Draft Report

केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report on

AQUIFER MAPS AND MANAGEMENT PLAN

Junagarh, Junagarh District, Gujarat

पश्चिमी मध्य क्षेत्र, अहमदाबाद

West Central Region, Ahmedabad

भारत सरकार
जल संसाधन, नदी विकास एवम् गंगा संरक्षण मंत्रालय
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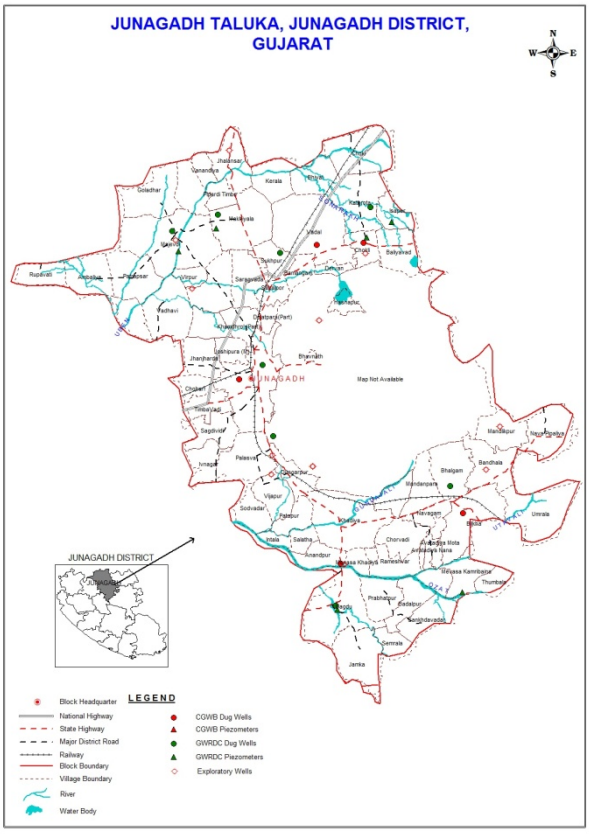
GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION



REPORT ON

AQUIFER MAPS & MANAGEMENT PLANS
JUNAGADH TALUKA, JUNAGADH DISTRICT, GUJARAT STATE

CENTRAL GROUND WATER BOARD
WEST CENTRAL REGION

AHMEDABAD

REPORT ON
AQUIFER MAPS & MANAGEMENT PLANS
JUNAGADHTALUKA, JUNAGADH DISTRICT, GUJARAT STATE

1. SALIENT FEATURES

<table>
<tr><td>1</td><td>Name of the TALUKA& Area, Location(Fig-1)</td><td colspan="4">Junagadh - 573.58 Km^2
21°18′50″ to 21°40′29″ N
70°03′01″ to 70°24′13″ E</td></tr>
<tr><td>2</td><td>No. of Town, villages</td><td colspan="4">1, 71</td></tr>
<tr><td>3</td><td>District/State</td><td colspan="4">Junagadh/Gujarat</td></tr>
<tr><td>4</td><td>Population (2011 Census)</td><td colspan="4">Male- 62381, Female- 57577, Total- 119,958</td></tr>
<tr><td>5</td><td>Normal Rainfall (mm)</td><td colspan="4">933.43 mm- Monsoon Rainfall (IMD) (in mm) (Long Term) 50
1031.80 mm -Average Monsoon Rainfall (in mm) (2003-12)</td></tr>
<tr><td>6</td><td>Agriculture (20015-16)</td><td colspan="4">
<table>
<tr><td colspan="2">Kharif Crops</td><td colspan="2">Rabi Crops</td></tr>
<tr><td>Crop</td><td>Area in Hact</td><td>Crop</td><td>Area in Hact</td></tr>
<tr><td>Groundnut</td><td>19950</td><td>Wheat</td><td>1050</td></tr>
<tr><td>Tal</td><td>265</td><td>Juvar</td><td>0</td></tr>
<tr><td>Castor</td><td>455</td><td>Castor</td><td>0</td></tr>
<tr><td></td><td></td><td>Gram</td><td>110</td></tr>
<tr><td>Bajri</td><td>115</td><td>Bajri</td><td>0</td></tr>
<tr><td>Tuver</td><td>410</td><td>Tuver</td><td>0</td></tr>
<tr><td>Mug</td><td>250</td><td>Mug</td><td>15</td></tr>
<tr><td>Udad</td><td>275</td><td>Mustered</td><td>0</td></tr>
<tr><td>Cotton</td><td>9210</td><td>Isabgol</td><td>0</td></tr>
<tr><td>Sugarcane</td><td>10</td><td>Sugarcane</td><td>5</td></tr>
<tr><td>Vegetables</td><td>1145</td><td>Vegetables</td><td>775</td></tr>
<tr><td>Fodder</td><td>1920</td><td>Fodder</td><td>950</td></tr>
<tr><td>Gam Guvar</td><td>240</td><td>Jira</td><td>340</td></tr>
<tr><td>Soyabin</td><td>85</td><td>Onion</td><td>320</td></tr>
<tr><td></td><td></td><td>Coriander</td><td>3305</td></tr>
<tr><td></td><td></td><td>Garlic</td><td>165</td></tr>
<tr><td></td><td></td><td>Methi</td><td>0</td></tr>
<tr><td>Total</td><td>23500</td><td>Total</td><td>7125</td></tr>
</table>
</td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">Existing and future water demands (MCM)</td><td colspan="2">Sector</td><td>Existing (MCM)</td><td>Future (MCM) (Year 2025)</td></tr>
<tr><td colspan="2">Domestic and Industrial</td><td>7.20</td><td>9.66</td></tr>
<tr><td colspan="2">Irrigation</td><td>71.79</td><td>38.00</td></tr>
<tr><td>8</td><td>Water level behaviour (2015)(Fig-2 & 3)</td><td colspan="4">14.41-52.75 m (Pre-monsoon)</td></tr>
</table>

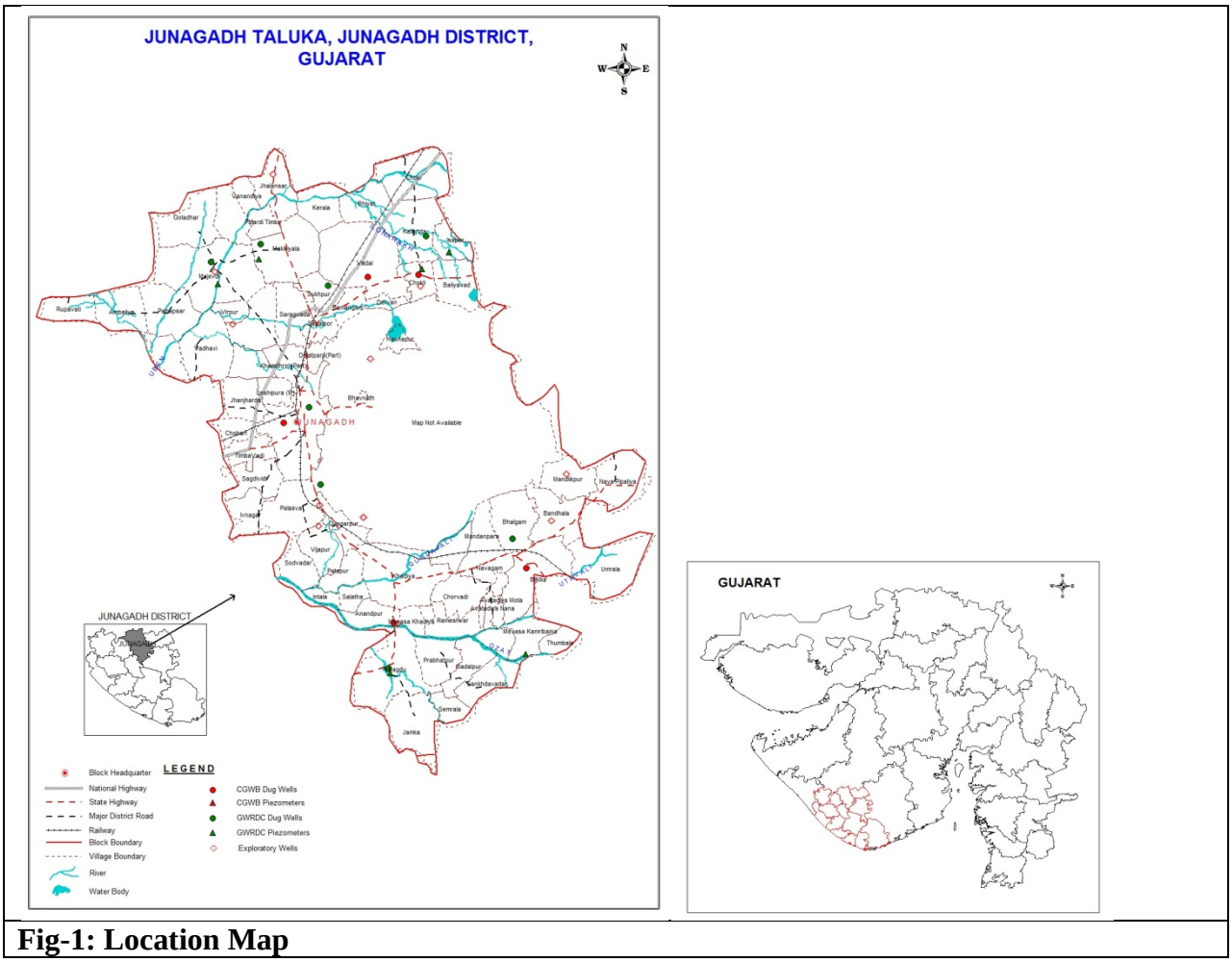


Fig-1: Location Map

1. **Hydrogeology:**

Main aquifer in the area is basaltic aquifer (Fig. 2) where the ground water exists upto the depth of weathering and in the fracture zones wherever encountered in the depth. The Miliolitic limestone are observed along the flanks of the Girnar hill. These milliolite limestone acts as a good reservoir for shallow ground water. Open dug wells are tapped to this formation app. down to a depth of 10m deep. The yield of these wells range from 100-200 m3/day. Two hydrogeological Cross sections are given in Fig. 3.

Subsurface Hydrogeology

As inferred from borehole data of the Junagadh Taluka, weathered and fractured Basalt forms the principal aquifer in the Taluka. Groundwater in this aquifer occurs under unconfined conditions and in the fractures encountered in the massive basaltic formation in the depth. The movement of groundwater is controlled by the extent of weathering, fracture and joints in the

trap formation. Groundwater exploration has been done down to a max. depth of 329 mbgl and the average discharge ranges from 12 to 19 lps by compressor during drilling.

2. AQUIFER DISPOSITION

Name of aquifer	Aquifer material	Nature of aquifer	Aquifer depth and zone encountered (m)	Nature of porosity	Compressor discharge	Quality
Miliolitic Limestone	Limestone	Unconfined	0 to 21.60	Primary and secondary (Porces, fractures and solution cavities)	-	-
Deccan Trap	Basalt	Unconfined (Weathered and fractured)	0 to 49	Secondary (weathered & fracture)	1 to 2 lps	Fresh
		Deep Fracture (Massive & amygdolidal)	Explore up to the depth of 329 m, zone encountered at 106 & 242	Secondary (fractures, joints, shears and flow contacts)	Compressor discharge 12 to 19 LPS	Fresh

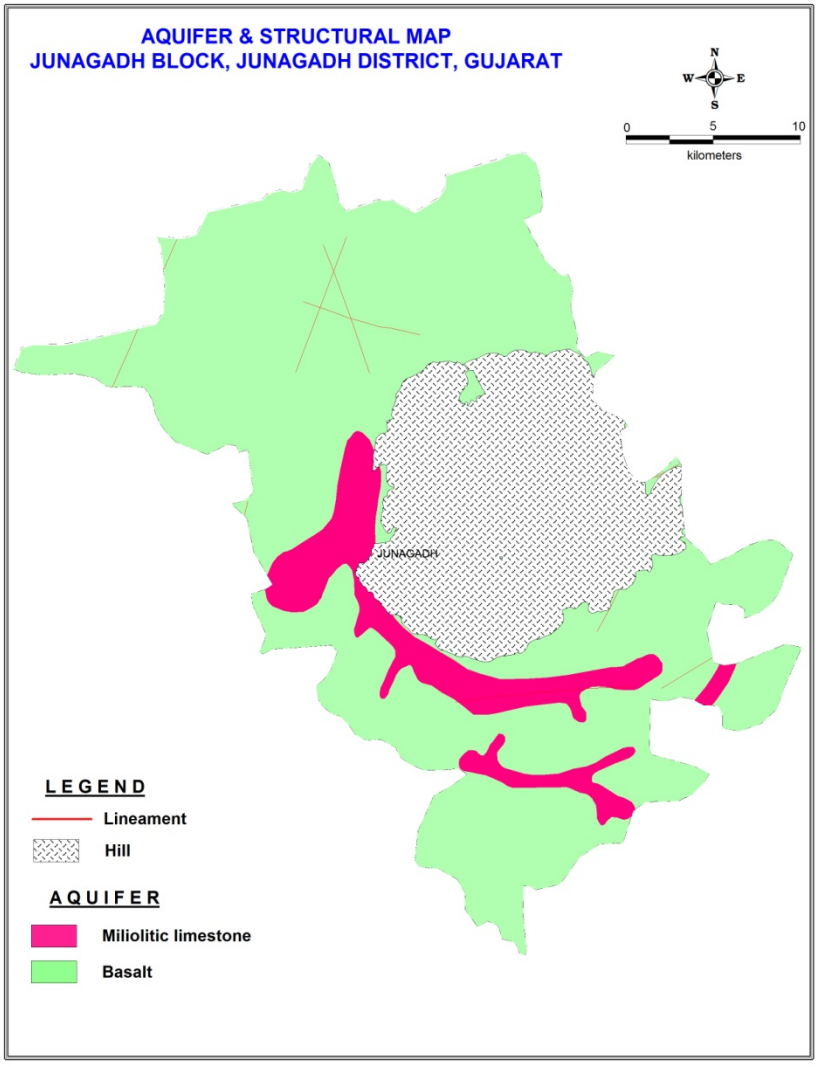
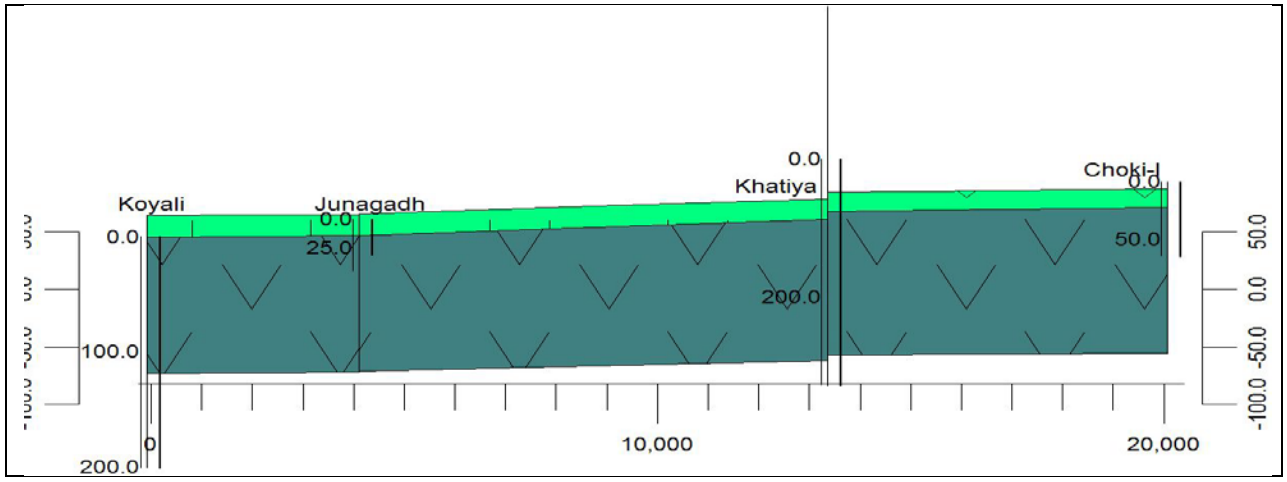


Fig 2: Aquifer disposition of the area



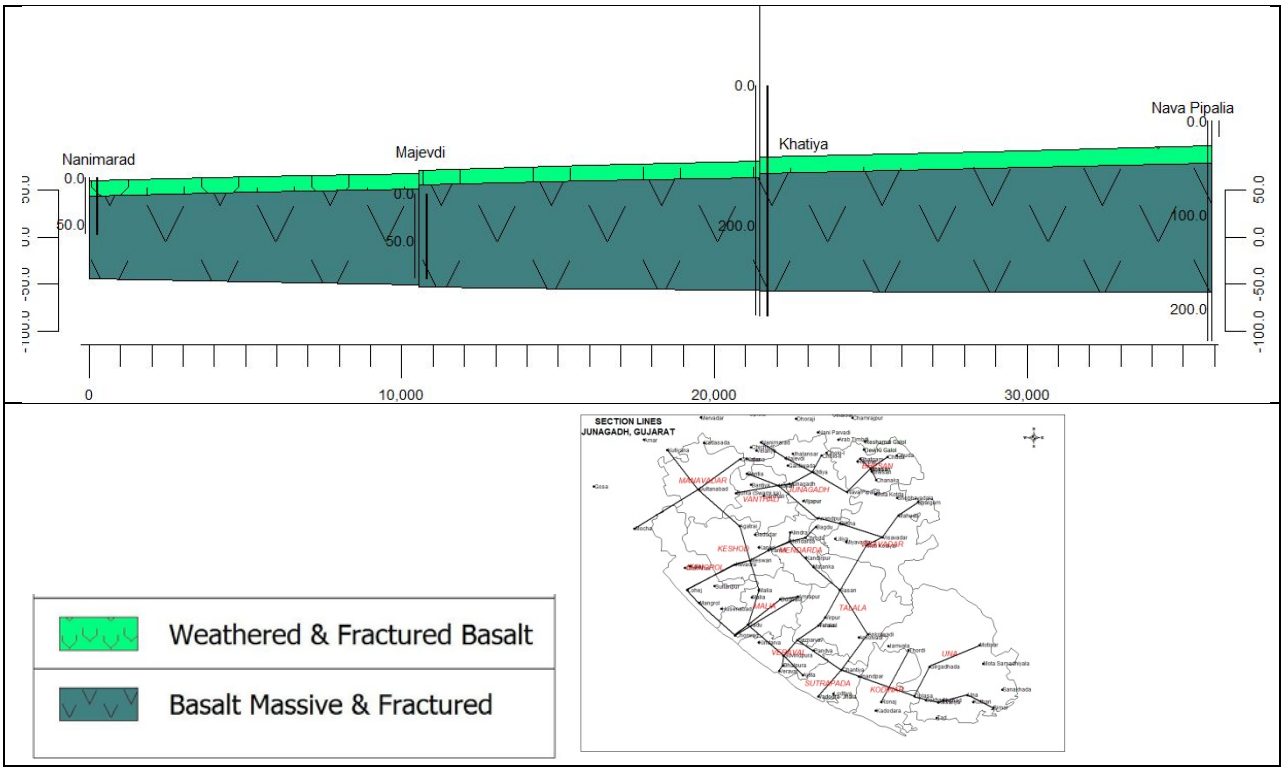


Fig-3: Stratigraphic Section

Depth to water level:

Depth to water level ranges between 14.41 to 52.75 m bgl in the taluka during the May 2015. Central part of the taluka observed shallow water level whereas Northern and Southern parts are deeper. Water level more than 40 are shown in isolated patchs in Northern and southern parts of taluka. Decadal average water level mostly between the period of May 2006 and 2015 ranges from 10.59 to 32.77m bgl. (Fig5). Major parts of the taluka shows decadal average water level ranges between 10 and 20 m bgl. (Fig.5).

Long term groundwater fluctuation of water level for pre-monsoon and post- monsoon period are depicted in Fig. 6 & 7 for the period of 1987 to 2015. Ranges of the long-term fluctuation is given in table below as per the observation station falling in the taluka.

Pre-monsoon(1987-2015)				Post-monsoon(1987-2015)			
Rise		Fall		Rise		Fall	
Min	Max	Min	Max	Min	Max	Min	Max
0.20	2.90	1.50	4.25	1.10	7.15	3.06	

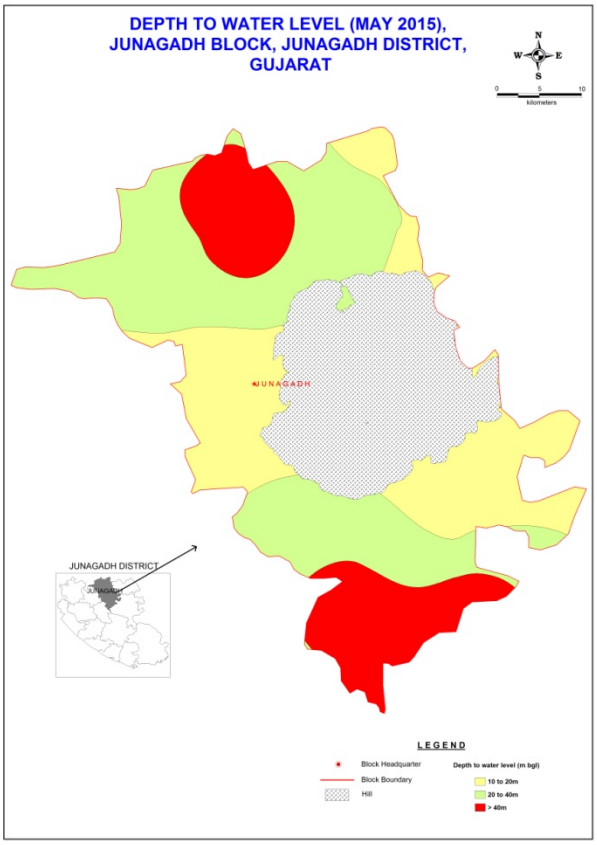


Fig 4: DTW Map (Pre monsoon)

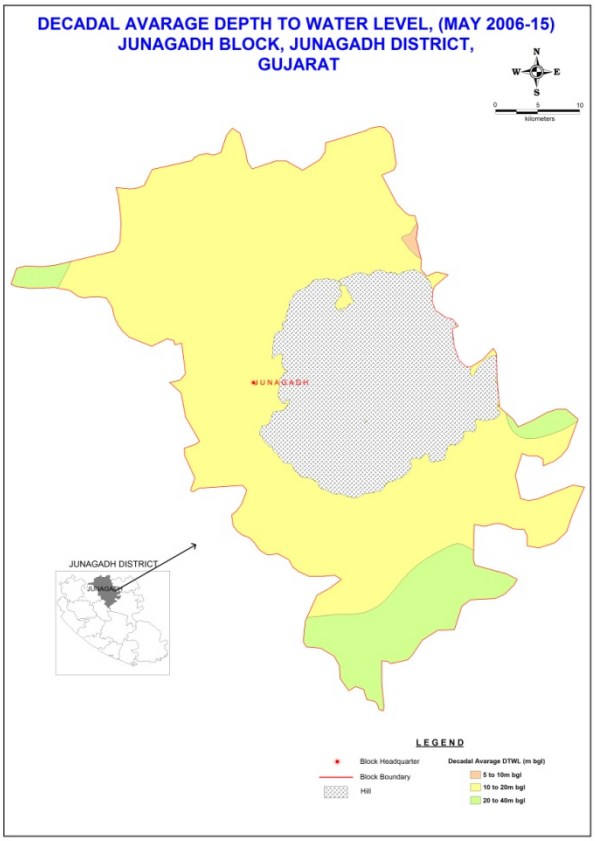


Fig 5: Decadal Average Depth to Water Level

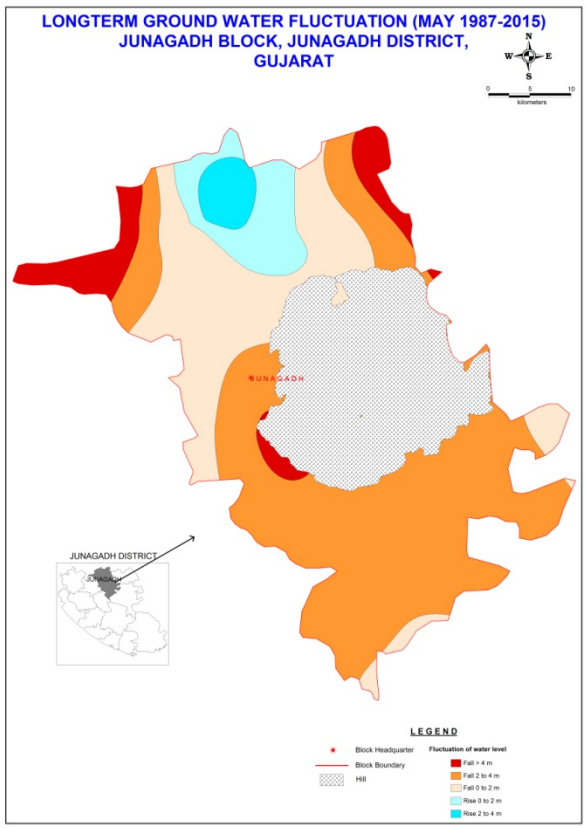


Fig.6 Absolute fluctuation Pre-monsoon

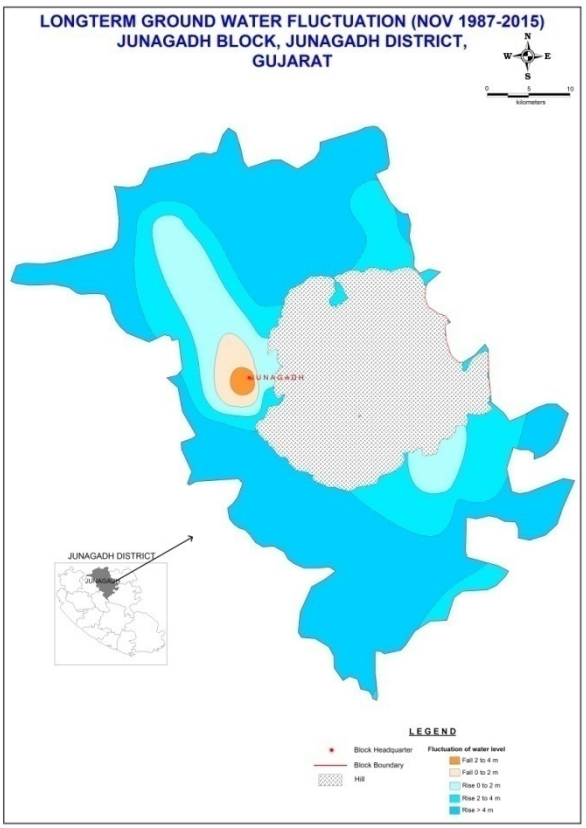


Fig. 7 Absolute fluctuation Post-monsoon

Water Table map (Fig 8) shows water table are ranges 5.86 m to 74.98 m above msl and groundwater flow direction are diverting from Girnar Hill from all the directions and forming one ground water trough in the northern part of the taluka.

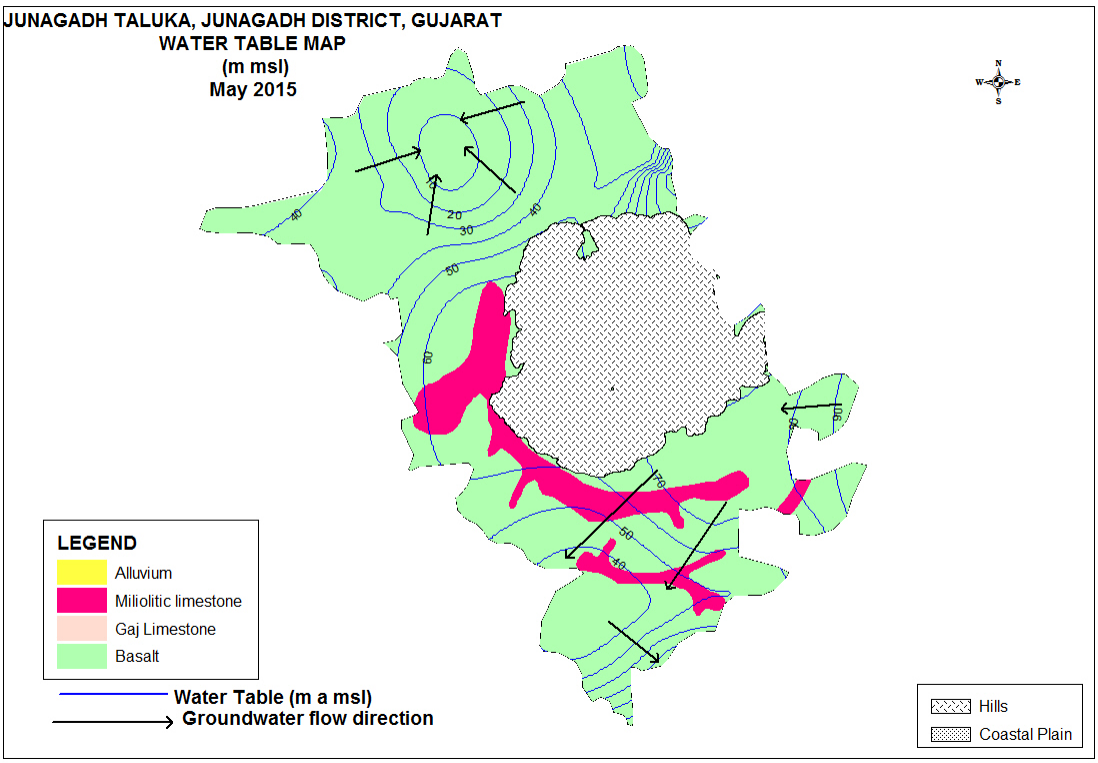


Fig 8: Water Table map with flow direction

3. Groundwater resource extraction, contamination.

Dynamic GW Resources in MCM

Total groundwater availability of the area is estimated in year 2013 is 119.45 MCM and total groundwater withdrawal for all purposes is 78.99 MCM. The stage of groundwater development is 66.13% and the taluka is categorized “Safe” (Table 2).

Table: 2 Groundwater resources 2013

S No.	Item	Fresh	Saline	Total
1	Area	573.58	-	573.58
2	Total GW Recharge (MCM)	125.73	-	125.73
3	Net GW Availability (MCM)	119.45	-	119.45
4	Gross Draft (MCM)	78.99	-	78.99
5	Net Availability for Future Irrigation (MCM)	38.00	-	38.00
6	Stage of GW Development %	66.13 (safe)	-	66.13 (safe)

In Storage GW Resources

Typr of Rock Formation	Total Unit Area (sq km)	Fresh Area (sq km)	Saline/Brackish Area (sq km)	Depth of Bedrock(Soft Rock Areas/Depth upto which the aquifer is commonly Developed (HR Areas) (m)	Average Pre monsoon Water Level in (m)	Total saturated Thickness m	Thickness of the Granular Zone-Fracture zone/Productive Zone below Premonsoon WL(M)	Average Specific Yield (Sy) Fraction	FRESH In storage GW Resources (MCM)	BRACKISH/SALINE In storage GW Resources (MCM)
Basalt Weathered	556.2341	556.23	0	18.43	13.59	4.84		0.02	53.84	0.00
Basalt-Massive-Fractured zone		556.23					11.15	0.01	62.02	0.00
Granophre	62.97255	62.97	0	18.43	8.06	10.37		0.02	13.06	0.00
Milliolitic Limestone	62.48623	62.49	0	21.79	14.96	6.83		0.1	42.68	0.00
Total	681.6929	681.69	0						171.60	0.00

Chemical quality of groundwater

Groundwater quality in general is good. Salinity is expressed in terms of total dissolved solids (TDS). Most of the area in the taluka (Fig. 9) falls TDS ranges 744 to 2100 mg/litre. Min. &Max. ranges of some of the constituents is given in the following Table.

Taluka	Total dissolved solids		Cl		F		HCO3	
	Min	Max	Min	Max	Min	Max	Min	Max
Junagadh	744	2100	206	960	0.14	1.69	171	403

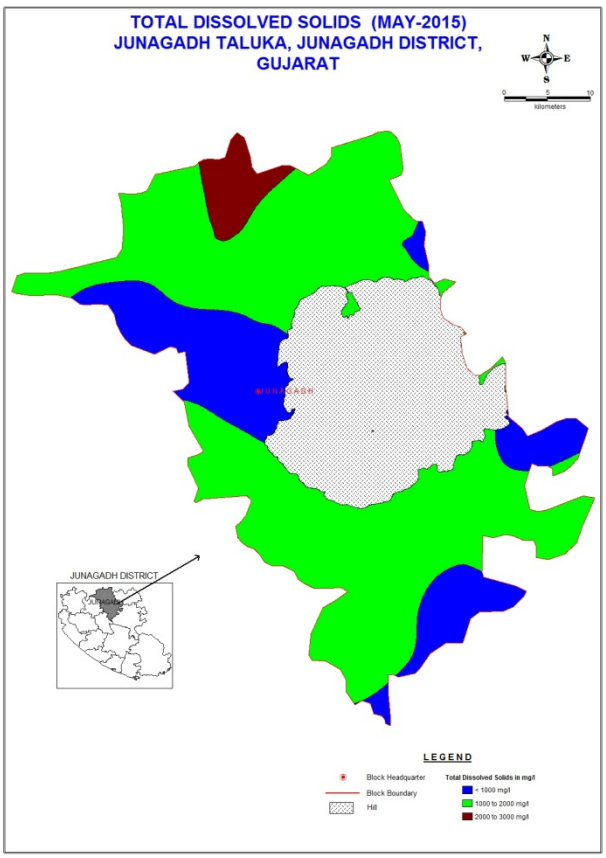


Fig.9 Iso-TDS May 2015

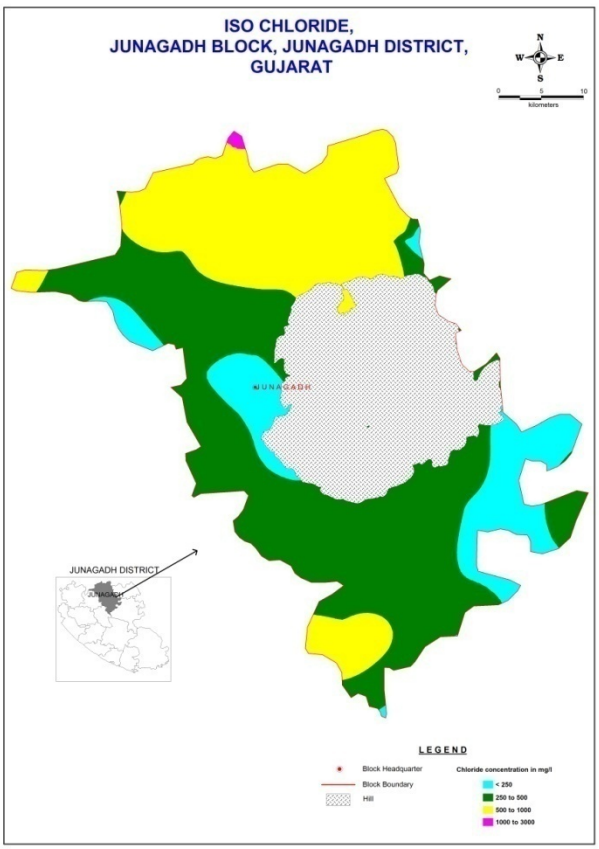


Fig. 10 Iso-Chloride May 2015

Ground Water Issues

- Sustainability of hard rock Aquifers
- Non Availability of sufficient Surface Water for Irrigation.
- Lack of awareness and involvement of stake holders in decision making.

4. Groundwater resource enhancement.

Table-3Computation of volume (MCM) of water required for recharge

Aquifer	Volume of unsaturated zone avilable for artificial recharge	Specific yiled factor	Volume of water required for recharge MCM	Volume of rain water planned for Artificial recharge (MCM)
Basalt	702.90	0.02	14.06	1.76
Milliolitic Limestone	103.00	1.02	105.06	0.33
Total	805.89		119.12	2.09

Table: 4 Computation of Recharge structures.

Aquifer	Area feasible for artificial recharge Sq. Km	Volume of rain water planned for Artificial recharge (MCM)	Volume of water planned for conservation through Farm Pond	Volume of water planned for recharge through Check Dam	No of Farm Pond (Unit storage 0.05MCM)	No of Check Dam (Unit 0.05 MCM)
Basalt	210.47	5.86	4.10	1.76	82	35
Milliolitic Limestone	29.45	0.82	0.49	0.33	9	6
Total	239.92	6.68	4.59	2.09	91	41

Financial Outlay of the Plan

The total estimated cost of the Plan is 1325.73 lakh, which includes Rs 328 lakh for ground water recharge activities, Rs 910 lakh (Farm ponds), 24.6 lakh for ground water monitoring (Piezometer construction) and Rs 63.13 lakh towards operation and maintenance charges. The tentative cost estimates of the various activities of the Plan are shown in Table 5.

Table: 5 Cost estimates of Recharge structures and monitoring well (Piezometers):

Feasible Artificial Recharge & Water Conservation structures/ activities	Tentative Design	Quantity (in nos. or area in sq. m)	Rainwater harvested (mcm)	Tentative unit cost (in Rs lakh)	Total tentative cost (in Rs lakh)	Expected Annual GW recharge/ conservation (mcm)
Recharge Structures/ Activities						
Check Dam		41	2.05	8	328	1.85
Sub total					328	1.85
Water Conservation Activities						
Farm Pond (3 fillings)	(30 m x 30m x 1.5 m) 900 sq.m or 0.1 ha	91	4.55	10	910	3.185
Impact assessment & Monitoring						
Piezometer	Up to 80 m bgl	41		0.6	24.6	
Impact assessment will be carried out by implemneting agency						
O & M - 5% of total cost of the scheme					63.13	
TOTAL					**1325.73**	

Note: Type, number and cost of structure may vary according to site after ground verification

The tentative location of villages for construction of Check Dams and their cost estimates are shown in Fig. 11 and Table 6.

Table-6 : TENTATIVE LIST OF VILLAGES WHERE ARTIFICIAL RECHARGE STRUCTREUS CAN BE TAKEN UP

Sr. no.	Vilage Name	Sr. no.	Vilage Name
1	Anandpur	21	Kathrota
2	Bagdu	22	Kathrota
3	Bandhala	23	Khadiya
4	Bandhala	24	Majevdi
5	Bhiyal	25	Mandlikpur
6	Bhiyal	26	Mandlikpur
7	Bilkha	27	Mevasa Khadiya
8	Choki	28	Nava Pipaliya
9	Chokli	29	Nava Pipaliya
10	Chokli	30	Nava Pipaliya
11	Dervan	31	Patapur
12	Hasnapur	32	Sagdividi
13	Intala	33	Salatha
14	Isapur	34	TimbaVadi
15	Jamka	35	TimbaVadi
16	Jamka	36	Umrala
17	Jamka	37	Umrala
18	Jamka	38	Vadal
19	Jhalansar	39	Vanandiya
20	Junagadh Mun. Corpor	40	Virpur
		41	Virpur

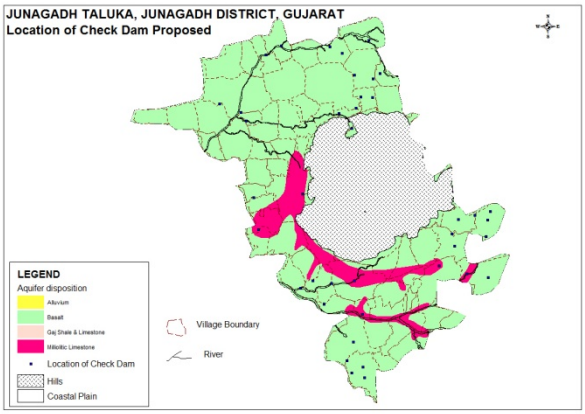


Fig. 8 tentative location of Check Dams

1. Demand Side Management:

As the surface water is not available to improve the supply of water, demand side management is essential.

Table: 7 Crop wise area in Hectares covered under micro irrigation methods (source Gujarat Green Revolution Company, Vadodara, Gujarat).

CROP	Area in Ha.	CROP	Area in Ha.	CROP	Area in Ha.	CROP	Area in Ha.
AMLA	11	COCONUT	6.54	JAMUN	3.12	SESAMUM	3.5
ANOLA	108	COTTON	1524.66	JETROPHA	45.34	SOFTGUARD	0.8
Banana	7.38	CUCUMBER	3.08	LEMON	18.05	SPONGE GOURD	1.6
BER	1.02	CUSTARD APPLE	42.61	Mango	164.19	STEVIA	0.85
BITTER GUARD	20.51	GARLIC	6	PAPAYA	12.31	TOMATO	3.26
BOTTLE GUARD	138.2	GOURDS	3.2	Pomogranate	6.01	VEGETABLE	0.8
BRINJAL	1.6	GRAM	0.4	PULSES	4.9	WATERMELON	5.01
CASHEW NUT	0.8	GREEN GRAM	12.49	RIDGEGOURD	28.12	WHEAT	240.5
CASTOR	85.83	GROUNDNUT	5633.27	SAG	1.74	Grand Total	8183.97
CHILLI	1.08	GUAVA	14.15	SANDLEWOOD	0.52		
CLUSTERBEAN	1.28	GUVAR	1	Sapota	19.25		

Water use efficiency by Drip Irrigation in Rabi crop season:

An area of 8184 hectare is covered by micro-irrigation scheme (MIS) under different crops grown in the district (Table 7). It is estimated the groundwater saving in the district by adopting the drip irrigation method to the main crop in Rabi season is about 1.31 MCM.It is estimated saving of groundwater through Drip irrigation separately to the Crop Cotton and Groundnut are 3.91 MCM and 4.56 MCM respectively (Table 8).

Table :8 Groundwater saving by Drip irrigation in MCM

Taluka	Rabi_Crops	Cotton crop		Groundnut crop		Total
		Summer	Kharif	Summer	Kharif	
Junagadh	1.31	1.28	2.63	0.93	3.63	9.78

Expected Benefits or outcome of the Plan

Ground water recharge and water conservation Plan of Junagadh Taluka, Junagadh district envisages gainful utilization of 0.59 MCM of volume of rain water planned for recharging of depleted aquifer system. Besides this, the proposed intervention would also lead to reduction of pre-existing ground water draft by 1.98 MCM annually through construction of farm ponds. By adopting the micro-irrigation area in the remaining area conserve the 9.86 MCM of groundwater draft in the district.

With the additional recharge and water conservation interventions as proposed in the Plan, it is anticipated that with enhanced recharge and reduction in ground water draft, the stage of ground water development will reduce to 54% from the existing 66%. The projected status of ground water resources and utilization scenario is presented in table 9.

Table :9 Projected Status of Groundwater Resource & Utilization on Recharge and Micro-Irrigation Interventions

Taluka	Net G.W. Availability (MCM)	Additional Recharge from RWH (mcm)	Total Net G.W. Availability after intervention (mcm)	Existing G.W Draft for all purpose (mcm)	Saving of Ground water through conservation (mcm)	Saving of Ground water through MIS (mcm)	Net GW draft after interventions (mcm)	Present stage of G.W. development (%)	Projected stage of G.W. Development (in %)
Junagadh	119.45	3.34	122.79	78.99	3.34	9.78	65.87	66	54

Projected irrigation potential:

It is estimated 2842 Ha additional irrigation potential may be created in the taluka on 70% of groundwater development Table 10.

Table: 10 Irrigation command area on 70% of development of groundwater

District	Development %	Net G.W. Availability (MCM)	Additional Recharge from RWH (mcm)	Total Net G.W. Availability after intervention (mcm)	Max GW avilable on 70% development MCM	Existing G.W Draft for all purpose (mcm)	Balanced GW avilable on 70% development and Existing Draft	Saving of Ground water through conservation (mcm)	**Net GW avilable for withdrawl after interventions (mcm)**	Average crop water requirement by Drip Irrigationm	Additional area to be Irrigate in sq. km	Area can be Irrigate in Ha
Junagadh	70	119.45	3.34	122.79	85.95	78.99	6.96	3.34	10.30	0.30	34.35	3434.92

CONCLUSION AND RECOMMENDATION:

1. It is recommended to increase the recharge of groundwater from external surface water sources. It is also important to properly maintain and timely operate the existing recharge and salinity control structures.
2. Recommended to construct the 41 check dam and 91 Farm ponds in the Taluka to recharge 1.85 MCM and conserve 3.19 MCM of rainfall runoff.
3. During the electrification of well/ bore wells, the micro-irrigation through drip/sprinkler irrigation should be made mendatory, so as to minimize use of groundwater.
4. 484 Hectares area may brought under micro-irrigation to adopt Drip method to save about 1.31 MCM of water during the Rabi crop season.
5. 8590 Hectare Groundnut crop area during pre-Kharif season and last phase of Kharif season may brought under Drip irrigation to save 4.56 MCM of water.
6. 4600 Hectare Cotton crop area during pre-Kharif season and last phase of Kharif season may brought under Drip irrigation to save 3.91 MCM of water.
7. 3435 Hectare land may additionally irrigated on 70% of groundwater development and observing all intervention proposed.

- **The implementation of the project would result in additional recharge. The other tangible/ non-tangible benefits of the project are:**

- Recharging the ground water will help in arresting the rapid decline in ground water resources and will also ensure improvement in quality of ground water by way of dilution.
- Proposed structures and measures will also enhance the ground water potential and would ensure sustainability of ground water resources.
- Surface runoff water stored or harnessed can be used as supplemental irrigational resources and will reduce the stress on the ground water.
- Besides, it will also help in reducing the amount and spate of storm water being drained by river and controlling soil erosion.