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GROUNDWATER BROCHURE

VALSAD DISTRICT

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Profile of Valsad District – Gujarat State

Sr No.	Particular / Items						
1	Gene	eral Information					
	i.	Geographic Area (Sq km) : 3055 Sq Km					
	ii.	Administrative Units : 5 Taluaka – Dharampur, Kaparda, Pardi, Umagam & Valsad					
	iii.	No of Villages / Towns : 434 Villages ; 5 Statutory Towns and 19 other Census Towns & Industrial Notified Areas.					
	iv.	Population (2011 Census) : 17,03,068 ; 73 % Rural & 23 % Urban ; Decennial Growth Rate of population 21 %					
	v.	Climate : Sub tropical with moderate to high humidity					
	vi.	Average Annual Rainfall (1981-2012) : District 2223 mm					
		1718 mm in Umargam to 2842 mm –Kaparda					
2	Physiographic Features						
	i.	Physiographic Zones :High Land plateau, , Piedmont Zone ,Intermediate Low Relief Plain & Costal Plain					
	ii.	Topography : Hilly Terrain –Elevation > 500 m to Coastal zone 8-2 m amsl					
	iii.	Drainage : Damanganga, Kolak, Par, Auranga, Kalu & Valori					
	iv.	iv. Hydro Geomorphic Zones : High to Moderate dissected plateau, Piedmont Zone, Alluvial Plain & Coastal Tidal – Mudflat zones					
3	Agriculture & Irrigation						
	i.	Area Reported for Land Use : 282237 ha					
	ii.	Area Under Cultivation: 158927 ha (52 %)					
	iii.	Forest & Hills : 123247 ha (40 %)					
	iv.	Irrigation Sources					
		a. Tube wells / wells : 229 / 9262 : Unit draft varies from 2.50 to 6.0 ha.m / year(Deccan trap area)					
		b. Canal Network Length : 65 km					
	v.	Irrigated Area					
		a. By Ground Water : 9,690 ha					
		b. By Surface Water : 13,288 ha (Damanganga & Kakrapar Project)					
4	Geole	ogy & Hydrogeology					
	i.	Major Geological Formation : Deccan Trap & Alluvium					
	ii.	Aquifer System: Both Unconfined & Semi to Confined system in Deccan Trap and Alluvium Formation					
	iii.	Groundwater Monitoring : 16 Open wells & 3 Piezometers					
	iv.	Depth to water level : 4 to 18 m bgl Pre monsoon and 2 to 10 m bgl post monsoon					
	v.	Groundwater Quality : Fresh to moderate in Deccan trap area and moderate to brackish in Alluvium area					

	vi.	Groundwater Exploration : Exploration up to 200 m at 18 locations; 20 Exploration Wells ; 8 Observation Wells	
	vii.	Aquifer Parameters : T varies from 20 to 250 $m^2/$ day ; Specific Yield : 6 % for Deccan Trap to 15 % for alluvium formation ;	
	viii.	Groundwater Resources :	
		a. Total Annual Ground Water Recharge : 430.80 mcm	
		b. Net Annual Ground Water Availability : 401.11 mcm	
		c. Gross Annual Draft : 162.16 mcm	
		d. Stage of Ground Water Development 40.43 % - Safe Category	
		i. Dharampur : 24.91 % - Safe Category	
		ii. Umargam : 44.81 % - Safe Category	
		iii. Pardi : 53.12 % - Safe Category	
		iv. Valsad : 62.11 % - Safe Category	
		v. Kaparada : 10.13 % - Safe Category	
5	Awa	reness & Training Activity of CGWB	
	i.	Mass Awareness Program Organized : Nil	
	ii.	Water Management Training Program Organized : Nil	
6	Artif	icial Recharge Work	
	i.	Project /Work Undertaken : Nil	
	ii.	Feasibility of AR Work : High potential for construction of various rcharge structures like check dams, recharge shaft, subsurface dam ; percolation tanks and recharge through dug wells / tube wells.	
7	Grou	indwater Development Regulation	
	i.	Notified Area / Blocks : Nil	
	ii.	Measures Required :	
		a. Regulation for further development in western part – coastal zone having limited thickness of fresh quality aquifer	
		b. Specific Monitoring Network to ascertain impact of development activity and extent of pollution	
8	Major	Groundwater Related Issues	
	i.	Uneven distribution and development of ground water resources	
	ii.	Quality constraint in alluvium areas of west and variable yield constraint in hard rock areas.	
	iii.	High intensity rainfall and vide scope of artificial recharge work	
	iv.	High development in coastal zone aquifer having limited thickness of fresh quality ground water	
	v.	Reported groundwater pollution due to industrial effluent in eastern part of the district	
	vi.	Copious surface water resources can be used conjunctively for sustained development of water resources of the district.	
1	1		

INTRODUCTION

Valsad district is one of the important tribal districts of Gujarat State. It has rich cultural background with affluent forest areas endowed with vivid fauna & flora. It is famous for its orchard plantations. There is rapid growth in agriculture as well as of industries in the district during recent past. Earlier (1951) it was a part of unified Surat District under Bombay Province. After formation of Gujarat State in 1960, it was separated from Surat district. Later on in year 1997, for administrative convenience, Valsad district is divided between two districts, namely Navsari comprising taluka areas of Navsari, Gandevi, Chikhali and Vansada while new Valsad district comprises taluka areas of Valsad, Pardi, Dharampur and Umergam.

LOCATION

Valsad district is located in southern part of Gujarat State. It has total geographical area of 3055 sq km, extended by the north latitude of 20°07' to 20°45' and east longitude of 72°43' to73°29'. It falls in the Survey of India sheets no 46-D/12, D/14, D/15, D/16 & 46-H/2, H/3, H/6, H/7. The district is bounded in the north & northeast by Navsari district and by Nasik district of Maharsahtra in the east & south. The Union territory of Dadra-Nagar Haveli lies in south while UT of Daman lies in west. The Arabian Sea forms western boundary.

Fig. 1 Location Map of Valsad District.



ADMINISTRATIVE UNITS

The district is divided into 5 Taluka for its administrative functioning. They are Dharampur, Kaprada, Pardi, Umargam and Valsad. Valsad town is the district headquarters. Valsad urban agglomerate includes 5 towns, namely Abrama, Kosamba, Nanakwada and Mogarwadi with other out growth area of Valsad city. There are 9 Municipal Category towns, 19 Census Towns with Industrial Notified Areas (INA) and total 434 villages.

Table : 1 Administrative Units, Area & Population - Valsad District

Sr	Taluka	Geographical	Area reported for land use (Sq.Km)			Population -Census 2011		
No	Name	Area (Sq.Km)	Total Area	Urban	Rural	Total	Urban	Rural
1	Dharampur		713.21	15.51	697.70			
2	Kaprada		936.62	0.00	936.62			
3	Pardi	NA	425.90	48.04	377.86		NA	
4	Umargam		361.78	18.71	343.07			
5	Valsad		509.88	42.76	467.12			
	Total	3035.00	2947.39	125.02	2822.37	17,03,068	6,34,075	10,68,993

(Source : District Census Data – 2011)

DEMOGRAPHIC PERTICULARS

According to the 2011 census the total population of Valsad district is 17,03,068 persons. Out of this nearly 73 % population is spread in 434 villages while 27 % of population is spread in 28 towns. The density of population in rural area is 365 souls per sq.km while in urban area it is around 3049 souls per sq.km. The decadal growth rate 2001-111 is 21 % . The demographic analysis reveals that during last two decade there has been rapid growth in urban population.

LAND USE PATTERN

As per Seasons & Crops Record, 1,58,990 hectares of land, excluding all type of

Table : 2	2 Details of Land Use – Valsad District Source	e : Agriculture Directorate Gov of Gujarat
Sr No	Land Use Classification	Area in Hectare
1-A	Geographic Area	3,05,500
1-B	Land Reported for Land Use (Include Forest Area)	2,82,237
2	Forest Area	1,23,247
3	Land Reported for Land Use (Exclude forest area)	1,58,990.46
4	Area Under Current Fallows	894.14
5	Uncultivated Land Excluding Fallow Land	18.64
6	Fallow Other than Current Fallows	3.40
7	Cultivable Waste Land	10.33
8	Total Uncultivated Land (5+6+7)	32.37
9	Land not Available for Cultivation	30.42
10	Net Area Cultivated (3-8-9)	1,58,927.67
11	Net Area Sown (10-4)	1,58,033.53
12	Irrigated Area	30,017.85
13	Un irrigated Area	1,28,189.73
14	Gross Cropped Area (12+13)	1,58,207.58

terrain areas, is accounted for land use record. Brief account of land use classification Valsad for district. is given in table 2 and shown graphically in figure no. 2 & 3

forest & hilly

Figure 2 Valsad District Land Use



Valsad District - Land Use (2005-06)





(Source Fig 2 & 3; data compiled from Agricultur Directorate Data)

IRRIGATION & AGRICULTURE

Valsad district has huge potential of surface water resources in the form of perennial river system comprising of Par, Wanki, Kolak, Damanganga and Varoli rivers and associated tributaries & springs in hilly terrains. Parts of Valsad district is covered by irrigation command of Daman Ganga Project and Ukai Project, and more than 50,000 ha area is irrigated in all three, Kharif, Rabi and Summer period through network of lined / unlined canal system. The canal network is also utilized for supply water for domestic and Industrial uses. Perusal of water release data of Daman Ganga Reservoir for year 2008-09 shows that nearly 15 % of water released through canal is used for industries. In year 2008-09, 4218 ha of area irrigated by 157.45 MCM of water during all three Kharif, Rabi & Hot season (table 3). In the same way nearly 16,000 ha area is under ground water irrigation and dug well are the main structures for ground water irrigation (Table 4 & 5).

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	Water Drawn	Water Utilised	Water Utilised	Area Irrigated
Season	from Head	by Industries in	for Irrigation in	Area Irrigated
	Point in MCM	MCM	MCM	in na. Are. Sqin
Kharif - 2008	20.68	10.25	10.43	942.85.61
Rabi 2008-09	79.69	10.70	68.99	1859.35.77
Hot 2009	83.98	5.95	78.03	1415.78.45
TOTAL	184.35	26.90	157.45	4218.00.00

Table 3 Water Released & Uses – Damanganga Project –Valsad Dis (Year 2008-09)

(Source : Damanganga Irrigation Project Office - Vapi, Valsad)

Table 4 Structures for Irrigation & Other Uses

Sr.	Structure	Nos.				
No						
1	Total Tank	1 560				
2	Non Irrigation Tank					
3	Canal No. / Length km NA / 6					
4	Lift Irrigation Sources	4				
5	Tube Wells for Irrigation	229				
6	Dug Wells for Irrigation	9262				
7	Domestic Wells	5670				
8	Abandoned Wells	170				
9	No. of Oil Engines	4592				
10	No. of Electric Pump	9711				

Table -5 Details of Irrigated Areas

	Area Irrigated (ha)
Canals	13,288
Tanks	910
Wells	9,280
TW	410
Other	6,128
	30,017

(Source : Tab 4, 5 & 6 – Agriculture Directorate, Government of Gujarat)

The district has varied agriculture crops, both food crops, horticulture & non food crops. Main food crops consist of food grains such as paddy, wheat, *jowar, bajra*, maize etc., and pulses. Total production of food crops in



2006-07 was 36 lakhs MT.

The horticulture crops being produced in the district are mangoes, cucurbits, chiku, banana, sugarcane & vegetables. Valsad district has highest production of mangoes;



more than 2 lakhs MT, while second highest production of cucurbits, over 50,000 MT was in the year 2006-07. Non food crops consists of cotton and fodder etc. As per *Season*

& *Crop Records*, there were 1,58,208 hectares of gross area under various crops in the district, out these 30,017 hectares were under irrigated crops. Details are given in table 6.

Item / Category Crop	Irrigated Area *	Non Irrigated Area *	Total Cropped Area *
Food Grain	11197.83	95963.03	107160.86
Fruits	9903.75	8334.66	18238.41
Vegetables	115.05	93.20	208.25
Other Food Items	7335.46	1884.88	9220.34
Total Food Crops	28552.09	106275.77	134827.86
Non Food Crop	1465.76	21913.96	23379.72
Total Cropped Area	30017.85	128189.73	158207.58

Table -6 Details of Areas under Food & Non-food Crops & Irrigation

* Area in Hectares

URABAN AREA & INDUSTRIES

Vasad, Vapi, Dharmpur, Pardi & Umargam are main urban areas. Since last three decades, Valsad is an industrial base for chemical, textiles, papers & pulp industries, which are major sectors of industrial development and also for employment, other than agriculture. Recently, it is also emerging as a horticulture hub of the State, showing significant increase in food produces and development in food based industries. As such, overall industrial development is seen all over the district, which has five industrial estates (Industrial Notified Area) and one Port Based Industrial Park for Chemical Sector. (Table7 & Fig 4)

Ir	ndustrial Estate	Area in Hectare	SURAT
1	Dungra	9.23	NAVSAR T
2	Pardi	22.74	BILIMORA DANGS
3	Dhrampur	35.47	VALSAD
4	Bhilad	63.38	- Area
5	Valsad	106.63	VALSAD
6	Umargam	388.00	Deve
7	Sarigam	395.00	SARIGAM
8	Vapi	1163.77	BHILAD
Ind	ustrial Park		UMBERGAON
1	Kalgam	400.00	Source - Valsed Dist Profile - Penert of Industry Dent GOG

Table : 7 Major Industrial Areas - Valsad District Fig 4 Map Showing Location Industrial Estates

Besides major industries of chemicals, textiles, printing, dyes, pharmaceuticals products & electronic equipments, food processing etc., there are more than 10,700 units in 5 talukas of the district, however, are generating about 58,600 jobs in small & medium enterprises (SMEs), involved in dye stuffs & optical, cotton textiles, chemicals, lathe & machines tools etc.

CLIMATE

Valsad district is located in south of *tropic of Cancer*, comes under heavy rainfall areas of South Gujarat, having sub-tropical climate with moderately high humidity. The main seasons prevailing in the district are (a) monsoon - mid of June to October, (b) winter - November to February, and (c) summer – March to June. Various

climatological data recorded over a decade (2000-2009) are analysed and presented in table 8 and also depicted graphically in figure - 5

	Max	Mimi	Max	Min	Wind	, , ,	
Month	Temp (°C)	Temp (°C)	Humidity (%)	Humidity (%)	Spd. Km / hr	Eto (mm/ month)	Rainfall (mm)
January	35.4	9.9	86.0	29.4	1.8	111.3	0.0
February	37.5	10.7	82.1	26.1	2.0	126.3	0.0
March	40.1	15.1	81.6	24.4	2.5	185.5	1.4
April	41.2	19.6	79.6	27.3	2.9	218.7	0.0
May	39.8	23.3	82.6	39.7	3.9	231.7	4.6
June	37.1	22.7	96.9	52.7	4.1	148.8	437.4
July	32.8	22.9	98.2	71.7	3.5	77.3	734.5
August	32.2	22.9	96.8	72.5	2.7	71.7	608.2
September	34.2	22.6	97.2	65.8	1.6	96.1	227.3
October	37.0	17.8	91.1	38.5	1.3	132.6	18.6
November	36.5	14.6	84.6	33.8	1.3	121.0	7.1
December	35.3	11.6	85.5	34.4	1.3	105.7	0.8
Total	-	-	-		-	-	2039.9
Average	36.6	17.8	88.5	43.0	2.4	135.6	-



The maximum daily temperature during the year ranges from 32.2 °C in August to 41.2 °C in April while minimum temperature ranges from 9.9 °C in January to 23.3°C in May. Maximum humidity ranges from 98.2 % to 79.6 % while minimum range is from 24.4 to 72.5 %. The wind speed ranges from 1.3 to 4.1 km / hrs, where as evapo transpiration

ranges from 71.7 to 231.7 mm / month; total for the year is around 1626 mm which is 79 % of annual rainfall. Rainfall analysis is discussed in detail in following section.

Rainfall

Valsad district receives much of its rainfall from the south-west monsoon during the period between June & September; its maximum intensity being in the month of July & August. Total rainy days ranges from 40 to 55 days / year. Long term annual rainfall data of 11 rain-gauge stations of the district from year 1981-2012 are statistically analyzed and presented in table No 8. The distribution of mean annual rainfall over the Valsad district, as isohyets is given in figure 6.

Table No 8 -	able No 8 - Statistical Analysis of Rainfall Data Rainfall in mm							
Name of		Average	Standard	Coefficient			Lowest RF - Year	
Stations	Stations No. of Years Annu		Annual RF Deviation	of Variation	Highest F	RF – Year		
Umargam	1996-2012	1718.63	520.45	30.28%	2334.00	2010	464.00	1997
Madhuban	1982-2012	2318.23	622.50	26.85%	3453.10	2004	1350.90	1987
Vapi	1993-2012	2279.29	463.52	20.34%	3133.00	2005	1578.00	2012
Kaparda	2000-2012	2842.78	693.08	24.38%	3944.00	2005	1999.40	2012
Nanaponda	2000-2012	2399.60	435.25	18.14%	3041.10	2005	1769.40	2012
Paria	2000-2010	2222.72	477.27	21.47%	3182.10	2003	1614.50	2002
Pardi	1981-2012	2009.62	497.12	24.74%	3344.00	1994	1360.00	1997
Dhrampur	1981-2012	2422.93	652.08	26.91%	4282.00	1994	1566.00	1986
Valsad	1981-2011	1825.48	614.23	33.65%	3232.00	1994	1200.30	1987
Jhuj	1981-2012	2023.13	578.66	28.60%	3537.40	1994	1289.20	2002
Bhilad	2000-2012	2394.21	371.36	15.51%	2784.30	2005	1581.20	2012

PHYSIOGRAPHY

The district has high variation in topography ranging from near sea levels all along western part to as high as 600.m amsl, in high relief tracks in eastern boundary. Based on topography and landforms, the main physiographic units identified in the district are narrow coastal plains having inter-tidal saline wastelands and adjoining alluvial plains in the west; and intermediate rocky table lands with contiguous high relief hill ranges in east. (Fig 7)

DRAINAGE

The Auranga, Par, Kolak, Daman Ganga and Kalu river forms main drainage basin in Valsad district. All the rivers originate in the eastern highland and flow towards west direction to the Arabian Sea. The rivers are perennial in nature. The flow of the water in the rivers is more during the rainy season. The drainage is dendrite to sub-dendrite type (Fig 8 – Drainage Basin).

SOILS

Based upon the works of Soil Survey Organization of State Government, the soils of the district have been classified into four major group such as i) Bilimora - Bedmal Series of hilly area ii) Baldha - Vadhawania Series of piedmont slope area, iii) Ena-Jalalpur – Sisodra Series in the midland and flood plain areas of the district and iv) Jal – AH – Dandi Series of soil along the coastal region (Fig 9).

HYDROGEOMORPHIC UNITS

The hydrogeomorphic units of Valsad district have been mapped in ISRO studies, on the basis of geomorphology, lithosrtaigraphy, underlying structures characteristics of rocks and topography of the area with application of remote sensing techniques. Various hydrogeomorhic units of Valsad district are shown in figure 10.









GEOLOGY

Geologically Valsad district is a northern extension of Deccan Plateau of Central India, belonging to late Cretaceous – early Eocene age and here, it is followed by Quaternary sediments. Map showing major geological formations and tectonic features are shown in figure 11, and the stratigraphy of Valsad district is presented in table 9.

Geological Age	Formation	Group	Lithology		
	Mahuva Formation		Younger tidal formation, spit / bar and shoal deposit		
Holocene	Akhaj Formation		Coastal dune deposit		
	Rann Clay Formation	on	Older tidal flat deposit		
	Katpur Formation		Flood plain deposit		
Upper	Extensivo I	Jaaaan	Granophyre and other basic dykes, sills		
Cretaceous to		Jeccali	& plugs		
Eocene	Intrusive	voicanic	Basalt & Dacite		

 Table : 9. Stratigraphy of Valsad District ¹



Deccan trap rocks are the oldest rock type, exposed in the Valsad district area. They are a direct result of the Deccan volcanism of late Cretaceous period, and are made up of a thick pile of nearhorizontal bedded lava flows. The exposed thickness of the basalt here is more than 600 m. The weathered part of the Deccan trap is locally known as muram . It is soft and easily crumbles pieces. into The thickness and areal extent of the weathered portion is very erratic; it ranges from 1 to more than 18 m at

places. Laterised and weathered basaltic outcrop in the form of hummocks of about 3 to 8 m height are observed near Pardi, west of Vapi and in many interior parts of Dharampur & Kaparada taluka areas.

¹ Compiled from Geological Survey Of India Map ; Valsad District Map & CGWB Reports.

The Valsad district area is best represented by the marine Quaternary sediments of early Holocene coastal deposits, comprising raised mudflats, stabilized (inland) coastal ridges and shelly beach rocks. River mouth shows raised mudflats that interrupt the sand ridges. The continental Quaternary sediments are underlain by basement rock, the Deccan trap. In river section of Damanganga, fluvial sediments, sands with cobbles and pebbles are resting over Deccan trap, represent lower portion of Quaternary continental deposits. The total exposed sequence is about 10 m. The youngest continental deposits are represented by the unconsolidated soil sand covers over low lying basalt rock in valleys & plains and also by the present day flood plains along the various river courses of the district area. Another distinct continental deposit in aeolian environment is in the form of costal dunes and raised beach landforms, in Umargam taluka area. The coast line is fringed with fine shore deposits forming sand hills and dunes. These dunes are 3 to 6 m high and exhibits false bedding due to aeolian action.

OCCURRENCE & DISTRIBUTION OF GROUND WATER

The groundwater in Valsad district occurs in porous unconsolidated formations and fissure formations both under water table conditions as well as under confined conditions. The unconsolidated formations comprise gravel, sand, silt, clay and *kankars* while the fissure formations mainly consist of basaltic rock. Generally the water table follows topographic configuration. The depth to water is greater in upland areas whereas in valley portion and shallow grounds, the levels are very close to surface. In hilly terrain of eastern, north-eastern and southeastern part of the district, spring zones are seen in river section and also along the section of the Daman Ganga, Kolak, Par & Auranga rivers of the district.

In major part of the district, basalt rock units form aquifers whereas alluvium deposits form aquifer system in north western part and in central part along river courses and also all along narrow coastal stripes of the district. The weathered basalts formations are covered by soil / *muram*, valley fill and piedmont deposits forming potential aquifers in the vicinity of rivers and in the vast undulating plains adjacent to hilly terrain. But their regional continuity and extension are limited due to heterogeneous nature of deposits with limited thickness and lateral extension. As such they rarely exceed a few square kilometers. The alluvium formation of Northwest along coastal area has major constraint of quality, which have high TDS in ground water. The interior patches have limited thickness and they form unique contiguous unconfined system of alluvium portion and underlying weathered basalt rock units. Map showing general hydrogeology of the district is given as figure 12.

GROUNDWATER REGIME MONITORING

Ground water regime monitoring is the basic component of groundwater management, and it is carried out in parts of Valsad district through National Hydrograph Network Stations (NHNS or NHS). NHSs are observation wells, comprising of dug wells and purpose built bore wells – known as piezometers. There are 19 NHS as shown in Map of NHS in figure 13. The hydrograph of few select stations are shown as figure 14a, 14b, 14c & 14d. Depth to water level map of pre monsoon and post monsoon period and annual fluctuation of water level are prepared with data of NHS for year 2009. With available data of systematic and reappraisal

hydrogeological surveys carried out in the district. The water table of the district is described bellows.



Depth to Water Level (May 2011)

The figure 15 shows depth to water level map of Valsad district, prepared on the basis of NHS data of May 2019. The eastern half of the district and southern part underlain by hard rock formation have water level in range of 3 to 9 m bgl while the western and north western part of the district is underlain by hard rock and unconsolidated formation respectively, have water level in range of 6 to 12 m bgl. Area around Valsad town have deep water level of more than 9 to 15 m bgl.

Depth to Water Level (Nov 2011)

The figure 16 shows depth to water level map of November 2011. The eastern and central of the district underlain by hard rock formation have water level in range of 0 to 3 m bgl while the western and south western part of the district is underlain by unconsolidated formation having water level in range of 3 to 6 m bgl. Area along Valsad town in Northwest, have deeper water levels of more than 6 to 9 m bgl.

Water Level Fluctuation (May - Nov 2011)

The figure 17 shows water level fluctuation map of the district for May- November 2011 period. The water level fluctuation ranges from -1 m to more than 8 m. In major part of the district it is in the range of 0 to 5 m, while around Valsad, it is 6 to more than 8 m

Water Table Map (May 2001)

The figure 18 shows the water table map in the district. The elevation of water table ranges from more than 500 m above msl in eastern highland of the district to as low as 20 m above msl along the coastal areas in the west. The movement of ground water in general is from eastern highland to west towards the coast line. In central and in south western parts along Daman ganga, Par & Kolak rive basin the water table counters show effluent nature of all streams, rivulets and rivers. The gradient is steep, 3.1 m / km, in the eastern hilly terrain. It becomes gentler, 1.25 m / km, towards western part occupied by semi-consolidated to un-consolidated formation areas.









GROUNDWATER EXPLORATION

The boreholes drilled by CGWB as a part of Ground Water Exploration work, in various parts of Valsad district have indicate that the sub surface geological formation



the district comprises of in layered sequences of Deccan Trap lave down to 250 m of explored depth. The yield of bore wells varies widely from few lps to more than 20 lps. Overall, deep ground water quality is suitable for both irrigation and domestic Map showing location of uses. exploration is shown in figure 19 depth range exploration The varies from 90 to 200 m. The litholog revels varied lave flows of few m to more than 20 m thick. Very few location intrappean red

bore 0.2 to 1.2 thickness are reported. Lateral correlation of lava flow is not extensive.

GROUND WATER RESOURCES

Annual ground water recharge of Valsad district, (GWRE 2009), is 430 MCM and keeping provision of 29.69 MCM for environmental / runoff purposes, net annual ground water availability is worked out to be of 401.11 MCM. The gross annual ground water draft in the district comes out to be 162.16 MCM out of which 136.64 MCM per year is due to irrigation while remaining 25.52 MCM is accounted for domestic and industrial uses. The stage of ground water development at year 2009, for all the talukas of the Valsad district computed range from 10.13 % to 62.11 % and all units of assessment (talukas) have been categorized as Safe, based on the stages of ground water development and the long-term trend of pre and post monsoon ground water levels. The average for district is 40.43 %. Taluka wise ground water resources and categorization for each assessment unit is shown in figure 20, and also presented in table 10.

Table 10. The details of ground	water resour	rces of Vals	ad District	(MCM / year)				
Name of Taluka	Dharampur	Umargam	Pardi	Valsad	Kaparada	Total		
Total Annual Ground Water Recharge	83.42	50.88	70.09	133.50	92.90	430.80		
Provision of Environmental / Base Flow	4.17	2.54	7.01	6.68	9.29	29.69		
Net Annual Ground Water Availability	43.98	40.47	57.55	126.76	69.86	338.62		
Ground Water Draft for Irrigation	16.48	17.38	26.17	71.81	4.80	136.64		
Existing Domestic & Industrial Draft	3.26	4.28	7.34	6.97	3.67	25.52		
Existing Gross Ground Water Draft for all uses	19.74	21.66	33.51	78.78	8.47	162.16		
Stage of Ground Water Development	24.91%	44.81%	53.12%	62.11%	10.13%	40.43%		
Category	Safe	Safe	Safe	Safe	Safe	Safe		



ESTIMATION OF IRRIGATION POTENTIAL

Umargaon

Net Annual GW Avilability

Dharampur

The existing irrigation potential created from ground water resources in Valsad district is 30,363 ha.m / year, whereas balance irrigation potential from ground water

Pardi

Valsad

Gross Draft

Kaparada

computed from *Balance Ground Water Availability for Future Irrigation Development* is 38,198 ha. Accordingly *Ultimate Irrigation Potential* from ground water for whole district is worked out to be 82,995 ha.m / year (table No11)

Sr. No.	Name of Taluka	Name of Taluka Available Ground Water Recharge Ground Water Draft for Irrigation		Irrigation Potential Created from Ground Water (NRI 0.5 m)	Allocation for domestic & Industrial need for the year 2025	Ground Water Balance	Balance Irrigation Potential from Ground Water (NRI 0.50 m)	Ultimate Irrigation Potential from Ground Water (NRI 0.50 m)	
		Ha.m / Year	Ha.m / Year	Hectare	Ha.m / Year	Ha.m / Year	Hectare	Hectare	
1	Dharampur	7925	1648	3662	457	5820	12934	16596	
2	Umargam	4834	1738	3862	600	2496	5546	9408	
3	Pardi	6659	2617	5816	1029	3013	6695	12511	
4	Valsad	12683	7181	15957	977	4525	10056	26013	
5	Kaparda	8826	480	1067	515	7831	17401	18468	
	Total	40926	13664	30363	3578	236849	52632	82995	

Table - 11. Irrigation Potential from Ground Water - Valsad district (2009)

HYDROCHEMISTRY

The Valsad district has two main hydrogeological provinces consisting of Deccan trap and Alluvium areas. Each terrain has varied hydro-geochemical regime. Groundwater of the district originates as rainwater that infiltrates through soil into flow system in the underlying geologic material. In Valsad district, higher plateau and hill zones of eastern part constitute as recharge areas, which is underlain by Deccan trap basalt rocks. The discharge area constitutes alluvium plain in western part of the district, facing Arabian Sea. As groundwater moves along flowlines from recharge areas to



discharge areas, its chemistry is altered by the effects of variety of geochemical processes which are reflected with incremental change of most of the major ions and upshot in ultimate high total dissolved solids in discharge areas.

The plot of data in Richard's diagram (Fig.21) revels that nearly 80 % of samples from Basalt aquifer areas of east & south east of Dharmpura Kaprada and Umargam taluka and central part of the district comprising of Valsad & Pardi taluka falls in class C1S1 to C1S3, representing low to medium salinity with low sodium hazard whereas most of the sample from alluvium areas of west & north west and coastal zones from Valsad, Pardi & Umargam talukas have medium to high sodium hazard and high salinity hazard, represent mature high TDS groundwater from discharge

area. The analytical result of representative samples collected during various surveys and exploration works along with NHS data are compiled and the range of major constituents and parameters are given below in table 12.

Table No. 12. Range of Chemical Constituents and parameters – Valsad District

			EC	Ca	Mg	Na	К	Cl	CO ₃	HCO ₃	SO_4	NO ₃	F
			μS at 25°C	Constituents in ppm (mg / I)									
а	Alluvium and Sedimentary Area : Unconsolidated Rock Overlying Hard rock Area.												
m pl es	Max	8.90	3700	273	122	460	32	1049	ND	573	130	128	1.6

	Min	7.55	350	8	2	11	1	14	ND	110	10	1	0.12
	Median	8.25	920	56	29	103	2	71	ND	317	48	6	0.50
	Average	8.26	1167	72	36	115	6	167	ND	338	55	15	0.58
b	Basalt Area : Weathered & consolidated extrusive rocks												
S	Max	8.70	9110	381	134	1333	109	2553	ND	1116	418	140	1.34
ple	Min	7.50	180	4	5	8	1	6	ND	6	5	1	0.06
am 5	Median	8.20	680	48	19	32	2	39	ND	275	32	7	0.26
s	Average	8.16	1154	66	30	124	9	187	ND	276	54	14	0.39

Ground Water Quality Maps

Map showing variation in chemical quality of ground water due to hydrogeological



factors. depicting aerial distribution of various water quality features, are used for groundwater resources management. Two maps showing aerial distribution of quality features in terms of conductance electrical (EC), measure of total dissolved salts in ground water and chloride content the basis on. of groundwater chemical quality data are presented below as Iso-con Map – fig 22 & Iso-chlor Map fig 23. The Iso con map shows

that major parts of the district which are underlain by Deccan trap rocks have EC is in range of 500 to 2000 μ S / cm at 25°C, while in areas underlain by alluvium formation and along costal strip it is more than 2000 μ S / cm at 25°C. At few areas in north west. EC more than 3000 μ S / cm at 25°C are also recorded. The chloride distribution is within 250 to 750 ppm in most of the areas except at some local patches and in alluvium areas. Some along the coast have more than 2000 ppm of chloride.



WATER POLLUTION

Valsad district has a number of chemical industries, including manufactures of pesticides, pharmaceuticals, dyes and due intermediates and sizeable number of paper

& pulp industries. The major affected rivers from the industrial effluents are the Damanganga, Kolak & Bil Khadi streams around Vapi, and local streams and beach areas along Tadgam, Nargol and Sardona villages, south of Sarigam Industrial Estate (Fig 24, a,b & c). Deterioration of groundwater quality all along Bill Khadi and Klau river of Vapi industrial area, in terms of colure pollution and Volatile Organic Chemicals in ground water has been reported in the study taken by the CGWB and other competent agencies. Recently, damage to the agriculture – orchards – and ground water due to effluents of Sarigam area industries are documented by the regulatory authorities. Later on, enforcing regulatory measures are made mandatory to release industrial effluents only after due treatment in ETPs and solid waste disposal at designated sites.



DRINKING & INDUSTRIAL WATER SUPPLY

Drinking water requirement of the district is adequately meet through both surface and ground water resources. In western parts where hard rock aquifers are prevalent, ground water is main local sources to meet drinking water demand. The eastern part of the district is having inferior quality of ground water, total 13 Regional Water Supply Schemes based on both ground water as well as surface water sources are completed by the State Ground Water Board Departments, which fulfill the drinking water demand of 108 villages. The industrial water demand of Vapi, Sarigam and other areas is also catered through Damnganag Based surface water sources by the GIDC.

GROUND WATER RELATED ISSUES & MEASURES

- In Valsad district, the overall stage of groundwater development is moderate (40 %), however, there is constraint of quality in the coastal areas and low yield in inland hard rock areas. Rapid urbanization and concurrent industrial activities are affecting ambient hydrogeological regime lately. With strategy of conjunctive use practices in alluvium areas in the west and by employing multidisciplinary approach for ground water development in eastern hard rock terrain, sustainable development of water source can be accomplished.
- <u>ii)</u> District receives high intensity monsoon rainfall of 1800 to 3300 mm during SW monsoon., There is large scope for harnessing available surplus monsoon rainfall runoff for artificial recharge to the ground water through construction of check dams, recharge shaft, percolation tanks, site specific recharge bore wells / dug wells, etc., in eastern high land areas and adjoining intermediate plain areas underlain by piedmont zones / weathered

hard rock (*muram*) deposit. All such measures can augment groundwater resources at local levels and can make drinking water supply schemes efficient and sustainable in long term.

- iii) There is relatively high ground water development along coastal zones, which also have limited thickness of good quality aquifer system. Sustainable groundwater management strategy to conserve existing resources and preventive actions to control contamination of freshwater resources are essential. Incidence of uncontrolled ground water development and industrial pollutions are recorded in the past, in the district. Strategy for regular monitoring for planned development and pollution control with adequate enforcement directive is essential to prevent recurrence of such incident in future. The part of the district is highly industrialized. Periodic monitoring of ground water should be mandatory.
- iv) The Central Ground Water Board has not conducted nay 'Mass Awareness Program' and 'Water Management Training Program' in the district. Taking into consideration of fast developments of last two decades and consequent ground water resources depletion and quality problems, such programs in regular basis can be arranged in the district for awareness and as a capacity building measures for technical officers / officials & Vos working in the field of ground water development and management.