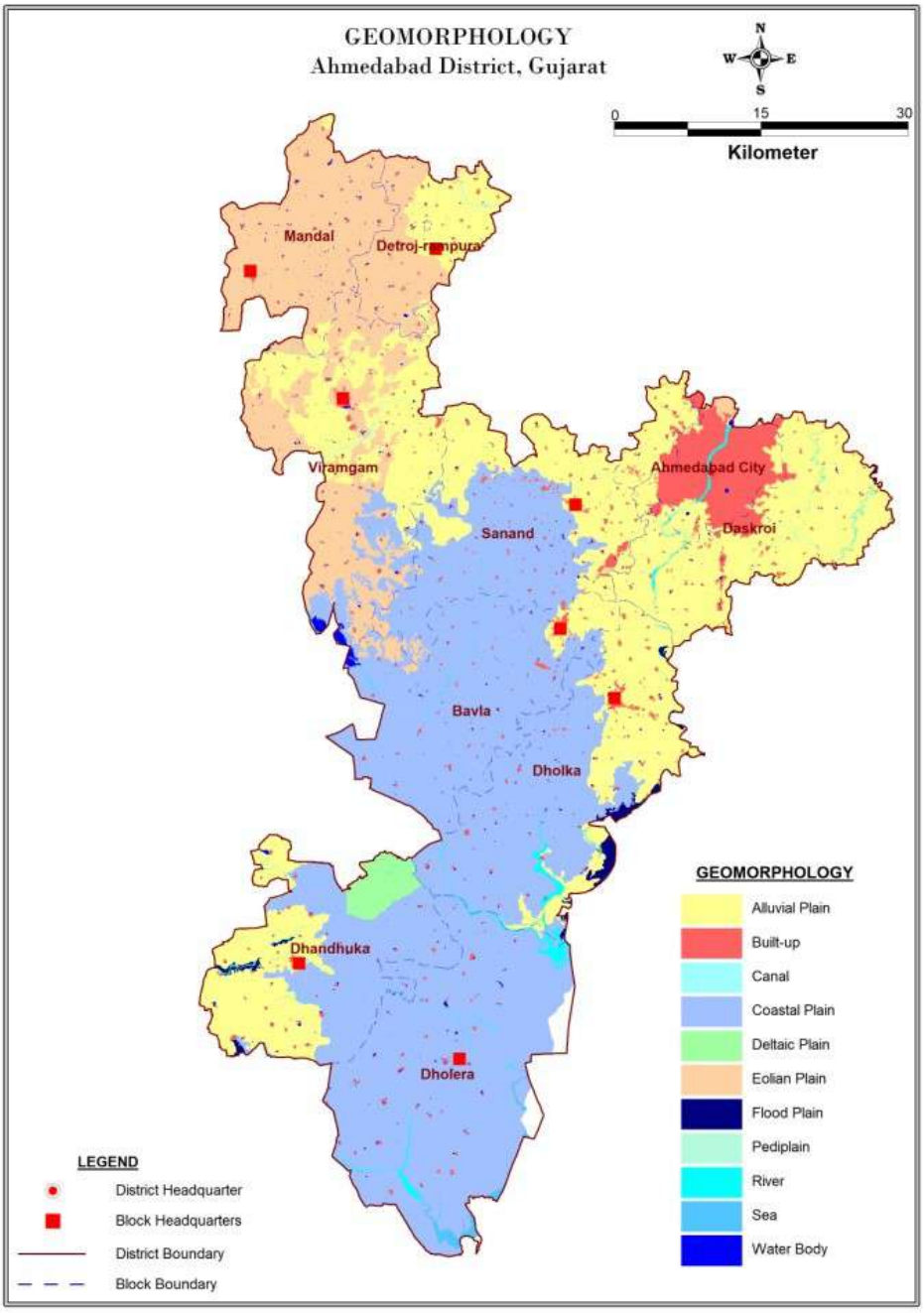


Fig 7 : Geomorphology

1.10 Drainage: There are not many rivers in the district. The river Sabarmati is the principal river in the district, which originates in Rajasthan State. It flows in the Ahmedabad city and passes through the Dascroi and on the borders of Dholka talukas with Kheda district before it debauches in to the Gulf of Khambat (Fig. 8).

The river Vatrak flows on the eastern border of the Dahegam talukas for a smaller length and joins Sabarmati. The Khari river and the Meshavo river drain the Dahegam and Dascroi talukas. The river Bhogavo with its branches Chatori and Omkar drains Dholka and Dholera talukas. The Bhadar river with branch Goma, river Lilka, Utavali and Ghela drains Dhadnhuka and Dholera talukas of the district. River Rodh drains Sanand and Dholka talukas. Rivers Shelwa and Andhli drain Dholka talukas.

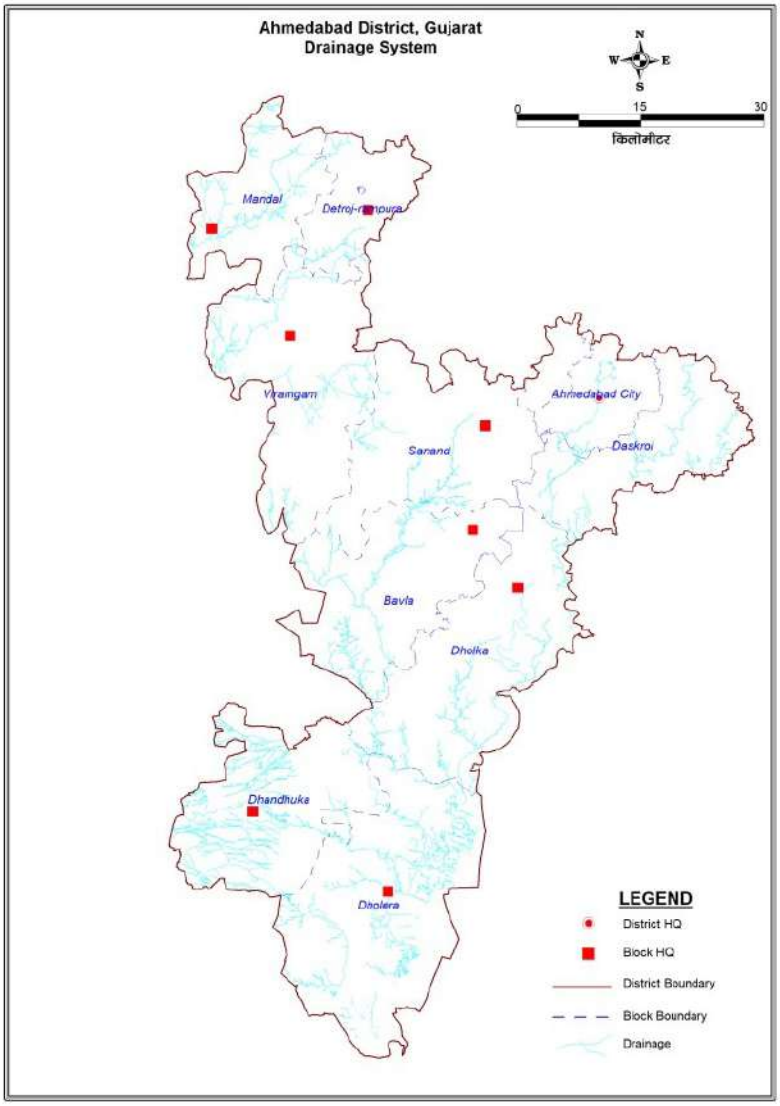


Fig 8: Drainage map of Ahmedabad District.

1.11 Prevailing Water Prevailing Water Conservation/ Recharge Practices

State is experiencing water shortage since last 3 decade owing to increase in water demand in agriculture sector. This has created lot of awareness and state is in practice of implementing various water conservation techniques including construction of large number of Artificial Recharge and Water conservation structures under different schemes by various departments. Efforts made and work undertaken/completed is given in Table 10.

Table 10: Details of recharge structure constructed by different State Government department till 31/03/2018.

Name of District	Check Dam	Bori Bandh	Khet Talavadi	Deepening of Ponds
AHMEDABAD	1255	4946	13010	1894

(Source GWRDC, Gandhinagar)

2. GEOLOGY & HYDROGEOLOGY

2.1 Geology : Major Geological formations occurring in the district are recent and sub recent formation ,except a few minor outcrop of Deccan traps in Dhandhuka talukas. The Geological map of the district is presented in Fig 9. The generalized stratigraphic sequence of Ahmedabad district is given below.

The district forms a part of the CAMBAY BASIN. The stratigraphic succession of the formations encountered within the drilled depth of the wells in the district along with its thickness and generalized lithology are presented below.

Deccan Traps : The Deccan trap occurs in the western part of Dhanduka talukas. The trap rock is pink and grey in color amygdaloidal in habit ,highly jointed and weathered when exposed. They are represented by basaltic lava flows vary in thickness from 20 to 30 meters, extensive in lateral extent with horizontal or sub-horizontal orientation dip not exceeding 0.05 degree towards east.

Alluvium : Thick post-Miocene alluvial deposit occupy the rest of the district. It covers almost all the older formation except the Deccan trap and limestone formation of Dhandukatalukas ,referred above in the south western part of the districts. It consists of fine to coarse –grained sand ,gravel silt and clay .Clay predominates over other material specially in the south and south western part of the district. The wind blown or aeolin deposits are found at top at places imparting mildly undulating topography .The river alluvium is found along the river course and adjoining parts in the rest of the area.The maximum thickness of alluvium of more than 400 mts is expected in the central part of the district near Dholka.

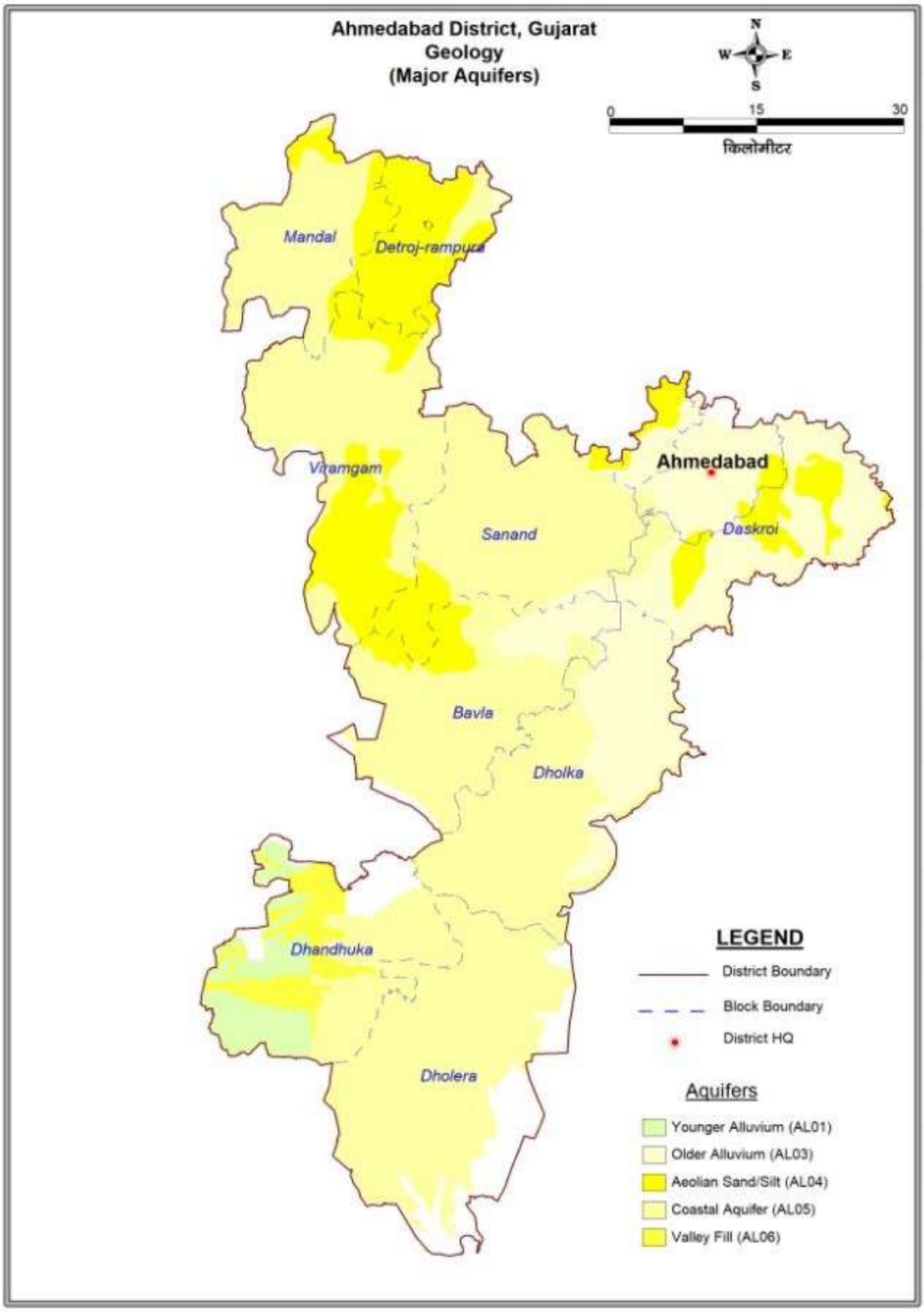


Fig 9 : Geology of Ahmedabad District.

Table: 11- Stratigraphic succession of geological formations.

Age	Formation	Thickness	Lithology
Holocene	Gujarat Alluvium,	100	Unconsolidated coarse sand, pebbly with kankar and minor clays.
Pleistocene	Jambusar	100	Sand, coarse grained with occ. Gravel
Pliocene	Broach	125	Greenish brown clays and sand clay alteration with variegated claystone.
Unconformity			
Upper to middle Miocene	Jhagadia	300	Greenish grey to variegated claystone with coarse to medium grained sand and minor coal.
Middle to lower Miocene	Kand	200	Greenish grey clay-stone with occasional bands of med to fine grained sands
Lower Miocene	Babaguru	125	Alternate bands of claystone and shale with minor sandstone beds.
Lower Miocene, to upper Oligocene	Tarakeshwar	125	Shale with minor clays and claystone with coarse to medium grained sands towards bottom.
Unconformity			
Lower Oligocene to upper Eocene	Tarapur shale.	175	Grey to greenish grey shale with argillaceous sandstone in the basal part.
Upper Eocene to middle Eocene	Kalol	250	Grey to dark grey shale with silty sandstone, siltstone and coal beds with minor sideriticclaystones and oolite with sideritic matrix in Bavla and Ambaliyara areas.
Unconformity			

Age	Formation	Thickness	Lithology
Lower Eocene	Cambay shale vagadkhol	>1500	Dark grey to black fissile, pyritic, carbonaceous shale with occasional siltstone bands towards bottom and reddish brown shale. The cambay shale Facies changes towards the basin margin to Vagadkhol formation with the lithology of trapoconglomerate, trap wash and brown clay / clay stone.
Unconformity			
Lower Eocene to upper Cretaceous	Deacon traps with intertrappean beds.	-	-

(Source: As per ONGC, as given in District Gazetter, 1984)

2.2 Hydrogeology : Major part of the District covered by the unconsolidated alluvial deposits whose alternate sand and clay formations form the prolific multi-aquifer systems. Ground water occurs both under phreatic as well as confined condition. However, its development depends upon the aquifer geometry and yield characters of the individual aquifers and / or the salinity of formation water.

Groundwater in Alluvial formation: The alluvial formation as mentioned earlier occupies the major part of the District. It includes post Miocene alluvial deposit at the top of underlined by older Miocene formation. The formation mainly consist of fine to coarse grained sand, gravel, silt, clay, claystone, siltstone and kankar. Groundwater occurs under Phreatic as well as confined aquifer in granular horizon within the. Hence a discussion of the two major unit of the porous formation, the upper unconfined and the lower confined aquifer are given as under.

Unconfined Aquifer (Phreatic) : The unconfined aquifer occurs in the upper horizons down to a maximum depth of 60 to 70 mbgl consisting of medium to fine grained sand, silt with local lenses of sandy clay and clay. Medium to fine grained sands are found in the north-eastern part of the district. In this area where only phreatic aquifer is present, base of the alluvium is marked by gravel. Fine grained sands with silt are found further south and south-west at Dholka and Sanand taluka. Ground water occurs under phreatic conditions in the north eastern part of the district. However, the intercalations of silt at places induces semi-confined conditions in the south and south western directions at Sanand and Dholka taluka. It bears potable and good quality water in the north eastern part of the district and

eastern part of Dascroi taluka (east of Khari river). It is being developed by dug, dug-cum-bored wells and tube wells. The depth of the dug wells and dug-cum-bored wells usually varies between 10 and 60 mbgl. The tube wells range between 42 and 167 mbgl. In the rest part of the area it bears brackish to saline ground water. Tube wells, tapping this aquifer invariably tap one or more aquifers occurring underneath. Yields of such tube wells varies between 225 and 3032 m3/day. Specific capacity of tube wells varies between 0.12 and 38.48 lpm/m, permeability varies between 0.49 and 105 m/day and transmissivity varies between 10.58 and 3867.29 m2/day.

Confined aquifers : The unconfined aquifer is underlined by persistent clay formation of considerable thickness in the entire area of the porous sedimentary formation. This separates the lower unit consisting of a few hundred meters of alternating sandy and argillaceous beds forming confined aquifer system. The arenaceous horizon of the confined aquifer, consists of medium to coarse grained sand with gravel interstratified locally with silty or clayey sand and clay lenses. Not only this; but the distribution of the confined aquifer in the district also varies considerably in the district. The sand content of aquifer decreases both in depth and space. It resulted in pinching out of certain type of aquifers occurring below 150 mbgl in the south and south western direction as seen in Kalyangadh and Bagodara bore holes**.** The ground water exploration carried out by CGWB has indicated that the confined aquifers with potable water occurs down to 300 to 350 m in the area towards north and north east of the low lying Bhal land in the district. Silent hydrogeological data is given in table 11.

Table: 12- Feasibility, Yield potential, Depth and Dia of ground water abstraction structures

Taluka	Area Type	Wells feasible	Suitable drilling technique	Depth of well (m)	Diameter	Discharge (lpm)
Bavla, Dholka, Mandal, Sanand&Viramgam	Soft Rock Area	Dug Well	Manual	15-30	1-3 m	200-300
		Tube Wells	Direct/ Reverse Rotary	100-200	200-250 mm	600-1000
				100-300	200-250 mm	1000-1200
City-Dascroi	Soft Rock Area	Dug Well	Manual	10-25	1-3 m	200-300
				15-30	1-3 m	200-300
		Tube Wells	Direct/	50-100	200-250 mm	200-400

			Reverse Rotary	100-300	200-250 mm	1000-1200
Detroj-Rampura	Soft Rock Area	Dug Well	Manual	15-30	1-3 m	200-300
		Tube Well	Direct/ Reverse Rotary	100-300	200-250 mm	1000-1200
Dhandhuka	Soft Rock Area	Dug well	Manual	10-25	1-3 m	200-300
				15-30	1-3 m	200-300
		Tube Wells	Direct/ Reverse Rotary	50-100	200-250 mm	200-400
				100-200	200-250 mm	600-1000

2.3 Ground Water Regime : Pre-Monsoon Phreatic Aquifers : Water level measurements was carried out using the existing National Hydrograph station of CGWB & GWRDC. This involved measurement of water levels of both the phreatic aquifer through dug wells and measurements of piezometric surface through the existing piezometers. The map depicting the depth to water level (Figure 8) has been prepared based on water level data for May 2017 collected from NHS observation wells of CGWB & GWRDC.

2.3.1 Depth To Water Level (Unconfined) May 2017: The depth to water level in the district, ranges between less than 2m to >40m bgl during May 2017. The shallower water levels less than 5 mbgl were confined in the southern part of district of Dhandhuka, Dholera, part of Dholka taluka and in few patches in other part. Water level between 5 to 10m bgl were mostly covered in central part and also observed in north-western part of district. Central part to mid-eastern and in small area of north western part showing depth to water level 10 to 20m bgl. Water level deeper water levels were observed in North-Eastern and as small patches in North-Western part of district (Fig 10).

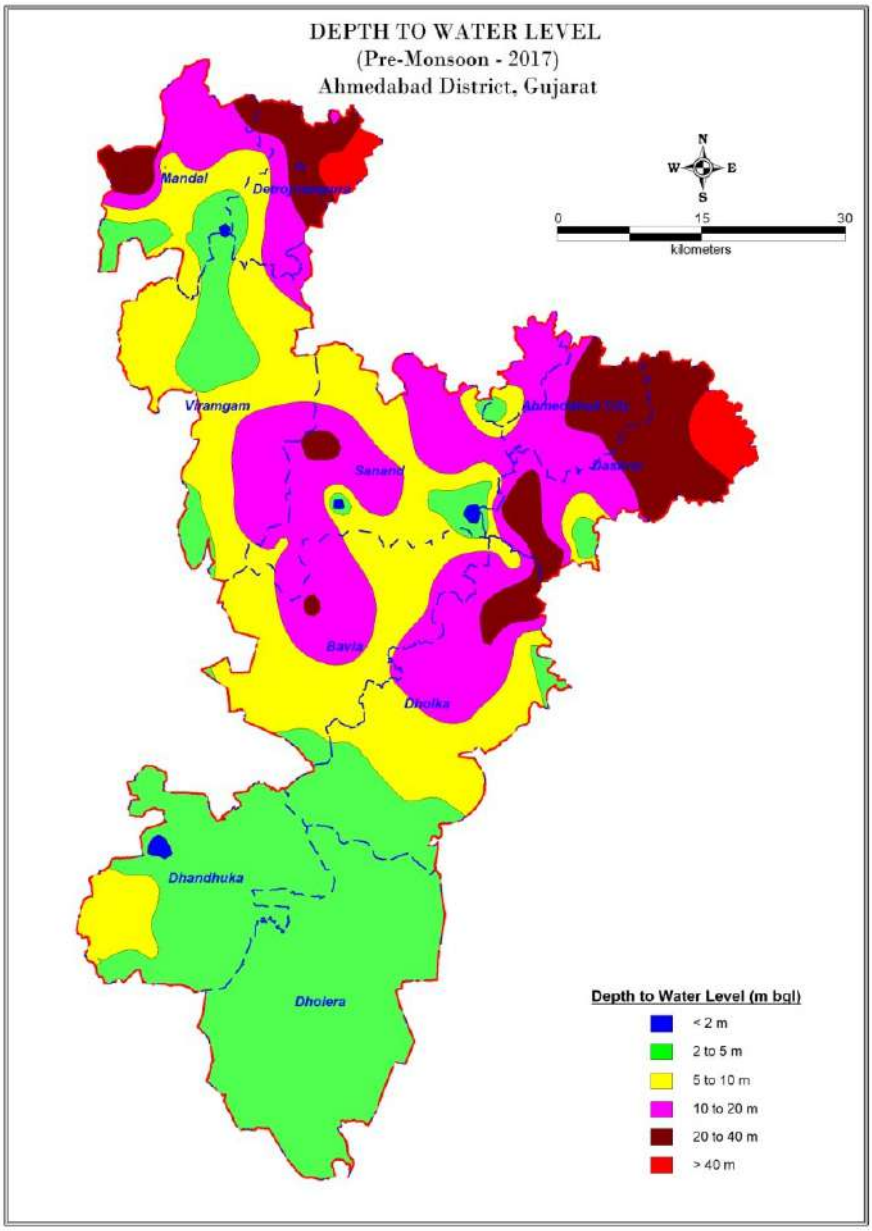


Figure -10 :Pre-Monsoon depth to water level(Phreatic), Ahmedabad district, Gujarat.

2.3.2 Depth To Water Level (Unconfined) November 2017: The post-monsoon depth to water level in the district, ranges between less than 2m to >40m bgl during November 2017 (Fig. 11). In major part of district mostly southern, western boarder and mid-north west part were mostly observed depth to water level less than 5m bgl. Water level ranges between 5 m and 10 m bgl were observed in central part and in small patches in mid-north eastern and mid-north western part of district. Water levels showing between 10 to 40m bgl observed in eastern, north-eastern part, northern part and in few patches in central part of district. Deeper water levels more than 40 observed in north-western part of district.

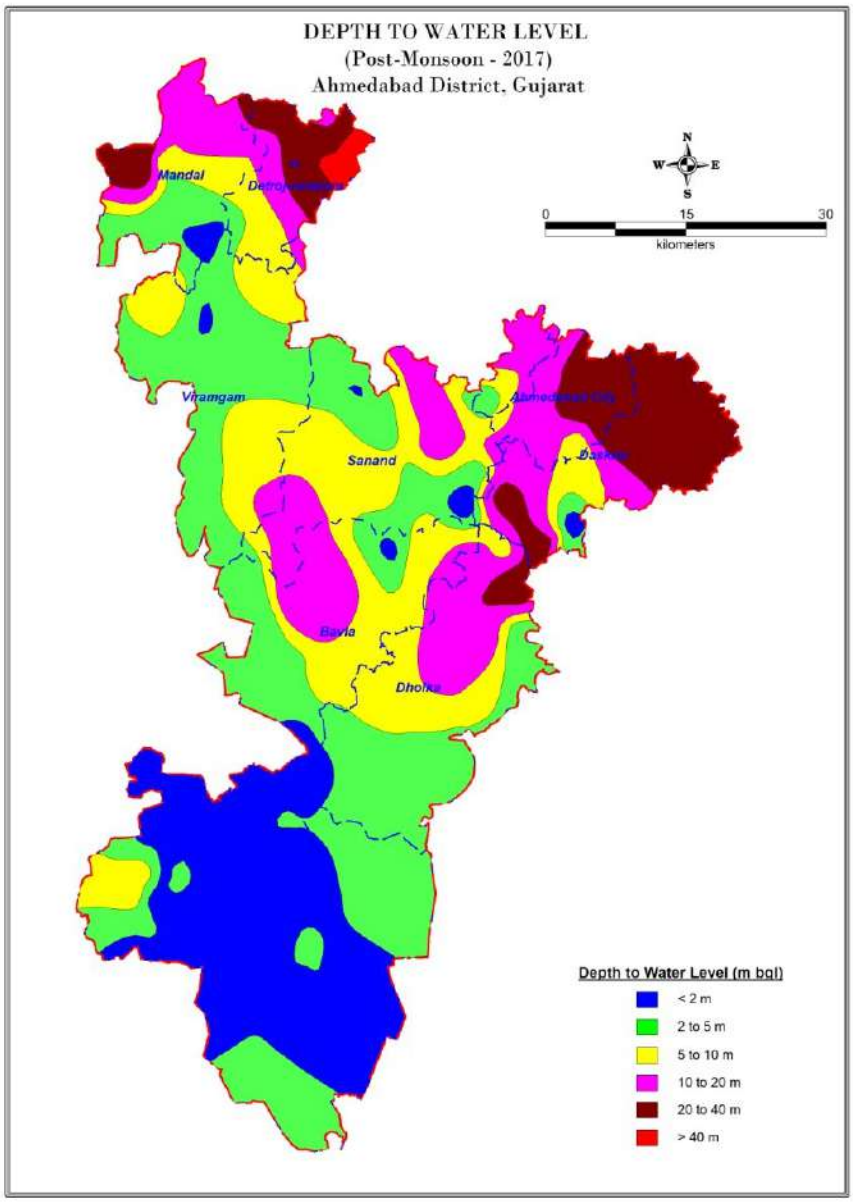


Figure -11 : Post-Monsoon (November 2017) depth to water level(Phreatic), Ahmedabad district Gujarat.

2.3.3 Water Table Contours (Unconfined) Pre-monsoon 2017: Maps of the elevation of the water level indicates that in the entire District the elevation of water table ranges from 0 to more than 40 mamsl during May 2017 (Fig. 12). The ground water flow direction of central and northern part is mostly towards north. Some part of North eastern part flow direction is towards northwest. However in Extreme South part ground water flow direction is towards west.

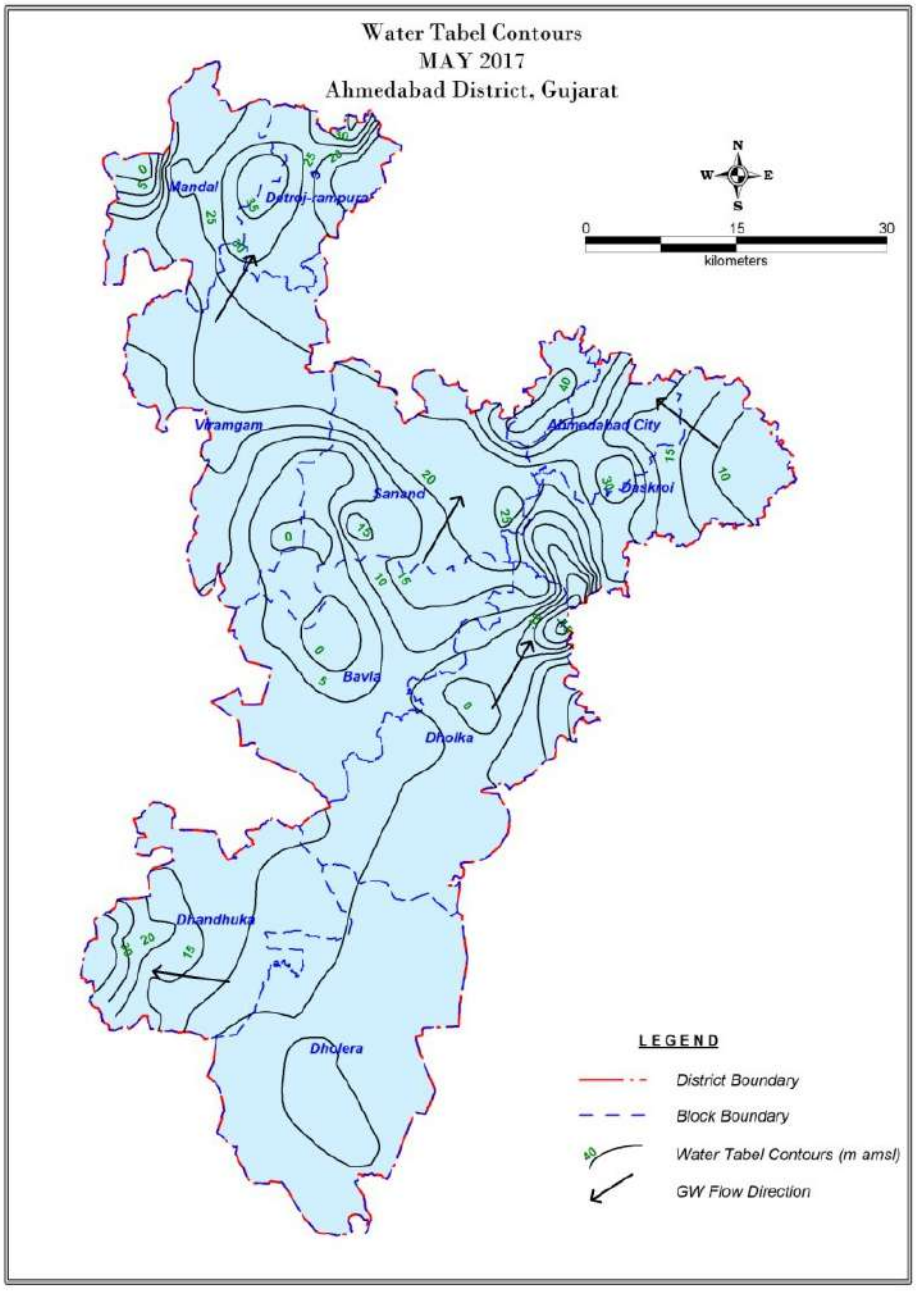


Figure -12: Pre Monsoon Water Table elevation (Phreatic), Ahmedabad District, Gujarat.

2.3.4 Water Table Contours (Unconfined) Post-monsoon 2017 : Maps of the elevation of the water level indicates that the entire District the elevation of water table ranges from below mean sea level to more than 40 mamsl (Fig 10) during November 2017(Fig. 13). The ground water flow direction is mostly towards northern east. However in Extreme southern part ground water flow direction is towards west.

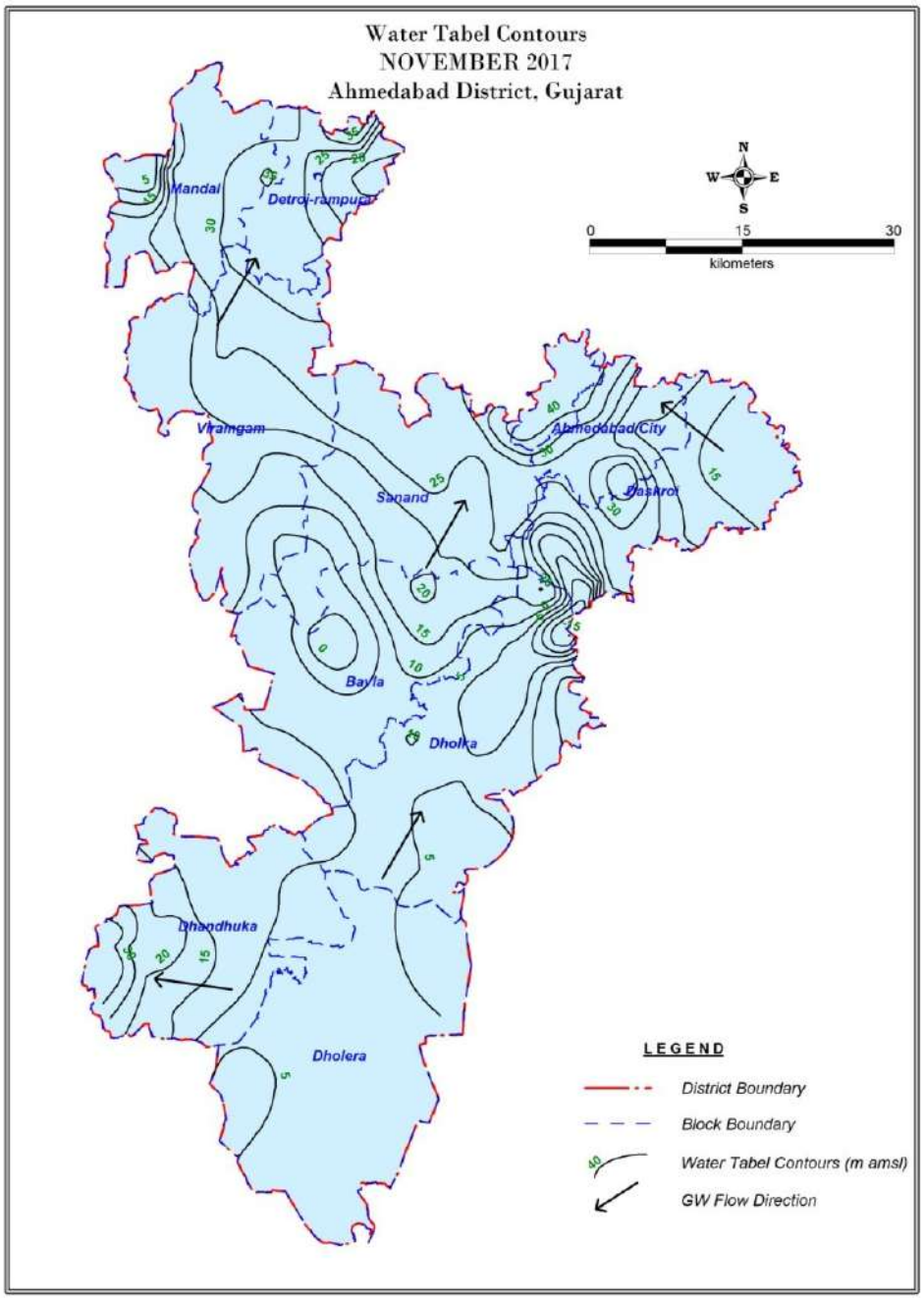


Figure -13: Post-Monsoon Water Table elevation (Phreatic), Ahmedabad District, Gujarat.

2.3.5 Water Level Fluctuation (Phreatic) Decadal Mean Pre Monsoon (2007-2017) Vs Pre Monsoon 2018: The fluctuation Decadal Mean Pre Monsoon Vs Pre Monsoon in the phreatic aquifers shows that there is distinct rise in water level of 0 to 2 meters observed in Northern part, central, mid-eastern part and in few patches in southern part of District (Fig. 14). The rise in water level in Pre Monsoon season more than 2 meters observed in the eastern part, and in few patches in northern part of District. The highest fall in water level (> 4 meters) mostly in central and mid-eastern part of District.

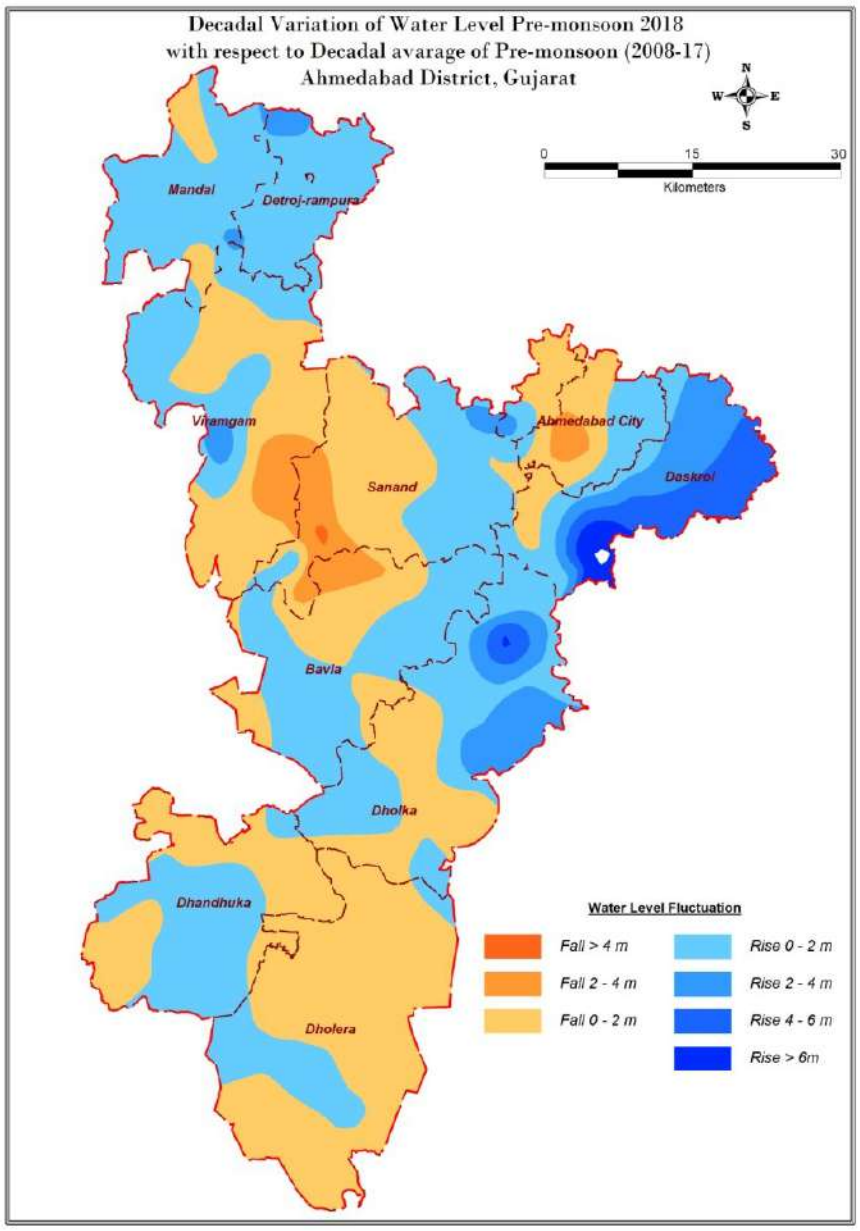


Figure-14: Water Level fluctuation (Phreatic) Decadal Mean Pre Monsoon(2008-2017) Vs Pre Monsoon 2018, Ahmedabad District, Gujarat.

2.3.6 Water Level Fluctuation (Phreatic) Decadal Mean Post Monsoon (2008-2017) Vs Post Monsoon 2018: The fluctuation Decadal Mean Post Monsoon Vs Post Monsoon in the phreatic aquifers shows that there is distinct rise in water level of 2 meters in the major part of District (Fig.15). The rise in water level in Post Monsoon season in the range of 2 to more then 6 meters has seen observed in the north eastern part of Daskroi and in few patches in central and northern part of District. The fall in water level observed most of southern part and in few patches in northern and central part of district.

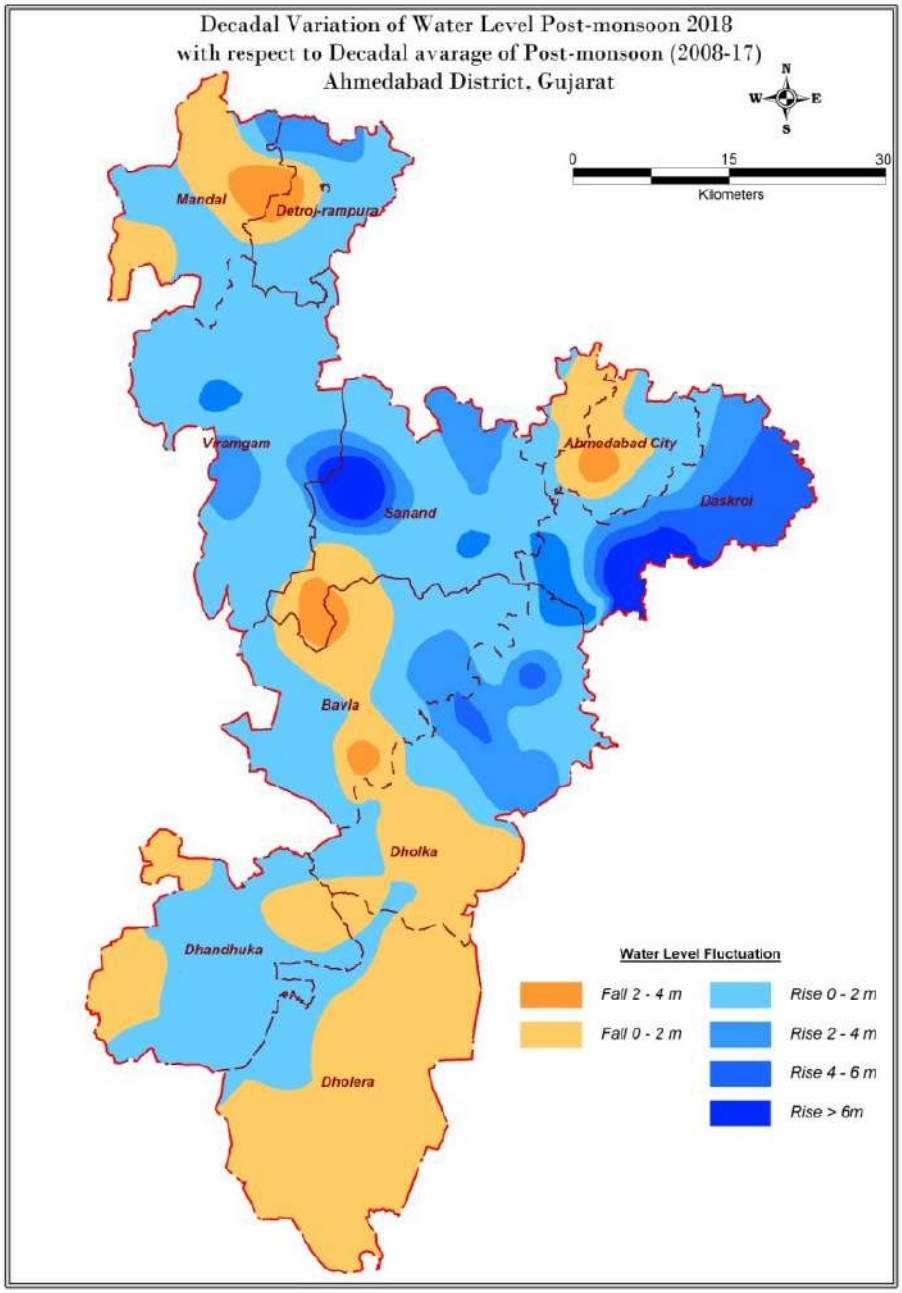


Figure-15 : Water Level fluctuation(Phreatic)Decadal Mean Post Monsoon(2008-2017) Vs Post Monsoon 2018, Ahmedabad District, Gujarat.

2.3.7 Decadal Average Depth To Water Level Pre-monsoon (2008-2017): The pre-monsoon decadal average depth to water level in the district, ranges between less than 2m to >40m bgl. In major part of district mostly observed decadal average depth to water level less than 10m bgl (Fig. 16). Decadal average depth to water level ranges between 10 m and 40 m bgl were observed in central part, eastern part and in small patches in northern part of district. Deeper decadal average depth to water level more then 40 observed in north-eastern part of district.

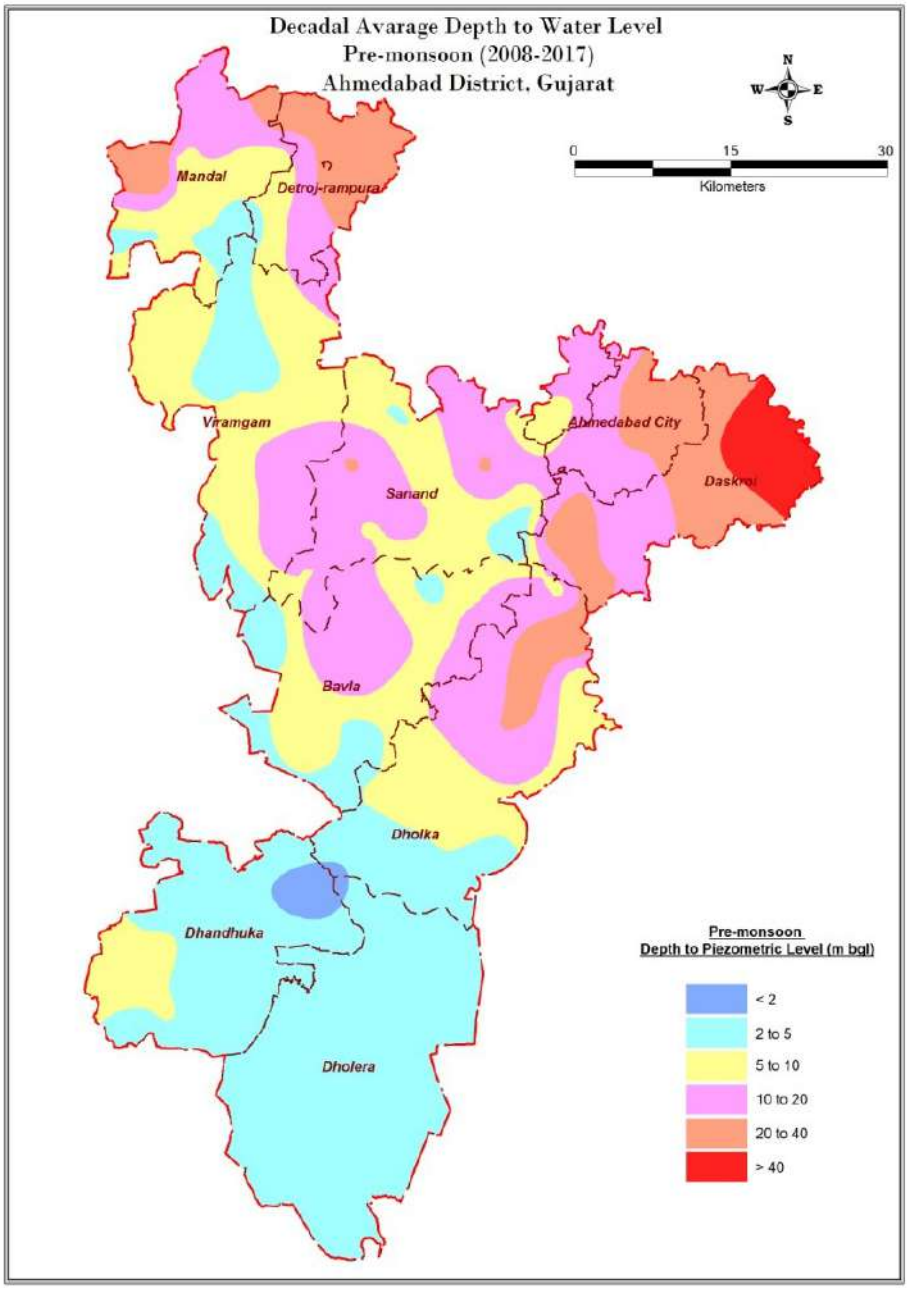


Figure-16: Decadal Average Depth To Water Level Pre-monsoon (2008-2017), Ahmedabad District, Gujarat.

2.3.8 Decadal Average Depth To Water Level Post-monsoon (2008-2017): The post-monsoon decadal average depth to water level in the district, ranges between less than 2m to >40m bgl. In major part of district mostly observed decadal average depth to water level less than 10m bgl (Fig. 17). Decadal average depth to water level less than 2m bgl were observed in southern part of district. Decadal average depth to water level ranges between 10 m and 40 m bgl were observed in central part, eastern part and in small patches in

northern part of district. Deeper decadal average depth to water level more then 40 observed in north-eastern part of district.

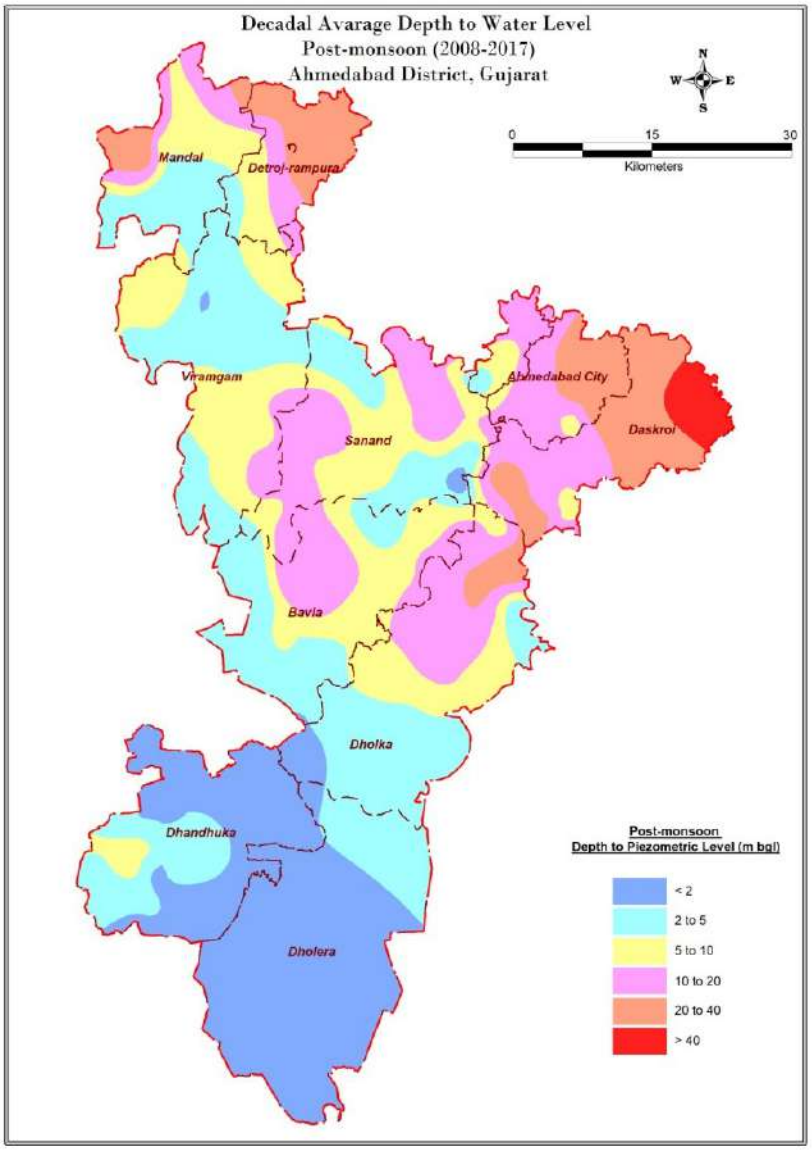
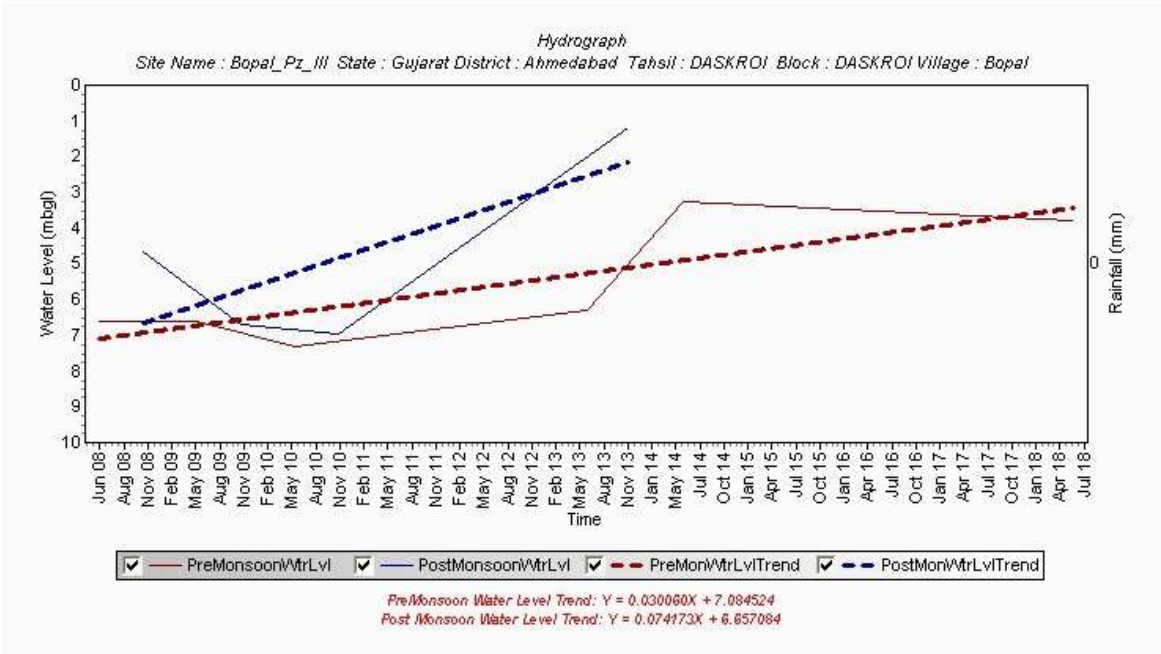
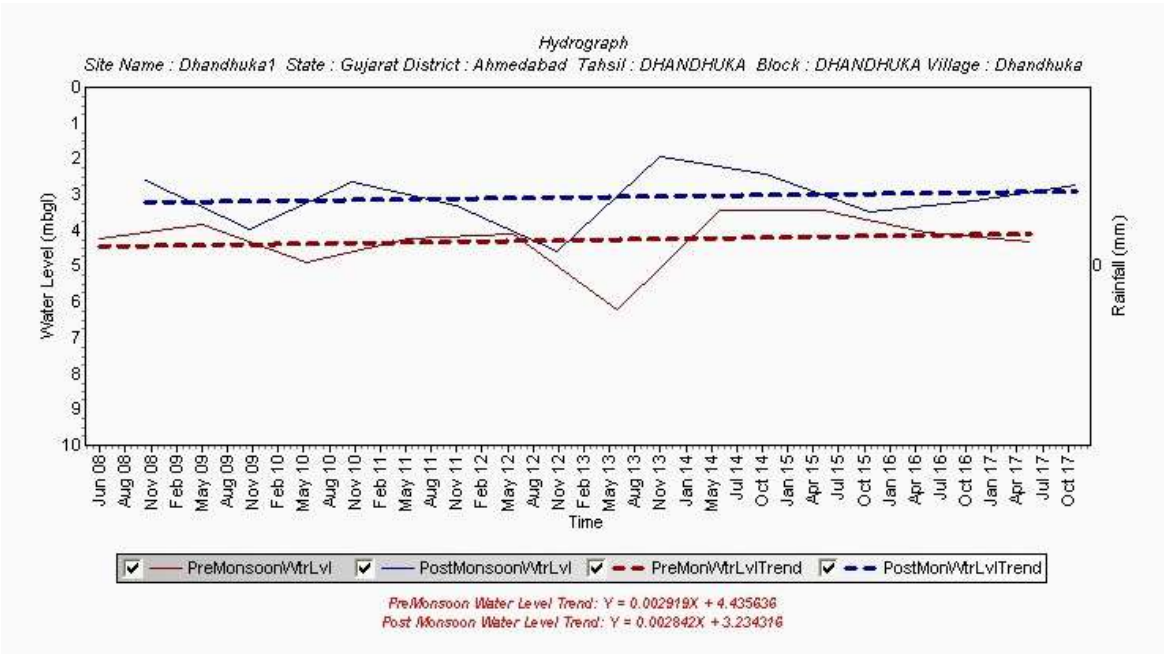


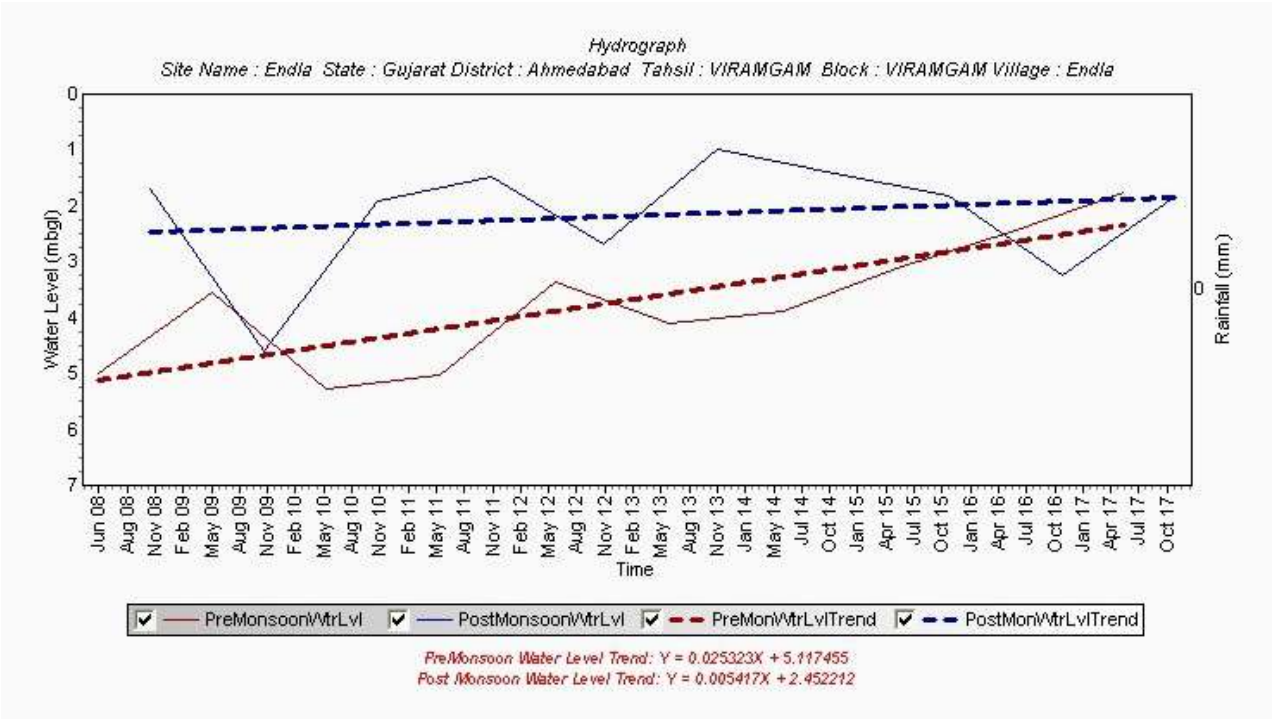
Figure-17: Decadal Average Depth To Water Level Post-monsoon (2008-2017), Ahmedabad District, Gujarat.

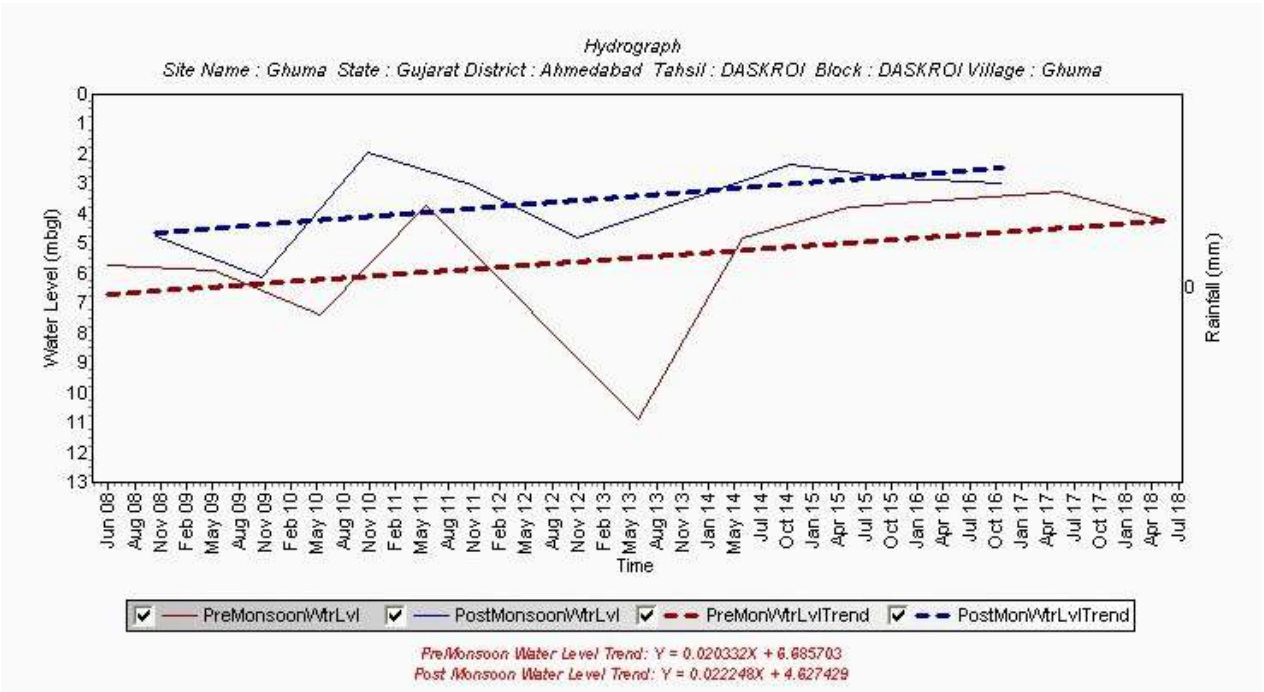
2.3.9 Long Term Water Level Trend – Phreatic aquifer : Overall trends of the water level of the CGWB and GWRDC taluka wise Pre & Post-monsoon water level trend for the period 2008 to 2017 have been computed for the district and it is observed that wells showing declining trend ranges from -0.01 to -1.06 m/year and wells showing rising trend ranges from 0.01 to 2.89 m/year. Selected hydrograph are being reproduced represented in this report for a synopsis assessment, which are shown subsequently (Fig. 18).

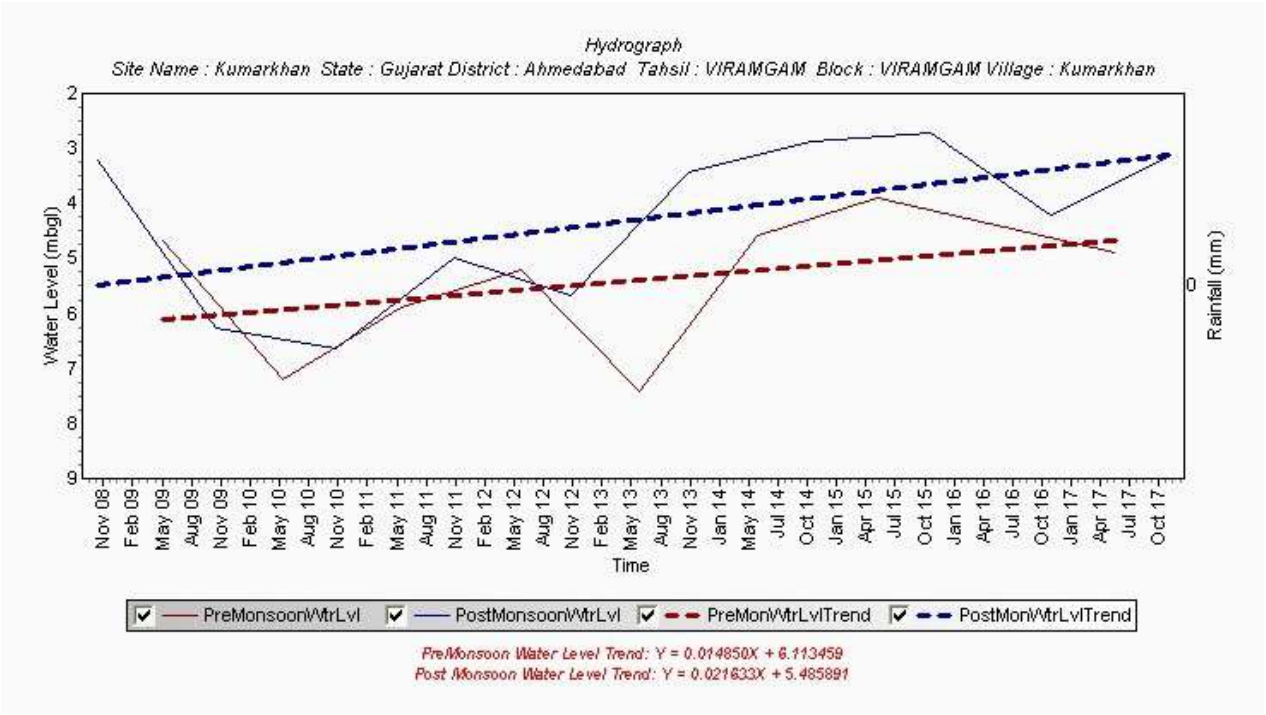
Fig 18 : Hydrograph (Phreatic Aquifer)

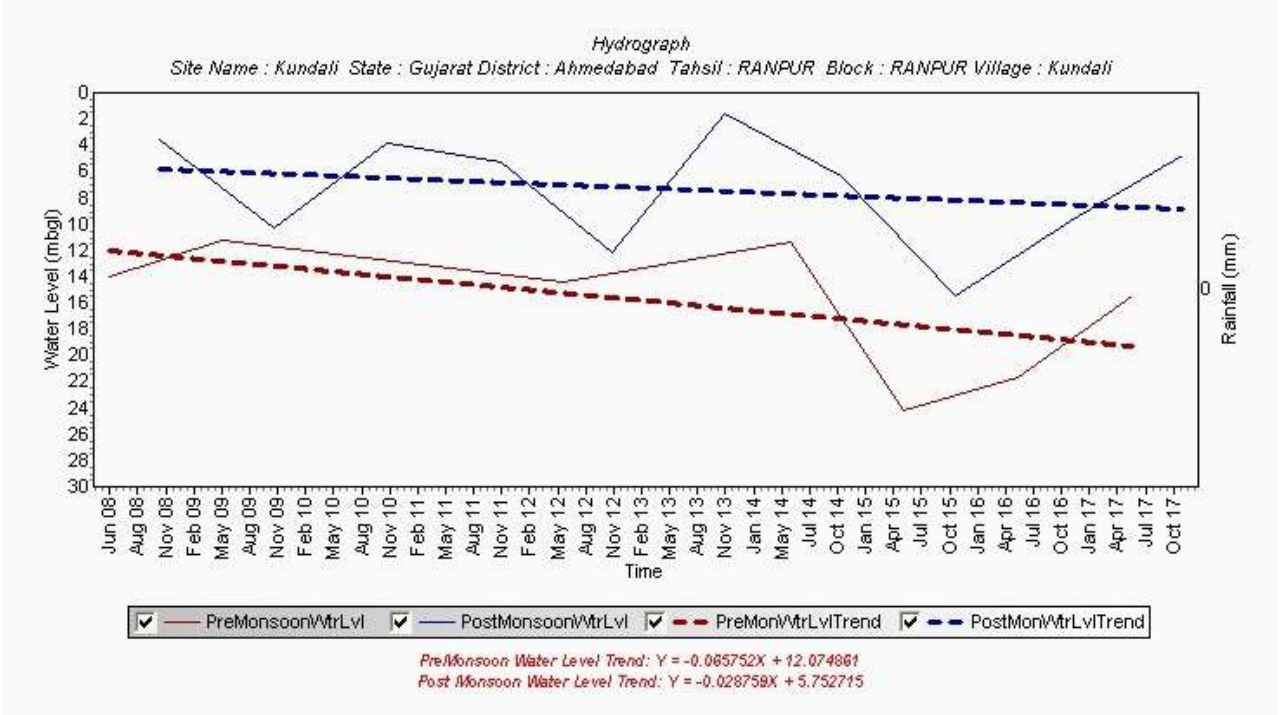


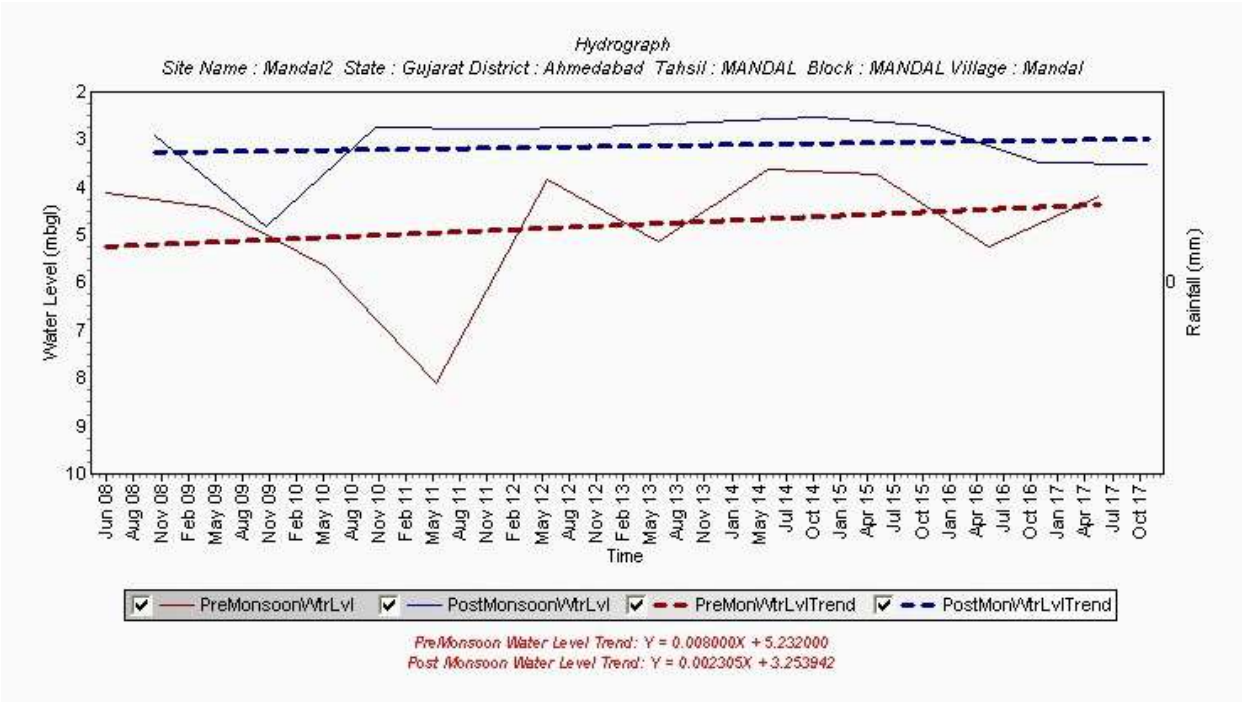


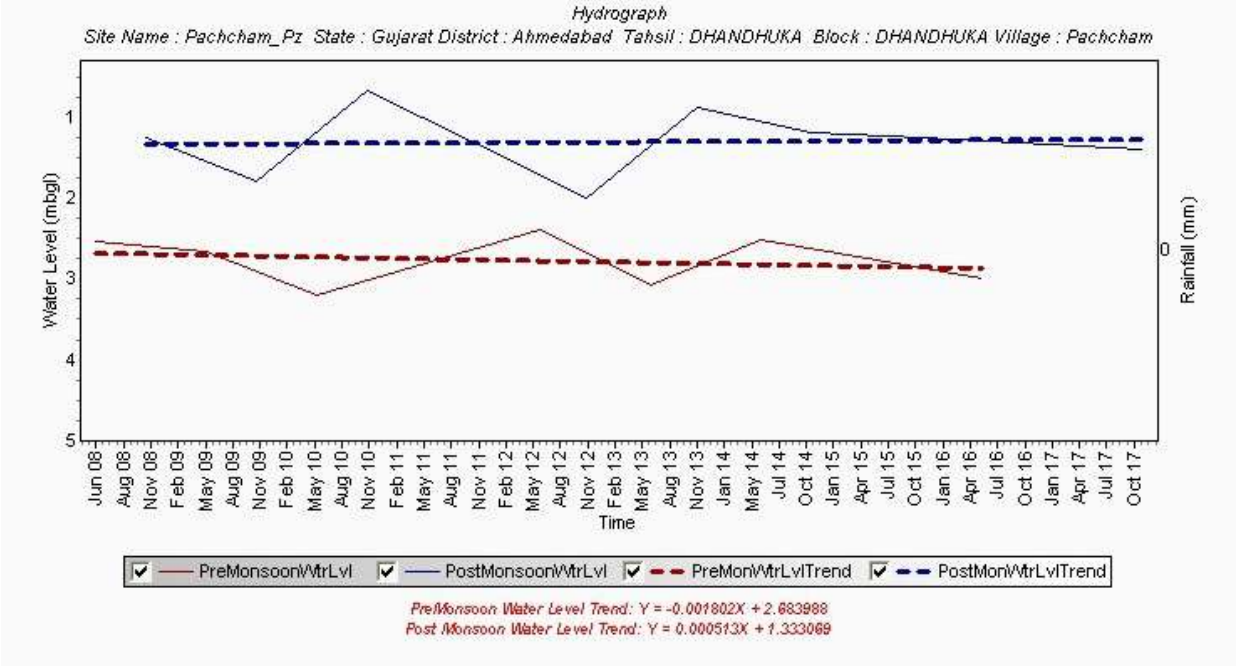

Hydrograph
Site Name : Endla State : Gujarat District : Ahmedabad Tahsil : VIRAMGAM Block : VIRAMGAM Village : Endla
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.025323X + 5.117455
Post Monsoon Water Level Trend: Y = 0.005417X + 2.452212

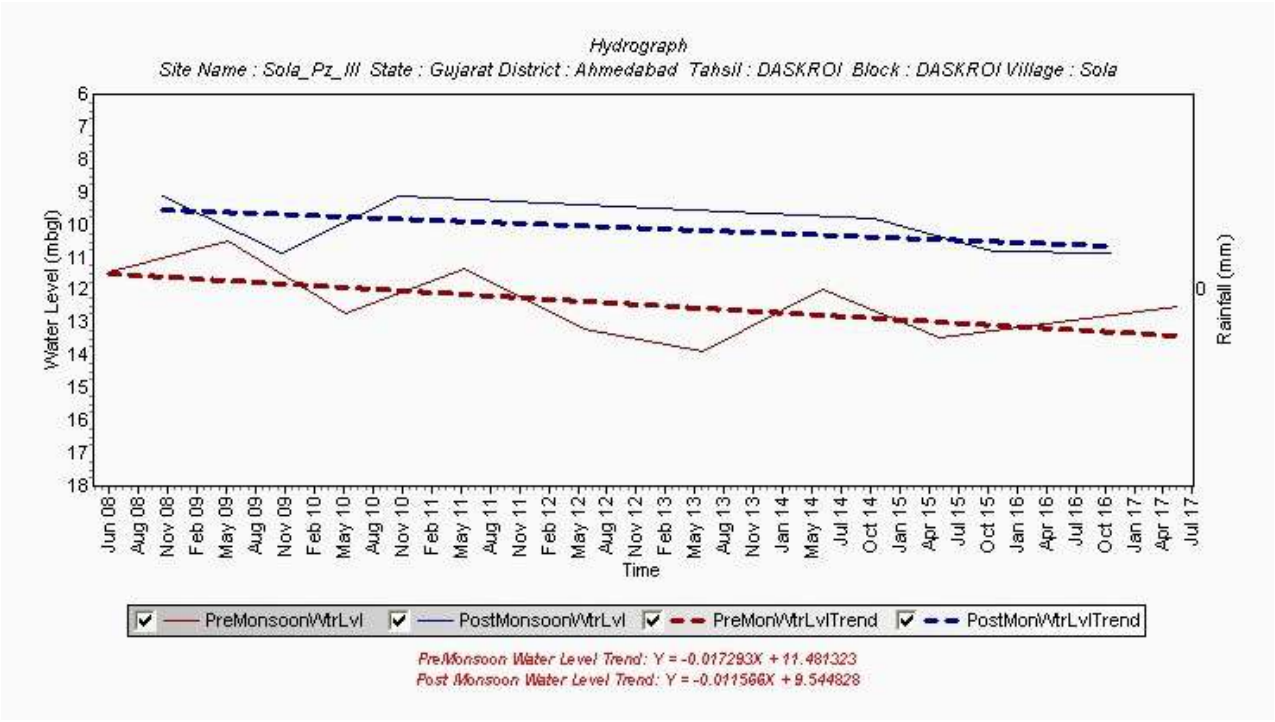

Hydrograph
Site Name : Ghuma State : Gujarat District : Ahmedabad Tahsil : DASKROI Block : DASKROI Village : Ghuma
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.020332X + 6.685703
Post Monsoon Water Level Trend: Y = 0.022248X + 4.627429

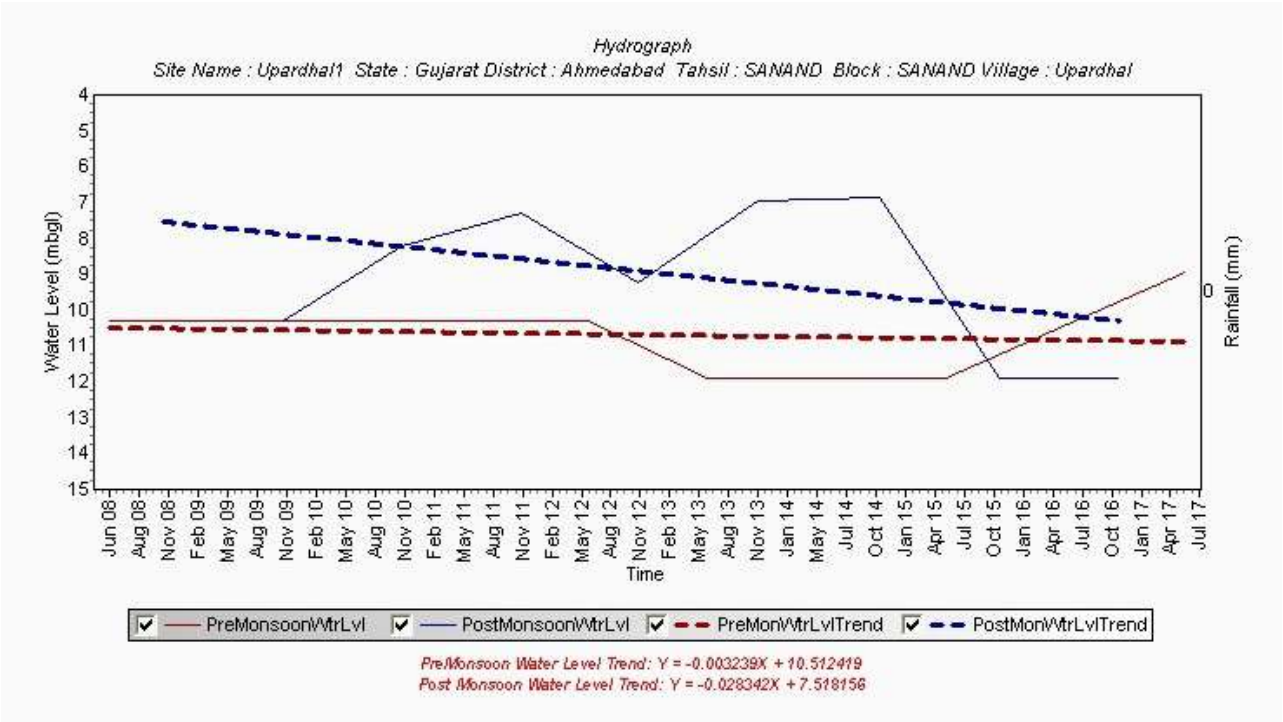

Hydrograph
Site Name : Kumarkhan State : Gujarat District : Ahmedabad Tahsil : VIRAMGAM Block : VIRAMGAM Village : Kumarkhan
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.014850X + 6.113459
Post Monsoon Water Level Trend: Y = 0.021633X + 5.485891


Hydrograph
Site Name : Kundali State : Gujarat District : Ahmedabad Tahsil : RANPUR Block : RANPUR Village : Kundali
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
PreMonsoon Water Level Trend: Y = -0.065752X + 12.074861
Post Monsoon Water Level Trend: Y = -0.028759X + 5.752715


Hydrograph
Site Name : Mandal2 State : Gujarat District : Ahmedabad Tahsil : MANDAL Block : MANDAL Village : Mandal
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.008000X + 5.232000
Post Monsoon Water Level Trend: Y = 0.002305X + 3.253942


Hydrograph
Site Name : Pachcham_Pz State : Gujarat District : Ahmedabad Tahsil : DHANDHUKA Block : DHANDHUKA Village : Pachcham
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
PreMonsoon Water Level Trend: Y = -0.001802X + 2.683988
Post Monsoon Water Level Trend: Y = 0.000513X + 1.333069


Hydrograph
Site Name : Sola_Pz_III State : Gujarat District : Ahmedabad Tahsil : DASKROI Block : DASKROI Village : Sola
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
PreMonsoon Water Level Trend: Y = -0.017293X + 11.481323
Post Monsoon Water Level Trend: Y = -0.011566X + 9.544828


Hydrograph
Site Name : Upardhal1 State : Gujarat District : Ahmedabad Tahsil : SANAND Block : SANAND Village : Upardhal
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
PreMonsoon Water Level Trend: Y = -0.003239X + 10.512419
Post Monsoon Water Level Trend: Y = -0.028342X + 7.518156

2.3.10 Pre Monsoon Depth of Piezometric surface May 2017 : A perusal of data and map reveals that the pre monsoon depth to piezometric surfaces varies from less than 10 m bgl to more than 120 meters below ground level (Fig. 19). Majority of the areas have the piezometric surface pegged less than 10 to 50 meters below ground level. Deeper piezometric surface (> 120 meters below ground level) are found in the talukas of Detroj Rampura, part of Viramgam and City-Daskroi.

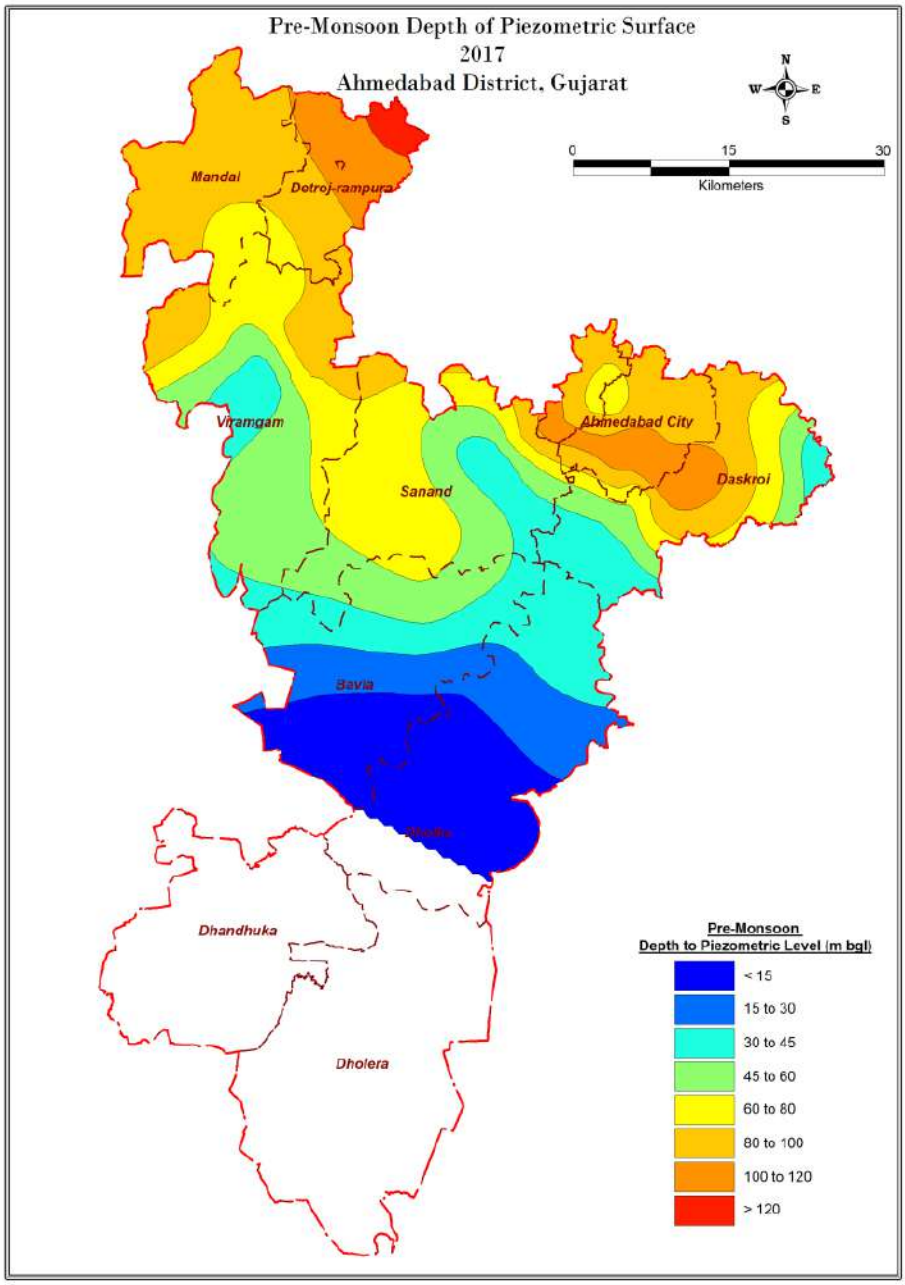


Figure – 19 : Pre Monsoon Depth to Piezometric surface 2017, Ahmedabad District, Gujarat.

2.3.11 Post Monsoon Depth of Piezometric Surface November 2017: A perusal of data and map reveals that the post monsoon depth to piezometric surfaces varies from less than 15 m bgl to more than 120 meters below ground level. Majority of the areas have the piezometric surface pegged between 10 to 80 meters below ground level. Relatively deeper piezometric surface (> 120 meters below ground level) are found in the talukas of City-Daskroi, Detroj Rampura (Fig. 20).

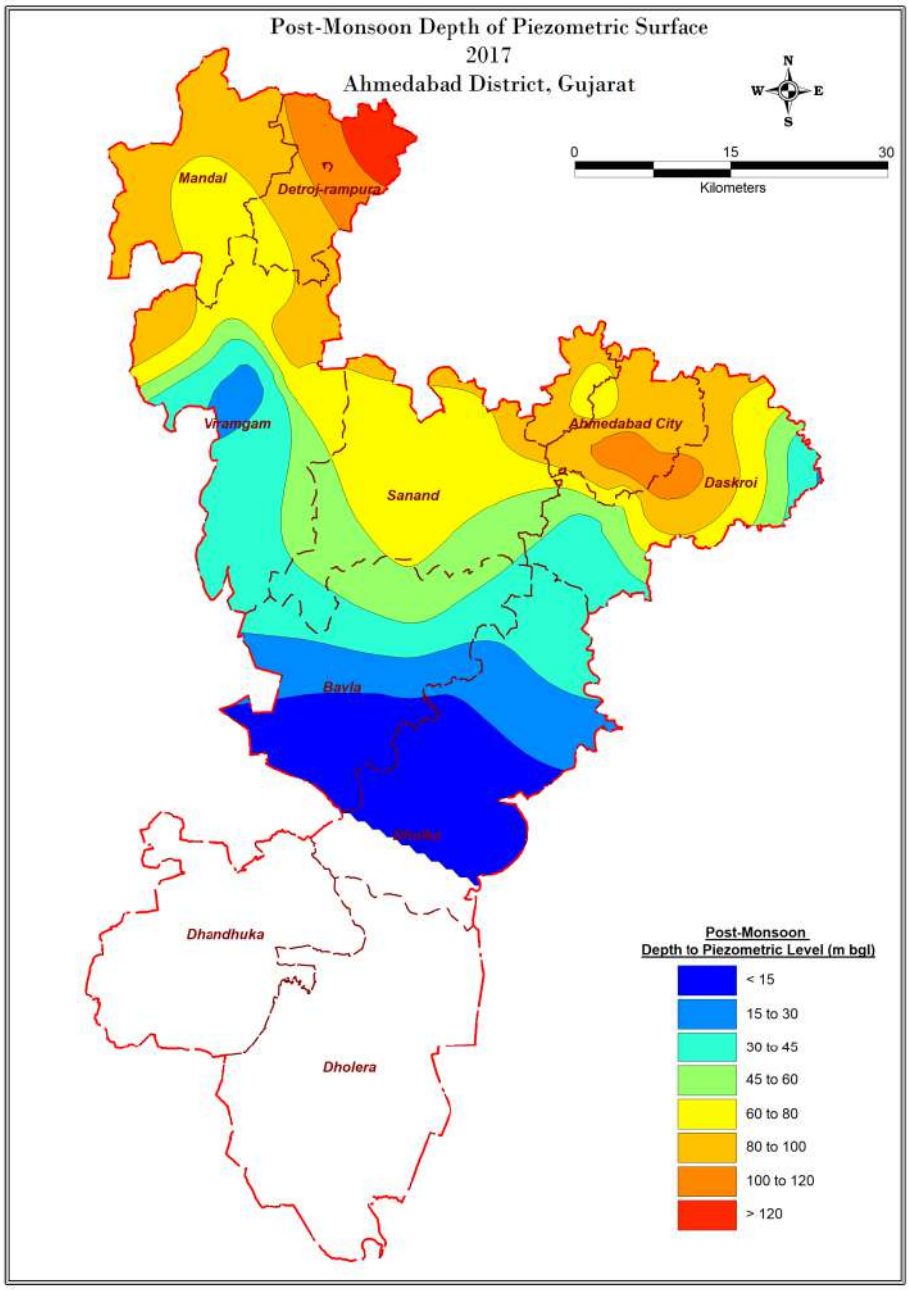


Figure -20: Post Monsoon Depth to Piezometric surface 2017, Ahmedabad District, Gujarat.

2.3.12 Water Table Contours Pre-monsoon(Confined), May 2017: The piezometric head of the piezometric surface elevation recorded in the district ranges between 70 mamsl to 20 m below msl (Fig. 21). A perusal of data and maps of Piezometric Surface elevation contour reveals that the pre monsoon elevation varies from 20 meters below mean sea level to more than 70 meters above mean sea level.

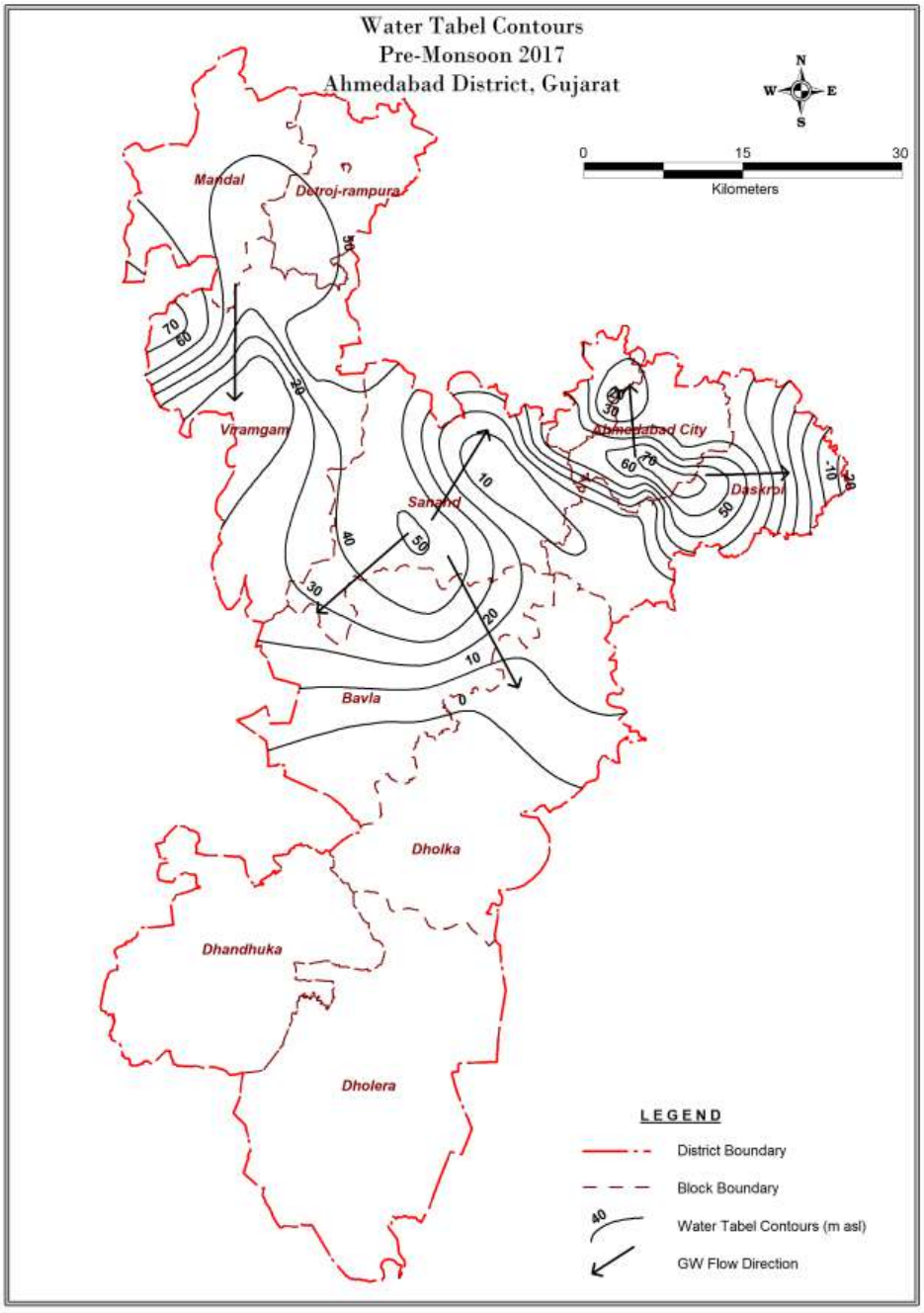


Figure -21: Water Table Contours Pre-monsoon(Confined), May 2017.

2.3.13 Water Table Contours Post-monsoon(Confined), November 2017: Post Monsoon Piezometric Surface Elevation : A perusal of data and maps of Piezometric Surface reveals that the post monsoon elevation varies from 5.90 meters below mean sea level more than 70 meters above mean sea level (Fig. 22).

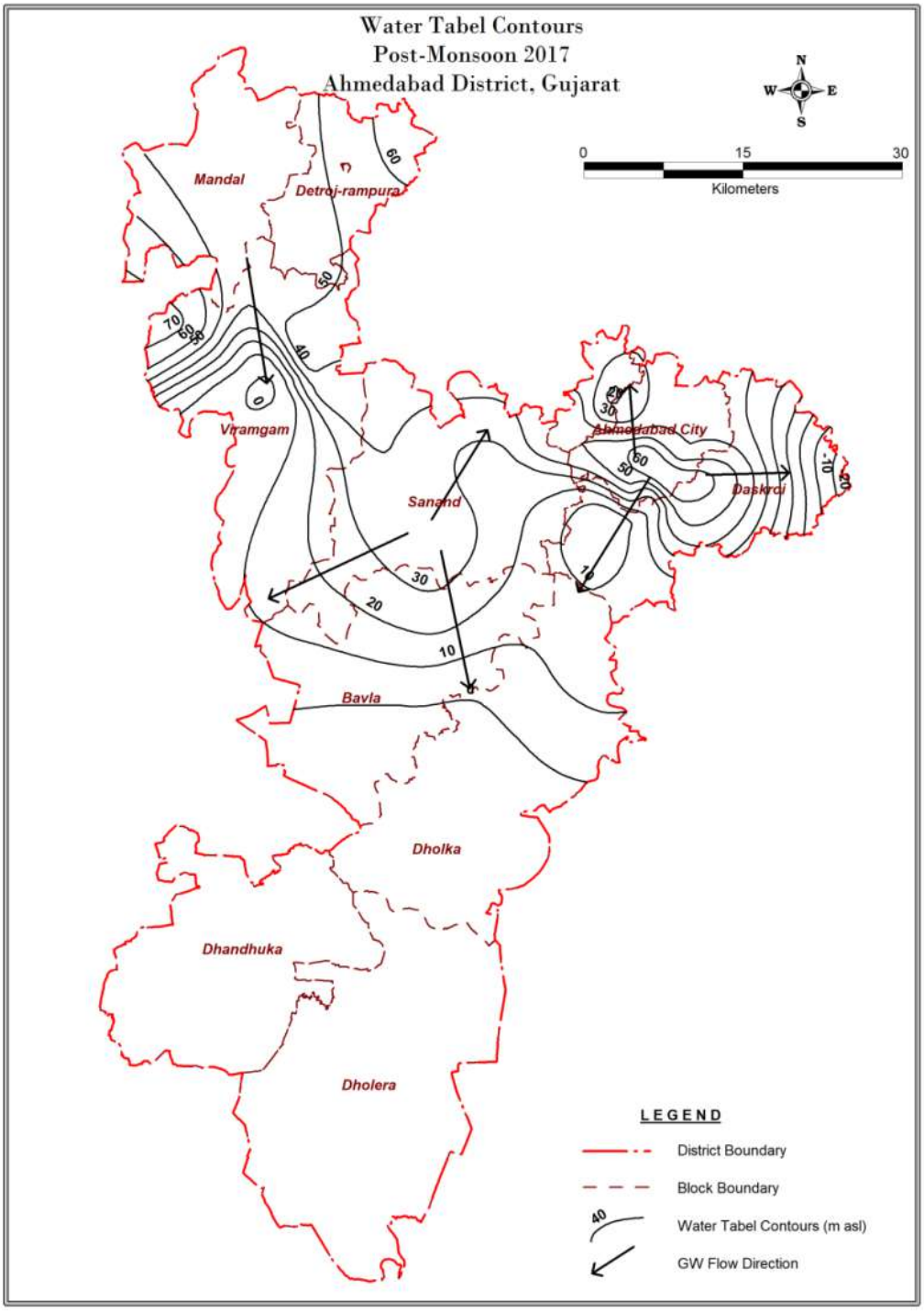


Fig 22: Post Monsoon elevation of Piezometric Surface, Ahmedabad District, Gujarat.

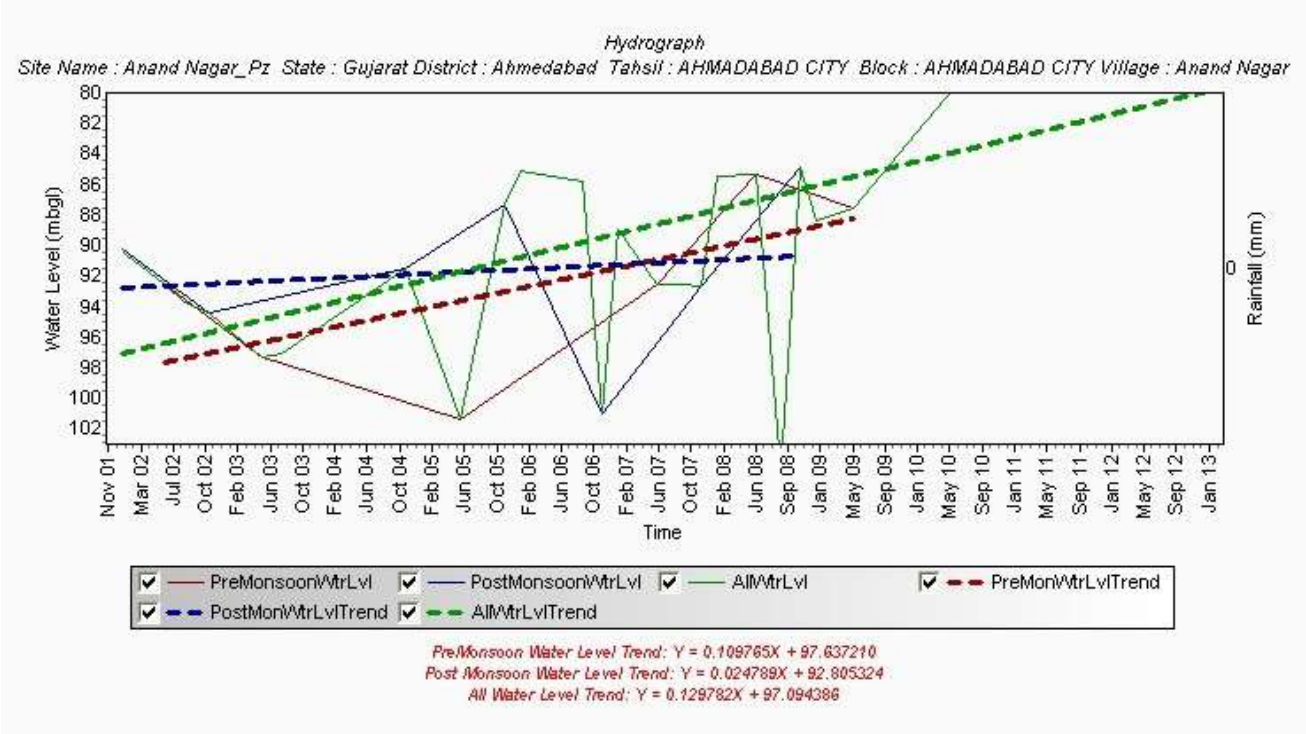
2.3.14 Long Term Water Level Trend – Confined aquifer

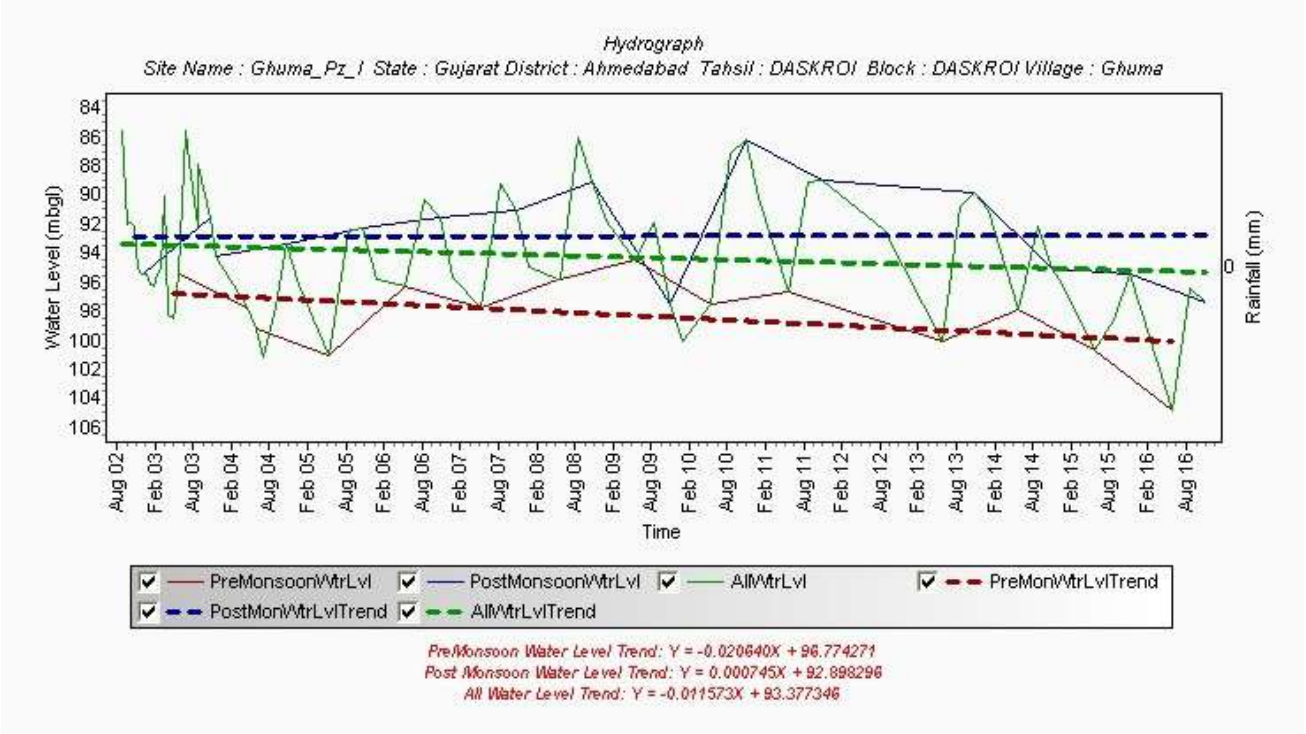
Long term trend water level is being deciphered from the hydrograph of the National Hydrograph Network Stations with depth to water level and seasonal trends plotted in a single figure for easy comprehensibility and it is observed that wells showing declining trend ranges from 0.108 to 1.72 m/year and wells showing rising trend ranges from 0.756 to 1.692 m/year. Selected hydrograph are being reproduced and represented in this report for a synopsis assessment (Table 13, Fig. 23).

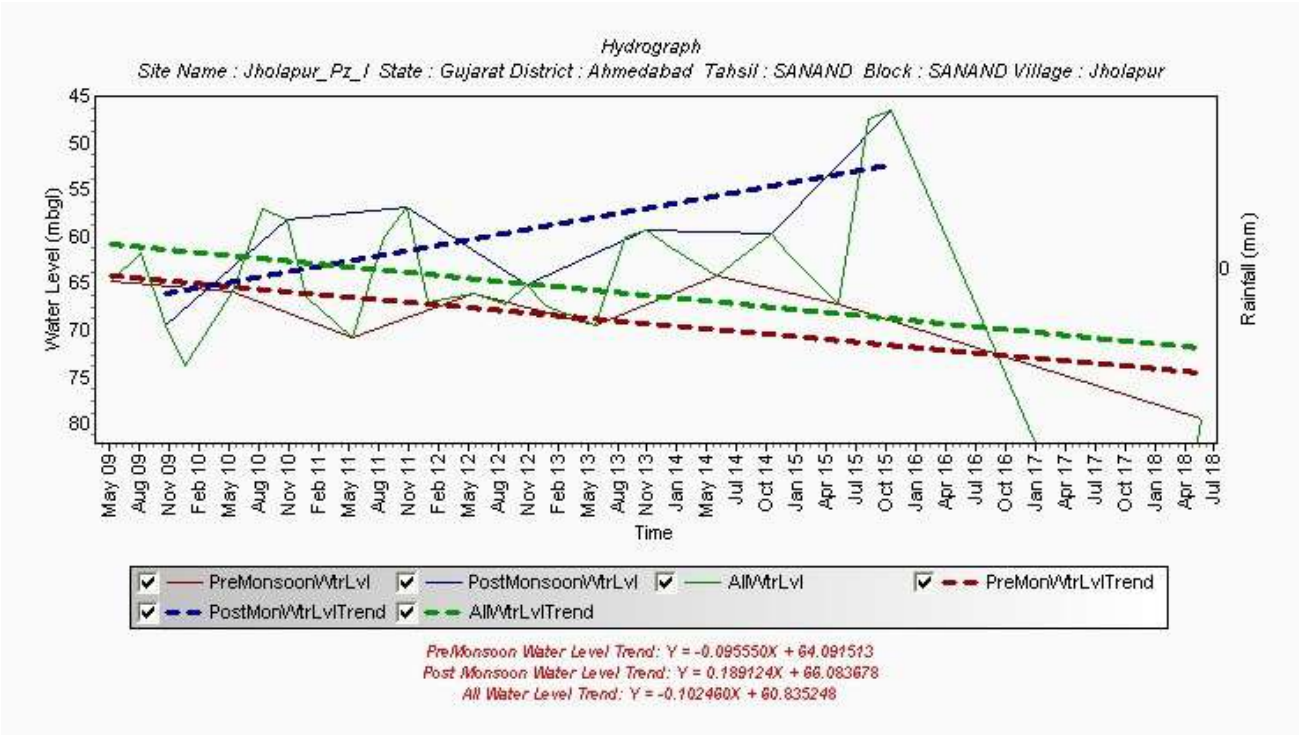
Table 13: Water level/ Piezometric head trend (Select CGWB Pz)

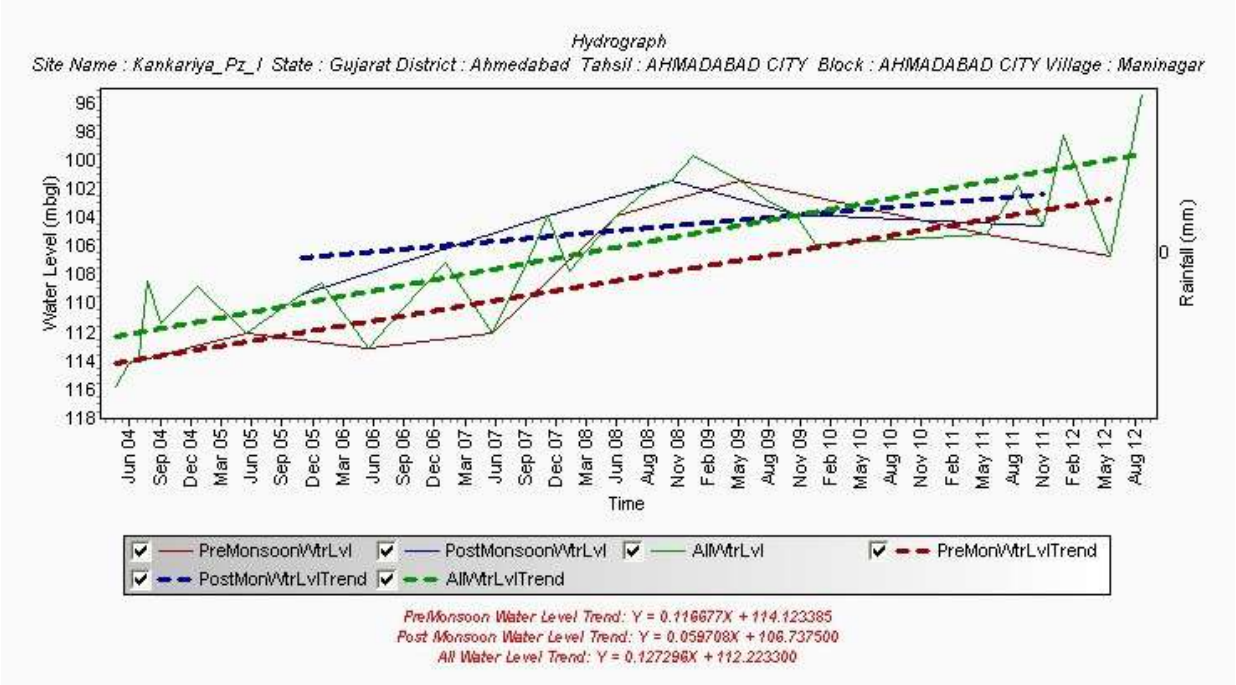
Location	Taluka	Data Period	Average trend m/year
Anand Nagar Pz	Ahmedabad City	2001-13	1.5564
Bagodara Pz I	Bavla	2010-18	-0.252
Ghuma Pz I	Daskroi	2002-16	-0.132
Jholapur Pz I	Sanand	2009-18	-0.144
Jholapur Pz II	Sanand	2009-15	1.236
Kankariya Pz I	Ahmedabad City	2004-12	1.524
Koth	Dholka	1996-2017	-0.216
Sanand I	Sanand	1996-17	-0.108
Vasai Pz I	Daskroi	2005-15	1.104
Vastrapur Lake Pz I	Ahmedabad City	2003-2018	0.552
Vatva Pz II	Ahmedabad City	2005-17	1.692
Visalpur Pz I	Ahmedabad City	2009-15	0.756

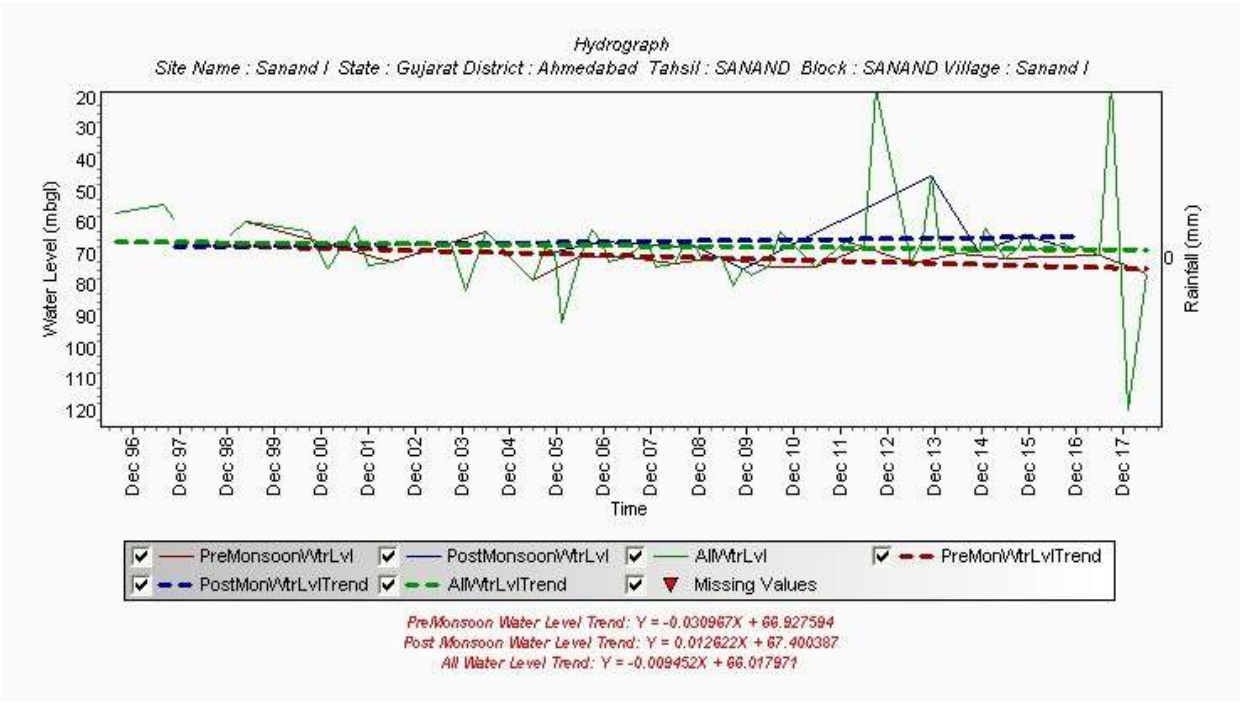
Fig 23 : Hydrograph (Confined Aquifer)

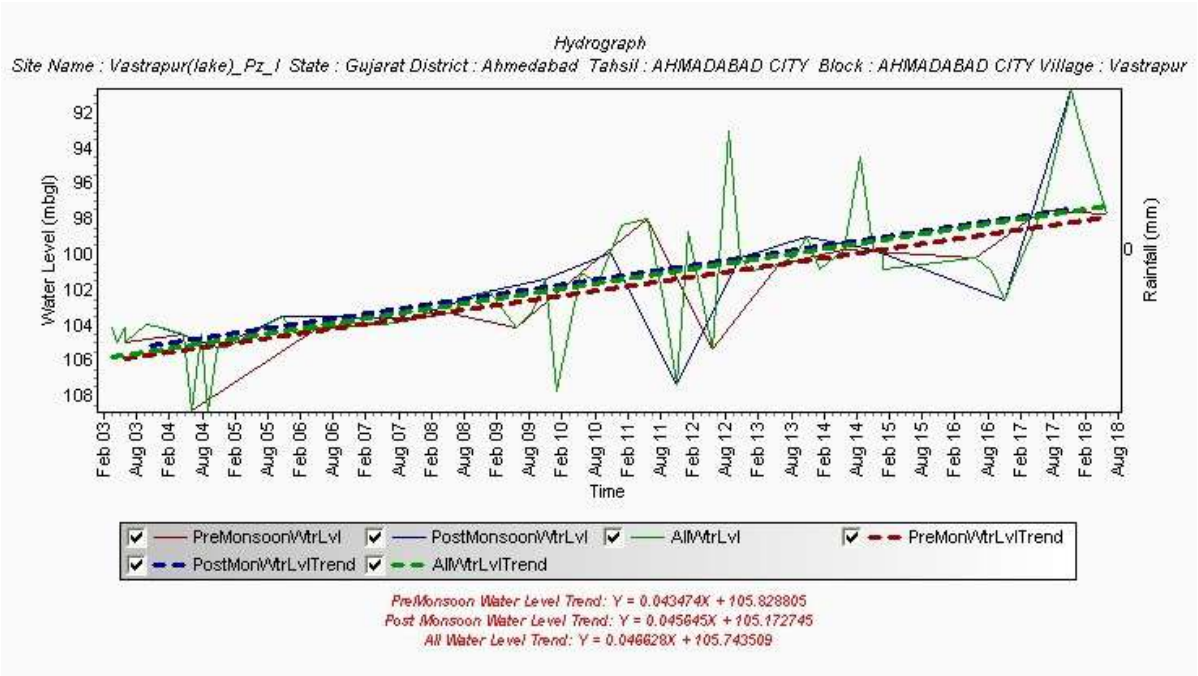


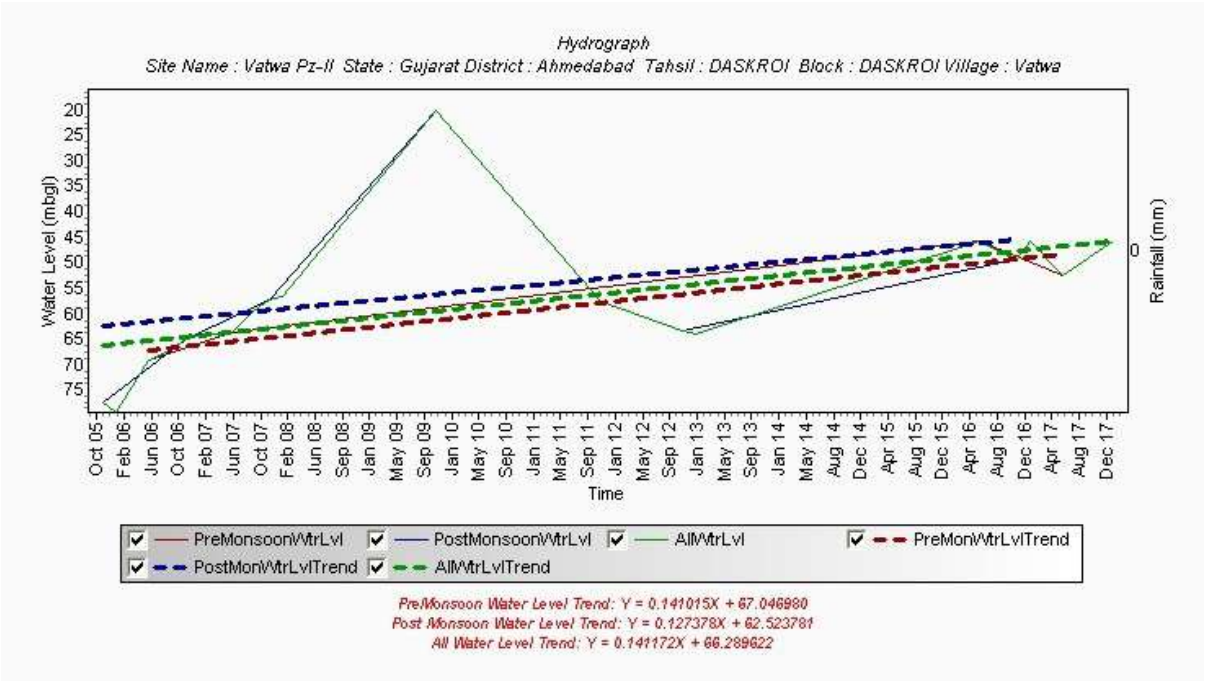



Hydrograph
Site Name : Jholapur_Pz_I State : Gujarat District : Ahmedabad Tahsil : SANAND Block : SANAND Village : Jholapur
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = -0.095550X + 64.091513
Post Monsoon Water Level Trend: Y = 0.189124X + 66.083678
All Water Level Trend: Y = -0.102460X + 60.835248


Hydrograph
Site Name : Kankariya_Pz_I State : Gujarat District : Ahmedabad Tahsil : AHMADABAD CITY Block : AHMADABAD CITY Village : Maninagar
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.116677X + 114.123385
Post Monsoon Water Level Trend: Y = 0.059708X + 106.737500
All Water Level Trend: Y = 0.127296X + 112.223300


Hydrograph
Site Name : Sanand I State : Gujarat District : Ahmedabad Tahsil : SANAND Block : SANAND Village : Sanand I
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
Missing Values
PreMonsoon Water Level Trend: Y = -0.030967X + 66.927594
Post Monsoon Water Level Trend: Y = 0.012622X + 67.400387
All Water Level Trend: Y = -0.009452X + 66.017971


Hydrograph
Site Name : Vastrapur(lake)_Pz_I State : Gujarat District : Ahmedabad Tahsil : AHMADABAD CITY Block : AHMADABAD CITY Village : Vastrapur
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.043474X + 105.828805
Post Monsoon Water Level Trend: Y = 0.045845X + 105.172745
All Water Level Trend: Y = 0.046628X + 105.743509


Hydrograph
Site Name : Vatwa Pz-II State : Gujarat District : Ahmedabad Tahsil : DASKROI Block : DASKROI Village : Vatwa
Water Level (mbgl)
Rainfall (mm)
Time
PreMonsoonWtrLvl
PostMonsoonWtrLvl
AllWtrLvl
PreMonWtrLvlTrend
PostMonWtrLvlTrend
AllWtrLvlTrend
PreMonsoon Water Level Trend: Y = 0.141015X + 67.046980
Post Monsoon Water Level Trend: Y = 0.127378X + 62.523781
All Water Level Trend: Y = 0.141172X + 66.289622

3. HYDROCHEMISTRY

The quality of ground water in the shallow aquifer has been studied based on the chemical analysis of water samples collected from NHS during May 2017. The statistical analysis of the chemical data is presented in Table 14.

Table 14: Statistical Analysis of Chemical Constituents (Shallow Aquifer), May 2017

Constituents	Minimum	Maximum
pH	2.10	9.40
TDS (mg/l)	360	43390
CO3 (mg/l)	12	36
HCO3 (mg/l)	37	1049
Cl (mg/l)	50	18400
NO3 (mg/l)	0.61	115
SO4 (mg/l)	2	5271
F (mg/l)	0.12	11.20
Alkalinity (mg/l)	77	2984
Ca (mg/l)	10	1000
Mg (mg/l)	3	1000
TH (mg/l)	88	7500
Na (mg/l)	49	9999
K (mg/l)	2.30	481.85
Fe (mg/l)	0.002	0.641

It is noticed that the ground water is relatively more saline in southern part comprising alluvium and soft rocks (fig 24). Occurrence of different chemical constituents in ground water is discussed below:

Total Dissolved Solid (TDS): Total Dissolved Solid is an overall parameter indicating salinity of ground water. The Total Dissolved Solid of ground water varies from 360 mg/l (Sarandi) to about 43390 mg/l (Otaria) (Fig. 24).

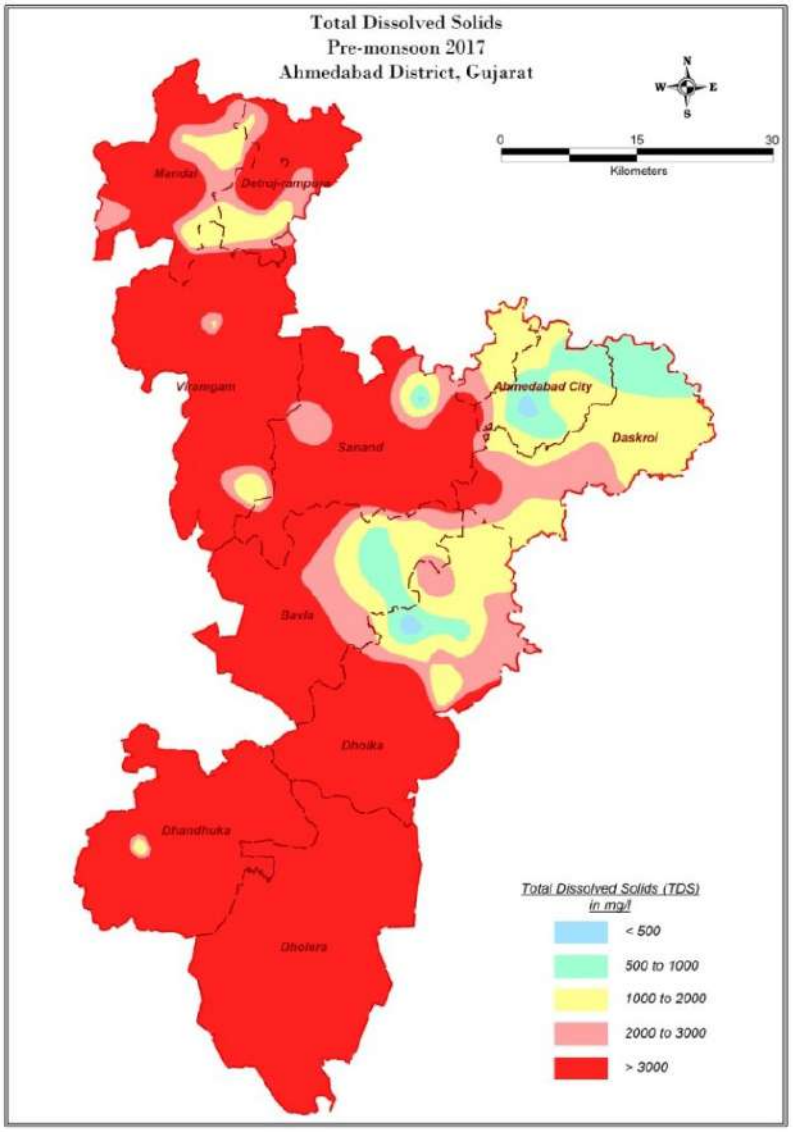


Fig 24 : Total Dissolved Map.

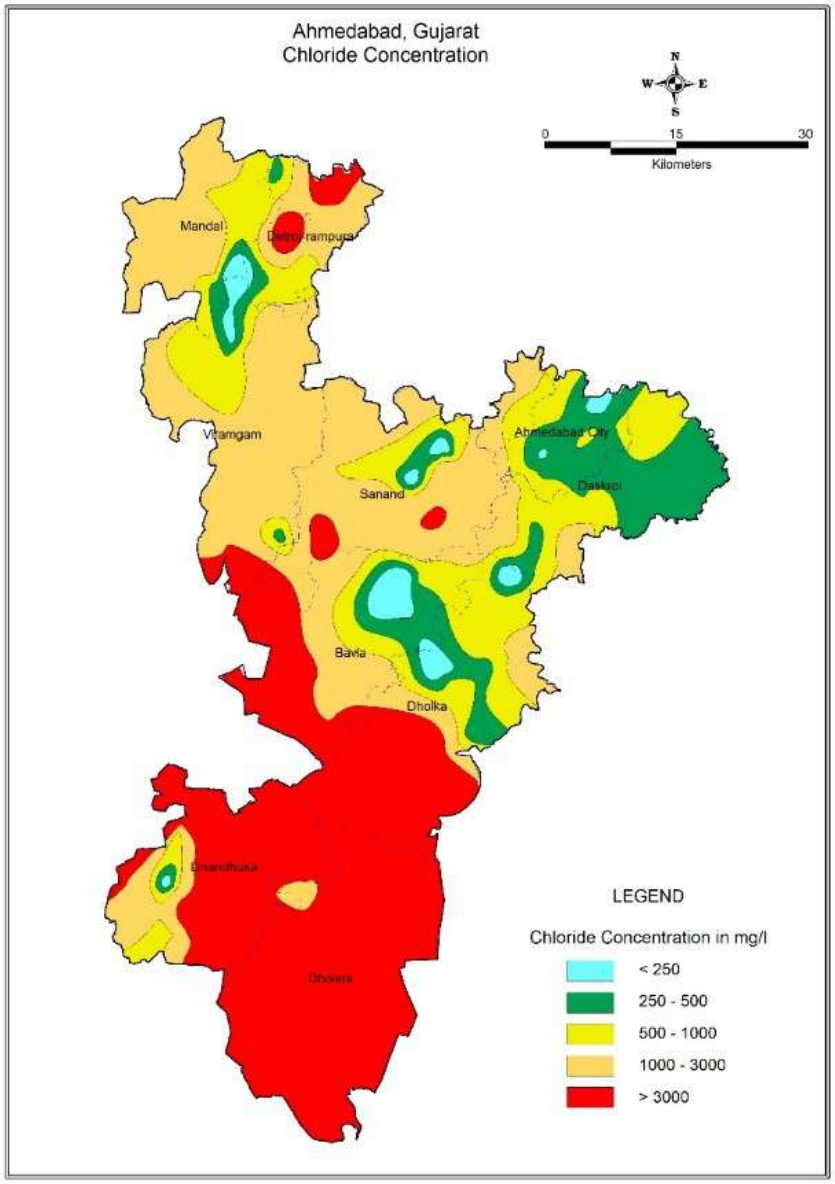
Hydrogen Ion Concentration (pH) : The pH is an indicator of acidity of the water. The shallow ground water in the district is generally alkaline with pH more than 7. The value of pH ranges between 2.10 & 9.40 in the district.

Carbonate (CO3) : The Carbonate concentration in large part of district varied between 12 mg/l to 36 mg/l.

Bicarbonate (HCO3) : The Bicarbonate concentration in district varied between 37 mg/l at Sitapur III to 1049 mg/l at Bagodara.

Chloride (Cl) : Chloride concentration in the shallow alluvial aquifer varies between 50 mg/l (Endla) and 18400 mg/l (Fedra). At 40 monitoring stations Chloride concentration was more

than 1000 mg/l which is beyond maximum desirable limit of 1000 mg/l as per BIS norms (Fig. 25).



.

Fig 25 : Chloride Contour Map.

Nitrate (NO3) *:* Nitrate concentration in the ground water in district varies between 0.61 mg/l (Sanand) and 115 mg/l (Tagadi). There are 3 stations (Fig. 26) where these values are more than the limits as per BIS drinking water standards (45 mg/l).

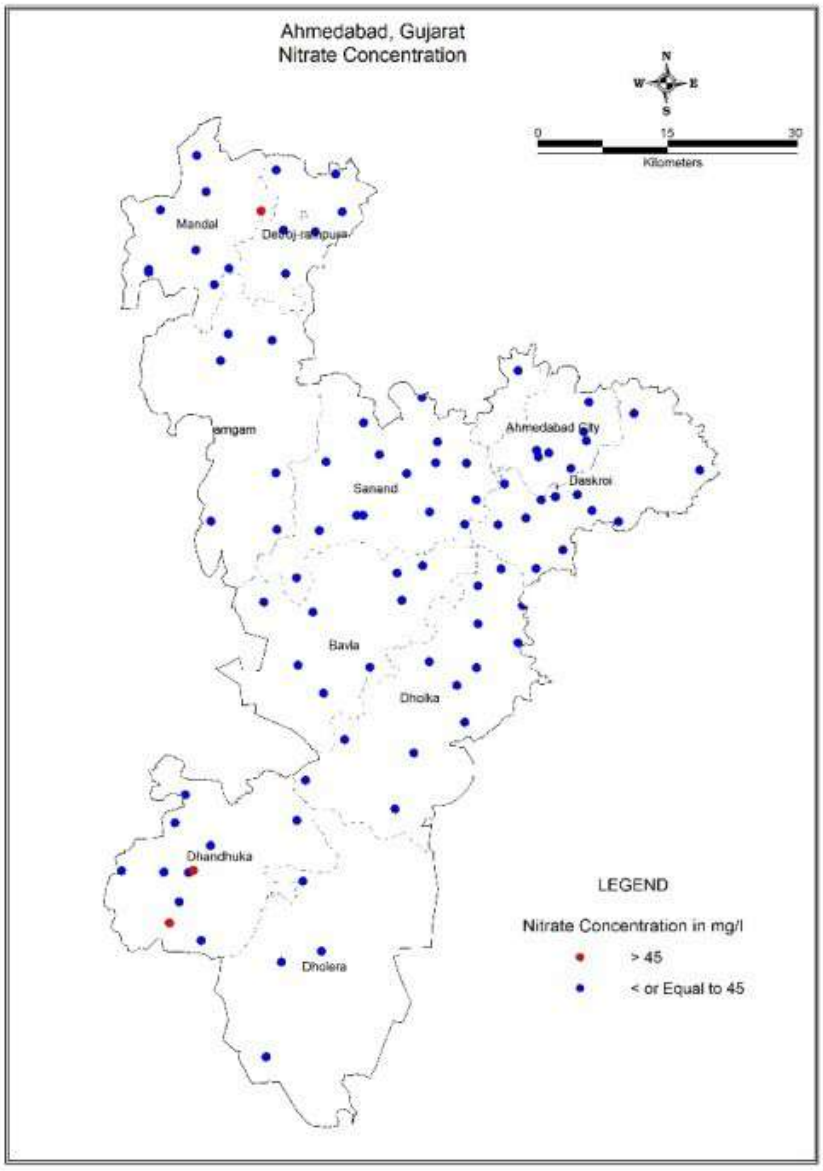


Fig 26 : Nitratre point location Map

Sulphate (SO4) *:* In the district area, the sulphate concentration varies from 2mg/l (Endla) to 5271 mg/l (Loliya).

Calcium (Ca) : Calcium concentration in district varies between 10mg/l (Gangad) and 1000 mg/l at Bhurakhi, Loliya, Nanibaru. The concentration of calcium is more than maximum permissible limits of 200 mg/l (as per BIS norms) at 13 sample location.

Fluoride (F) : Fluoride concentration in ground water varies between almost 0.12 at Raika and 11.20 mg/l at Kumarkhan (Fig. 27). High concentration of fluoride exceeding maximum desirable limit of 1(mg/l) is found at 14 sample point.

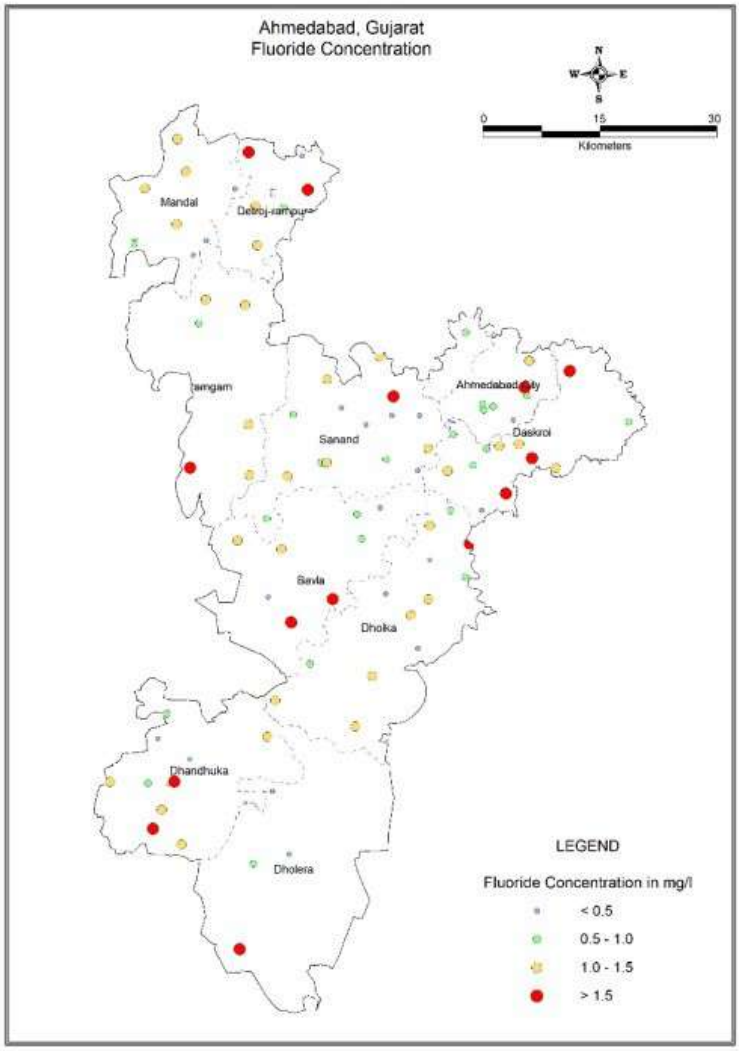


Fig 27 : Fluoride point location Map

Magnesium (Mg) : The Concentration of Magnesium in areas ranges from 3 mg/l (Sarandi) to 1000mg/l Otaria, Bhumali, Loliya.

Sodium (Na) : Sodium concentration in area varies between 49 mg/l (Viramgam) and 9999 mg/l at Frdra, Dholera, Otaria.

Potassium (K) : The concentration of Potassium in shallow ground water ranges from 2.30 mg/l (Lambha) to 481.85 mg/l (Fedra).

Iron (Fe) : The Iron concentration in the shallow ground water in the district is generally low, ranging between 0.002 (Viramgam) to about 0.641(Dhandhuka)mg/l which is within the permissible limit.

Total Hardness as CaCO3 (TH) : Total Hardness in ground water range between 88 mg/l (Gangad, Nidhrad & Lambha) and 7500 mg/l (Loliya & Nani Boru).

4. DATA INTERPRETATION, INTEGRATION and AQUIFER MAPPING

4.1 Data Collection and Generation

Central Ground Water Board and GWRDC are the only two agencies in the State that carry out Systematic hydrogeological and hydrochemical data generation and analysis. Data Collected and generated by CGWB and GWRDC are compiled for the following Item wise summary of the Hydrogeological, Hydrochemical, Geophysical, and Exploratory drilling data is given in the respective tables (Table 15) including data generated under NAQUIM

The historical data on ground water regime as well as ground water exploration carried out by CGWB and State government agencies is collected and compiled and used for initial analysis. Hydrogeological data of CGWB exploratory wells, CGWB/State govt. Piezometers, Production wells for water supply and Irrigation tubewells have been compiled and analysed. These data contain partial information on lithology, Depth, Zones tapped, Inferred zones from E-logs, Water level, discharge, chemical quality etc.

Table 15: Data Collection and generation for preparation of Aquifer map and management Plan

Sr. No	Item	Sub Item	Source wise data collected and compiled		
			CGWB	GWRDC	Total
1	Ground water Level data	NHS Phreatic	20	81	100
2		NHS Piezo metric	15	17	32
3	Ground Water Quality Data	DW/EW	10	95	105
5	Exploratory Well Data		20	-	20

During the course of National Aquifer Mapping and management plan all the historical data available with the Central Ground Water Board in terms of Ground Water Regiem Monitoring, Ground water Exploration etc compiled and collated.

Though a number of well have been constructed in all the formation and aquifers of Ahmedabad district, a total of validated 20 lithologs of exploratory wells and piezometers constructed by CGWB and GWRDC, State Gujarat falling in Ahmedabad district and adjoining area were utilised to decipher the subsurface geometry of the aquifer and generated 6 no. of cross sections, Fence daigram and 3-D map. The rest of the wells of CGWB as well as that from the other agencies were utilized for validating this Map.

4.2 Aquifer Demarcation : The existing data of lithological logs of Exploratory wells and VES interpretations through geophysical studies carried out by CGWB and State Ground Water Departments (GWRDC), the following three type of Aquifers can be demarcated and the details are given below.

Aquifer - I : These are the unconfined aquifer, occurring up to the depth from 0 to 78 meters below ground level.

Aquifer -II : These are confined aquifers occur between the depth range of 43 to 136 meters below ground level.

Aquifer Group - III (Confined III & Confined IV) : These are confined aquifers occurring in the depth range of 78 to 350 meters below ground level.

The Daccan trap basement is encountered at the boreholes drilled in the southern part of the district in the Dhandhuka taluka and at the western margin of Dholka taluka. It encountered in the boreholes of at Dhandhuka, Dholera and at Haebatpur at 79, 347.5 and 198 mbgl respectively.

The oldest sedimentary formations encountered in the boreholes drilled for Ground water exploration and development are the Miocene formations of Tertiarty age. It consists of medium grained sand, sandstone and siltstone inter bedded with bluish grey or grey clay deposited in a shallow marine and brackish environment. The bluish grey or grey coloured clay is considered as the marker bed for the Miocene formations. However these Miocene sediments grade upward into post Miocene and quaternary deposits with out distinct lithological break. The Miocene sediments are encountered at depths ranging between 193 and 251 m.bgl in Dholera taluka in the south, at 248 m.bgl at Shiyal in Dholka taluka and around 390 m.bgl at Odki and at Virochannagar of Viramgam and Sanand taluka respectively.

The post Miocene sediments of the districts consist mainly of sands, gravel intercalated with silt, clay and kankar. Sands are fine to coarse grained with occasional gravel. It thickness ranges between 65 to more than 251 m in Dhdhuka taluka in south and around 248 m in the western Dholka and around 390 m at Viramgam taluka in the North west. The thickness of the post Miocene alluvial formations increases at the central part of the district around

Bavla & Dholka of Dholka taluka. The thickness of clay bed increases bekow 150 mbgl towards south west in the Bhal area as indicated by bore holes at Bagodara and Kalyangarh.

Table 16 : Aquifer wise Hydrogeological Properties

Aquifer Group	Depth of occurrence of top of Aquifer	Generalized Thickness	Yield (lpm)	Quality/TDS (ppm)	Transimissivity (m2/day)	Water Level/ Piezometric head (mbgl)	Aquifer Type
Unconfined Aquifer	0 to 78	24 to 78	0.4 -780	560 to 63999	1.78- 687	0. to 42.22	Phreatic
Confined Aquifer I	43 to 136	18-72	0.80-900	783-4400	56.87-861	12.72-100.85	Confined
Aquifer Group II (Confined III & IV)	78 to 350	15-101	1.32-696	780-39200	11 to 86	8.3-125.1	Confined

4.3 Aquifer Disposition : Six hydrogeological cross sections are drawn from North- East & North- West to South- West & North- West and North-West to South- East directions across the area are shown in **Fig.** 28. Sub surface hydrogeological cross sections depicting the sub surface geology and aquifer systems are presented in **Fig. 29 to Fig. 38.**

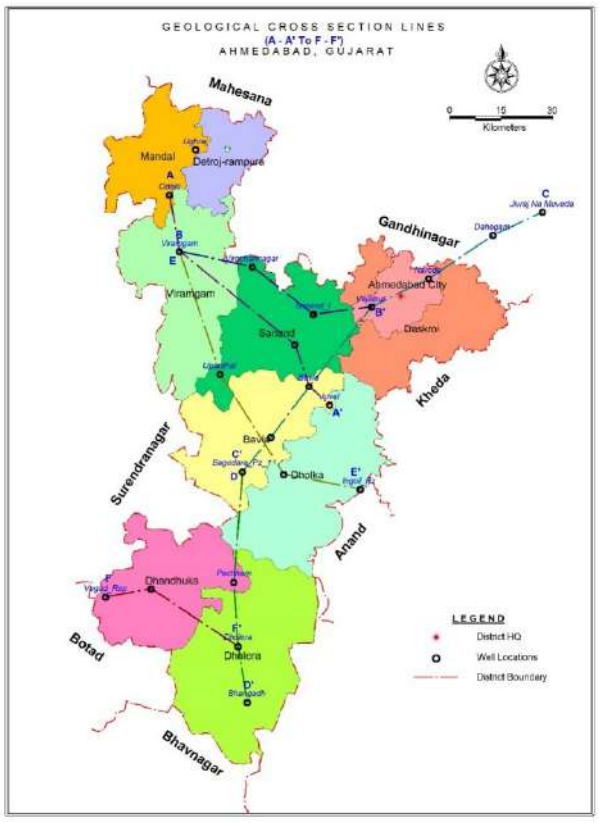


Fig 28 : Hydrogeological Cross Section Lines.

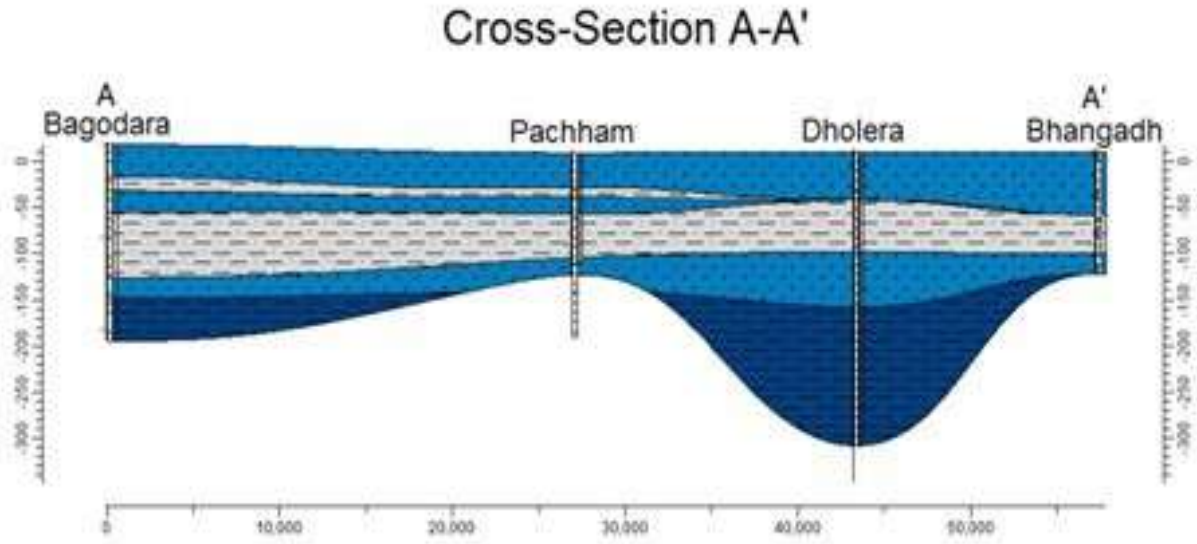


Fig 29 : Hydrogeological cross section along Bagodara- Bhangadh (A-A'), Ahmedabad district.

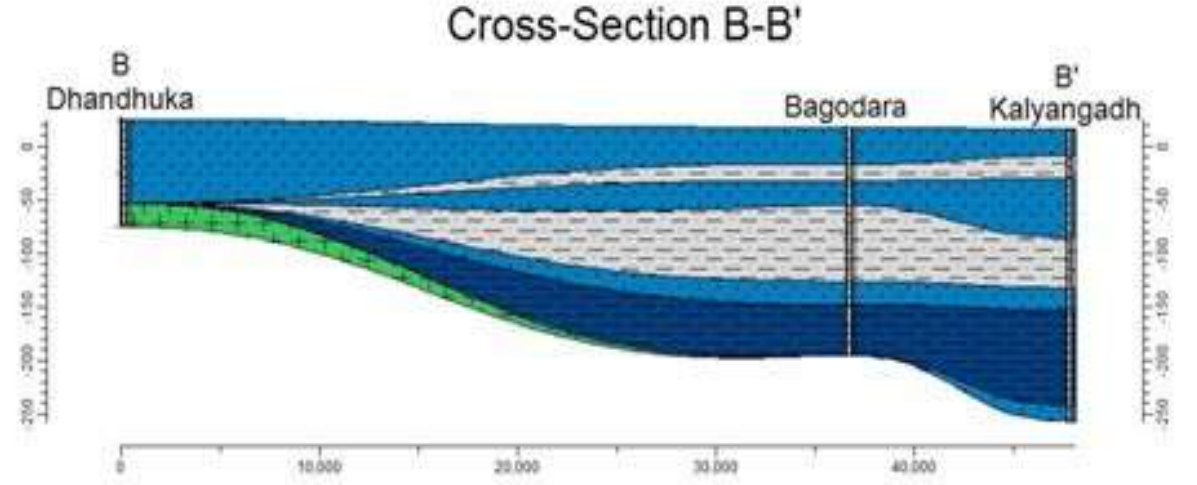


Fig 30 : Hydrogeological Cross Section along Dhandhuka-Kalyangadh (B-B'), Ahmedabad district.

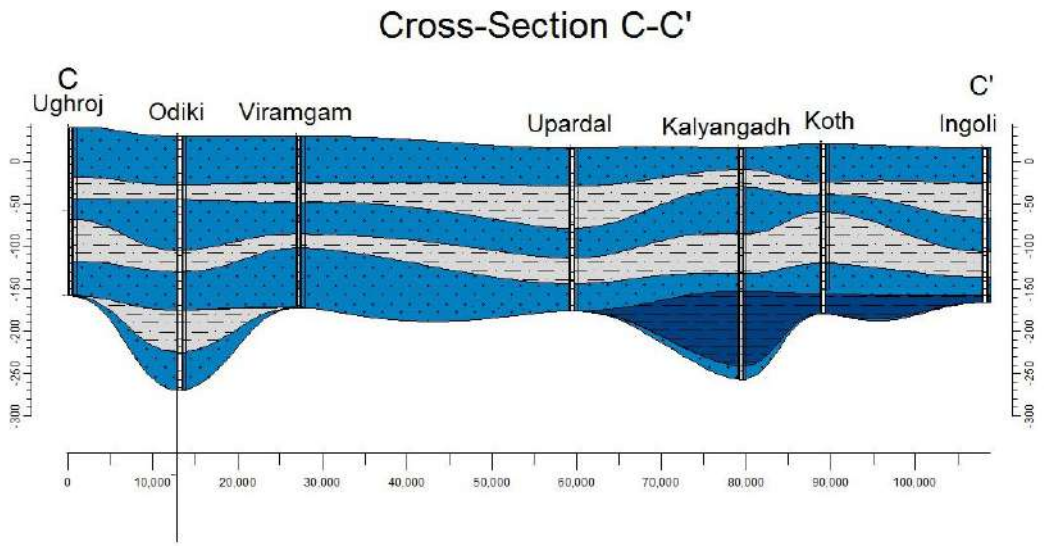


Fig 31 : Hydrogeological Cross Section along Ughroj- Ingoli (C-C'), Ahmedabad district.

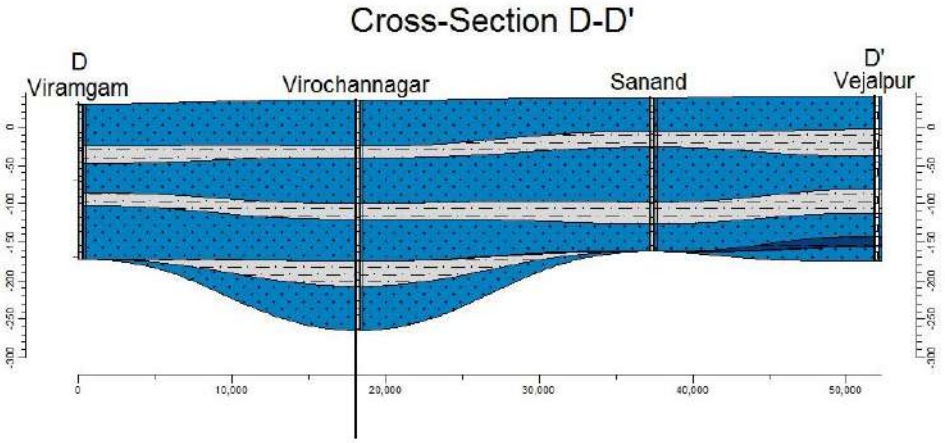


Fig 32 : Hydrogeological Cross Section along Viramgam- Vejalpur (D-D'), Ahmedabad district.

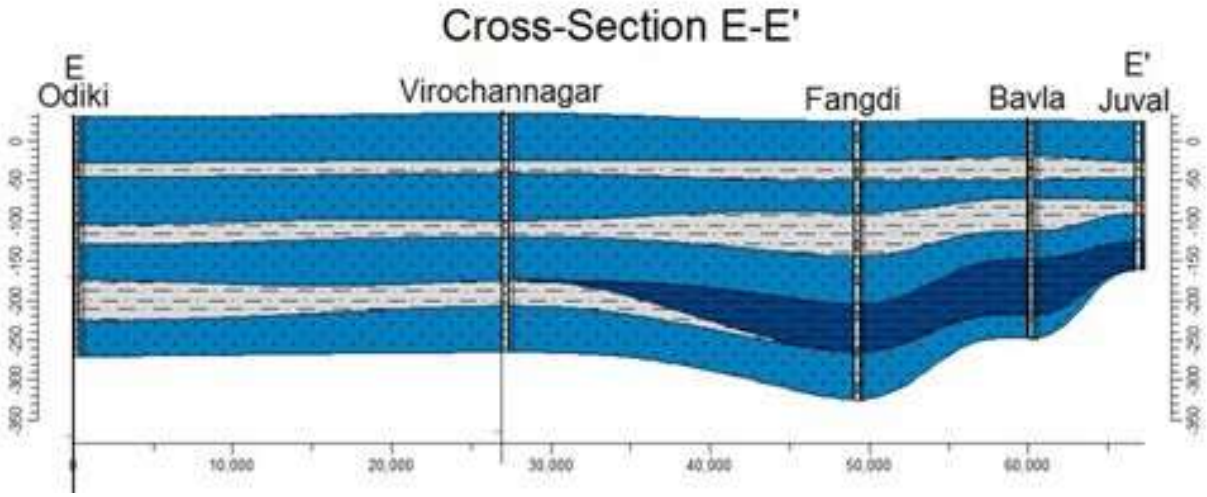


Fig 33 : Hydrogeological Cross Section along Odiki-Juval(E-E'), Ahmedabad district.

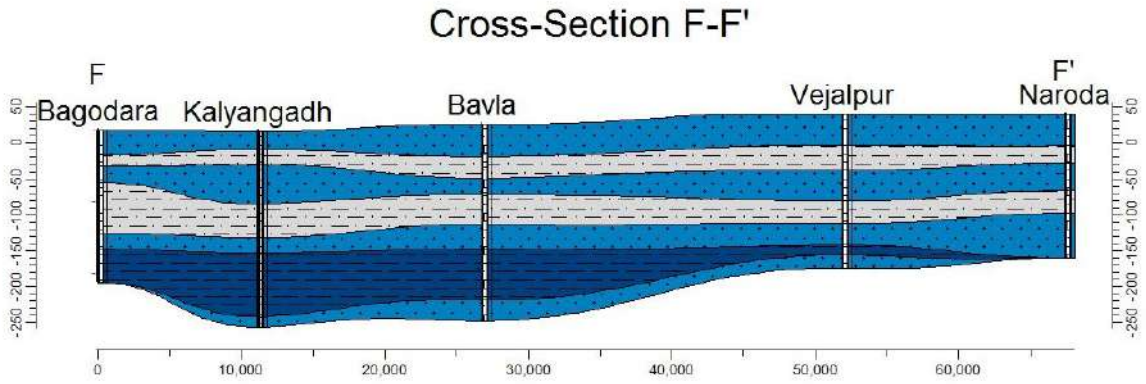


Fig 34 : Hydrogeological Cross Section along Bagodara-Naroda(F-F'), Ahmedabad district.

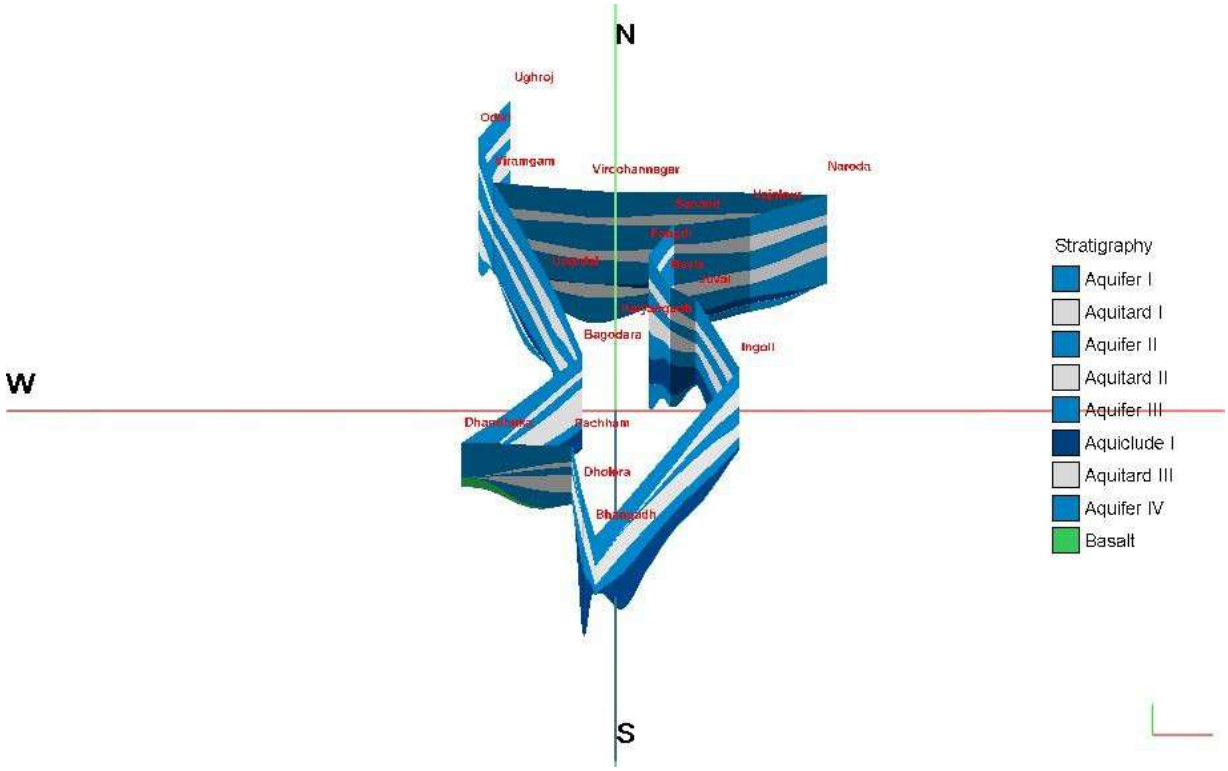


Fig 35 : Hydrogeological Panel Diagram of alluvium and Hard rock Aquifer system of Ahmedabad district.

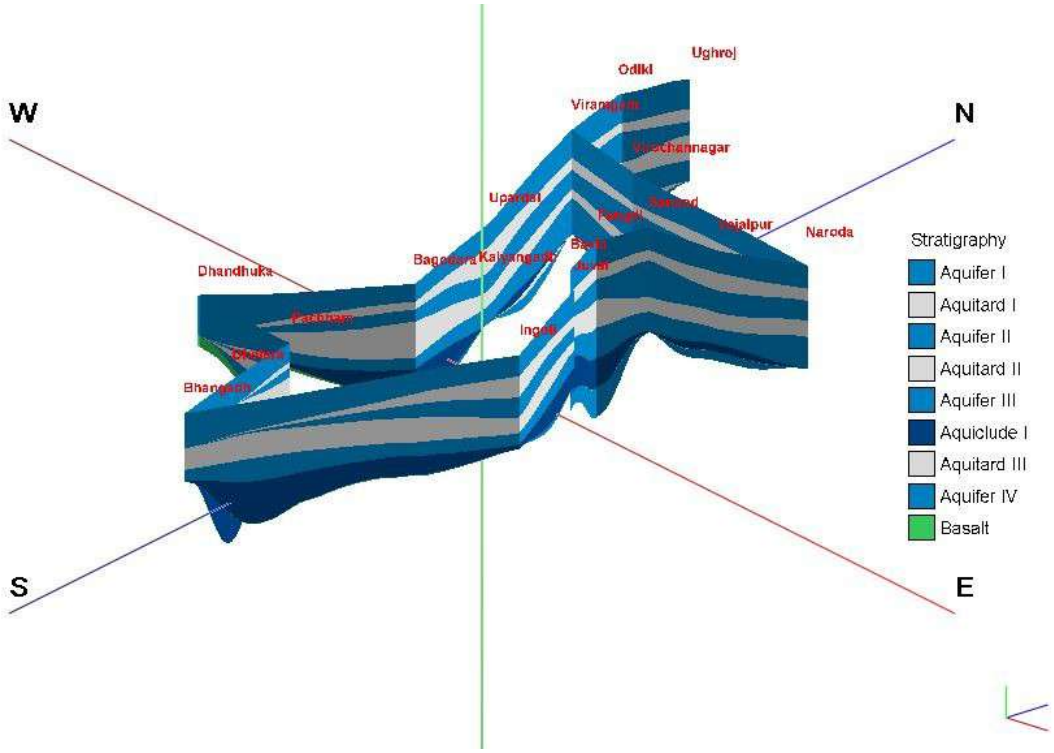


Fig.36 : Hydrogeological Panel Diagram of Alluvium and Hard rock Aquifer system of Ahmedabad district.

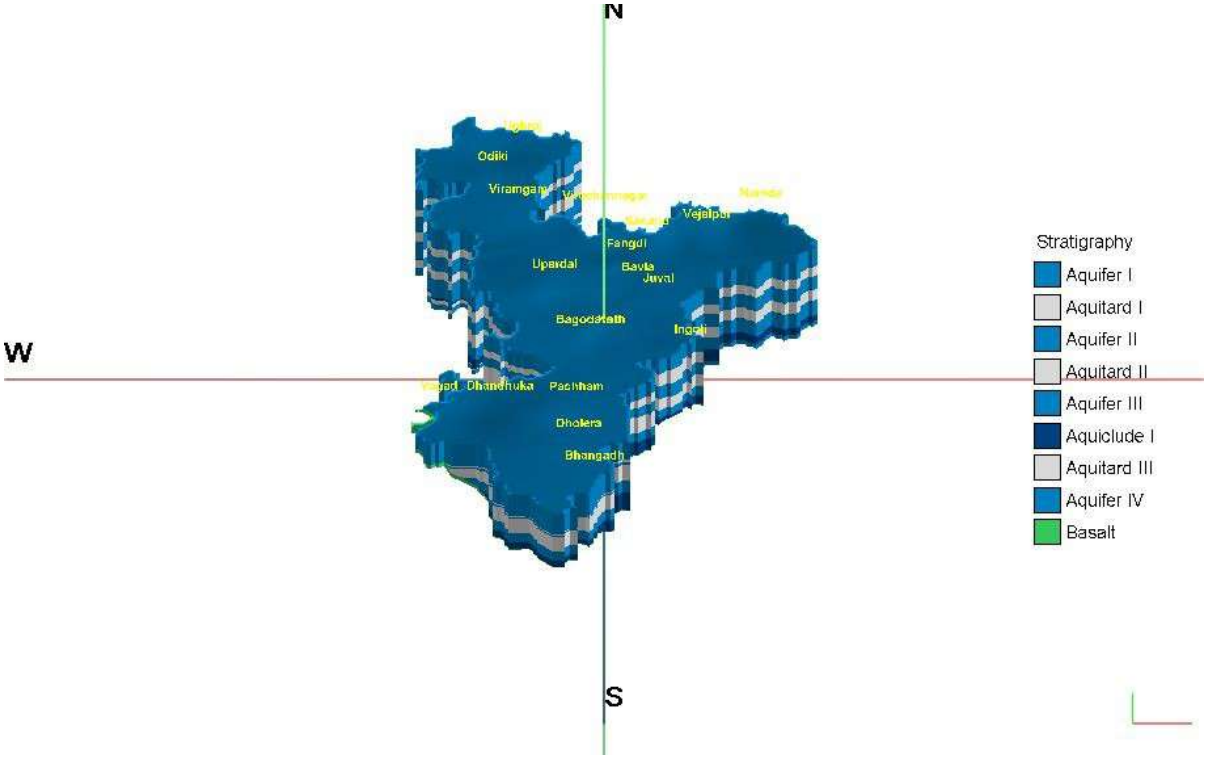


Fig. 37 : Hydrogeological 3D model of Alluvium and Hard rock Aquifer system of Ahmedabad district.

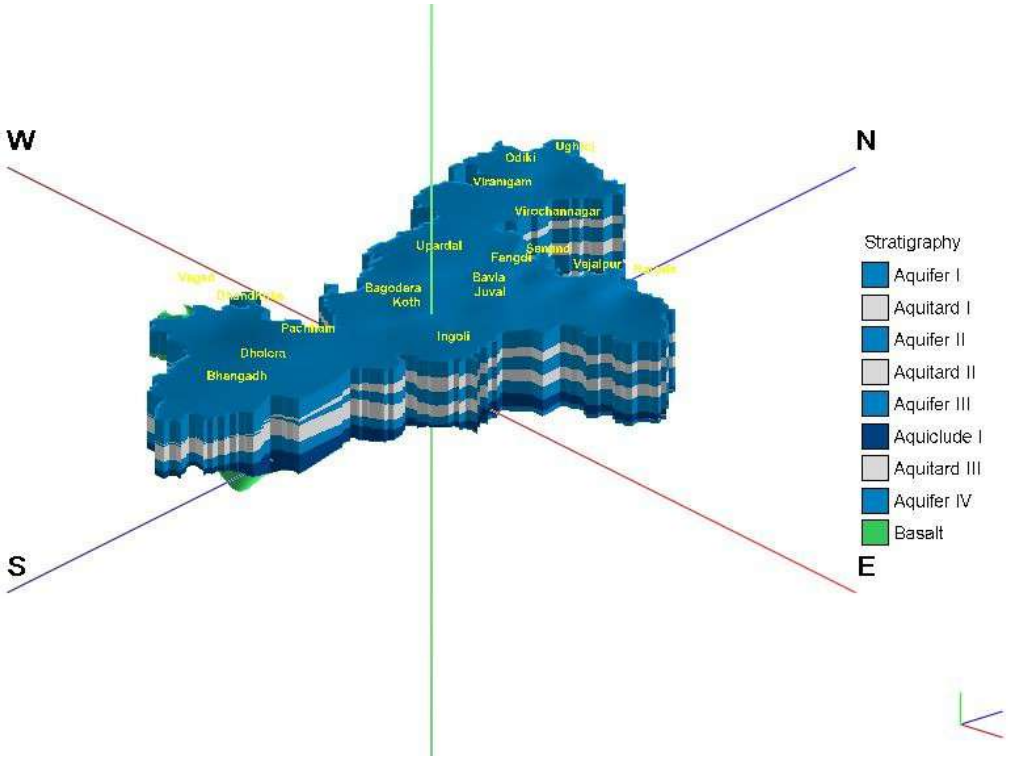


Fig.38 : Hydrogeological 3D model of Alluvium and Hard rock Aquifer system of Ahmedabad district.

5 GROUND WATER RESOURCES

The water resources of a district are an essential factor for its development. Ground water is becoming an important component of the water resources over surface water due to its some inherent advantage. Realistic estimation of groundwater resource forms the fundamental basis for its sustainable management and lays the basic foundation for future developmental planning. Therefore a proper assessment of the groundwater resources of the district is essential for its development.

Groundwater recharge to shallow aquifer in the district is mainly through infiltration from rainfall, return flow from applied irrigation, seepage through canal ,tank, river/stream beds. The confined aquifer gets major part of recharge from the recharge area occurring outside the district. Recharge to confined aquifer also occurs due to difference in head existing between the aquifers, the aquifers with lower head gets recharge from aquifer having higher head.

The assessment of ground water resources involves a relatively complex process of computation after duly considering the various factor related to inflow and outflow of this natural resources Earlier the ground water resources for the state was estimated based on GEC-1984 norms and guidelines.Subsequently a committee was formed in 1997 to update ground water resources based on revised Methodology (Ground Water Resources Estimation Committee, 1997 – GEC – 1997).Based on the GEC-1997 norms. Wherein it was envisaged that the Ground water through rainfall recharge during monsoon to be computed considering the following; Rainfall infiltration factor method & Water level fluctuation method.GEC-1997 has recommended to categorize the assessment sub unit based on the stage of ground water development and the long term ground water level trend.

5.1 Methodology : Estimation of Ground Water Resources for Gujarat has been carried out as per the methodology recommended by the Ground Water Resources Estimation Committee (GEC- 97 and 2004) set up by Ministry of Water Resources, Govt. of India. The methodology and norms adopted for evaluating ground water Resources are given below. Gujarat state has large area underlain by brackish to saline quality ground water and therefore, as per the suggestion of State Level Committee, groundwater resources estimation is carried out for both fresh groundwater area and saline groundwater areas of the State and presented in this report as Part I & Part II respectively.

5.2 Assessment Year : Gujarat experiences rainfall mainly due to southwest Monsoon. It generally commences by second week of June and lasts till mid-September. The four months period i.e. between June and September is considered for computation of monsoon recharge and from October to May (eight months) is considered as the non-monsoon period. Ground Water Resources assessment has been carried out season wise. Recharge from rainfall and other sources during monsoon season and non-monsoon season were computed separately as per GEC-97. The Ground Water Resources presented in this report is made on average of 10 years data i.e. for the period from 2007 to 2016 (Table 16).

5.3 Unit Area for Ground Water Recharge Assessment: Taluka/block is considered as a Unit area for ground water recharge assessment as per the previous estimation report of 2009. As per new census, the tehsil or taluka as the smallest administrative unit is taken as the basic unit for Ground Water Recharge Assessment.

5.4 Delineation of Sub-Area in the Unit: For the purpose of classification of the unit area into alluvial or hard rock areas, dominant hydrogeology of the unit was considered and demarcated on maps and areas were calculated. The areas falling in major and medium surface water irrigation schemes were demarcated and unit wise areas calculated. In Gujarat State major part particularly North Gujarat, Saurashtra and Kachchh regions have arid to semi-arid climate with very high drought frequency, water in most of the irrigation schemes/dams is reserved and caters to water supply needs. Thus ground water resources in command and non-command areas are worked out separately in proportion to available data.

5.5 Suitable Area

For determining the suitable area for ground water recharge, predominant hilly areas (slope more than 20%) & saline areas having TDS content in ground water more than 2500 ppm were delineated from the total geographical area of the unit.

As recommended in GEC-97, the net annual ground water availability and stage of ground water development was compared with the time series data or long term hydrograph(s) (data for last 5 years 2003-2007), which are the indicators of ground water regime, showing pre & post-monsoon water level trends in order to categorize the area.

Table 17: Ground Water Resources 2017

Taluka Wise Ground Water Resources, Availability, Utilization and Stage of Ground Water Development (2017)															
District : Ahmedabad															
Sr. No.	Taluka	ANNUAL REPLENISHABLE GROUND WATER RESOURCE (mcm)					Natural Discharge during non-monsoon season (mcm) (5 % of 7 WTF & 10 % RIF)	Net Annual Ground Water Availability (mcm) (7- 8)	ANNUAL GROUND WATER DRAFT (mcm)			Projected Demand for Domestic and Industrial uses upto 2025 (mcm)	Ground Water Availability for future irrigation (mcm) {(9)-(10+13)}	Stage of Ground Water Development (%) (12/9) * 100	Category
		Monsoon		Non Monsoon		Total Annual Ground Water Recharge (3+4+5+6)			Irrigation	Domestic And Industrial uses	Total (10 + 11)				
		Recharge from rainfall	Recharge from other sources	Recharge from rainfall	Recharge from other sources										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Bavla	30.51	14.81	0.00	14.61	59.93	3.00	56.93	27.29	0.54	27.83	3.18	26.46	48.88	Safe
2	City-Daskroi	187.16	29.98	0.00	36.52	253.67	12.68	240.99	181.00	24.10	205.10	5.55	54.44	85.11	Semi critical
3	Detroj-Rampura	28.10	2.94	0.00	3.53	34.57	1.73	32.84	24.24	1.42	25.66	1.67	6.93	78.13	Semi critical
4	Dhandhuka	Saline													
5	Dholera	Saline													
6	Dholka	62.41	10.15	0.00	9.01	81.57	4.08	77.49	57.12	4.26	61.37	4.31	16.07	79.20	Semi critical
7	Mandal	16.38	5.15	0.00	8.31	29.84	1.49	28.35	8.64	0.22	8.86	1.42	18.29	31.24	Safe
8	Sanand	55.38	23.06	0.00	25.82	104.25	5.21	99.04	52.70	2.88	55.58	4.78	41.56	56.12	Safe
9	Viramgam	12.44	1.54	0.00	0.66	14.63	0.73	13.90	8.04	3.29	11.33	3.89	1.97	81.53	Semi critical
Total		**392.37**	**87.64**	**0.00**	**98.45**	**578.46**	**28.92**	**549.54**	**359.02**	**36.70**	**395.72**	**24.80**	**165.72**	**72.01**	**Semi critical**

Source: Report on Dynamic Ground water Resources of Gujarat State.

6. Ground Water Related Issues

In phreatic aquifer

6.1 Salinity: Major part of Phreatic aquifer in Ahmedabad district are saline in nature having TDS ranges from 360 to 43390 ppm. Phreatic Aquifer (Aquifer I); Shows considerable variation from Highly saline to Fresh. Fluoride above BIS standard in presence in isolated patches. Dhandhuka and Dholera taluka are saline block (GWRE 2017).

6.2 Decline of Ground Water : In Decadal Groundwater trends Pre monsoon (2008-17) map observed that central and southern part of district comprising Dholera, part of Viramgam, Dholka, Bavla, Sanand, Daskroi, Ahmedbada city and Dhandhuka taluka declined >10 Cm/year (Fig. 39). In northern and north eastern part of district comprising Detroj Rampura, Mandal and part of City-Daskroi, Viramgam, part of Sanand, Bavla, Dholka and Dhadhuka taluka observed ground ground water trend rise >10 Cm/year.

In phreatic aquifer, it is observed at Jholapur Pz III of Sanand taluka, water level was 19.65m bgl in 2009 and it decline to 38.1 in 2018. Post-Monsoon depth to water level (Phreatic), Ahmedabad district, Gujarat it is observed that depth to water level more than 40 m bgl in eastern part of Ahmedabad city, Daskroi and Detroj Rampura taluka.

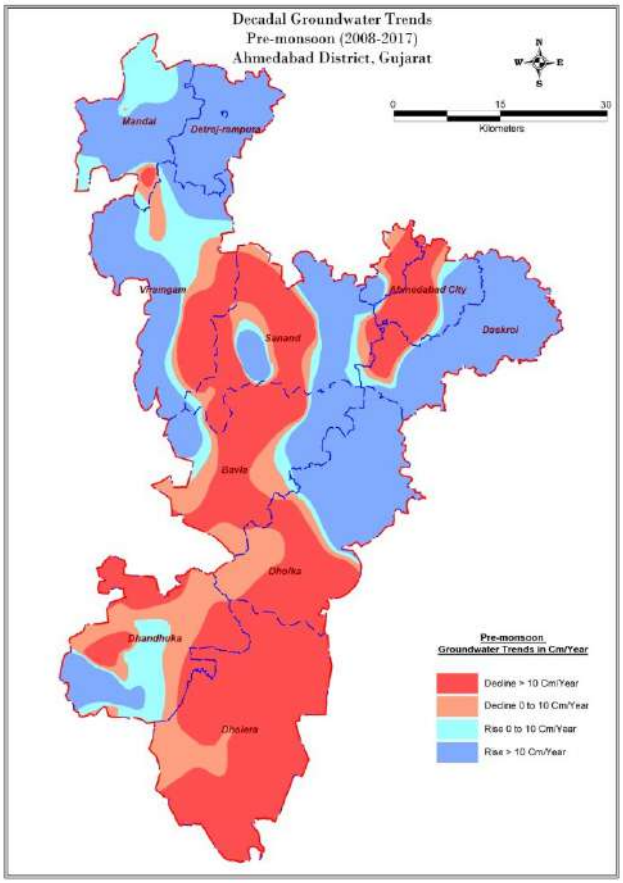


Fig. 39: Decadal Groundwater Trends Pre- monsoon (2008-2017)

In Decadal Groundwater trends in Post monsoon (2008-17) is observed (Fig. 40) that central and southern part of district comprising Dholera, part of Sanand, Dholka, Bavla, Mandal and City Daskroi taluka declined >10 Cm/year. In north eastern, central, northern and south western part of district observed ground ground water trend rise >10 Cm/year.

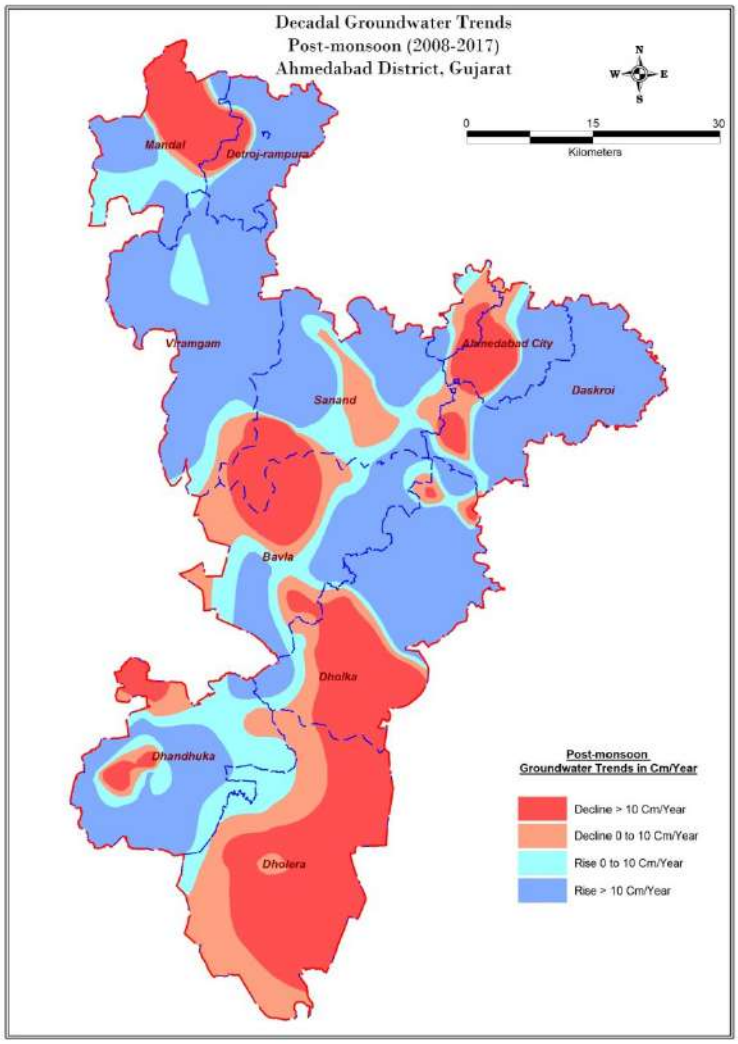
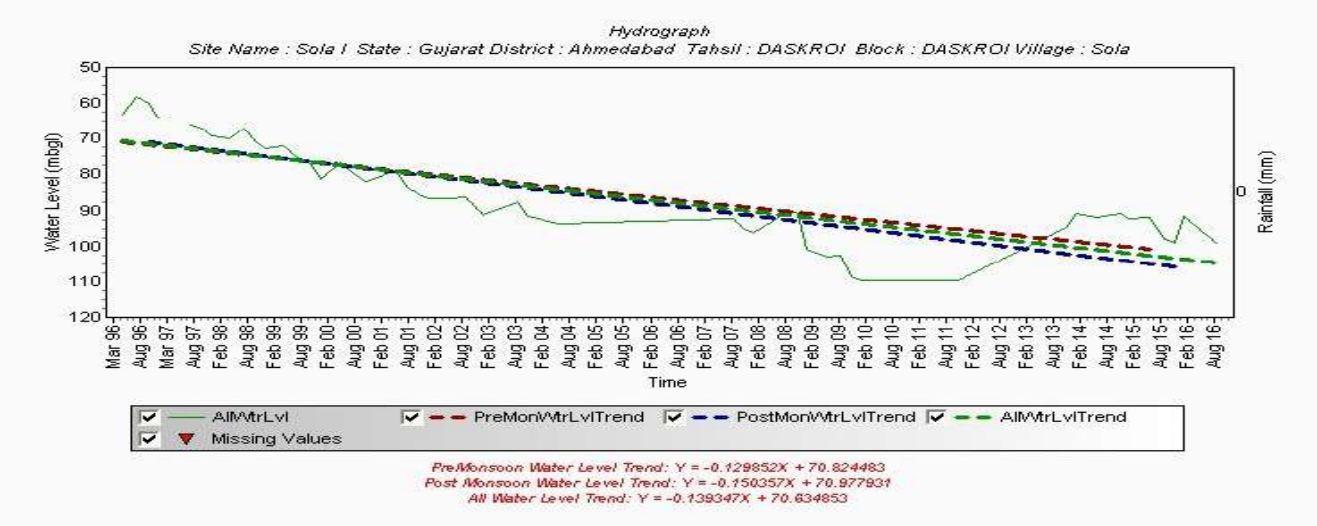


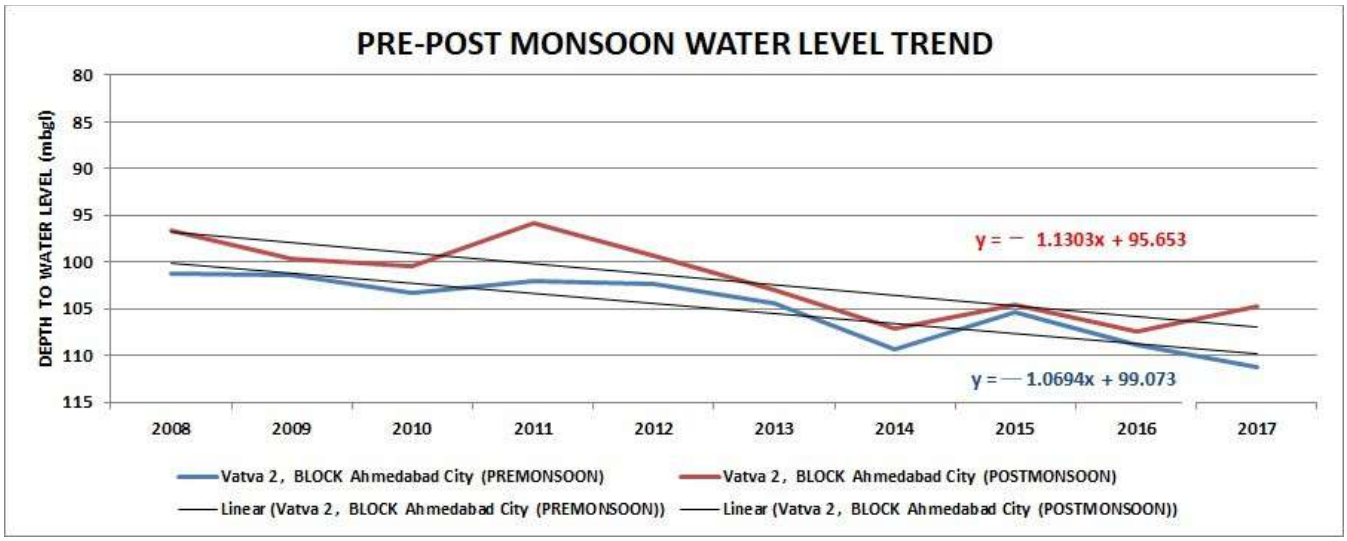
Fig. 40: Decadal Groundwater Trends Post- monsoon (2008-2017)

In confined aquifer

6.3 Salinity: Deeper Aquifer (Both Aquifer II & III); Generally fresh (TDS<2000 ppm) in the north eastern and central parts and gradual increase in salinity toward Bhal area in south and south western direction and towards northern half of Viramgam Taluka.

6.4 Decline of Piezometric Head : In Deep confined aquifer III piezometric head are decline from 0.13 to 1.72 m/yr in Ahmedabad city area. At Ahmedabad cant_Pz_I of Ahmedabad district, water level measured 60.28 mbgl in 1987 was declined to 98.15 bgl in 2013. At Sola Pz-II and Sola Pz I, in 1996 water level measured was 62.71 and 63.01 mbgl respectively was declined to 100.85 bgl in 2017 and to 99.37 mbgl in 2016 respectively. Declines in the water level are summarized in the table.





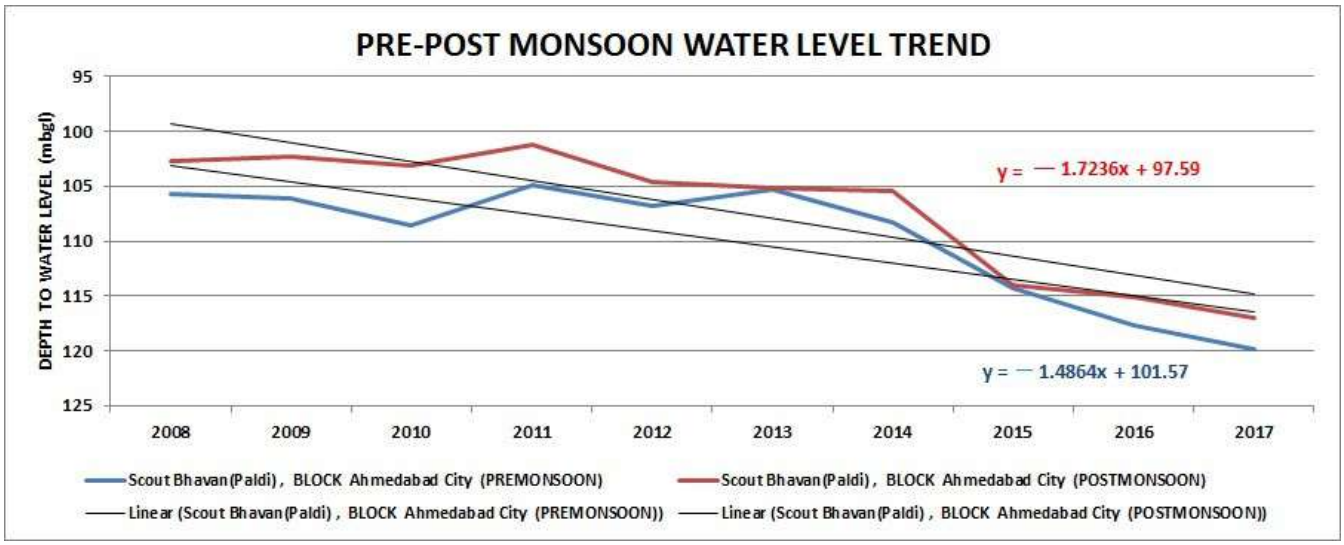


Fig. 41. Hydrographs of observation well at Sola Pz_I (CGWB), Vatva Pz_II (CGWDC) and Paldi (GWRDC)

Table 18 : Ground Water Decline in Confined Aquifer.

Sr. No	Taluka	Well Location	WL(m bgl)	Year	WL(m bgl)	Year	Decline(meter)
1	Ahmedabad City	Sola_II	62.71	1996	100.85	2017	-38.14
2	Ahmedabad City	Sola I	63.01	1996	99.37	2016	-36.36
3	Ahmedabad City	Ghuma_Pz_I	85.54	2002	97.35	2016	-11.81
4	Sanand	Sanand I	56.67	1996	76	2018	-19.33
5	Sanand	Jholapur_Pz_I	64.65	2009	79.3	2018	-14.65
6	Ahmedabad City	Vasana(Barriage)	98.9	2007	105.1	2018	-6.2
7	Ahmedabad City	Scout Bhavan(Paldi)	109.15	2007	122.35	2018	-13.2
8	Ahmedabad City	Vatva-1	107.1	2007	126.2	2018	-19.1
9	Ahmedabad City	Vatva-2	105.1	2007	112.6	2018	-7.5

7. MANAGEMENT STRATIGIES

The uneven distribution of groundwater availability and its utilization indicates that a single management strategy cannot be adopted and requires integrated hydrogeological aspects along with socio-economic conditions to develop appropriate management strategy. The study suggests notable measures for sustainable groundwater management, which involves a combination of various measures given below.

1. Supply side measures
2. Demand side measures
3. Regulatory measures
4. Institutional measures

7.1 SUPPLY SIDE MANAGEMENT THROUGH ARTIFICIAL RECHARGE TO GROUND WATER AND WATER CONSERVATION PLAN.

IDENTIFICATION OF AREA, SUB-SURFACE STROAGE SPACE AND WATER REQUIREMENTS.

During the course of surveys and aquifer Mapping utilizing the existing data it is observed that large amount of subsurface storage space is available in the system to accommodate the surplus monsoon runoff viz a viz additional water if made available to the system from any other distance sources, It is estimated that unsaturated zone - about 1825.46 MCM space is available in the district to accommodate the recharge water in unconfined system. Taluka wise detail is given in table- 18, and area feasible and most suitable for Artificial Recharge is given in the map 41. However feasibility of each of the recharge structures in these areas and locally identified areas in the rest of the area can only be firmed up after detail hydrogeological investigation specific to site and structure feasible.

It is observed that unsaturated zone available in the system can be used for augmenting the ground water recharge in the area provided sufficient quantity of surplus water is available for recharge. In the areas where surplus source water is not available, recharge to the ground water system using water diverted from water surplus area to water deficit area is also considered and implemented. Successful implementation of such projects in the past hold the key for successful completion of additional such recharge project in the area at technically feasible sites.

An area of about 335.72 sq. km has been identified in District Ahmedabad of Gujarat State. Alluvium is the main water bearing geological formations occurring in the District. The thickness of available unsaturated zone is computed based on the decadal average depth to water level of post monsoon period (2008-17) data (fig. 18), long term trend of ground water level (2008-17) (fig. 40) and total dissolved solid data of premonsoon period 2017 (fig. 24), four categories were identified as follows.

Area showing declining trend > 0.10 cm / year and water level between 6-9 m bgl.
Area showing declining trend 0 to 0.10 cm / year and water level between 6 -9 m bgl.
Area showing declining trend > 0.10 cm / year and water level between > 9 m bgl.
Area showing declining trend 0 to 0.10 cm / year and water level between > 9 m bgl

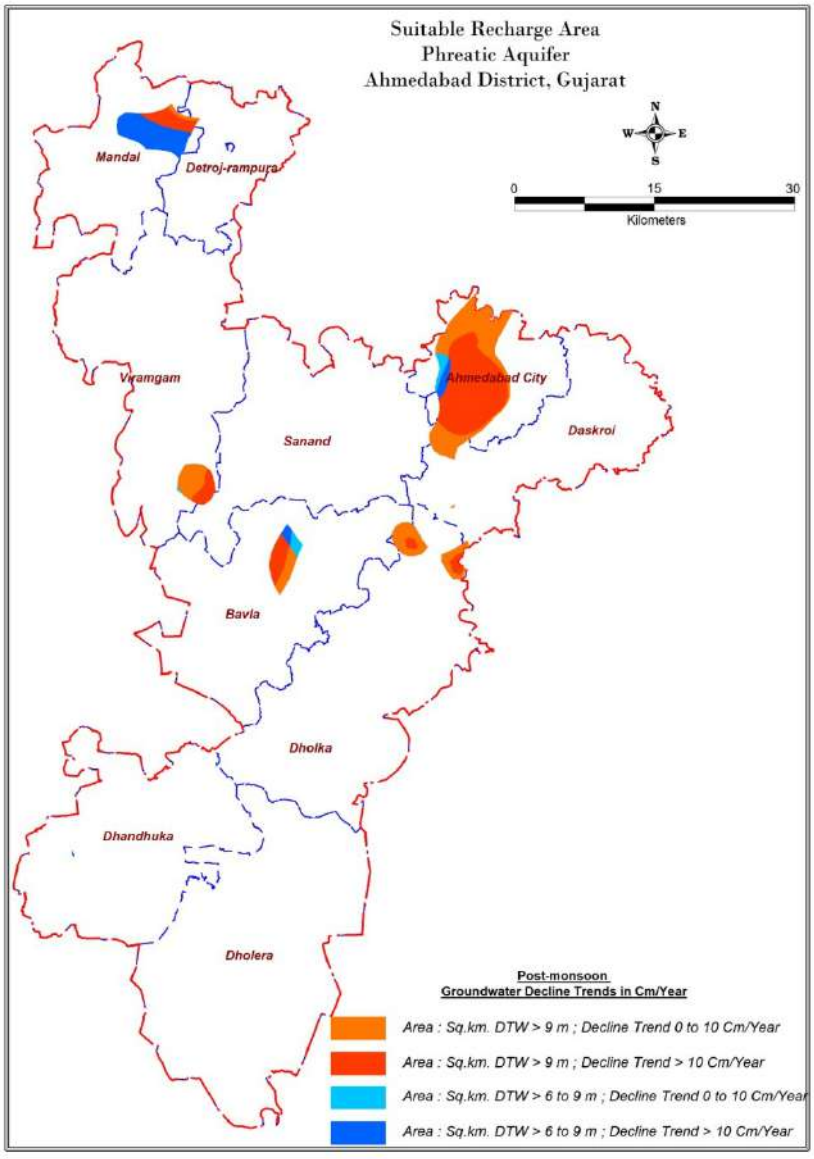


Figure 42 : Suitable Recharge Area Map Phreatic Aquifer.

Table 19 : Recharge structure Number.

Taluka Name	Area feasible for artificial recharge Sq.Km	Volume of unsaturated zone available for artificial recharge MCM	Specific yield factor	Volume of water required for recharge MCM	Volume of rain water (non committed) considered for Artificial recharge (MCM)	Percolation Tank/ (Unit storage @ 0.14 MCM)	Recharge Shaft (Unit storage 0.03 MCM)
BAVLA	36.53	196.72	0.1	19.67	1.75	13/1.75	
City DASKROI	175.81	1021.30	0.1	102.13	7.25	30/4.2	102/3.05
DETROJ_RAMPURA	1.53	9.00	0.1	0.90	0.63	5/0.63	
DHOLKA	29.12	174.70	0.1	17.47	2.9	20/2.90	
MANDAL	61.42	236.95	0.1	23.69	0.57	4/0.57	
SANAND	5.31	31.85	0.1	3.19	0.69	5/0.69	
VIRAMGAM	26.02	154.95	0.1	15.49	0.26	2/0.26	
Total	335.72	1825.46	0.1	182.55	14.05		

It is estimated that about 182.55 MCM water is required to recharge this unsaturated space. Surface runoff of 21.52 MCM/year is planned for recharge to ground water system. Augmentation of Ground water Recharge of 14.05 MCM through Artificial Recharge by construction of 79 Percolation Tanks and 102 Recharge shafts structures. Rain water Harvesting and Considering the average cost of construction of a recharge structures these structures can be constructed at favorable locations at the cost of 59.15 Crore.

This proposal is generalized based on major criteria however other structures may also be feasible i.e Recharge through Shallow tubewell/Dugwells in combination with Pit/Shaft and farm pond as per prevailing site specific condition for eventual recovery during lean period for sustainability of Crops. In the field Artificial recharge scheme is implemented coupled with observation well/piezometer for monitoring the impact of Artificial recharge to the ground water system. Separate budget proposal should be considered on actual basis as per site condition for monitoring and surveillance of the recharge structures on long term basis.

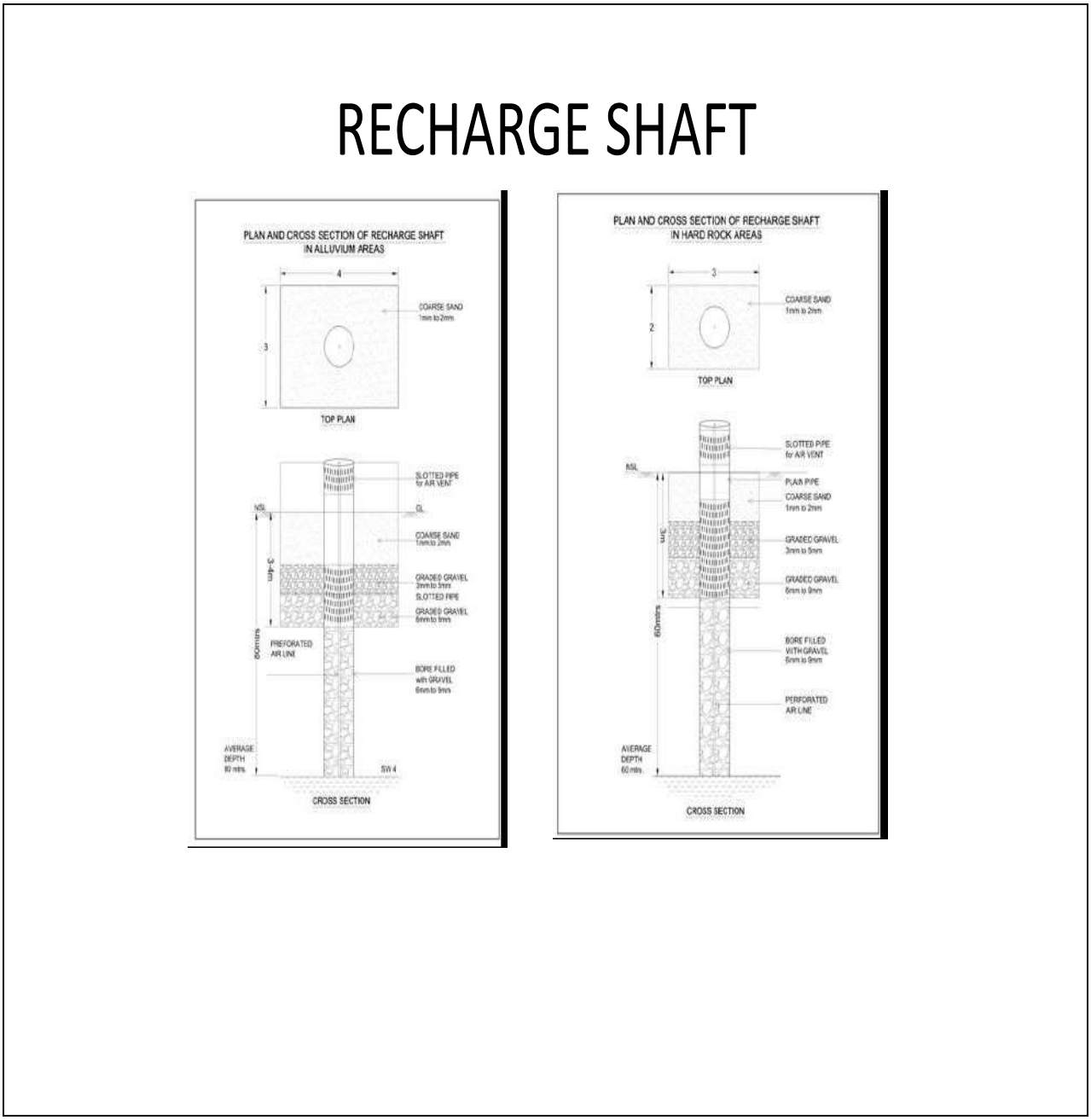


Figure 43: Schematic designs of recharge structures

7.2 Demand side management through irrigation efficiency/ Ground water use efficiency

Demand Side Management: As the surface water is not available to improve the supply of water, demand side management is essential. Adoption of Micro irrigation is need of the hour.

Groundwater use efficiency in Agriculture : Improvement in irrigation efficiency will go a long way to reduce the over draft . Increasing the water use efficiency of irrigation water is

the selection of proper irrigation method. Different methods are used to apply irrigation water to the crop depending upon the source of supply of water, topography, quantity of water to be applied, crop and planting/sowing method of the crop etc. The methods are classified as surface, sub surface, pressurised irrigation, sprinkler drip etc.

In surface method of irrigation water is applied directly to the soil surface from a channel or open ditch located at the upper reach of the field. Surface irrigation methods are conventional ones, have many drawbacks of which, the poor irrigation and water use efficiencies are most important. Controlled irrigation like drip and sprinkler can overcome above the said drawbacks considerably.

Drip Irrigation: Drip irrigation is a method of irrigation wherein water is carried to the plant under low pressure: through small diameter plastic pipes and delivered at the root zones, drop by drop through an emitting device. This is based on the fundamental concept of irrigation only the root zone of the crop rather than the entire land surface, as done in the surface irrigation. The system has its advantages and limitations. Its advantages are in terms of savings of the water over flow irrigation, effective use of fertilizers, less labour and energy cost. The limitation for adopting of this method is its high initial cost, which is beyond the purchasing capacity for small and marginal farmers . Drip irrigation is essential because water resource management is very crucial for India and this can be best done through micro irrigation technology. Problems of water logging and secondary salinization on the rise in canal command areas and fast receding water table in the tube well may reduce by adopting this method of irrigation. About 26 to 39% of water in general can save over the conventional irrigation methods in the area. Runoff and deep percolation loses are nil or negligible. This method of irrigation enhance the yield of the cop due to proper air, water ratio in the soil and better nutrient availability.

Table 20 : Volume of water saved by adopting Micro irrigation practices

Taluka Name	Irrigation through ground water in Non Monsoon [Ha]	Area already Covered under MIS (Ha) GGRC (2016-17)	Area Proposed under MIS* (Ha)	Irrigation Draft for MIS (mcm) Water Saving
Bavla	4366	220.68	2901.72	4.35
City-Daskroi	28960	2256.35	18692.56	28.04
Detroj-Rampura	3878	332.73	2481.69	3.72
Dholka	9138	2459.28	4675.10	7.01
Mandal	1382	5440.27	0.00	0.00
Sanand	8432	3463.02	3478.29	5.22
Viramgam	1286	2289.04	0.00	0.00
Total	57442	16461.37	28686.44	48.34
**Irrigation Draft for MIS=(Area Proposed under MIS*Δ GW Requirement(0.5)*0.3)/100*				
70% of the remaining GIA proposed for Micro Irrigation				

At present, the most suitable water-saving technologies available are Drip Irrigation and Sprinkler Irrigation. All the agencies concerned, including banks, are required to put in their best efforts to promote the activity. Even though subsidy is available for Drip irrigation system, spread of the same is on lower side in the district. The lower spread of Drip irrigation system can be attributed to the fact that irrigation wells are shared by the farmers with different land holdings on partnership basis and partners do not agree to share irrigation well for Drip irrigation.

7.3 Ground water Management in Saline Block

In Ahmedabad district Dhandhuka and Dholera taluka are saline (GWRE 2013). Water conservation measure such as farm pond/ village pond are suitable to improve overall quality of ground water. Surface runoff available for conservation (runfoff*0.03%) 43.83 mcm through farm pond/ village pond or through recharge shaft.

Table 21 : Surface runoff available for Conservation.

Taluka	Area in Sq. km	Avg. rainfall (m)	Surface runoff available for Conservation (MCM)
Dhandhuka	787.03	0.698	16.48
Dholera	1193.13	0.764	27.35
Total	1980.16	0.731	43.83

8. Improvement in Ground water development Scenario

Data generation and integration made in Ground Water for the preparation of Ground Water management Plan with information compiled and analyzed aquifer group wise is the first of in its kind and never done before at this scale for the area as a whole. Ground Water Management Plan thus prepared involving Local bodies, resource persons from Central and State Government Organizational and NGOs, Socioeconomic experts etc. after discussion in corridors of power will take it a long way in redefining the planning activities by the people for the people based on scientific information for the development of Ground water resources in the area for the benefit to the larger population of the area.

It is considered that an integrated water resources management with equitable distribution of available Water. Redistribution of pumping pattern, shift in more water efficient cropping pattern as per locally available water to be adopted. Institutional finance and appropriate technology should be freely made available to any individual or cooperative group of farmers that undertake resource augmentation and management measures. Cooperative irrigation scheme as already existing in the area should be encouraged/ rationalized at PRI level.

Effective Water management by Stakeholders, Community participation, Socio economic sensitization, NGO's (Sustainability) Conjunctive use of surface and ground water is proposed. Resultant /Expected Change in scenario of groundwater resources through integrated approach/interventions are given below in Table 22.

Table 22: Summary of Management Plan

Change in GW Scenario after introducing additional area under MIS and Recharge in Ahmedabad District																	
Taluka	**Net Annual Ground Water Availability (mcm) 2017**	**Irrigation Draft (mcm) 2017**	**Domestic And Industrial uses Draft 2017**	**Total Draft (mcm) 2017**	**Irrigation through ground water in Non Monsoon [Ha]**	**Area already Covered under MIS (Ha) GGRC**	**Area Proposed under MIS* (Ha)**	**Δ GW Requirement**	**Irrigation Draft for MIS (mcm) Water Saving**	**Irrigation Draft After MIS (mcm)**	**Total Draft after MIS (mcm) 2017**	**Additional Recharge from Recharge Intervention (mcm)**	**Total Net G.W. Availability after intervention (mcm)**	**Stage of Ground Water Development (%) (GWRE 2017)**	**Category (GWRE 2017)**	**Stage of Ground Water Development (%) after MIS**	**Category after MIS & Recharge Intervenation**
Bavla	56.93	27.29	0.54	27.83	4366	220.68	2901.724	0.5	4.35	22.93	23.47	1.75	58.68	48.88	Safe	40.00	Safe
City-Daskroi	240.99	181.00	24.10	205.10	28960	2256.35	18692.56	0.5	28.04	152.96	177.06	14.72	255.71	85.11	Semi critical	69.24	Semi-critical
Detroj-Rampura	32.84	24.24	1.42	25.66	3878	332.73	2481.689	0.5	3.72	20.52	21.94	0.63	33.47	78.13	Semi critical	65.54	Safe
Dholka	77.49	57.12	4.26	61.37	9138	2459.28	4675.104	0.5	7.01	50.10	54.36	2.9	80.39	79.20	Semi critical	67.62	Safe
Mandal	28.35	8.64	0.22	8.86	1382	5440.27	0	0.5	0.00	8.64	8.86	0.57	28.92	31.24	Safe	30.62	Safe
Sanand	99.04	52.70	2.88	55.58	8432	3463.02	3478.286	0.5	5.22	47.48	50.36	0.69	99.73	56.12	Safe	50.50	Safe
Viramgam	13.90	8.04	3.29	11.33	1286	2289.04	0	0.5	0.00	8.04	11.33	0.26	14.16	81.53	Semi critical	80.03	Semi-critical
Ahmedabad	549.54	359.02	36.70	395.72	57442	16461.37	32229.36		48.34	310.68	347.38	21.52	571.06	72.01	Semi critical	60.83	Safe
*Irrigation Draft for MIS=(Area Proposed under MIS*Δ GW Requirement*0.3)/100																	
70% of the remaining GIA proposed for Micro Irrigation																	

Looking at the Management Plan including demand side and supply side interventions the best we can achieve is to bring the district under Safe Category with stage of ground water development upto 60.83%. Viramgam talukas will still be under Semi critical category with SGWD of 80.03%.

As per the directions and deliberations at CHQ, Management plan should be prepared in such a manner to convert the district into Safe Category. As we can see above all possible interventions are exhausted. In such scenario quantum of additional water has been calculated in respect of individual talukas to turn them into safe category. It is estimated that additional 2.1 mcm water is required to convert the Viramgam taluka into safe category. Taluka wise breakup is provided as below.

Table 23: Final Management Plan

Taluka	Net Annual Ground Water Availability (mcm) 2017	Total Draft (mcm) 2017	Total Draft after MIS (mcm) 2017	Additional Recharge from Recharge Intervention (mcm)	Total Net G.W. Availability after intervention (mcm)	Stage of Ground Water Development (%) (GWRE 2017)	Category (GWRE 2017)	Stage of Ground Water Development (%) after MIS	Category after MIS & Recharge Intervenation	Additional Water Required to convert Taluka into safe category (mcm)	Satge of Grund Water Development (%) after MIS, Recharge and additional water outsourced	Projected category after all Intervention
Bavla	56.93	27.83	23.47	1.75	58.68	48.88	Safe	40.00	Safe		40.00	Safe
City-Daskroi	240.99	205.10	177.06	14.72	255.71	85.11	Semi critical	69.24	Safe		69.24	Safe
Detroj-Rampura	32.84	25.66	21.94	0.63	33.47	78.13	Semi critical	65.54	Safe		65.54	Safe
Dholka	77.49	61.37	54.36	2.9	80.39	79.20	Semi critical	67.62	Safe		67.62	Safe
Mandal	28.35	8.86	8.86	0.57	28.92	31.24	Safe	30.62	Safe		30.62	Safe
Sanand	99.04	55.58	50.36	0.69	99.73	56.12	Safe	50.50	Safe		50.50	Safe
Viramgam	13.90	11.33	11.33	0.26	14.16	81.53	Semi critical	80.03	Semi-critical	2.1	69.70	Safe
Ahmedabad	549.54	395.72	347.38	21.52	571.06	72.01	Semi critical	60.83	Safe		56.17	Safe

9. Conclusion and Recommendation

- The district has nine talukas of the District include 474 villages, 1 deserted village, 1 corporation, 1 cantonment area and 7 municipalities.

- Geomorphologically the district can be divided into two zones i.e flat alluvial peneplain and low hills. The climate of the district is semi-arid with annual normal rainfall of 658 mm.

- Geologically the area is part of Cambay basin and is occupied by the Quaternary alluvium and basaltic formation.

- As per the GWRE, 2017 report, the Stage of Ground Water Development varies from 31.24 % (Mandal Taluka) to 85.11 % (City Daskroi Taluka). The overall development in the district is 72.01 %, and as a whole the Ahmedabad district is Semi Critical.

- Based on NAQUIM studies the unconfined aquifer occurs within the depth range of 0 to 78m bgl. Aquifers II (Confined) occur within the depth range of 43 to136 m bgl and aquifer group III (confined II and confined III) occur within the range of 78 to 350 m bgl. The thickness of the unconfined aquifer ranges from 24 to 78 m. Confined aquifer I ranges in thickness from 18 to 72 m whereas the thickness of the confined aquifer III and IV ranges from 15 to 101m.

- The depth to water level in the district, ranges between less than 2m to >40m bgl during May 2017. The post-monsoon depth to water level in the district, ranges between less than 2m to >40m bgl during November 2017.

- Nitrate concentration in the ground water in district varies between 0.61 mg/l (Sanand) and 115 mg/l (Tagadi). where these values are more than the limits as per BIS drinking water standards (45 mg/l). Fluoride concentration in ground water varies between almost 0.12 at Raika and 11.20 mg/l at Kumarkhan. High concentration of fluoride exceeding maximum desirable limit of 1(mg/l) is found at 14 sample point.

- In phreatic Aquifer TDS ranges in between 360 to 43390 mg/l. 335.72 sq.km area is identified for artificial recharge to unconfined system.
- There is a great need for management of resources for sustainable development. The north-eastern part of the district comprising Dascroi -City taluka and Dholka taluka needs immediate attention of the authorities to safeguard the groundwater scenario. These areas need conservation and augmentation measures of the groundwater resources.

- 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 augmentation measures like diverting of excess flow to artificial recharge ponds and other suitable structures, designing and construction of rainwater harvesting structures in the city area are to be planned and implemented. Liberal institutional finance with some attractive subsidy can be made available for those who come forward to implement the above schemes.
- The land holding of the group of farmers under public tubewell irrigation should be brought under the provision of the change in crops, irrigation practices and installation of drip/sprinkler irrigation technique, soft term institutional finances to the farmers and liberal subsidies in equipments are suggested.
- Aquifer geometry towards further south and south-west and north west are to be ascertained along with its parameters by taking a few more exploratory drilling at suitable locations in the district.
- The aquifers of the deeper Miocene formations identified at some deep exploratory boreholes, needs further detailed study in the area. Its aquifer geometry is to be delineated and parameters are to be collected properly by planning and implementing suitable exploratory drilling programmes in the district.
- Since considerable areas are characterised by saline water bearing aquifers, research can be taken up to find suitable salt resistant crops for the area for effective use of saline waters.
- The management plan comprises two components; supply side intervention and demand side intervention. In supply side management plan 79 nos. of percolation tank and 102 nos. of recharge shaft is proposed to recharge 14.05 MCM of surface runoff. In demand side intervention an additional area of 28686.44 ha can be brought under Micro Irrigation System which would saving 48.34 MCM ground water which will improve the stage of ground water extraction. In Dhandhuka and Dholera taluka which are saline block (GWRE 2017), rain water harvesting structure such as pond may constructed to store surface runoff for future uses.

10. REFERENCES

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2. Central Ground Water Board, MOWR, Govt. Of India, 2013 Dynamic Ground water Resources of India.
3. Jilla Panchayat, Ahmedabad, 2017-18, Jillani Ankadakiya Roop Rekha, Ahmedabad.
4. Census of India 2011, District Census Handbook, Ahmedabad District.

And several other unpublished reports of CGWB and Government Website.

MANAGEMENT PLAN OF
AHMEDABAD CITY, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	460 sq. km		
Population (2011 Census)	5585528		
Average Annual Rainfall	788.90		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources, City & Dascroi (2017)	Fresh: 240.99 MCM		
Net Groundwater Draft, City & Dascroi (2017)	Fresh: 205.10 MCM		
Stage of Groundwater Development City & Dascroi (2017)	85.11 % (Semi Critical)		
Existing and future water demands (MCM) City & Dascroi (2017)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	24.10	5.55
	Irrigation	181	54.44

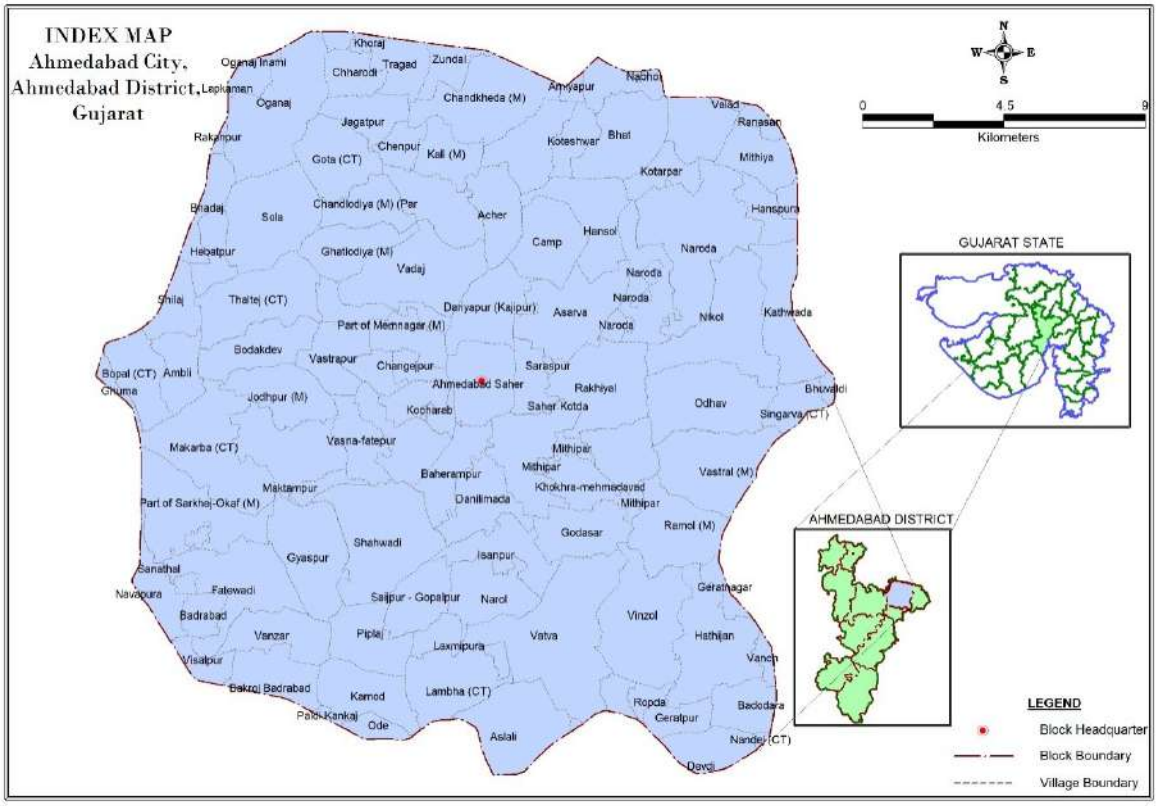


Fig. 1: Location Map

1. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel. The groundwater quality is saline at shallow depths and there is wide variation in quality regionally.

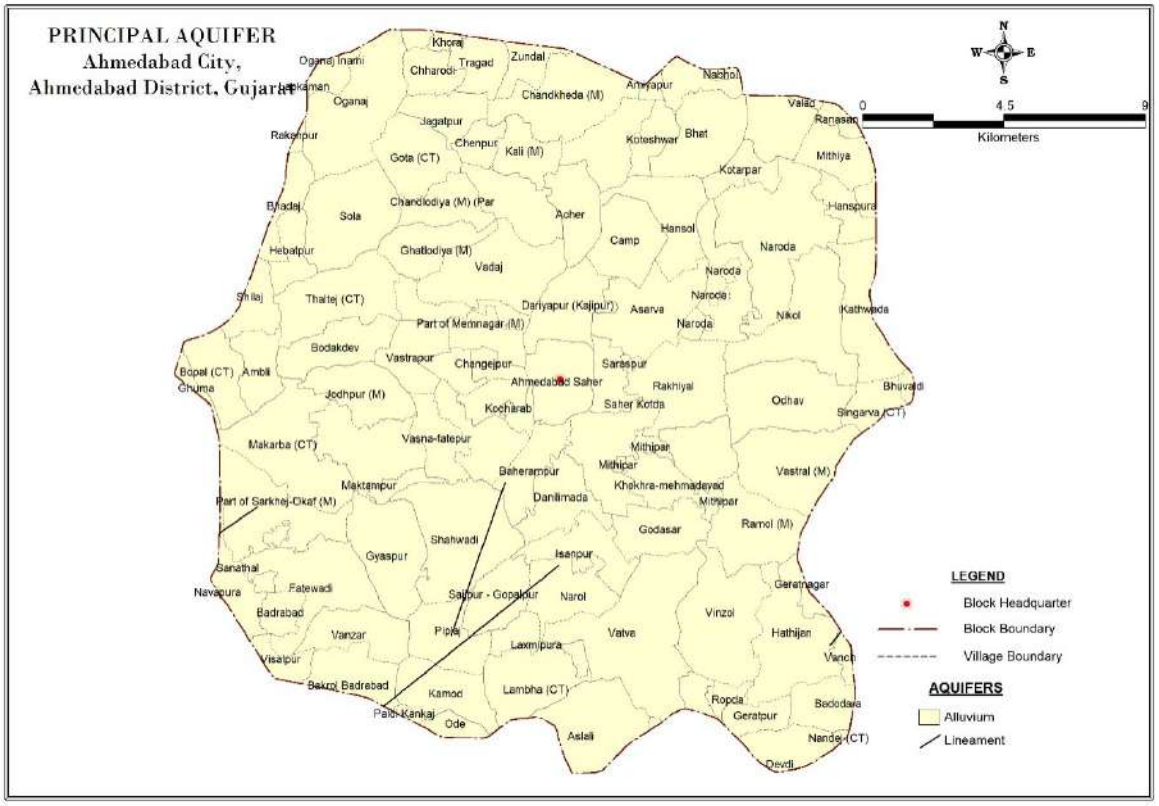


Fig.2: Major Aquifer

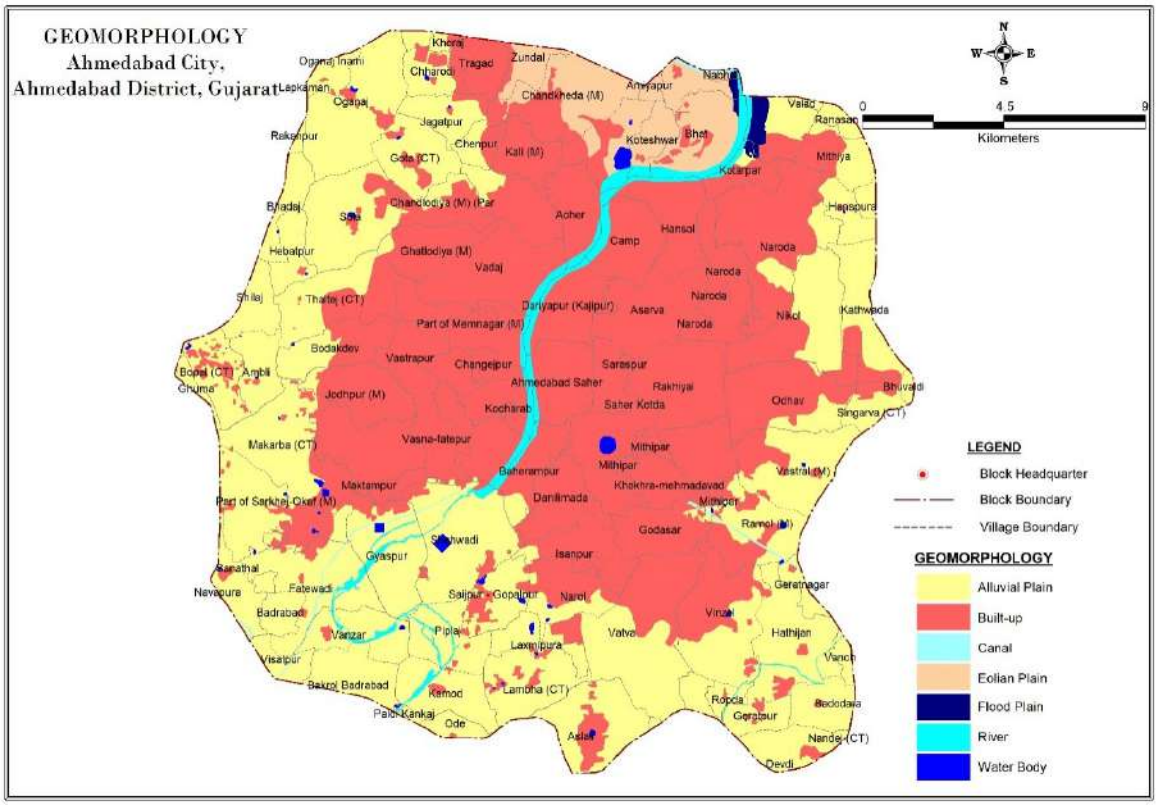


Fig.3: Geomorphology

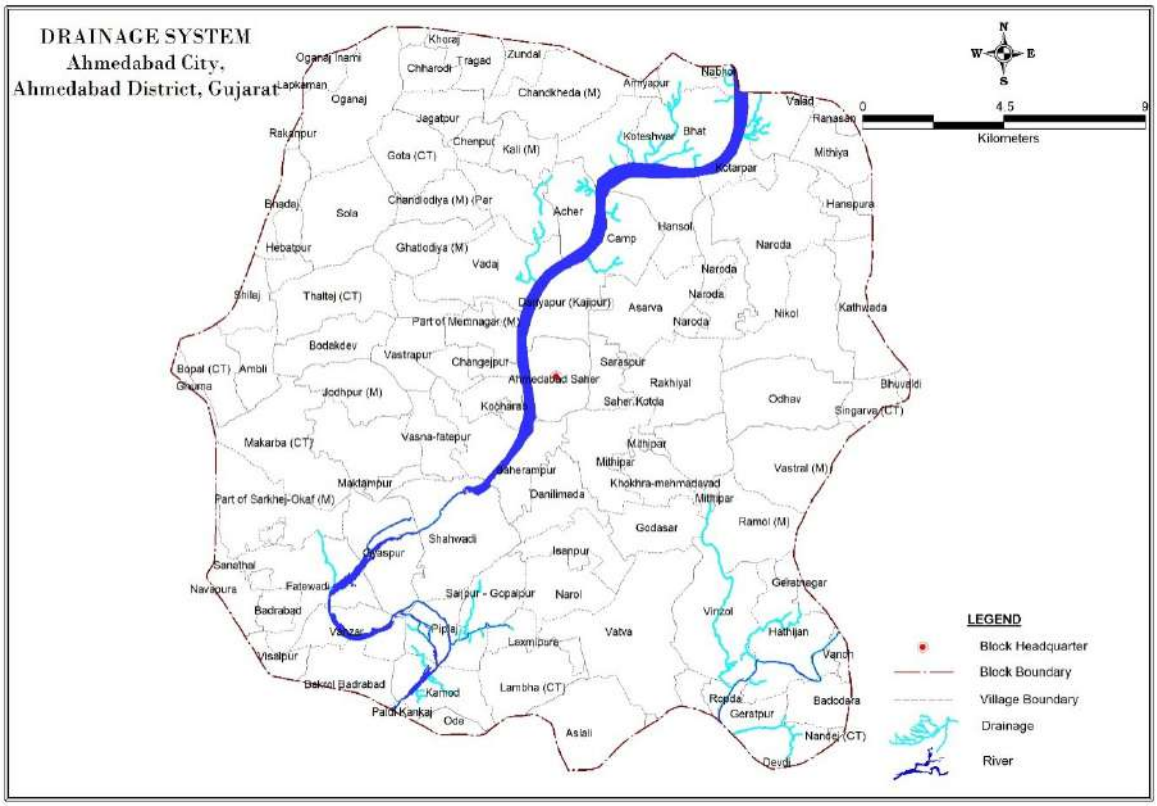


Fig. 4: Drainage Map

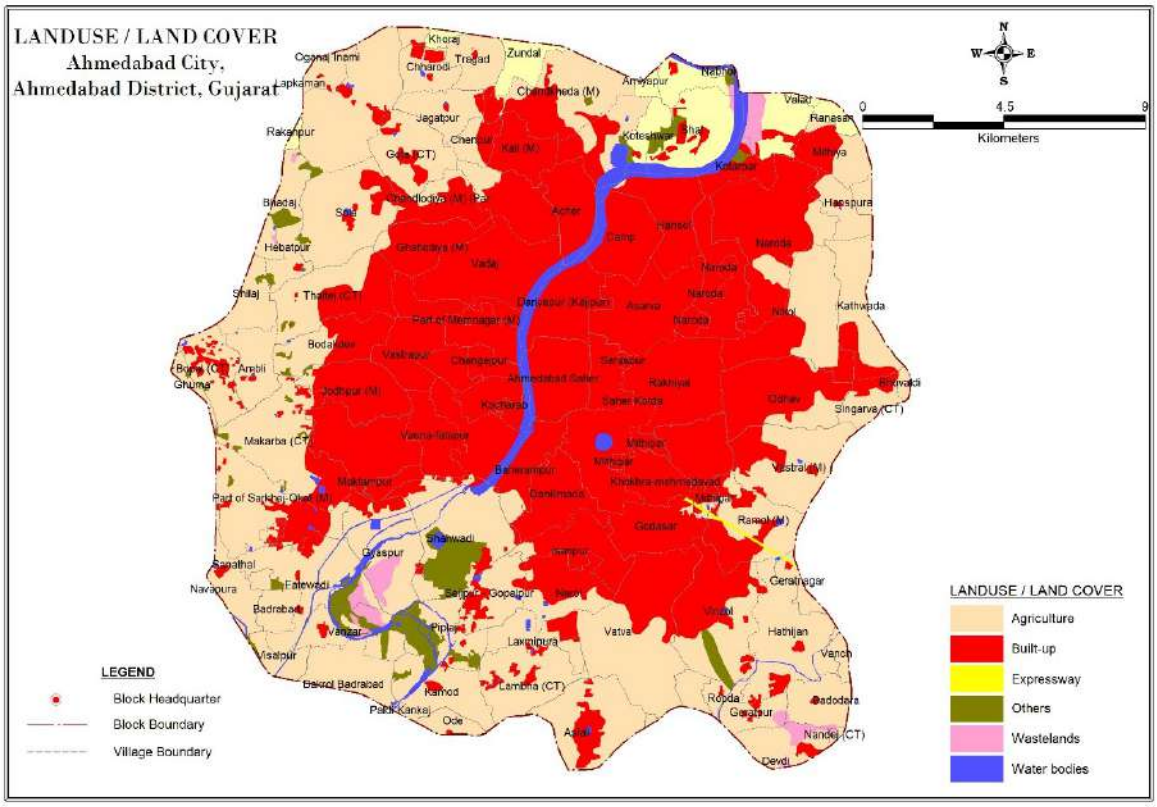


Fig. 5: Land Use Land Cover

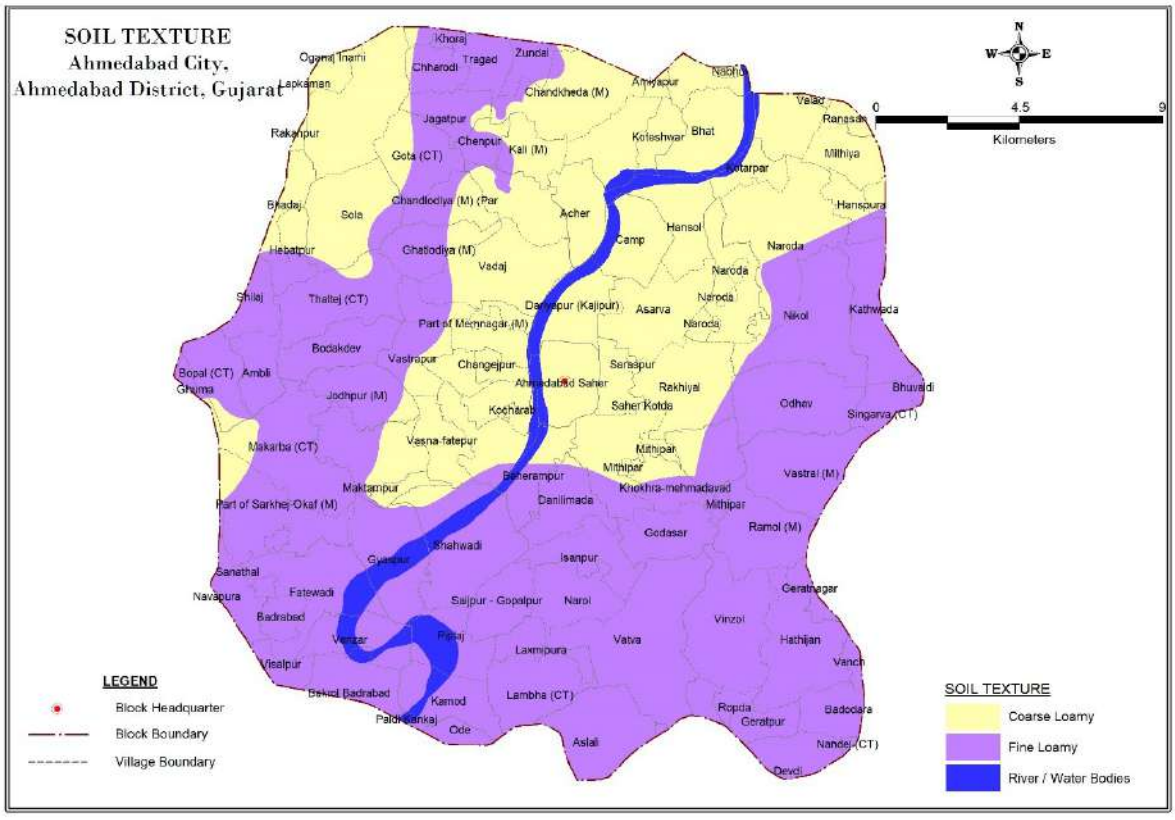


Fig. 6 Soil Map

2. Subsurface Hydrogeology

The area has multi-layer aquifer system. Aquifer I (unconfined) depth of occurrence upto 62 mbgl , Aquifer II (confined) depth of occurrence 83 to 126 mbgl , Aquifer III (confined) depth of occurrence 156 to 218 mbgl, Aquifer IV (confined) depth of occurrence 201 to 219 mbgl. Aquifer I (unconfined) Transimissivity 21.5 m (m2/day), Aquifer II (confined) Transimissivity 59 (m2/day), Aquifer III (confined) Transimissivity 11 (m2/day). Water level of aquifer I varies from 7.90 to 35.10 mbgl, Piezometric head of aquifer II varies from 33.11 to 46.22 mbgl, Piezometric head of aquifer III varies from 61.4 to 125.1mbgl. In Aquifer I (unconfined) discharge varies from 0.42 to 1.09 lps Aquifer II (confined) discharge varies from 0.20 to 2.85 lps, Aquifer III (confined) discharge varies from 0.25 to 7 lps.

Hydrogeological section for Ahmedabad City Depicting Aquifer

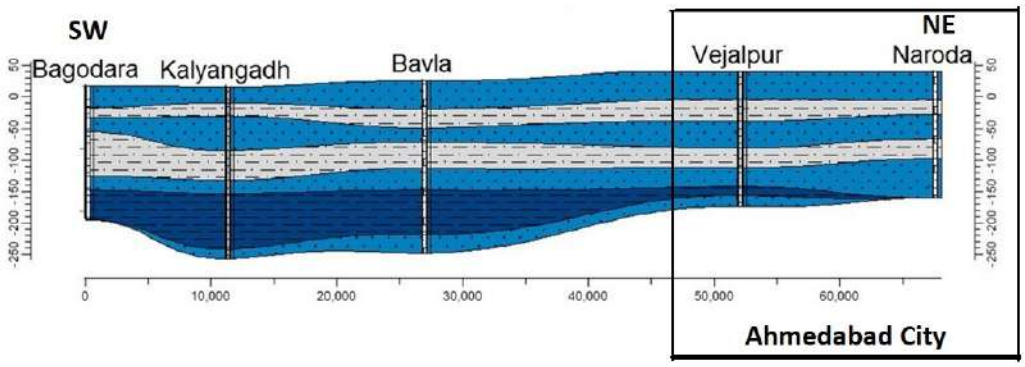
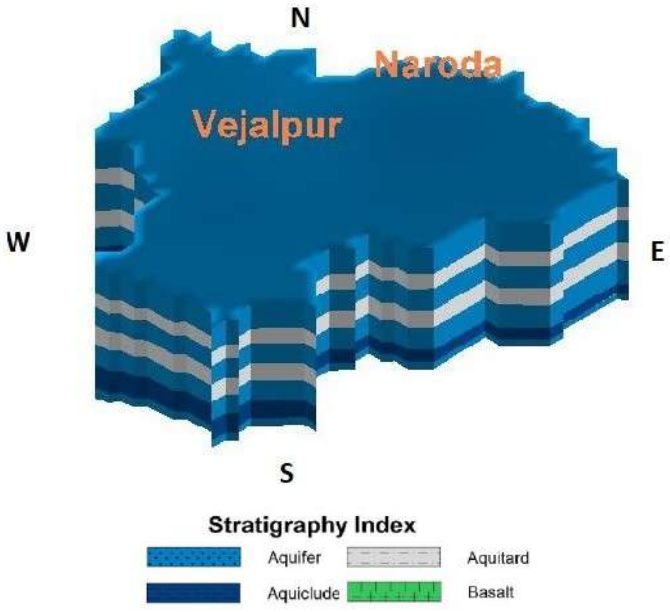


Fig.4: Stratigraphic Section



3D Solid Model of Ahmedabad City Depicting Aquifer

Table; 1 Aquifer characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lps)	Quality/Ec µS/cm	Transimissivity (m2/day)	Water Level/ Piezometric head (mbgl)
Aquifer I	Upto 62	48 to 62	0.42 to 1.09	625-3125	21.5	7.90 to 35.10
Aquifer II (Confined)	83 to 126	39 to 43	0.20 to 2.85	1200 to 3930	59	33.11 to 46.22
Aquifer III (Confined)	156 to 218	30 to 62	0.25 to 7	783 to 2680	11	61.4 to 125.1
Aquifer IV (Confined)	201 to 219	18	-			

Aquifer Group wise Water Level maps

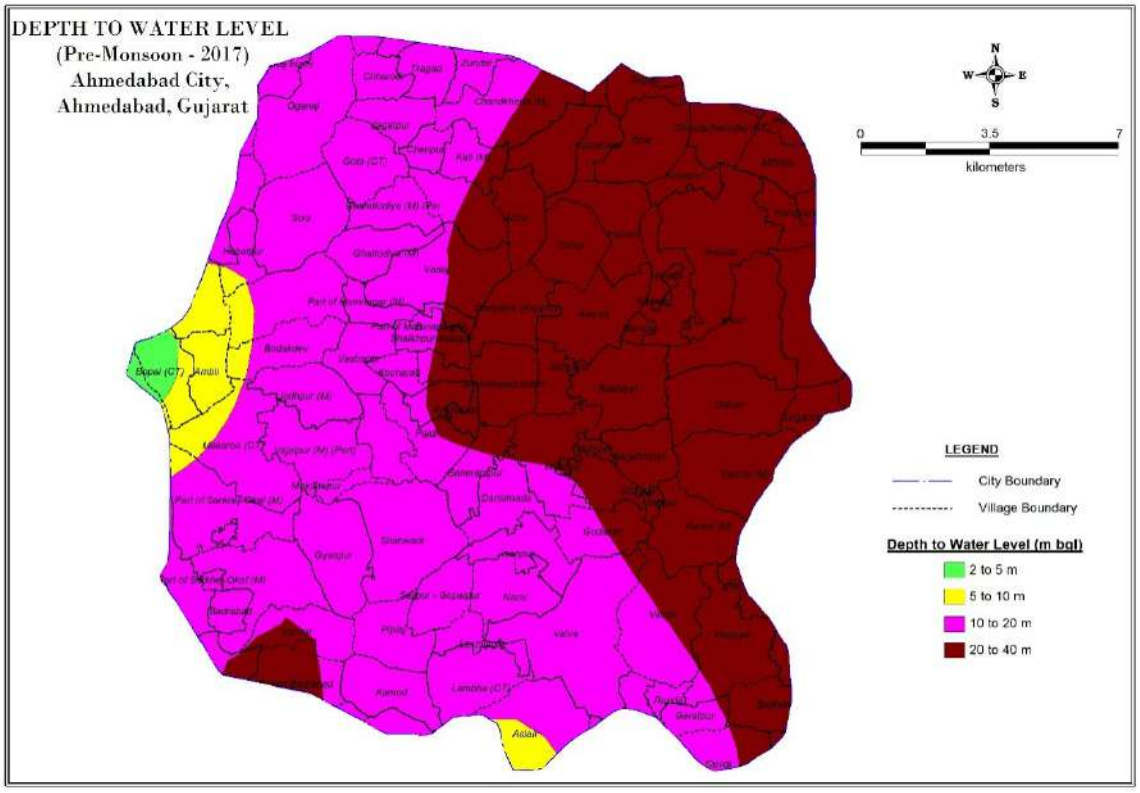


Fig.7: Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

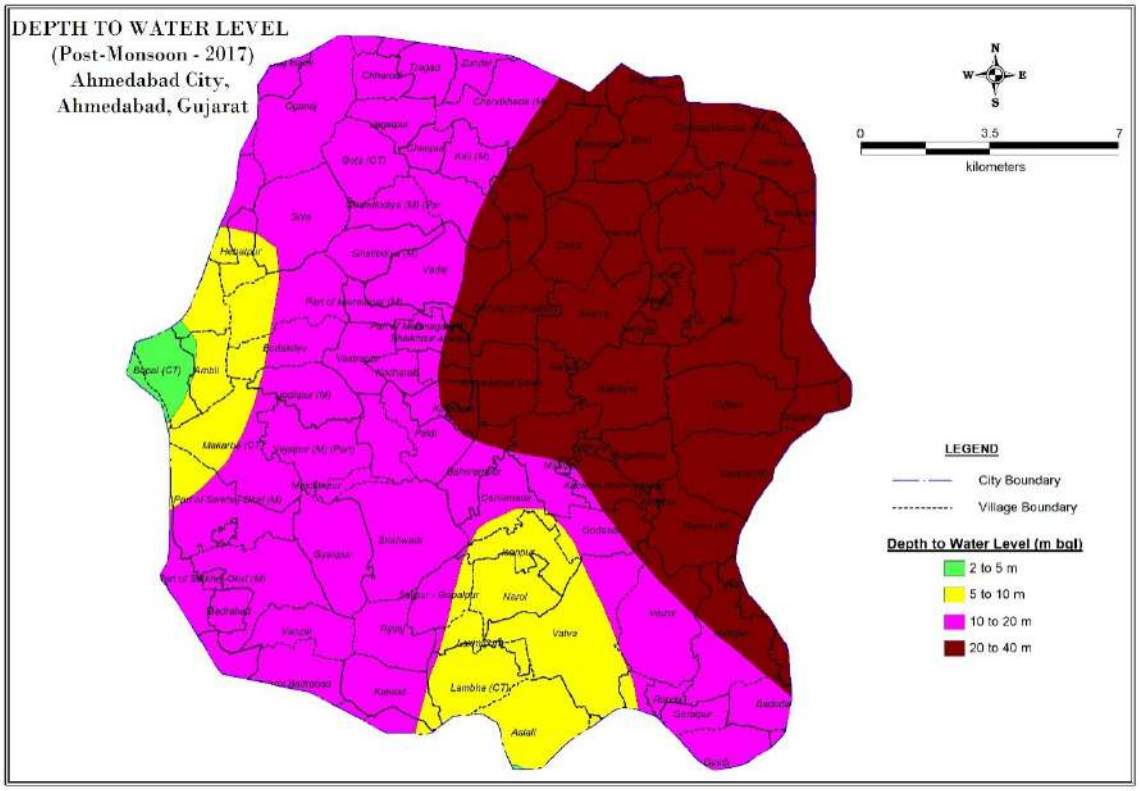


Fig.8: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

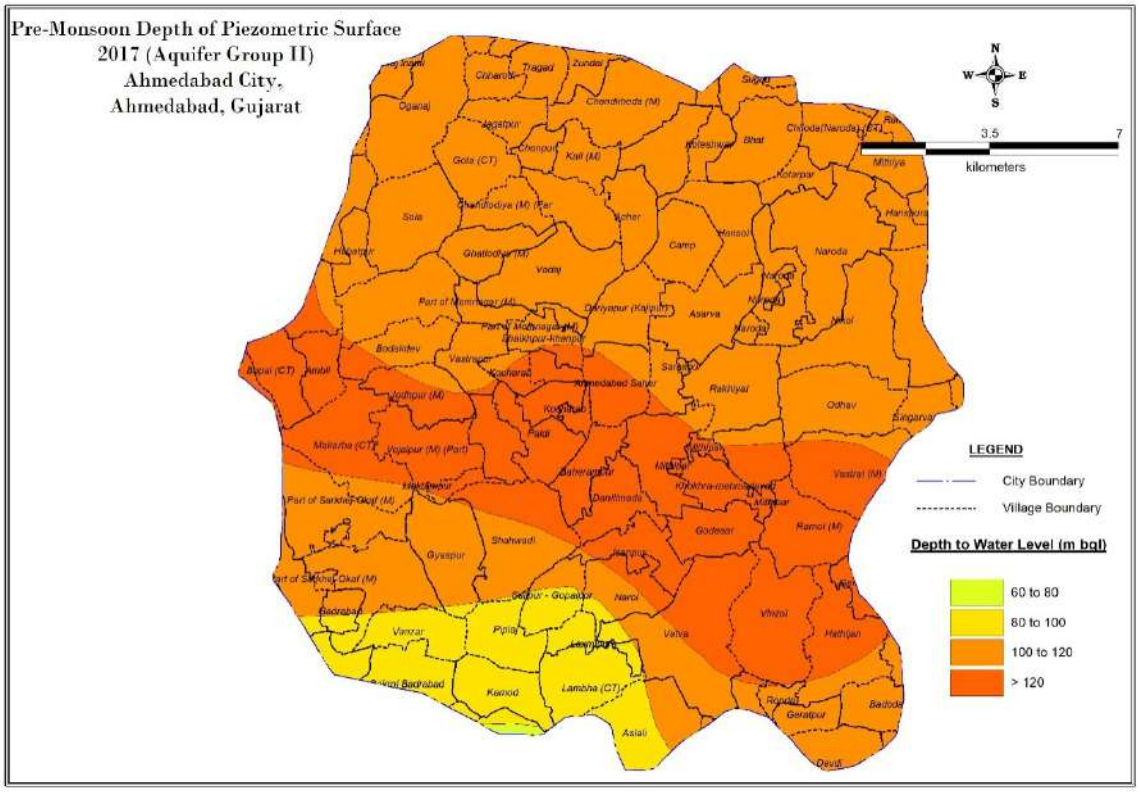


Fig.9: Pre-Monsoon Depth of Piezometric Surface- Confined Aquifer

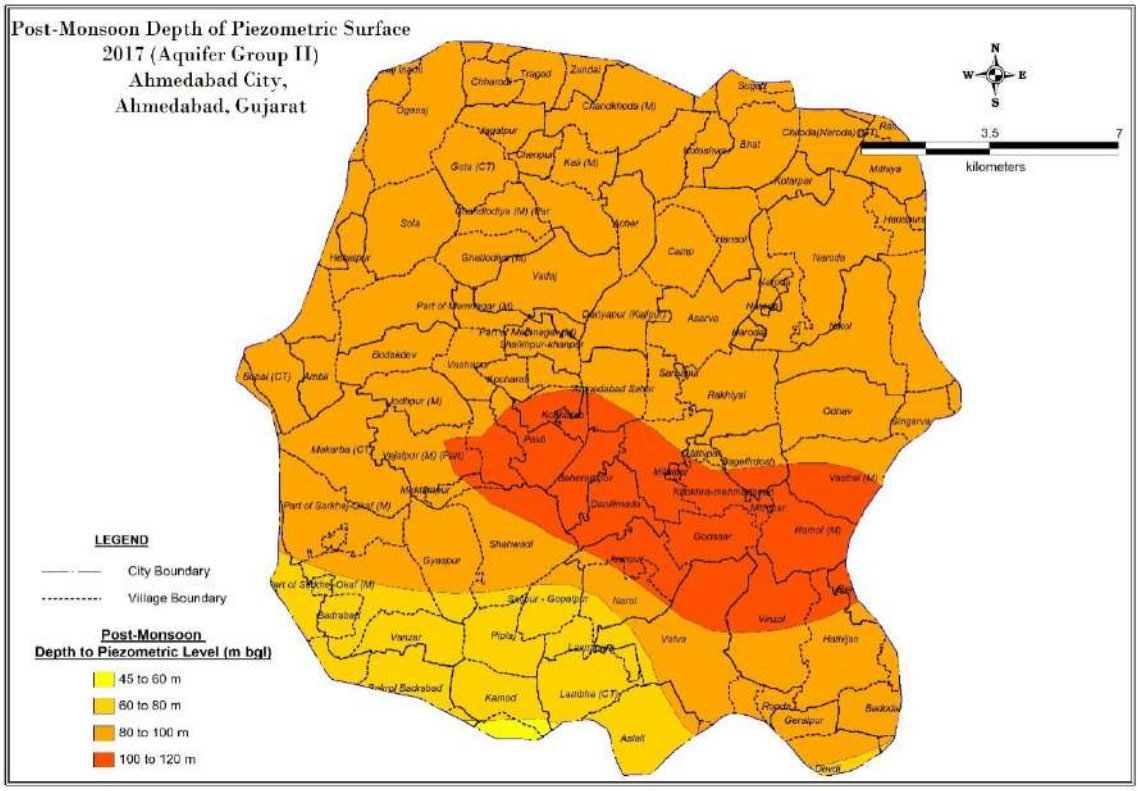


Fig.10: Post-Monsoon Depth of Piezometric Surface- Confined Aquifer

3. Dynamic Ground Water Resources in MCM

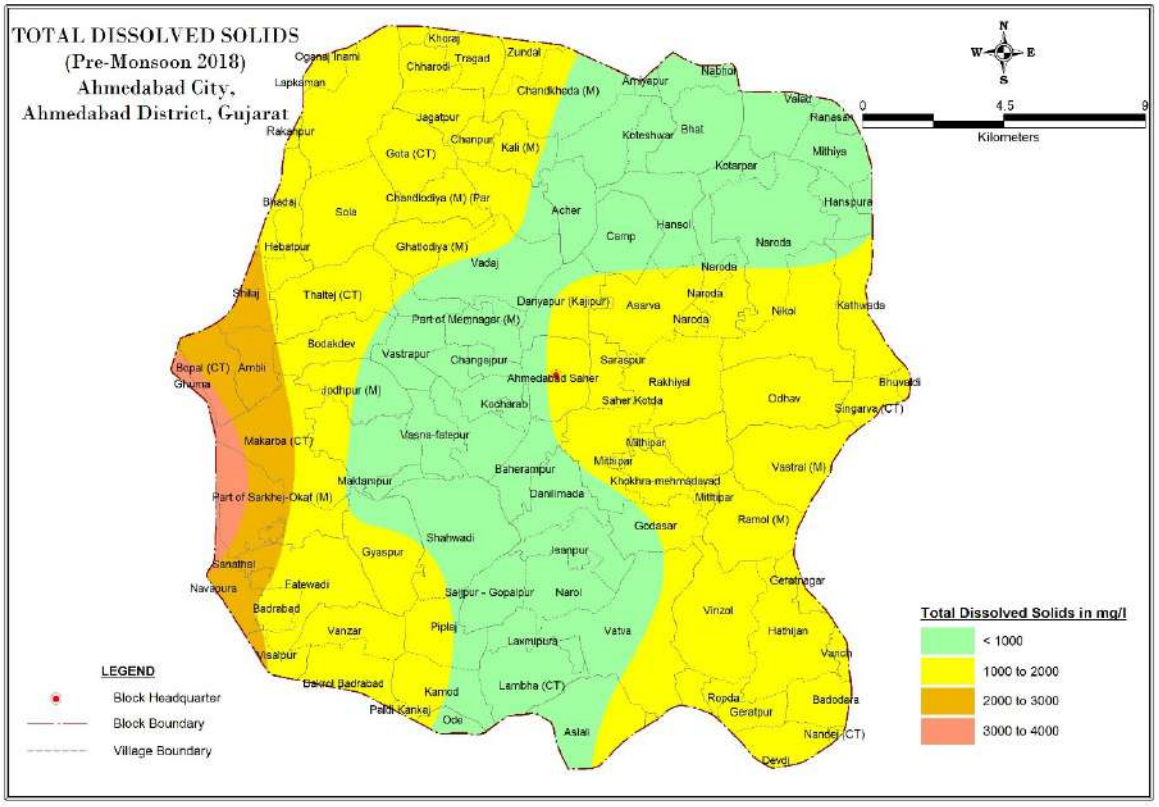
Total fresh groundwater availability of the Ahmedabad city and Dascroi is estimated in year 2017 is 240.99 MCM and total groundwater withdrawal for all purposes is 205.10 MCM. The stage of groundwater development is 111.07% and the Taluka is categorized “Semi Critical”.

Table: 2 Dynamic Groundwater resources 2017

S No	Item	Fresh
1	Area, Ahmedabad City and Dascroi (sq.km)	956.27
2	Total GW Recharge (MCM)	253.67
3	Net GW Availability (MCM)	240.99
4	Gross Draft (MCM)	205.10
5	Net Availability for Future Irrigation (MCM)	54.44
6	Stage of GW Development %	85.11

4. Chemical quality of groundwater

- Phreatic Aquifer (Aquifer I); Shows EC value ranges from 625-1203 µS/cm, suitable for drinking.
- Deeper Aquifer (Both Aquifer II & III); Generally fresh is good for drinking and Irrigation purpose.

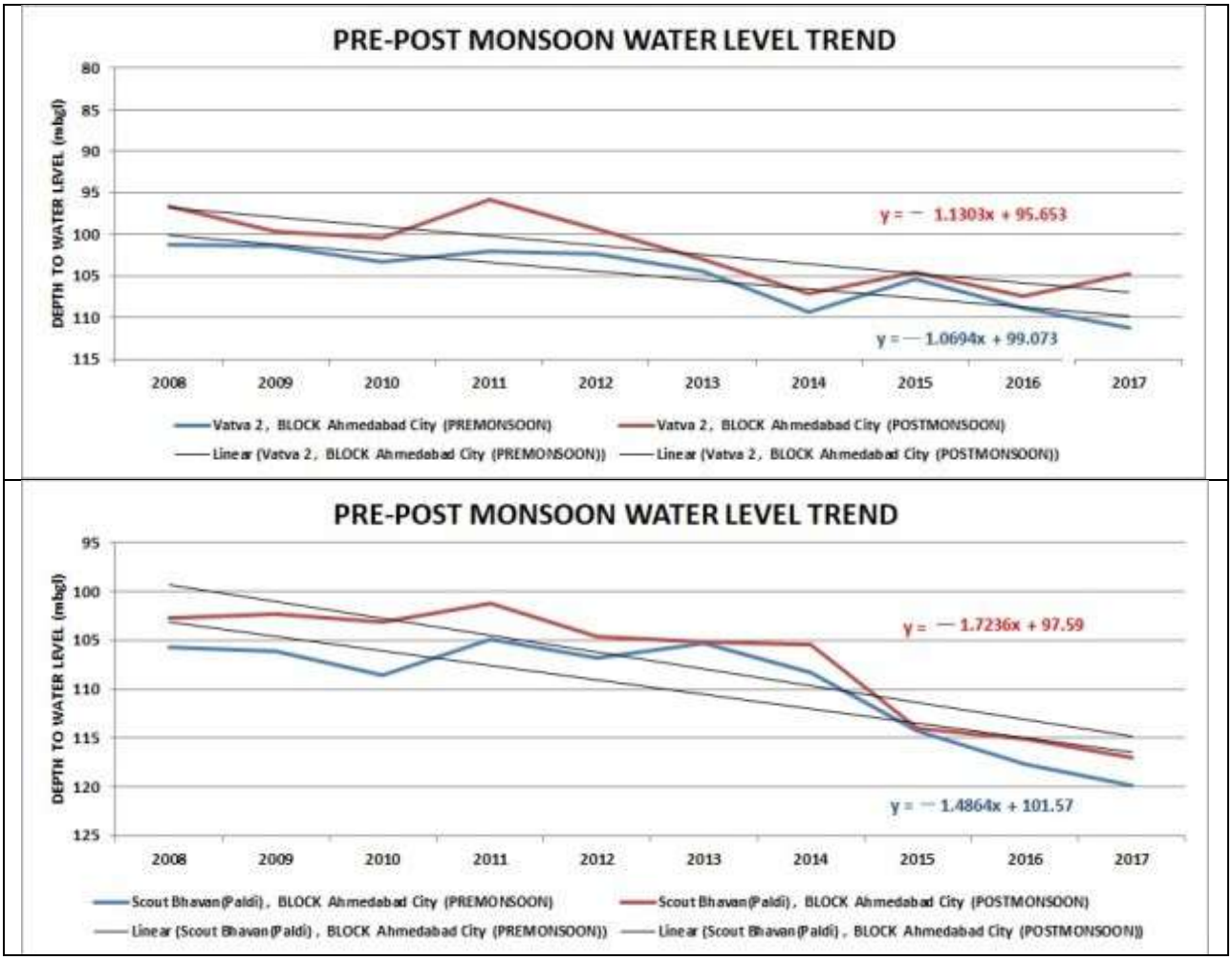


Total Dissolved Solids (TDS) Map- Unconfined Aquifer

5. Groundwater issues

1. Depletion of Ground Water and Declining trend (Phreatic Aquifer) in ground water levels.

2. In Deep confined aquifer III piezometric head are decline from 0.13 to 1.7 m/yr in Ahmedabad city area.



6. Groundwater Management

There are about 1191843 household in Ahmedabad city, considering 10% houses are suitable for harvesting and recharge and considering 100 sq. m as typical house hold roof top area available for harvesting (80% of normal rainfall) has been estimated to 7.51 MCM/yr.

There are 45 numbers natural lakes in Ahmedabad city. Natural drains which were leading to the lakes and also lake itself need desiltation to increase recharge.

7. Artificial Recharge & Conservation Possibilities

Ground water resources in the taluka should be augmented by through Roof Top Rain Water Recharge structure and it would lead to saving 7.51 MCM of ground water and improve stage of ground water of City-Daskroi taluka from semi critical (85.11%) to safe category (69.23%).

MANAGEMENT PLAN OF
BAVLA TALUKA, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	774.55 sq. km		
No. of Town, villages	48		
Population (2011 Census)	158191		
Average Annual Rainfall	645		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources (2017)	Fresh: 56.93 MCM		
Net Groundwater Draft	Fresh: 27.83 MCM		
Stage of Groundwater Development	48.88% (Safe)		
Existing and future water demands (MCM)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	0.54	3.18
	Irrigation	27.29	26.46

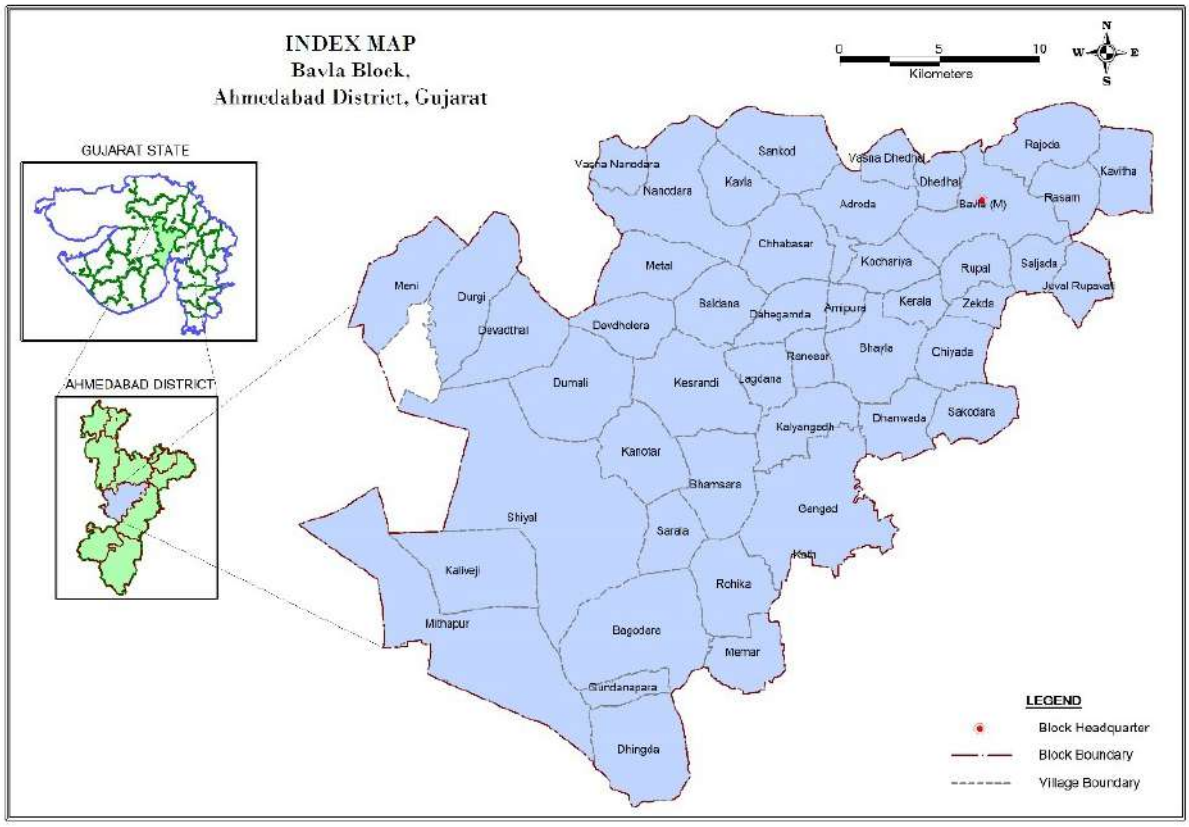


Fig. 1: Location Map

1 Land Use Classification

Taluka Name	Bavla
Area according to village papers (Ha)	75853
Area under Forest (Ha)	0
Barren & uncultivable land (Ha)	10046
Land put to non agricultural uses (Ha)	1350
Cultivable waste (Ha)	8942
Permanent pastures & other grazing lands (Ha)	2619
Current fallow (Ha)	1299
Fallow land other than current fallow (Ha)	954
Net area sown (Ha)	50643
Area sown more than once (Ha)	21069
Gross Cropped area (Ha)	71712

2. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel.

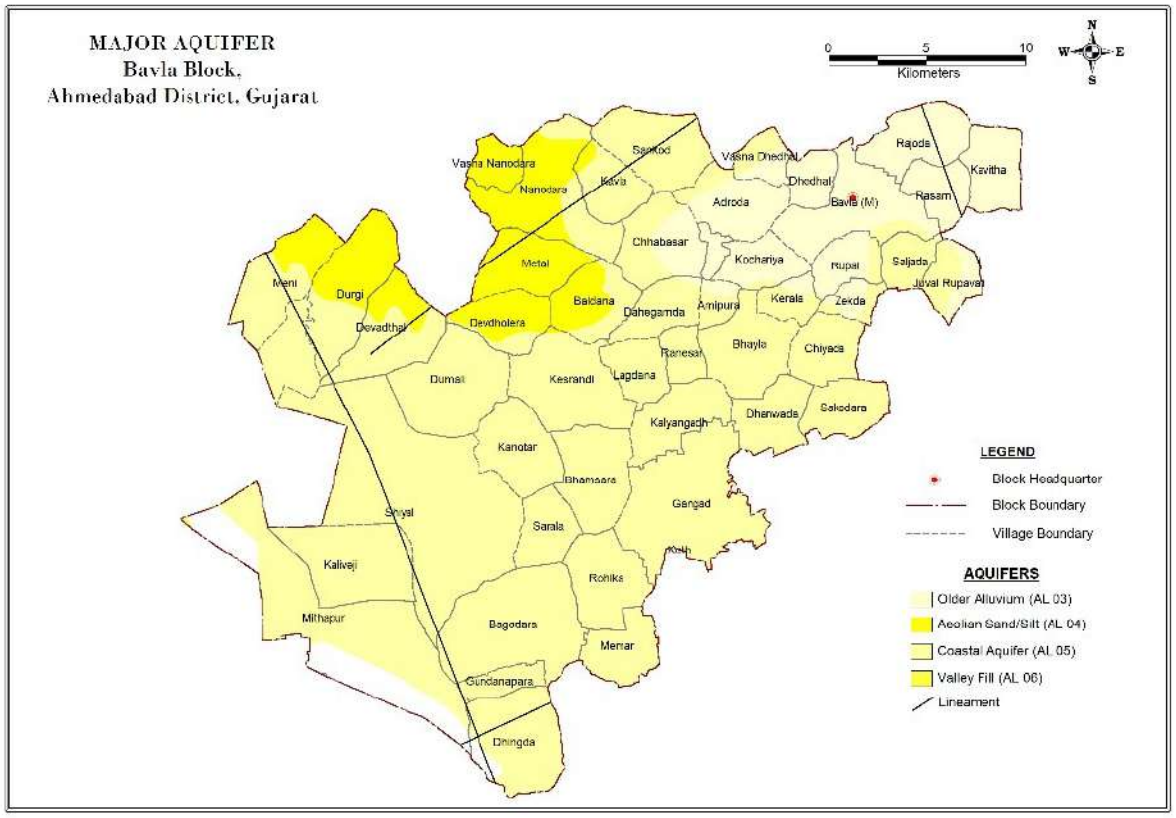


Fig.2: Major Aquifer

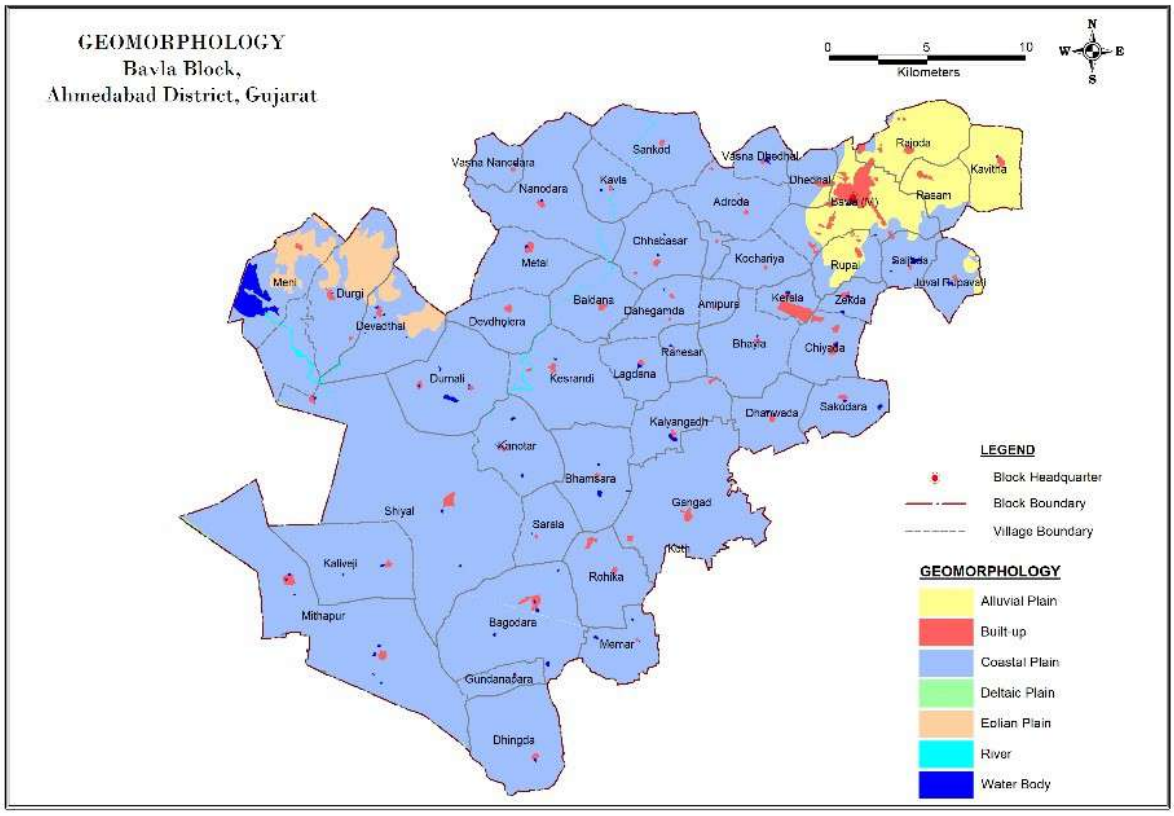


Fig.3: Geomorphology

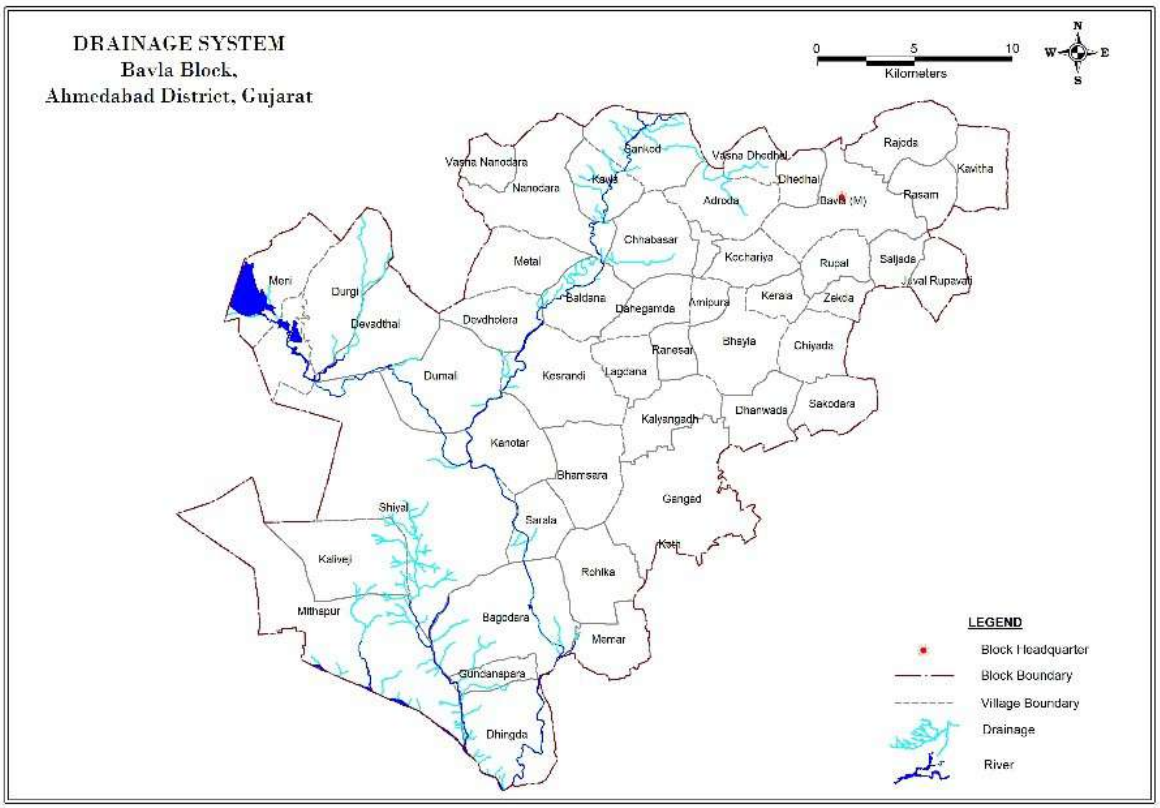


Fig. 4: Drainage Map

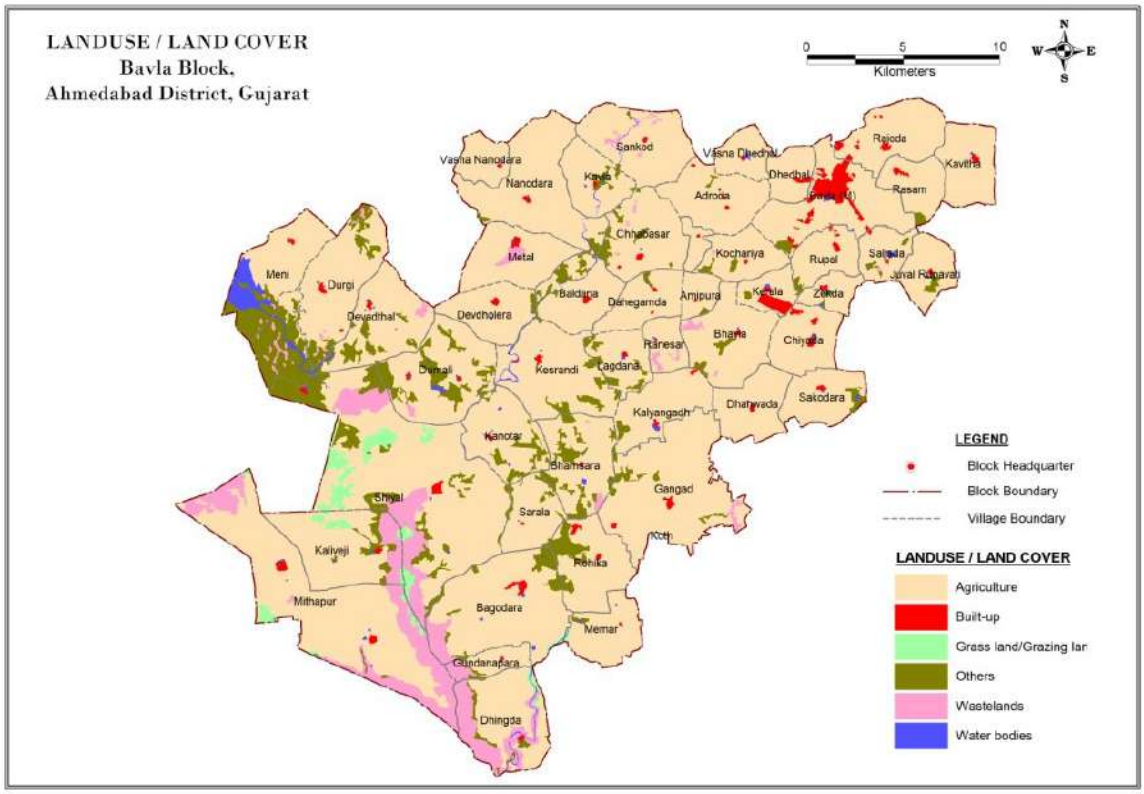


Fig. 5: Land Use Land Cover

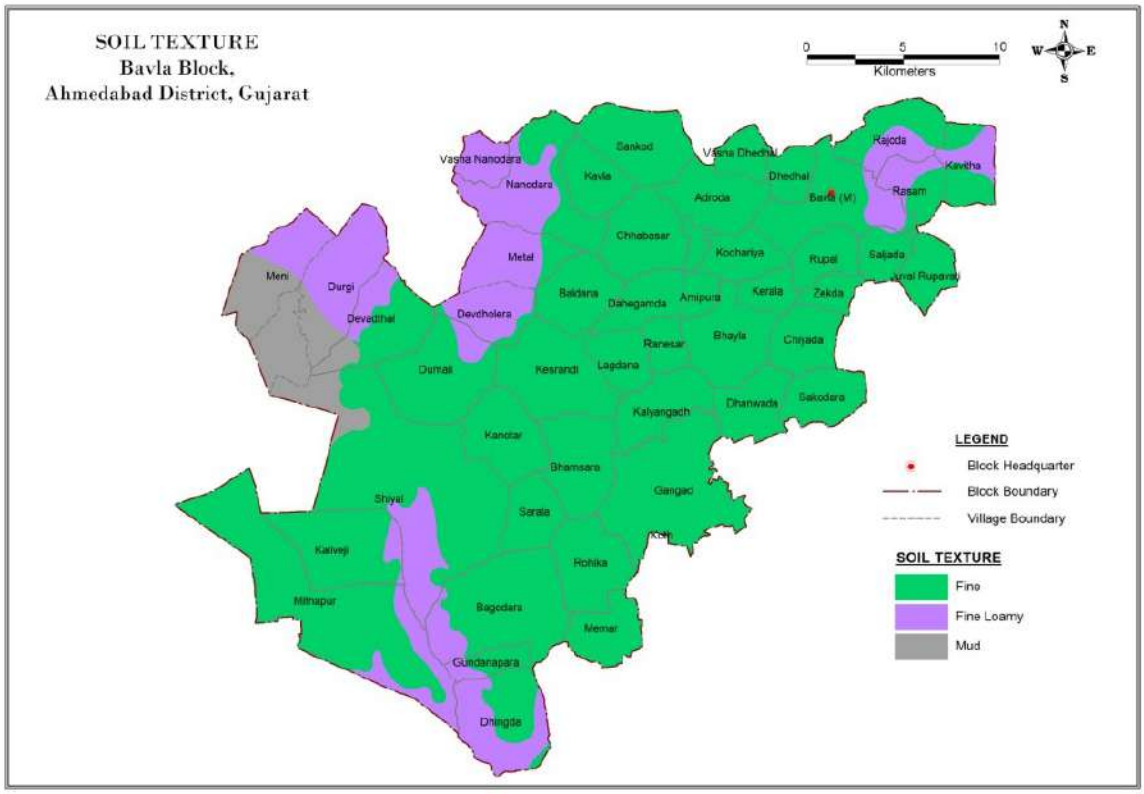


Fig. 6 Soil Map

3. Subsurface Hydrogeology

On inferred from borehole data of the Bavla Taluka Quarternary Alluvium forms the principal aquifer in the Taluka. The area has multi-layer aquifer system. Aquifer I (unconfined) depth of occurrence upto 50mbgl , Aquifer II (confined) depth of occurrence 46 to 101 mbgl , Aquifer III (confined) depth of occurrence 112 to 175 mbgl, Aquifer IV (confined) depth of occurrence 245 to 274 mbgl. Aquifer I (unconfined) thickness varies from 25 to 50 mt. Aquifer II (confined) thickness varies from 23 to 55 m, Aquifer III (confined) thickness varies from 20 to 63 m, Water level of aquifer I varies from 1.50 to 20.39 mbgl, Piezometric head of aquifer III varies from 5.94 to 7.17 mbgl. In Aquifer I (unconfined) discharge 8 lps Aquifer II (confined) discharge 10.34 lps, Aquifer III (confined) discharge varies from 9.5 to 10.34 lps.

Hydrogeological section for Bavla Taluka Depicting Aquifer

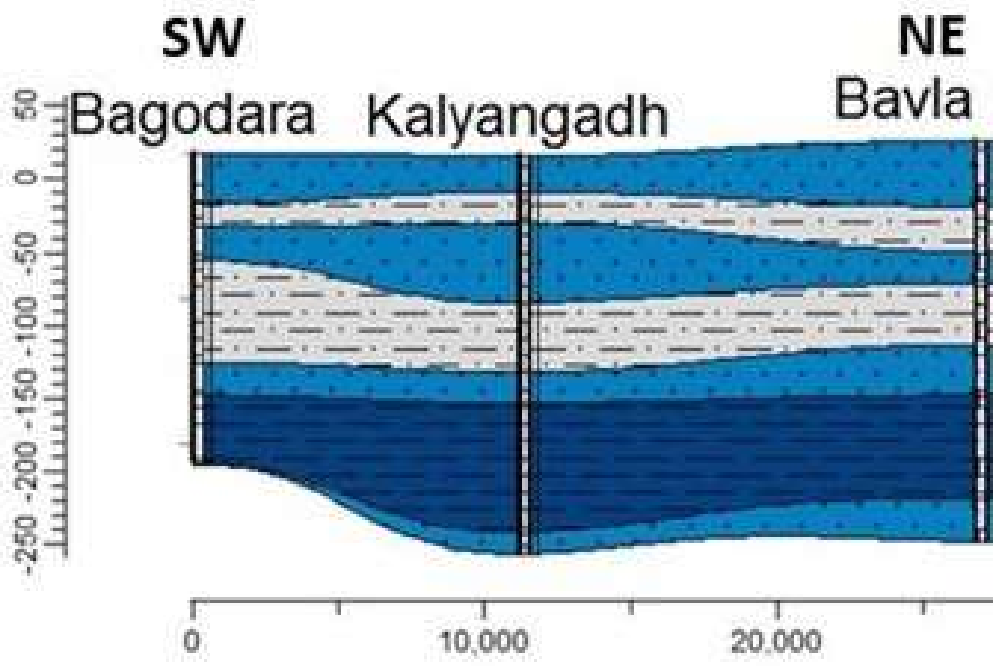


Fig.7: Stratigraphic Section

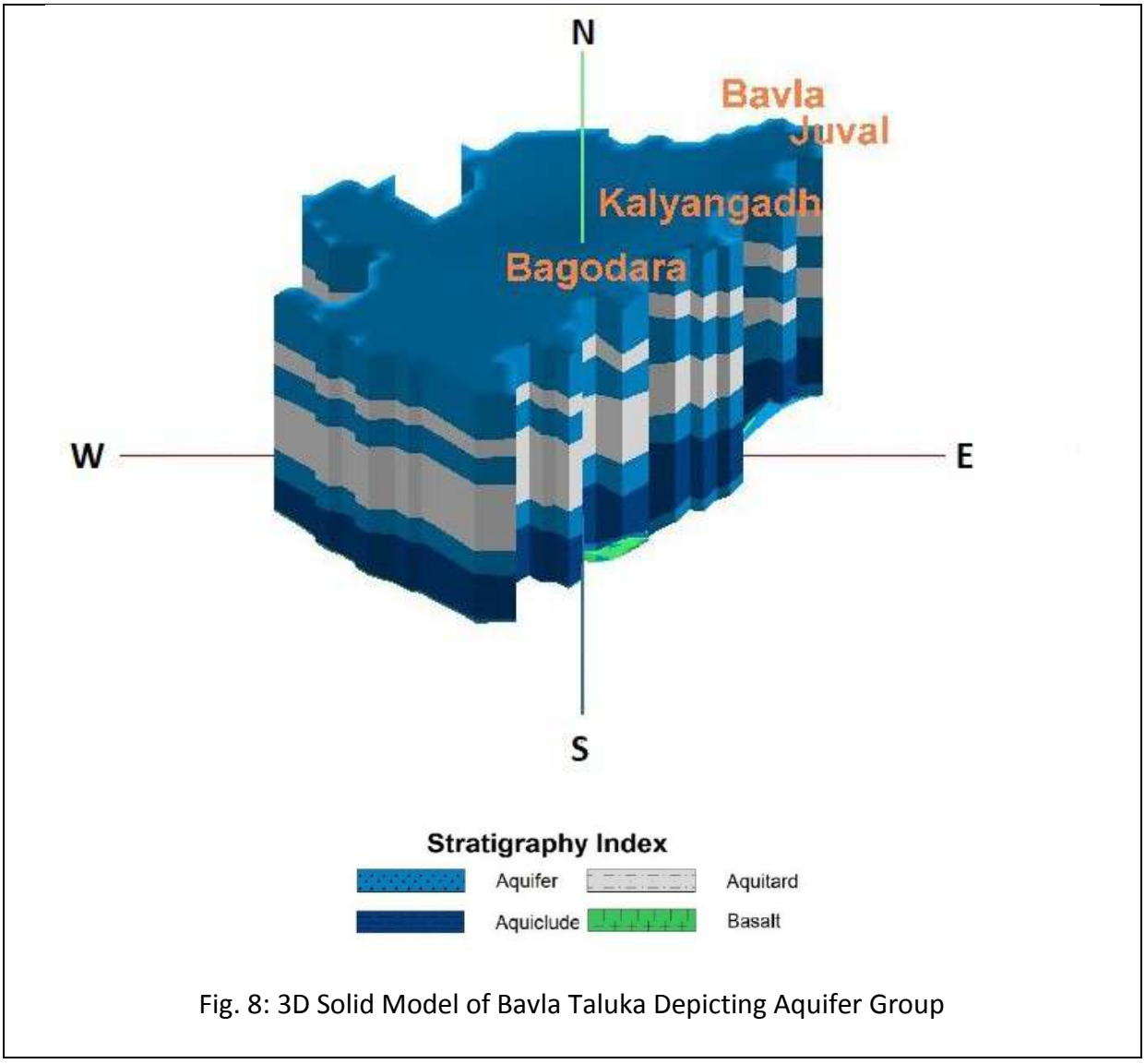


Fig. 8: 3D Solid Model of Bavla Taluka Depicting Aquifer Group

Table: Aquifer characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lps)	Quality/EC µS/cm	Water Level/ Piezometric head (mbgl)
Aquifer I	0 to 50	25 to 50	8	969 to 26859	1.50 to 20.39
Aquifer II (Confined)	46 to 101	23 to 55	10.34	3950	-
Aquifer III (Confined)	112 to 175	20-63	9.5 to 10.34	2920 to 3950	5.94 to 7.17
Aquifer IV (Confined)	245-274	15-28	-	-	-

Aquifer Group wise Water Level maps

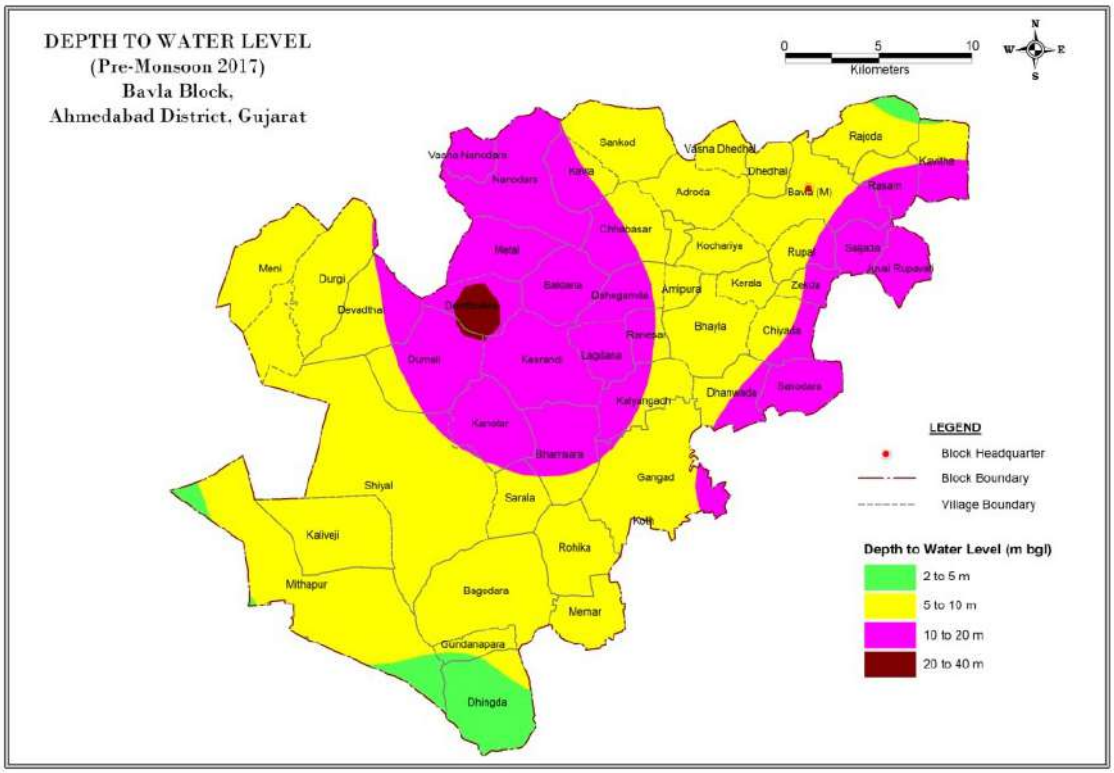


Fig. 9: Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

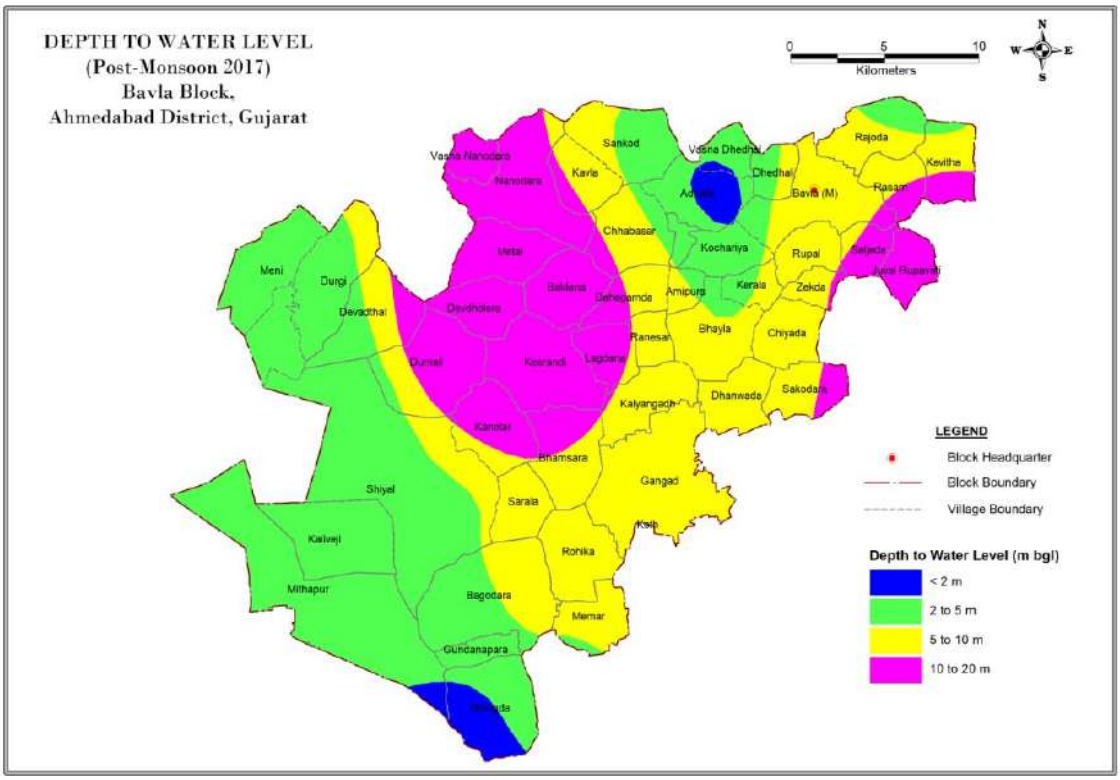


Fig. 10: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

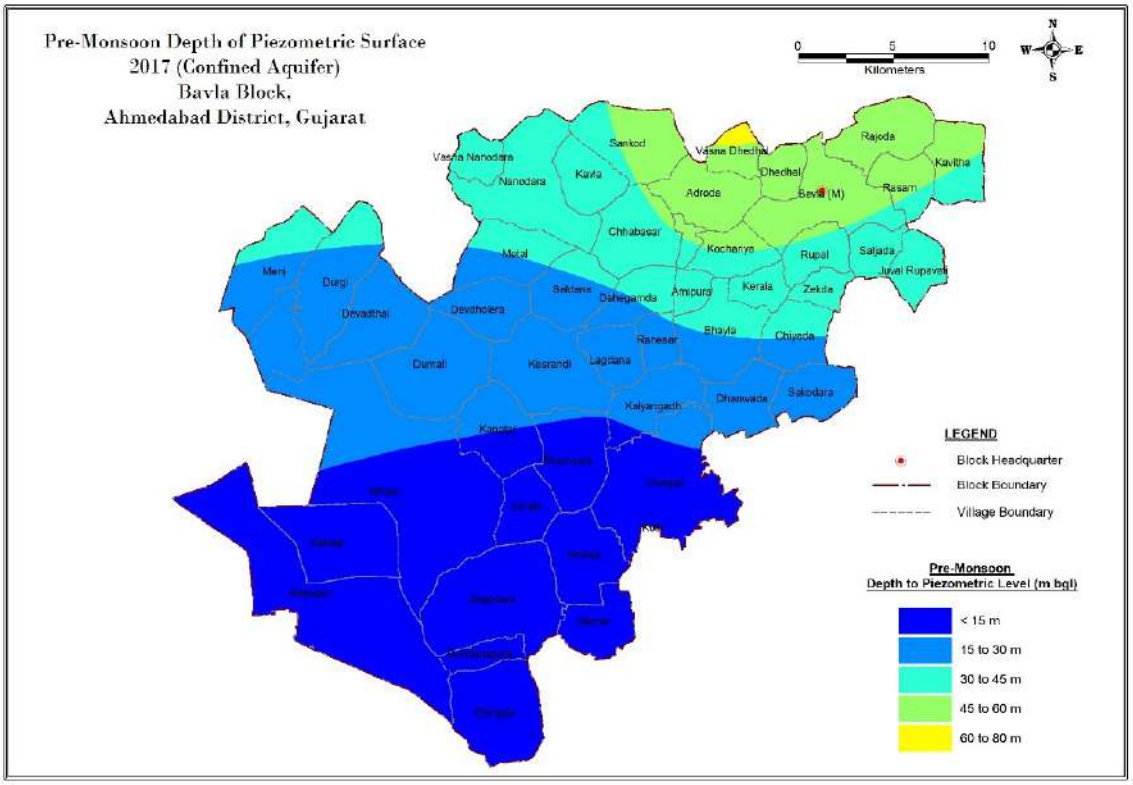


Fig. 11: Pre-Monsoon Depth of Piezometric Surface- Confined Aquifer

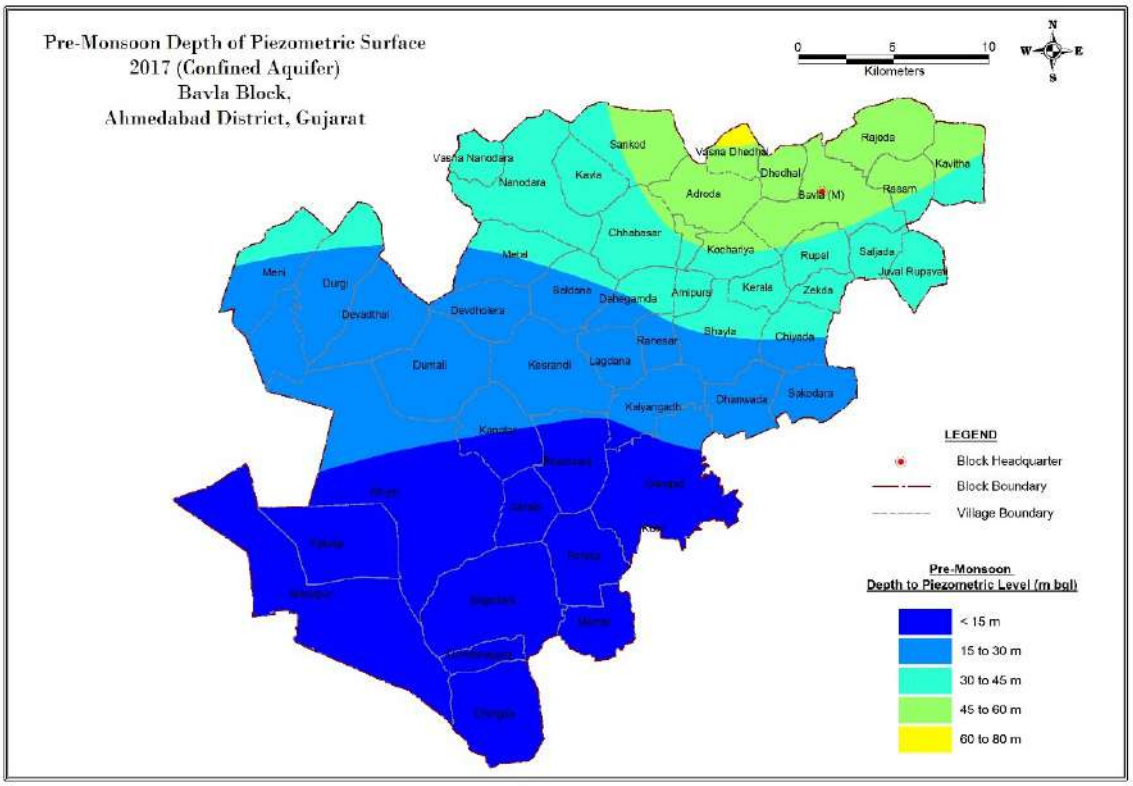


Fig.12: Post-Monsoon Depth of Piezometric Surface- Confined Aquifer

4. Dynamic Ground Water Resources in MCM

Total fresh groundwater availability of the area is estimated in year 2017 is 56.93 MCM and total groundwater withdrawal for all purposes is 27.83 MCM. The stage of groundwater development is 48.88 % and the Taluka is categorized “Safe”. Total Saline groundwater availability of the area is estimated in year 2017 is 109.43 MCM and total groundwater withdrawal for all purposes is 34.31 MCM. The stage of groundwater development is 31.35% and the Taluka is categorized “Safe”.

Table 3: Dynamic Groundwater resources 2017

S No	Item	Fresh	Saline
1	Area (sq.km)	157.08	617.47
2	Total GW Recharge (MCM)	59.93	121.59
3	Net GW Availability (MCM)	56.93	109.43
4	Gross Draft (MCM)	27.83	34.31
5	Net Availability for Future Irrigation (MCM)	26.46	74.10
6	Stage of GW Development %	48.88	31.35

5. Chemical quality of groundwater

Ground water quality is one of the major issues in the area. Phreatic Aquifer (Aquifer I); Shows considerable variation from highly saline to Fresh EC value ranges from 969 to 26859 µS/cm. Deeper confined aquifer are brackish to saline in nature.

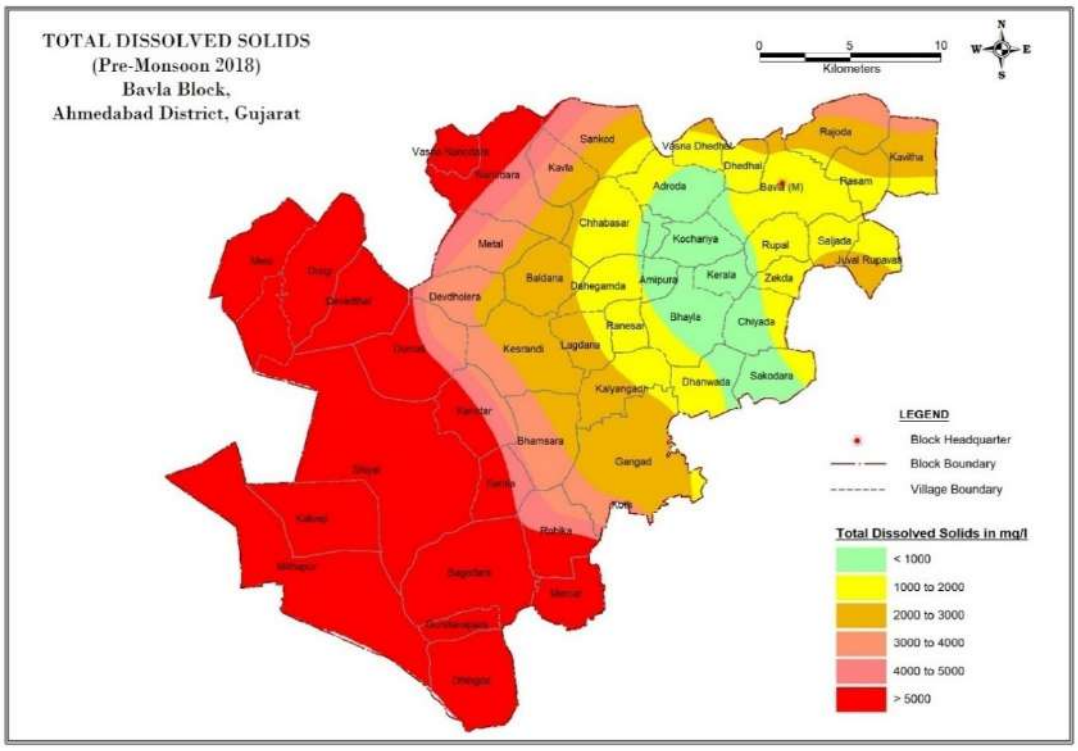


Fig.13: Total Dissolved Solids (TDS) Map- Unconfined Aquifer

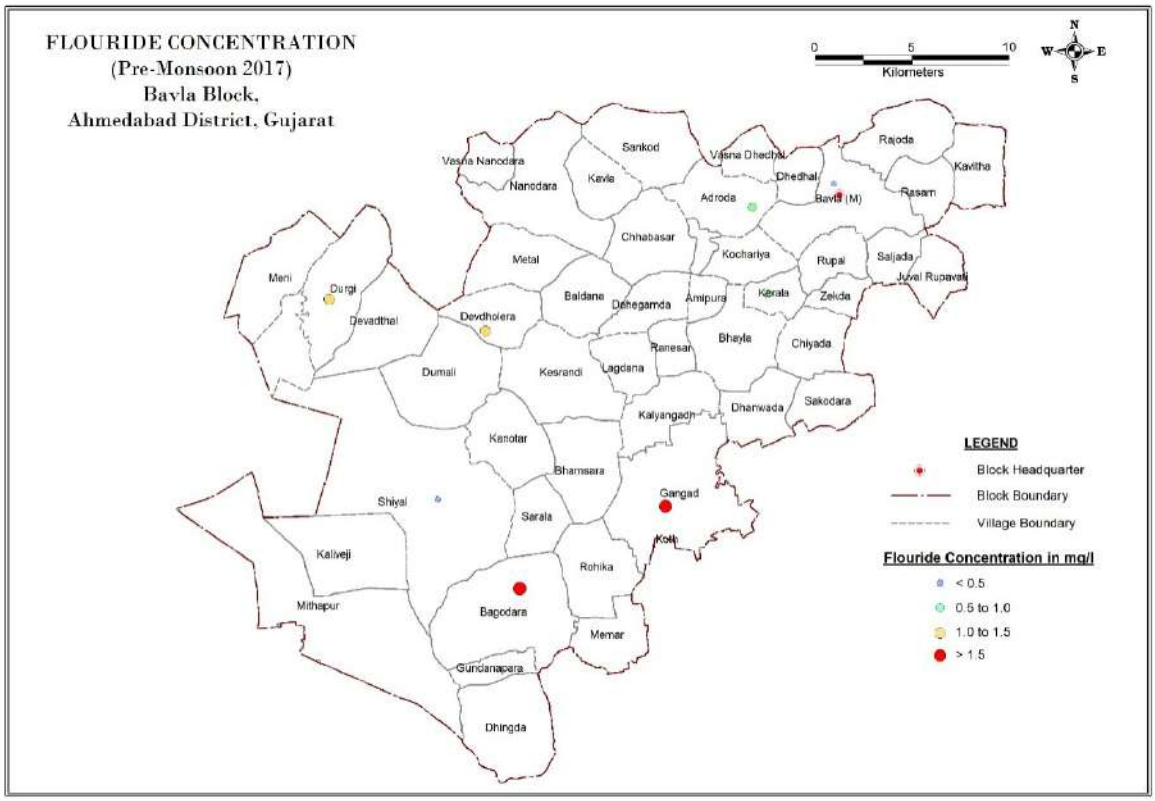


Fig.14: Fluoride Map- Unconfined Aquifer

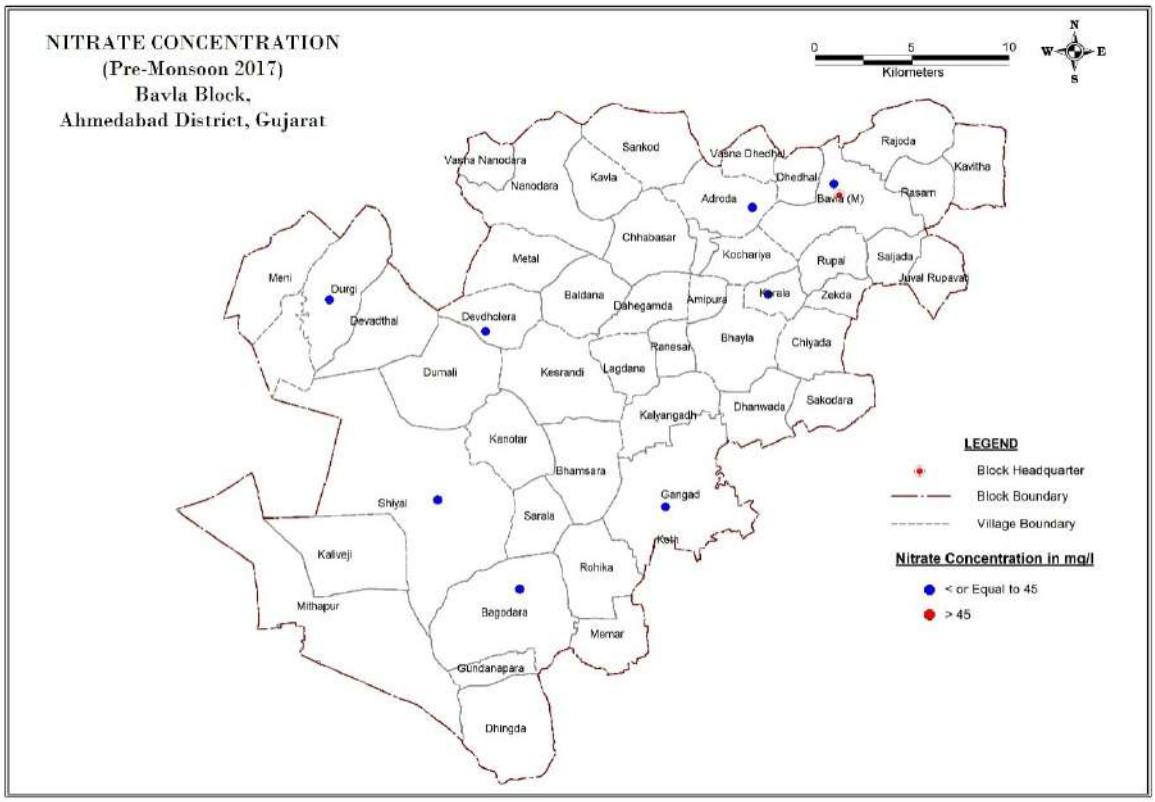


Fig.15: Nitrate Map- Unconfined Aquifer

6. Groundwater issues

Decline in water levels in central part (Water level trend; -0.03 m/yr to -0.37 m/yr during pre-monsoon & -0.07 m/yr to -0.27 m/yr during post monsoon period). Ground water quality is saline in western part (Electrical conductivity varies from 969 to 26859 µS/cm in phreatic aquifer) and fluoride above BIS standard found in southern part of taluka.

7. Groundwater Management

Supply Side management-Proposed Recharge Structures- Percolation tank- 13 nos. (in Existing village ponds) & net water recharge through shaft is 1.75 MCM. In Demand Side Management Micro Irrigation System proposed in 2901.72 ha area and water saving is 4.35 MCM. Net water saving : 6.1 MCM.

Supply Side Intervention	
Volume of subsurface storage space available of artificial recharge (MCM)	905.91
Surplus available (MCM)	1.75
Percolation tank proposed	13
Water availability after additional recharge	1.75 MCM

Demand Side Intervention	
Use of Micro Irrigation Systems (Drift & Sprinkler)	
Irrigated area proposed under MIS* (Ha)	2901.72
Water saving by MIS (MCM)	4.35

8. Artificial Recharge & Conservation Possibilities

Ground water resources in the taluka should be augmented by means artificial recharge through percolation tanks. In saline area of the taluka surface runoff may harvest by constructing ponds. Adoption of Micro Irrigation system in the taluka would lead to considerable saving of ground water and improve stage of ground water from 48.88 % to 40.01%.

MANAGEMENT PLAN OF

DASCROI TALUKA, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	451.27 sq. km		
No. of Town, villages	64		
Population (2011 Census)	321817		
Average Annual Rainfall	505.20		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources, City & Dascroi (2017)	Fresh: 240.99 MCM		
Net Groundwater Draft, City & Dascroi (2017)	Fresh: 205.10 MCM		
Stage of Groundwater Development City & Dascroi (2017)	85.11 % (Semi Critical)		
Existing and future water demands (MCM) City & Dascroi (2017)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	24.10	5.55
	Irrigation	181	54.44

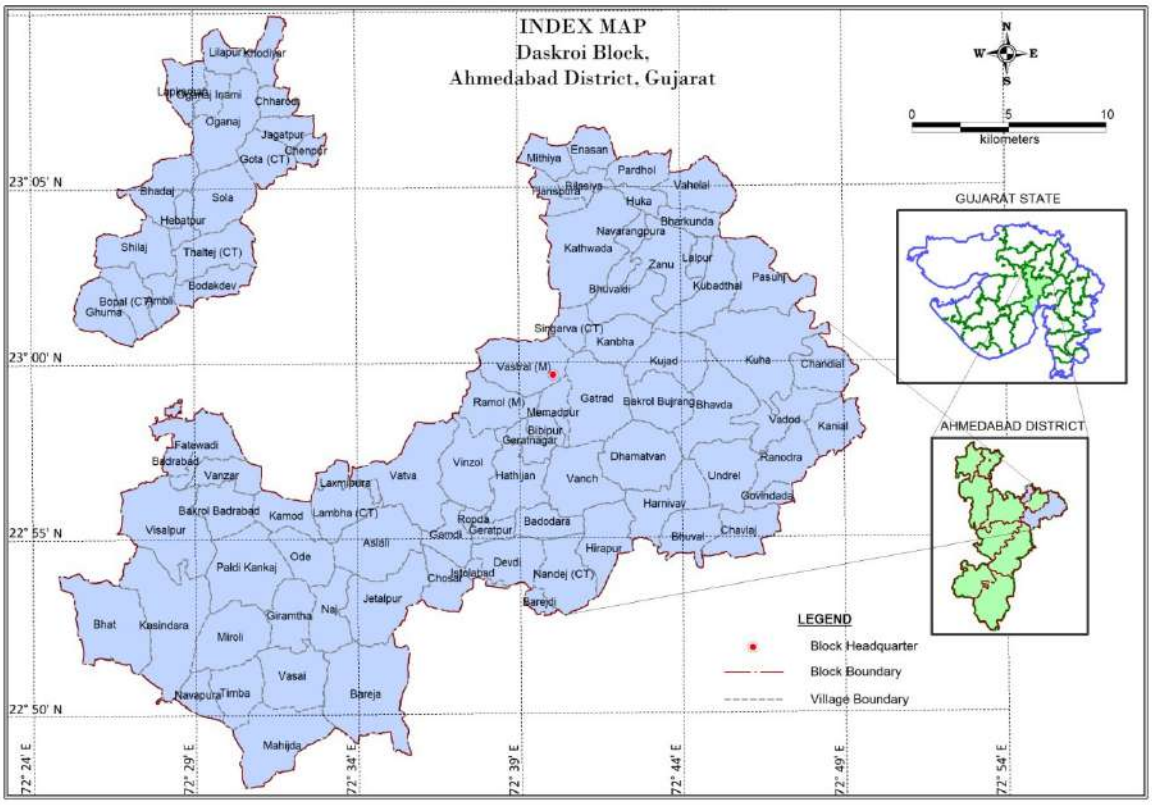


Fig. 1: Location Map

1. Land Use Classification

Table: 1 Land Use Classification

Taluka Name	Daskroi
Area according to village papers (Ha)	69887
Area under Forest (Ha)	0
Barren & uncultivable land (Ha)	705
Land put to non agricultural uses (Ha)	8330
Cultivable waste (Ha)	950
Permanent pastures & other grazing lands (Ha)	5638
Current fallow (Ha)	602
Fallow land other than current fallow (Ha)	0
Net area sown (Ha)	53632
Area sown more than once (Ha)	9528
Gross Cropped area (Ha)	63160

2. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel. The groundwater quality is saline at shallow depths and there is wide variation in quality regionally.

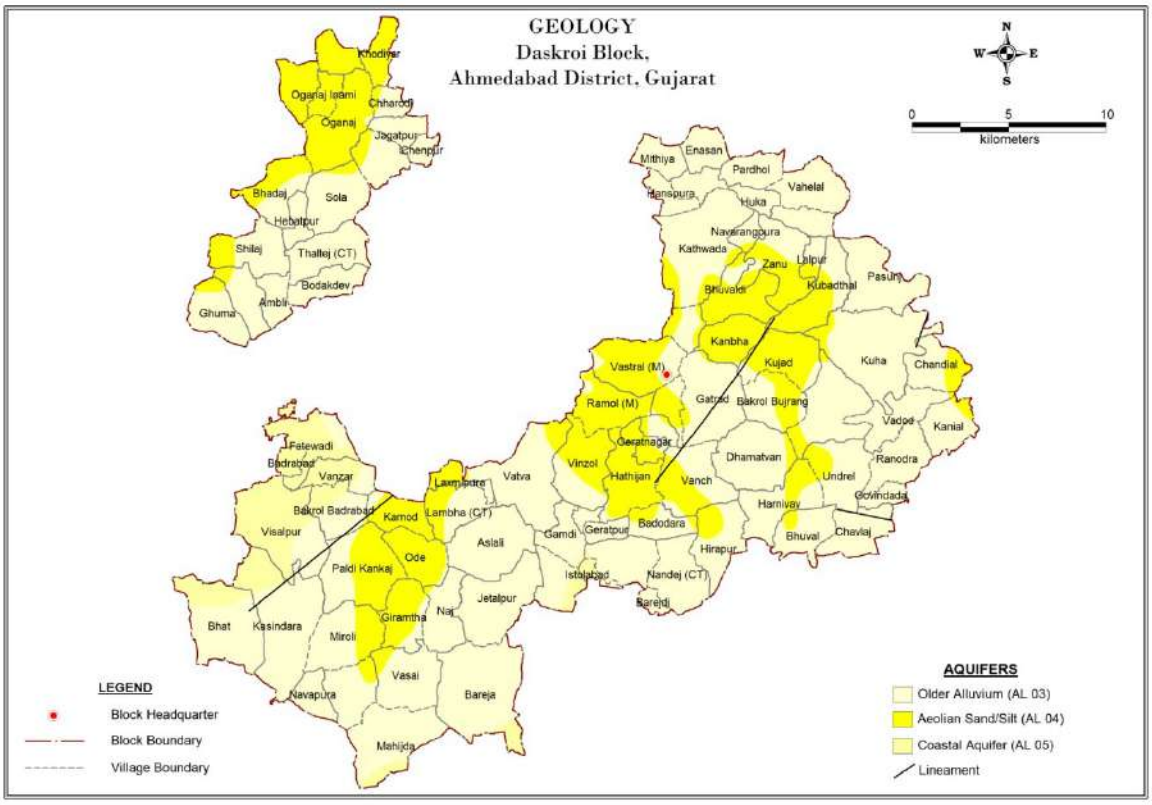


Fig.2: Major Aquifer

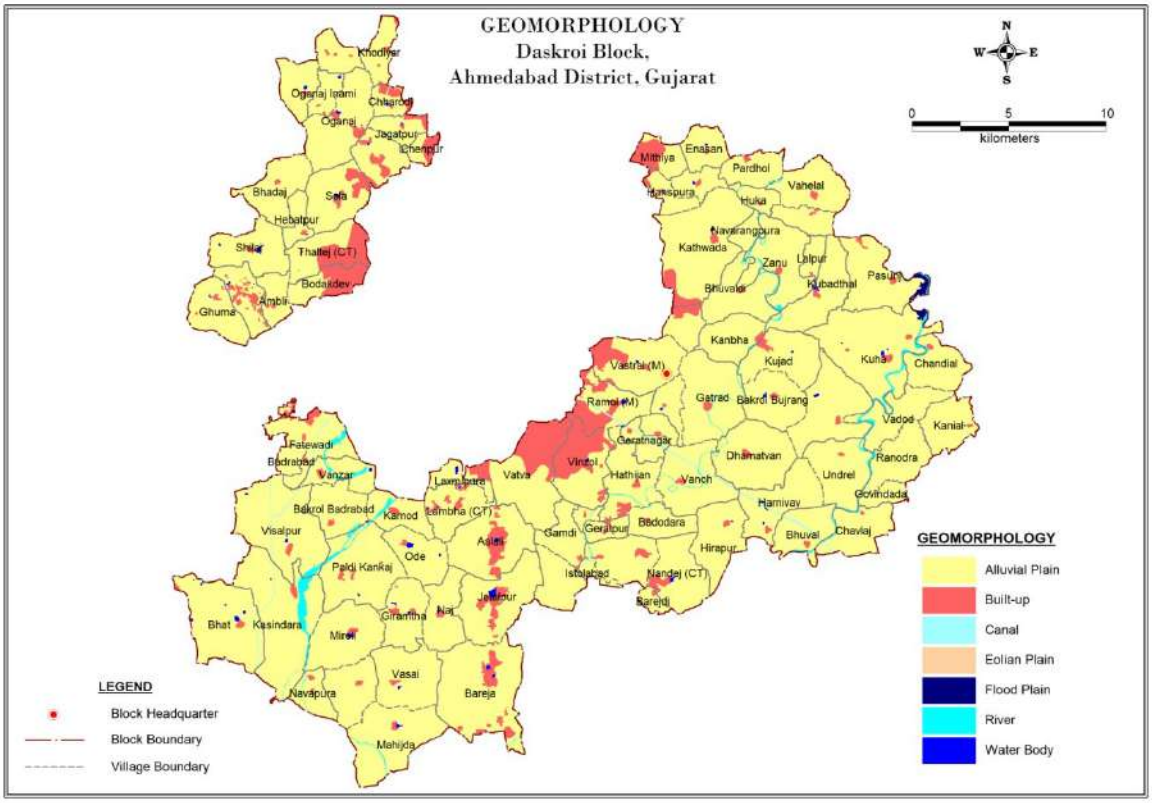


Fig.3: Geomorphology

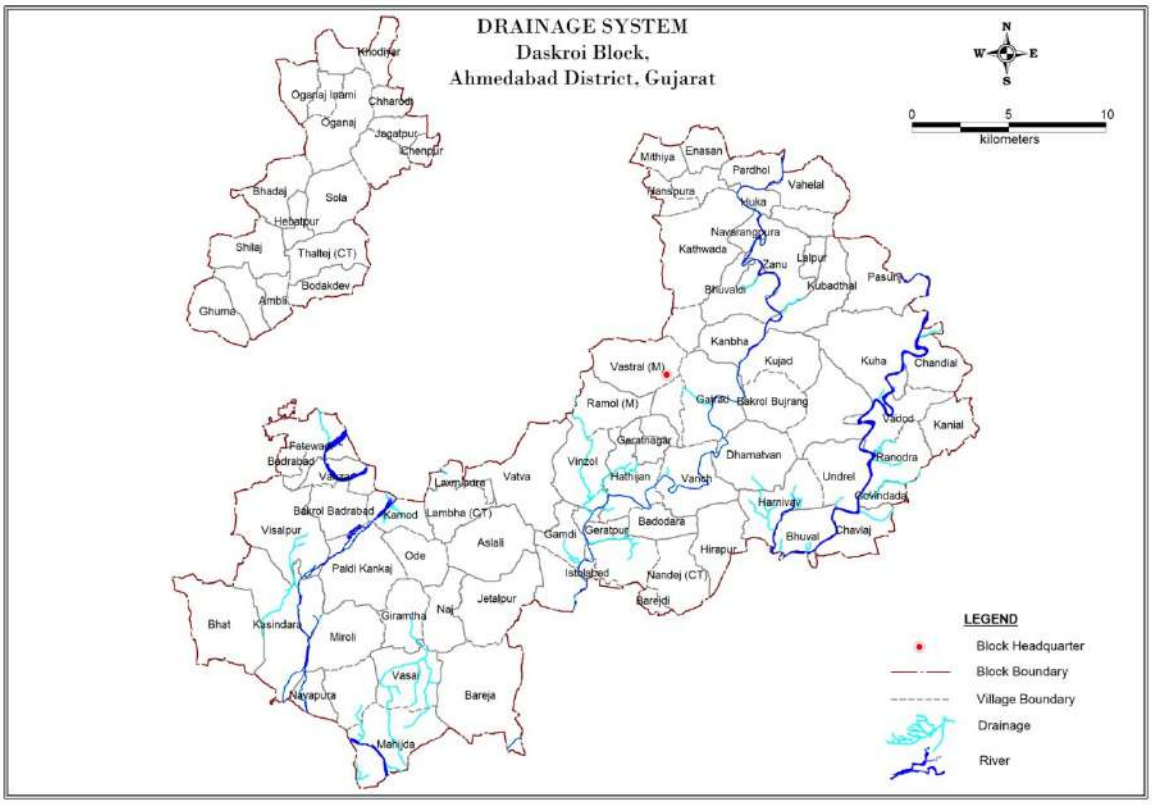


Fig. 4: Drainage Map

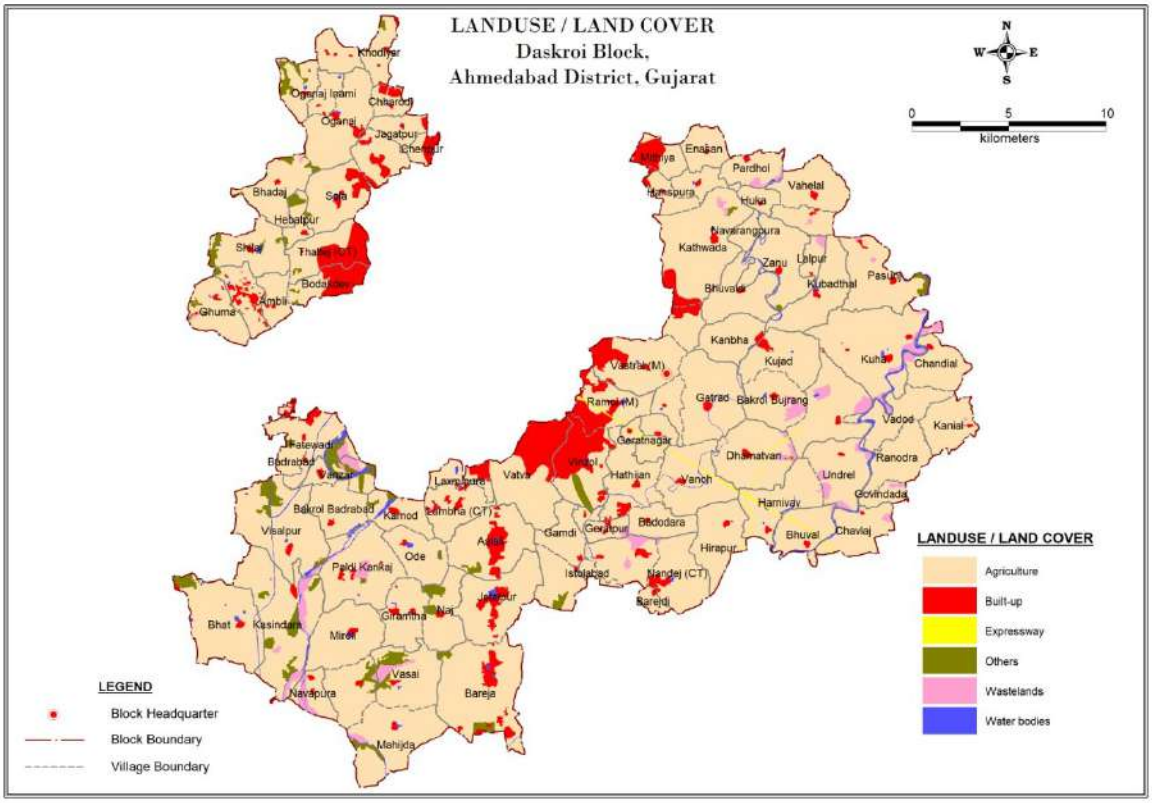


Fig. 5: Land Use Land Cover

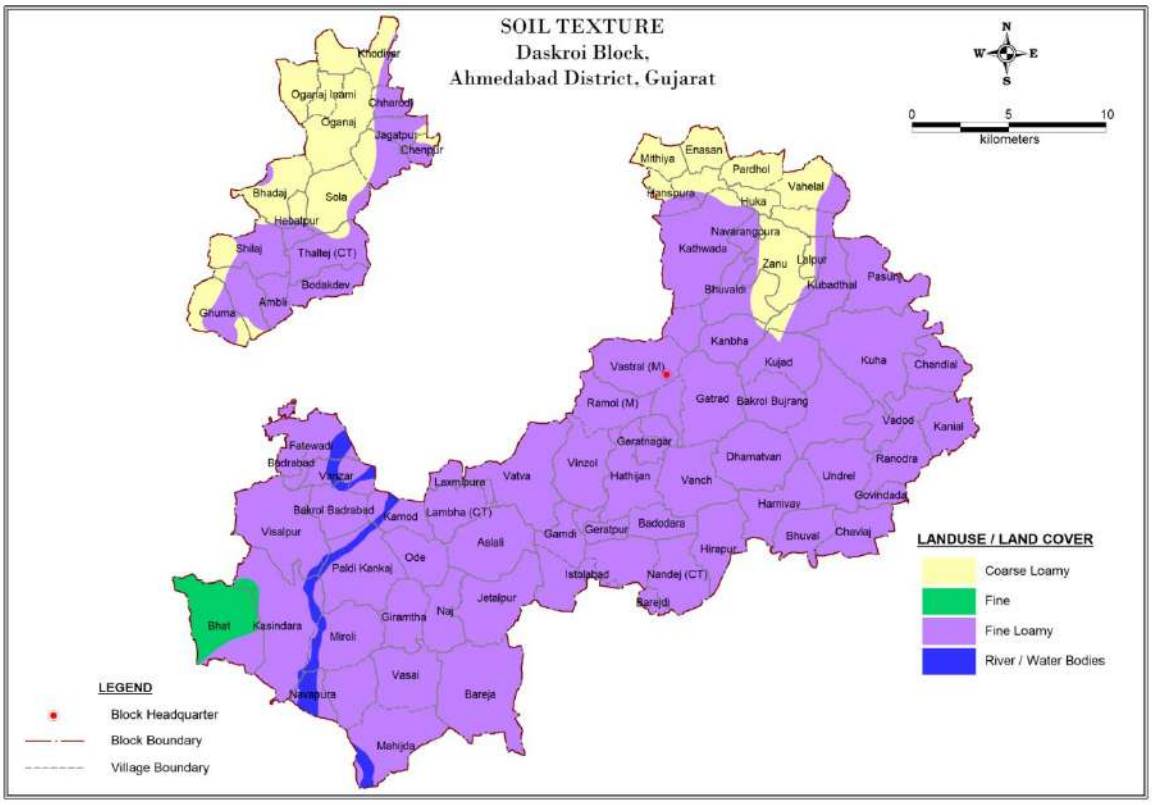


Fig. 6: Soil Map

3. Subsurface Hydrogeology

The area has multi-layer aquifer system. Aquifer I (unconfined) depth of occurrence upto 62 mbgl , Aquifer II (confined) depth of occurrence 83 to 126 mbgl , Aquifer III (confined) depth of occurrence 156 to 218 mbgl, Aquifer IV (confined) depth of occurrence 201 to 219 mbgl. Aquifer I (unconfined) thickness varies from 48 to 62 mt. Aquifer II (confined) thickness varies from 39 to 43 m, Aquifer III (confined) thickness varies from 30 to 62 m, Water level of aquifer I varies from 0.65 to 42.22 mbgl, Piezometric head of aquifer II varies from 26.11 to 63.9 mbgl, Piezometric head of aquifer III varies from 87 to 104 mbgl. In Aquifer I (unconfined) discharge 4 lps Aquifer II (confined) discharge 1 lps, Aquifer III (confined) discharge varies from 1.16 to 4 lps.

Hydrogeological section for Daskroi Taluka Depicting Aquifer

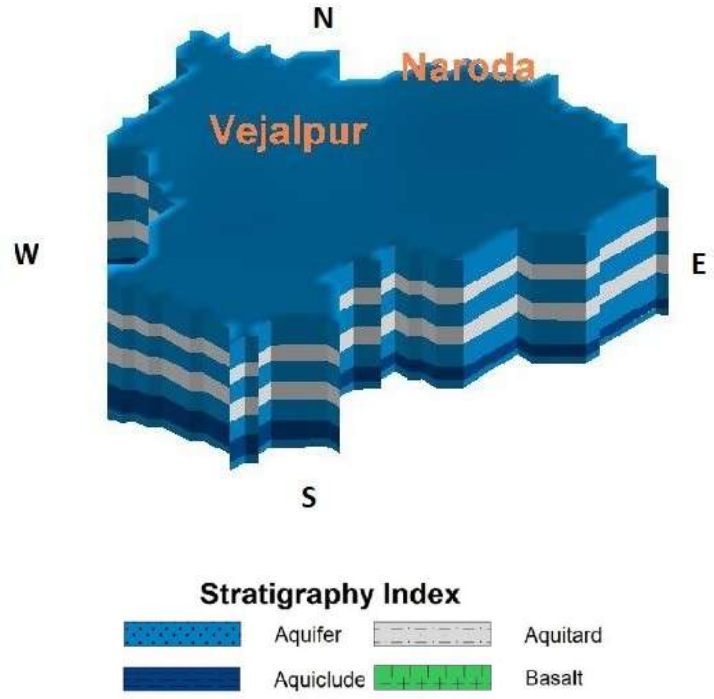


Fig.7: 3D Solid Model of Daskroi Taluka Depicting Aquifer

Table: 2 Aquifer Characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lps)	Quality/EC µS/cm	Water Level/ Piezometric head (mbgl)
Aquifer I	Upto 62	48 to 62	4	2670	0.65 to 42.22
Aquifer II (Confined)	83 to 126	39 to 43	1	3010	26.11 to 63.9
Aquifer III (Confined)	156 to 218	30 to 62	1.16 to 4	1099 to 1855	87 to 104
Aquifer IV (Confined)	201 to 219	18	-	-	-

4. Aquifer Group wise Water Level maps

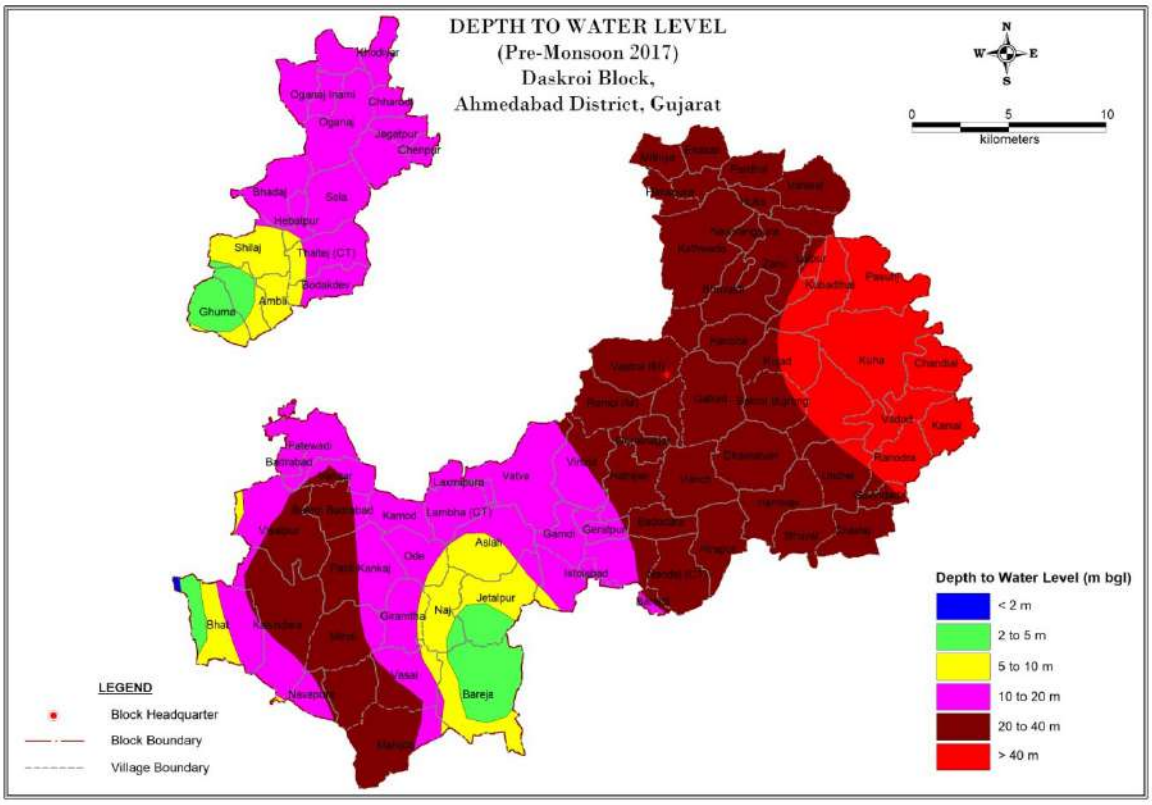


Fig.8: Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

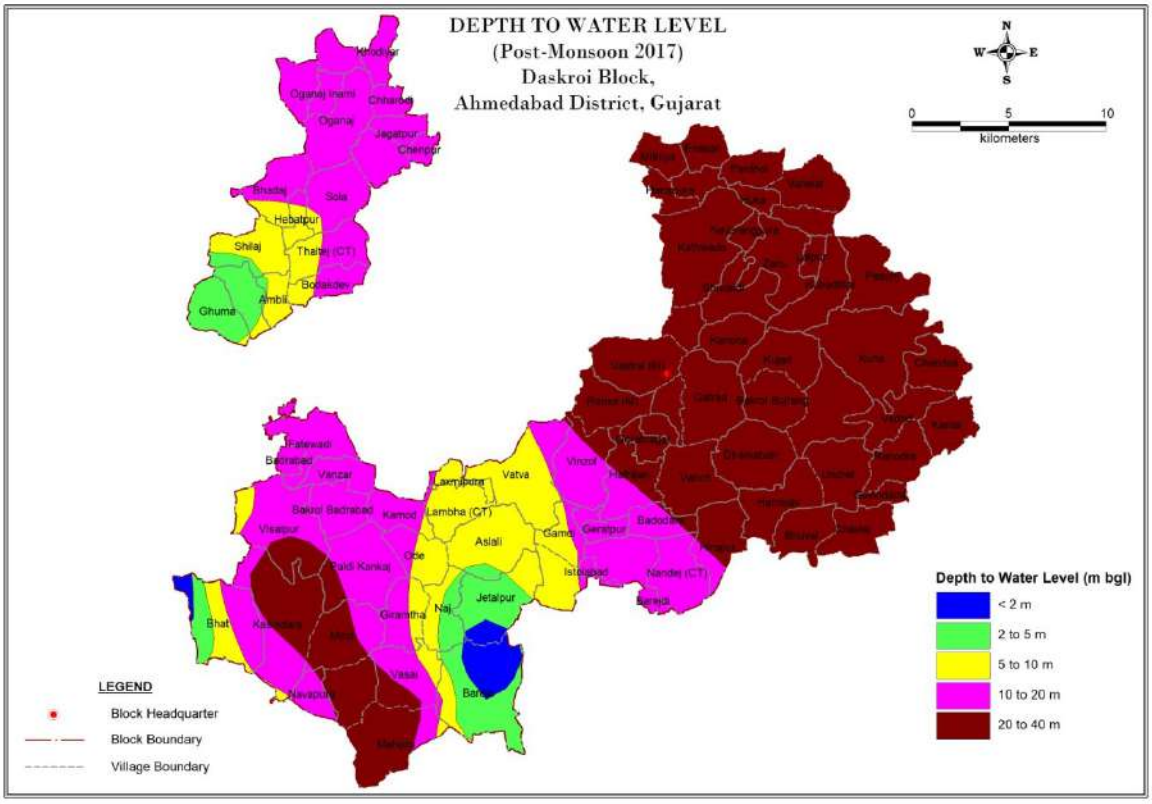


Fig.9: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

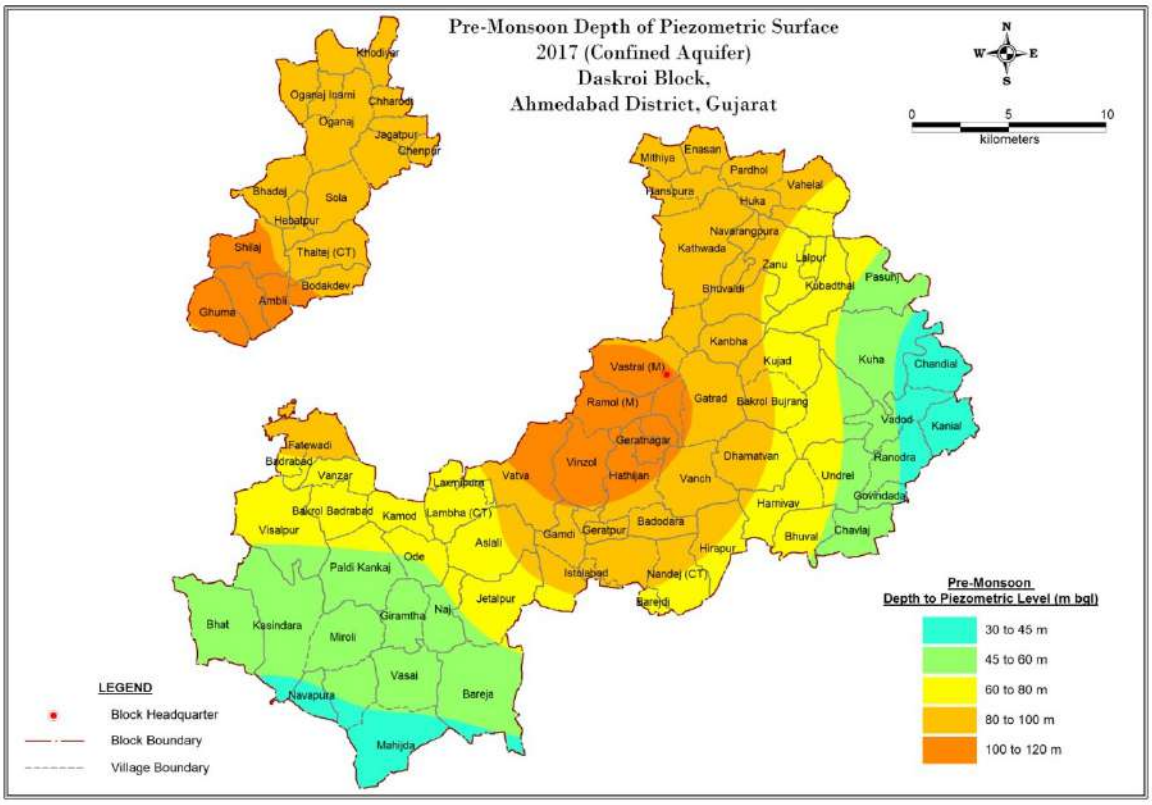


Fig.10: Pre-Monsoon Depth of Piezometric Surface- Confined Aquifer

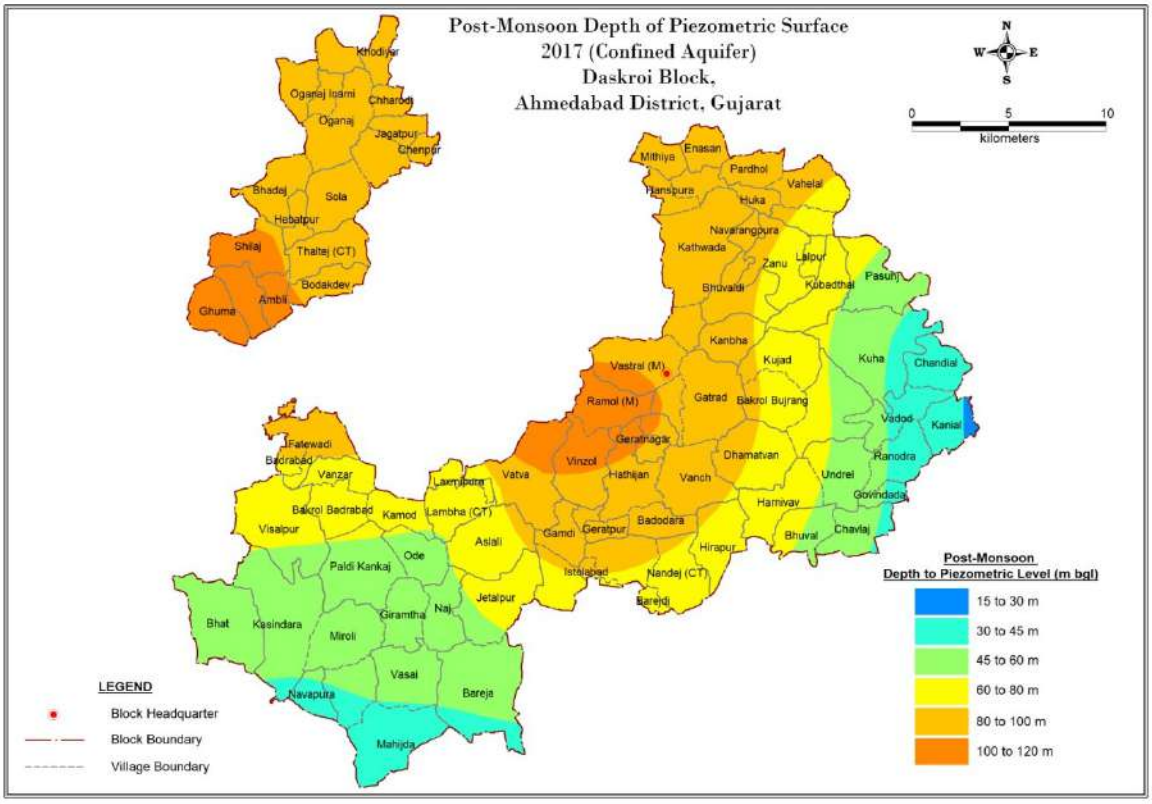


Fig.11: Post-Monsoon Depth of Piezometric Surface- Confined Aquifer

4. Dynamic Ground Water Resources in MCM

Total fresh groundwater availability of the Ahmedabad city and Dascroi is estimated in year 2017 is 240.99 MCM and total groundwater withdrawal for all purposes is 205.10 MCM. The stage of groundwater development is 111.07% and the Taluka is categorized “Semi Critical”.

Table: 3 Dynamic Groundwater resources 2017

S No	Item	Fresh
1	Area, Ahmedabad City and Dascroi (sq.km)	956.27
2	Total GW Recharge (MCM)	253.67
3	Net GW Availability (MCM)	240.99
4	Gross Draft (MCM)	205.10
5	Net Availability for Future Irrigation (MCM)	54.44
6	Stage of GW Development %	85.11

5. Chemical Quality of groundwater

Phreatic Aquifer (Aquifer I); TDS value more than 2000 ppm is found mostly in south and western part of taluka. Suitable for drinking and agriculture.

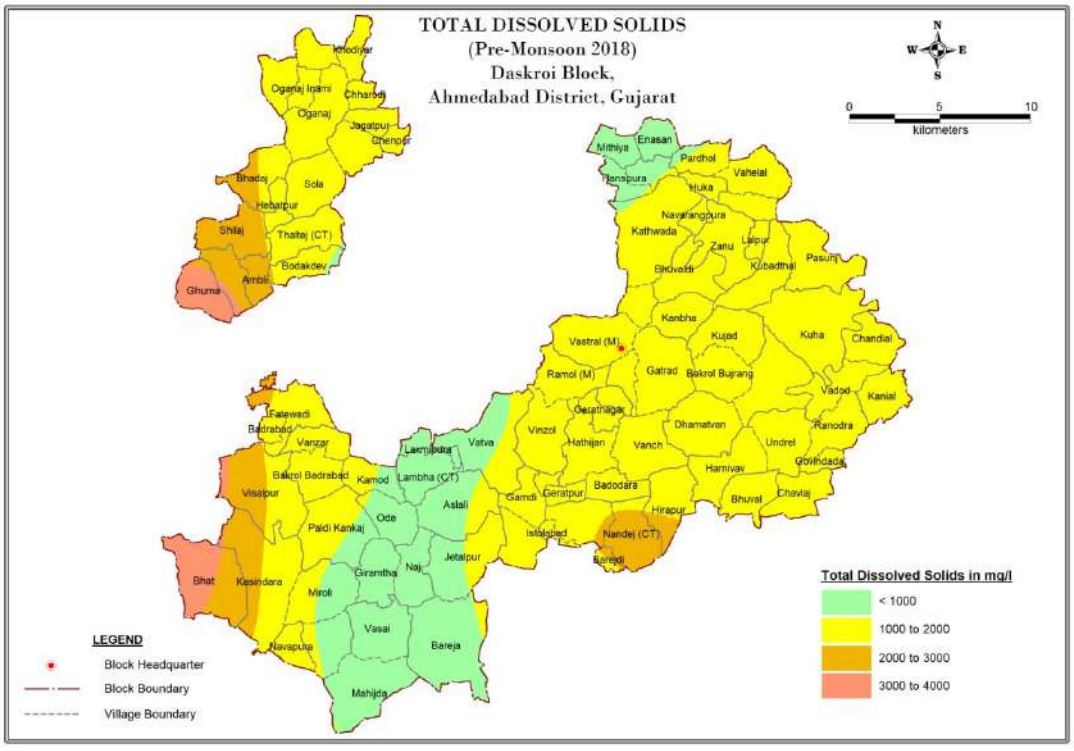


Fig.12: Total Dissolved Solids (TDS) Map- Unconfined Aquifer

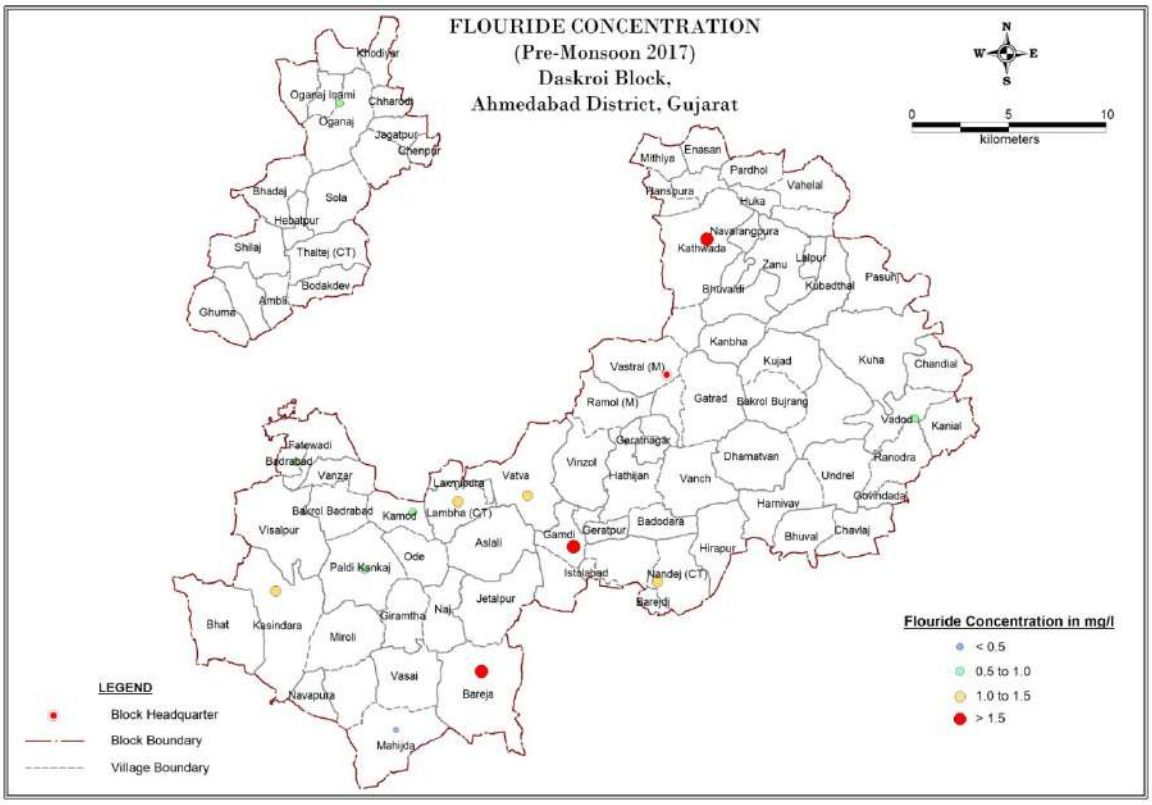


Fig. 13: Fluoride Map- Unconfined Aquifer

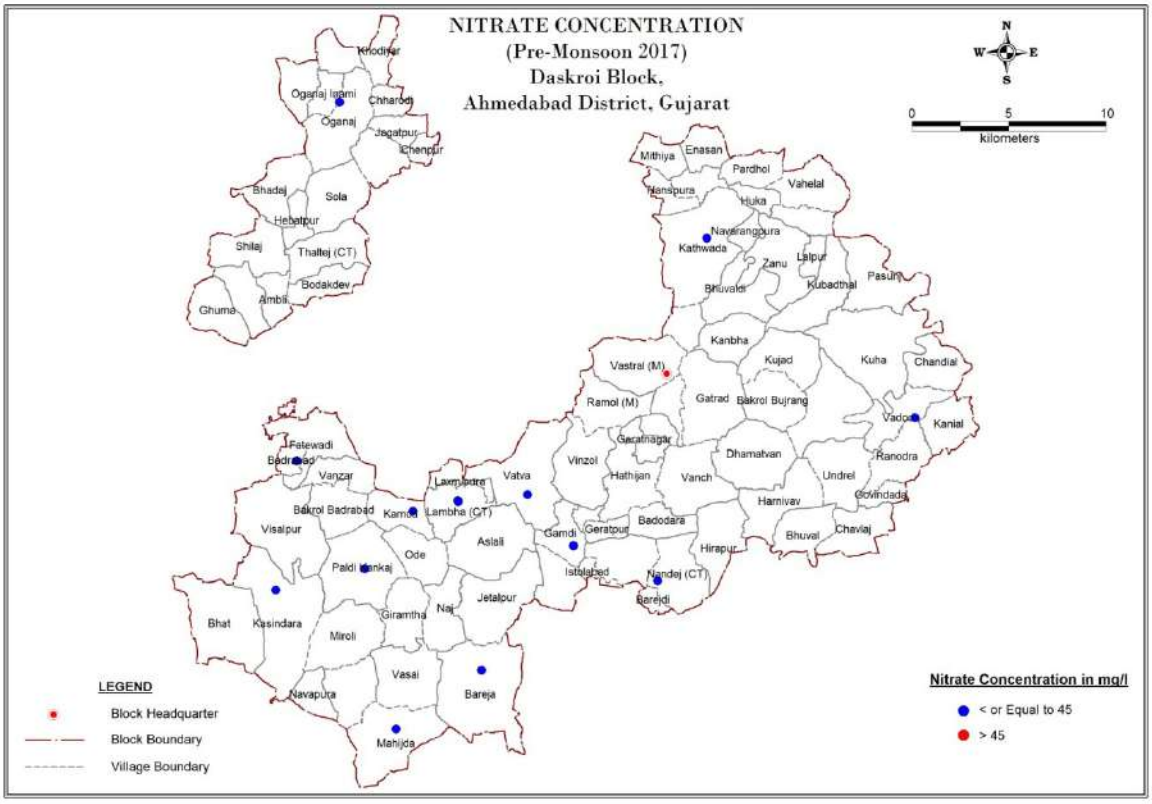


Fig. 14: Nitrate Map- Unconfined Aquifer

6. Groundwater issues

Depletion of Ground Water (phreatic aquifer), depth to water level varies from 0.66 to 42.22 mbgl. Deeper water level is found in north-eastern and eastern part of taluka. Fluoride above BIS standard found in scattered in the taluka.

7. Groundwater Management

Supply Side management-Proposed Recharge Structures- Recharge Shaft-102 nos. (in Existing village ponds) & percolation tank 30 nos., net rain water recharge through shaft & percolation tank is 7.25 MCM. In Demand Side Management Micro Irrigation System proposed in 18692.55 ha area and water saving is 28.04 MCM. Net water saving: 35.29 MCM.

Table: 3 Supply Side Intervention

Supply Side Intervention	
Volume of subsurface storage space available of artificial recharge (MCM)	3496.20
Surplus available (MCM)	7.25
Recharge Shaft proposed in existing ponds/water bodies	102
Percolation tank proposed	30
Water availability after additional recharge	7.25 MCM

Table: 4 Demand Side Intervention

Demand Side Intervention	
Use of Micro Irrigation Systems (Drift & Sprinkler)	
Irrigated area proposed under MIS* (Ha)	18692.55
Water saving by MIS (MCM)	28.04

8. Artificial Recharge & Conservation Possibilities

Ground water resources in the block augmented by means artificial recharge through recharge shafts and percolation tank and adoption of Micro Irrigation System in the taluka would lead to 35.29 MCM saving of ground water and improve stage of ground water from semi critical (85.11%) to safe category (69.23%).

MANAGEMENT PLAN OF
DETROJ RAMPURA TALUKA, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	350 sq. km		
No. of villages	52		
Population (2011 Census)	83199		
Average Annual Rainfall	632.70		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources (2017)	Fresh: 32.84 MCM		
Net Groundwater Draft	Fresh: 25.66 MCM		
Stage of Groundwater Development	78.13 % (Semi Critical)		
Existing and future water demands (MCM)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	1.42	1.67
	Irrigation	24.24	6.93

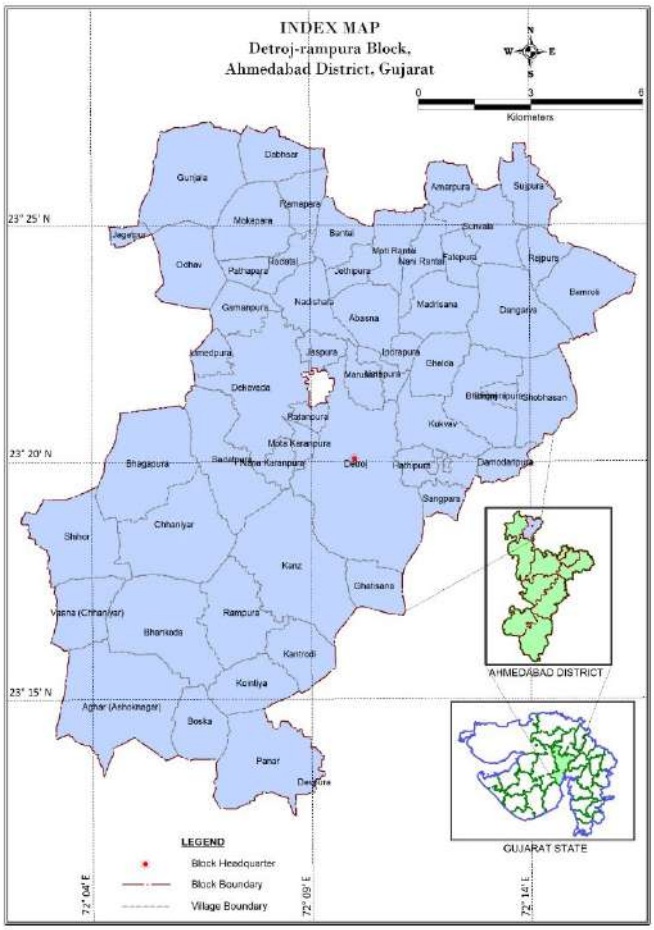


Fig. 1: Location Map

1. Land Use Classification

Table: 1 Land Use Classification

Taluka Name	**Detroj-Rampura**
Area according to village papers (Ha)	33304
Area under Forest (Ha)	0
Barren & uncultivable land (Ha)	888
Land put to non agricultural uses (Ha)	2530
Cultivable waste (Ha)	1003
Permanent pastures & other grazing lands (Ha)	945
Current fallow (Ha)	109
Fallow land other than current fallow (Ha)	0
Net area sown (Ha)	27829
Area sown more than once (Ha)	11100
Gross Cropped area (Ha)	38929

2. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel. The groundwater quality is saline at shallow depths and there is wide variation in quality regionally.

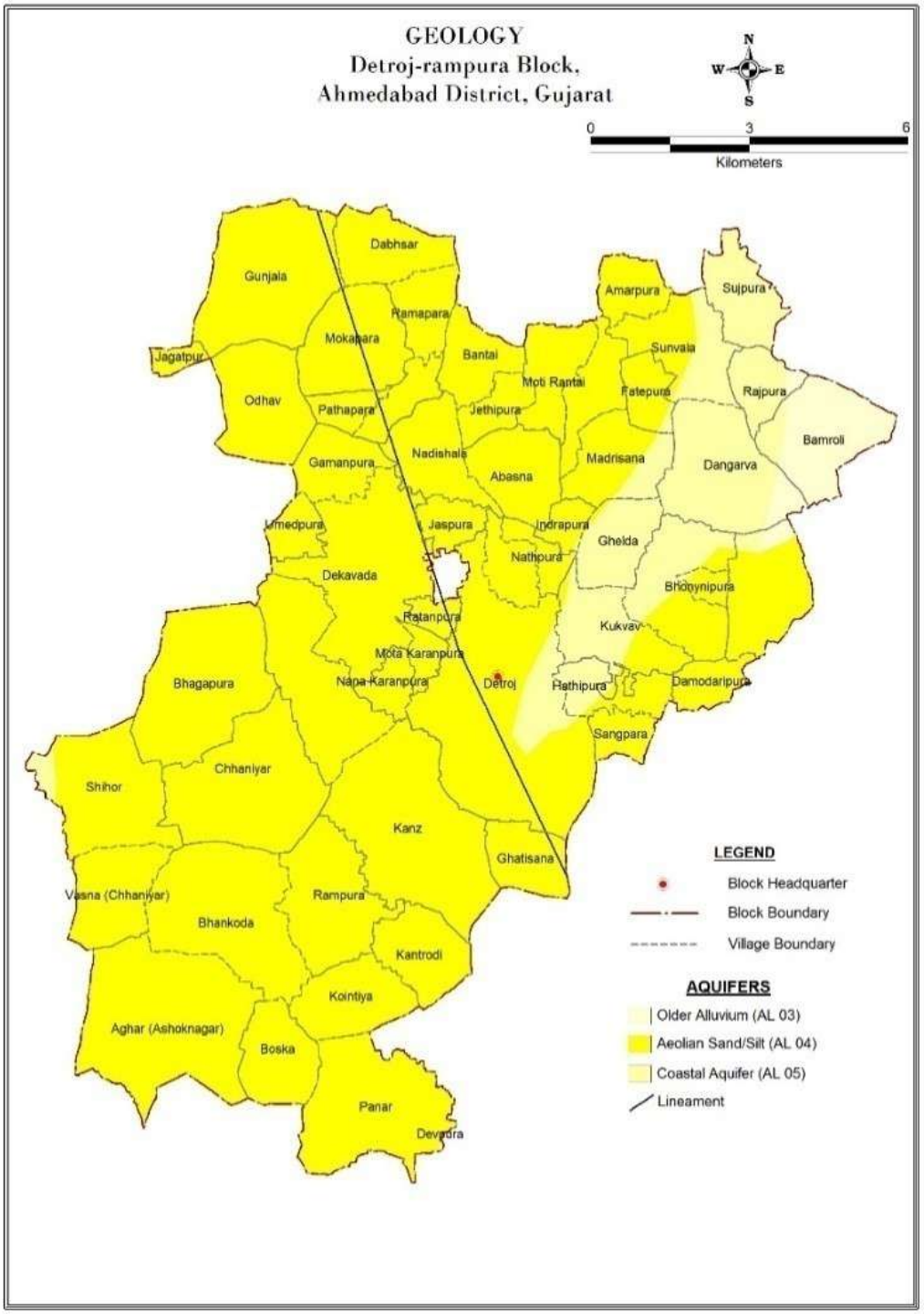


Fig.2: Major Aquifer

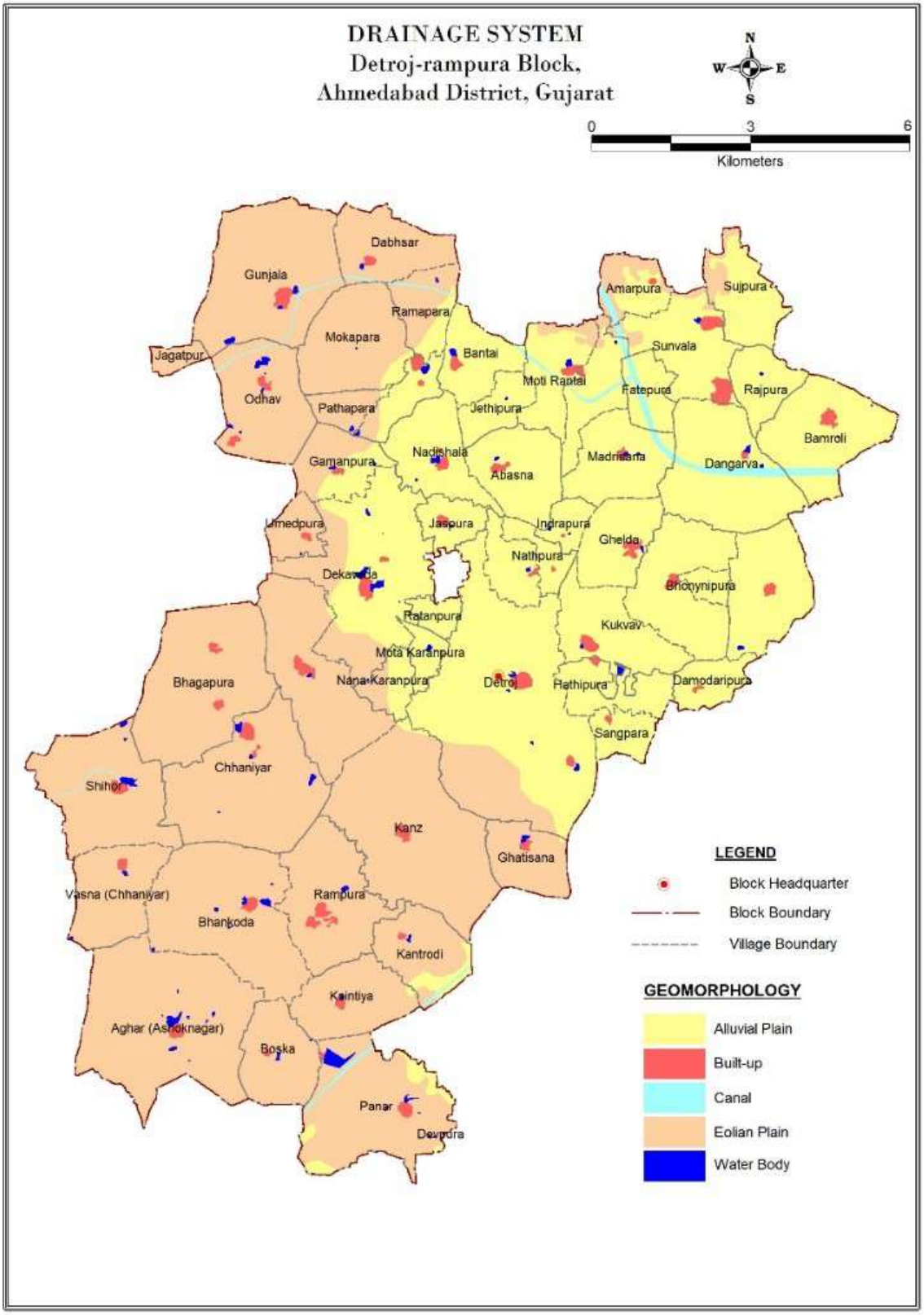


Fig.3: Geomorphology

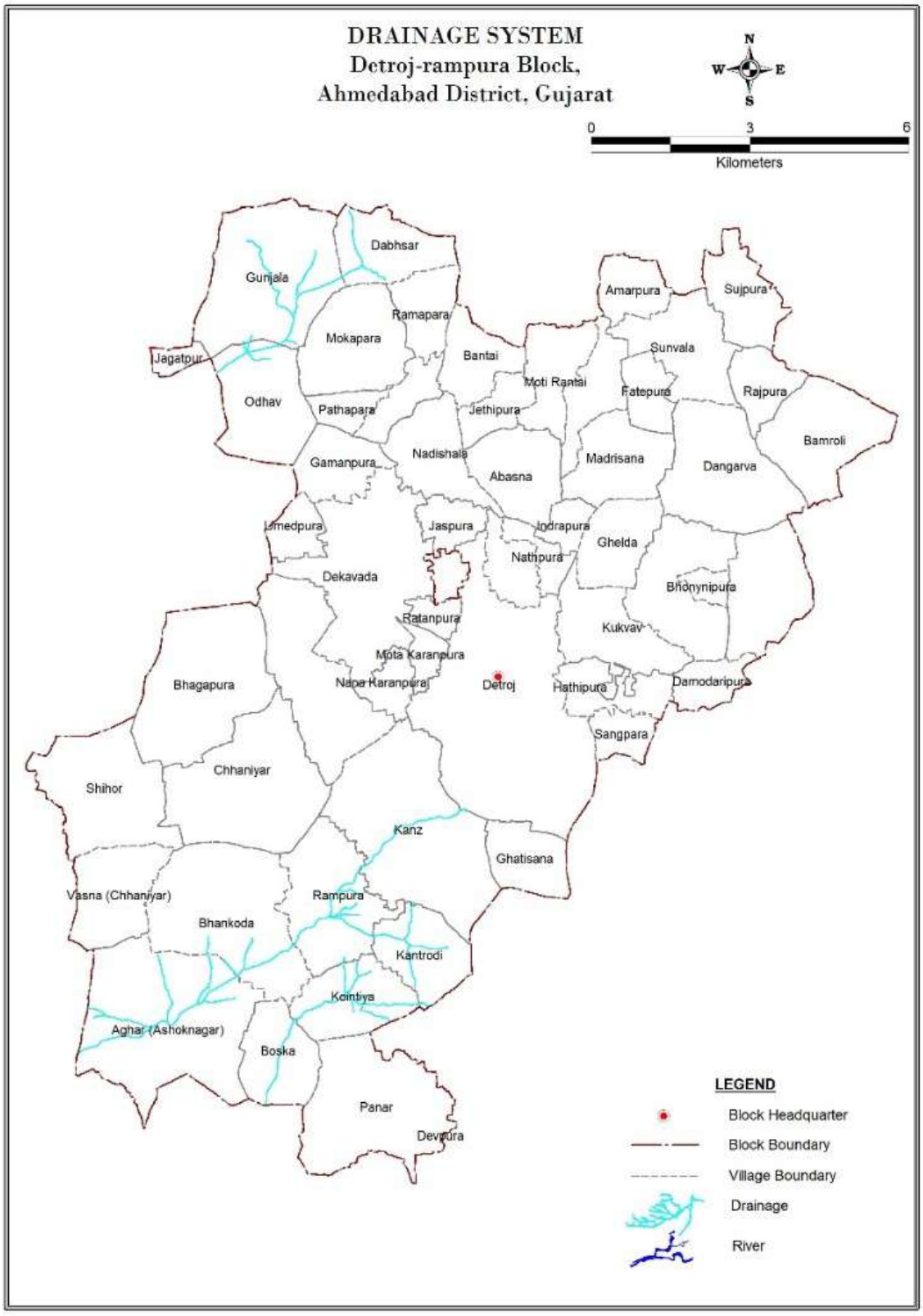


Fig. 4: Drainage Map

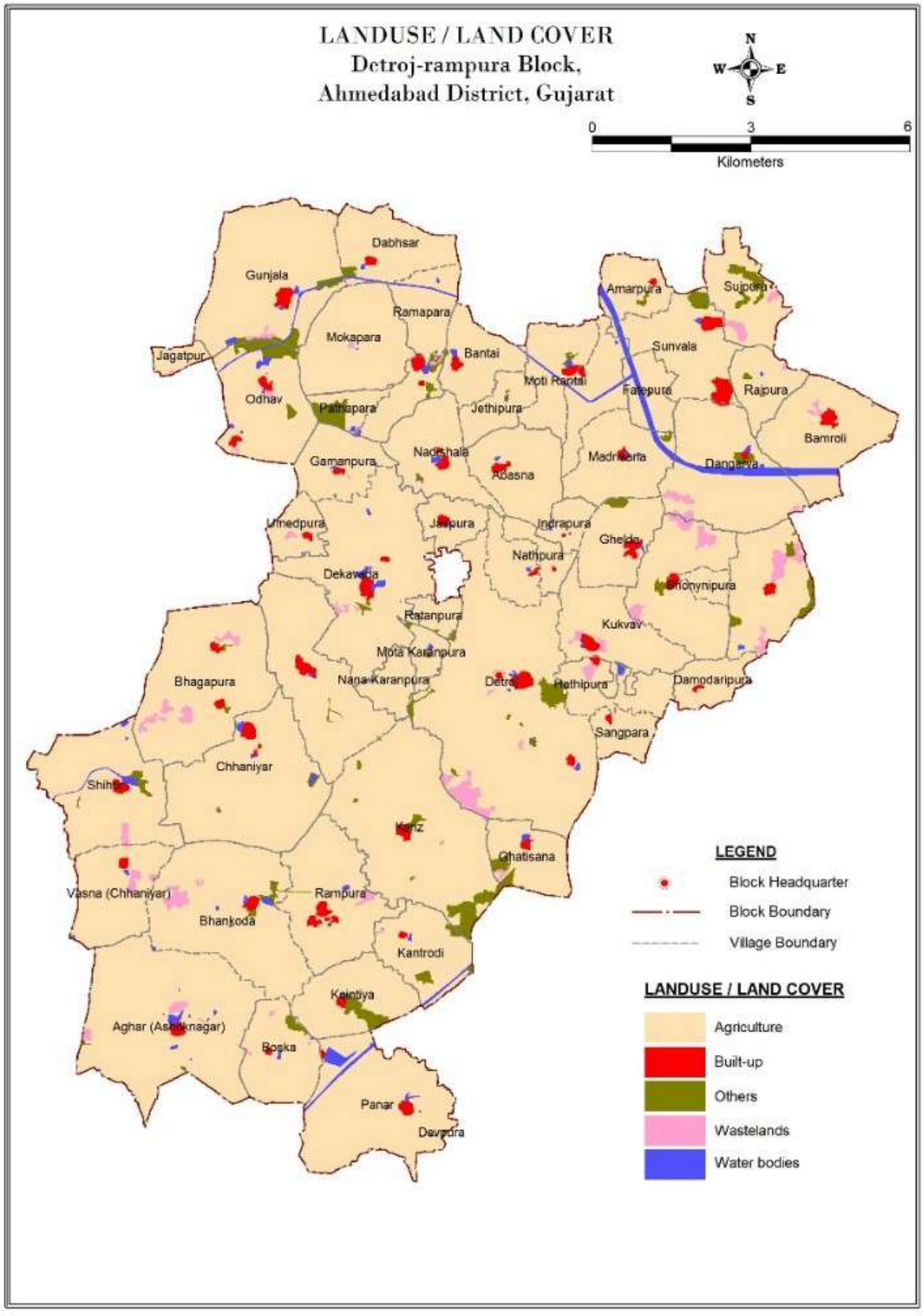


Fig. 5: Land Use Land Cover

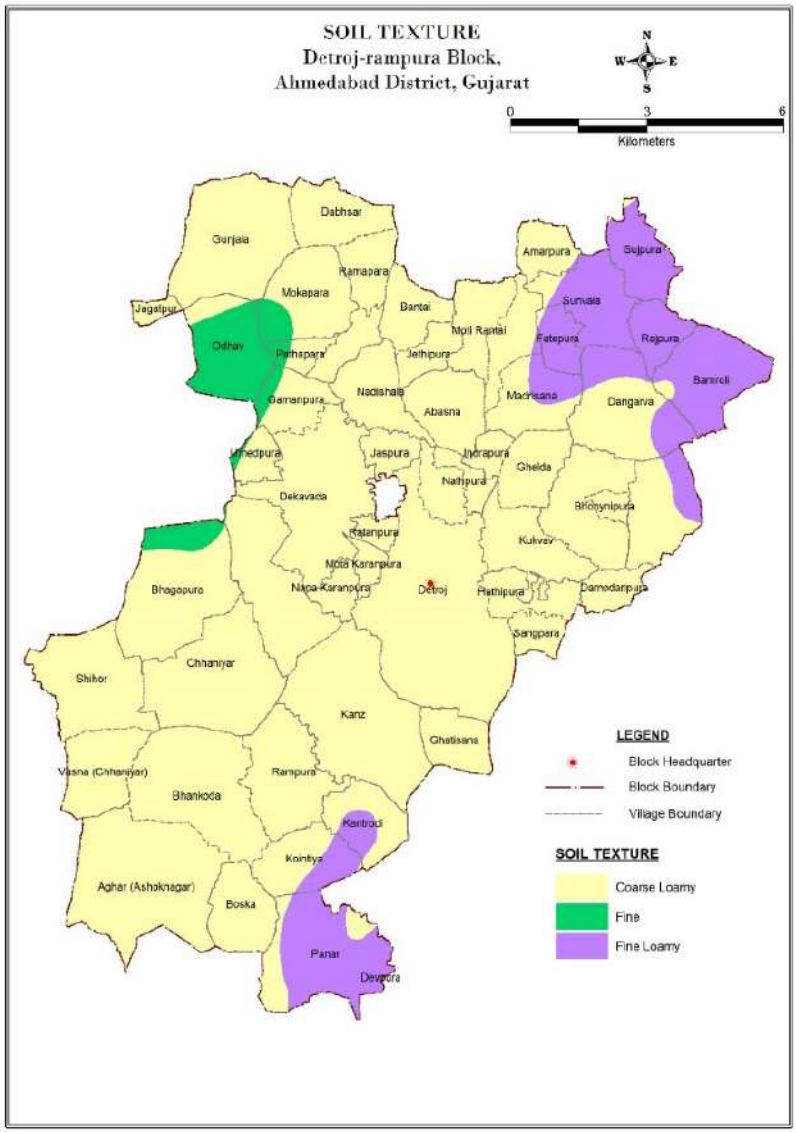


Fig. 6 Soil Map

3. Subsurface Hydrogeology

The area has multi-layer aquifer system. Aquifer I (unconfined) depth of occurrence upto 62 mbgl , Aquifer II (confined) depth of occurrence 73 to 135 mbgl , Aquifer III (confined) depth of occurrence 143 to 200 mbgl, Aquifer IV (confined) depth of occurrence 255 to 300 mbgl. Aquifer I (unconfined) thickness varies from 57 to 62 mt. Aquifer II (confined) thickness varies from 37 to 60 m, Aquifer III (confined) thickness varies from 45 to 57 m, Water level of aquifer I varies from 9.10 to 45.10 mbgl. In Aquifer I (unconfined) discharge 12 to 21 lps Aquifer II (confined) discharge 1.2 lps, Aquifer III (confined) discharge varies from 1 to 1.75 lps.

Hydrogeological section for Detroj Rampura Taluka Depicting Aquifer

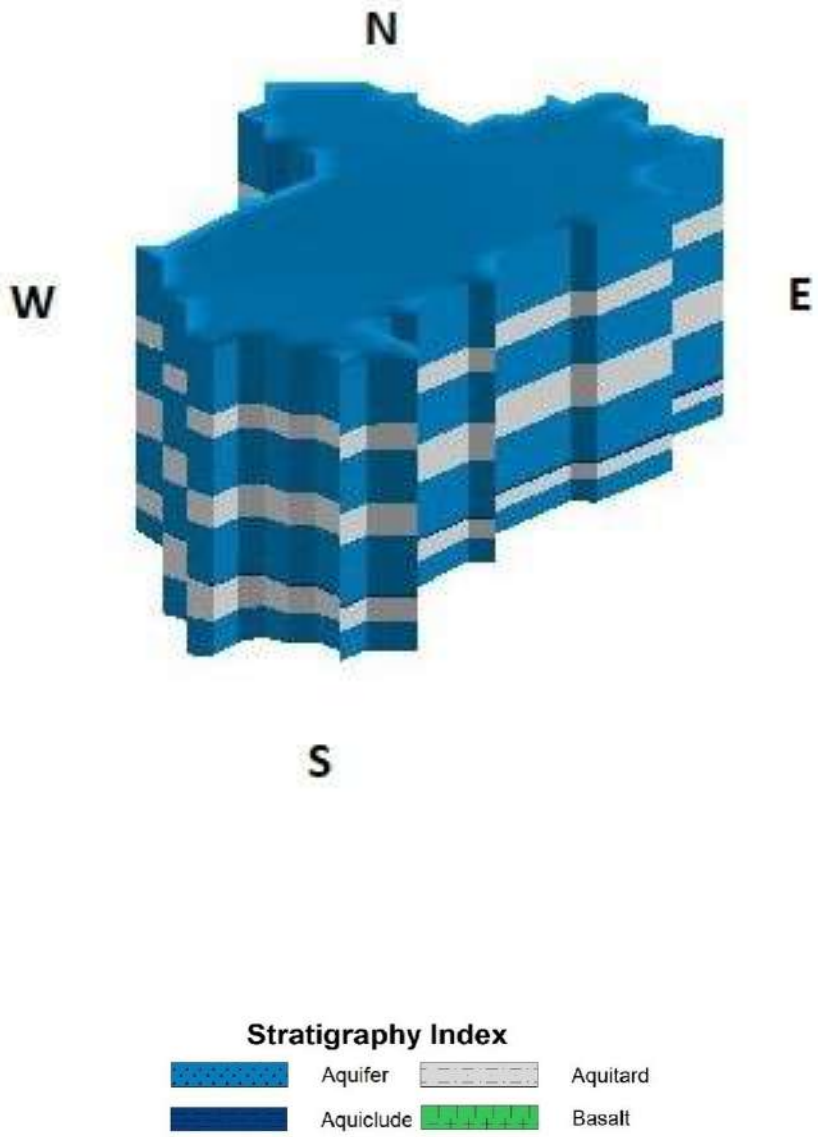


Fig.7: 3D Solid Model of Detroj Rampura Taluka Depicting Aquifer

Table; 2 Aquifer characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lps)	Quality/Ec µS/cm	Water Level/ Piezometric head (mbgl)
Aquifer I	0 to 62	57 to 62	12 to 21	2078 to 20297	9.10 to 45.10
Aquifer II (Confined)	73 to 135	37 to 60	1.2	5660	-
Aquifer III (Confined)	143 to 200	45 to 57	1 to 1.75	2500 to 2780	-
Aquifer IV (Confined)	255 to 300	45			

Aquifer Group wise Water Level maps

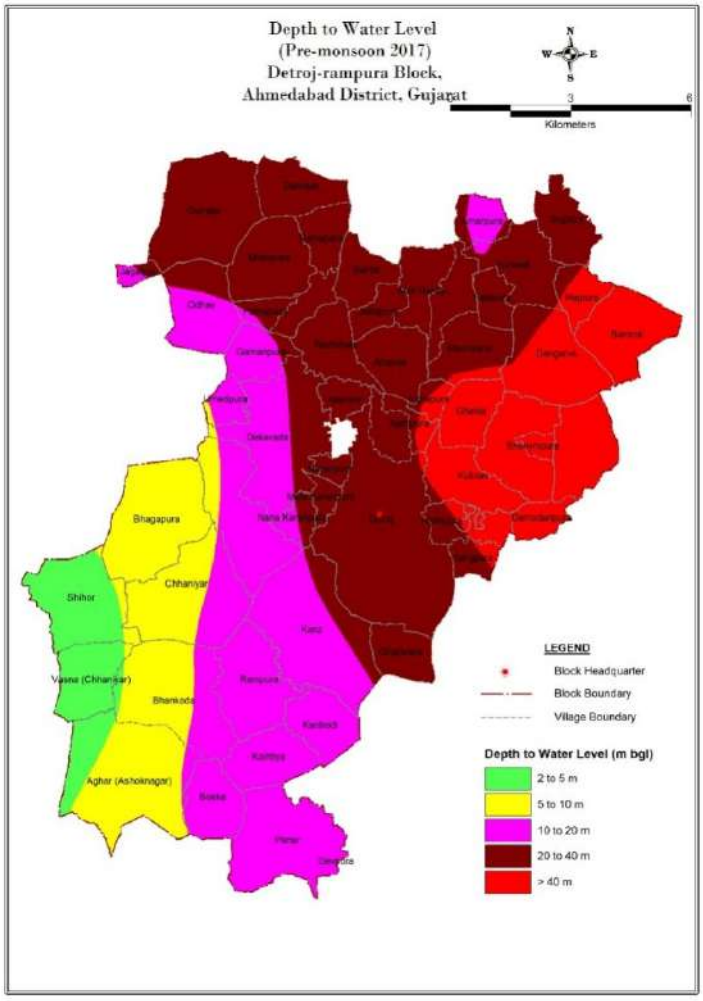


Fig.8: Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

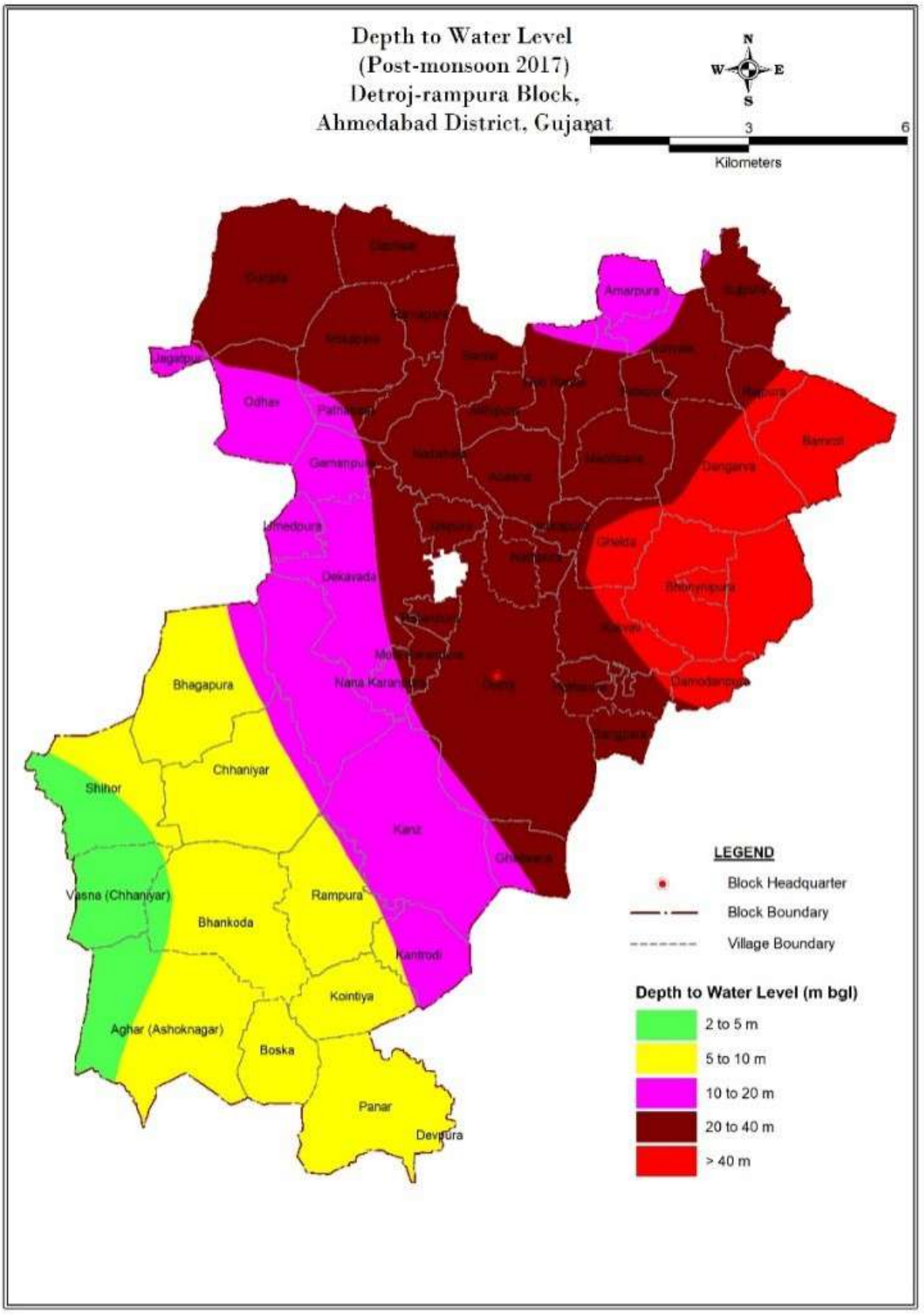


Fig. 9: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

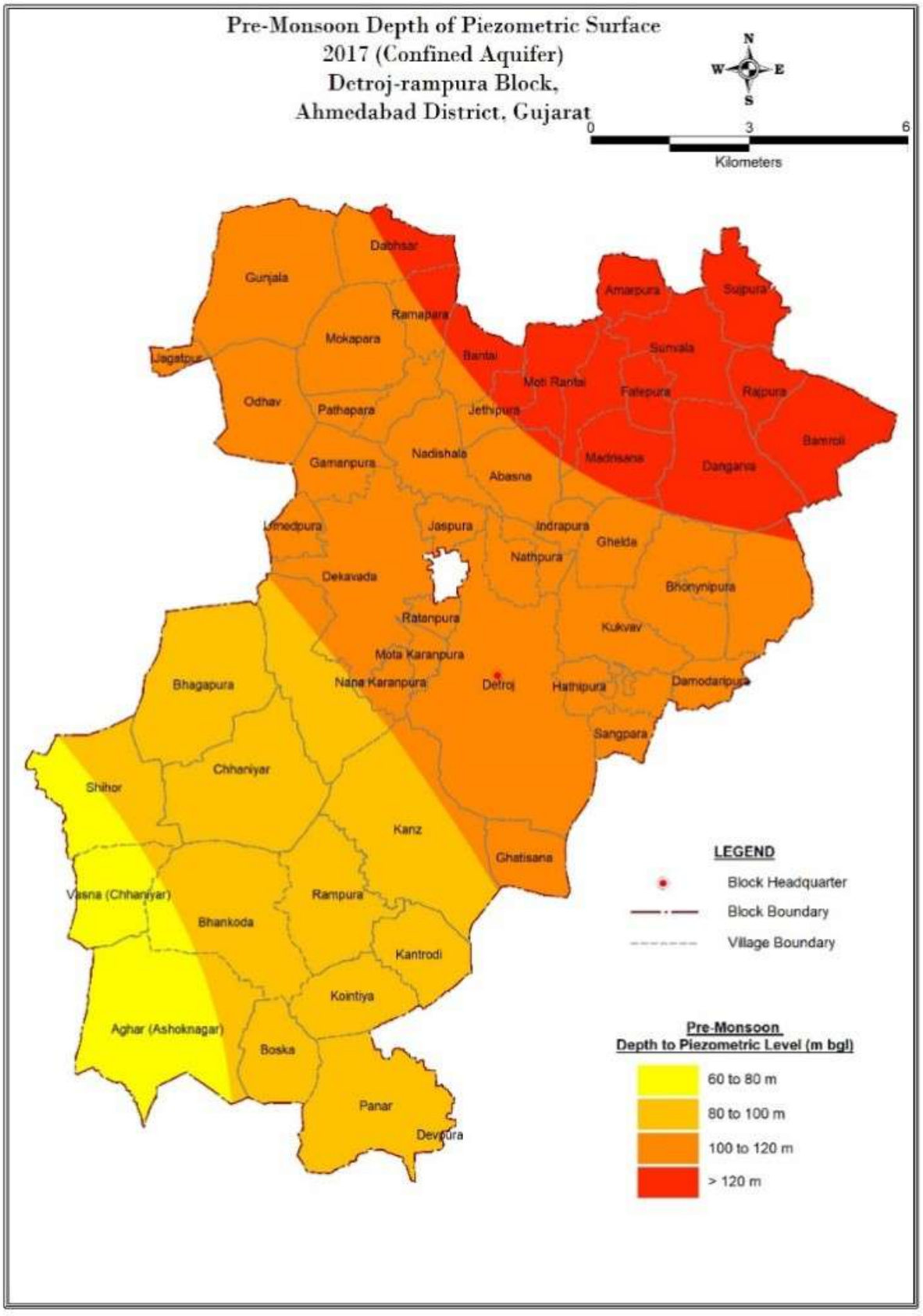


Fig. 10: Pre-Monsoon Depth of Piezometric Surface- Confined Aquifer

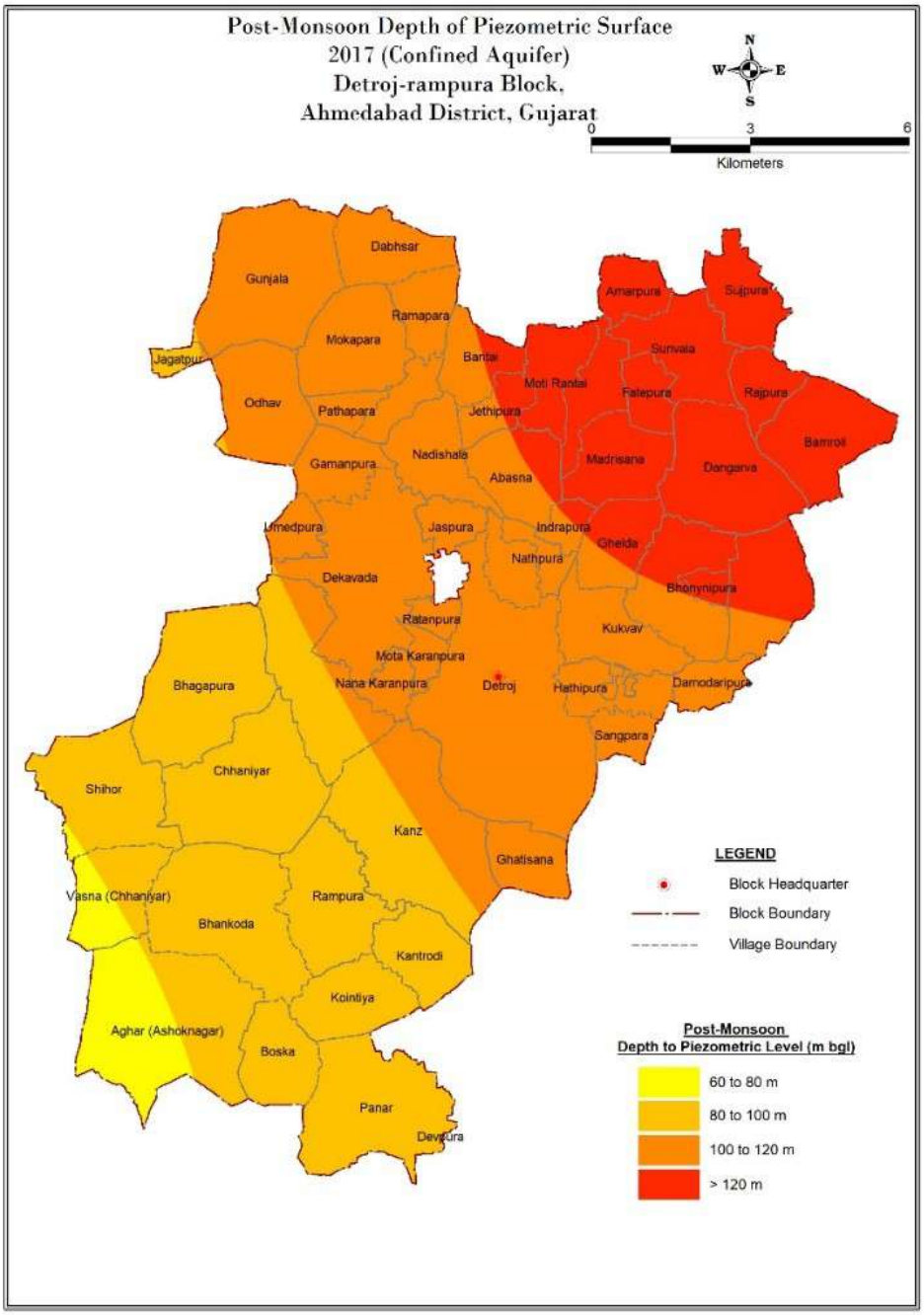


Fig. 11: Post-Monsoon Depth of Piezometric Surface- Confined Aquifer

4. Dynamic Ground Water Resources in MCM

Total fresh groundwater availability of the area is estimated in year 2017 is 32.84 MCM and total groundwater withdrawal for all purposes is 25.66 MCM. The stage of groundwater development is 78.13% and the Taluka is categorized “Semi Critical”. Total Saline groundwater availability of the area is estimated in year 2017 is 34 MCM and total groundwater withdrawal for all purposes is 11.66 MCM. The stage of groundwater development is 34.29% and the Taluka is categorized “Safe”.

Table: 3 Dynamic Groundwater resources 2017

S No	Item	Fresh	Saline
1	Area (sq.km)	160.72	189.28
2	Total GW Recharge (MCM)	1.73	35.79
3	Net GW Availability (MCM)	32.84	34
4	Gross Draft (MCM)	25.66	11.66
5	Net Availability for Future Irrigation (MCM)	6.93	21.44
6	Stage of GW Development %	78.13	34.29

5. Chemical quality of groundwater

Phreatic Aquifer shows considerable variation in TDS ranges from 1330 to 20296 ppm. Ground water suitable for drinking drinking and irrigation is mostly observe in south western part of taluka.

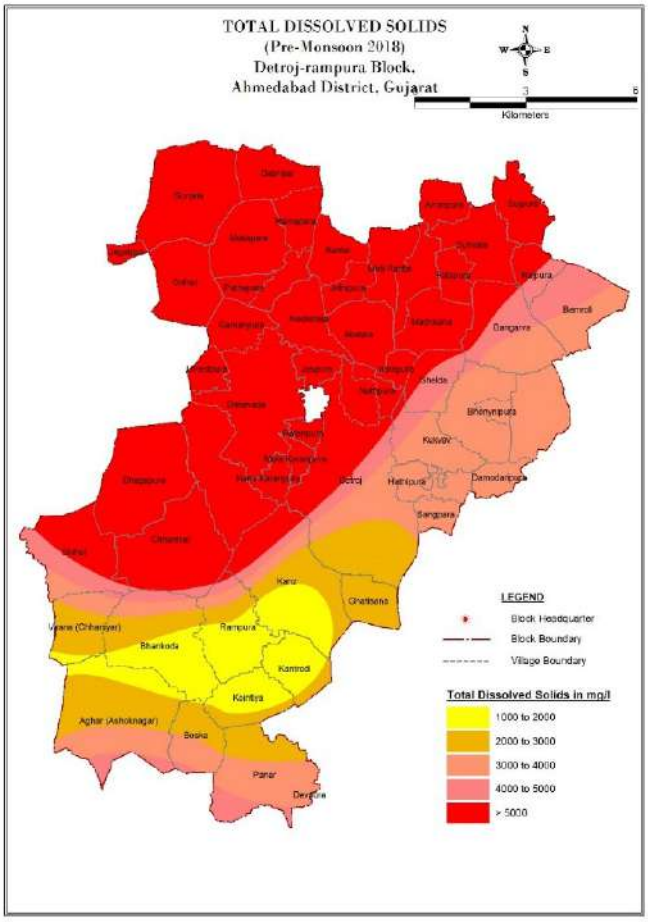


Fig. 12: Total Dissolved Solids (TDS) Map- Unconfined Aquifer

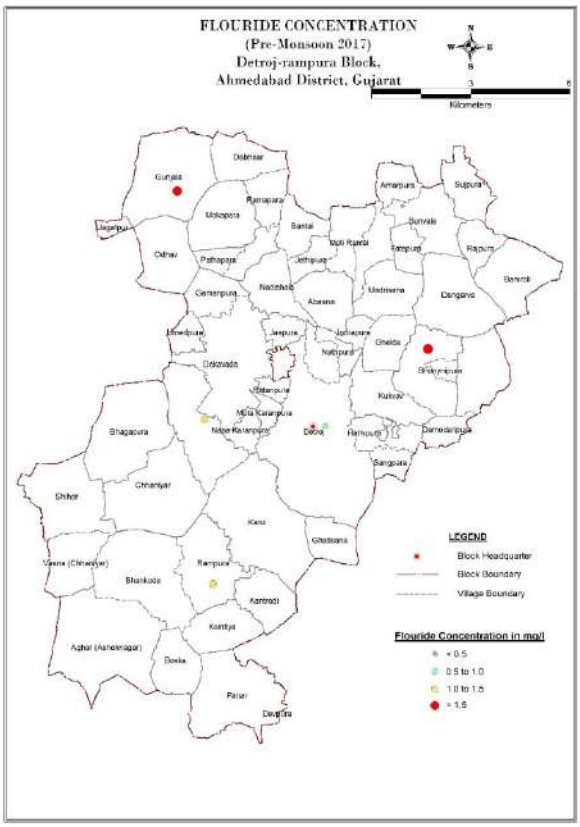


Fig. 13: Fluoride Map- Unconfined Aquifer

Fig. 14: Nitrate Map- Unconfined Aquifer

6. Groundwater issues

Quality of ground water, considerable variation in TDS ranges from 1330 to 12990 ppm. Fluoride above BIS standard found in northern part of taluka. Decline of ground water in phreatic aquifer, ranges from 12.58 m bgl to 45.70 m bgl.

7. Groundwater Management

Supply Side management-Proposed Recharge Structures- Percolation tank -5 nos. & net water recharge through percolation tank is 0.63 MCM. In Demand Side Management Micro Irrigation System proposed in 2481.68 ha area and water saving is 3.72 MCM. Net water saving : 4.35 MCM.

Supply Side Intervention	
Volume of subsurface storage space available of artificial recharge (MCM)	398.99
Surplus available (MCM)	0.63
Percolation tank proposed	5
Water availability after additional recharge	0.63 MCM

Demand Side Intervention	
Use of Micro Irrigation Systems (Drift & Sprinkler)	
Irrigated area proposed under MIS* (Ha)	2481.68
Water saving by MIS (MCM)	3.72

8. Artificial Recharge & Conservation Possibilities

Ground water resources in the block augmented by means artificial recharge through percolation tank and adoption of Micro Irrigation System in the taluka would lead to 4.35 MCM saving of ground water and improve stage of ground water from semi critical (78.13%) to safe category (65.55%).

MANAGEMENT PLAN OF
DHANDHUKA TALUKA, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	722.35 sq. km		
No. of Town, villages	46		
Population (2011 Census)	74960		
Average Annual Rainfall (in mm)	722.20		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources (2017)	Saline: 80.87 MCM		
Net Groundwater Draft	Saline: 10.07 MCM		
Stage of Groundwater Development	12.46 % (Safe)		
Existing and future water demands (MCM)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	1.78	2.10
	Irrigation	8.29	70.47

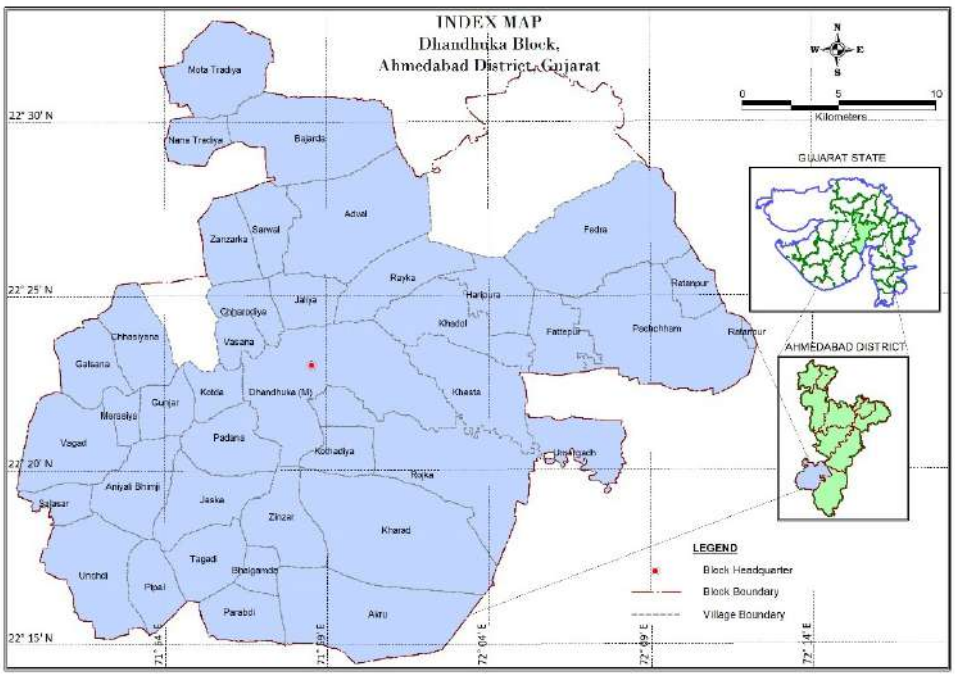


Fig. 1: Location Map

1 Land Use Classification

Table: 1 Land Use Classification

Taluka Name	**Dhandhuka**
Area according to village papers (Ha)	82786
Area under Forest (Ha)	0
Barren & uncultivable land (Ha)	1884
Land put to non agricultural uses (Ha)	894
Cultivable waste (Ha)	5442
Permanent pastures & other grazing lands (Ha)	1367
Current fallow (Ha)	1462
Fallow land other than current fallow (Ha)	759
Net area sown (Ha)	70978
Area sown more than once (Ha)	7523
Gross Cropped area (Ha)	78501

2. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel. The groundwater quality is saline at shallow depths and there is wide variation in quality regionally.

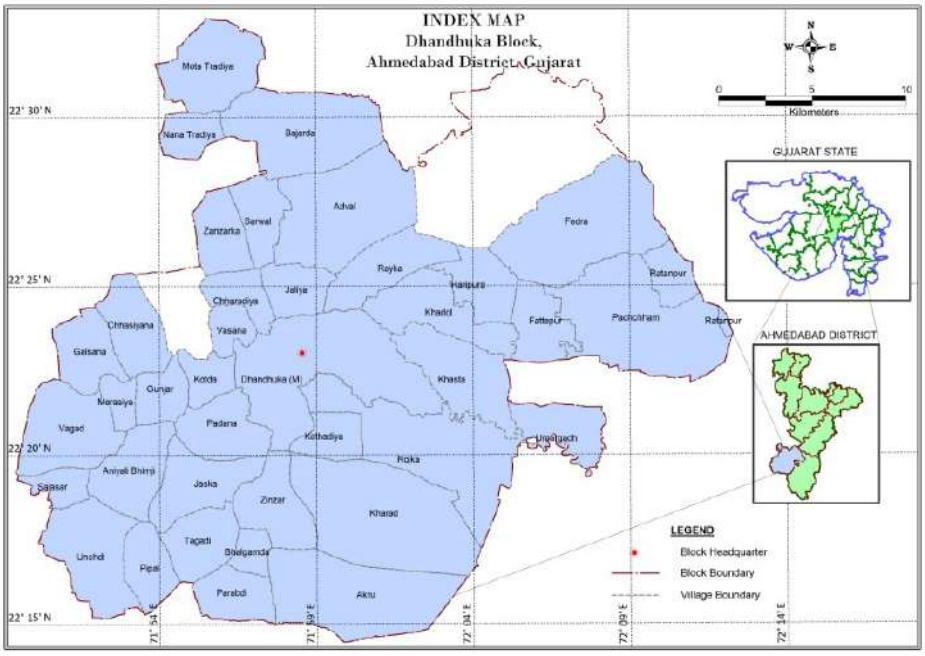


Fig.2: Major Aquifer

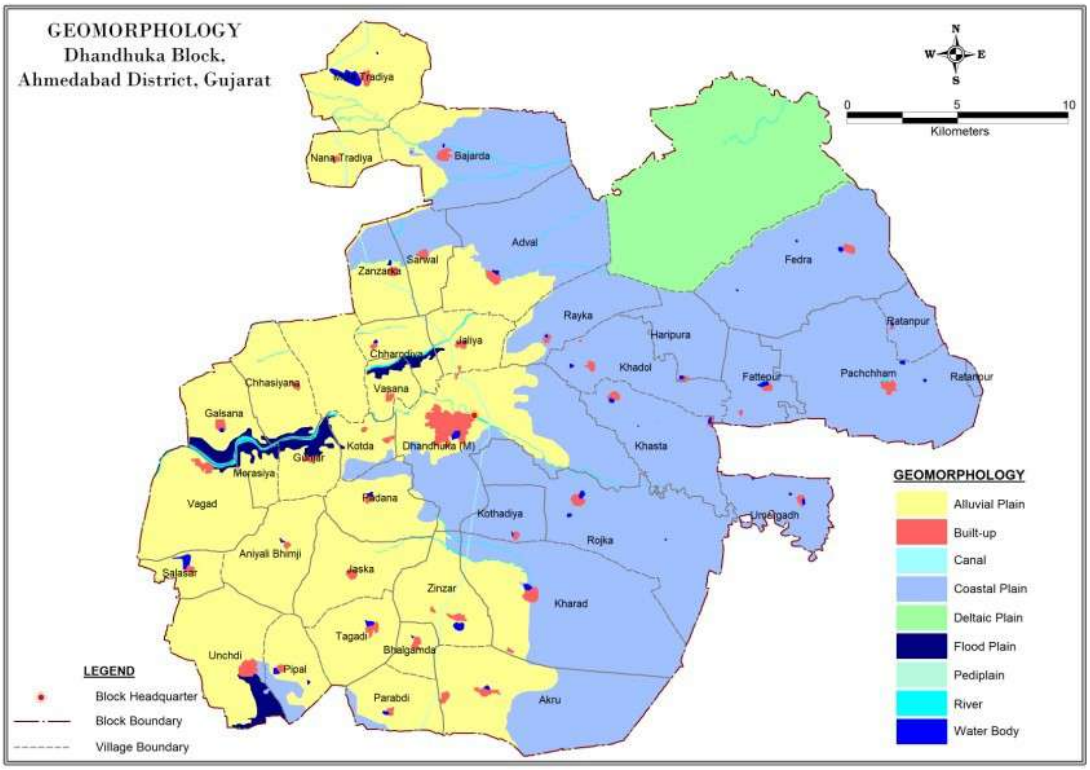


Fig.3: Geomorphology

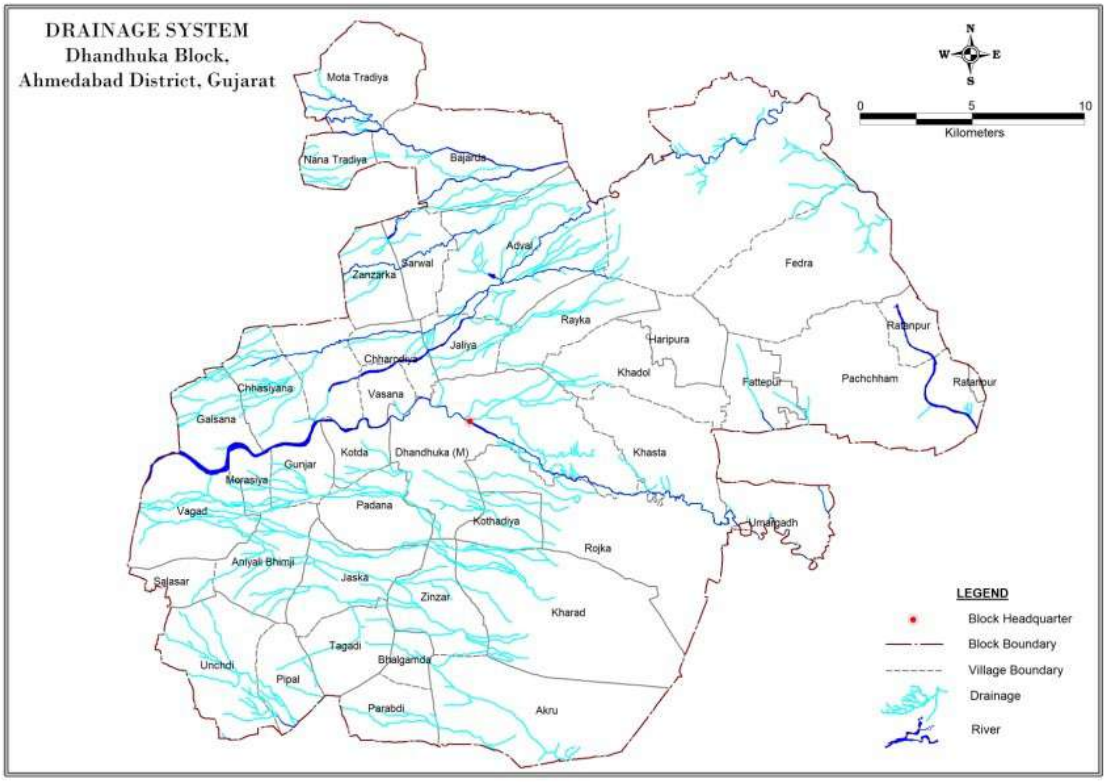


Fig. 4: Drainage Map

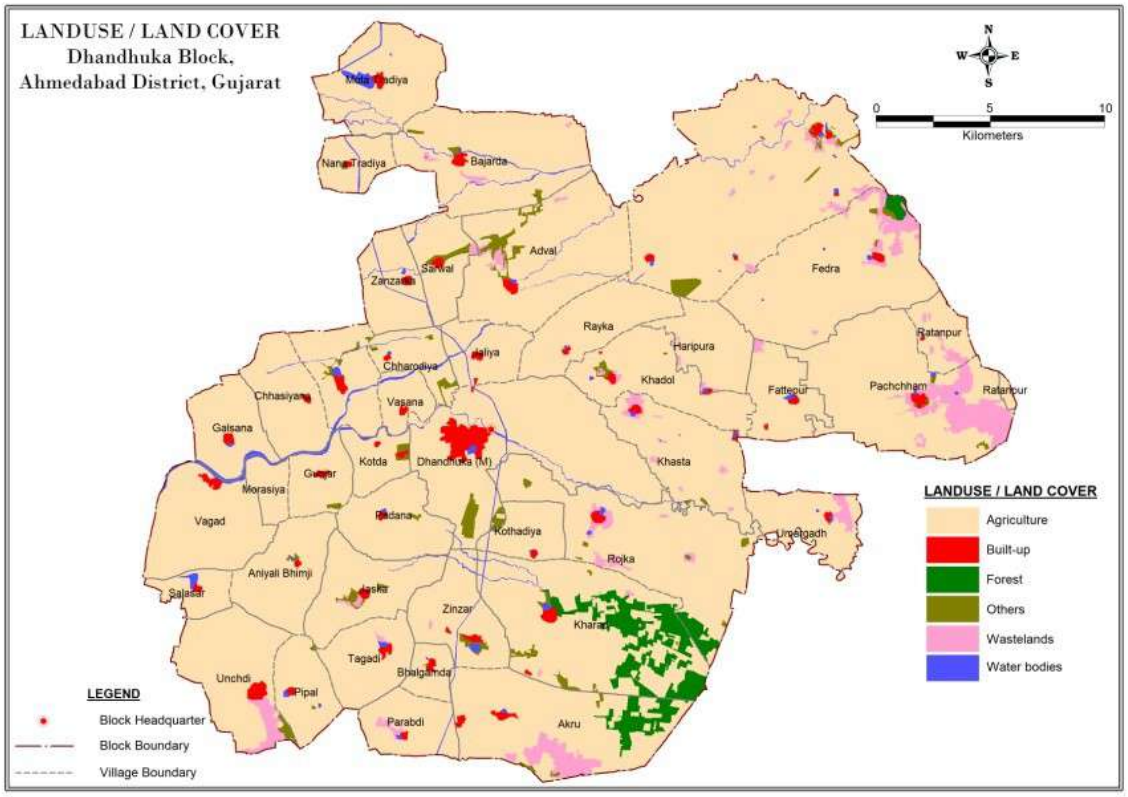


Fig. 5: Land Use Land Cover

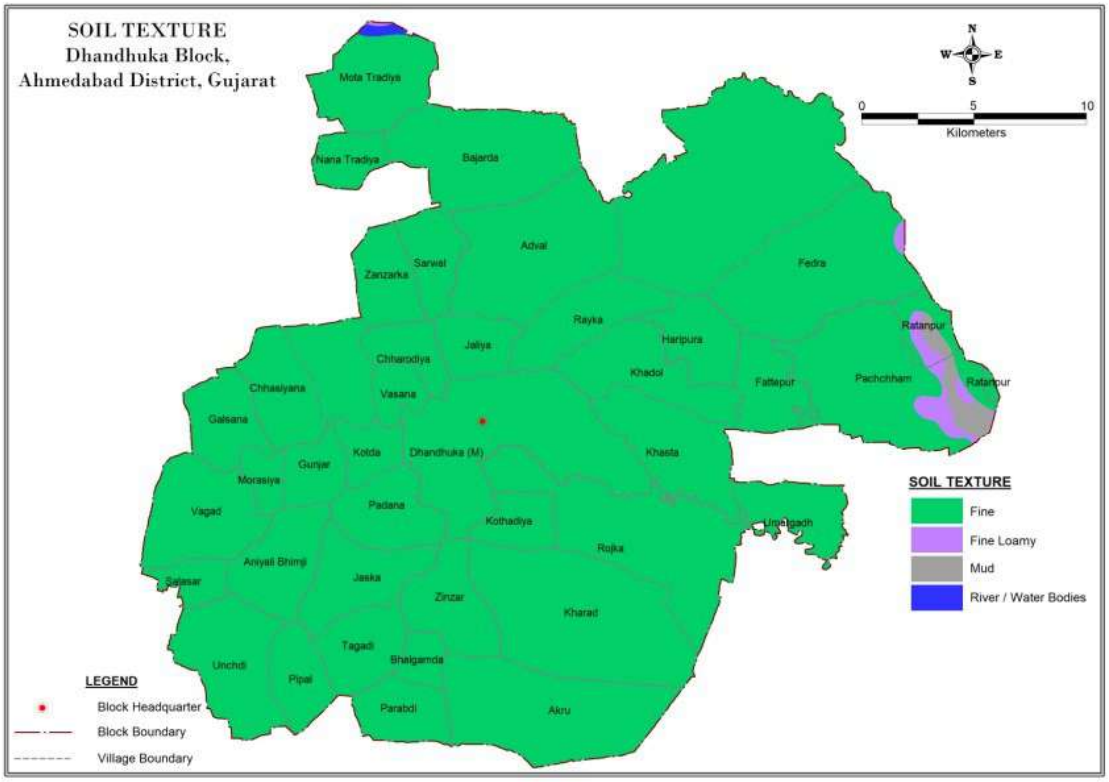


Fig. 6 Soil Map

3. Subsurface Hydrogeology

Aquifer (Alluvium) depth of occurrence upto 78 mbgl , Basaltic aquifer depth of occurrence varies from 3 m to more than 100 m. Water level of Aquifer (Alluvium) is varies from 0.10 to 10.10 m bgl. In Aquifer (Alluvium) discharge varies from 0.75 to 1.35 lps

Hydrogeological section for Bavla Taluka Depicting Aquifer

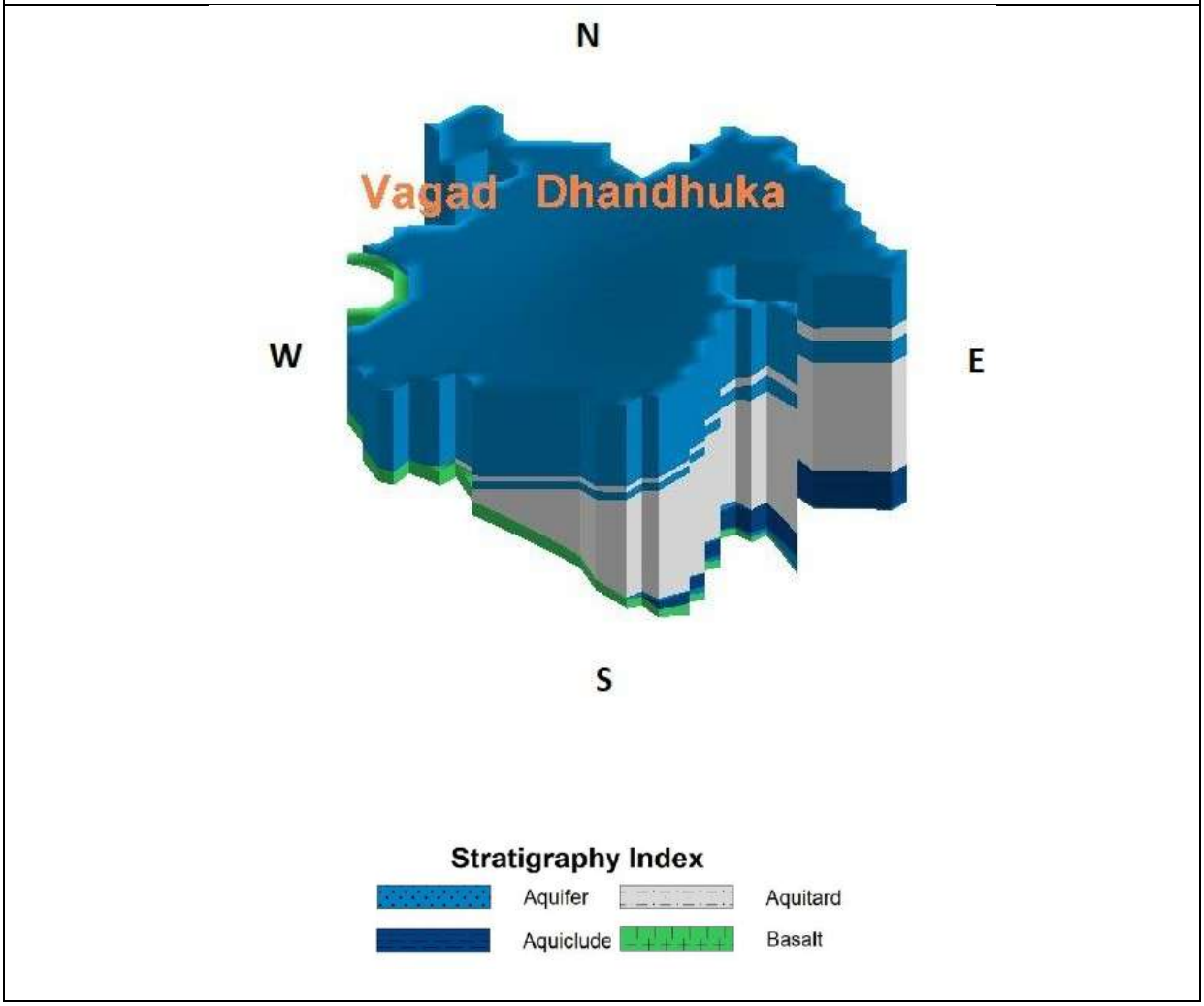


Fig.7: 3D Solid Model of Bavla Taluka Depicting Aquifer

Table; 2 Aquifer characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lps)	Quality/Ec µS/cm	Water Level/ Piezometric head (mbgl)
Aquifer (Alluvium)	Up to 74	78	0.75 to 1.35	1281 to 67766	0.10 to 10.10
Basalt	3 to More than 100m	-	-	-	-

Aquifer Group wise Water Level maps

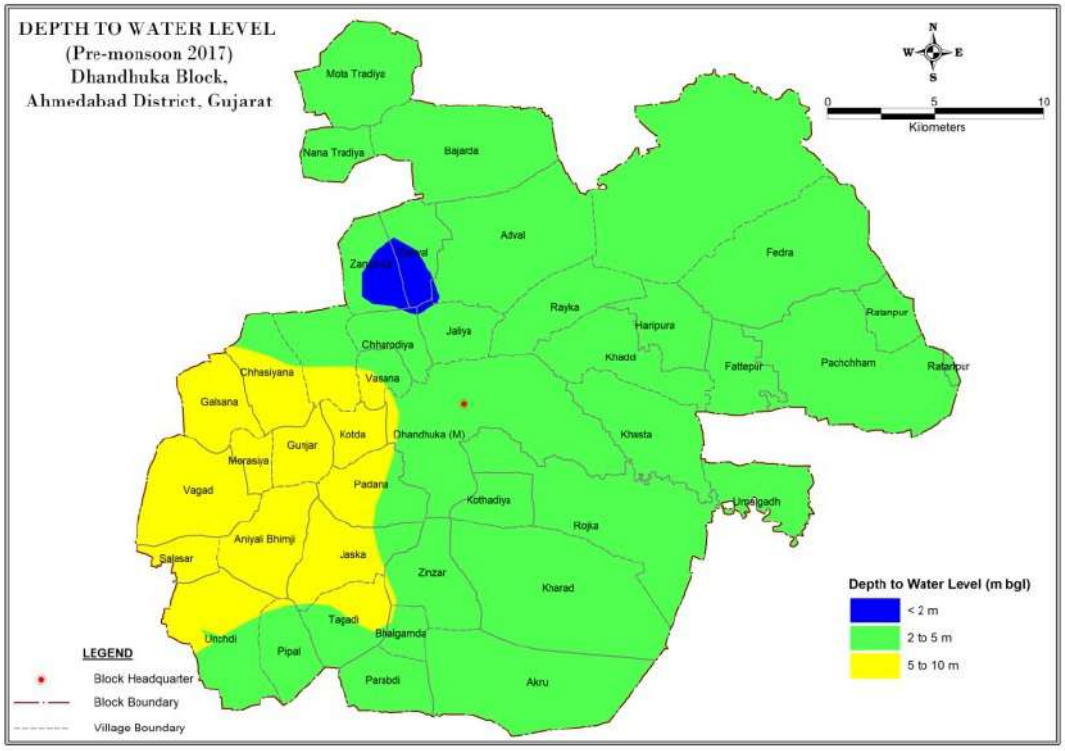


Fig: 8 Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

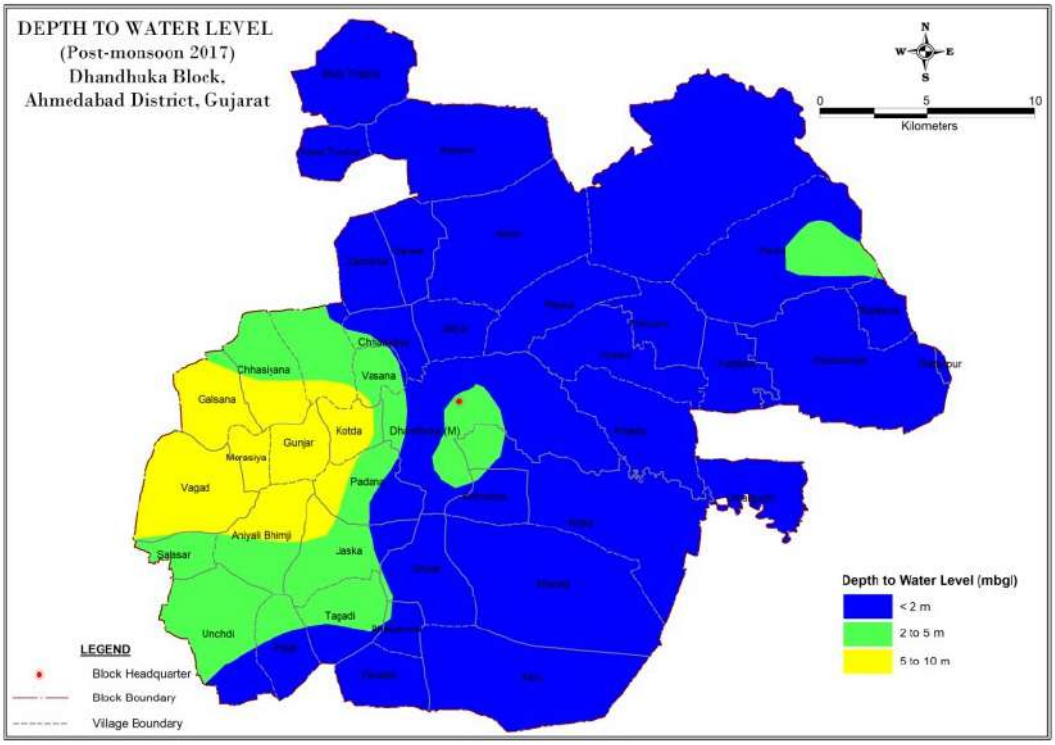


Fig.9: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

4. Dynamic GW Resources in MCM

Total Saline groundwater availability of the area is estimated in year 2017 is 80.87 MCM and total groundwater withdrawal for all purposes is 10.07 MCM. The stage of groundwater development is 12.46% and the Taluka is categorized “Safe”.

Table: 2 Dynamic Groundwater resources 2017

S No	Item	Saline
1	Area (sq.km)	722.35
2	Total GW Recharge (MCM)	85.12
3	Net GW Availability (MCM)	80.87
4	Gross Draft (MCM)	10.07
5	Net Availability for Future Irrigation (MCM)	70.47
6	Stage of GW Development %	12.46

5. Chemical quality of groundwater

Phreatic Aquifer (Aquifer I); Saline EC values ranges from 1281 to 67765 µS/cm.

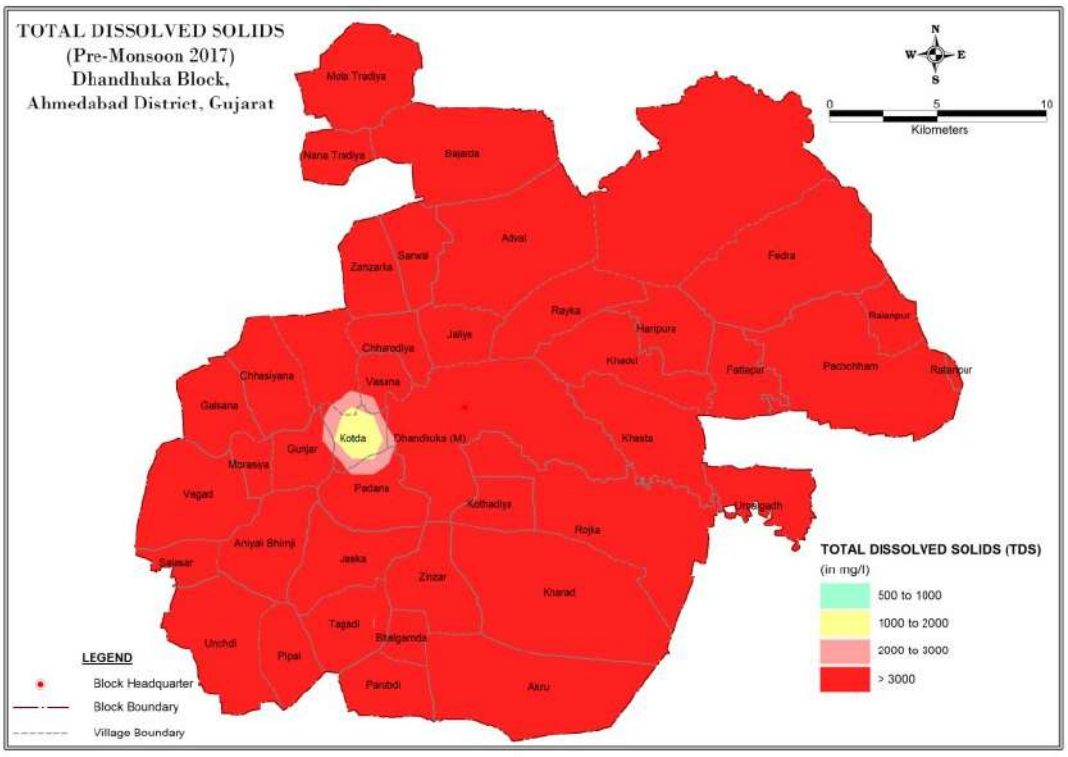


Fig.10: Total Dissolved Solids (TDS) Map- Unconfined Aquifer

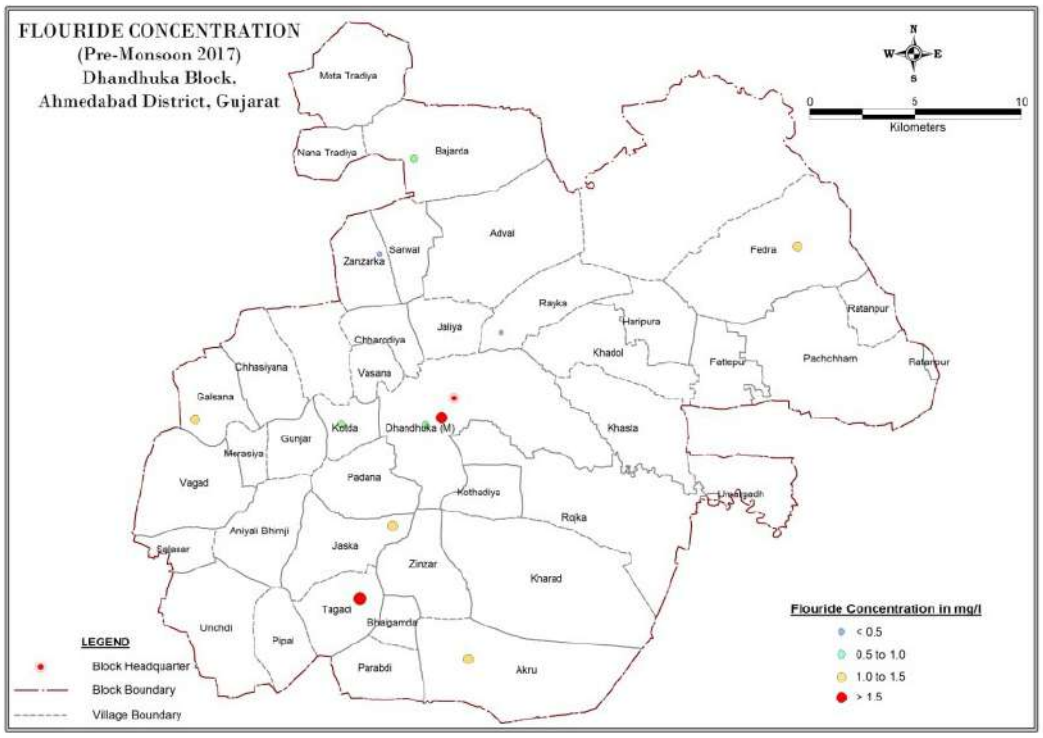


Fig.11: Fluoride Map- Unconfined Aquifer

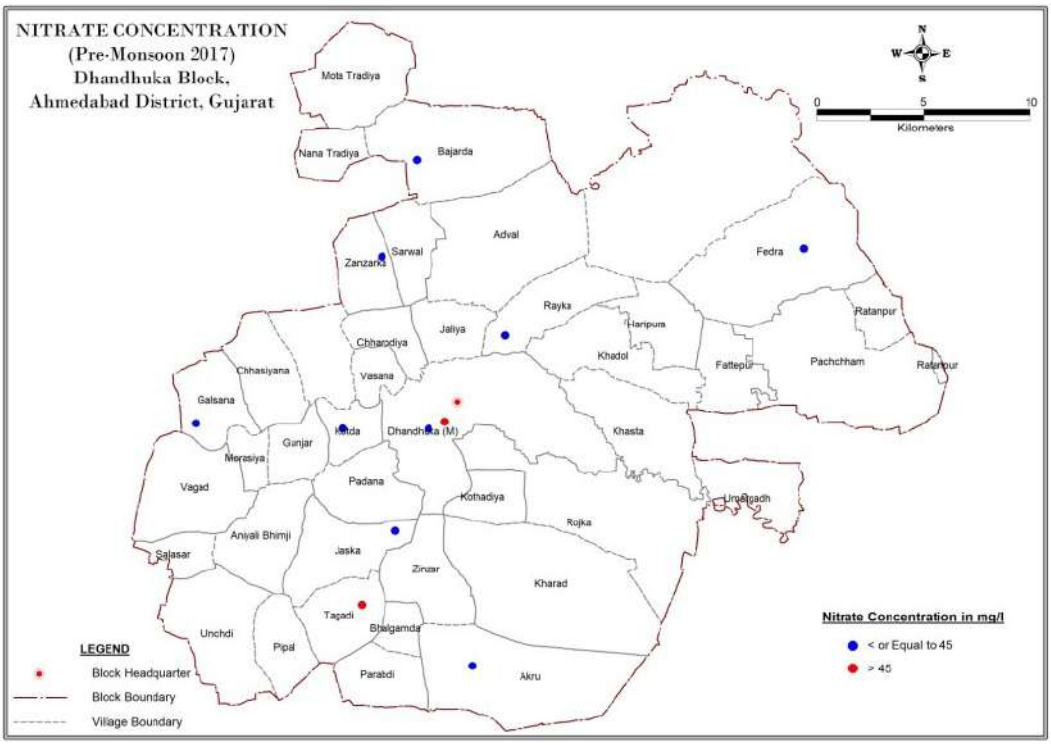


Fig.12: Nitrate Map- Unconfined Aquifer

7. Groundwater issues

Quality Issues: Phreatic Aquifer (Aquifer I); Saline, EC values >2500 µS/cm.

8. Groundwater Management

Supply Side management-Proposed Rain water harvesting Structures ponds to store for future uses. Suitable salt resistance crop may be irrigated by ground water in the area.

9. Artificial Recharge & Conservation Possibilities

Ground water is saline to brackish in nature. As per GWRE 2017 Dhandhuka taluka is under saline category. Rain water harvesting structures like ponds to be constructed to store surface runoff. Suitable salt resistance crop may be irrigated in the area.

MANAGEMENT PLAN OF
DHOLERA TALUKA, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	1046.88 sq. km		
No. of villages	33		
Population (2011 Census)	50821		
Average Annual Rainfall (in mm)	722.20		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources (2017)	Saline: 108.09 MCM		
Net Groundwater Draft	Saline: 1.18 MCM		
Stage of Groundwater Development	% (Safe)		
Existing and future water demands (MCM)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	0.69	0.82
	Irrigation	0.49	106.78

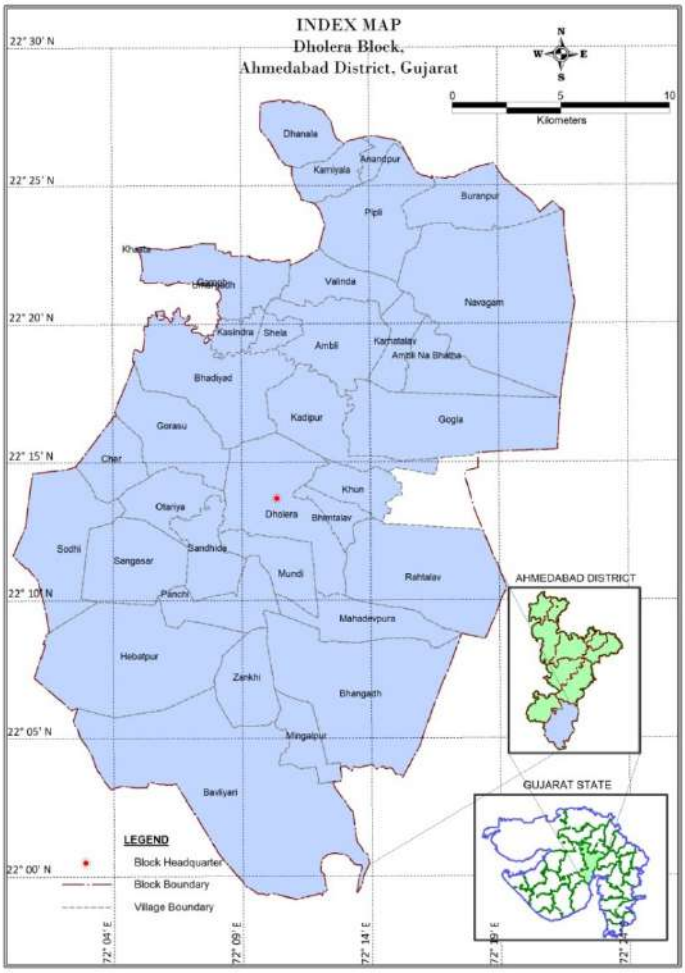


Fig. 1: Location Map

1 Land Use Classification

Table 1: Land Use Classification

Taluka Name	Dholera
Area according to village papers (Ha)	118366
Area under Forest (Ha)	8234
Barren & uncultivable land (Ha)	26957
Land put to non agricultural uses (Ha)	10496
Cultivable waste (Ha)	9048
Permanent pastures & other grazing lands (Ha)	7194
Current fallow (Ha)	987
Fallow land other than current fallow (Ha)	1226
Net area sown (Ha)	54224
Area sown more than once (Ha)	7348
Gross Cropped area (Ha)	61572

2. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel. The groundwater quality is saline at shallow depths and there is wide variation in quality regionally.

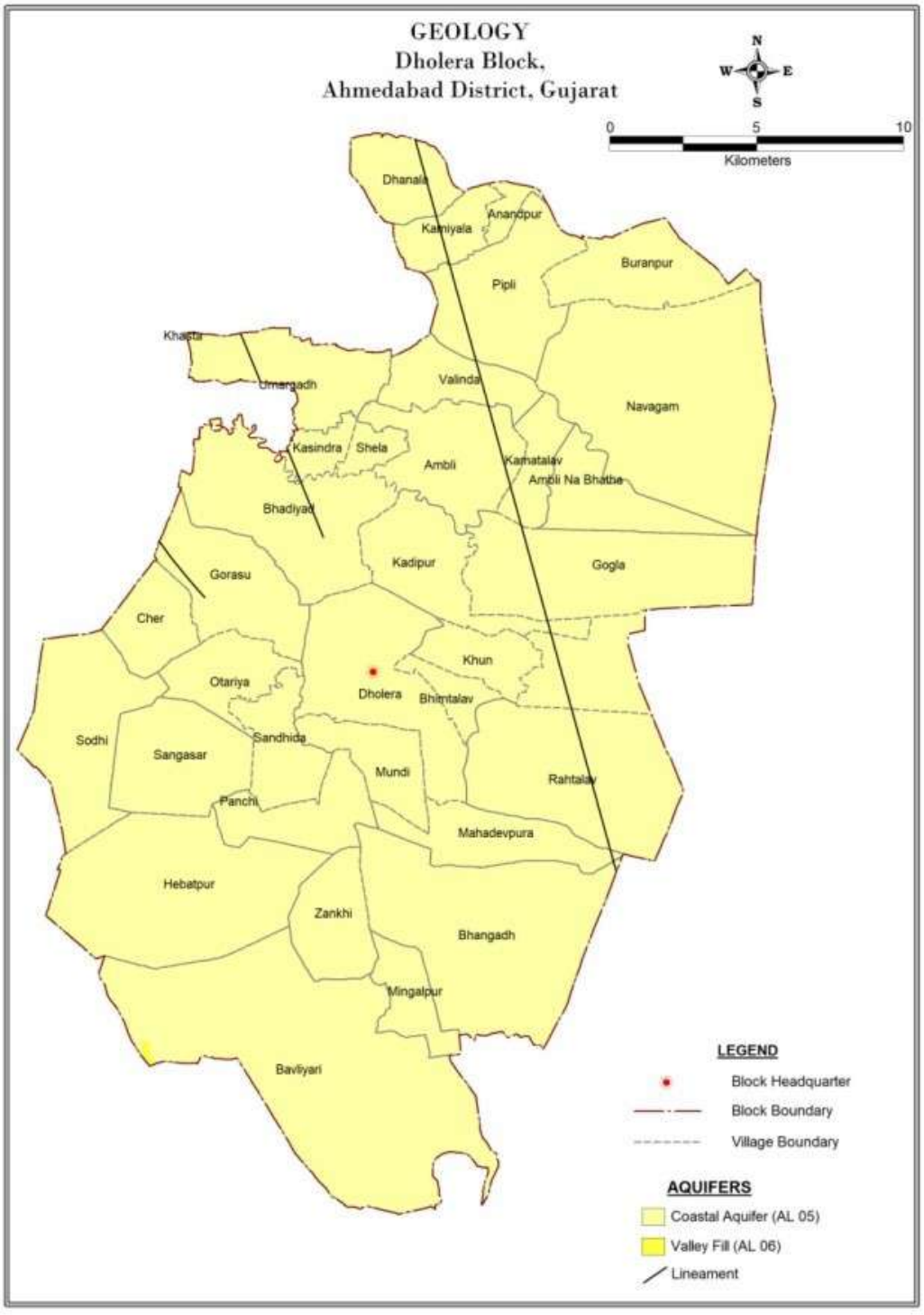


Fig.2: Major Aquifer

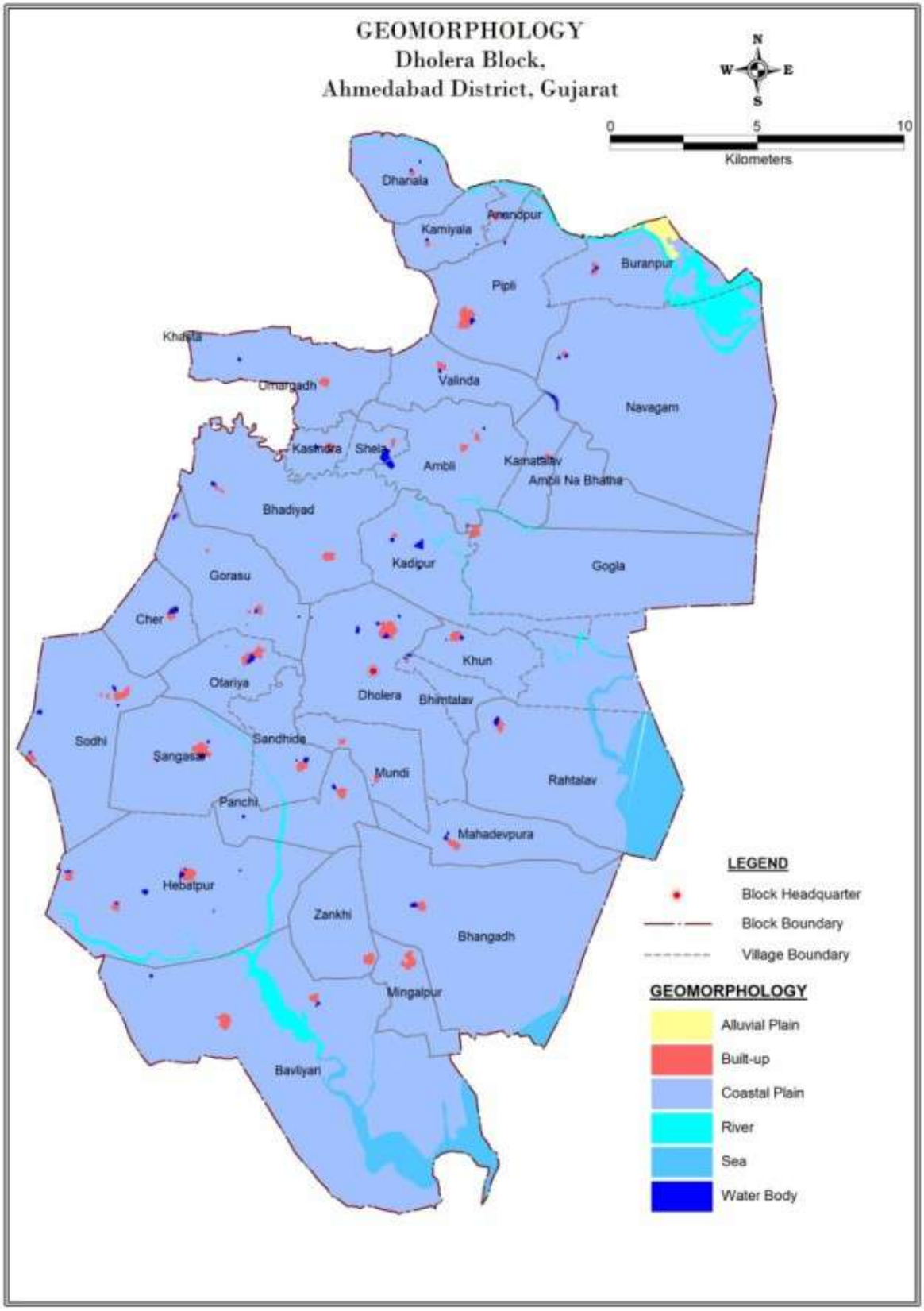


Fig.3: Geomorphology

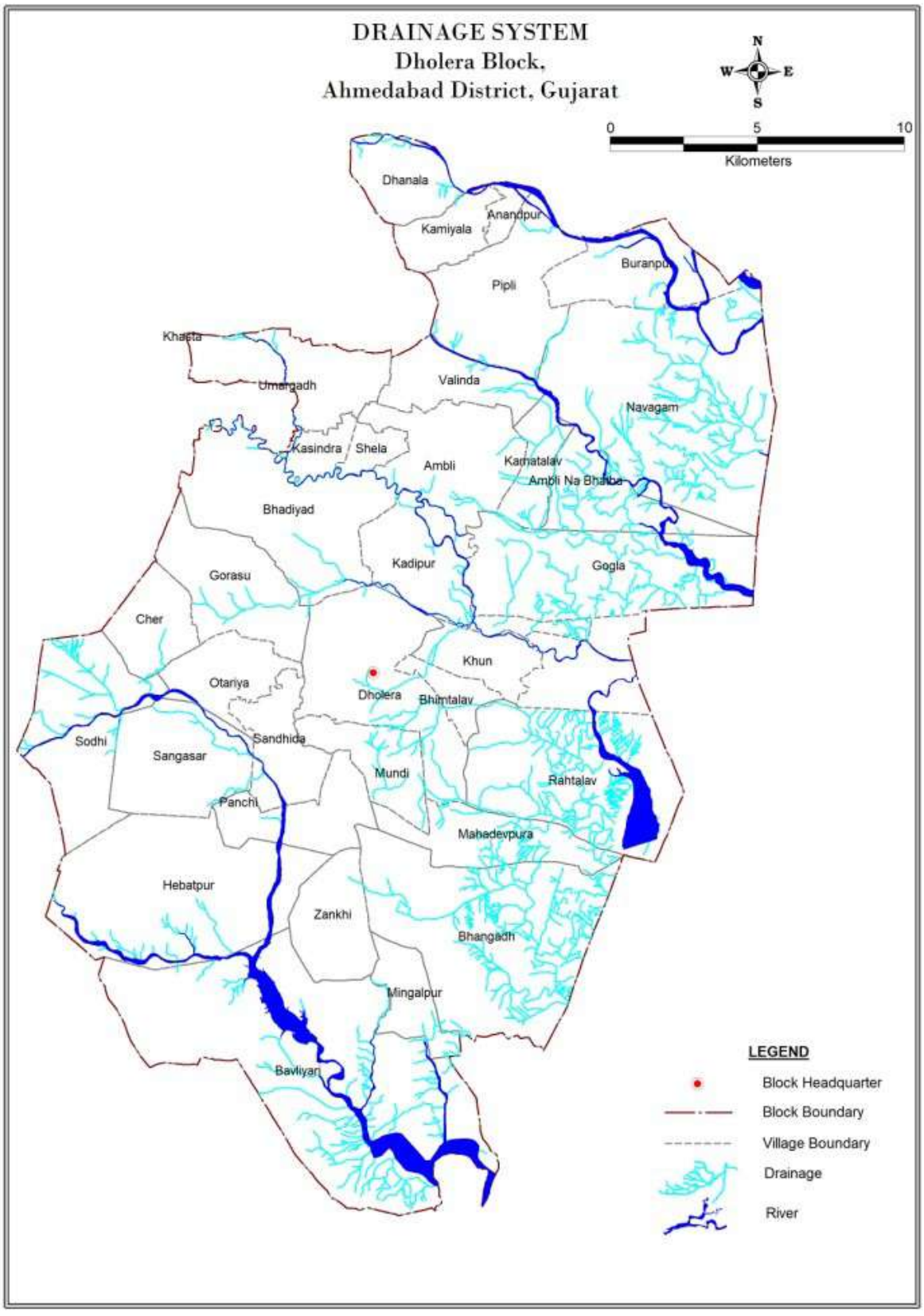


Fig. 4: Drainage Map

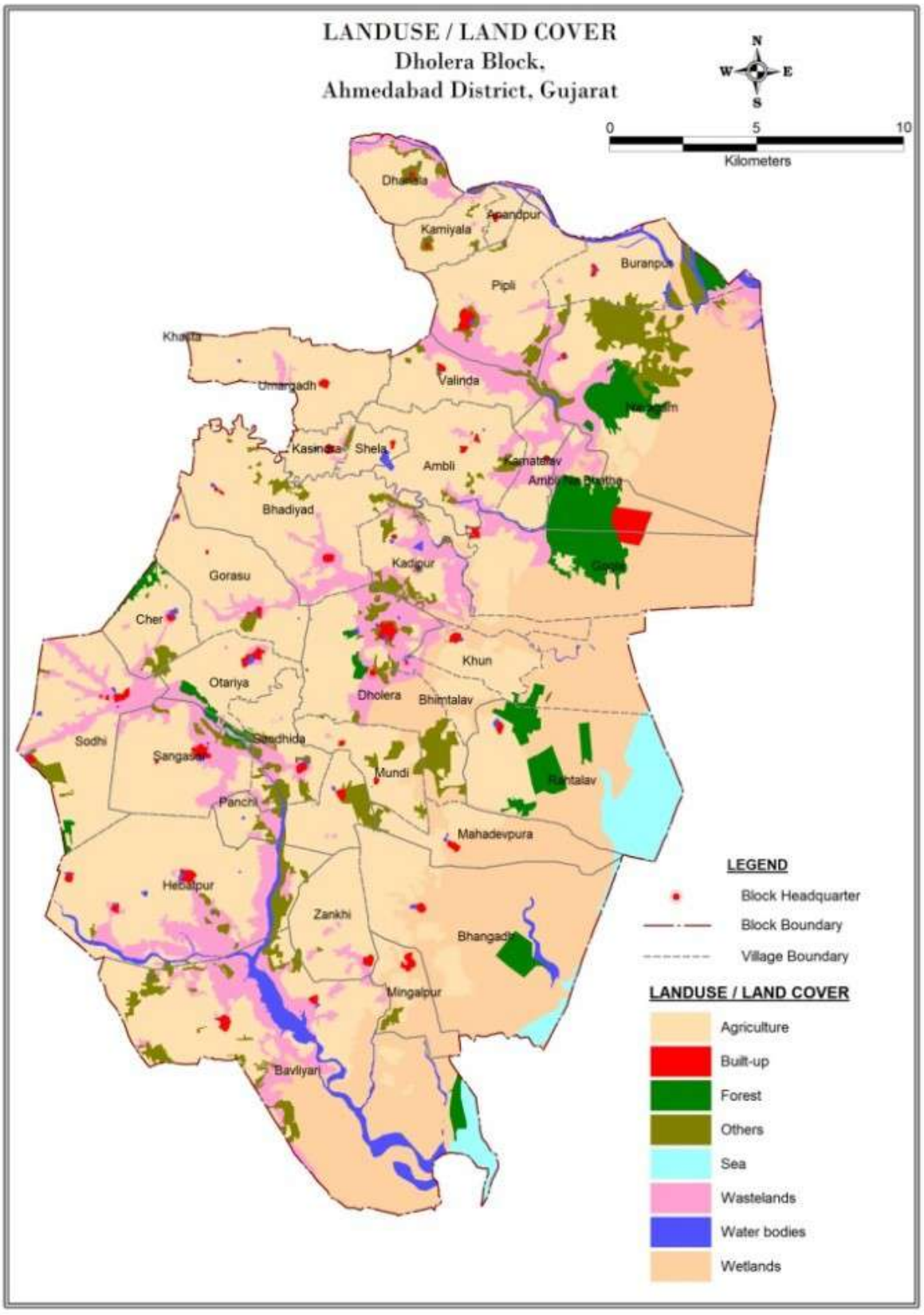


Fig. 5: Land Use Land Cover

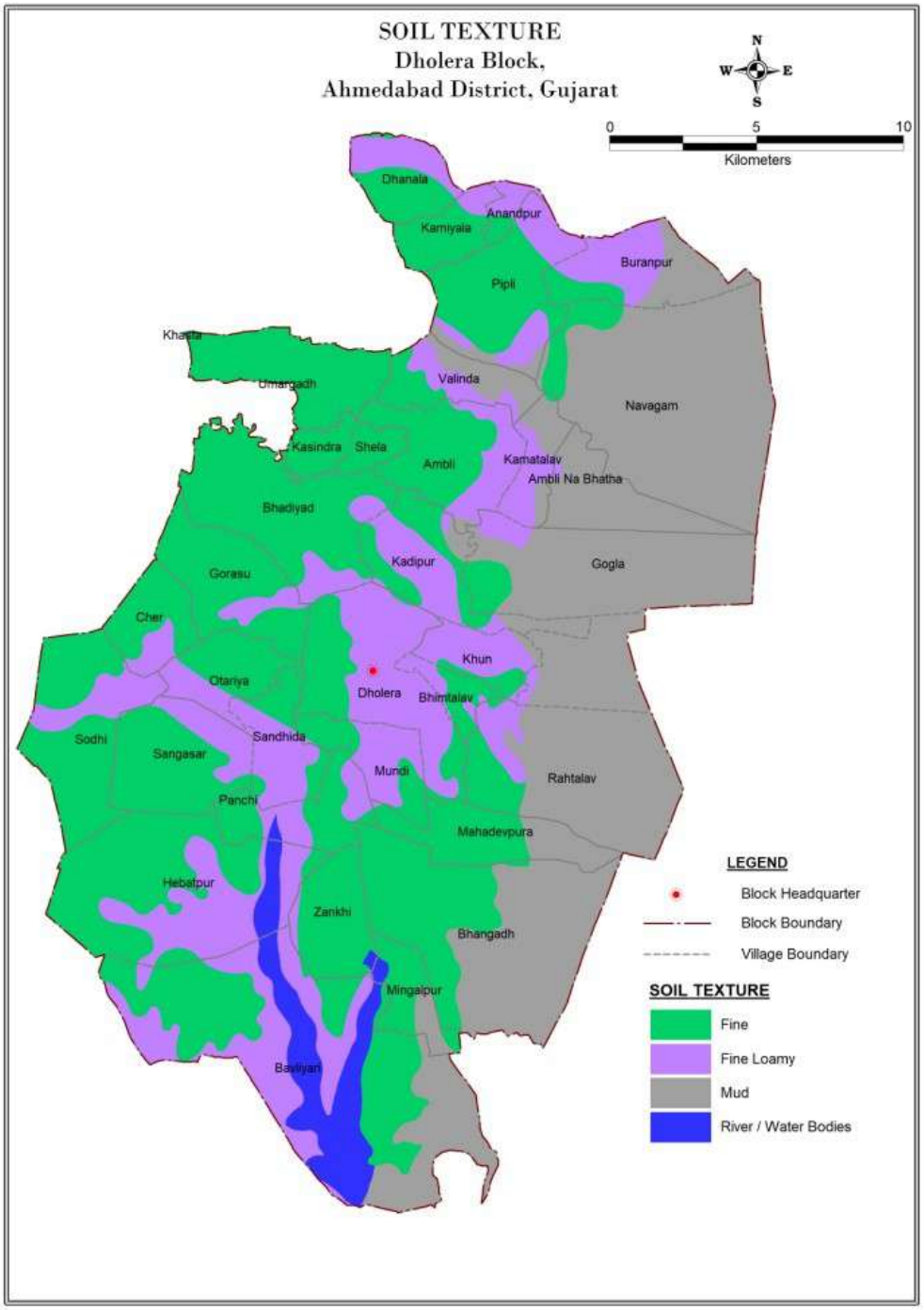


Fig. 6 Soil Map

3. Subsurface Hydrogeology

The area has multi-layer aquifer system. Aquifer I (unconfined) depth of occurrence upto 74 mbgl , Aquifer II (confined) depth of occurrence 48 to 66 mbgl , Aquifer III (confined) depth of occurrence 108 to 168 m. Water level of Aquifer I is varies from 0.10 to 4.10 mbgl. In Aquifer I discharge varies from 2.82 to 10 lps.

Hydrogeological section for Dholera Taluka Depicting Aquifer

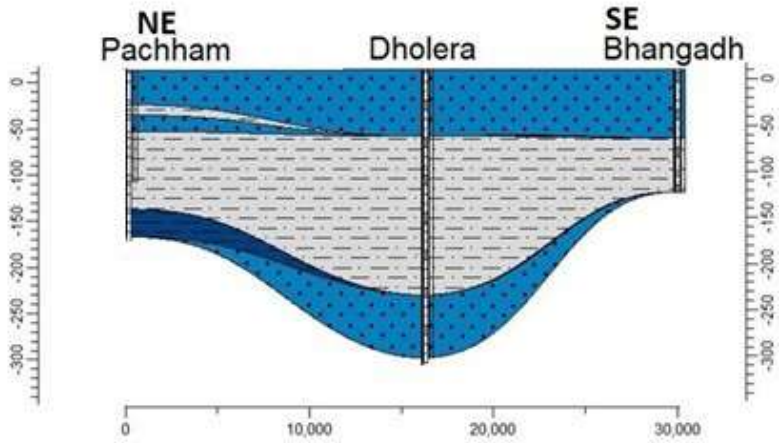


Fig.7: Stratigraphic Section

Fig.8: 3D Solid Model of Dholera Taluka Depicting Aquifer

Table; 2 Aquifer characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lps)	Quality/Ec µS/cm	Transimissivity (m2/day)	Water Level/ Piezometric head (mbgl)
Aquifer I	Up to 74	37 to 74	2.82 to 10	9984 to 145563	494	0.10 to 4.10
Aquifer II (Confined)	48 to 66	18	-	-	-	-
Aquifer III (Confined)	108 to 168	22 to 60	-	-	-	-

Aquifer Group wise Water Level maps

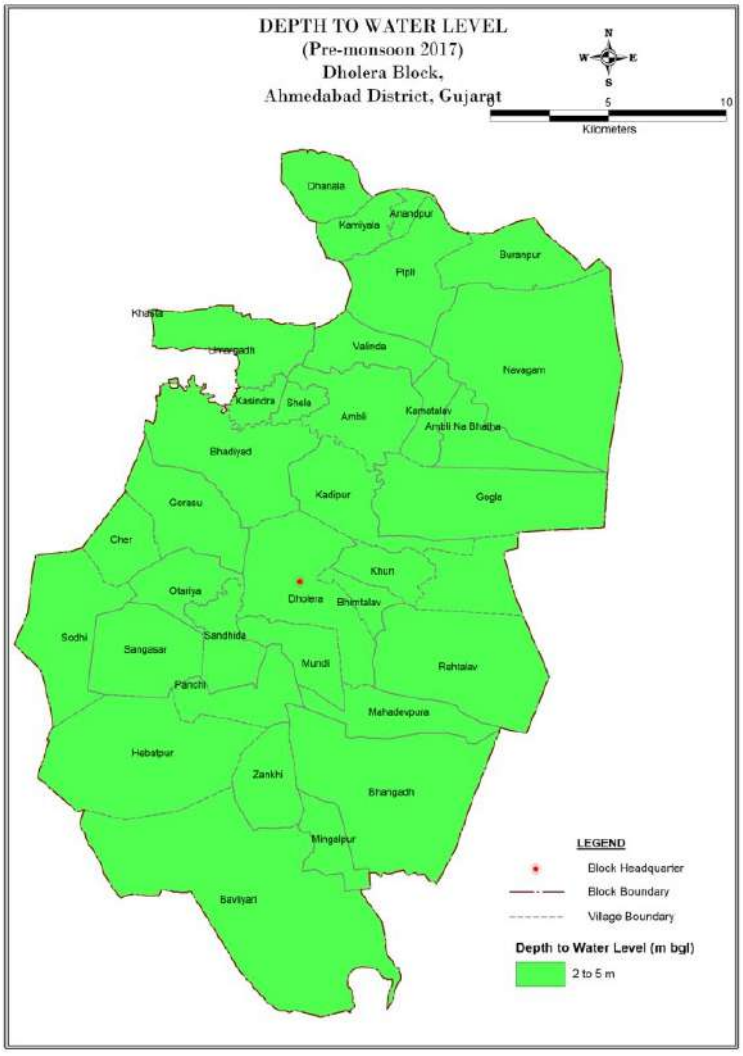


Fig.9: Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

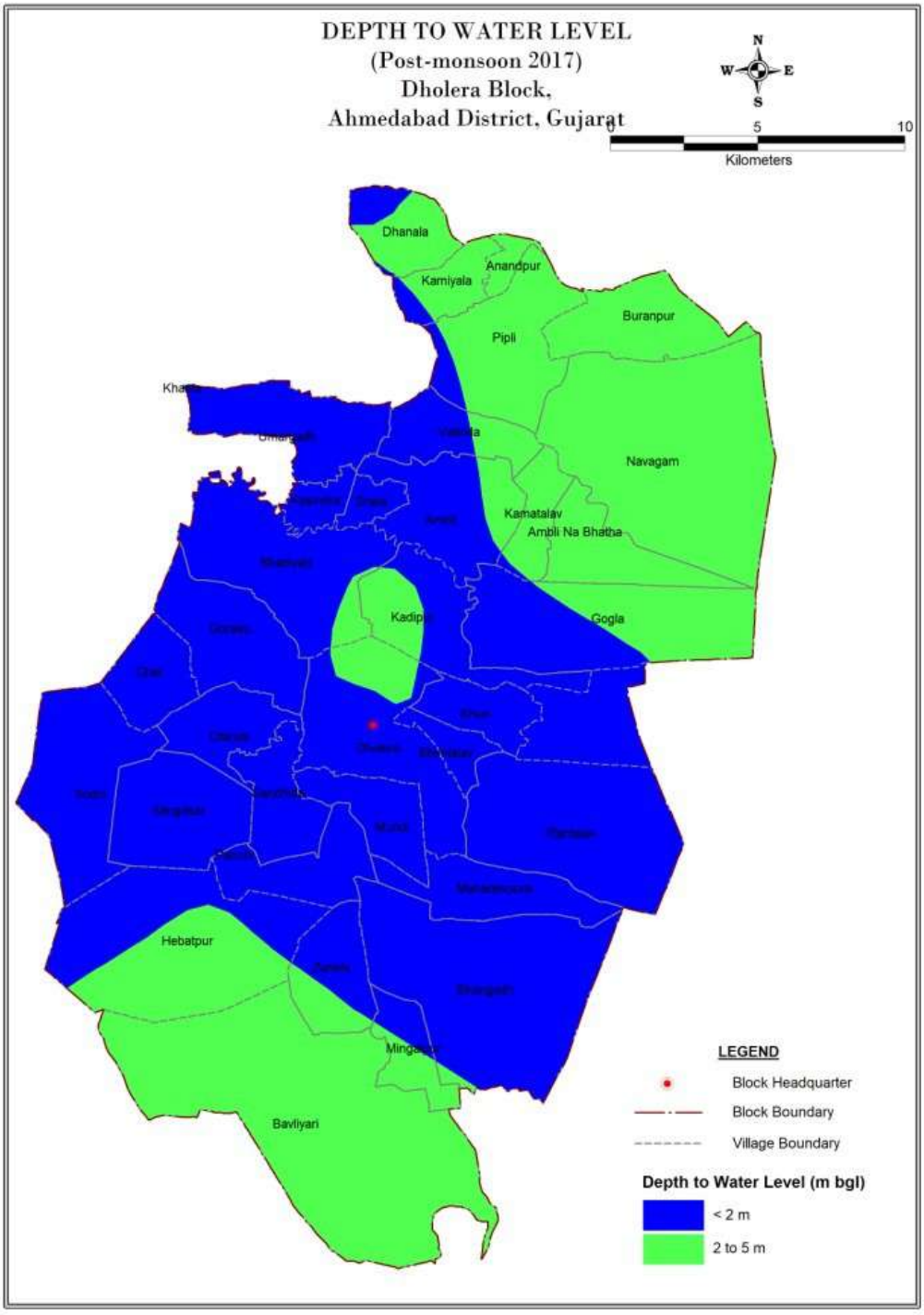


Fig.10: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

4. Dynamic Ground Water Resources in MCM

Total Saline groundwater availability of the area is estimated in year 2017 is 108.09 MCM and total groundwater withdrawal for all purposes is 1.18 MCM. The stage of groundwater development is 1.09% and the Taluka is categorized “Safe”.

Table: 3 Dynamic Groundwater resources 2017

S No	Item	Saline
1	Area (sq.km)	1046.88
2	Total GW Recharge (MCM)	113.78
3	Net GW Availability (MCM)	108.09
4	Gross Draft (MCM)	1.18
5	Net Availability for Future Irrigation (MCM)	106.78
6	Stage of GW Development %	1.09

5. Chemical quality of groundwater

Phreatic Aquifer (Aquifer I); Saline to brackish EC values ranges from 9984 to 67797 µS/cm. Deepr aquifer also saline in nature.

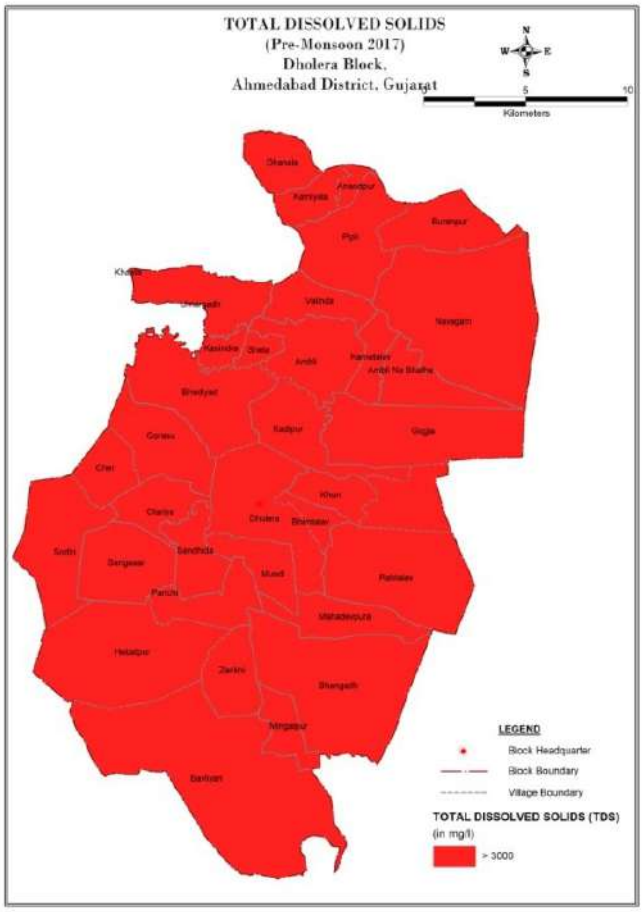


Fig.11: Total Dissolved Solids (TDS) Map- Unconfined Aquifer

Fig.12: Fluoride Map- Unconfined Aquifer

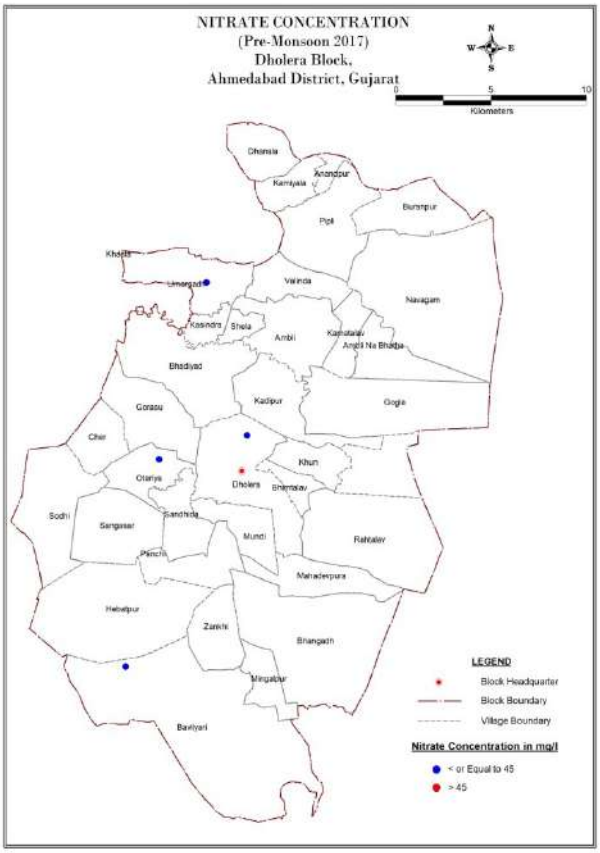


Fig.13: Nitrate Map- Unconfined Aquifer

7. Groundwater issues

Quality Issues: Phreatic Aquifer (Aquifer I); Saline to brine EC values ranges from 9984 to 67797 µS/cm.

8. Groundwater Management

Supply Side management-Proposed Rain water harvesting Structures ponds to store for future uses. Suitable salt resistance crop may be irrigated in the area.

9. Artificial Recharge & Conservation Possibilities

Ground water is saline to brackish in nature. As per GWRE 2017 Dholera taluka is under saline category. Rain water harvesting structures like ponds to be constructed to store surface runoff. Suitable salt resistance crop may be irrigated in the area.

MANAGEMENT PLAN OF
DHOLKA TALUKA, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	1019.93 sq. km		
No. of Town, villages	71		
Population (2011 Census)	249852		
Average Annual Rainfall	677		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources (2017)	Fresh: 77.49 MCM		
Net Groundwater Draft	Fresh: 61.37 MCM		
Stage of Groundwater Development	79.20% (Semi Critical)		
Existing and future water demands (MCM)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	4.26	4.31
	Irrigation	57.12	16.07

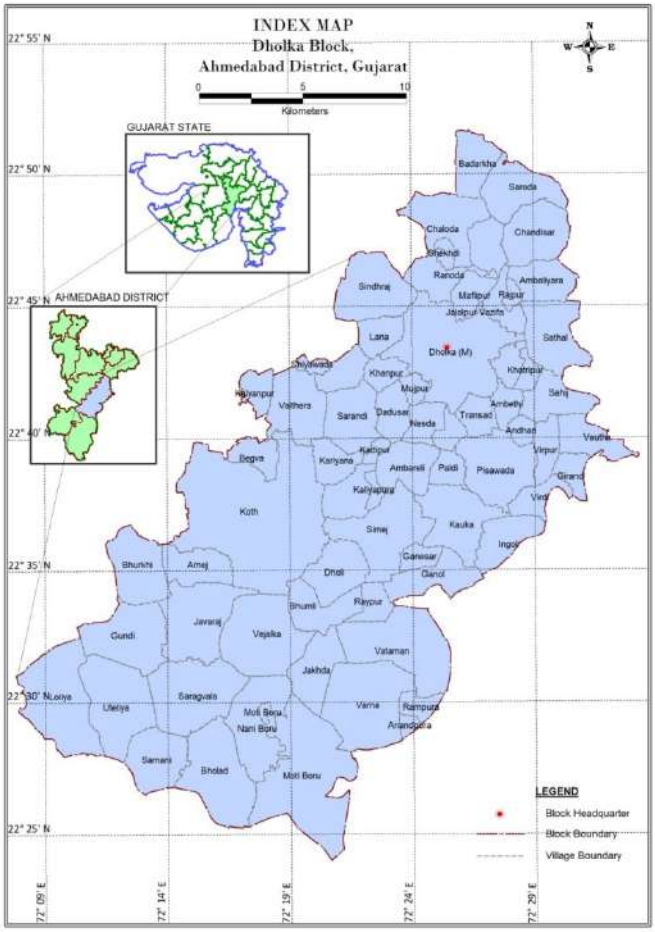


Fig. 1: Location Map

1 Land Use Classification

Table.1: Land Use Classification

Taluka Name	**Dholka**
Area according to village papers (Ha)	96878
Area under Forest (Ha)	0
Barren & uncultivable land (Ha)	6354
Land put to non agricultural uses (Ha)	7666
Cultivable waste (Ha)	4840
Permanent pastures & other grazing lands (Ha)	3220
Current fallow (Ha)	765
Fallow land other than current fallow (Ha)	483
Net area sown (Ha)	73550
Area sown more than once (Ha)	29773
Gross Cropped area (Ha)	103323

2. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel. The groundwater quality is saline at shallow depths and there is wide variation in quality regionally.

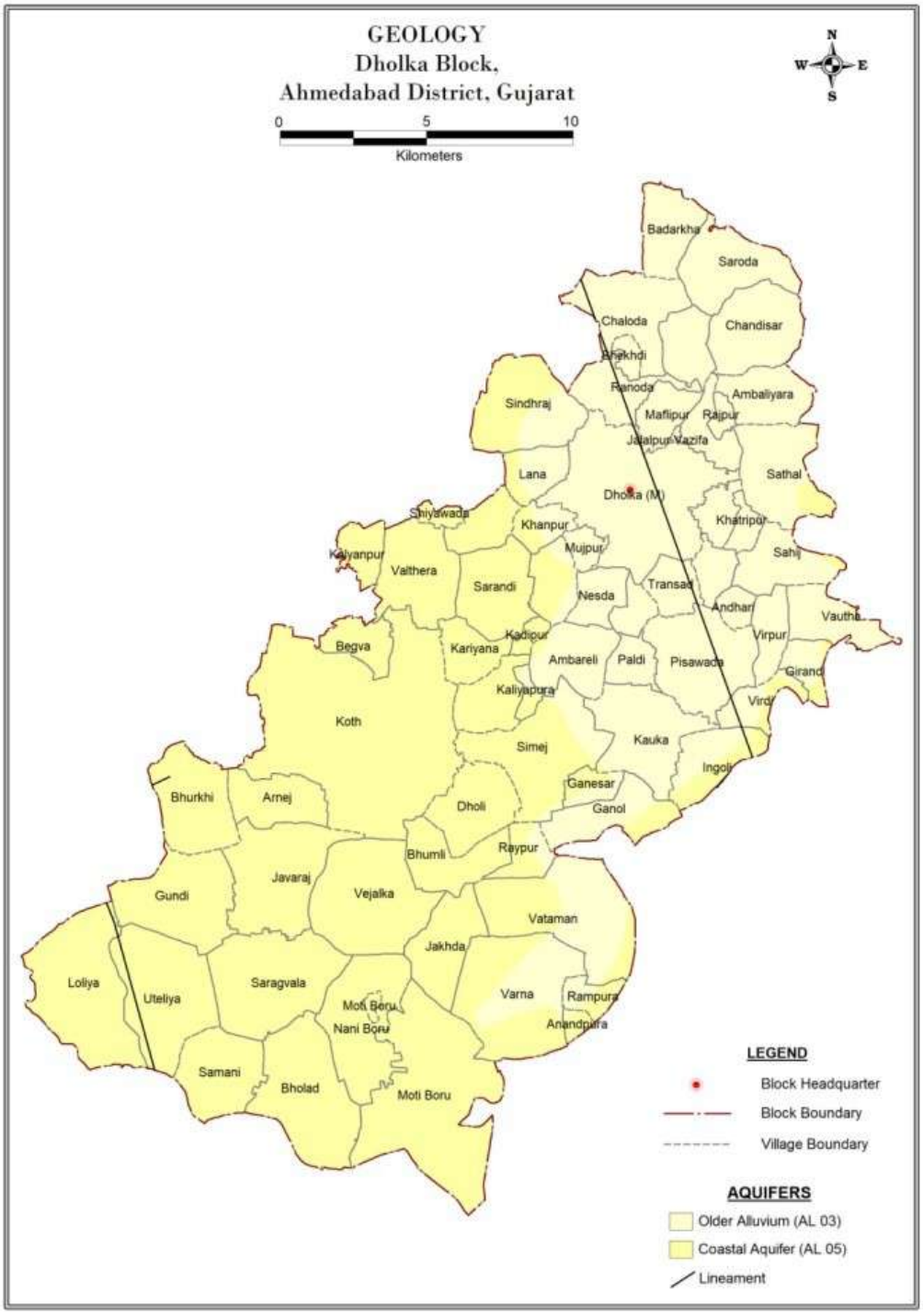


Fig.2: Major Aquifer

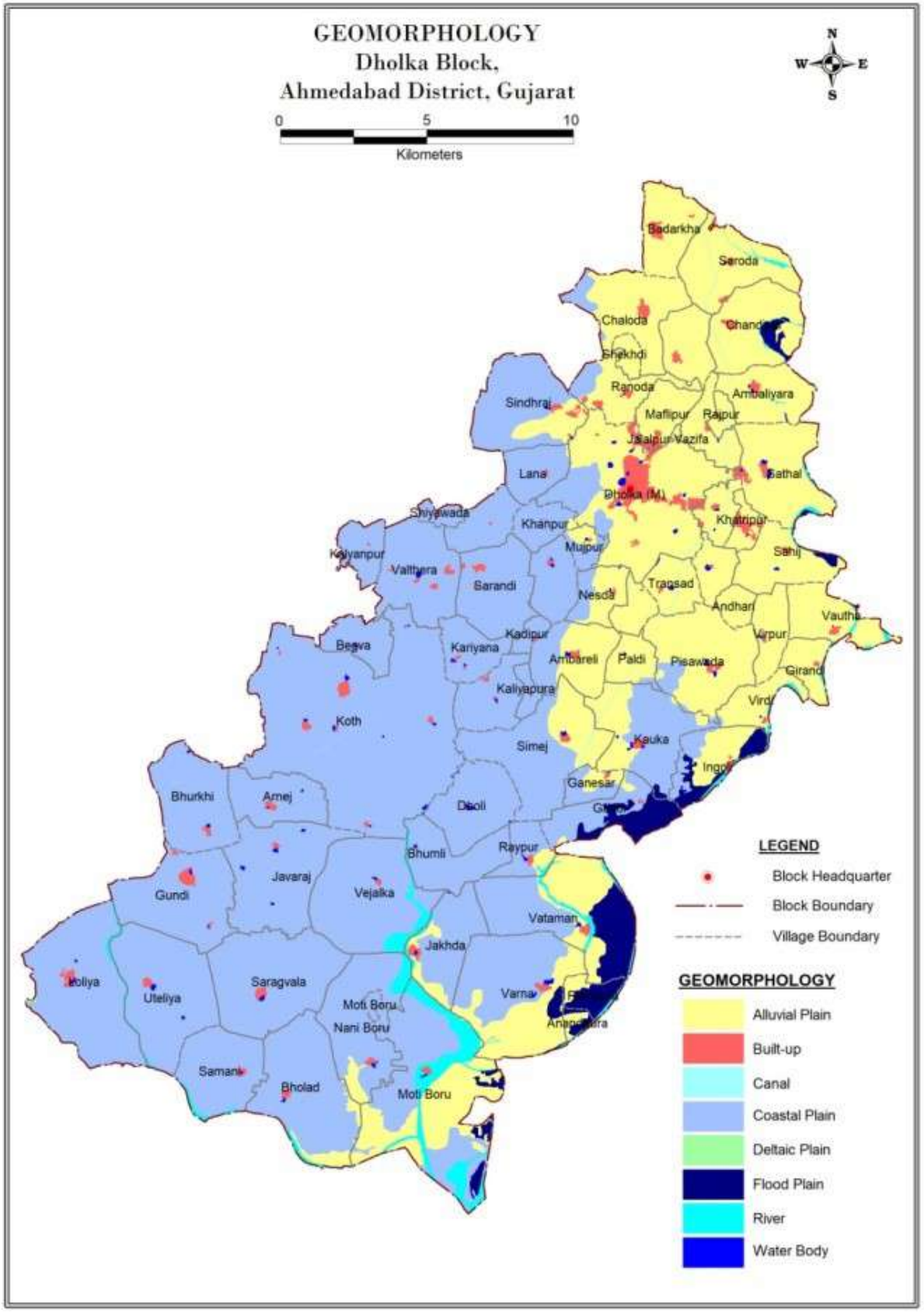


Fig.3: Geomorphology

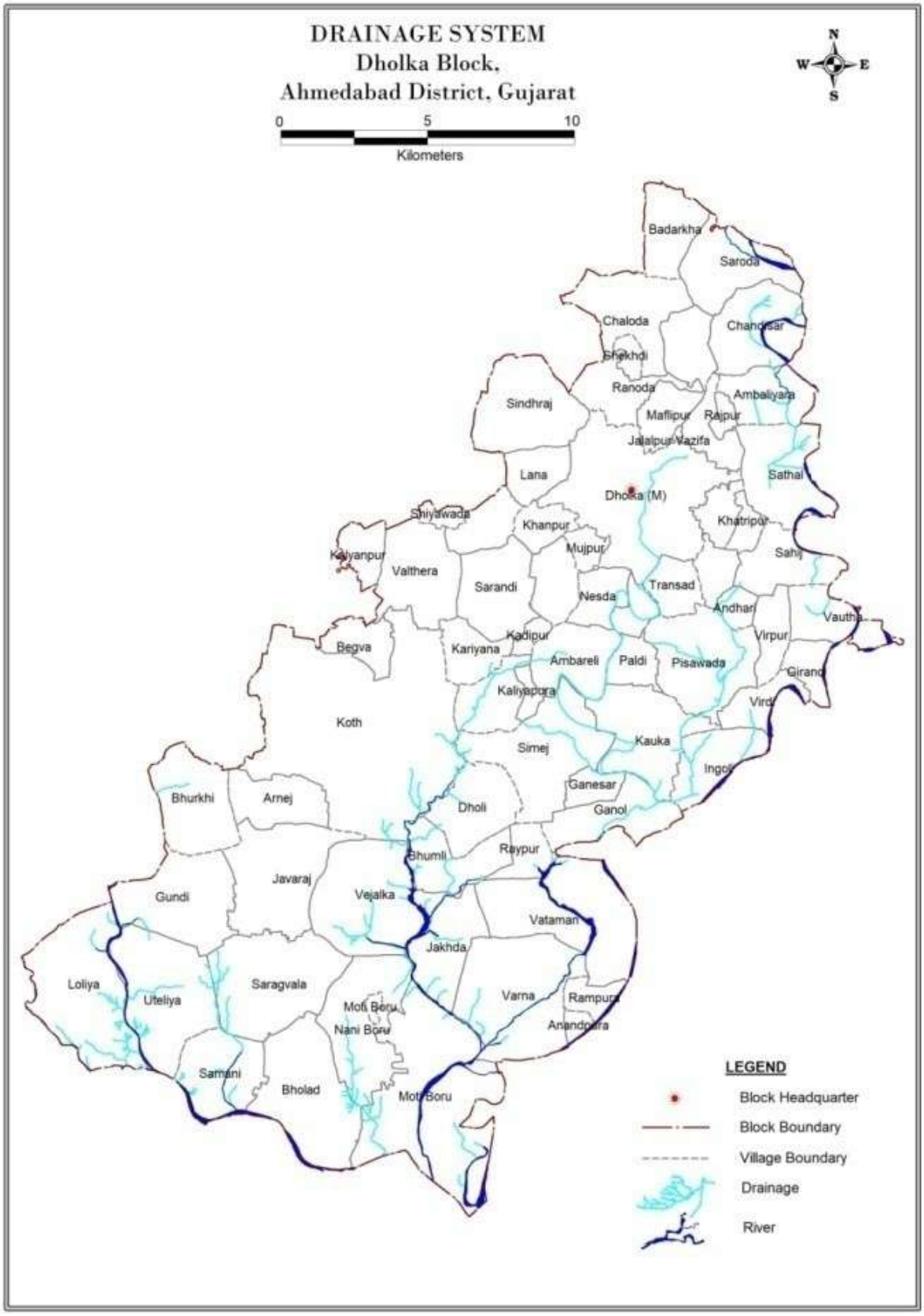


Fig. 4: Drainage Map

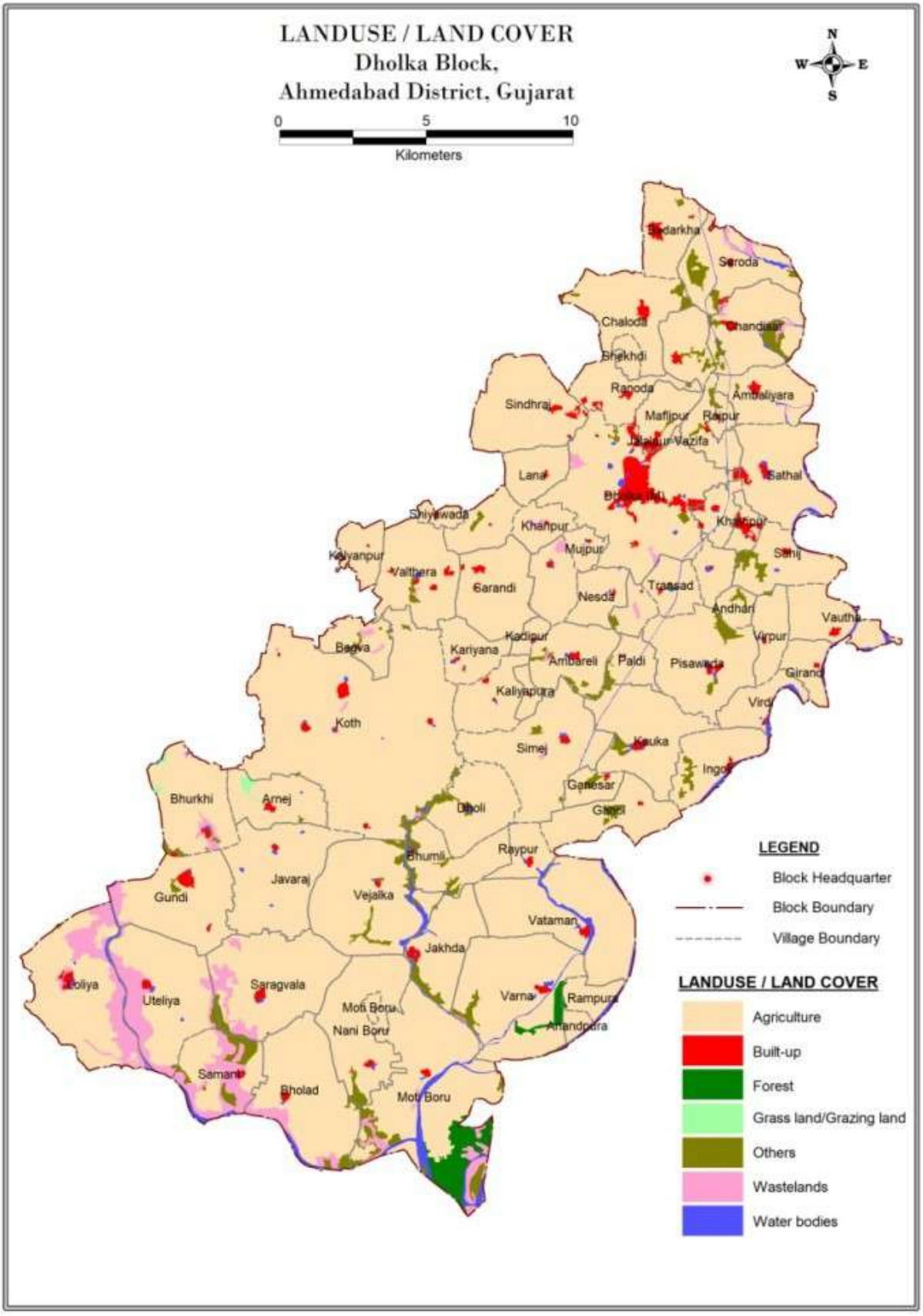


Fig. 5: Land Use Land Cover

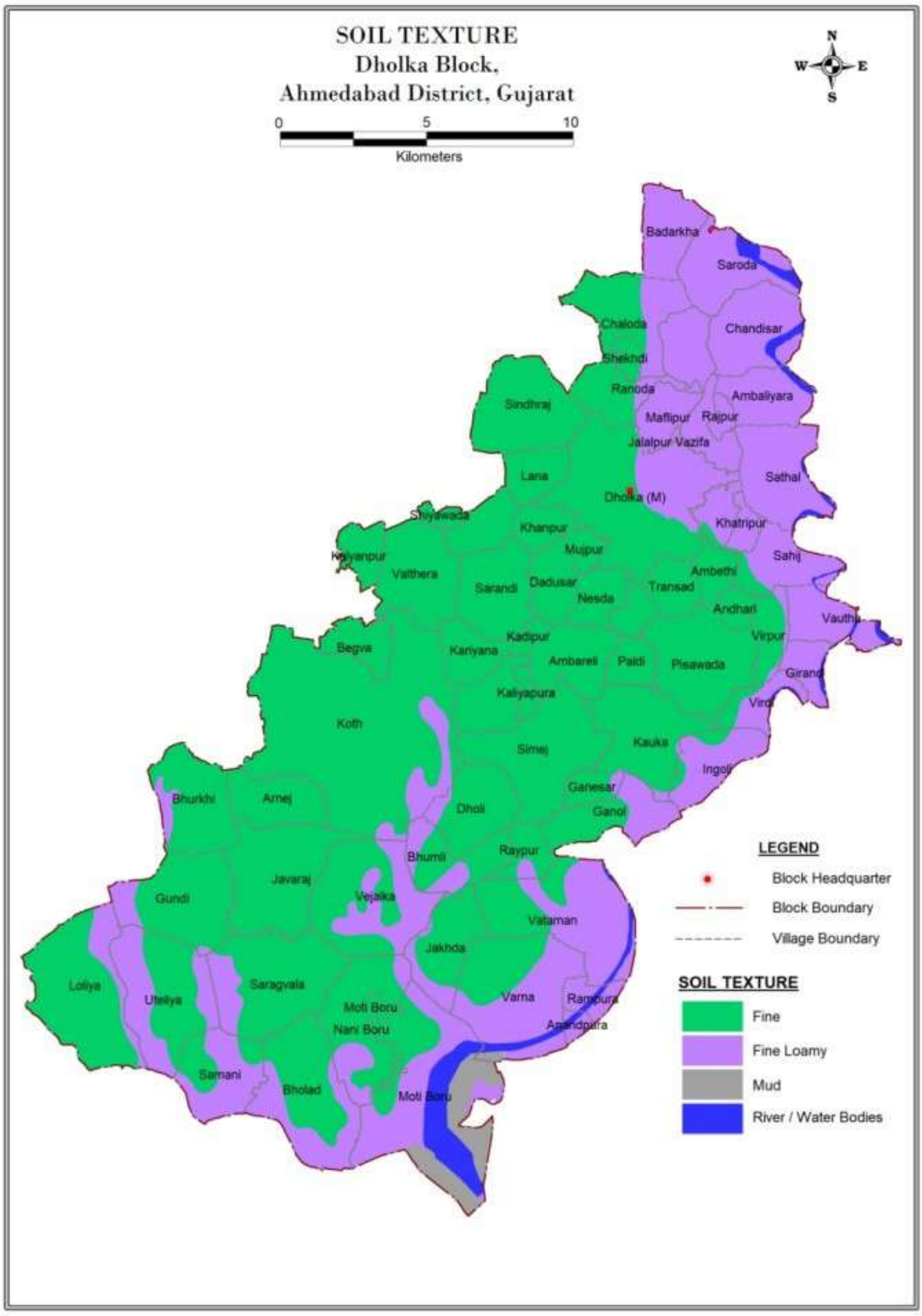


Fig. 6 Soil Map

3. Subsurface Hydrogeology

The area has multi-layer aquifer system. Aquifer I (unconfined) depth of occurrence upto 45 mbgl , Aquifer II (confined) depth of occurrence 60 to 122 mbgl , Aquifer III (confined) depth of occurrence 141 to 174 mbgl. Aquifer I (unconfined) thickness varies from 41 to 45 mt. Aquifer II (confined) thickness varies from 20 to 40 m, Aquifer III (confined) thickness varies from 22 to 31 m, Water level of aquifer I varies from 0.20 to 30.60 mbgl. Piezometric head of aquifer III varies from 9.95 to 38.60 mbgl. In Aquifer I (unconfined) discharge 8 lps Aquifer II (confined) discharge 15 lps, Aquifer III (confined) discharge varies from 6 to 9.50 lps.

Hydrogeological section for Dholka Taluka Depicting Aquifer

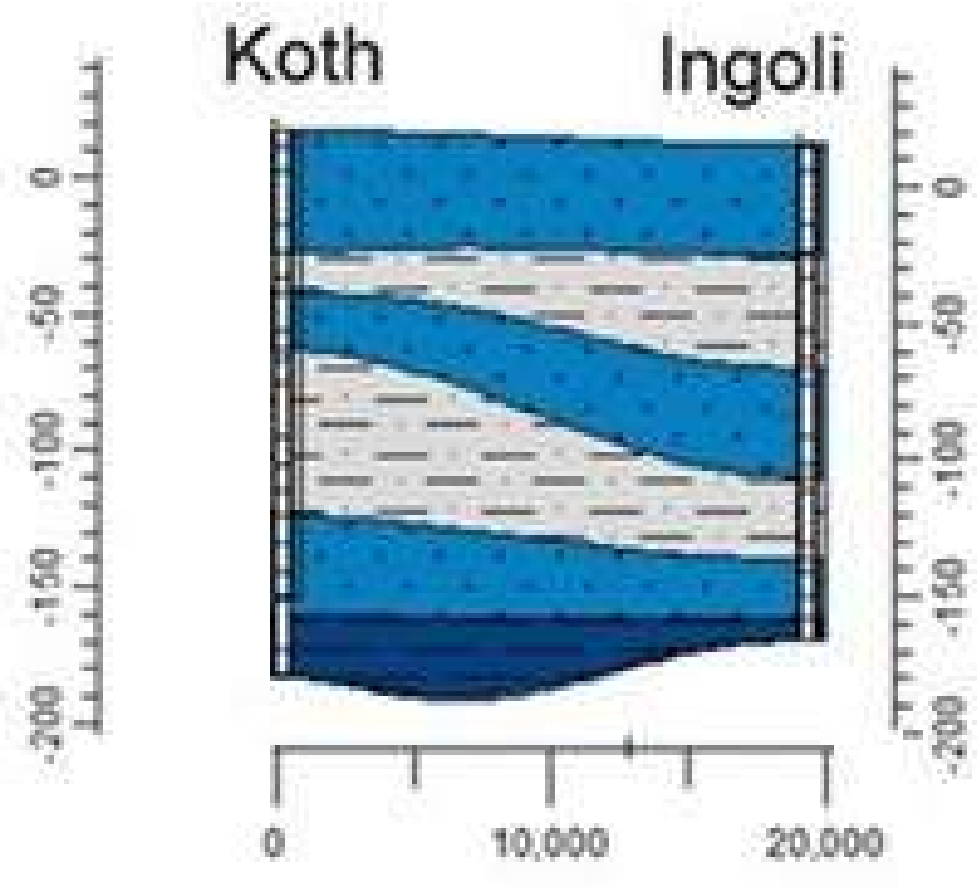


Fig.7: Stratigraphic Section

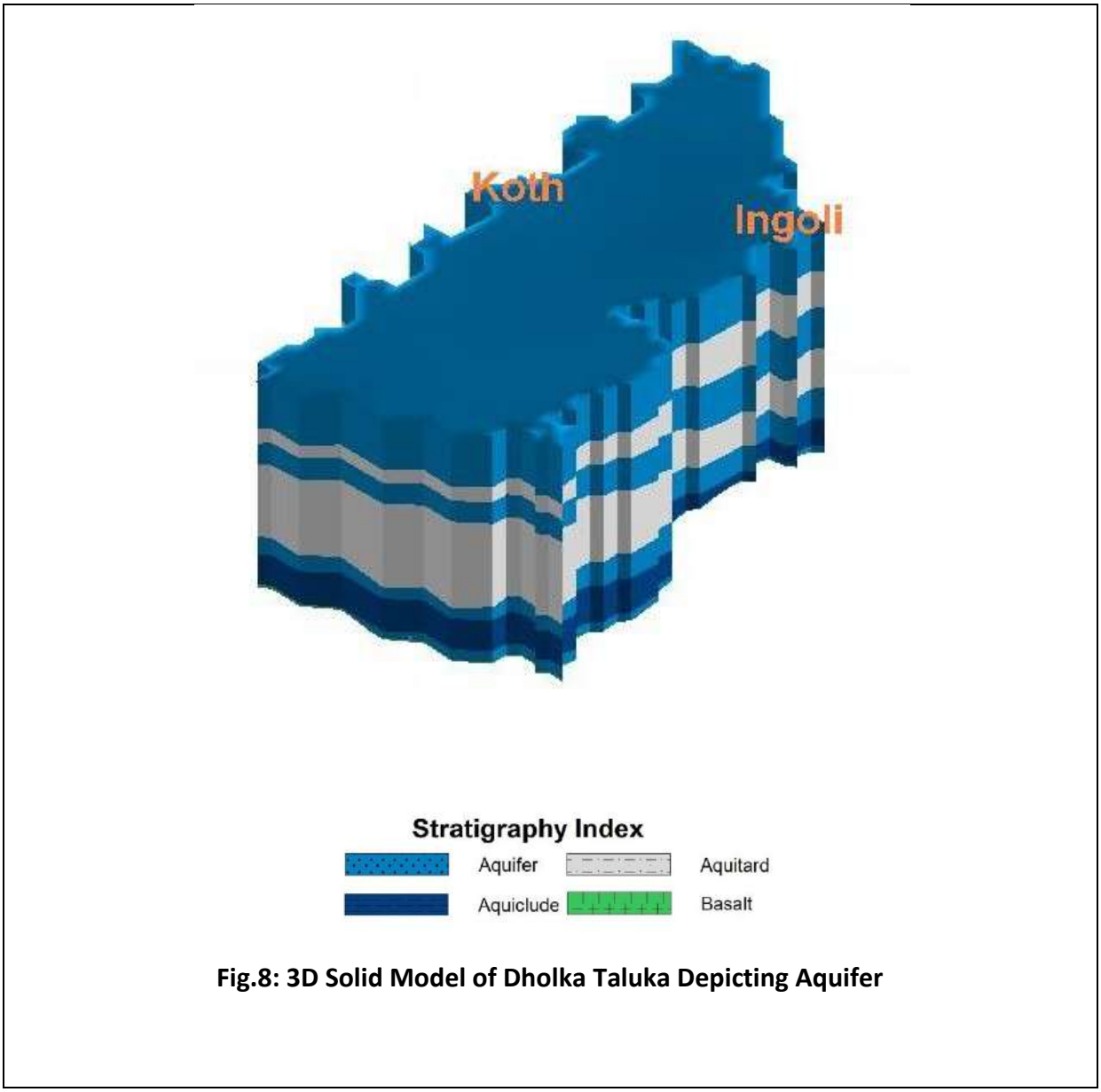


Fig.8: 3D Solid Model of Dholka Taluka Depicting Aquifer

Table; 2 Aquifer characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lps)	Quality/Ec µS/cm	Transimissivity (m2/day)	Water Level/ Piezometric head (mbgl)
Aquifer I	Upto 45	41 to 45	8	563 to 54719	45	0.20 to 30.60
Aquifer II (Confined)	60 to 122	20 to 40	15	3800	861	-
Aquifer III (Confined)	141 to 174	22 to 31	6 to 9.50	2920 to 3800	171	9.95 to 38.60

Aquifer Group wise Water Level maps

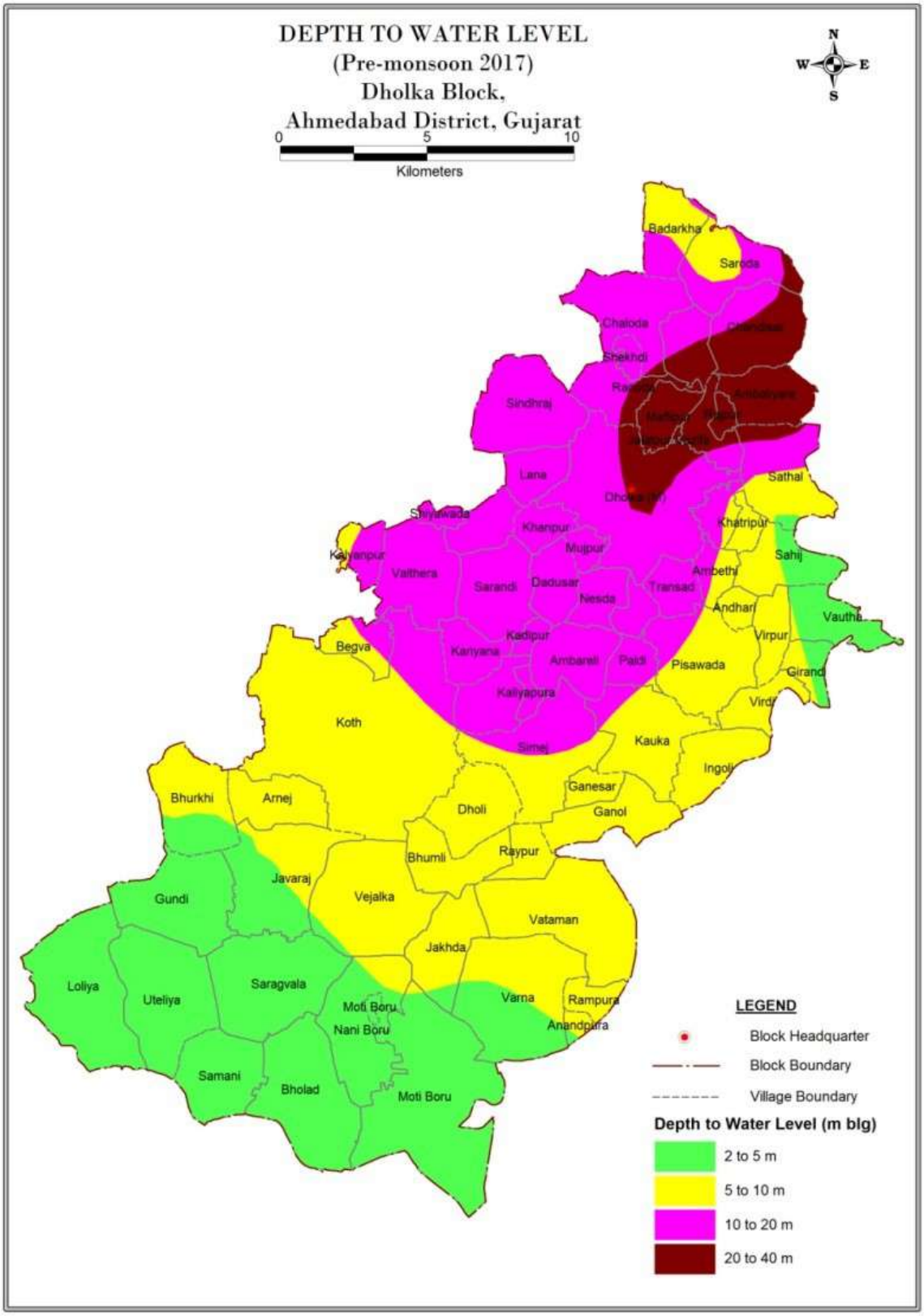


Fig.9: Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

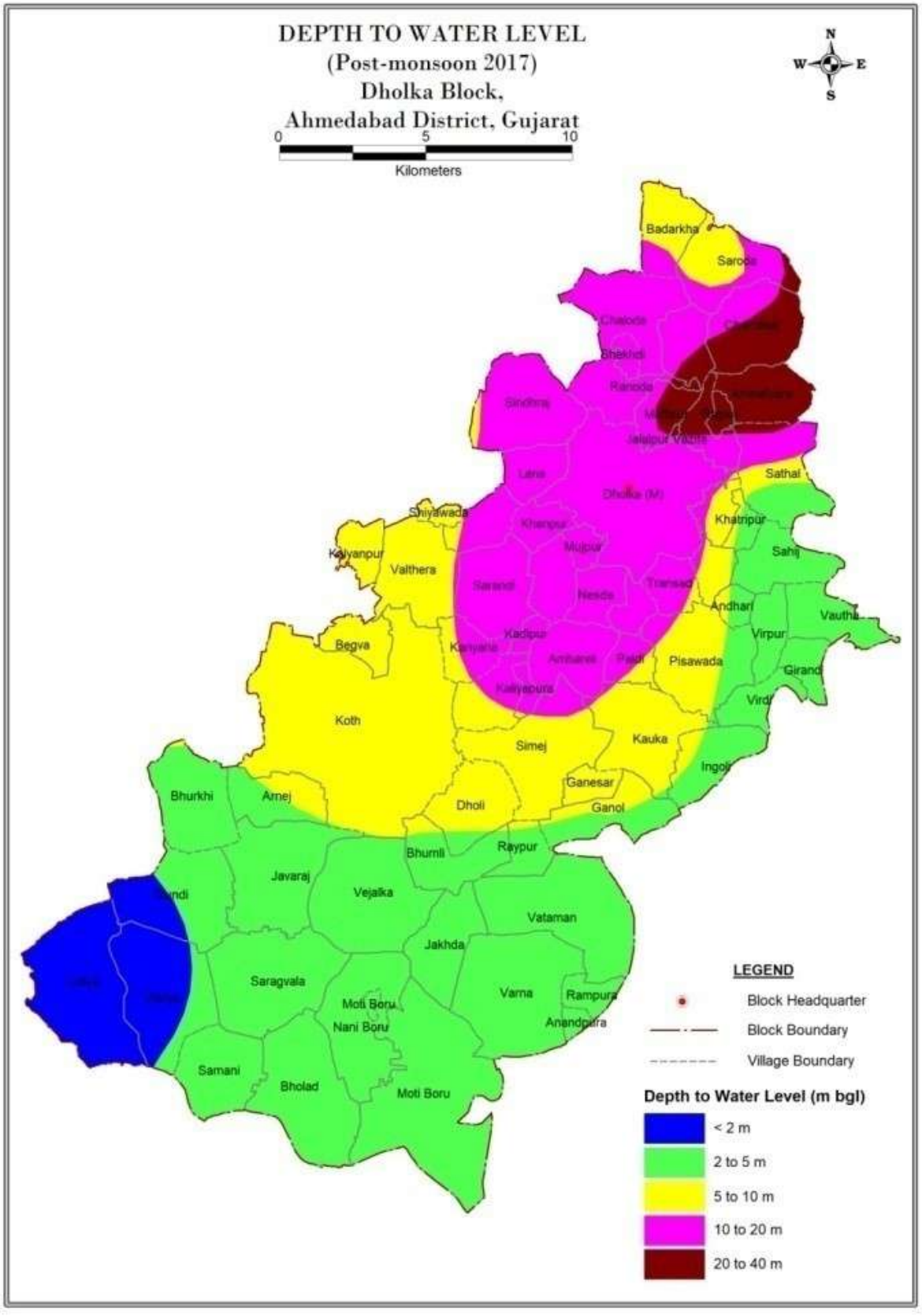


Fig.10: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

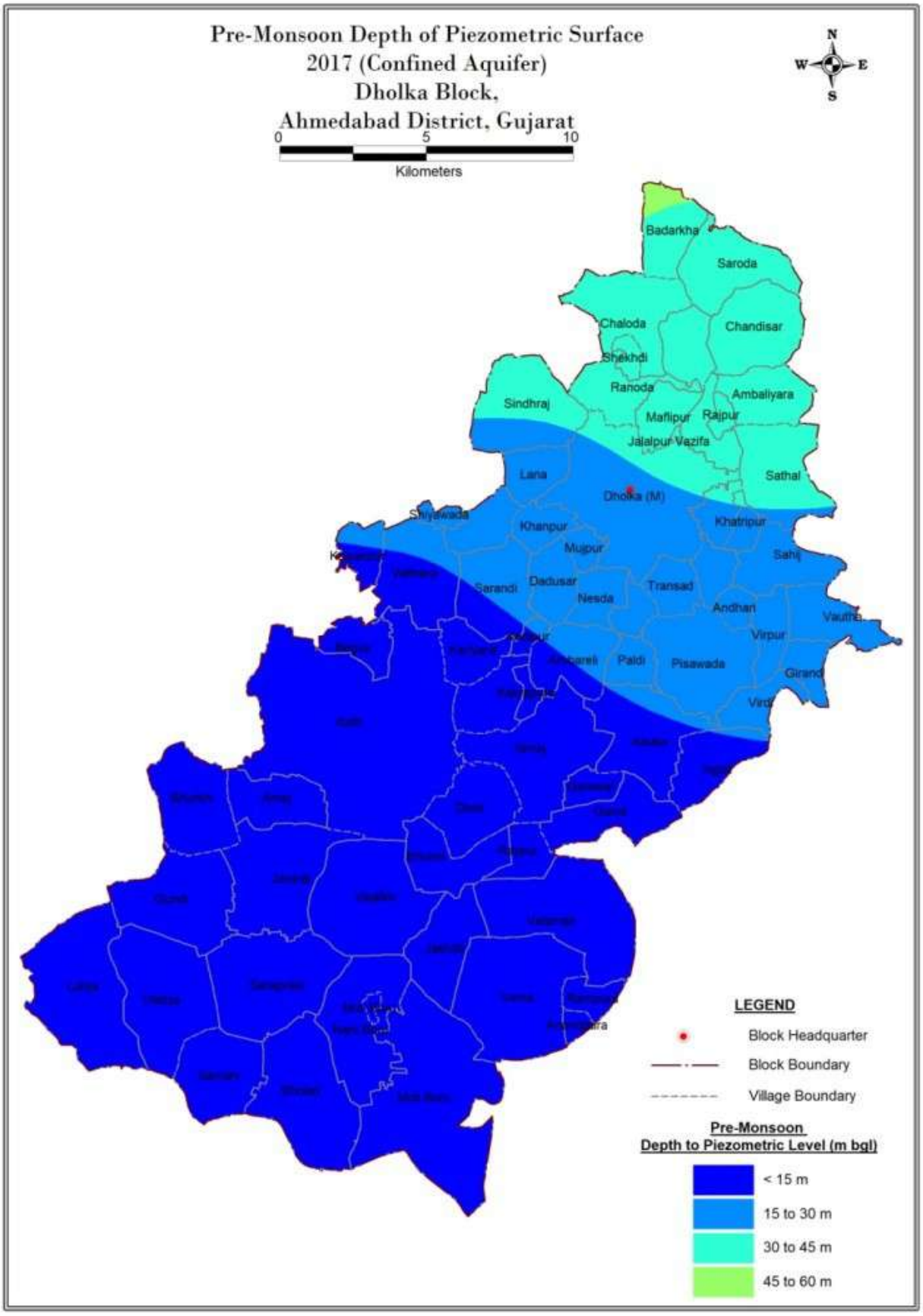


Fig.11: Pre-Monsoon Depth of Piezometric Surface- Confined Aquifer

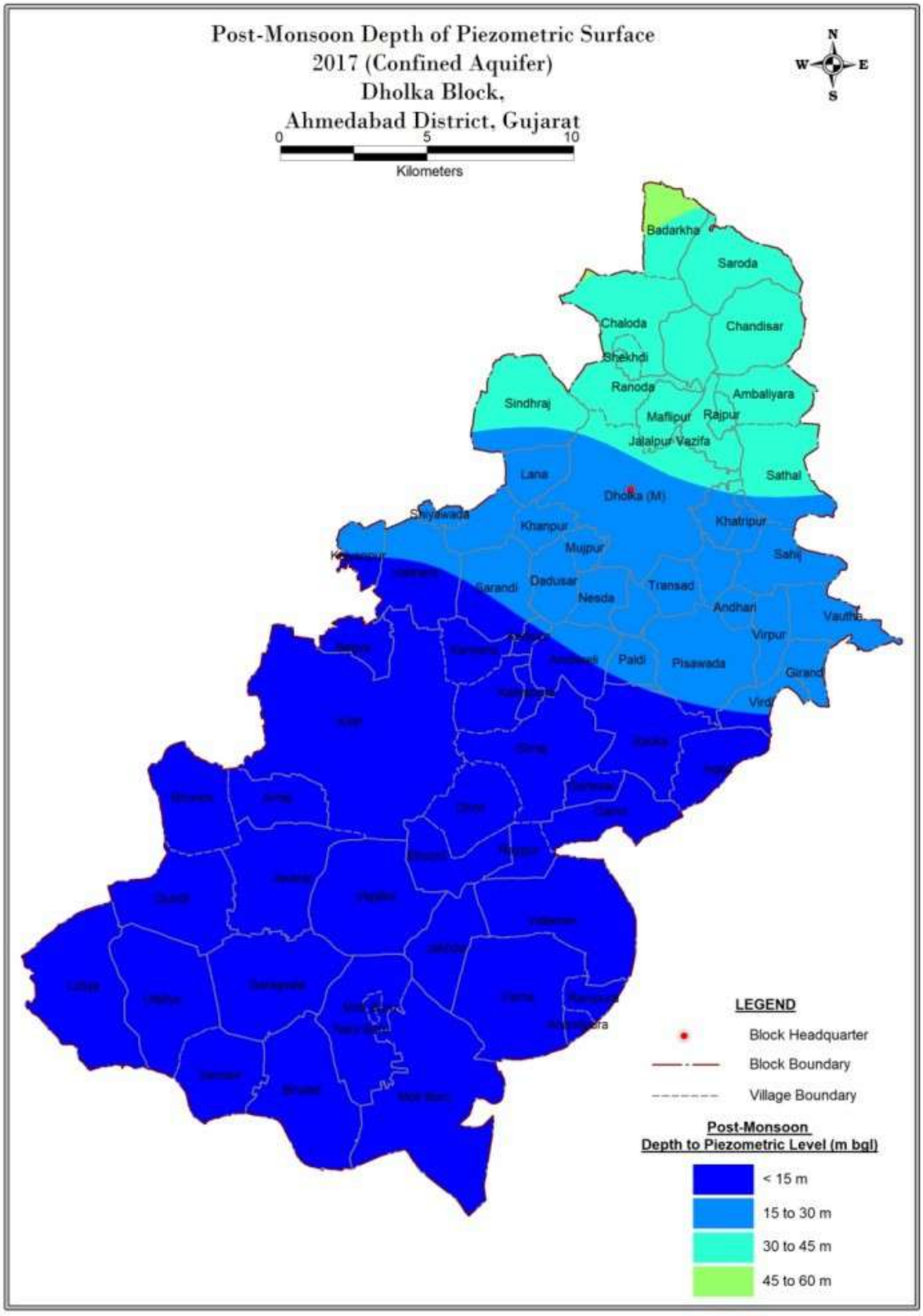


Fig.12: Post-Monsoon Depth of Piezometric Surface- Confined Aquifer

4. Dynamic Ground Water Resources in MCM

Total fresh groundwater availability of the area is estimated in year 2017 is 77.49 MCM and total groundwater withdrawal for all purposes is 61.37 MCM. The stage of groundwater development is 79.20% and the Taluka is categorized “Semi Critical”. Total Saline groundwater availability of the area is estimated in year 2017 is 113.80 MCM and total groundwater withdrawal for all purposes is 19.23 MCM. The stage of groundwater development is 16.90% and the Taluka is categorized “Safe”.

Table: 3 Dynamic Groundwater resources 2017

S No	Item	Fresh	Saline
1	Area (sq.km)	385.38	634.55
2	Total GW Recharge (MCM)	81.57	119.79
3	Net GW Availability (MCM)	77.49	113.80
4	Gross Draft (MCM)	61.37	19.23
5	Net Availability for Future Irrigation (MCM)	16.07	92.90
6	Stage of GW Development %	79.20	16.90

5. Chemical quality of groundwater

Groundwater quality is one of the major issues in the area. Phreatic Aquifer (Aquifer I); Shows considerable variation from highly saline to Fresh EC value ranges from 562 to 54718 µS/cm. Deeper confined aquifer are brackish to saline in nature.

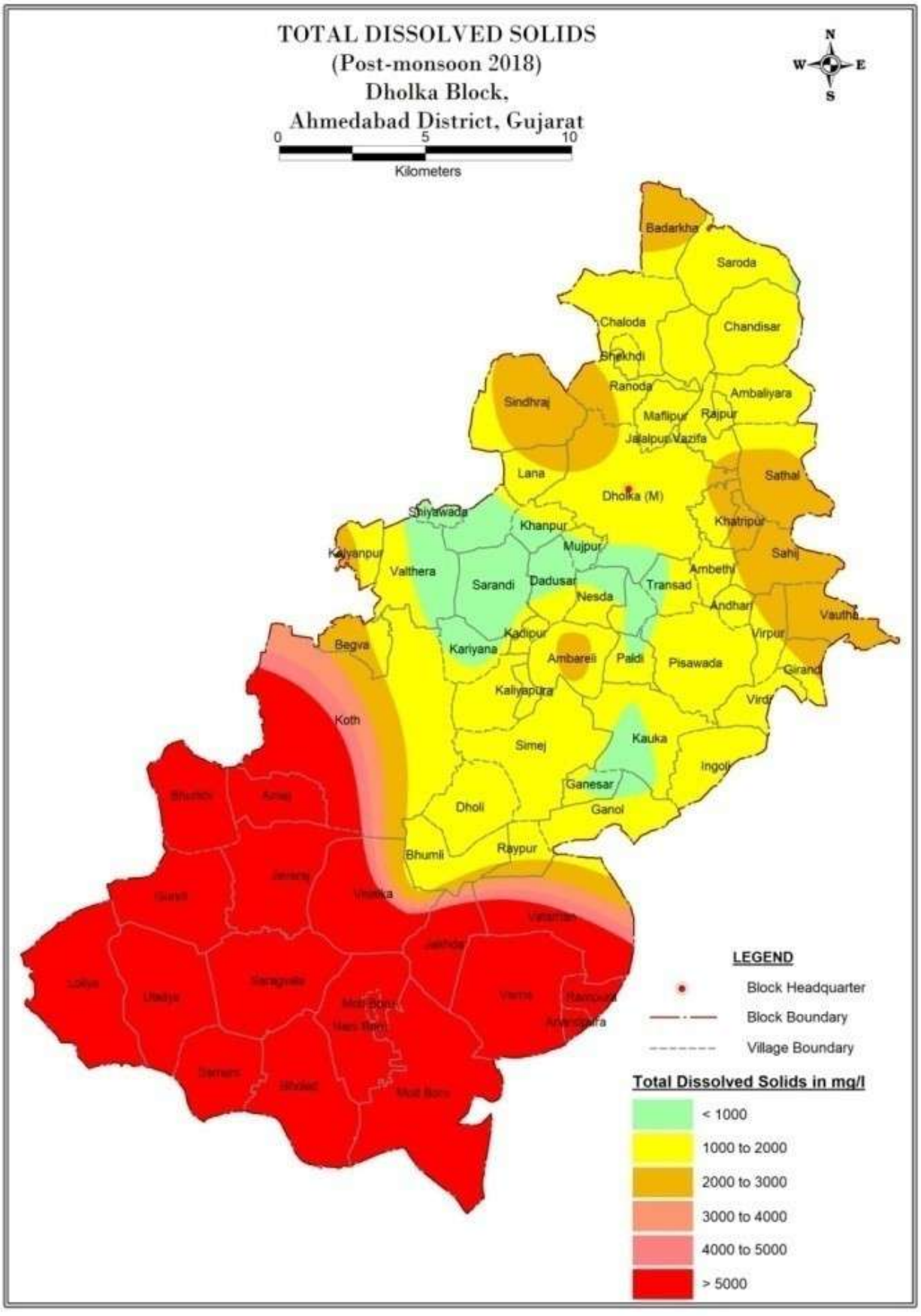


Fig.13: Total Dissolved Solids (TDS) Map- Unconfined Aquifer

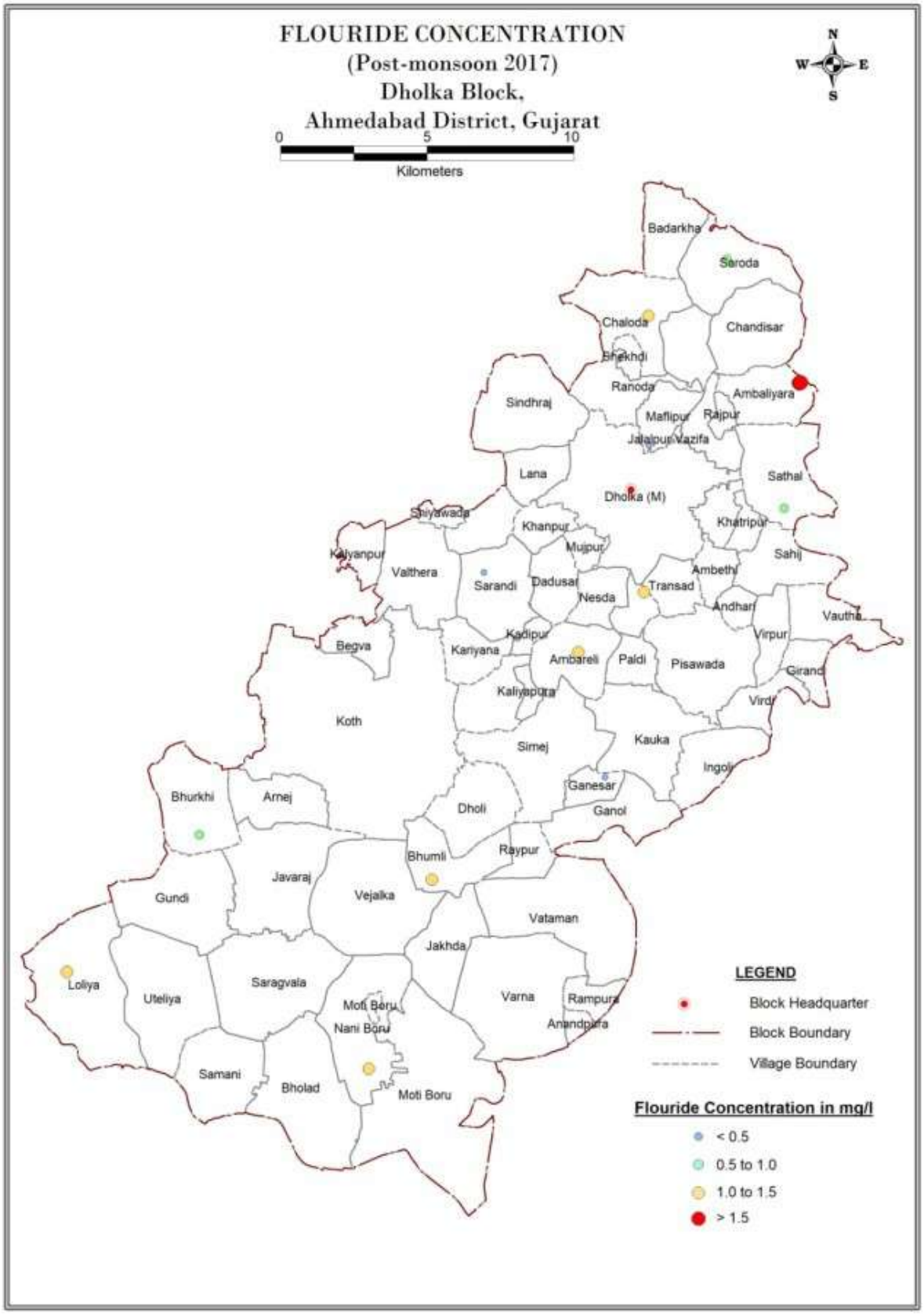


Fig.14: Fluoride Map- Unconfined Aquifer

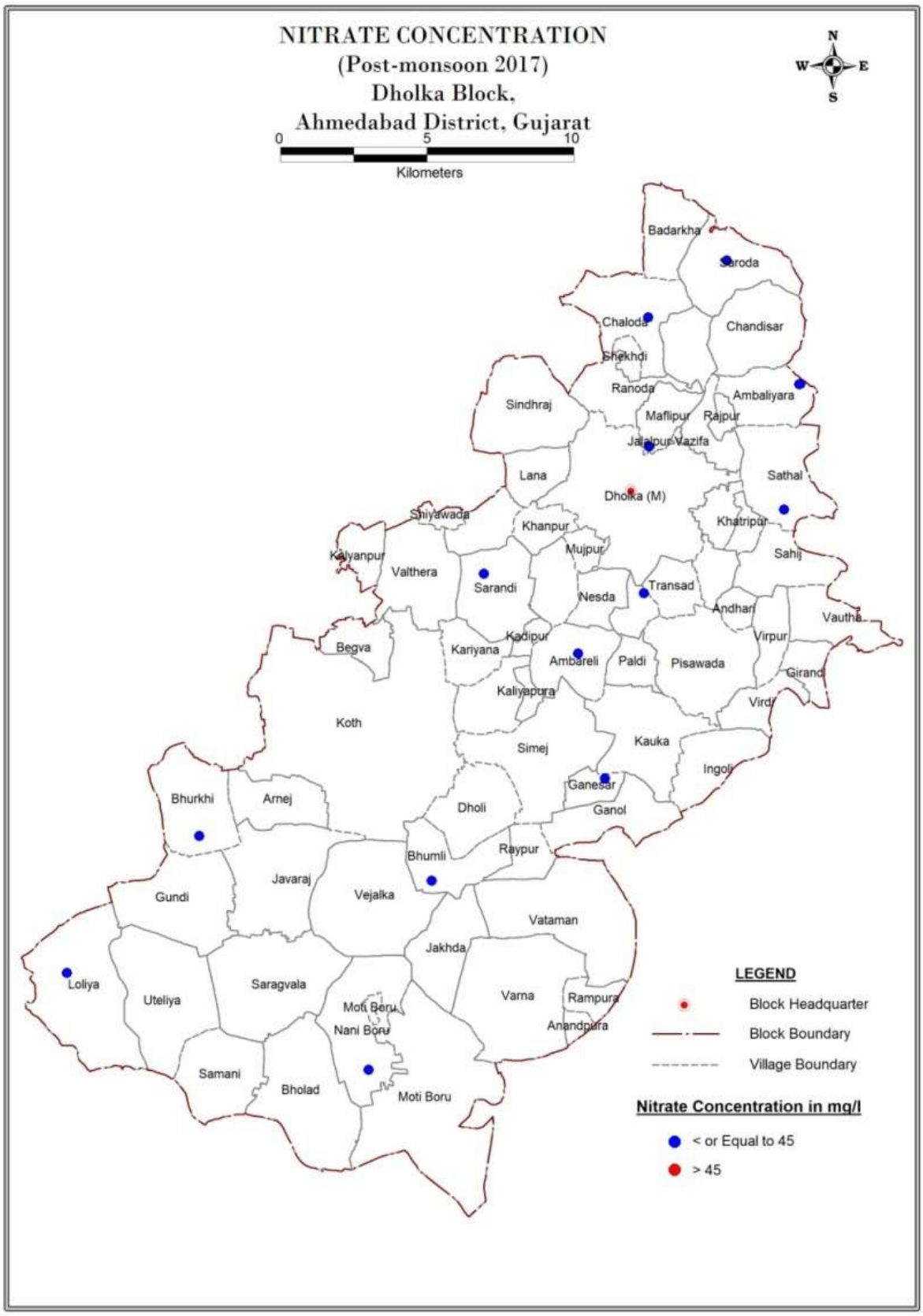


Fig.15: Nitrate Map- Unconfined Aquifer

6. Groundwater issues

- Phreatic aquifer (fresh area) showing depth to water level 10 to 29.20 m bgl.
- Quality Issues (Shows considerable variation from highly saline to Fresh.

7. Groundwater Management

Supply Side management-Proposed Recharge Structures- Percolation tank -20 nos. & net water recharge through percolation tank is 2.90 MCM. In Demand Side Management Micro Irrigation System proposed in 4675.10 ha area and water saving is 7.01 MCM. Net water saving : 9.91 MCM.

Supply Side Intervention	
Volume of subsurface storage space available of artificial recharge (MCM)	1933.70
Surplus available (MCM)	2.90
Percolation tank proposed	20
Water availability after additional recharge	2.90 MCM

Demand Side Intervention	
Use of Micro Irrigation Systems (Drift & Sprinkler)	
Irrigated area proposed under MIS* (Ha)	4675.104
Water saving by MIS (MCM)	7.01

9. Artificial Recharge & Conservation Possibilities

Ground water resources in the block augmented by means artificial recharge through percolation tank and adoption of Micro Irrigation System in the taluka would lead to 9.91 MCM saving of ground water and improve stage of ground water from semi critical (79.20%) to safe category (67.63%)

MANAGEMENT PLAN OF
MANDAL TALUKA, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	473.85 sq. km		
No. of villages	37		
Population (2011 Census)	70346		
Average Annual Rainfall	500.80		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources (2017)	Fresh: 28.35 MCM		
Net Groundwater Draft	Fresh: 8.86 MCM		
Stage of Groundwater Development	31.24 % (Safe)		
Existing and future water demands (MCM)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	0.22	1.42
	Irrigation	8.64	18.29

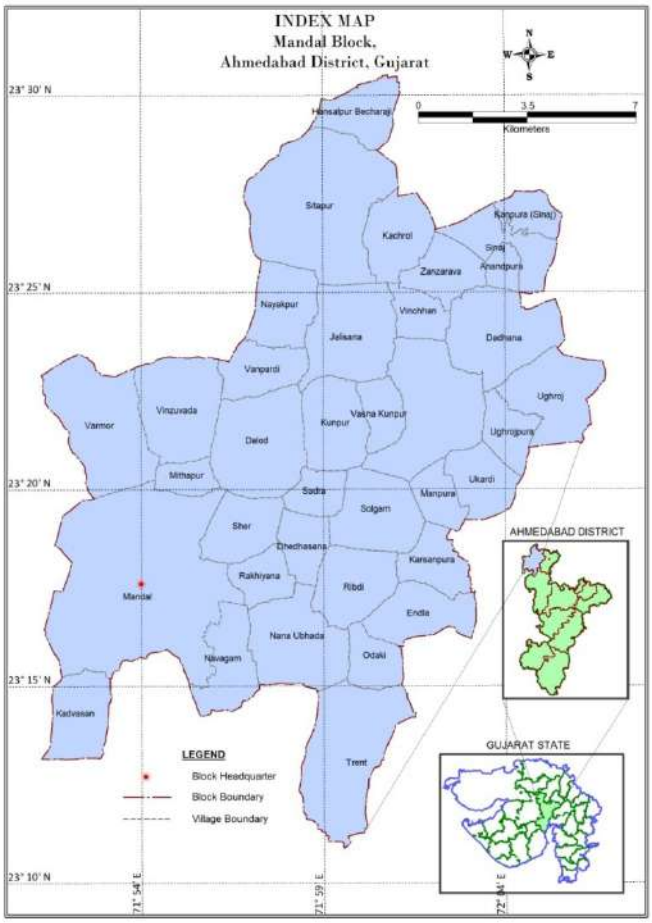


Fig. 1: Location Map

1 Land Use Classification

Table.1: Land Use Classification

Taluka Name	Mandal
Area according to village papers (Ha)	47674
Area under Forest (Ha)	0
Barren & uncultivable land (Ha)	2010
Land put to non agricultural uses (Ha)	3215
Cultivable waste (Ha)	850
Permanent pastures & other grazing lands (Ha)	1610
Current fallow (Ha)	95
Fallow land other than current fallow (Ha)	0
Net area sown (Ha)	38894
Area sown more than once (Ha)	8250
Gross Cropped area (Ha)	47144

2. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel. The groundwater quality is saline at shallow depths and there is wide variation in quality regionally.

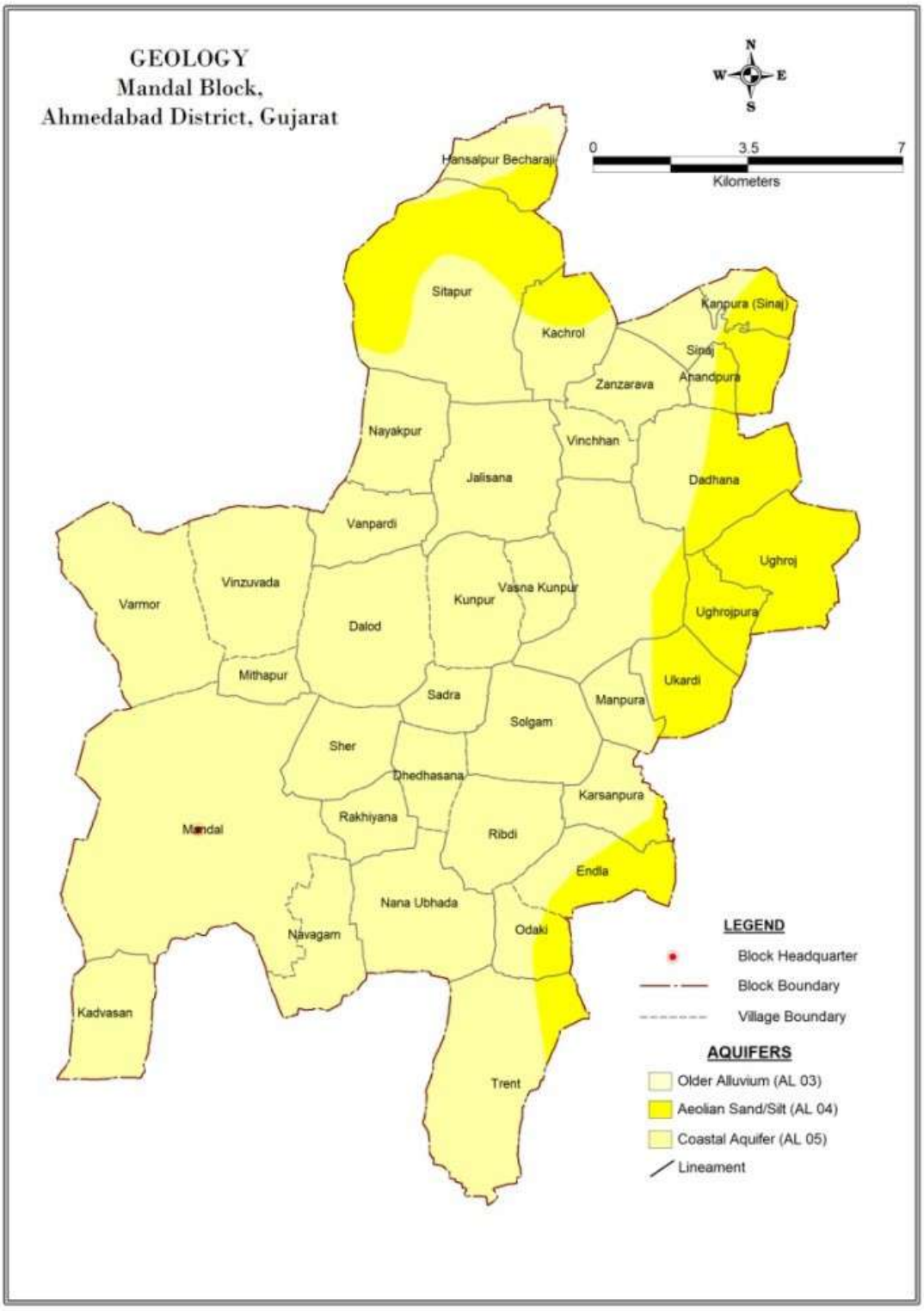


Fig.2: Major Aquifer

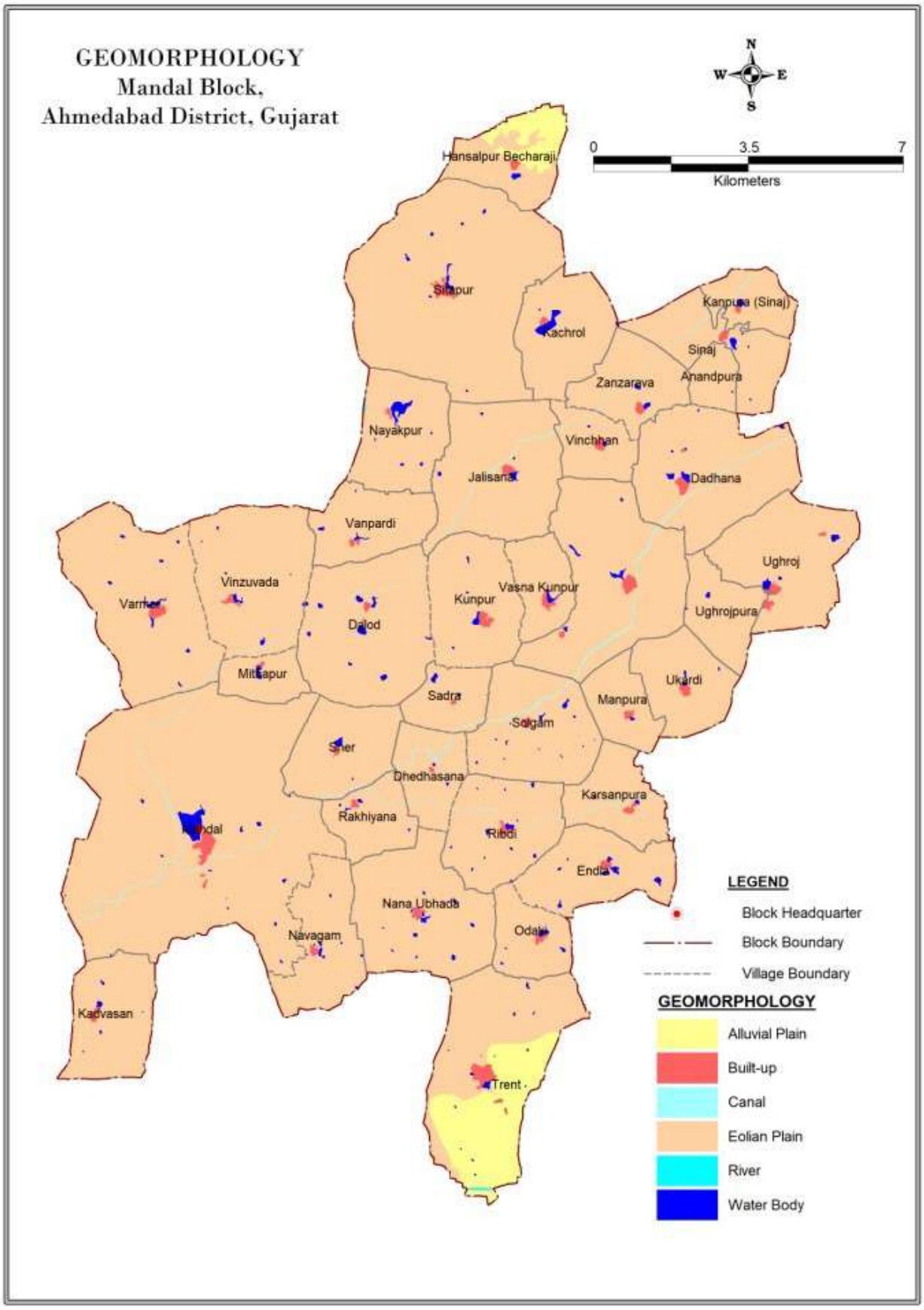

GEOMORPHOLOGY
Mandal Block,
Ahmedabad District, Gujarat
N
W
E
S
0
3.5
7
Kilometers
Hansalpur Becharaji
Sitapur
Kachrol
Kanpura (Sinaj)
Sinaj
Anandpura
Zanzarava
Nayakpur
Vinchhan
Jalisana
Dadhana
Vanpardi
Ughroj
Vinzuvada
Vasna Kunpur
Kunpur
Ughrojpura
Dalod
Mitsapur
Sadra
Manpura
Ukardi
Salgam
Dhedhasana
Karsanpura
Rakhiyana
Ribdi
Endla
Nana Ubhada
Navagam
Odal
Kadvasan
Trent
LEGEND
Block Headquarter
Block Boundary
Village Boundary
GEOMORPHOLOGY
Alluvial Plain
Built-up
Canal
Eolian Plain
River
Water Body

Fig.3: Geomorphology

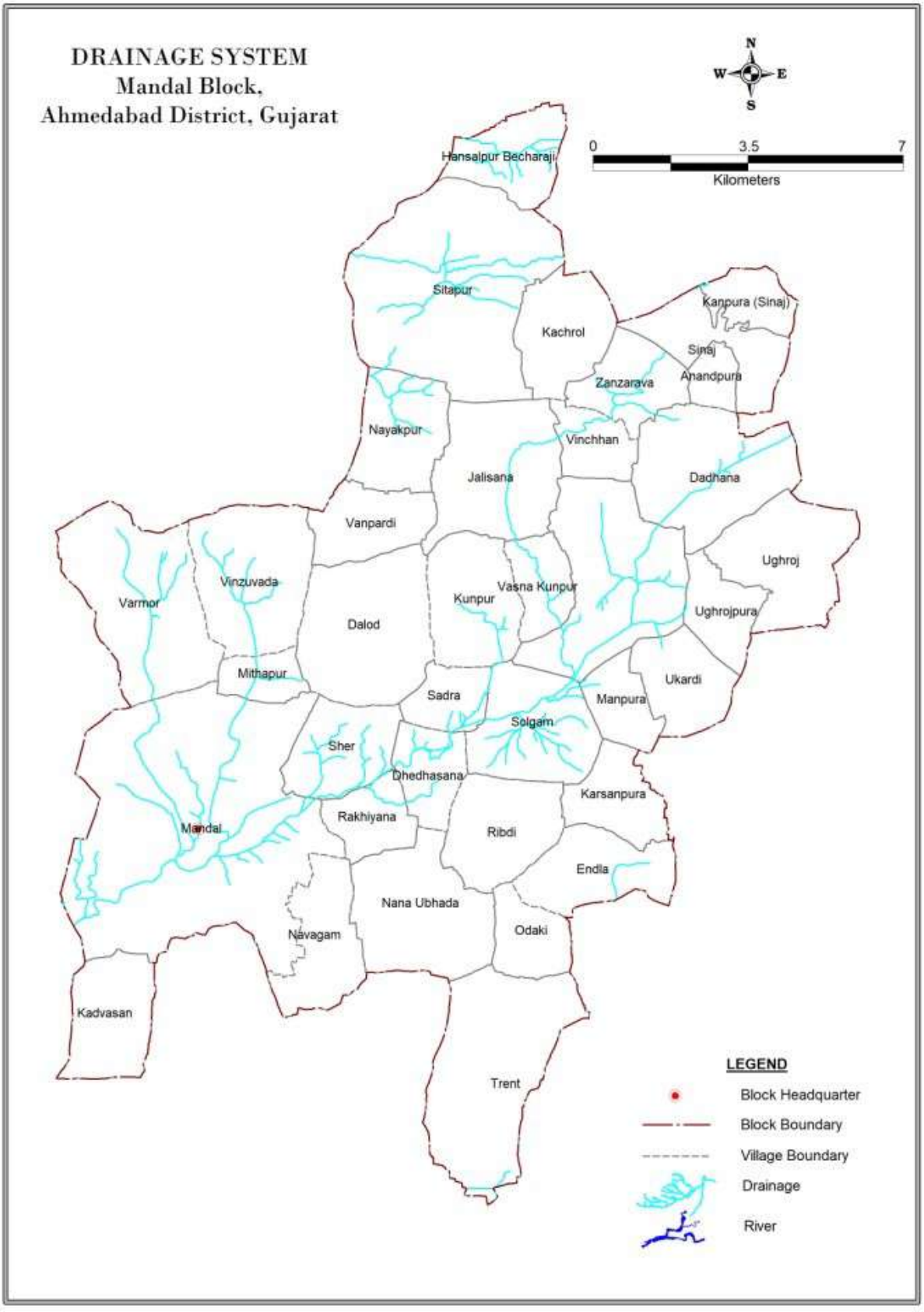


Fig. 4: Drainage Map

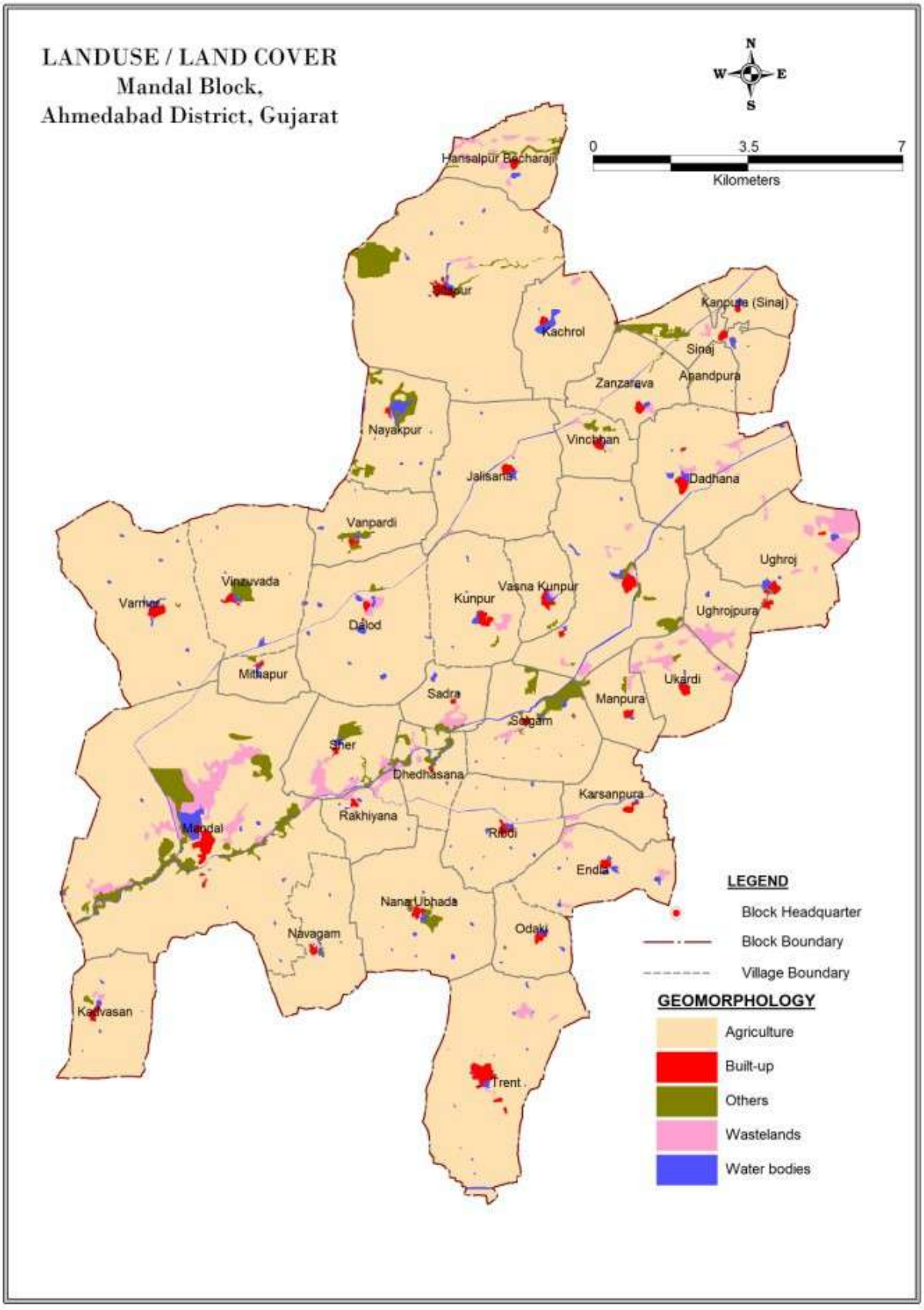


Fig. 5: Land Use Land Cover

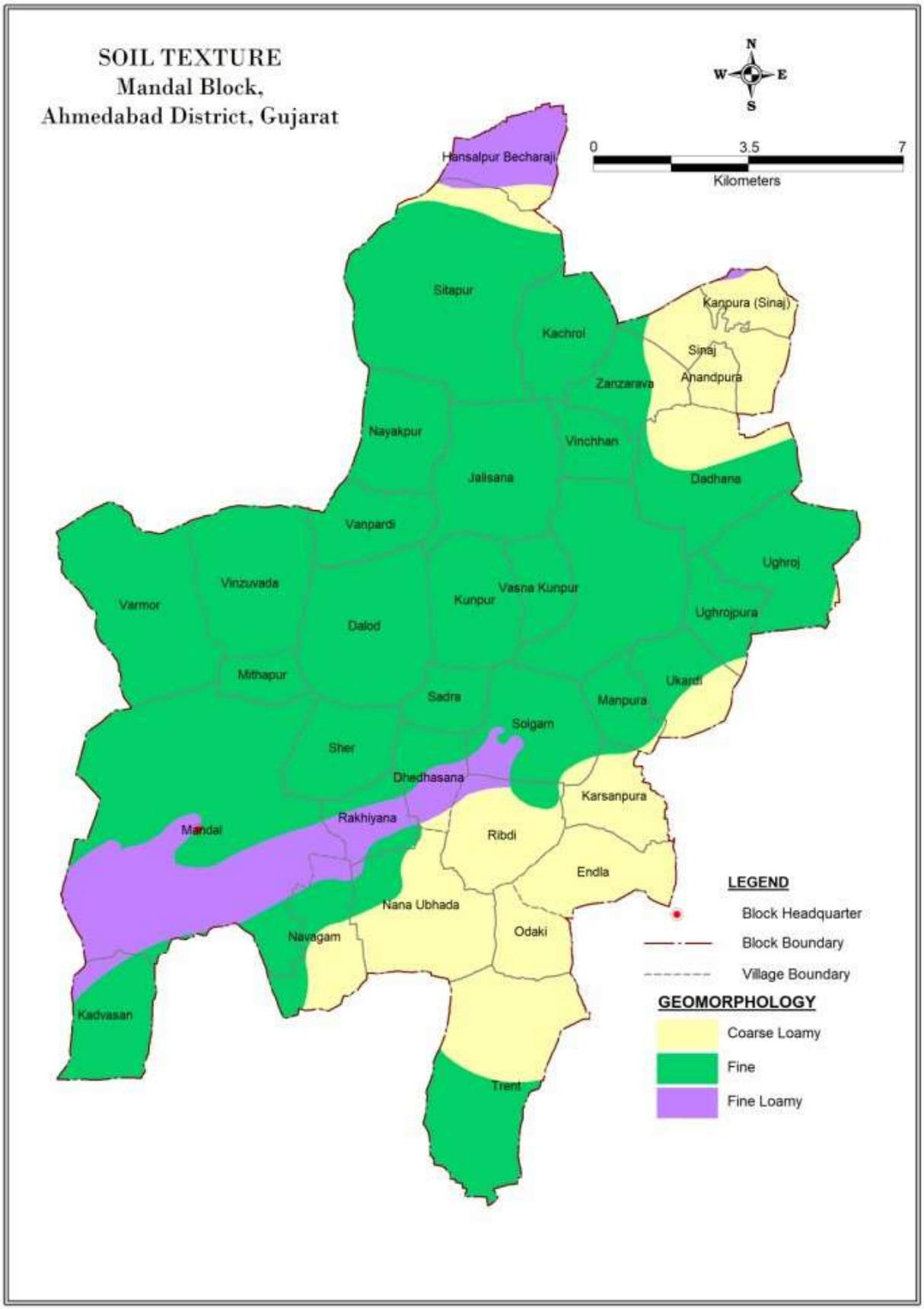


Fig. 6 Soil Map

3. Subsurface Hydrogeology

The area has multi-layer aquifer system. Aquifer I (unconfined) depth of occurrence upto 62 mbgl , Aquifer II (confined) depth of occurrence 75 to 135 mbgl , Aquifer III (confined) depth of occurrence 143 to 205 mbgl. Aquifer IV (confined) depth of occurrence 255 to 300 mbgl. Aquifer I (unconfined) thickness varies from 57 to 62 mt. Aquifer II (confined) thickness varies from 37 to 60 m, Aquifer III (confined) thickness varies from 45 to 57 m, Aquifer IV (confined) thickness around 45 m, Water level of aquifer I is 6.91 mbgl. Piezometric head of aquifer III is 135.21 mbgl. In Aquifer I (unconfined) discharge 0.14 to 6 lps, Aquifer III (confined) discharge varies from 2.07 lps.

Hydrogeological section for Mandal Taluka Depicting Aquifer Group I, II and III

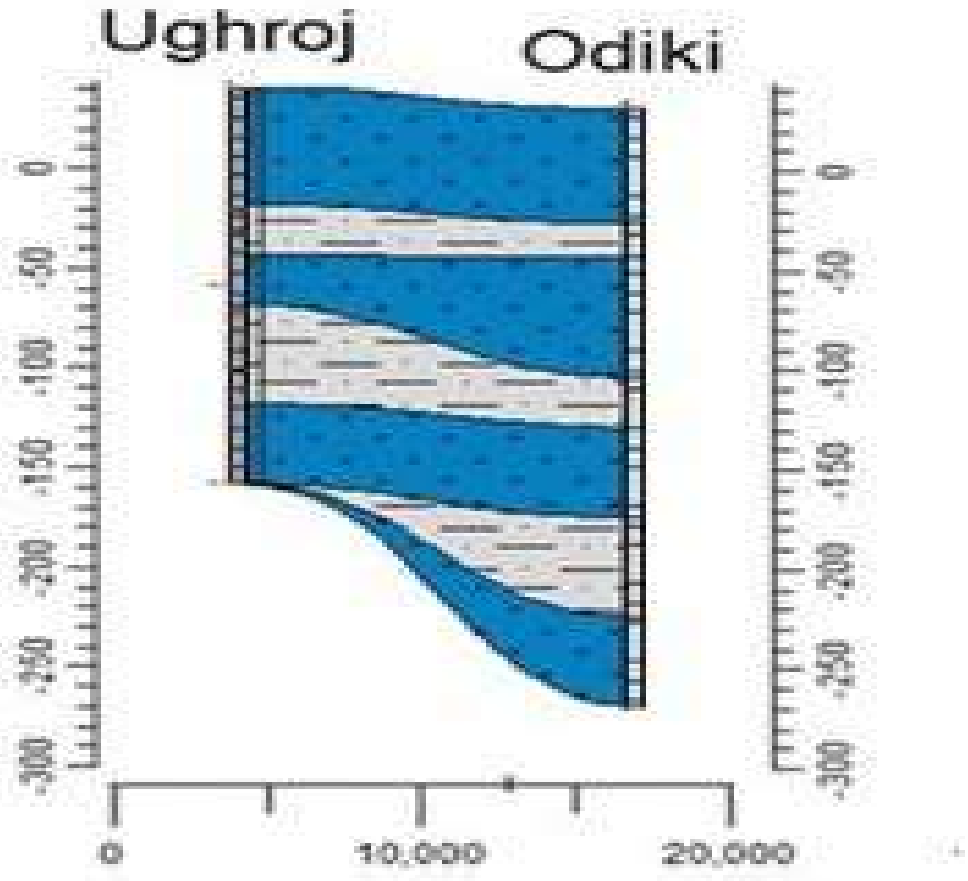


Fig.7: Stratigraphic Section

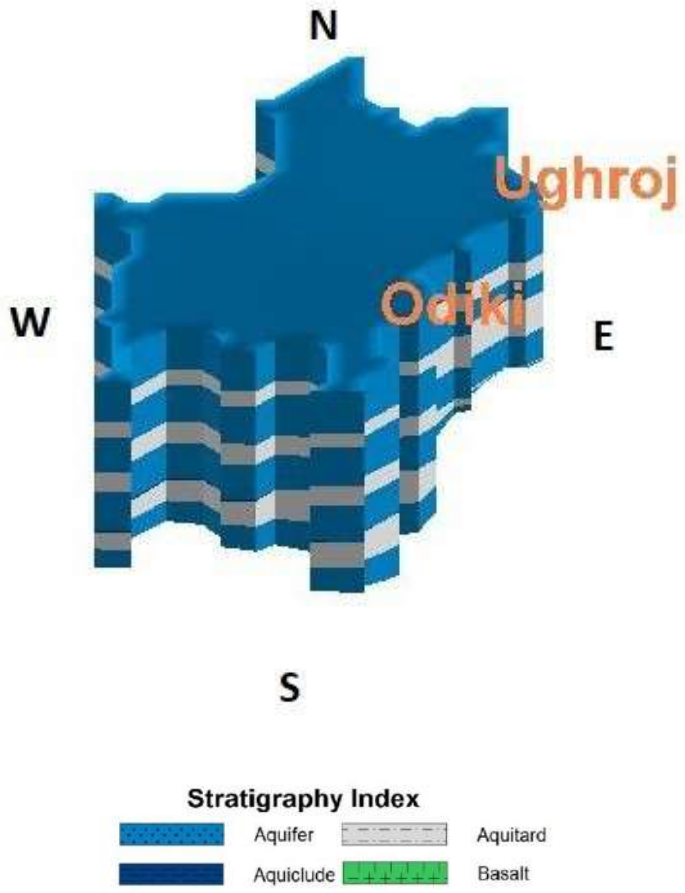


Fig.8: 3D Solid Model of Mandal Taluka Depicting Aquifer

Table; 2 Aquifer characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lpm)	Quality/Ec µS/cm	Transimissivity (m2/day)	Water Level/ Piezometric head (mbgl)
Aquifer I	Upto 62	57 to 62	0.14 to 6	1719 to 11469	6.91	1.40 to 35.70
Aquifer II (Confined)	75 to 135	37 to 60	-	-	-	-
Aquifer III (Confined)	143 to 205	45 to 57	2.07	5890	135.21	53.8 to 89.4
Aquifer IV (Confined)	255 to 300	45	-			

Aquifer Group wise Water Level maps

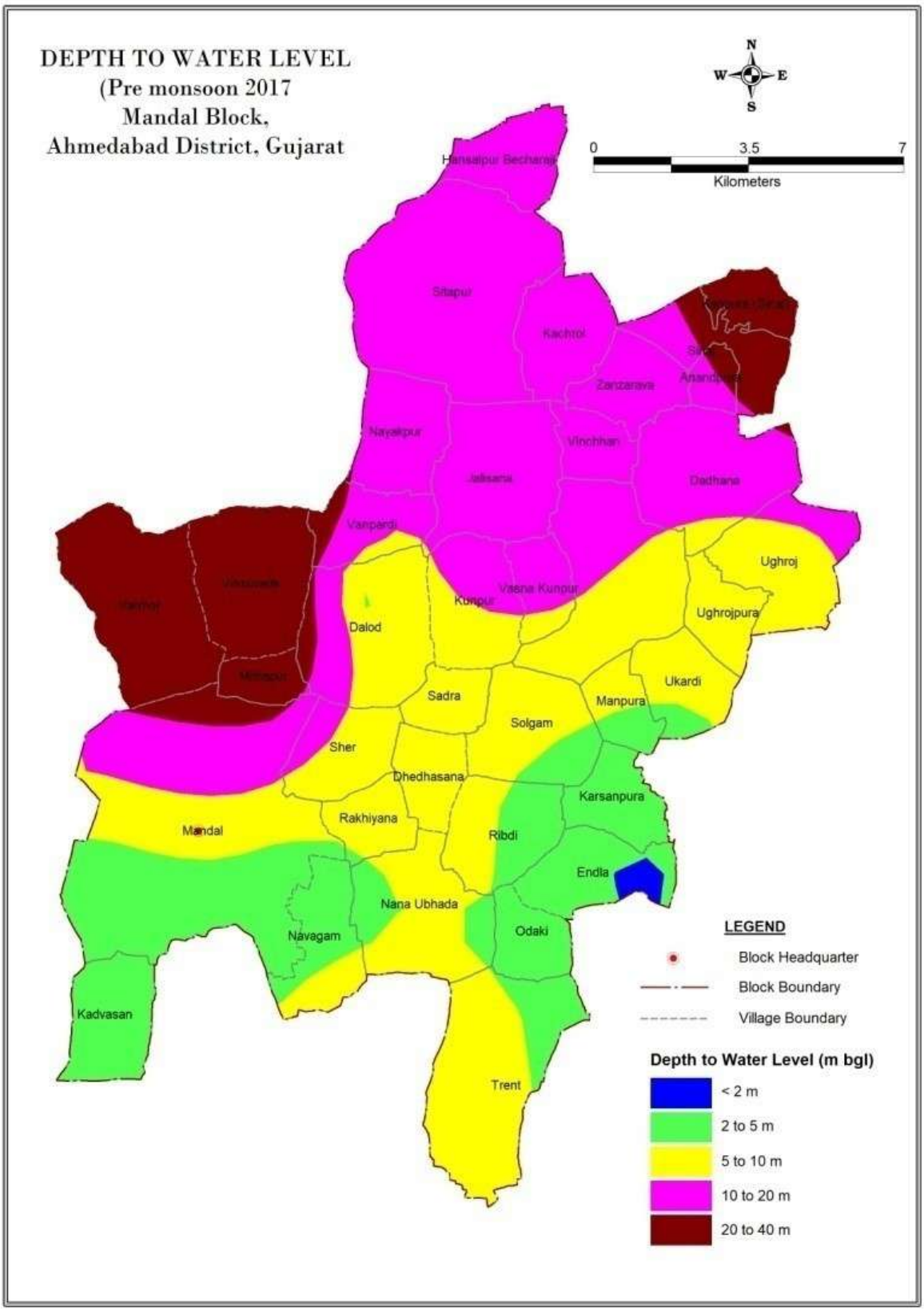


Fig.9: Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

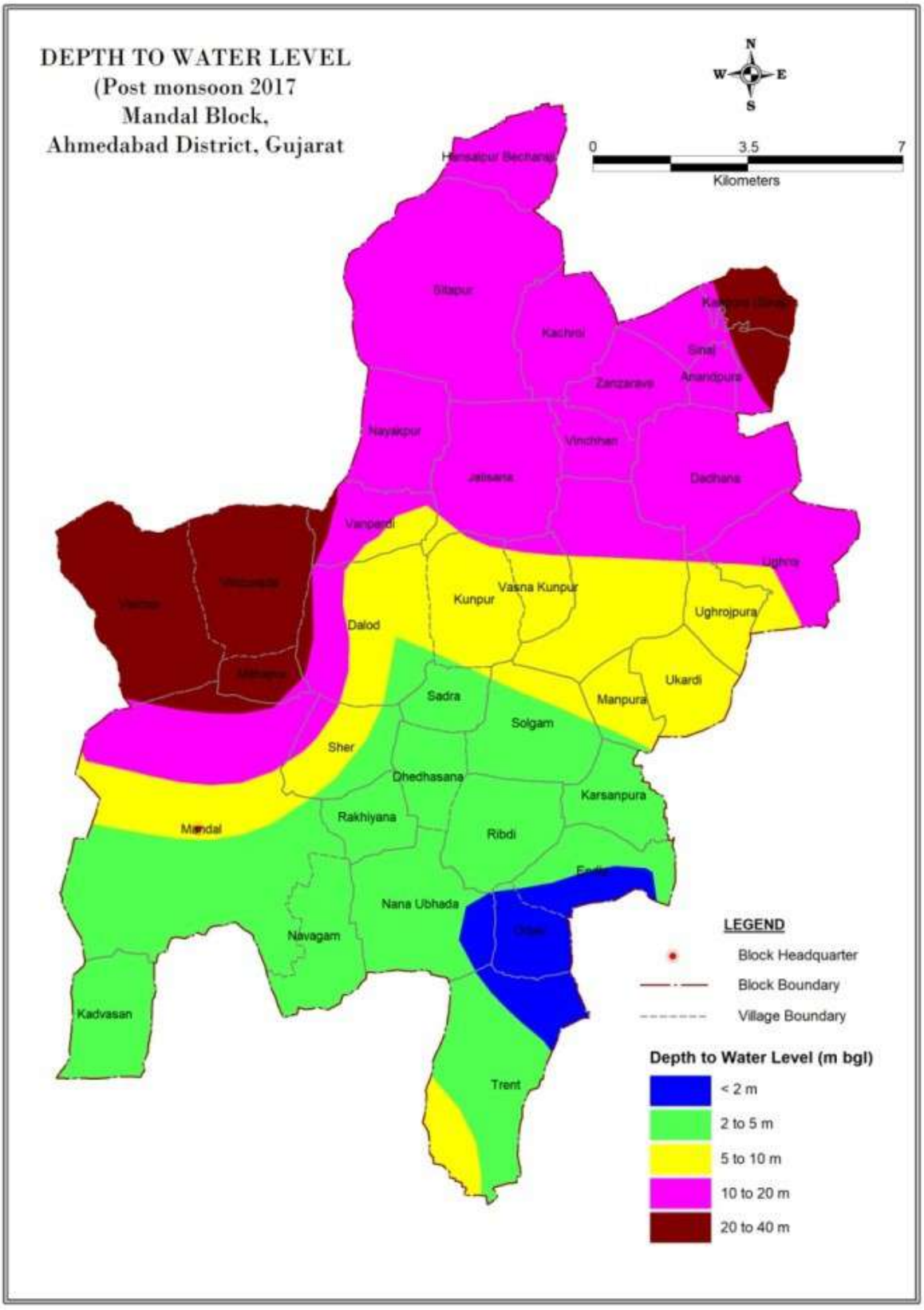


Fig.10: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

Fig.11: Pre-Monsoon Depth of Piezometric Surface- Confined Aquifer

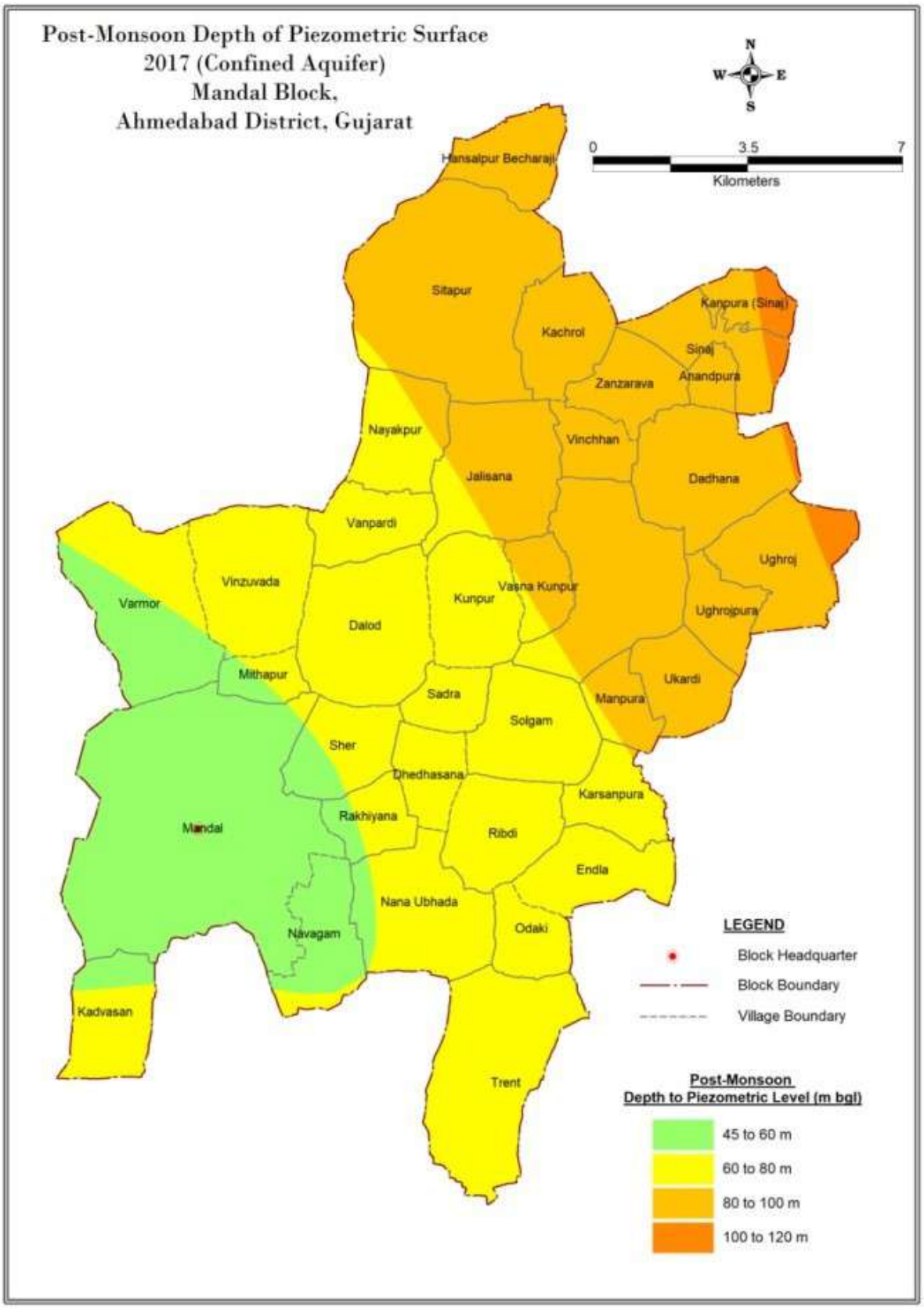


Fig. 12: Post-Monsoon Depth of Piezometric Surface- Confined Aquife

4. Dynamic Ground Water Resources in MCM

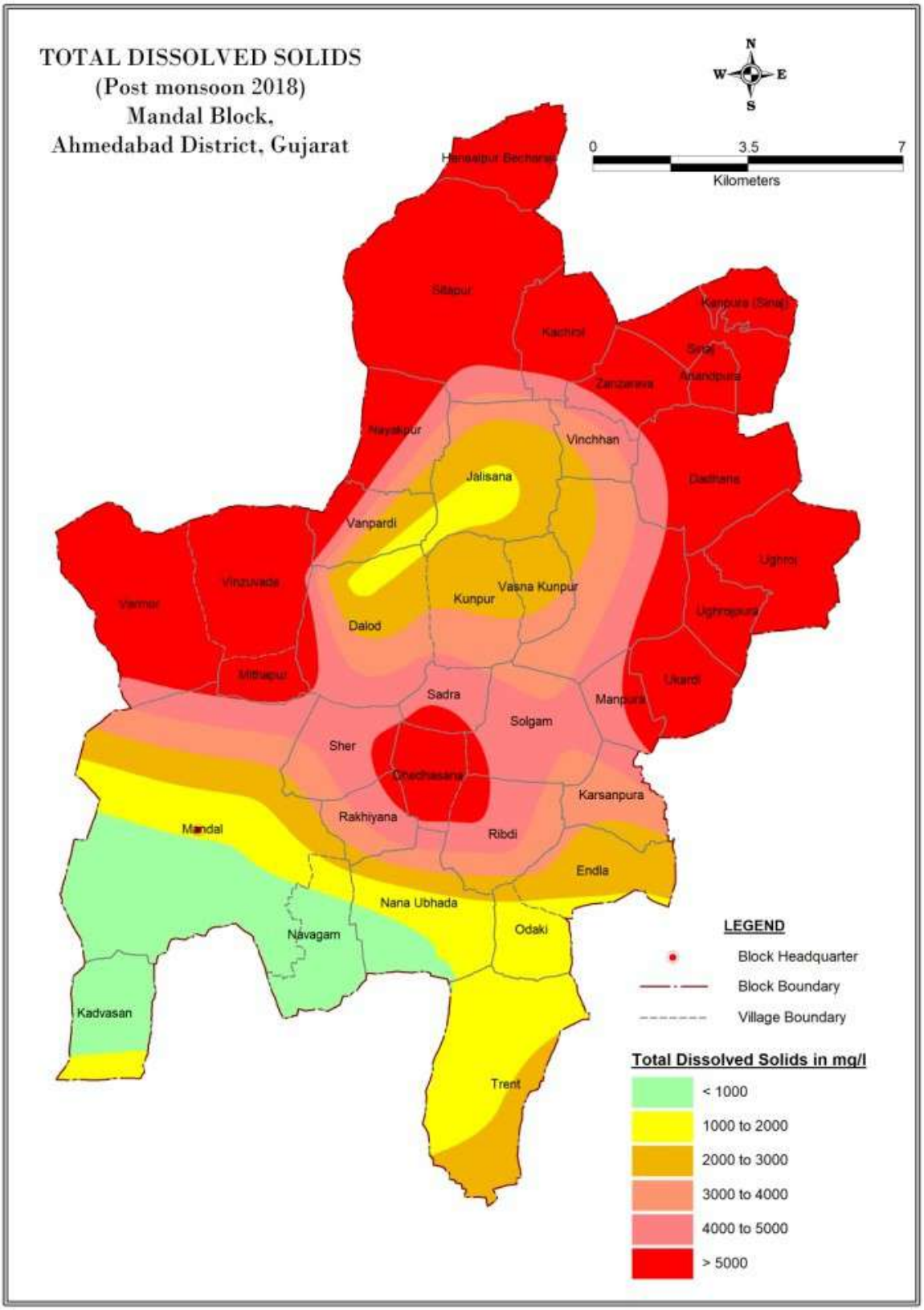
Total fresh groundwater availability of the area is estimated in year 2017 is 28.35 MCM and total groundwater withdrawal for all purposes is 8.86 MCM. The stage of groundwater development is 31.24 % and the Taluka is categorized “Safe”. Total Saline groundwater availability of the area is estimated in year 2017 is 76.84 MCM and total groundwater withdrawal for all purposes is 16.61 MCM. The stage of groundwater development is 21.62% and the Taluka is categorized “Safe”.

Table: 3 Dynamic Groundwater resources 2017

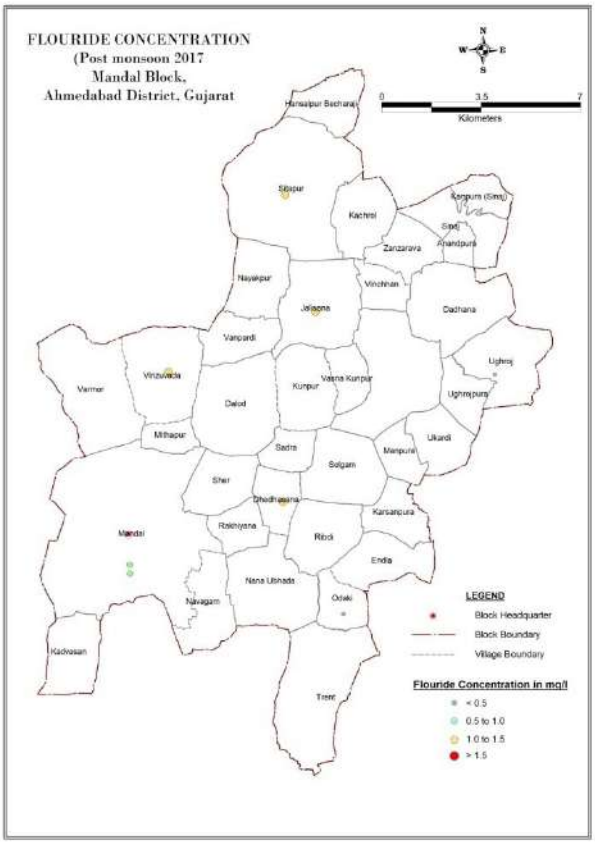
S No	Item	Fresh	Saline
1	Area (sq.km)	81.93	391.92
2	Total GW Recharge (MCM)	29.84	80.88
3	Net GW Availability (MCM)	28.35	76.84
4	Gross Draft (MCM)	8.86	16.61
5	Net Availability for Future Irrigation (MCM)	18.29	59.79
6	Stage of GW Development %	31.24	21.62

5. Chemical quality of groundwater

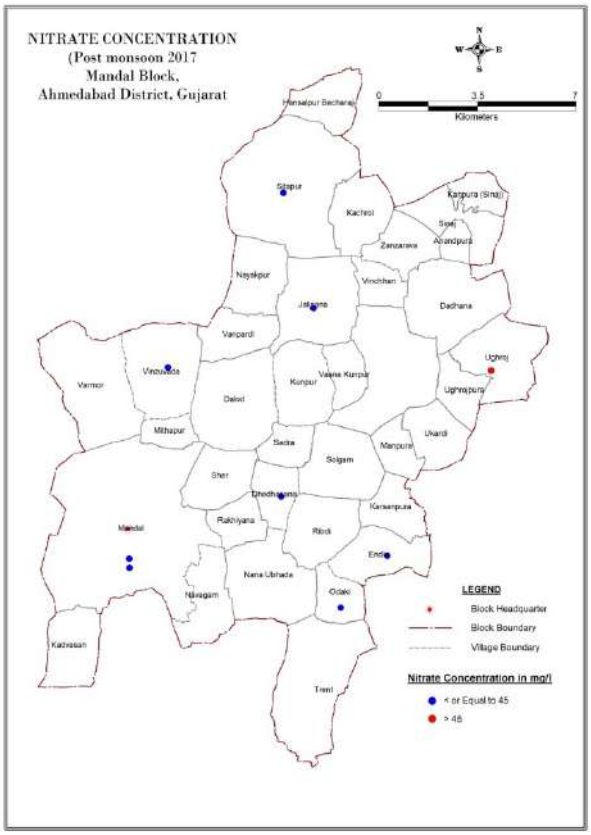
Phreatic Aquifer (Aquifer I); Shows considerable variation from highly saline to fresh. TDS value ranges from 616 to 7340 ppm. Deeper Aquifer (Aquifer III) is also saline.



Total Dissolved Solids (TDS) Map- Unconfined Aquifer



Fluoride Map- Unconfined Aquifer



Nitrate Map- Unconfined Aquifer

6. Groundwater issues

- Depletion of Ground Water level in (Phreatic Aquifer) more than 20 m bgl in north western part.
- Quality Issues (Highly saline to fresh, TDS value ranges from 616 to 7340 ppm. Deeper Aquifer (Aquifer III) is also saline)

7. Groundwater Management

Supply Side management-Proposed Recharge Structures- Percolation tank -4 nos. & net water recharge through percolation tank is 0.57 MCM.

Supply Side Intervention	
Volume of subsurface storage space available of artificial recharge (MCM)	272.34
Surplus available (MCM)	0.57
Percolation tank proposed	4
Water availability after additional recharge	0.57 MCM

8. AR & Conservation Possibilities

Ground water resources in the block augmented by means artificial recharge through percolation tank would lead to 0.57 MCM saving of ground water and improve stage of ground water from 31.25% to 30.64%.

MANAGEMENT PLAN OF
SANAND TALUKA, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	784.52 sq. km		
No. of villages	67		
Population (2011 Census)	237845		
Average Annual Rainfall	579		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources (2017)	Fresh: 99.04 MCM		
Net Groundwater Draft	Fresh: 55.58 MCM		
Stage of Groundwater Development	56.12% (Safe)		
Existing and future water demands (MCM)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	2.88	4.78
	Irrigation	52.70	41.56

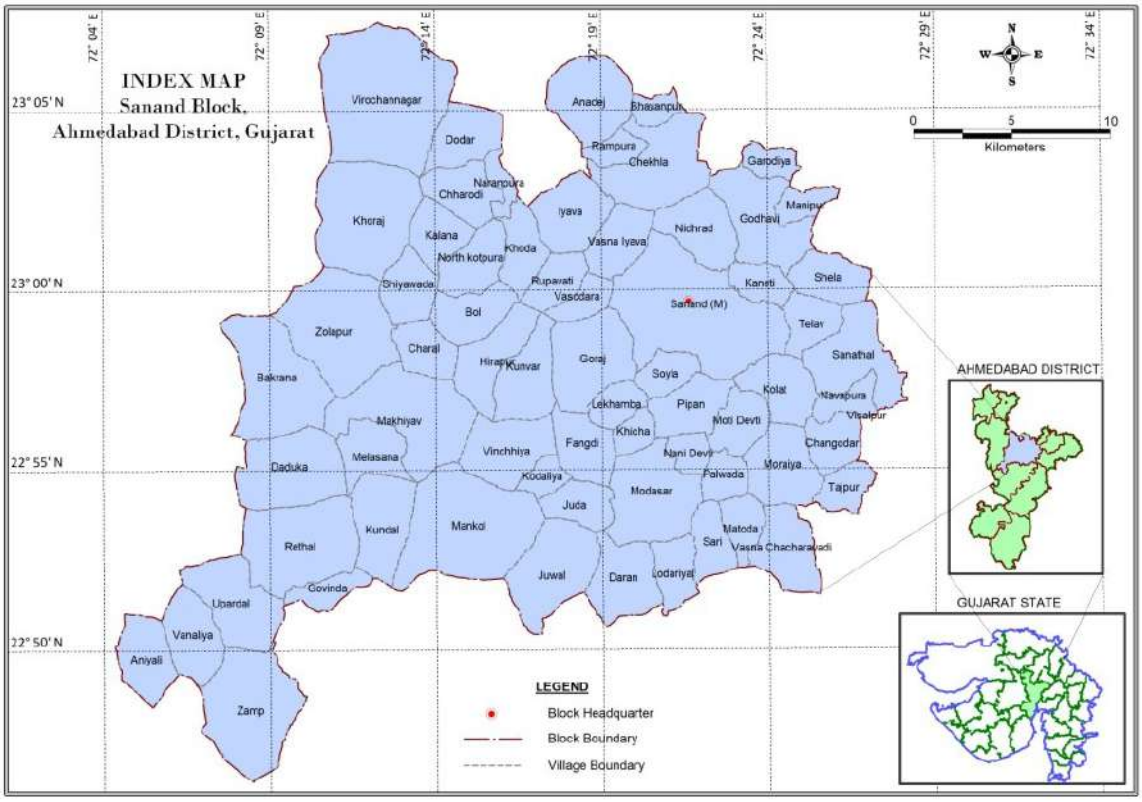


Fig. 1: Location Map

1 Land Use Classification

Table:1: Land Use Classification

Taluka Name	**Sanand**
Area according to village papers (Ha)	75972
Area under Forest (Ha)	0
Barren & uncultivable land (Ha)	2100
Land put to non agricultural uses (Ha)	5450
Cultivable waste (Ha)	2902
Permanent pastures & other grazing lands (Ha)	1180
Current fallow (Ha)	296
Fallow land other than current fallow (Ha)	0
Net area sown (Ha)	64024
Area sown more than once (Ha)	30656
Gross Cropped area (Ha)	94680

2. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel.

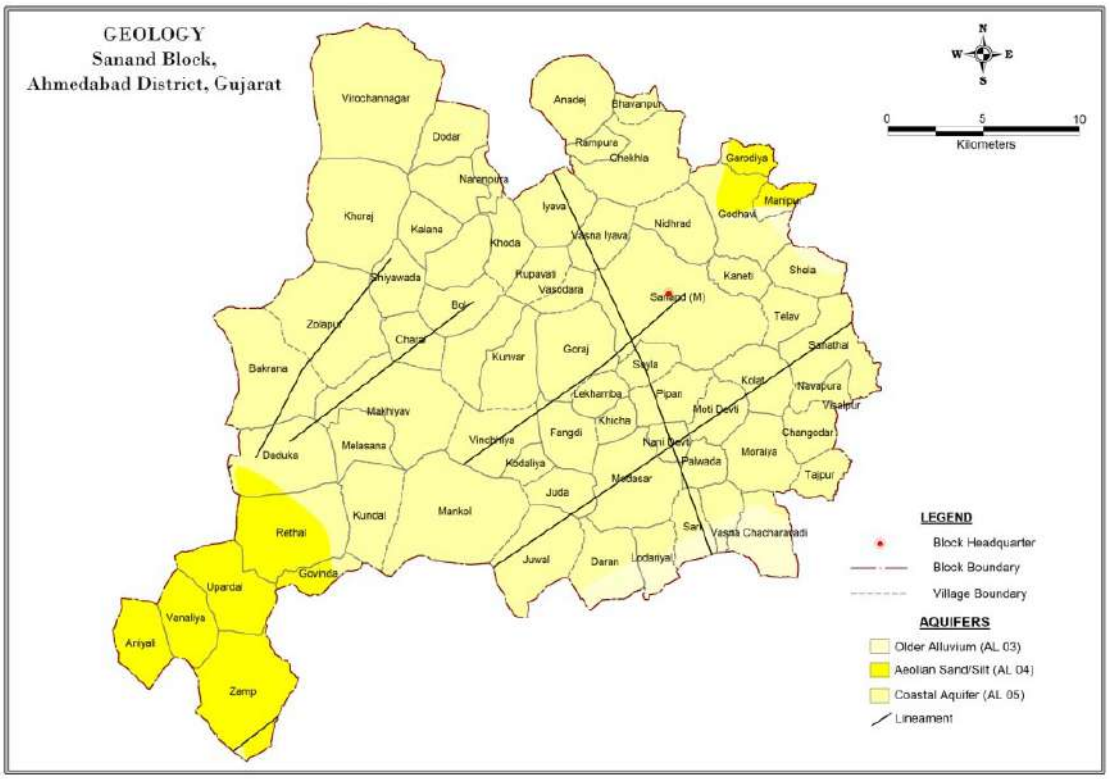


Fig.2: Major Aquifer

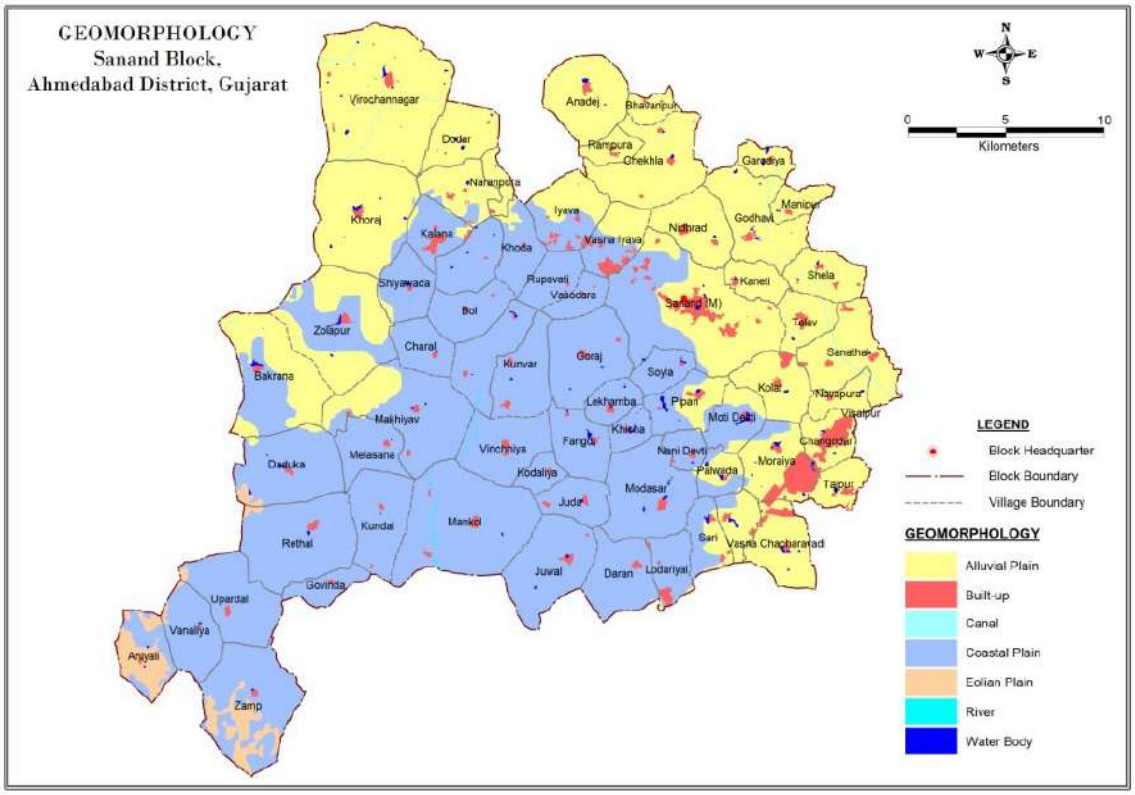


Fig.3: Geomorphology

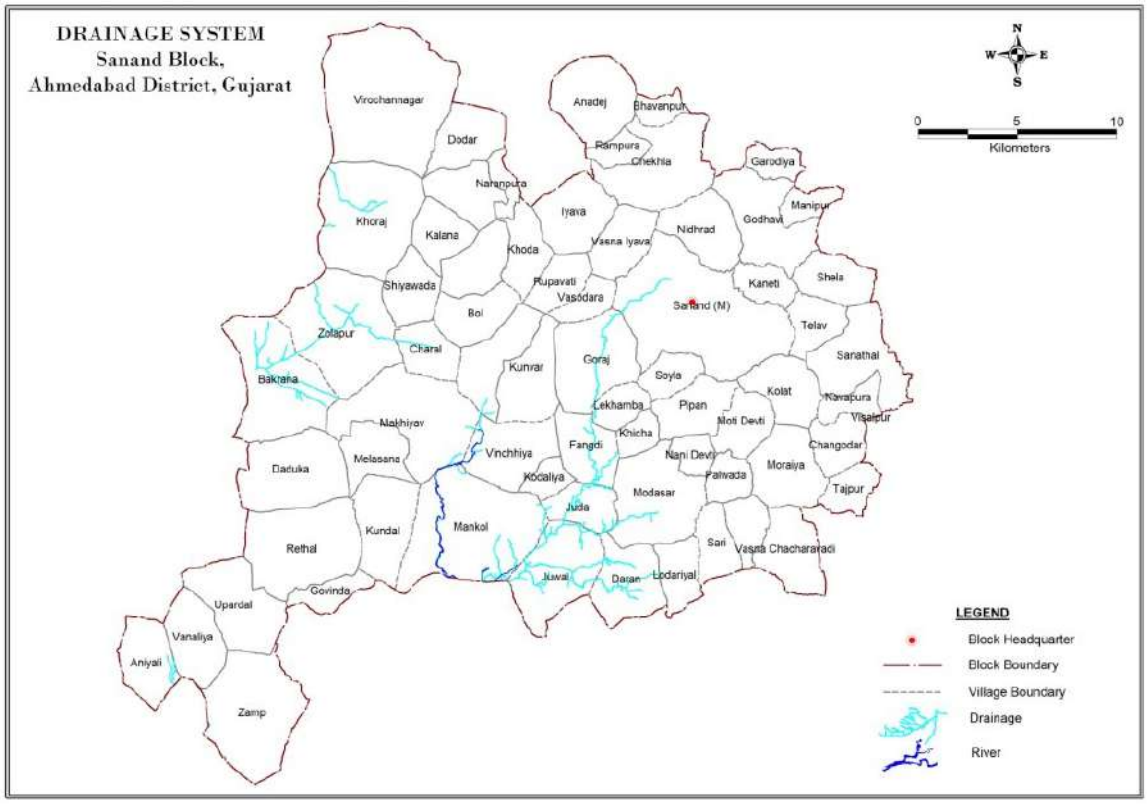


Fig. 4: Drainage Map

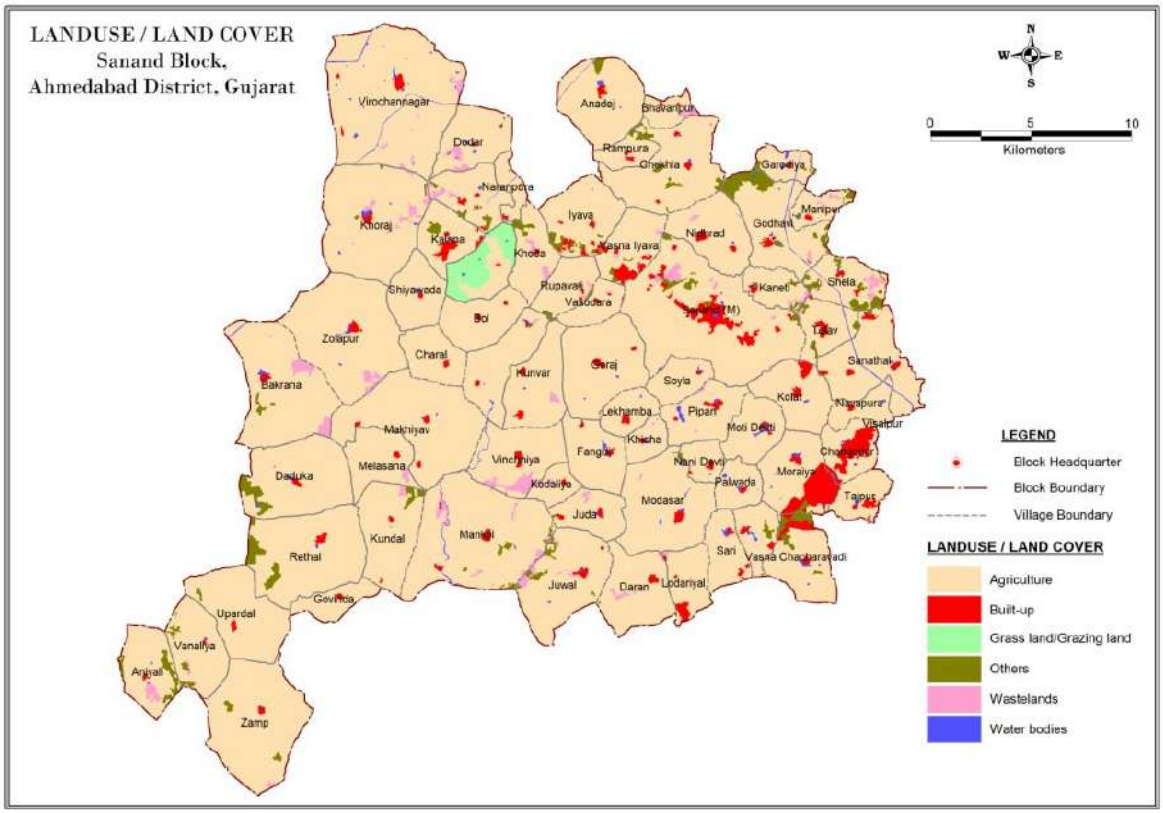


Fig. 5: Land Use Land Cover

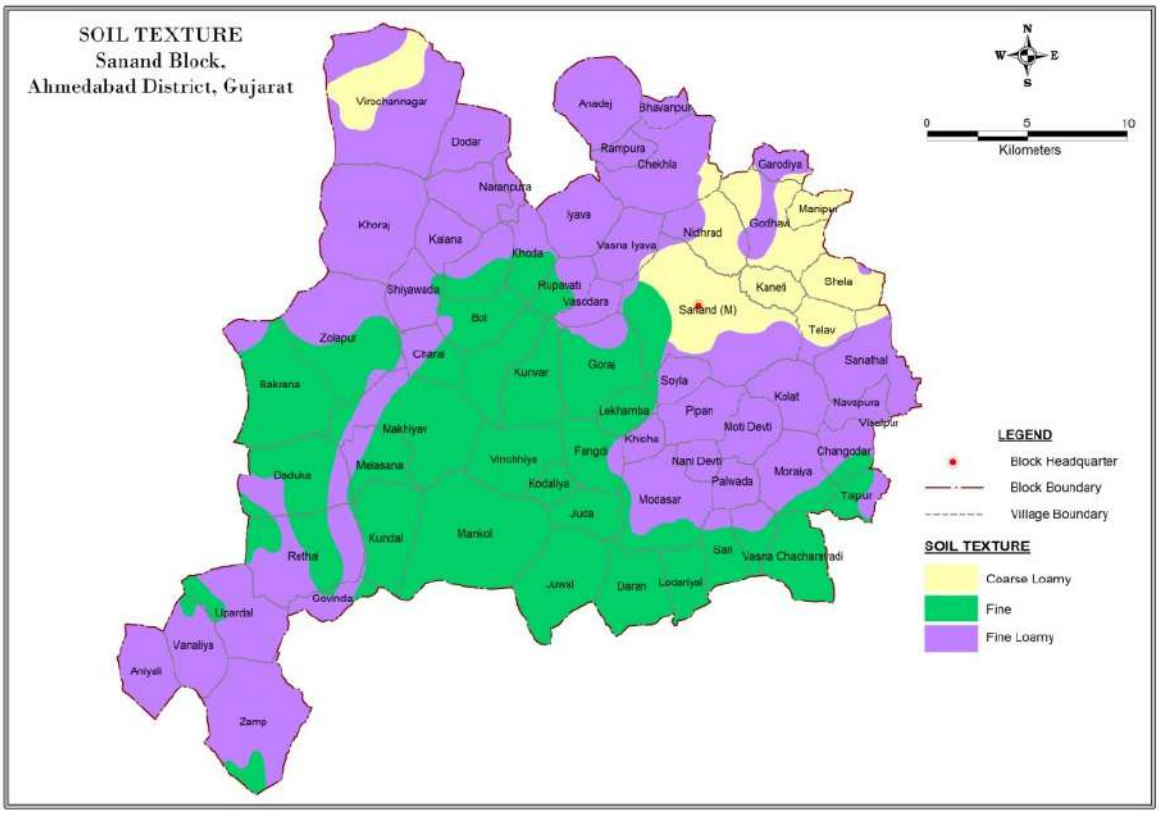


Fig. 6 Soil Map

3. Subsurface Hydrogeology

The area has multi-layer aquifer system. Aquifer I (unconfined) depth of occurrence upto 50 mbgl , Aquifer II (confined) depth of occurrence 59 to 136 mbgl , Aquifer III (confined) depth of occurrence 100 to 230 mbgl. Aquifer IV (confined) depth of occurrence 290 to 350 mbgl. Aquifer I (unconfined) thickness varies from 44 to 50 mt. Aquifer II (confined) thickness varies from 31 to 72 m, Aquifer III (confined) thickness varies from 36 to 60 m, Aquifer IV (confined) thickness around 60 m. Water level of aquifer I is varies from 0.50 to 21.80 mbgl. Piezometric head of aquifer II varies from 17.55 to 59.9 mbgl. Piezometric head of aquifer III varies from 35.6 to 79.33 mbgl. In Aquifer I (unconfined) discharge varies from 0.40 to 0.70 lps, Aquifer II (confined) discharge varies from 4.4 to 13 lps. Aquifer III (confined) discharge varies from 3 to 3.6 lps.

Hydrogeological section for Sanand Taluka Depicting Aquifer

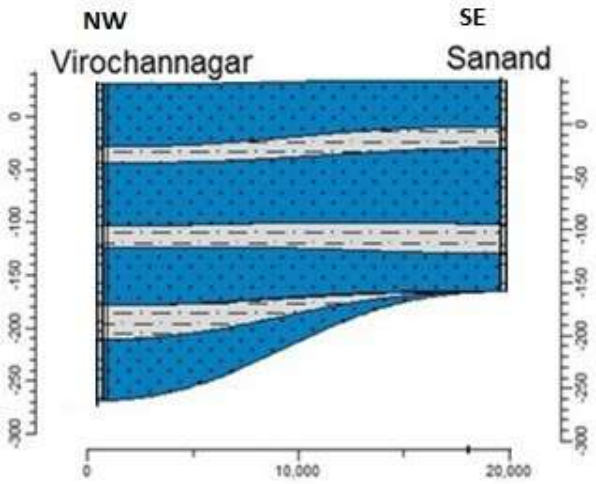


Fig.7: Stratigraphic Section

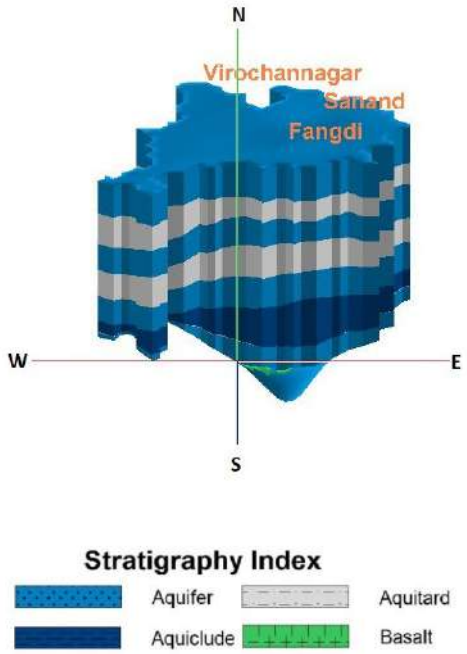


Fig. 8: 3D Solid Model of Sanand Taluka Depicting Aquifer

Table; 2 Aquifer characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lpm)	Quality/Ec µS/cm	Transimissivity (m2/day)	Water Level/ Piezometric head (mbgl)
Aquifer I	Upto 50	44 to 50	0.40 to 0.70	578 to 13219	1.78	0.50 to 21.80
Aquifer II (Confined)	59 to 136	31 to 72	4.4 to 13	4300 to 6520	555	17.55 to 59.9
Aquifer III (Confined)	100 to 230	36 to 60	3 to 3.6	928 to 1738	-	35.6 to 79.33
Aquifer IV (Confined)	290 to 350	60	--	1971	-	

Aquifer Group wise Water Level maps Taluka

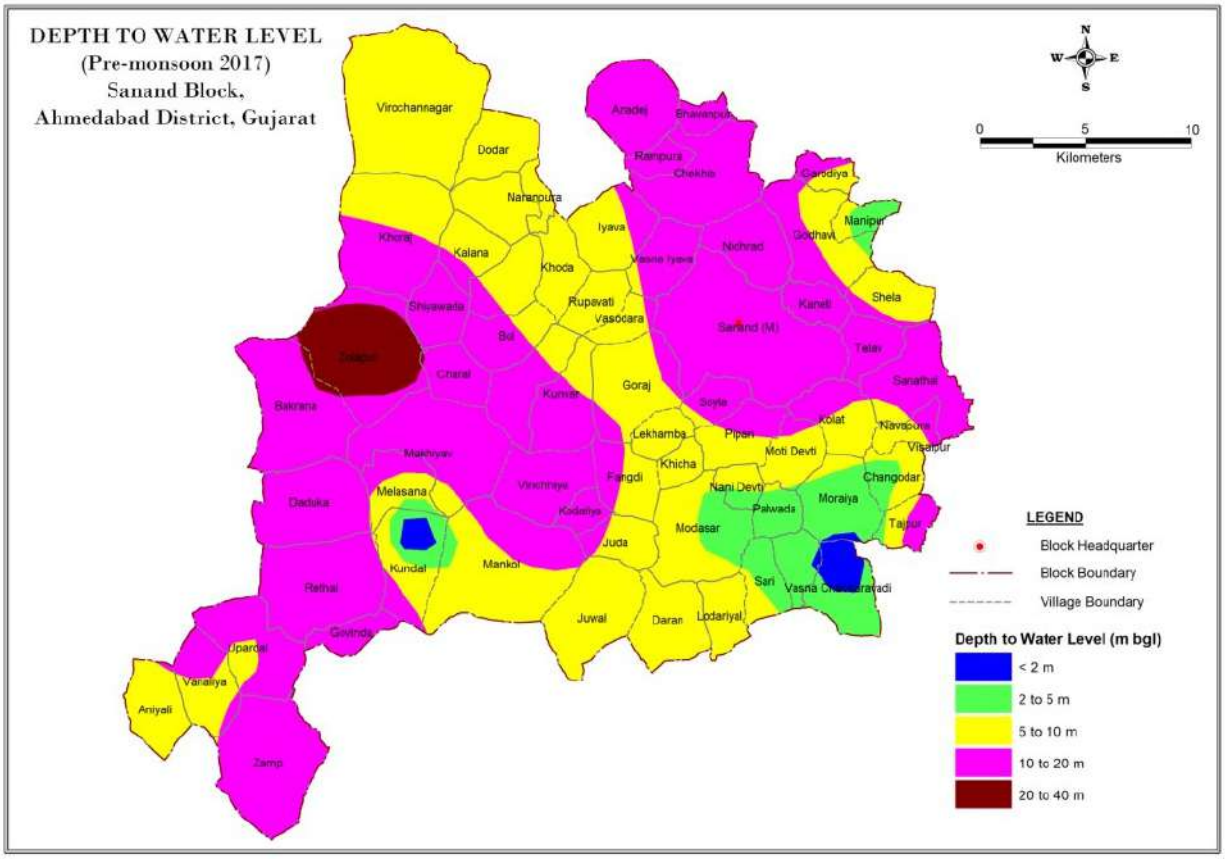


Fig.9: Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

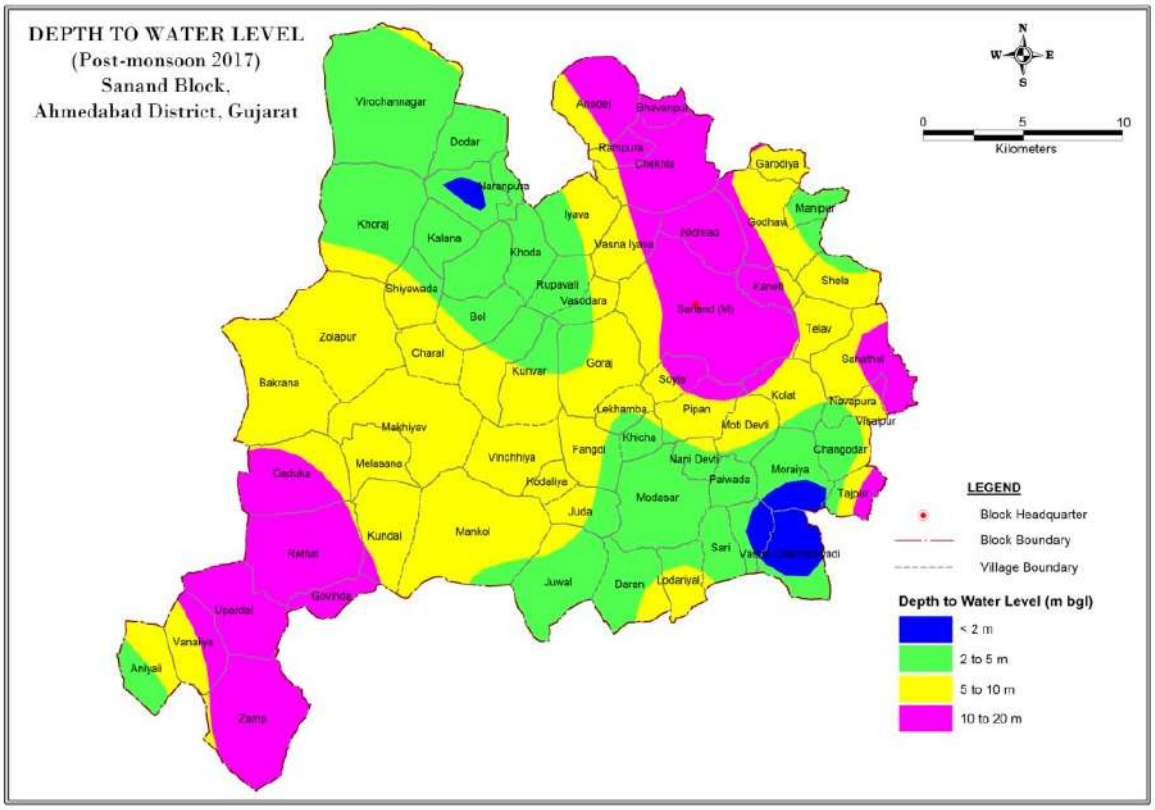


Fig. 10: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

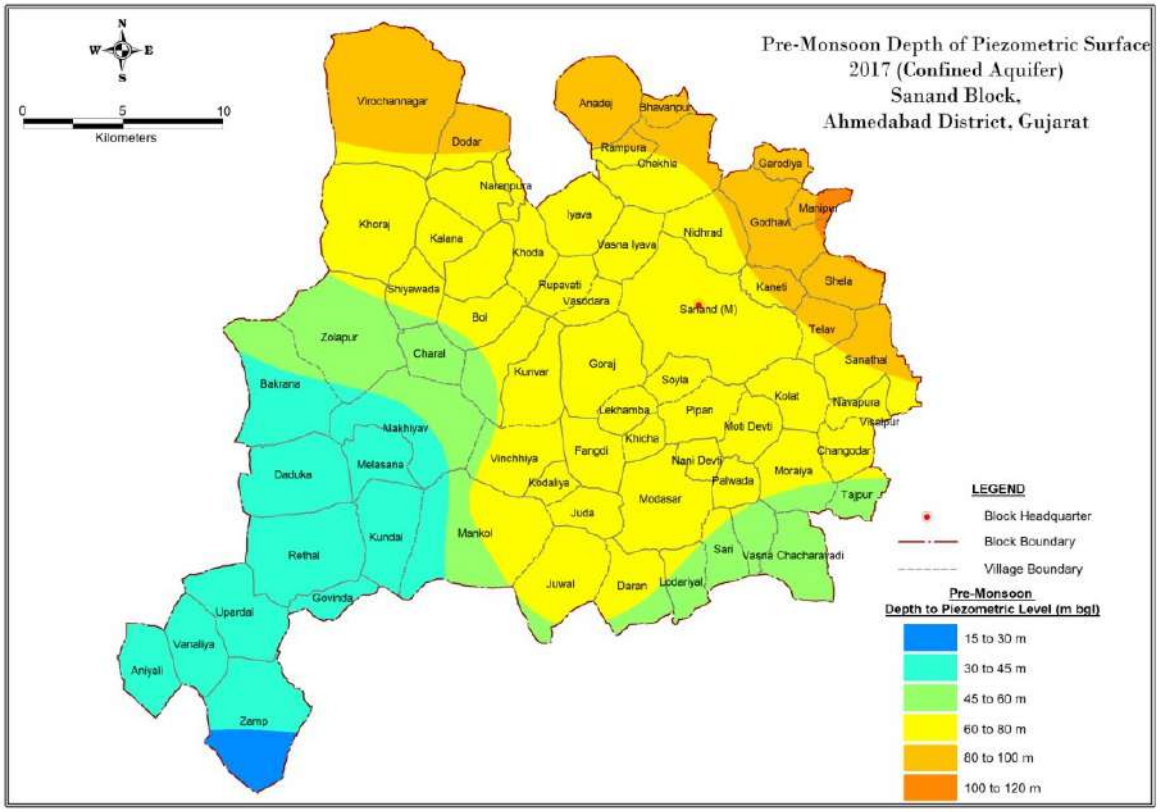


Fig.11: Pre-Monsoon Depth of Piezometric Surface- Confined Aquifer

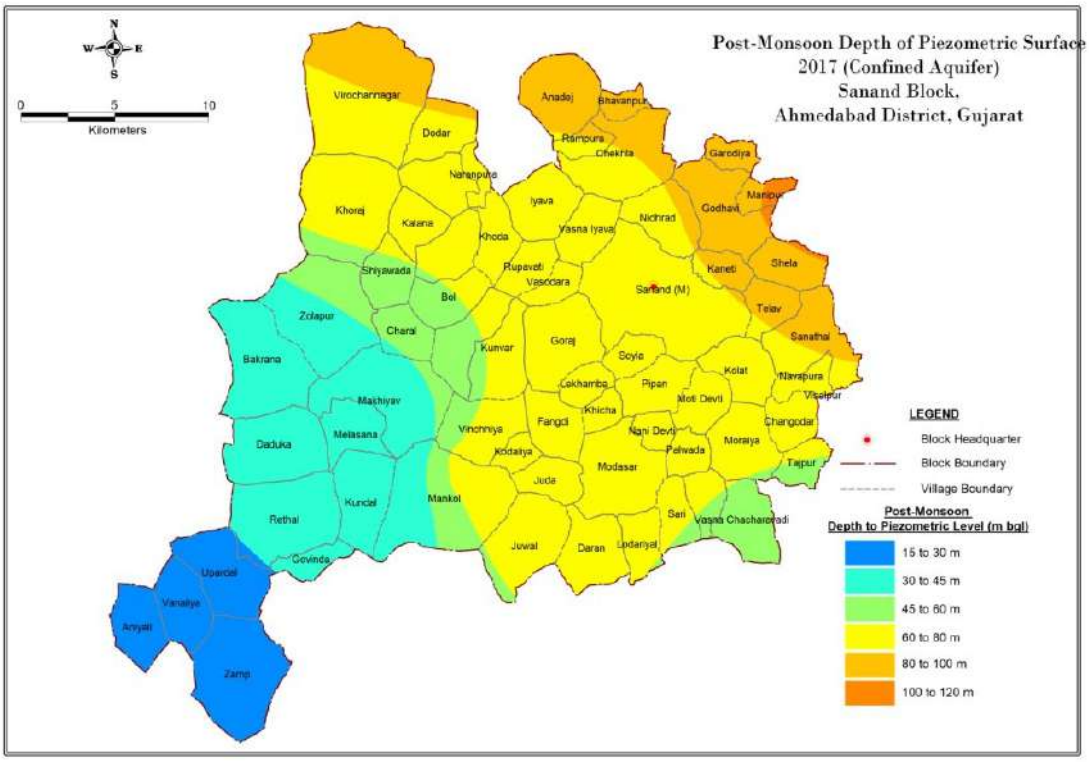


Fig.12: Post-Monsoon Depth of Piezometric Surface- Confined Aquifer

4. Dynamic Ground Water Resources in MCM

Total fresh groundwater availability of the area is estimated in year 2017 is 99.04 MCM and total groundwater withdrawal for all purposes is 55.58 MCM. The stage of groundwater development is 56.12 % and the Taluka is categorized “Safe”. Total Saline groundwater availability of the area is estimated in year 2017 is 40.22 MCM and total groundwater withdrawal for all purposes is 22.06 MCM. The stage of groundwater development is 45.62% and the Taluka is categorized “Safe”.

Table.3: Dynamic Groundwater resources 2017

S No	Item	Fresh	Saline
1	Area (sq.km)	553.56	230.96
2	Total GW Recharge (MCM)	104.25	42.34
3	Net GW Availability (MCM)	99.04	40.22
4	Gross Draft (MCM)	55.58	22.06
5	Net Availability for Future Irrigation (MCM)	41.56	14.56
6	Stage of GW Development %	56.12	45.62

5. Chemical quality of groundwater

- Phreatic Aquifer (Aquifer I); Shows ground water highly saline (>2000 ppm).
- Deeper Aquifer (Both Aquifer III & IV); Generally fresh (TDS<2000 ppm). Aquifer II is saline in nature TDS value ranges from 2752 ppm to 4172 ppm.

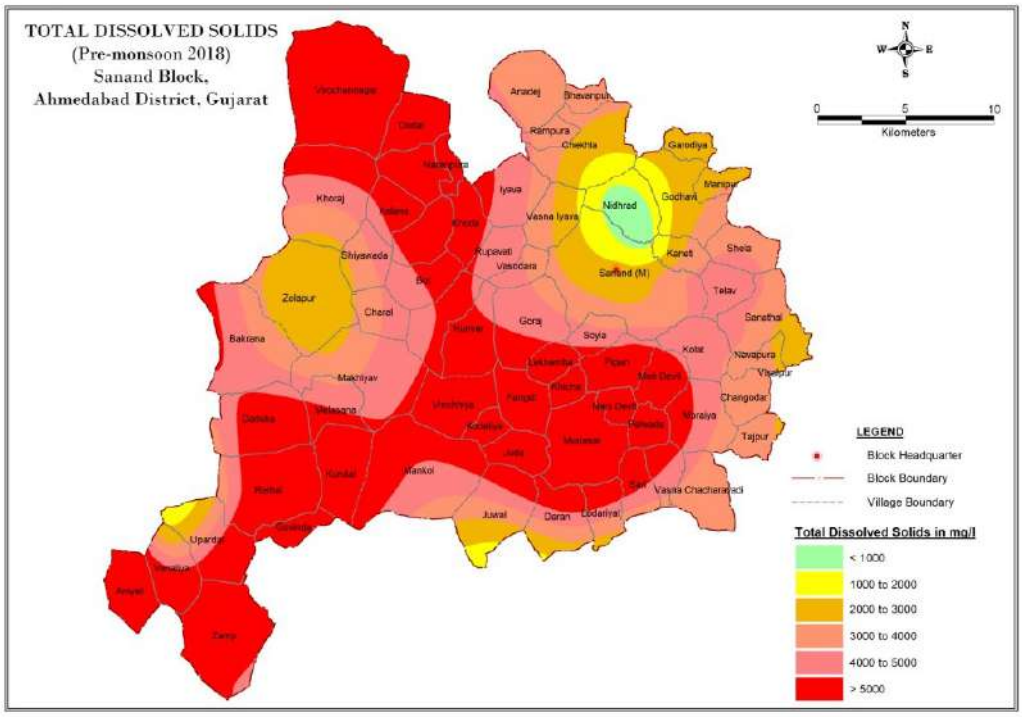


Fig. 13: Total Dissolved Solids (TDS) Map- Unconfined Aquifer

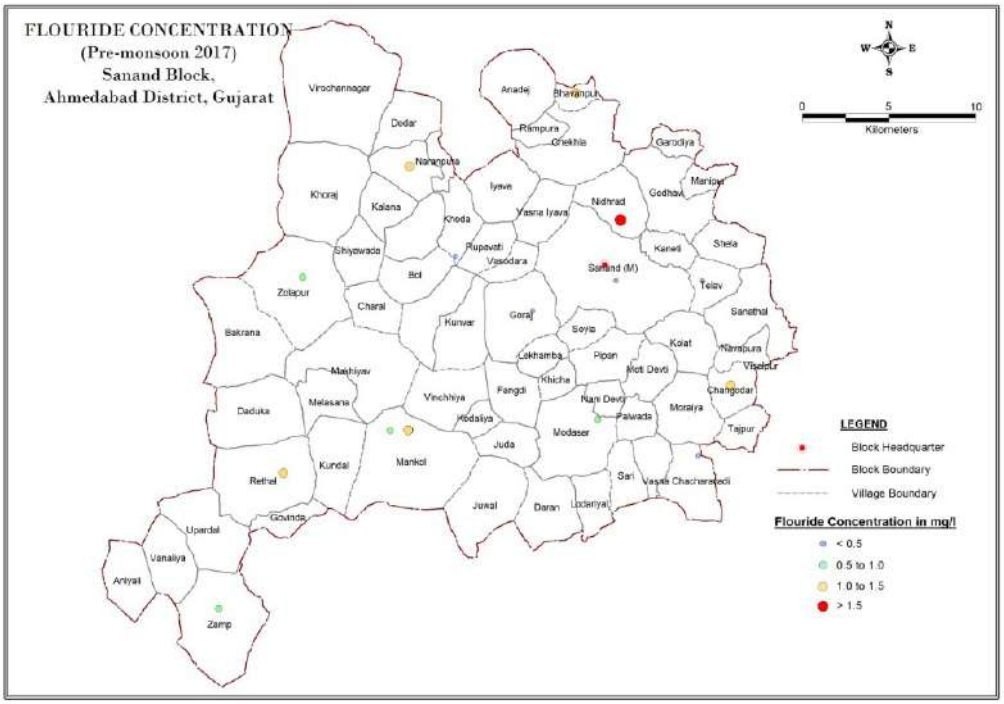
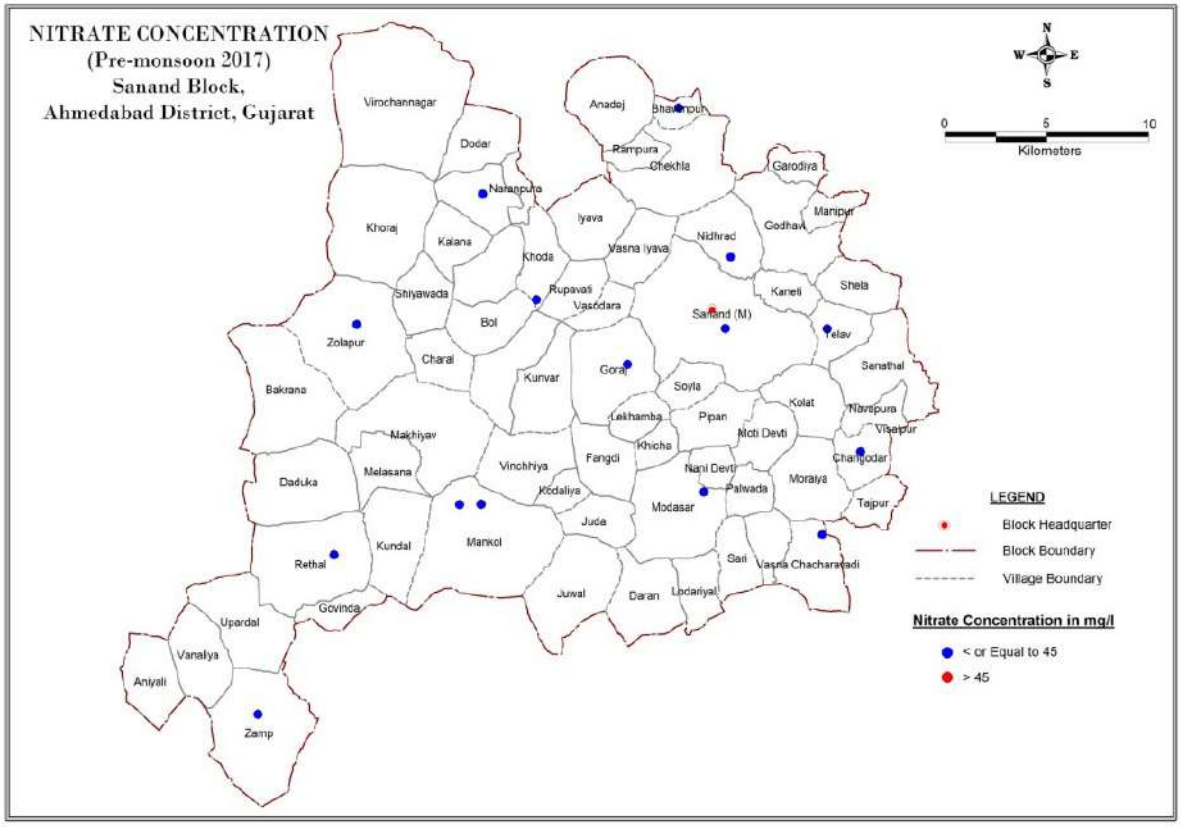


Fig.14: Fluoride Map- Unconfined Aquifer



Nitrate Map- Unconfined Aquifer

6. Groundwater issues

Phreatic aquifer is saline in nature having TDS more than >2000 ppm in major part of district.

7. Groundwater Management

Supply Side management-Proposed Recharge Structures- Percolation tank -5 nos. & net water recharge through percolation tank is 0.69 MCM. In Demand Side Management Micro Irrigation System proposed in 3478.28 ha area and water saving is 5.22 MCM. Net water saving: 5.91 MCM.

Supply Side Intervention	
Volume of subsurface storage space available of artificial recharge (MCM)	470.96
Surplus available (MCM)	0.69
Percolation tank proposed	5
Water availability after additional recharge	0.69 MCM

Demand Side Intervention	
Use of Micro Irrigation Systems (Drift & Sprinkler)	
Irrigated area proposed under MIS* (Ha)	3478.28
Water saving by MIS (MCM)	5.22

8. Artificial Recharge & Conservation Possibilities

Ground water resources in the block augmented by means artificial recharge through percolation tank and adoption of Micro Irrigation System in the taluka would lead to 5.91 MCM saving of ground water and improve stage of ground water from 56.12% to 50.50%.

MANAGEMENT PLAN OF
VIRAMGAM TALUKA, AHMEDABAD DISTRICT, GUJARAT STATE

Geographical Area	890.30 sq. km		
No. of villages	68		
Population (2011 Census)	193283		
Average Annual Rainfall	579		
Major Drainage System	Sabarmati		
Major Geological Formation	Alluvium		
Major Aquifer	Older & Younger Alluvium		
Utilizable Groundwater Resources (2017)	Fresh: 13.90 MCM		
Net Groundwater Draft	Fresh: 11.33 MCM		
Stage of Groundwater Development	81.53% (Semi Critical)		
Existing and future water demands (MCM)	Sector	Existing	Future (Year 2025)
	Domestic & Industrial	3.29	3.89
	Irrigation	8.04	1.97

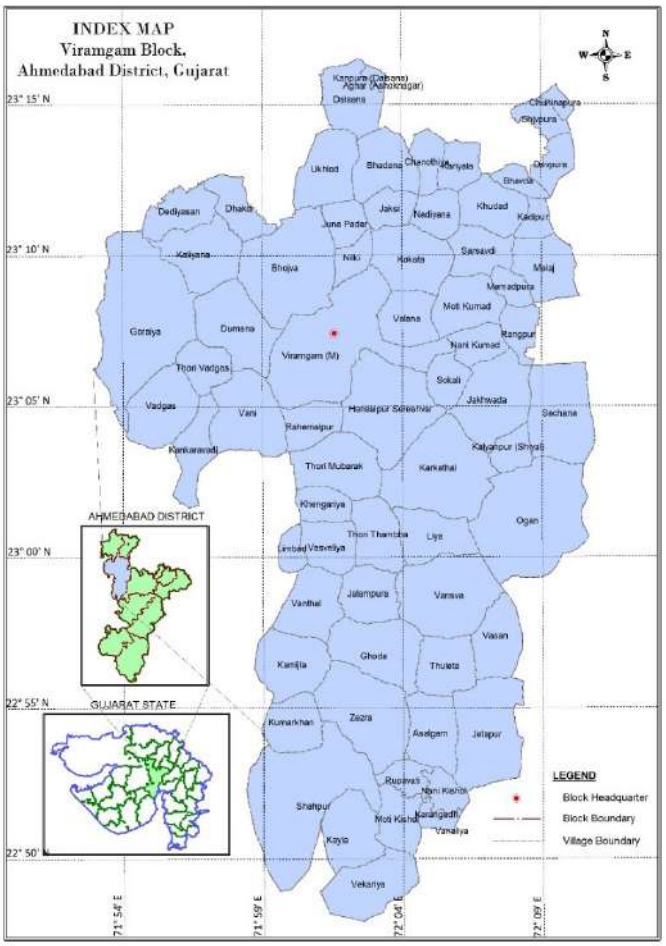


Fig. 1: Location Map

1 Land Use Classification

Table 1: Land Use Classification

Taluka Name	**Viramgam**
Area according to village papers (Ha)	84295
Area under Forest (Ha)	0
Barren & uncultivable land (Ha)	3200
Land put to non agricultural uses (Ha)	6588
Cultivable waste (Ha)	2145
Permanent pastures & other grazing lands (Ha)	2550
Current fallow (Ha)	325
Fallow land other than current fallow (Ha)	0
Net area sown (Ha)	69487
Area sown more than once (Ha)	18546
Gross Cropped area (Ha)	88033

2. Hydrogeology

Alluvial formations form aquifers in the area (Fig.2) namely Sand of various sizes and Gravel. The groundwater quality is saline at shallow depths and there is wide variation in quality regionally.

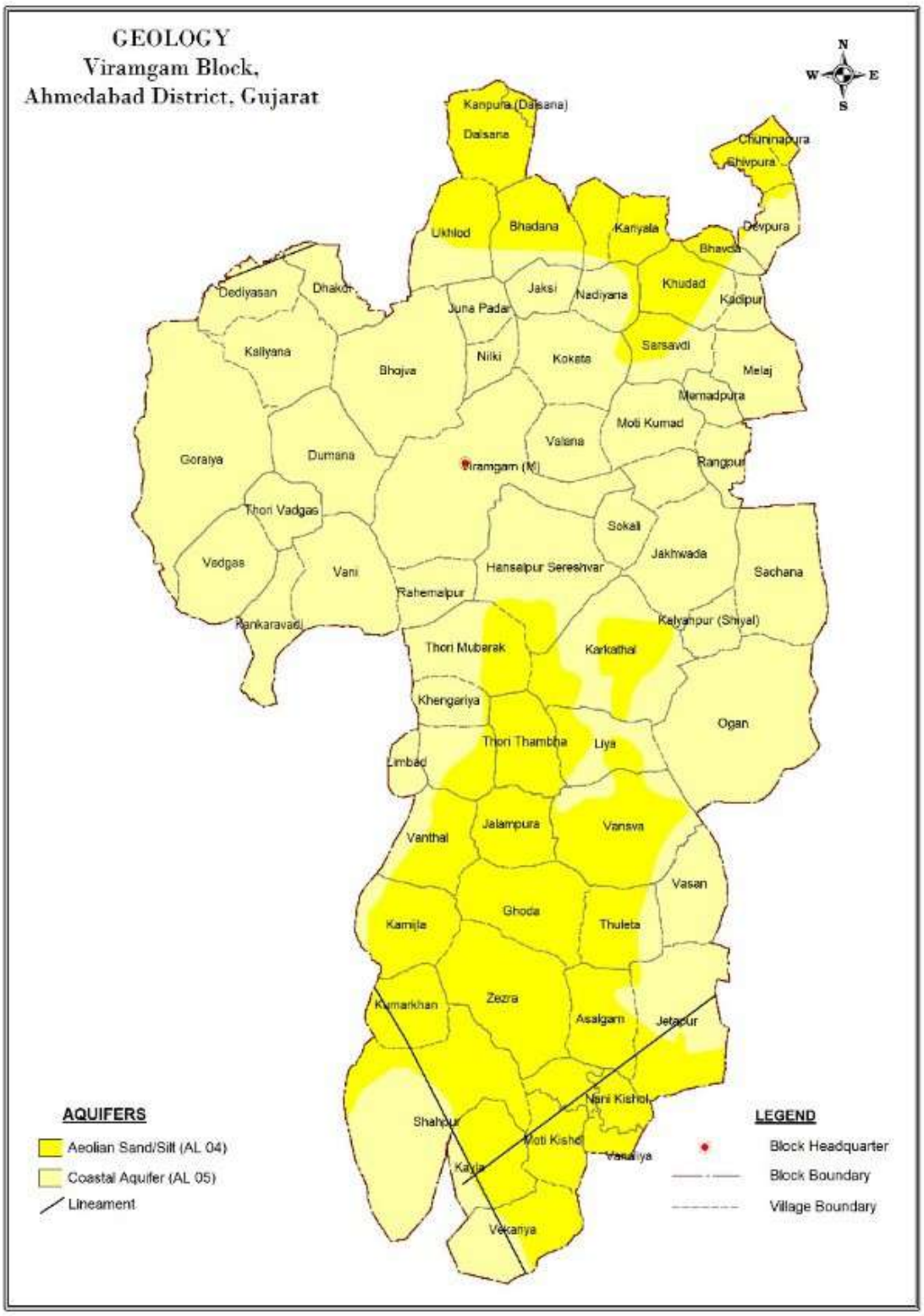


Fig.2: Major Aquifer

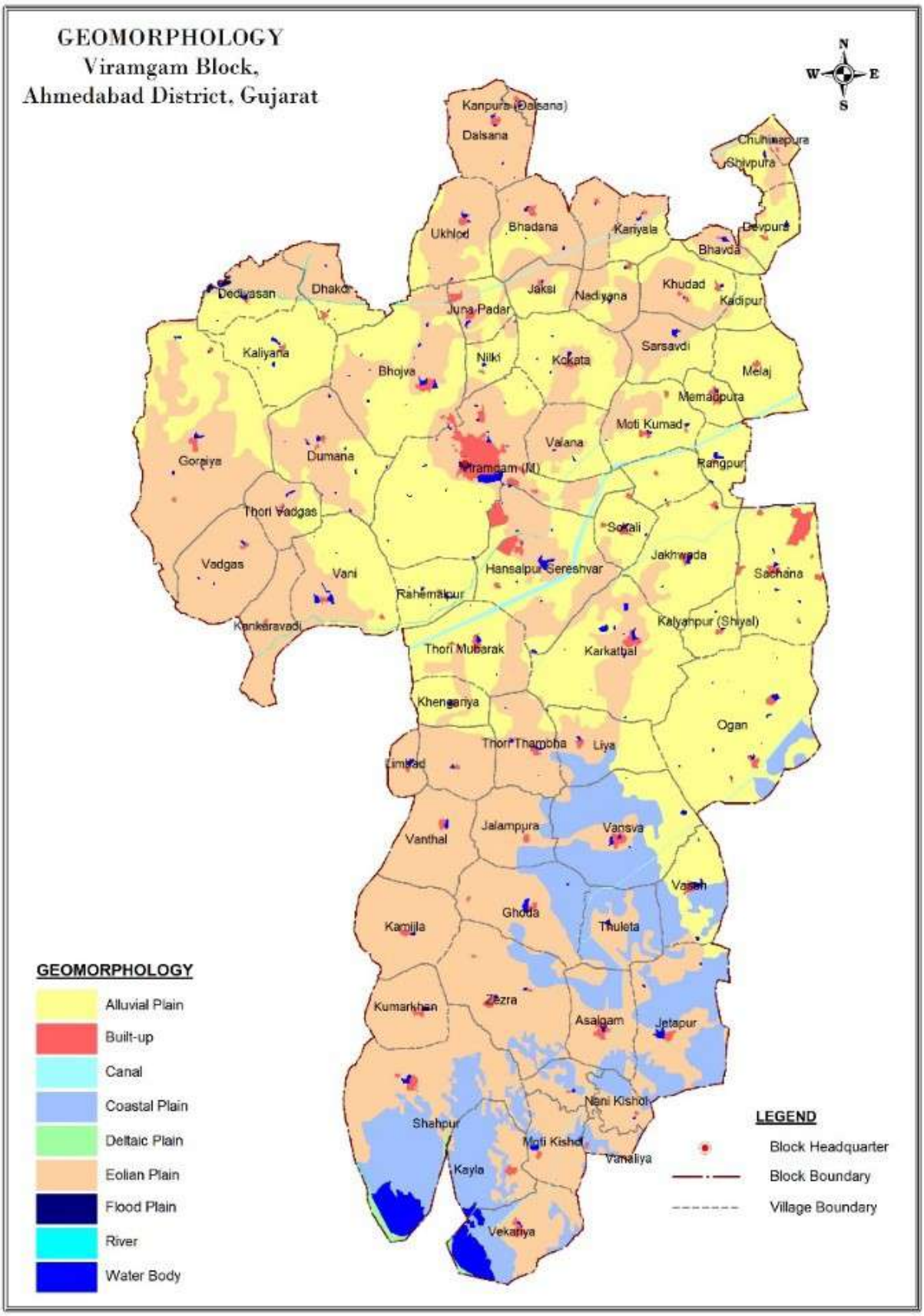


Fig.3: Geomorphology

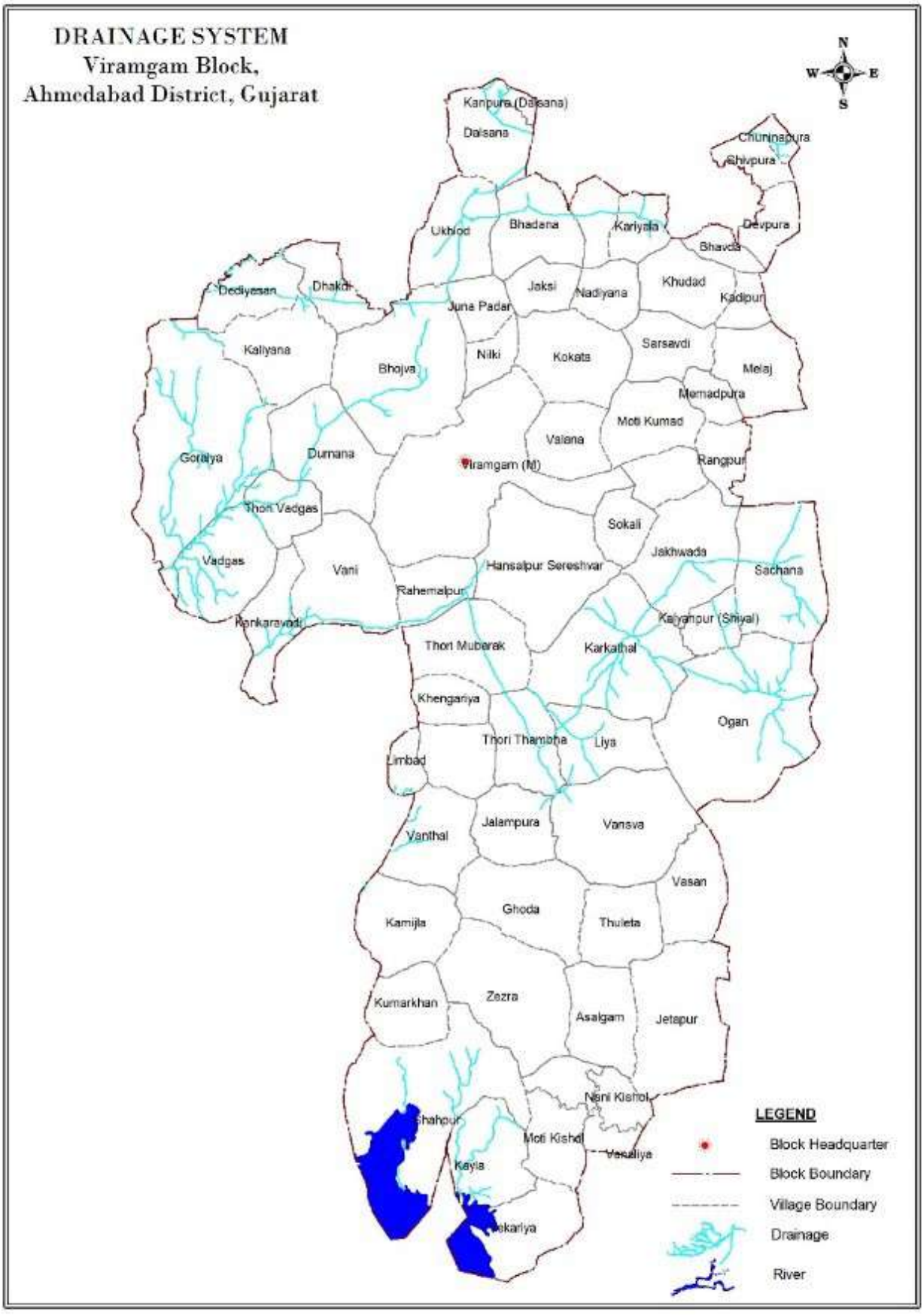


Fig. 4: Drainage Map Land Use Land Cover

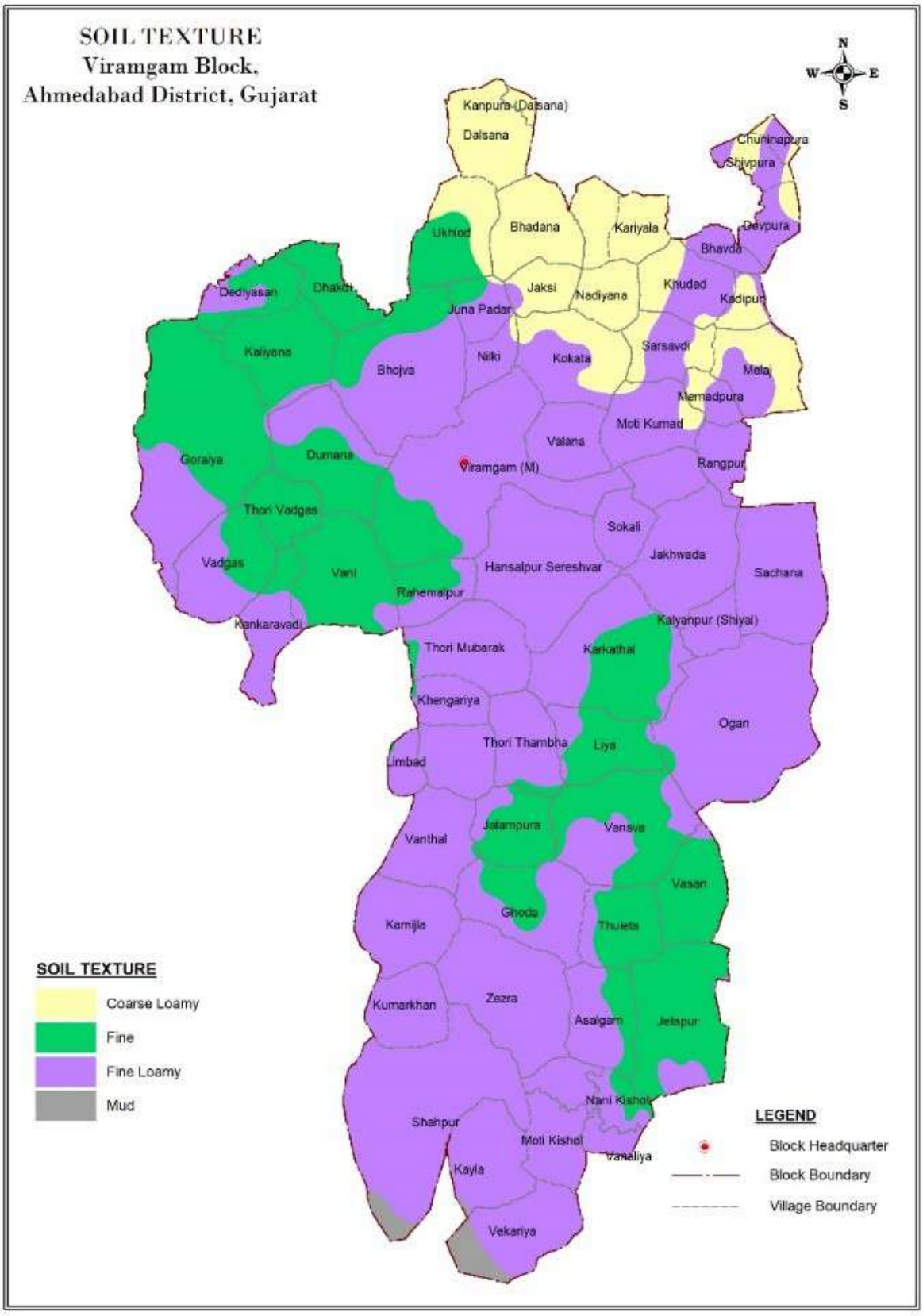


Fig. 5 Soil Map

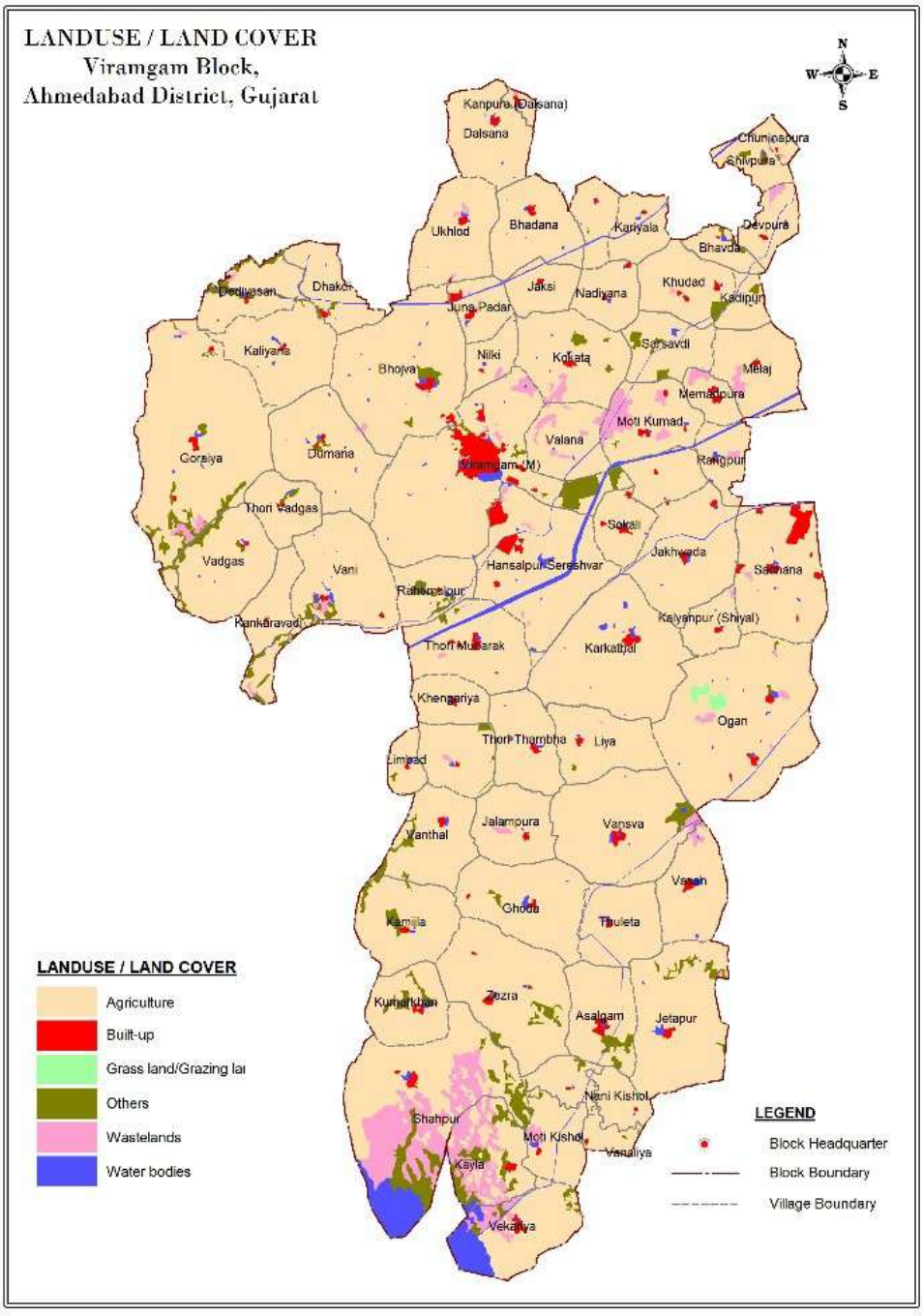


Fig. 6: Land Use/ Land Cover

3. Subsurface Hydrogeology

The area has multi-layer aquifer system. Aquifer I (unconfined) depth of occurrence upto 60 mbgl , Aquifer II (confined) depth of occurrence 75 to 135 mbgl , Aquifer III (confined) depth of occurrence 155 to 210 mbgl. Aquifer IV (confined) depth of occurrence 242 to 300 mbgl. Water level of aquifer I is varies from 1.73 to 16.10 mbgl. Piezometric head of aquifer II varies from 27.41 to 28.86 mbgl. Piezometric head of aquifer III varies from 26.37 to 88.67 mbgl. In Aquifer I (unconfined) discharge upto 1.5 lps, Aquifer II (confined) discharge varies from 1.44 to 14.98 lps. Aquifer III (confined) discharge varies from 1.01 to 10 lps.

Hydrogeological section for Viramgam Taluka Depicting Aquifer

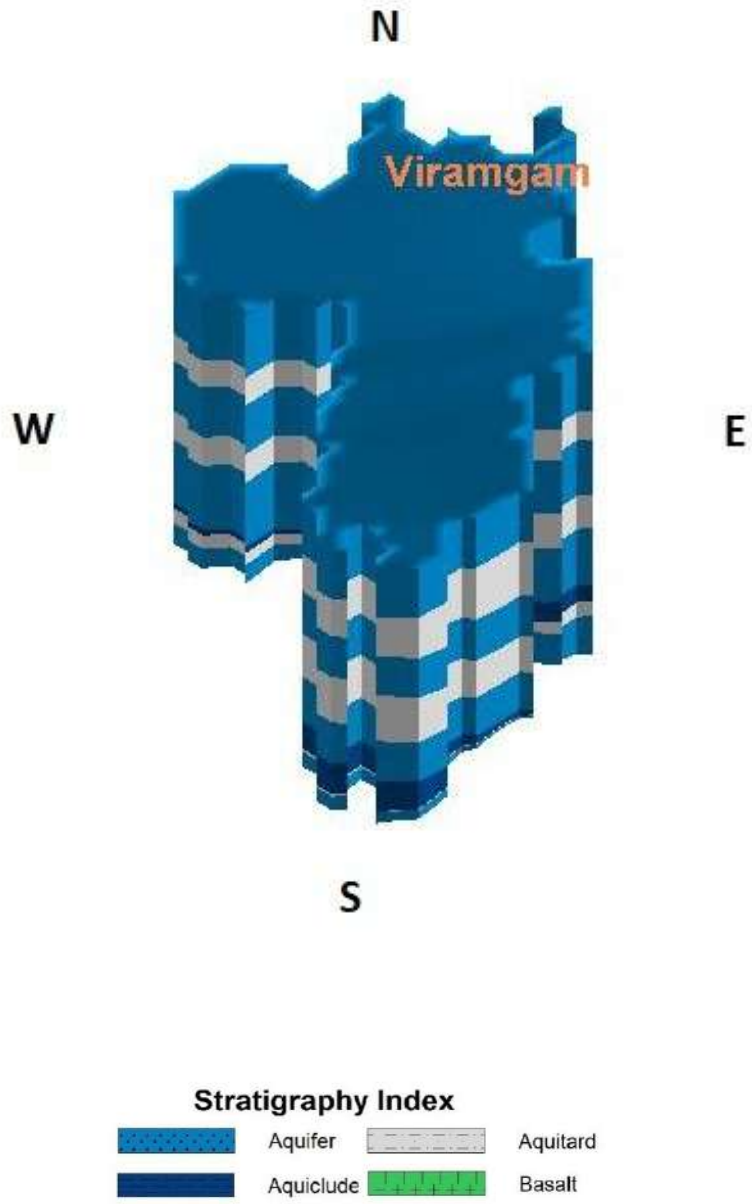


Fig.7: 3D Solid Model of Viramgam Taluka Depicting Aquifer

Table; 2 Aquifer characteristics

Aquifer Group	Aquifer Depth (m)	Generalized Thickness (m)	Discharge (lps)	Quality/Ec µS/cm	Transimissivity (m2/day)	Water Level/ Piezometric head (mbgl)
Aquifer I	Upto 60	60	1.5	717 to 22031	-	1.73 to 16.10
Aquifer II (Confined)	75 to 135	61	1.44 to 14.98	2183 to 8200	15.83 to 200.46	27.41 to 28.86
Aquifer III (Confined)	155 to 210	55	1.01 to 10	1465 to 6901	3.01 to 40.85	26.37 to 88.67
Aquifer IV (Confined)	242 to 300	58	-	-	-	

Aquifer Group wise Water Level maps

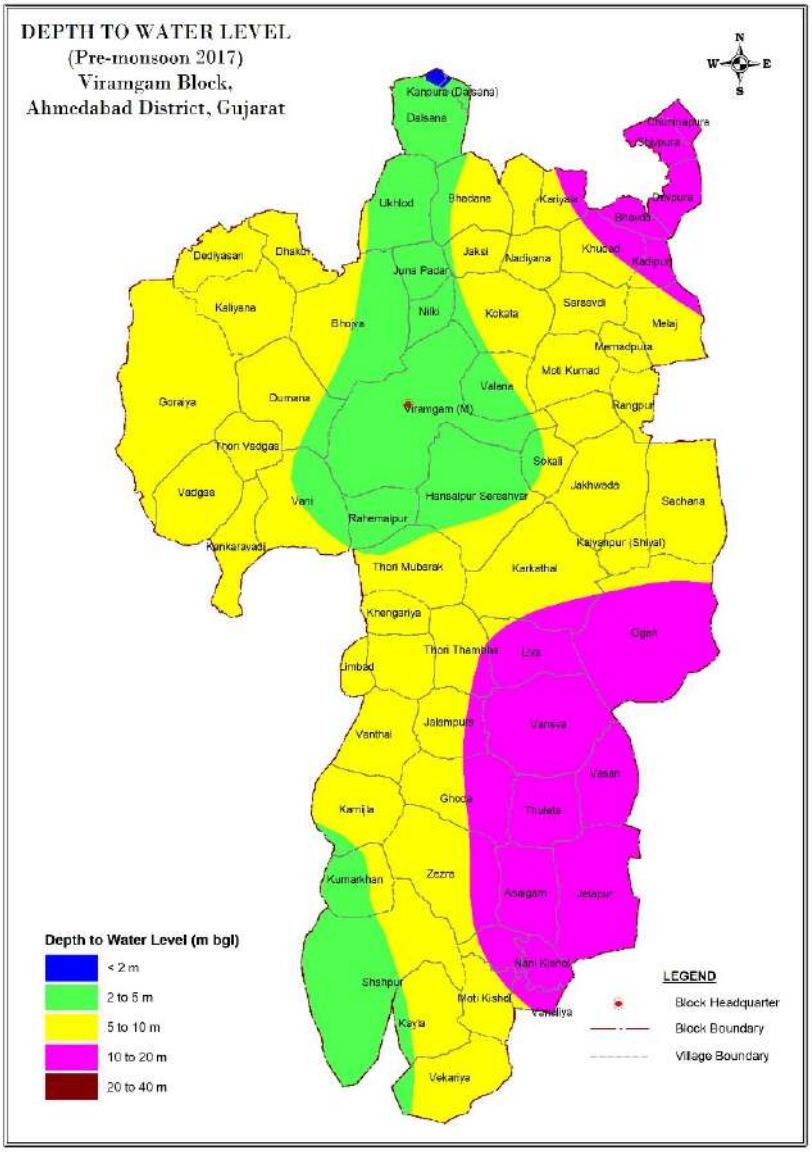


Fig.8: Pre Monsoon Depth to Water Level Map- Unconfined Aquifer

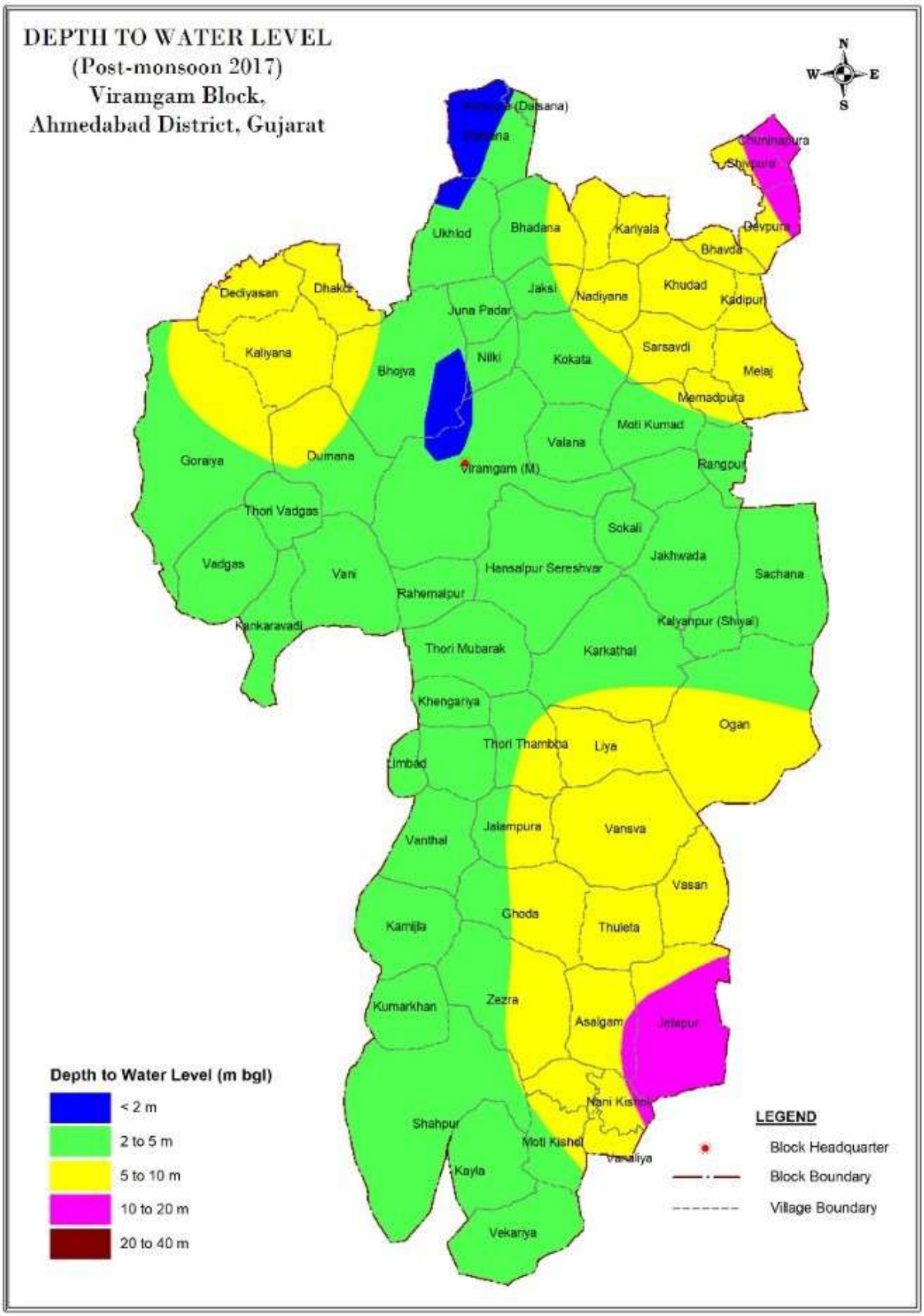


Fig.9: Post Monsoon Depth to Water Level Map- Unconfined Aquifer

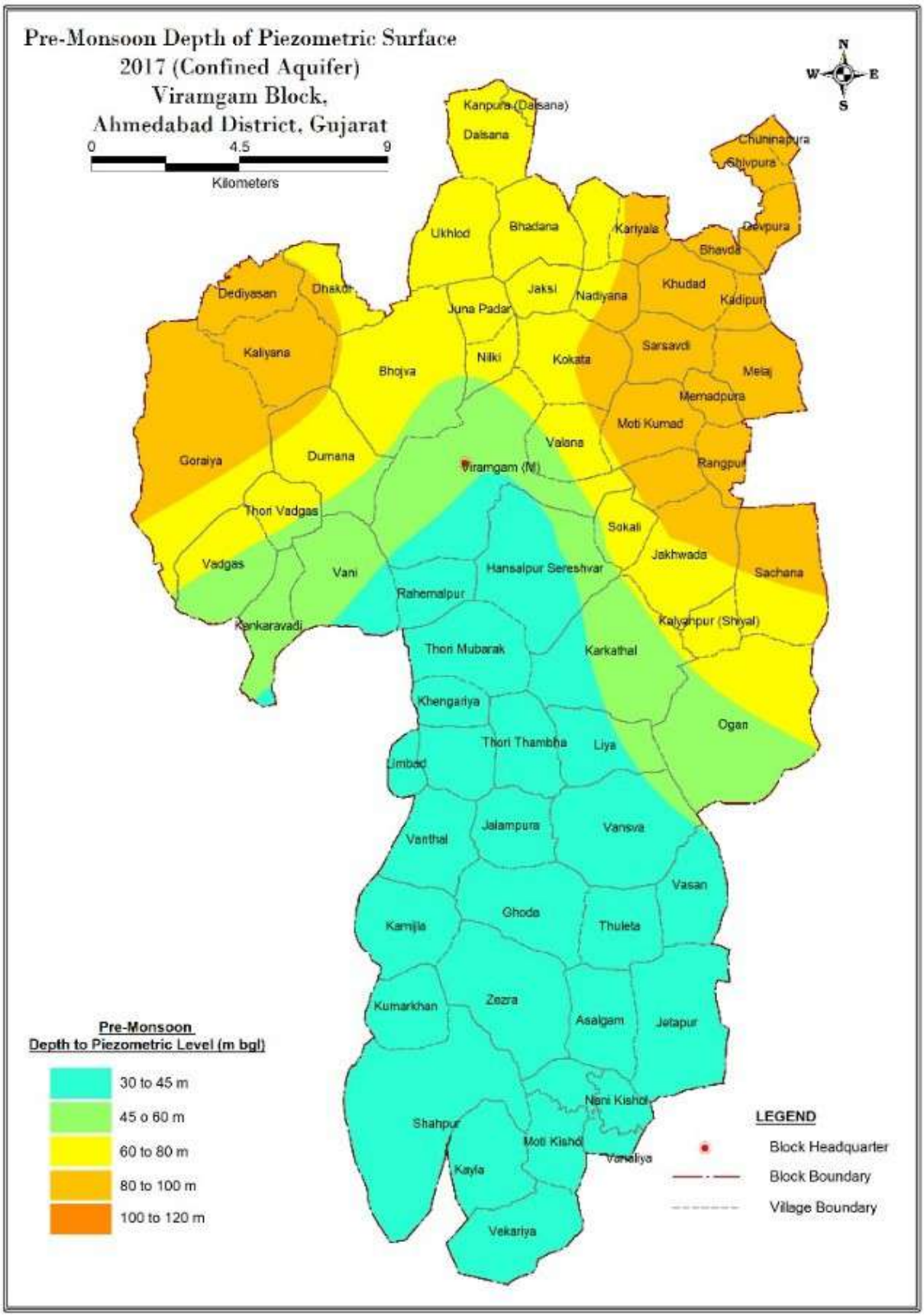


Fig.10: Pre-Monsoon Depth of Piezometric Surface- Confined Aquifer

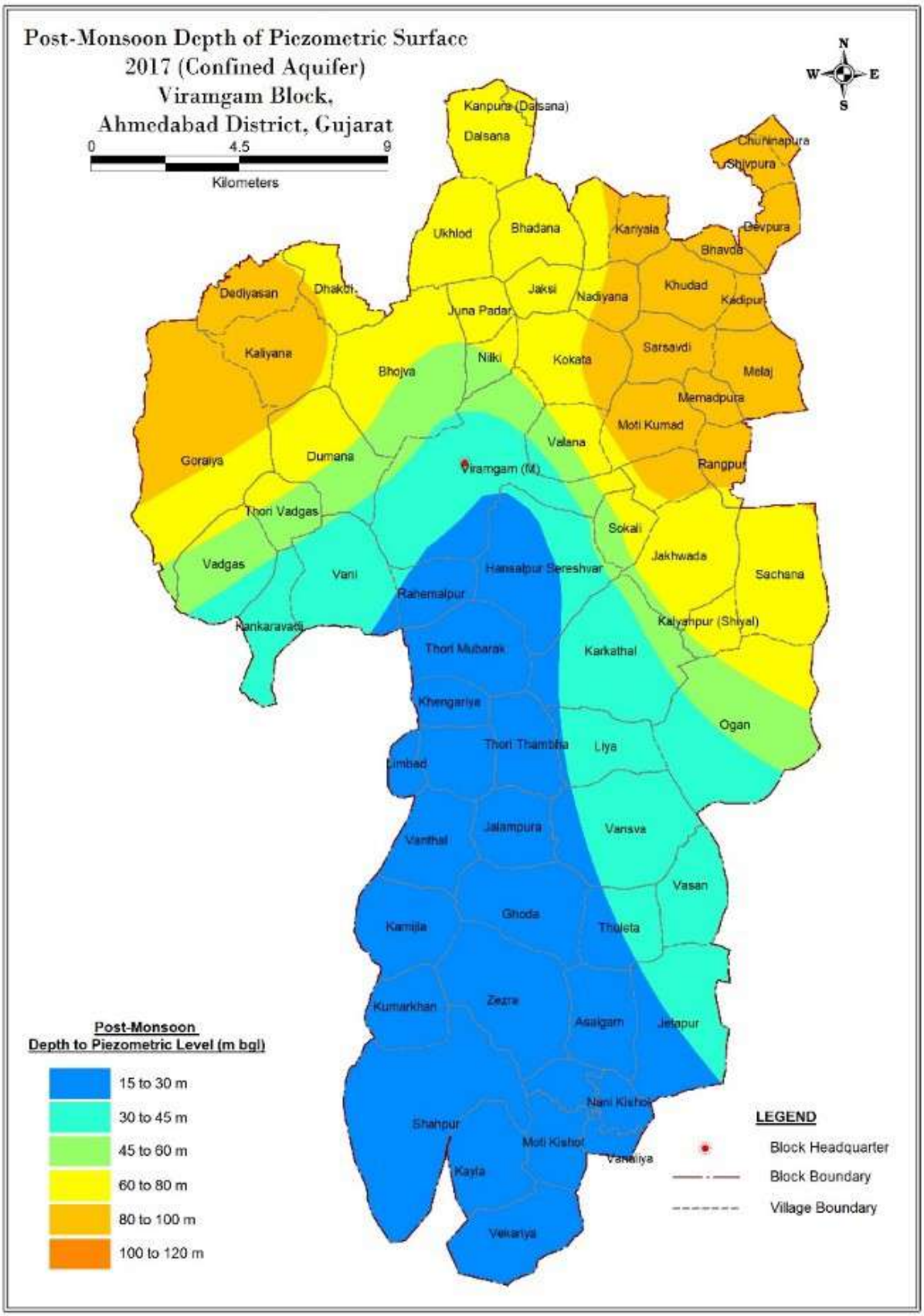


Fig.11: Post-Monsoon Depth of Piezometric Surface- Confined Aquifer

4. Dynamic Ground Water Resources in MCM

Total fresh groundwater availability of the area is estimated in year 2017 is 13.90 MCM and total groundwater withdrawal for all purposes is 11.33 MCM. The stage of groundwater development is 81.53 % and the Taluka is categorized “Semi Critical”. Total Saline groundwater availability of the area is estimated in year 2017 is 72.46 MCM and total groundwater withdrawal for all purposes is 17.73 MCM. The stage of groundwater development is 24.46% and the Taluka is categorized “Safe”.

Table: 3 Dynamic Groundwater resources 2017

S No	Item	Fresh	Saline
1	Area (sq.km)	138.56	751.74
2	Total GW Recharge (MCM)	14.63	76.27
3	Net GW Availability (MCM)	13.90	72.46
4	Gross Draft (MCM)	11.33	17.73
5	Net Availability for Future Irrigation (MCM)	1.97	53.61
6	Stage of GW Development %	81.53	24.46

5. Chemical quality of groundwater

- Phreatic Aquifer (Aquifer I); Shows considerable variation from highly saline to fresh. TDS value ranges from 1000 to 7600 ppm.
- Deeper Aquifer (Both Aquifer II & III); Generally highly saline to fresh (TDS 1465 to 8200 ppm).

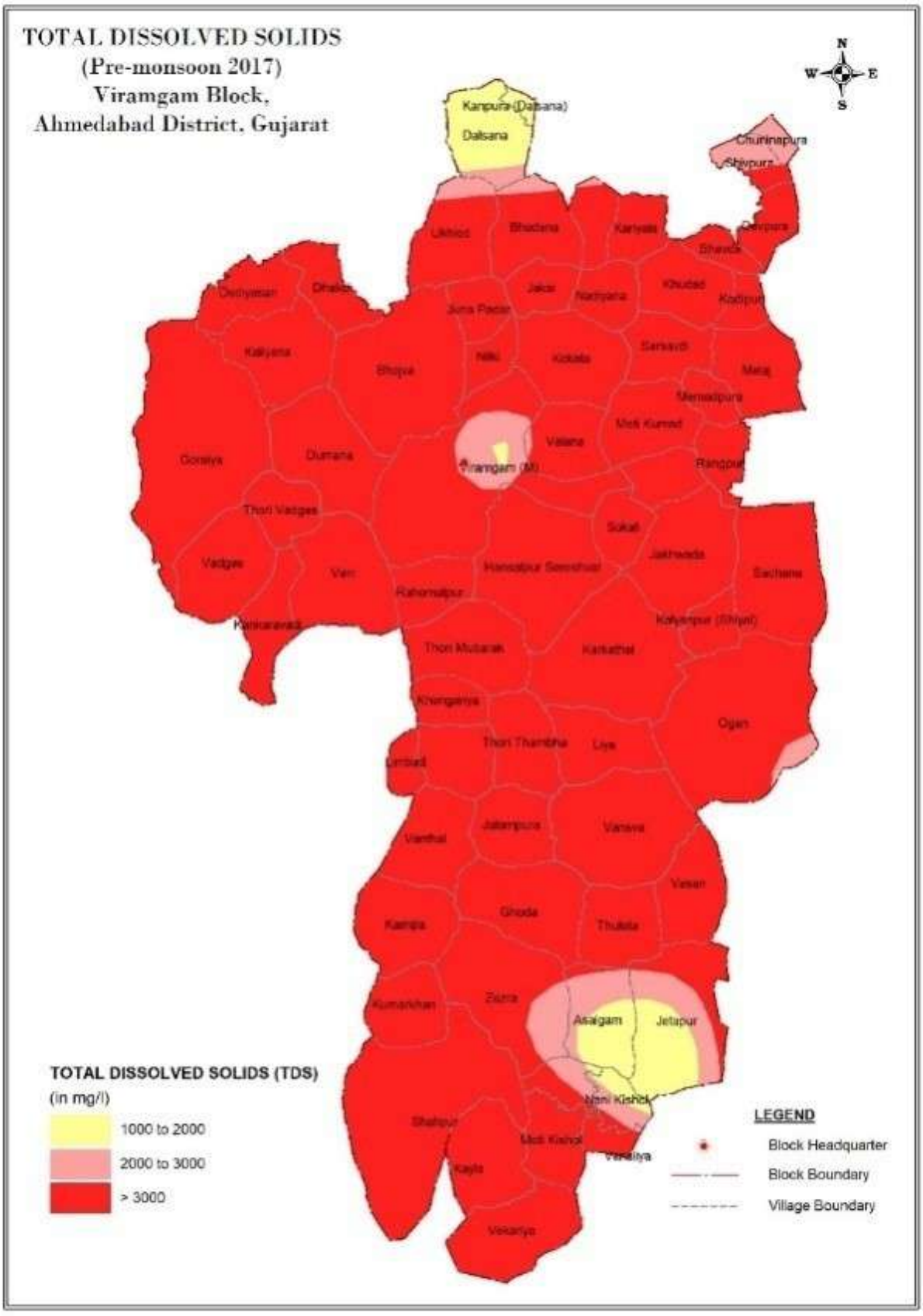


Fig.12: Total Dissolved Solids (TDS) Map- Unconfined Aquifer

Fig.13: Fluoride Map- Unconfined Aquifer

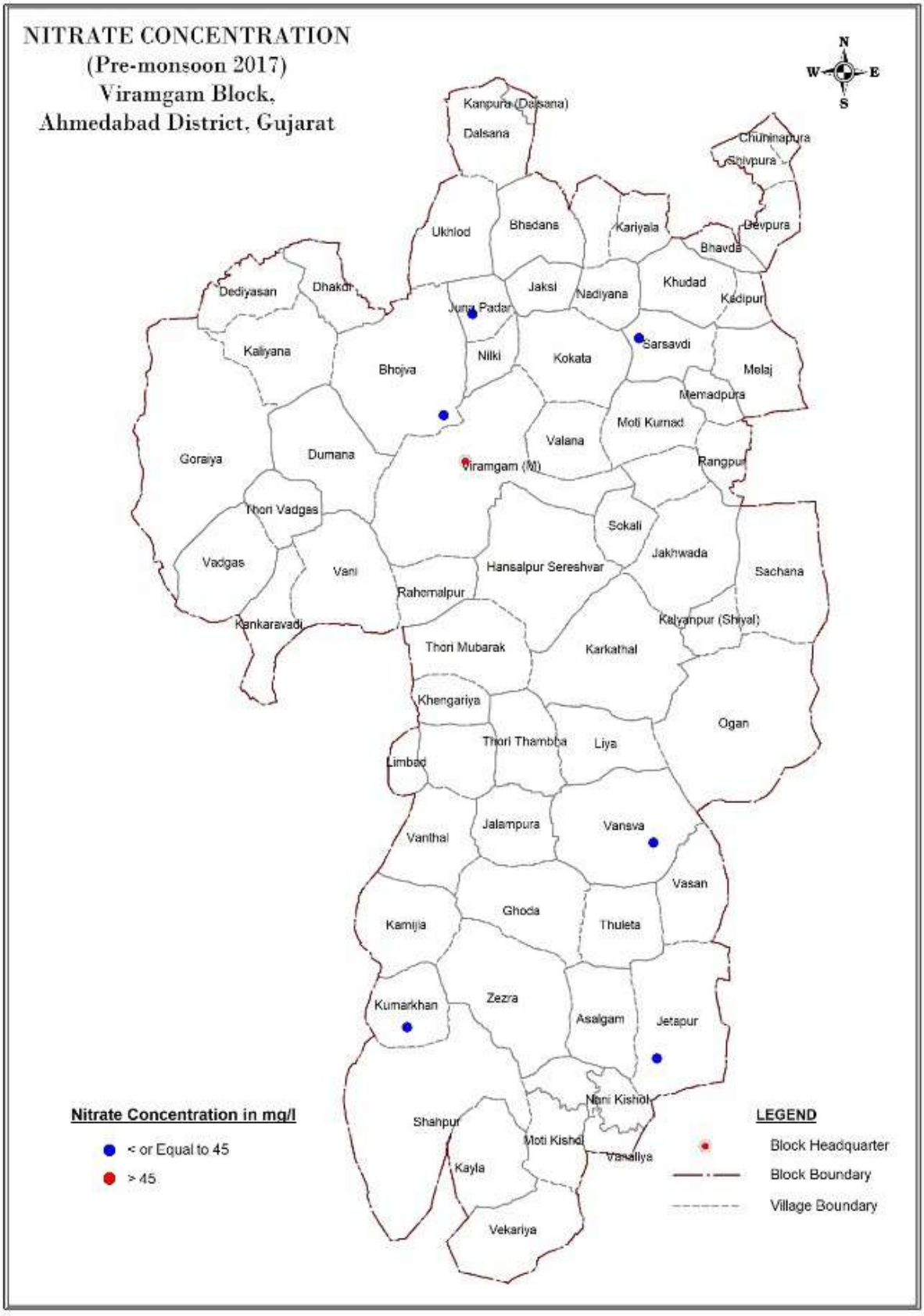


Fig. 14: Nitrate Map- Unconfined Aquifer

7. Groundwater issues

Major part of the district is saline having TDS value>2000 ppm.

8. Groundwater Management

Supply Side management-Proposed Recharge Structures- Percolation tank- 2 nos. & net water recharge through percolation tank is 0.26 MCM.

Supply Side Intervention	
Volume of subsurface storage space available of artificial recharge (MCM)	178.32
Surplus available (MCM)	0.26
Percolation tank proposed	2
Water availability after additional recharge	0.26 MCM

9. **Artificial Recharge & Conservation Possibilities**

Ground water resources in the block augmented by means artificial recharge through percolation tank would lead to 0.26 MCM saving of ground water and improve stage of ground water from 81.51% to 80.00%.

Annexure I

Bore	Enabled	Village_well	Elevation	CollarElevation	TotalDepth	Easting	Northing	Longitude	Latitude
Odiki	1	Odiki	30	30	480.00	809926	2575403	72.029039	23.258771
Virochannagar	1	Virochannagar	35	35	441.00	830702	2557959	72.228069	23.097402
Fangdi	1	Fangdi	25	25	350.00	841596	2538866	72.33004	22.923003
Bavla	1	Bavla	26	26	274.00	845296	2528614	72.363781	22.829793
Juval	1	Juval	24	24	185.00	850457	2524179	72.412989	22.788727
Viramgam	1	Viramgam	30	30	202.00	812646	2561477	72.052742	23.132638
Sanand	1	Sanand	38	38	200.00	846090	2546541	72.375509	22.99129
Vejalpur	1	Vejalpur	45	45	219.00	860497	2548569	72.5163	23.006525
Kalyangadh	1	Kalyangadh	16	16	273.00	836094	2515887	72.271512	22.716876
Bagodara	1	Bagodara	18	18	213.00	829150	2507199	72.202182	22.639879
Naroda	1	Naroda	58	58	218.00	874414	2555794	72.653596	23.068587
Pachham	1	Pachham	9	9	132.00	827461	2479862	72.180116	22.393632
Dholera	1	Dholera	10	10	358.00	829172	2463960	72.193442	22.249864
Bhangadh	1	Bhangadh	10	10	132.00	831297	2450192	72.21121	22.125271
Upardal	1	Upardal	16	16	192.00	823225	2531232	72.149576	22.857806
Koth	1	Koth	21	21	198.00	839429	2506779	72.30196	22.634067
Ingoli	1	Ingoli	16	16	182.00	858410	2503371	72.485579	22.599433
Dhandhuka	1	Dhandhuka	25	25	100.00	807039	2477894	71.981626	22.379655
Vagad	1	Vagad	40	40	10.00	795834	2475690	71.872506	22.361736
Ughroj	1	Ughroj	42	42	200.00	816190	2586757	72.092563	23.359985

Annexure II

Bore	Depth1	Depth2	Aquifer
Odiki	0	57.5	Aquifer I
Odiki	57.5	75	Aquitard I
Odiki	75	135	Aquifer II
Odiki	135	160	Aquitard II
Odiki	160	205	Aquifer III
Odiki	205	205	Aquiclude I
Odiki	205	255	Aquitard III
Odiki	255	300	Aquifer IV
Odiki	300	300	Basalt
Virochannagar	0	60	Aquifer I
Virochannagar	60	75	Aquitard I
Virochannagar	75	135	Aquifer II
Virochannagar	135	155	Aquitard II
Virochannagar	155	210	Aquifer III
Virochannagar	210	210	Aquiclude I
Virochannagar	210	242	Aquitard III
Virochannagar	242	300	Aquifer IV
Virochannagar	300	300	Basalt
Fangdi	0	50	Aquifer I
Fangdi	50	75	Aquitard I
Fangdi	75	115	Aquifer II
Fangdi	115	170	Aquitard II
Fangdi	170	230	Aquifer III
Fangdi	230	290	Aquiclude I
Fangdi	290	290	Aquitard III
Fangdi	290	350	Aquifer IV
Fangdi	350	350	Basalt
Bavla	0	40	Aquifer I
Bavla	40	60	Aquitard I
Bavla	60	95	Aquifer II
Bavla	95	112.5	Aquitard II
Bavla	112.5	175	Aquifer III
Bavla	175	245	Aquiclude I
Bavla	245	245	Aquitard III
Bavla	245	274	Aquifer IV
Bavla	274	274	Aquitard III
Bavla	274	274	Basalt
Juval	0	50	Aquifer I
Juval	50	70	Aquitard I
Juval	70	97.5	Aquifer II
Juval	97.5	115	Aquitard II
Juval	115	150	Aquifer III
Juval	150	185	Aquiclude I

Juval	185	185	Aquitard III
Juval	185	185	Aquifer IV
Juval	185	185	Basalt
Viramgam	0	43.9	Aquifer I
Viramgam	43.9	61.46	Aquitard I
Viramgam	61.46	94.4	Aquifer II
Viramgam	94.4	101	Aquitard II
Viramgam	101	202	Aquifer III
Viramgam	202	202	Aquiclude I
Viramgam	202	202	Aquitard III
Viramgam	202	202	Aquifer IV
Viramgam	202	202	Basalt
Sanand	0	44	Aquifer I
Sanand	44	64	Aquitard I
Sanand	64	136	Aquifer II
Sanand	136	164	Aquitard II
Sanand	164	200	Aquifer III
Sanand	200	200	Aquiclude I
Sanand	200	200	Aquitard III
Sanand	200	200	Aquifer IV
Sanand	200	200	Basalt
Vejalpur	0	48	Aquifer I
Vejalpur	48	83	Aquitard I
Vejalpur	83	126	Aquifer II
Vejalpur	126	157	Aquitard II
Vejalpur	157	187	Aquifer III
Vejalpur	187	201	Aquiclude I
Vejalpur	201	201	Aquitard III
Vejalpur	201	219	Aquifer IV
Vejalpur	219	219	Basalt
Dahegam	0	24	Aquifer I
Kalyangadh	0	25	Aquifer I
Kalyangadh	25	46	Aquitard I
Kalyangadh	46	101	Aquifer II
Kalyangadh	101	148	Aquitard II
Kalyangadh	148	169	Aquifer III
Kalyangadh	169	258	Aquiclude I
Kalyangadh	258	258	Aquitard III
Kalyangadh	258	273	Aquifer IV
Kalyangadh	273	273	Basalt
Bagodara	0	35	Aquifer I
Bagodara	35	50	Aquitard I
Bagodara	50	73	Aquifer II
Bagodara	73	144	Aquitard II
Bagodara	144	166	Aquifer III
Bagodara	166	213	Aquiclude I
Bagodara	213	213	Aquitard III

Bagodara	213	213	Aquifer IV
Bagodara	213	213	Basalt
Naroda	0	62.4	Aquifer I
Naroda	62.4	85.8	Aquitard I
Naroda	85.8	124.8	Aquifer II
Naroda	124.8	156	Aquitard II
Naroda	156	218	Aquifer III
Naroda	218	218	Aquiclude I
Naroda	218	218	Aquitard III
Naroda	218	218	Aquifer IV
Naroda	218	218	Basalt
Pachham	0	37	Aquifer I
Pachham	37	48	Aquitard I
Pachham	48	66	Aquifer II
Pachham	66	120	Aquitard II
Pachham	120	150	Aquifer III
Pachham	150	200	Aquiclude I
Pachham	132	132	Aquitard III
Pachham	132	132	Aquifer IV
Pachham	132	132	Basalt
Dholera	0	72	Aquifer I
Dholera	72	72	Aquitard I
Dholera	72	72	Aquifer II
Dholera	72	244	Aquitard II
Dholera	244	244	Aquifer III
Dholera	244	244	Aquiclude I
Dholera	244	244	Aquitard III
Dholera	244	312	Aquifer IV
Dholera	312	312	Basalt
Bhangadh	0	74	Aquifer I
Bhangadh	74	74	Aquitard I
Bhangadh	74	74	Aquifer II
Bhangadh	74	132	Aquitard II
Bhangadh	132	132	Aquifer III
Bhangadh	132	132	Aquiclude I
Bhangadh	132	132	Aquitard III
Bhangadh	132	132	Aquifer IV
Bhangadh	132	132	Basalt
Upardal	0	45	Aquifer I
Upardal	45	59	Aquitard I
Upardal	59	90	Aquifer II
Upardal	90	100	Aquitard II
Upardal	100	155	Aquifer III
Upardal	155	192	Aquiclude I
Upardal	192	192	Aquitard III
Upardal	192	192	Aquifer IV
Upardal	192	192	Basalt

Koth	0	45	Aquifer I
Koth	45	60	Aquitard I
Koth	60	80	Aquifer II
Koth	80	141	Aquitard II
Koth	141	172	Aquifer III
Koth	172	200	Aquiclude I
Koth	200	200	Aquitard III
Koth	200	200	Aquifer IV
Koth	200	200	Basalt
Ingoli	0	41	Aquifer I
Ingoli	41	82	Aquitard I
Ingoli	82	122	Aquifer II
Ingoli	122	152	Aquitard II
Ingoli	152	174	Aquifer III
Ingoli	174	182	Aquiclude I
Ingoli	182	182	Aquitard III
Ingoli	182	182	Aquifer IV
Ingoli	182	182	Basalt
Dhandhuka	0	78	Aquifer I
Dhandhuka	78	78	Aquitard I
Dhandhuka	78	78	Aquifer II
Dhandhuka	78	78	Aquitard II
Dhandhuka	78	78	Aquifer III
Dhandhuka	78	78	Aquiclude I
Dhandhuka	78	78	Aquitard III
Dhandhuka	78	78	Aquifer IV
Dhandhuka	78	100	Basalt
Vagad	0	10	Basalt
Ughroj	0	62	Aquifer I
Ughroj	62	73	Aquitard I
Ughroj	73	110	Aquifer II
Ughroj	110	143	Aquitard II
Ughroj	143	200	Aquifer III
Ughroj	200	200	Aquiclude I
Ughroj	200	200	Aquitard III
Ughroj	200	200	Aquifer IV
Ughroj	200	200	Basalt