



केंद्रीय 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 GANDHINAGAR DISTRICT, GUJARAT STATE

पश्चिम मध्य क्षेत्र, अहमदाबाद
West Central Region, Ahmedabad

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES GANDHINAGAR DISTRICT, GUJARAT STATE

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**AQUIFER MAP&MANAGEMENT PLAN OF
GANDHINAGAR DISTRICT GUJARAT
(2163 sq. km)**

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GANDHINAGAR DISTRICT AT A GLANCE

SL No.	Items	Statistics
1.	General Information	
	i) Geographical Area (Sq. Km)	2163
	ii) Administrative Divisions (As on 2011) Number of Taluka Number of Villages	4 252
	iii) Populations (As per 2011 census)	13,91,753
	iv) Average Annual Rainfall (mm)	744
2.	GEOMORPHOLOGY	
	Major Physiographic Units	Alluvial plain
	Major Drainages	Sabarmati
3.	LAND USE (Sq. Km)	
	a) Forest area	24
	b) Net area sown	1545
	c) Uncultivable area	233
	d) Cultivable	1438
	e) Waste Land	243
4.	MAJOR SOIL TYPES	Sandy Loam
5.	AREA UNDER MAJOR CROPS IN KHARIFF,RABI & SUMMER SEASON(Area in Sq Km) Rice (85 Sq Km), Bajra (143 Sq Km), Wheat (309 Sq Km), Jowar (12.08 Sq Km) , Maize (0.41 Sq Km), Mung (23.91Sq Km), Math (0.25 sq km), Ground Nut (02 Sq Km), Sesamum (10.45 Sq Km), rapes and Mustard (15 Sq Km), Cstor(295.98 Sq. Km)Udid(38.1 Sq km),Tur(33.1 Sq km),Cotton(311 Sq km),Tobacco(25 Sq km),Gaur seed (90.60 Sq km),Fennel (88.90 Sq km).	
6.	IRRIGATION BY DIFFERENT SOURCES (Numbers of structures) 5th MI Census	
	Dug wells	2328
	Deep Tube wells/Shallow Tube wells	818/1385
	Tanks/Ponds/Water conservation structures	1
	Canals	1
	Other Sources	3
	Net Irrigated area(sq. km.) (2014-15)	642
	Gross Irrigated area (sq. km.) (2014-15)	1438
7.	NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB (As on 31-03-2018)	26
	No of Dug Wells	02
	No of Piezometers	24
8.	PREDOMINANT GEOLOGICAL FORMATIONS	
	Alluvium/ Tertiaries	

9.	HYDROGEOLOGY Major Water Bearing Formation:- Quaternary alluvium				
	Depth to water level during 2016-2017				
		Phreatic aquifer (DTW)		Confined aquifer (Pz head)	
		Min.	Max.	Min.	Max.
	Pre-monsoon	9.45m (Dahegam)	72.40m (Mubarakpura)	39.30 m (Nasmed)	194.60 m (CharadaPz-I)
	Post-monsoon	3.03m (Dahegam)	71.20m (Mubarakpura)	33.30 m (Nasmed)	194.42 m (CharadaPz-I)
	Long Term (10 Years) Water Level Trend (2008 to 2017)				
	Trend	Pre-Monsoon		Post- Monsoon	
	Rise (m/Yr)	0.0257(Patnakuva) to 2.7228 (Amrapur III)		0.02260(Kasturinagar) to 1.332856 (Hilol)	
	Fall (m/Yr)	0.5046 (DahegamPz I) to 4.5968(Charada)		0.24124(Dahegam I) to 5.13321(PethapurPz-I)	
10.	GROUND WATER EXPLORATION BY CGWB (As on 31 -03 -2018)				
	No of wells drilled (EW, OW, Pz, SH, Total)				
	EW= 31	OW = 8	Pz= 33	SH= 01	Total =73
	Depth Range(m)				34- 614
	Discharge (Litres per second)				6- 20 lps
	Transmissivity (m ² /day)				350-1100
11	GROUND WATER QUALITY				
	Presence of chemical constituents more than permissible limit)				Fluoride : 19 Villages
	Type of water				Overall Fresh
12	DYNAMIC GROUND WATER RESOURCES (2017)				
	Annual Replenishable Ground Water Resources (MCM)				494.81
	Net Ground water Availability (MCM)				470.07
	Total Extraction				533.77
	Projected Demand for Domestic and industrial Uses up to 2025 (MCM)				24.98
	Stage of Ground Water Development (%)				113.55
13	MAJOR GROUND WATER PROBLEMS AND ISSUES				
	<ul style="list-style-type: none"> • Over exploitation of ground water. • Decline in Groundwater levels (Unconfined & Confined Aquifers) • Fluoride concentration more than permissible limit occurred in Isolated Patches. 				

AQUIFER MAP AND MANAGEMENT PLAN GANDHINAGAR DISTRICT

INTRODUCTION

Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. There has been a paradigm shift from “groundwater development” to “groundwater management”. An accurate and comprehensive micro-level picture of groundwater in India through aquifer mapping indifferent hydrogeological settings will enable robust groundwater management plans at the appropriate scale to be devised and implemented for this common-pool resource. This will help achieving drinking water security, improved irrigation facility and sustainability in water resources development in large parts of rural India, and many parts of urban India as well. The aquifer mapping program is important for planning suitable adaptation strategies to meet climate change also. Thus the crux of NAQUIM is not merely mapping, but reaching the goal – that of ground water management through community participation.

Objective:

The primary objective of the Aquifer Mapping Exercise can be summed up as “Know your Aquifer, Manage your Aquifer”. Demystification of Science and thereby involvement of stake holders is the essence of the entire project. The involvement and participation of the community will infuse a sense of ownership amongst the stakeholders. This is an activity where the Government and the Community work in tandem. Greater the harmony between the two, greater will be the chances of successful implementation and achievement of the goals of the Project. As per the Report of the Working Group on Sustainable Ground Water Management, “It is imperative to design an aquifer mapping programme with a clear-cut groundwater management purpose. This will ensure that aquifer mapping does not remain an academic exercise and that it will seamlessly flow into a participatory groundwater management programme. The aquifer mapping approach can help integrate ground water availability with ground water accessibility and quality aspects.

Methodology:

Methodology involves creation of database for each of the principal aquifer. Delineation of aquifer extent (vertical and lateral). Standard output for effective presentation of scientific integration of Hydrogeological, geophysical, geological, hydro chemical data facts and on GIS platform, identification of issues, manifestation of issues and formulation of strategies to address the issues by possible interventions at local and regional level.

The activities of the Aquifer Mapping can be grouped as follows.

Data Compilation & Data Gap Analysis:

One of the important aspect of the aquifer mapping programme was the synthesis of the large volume of data already collected during specific studies carried out by Central Ground Water Board and various Government organizations with a new data set generated that broadly describe an aquifer system. The data were assembled from the available sources, analyzed, examined, synthesized and interpreted. These sources were predominantly non-computerized data, which was

converted into computer based GIS data sets and on the basis of available data, data gaps were identified.

Data Generation:

There a strong need for generating additional data to fill the data gaps to achieve the task of aquifer mapping. This was achieved by multiple activities such as exploratory drilling, geophysical techniques, hydro-geochemical analysis, remote sensing, and hydrogeological surveys to delineate multi aquifer system to bring out the efficacy of various geophysical techniques and a protocol for use of geophysical techniques for aquifer mapping in different hydrogeological environs.

Aquifer Map Preparation:

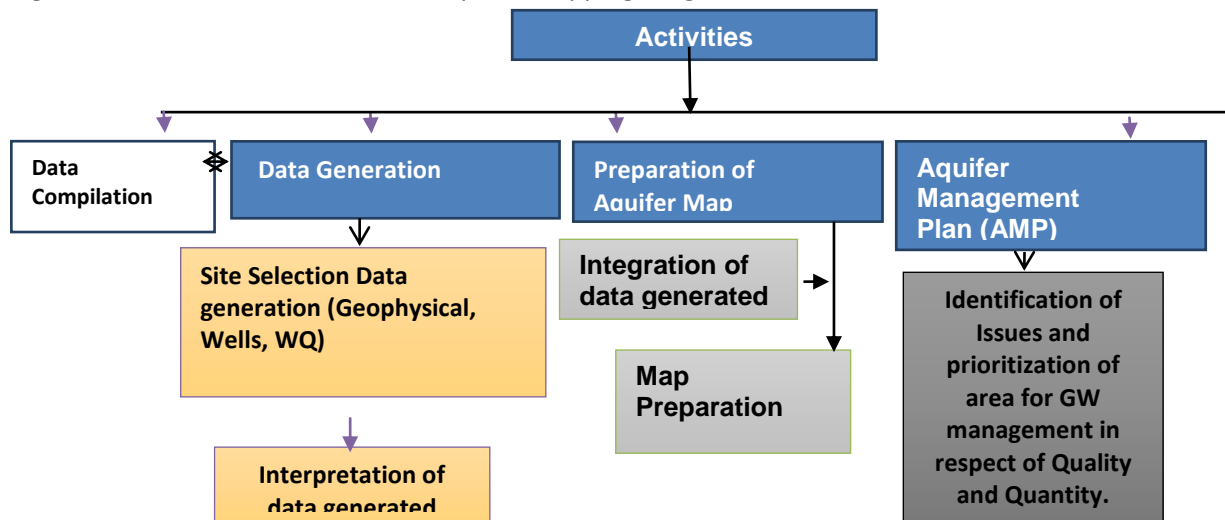
On the basis of integration of data generated from various studies of hydrogeology & geophysics, aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared bringing out details of Aquifers, these are termed as Aquifer maps providing spatial variation (lateral & vertical) in reference to aquifer extremities (i.e. quality & quantity).

Aquifer Management Plan Formulation:

Aquifer response Model has been utilized to identify a suitable strategy for sustainable development of the aquifer in the area.

All the above activities under the ground National Aquifer Mapping programme is depicted/elaborated in Annexure –I and presented in figure 1.

Figure – 1 Activities under National Aquifer Mapping Programme



Locations, Extent and Accessibility

Gandhinagar District is an administrative division of Gujarat, India, whose headquarters are at Gandhinagar, the state capital. It was organized in 1964. According to 2011 Census Gandhinagar district has a population of 1,387,478 within 252 villages spread over a geographical area of 2163 Sq KM resulting in a population density of 660 inhabitants per square kilometre. The district includes Gandhinagar with three Suburbs - Chandkheda, Motera and Adalaj. The four talukas are - Gandhinagar, Kalol, Dahegam and Mansa. Gandhinagar district is bounded by the districts of Sabarkantha and Aravalli to the northeast, Kheda to the southeast, Ahmedabad to the southwest, and Mehsana to the northwest.

The district Gandhinagar lies between Latitude: 22°56' to 23°36' and Longitude: 72°23' to 73°05' and falls in Survey of India Topo sheet No 46A/7, A/8, A/10, A/11, A/12, A/15 & A/16 covering all the four taluka. Table No-1 District bounds Latitudes and Longitudes.

District Name	RL (amsl)	Latitude	Longitude
Gandhinagar	Range 56 - 126	22°56' to 23°36'	72°23' to 73°05'

The area is well connected by roads and railways. The National Highway no. 8 and 8 C run through the district connecting it with major cities of the state as also with the rest of India. It is connected with Ahmedabad by Sarkhej-Gandhinagar Highway (28 km) and with Vadodara by the Ahmedabad-Vadodara highway (139 km). It is well connected with the major districts of the state Mahesana, Rajkot, Jamnagar, Valsad, Ankeswar, Surat etc. Western Railways connect Gandhinagar with major cities in India such as Delhi, Mumbai and Ahmedabad. Ahmedabad is the nearest airport, which is about 22km from the district head quarters. In general, the area is well connected and having good system of communication and accessibility by all-weather motorable roads.

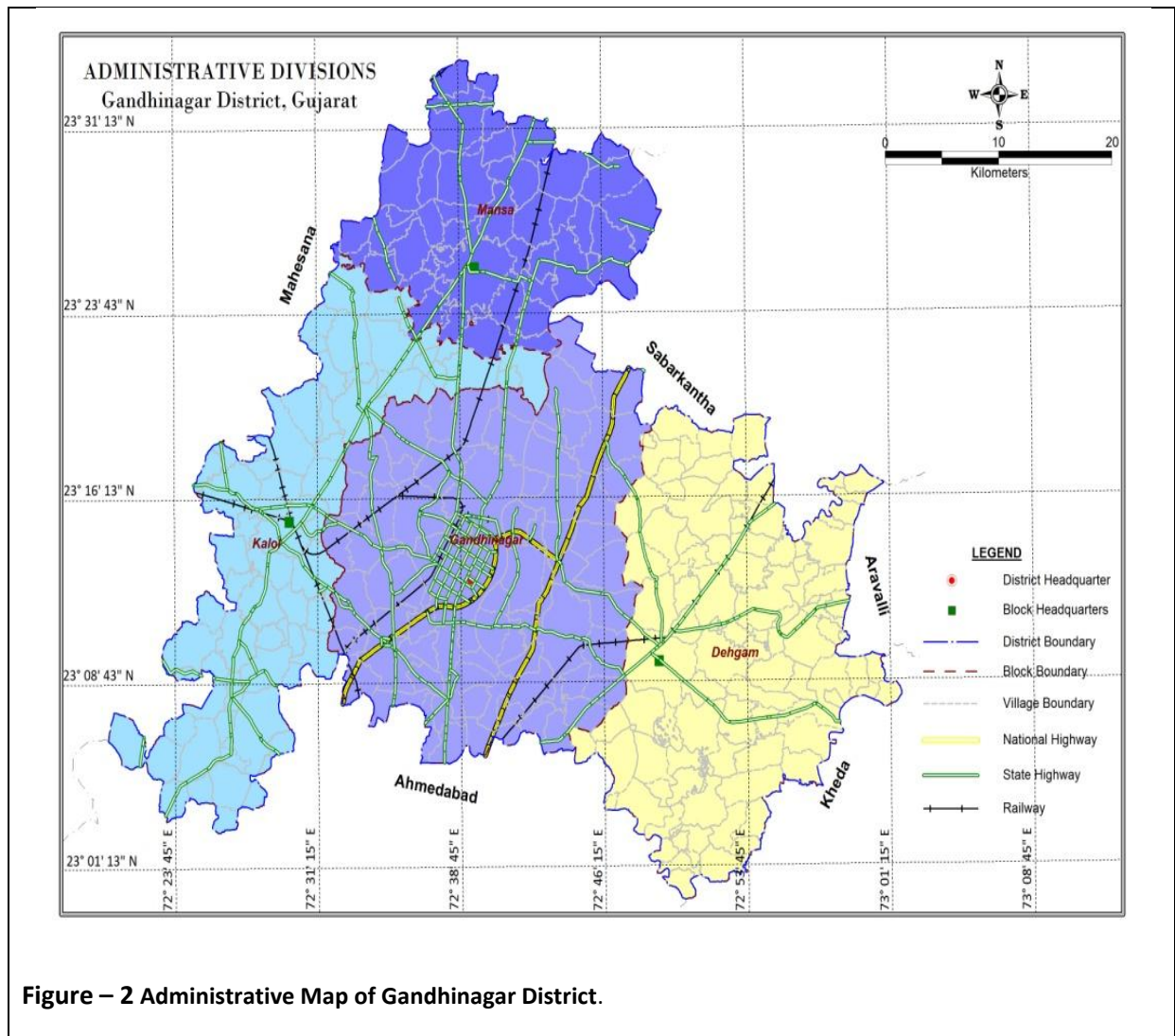


Figure – 2 Administrative Map of Gandhinagar District.

Demography

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

Soil

As per U.N.D.P project studies western part of the district is characterized by alkaline and saline soils, which are typically deep, grey, calcareous sandy clay loam with very low permeability. The rest of the district is characterized by soils which are sandy loam type of light grey to brown colour. As per U.N.D.P studies they are generally deep with moderate to good permeability and drainage.

Land use irrigation and cropping pattern

The total geographical area of Gandhinagar district is 2, 16, 300 hectares out of which nearly 2,044 hectares (or 0.9%) is under forests. Another 17,751 hectares (or 8%) of area is under cultivable wastes, permanent pastures and miscellaneous tree crops. Another 22,632 hectares (or 10%) of the land is under other uses including non-agricultural uses. The net sown area of the districts is roughly around 1,64,954 hectares constituting 76% of total geographical area of the district. Nearly 1, 06,796 hectares were sown more than once constituting 49% of the total geographical area of the district. The gross cropped area of the district was 2, 17,228 hectares constituting 101% of the total geographical area of the district. The cropping intensity of district stood at 132%. The Taluka-wise land use pattern is presented in the table below.

Table No-2 Land Use Pattern in Gandhinagar District (Area in Ha)

Sl.No	Name of Taluka	Total Geographical Area	Area under Agriculture				Area under forest	Area under wasteland	Area under other uses
			Gross Cropped Area (1)	Net Sown Area (2)	Area sown more than once (1-2)	Cropping intensity (%)			
1	Dehgam	61947	71286	46086	25200	183	887	0	4160
2	Gandhinagar	68789	82705	48767	33938	170	0	5160	12927
3	Kalol	48731	63237	48767	22418	182	0	0	3510
4	Mansa	36371	54522	29282	25240	116	1157	0	2035
5	Grand Total	215838	217228	164954	106796	132	2044	5160	22632

Source: Government of Gujarat, Season and Crop Reports, Gandhinagar

Cropping Pattern:

The cropping pattern in the district suggests that high value crops like wheat, cotton, tobacco, vegetables, fruits, flowers etc. are raised by the farmers. For instance, a total of 60,341 hectares (or 28%) of area is under cereal crops; 31,633 (or 15%) of area is under fiber crops; 35556 (or 16%) is under oilseeds followed by 32,675 hectares (or 12%) under horticulture crops-flowers, fruits and vegetables. The rest of the area is accounted for by crops covering condiments, spices and fiber crops. These statistics and the below figures presents a well-diversified crop structure consisting of high value crops meeting the increasing market demands.

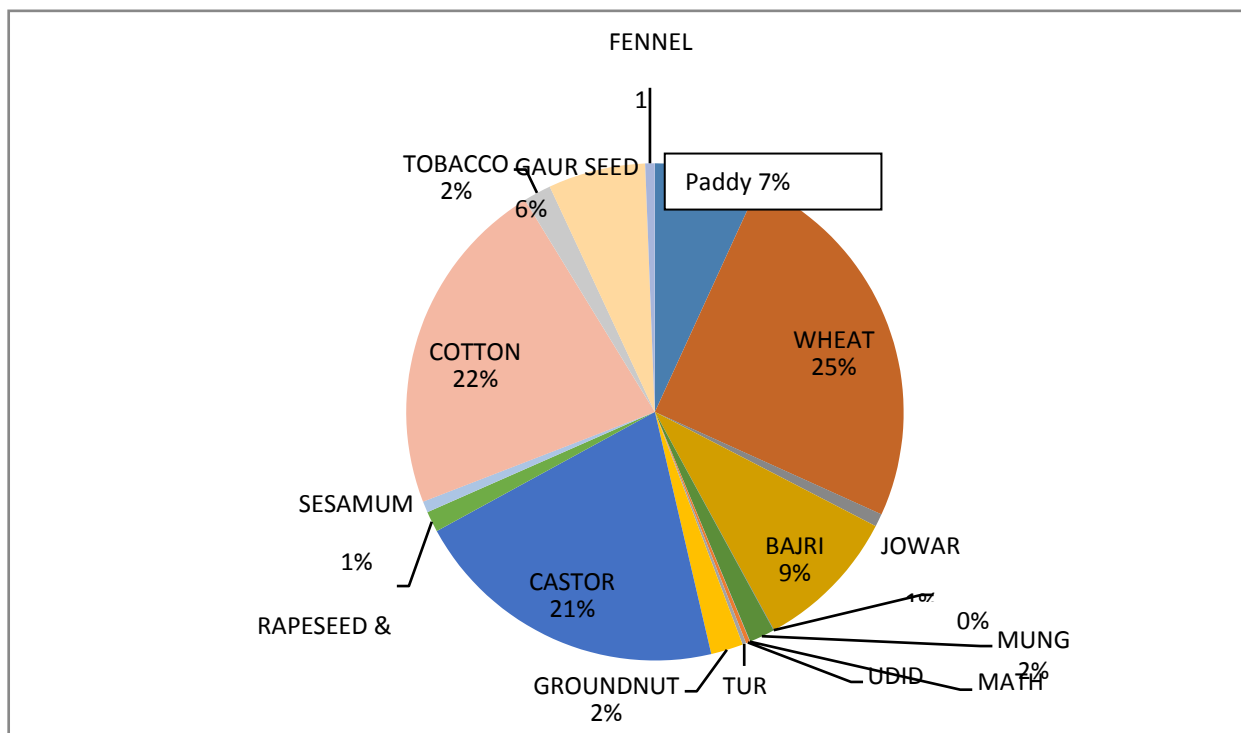


Figure-3: Area under Major Crops in Gandhinagar District (%)

Crop Calendar

Table no-3

20-Jun		Starting time of Rainy Season	
30 Octo to 15 November		Ending Time of Rainy Season	
Sr.No.	Crops Name	Sown Time	Crops Pruning Time
1	Bajri	20 June to 5 July	20 saptember to 30 September
2	Divela	15 July to 15 August	Febuary to April
3	Peddy	15 July to 15 August	15 October to November
4	Cotton	5 June to 30 June	Dicember to 15 Febuary
5	Mung	20 June to 15 July	10 Saptember to 10 October
6	Tuver	20 June to 15 July	25 January to 20 February
7	Variyali	5 August to 15 August	20 Dicember to 15 February
8	Wheat	15 November to 30 Dicember	15 March to 30 march
9	Mustard	15 October to 25 October	25 January to 15 February
10	Potato	15 November to 15 Dicember	15 february to 10 March
11	Groundnuts	20-Jun	20 to 25 October

Source: Department of Agriculture, Season and Crop Reports, Government of Gujarat, Gandhinagar.

Crop area in Hectare grown different crops for Kharif, Rabhi and Summer seasons year 2017-18

Table no-4: Crop area in Hectares in Kharif season year 2017-18

Taluka wise Food Crops Area(Kharif Season)																									
Sr.No.	Taluka	Paddy(dharu)	Paddy (Piyat)	Paddy(Oran)	Bajri	Juvar	Corn	Other Grain	Tuver	Mung	Math	Adad	Other	Groundnuts	Tul	Divela	Soyabin	Variyali	Cotton	Cotton	Tobbaco	Guvar	Vegetables	Grass	Totaal
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	Gandhinaagar	0	2357	0	10	0	0	0	18	282	17	134	46	941	63	8613	0	0	5949	0	0	888	6430	13231	38979
2	Dahegam	0	3568	0	1527	42	145	4	138	1022	58	824	0	3582	64	7677	0	807	6200	0	0	4823	4186	8024	42691
3	Kalol	0	3953	0	39	65	0	0	60	360	5	41	0	170	50	8788	0	0	2066	0	0	866	1123	17361	34947
4	Mansa	0	23	0	0	0	0	0	0	548	8	312	0	375	140	3468	0	107	9487	0	0	1919	2629	8907	27923
5	Total	0	9901	0	1576	107	145	4	216	2212	88	1311	46	5068	317	28546	0	914	23702	0	0	8496	14368	47523	144540

Source: Department of Agriculture, Season and Crop Reports, Government of Gujarat, Gandhinagar.

Table no:5 Crop area in Hectares in Ravi season year 2017-18

Talukawise Food Crops Area (Ravi Season)																								
Sr.No.	Taluka Name	Average of the last 10 years	Paddy(dharu)	Paddy (Piyat)	Juvar	Corn	Other Grain	Gram	Other	Rai	Other Oil	Sugercan	Tobbaco	Coriander	Cumin	Garlic	Sava	Isabgul	Variyali	Onion	Potato	Other Vegetables	Grass	Ravi Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	Gandhinaagar	17859	8200	0	0	0	14	3	0	283	0	0	148	0	0	0	5	0	43	0	2157	2467	4550	17870
2	Dahegam	16994	7129	0	0	0	0	43	0	164	0	0	288	0	0	0	0	0	1082	0	3189	1594	4482	17971
3	Kalol	12907	7510	0	0	0	0	152	0	243	0	0	331	26	0	0	0	0	30	10	172	792	4415	13681
4	Mansa	18426	5843	0	0	0	0	614	0	260	0	0	2828	0	0	0	0	0	329	0	1720	1928	8376	21898
5	Total		28682	0	0	0	14	812	0	950	0	0	3595	26	0	0	5	0	1484	10	7238	6781	21823	71420

Source: Department of Agriculture, Season and Crop Reports, Government of Gujarat, Gandhinagar.

Table no:6 Crop area in Hectares in Ravi season year 2017-18

Taluka wise Food Crops Area																
Sr.No.	Taluka Name	Average of the last 3 years	Paddy(Bajri	Corn	Mung	Adad	Groundnuts	Til	Onion	Sugarcane	Vegetables	Grass	Gubar Gam	Other Crops	District Summerr Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1	Gandhinagar	9591	0	1257	25	13	0	25	0	0	0	1117	1737	2	90	4266
2	Dahegam	8558	76	3565	0	50	0	75	0	0	0	1377	2950	0	58	8151
3	Kalol	4250	52	1189	0	0	0	1	0	0	0	658	1685	0	0	3585
4	Mansa	7969	0	742	0	6	0	0	2	0	0	968	5119	73	0	14879
5	Total		128	6753	25	69	0	101	2	0	0	4120	11491	75	148	22912

Source: Department of Agriculture, Season and Crop Reports, Government of Gujarat, Gandhinagar

Hydrometeorology

The district experiences semi-arid type of climate. The rainy season lasts from June to September and coincides with south-west monsoon. Winter season last from November to February and summer season from March to June. About 95% of the annual rainfall is received during south-west monsoon season (June to Sept.), July being the heavy rainfall month. There is no climatological station in Gandhinagar, however, the IMD Station located at Ahmedabad Airport is quite close to Gandhinagar and is representative for the district. The annual normal rainfall (1930-60) for the Ahmedabad IMD Station is about 739 mm. The climatological data for Ahmedabad IMD Station is given in table no 7 and figure respectively.

The general temperature in Gandhinagar district increases rapidly from February to May, the later being the hottest month with mean daily maximum and minimum temperature as 41° and 28°C respectively. The district is sometimes affected by cold waves due to western disturbances that pass across north India causing minimum temperature to drop the freezing point.

In the monsoon months, the relative humidity is generally 79% or more. However, the rest of the year is comparatively dry. March and April are the driest months where the humidity is less than 45% dropping to 32% or less in the afternoons.

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

Climatological data of Ahmedabad IMD station which is nearest is given in the table 7.

Table: 7- Ahmadabad IMD Station - Climatological Data

<u>Climatological Data</u>								
Station:	Ahmedabad				District	Ahmedabad		
Altitude:	55	m AMSL			HA	13	0.7187828	
Latitude:	23°04'	N			Longitude:	72°38'	E	
Month	Max Temp (°C)	Mini Temp (°C)	Humidity (%)	Wind Spd. Kmpd	Sunshine (Hours)	Solar Rad. (MJ/m2/d)	Eto (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	-

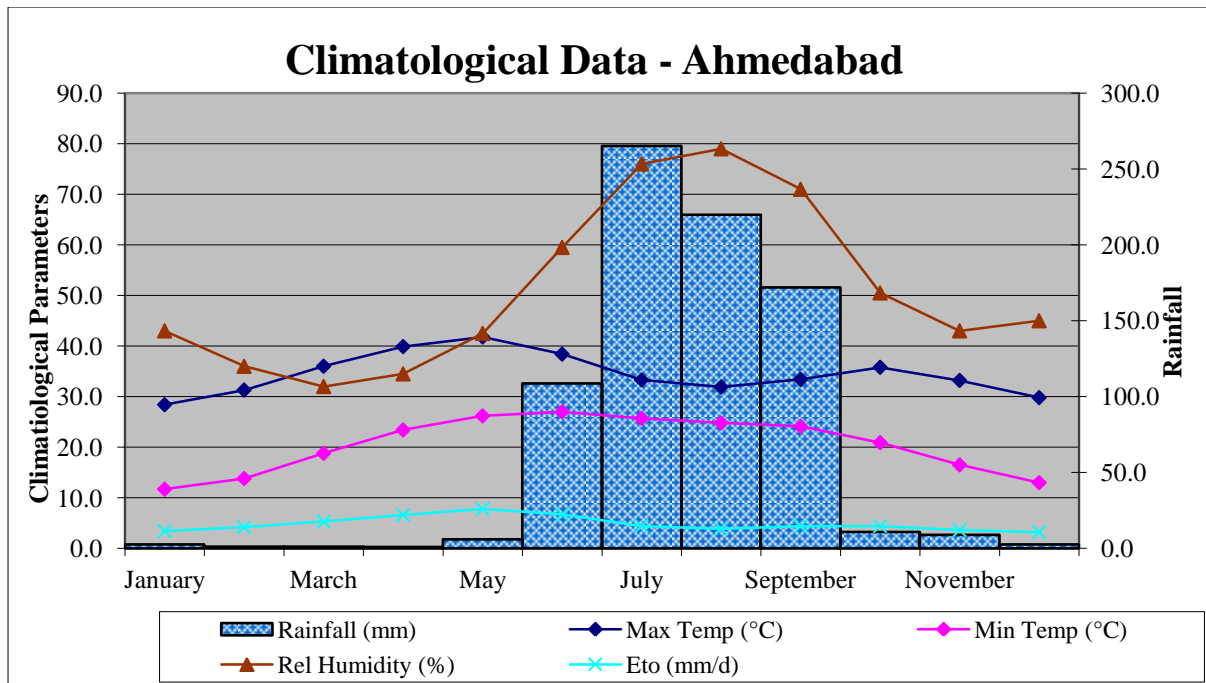


Figure No-4 Climatological Data

GEOMORPHOLOGY

Physiography

The entire district is part and parcel of the North Gujarat plain with neither hilly features nor any prominent natural water bodies. The Sabarmati, the Khari and the Meshwo are the major rivers draining the district.

Drainage

The Sabarmati River, which flows through the district in north- south direction, is the principal river of the district. Sabarmati originate at the place near Vekaria in the Rajasthan State. Thereafter it touches the borders of three districts i.e. Banaskantha, Sabarkantha and Mahesana respectively. The Sabarmati flows along the eastern border of the Mansa taluka, subsequently it enters Gandhinagar district near Mahudi. The Sabarmati flows through the central part of Gandhinagar taluka before it enters the Ahmedabad district.

The Sabarmati was once a perennial river however, after construction of dam near Dharoi, it is generally dry during lean periods except for a small channel of flow due to water released from Dharoi dam for water supply to Ahmedabad. Recently water from Narmada canal is being released to the river as a result of which the river retains water downstream of Narmada canal.

The river has high banks particularly in its upper reaches where they sometimes rise to a height of 60 m. The river for most of the part is shallow and sluggish with a winding and often changing course through a broad bed of sand. Even in the lower part the rivers has well marked bluff rising from 0-15 mts above its bed.

The Khari is the tributary of Sabarmati River. It originates near village Kesarpura in Himatnagar taluka of Sabarkantha district. It enters the district near village Chaudhary, passes through the

northwestern part of Dahegam and southeastern part of the Gandhinagar talukas and finally enters Ahmadabad district near village Vahelal. Out of its entire length of 160 km the Khari flows for about 40 km in the Gandhinagar district.

The Meshwo originates in the Udaipur district of Rajasthan near village Kanboi/Ukhedi and flows in the southwesterly direction. It follows northeastern border of Dahegam taluka before entering the district near village Sahebnamubada. It enters Ahmedabad district near village Kuha.

The Vatrak flows along southeastern boarder of Dahegam taluka for a few km. One of the most important features of the drainage of the district is lack of any definite drainage system in the western part and other is artificial drainage i.e. The Narmada Canal System.

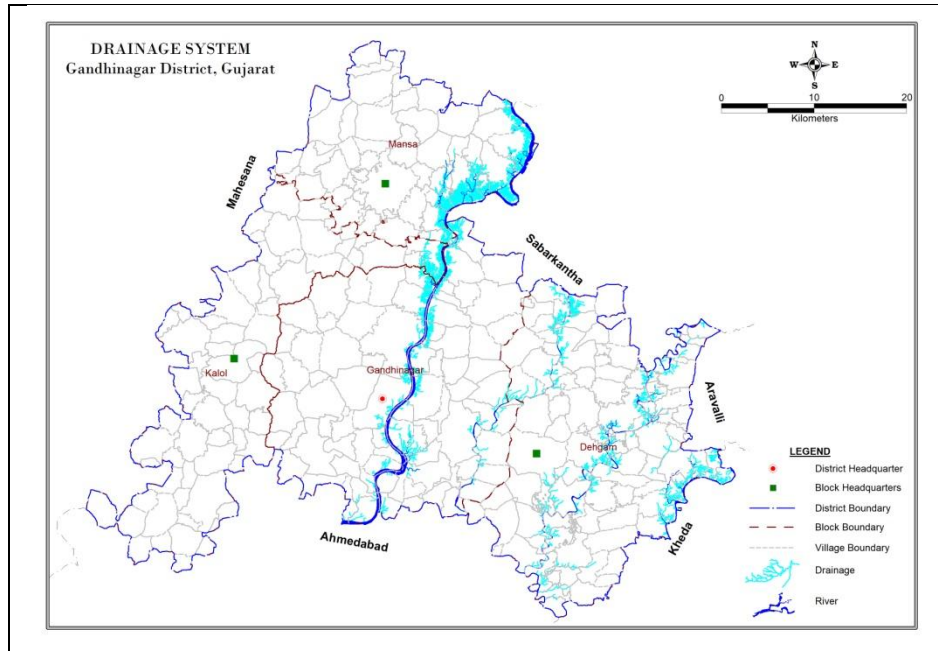


Figure No-5 Drainage System

Previous work

Though Central Ground Water Board as such has not carried out systematic hydrogeological survey of Gandhinagar district, parts of this district have been included under different studies in past. Parts of Mehsana district that forms a part of Gandhinagar district were covered in the systematic survey done by Sh. M.M. Oza between 1962-67, under Geological Survey Of India. Later some western parts of Gandhinagar were included in the U.N.D.P project study of CGWB in 1971-74. In 1973 a short-term water supply investigation by Sh. S.K. Doshi, covered some area on eastern part of the district. Sh. J.N. Bhagat, Dr. A.K. Jain, B.Mahapatra and A.B. Kawde of CGWB, WCR carried out Reappraisal Hydrogeological Survey in the some of talukas falling in other districts in past but now covering in Gandhinagar district, during 1996-97 and 2004-2005 in parts of Ahmedabad district during 1989-90 respectively. Exploration drilling was first taken up during UNDP project during 1971-74 and thereafter under various programme of CGWB.

Three District reports of the erstwhile Gandhinagar district have so far been compiled first by shri P.S Mishra in 1981 and Second by Shri ArunKumar, P K Parchure in March 2000 and third by Shri P.K Jain In the October 2005.

2. GEOLOGY AND HYDROGEOLOGY

Geology

Geologically the area is part of Cambay basin and is part of North Gujarat alluvial Plain. The Cambay basin was formed as a tectonic graben at the end of Mesozoic era, through development of tensional faults accompanied by large scale volcanic activity (Raju, 1969). The main fault system trends **NNW-SSE**, approximately parallel to the Aravali hills. The basin was subsequently filled with tertiary and quaternary sediments. It is assumed that the subsidence ceased in the late Miocene times.

The whole of the district is underlain by quaternary & Tertiary sediments deposited in the Cambay basin. These sediments rest on the Deccan Traps in most parts of the district.

The area is occupied by the Quaternary Alluvium comprising silt, sand, clay, gravel and kankar. The quaternary alluvium is underlain by the Tertiary sediments followed by Deccan trap and Himatnagar Sandstone.

Generalized geological succession for the north Gujarat area, as established by Oil and Natural Gas Corporation (ONGC) is given below.

Table no-8 Generalized geological succession for the north Gujarat area

Period	Age	Lithology	Thickness
Quaternary	Holocene	Alluvium	Max. 700 m
	Pleistocene		About 400m near Gandhinagar
Tertiary	Miocene	Sandstone and Shale	Max. 900m
	Oligocene	Sandstone, Shale and Limestone	Max. 160m
	Eocene	Shale, Siltstone with minor sandstone and limestone intercalation's	About 100m
Mesozoic	Cretaceous	Deccan Trap	
		Himatnagar Sandstone	

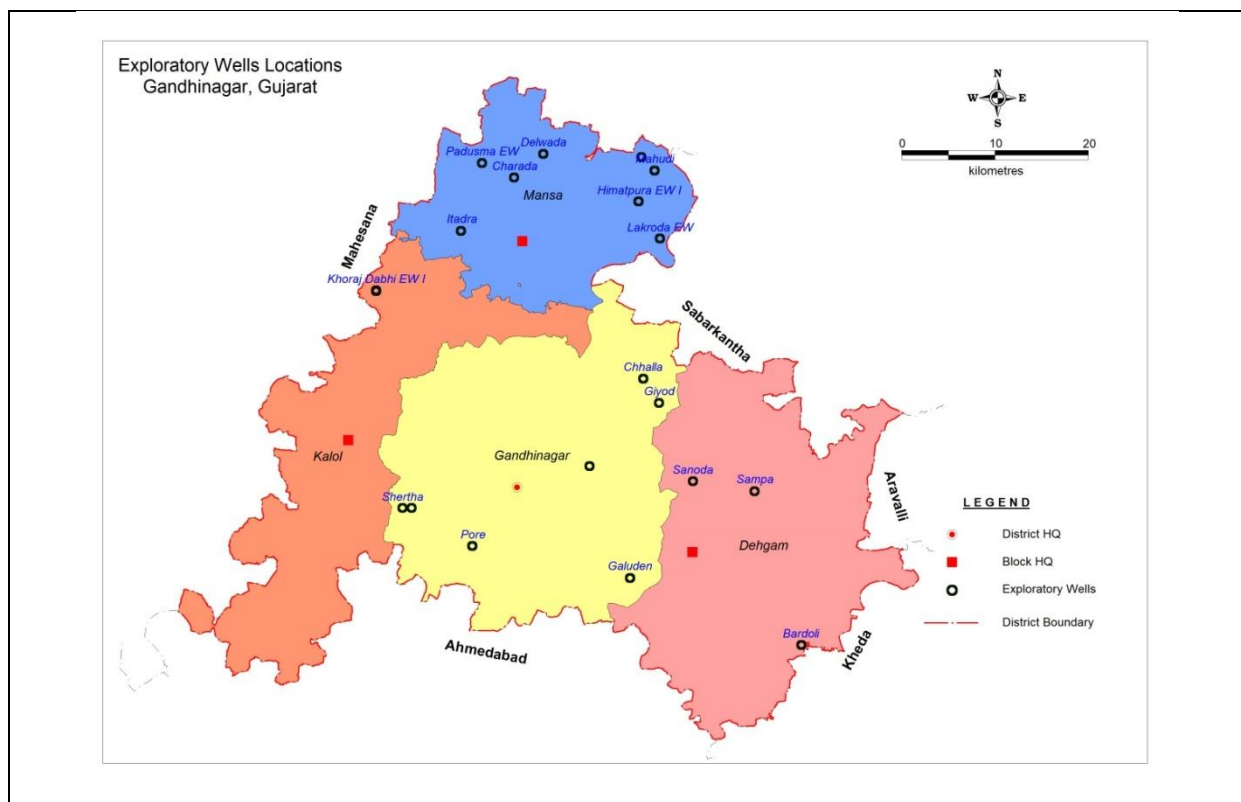
Exploratory Drilling

During UNDP project (1971-74) two boreholes were drilled at Sardhav in the north-western part of district. These were converted into piezometers. Subsequently, three piezometers tapping different aquifers zones were constructed in the Sachivalay complex by CGWB during 1985-86 under its piezometer construction programme. Two deposit wells down to the 200 m depth, were also constructed at Palej Agriculture Farm during 1981. Under Hydrology project five piezometers one each at Nardipur and Mansa and three at Kalol were constructed. One artificial recharge cum piezometer was constructed at IFFCO Kalol. Besides these a number of Exploratory and observations wells are constructed in the district. Hydrogeological details of these wells are given in table no =9

Table no =9 Exploratory Drilling Details

Salient Features	EW	OW	Pz	Slim Hole	Total
Total Nos.	31	08	33	1	73
Drill Depth range (mbgl)	34-614				
Depth Constructed range (mbgl)	20-534				
Static Water Level (mbgl)	5.13-164				
Discharge (LPS)	6-20				
Transmissivity (m² / day)	350-1100				

Figure No:-6 Exploratory well Locations



Subsurface Geology

ONGC has established that the thickness of alluvium in the North Gujarat is about 700 m. However, as per the studies carried out by CGWB under UNDP Project the Miocene formations were encountered within 611 m at the deepest borehole drilled in the district at Sardhao. Later exploration in the district has revealed that the thickness of quaternary alluvium increases from east to west. The thickness of the quaternary alluvium is less than 50 m in the eastern part whereas; it is more than 400 m in the western part. Sub-surface geological sections prepared based on data of these bore holes drilled by CGWB.

The study of these logs reveals that there is a sequence of alternating layers of granular sandy and clayey horizons within a depth of 400m. The uppermost granular zone varies in thickness from 5 to 90 m. The quaternary alluvium is underlain by a thick clay bed followed by alternating sequence of arenaceous and argillaceous horizons of Miocene age. In eastern part the Miocene is underlain by Basalts. The Basalts are underlain by Himmatnagar sandstone of Mesozoic age, however at a few places Mesozoic's are directly overlain by Miocene where Alluvium thickness is less and the basement is encountered at a depth of 70 to 100 meters below ground level restricting the total depth of the tube wells up to this depth.

The oldest sedimentary formations encountered in the boreholes belongs to Himmatnagar sandstone of cretaceous age. Himmatnagar sandstone overlies the Pre Cambrian basement. The Himmatnagar sandstone is a medium to fine grained poorly cemented sandstone with shale and conglomerate beds. At Pilwai in Vijapur taluka, Mahesana district, Himmatnagar sandstone was encountered below thick basaltic horizons that occur in the depth range of 294 to 537 mbgl.

Miocene sediments are encountered in the district ranging in depth from less than 50 m in eastern part to more than 400 m in the western part of the district. Sub-surface geological sections showing Bluish grey or grey clay is considered marker bed defining top of Miocene sediments. These Miocene beds grade upward into post Miocene and Quaternary deposits without distinct Lithological break.

Post Miocene alluvium has the thickness of more than 400 m in the western part of the district. It mainly consists of sands, Gravels intercalated with clay. The nature of sediments is more uniform towards east. Towards west the argillaceous intercalations are seen. Sands are fine to very coarse grained with occasional gravel and boulder beds. Clays are brownish buff or yellowish in colour and moderately sticky.

Hydrogeology

Aquifer System

Geological survey of India during its studies had identified three confined aquifers within a depth of 600 m in the adjoining Mahesana district. These were designated as "A", "B" and "C" aquifers. Subsequently, the studies carried out by CGWB under UNDP project, which also covered the northern part of Gandhinagar district, a multiple aquifer system was established. A brief discussion of these aquifers is given in table no-10

Table No:-10 Regional aquifer system established as per CGWB / UNDP Work.

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

A total of 7 aquifers zones were identified as "A", "B", "C", "D", "E", "F" and "G" separated from each other by a number of aquitards/aquicludes of varying thickness. Similar sequence of aquifers has also been observed at the deep exploratory well, drilled under the UNDP project, at Sardhav village in NW part of the district.

As observed from the Hydrogeological sections the thickness of quaternary alluvium is limited in the eastern part and all the aquifers are not developed in this part. Moreover the identification of different aquifers becomes very difficult in the eastern part due to limited thickness of aquiclude. However; the aquifer system is well developed in the western part.

The aquifer system in the area down to explored depth of 611m in which 352m of post Miocene sediments are forming aquifers A, B, C, D and E. The post Miocene sediments are underlain by Miocene sediments of 259m includes aquifers F and G. It is logically inferred that the aquifers in the entire district are the southward and eastward extension of those identified in the UNDP Project area.

The aquifer “A” in the district occurs as phreatic or unconfined aquifer. The thickness varies from less than 25 m in the east to more than 80 m in the western part. Most of the dug wells and shallow tube wells tap this aquifer. However, over the years it has gone dry and at present occurs as saturated zone only in the vicinity of Sabarmati River and in the eastern parts of Dahegam & Gandhinagar talukas. The aquifer “B” and “C” called Confined I and Confined II, which occurs within a depth of 240 m, is the most exploited aquifer in the district and most of the tube wells constructed tap this aquifer. However aquifer “D” called as Confined III is also developed in some parts of the district particularly in Mansa and Kalol Talukas. The deeper aquifers, i.e., “E”, “F” and “G” are required to be properly explored in future.

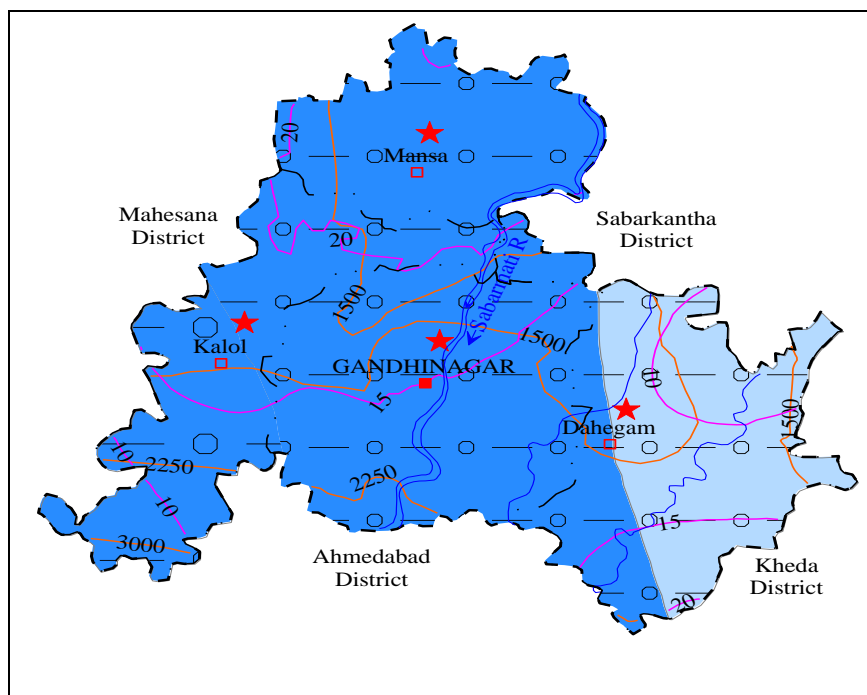
User Aquifer:






The most prolific and most exploited aquifers in the district range from about 50m to more than 300m. The depth of tube wells gradually increases from east to west. The Dug-Cum-Bore wells and shallow tube wells (<100 m) are feasible in the eastern part. However In the western part only deep tube wells are feasible.

As the production tube wells are tapping multiple aquifers in the district for production as well as irrigation purposes, to understand the behavior of the ground water regime it needs to be treated as a single aquifer system. Therefore all the potential zones being developed in an area are grouped together and are termed as “user aquifer”. The user aquifer may be defined as the aquifer or a group of aquifers being developed at a particular place. Its combination may vary from place to place.

The Gujarat Water Supply & Sewerage Board (GWS&SB), Govt. of Gujarat is constructing production wells for water supply in the district. The feasible depth of tube wells ranges from less than 100m in the east to more than 300m in parts of Mansa Taluka. The feasible depth of the ground water abstraction structures in the district is depicted in the Fig 7.below.

(Fig No: - 7 Feasible G W abstraction structures and Artificial recharge structures in Gandhinagar district.)



	Wells Feasible	Rigs Suitable	Depth of Well (m)	Discharge (lpm)	Artificial Recharge Structure Suitable
 Soft Rock Aquifer	Dug Well	Manual	10-25	200-300	Percolation Tanks/ Ponds, Recharge Wells,
	Tubewell	Direct Rotary, Reverse Rotary	50-100	600-800	
 Soft Rock Aquifer	Tubewell	Direct Rotary Reverse Rotary	100-300	600-1200	Percolation Tanks/ Ponds, Recharge Wells, Recharge Shaft
	Over Exploited Taluka				
	Drainage			District/Taluka HQ	

Behaviour of Ground Water Regime

The phreatic aquifer in major part of the district is dry. It forms aquifer only in north eastern part i.e. eastern part of Dahegam and Gandhinagar talukas and in the vicinity of the Sabarmati River. Central Ground Water Board monitors the behaviour of ground water regime through its network of NHS and Piezometers. Besides these, state ground water board i.e. Gujarat Water resources and Development Corporation (GWRDC) has a number of observation wells, Piezometers and tube wells for monitoring of ground water regime.

Based on Hydrogeological sections and water level data generated by CGWB and GWRDC the thickness of Unconfined Aquifer varies from less than 25 m in the east to more than 80 m in the western part. Most of the dug wells and shallow tube wells tap this aquifer. The aquifer **“B” and “C” called Confined I and Confined II**, which occurs within a depth of 240 m, is the most exploited aquifer in the district and most of the tube wells constructed to tap this aquifer. However aquifer **“D” called as Confined III** is also developed in some parts of the district particularly in Mansa and Kalol Talukas. The following maps have been generated to understand the behaviour of ground water regime.

1. Phreatic or Unconfined Aquifer
 - Depth to Water Level Post monsoon November 2017.
 - Depth to Water Level Pre monsoon May 2017.
2. Phreatic Depth to water Table map Nov-2017.
3. Confined Aquifer (Confined I & II)
 - Decadal Average Depth to water level map Confined Aquifer I (2009-2018).
 - Decadal Average Depth to water level map Confined Aquifer II (2009-2018).

Unconfined Depth to water level May-2017.

The ground water level of phreatic aquifer during the Pre monsoon period (May 2017) the shallowest water level 9.45 mbgl recorded at (Dahegam, Ta-Dahegam) and deepest water level 72.20mbgl recorded at (Mubarak Pura, Ta-Kalol).The Eastern and western part of the district i.e. Kalol and Dahegam talukas water level ranges 10 to 50 mbgl.The central part of Gandhinagar taluka, NW part of Kalol taluka and Northern part of Mansa taluka water level ranges 50 to 70 mbgl.

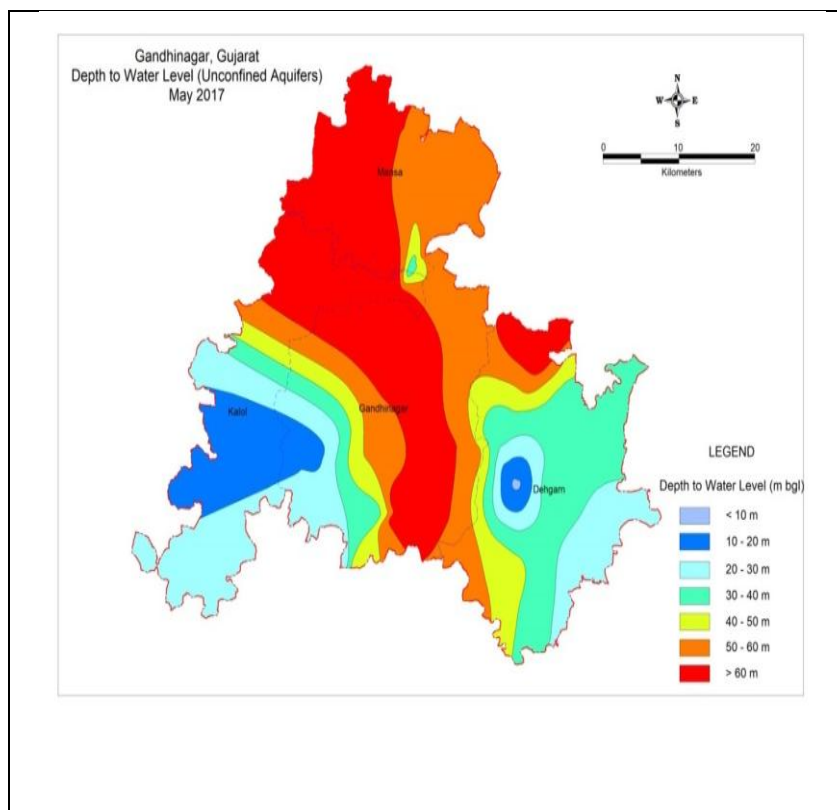


Fig No :- 9 Depth to Water Level map pre monsoon May-2017

Unconfined Depth to water level Nov-2017.

The ground water level of phreatic aquifer during the post monsoon period (November 2017) the shallowest water level 3.03mbgl recorded at (Dahegam, Ta-Dahegam) and deepest water level 71.20mbgl recorded at (Mubarak Pura, Ta-Kalol).The Eastern and western part of the district i.e.Kalol and Dahegam talukas water level ranges 10 to 50 mbgl.The central part of Gandhinagar taluka, NW part of Kalol taluka and Northern part of Mansa taluka water level ranges 50 to 70 mbgl.

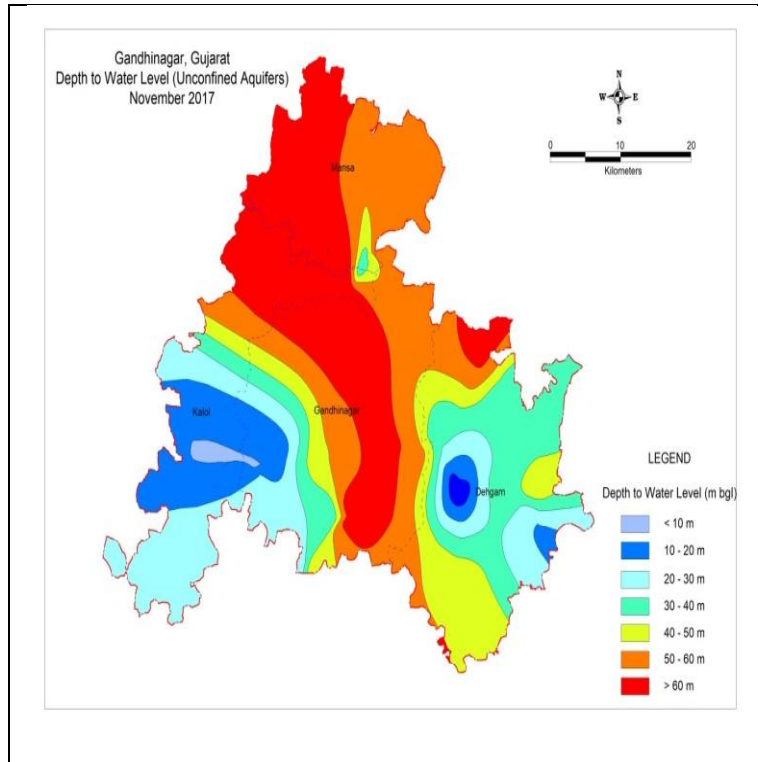


Fig No: - 8 Depth to Water Level map post monsoon Nov-2017

Unconfined Depth to water Table Nov-2017.

The map showing depth to water table above mean sea level of Nov-2017 is given as figure no 10. The map reveals that the depth to water table with reference to mean sea level decreases from east to west i.e in general ground water is flowing from East to West direction.

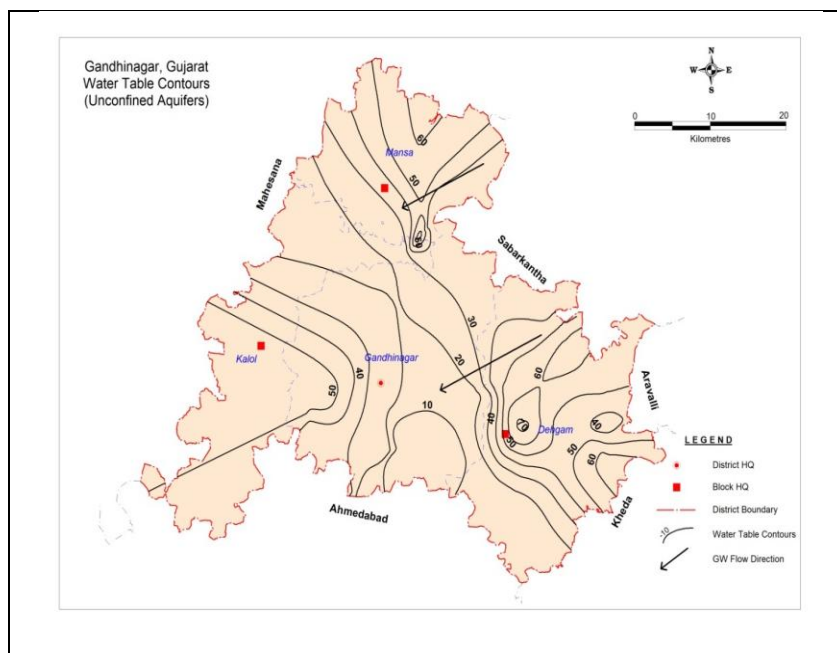


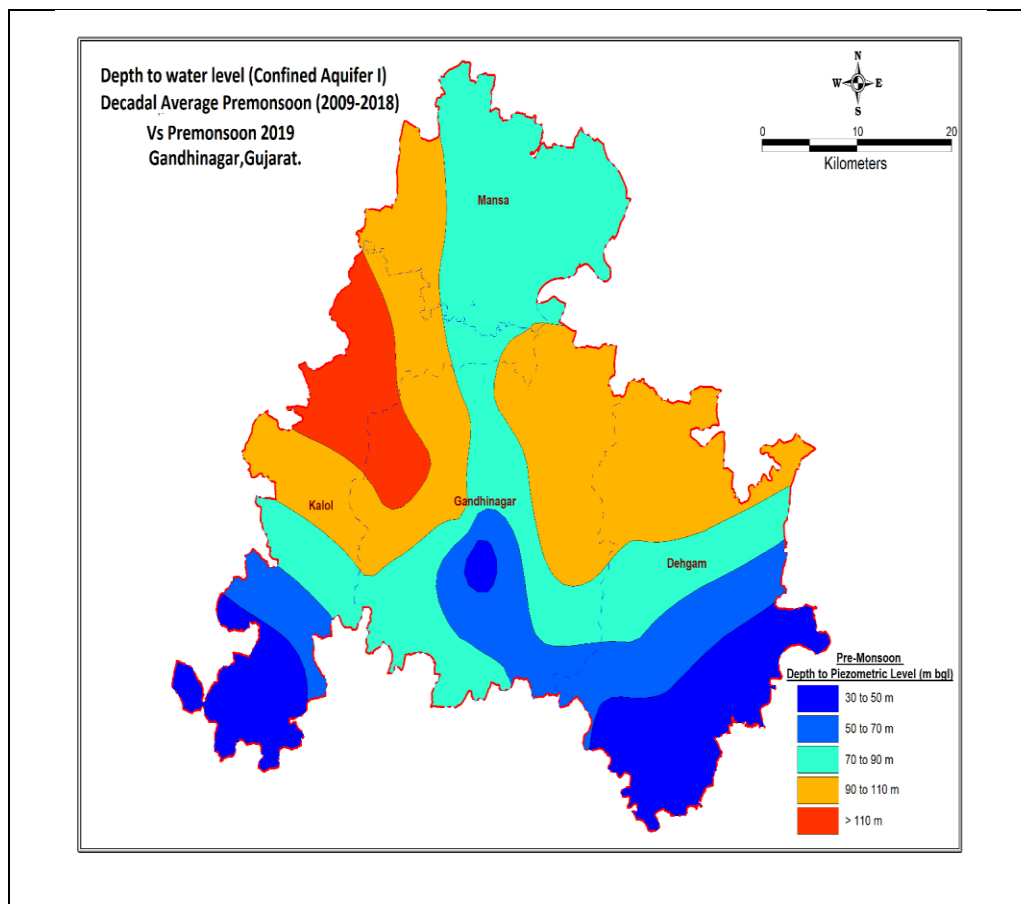
Figure no: - 10 Unconfined Depth to water Table Nov-2017.

The first and second confined aquifers are combined together and tapped by users and are being developed in major part of the district and as a result it is at present is most exploited aquifers. It has been reported that the water levels are declining at an alarming rate in the district and farmers are being forced to increase pump setting by about 3 m (10 ') every year. On the basis of the pumping test conducted by CGWB on deeper aquifers, it is estimated that about 20 m of submergence is sufficient for a pumping rate of about 10 lps. Therefore, it is essential to know the pumping heads and changes if any in space and time. The depths to piezometer surface pertaining to pre monsoon have been prepared for Confined Aquifers (first and second).

Decadal Average Depth to water level map Confined Aquifer I.

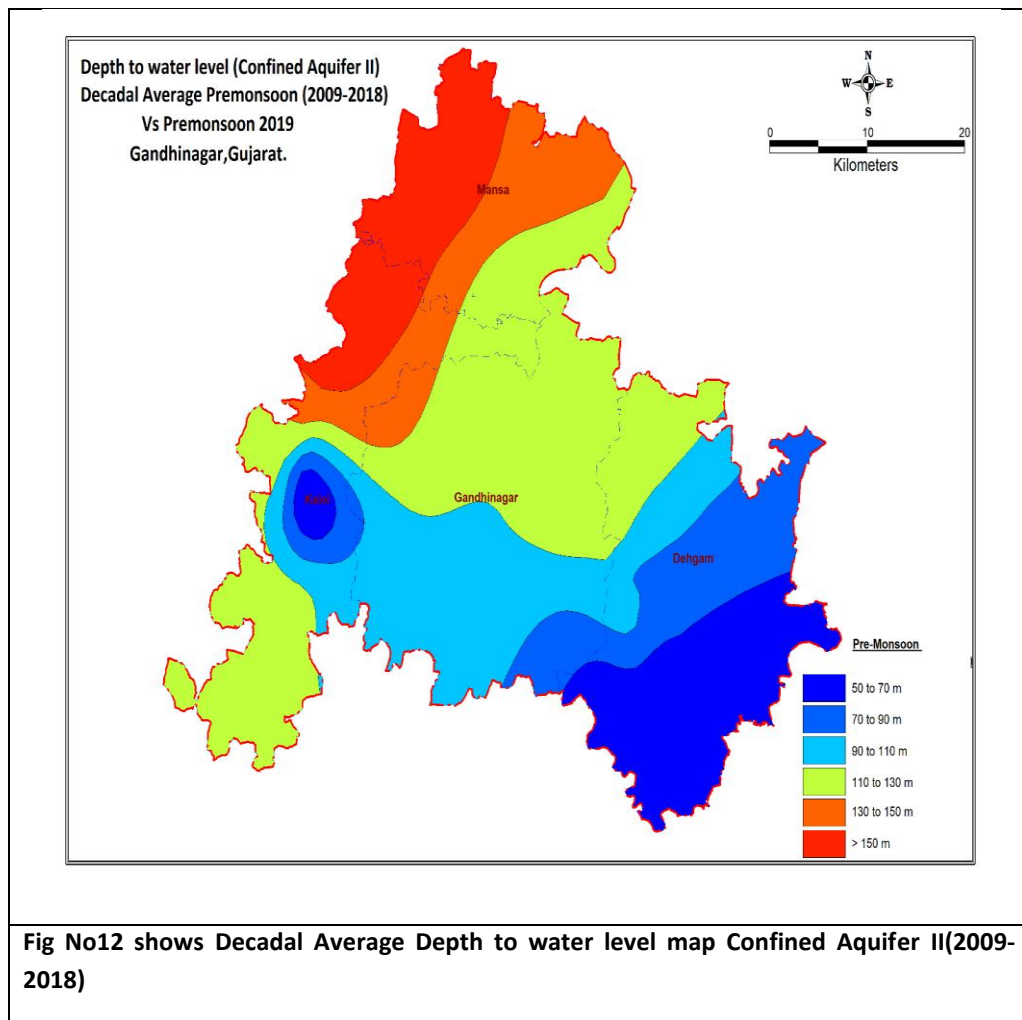
The decadal average depth to water level map of Confined aquifer I during the pre monsoon period (2009-2018) the shallowest water level 48.69 mbgl recorded at (Indroda, Ta-Gandhinagar) and deepest water level 118.43 mbgl recorded at (Dinguicha-I, Ta-Kalol).Major part of the district water level ranges 48.69 to 118.43 mbgl. The Eastern part of Gandhinagar & Dahegam and southern part of Kalol taluka water level ranges 30 to 70 mbgl. Western part of Kalol and Northern part of Mansa taluka water level ranges 70 to 110 mbgl. North western part of Kalol taluka water level is more than 110 mbgl. **Fig No-11 shows Decadal Average Depth to water level map Confined Aquifer I(2009-2018)**

Fig No:-11 Decadal Average Depth to water level map Confined Aquifer I (2009-2018)



Decadal Average Depth to water level map Confined Aquifer II.

The decadal average depth to water level map of Confined aquifer I during the pre monsoon period (2009-2018) the shallowest water level 58.05 mbgl recorded at (Kalol, Ta-Kalol) and deepest water level 194.60mbgl recorded at (CharadaPz-I, Ta-Mansa).Major part of the district water level ranges 58.05 to 194.60 mbgl. The Eastern part of Gandhinagar & Northern part of Dahegam and southern part of Kalol taluka water level ranges 50 to 130 mbgl.North western part of Kalol and Northwester part of Mansa taluka water level ranges 130 to 150 mbgl.North extreme part of Mansa taluka water level is more than 150 mbgl. **Fig No12 shows Decadal Average Depth to water level map Confined Aquifer II (2009-2018).**



3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

In order to establish the three dimensional disposition of aquifer system in the area, the existing data of litho logical logs and Electrical logs of Exploratory wells studies carried out by CGWB and state Ground water Departments(GWRDC & GWSSB) were used to prepare a hydro geological cross sections, Fence diagram and 3D Model. The data has been analysed using Rockworks 16 software and is presented below in the Hydrogeological cross sections A-A' to H-H' and Solid Model of the district showing the depiction of Aquifer Groups and Aquitard up to 300m. Map showing section lines are presented in Fig. 13. The stratigraphic sections depicting unconfined aquifer, Aquifer group I, II and III are placed at Figs 14 (A to H). Fence Diagram and 3D Solid Model of Gandhinagar district is depicted in Fig. 15 and 16, respectively.

A total of 73 exploratory wells and piezometers constructed by CGWB. And 23 litho logs and Electrical logs are utilised to decipher the subsurface geometry of the aquifer by using Rockworks 16 software hydro geological cross sections, Fence diagram and 3D Model up to the depth of 300 mbgl.

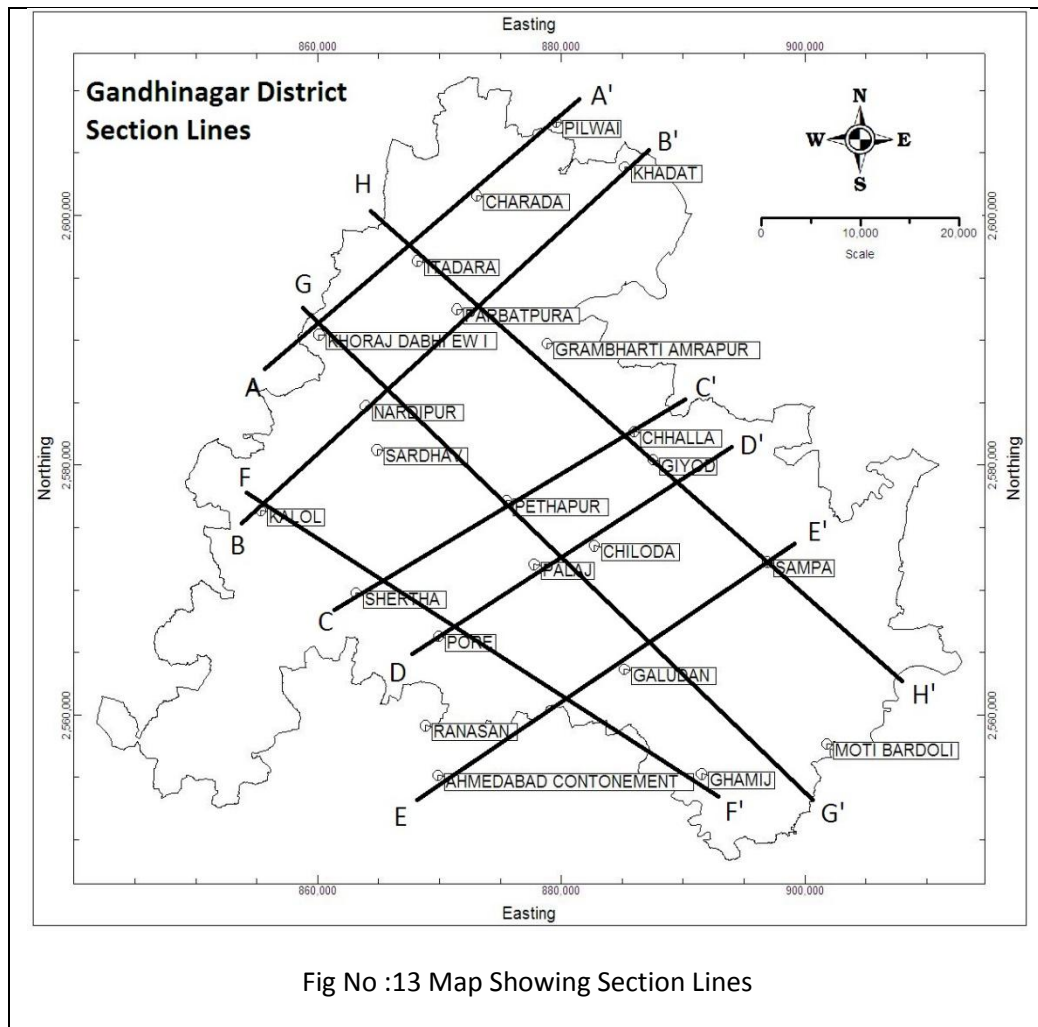
Table No: - 11 Data integration

Type of Data & source	No Of Wells
Aquifer Disposition	
CGWB	73
Long term Fluctuation	
CGWB+GWRDC	38+43=81
Decadal Analysis water Level	
CGWB+GWRDC	38+43=81
Analysis of water Quality	
CGWB+GWRDC	3+45

Conceptualization of Aquifer system in 2D

Eight hydrogeological cross sections are drawn from North-East to South-West and North-West to South-East directions across the area represented in Figs 14 (A to H)

Litho logical logs and Electrical logs of subsurface are correlated based on the position and depth of the geological formations and prepared eight cross sections one fence diagram and one 3D solid model of Gandhinagar district.



1. Section A-A' drawn North-East to South-West direction to a distance about 33 km from Khoraj Dhabhi to Pilvai and passing from location Parbatpura. By using this section we can identify and demarcate the Aquifers and Aquitards from top to bottom. The unconfined Aquifer at top and Confined I, II & III Aquifers are in the bottom in between clay layers are separate the Multi layered Aquifer system.
2. Section B-B' North-East to South-West direction to a distance about 45 km from Kalol to Khadat and passing from location Sarthav, Nardipur, Parbatpur.
3. Section C-C' North-East to South-West direction to a distance about 28 km from Shertha to Giyod and passing from location Pethapur.
4. Section D-D' North-East to South-West direction to a distance about 25 km from Pore to Giyod and passing from location Palaj and Chiloda.
5. Section E-E' North-East to South-West direction to a distance about 31 km from Ahmedabad Cantonment to Sampa and passing from Galudan
6. Section F-F' North-West to South-East direction to a distance about 41 km from Kalol to Ghamij and passing from location Shertha and Pore.
7. Section G-G' North-West to South-East direction to a distance about 50 km from K Dhabhi to Ghamij and passing from location Nardipur, Sardhav, Pethapur, palaj and Galudan.
8. Section H-H' North-West to South-East direction to a distance about 55 km from Itadara to Moti Bardoli and passing from location Grambarati Amrapur, Giyod and Sampa.

Fig no : 14 –A Hydrogeological cross Section between Khoraj Dabhi to Pilwai (A-A')

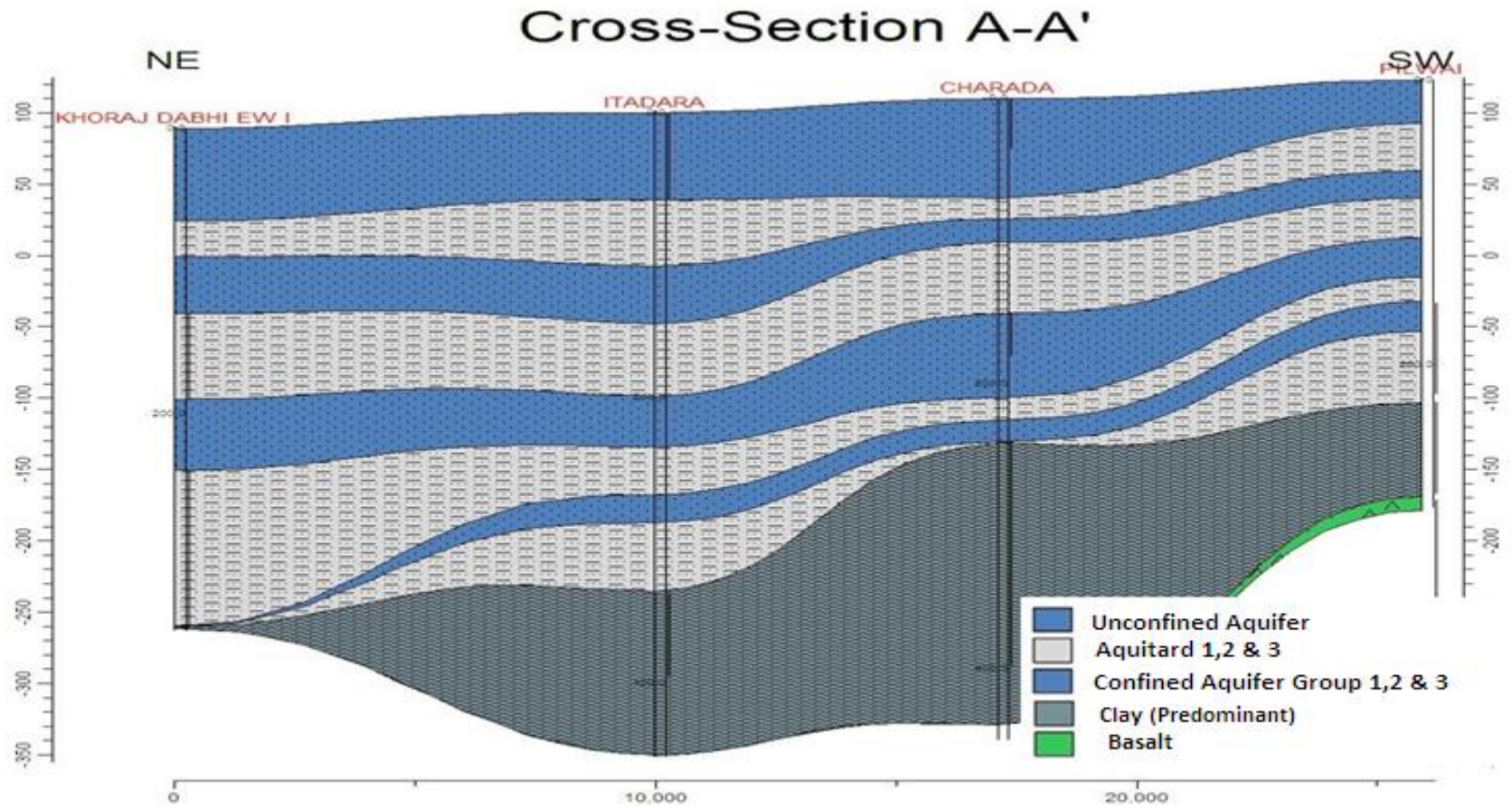


Fig no : 14 –B Hydrogeological cross Section between Kalol to Khadat (B-B')

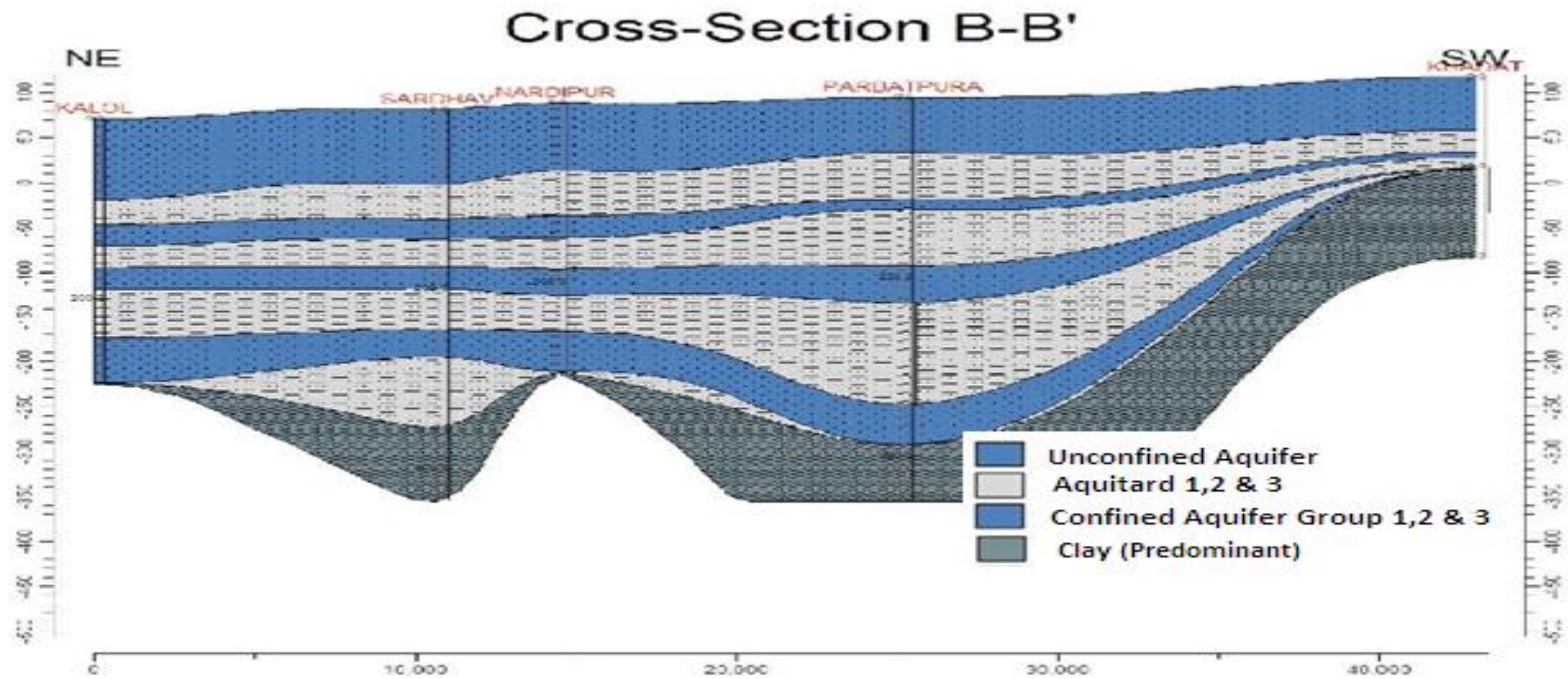


Fig no : 14 –C Hydrogeological cross Section between Shertha to Giyod (C-C')

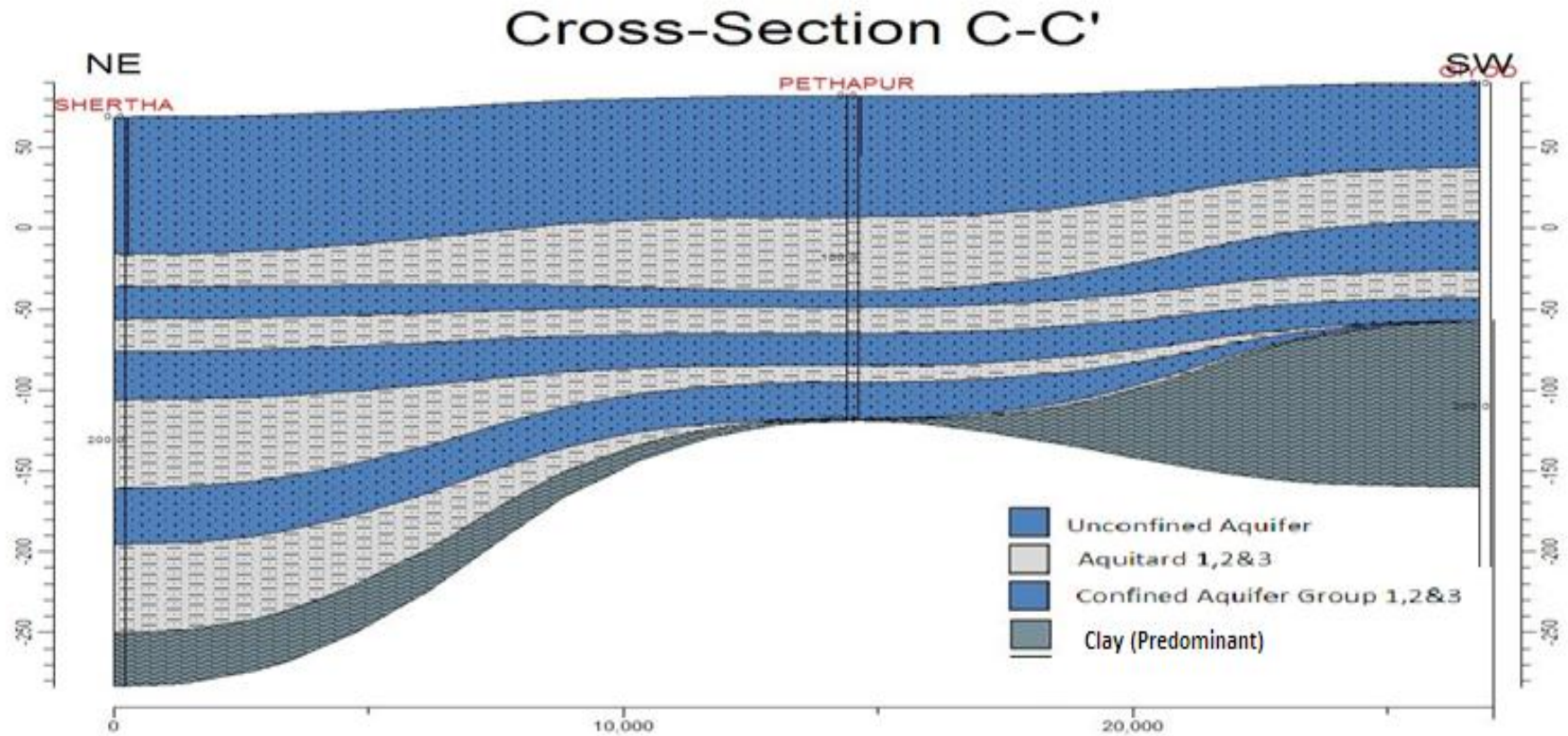


Fig no : 14 –D Hydrogeological cross Section between Pore to Giyod (D-D')

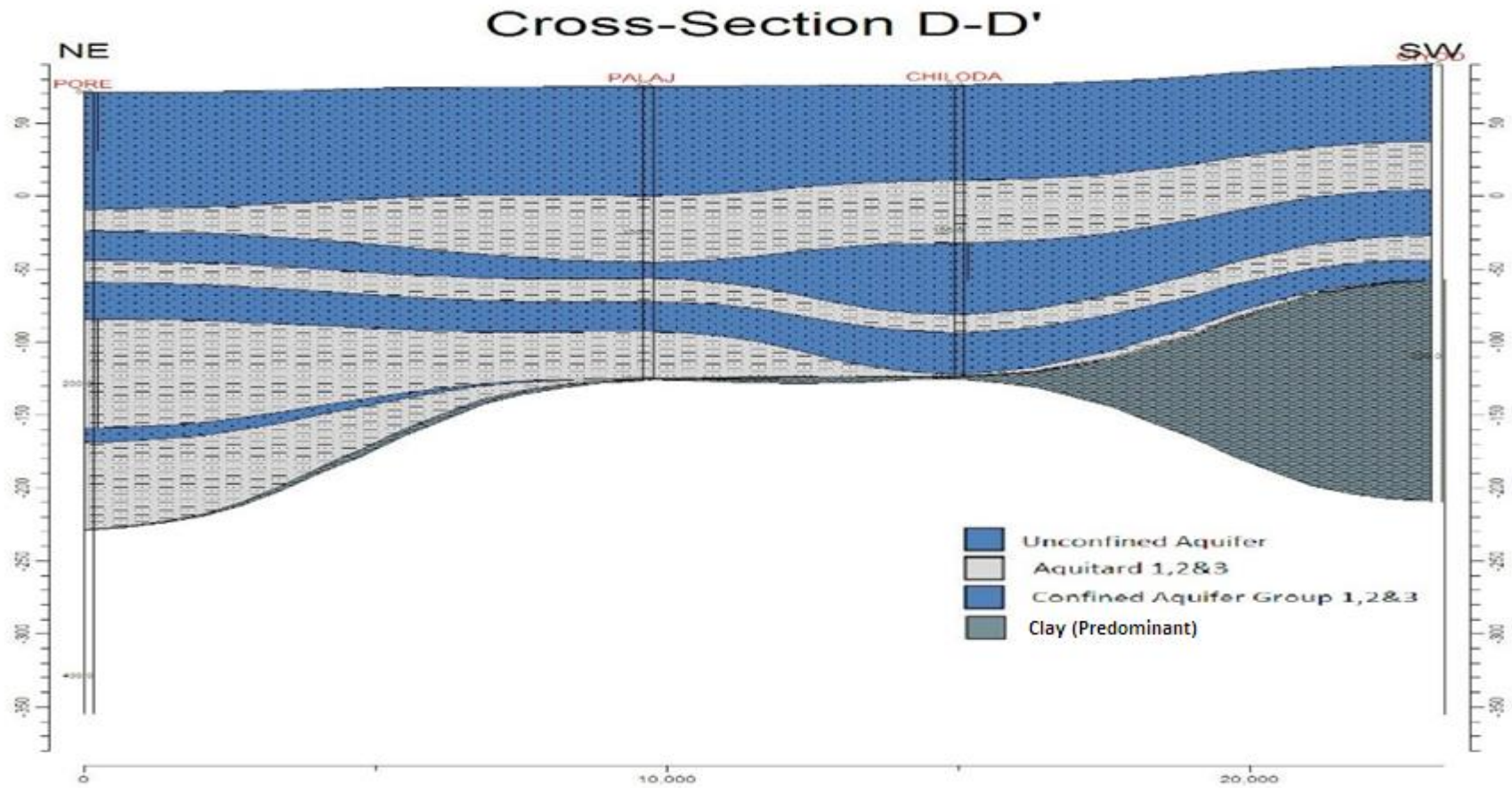


Fig no : 14 –E Hydrogeological cross Section between Ahmedabad to Sampa (E-E')

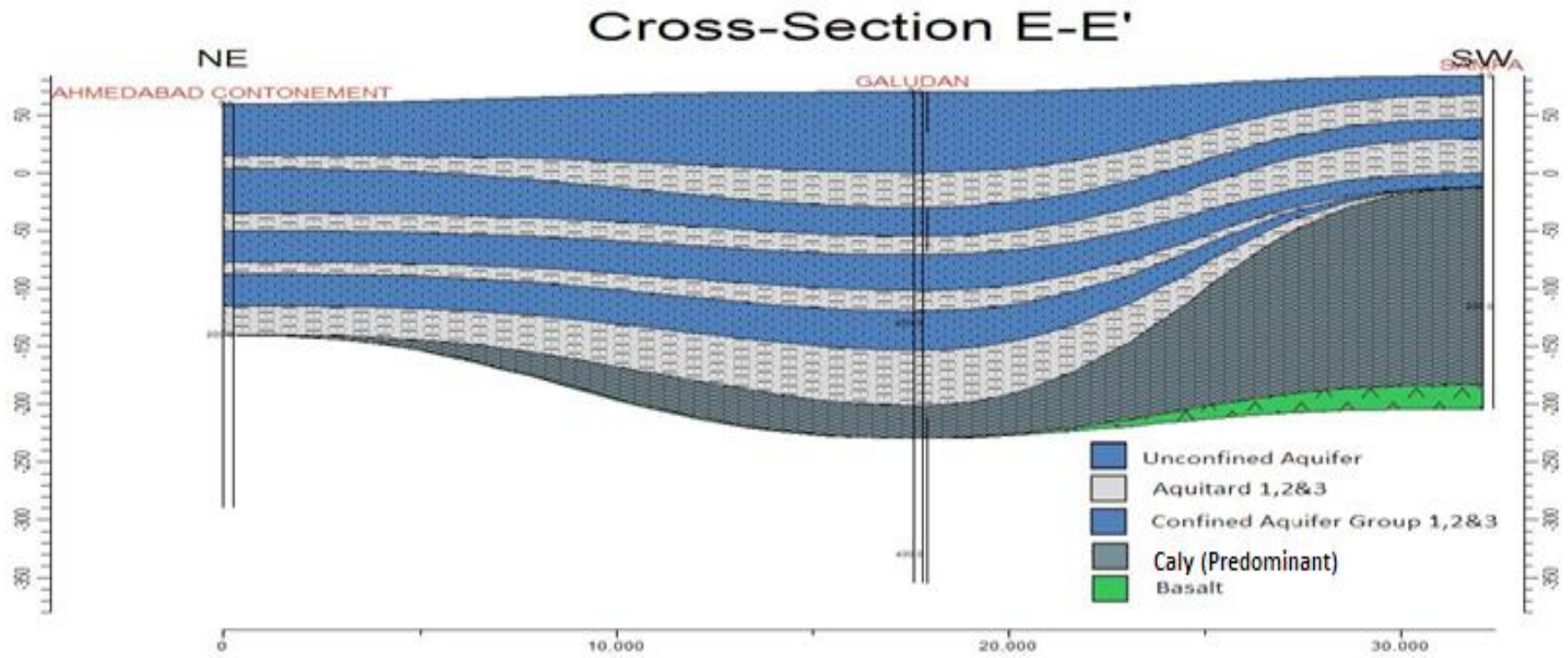


Fig no : 14 –F Hydrogeological cross Section between Kalol to Gamij (F-F')

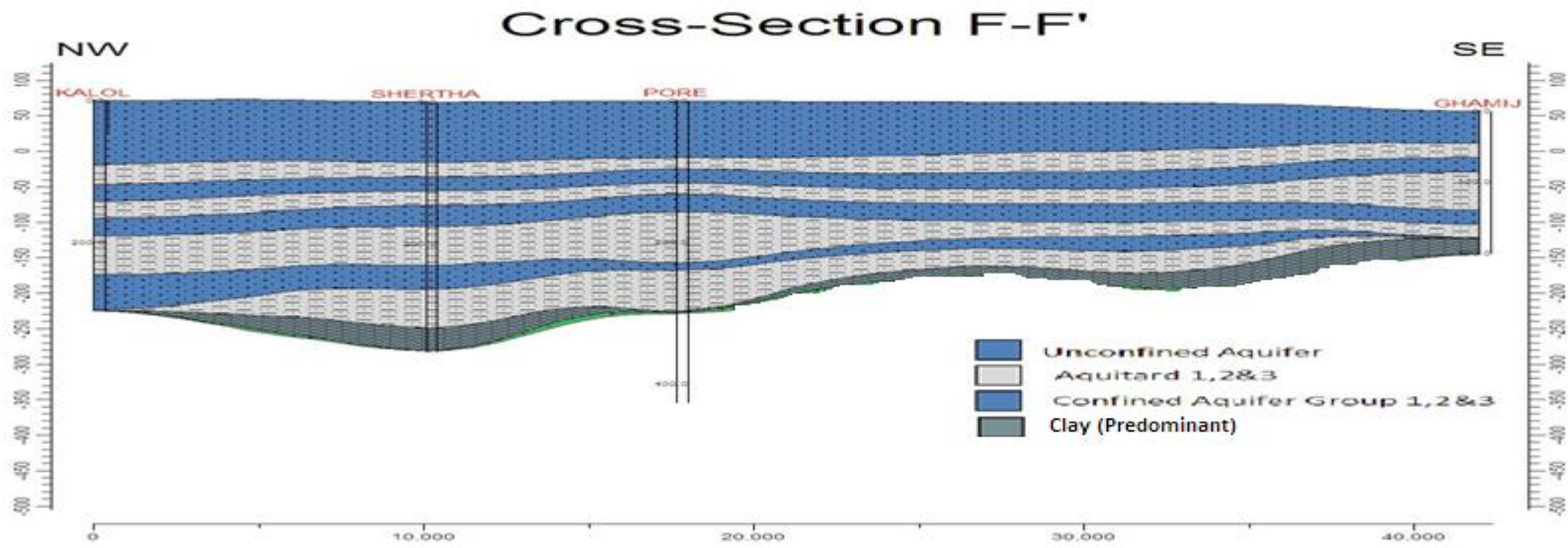


Fig no : 14 –G Hydrogeological Cross section G-G' from K Dhabhi to Ghamij

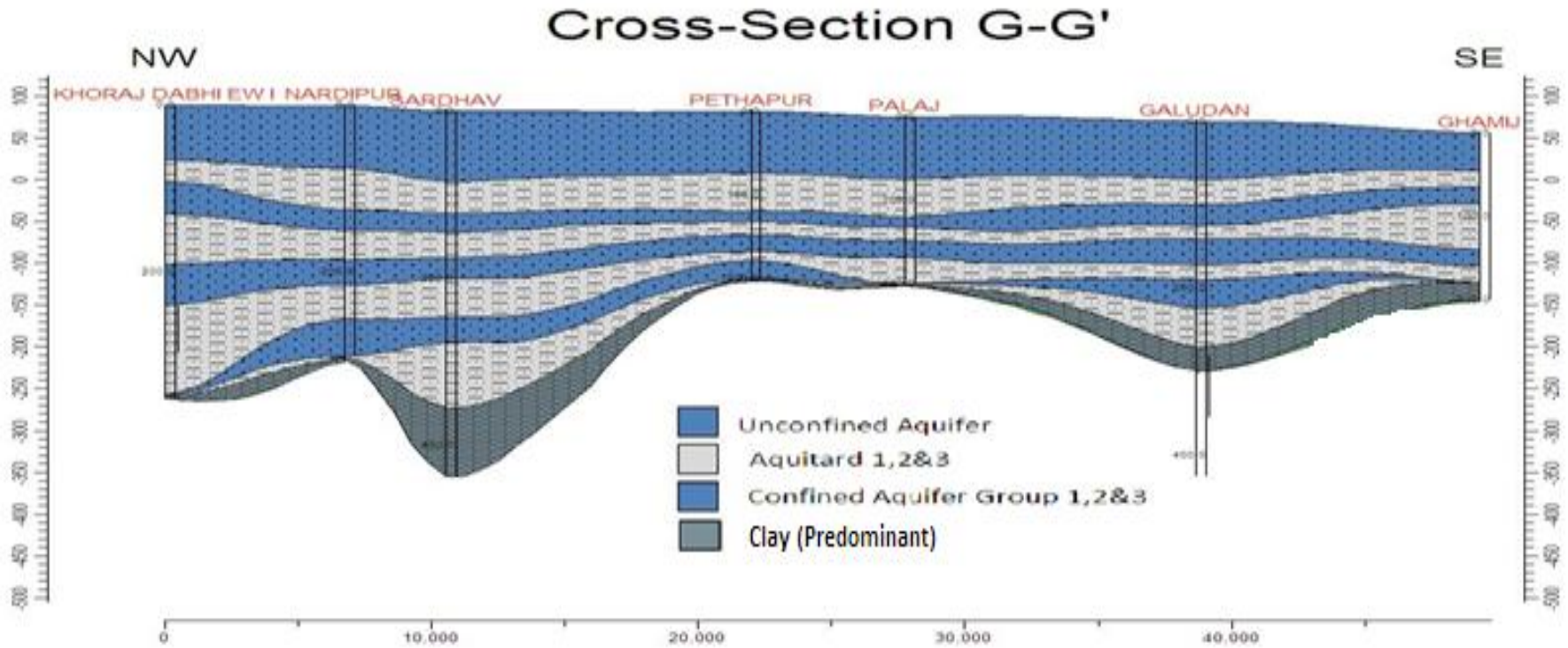


Fig no : 14 –H Hydrogeological Cross section H-H' from Itadara to M Bardoli

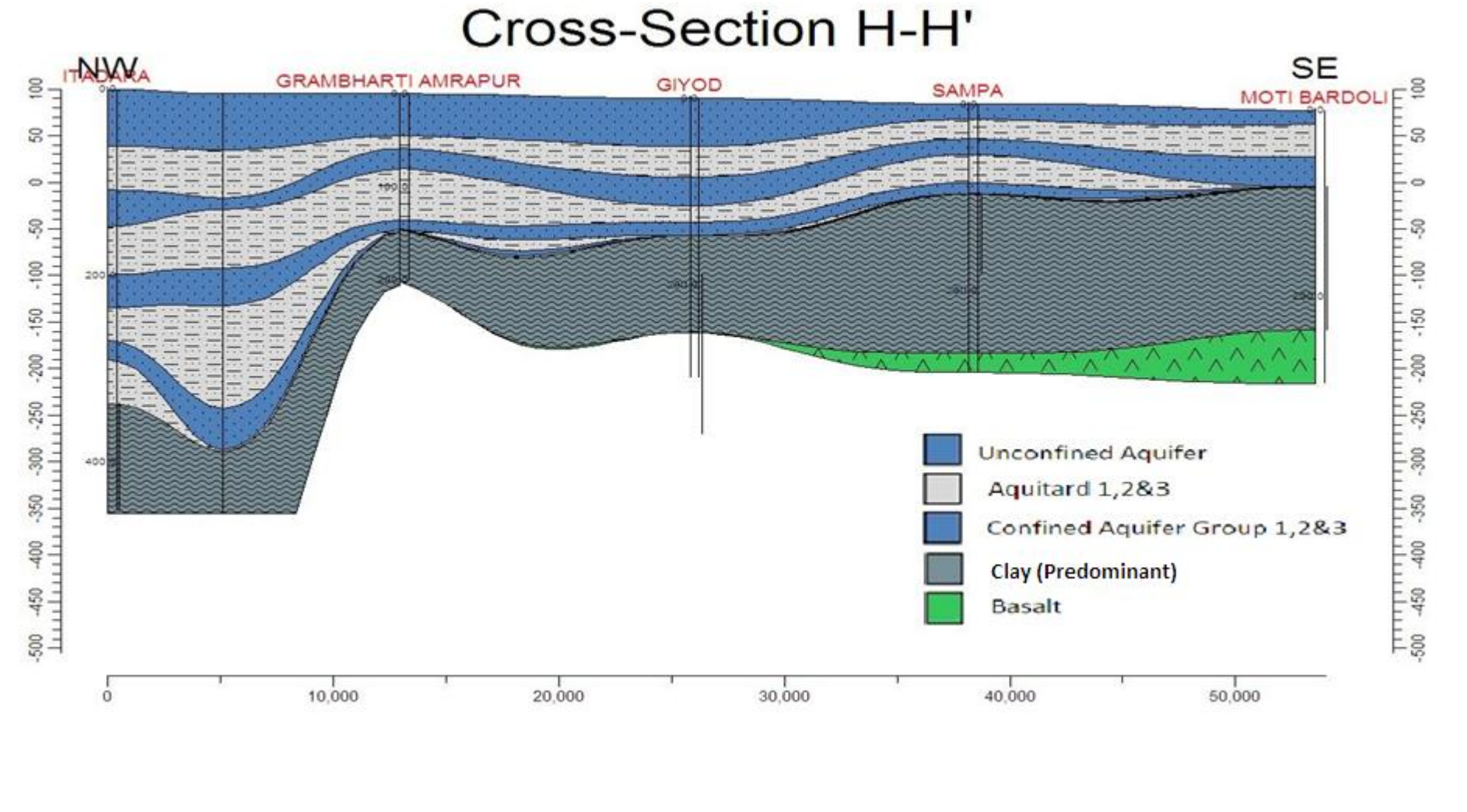


Fig no : 15 Fence Diagram of Gandhinagar District

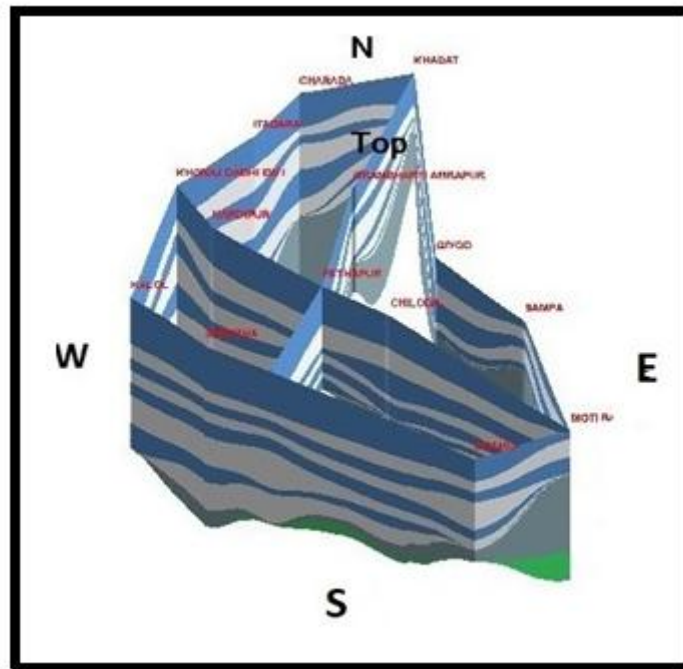
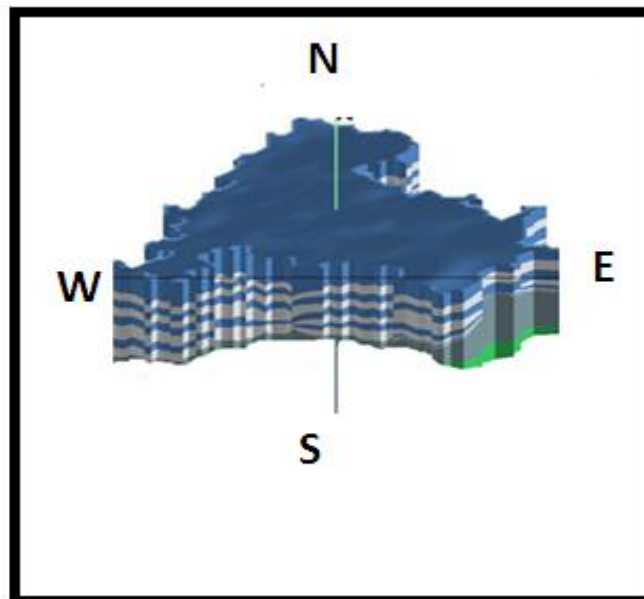


Fig no : 16 3 D Solid Model of Gandhinagar District



The study of these 2D sections, Fence and 3D solid model reveals that there is a sequence of alternating layers of granular sandy and clayey horizons within a depth of 300 m. The uppermost granular zone varies in thickness from less than 25 m in East to more than 80 m to the West. The quaternary alluvium is underlined by a thick clay bed followed by alternating sequence of arenaceous and argillaceous horizons of Miocene age. In the eastern part of the Miocene is underlined by Basalts.

Miocene sediments are encountered in the district ranging in depth from less than 50 m in eastern part to more than 300 m in the western part of the district. They consist of medium grained sand, Clay, Sandstone, siltstone interbedded with clay and claystone. Bluish grey or grey clay is considered marker bed defining top of Miocene sediments. These Miocene beds grade upward into post Miocene and Quaternary deposits without distinct Lithological break.

Post Miocene alluvium has thickness of more than 300 m in the western part of the district. It mainly consists of sands, gravels intercalated with clay. The nature of sediments is more uniform towards east. Towards west the argillaceous intercalations are seen. Sands are fine to very coarse grained with occasional gravel and boundary beds. Clays are brownish buff or yellowish in colour and moderately sticky.

Finally the study of these sections reveals that the identification and delineating the Aquifers vertically and laterally. The Aquifers are regionally developed in entire district of Gandhinagar. The upper Unconfined and lower Confined I, II & III with alternating clay beds are deciphered within the depth of 300 mbgl.

The unconfined aquifer occurs within the depth range of 35 to 90m bgl. Confined aquifers I, II and III occur within the depth range of 55 to 150 m bgl, 90-210 m bgl and 245-300 m bgl respectively. The thickness of the unconfined aquifer ranges from 15 to 90 m. Confined aquifer I ranges in thickness from 10 to 30 m whereas the thickness of the confined aquifer II and III ranges within 10 to 50m and 15 to 50m respectively. In phreatic Aquifer TDS ranges in between 500 to 1000 mg/l whereas in Confined Aquifer TDS ranges in between 500 to 2000 mg/l.

Aquifer Characterization and Disposition.

On the basis of Hydrogeological cross sections the following salient features of aquifer system in the area is summarised below Table No :-12

Table No:-12

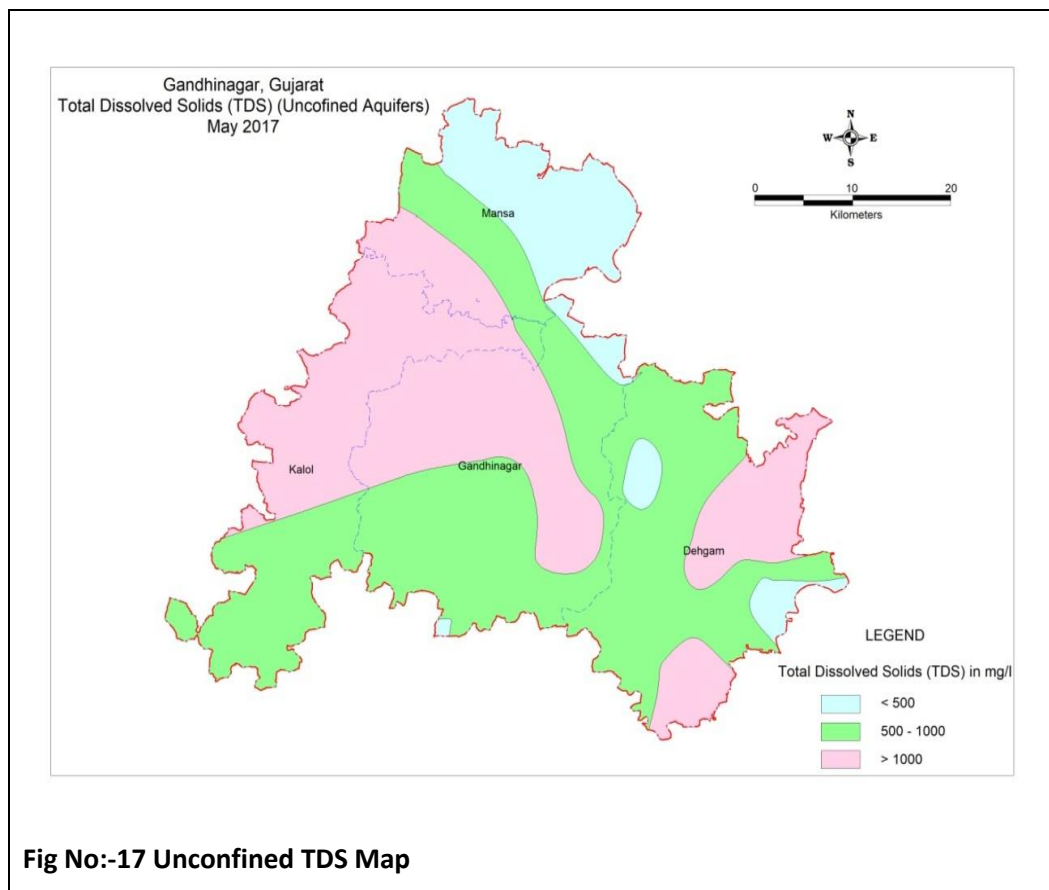
Aquifer Characterisation and Disposition										
	Aquifer Nomenclature	Lithological	Depth of occurrence of top of Aquifer	Thickness	Water Level (mbgl)	Quality (TDS)	Discharge	Transmissivity	Nature of Aquifer	Remarks
		Characteristics	Aquifer	Range	Range	Range	Range	Range		
			(mbgl)	(m)	(mbgl)	Mg/l	lps	m ² /day		
Recent to Miocene	Un Confined Aquifer	Coarse sand, gravel, pebbles, medium and fine sands & clayey sand.	0 to 90	15-90	3 to 71	500 to 1300	0.1 to 12	-	Phreatic	Variable water quality
	Confined Aquifer I	Medium to coarse sand and gravel interbedded with sandy clay	55-150	10 to 30	30 to 115	500 to 2000	0.1 to 30	11.35 to 88	Confined	Generally good water quality
	Confined Aquifer II	Fine to medium sand interbedded with sand and sandy clay	90-210	10 to 50	60 to 155	500 to 2000	1 to 20	39.69 to 445	Confined	Generally good water quality
	Confined Aquifer III	Medium sand interbedded with sandy clay	245-300	15-50	135 to 194	500 to 2000	1.75 to 25	53.13 to 237.44	Confined	Variable water quality

4. HYDROCHEMISTRY

Groundwater in the district is in general potable and fresh, both in phreatic and confined aquifers within 200 m depth.

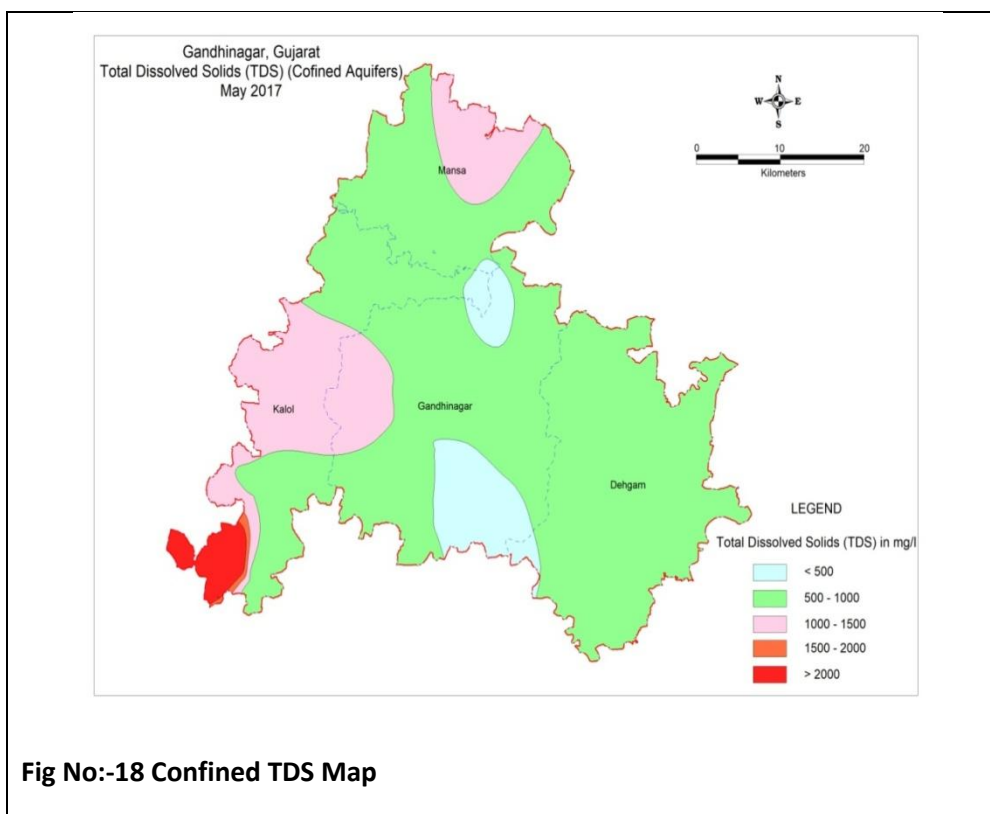
Unconfined aquifer (Phreatic)

Based on water quality data generated by CGWB and GWRDC the Unconfined Aquifer TDS map has been prepared. The quality (TDS) of Unconfined Aquifer in entire Gandhinagar district within permissible limit. BIS standards says that the maximum desirable TDS is 500 mg/l and the maximum permissible level is 2000 mg/l.



Confined aquifers

The Gujarat Water resources and Development Corporation (GWRDC) Ltd., Govt. of Gujarat is monitoring ground water quality of tube wells, the map showing TDS of User Aquifer premonsoon period of 2017 is presented as figure no 18 .It is observed that the ground water quality deteriorates from east to western parts of the district i.e. in the ground water flow direction. The TDS varies from about 500 mg/l to more than 2700 mg/l. However, in major part of the district the ground water quality is potable with less than 2000 TDS. Higher TDS is observed in western part around Chhatral.



Ground water Quality is monitored through Ground water Monitoring stations in the district. Analysis of ground water quality data for May 2017 is presented as below.

Table no-13-Range of Different Chemical Constituents in Ground Water in Unconfined Aquifer.

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

Ground water Quality Problem

According to Gujarat Water Supply & Sewerage Board (GWSSB), the villages / hamlets facing Ground Water quality problems are increasing every year. As per GWSSB present areas with ground water quality problems (Fluoride) in Unconfined Aquifer given as Figure No:-19

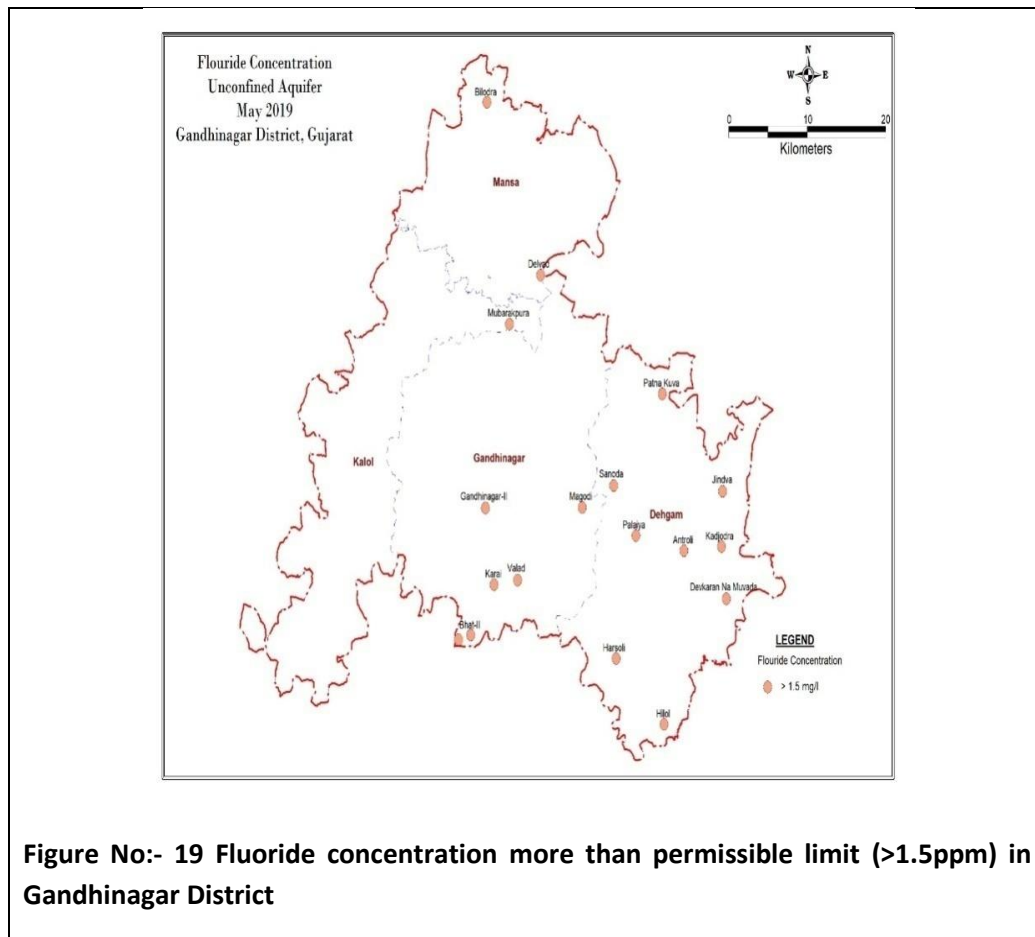
Taluka wise Ground water Quality Problems

Gandhinagar: In eastern part of the taluka the ground water quality deteriorates at depth. The fluoride content of groundwater in the proximity of river Sabarmati is more than 1.5 PPM. The fluoride content is more than permissible limit in 06 villages/ hamlets.

Kalol: The quality of ground water in the shallow aquifer is poor in the south western part. The fluoride content is more than permissible limit in 02 villages/ hamlets.

Mansa: The quality of ground water i.e. TDS deteriorates at depth, whereas, at shallow depth the concentration of Fluoride is more. The fluoride content is more than permissible limit in 02 villages/ hamlets.

Dahegam: The fluoride content is more than permissible limit in 09 villages/ hamlet. In the eastern and north eastern part Granular horizons are limited due to the predominant clay horizons encountered from 40 to 100 mbgl, the depth of tube wells in this area is limited and due to over exploitation the yield of tube wells has reduced. In the eastern part the ground water quality deteriorates at depth.



5. GROUND WATER RESOURCES

The ground water resources of the district were calculated as on March 2017 in collaboration with the Government of Gujarat using the methodology suggested by Ground Water Resource Estimation Committee (GEC-15). These resources were computed after reorganisation of the districts.

Ground Water Recharge

The Annual Ground Water Recharge varies from 9073.64 ha.m (Mansa taluka) to 14659.80 ha.m (Dehgam Taluka). The Gross Annual Ground Water Recharge in the district is 49481.81 ha.m. The net available recharge after leaving natural discharge from monsoon period varies from 8619.96 ha.m (Mansa Taluka) to 13926.81 ha.m (Dehgam Taluka). The net available recharge in the district is 47007.72 ha.m.

Ground Water Draft

The ground water draft from irrigation and Domestic /Industrial sources is presented in Table: 14. The Existing Gross Ground Water Draft for all uses varies from 12011.98 ha.m (Mansa taluka) to 14805.02 ha.m (Dahegam Taluka). The Gross Ground Water Draft for All uses in the district is 53377.70 ha.m.

Ground Water Balance for Irrigation

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

Table No:-14 Ground Water Resource Potential (GWRE-2017)

Sl. No	District	Assessment Unit Name	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Recharge (Ham)	Current Annual Ground Water Extraction(Ham)				Stage of Ground Water Extraction (%)	Categorization
						Irrigation Use	Industrial Use	Domestic Use	Total Extraction		
1	2	3	4	5	6	7	8	9	10	11	12
1	Gandhinagar	Dehgam	14659.80	732.99	13926.81	14369.00	65.52	371.30	14805.82	106.31	OE
2	Gandhinagar	Gandhinagar	14024.91	701.25	13323.67	12948.00	136.75	774.91	13859.66	104.02	OE
3	Gandhinagar	Kalol	11723.45	586.17	11137.28	12121.00	86.89	492.36	12700.25	114.03	OE
4	Gandhinagar	Mansa	9073.64	453.68	8619.96	11676.00	50.40	285.59	12011.98	139.35	OE
	Gandhinagar		49481.81	2474.09	47007.72	51114.00	339.56	1924.15	53377.70	113.55	

Level of Ground Water Development & Stage

The level of Ground Water Development varies between 104.02 % (Gandhinagr Taluka) and 139.35 % (Mansa Taluka). The overall development in the district is 113.55 %. All the four talukas are categorised as Over Exploited.

Table: 15 Stage of Ground Water Development (GWRE-2017)

Sl. No	Assessment Unit Name	Annual Extractable Ground Water Recharge (Ham)	Current Annual Ground Water Extraction(Ham)		Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Categorization (OE)
			Irrigation Use	Total Extraction				
1	2	3	4	5	6	7	8	9
1	Dehgam	13926.81	14369.00	14805.82	482.00	0.00	106.31	Over Exploited
2	Gandhinagar	13323.67	12948.00	13859.66	1006.00	0.00	104.02	Over Exploited
3	Kalol	11137.28	12121.00	12700.25	639.00	0.00	114.03	Over Exploited
4	Mansa	8619.96	11676.00	12011.98	371.00	0.00	139.35	Over Exploited
		47007.72	51114.00	53377.70	2498.00	0.00	113.55	

Categorisation of GW Assessment Units (GWRE-2017)

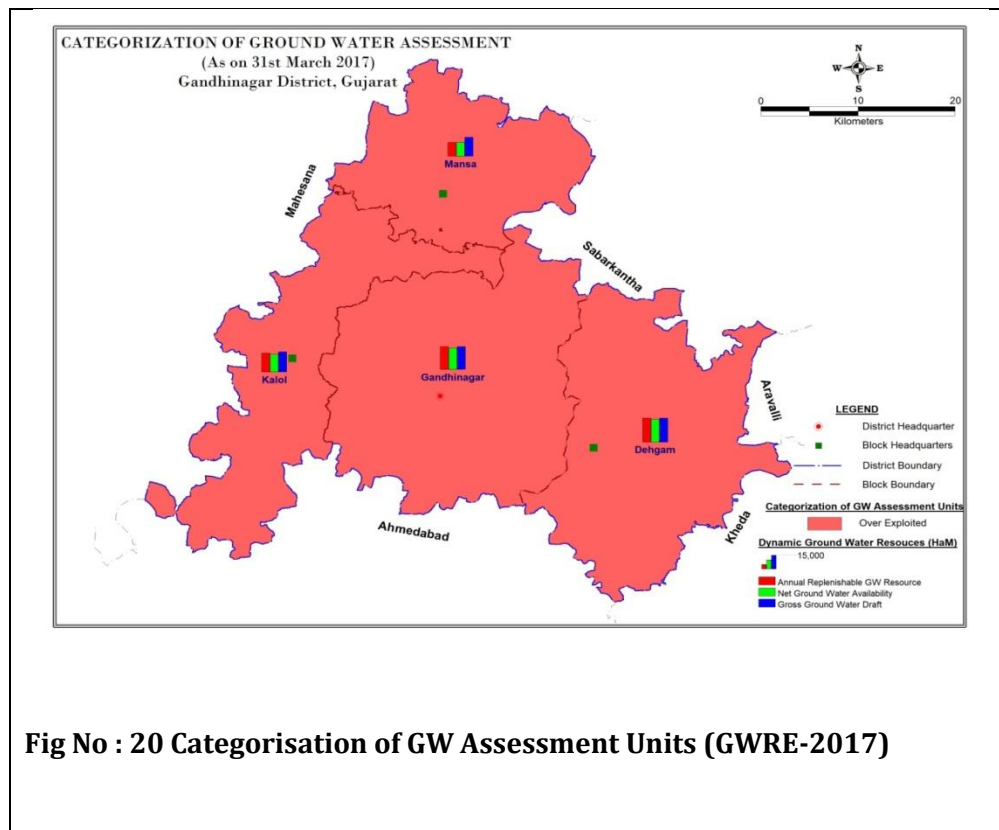


Fig No : 20 Categorisation of GW Assessment Units (GWRE-2017)

6. GROUND WATER RELATED ISSUES and REASONS FOR ISSUES

Issues and Reasons

Traditional agricultural /irrigation practices, flood irrigation practices, increase in water demand, irrigation practices based on power supply. Farmers irrigate the crops when power supply is available rather than waiting for the wilting to start. Following are the issues identified for aquifer management in the area:

- Arid/Semi arid area
- High rate of Evapotranspiration
- Over exploitation of groundwater
- Decline in groundwater levels
- Decline in Piezometric heads of confined aquifer
- Increase in well depth as water levels become deeper
- Increase in depth of prime mover/pump setting
- Decline in well yields
- Large scale groundwater development over the years: Level of groundwater development 2004-184%, 2009–165%, 2011-145%, 2013 – 145% and 2017-113.55%.

Over exploitation of groundwater, Lateral and Vertical change in groundwater yield and quality, high demand of water for existing irrigation practices are some of the major groundwater related issues in the area. Out of the total area of district about 80% area is experiencing steadier decline in groundwater level over the years. The data of the post monsoon trend in absolute with the time is tabulated below and the hydrographs of selected Observation wells for Phreatic Aquifer, Confined aquifer group I and Confined aquifer group II and is presented below.

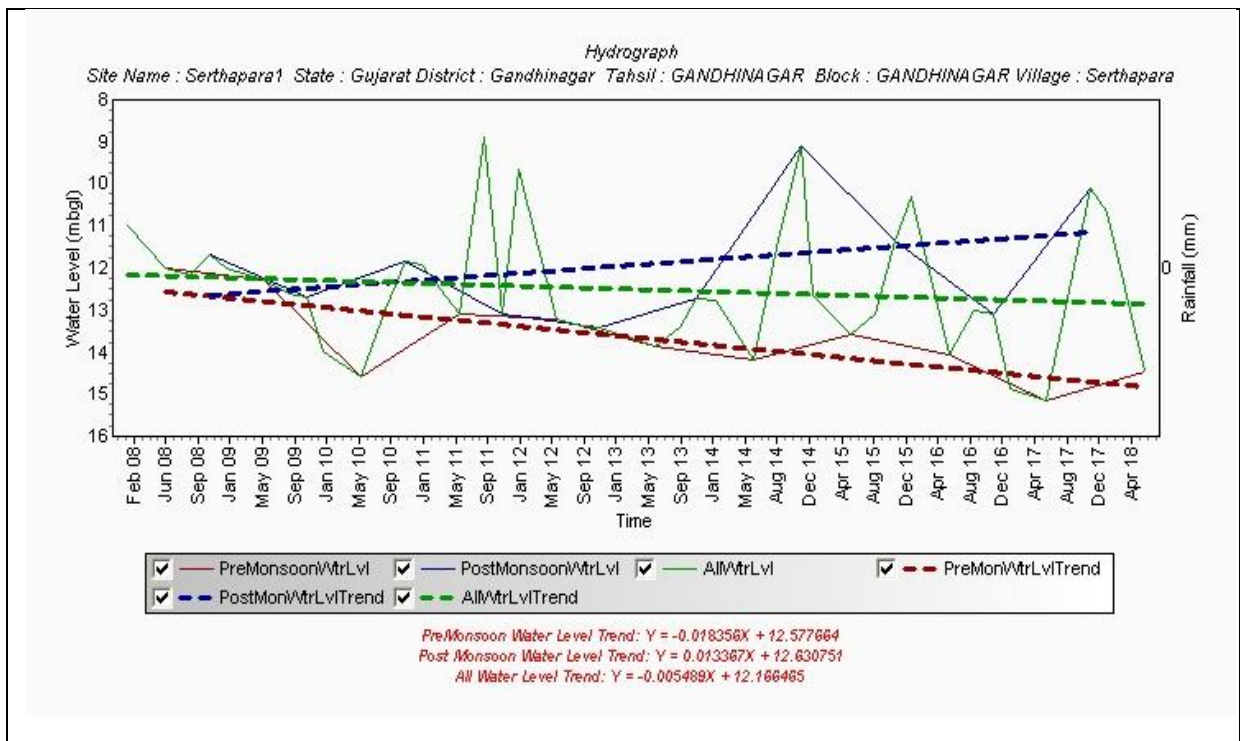
Water level Trends of Unconfined/ Phreatic Aquifer

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 the 50% of wells showing declining trend and ranges 0.0416 (Sarhapara) of Gandhinagar to 0.9286 m/year (Kadjodra) of Dahegam taluka, and 50% of wells showing rising trend ranges from 0.0229 (Valad of Gandhinagar) to 3.7671 m/year (Amrapur, Mansa).Hydrographs of the selected stations showing water level along with trends are presented in fig no 21 given in the below table no-16

Sr.No.	Taluka	Village	Aquifer	Period of Data Analyzed	Water Level Trend (Pre&Post)
1	Dehgam	Devkaran Na Muvada	Unconfined	2008-2017	-0.6023(Fall)
2	Dehgam	Palaiya	Unconfined	2008-2017	-0.2253(Fall)
3	Dehgam	Harsoli	Unconfined	2008-2017	-0.4157(Fall)
4	Dehgam	Hilol	Unconfined	2008-2017	1.5343(Rise)
5	Dehgam	Kadjodra	Unconfined	2008-2017	-0.9286(Fall)
6	Dehgam	Rakhiyal	Unconfined	2008-2017	1.1450(Rise)
7	Dehgam	Patna Kuva	Unconfined	2008-2017	0.1943(Rise)
8	Dehgam	Antroli	Unconfined	2008-2017	0.4971(Rise)
9	Dehgam	Devkaran Na Muvada	Unconfined	2008-2017	-0.2850(Fall)
10	Dehgam	Jindva	Unconfined	2008-2017	-0.7897(Fall)
11	Dehgam	Sanoda	Unconfined	2008-2017	0.9779(Rise)

12	Gandhinagar	Bhat-II	Unconfined	2008-2017	-0.7300(Fall)
13	Gandhinagar	Gandhinagar-II	Unconfined	2008-2017	0.4621(Rise)
14	Gandhinagar	Karai	Unconfined	2008-2017	-0.2029(Fall)
15	Gandhinagar	Koteshwar	Unconfined	2008-2017	-0.4307(Fall)
16	Gandhinagar	Magodi	Unconfined	2008-2017	0.0971(Rise)
17	Gandhinagar	Valad	Unconfined	2008-2017	0.0229(Rise)
18	Kalol	Mubarakpura	Unconfined	2008-2017	0.2386(Rise)
19	Mansa	Bilodra	Unconfined	2008-2017	-0.7886(Fall)
20	Mansa	Delvad	Unconfined	2008-2017	0.3321(Rise)
21	GANDHINAGAR	Adalaj_Pz_III	Unconfined	2008-2017	0.0687(Rise)
22	MANSA	Amrapur Pzii	Unconfined	2008-2017	3.7671(Rise)
23	DEHGAM	Dahegam II	Unconfined	2008-2017	0.4826(Rise)
24	Kalol	Kasturinagar(IFFCO)	Unconfined	2008-2017	-0.0826(Fall)
25	MANSA	Lodra	Unconfined	2008-2017	0.6331(Rise)
26	Dehgam	Paliya	Unconfined	2008-2017	-0.1935(Fall)
27	Gandhinagar	Serthapara1	Unconfined	2008-2017	-0.0416(Fall)

It is observed that the trend of the hydrographs showing 50% declining and 50% rising trend. It is also observed that the shallow piezometers tapping Unconfined Aquifer in the vicinity of Sabarmati River and Narmada Main Canal show rise at some places.



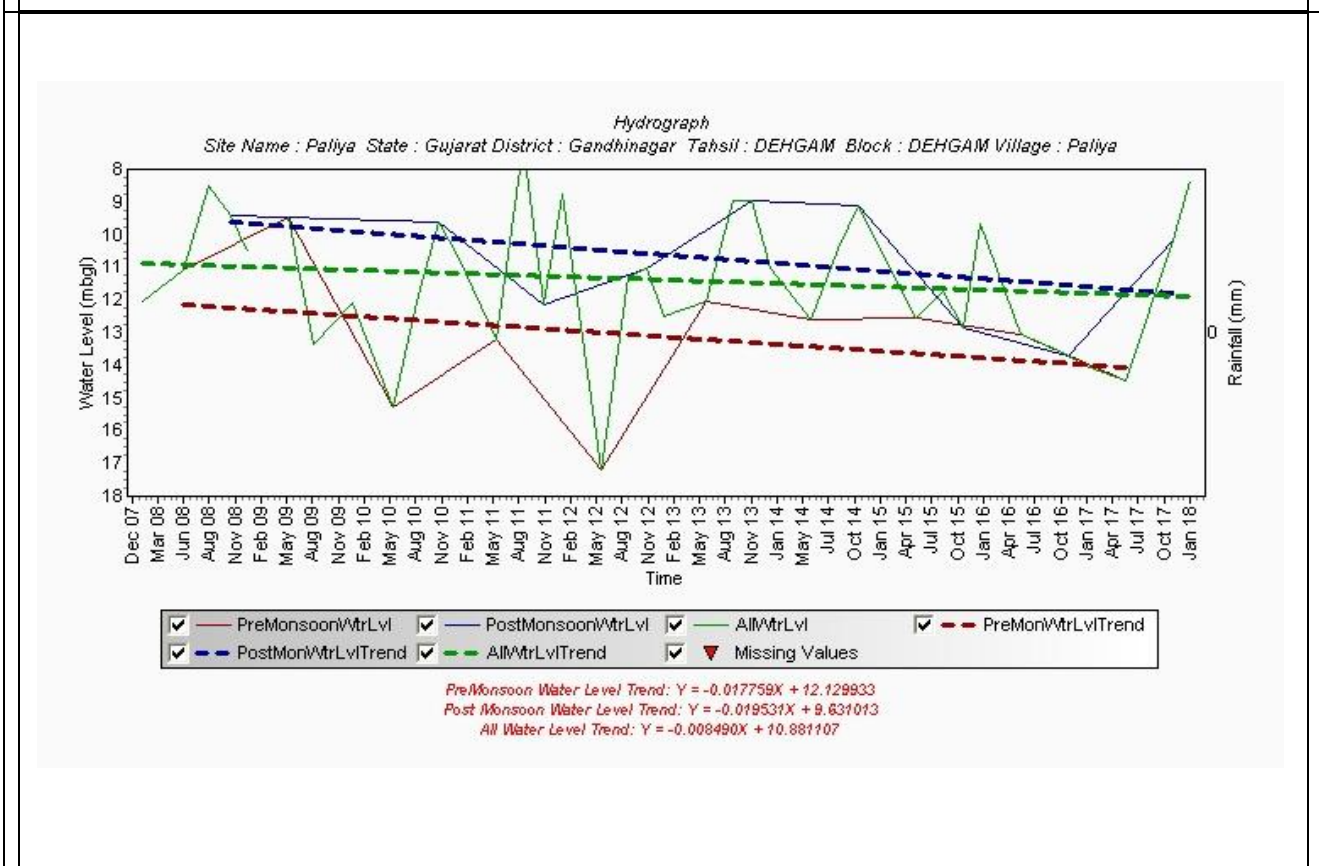
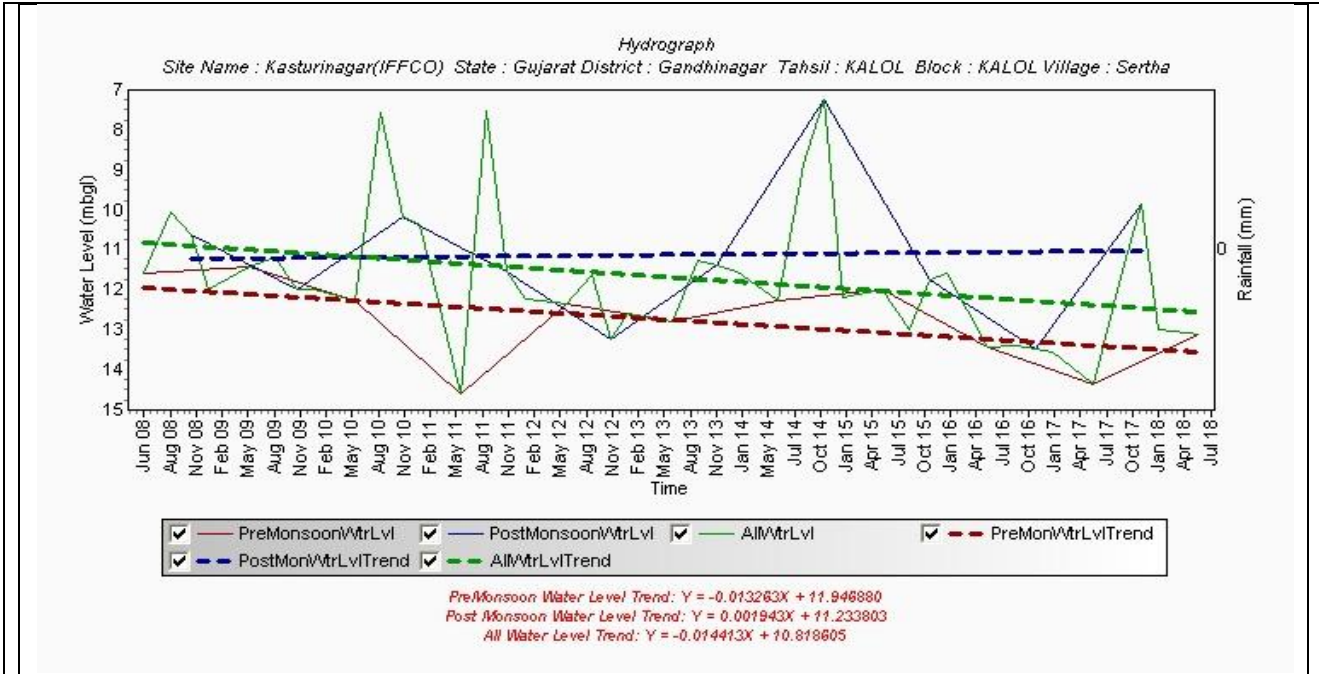


Fig No: 21 Unconfined Hydrographs

Confined Aquifer group I

Almost all the piezometers tapping Confined Aquifer Group I show fall in long term. The data of the trend in absolute with the time is tabulated below and the hydrographs of selected Piezometers is also presented.

Table 17. Water level/Piezometric head trend of Confined Aquifer Group I

Sr.No	Tahsil / Taluk	Village	Aquifer	Period of Data Analyzed	Water Level Trend (Pre&Post)
1	Kalol	Dingucha-I	Confined Aquifer Group-I	2008-2017	-0.32857 (Fall)
2	Kalol	Limbodara	Confined Aquifer Group-I	2008-2017	0.095715(Rise)
3	Kalol	Nasmed(Dabhla)	Confined Aquifer Group-I	2008-2017	1.302857(Rise)
4	Mansa	Pundhara-I	Confined Aquifer Group-I	2008-2017	-0.12857(Fall)
5	Gandhinagar	Isanpur Mota-I	Confined Aquifer Group-I	2008-2017	-0.36303(Fall)
6	Gandhinagar	Medra	Confined Aquifer Group-I	2008-2017	-0.52333(Fall)
7	Gandhinagar	Shertha	Confined Aquifer Group-I	2008-2017	0.353428(Rise)
8	Gandhinagar	Unava	Confined Aquifer Group-I	2008-2017	0.082(Rise)
9	Gandhinagar	Koba	Confined Aquifer Group-I	2008-2017	-1.06667(Fall)
10	Gandhinagar	Bhat-I	Confined Aquifer Group-I	2008-2017	-0.48758(Fall)
11	Gandhinagar	Adraj Moti	Confined Aquifer Group-I	2008-2017	-1.54152(Fall)
12	Gandhinagar	Isanpur Mota-II	Confined Aquifer Group-I	2008-2017	-2.21485(Fall)
13	Gandhinagar	Indroda	Confined Aquifer Group-I	2008-2017	1.355714(Rise)
14	Kalol	Aluva	Confined Aquifer Group-I	2008-2017	-0.00273(Fall)
15	Mansa	Kharna-I	Confined Aquifer Group-I	2008-2017	-0.09879(Fall)
16	Mansa	Kharna-II	Confined Aquifer Group-I	2008-2017	-0.55(Fall)
17	Mansa	Rangpur-I	Confined Aquifer Group-I	2008-2017	0.110303(Rise)
18	Mansa	Rangpur-II	Confined Aquifer Group-I	2008-2017	-0.55848(Fall)
19	Dehgam	Dehgam-II	Confined Aquifer Group-I	2008-2017	-0.26812(Fall)
20	Dehgam	Dehgam-III	Confined Aquifer Group-I	2008-2017	-0.08818(Fall)
21	Dehgam	Dharisana	Confined Aquifer Group-I	2008-2017	-0.45758(Fall)
22	Gandhinagar	Adalaj_Pz_II	Confined Aquifer Group-I	2008-2017	-0.09578(Fall)
23	MANSA	Amrapur Pzii	Confined Aquifer Group-I	2008-2017	1.072162(Fall)
24	Gandhinagar	Pethapur_Pz-II	Confined Aquifer Group-I	2008-2017	-5.03(Fall)

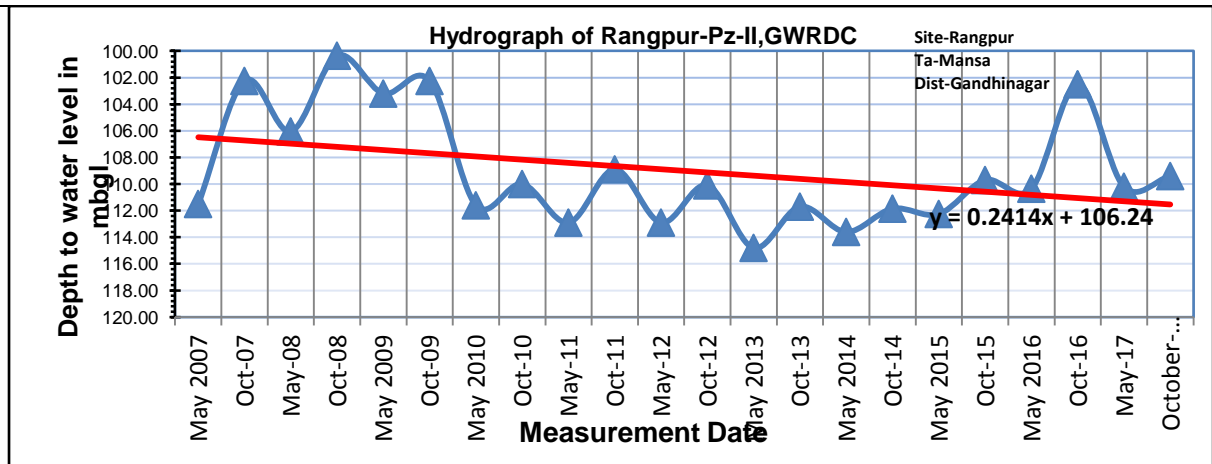
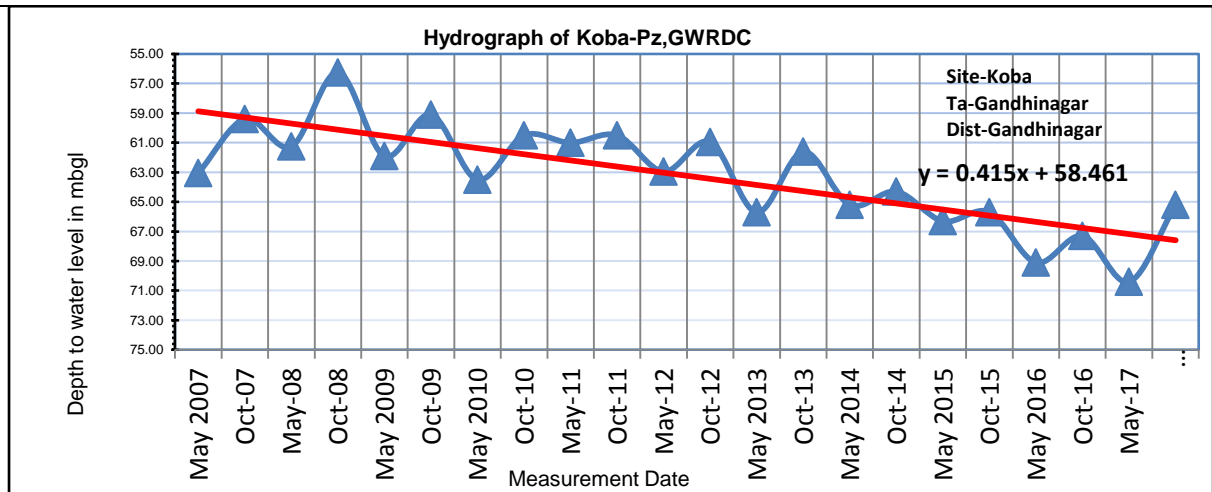
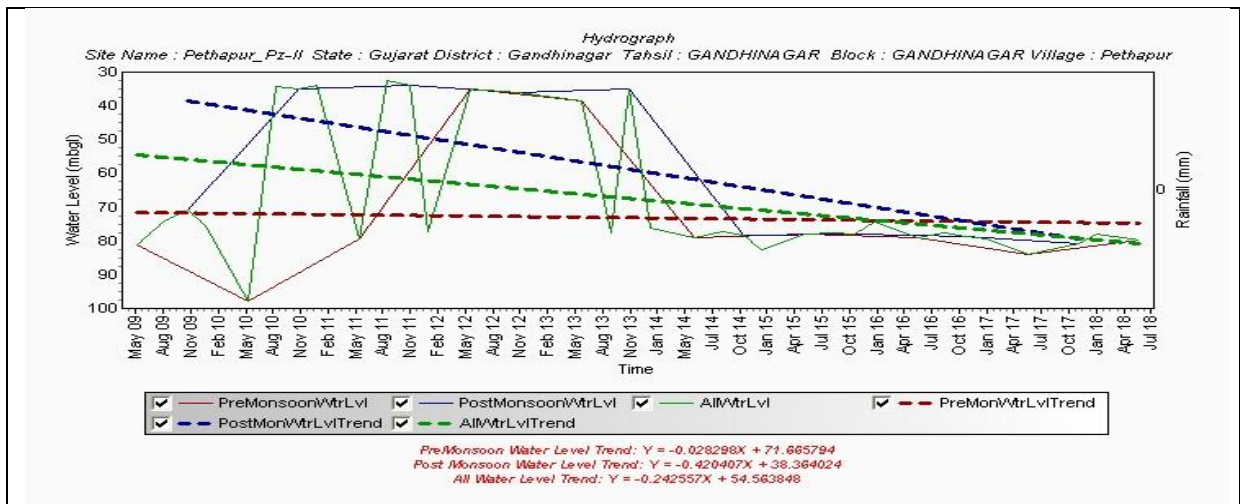


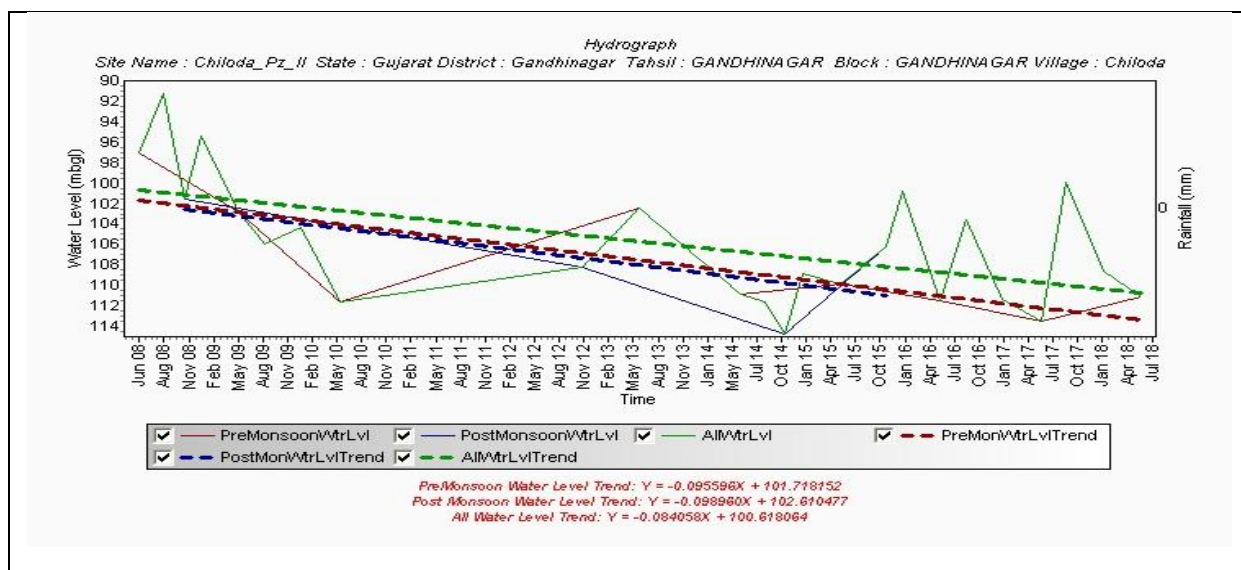
Fig No: 22 Confined Aquifer Group I Hydrographs

Confined Aquifer group II

Piezometers tapping Confined Aquifer group II show varying degrees of fall in long term. The data of the trend in absolute with the time is tabulated below and the hydrographs of selected Piezometers tapping Aquifer Group II is also presented. This Aquifer Group is the most developed for Irrigation purpose in the district hence we can see large decline with time in absolute term.

Table No: 18

Sr.No	Tahsil / Taluk	Village	Aquifer	Period of Data Analyzed	Water Level Trend (Pre&Post)
1	Kalol	Dingucha-II	Confined Aquifer Group-II	2008-2017	-1.74429(Fall)
2	Mansa	Pundhara-II	Confined Aquifer Group-II	2008-2017	0.447143(Rise)
3	Gandhinagar	Gandhinagar	Confined Aquifer Group-II	2008-2017	-1.06424(Fall)
4	Gandhinagar	Isanpur Mota-III	Confined Aquifer Group-II	2008-2017	-1.10152(Fall)
5	Kalol	Bhoyan Moti	Confined Aquifer Group-II	2008-2017	-1.50286(Fall)
6	Mansa	Kharna-III	Confined Aquifer Group-II	2008-2017	-0.75636(Fall)
8	Kalol	Rancharada	Confined Aquifer Group-II	2008-2017	-1.60879(Fall)
9	Kalol	Chhatral	Confined Aquifer Group-II	2008-2017	-0.95424(Fall)
10	Dehgam	Dehgam-I	Confined Aquifer Group-II	2008-2017	-0.24121(Fall)
11	Gandhinagar	Adalaj_Pz_I	Confined Aquifer Group-II	2008-2017	-1.04851(Fall)
15	Gandhinagar	Chiloda_Pz_II	Confined Aquifer Group-II	2008-2017	-1.18852(Fall)
16	DEHGAM	Dahegam I	Confined Aquifer Group-II	2008-2017	-1.13533(Fall)
17	KALOL	Kalol(Rep)Pz_II	Confined Aquifer Group-II	2008-2017	0.385(Rise)
18	Gandhinagar	Palaj_Pz-I	Confined Aquifer Group-II	2008-2017	-3.137(Fall)
19	Gandhinagar	Pethapur_Pz-I	Confined Aquifer Group-II	2008-2017	-5.13321(Fall)



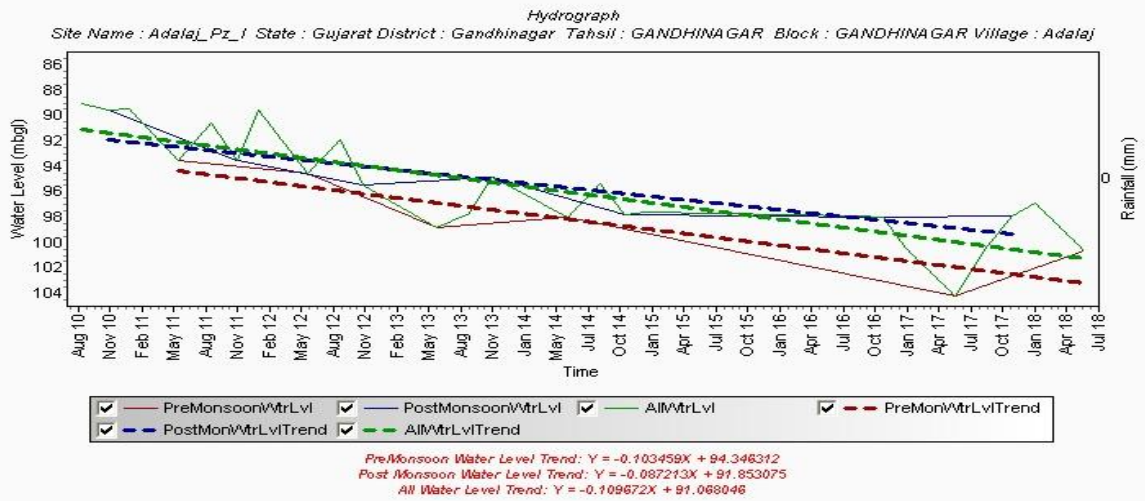
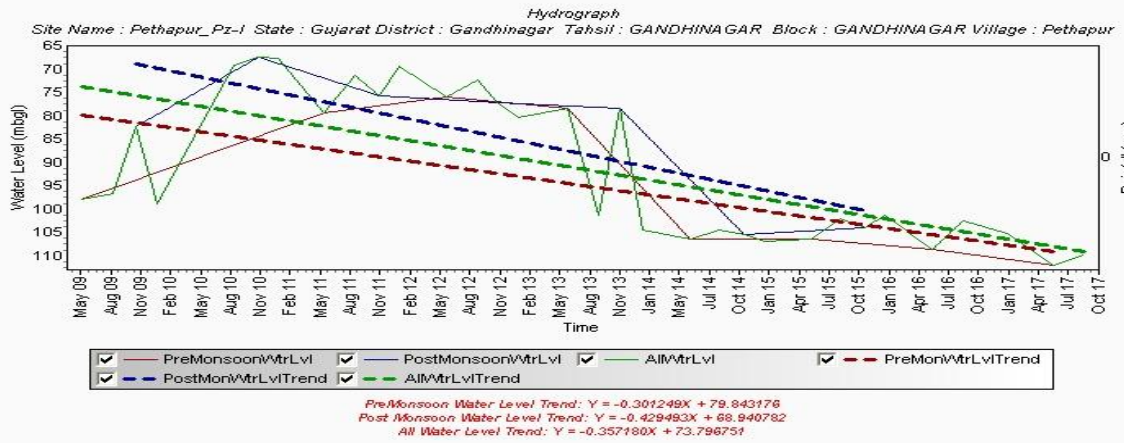
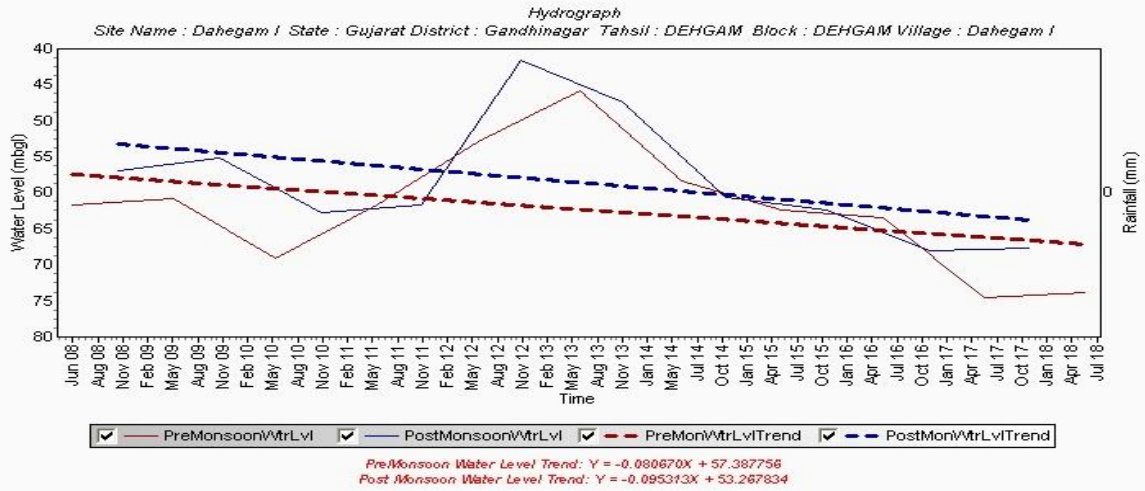


Fig No: 23 Confined Aquifer Group II Hydrographs

Confined Aquifer group III

The Confined Aquifer group III occurring between 200 to 300 m depth are now being tapped at places, however these are required to be explored and tested. Recently in Gandhinagar district, ground water exploration work was carried out for the Confined Aquifer group III, static water level is ranges between 101.7 to 141mbgl. No long term water level record available for Confined Aquifer group III.

Notification

As discussed earlier the level of ground water development is very high in the district and all the talukas are in the Over Exploited category.

The Central Ground Water Authority, vide public notice no.7/2000,declared ground water aquifers below 200m depth as “PROTECTED AQUIFERS” exclusively for drinking & domestic water use in Gandhinagar taluka.

Areas Notified by CGWA/SGWA

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

CGWA has notified three talukas of the Gandhinagar district vide its Public Notice with details as below. Table No:-19

Sr. No.	Area Notified	Public Notice No.	Date	Subject	Directions
1.	Gandhinagar Taluka	Public Notice No.7 / 2000	02.09.2000	Declaration of Ground Water Aquifers below 200M. Depth as “Protected Aquifers” exclusively for drinking & Domestic water use in Gandhinagar Taluka	The Aquifers located below 200 m depth are declared as “Protected Aquifers” and shall be used for construction of tubewells for drinking and domestic and water supply only. No well shall be constructed by any person /agency tapping the aquifer zones located below 200 m depth without prior specific approval of the Authority.
2.	Kalol Taluka	Public Notice No.1 / 2012	27-11-2012	Declaration of the Areas as “Notified Area” for regulation of Groundwater Abstraction/ Development	1. No person/agencyorganisation/industry will construct /install any new structure for extraction of ground water resources without prior specific approval of the Authorized Officer i.e. Chief Officer –in-charge of Revenue District (whether called district Collector, Deputy Commissioner or by any other name) of the district and subject to the guidelines/safeguards envisaged from time to time in this connection by the Authority for ground water extraction and rainwater harvesting

3.	Mansa Taluka				<p>/recharge etc.</p> <p>2. The authorized officer shall ensure that no person/organisation/industry/builder/developer shall undertake the operation of drilling, construction, installation of new abstraction structure and any scheme /project for ground water development and management in the notified area without his prior specific approval after the publication of this Public Notice.</p>
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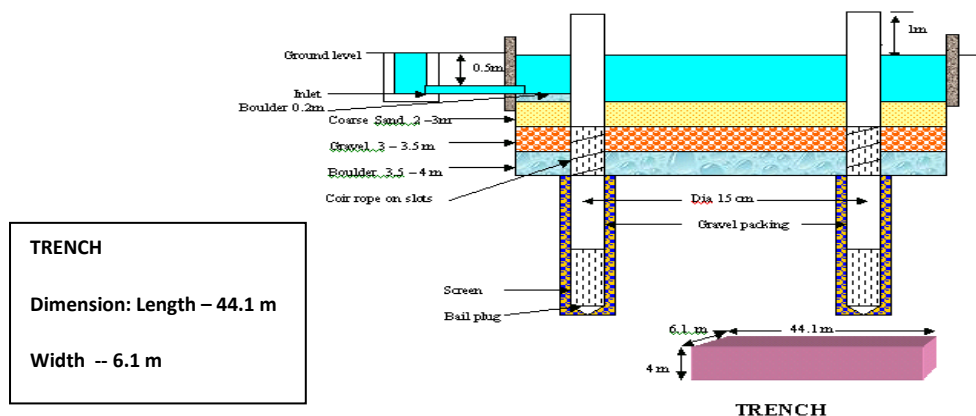
Ground Water Development

As per the GWRE, 2017 report, all the Four Talukas of the district are Over Exploited. The level of Ground Water Development varies from 104.02% (Gandhinagar Taluka) to 139.35 % (Mansa Taluka). The overall development in the district is 113.55 %, and as a whole the Gandhinagar district is Over Exploited. Though, Improvement in Groundwater development is observed as a perusal of GWRE 2004, 2009, 2011, 2013 and 2017, but there is no scope for further development of groundwater resources in the district. Great need of artificial recharge and rainwater harvesting is required for efficient management of groundwater resources in the district.

Previous work on Water Conservation and Artificial Recharge

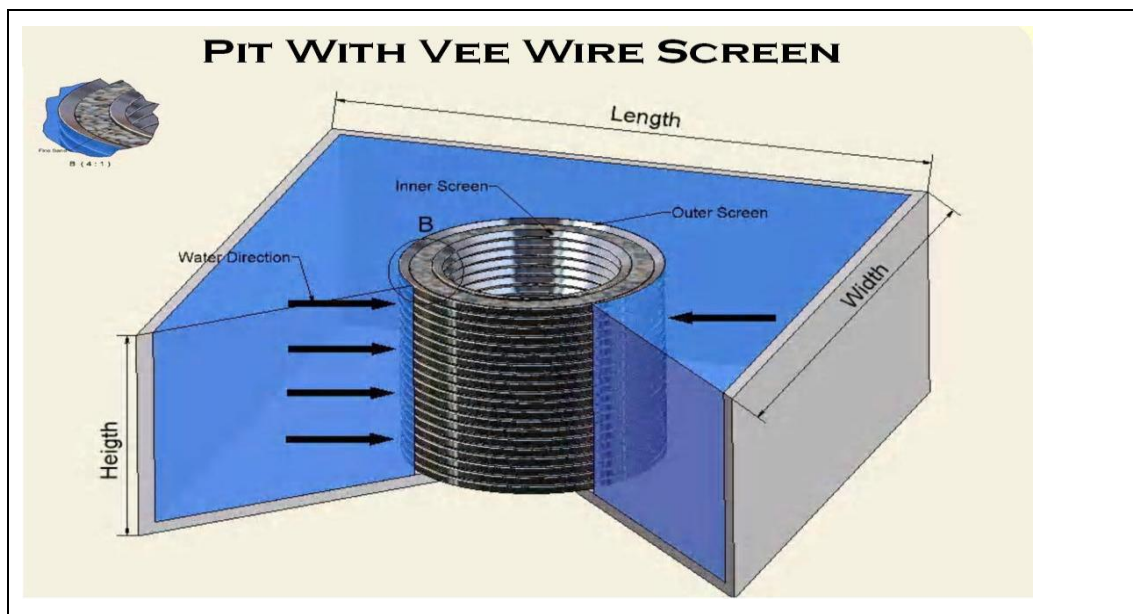
Rainwater harvesting and artificial recharge activities taken up by Govt. Agencies, NGOs etc. are as below.

1. Central Ground Water Board in the early eighties has carried out pilot for technical feasibility and economic viability of artificial recharge of groundwater studies in North Gujarat alluvial plains (UNDP/CGWB-1986)
2. Under the aegis of Central Ground Water Board, IFFCO has implemented Rain water harvesting by constructing Recharge Trench along with two recharge wells at Kasturinagar colony, village Sertha, taluka Kalol. 29376 m³/yr of rainwater is expected to recharge the groundwater. The design of the recharge structure is as below figure no 24



3. The Gujarat Water Supply and Sewerage Board (GWSSB), Govt. of Gujarat converted one failed tubewell at village Tara na Chhapra in Dahegam taluka into recharge well by suitably modifying its design. The design modification includes fixing double screens (Johnson) at the

surface and providing filter media between the screens. It provides for backwashing of filter media and the recharging water can be seen from the top. During the experiment 22000 Ltrsof water was recharged in 20 minutes. A recharge rate of 20 lps is estimated. It is reported by the local public that during monsoon lot of water was recharged through this well. The design of recharge well is given as below as fig no 25.



4. GWSSB, Govt of Gujarat has taken up artificial recharge on 15 failed tube wells in Dahegam taluka. Constructed 15 new recharge tube wells in ponds in Gandhinagar taluka.
5. Capital project has constructed 175 recharge wells of 40/ 60 m depth in the Gandhinagar city.
6. A new check dam on river Sabarmati is under construction near Gandhinagar.
7. At village Sargasan in Gandhinagar taluka VIKSAT has constructed percolation well in the village pond.
8. Details of works completed by all Departments till 31-03-2018 in Gandhinagar district.

Table No:-20

Sr No	Name of District	Check Dam	Bori bandh	KhetTalavadi	Deepening of Ponds
1	Gandhinagar	837	2475	3798	736

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

Taluka wise Suitable Artificial Recharge Structures

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

Table No:-21

The drinking water supply as well as irrigation is mostly ground water based. The irrigation potential has not only been created to its capacity but has already exceeded.

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

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

7. MANAGEMENT STRATEGIES IN GANDHINAGAR DISTRICT

High dependence on groundwater coupled with absence of augmentation measures has led to a steady fall in water levels and desaturation of Phreatic aquifer is dry in major part of the district, raising questions on sustainability of existing groundwater structures, food and drinking water security.. Thus, management of ground water resources could be developed/augmentated in a judicious way.

Management plan

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.

- | | |
|-------------------------|---------------------------|
| a) Supply side measures | c) Regulatory measures |
| b) Demand side measures | d) Institutional measures |

SUPPLY SIDE INTERVENTIONS

ARTIFICIAL RECHARGE TO GROUND WATER AND WATER CONSERVATION PLAN

IDENTIFICATION OF RECHARGE AREA

An area of about 2224.73 sq. km has been identified in District Gandhinagar of Gujarat State. Alluvium is the main water bearing geological formations occurring in the District. The thickness of available unsaturated zone (below 6 m bgl) is computed on basis of Post monsoon (2008-17) decadal average depth to water level map (Fig 26). Based on the decadal average depth to water level of post monsoon period (2008-17) data and long term trend of ground water level (2008-17) 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.

Fig. – 26: Feasible area for Artificial recharge

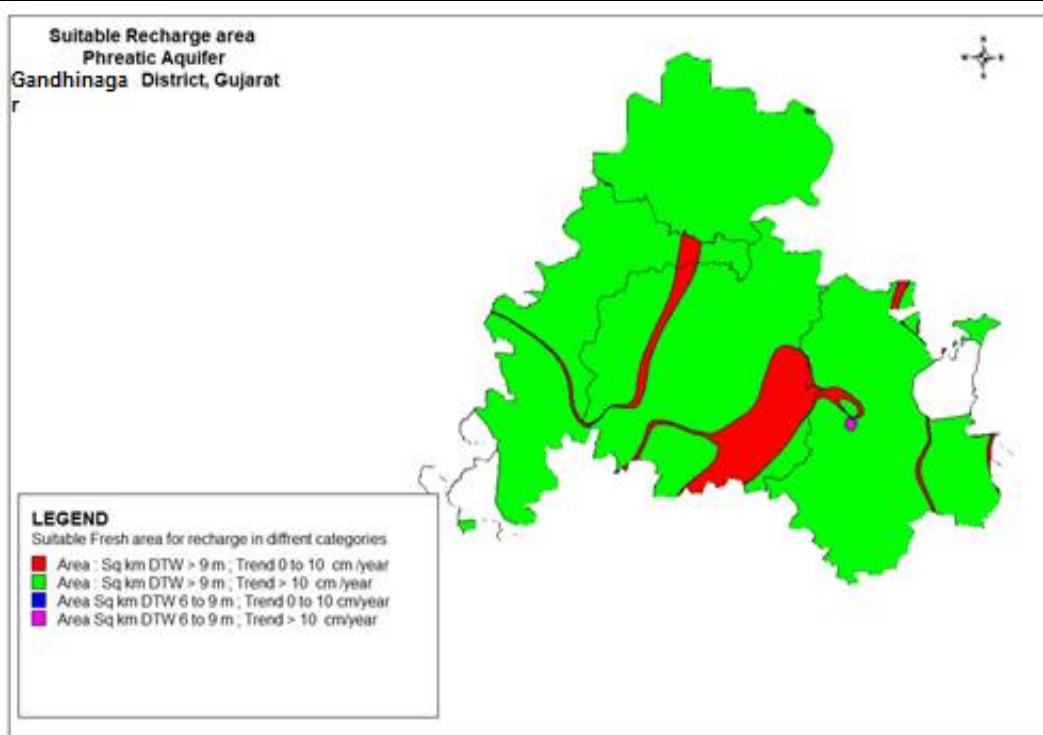


Table-22 Identification of suitable area for Artificial Recharge in Gandhinagar District

DNAME	TNAME	Aquifer	Area : Sq km DTW > 9 m ; Trend > 10 cm /year	Area : Sq km DTW > 9 m ; Trend 0 to 10 cm /year	Area Sq km DTW 6 to 9 m ; Trend > 10 cm/year	Area Sq km DTW 6 to 9 m ; Trend 0 to 10 cm/year	Total Area Feasible for AR
GANDHINAGAR	DEHGAM	Alluvium	558.90	19.10	2.24	0.05	580.29
GANDHINAGAR	GANDHINAGAR	Alluvium	673.08	140.44			813.52
GANDHINAGAR	KALOL	Alluvium	417.72	13.27			430.99
GANDHINAGAR	MANSA	Alluvium	381.82	18.11			399.93
Total			2031.52	190.93	2.24	0.05	2224.73

A total of 2224.73 sq. km area spread over the district having water level & trend as above is computed (Table 22) and same is depicted as suitable areas for artificial recharge.

Table-23 Computation of volume of unsaturated zone available for recharge							
DNAME	TNAME	Aquifer	Area : Sq km DTW > 9 m ; Trend > 10 cm /year	Area : Sq km DTW > 9 m ; Trend 0 to 10 cm /year	Area Sq km DTW 6 to 9 m ; Trend > 10 cm/year	Area Sq km DTW 6 to 9 m ; Trend 0 to 10 cm/year	Volume of Unsaturated zone available for artificial recharge
	Avg. Depth unsaturated below 6 m bgl(Excluding clay& impervious hard zones)		6 m	6 m	3 m	3 m	
Gandhinagar	DEHGAM	Alluvium	3353.4	114.6	6.72	0.15	3474.87
Gandhinagar	GANDHINAGAR	Alluvium	4038.48	842.64			4881.12
Gandhinagar	KALOL	Alluvium	2506.32	79.62			2585.94
Gandhinagar	MANSA	Alluvium	2290.92	108.66			2399.58
Total			12189.12	1145.52	6.72	0.15	13341.51

SUB-SURFACE STORAGE SPACE AND WATER REQUIREMENT

Further, while calculating the total volume of unsaturated zone available for recharge, clay & massive non porous intervening zones have been deleted from the total thickness of potential zone for recharge. Average specific yield data of above formations, as per norm of GWRE were considered to compute volume of water required for recharge to saturate dry zones. Storage space volume available in aquifers is 13341.51 MCM. On the basis of specific yield factor of major aquifer system considered, the volume of water required for artificial recharge to fully saturate aquifer (below 6 m bgl) in each talukas areas is around 2001.22 MCM (Table 24)

Table-24 Computation of volume of water required for recharge

Taluka	Aquifer	Volume of unsaturated zone available for artificial recharge MCM	Specific yield factor	Volume of water required for recharge MCM
DEHGAM	Alluvium	3474.87	0.15	521.2305
GANDHINAGAR	Alluvium	4881.12	0.15	732.168
KALOL	Alluvium	2585.94	0.15	387.891
MANSA	Alluvium	2399.58	0.15	359.937
Grand Total		13,341.51		2001.22

SOURCE WATER AVAILABILITY

The availability of source water, one of the prime requisites of artificial recharge has been worked out based on basin approach by the Ground Water Department of Gujarat State. Considering monsoon rainfall as main source of water, basin wise source water availability is computed. Broadly, the data of each basin takes in to account of committed runoff, provision for future planning and surplus water available. The quantity considered available for artificial recharge includes provisions for future planning with surplus water available. This availability so worked out is for entire basin has been further redistributed on prorata basis for different districts for planning of Artificial Recharge. The Gujarat Government is planning to take up ambitious project of Kalpasar in the Gulf of Cambay by creating a fresh water reservoir by conserving fresh water of Sabarmati, Mahi, Dadhar, and Narmada rivers of mainland Gujarat and other minor rivers of Saurashtra Region flowing into Gulf of Cambay. The surplus water of all these rivers is accounted for Kalpasar Project and therefore. As per Master plan for Artificial Recharge (2013) to Ground water in Gujarat state The total surplus water available for planning of artificial recharge in the Gandhinagar district is 12.17 MCM/yr. Taking in to consideration of various types of artificial recharge structures constructed up to year 2018, total 727 Check Dams and 52 Percolation tanks has been constructed for Ground Water recharge which can accommodate 41.55 MCM recharge to Ground Water. The balance volume of surplus available is Nil. At present No additional / Surplus runoff is available.

Hence No water conservation structures like Check dams / Percolation tanks are suggested in the district as Non-Committed runoff is not available.

Table No 25		Feasibility of Artificial Recharge in Gandhinagar District.												
Sr No	District Name	Area of District in sqkm	Decadal Average (2008-17) Post Monsoon Depth to Water Level (m bgl)	Area Feasible for Artificial Recharge(Sq/Km)	Volume of unsaturated zone available for recharge (MCM)	Volume of Water required for recharge (MCM)	Surplus Runoff Available District (As per Master Plan 2013) (MCM)	Up to 2018 (total 727 CD & 52 PT) which can accommodate 41.55 MCM	Balance Volume of Surplus Local / Distant Sources available for recharge (MCM)	Additional Percolation Tank Structure Proposed Recharge Capacity @0.14 MCM	Additional Check Dam Structure Proposed Recharge Capacity @0.05 MCM	PT	CD	Total Coast (Rs Cores)
1	Gandhinagar	2163.00	37.35	2224.73	13341.51	2001.22	12.17	41.55	0.00	Taking in to consideration of various types of artificial recharge structures constructed up to year 2018, total 727 Check Dams and 52 Percolation tanks has been constructed for Ground Water recharge which can accommodate 41.55 MCM recharge to Ground Water. Hence No water conservation structures like Check dams / Percolation tanks are suggested in the district as Non-Committed runoff is not available.				

Demand side intervention

Farmers of Gandhinagar have realized the importance of high value agriculture and cash crops and are proactive for suitable crop diversification and absorption of micro irrigation technologies. Thus, to enable and to support the transformation of agriculture, the development of land is a must to avoid crop stress on moisture, nutrition, etc. Demand side management by Micro Irrigation System i.e. Sprinkler and drip irrigation (in practice in about 19% of area irrigated by groundwater), By adding about 15% of the balance area every year in a phased manner, water saving of about 70.09 MCM in Gandhinagar can be achieved. It is necessary to bring more and more area of the group of farmers under public tube well/community irrigation by installation of drip/sprinkler irrigation techniques.

Table No: 26 Volume of water which can be saved by adopting Micro irrigation practices in Gandhinagar District.

Sr No	Taluka	Irrigation Draft (mcm)	Gross Irrigated Area by GW (Ha)	Area already Covered under MIS (Ha) GGRC	Area Proposed under MIS* (Ha)	Irrigation Draft After MIS (mcm)
1	Dahegam	143.69	22990	8802	9932	128.79
2	Gandhinagar	129.48	20716	4442	11392	112.39
3	Kalol	121.21	19394	903	12944	101.79
4	Mansa	116.76	18682	883	12459	98.07
	Total	511.14	81782	15030	46726	441.05

**Irrigation Draft for MIS=(Area Proposed under MIS*Δ GW Requirement*0.3)/10
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.

Improvement in Groundwater Development Scenario in Gandhinagar District.

It is observed that by taking demand side intervention in a phased manner, groundwater development in the district can be brought at about 97.29%. Water conservation measures in the district is already adequate with existing structures can recharge all the non committed surplus runoff and artificial recharge interventions over the period of time in long run, stage of groundwater development can be managed within 100% and to some extent relief can be provided to the overexploited area of the district that can be brought under critical category.

Table 27. Expected change in scenario of groundwater resources through integrated approach/interventions in Gandhinagar district.

Sr No	Taluka	Stage of groundwater extraction (2017)	Category (GWRE 2017)	Stage of groundwater extraction after Implementing micro irrigation (2017)	Artificial recharge	Category after the interventions
				Demand side	Supply Side	
1	Dahegam	106.31	OE	98.46	Not proposed as recharge capacity through AR structures in the district is more than the surplus non committed runoff.	Critical
2	Gandhinagar	104.02	OE	93.79		Critical
3	Kalol	114.08	OE	99.63		Critical
4	Mansa	139.35	OE	122.31		OE

Expected Results and Outcome.

By adopting above management strategies, No water conservation structures like Check dams / Percolation tanks are suggested in the district as Non-Committed runoff is not available. However, adoption of Micro Irrigation system in 46726 ha area of the district would lead to considerable saving of ground water (about 70.09 MCM) and stage of Ground water Extraction in Gandhinagar, Dahegam and Kalol talukas may improve from Over Exploited category to Critical Category but Mansa taluka is remain in same category.

8. CONCLUSION AND RECOMMENDATIONS

Summary and Conclusions

The Gandhinagar district was one of the **smallest districts** in Gujarat. The district has **four talukas** namely, the Gandhinagar, Kalol, Mansa and Dahegam Talukas.

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

The **climate** of the district is semi-arid with annual normal rainfall of 744 mm.

The total geographical area of Gandhinagar district is 2, 16, 000 hectares out of which nearly 2,044 hectares (or 0.9%) is under forests. Another 17,751 hectares (or 8%) of area is under cultivable wastes, permanent pastures and miscellaneous tree crops. Another 22,632 hectares (or 10%) of the land is under other uses including non-agricultural uses.

The net sown area of the districts is roughly around 1,64,954 hectares constituting 76% of total geographical area of the district. Nearly 1, 06,796 hectares were sown more than once constituting 49% of the total geographical area of the district. The cropping intensity of district stood at 132%.

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

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

The potentiometric heads of first confined aquifer ranges between 48.69 mbgl to 118.43mbgl, whereas, second confined aquifer ranges from approximately 58.05 mbgl to 155.26 mbgl.

An overall decline of water level is observed at selected Piezometers tapped to confined aquifers.

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

As per the GWRE, 2017 report, all the Four Talukas of the district are Over Exploited. The level of Ground Water Development varies from 104.02% (Gandhinagar Taluka) to 139.35 % (Mansa Taluka). The overall development in the district is 113.55 %, and as a whole the Gandhinagar district is Over Exploited.

Based on NAQUIM studies the unconfined aquifer occurs within the depth range of 35 to 90m bgl. Confined aquifers I, II and III occur within the depth range of 55 to 150 m bgl, 90-210 m bgl and 245-300 m bgl respectively. The thickness of the unconfined aquifer ranges from 15 to 90 m. Confined aquifer I ranges in thickness from 10 to 30 m whereas the thickness of the confined aquifer II and III ranges within 10 to 50m and 15 to 50m respectively.

In phreatic Aquifer TDS ranges in between 500 to 1000 mg/l whereas in Confined Aquifers TDS ranges in between 500 to 2000 mg/l.

2224.73 sq.km area is identified for artificial recharge to unconfined system. The volume of water required for artificial recharge to fully saturate unconfined aquifer in each talukas areas is around 2001.22 MCM.

Recommendations

From the conclusions drawn, it is evident that not much scope exists for development of ground water resources to increase the irrigation potential in the district. Keeping in mind the existing scenario, recommendations are accordingly made out for development, augmentation and management of ground water resources.

Supply side management: An area of 2224.73 Km² has been identified for artificial recharge of groundwater to unconfined aquifer. The volume of water required for artificial recharge to fully saturate aquifer (below 6 m bgl) in each taluka areas is around 2001.22 MCM.

Taking in to consideration of various types of artificial recharge structures constructed up to year 2018, total 727 Check Dams and 52 Percolation tanks has been constructed for Ground Water recharge which can accommodate 41.55 MCM recharge to Ground Water. Hence No water conservation structures like Check dams / Percolation tanks are suggested in the district as Non-Committed runoff is not available.

However, adoption of Micro Irrigation system in 46726 ha area of the district would lead to considerable saving of ground water (about 70.09 MCM) and stage of Ground water Extraction in Gandhinagar, Dahegam and Kalol talukas may improve from Over Exploited category to Critical Category but Mansa taluka is remain in same category.

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.

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.

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

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

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

Further improvement of groundwater stage under safe category, the other practices as filling and inter linking of village ponds with the available surplus surface water. Recharge groundwater through recharge shaft where the phreatic aquifer is overlain by impervious layers. Recycling of Gray water generated from domestic use may utilized other for other purposes except drinking.

Basin/Sub-basin

Sabarmati/Meshwo and Khari

Principal Aquifer System

Quaternary Alluvium

Major Aquifer System

Older & Younger Alluvium



Normal Annual Rainfall

729 mm

Aquifer Disposition

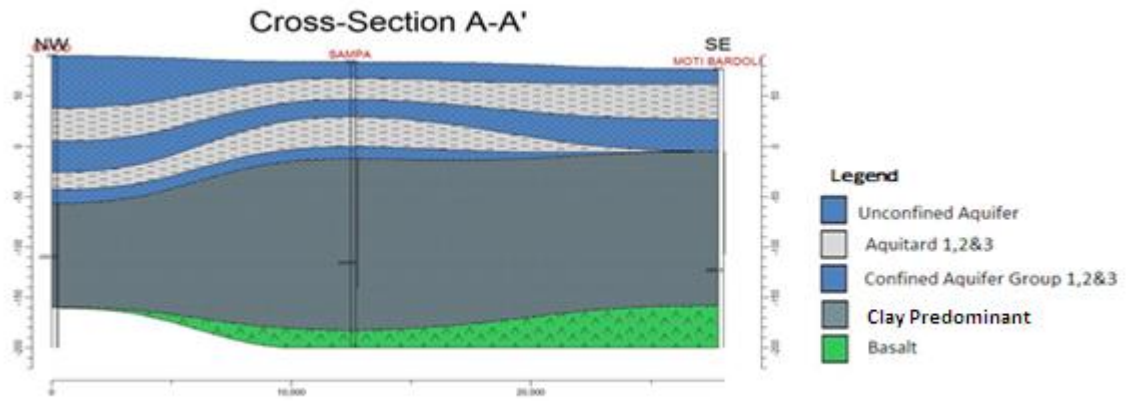
Aquifer Disposition

Three aquifer Groups: (Multi Layered aquifer system of Sand and Clay)

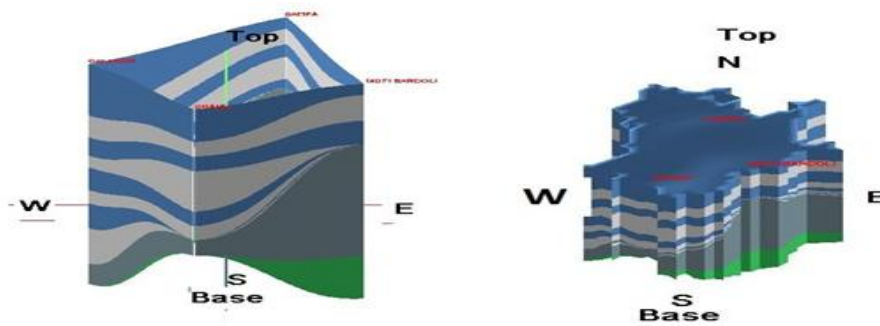
- The area has **multi-layer aquifer system**.
- The aquifers are of phreatic and confined (I, II,) in nature.
- Blue clay (Tertiary) – A marker horizon between quaternary and tertiary aquifer systems.
- Tube wells tapping **Aquifer zones below Blue clay** are yielding relatively poor quality of groundwater and are with comparatively of higher temperature.

Sr No	TALUKA	PHREATIC AQUIFER DEPTH OF OCCURENCE (mbgl)	Confined Aquifer I Depth of occurrence (mbgl)	Confined Aquifer II depth of occurrence (mbgl)	Confined Aquifer III Depth of occurrence (mbgl)	Suitability	
						Drinking	Irrigation
1	DAHEGAM	0 to 45	55 to 85	90 to 110	-	Y	Y

Sub Surface Regionalised Aquifer Groups (Down to 300 m)



Aquifer section along Giyod to Moti Bardoli



Fence & 3-D Aquifer Model of Dahegam Block

Aquifer Characteristics

Aquifer Characterisation and Disposition										
Stratigraphy	Aquifer Nomenclature	Lithological	Depth range	Thickness	Water Level (mbgl)	Quality(TDS)	Discharge	Transmissivity	Nature of aquifer	Remarks
		Characteristics	Aquifer	Range	Range	Range	Range	Range		
			(mbgl)	(m)	(mbgl)	Mg/l	lps	m ² /day		
Recent to Miocene	Un Confined Aquifer	Coarse sand, gravel, pebbles, medium and fine sands & clayey sand.	0 to 45	15-45	9.45 to 36.30	500 to 1300	0.1 to 12	-	Phreatic	Variable water quality
	Confined Aquifer I	Medium to coarse sand and gravel inter bedded with sandy clay	55-85	10 to 30	50 to 75	500 to 2000	0.1 to 30	11.35 to 88	Confined	Generally good water quality
	Confined Aquifer II	Fine to medium sand interbedded with sand and sandy clay	90-110	10 to 20	74 to 102	500 to 2000	1 to 20	39.69 to 445	Confined	Generally good water quality

Groundwater Quality

- Predominantly Potable and fit for domestic, drinking, irrigation and other Industrial purposes. **Fluoride** in few samples is more than the permissible limits.
- Due to fluoride there is no major health issue because for drinking water people are using Narmada Canal Water.

Groundwater Resource

- *GW Availability 13926.81 ham (Dynamic)
- *GW Draft 14805.82 ham
- *Stage of GW Development 106.31%
- *Total Ground Water resource including both dynamic & In storage for district is 68777.81 ham. (Dynamic: 13926.81 ham & In storage: 54851 ham)

Existing and Future Water Demand

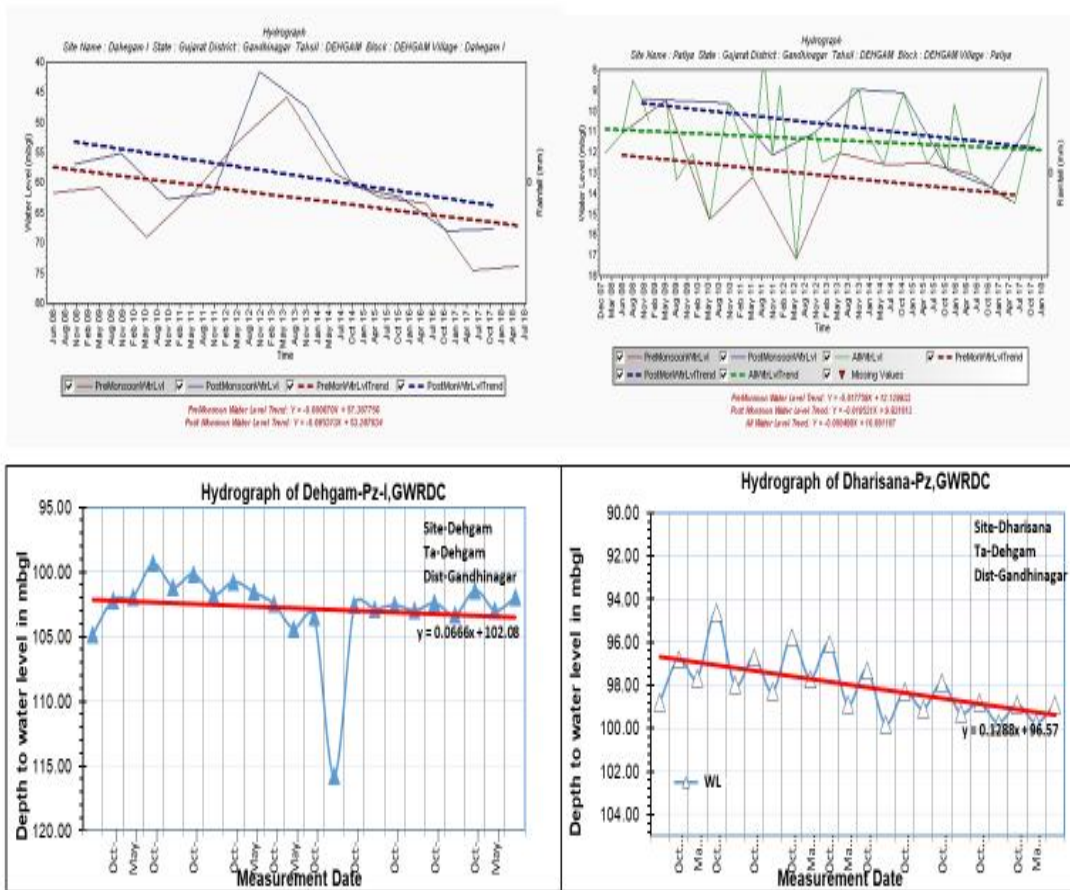
- *Present demand for All Usage: 14805.82 ham.
- *Annual Ground Water allocation for Domestic use as on 2025 is 482.00 ham.
- *Net Ground Water availability for future use is 0.00 ham.

Aquifer Management plan

Groundwater Management Issues

Over-Exploitation of Ground Water and Declining trend in ground water levels of both Phreatic and Confined Aquifers.

- As per GWRE-2017 Dahegam taluka is Over Exploited.



Selected Hydrographs showing declining WL Trend

Groundwater Management Plan SUPPLY SIDE MANAGEMENT

- As per Masterplan for Artificial Recharge to Ground Water in Gujarat state 2013, Non committed run off available for recharge is 3.16 MCM for entire Dahegam taluka of Gandhinagar district.
- During(2013 to 2019) 108 Check Dams and 4 Percolation tanks has been constructed for Ground Water recharge which can accommodate 5.8 MCM recharge to Ground Water.
- At present No additional / Surplus runoff is available.

DEMAND SIDE MANAGEMENT

- As on date 8802 ha area is covered under Micro Irrigation System. An additional area of 9932 ha can be brought under Micro Irrigation System which would save 14.90 MCM Ground Water which in turn will improve the Stage of Ground Water Extraction as shown in following table.

Change in GW Scenario after introducing additional area under MIS in Dahegam Taluka																	
Sr No	Taluka	Net Annual Ground Water Availability (mcm) 2017	Net Annual Ground Water Availability (mcm) after reducing GW irrigation return flow 2017	Irrigation Draft (mcm) 2017	Domestic And Industrial uses Draft 2017	Total Draft (mcm) 2017	Gross Irrigated Area by GW (Ha)	Area already Covered under MIS (Ha) GGKC	Area Proposed under MIS* (Ha)	Δ GW Requirement	Irrigation Draft for MIS (mcm)	Irrigation Draft After MIS (mcm)	Total Draft after MIS (mcm)	Stage of Ground Water Development (%) (GWRE 2017)	Category (GWRE 2017)	Stage of Ground Water Development (%) after MIS	Category after MIS
1	Dahegam	139.26	135.24	143.69	4.36	148.05	22990	8802	9932	0.5	14.90	128.79	133.15	106.31	OE	98.46	Critical
*Irrigation Draft for MIS=(Area Proposed under MIS*Δ GW Requirement*0.3)/100																	
70% of the remaining GIA proposed for Micro Irrigation																	

AR & Conservation Possibilities

No water conservation structures like Check dams / Percolation tanks are suggested as Non Committed runoff is not available in Dahegam taluka. However adoption of Micro Irrigation system in 9932 ha area of the Dahegam taluka would lead to considerable saving of ground water and stage of Ground water Extraction in Dahegam taluka may improve from Over Exploited category to Critical Category.

Management Plan of Gandhinagar Block for Gandhinagar District, Gujarat state.

General Information

State Name

Gujarat

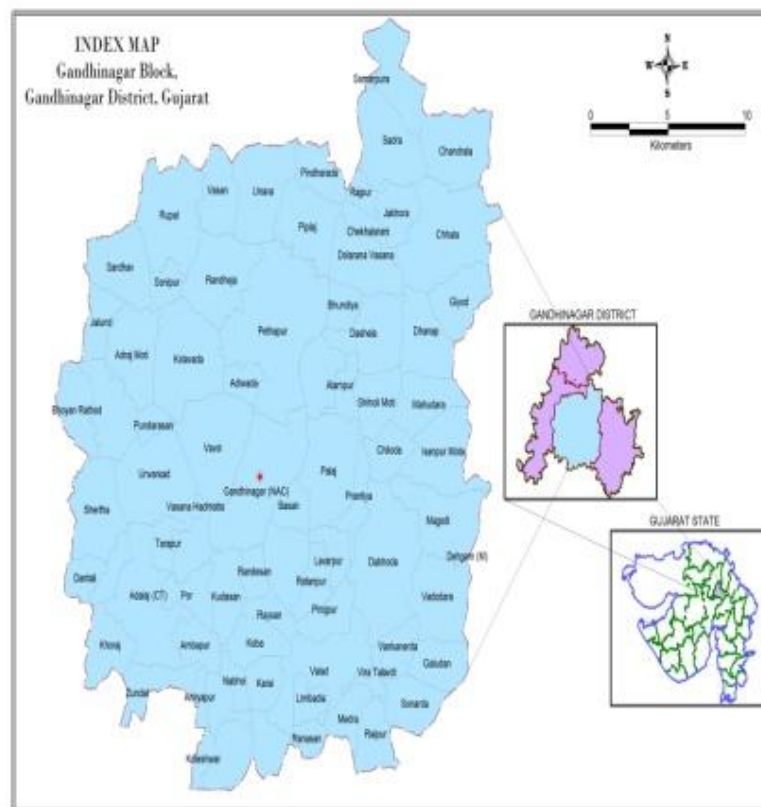
District name

Gandhinagar

Block

Gandhinagar

Location



Geographical Area: 813.52 sq. km.

Aquifer Mapping Area: 813.52 sq. km.

Area Under Major Crops: - Cotton, Castor, Paddy, Wheat, Bajri, Vegetables & Forage.

Gross Cropped Area: 82705 Ha

Net Sown Area: 48767 Ha

Area Sown more than once: 33938 Ha

Cropping Intensity %: 170 %

Irrigation Practices: Flooding: 32522 Ha, Rain fed: 34032 Ha & MIS: 4442 Ha.

Canal Command Area: 2236 Ha.

Area Irrigated by Ground Water: 32522 Ha. (32 Dug wells & 3022 Deep Tube Wells).

Basin/Sub-basin

Sabarmati/Meshwo and Khari

Principal Aquifer System

Quaternary Alluvium

Major Aquifer System

Older & Younger Alluvium



Normal Annual Rainfall

691 mm

Aquifer Disposition

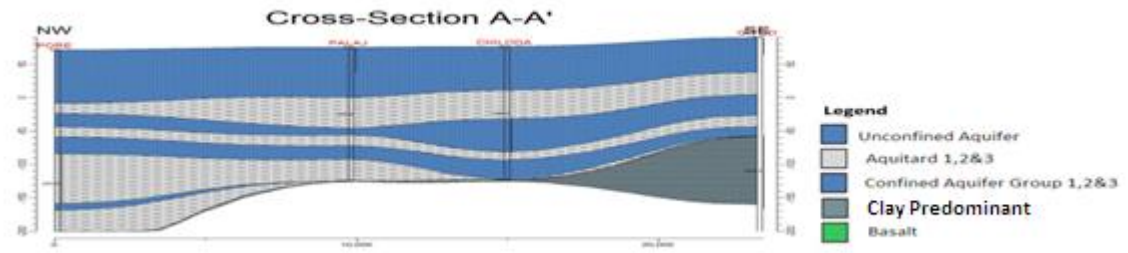
Aquifer Disposition

Four aquifer Groups: (Multi Layered aquifer system of Sand and Clay)

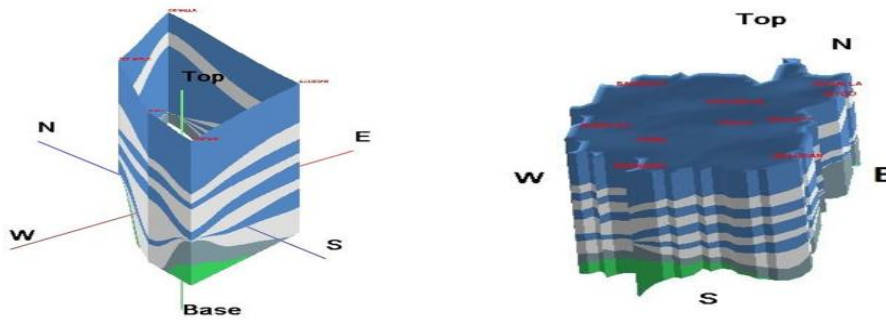
- The area has **multi-layer aquifer system**.
- The aquifers are of phreatic and confined (I, II, III) in nature.
- Blue clay (Tertiary) – A marker horizon between quaternary and tertiary aquifer systems.
- The depth of Tube wells range from about 50m in eastern part to more than 300m in western part.
- Tube wells tapping **Aquifer zones below Blue clay** are yielding relatively poor quality of groundwater and are with comparatively of higher temperature.

Sr No	TALUKA	PHREATIC AQUIFER DEPTH OF OCCURENCE (mbgl)	Confined Aquifer I Depth of occurrence (mbgl)	Confined Aquifer II depth of occurrence (mbgl)	Confined Aquifer III Depth of occurrence (mbgl)	Suitability	
						Drinking	Irrigation
1	GANDHINAGAR	0 to 70	115 to 150	175 to 200	245 to 300	Y	Y

Sub Surface Regionalised Aquifer Groups (Down to 300 m)



Aquifer section along Pore to Giyod



Fence & 3-D Aquifer Model of Gandhinagar Block

Aquifer Characteristics

Aquifer Characterisation and Disposition										
Stratigraphy	Aquifer Nomenclature	Lithological	Depth range	Thickness	Water Level (mbgl)	Quality(TDS)	Discharge	Transmissivity	Nature of aquifer	Remarks
		Characteristics	Aquifer	Range	Range	Range	Range	Range		
			(mbgl)	(m)	(mbgl)	Mg/l	lps	m ² /day		
Recent to Miocene	Un Confined Aquifer	Coarse sand, gravel, pebbles, medium and fine sands & clayey sand.	0 to 70	15-70	15 to 51	500 to 1300	0.1 to 12	-	Phreatic	Variable water quality
	Confined Aquifer I	Medium to coarse sand and gravel inter bedded with sandy clay	115-150	10 to 30	44 to 119	500 to 2000	0.1 to 30	11.35 to 88	Confined	Generally good water quality
	Confined Aquifer II	Fine to medium sand interbedded with sand and sandy clay	178-200	10 to 25	104 to 113	500 to 2000	1 to 20	39.69 to 445	Confined	Generally good water quality
	Confined Aquifer III	Medium sand interbedded with sandy clay	245-300	15-50	135 to 194	500 to 2980	1.75 to 25	53.13 to 237.44	Confined	Variable water quality

Groundwater Quality

- Predominantly Potable and fit for domestic, drinking, irrigation and other Industrial purposes. **Fluoride** in few samples is more than the permissible limits.
- Due to fluoride there is no major health issue because for drinking water people are using Narmada Canal Water.

Groundwater Resource

- *GW Availability 13323.67 ham (Dynamic)
- *GW Draft 13859.66 ham
- *Stage of GW Development 104.02%
- *Total Ground Water resource including both dynamic & In storage for district is 63063.67 ham. (Dynamic: 13323.67 ham & In storage: 49740 ham)

Existing and Future Water Demand

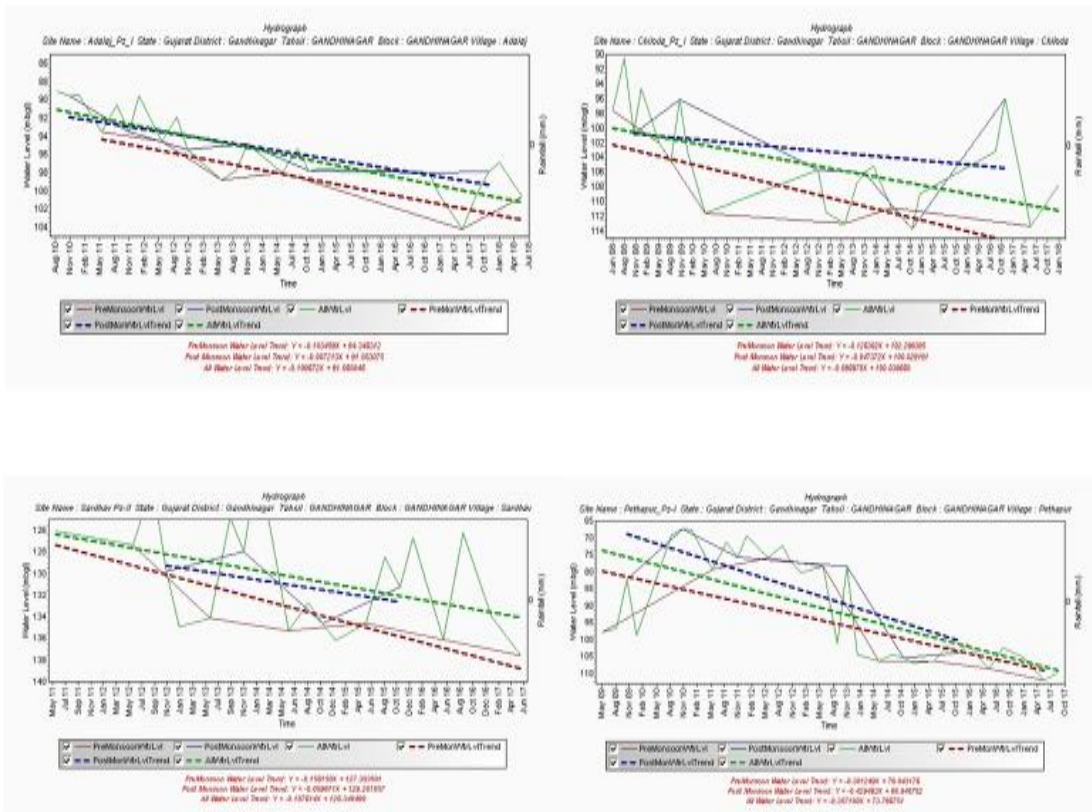
- *Present demand for All Usage: 13859.66 ham.
- *Annual Ground Water allocation for Domestic use as on 2025 is 1006.00 ham.
- *Net Ground Water availability for future use is 0.00 ham.

Aquifer Management plan

Groundwater Management Issues

Over-Exploitation of Ground Water and Declining trend in ground water levels of Confined Aquifers.

- As per GWRE-2017 Ganhinagar taluka is Over Exploited.



Select Hydrographs showing declining WL Trend

Groundwater Management Plan SUPPLY SIDE MANAGEMENT

- As per Masterplan for Artificial Recharge to Ground Water in Gujarat state 2013, Non committed run off available for recharge is 4.38 MCM for entire Gandhinagar taluka of Gandhinagar district.
- During(2013 to 2019) 498 Check Dams and 5 Percolation tanks has been constructed for Ground Water recharge which can accommodate 25.4 MCM recharge to Ground Water.
- At present No additional / Surplus runoff is available.

DEMAND SIDE MANAGEMENT

- As on date 4442 ha area is covered under Micro Irrigation System. An additional area of 11392 ha can be brought under Micro Irrigation System which would save 17.09 MCM Ground Water which in turn will improve the Stage of Ground Water Extraction as shown in following table.

Change in GW Scenario after introducing additional area under MIS in Gandhinagar Taluka																	
Sr No	Taluka	Net Annual Ground Water Availability (mcm) 2017	Net Annual Ground Water Availability (mcm) after reducing GW irrigation return flow 2017	Irrigation Draft (mcm) 2017	Domestic And Industrial Uses Draft 2017	Total Draft (mcm) 2017	Gross Irrigated Area by GW (Ha)	Area already Covered under MIS (Ha) GGRC	Area Proposed under MIS* (Ha)	Δ GW Requirement	Irrigation Draft for MIS (mcm)	Irrigation Draft After MIS (mcm)	Total Draft after MIS (mcm)	Stage of Ground Water Development (%) (GWRE 2017)	Category (GWRE 2017)	Stage of Ground Water Development (%) after MIS	Category after MIS
1	Gandhinagar	133.23	129.60	129.48	9.16	138.64	20716	4442	11392	0.5	17.09	112.39	121.55	104.02	OE	93.79	Critical
*Irrigation Draft for MIS=(Area Proposed under MIS*Δ GW Requirement*0.3)/100																	
70% of the remaining GIA proposed for Micro Irrigation																	

AR & Conservation Possibilities

No water conservation structures like Check dams / Percolation tanks are suggested as Non-Committed runoff is not available in Gandhinagar taluka. However, adoption of Micro Irrigation system in 11392 ha area of the Gandhinagar taluka would lead to considerable saving of ground water and stage of Ground water Extraction in Gandhinagar taluka may improve from Over Exploited category to Critical Category.

Management Plan of Kalol Block for Gandhinagar District, Gujarat state.

General Information

State Name

Gujarat

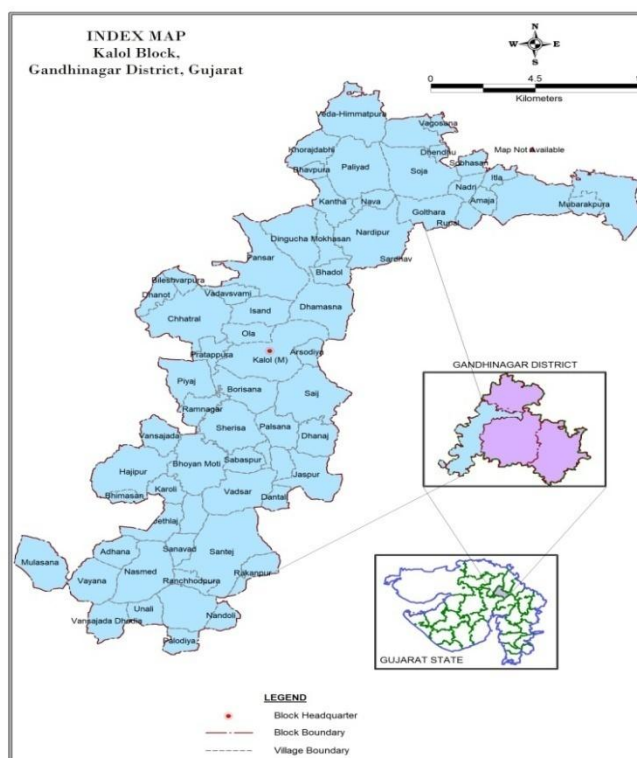
District name

Gandhinagar

Block

Kalol

Location



Geographical Area: 430.99 sq. km.

Aquifer Mapping Area: 430.99 sq. km.

Area Under Major Crops: - Cotton, Castor, Paddy, Wheat, Bajri, Vegetables & Forage.

Gross Cropped Area: 63237 Ha

Net Sown Area: 40819 Ha

Area Sown more than once: 22418 Ha

Cropping Intensity %: 182 %

Irrigation Practices: Flooding: 25289 Ha, Rain fed: 7243 Ha & MIS: 903 Ha.

Canal Command Area: 263.86 Ha.

Area Irrigated by Ground Water: 25286 Ha. (0 Dug wells & 1365 Deep Tube Wells).

Geographical Area

430.99 sq. km.

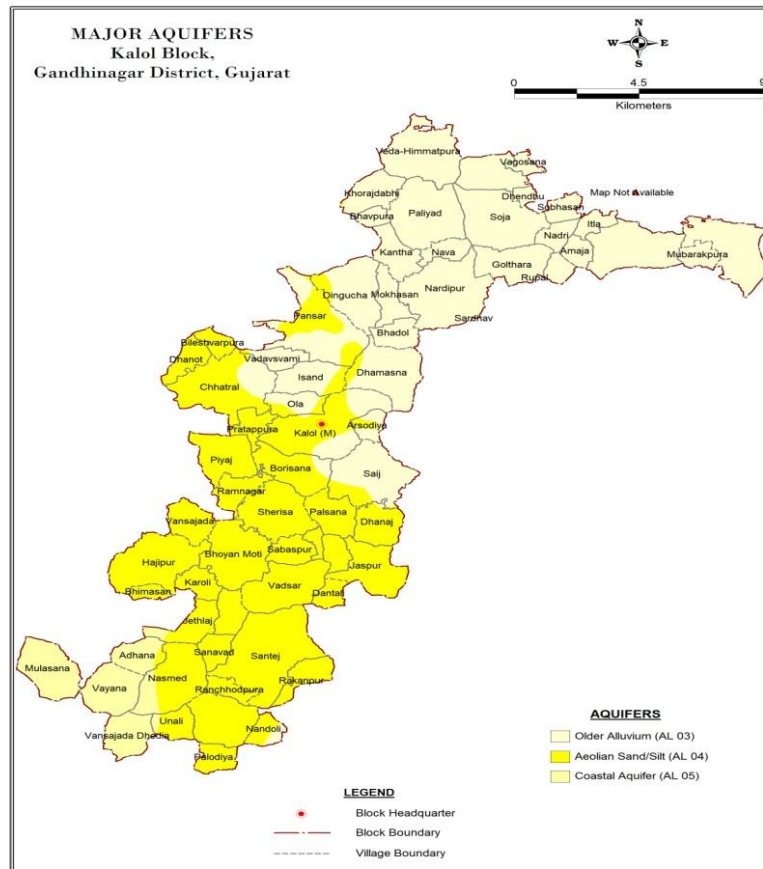
Basin/Sub-basin

Sabarmati/Meshwo and Khari

Principal Aquifer System

Quaternary Alluvium

Major Aquifer System
Older & Younger Alluvium



Normal Annual Rainfall
767.36 mm

Aquifer Disposition

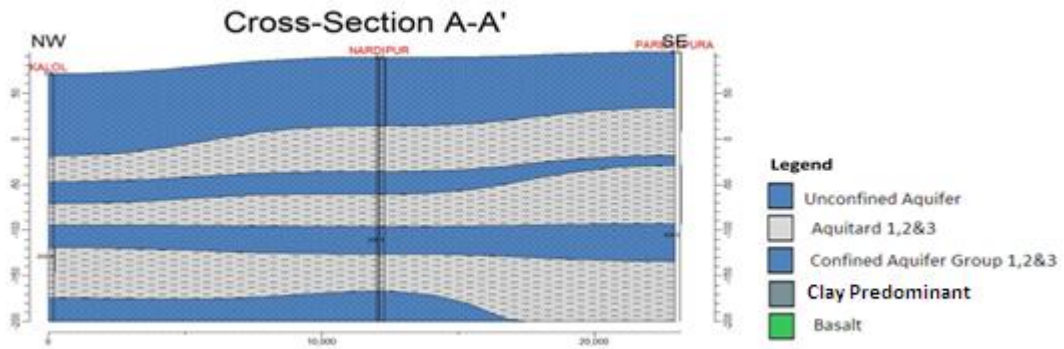
Aquifer Disposition

Four aquifer Groups: (Multi Layered aquifer system of Sand and Clay)

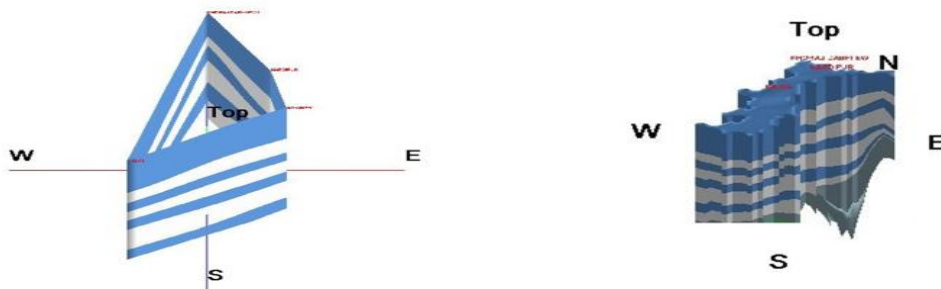
- The area has **multi-layer aquifer system**.
- The aquifers are of phreatic and confined (I, II, III) in nature.
- Blue clay (Tertiary) – A marker horizon between quaternary and tertiary aquifer systems.
- Tube wells tapping **Aquifer zones below Blue clay** are yielding relatively poor quality of groundwater and are with comparatively of higher temperature.

Sr No	TALUKA	PHREATIC AQUIFER DEPTH OF OCCURENCE (mbgl)	Confined Aquifer I Depth of occurrence (mbgl)	Confined Aquifer II depth of occurrence (mbgl)	Confined Aquifer III Depth of occurrence (mbgl)	Suitability	
						Drinking	Irrigation
1	KALOL	0 to 90	110 to 150	165 to 190	240 to 300	Y	Y

Sub Surface Regionalised Aquifer Groups (Down to 300 m)



Aquifer section along Kalol to Parbatpura



Fence & 3-D Aquifer Model of Kalol Block

Aquifer Characteristics

Aquifer Characterisation and Disposition										
Stratigraphy	Aquifer Nomenclature	Lithological	Depth range	Thickness	Water Level (mbgl)	Quality(TDS)	Discharge	Transmissivity	Nature of aquifer	Remarks
		Characteristics	Aquifer	Range	Range	Range	Range	Range		
			(mbgl)	(m)	(mbgl)	Mg/l	lps	m ² /day		
Recent to Miocene	Un Confined Aquifer	Coarse sand, gravel, pebbles, medium and fine sands & clayey sand.	0 to 90	15-90	14 to 71	500 to 1300	0.1 to 12	-	Phreatic	Variable water quality
	Confined Aquifer I	Medium to coarse sand and gravel inter bedded with sandy clay	110-150	10 to 30	39 to 117	500 to 2000	0.1 to 30	11.35 to 88	Confined	Generally good water quality
	Confined Aquifer II	Fine to medium sand interbedded with sand and sandy clay	165-190	10 to 25	54 to 152	500 to 2000	1 to 20	39.69 to 445	Confined	Generally good water quality
	Confined Aquifer III	Medium sand interbedded with sandy clay	240-300	15-50	135 to 160	500 to 2980	1.75 to 25	53.13 to 237.44	Confined	Variable water quality

Groundwater Quality

- Predominantly Potable and fit for domestic, drinking, irrigation and other Industrial purposes. **Fluoride** in few samples is more than the permissible limits.
- Due to fluoride there is no major health issue because for drinking water people are using Narmada Canal Water.

Groundwater Resource

- *GW Availability 11137.28 ham (Dynamic)
- *GW Draft 12700.25 ham
- *Stage of GW Development 114.03%
- *Total Ground Water resource including both dynamic & In storage for district is 33851.28 ham. (Dynamic: 11137.28 ham & In storage: 22714 ham)

Existing and Future Water Demand

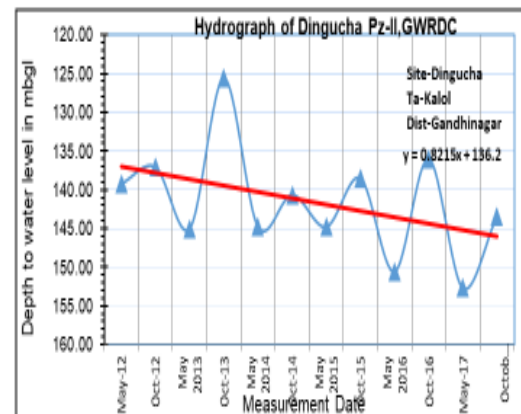
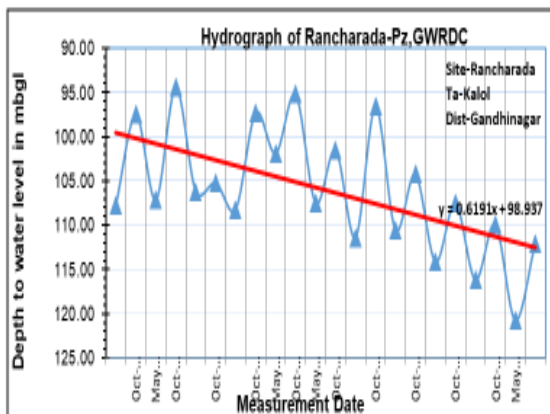
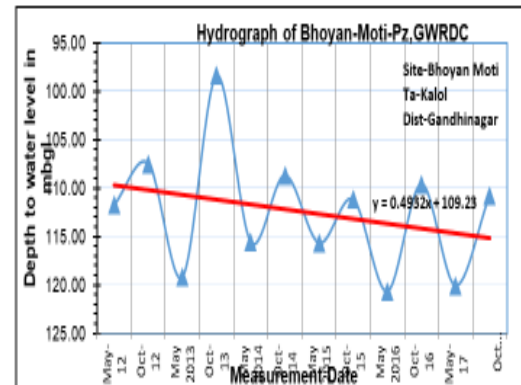
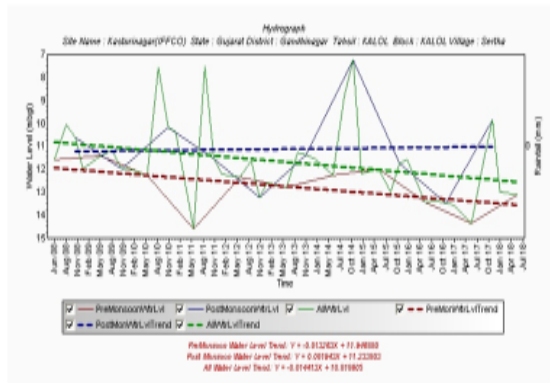
- *Present demand for All Usage: 12700.25 ham.
- *Annual Ground Water allocation for Domestic use as on 2025 is 639.00 ham.
- *Net Ground Water availability for future use is 0.00 ham.

Aquifer Management plan

Groundwater Management Issues

Over-Exploitation of Ground Water and Declining trend in ground water levels of Phreatic and Confined Aquifers.

- As per GWRE-2017 Kalol taluka is Over Exploited.



Selected Hydrographs showing declining WL Trend

Groundwater Management Plan SUPPLY SIDE MANAGEMENT

- As per Masterplan for Artificial Recharge to Ground Water in Gujarat state 2013, Non committed run off available for recharge is 2.31 MCM for entire Kalol taluka of Gandhinagar district..
- During(2013 to 2019) 97 Check Dams and 3 Percolation tanks has been constructed for Ground Water recharge which can accommodate 5.15 MCM recharge to Ground Water.
- At present No additional / Surplus runoff is available.

DEMAND SIDE MANAGEMENT

- As on date 903 ha area is covered under Micro Irrigation System. An additional area of 12944 ha can be brought under Micro Irrigation System which would save 19.42 MCM Ground Water which in turn will improve the Stage of Ground Water Extraction as shown in following table.

Change in GW Scenario after introducing additional area under MIS in Kalol Taluka																	
Sr No	Taluka	Net Annual Ground Water Availability (mcm) 2017	Net Annual Ground Water Availability (mcm) after reducing GW Irrigation return flow 2017	Irrigation Draft (mcm) 2017	Domestic And Industrial uses Draft 2017	Total Draft (mcm) 2017	Gross Irrigated Area by GW (Ha)	Area already Covered under MIS (Ha) GSFC	Area Proposed under MIS* (Ha)	Δ GW Requirement	Irrigation Draft for MIS (mcm)	Irrigation Draft After MIS (mcm)	Total Draft after MIS (mcm)	Stage of Ground Water Development (%) (GWRE 2017)	Category (GWRE 2017)	Stage of Ground Water Development (%) after MIS	Category after MIS
1	Kalol	111.37	107.98	121.21	5.79	127.00	19394	903	12944	0.5	19.42	101.79	107.58	114.03	OE	99.63	Critical
*Irrigation Draft for MIS=(Area Proposed under MIS*Δ GW Requirement*0.3)/100																	
70% of the remaining GIA proposed for Micro Irrigation																	

AR & Conservation Possibilities

No water conservation structures like Check dams / Percolation tanks are suggested as Non-Committed runoff is not available in Kalol taluka. However, adoption of Micro Irrigation system in 12944 ha area of the Kalol taluka would lead to considerable saving of ground water and stage of Ground water Extraction in Kalol taluka may improve from Over Exploited category to Critical Category.

Management Plan of Mansa Block for Gandhinagar District, Gujarat state.

General Information

State Name

Gujarat

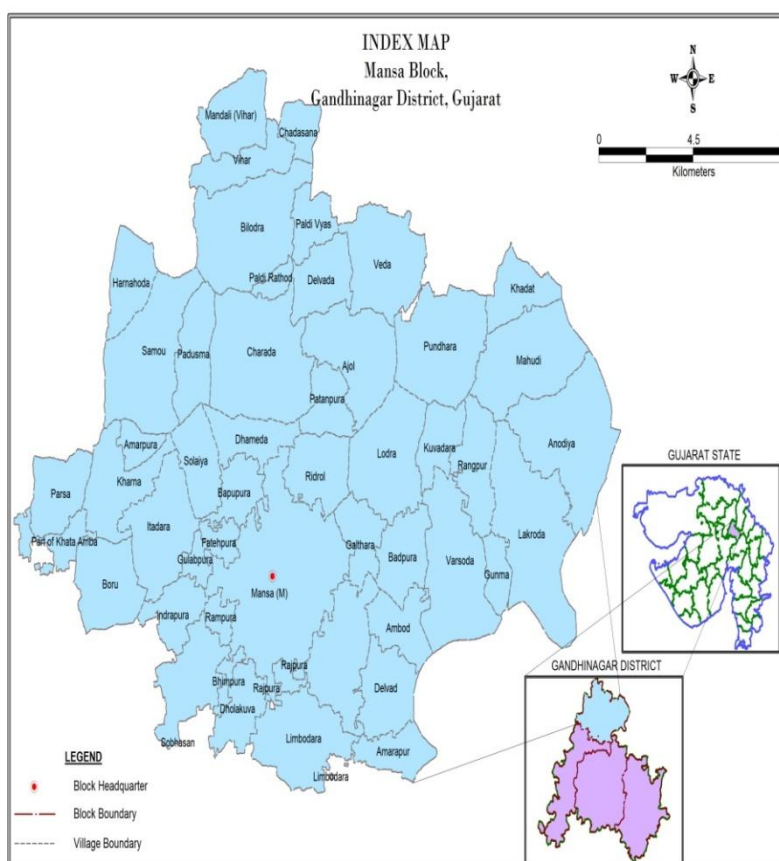
District name

Gandhinagar

Block

Mansa

Location



Geographical Area: 399.93 sq. km.

Aquifer Mapping Area: 399.93 sq. km.

Area Under Major Crops: - Cotton, Castor, Paddy, Wheat, Bajri, Vegetables & Forage.

Gross Cropped Area: 54522 Ha

Net Sown Area: 29282 Ha

Area Sown more than once: 25240 Ha

Cropping Intensity %: 116 %

Irrigation Practices: Flooding: 39956 Ha, Rain fed: 9315 Ha & MIS: 883 Ha.

Canal Command Area: 283.74 Ha.

Area Irrigated by Ground Water: 39956 Ha. (0 Dug wells & 1468 Deep Tube Wells).

Geographical Area

399.93 sq. km.

Basin/Sub-basin

Sabarmati/Meshwo and Khari

Principal Aquifer System

Quaternary Alluvium

Major Aquifer System

Older & Younger Alluvium



Normal Annual Rainfall

777.84 mm

Aquifer Disposition

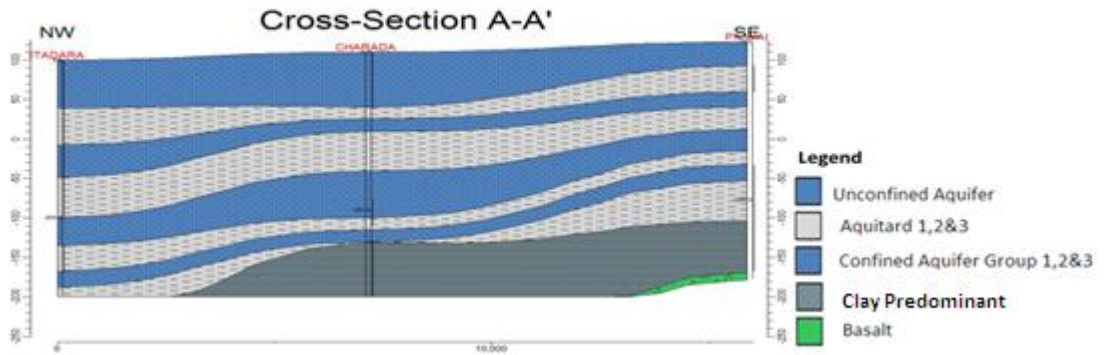
Aquifer Disposition

Four aquifer Groups: (Multi Layered aquifer system of Sand and Clay)

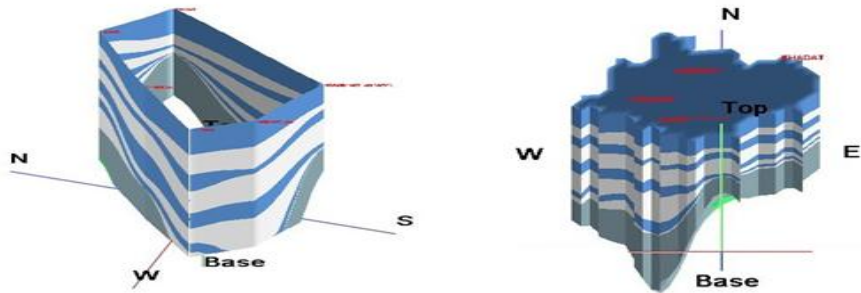
- The area has **multi-layer aquifer system**.
- The aquifers are of phreatic and confined (I, II, III) in nature.
- Blue clay (Tertiary) – A marker horizon between quaternary and tertiary aquifer systems.
- The depth of Tube wells range from about 100m in eastern part to more than 300m in western part.
- Tube wells tapping **Aquifer zones below Blue clay** are yielding relatively poor quality of groundwater and are with comparatively of higher temperature.

Sr No	TALUKA	PHREATIC AQUIFER DEPTH OF OCCURENCE (mbgl)	Confined Aquifer I Depth of occurrence (mbgl)	Confined Aquifer II depth of occurrence (mbgl)	Confined Aquifer III Depth of occurrence (mbgl)	Suitability	
						Drinking	Irrigation
1	MANSA	0 to 70	100 to 150	185 to 210	260 to 300	Y	Y

Sub Surface Regionalised Aquifer Groups (Down to 300 m)



Aquifer section along Itadra to Pilwai



Fence & 3-D Aquifer Model of Mansa Block

Aquifer Characteristics

Aquifer Characterisation and Disposition										
Stratigraphy	Aquifer Nomenclature	Lithological	Depth range	Thickness	Water Level (mbgl)	Quality(TDS)	Discharge	Transmissivity	Nature of aquifer	Remarks
		Characteristics	Aquifer	Range	Range	Range	Range	Range		
			(mbgl)	(m)	(mbgl)	Mg/l	lps	m ² /day		
Recent to Miocene	Un Confined Aquifer	Coarse sand, gravel, pebbles, medium and fine sands & clayey sand.	0 to 70	15-90	31to 65	500 to 1300	0.1 to 12	-	Phreatic	Variable water quality
	Confined Aquifer I	Medium to coarse sand and gravel inter bedded with sandy clay	100-150	10 to 30	38 to 110	500 to 2000	0.1 to 30	11.35 to 88	Confined	Generally good water quality
	Confined Aquifer II	Fine to medium sand interbedded with sand and sandy clay	85-210	10 to 50	100 to 161	500 to 2000	1 to 20	39.69 to 445	Confined	Generally good water quality
	Confined Aquifer III	Medium sand interbedded with sandy clay	260-300	15-50	135 to 194	500 to 2980	1.75 to 25	53.13 to 237.44	Confined	Variable water quality

Groundwater Quality

- Predominantly Potable and fit for domestic, drinking, irrigation and other Industrial purposes. **Fluoride** in few samples is more than the permissible limits.
- Due to fluoride there is no major health issue because for drinking water people are using Narmada Canal Water.

Groundwater Resource

- *GW Availability 8619.96 ham (Dynamic)
- *GW Draft 12011.98 ham
- *Stage of GW Development 139.35%
- *Total Ground Water resource including both dynamic & In storage for district is 23911.96 ham. (Dynamic: 8619.96 ham & In storage: 15292 ham)

Existing and Future Water Demand

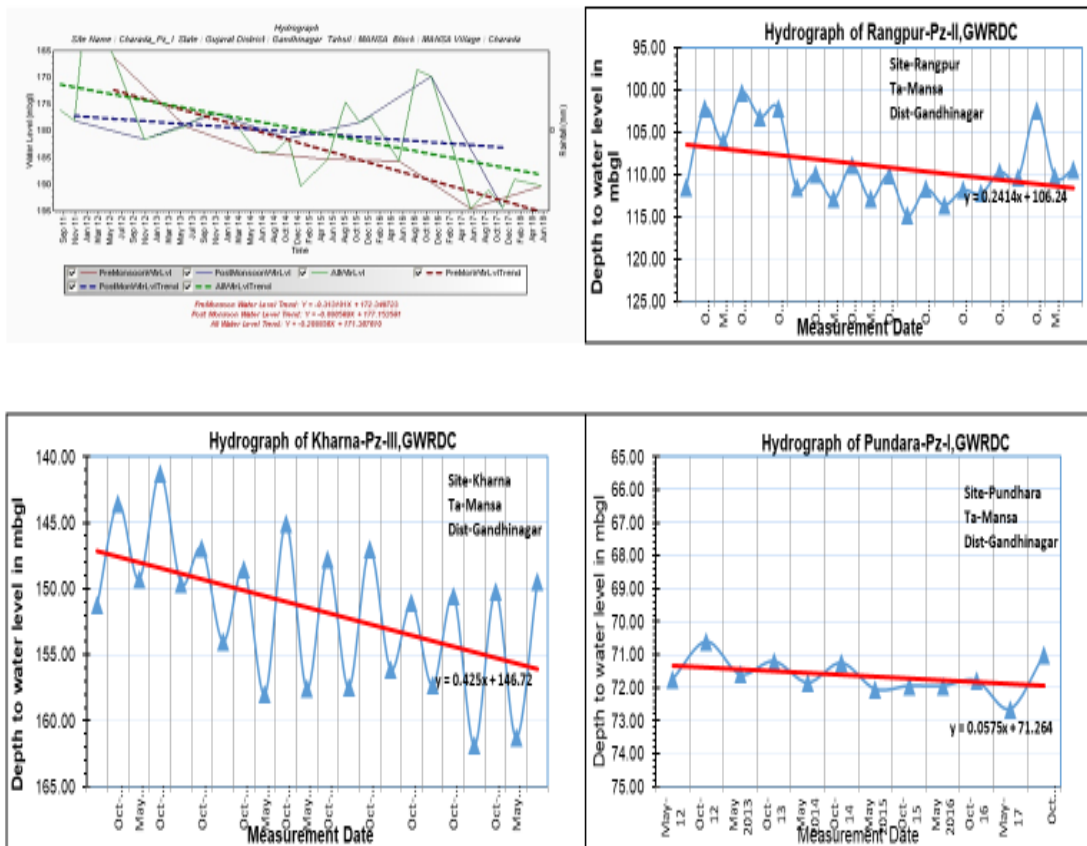
- *Present demand for All Usage: 12011.98 ham.
- *Annual Ground Water allocation for Domestic use as on 2025 is 371.00 ham.
- *Net Ground Water availability for future use is 0.00 ham.

Aquifer Management plan

Groundwater Management Issues

Over-Exploitation of Ground Water and Declining trend in ground water levels of Phreatic and Confined Aquifers.

- As per GWRE-2017 Mansa taluka is Over Exploited.



Selected Hydrographs showing declining WL Trend

Groundwater Management Plan

SUPPLY SIDE MANAGEMENT

- As per Masterplan for Artificial Recharge to Ground Water in Gujarat state 2013, Non committed run off available for recharge is 2.19 MCM for entire Mansa taluka of Gandhinagar district..
- During(2013 to 2019) 134 Check Dams and 56 Percolation tanks has been constructed for Ground Water recharge which can accommodate 12.3 MCM recharge to Ground Water.
- At present No additional / Surplus runoff is available.

DEMAND SIDE MANAGEMENT

- As on date 883 ha area is covered under Micro Irrigation System. An additional area of 12495 ha can be brought under Micro Irrigation System which would save 18.69 MCM Ground Water but there will no improvement in the Stage of Ground Water Extraction as shown in following table.

Change in GW Scenario after introducing additional area under MIS and Recharge in Mansa Taluka																	
Sr No	Taluka	Net Annual Ground Water Availability (mcm) 2017	Net Annual Ground Water Availability (mcm) after reducing GW Irrigation return flow 2017	Irrigation Draft (mcm) 2017	Domestic And Industrial uses Draft 2017	Total Draft (mcm) 2017	Gross Irrigated Area by GW (Ha)	Area already Covered under MIS (Ha) GGRC	Area Proposed under MIS* (Ha)	Δ GW Requirement	Irrigation Draft for MIS (mcm)	Irrigation Draft After MIS (mcm)	Total Draft after MIS (mcm)	Stage of Ground Water Development (%) (GWRE 2017)	Category (GWRE 2017)	Stage of Ground Water Development (%) after MIS	Category after MIS
1	Mansa	86.19	82.92	116.76	3.35	120.11	18682	883	12459	0.5	18.69	98.07	101.42	139.35	OE	122.31	OE
*Irrigation Draft for MIS=(Area Proposed under MIS*Δ GW Requirement*0.3)/100																	
70% of the remaining GIA proposed for Micro Irrigation																	

AR & Conservation Possibilities

No water conservation structures like Check dams / Percolation tanks are suggested as Non Committed runoff is not available in Mansa taluka. However adoption of Micro Irrigation system in 12459 ha area of the Mansa taluka would lead to considerable saving of ground water but there will no improvement in the Stage of Ground Water Extraction in Mansa taluka it remains in same Over Exploited category.

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8. Narmada Water Resources, Water supply &Kalpsar Department, Govt. Of Gujarat, Mukteshwar Irrigation Scheme, Salient features.
9. Narmada Water Resources, Water supply &Kalpsar Department, Govt. Of Gujarat, Gandhinagar.

And several other unpublished reports of CGWB and Govt websites.

Annexure 1 Unconfined Pre-Post WL, Decadal Average, Fluctuation and Water Table list

Sr.No.	Tahsil / Taluk	Village	Geology	Elevation of Ground Level	Latitude	Longitude	Drilled Depth	Water Level October 2007	Water Level October 2008	Water Level October 2009	Water Level October 2010	Water Level October 2011	Water Level October 2012	Water Level October 2013	Water Level October 2014	Water Level October 2015	Water Level October 2016	Decadal Average	Water Level October 2017	Fluctuation	Water table
1	Dehgam	Devkaran Na Muvada	ALV	82	23.12	72.95	19.5	10.1	8.3	10.1	10.2	16.1	16.2	15.2	13.2	14.7	15.45	12.96	15.2	-2.24	66.8
2	Dehgam	Palaiya	ALV	77	23.17	72.84	17	9.4	10.95	11.55	13.55	12.25	11.55	10.25	9.75	12.25	14.65	11.61	15.3	-3.69	61.7
3	Dehgam	Harsoli	ALV	63	23.07	72.82	90						44.6	45.1	44	43.9	44.9	44.5	48.3	-3.8	14.7
4	Dehgam	Hilol	ALV	62	23.02	72.88	90						39.6	33.5	32.1	33	29.9	33.62	32.25	1.37	29.75
5	Dehgam	Kadjodra	ALV	83	23.16	72.95	48						36.4	38	36.8	37.25	39.25	37.54	45.8	-8.26	37.2
6	Dehgam	Rakhiyal	ALV	96	23.25	72.91	60						40.2	36.5	33.4	33.8	33.55	35.49	33.75	1.74	62.25
7	Dehgam	Patna Kuva	ALV	101	23.29	72.88	90						65.3	64.8	63.7	64.7	64.9	64.68	62.5	2.18	38.5
8	Dehgam	Antroli	ALV	80	23.16	72.90	60						37.3	38	35.7	33.2	34.8	35.8	34.7	1.1	45.3
9	Dehgam	Devkaran Na Muvada	ALV	82	23.12	72.96	55	17.8	18.75	20.75	23.1	23.95	24.5	22.25	21	21.6	22.9	21.66	23.2	-1.54	58.8
10	Dehgam	Jindva	ALV	88	23.21	72.95	63.41	28.5	28.45	32.2	33.15	35.2	36.2	35.9	35.7	36	36.2	33.75	36.3	-2.55	51.7
11	Dehgam	Sanoda	ALV	82	23.21	72.81	88	31.8	34.6	35.7	39.2	55.2	55	33.5	33.2	33.85	32.6	38.46	33.3	5.16	48.7
12	Gandhinagar	Bhat-II	ALV	55	23.10	72.63	76						37.8	37.75	38.95	39.7	40.9	39.02	41.6	-2.58	13.4
13	Gandhinagar	Gandhinagar-II	ALV	75	23.20	72.60	90						53.6	51.1	50.7	51	51.3	51.54	49.4	2.14	25.6
14	Gandhinagar	Karai	ALV	59	23.14	72.66	60						37.1	36.6	36.2	35.2	37.4	36.5	36	0.5	23
15	Gandhinagar	Koteshwar	ALV	54	23.09	72.62	60						22.1	21.5	24.8	24.7	24.5	23.52	23.6	-0.08	30.4
16	Gandhinagar	Magodi	ALV	75	23.20	72.77	90						59	58.8	58.7	58.7	58.65	58.77	57.7	1.07	17.3
17	Gandhinagar	Valad	ALV	63	23.14	72.69	90						66	65.2	65.3	65.25	65.4	65.43	65	0.43	-2
18	Kalol	Mubarakpura	ALV	92	23.35	72.68	90						72.1	71.4	74.3	72.4	71.6	72.36	71.2	1.16	20.8
19	Mansa	Bilodra	ALV	117	23.52	72.66	90						61.9	63.7	65.15	65.25	66.6	64.52	65.5	-0.98	51.5
20	Mansa	Delvad	ALV	82	23.38	72.72	90						52.5	53.2	51.2	50.55	51.2	51.73	52	-0.27	30
21	GANDHINAGAR	Adalaj_Pz_III	ALV	64	23.17	72.56	47				23.72	23.78	24.3	22.83	24.55			23.84	23.45	0.39	40.55

22	MANSA	Amrapur Pziii	ALV	94	23.37	72.71	72						59.18	58.9	57.65			58.58	31.76	26.82	62.24
23	DEHGAM	Dahegam II	ALV	75	23.17	72.84	67	6.27	7.85	10.08	11.32	6.63			4.05			7.7	3.03	4.67	71.97
24	KALOL	Kasturinagar(I FFCO)	ALV	74	23.19	72.55	48	11.3	10.63	12	10.19	11.56	13.22	11.38	7.25	11.73	13.48	11.27	9.85	1.42	64.15
25	MANSA	Lodra	ALV	111	23.46	72.72	60								53.1	54.28	45.43	50.94	51.55	-0.61	59.45
26	DEHGAM	Paliya	ALV	77	23.17	72.84	50.0 1	10.05	9.43		9.62	12.12	11.02	8.94	9.12	12.87	13.69	10.76	10.17	0.59	66.83
27	GANDHIN AGAR	Serthapara1	ALV	66	23.19	72.57	21.4 5	10.9	11.68	12.68	11.82	13.08	13.42	12.74	9.1	11.36	13.11	11.99	10.1	1.89	55.9

Annexure 2 Confined Aquifer I Decadal Average, Fluctuation and Water Table list

Sr.No.	Tahsil / Taluk	Village	Geology	Elevation of Ground Level	Y_LAT	X_LONG	Drilled Depth	Aquifer	Decadal Avarage	Water Level May 2017	Fluctuation	Water Table
1	Kalol	Dingucha-I	ALV	82	23.331111	72.512222	150	Confined-I	118.43	117.5	0.93	-35.5
2	Kalol	Limbodara	ALV	101	23.382778	72.675556	140	Confined-I	79.32	79.2	0.12	21.8
3	Kalol	Nasmed(Dabhla)	ALV	51	23.098611	72.416389	120	Confined-I	41.69	39.3	2.39	11.7
4	Mansa	Pundhara-I	ALV	113	23.482222	72.740278	100	Confined-I	71.84	72.65	-0.81	40.35
5	Gandhinagar	Isanpur Mota-I	ALV	80	23.215556	72.773333	120	Confined-I	92	93.64	-1.64	-13.64
6	Gandhinagar	Medra	ALV	66	23.12	72.705833	121	Confined-I	68.38	68.65	-0.27	-2.65
7	Gandhinagar	Shertha	ALV	68	23.198889	72.551111	120	Confined-I	89.9	92.3	-2.4	-24.3
8	Gandhinagar	Unava	ALV	86.42	24.3675	72.657222	120	Confined-I	89.44	88.1	1.34	-1.68
9	Gandhinagar	Koba	ALV	66	23.138333	72.643056	120	Confined-I	63.99	70.4	-6.41	-4.4
10	Gandhinagar	Bhat-I	ALV	58	23.105	72.635556	120	Confined-I	80.57	83.6	-3.03	-25.6
11	Gandhinagar	Adraj Moti	ALV	78	23.2625	72.568056	150	Confined-I	111.68	119.9	-8.22	-41.9
12	Gandhinagar	Isanpur Mota-II	ALV	80	23.215833	72.773333	150	Confined-I	112.65	114.9	-2.25	-34.9
13	Gandhinagar	Indroda	ALV	71	23.2	72.658333	100	Confined-I	48.69	44.9	3.79	26.1
14	Kalol	Aluva	ALV	92	23.356389	72.71	120	Confined-I	94.72	94.3	0.42	-2.3
15	Mansa	Kharna-I	ALV	102	23.452778	72.591111	120	Confined-I	100.56	98.85	1.71	3.15

16	Mansa	Rangpur-I	ALV	116	23.459722	72.766667	120	Confined-I	38.27	38.7	-0.43	77.3
17	Mansa	Rangpur-II	ALV	116	23.459722	72.766944	150	Confined-I	110.92	110.2	0.72	5.8
18	Dehgam	Dehgam-II	ALV	74	23.169444	72.810278	135	Confined-I	104.12	103.2	0.92	-29.2
19	Dehgam	Dehgam-III	ALV	75	23.169722	72.810278	97	Confined-I	49.46	50.1	-0.64	24.9
20	Dehgam	Dharisana	ALV	95	23.257222	72.854722	133	Confined-I	98.73	99.75	-1.02	-4.75
21	GANDHINAGAR	Adalaj_Pz_II	ALV	66	23.175	72.558333	138	Confined-I	72.26	84.67	-12.41	-18.67
22	MANSA	Amrapur Pzii	ALV	94	23.373611	72.705	150.33	Confined-II	84.67	84.24	0.43	9.76
23	GANDHINAGAR	Gandhinagar II	ALV	79	23.234722	72.641667	120	Confined-I	82.46	91.83	-9.38	-12.83
24	GANDHINAGAR	Palaj_Pz-II	ALV	76	23.214444	72.690278	110	Confined-I	59.95		59.95	76
25	GANDHINAGAR	Pethapur_Pz-II	ALV	83	23.267222	72.673056	122	Confined-I	71.03	83.89	-12.86	-0.89

Annexure 3 Confined Aquifer II Decadal Average and Fluctuation

Sr.No	Tahsil / Taluk	Village	Elevation of Ground Level	Y_LAT	X_LONG	Drilled Depth	Aquifer	Water Level May 2007	Water Level May 2008	Water Level May 2009	Water Level May 2010	Water Level May 2011	Water Level May 2012	Water Level May 2013	Water Level May 2014	Water Level May 2015	Water Level May 2016	Decadal Average	Water Level May 2017	Fluctuation
1	Kalol	Dingucha-II	84	23.33	72.51	240	Confined-II						139.2	145	144.8	144.8	150.6	144.88	152.7	-7.82
2	Mansa	Pundhara-II	124	23.48	72.74	180	Confined-II						143.5	147	142	142.1	141.45	143.21	143.15	0.06
3	Gandhinagar	Gandhinagar	76.22	23.20	72.65	200	Confined-II	97.9	95.7	94.35	97.3	97.3	99.5	102.7	101.4	102.7	105.15	99.4	106.9	-7.5
4	Gandhinagar	Isanpur Mota-III	85.62	23.22	72.77	200	Confined-II	114.1	106.9	104.9	110.2	110.1	113.3	124.8	113.8	113.1	113.95	112.52	115.3	-2.78
5	Kalol	Bhoyan Moti	55	23.16	72.45	240	Confined-II						111.75	119.2	115.6	115.7	120.7	116.59	120.1	-3.51
6	Mansa	Kharna-III	98.76	23.45	72.59	200	Confined-II	151.25	149.3	149.6	154	158	157.6	157.5	156.1	157.35	161.9	155.26	161.3	-6.04
7	Kalol	Rancharada	47.46	23.07	72.44	240	Confined-II	107.75	107.15	106.2	108.2	101.9	107.5	111.4	110.55	114.15	116.2	109.1	120.8	-11.7
8	Kalol	Chhatral	66.4	23.27	72.45	200	Confined-II	112.65	111.4	112.25	118.1	118.1	117	119.4	116.95	115.1	117.25	115.82	120.2	-4.38
9	Dehgam	Dehgam-I	76.22	23.17	72.81	191	Confined-II	104.85	101.9	101.15	101.75	101.55	104.4	115.75	102.85	102.95	103.3	104.05	102.95	1.1
10	GANDHINAGAR	Adalaj_Pz_I	65	23.18	72.56	200	Confined-II					93.52	94.56	98.83	97.97			96.22	104.16	-7.94
11	MANSA	Amrapur Pzi	90	23.37	72.71	200.78	Confined-II					114.01	109.6	119.47	114.8	114.84	116.48	114.87	112.82	2.05
12	MANSA	Charada Pz -II	112	23.48	72.65	174	Confined-II					108.15	100.44	102.47	99.3	99.05	99.59	101.5	100.77	0.73

13	GANDHINAGAR	Chiloda_Pz_I	75	23.23	72.74	200	Confined-II	103.64	97.7	102.09	111.65			113.02	110.86			106.49	113.34	-6.85
14	GANDHINAGAR	Chiloda_Pz_II	75	23.23	72.74	166.97	Confined-II	103.87	97	102.78	111.65			102.47	110.86	109.84	111.43	106.24	113.45	-7.21
15	DEHGAM	Dahegam I	65	23.17	72.84	200	Confined-II	64.8	61.64	60.71	69.06	61.75	52.92	45.76	58.4	62.45	63.35	60.08	74.56	-14.48
16	KALOL	Kalol(Rep)_Pz_I	69	23.24	72.49	202.53	Confined-II				67.73	56.42	56.36		55.44		54.28	58.05	54.43	3.62
17	GANDHINAGAR	Palaj_Pz-I	78	23.21	72.69	200.78	Confined-II			95.41	100.58	100.62	101.38					99.5		99.5
18	GANDHINAGAR	Pethapur_Pz-I	80	23.27	72.67	200	Confined-II			97.83		79.38	75.98	78.5	106.48	106.5	108.6	93.32	112.01	-18.69

Annexure 4 Confined water Quality TDS						
Sr No	District	Taluka	Village	Y_LAT	X_LONG	Total Dissolved Solids-MAY-17
1	Gandhinagar	Gandhinagar	Bhat-II	23.105	72.63555556	410.00
2	Gandhinagar	Gandhinagar	Gandhinagar-II	23.23472222	72.64166667	800.00
3	Gandhinagar	Kalol	Dingucha-I	23.33111111	72.51222222	1590.00
4	Gandhinagar	Kalol	Dingucha-II	23.33083333	72.51222222	430.00
5	Gandhinagar	Kalol	Limbodara	23.38277778	72.67555556	830.00
6	Gandhinagar	Kalol	Nasmed	23.09861111	72.41638889	3210.00
7	Gandhinagar	Mansa	Pundhra-I	23.48222222	72.74027778	1300.00
8	Gandhinagar	Mansa	Pundhra-II	23.4825	72.74083333	1140.00
9	Gandhinagar	Gandhinagar	Indroda	23.2	72.65833333	430.00
10	Gandhinagar	Kalol	Bhoyan Moti	23.16305556	72.445	960.00
11	Gandhinagar	Gandhinagar	IsanpurMota-I	23.21555556	72.77333333	440.00
12	Gandhinagar	Gandhinagar	Medra	23.12	72.70583333	400.00
13	Gandhinagar	Gandhinagar	Unava	24.3675	72.65722222	710.00
14	Gandhinagar	Gandhinagar	Gandhinagar-I	23.20222222	72.64972222	770.00
15	Gandhinagar	Gandhinagar	Koba	23.13833333	72.64305556	520.00
16	Gandhinagar	Gandhinagar	Bhat-I	23.105	72.63555556	750.00
17	Gandhinagar	Gandhinagar	Adraj Moti	23.2625	72.56805556	1160.00
18	Gandhinagar	Gandhinagar	IsanpurMota-II	23.21583333	72.77333333	570.00
19	Gandhinagar	Gandhinagar	IsanpurMota-III	23.21583333	72.77333333	820.00
20	Gandhinagar	Kalol	Aluva	23.35638889	72.71	420.00
21	Gandhinagar	Mansa	Kharna-I	23.45277778	72.59111111	780.00
22	Gandhinagar	Mansa	Kharna-III	23.4525	72.59138889	660.00
23	Gandhinagar	Mansa	Rangpur-I	23.45972222	72.76666667	740.00
24	Gandhinagar	Mansa	Rangpur-II	23.45972222	72.76694444	990.00
25	Gandhinagar	Kalol	Rancharada	23.07138889	72.44	740.00
26	Gandhinagar	Kalol	Chhatral	23.27416667	72.44944444	1240.00
27	Gandhinagar	Dehgam	Dehgam-I	23.16916667	72.81	810.00
28	Gandhinagar	Dehgam	Dehgam-II	23.16944444	72.81027778	750.00
29	Gandhinagar	Dehgam	Dehgam-III	23.16972222	72.81027778	400.00
30	Gandhinagar	Dehgam	Dharisana	23.25722222	72.85472222	880.00

Annexure 5 Un Confined water Quality TDS						
Sr No	District	Taluka	Village	Y_LAT	X_LONG	Total Dissolved Solids-MAY-17
1	Gandhinagar	Dehgam	Harsoli	23.08	72.82	890.00
2	Gandhinagar	Dehgam	Hilol	23.03	72.88	1260.00
3	Gandhinagar	Dehgam	Kadjodra (ThambhaliyaJuna)	23.17	72.95	1320.00
4	Gandhinagar	Gandhinagar	Karai	23.14	72.66	580.00
5	Gandhinagar	Gandhinagar	Koteshwar	23.10	72.62	490.00
6	Gandhinagar	Dehgam	Patnakuva	23.29	72.88	700.00
7	Gandhinagar	Dehgam	Antroli	23.17	72.90	1130.00
8	Gandhinagar	Gandhinagar	Magodi	23.20	72.77	1060.00
9	Gandhinagar	Gandhinagar	Valad	23.14	72.69	970.00
10	Gandhinagar	Kalol	Mubarakpura	23.35	72.68	1130.00
11	Gandhinagar	Mansa	Bilodra	23.53	72.65	410.00
12	Gandhinagar	Mansa	Delvad	23.39	72.72	500.00
13	Gandhinagar	Dehgam	Devkaran-namuvada	23.13	72.96	350.00
14	Gandhinagar	Dehgam	Jindva	23.21	72.95	660.00
15	Gandhinagar	Dehgam	Sanoda	23.22	72.81	410.00

Annexure 6 Exploration Details drilled by CGWB

Sl.No	XLON G	YLAT	WELL_TYPE	VILLAGE	DISTRICT	TALUKA	DEPTH_DR	DEPTH_CONS	ZFrom
1	72.55	23.20	EW	Shertha	Gandhinagar	GANDHINAGAR	353.11	346	
2	72.56	23.20	OW	Sertha	Gandhinagar	kalol	453.00	344.00	202-331
3	72.68	23.50	EW-I	Delwada	Gandhinagar	Mansa	252.00	Abon	Abon.
4	72.68	23.50	EW-II	Delwada	Gandhinagar	Mansa	442.00	427.00	271-424
5	72.43	23.44	EW	Itadra	Gandhinagar	Mansa	452.00	441.00	377-438
6	72.43	23.44	OW	Itadra	Gandhinagar	Mansa	411.15	410.00	
7	72.78	23.49	EW-I	Mahudi	Gandhinagar	Mansa	324.11	212	169-175 182- 188 191-197 200-209
8	72.78	23.49	EW-II	Mahudi	Gandhinagar	Mansa	244	110	74-80 92-107
9	72.78	23.49	EW-III	Mahudi	Gandhinagar	Mansa	116.8	110	74-80 92-108
10	72.77	23.31	EW_I	Chhalla	Gandhinagar	Gandhinagar	34.60	-	-
11	72.77	23.31	EW-II	Chhalla	Gandhinagar	Gandhinagar	200.00	163.00	94-106 114-118 126-138 144-160
12	72.82	23.22	EW	Sanoda	Gandhinagar	Gandhinagar	200.00	177.00	117-123 138-144 153-159 163-166 168-174
13	72.77	23.50	EW	Khadat	Gandhinagar	Mansa	200.00	134.00	76-82 86-89 108-120 128-131
14	72.92	23.08	EW I	Bardoli	Gandhinagar	Dahegam	294.8	293.0	238-244,246-252,254-260,265-271,273-279,280-283,285-291
15	72.92	23.08	EW II	Bardoli	Gandhinagar	Dahegam	90.0	87.0	54-66,78-84
16	72.72	23.23	EW	Chiloda (Army)	Gandhinagar	Gandhinagar	201.0	200.0	112-115,123-126,132-138,145-148,155-158,173-179,189-192,195-198
17	72.76	23.14	EW -I	Galuden	Gandhinagar	Gandhinagar	450.0	296.0	181-184,187-190,196-199,204-207,221-227,233-236,255-268,272-275,280-283, 287-290
18	72.76	23.14	EW - II	Galuden	Gandhinagar	Gandhinagar	200.0	169.0	107-110,116-119,125-128,136-142,151-157,160-163,166-169
19	72.79	23.29	EW - I	Giyod	Gandhinagar	Gandhinagar	450.0	187.0	151-154,157-169,174-177,181-185
20	72.88	23.21	EW	Sampa	Gandhinagar	Dahegam	289.6	Abnd.	
21	72.92	23.08	OW-I	Bardoli	Gandhinagar	Dahegam	90.87	87.00	54-66,75-84
22	72.61	23.16	EW-I	Pore	Gandhinagar	Gandhinagar	340	304	234-237 242-248 258-264 272-278 292-299
23	72.61	23.16	EW-II	Pore	Gandhinagar	Gandhinagar	450	388	322-334 356-368 382-385
24	72.61	23.16	OW	Pore	Gandhinagar	Gandhinagar	310	304	234-237 245-248 261-264 275-278 296-299
25	72.65	23.48	SH	Charada	Gandhinagar	Mansa			
26	72.79	23.43	EW	Lakroda EW	Gandhinagar	Mansa	202.67	121	76-88 104-116
27	72.79	23.43	OW	Lakroda OW	Gandhinagar	Mansa	128.54	121	76-88 104-116

28	72.52	23.38	EW	KhorajDabhi EW I	Gandhinagar	Kalol	351	341	324-330 333-336
29	72.52	23.38	EW	KhorajDabhi EW II	Gandhinagar	Kalol	312.5	312	253-256, 271-274, 280-283, 302-308
30	72.77	23.46	EW	Himatpura EW I	Gandhinagar	Mansa	200.5	137	122-134
31	72.77	23.46	EW	Himatpura EW II	Gandhinagar	Mansa	113	111	72-78 94-106
32	72.62	23.49	EW	Padusma EW	Gandhinagar	Mansa	201.75	185	104-110, 122-128, 136-142, 160-178
33	72.52	23.38	EW	KhorajDabhi EW III	Gandhinagar	Kalol	231.25	230	142-154 , 166-178, 181-187, 217-223
34	72.52	23.38	EW	KhorajDabhi EW IV	Gandhinagar	Kalol	125	125	59-65, 78-84, 96-102, 115-121
35	72.52	23.38	EW	KhorajDabhi OW of EW III	Gandhinagar	Kalol	200.84	202	142-154, 166-178, 181-187, 193-199
36	72.52	23.38	OW	KhorajDabhi OW of EW IV	Gandhinagar	Kalol	126	125	59.0-65.0, 78.0-84.0, 96.0-102.0, 115.0-121.0,
37	72.52	23.38	OW	Khorajdabh OW I	Gandhinagar	Kalol	350	341	324.0-330.0, 333.0-336.0
38	72.52	23.38	OW	Khorajdabh OW II	Gandhinagar	Kalol	318	312	253.0-256.0, 271.0-274.0, 280.0-283.0, 302.0-308.0.

Annexure 7 Piezometers Dertails drilled by CGWB

SI.No	XLONG	YLAT	WELL_TYPE	VILLAGE	DISTRICT	TALUKA	DEPTH_DR	DEPTH_CONS	ZFrom
1	72.56	23.18	Pz	Adalaj I	Gandhinagar	Gandhinagar	200	192	
2	72.56	23.18	Pz	AdalajPz-II	Gandhinagar	Gandhinagar	138	138	
3	72.56	23.18	Pz	AdalajPz-III	Gandhinagar	Gandhinagar	47	47	
4	72.71	#VALUE!	Pz III	Amrapur (Grambharti) Pz III	Gandhinagar	Mansa	72	72	36-39, 60-69
5	72.71	23.37	Pz I	Amrapur (Grambharti)Pz I	Gandhinagar	Mansa	200.78	201	162-165, 167-170, 192-198
6	72.71	23.37	Pz II	AmrapurGrambhartiPz II	Gandhinagar	Mansa	150.33	147	85-88, 121-124, 138-144
7	72.57	23.42	Pz I	BoruPz-I	Gandhinagar	Mansa	200	172	139-142, 150-153, 163-169
1	72.55	23.20	EW	Shertha	Gandhinagar	GANDHINAGAR	353.11	346	
8	72.57	23.42	Pz II	BoruPz-II	Gandhinagar	Mansa	80	77	28-34, 49-52, 58-61, 68-74
9	72.65	23.48	Pz-I	Charada	Gandhinagar	Mansa		239.00	212-218 ;227-236
10	72.65	23.48	Pz-II	Charada	Gandhinagar	Mansa		174.00	158-170
11	72.74	23.23	Pz-II	Chiloda	Gandhinagar	Chiloda	166.97	151	112-115 120-123 135-138 145-148
12	72.74	23.23	Pz-I	Chiloda	Gandhinagar	Chiloda	200	199	172-178 190-196
13	72.83	23.16	Pz-1	Dahegam	Gandhinagar	DEHGAM	200	101	
14	72.83	23.16	Pz-2	Dahegam	Gandhinagar	DEHGAM	67	20	
15	72.65	23.22	Pz-1	Gandhinagar Pz-1	Gandhinagar	GANDHINAGAR	202.2	189	
16	72.65	23.22	Pz-2	Gandhinagar Pz-2	Gandhinagar	GANDHINAGAR	120	120	
17	72.65	23.22	Pz-3	Gandhinagar Pz-3	Gandhinagar	GANDHINAGAR	64.5	48	
26	72.65	23.48	SH	Charada	Gandhinagar	Mansa			
18	72.47	23.26	Pz-1	Kalol	Gandhinagar	KALOL	294.98	281	
19	72.47	23.26	Pz-2	Kalol	Gandhinagar	KALOL	194		
20	72.47	23.26	Pz-2	Kalol	Gandhinagar	KALOL	137		
21	72.47	23.26	Pz	KalolPz-I	Gandhinagar	Kalol	202.53	195	150-153,165-168,170-174,180-183,189-192
22	72.47	23.26	Pz	KalolPz-II	Gandhinagar	Kalol	63	63	36-39,45-48,58-61
23	72.56	23.33	Pz-1	Nardipur	Gandhinagar	KALOL	300	120	
24	72.56	23.33	Pz-2	Nardipur	Gandhinagar	KALOL	300	35	

25	72.69	23.21	Pz I	PalajPz I	Gandhinagar	Gandhinagar	200.78	202.4	147-150; 195-198	154-157;	174-177;	180-183;
26	72.69	23.21	Pz	Palej II	Gandhinagar	Gandhinagar	110	106				
27	72.69	23.21	Pz	Palej III	Gandhinagar	Gandhinagar	65.38	63				
28	72.20	22.99	Pz	Pethapur I	Gandhinagar	Gandhinagar	200	195	146-149,188-191			
29	72.20	22.99	Pz	Pethapur II	Gandhinagar	Gandhinagar	122	121	104-107,115-118			
30	72.20	22.99	Pz	Pethapur III	Gandhinagar	Gandhinagar	55	55	47-53			
31	72.57	23.30	Pz	Sardhao	Gandhinagar	GANDHINAGAR	611	534				
32	72.57	23.30	Pz	Sardhao II	Gandhinagar	GANDHINAGAR	408.5	398	257			
33	72.57	23.30	PZ-I	Sardhav	Gandhinagar	Gandhinagar	450.69	390.00	326-329	344-356	384-387	
34	72.57	23.30	PZ-II	Sardhav	Gandhinagar	Gandhinagar	330.64	266.00	206-212	240-249	260-263	
35	72.57	23.30	PZ-III	Sardhav	Gandhinagar	Gandhinagar	200.00	187.00	161-170		181-184	
27	72.79	23.43	EW	Lakroda EW	Gandhinagar	Mansa	202.67	121	76-88	104-116		

Annexure 8 Well inventory data

Sr. No.	Village	Location	Owner	Taluka	District	Well Type	Lattitude	Longitude	Total Depth (mt)	Dia. (m)	M P. (m agl)	S W L. (m bmp)	Date of measurement	Use.	Aquifer material.	Remarks.
1	Kalyanpur	About 2 km from Kalol on Kalollschon road, About 500 m from TeresiaMahadev temple.	Kanubhai Patel	Kalol	Gandhinagar	TW	23°16'05.1"	72°30'18.7"	182.88	0.3048	0.55	106.68	9.07.2015	Irrigation	Alluvial	
2	Dhamasana	About 5 km from Kalol, behind 2 km from Dhamasana on Kalol-Mansa high way, 1 km from Terusa village towards Dhamasana.	Natwar Haribhai	Kalol	Gandhinagar	TW	23°16'29.2"	72°31'18.7"	190.5	0.3048	0.5	129.54	9.07.2015	Irrigation	Alluvial	
3	Mokhasana	On the way of Bhodsatmokhasana road. About 2 km from the Bhodsat, left side of the Bhodal-Mokhasana road.	BabuSamdash Patel	Kalol	Gandhinagar	TW	23°18'48.0"	72°32'04.9"	274.32	0.3048	0.6	140.2	9.07.2015	Irrigation	Alluvial	
4	Mokhasana	Near Pate Tribhuban Dash farm. On the Mokhasana to Dingucha road, behind 3 km from Dingucha.	Kanchan bhaiSridas	Kalol	Gandhinagar	TW	23°20'1.6"	72°31'37.9"	182.88		0.73	121.92	9.07.2015	Irrigation	Alluvial	
5	Dingucha	On Dingucha to Pansa road, 3.5 km from Dingucha.	ChandubhaiKantibhai Patel	Kalol	Gandhinagar	TW	23°19'26.9"	72°30'25.6"	228.6	0.3048	0.52	152.4	9.07.2015	Irrigation	Alluvial	

6	Adraj Moti	Lest side of Moti-Sardhav road, 500 mt from village.	MonajiGugaji	Gandhina gar	Gandhin agar	TW	23°16'03.0"	72°33'55.0"	182.88	0.254	0.7	103.63	13.07.2015	Domestic	Alluvial
7	Jalund	Right side of Jalund-Sardrav road, 3km away from adrajmoti.	JalajibaldevjiBage	Gandhina gar	Gandhin agar	TW	23°16'24.9"	72°32'49.8"	182.88	0.254	0.8	115.82	13.07.2015	Irrigation	Alluvial
8	Sardhav	On the Dhamasana - sadhav road, 1km behind Sardhav village, 400 mt right side from the main road.	Bharat bhai Jayanti bhai Patel	Gandhina gar	Gandhin agar	TW	23°17'44.9"	72°33'38.2"	22.5	0.3048	0.4	121.92	13.07.2015	Irrigation	Alluvial
9	Sonipur	400 mt right side of Sadhav-Sonipur road. 2km from Sardhav.	SatujiNathaji Thakur	Gandhina gar	Gandhin agar	TW	23°17'22.8"	72°35'28.5"	182.88	0.254	0.4	140.2	13.07.2015	Irrigation	Alluvial
10	Rupal	On RupalChanasma road, 1km from main road near Rupal village.	Sailash Bhai Visa Vhai Patel	Gandhina gar	Gandhin agar	TW	23°18'37.7"	72°36'1.3"	243.84	0.2032		140.2	13.07.2015	Irrigation	Alluvial
11	Golthara	On Rupal to Golthara road, 0.5 km from Golthara village.	Bishnujikadaji Thakur	Gandhina gar	Gandhin agar	TW	23°20'33.6"	72°36'09.6"	243.84	0.2032	0.55	195.07	13.07.2015	Irrigation	Alluvial
12	Amja	Near Over head tank.	Panchayat	Kalol	Gandhin agar	TW	23°21'10.5"	72°37'06.5"	259.08		0.3048	161.54	13.07.2015	Domestic	Alluvial
13	Unava	Near Over head tank.	Panchayat	Gandhina gar	Gandhin agar	TW	23°20'03.9"	72°39'28.5"	167.64	0.254	0.67	115.82	13.07.2015	Domestic	Alluvial

14	Vasan	500 mt from Vasant village Over head tank.	ShankarjiBabuji	Gandhinagar	Gandhinagar	TW	23°19'03.8"	72°37'41.01"	228.6	0.3048	0.57	182.88	13.07.2015	Irrigation	Alluvial
15	Randheja	Near to Randheja village approaching from Mansa, 500 mt left side of the road.	Sakrabairevndas Patel	Gandhinagar	Gandhinagar	TW	23°17'22.6"	72°38'57.5"	213.36	0.3048	0.78	97.54	13.07.2015	Irrigation	Alluvial
16	HALISA	HALISA:-Inside village near O.H.T.& clock tower &Pagarsala on road side.	Public	Dehgaon	Gandhinagar	T.W			137.16		0.2		26-07-2014	Domestic	Alluvial
17		Inside village near O.H.T. & 200 mts from Anganbari& temple.	Public	Gandhi Nagar	Gandhinagar	T.W			182.88		0.25		26-07-2014	Domestic	Alluvial
18	MOTIPURA	MOTIPURA:- Inside village on bus stand,near O.H.T &temple.	Public	Gandhi Nagar	Gandhinagar	T.W			137.16		0.2		26-07-2014	Domestic	Alluvial
19	DEVKARAN-KA-MUWAD	DEVKARAN-KA-MUWADA:- (NHS Pzm)	GWRDC	Dehgaon	Gandhinagar	Pzm					0.15	28.97	29-07-2014	Monitoring	Alluvial
20	ISANPUR-DODIA	ISANPUR-DODIA:-Inside village near school & water tank.	Public	Dehgaon	Gandhinagar	T.W			155.44		0.2		29-07-2014	Domestic	Alluvial
21	BAHIAL	BAHIAL:-Inside village near O.H.T & Jay-Ambey Mata temple.	Public	Dehgaon	Gandhinagar	T.W			121.92		04:48		29-07-2014	Domestic	Alluvial

22	PALUNDR	PALUNDR:- Inside village near Ranji temple in Ambika Nagar.	Public	Dehgaon	Gandhin agar	T.W			158.49		0.2		30-07-2014	Domestic	Alluvial	
23	GAMIJ	GAMIJ:- Inside village in water works compound.	Public	Dehgaon	Gandhin agar	T.W			152.4		0.2		30-07-2014	Domestic	Alluvial	
24	HILOL	HILOL:-At the entrance of village,near water tanki and Hanuman Dada temple.	Public GWRDC (Pzm)	Dehgaon	Gandhin agar	Pzm					0.15	32.87	30-07-2014	Monitoring	Alluvial	
25	DEMALIA	DEMALIA:-Inside village near Panchayat office & small O.H.T.	Public	Dehgaon	Gandhin agar	T.W			121.92		0.2		30-07-2014	Domestic	Alluvial	
26	KAROLI	KAROLI:- Inside village near O.H.T & near Ramapur temple and Dargah.	Public	Dehgaon	Gandhin agar	T.W			121.92		0.2		30-07-2014	Domestic	Alluvial	
27	HARSOLI:	HARSOLI:-50mts before canal on L.H.S. Of road on old abandoned road in the house compound of Punjsi-Chatursichauhan .About 1 km before village on canal.	GWRDC	Dehgaon	Gandhin agar	Pzm					0.3	46.85	30-07-2014	Monitoring	Alluvial	
28	VASNA-RATHOR	VASNA-RATHOR:-Inside village near O.H.T toward Ganespura near Trijunction of road.	Public	Dehgaon	Gandhin agar	T.W			152.4		0.25		30-07-2014	Domestic	Alluvial	

29	SONARDA	SONARDA:- Inside village,near O.H.T.	Public	Gandhina gar	Gandhin agar	T.W			152. 4		0.2		30-07- 2014	Domest ic	Alluvi al	
30	VADODARA	VADODARA:- Inside village near temple.	Public	Gandhina gar	Gandhin agar	T.W			182. 88		0.2		30-07- 2014	Domest ic	Alluvi al	
31	KALYANJI- MUWADA:	KALYANJI- MUWADA:-T.W is located on river bank,while going to Piplaj.	Public	Dehgaon	Gandhin agar	T.W			60.9 6		0.2		31-07- 2014	Domest ic	Alluvi al	
32	MOTI- MACHHANG	MOTI- MACHHANG:- Outside village after crossing village in Panchyat waste land.	Public	Dehgaon	Gandhin agar	T.W			51.8 1		0.2		31-07- 2014	Domest ic	Alluvi al	
33		MOTI- MACHHANG- T.W is on river bank near Sati Mata temple outside village.	Public	Dehgaon	Gandhin agar	T.W			45.7 2		04:48		31-07- 2014	Domest ic	Alluvi al	
34	JINDWA	JINDWA:-IN Sarvodaya high school compound near main gate.	GwrdcPzm	Dehgaon	Gandhin agar	Pzm					0.15	36.28	31-07- 2014	Monito ring	Alluvi al	
35	THARAKUA	THARAKUA:(T.W):-Behind Primary school on road side.	Public	Dehgaon	Gandhin agar	T.W			60.9 6		0.2		31-07- 2014	Domest ic	Alluvi al	
36	SIYAVADA	SIYAVADA:(T.W): - In Matavasarea,ne arShivji temple.	Public	Dehgaon	Gandhin agar	T.W			60.9 6		0.2		31-07- 2014	Domest ic	Alluvi al	

37	LAVAD	LAVAD:(T.W):- Inside village near O.H.T, Panchayat Ghar&temple.	Public	Dehgaon	Gandhin agar	T.W			121. 92		0.2		31-07- 2014	Domestic	Alluvi al	
38	SAMPA	SAMPA:(T.W):- Inside village near school & O.H.T.	Public	Dehgaon	Gandhin agar	T.W			121. 92		0.2		31-07- 2014	Domestic	Alluvi al	
39	BABALPURA	BABALPURA- JUNA:(T.W)- Inside village,nearAnga nbari& school.	Public	Dehgaon	Gandhin agar	T.W			121. 92		0.2		31-07- 2014	Domestic	Alluvi al	
40	DEHGAON	DEHGAON (NHS):-About 30 mts RHS of Dehgaon- Bahyad road in field. About 1 km from dehgaon- BahyodTrijuncti on of road.	Private	Dehgaon	Gandhin agar	D.W			17		3	13.1	31-07- 2014	Irrigatio n.	Alluvi al	
41	GANESHPURA	GANESHPURA (T.W):-Inside village near O.H.T.& temple.	Private	Dehgaon	Gandhin agar	T.W			137. 16		0.2		31-07- 2014	Domestic	Alluvi al	
42	DEHGAON(Pzm- I)	DEHGAON(Pzm- I):-GWRDC Pzm,near I.T.I (Govt.& L&T) gate on by pass road to district judge court.	GWRDC	Dehgaon	Gandhin agar	Pzm					0.15	102.42	31-07- 2014	Monito ring	Alluvi al	

Annexure 9 Litholog data			
SITE:SERTHA EW (Gandhinagar/Gandhinagar)			
LITHOLOGY	DEPTH (m)		THICKNES S (m)
	From	To	
Top Soil:Top black colored soil with fine grained wind blown sand	0	3	3
Sand:Fine to medium grained yellowish brown colored sand	3	20	17
Clay:Brown to buff colored loose clay	20	25	5
Sand:Medium to coarse grained,brownish and brownish black sand, gravels	25	35	10
Clay:Yellowish brown colored clay	35	55	20
Sand:Medium grained,brownish colored sand with gravels	55	64	9
Clay:Earthy brown colored,slightly sticky clay	64	73	9
Mixed Zone:Earthy brown colored clay mixedd with about 40% of medium grained sand and gravels	73	78	5
Clay:Earthy brown colored slightly sticky clay	78	81	3
Mixed Zone:Variagated clay mixed with about 40% to 50%of coarse grained sand and gravels	81	95	14
Clay:Earthy brown colored clay	95	104	9
Sand:Medium to coarse grained,brownish colored sand with occasional gravels	104	109	5
Clay:Earthy brown colored clay	109	112	3
Mixed Zone:Earthy brown colored clay mixed with about 40%of medium to coarse grainedd sand	112	117	5
Clay:Earthy brown colored clay	117	120	3
Mixed Zone:Earthy brown colored clay mixed with fine to medium grained brown colored sand	120	126	6
Clay:Earthy brown colored and buff white colored variagated clay	126	135	9
Mixed Zone:Fine to coarse grained,brown colored sand with occasional trap pieces and gravel's mixed with earthy brown colored clay	135	146	11
Clay: Earthy brown colored clay	146	151	5
Sand:Brownish to yellowish brown colored fine to coarse grained sandwith gravel's	151	160	9

Clay:Earthy brown colored clay	160	166	6
Mixed Zone:Medium to coarse grained sand mixed with earthy brown colored clay	166	175	9
Clay:Yellowish brown to dark brown toreddish brown colored sticky clay	175	203	28
Mixed Zone:Fine to coarse grained,brown colored sand mixed with brown colored clay	203	212	9
Clay:brown to reddish brown colored variagated and sticky clay	212	240	28
Sand:Fine to medium grained brown colored sand	240	249	9
Clay:Yellowish brown and reddish brown colored variagated clay	249	258	9
Sand:fine to coarse grained brownish colored sand with occasional gravel's	258	267	9
Clay:Yellowish and reddish brown colored variagated and sticky clay	267	275	8
Mixed Zone:Yellowish brown colored clay mixed with about 20%to30% of medium grained sand	275	284	9
Clay:Yellowish brown to dark brown colored slightly sticky clay	284	290	6
Mixed Zone:Dark brown,reddish brown and occasionally pinkish colored variagated clay mixed with about 20%to30% of fine to medium grained sand	290	305	15
Clay:Brownish black colored sticky clay with occasional trap pieces and gravel's	305	314	9
Sand:Fine to coarse grained, yellowish brown colored sand	314	320	6
Clay/claystone:Brownish black colored claystone with clay	320	325	5
Mixed Zone:Fine to coarse grained,yellowish brown colored sand mixed with brownish black colored clay and claystone with occasional bluish grey colored claystone	325	343	18
Clay/claystone:Brownish colored clay,brownish black colored claystone with ocassional bluish grey colored claystone	343	353	10
KALOL Pz			
Top Soil and Sand: Yellowish brown; well sorted sand; fine grained.	0	5.7	5.7
Silt and Clay: Brownish silt with equal portion of dark brownish clay.	5.7	6.8	1.1
Sand:Yellowish; fine ot coarse grained ; coarse grained sand in little portion.	6.8	13.3	6.5
Sand and Gravel: Yellowish brown sand mixed with dark grey kanker and gravel	13.3	24.07	10.77
Sand: Light yellowish with sorted fine grained sand mixed with little portion of kanker and gravel.	24.07	27.07	3
Clay: Earthy brown, sticky claywith very little silt and sand.	27.07	33.82	6.75
Clay mixed with sand: Sticky brownish clay mixed with equal portion of fine sand.	33.82	37.57	3.75
Sand: Yellowish brown; fine to coarse grained.	37.57	40.57	3
Clay: Earthy brown, sticky .	40.57	44.2	3.63
Sand, Kanker and Gravel: Yellowish brown sand mixed with moderate amount of kanker and gravel.	44.2	47.2	3

Sand: Earthy brown sand, fine grained.	47.2	50.9	3.7
Sand with Clay: Sand brownish with little portion of sticky clay.	50.9	53.9	3
Sand: Pure sand; yellowish fine to medium grained.	53.9	60.8	6.9
Clay: Sticky brown clay.	60.8	67.57	6.77
Sand: Brownish; fine grained with little portion of dark sand.	67.57	71.47	3.9
Clay: earthy brown; sticky, Clay mixed with silt.	71.47	81.27	9.8
Clay, silt and sand mixed zone: Good portion fo brownish sticky clay mixed with equal portion of fine sand.	81.27	101.5 3	20.26
Clay and sand: earthy brown sticky, clay mixed with equal portion of sand.	101.5	108.2 8	6.75
Sand: Earthy brown sand, fine grained sand mixed with little portion of gravel.	108.3	135.2 1	26.93
Clay with Sand: Earthy brown sticky clay mixed with good portion of silt and sand.	135.2	138.9 1	3.7
Sand: Fine to coarse grained; brownish.	138.9	145.8 9	6.98
Sand mixed with Clay: fine grained sand mixed with equal portion of clay and occasional gravel.	145.9	169.0 1	23.12
Sand: Fine to coarse grained with little amount of clay.	169	175.7 6	6.75
Sand and Clay mixed zone: Sand fine grained mixed with yellowish clay sticky in good portion.	175.8	189.0 3	13.27
Sand: Yellowish brown; fine to coarse grained, occasional gravel.	189	202.5 3	13.5
Palaz Litholog			
Sand: yellowish coloured, fine to coarse grained, subrounded grains, coarsening down sequence	0	20	20
Clay: yellowish coloured, soapy and slippery feel with little sand grains	20	34	14
Sand: Yellowish coloured, fine grained, well sorted and rounded grains of quartz and feldspar.	34	45	11
Clay: yellowish coloured, soapy and slippery feel with little sand grains	45	51	6
Sand: yellowish coloured, fine to medium grained mixed with little clay.	51	61	10
Mixed: Sand mixed with yellowish coloured clay, sand grains of variable sizes, bottom part clayey.	61	75	14
Clay: yellowish coloured, soapy and slippery feel with little sand grains	75	84	9
Sand: yellowish coloured, fine to medium grained, subrounded grains, coarsening down sequence	84	90	6
Clay: yellowish coloured, soapy and slippery feel mixed with sand (~ 10%)	90	101	11
Sand: yellowish coloured, fine to medium grained, subrounded grains	101	103	2
Clay: yellowish coloured, soapy and slippery feel mixed with sand	103	121	18

Sand: yellowish coloured, medium to coarse grained, subrounded grains, mixed with little clay	121	131	10
Clay: yellowish coloured, soapy and slippery feel mixed with sand (~ 5%)	131	147	16
Sand: yellowish coloured, medium to coarse grained, subrounded grains, mixed with little clay	147	167	20
Clay: yellowish coloured, soapy and slippery feel mixed with sand (~ 5%)	167	174	7
Sand: yellowish coloured, medium to coarse grained, subrounded grains, mixed with little clay	174	177	3
Mixed: Predominantly sand, medium to coarse grained mixed with little clay.	177	194	17
Sand: Yellowish coloured, Fine to coarse grained sand, mixed with little clay. Coarsening down sequence.	194	202	8
Pethapur Litholog			
Top Soil Mixed with silt: Earthy brown coloured, very fine grains	0	16	16
Clay: Earthy Brown coloured, soapy and slippery feel	16	25	9
Sand: Earthy brown coloured, fine grained	25	30	5
Clay: Earthy brown coloured, soapy and slippery feel with little sand grains	30	46	16
Sand: Earthy brown coloured, fine to medium grained mixed with little clay .	46	53	6
Clay: Earthy brown coloured, soapy and slippery feel with little sand grains	53	61	9
Mixed: Sand mixed with yellowish coloured clay, sand grains of variable sizes, bottom part clayey.	61	75	14
Clay: yellowish coloured, soapy and slippery feel with little sand grains	75	84	9
Sand: yellowish coloured, fine to medium grained, subrounded grains, coarsening down sequence	84	90	6
Clay: yellowish coloured, soapy and slippery feel mixed with sand (~ 10%)	90	101	11
Sand: yellowish coloured, fine to medium grained, subrounded grains	101	103	2
Clay: yellowish coloured, soapy and slippery feel mixed with sand	103	121	18
Sand: yellowish coloured, medium to coarse grained, subrounded grains, mixed with little clay	121	131	10
Clay: yellowish coloured, soapy and slippery feel mixed with sand (~ 5%)	131	147	16
Sand: yellowish coloured, medium to coarse grained, subrounded grains, mixed with little clay	147	167	20
Clay: yellowish coloured, soapy and slippery feel mixed with sand (~ 5%)	167	174	7
Sand: yellowish coloured, medium to coarse grained, subrounded grains, mixed with little clay	174	177	3

Mixed: Predominantly sand, medium to coarse grained mixed with little clay.	177	194	17
Sand: Yellowish coloured, Fine to coarse grained sand, mixed with little clay. Coarsening down sequence.	194	202	8
Sardhav PZ - Gandhinagar			
Sand: Light Brown in Colour, Medium to coarse grained, Mixed	0	3	3
Sand : Light brown in colour, coarse grained	0	15	12
Sand: Light Brown in Colour, Medium to fine grained, mixed with silt	15	22	7
Sand : Light brown in colour, coarse grained, rounded, grains of quartz and felspar	22	25	3
Clay : Brown in colour, Mixed with coarse grained sand particles	25	28	3
Sand : Light Brown in color, coarse Grained with Gravel	28	36	8
Clay : Brown in colour, Mixed with coarse grained sand particles	36	43	7
Sand : Brown in Colour, Coarse to medium grained, with little clay	43	49	6
Clay : bBrown in colour	49	57	8
Sand : Brown in Colour, Coarse to medium grained, with little clay	57	65	8
Clay : Brown in colour, Mixed with medium graine sand particles	65	78	13
Sand : Brown in Colour, Coarse to medium grained, with little clay	78	85	7
Clay : Brown in colour, Mixed with medium graine sand particles	85	89	4
Sand : Light brown in colour, coarse grained, with gravel, grains of felspar and quartz, rounded.	89	94	5
Clay : Brown in colour, Mixed with medium grained sand particles	94	107	13
Sand : Reddish brown in colour, Coarse to Medium grained	107	112	5
Clay : Brown in Colour	112	146	34
Sand : Brown in Colour, Coarse to medium grained, with little clay	146	150	4
Clay : Reddish brown in colour	150	160	10
Sand : Brown in colour, Fine to medium grained	160	170	10
Clay : Brown in colour, mixed with fine grained sand particles	170	180	10
Sand : Brown in colour, fine grained, equigranular	180	185	5
Clay : Reddish brown in colour	185	196	11
Sand : Reddish brown in colour, medium to fine grained	196	199	3
Clay : reddish brown in colour with little sand	199	205	6
Sand : Brown in colour, medium to fine grained	205	212	7
Clay : Brown in colour with fine Sand	212	226	14
Sand : Brown in colour, fine grained, equigranular	226	229	3
Clay : Brown in colour with fine sand	229	235	6
Sand : brown in colour, medium to fine grained	235	249	14
Clay : brown in colour with fine sand	249	256	7
Sand : Brown in Colour, Coarse to medium grained, with little clay	256	263	7
Clay : brown in colour with fine sand	263	288	25
Sand : brown in colour, medim to fine grained	288	300	12
Clay : brown in colour, medium to fine grained	324	329	5
Clay : brown in colour with fine sand	329	344	15

Sand : brown in colour, fine grained, with little clay	344	357	13
Clay : brown in colour with fine sand	357	384	27
Sand : brown in colour, fine to medium grained, with little clay	384	395	11
Clay : blue in colour, with little sand	395	450	55
Khadat - Gandhinagar			
Top Soil, Sand with silt, fine grained, light brown	0	3	3
Sand with silt, Very fine grained, light brown	3	15	12
sand, Fine to medium grained, light brown	15	21	6
Clayey sand : medium grained, light brown, with clay-15%	21	24	3
Sandy Clay: light brown, clay-60%	24	27	3
Sand : medium grained, quartz>felspar	27	33	6
Sand : Very coarse grained, (Pink felspar)	33	42	9
Mixed, with big grains of quartz & felspar	42	48	6
Sand : medium to coarse grained, light brown	48	60	12
Mixed, Clay-60 to 80 %(with big grains of quartz & felspar)	60	84	24
Sand : medium to coarse grained	84	87	3
Clayey Sand : Fine to medium grained, clay - 40%	87	90	3
Clay, Light brown	90	102	12
Clay, blue	102	108	6
Sand , medium to coarse, (bluish tint)	108	114	6
Clayey sand, Clay -30%, blue	114	117	3
sandy clay, clay>60%,blue	117	120	3
Clay, blue	120	129	9
Sandy clay (clay-75% & more), blue, sand grains medium to coarse.	129	144	15
clay, Blue	144	174	30
Sandy Clay, (clay-75%&more) sand grains fine to medium, blue coloured.	174	189	15
clay, blue	189	192	3
sandy Clay (Clay-80% & more), sand grains coarse, blue coloured	192	198	6
Chhalla - Gandhinagar			
Top Soil : Brownish; Fine to medium to coarse grained	0	7	
Sand : Pinkish yellow; Fine Grained	7	13	
Gravel : Brown; Coarse grained	13	19.8	
Sand : Pinkish yellow; Fine to medium Grained	19.8	26.56	
Gravel : Dark grey; Coarse grained	26.56	30.28	
Sand : brownish to pinkish; fine to medium grained	30.28	34.28	
Clay : Brownish; Little sticky	34.28	44.07	
Sand : Greyish; Fine to medium to little coarse grained	44.07	52.94	
Sandy Clay : Lighty brown to yellow (clay-65%)	52.94	56.74	
clayey sand : light brown(clay-40%)	56.74	59.74	
Sand : Pinkish Yellow; Fine to medium grained	59.74	66.52	
Sand : Pinkish Yellow; Coarse to very coarse grained	66.52	75.32	

Clay : Light Brown; little sticky	75.32	77.02	
Clayey sand : light brown; Fine to medium grained sand;(clay -20%)	77.02	80.02	
Sand : Brownish; fine to medium to coarse grained	80.02	114.0 8	
Sand : Grey; fine grained	114.1	118.4 4	
Sand : grey; fine to medium grained	118.4	127.3 2	
Sand : Pinkish; medium to coarse grained	127.3	131.2	
Sand : greyish ; Medium to Coarse grained	131.2	147.7 7	
Sand : greyish; fine to medium grained	147.8	181.7 8	
Clay: dark bluish grey; Little sticky.	181.8	200.7 5	
Galuden- Gandhinagar			
Top Soil Light Brown inColour	0.00	3.6	3.60
Clay With 10% clay, light brown in Color	3.6	6.6	3.00
Clay With 10% clay, light brown in Color	6.6	10.1	3.50
Sandy Clay light brown in colour, Sand medium grained	10.1	13.1	3.00
Sandy Clay light brown in colour, Sand medium grained	13.1	16.35	3.25
Clay with 10% clay, Earthy brown in color	16.35	19.35	3.00
Fine grained sand light brown in colour	19.35	22.6	3.25
Fine grained sand light brown in colour	22.6	25.5	2.90
Clayey sand. Sand Grains medium to coarse grained	25.5	29.3	3.80
Clayey Sand. Sand grains Coarse grained	29.3	32.03	2.73
Sand coarse light brown colour	32.03	35.25	3.22
Sand coarse light brown colour	35.25	38.25	3.00
Sand Medium to Coarse grained. Light and dark grains	38.25	41.41	3.16
Sand Medium to Coarse grained. Light and dark grains	41.41	44.41	3.00
Sand Medium to Coarse grained. Light and dark grains	44.41	47.66	3.25
Sand Medium to Coarse grained. Light and dark grains	47.66	50.66	3.00
Sand Medium to Coarse grained. Light and dark grains	50.66	53	2.34
Clayey Sand	53	56.9	3.90
Clayey sand	56.9	60.12	3.22
Coarse grained sand light brown in colour	60.12	63.12	3.00
Clayey Sand. Light brown sand grains coarse grained	63.12	66.35	3.23
Clayey Sand. Light brown sand grains coarse grained	66.35	69.35	3.00
sandy Clay Light in brown colour	69.35	72.54	3.19
sandy Clay Light in brown colour	72.54	75.54	3.00
Sandy clay, light brown in colour, Sand grains Medium to coarse	75.54	78.77	3.23
Sand, light brown in colour,sand grains medium to coarse with 5% clay	78.77	81.77	3.00
Clayey Sand	81.77	85	3.23
Sand, light brown in colour,sand grains medium to coarse with 5%	85	88	3.00

clay			
clayey sand	88	91.23	3.23
Clay with 10% sand, Sand grain medium to coarse	91.23	94.23	3.00
Clay, Light brown in colour	94.23	97.48	3.25
Clay, Light brown in colour	97.48	100.4 8	3.00
Sand Medium to Coarse grained.	100.5	103.7 1	3.23
Sand Medium to Coarse grained.	103.7	106.7 1	3.00
Sand coarse light brown colour	106.7	109.9 6	3.25
Sand coarse light brown colour	110	112.9 6	3.00
Sand coarse light brown colour	113	116.2	3.24
Sand coarse light brown colour	116.2	119.2	3.00
Clayey sand	119.2	122.4 5	3.25
sand with 10% clay	122.5	125.4 5	3.00
Sandy Clay light brown in colour	125.5	128.7	3.25
Sandy Clay light brown in colour	128.7	131.7	3.00
sand with 10% clay	131.7	137.9 4	3.00
Clayey Sand	137.9	141.1 7	3.23
Sand with 10% clay	141.2	144.1 7	3.00
Sand coarse grained	144.2	147.4	3.23
Sand coarse grained	147.4	150.4	3.00
Sand coarse to medium grained with 5% clay	150.4	153.6 4	3.24
Sand coarse light brown in colour	153.6	156.6 4	3.00
Sand coarse light brown in colour	156.6	159.8 7	3.23
Sand coarse light brown in colour	159.9	162.8 7	3.00
Sand coarse light brown in colour	162.9	166.1 3	3.26
Sand Coarse to medium, Light brown in colour	166.1	169.1 3	3.00
Sandy Clay	169.1	172.3 8	3.25
Clay	172.4	175.3 8	3.00
Sand With 10% Clay, Dark brown in colour	175.4	179.6 4	4.26
Sand With 10% Clay, Dark brown in colour	179.6	182.6	3.00

		4	
Clayey Sand	182.6	185.8 9	3.25
Clayey sand	185.9	188.8 9	3.00
Sand with 10% clay, sand grains medium to coarse	188.9	192.8 9	4.00
Sand with 10% clay, sand grains medium to coarse	192.9	196.1 5	3.26
Sand Coarse with 5% clay	196.2	199.1 5	3.00
Sand Coarse with 5% clay	199.2	202.3 4	3.19
Sand Medium to coarse, dark brown in colour	202.3	205.3 4	3.00
Sand Medium to coarse, dark brown in colour	205.3	208.5 5	3.21
Sand Medium to coarse, dark brown in colour	208.6	211.5 5	3.00
Sand with 10% clay, brown in colour	211.6	214.7 8	3.23
Chiloda- Gandhinagar			
Top Soil, Dirty brown coloured	0	3	3
Silty sand, Fine grained, Earthy brown	3	6	3
Silty sand, Medium to coarse grained, Yellowish brown	6	12	6
Sand, coarse grained, yellowish brown	12	15	3
Sand, coarse grained, yellowish brown,with Kankar	15	30	15
Sand, Coarse grained, yellowish brown big grains of pink felspar & quartz.	30	42	12
Sand , coarse grained, Yellowish brown with Kankars.	42	48	6
Clay, yellowish brown	48	57	9
Sandy clay, Yellowish brown, Sand fine grained	57	60	3
Sand, Fine grained , yellowish brown	60	69	9
Clayey Sand, sand medium to coarse graine yellowish brown	69	78	9
Clay, yellowish brown	78	84	6
Sandy clay, sand coarse grained(quartz & felspar grans), yellowish brown	84	108	24
Sand, coarse grained, yellowish brown	108	117	9
Sand, mediu to coarse grained, yellowish brown	117	126	9
Sand, coarse grained, yellowish brown	126	138	12
Sandy clay, sand coarse grained, yellowish brown.	138	141	3
Clayey sand, sand coarse grained, yellowish brown	141	144	3
Sand, coarse grained, yellowish brown	144	150	6
Sand, fine to medium grained, yellowish brown	150	153	3
Sand, coarse grained, yellowish brown	153	156	3
Sand, fine to medium grained, yellowish brown	156	159	3

Clayey sand, Sand medium to coarse grained, yellowish brown	159	162	3
Sandy clay, sand medium grained, yellowish brown	162	165	3
Clay, Yellowish brown	165	168	3
Sandy clay, Sand sand medium grained, yellowish brown	168	171	3
Sand medium grained, yellowish brown	171	174	3
Sand, coarse grained, yellowish brown	174	192	18
Sand, medium to coarse grained, yellowish brown	192	201	9
Giyod- Gandhinagar			
Top soil with clay silt; light brown coloured	0	3	3
Sand: Fine grained, light brown coloured	3	8	5
Silt: Fine grained, light brown coloured	8	12	4
Sand: Fine grained, light brown coloured	12	17	5
Sand: Fine Sand with 10% silt, light brown coloured	17	22	5
Mixed zones: sand & clay, clay sand fine to coarse grained, light brown coloured clay	22	32	10
Clay: silty, brown coloured	32	42	10
Sand: fine sand with 10% silt, buff white coloured	42	52	10
Sand: fine to coarse grained, sunabhalar quartzite, light brown coloured with intercalation of clay lenses	52	116	64
Mixed zones: fine to coarse sand with light grey coloured clay lenses	116	133	17
Sand : fine sand with 10% silt, buff white coloured	133	137	4
Sand: fine to coarse grained, with 20% silt, light grey coloured	137	147	10
Clay: Sticky , grey coloured	147	150	3
Sand: Fine to coarse grained , light grey coloured	150	154	4
Mixed Zones: sand & clay, fine to coarse grained, grey coloured clay	154	169	15
Clay: Sticky , Dark grey coloured	169	172	3
Sand : fine to coarse grained, light grey coloured	172	178	6
Clay: Sticky, grey coloured	178	181	3
Sand: Fine to coarse grained , light grey coloured	181	188	7
Clay: Sticky, grey coloured	188	306	118
Mixed zones: sand & clay, sand fine to coarse grained, grey coloured clay	306	327	21
Clay: sticky , light grey colour	327	406	79
Clay: sticky , dark grey coloured with little sand lenses in between	406	450.9 4	44.94
Gram Bharti(Amrapur)- Gandhinagar			
Sand : Yellowish brown Coloured, Fine to Medium Grained, Subrounded, well sorted	0	40	40
Gravel : Mixture of Quartz, felspar and black fragments, Subangular to subrounded shape	40	45	5
Clay : Yellowish brown coloured, sopay and slippery feel with little sand grains	45	58	13

Sand : Yellowish brown coloured, Medium Grained, Subrounded, well sorted with little clay	58	70	12
Mixed : Clay with coarse to very coarse grains sand 50%	70	79	9
Clay : Yellowish brown coloured, Sopy and slippery feel	74.11	91.36	17.25
Mixed : Clay with coarse grained sand (50%) subangular to subrounded grains of quartz, felspar and black fragments	91.36	98.14	6.78
clay : Yellowish brown coloured, sticky	98.14	114.8 2	16.68
Mixed : yellowish brown clay with fine to medium sand (20%),subrounded grains of quartz, felspar and black fragments	114.8	135	20.18
Sand : Yellowish brown coloured, Fine to medium grained, subrounded, quartz and feldspar grains.	135	145	10
Mixed : Clay with Medium to coarse grained Sand (20%), Subangular to Subrounded grains of quartz, feldspar and black fragments	145	149	4
Clay/Clay stone: Grayish green, sticky, a few needle shaped cuttings	149	157	8
Mixed : Sand with clay/clay stone, Medium to coarse sand (50%), Quartz, feldspar	157	170	12
Mixed : Sand with clay/clay stone, Medium to coarse sand (50%), Quartz, feldspar	170	185	15
Mixed : Sand with clay/clay stone, Medium to coarse sand (50%), Quartz, feldspar	185	200	15
Moti bardoli-Dahegam, Gandhinagar			
Top Soil : Silty clay & Fine silt, brown Coloured	0	15	15
Clay : Brown coloured, sticky	15	36	21
Mixed zones : Clay, brown coloured, sticky with few thin fine to medium grained sand horizons	36	42	6
Sand : Fine to Medium grained , Brown Coloured	42	45	3
Clay : brown coloured, sticky	45	50	5
Sand : Fine to Medium grained; brown Coloured	50	62	12
Mixed Zones: Fine grained sand with clay, Brown Coloured	62	82	20
Clay : greyish blue Coloured, sticky with few thin horizons of fine to medium sand lenses	82	235	153
Basalt : Grey coloured with Clay	235	250	15
Basalt : Grey coloured, soft & friable Pieces	250	263	13
Basalt : Light brown to red coloured	263	281	18
Basalt : Black coloured	281	293.4 8	12.48
Sanmapa- Dahegam, Gandhinagar			
Top Soil with fine grained Quartzitic sand	0.00	16.34	16.34
Clay : Light brown coloured - soft & non sticky	16.34	37.05	20.71
Sand : Medium to coarse grained _ quartzitic	37.05	54.86	17.81
Clay : Light brown coloured - Sticky	54.86	84.79	29.93

Sand : Medium to coarse grained - Quartzite with little grey coloured clay lense in between	84.79	96.81	12.02
Clay : grey to blue coloured, sticky and hard at places	96.81	240.5 5	143.74
SST? Reddish brown to buff white coloured	240.6	246.6 1	6.06
clay Stone : grey coloured	246.6	252.8 9	6.28
SST? Reddish brown to buff white coloured	252.9	265	12.11
	265	267.8 7	2.87
Basalt : Reddish brown to grey coloured- (vesicular type?)	267.9	288.9 1	21.04
Itadra- Mansa, Gandhinagar			
Top Soil : Greyish brown in colour, fine grained sand	0	3.8	3.8
Sand : Brownish in colour Fine grained Sand	3.8	6.8	3
Sand : Brown, Fine Grained	6.8	13.63	6.83
Sandyclay : Brownish black colour fine to medium grained sand mixed with brownish black clay	13.63	19.84	6.21
Sand - brown, with fine to medium garined sand	19.84	31.95	12.11
Sand : brown , fine to medium grained with gravel	31.95	41.05	9.1
Sand : Brown in colours fine to medium grained with few gravel	41.05	55.76	14.71
Sandy : Clay - brown in color with, medium grained sand, clay with kankar	55.76	58.62	2.86
Sandy Clay _ brown, fine grained sand with clay	58.62	61.62	3
Sand : Brown in colour very fine to fine grained sand	61.62	70.3	8.68
Sand : brown, fine to medium grained , with few gravel	70.3	73.3	3
Caly : Yellowish brown, sticky with	73.3	76.14	2.84
Sandy clay: brown in colour with fine to medium grained sand	76.14	79.14	3
Sand : brown in colour fine to medium grained with clay	79.14	87.82	8.68
Sandy clay _ yellowish brown in colour sand and clay fine to medium grained sand	87.82	90.82	3
Sand : Yellowish brown in colour fine to medium grained sand	90.82	108.7 1	17.89
Clay : brownish brown in colour fine to medium grained sand	108.7	121.2	12.49
Sand : brown in colour medium grained sand	121.2	124.0 5	2.85
Sandy clay : brown in colour with clay	124.1	127.0 5	3
Sand : brown in colour finne grained sand	127.1	138.5 2	11.47
Sandy clay : Reddish brown in colour clay with fine grained sand	138.5	147.1 8	8.66
Sand: Brown in colour fine to medium grained sand	147.2	168.0 7	20.89
Sandy Clay: Reddish brown in colour with fine grained sand	168.2	173.8	5.71

		8	
Sandy clay: brown in colour with fine to medium grained sand	173.9	176.7 2	2.84
Sandy clay: brown in colour with fine to medium grained sand	176.7	179.7 2	3
Clay : Brownish in colour clay	179.7	192.1 6	12.44
sandy Clay: Brown in colour with fine to medium grained sand with few clay stone	192.2	227.8 3	35.67
Sand : Yellowish in brown in color fine to medium grained sand Quartzitic sand	227.8	239.8 7	12.04
Sandy Clay: Brown in colour fine to medium grained sand with clay 20%	239.9	246.1	6.23
Clay : brown in colour sticky	246.1	266.8 2	20.72
Sandy clay : brown in colour with fine to medium grained sand with occasnl gravels	266.8	287.7 3	20.91
sandy Clay : brown in colou e clay with fine grained sand to medium grained sand	287.7	290.5 6	2.83
Sandy Clay : reddish brown in colour clay with fine tp medium grained sand	290.6	370.1 7	79.61
sand : Brown in colour fine to medium grained sand	370.2	376.0 1	5.84
Sandy Clay : Brown in colour with medium grained sand	376	379.0 1	3
Sandy c;lay : brown in colour fine to medium grained sand	379	388.0 8	9.07
Clay : Black in colour with clay stone	388.1	393.9 1	5.83
Sand : Brown in colour very fine grained sand	393.9	406.3 8	12.47
Sand : brown in colour fine to medium grained sand	406.4	430.5 8	24.2
Sandy Clay : clay with sand variegated clay with blackish coloured clay stone with 30% fine to medium grained sand	430.6	452	21.42
Ranasan, Gandhinagar			
Top Soil & Sand fine & uniform ; Quartz grains	0	6.8	6.8
Mixed Zone : Mostly Sandy : Fine to medium grained granular zones with lenses of silt	6.8	31.78	31.78
Sand : Medium Sized, brown coloured	31.78	46.69	14.91
Sand : Medium to coarse , rounded to sub rounded	46.69	64.8	18.11
Sand : Fine to coarse, Brown coloured	64.8	71.03	6.23
clay : Yellowish	71.03	74.03	3
Mixed Zone : silt & clay, Brown Coloured	74.03	77.3	3.27
Sand : Fine to coarse, Brown coloured	77.3	80.3	3
Sand : Medium to coarse, Rounded to subrounded	80.3	98.03	17.73

Clay, Varigated	98.03	115.9	17.87
Sand : Medium to coarse, Rounded to subrounded	115.9	124.5 3	8.63
clay : gray,& yellow coloured, sticky	124.5	167.2	42.67
Clay : Light brown coloured sticky, with occasional chips of rock & sand grains	167.2	170.2	3
Mixed: Clay & sand 50 % each	170.2	182.6 2	12.42
Clay : Gray coloured , Sticky	182.6	186.6 4	4.02
Clay : gray coloured with 10% sand	186.6	191.6 7	5.03
Sand : Medium grained with 10% clay	191.7	200.5 1	8.84
Clay : Gray coloured with 10% sand	200.5	215.4 6	14.95
Sand : Coarse to fine grained sands with chips of pink to gray coloured rocks	215.5	221.2 7	5.81
Sand : Coarse to fine grained sands with chips of pink to gray coloured rocks	221.3	227.5 3	6.26
Basalt : light brown to gray coloured , cutting are in form of fine angular chips-fractured zone	227.5	237	9.47
Basalt : Weathered , reddish brown coloured subangular chips with 10% sticky gray coloured	237	246	9
basalt : Light gray coloured chips with zeolites/calsite grains, Amygdular type	246	294	48
Basalt : Reddish brown coloured subrounded grains & chips-vesicular type basalt	294	312	18
Basalt : Reddish brown to gray coloured chips with pieses of zeoloites; vesicular type Basalt	312	337.5 6	25.56
NARDIPUR Pz-GANDHINAGAR			
Top soil: Brounish,silty to fine ,air blown,well sorted quartz felpar rich.	0	3	3
Sand: Brounish,silty to fine ,air blown,well sorted quartz felpar rich.	3	27	24
Sand:Medium earthy broun colour	27	37	10
Clay:Brounish pink	37	41	4
Sand:Fine grained sand	41	43	2
ClayeySand:Fine quartz ,Angular	43	53	10
Clay:yellowish	53	56	3
Sand:Silty to fine	56	62	6
Sandy clay:	62	64	2
Sand:Fine to silty,Medium to coarse grained.	64	85	21
Clay:Bruwnish Sticky	85	95	10
Sand+Gravel:Quartz,angular with coarse sand with clay	95	121	26
Clay:Brownish stickey,pieces of clay stone.	121	131	10

Sandy clay:Coarse to gravelly with clay intercalations.	131	145	14
Clay:Mixed with silt	145	154	9
Sand:Fine to medium sand with silt	154	159	5
Clay:brownish sticky	159	169	10
Sand:Coarse to gravekl	169	179	10
Clay:Brownish stickey with sand intercalations.	179	202	23
Sand:Medium to coarse with clay intercalations	202	232	30
Clay:yellowish stickey	232	243	11
Sand:Coarse to gravelly sand.	243	248	5
Clay:yellowish stickey	248	254	6
Sand+Clay:Coarse to gravelly sand with 40% clay	254	271	17
Clay+Sand:Yellowish stickey clay with 30% coarse sand.	271	280	9
Sand+Clay:Medium to coarse sand with clay intercalations.	280	299.3 1	19.31
Charada SH, Mansa, Gandhinagar			
Top Soil : Dark brown; fine grained, homogeneous	0.00	6.60	6.60
Mixed : Sand : light brown; fine grained. Clay: brown;sticky	6.60	13.10	6.50
Sand : light brown; fine grained	13.10	19.60	6.50
Sand: Dull brownish; medium to little coarse grained, subangular pink and subangular quartz.	19.60	25.74	6.14
Sand : Dull brownish ; medium grained, homogeneous,subrounded quartz	25.74	28.96	3.22
Mixed: sand: Brown:Medium grained.clay:brwon.sticky	28.96	31.96	3.00
Sand : Dull brownish;Medium grained, homogeneous,rounded Quartz	31.96	35.22	3.26
Sand: Dull brownish; medium to little coarse grained, subangular quartz and feldspar.	35.22	38.22	3.00
Sand : Dull pinkish brownish; coarse grained, subangular quartz and feldspar,homogeneous	38.22	44.05	5.83
Mixed : sand :Dull brown;medium grained.clay:brown;sticky	44.05	49.86	5.81
Sand : Pinkish brownish;medium grained,subrounded quartz and feldspar, homogeneous	49.86	62.22	12.36
Clay : Light brown; sticky, with very little fine grained sand	62.22	71.57	9.35
Mixed: sand :brownish;medium to little coarse grained Clay: brown;sticky	71.57	86.49	14.92
Sand : Redish brown;medium grained	86.49	89.53	3.04
		102.2	
Sand : Redish brown;medium to little coarse grained	89.53	4	12.71
	102.2	130.3	
Clay : Redish brown; sticky, with very little medium grained sand	4	0	28.06
	130.3	133.4	
Mixed : sand; light brown medium grained.clay:Light brown;sticky	0	5	3.14
Sand : Dull brownish; Medium grained,subrounded quartz and feldspar	133.4	148.8	
	5	0	15.35

Clay : Light brown ,sticky	148.8 0	152.0 5	3.25
Clay : Light brown;Sticky with very little medium grained sand	152.0 5	167.1 1	15.06
Sand :brown ;medium to coarse grained,subrounded quartz,feldspar.	167.1 1	172.9 4	5.83
Sand : brown;Fine to medium grained	172.9 4	176.4 5	3.51
Clay : Light brown sticky	176.4 5	179.4 5	3.00
Sand : Brown; Medium Grained	179.4 5	185.9 1	6.46
Clay : Light brown ;sticky	185.9 1	203.4 7	17.56
Mixed: sand Brown; medium grained.clay:brown.sticky	203.4 7	206.7 3	3.26
Clay : Light brown; Sticky, with very little medium grained sand	206.7 3	215.5 7	17.90
Clay : Light brown; Sticky, with very little medium grained sand	215.5 7	218.7 9	3.22
Sand : Light brown Medium grained	218.7 9	221.7 9	3.00
Mixed: sand Light brown;Medium grained.clay:brown,sticky	221.7 9	224.9 3	3.14
Sand : Dull greyish;coarse grained,subangular quartz and feldspar, with some grey coloured clay lenses which meshes easily,and imparts colour to the sample.	224.9 3	240.3 3	15.40
Clay : Blue sticky, hard,shrinks on drying	240.3 3	429.7 0	189.37
Clay : Blue;sticky,hard,shrinks on drying,with very little medium grained sand	429.7 0	450.4 3	20.73
Dahegam			
Sandy Soil : Upper Sandy soil, yellowish in colour, very fine sand	0.00	6.00	6.00
Clay : yellowish clay with very fine sand	6.00	12.00	6.00
Clay with Kankar- yellowish clay with about40% Kankars	12.00	36.00	24.00
Sandy Clay- Yellowish clay with about 50% fine sand	36.00	42.00	6.00
Clay Sand : Yellowish clay with about 70 % , Medium sand	42.00	51.00	9.00
Gravel - Mixture of subrounded to angular gravel	51.00	57.00	6.00
gravels with clay- about 80% gravel and 20% clay	57.00	63.00	6.00
Gravel - angular to subangular gravel, transparent to yellowish shine color	63.00	69.00	6.00
Gravel with Clay : about 60% gravels and 40% yellowish caly clay	69.00	84.00	15.00
Gravels - transparent to ywlloeish garvels	84.00	108.0 0	24.00
Gravels with clay - about 80% gravel with clay	108.0 0	111.0 0	3.00

Gravel with medium sand - about 60% gravels and 40% medium sand yellowish in color	111.0 0	120.0 0	9.00
Gravels - Gravels with about 10 % clay	120.0 0	129.0 0	9.00
Garvel with clay : about 50% clay with the remaining propostion of gravels.	129.0 0	132.0 0	3.00
Clay - Dark Brown clay with about 20% gravels	132.0 0	135.0 0	3.00
Clay with gravels - About 30% gravel with dark brown clay	135.0 0	139.0 0	4.00
Clay - Clays with 10% Kankars	139.0 0	200.0 0	61.00
Kasturinagar-IFFCO			
Topsoil:Topsoil with silt	0.00	3.05	3.05
Sand:Fine grained	3.05	12.20	9.15
Kankar and sand	12.20	15.25	3.05
Clay	15.25	18.30	3.05
Clay with silt	18.30	22.85	4.55
Sand:	22.85	25.90	3.05
Kankar sand and gravel	25.90	32.00	6.10
Sand	32.00	35.00	3.00
Sand with gravel	35.00	41.15	6.15
clay	41.15	44.20	3.05
Sanoda-Gandhinagar			
Top soil with clayey silt; Light brown coloured	0	3	3
Sand ; Fine grained; Light brown coloured	3	7	4
Silt ; Clay ; Light yellow coloured	7	12	5
Sand ; with kankar ; Light brown coloured	12	18	6
Clay : sticky , reddish brown coloured	18	23	5
Mixed zones ; Sand & Clay ; Sand -Fine to coarse grained; Light brown coloured clay	23	34	11
Clay ; Silty, Brown coloured	34	38	4
Mixed zones ; Sand & Clay ; Sand -Fine to coarse grained; Light brown coloured clay	38	44	6
Sand : Fine to coarse grained, sub angular quartzitic ; Light brown coloured with intercalation of clay lenses	44	51	7
Mixed Zones ; Fine to coarse sand with light grey coloured clay lenses	51	55	4
Sand ; Fine sand with 10 % silt ; Buff white coloured.	55	68	13
Mixed Zones ; Fine to coarse sand with light grey coloured clay lenses	68	78	10
Sand ; Coarse grained with kankars.	78	85	7
Mixed Zones ; silty sa nd light grey coloured clay lenses	85	88	3
Sand ; Coarse grained with pieces gravels	88	99	11

Clay ; Sticky, Grey coloured	99	101	2
Sand ; Fine to coarse grained ; Light brown coloured.	101	105	4
Clay ; Sticky, Grey coloured	105	110	5
Mixed zones ; Sand & Clay ; Sand -Fine to coarse grained; Grey coloured clay	110	125	15
Clay ; Sticky, Grey coloured	125	138	13
Sand ; Fine to coarse grained ; Light brown coloured.	138	144	6
Clay ; Sticky, Light grey coloured	144	152	8
Sand ; Fine to coarse grained ; Light brown coloured.	152	160	8
Clay ; Sticky, Light brown coloured with little kankar	160	168	8
Mixed ; Sand with kanakar and clay lenses of light grey to buff white coloured	168	174	6
Clay ; Sticky, Grey coloured	174	184	10
Sand ; fine to coarse grained light brown colourd	184	190	6
Mixed zone ; Sand & Silt with Clay lenses ; Light yellow coloured	190	194	4
Clay ; Sticky, Grey coloured	194	200.5	6.5
Pore-Gandhinagar			
Top soil, earthy, silty, brownish yellow coloured.	0	5	5
Fine sand with silt, yellowish brown coloured, with few kankar.	5	37	32
Alternate sequence of Sand and clay, sand yellowish brown, medium to coarse, clay yellowish and sticky.	37	70	43
Sand, yellowish, fine to medium grained.	70	74	4
Clay: yellowish and sticky.	74	82	8
Clay: yellowish, sticky with fine grained sand<10%.	82	96	14
Sand, yellowish brown, medium to coarse, angular to sub angular.	96	101	5
Clay: yellowish and sticky.	101	105	4
Sand, yellowish brown, medium to coarse, angular to sub angular.	105	118	13
Clay: yellowish and sticky.	118	127	9
Sand, yellowish brown, medium to coarse.	127	132	5
Clay: yellowish and sticky with fine to medium grained sand (<10%).	132	136	4
Alternate sequences of sand and clay, sand fine to medium, sub rounded to sub angular with few black coloured fragments, clay sticky and yellowish (<20%)	136	147	11
Sand: yellowish brown, coarse grained, sub rounded to sub angular with gravel.	147	156	9
Alternate sequences of sand and clay, clay brownish yellow in colour, sand fine to medium grained.	156	172.5	16.5

Sand: coarse grained, variegated, sub rounded to sub angular.	172.5	182	9.5
Alternate sequences of sand and clay, sand fine to coarse grained, angular to sub angular, clay yellowish and sticky.	182	207	25
Clay: yellowish and sticky.	207	210	3
Sand: fine to medium grained with few coarse grains, sub angular to sub rounded, qtz. grains prominent.	210	216	6
Clay: yellowish and sticky.	216	234	18
Sand: yellowish, medium grained.	234	238	4
Clay: yellowish and sticky.	238	242	4
Alternate sequences of sand and clay, sand medium grained, angular to sub angular, clay yellowish and sticky (<20%).	242	248	6
Clay, yellowish, sticky, a bluish grey patch is seen,	248	254	6
Sand: yellowish, medium grained.	254	265	11
Clay: yellowish, sticky, a bluish grey patch is seen.	265	272	7
Alternate sequences of sand and clay, sand medium grained, angular to sub angular, clay yellowish with bluish grey patch, sticky(<20%).	272	278	6
Sand: yellowish, fine to medium grained.	278	302	24
Clay: bluish grey in colour.	302	308	6
Alternate sequences of sand and clay, sand medium grained, angular to sub angular, clay bluish grey.	308	320	12
Sand: dark brown, medium to coarse grained.	320	335	15
Alternate sequences of sand and clay, sand fine to medium grained, angular to sub angular, clay bluish grey.	335	345	10
Sand, dark coloured, fine to medium grained.	345	354	9
Alternate sequences of sand and clay, sand coarse grained, dark coloured, clay bluish grey (<20%).	354	395	41
Sand, dark coloured, medium to coarse grained.	395	400	5
Alternate sequences of sand and clay, sand coarse grained, dark coloured, clay bluish grey with a reddish brown patch.	400	450	50
Kalol Pz			
Top Soil and Sand: Yellowish brown; well sorted sand; fine grained.	0	5.7	5.7
Silt and Clay: Brownish silt with equal portion of dark brownish clay.	5.7	6.8	1.1
Sand: Yellowish; fine to coarse grained ; coarse grained sand in little portion.	6.8	13.3	6.5
Sand and Gravel: Yellowish brown sand mixed with dark grey kanker and gravel	13.3	24.07	10.77

Sand: Light yellowish with sorted fine grained sand mixed with little portion of kanker and gravel.	24.07	27.07	3
Clay: Earthy brown, sticky claywith very little silt and sand.	27.07	33.82	6.75
Clay mixed with sand: Sticky brownish clay mixed with equal portion of fine sand.	33.82	37.57	3.75
Sand: Yellowish brown; fine to coarse grained.	37.57	40.57	3
Clay: Earthy brown, sticky .	40.57	44.2	3.63
Sand, Kanker and Gravel: Yellowish brown sand mixed with moderate amount of kanker and gravel.	44.2	47.2	3
Sand: Earthy brown sand, fine grained.	47.2	50.9	3.7
Sand with Clay: Sand brownish with little portion of sticky clay.	50.9	53.9	3
Sand: Pure sand; yellowish fine to medium grained.	53.9	60.8	6.9
Clay: Sticky brown clay.	60.8	67.57	6.77
Sand: Brownish; fine grained with little portion of dark sand.	67.57	71.47	3.9
Clay: earthy brown; sticky,Clay mixed with silt.	71.47	81.27	9.8
Clay, silt and sand mixed zone: Good portion fo brownish sticky clay mixed with equal portion of fine sand.	81.27	101.5 3	20.26
Clay and sand: earthy brown sticky, clay mixed with equal portion of sand.	101.5 3	108.2 8	6.75
Sand: Earthy brown sand, fine grained sand mixed with little portion of gravel.	108.2 8	135.2 1	26.93
Clay with Sand: Earthy brown sticky clay mixed with good portion of silt and sand.	135.2 1	138.9 1	3.7
Sand: Fine to coarse grained; brownish.	138.9 1	145.8 9	6.98
Sand mixed with Clay: fine grained sand mixed with equal portion of clay and occasional gravel.	145.8 9	169.0 1	23.12
Sand: Fine to coarse grained with little amount of clay.	169.0 1	175.7 6	6.75
Sand and Clay mixed zone: Sand fine grained mixed with yellowish clay sticky in good portion.	175.7 6	189.0 3	13.27
Sand: Yellowish brown; fine to coarse grained, occasional gravel.	189.0 3	202.5 3	13.5