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Technical Report Series

GROUNDWATER BROCHURE THE DANG DISTRICT GUJARAT

Compiled
by

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THE DANG DISTRICT AT A GLANCE

Sl.No.	Items	Statistics
1	GENERAL INFORMATION	
	i) Geographical area as per state territory/as per village papers (Sq. Km)	**1764**
	ii) Administrative Divisions (As on 3/2010) : Number of Talukas/ Number of villages/ No of villages having drinking water facility as on 1.04.2009	**One / 311/311**
	iii) Populations (As on 2011 census) Population density	**227000 126/sq.km**
	iv) Average Annual Rainfall (mm) (1951to 1980) normal annual rain fall (mm), 2011	**1928, 1635**
2	GEOMORPHOLOGY	
	Major Physiographic Units: Deccan Trap country, terraced topography with flat topped conical hills, Small plateau and steep sided narrow valleys. (RL between 105 to 1317 m above sea level)	
	Major Drainages: Purna, Ambika, Khapri , Gira and Ghogha	
3	MAJOR SOIL TYPES: **Lateritic soils, deep black clayey and loamy soils and red sandy soils.**	
4	NUMBERS OF GROUND WATER MONITORING WELLS **CGWB (As on 31-03-2012) No of Dug Wells** **No of Piezometers**	 **25** **2**
5	PREDOMINANT GEOLOGICAL FORMATIONS: **Deccan trap basalt with dykes.**	
6	HYDROGEOLOGY	
	➢ **Major Water Bearing Formations: Deccan trap basalt with dikes and alluvium.** ➢ **Pre- monsoon depth to water level (May 2012) 2.89m (Jakhana) to 12.38 m (Mheskatri)** ➢ **Post- monsoon depth to water level (November 2012) 0.50m (Jakhana/ChinchPada/Ghubita) to 9.55m (Mhesktri)** ➢ **The seasonal (Pre-Post Monsoon) fluctuation rise 2.30 m (Jakhana) to 9.55m (Chikhli)** ➢ **Long term water level trend in 10 yrs pre-monsoon(May 2003-May2012) Rise 0.005m/yr (Chinchpada) to 0.26 m/yr (Bhenskatri) Fall 0.020m/yr (Ghubita) to 0.28 m/yr (Nanak Khadi)** ➢ **Long term water level trend in 10 yrs post- monsoon(November 2003 –November 2012) Rise .0.005 m/yr (Umberpada) to 0.32m/yr (Borigaotha) Fall 0.003 m/yr (Ahwa1) to 0.33m/yr (Bhenskatri)**	
7	GROUND WATER QUALITY (May/2012) **EC 370 µS/cm (Nana pada) to 776 µS/cm (Sodmal**	
	Type of waters: In General potable and fresh.	
8	DYNAMIC GROUND WATER RESOURCES (3/2011)- in Ha m	
	Annual Replenishable Ground Water Resources	**8647.93 ham**
	Net Annual Ground Water Development	**1467.50 ham**
	Projected Demand for Domestic and industrial Uses upto 2025	**758 ham**
	Stage of Ground Water Development	**16.97%**
9	GROUND WATER CONTROL AND REGULATION (3/2007)	
	Number of OE/Critical/Semi-Critical Talukas	NIL
10	Net Irrigated area**.**	**10680 ha.**
11	Major Crops: **Forest Produce:**	**- Paddy, Jowar, Millets Viz Nagli, Vari, Pulses like Tur, Udad & Fruits.** **- Bamboo,Gum,Medicinal Herbsand Teakwood.**
12	MAJOR GROUND WATER ISSUES i) Excess run off due to rugged topography ii) Climatic changes and dependency on rainfall iii) Land use pattern iv) Heterogeneity of aquifer, construction of ground water structures, Low yield of wells v) Pumping pattern & Optimum use of water vi) Water conservation vii) Rain water harvesting and recharge to ground water viii) Feasible artificial recharge projects	

DISTRICT GROUND WATER BROCHURE
THE DANG

1.0 Introduction

The Dangs is one of the most delightful districts of Gujarat and is located high in the Saputara hills, the original home of the 'adivasis', and the tribal population of Gujarat. In ancient Indian Scriptures Dang is known as ‘Dand Aranyaka’, meaning Bamboo Fore.

The Dang district is situated in the southeast part of Gujarat state and lies between 20^0 33’50” to 21^0 04’ 52” North latitudes and 73^0 27’58” to 73^0 56’38” East longitudes. To the north and west of Dang lies Surat and Navsari districts of Gujarat whereas to its east and south are the districts of the Maharastra state The Dang district has Ahwa taluka comprised of 311 Villages. The district headquarters is located at Ahwa and other major towns are Wagad and Saputara. The district occupies an area of 1764 km² and has a population of 227000 (2011 census). It is the most backward districts of Gujarat and is 100% rural. The administrative map of the district is given at Fig.-1

The district is hiily, with a few high hills in the east and south, and the rest of the district is occupied by a mass of flat topped low lying hills. It has four main valleys formed by Gira, Purna, Khapri and Ambika rivers.These valleys has extensive slope towards the western side and contains compact forest areas with luxuriant vegetation. Purva and Ambica, are the two major rivers of the Dang. The other rivers are Khapri, Gira and Ghoghal. All the rivers are flowing from east to west into the Arabian Sea.

The area experiences dry climate in winter between November to March and thereafter humidity increases. The monsoon sets during the month of Jun and lasts till October. Average annual Rainfall of the area (2011) is 1635 mm.

The district is covered by Deccan lava flows belonging to the basaltic plateau which are uniform in composition. Geologically, the entire district is occupied by Deccan trap Basalt, Which is hard in nature. These are having less cracks, fissures, and joints. Basalt are poor aquifers. Lateritic soils cover almost the whole district except for two pockets one in the west and other in the east, having deep black and red sandy soils. The land of the district is fertile and rocky. Maize, Rice, Groundnuts, Nagli (raggi), Euphorbia,etc. are the major cultivations. Wheat, Black Gram, Udad, etc are also grown in the area.

The 73 % area of Dang district is covered under Reserved & Protected forest. The entire tract of the forest is compact and continuous. The reserved forest are found only on larger hills capped with reddish to grey soils, while the protected forests occupies the gently sloping hillocks, plateaus, flat and undulating low lying areas covered with thick column

of fertile soils. Within the protected forests certain areas have been subjected to intermittent and rotational cultivation. Some areas in the reserved forest spread over in manatee compartments are leased out for cultivation in different years under special circumstances. Out of the net sown area 57843 ha. , 1680 ha. is irrigated in the district.

In spite of high rainfall the district experiences problem of drinking water in summer season. This is due to steep slopes causing heavy run-off. Drinking water sources are mainly hand-pumps, wells and Regional water supply schemes. In general the quality of water good and potable. The district is free from Fluoride problem. The average depth of the bores is 90 m., for hand pumps and the most frequent depth range is 60 - 120 meters for HP and borewells.

1.1 Studies/Activities by CGWB

In 1949 Sir C.S. Fox visited the district in connection with drinking water problems of Dang Villages. He has concluded that surface water must be stored as the lava flows are fine textured and un weathered.

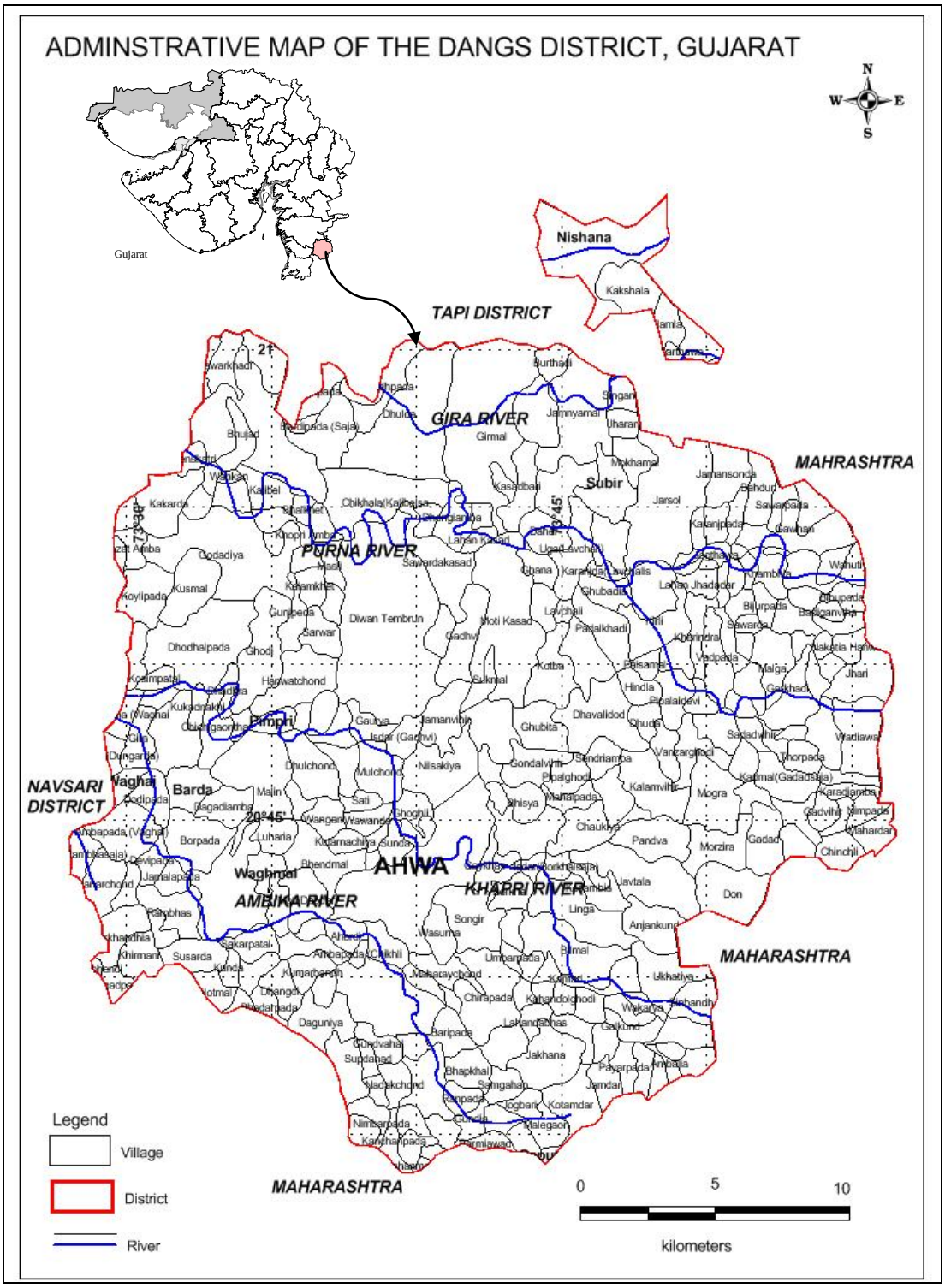
Geological Survey of India carried out geological mapping of the area between 1973 and 1976 (S/Shri B.K. Mohinty and A.K. Roy). Systematic hydrogeological surveys carried out by Shri G.S. Mittal of CGWB in the year 1978 - 79.

Ground water exploration studies by test drilling in the district was first taken up in 1987-88 when four EW, down to 90m depth were drilled. Thereafter, 15 boreholes (12 EW & 3 OW), in the depth range of 146 to 202m were drilled in 1989-90. Hydrogeological studies and exploratory drilling carried out in the district broadly indicated the presence of unconfined and semi-confined aquifer system to the explored depth of 200m.

2.0 Rainfall and climate

Entire Dang district falls under South Gujarat (Heavy Rainfall) Sub Zone. The district has, in general dry tropical climate except during the monsoon season where it experiences high precipitation, high evaporation and large daily fluctuations in temperature. The period from June to September constitute the southwest monsoon season. October and November may be termed the post monsoon or retreating monsoon season. The cold season starts from December and last upto February followed by hot season from March to May. Moisture incursions occasionally take place, sometimes initiating dry summer or dust storms. Some of the storms and depressions from the Arabian Sea in the latter half of the summer and in the

Fig-1The Dang District , Gujarat



post monsoon season affect the district and its neighbourhood causing widespread rains and gusty winds. The annual mean maximum and minimum temperature recorded at Ahwa for the past few decades stands at 45^0 C and 10^0 C respectively. District receives heavy rainfall in monsoon season, but outside the monsoon there is hardly any shower. The average annual rainfall is given in the table 1a & 1b. On an average there are 77 rainy days (i.e. days with rainfall of 2.5 mm or more) in a year in the district. The number varies from 74 at Waghai to 80 at Ahwa.

Table 1a – Normals and Extreme of Rainfall (in mm) (1951-1980)

Month	Waghai	Ahwa	The Dang
January	1.5	3.7	2.6
February	0.5	1.1	0.8
March	0.4	2.6	1.5
April	1.0	5.9	3.5
May	12.4	13.9	13.1
June	239.4	214.2	227.1
July	828.2	680.0	754.1
August	526.9	493.5	510.2
September	372.1	309.5	340.8
October	52.8	57.5	55.1
November	19.2	13.1	16.1
December	2.5	3.3	2.9
Total	2057.4	1798.3	1927.8

Table 1b. - District wise Summary

The Dang district Ahwa Station	**Month ->**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Total**
District wise Monthly average rainfall	**(in MM), 2011**	**62**	**1017**	**417**	**139**		**1635**
Spread and range of rainfall	**Spread of rainfall – 23rd June to 23rd Sept,** 2001-2011	**Maximum(Total) Rainfall(mm) in a year**			**Minimum(Total) Rainfall(mm) in a year**		
		3825 (2005)			**1316 (2009)**		
Note: There was no rain during the month Jan to May, Oct to December. Source Directorate of Agriculture, Gujarat State, GandhiNagar.							

3.0 Geomorphology, Soil and Agriculture

3.1 Physiography

Entire area is a part of Deccan Trap country, and exhibits rugged and terraced topography with flat topped conical hills, small plateau and steep sided narrow valleys. The highest elevation of the area is 1055.52 m (Sanjan hill) and lowest 111.55 m near Dongarda village.

3.2 Drainage:

Purna, Ambica and Khapri, are the three major rivers draining the district of the Dang. The other rivers are Gira and Ghoghal. Almost all the streams are ephemeral but they become perennial before emerging out of Dangs on north-western side. All the rivers are flowing into the Arabian Sea.

3.3 Soil:

Lateritic soils cover almost the whole district except for two pockets one in the west and the other in the east, capped by deep black and red sandy soils. Basaltic lava flows are covered with black clayey to loamy soil. It is in general about a meter in thickness. The colour of soil turns red due to high iron content at some places.

3.4 Surface Water Resources:

The major source of the surface water is the perennial flows in Ambika, Khapri and Purana rivers. There are two major irrigation projects, one on River Sharpa Ganga at Saputara and the other on a tributary of Khapri river at Bhisia. The salient features of these projects are given below in table-2.

Table-2 Medium & Major Irrigation Schemes

Sr. No	Name of scheme (Gross command area, sq.km.)	Storages (MCM)
1	**Saputara (0.56)**	**0.636**
2	**Bhisia (3.51)**	**0.707**

There are surface water storage tanks at Chikhli (Capacity 817.20 m^3) and Sulia Barda (408.60 m^3). Many more storage tanks are constructed in the area. Apart from Storage tanks Lift Irrigation scheme have been tried at Ambapara (command 60 ha.) and Kudkas (command 50 ha.)
Numerous springs scattered all over the district have been reported in the past. These were reported having the discharges from five to less than half litre per minute. Some of the important locations reported earlier are near Wagai, Sati, Chinhana, Sonda etc.

3.5. Irrigation- Area Irrigated by different Sources

The irrigation facilities are not well under developed owing to technological and environmental factors. Hence, The Dang is pre-dominantly dependent on rain fed agriculture and has the lowest percentage of irrigated land in Gujarat.

The area irrigated by different sources in the district during 2004 – 05 are presented in table -3 a. The table indicates that wells/borewells are the main source of irrigation in the district The gross area irrigated for both the sources taken together was 600 ha.

for the year 2004 – 05. Around 1955 tubewells and Dug wells are in operation. In all 1293 agriculture structures were energised (1265 Oil + 28 Electrical) in the district.

Table-3a Area irrigated by different sources
(2004-05) Area in hectares)

Sr No.	Source	Area irrigated	Sr No.	Source	Area irrigated
1	Wells/ Wells (Electrified)	1600	5	Storage Ponds	4288
2	Borewells /BW (Electrified	160	6	Net Irrigated Area	10680
3	Rivers/Channels	2347	7	Gross Irrigated Area	600
4	Check dams	2285	8	Irrigation intensity	

Source: District Plan Report, The Dang pg 3&4

3.6 Agriculture

Emerging from the traditional system of slash and burn agriculture, subsistence farming is the primary source of livelihood for the tribal population of the Dang. Subsistence farming is being carried out here much due to the kind of poverty levels that exist in the district and also the inability to take risks due to higher degrees of vulnerability. Shifting cultivation is not practiced due to high pressure on land. Adar represents the tradition of slash and burn is currently limited to nurseries to grow saplings of rice, ragi and varai. Due to lack of irrigation facilities, low productivity and physical features of the land, the time for agricultural activities is limited to monsoon. The quality of land is poor and 66% of the agricultural land is situated on slopes, where irrigation is difficult. The elevated land and wide spread deforestation has been cause for increase in erosion, which is strongly affecting the agricultural productivity. Due to the high degree of slope and the high annual rain fall, the soil is also washed away thus depriving the land of the precious top soil. Repeated instances during every monsoon have depreciated land of its quality. This has put the limitation on the agricultural potential and also for the production of cash crops. Some cash crop like groundnut is being cultivated, but only for consumption purpose rather than for commercial use. Due to the low agricultural productivity, the lack of land for cultivation and the limited opportunities for irrigation, the majority of the population migrates during the winter and summer months to be engaged in agricultural labour and construction work.

Due to very small holding and very low productivity of the land, most household live by maintaining diversified pattern of occupations. No single activity provides sufficient resource to ensure their livelihood. Agriculture in the district is predominantly rain fed and monsoon cropped. Only about 7.68% of cultivable land in the Dang district is under irrigation. Land Utilization Pattern for the district in 2004-05 is given in table 3b. During 2011, Forest area reported is 1598 Sq.km and Land not available for cultivation is 126 Sq.km.

Table-3b Land Utilization Pattern for the district

	Land Utilization	Area (ha.) in 2004-05
1.	Total Geographical Area	172356
2.	Forest Area	101329
3.	Uncultivable Area	3894
4.	Permanent Pasture & Other Grazing Land	262
5.	Current fallows	1524
6.	Net Area Sown	57843
7.	Area Sown more than once	4535
8.	Cultivable Area	70845
9.	Total Area under irrigation	10500
10.	Cropping Intensity	122%
11.	Land not available for cultivation	11660

Source: 1. District Plan Report (2009-10)-The Dang, 2 Cropped area of Dangs has been included in forest areas.

Depth of soil is shallow to moderate (0 to 25 cm) in hilly forest, 45 to 150 cms (deep to very deep) in predominant slope and flood plains alluvial areas. The soil slope is 3.5 percent on hill, 0.1 percent in plateau and 1.3 percent in mid land flood plains.

The land of the district is fertile and rocky. The colour of the soil is either red or black. Maize, Rice, Groundnuts, Nagli (raggi), Euphorbia,etc. are the major crops. Wheat, Black Gram, Udad, etc are also grown.

Despite the fact that the district receives heavy rainfall, the groundwater recharge is less due to high runoff of surface water and poor storage capacity of basaltic rock. The prominent changes that have happened in the agriculture during 2006-07 vis-à-vis 2005-06 are increase in acreage under 6 crops mainly paddy (by 925 ha), groundnut (by 1900 ha) and warai (by 650 ha).

4.0 Ground Water Scenario

The geological formations in the area are of Cretaceous-Eocene age, represented by the succession of predominantly basaltic lava flows, associated with basic intrusions. Recent alluvium deposit of clay and sand occur along Purna River. The general sequence of the rock formations is as follows:

Quarternary ..... Clay and sand (Alluvium)
Creataceous to Eocene ..... Deccan Trap (basalts)

Deccan lava flows are the major geological horizon occurring between 700-1000 m above mean sea level. The basalts are predominantly of ‘pahoe’ type in which 10 flows have been delineated within the elevations of 700 m and 1000 m above mean

sea level. In the area starting from Saputara Ghat section to Chinchili Grakhadi side Ghat section the individual flows are as thick as 70 m to less than 10 meters.

Based on the lithology, the individual lava flows may broadly be divided into three units viz;

1. The basal unit comprises chilled greyish coloured basalt containing pipe amygdales. They are generally filled with zeolites, chalcedony and cherty minerals.
2. The middle unit comprises fine to medium grained basalt and is very hard and compact.
3. The upper unit consist of vesicular basalt, which is medium to coarse grained and soft in nature. The diameter of vesicles very between one to five mm. The vesicles are rounded or oval shaped and generally filled with zeolites, quartz etc.

4.1 Hydrogeology

Ground water occurrence is governed and controlled by the contrasting water bearing properties of different lithological units. In this area different units of basaltic lava flows form the major aquifer system. Ground water occurs under phreatic condition. The unconfined aquifer is the most extensive aquifer comprising of weathered and fractured volcanic rocks in the district. The areal extent and thickness of weathered mantle is highly variable. Thickness of the weathered mantle ranges from less than 1 m to about 8 m followed by very common spheroidal weathering.

In Basalts, the weathered zones, jointed and fractured units in the interflow junctions consisting of vesicular horizons form the potential aquifers. Ground water occurs under water table conditions in the weathered, fractured and vesicular horizons of traps. Depth of open wells range between 18 to 20 m with water levels in the range of 2 to 12 m. bgl. The southern portion of the area is criss-crossed by dykes which control the movement of groundwater in the formation.

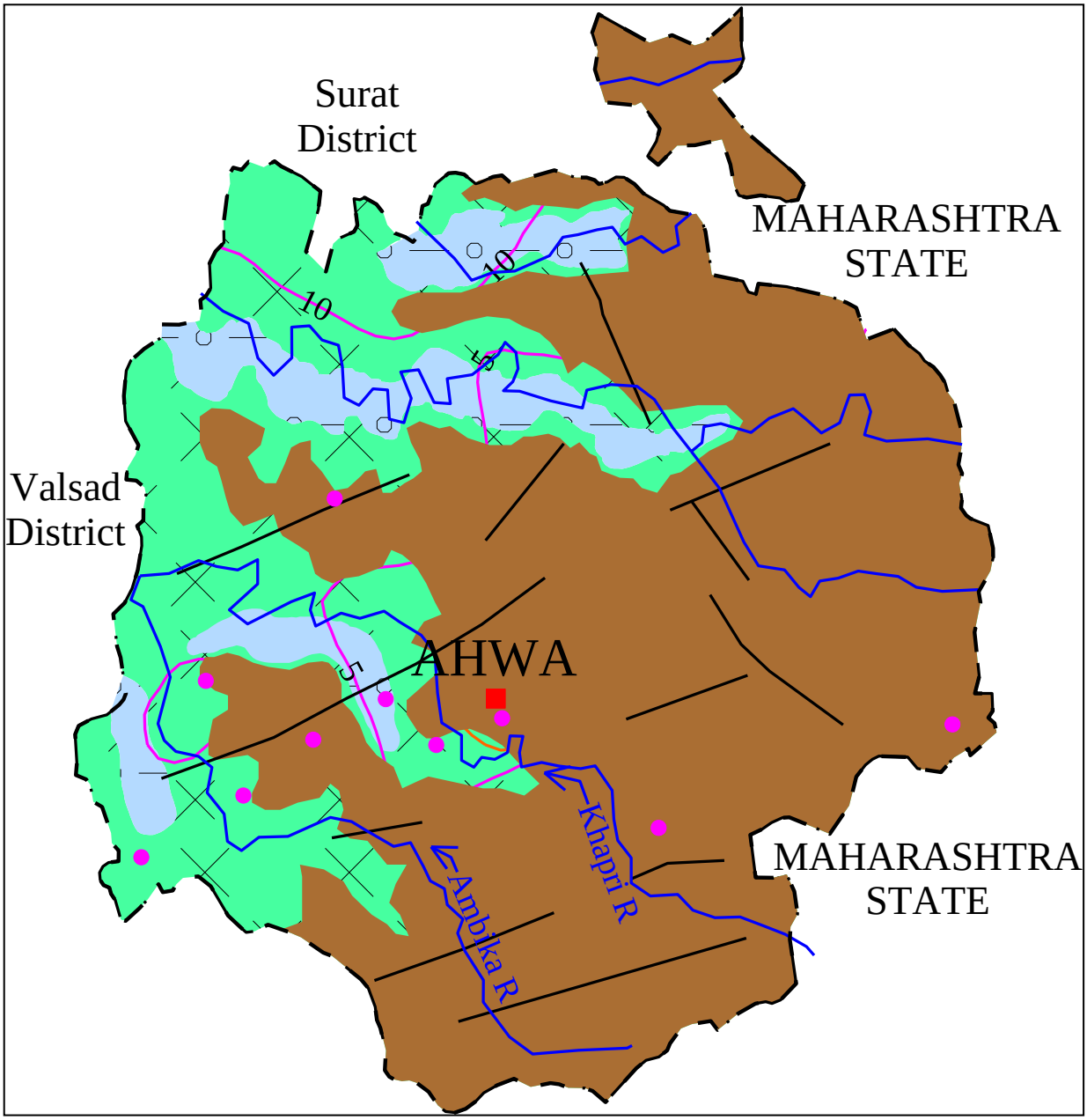
The specific yield of the wells tested varies from 0.0 – 26 percent in weathered basalt and 0.11 to 1.14 in semi weathered to massive basalt. Yield of the wells constructed in weathered and amygdaloidal/zeolitic basalt varies from 15 to 1200 lpm and 20 to 165 lpm in semi weathered to massive basalt

The specific capacity of the wells varies from less than 25 lpm/m to 250 lpm/m. Optimum yield of the well ranges from 15 to 1200 lpm. Transmissivity of the basalt ranges from 15 m^2/day to 152 m^2/day.

In 16 Exploratory wells were drilled in the district four wells were drilled upto 90 m depth and 12 wells in the depth range of 145-200 m. All the boreholes were drilled in the Deccan Trap Basalt. These wells have yielded negligible to 450 lpm for the drawdown in the range of 6-60m. Out of the 16 exploratory wells, 6 wells yielded more than 100 lpm and 4 wells were hydraulically failure. Electrical conductivity of the water ranged from 350-800 µs/cm. Hydrogeology of the Dang District is summarized in the Fig:2

Fig: 2 – HYDRGEOLOGY

THE DANGS DISTRICT, GUJARAT STATE



Legend

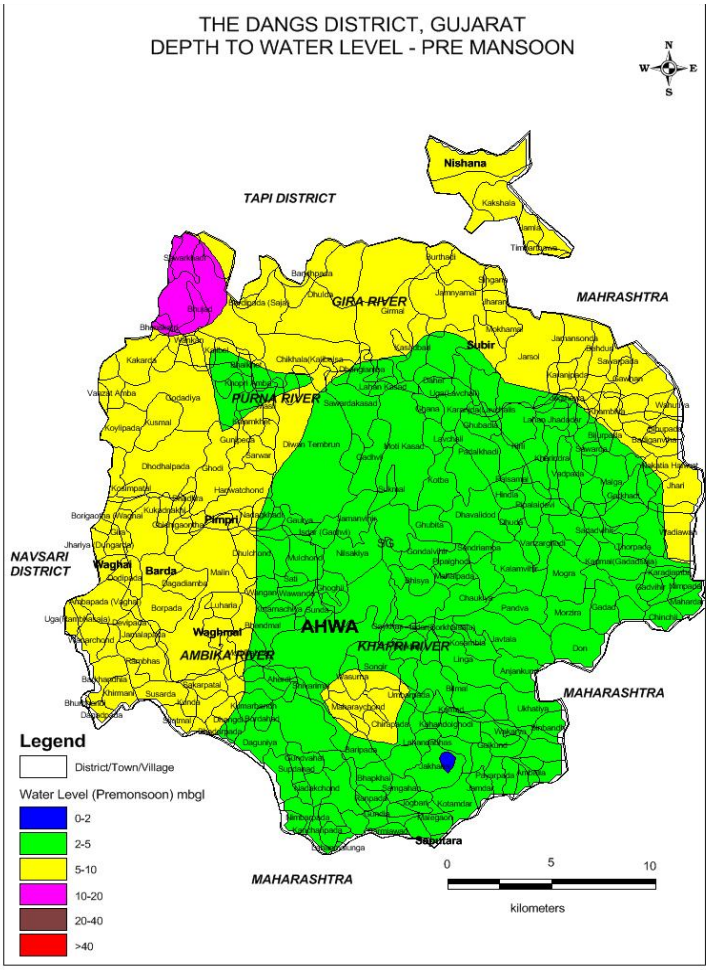
	Wells Feasible	Rigs Suitable	Depth of Well (m)	Discharge (lpm)	Artificial Recharge Structure Suitable
Soft Rock Aquifer	Dug Well	Manual	10-25	150-250	Percolation Tanks/ Ponds, Recharge Wells,
Hard Rock Aquifer	Dug Well Borewell	Manual Down the Hole Hammer (DTH)	10-25 100-200	80-150 100-300	Percolation Tanks/ Ponds, Recharge Wells, Check Dams, Nalla Bunds.
Hilly Areas	Not Suitable. Shallow open wells & springs in valleys / low-lying areas.				Check Dam, Nalla Bund, Gully Plug
Saline Areas	Not Suitable except localised fresh water pockets				
20	Pre-monsoon Decadal mean (1993-2000) Depth to Water Level (mbgl)		2000	Electrical Conductivity (µS/cm at 25° C)	
	Drainage			District/Taluka HQ	
	Dyke			Spring	

4.1.1 Depth to Water Levels:

Since 1969, Central Ground Water Board, as a part of its national programme, has established a network of observation wells in the state of Gujarat and UT of Daman and Diu for periodic monitoring of water levels and the quality of groundwater. At present 1039 (dugwells-655 & 384 piezometers) Groundwater monitoring Stations including 21 open wells and 3 Piezometers in The Dang district The ground water scenario of the district is presented here.

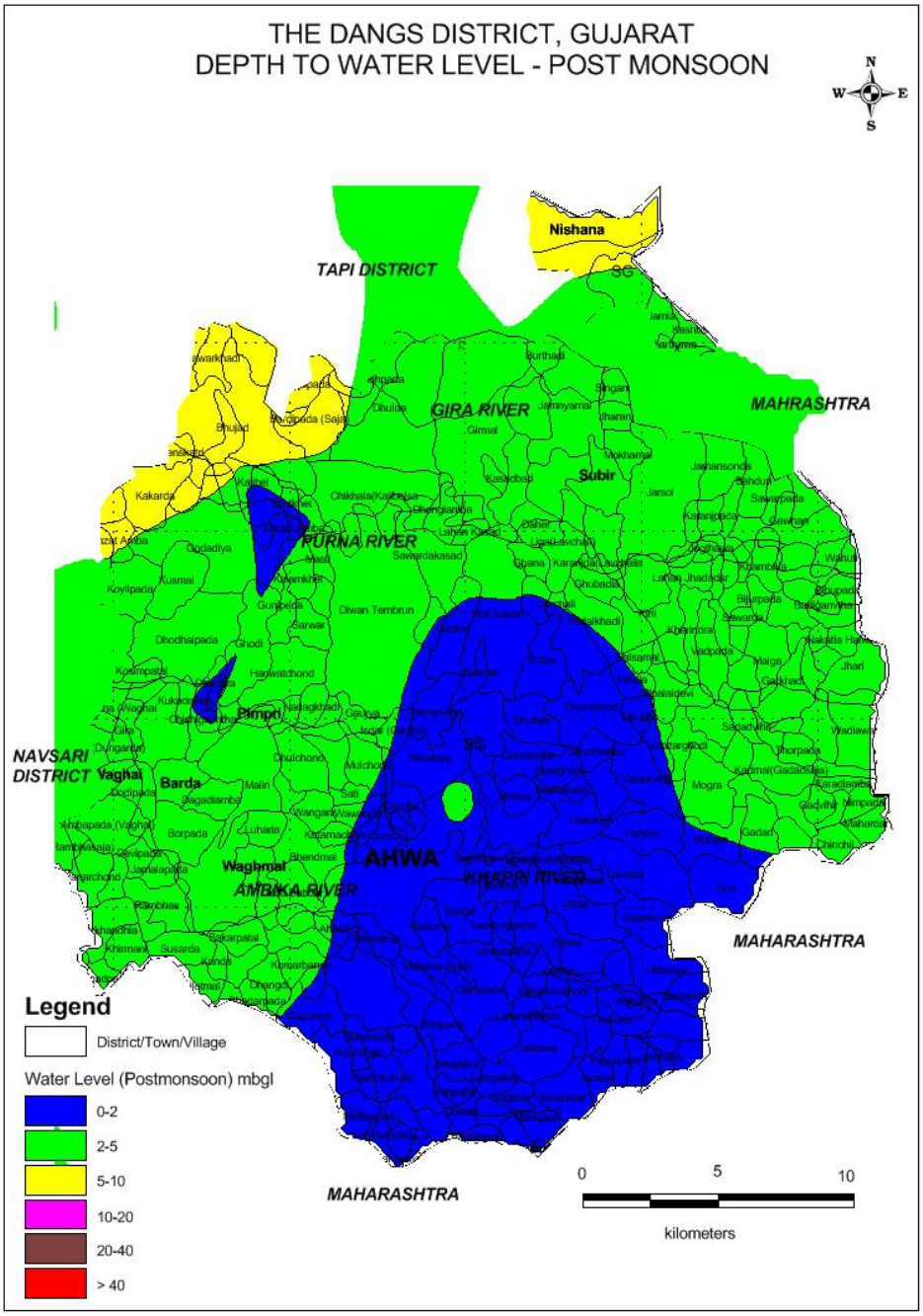
Depth to Water Level map of pre monsoon period (Fig.- 3) indicate that 47% area fall in the range of >2 to 5 m bgl, largely in the Eastern part of the district, 42% area have water levels in the range of 5 to 10 mbgl localized in central part and deeper water level of more than 10 m bgl are observed in western part of the district in 11% of area. The shallowest water level of 2.89 m bgl was observed at Jakhna and the deepest water level of 12.38 m bgl at Mheskatri.

Fig: 3-DEPTH TO WATER LEVEL PRE MONSOON 2012
THE DANG DISTRICT GUJARAT



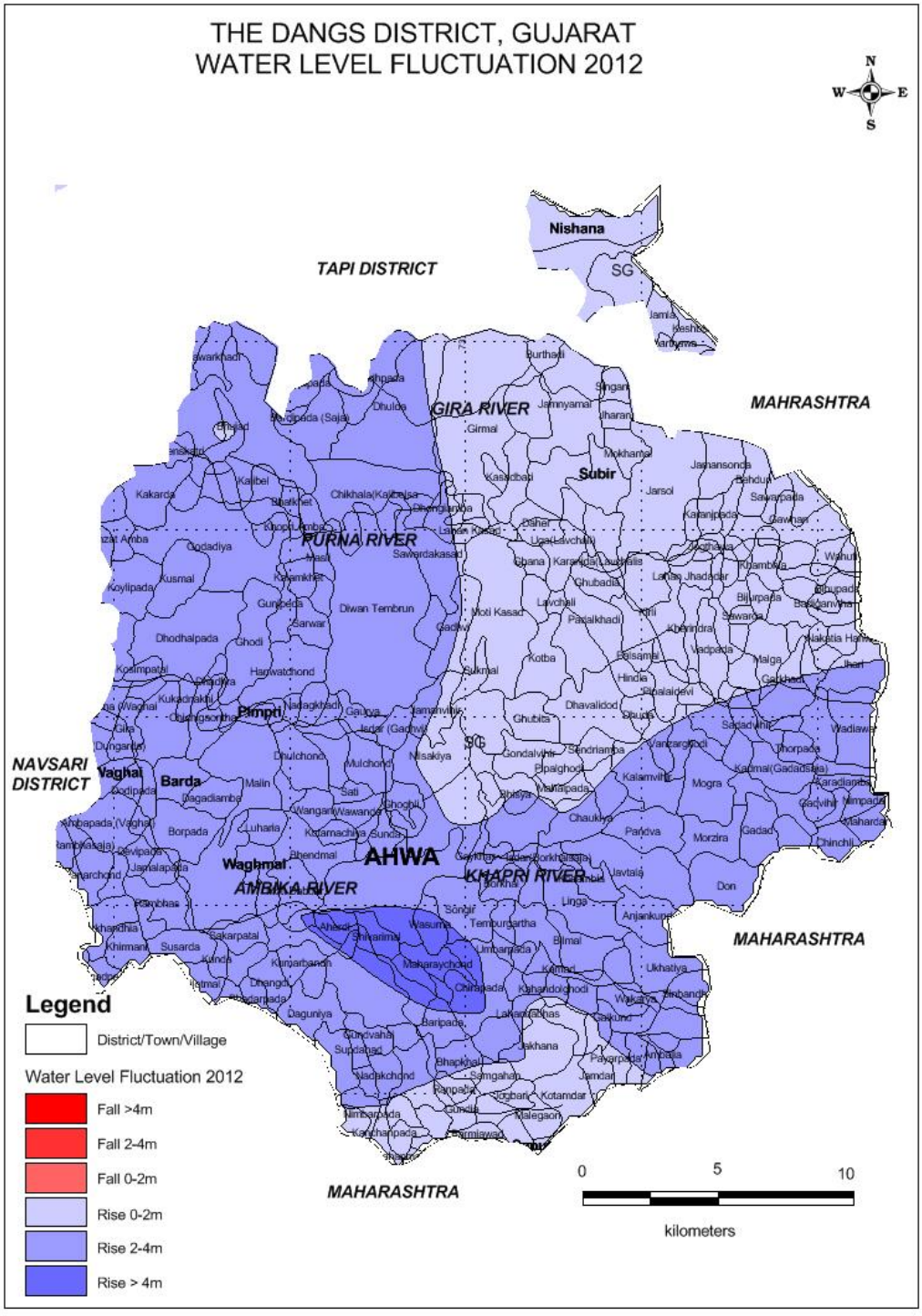
During post monsoon period (Fig.-4), 47% area has water level in the range of <= 2m bgl and 53% area has water levels in the range of >2 to 5 m bgl. The shallow water level around 0.50m bgl was observed at Jakhana/ChinchPada/Ghubita and the deepest water level of 9.55 m bgl at Meshkatri.

Fig: 4-DEPTH TO WATER LEVEL POST MONSOON 2012
THE DANG DISTRICT GUJARAT



Pre-monsoon to post monsoon fluctuation in the water level ranges from 2.3 m at Jakhana to about 9.55 m at Chikhli Fig:5

Fig: 5-SEASONAL WATER LEVEL FLUCTATION 2012
THE DANG DISTRICT GUJARAT

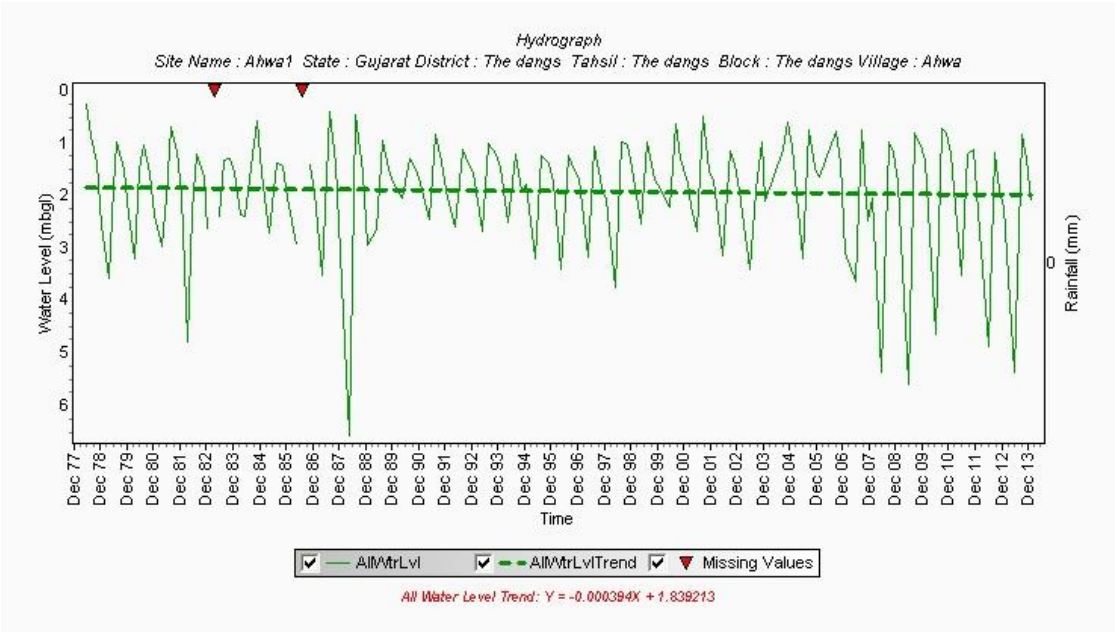


4.1.2 Long Term Water Level Trends: Rise and fall of water levels

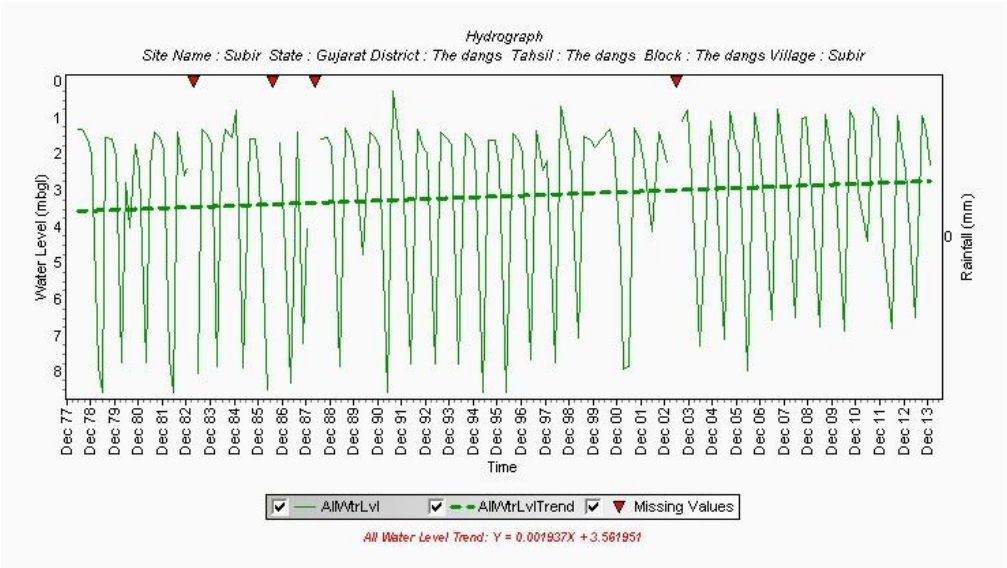
Behaviour of ground water regime over longer period (2003-2012), the data of NHS was analysed and the same is presented in table 4a & b. The hydrograph of few representative wells are given in Fig. 6a – 6d.

Fig: 6a-6d HYDROGRAPKS OF SELECTED GROUNDWATER MONITORING STATIONS INTHE DANG DISTRICT GUJARAT

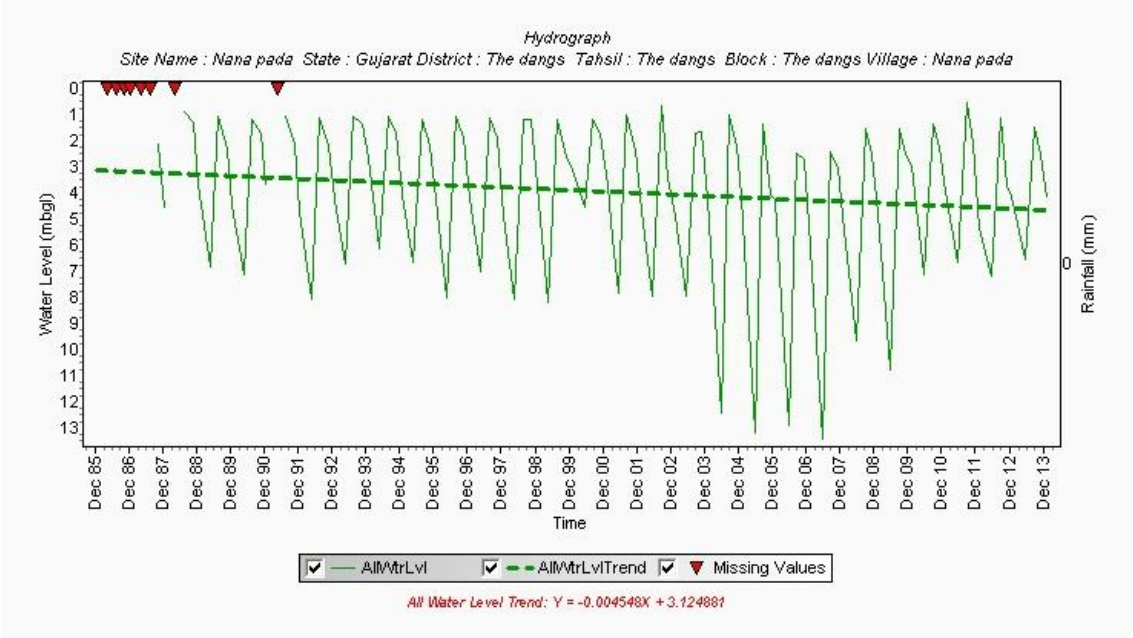
6.a - AHWA



6.b - SUBIR



6.c – NANA PADA



6.d. CHINCHNOGAOTHA

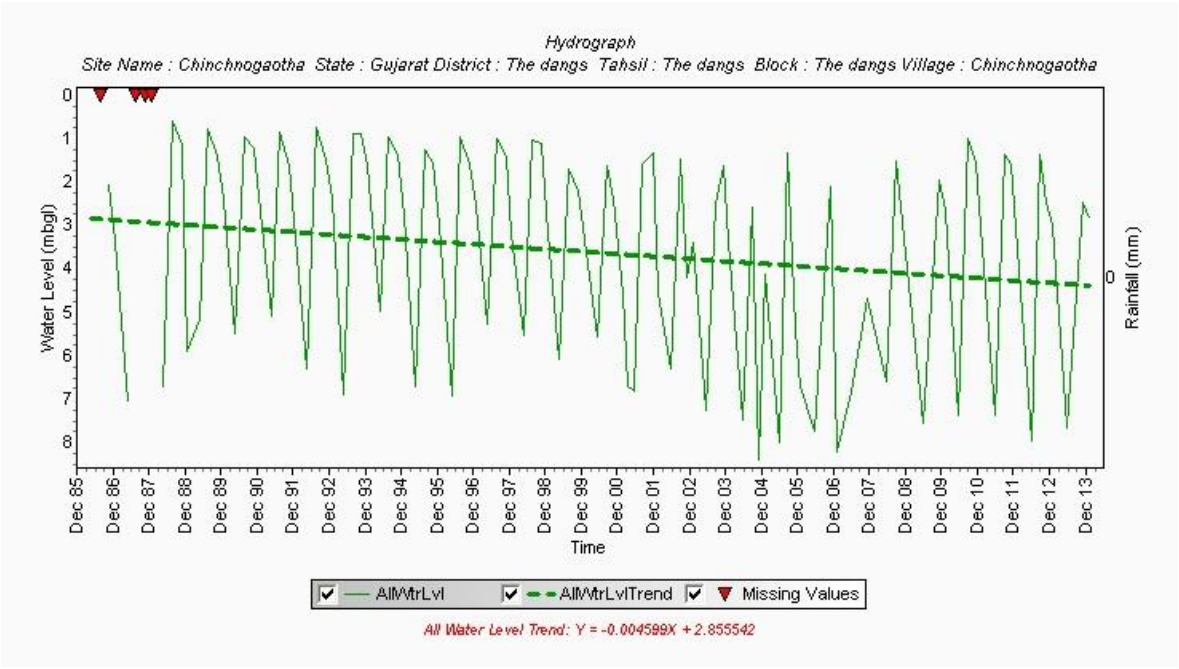


Table – 4a Long Term Premonsoon Water Level Trends (2003 -2012)

Location	Rise (m/year)	Fall (m/year)	Location	Rise (m/year)	Fall (m/year)
Aherdi	**0.1146**		**Ghubita**		**0.0279**
Ahwa_Pz		**0.1037**	**Jakana**	**0.0313**	
Ahwa1		**0.1447**	**Kakshala**		
Bardipada			**Kalibel**		**0.0521**
Bari pada	**0.0860**		**Mahal**		**0.1542**
Bhenskatri	**0.2628**		**Malegaon**	**0.1020**	
Bori gaotha	**0.2107**		**Mheskatri**		**0.0646**
Chikhli	**0.0034**		**Nadak khadi**		**0.2860**
Chinchnogaotha	**0.0914**	**0.0574**	**Nana pada**	**0.2004**	
Chinchpada	**0.0057**		**Sodmal**	**0.1574**	
Dhumkal		**0.1025**	**Subir**		**0.1095**

Gadad		**0.0372**	**Umberpada**	**0.2543**	

Table – 4b Long Term Postmonsoon Water Level Trends (2003 -2012)

Location	Rise (m/year)	Fall (m/year)	Location	Rise (m/year)	Fall (m/year)
Aherdi		**0.2414**	**Ghubita**		**0.0096**
Ahwa_Pz	**0.0444**		**Jakana**	**0.0315**	**0.0373**
Ahwa1		**0.0029**	**Kakshala**		
Bardipada			**Kalibel**	**0.0321**	
Bari pada	**0.0554**		**Mahal**	**0.0156**	
Bhenskatri		**0.3357**	**Malegaon**		**0.0362**
Bori gaotha	**0.3210**		**Mheskatri**	**0.0416**	
Chikhli	**0.0097**		**Nadak khadi**		**0.0126**
Chinchnogaotha	**0.2514**		**Nana pada**	**0.0061**	
Chinchpada	**0.0231**		**Sodmal**	**0.0231**	
Dhumkal		**0.0235**	**Subir**		**0.0061**
Gadad	**0.0142**		**Umberpada**	**0.0053**	

On perusal of the tables 4a & b it is seen that long term trend in last 10 years varies from 0.028 m/Yr fall(Ghubita PZ) to 0.26 m/yr rise (Bhenskatri) during pre monsoon period and 0.006 m/yr fall (Subir) to 0.32 m/yr rise (Borigoatha) during post monsoon period.

4.2 Ground Water Resources

The ground water resources of the district for the year 2009 are presented in Table no.- 5. As ground water development is minimal, the only taluka Ahwa of The Dang district is categorized as Safe.

4.3 Ground Water Quality

The analysis of ground water samples collected during the NHS monitoring of May 2012is summarised in the following table.

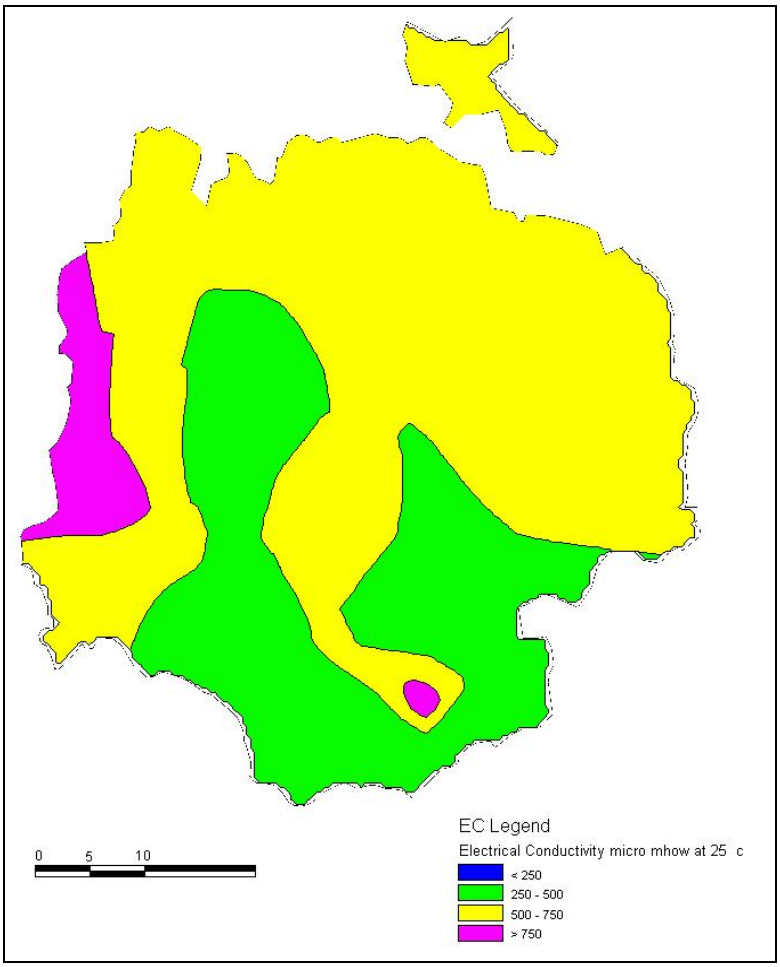
Chemical constituents	**Units**	**Range**
EC	uS/cm	370 - 693
Cl	mg/l	14 - 135
NO3	mg/l	4 - 49
F	mg/l	Neg. - 0.27

Table-5 Ground Water Development Potential of The Dang district and Categorization of taluka for Ground Water Development **(in ha. m)**

Sr. No.	**Assessment Unit/ Taluka**	**Net Annual Ground Water Availability**	**Existing Gross Ground Water Draft for irrigation**	**Existing Gross Ground Water Draft for domestic and industrial water supply**	**Existing Gross Ground Water Draft for All uses (4+5)**	**Allocation for domestic and industrial requirement supply upto next 25 years**	**Net Ground Water Availability for future irrigation development (3-4-7)**	**Stage of Ground Water Development {(6/3)*100} (%)**
	Ahwa	8647.93	901.50	566	1467.50	758	6988.43	16.97
TOTAL								SAFE

In general ground water quality of the district is fresh and potable. The ISO Electrical conductivity Map of The Dang District is presented in Fig. 7

Fig.7 ELECTRICAL CONDUCTIVITY MAP PRE MONSOON THE DANG DISTICT GUJARAT (2010)



As per the available information about drinking water sources (handpumps, wells and Regional water supply schemes) the Groundwater quality is fresh and other parameters i.e. EC, Cl, NO3, F are well within the permissible limits. This is the only Flouride free district in the state of Gujarat. During 2005 Groundwater samples collected from NHS wells of CGWB were analysed for the presence of Total Iron. it was found that the presence of total Iron as 4.23mg/l at Aherdi and 3.35 mg/l at Chikhali indicating high Iron content in some of the groundwater samples. As such there are no significant issues related to quality of groundwater in the district

4.4 Status of Ground Water Development

Even though the Dang has a high annual rainfall compared with the average rainfall of the whole of Gujarat (852.65mm), both drinking and irrigation is scarce. The 85 percent of the population is dependent on agriculture for their livelihood. Groundwater development in the district is by dug

wells, dug-cum-bored and shallow tubewells. Existing Irrigation scenario from ground water sources as per MI census 2000-01 there are 1535 dugwells out of which 1240 are in use. Irrigation potential created through these dugwells is 4063 ha. and potential utilized is 3669 ha. area. There are a few deep tubewells in use.

Apart from Irrigation, groundwater is extensively used for drinking purpose in most parts of the district through dugwell/handpump and through borewells in isolated tribal pockets. The drinking water supply system (centralized supply, hand pumps and open wells) and the groundwater availability are not in balance. The unsustainable use of groundwater along with the undulating land and lack of any recharging mechanism has led to ground water depletion. Geologically, the district is composed of Deccan trap Basalt which is hard in nature. There are less cracks, fissures, and joints. Basalt acts as poor aquifers. Summarized details of user aquifers for drinking water from the user point of view is given in table-7a. As per District statistical handbook, 2011 there are 957 irrigation Dugwells and 1007 domestic wells. In all 1474 wells are energised.

Table – 7a Summary of Drinking Water Structures and Groundwater Situation in The Dang district

Sr No.	Taluka	Area (sq.Km.)	Hard Rock Area suitable for GWD (sq.Km.)	Geological Formations	Normal Depth Range of wells (m)	Pumping Water level (m)	Quality (TDS) (mg/l)	F (mg/l)	No of Drinking water wells	GW Resource Category
1	**Ahwa**	**1724**	**-**	**Basalt**	**60-120**	**60-80**	**750-1000**	**0-0.5**	**1007**	**Safe**

Almost all water supplies systems (be it for drinking or irrigation purposes) in the Dang district is based on groundwater reserves. This has immense pressure on the ground water reservoirs in certain pockets. The lack of adequate groundwater recharge and rain water harvesting mechanism is one of the main reasons for the scarcity of water. Breakup of the different schemes operating for water supply in the Dang district is summerised Table 7b.

Table – 7b Summary of different Drinking Water Schemes and Villages Covered in The Dang district

A	**Different Schemes for drinking Water Supply in The Dang District**	**Nos of Schemes**	**Villages included**
	Total Villages - 311		MWSS-112 Independent Pipe -137 Handpump – 6 Open well - 35 Mini Pipeline/other - 21
B	**No of MWSS/RWSS**	**23**	**112 Villages**

	Tube wells	2	UmarPada, Mahal
	Check Dam	6	Bhesya, Galkund, Subir, Pali samaj, Kotala, Jamnyamal.
	Dug/open Wells	14	Bhedmal, Bhesiamal, Mahardhar, Kotmal,Sati,Hawant Chod,Lavyali etc.
	Intake well	1	Sati
C	**No of Handpump Installed**	**4474**	
	In operation	4374	
D	**No of Deep Tube wells**	73	

It is reported that Water supply in the district for industrial purposes is supplied from two main sources, Viz Gujarat Water Supply & Sewerage Board and Irrigation Canals. Almost all water supply system in the district are based on groundwater reserves. Centralised Water Supply Infrastructure facilities is available including drinking water: Tanks in 168, Stand post in 154 , pipeline in 98, Cattle trough in 168 and washing facilities in 6 villages. However industrial development in the district is not significant.

5.0 Ground Water Management Strategy

Judicious and cautious approach for developing ground water resources is to be adopted. There is an urgent need for management of the resources for sustainable development. Suitable recharge structures are to be practiced in the area along with the regulated withdrawal of ground water to minimize the effect of stress on the groundwater regime. Status of availability of agriculture land and source of irrigation is summarized in table-8.

Table - 8 Agricultural land and source of irrigation

(area in ha.)

Sl. No.	Name of taluka	Net area irrigated through			
		Major/ medium scheme	**Groundwater**	**Surface water**	**Total**
1	**Ahwa**	**CheckDams; 2285** **Storage Ponds: 4288**	**Dug Wells 1600** **Tube Wells 160**	**2347**	**10680**
	TOTAL				

(Source: District Plan Report 2009-10)

6.0 Water Conservation:

Percolation tanks/ponds, Recharge wells, Recharge shaft, check dams, nalla bunds and gully plugs, are the recharge structures feasible in the district depending on the terrain conditions. In the phreatic aquifers with deep water levels and de-saturated zones, spreading channels, recharge pits, recharge ponds etc are suitable to utilize surplus runoff and tail end releases from the canals.

The Dang with the highest precipitation in Gujarat faces severe water scarcity. Steep slopes and rolling terrain increases the runoff and thereby lower the potential for recharge in to the consolidated and impervious country rocks. The water scarcity is common after monsoon is over and particularly during summer. Integrated Watershed Development Projects are required in the area specially in the eastern part of the district. Construction of check dams will increase in agricultural productivity, thereby create more employment through agriculture and also provides employment to villagers during the construction of these structures. People perceive construction of check dams as provider of employment during lean periods.

The suitability of irrigation structures in the North and South Dang differ. In South Dang more check dams are feasible, since most of the rivers in the Dang flow through the area. The North Dang (which is more hilly) the ponds are the best suitable water conservation structure.

Large number of Rainwater harvesting schemes depending on the suitable hydrogeological conditions have been constructed in the district viz. Check dams, Recharge tube wells, deepening of the village ponds etc. It is observed that Recharge structures have shown good impact on the groundwater scenario. Rain water harvesting and water conservation schemes are need to be encouraged in the district.

7.0 Ground Water Related Issues, Limitations and Problems

A livelihood of communities in the Dang is primarily dependant on land – based activities. It becomes important that land development initiated to increase the productivity in the category of: cultivated, forest, waste and grazing lands. Land development in the Dang has to be approached from a watershed perspective. A watershed management approach encompasses the integration of soil and moisture conservation technologies to treat a defined natural drainage for optimal development of land, water and biomass which would enhance the productivity helping communities in a sustainable manner. Activities envisioned, implemented and owned by the community should be tailored to overcome specific constraints of land productivity.

- Heavy rainfall runoff coupled with the hilly terrain and effects of ‘Climate change’ on rainfall pattern places large dependency on Monsoon.

- Failures of large number of bore wells have been reported in the district. Farmers are forced to go for deeper wells which are leading them to invest more money and secondly the cost of irrigation becomes uneconomical with depth. Erratic power supply is also grave concern for the farmers in the area.

- Flood irrigation technique is in practice in some parts of the area is also the major cause of wastage of ground water as there is no control on the watering depth.
- Common Irrigation Infrastructure- : The rolling and very steeply sloped terrains in the Dang limits the development of surface water harvesting. Hence, the most viable option is the construction of check dams and check walls, followed by a limited opportunity for the creation of ponds.

8.0 Recommendations

- Judicious and cautious approach for developing ground water resources should be adopted together with creating awareness about cautious use of this limited resource among the farmers in general and other ground water users.

- Artificial recharge should be taken up on large scale through appropriate techniques on a regional scale with active community participation. Institutional finance and appropriate technology should be freely made available to any individual or cooperative group of farmers that undertake resource augmentation and management measures.

- Artificial recharge practices should be encouraged by diverting surplus run-off during monsoon into ponds, percolation tanks, Spreading basins, abandoned dugwells etc.

- Augmentation of ground water resource with artificial recharge and roof top rain water harvesting and Construction of water conservation structures like check dams and check walls etc., which partially serve to meet the water requirement for domestic and irrigation use should be constructed at suitable locations for storage of water.

- Farmers may be encouraged to cultivate less water intensive crops. Apart from this organic farming and marketing of organic food products may also be promoted.

- Irrigation facilities should be enhanced to provide secure livelihoods to the community and to overcome the impacts of uncertainties of monsoon. As a remedial measure to arrest migration, communities have suggested the creation of irrigation facilities. Due to limiting topographical and geological factors in the Dang, it is difficult to develop privately owned irrigation facilities on a large scale. Considering this fact, the creation of new infrastructure has to focus on development of community based irrigation facilities.

- Though there is no trace of nitrate pollution in groundwater, In order to have check on the concentration of nitrate in ground water in future, use of bio pesticides, organic farming, bio fertilizers etc should be encouraged.

- Schemes involving effective management of existing surface water reservoirs and extensive recharge of ground water through different methods should be exercised.

- The land holding of the group of farmers under public tubewell irrigation should be brought under the provision of the change in crops, irrigation practices and installation of drip/sprinkler irrigation technique.