



## केंद्रीय भूमि जल बोर्ड

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

भारत सरकार

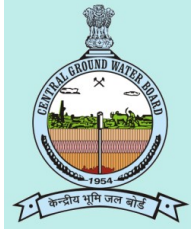
### **Central Ground Water Board**

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

## **AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES**

**GOKAK TALUK,  
BELAGAVI DISTRICT, KARNATAKA**

दक्षिण पश्चिमी क्षेत्र, बेंगलोर  
South Western Region, Bengaluru



## **AQUIFER MANAGEMENT PLAN OF GOKAK TALUK, BELAGAVI DISTRICT, KARNATAKA STATE**

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# **AQUIFER MANAGEMENT PLAN OF GOKAK TALUK, BELAGAVI DISTRICT, KARNATAKA STATE**

## **1.0 SALIENT INFORMATION**

Name of the taluk: **Gokak**

District: Belagavi

State: Karnataka

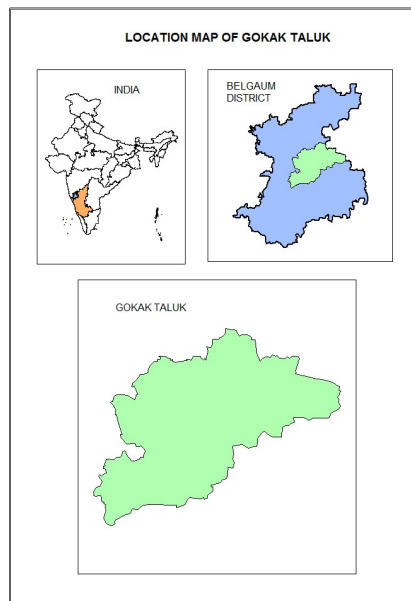
Area: 1543 sq.km.

Population: 612163

Annual Normal Rainfall: 482 mm

### **1.1 Aquifer management study area**

Aquifer mapping studies have been carried out in Gokak taluk, Belagavi district of Karnataka, covering an area of 1543 sq.kms under National Aquifer Mapping Project. Gokak taluk of Belagavi district is located between North Latitudes  $16^{\circ}00'48.6''$  and  $16^{\circ}23'31.2''$  and East Longitudes between  $74^{\circ} 38' 42.36''$  to  $75^{\circ}14'04.66''$  and is falling in Survey of India Toposheets Nos 47L/12, 47L/15, 47L/16, 47P/3, 47P/4, 48I/9 and 48I/13. The study area is bounded on the North by Chikkodi and Raibag taluks of Belagavi district, west by Hukkeri and Belagavi taluks of Belagavi district, on the east by Bagalkot district and on the south by Ramdurga, Saundatti and Bailahongala taluks of Belagavi district. Location map of Gokak taluk of Belagavi district is presented in **Fig-1**. Gokak is taluk head quarter and there are two other towns in this taluk namely Mudalagi and Ghataprabha. There are 131 villages in this taluk.



**Fig-1: Location map of Gokak taluk**

## 1.2 Population

According to 2011 census, the population in Gokak taluk is 612163. Out of which 307626 are male while 304537 are female. The average sex ratio is 990. The Gokak taluk has an overall population density of 397 persons per sq.km. The decadal variation in population from 2001-2011 is 16.36%.

## 1.3 Rainfall

Gokak taluk has semi-arid climate. The area falls under Northern transitional agro-climatic zone of Karnataka state. The normal annual rainfall in Gokak taluk for the period 1941 to 2000 is 482mm. Seasonal rainfall pattern indicates that, major amount of (297 mm) rainfall was recorded during South-West Monsoon seasons which contributes about 62% of the annual normal rainfall followed by North-East Monsoon season (118 mm) constituting 24% and remaining (67 mm) 14% in Pre-Monsoon season.

On Computations were carried out for the 30 year block of 1981-2010, the mean monthly rainfall at Gokak taluk is ranging between 2 mm during January to 100 mm during June. The coefficient of variation percent for pre-monsoon, monsoon and post-monsoon season is 75, 39 & 64 percent respectively. Annual CV at this station works out to be 28 percent (**Table-1**).

**Table-1: Statistical Analysis of Rainfall Data of Gokak taluk, Belagavi district (1981 to 2010)**

STATION		JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
GOKAK	NRM	2	0	6	15	44	67	100	53	54	90	297	83	27	8	118	482
	STDEV	5	0	24	17	44	50	57	40	25	68	115	64	34	22	75	236
	CV%	301	-	410	116	100	75	57	74	47	75	39	77	126	262	64	28

## Assessment of Drought

Rainfall data has been analysed for 106 years using IMD method to assess the drought condition in Gokak taluk. The results of the classification are listed in the **Table 2**. It is observed that the Gokak taluk has experienced alternating no drought to severe drought conditions over the years.

Table 2: Classification of drought and its periodicity (IMD, 1971)						
% Deviation	>0	0 to -25	-25 to -50	50 to 75	<-75	Probability of drought occurrences
Category	No drought	Mild (Normal)	Moderate	Severe	Acute	
	Years					
	63	23	16	4	0	Once in 5 years

The details of the drought assessment are discussed as herein under. Out of 106 years of analysis in Gokak taluk, “No Drought” condition is experienced in 63years, “Mild Drought” condition is experienced in 23 years and “Moderate Drought” condition experienced in 16 years. Further it is observed that “Severe Drought” condition is experienced in 4 years i.e., during 1976, 1984, 2003 and 2016 in Gokak taluk. Based on occurrence and frequency of past drought events, the probability of occurrence of various intensities of drought at each station has been studied. It has been observed that the frequency of occurrence of drought is **once in 5 years** at Gokak taluk.

#### 1.4 Agriculture & Irrigation

Agriculture is the main occupation in Gokak taluk. Major Kharif crops are Maize, Bajra, Jowar, Tur and Vegetables. Main crops of Rabi season are Maize, Bajra, Jowar and Sunflower (**Table-3**). Water intensive crops like sugarcane and paddy are grown in 36% of total crop area. Maize is grown in 36% and oil seeds in 4% of total crop area of taluk. Bajra & jowar account 6% of total crop area.

**Table 3: Cropping pattern in Gokak taluk 2016-2017 (Ha)**

Year	Wheat	Maize	Paddy	Jowar	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
Area under cultivation (in ha)										
2017-2018	8206	44033	22	7233	5493	4374	1056	4845	44514	1594

Source: District at a glance 2017-18, Govt. of Karnataka

It is observed that net sown area accounts 59% and area sown more than once is 21% of total geographical area in Gokak taluk (**Table 4 & Fig.2**). Area not available for cultivation and Fallow land cover 8% &18% of total geographical area respectively. 29% of net area irrigated is only from bore wells and 2% from lift irrigation (**Table 5**).

**Table 4: Details of land use in Gokak taluk 2016-2017 (Ha)**

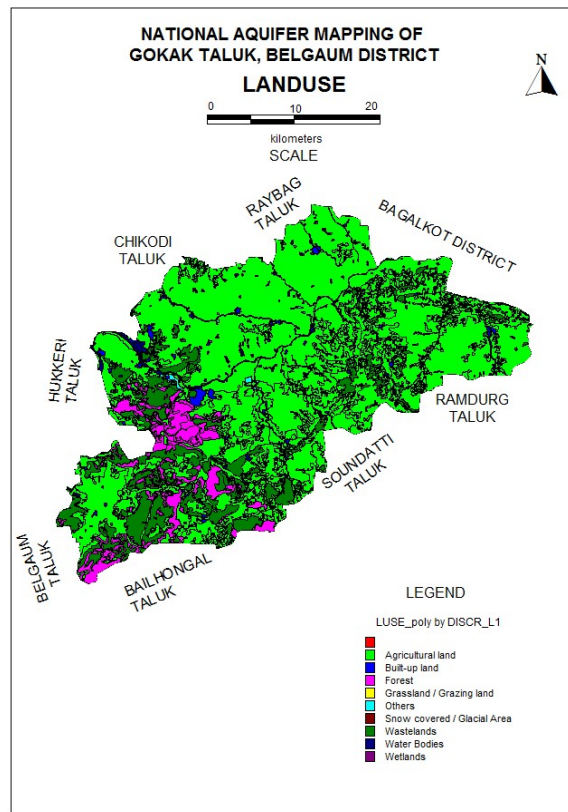
Total Geographical Area	Area under Forest	Area not available for cultivation	Other uncultivable land	Fallow land	Net sown area	Area sown more than once	Total area sown
154308	22284	11681	1771	27309	91263	32066	123329

Source: District at a glance 2017-18, Govt. of Karnataka

**Table 5: Irrigation details in Gokak taluk (in ha)**

Source of Irrigation	Net area irrigated (Ha.)	% of area
Canals	20960	23%
Tanks	0	0
Wells	19285	21%
Bore wells	26408	29%
Lift Irrigation	1820	2%
Other Sources	22861	25%
<b>Total</b>	<b>91332</b>	<b>100%</b>

Source: District at a glance 2017-18, Govt. of Karnataka

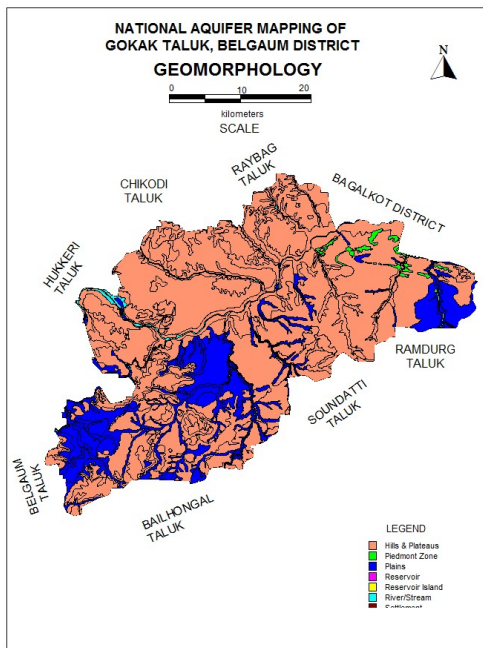


**Fig.2: Land use pattern**

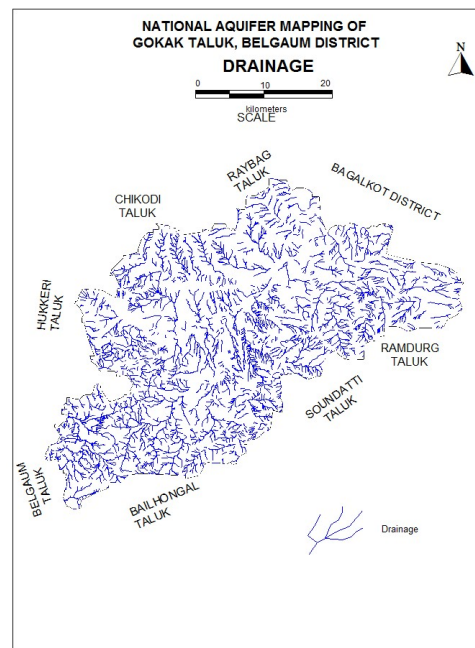
### 1.5 Geomorphology, Physiography & Drainage

Gokak taluk is a plateau region formed by basaltic lava flows, which represents “Deccan penneplain”. The north and central part of the taluk is depicted by plateau and hills with piedmont in the north eastern part. The central and south western parts exhibit moderate to gently “undulating terrain” having sparsely distributed knolls and tors. The remaining part of the taluk is in general a “plateau area”. The elevation in the area varies from 573 m amsl in the North eastern part to 794 m amsl in the central part of the taluk. This has its bearing on the regional slope which is towards northeast. The differential altitude is significant because it is likely to cause irregular ground water flow patterns on the micro scale.

Topography is dominantly controlled by geological structures. The Gokak sandstone hillocks are predominant in the southern and central parts of the taluk. The entire Gokak taluk falls in Ghataprabha river sub basin of Krishna river basin. Hirehalla nala drains in the northern part of the taluk. The Drainage pattern is dendritic to subdendritic (**Fig.-3**).



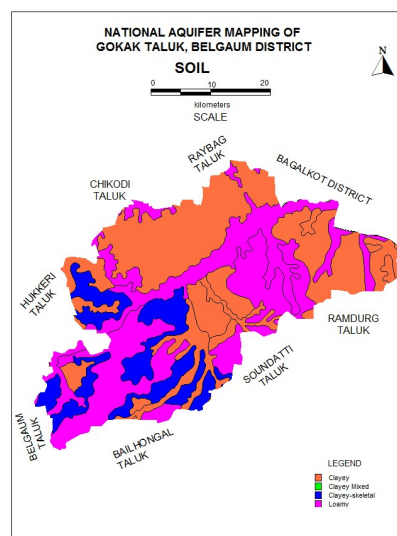
**Fig-2: Goemorphology map**



**Fig.3: Drainage map**

### 1.6 Soil

The soils of Gokak taluk can broadly be classified into Black cotton soils, Red soils and Red sandy soil. These soils vary in depth and texture, depending on the parent rock type, physiographic settings and climatic conditions. Black cotton soils are mature soils with high humus and are mildly alkaline in nature. Along the Ghataprabha river these soils are overlapped by alluvial clayey materials. Black cotton soils are the product of highly weathered and decomposed basaltic rocks. Red soils are sandy in nature and derived from weathering of vesicular basalt. Red sandy soils are sandy in nature and derived from the weathering of sand stone of Kaladgi formation.



**Fig-4: Soil map**

## 1.7 Ground water resource availability and extraction

Aquifer wise total groundwater resources up to 200 m depth is given in **Table-6**.

**Table-6: Total Ground Water Resources (2017) (Ham)**

Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
	Phreatic	Fractured (Down to 200m)	Dynamic + phreatic in-storage + fractured
8186	2326	2841	13353

## 1.8 Existing and future water demands (as per GEC-2017)

- Net ground water availability for future irrigation development : 13.97 MCM
- Domestic (Industrial sector) demand for next 25 years : 13.57 MCM

## 1.9 Water level behavior

### (a) Depth to water level

#### Aquifer - I

- Pre-monsoon: 1.65 – 12.24 mbgl (Fig.-6)
- Post-monsoon: 1.33 – 7.51 mbgl (Fig.-7)

#### Aquifer - II

- Pre-monsoon: 7.56 -17.73 mbgl (Fig.-8)
- Post-monsoon: 6.92 – 9.06 mbgl (Fig.-9)

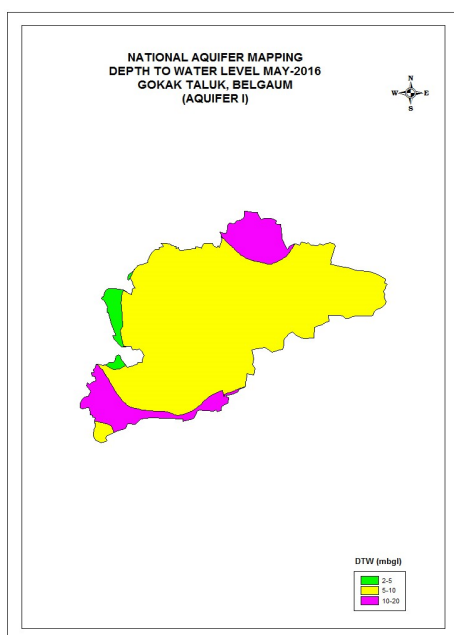
### (b) Water level fluctuation

#### Aquifer-I (Fig.-10)

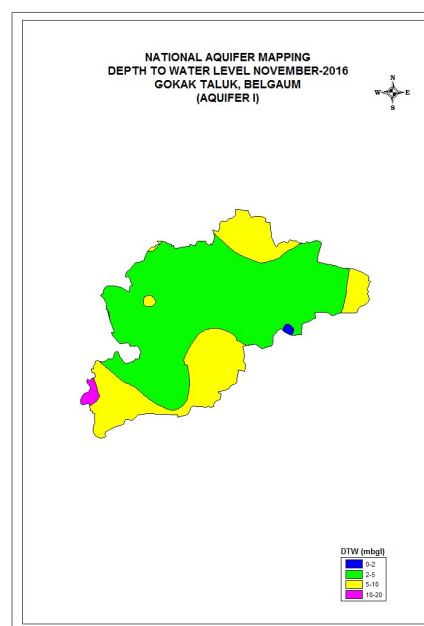
- Seasonal Fluctuation: Rise ranges 0.32 – 5.70 m;  
Fall ranges nil

#### Aquifer-II (Fig.-11)

- Seasonal Fluctuation: Rise shows 0.33-10.74 m;  
Fall ranges 0.0 – 0 .52 m

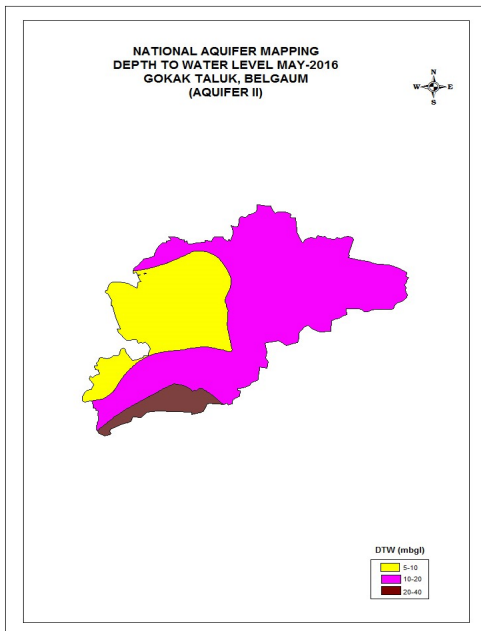


**Fig-6: Pre-monsoon DTW (Aq-I)**

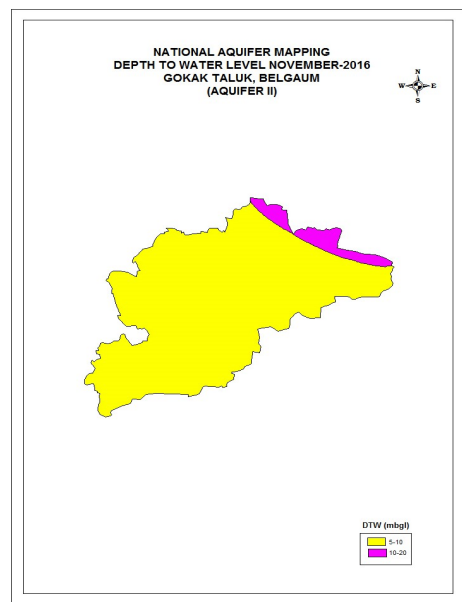


**Fig. 7: Post monsoon DTW (Aq-I)**

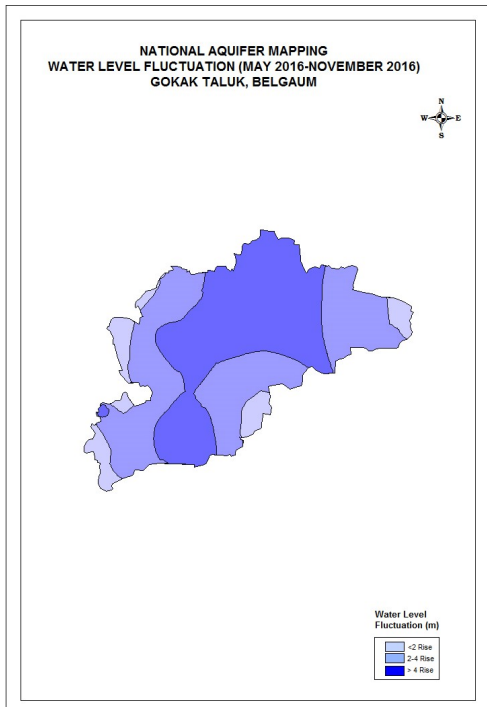




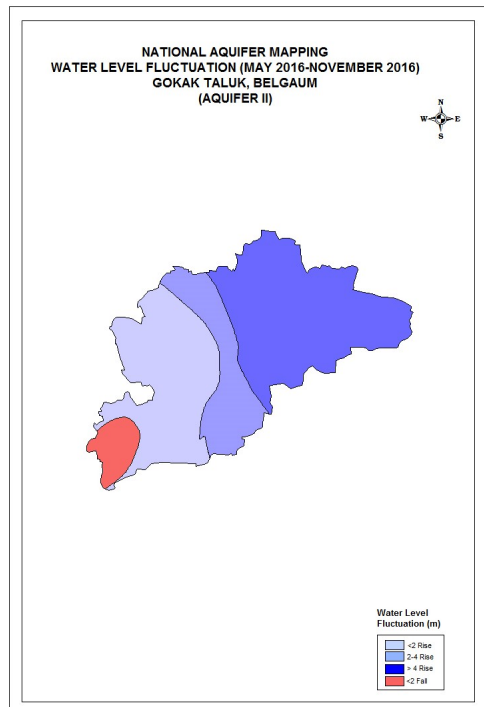
**Fig-8: Pre-monsoon DTW (Aq-II)**



**Fig-9: Post monsoon DTW (Aq-II)**



**Fig-10: Water Level Fluctuation (Aq-I)**



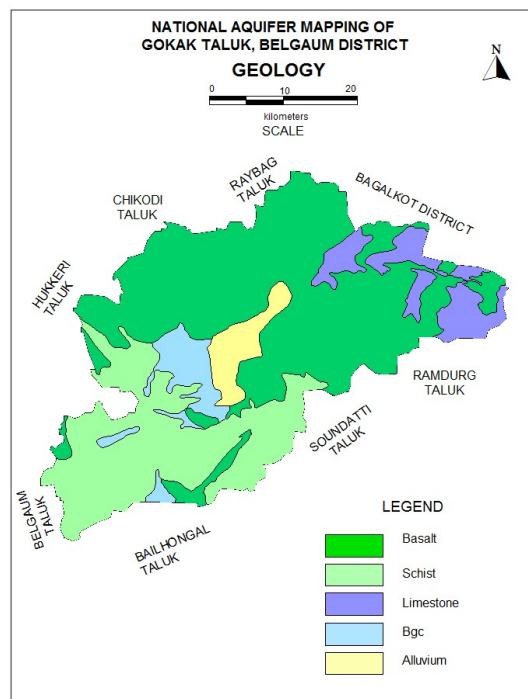
**Fig-11: Water Level Fluctuation (Aq-II)**

## 2. AQUIFER DISPOSITION

### 2.1 Number of aquifers: In Gokak taluk there are mainly two types of aquifer systems

- i. **Aquifer-I (Phreatic aquifer)** Weathered Basalt
- ii. **Aquifer-II (Fractured aquifer)** Fractured Basalt and Vesicular Basalt

In Gokak taluk, Basalt is the main water bearing formations (**Fig-12**). Ground water occurs within the weathered and fractured Basalt under water table condition and semi-confined condition. In Gokak taluk bore wells were drilled from a minimum depth of 80 mbgl to a maximum of 200 mbgl. Depth of weathered zone ranges from 5 mbgl to 20 mbgl. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 10 to 190 mbgl. Yield ranges from 0.20 to 8.5 lps. The basic characteristics of each aquifer are summarized in **Table-7 & 8**.



**Fig-12: Geology map**

**Table-7: Details of Ground Water Exploration**

Sl. No.	Location with coordinates	Depth drilled (m)	Depth of Well (m)	Thickness of weathering (m)	Length of casing lowered with dia. (m) agl	Fractures Encountered (mbgl)		Aquifer	SWL mbgl	Discharge (lpm)	D.D. (m)	T (m <sup>2</sup> /d)
						From	To					
1	Gokak EW 16° 10' 5.16" 74° 49' 54.8"	202.60	202.60	19.50	20.00	-	-	Sandstone /shale/ gneiss	>100 m	Negligible	-	-
2	Muduvala EW 16° 02' 50.7" 74° 43' 24.4"	202.60	202.60	15.50	16.00	190.40	191.43	Quartzite/ Sandstone /shale	18.43	1.50	34.34	1.48
3	Khangaon EW 16° 02' 50.7" 74° 43' 24.4"	202.60	202.60	5.50	6.00	172.00	173.00	Sandstone /shale	19.27	0.073	-	-
4	Vaderahatti EW 16° 14' 59.4" 74° 54' 30.2"	202.60	202.60	17.50	18.00	68.40	69.40	Basalt/Sandstone	10.83	1.30	34.38	2.05
5	Hunshyala EW 16° 14' 10.9" 74° 54' 15.6"	202.60	202.60	5.50	6.00	10.40 53.0	10.40 56.0	Basalt/Gr. gneiss	2.54	0.215 0.731	19.37	9.39
6	Kaujalagi EW 16° 12' 11.16" 75° 03' 36.36"	202.60	202.60	17.50	18.00	-	-	Basalt/Gr. gneiss	63.44	Negligible	63.44	-
7	Mannikeri EW 16° 09' 23.7" 75° 04' 03.8"	143.90	143.90	18.50	19.00	47.0 101.90	50.0 105.0	Quartzite	38.95	2.47 8.41	0.85	297
8	Mannikeri OW 16° 09' 23.7" 75° 04' 03.8"	120.70	120.70	5.50	6.00	47.0 101.90	50.0 105.0	Quartzite	35.01	2.47 8.41	1.03	241
9	Maradi shivapur EW 16° 06' 53.8" 74° 57' 09.6"	153.70	153.70	11.50	12.0	25.70 105.0	28.70 108.0	Sandstone / shale/ Gr.Gneiss	4.29	0.441 1.79	12.34	13.26
10	Maradi shivapur OW 16° 06' 53.4" 74° 57' 10.1"	135.50	135.50	11.50	12.0	27.70 108.0	28.70 111.10	Sandstone /shale/Gr. Gneiss	6.50	0.731 1.79	12.40	27.92
11	Kolavi EW 16° 06' 25.9" 74° 49' 36.8"	202.60	202.60	14.0	14.50	27.70	28.70	Sandstone / shale	9.53	0.215		
12	Yadavad EW 16° 14' 21.3" 75° 10' 44.4"	202.60	202.60	11.50	12.0	129.40	132.40	Limestone (Dolomite)	6.08	0.441	6.08	4.88
13	Bagarnal EW 16° 08' 20.8" 75° 01' 01.01"	202.60	202.60	11.50	12.0	44.0 105.0	47.0 108.0	Sandstone / shale	5.01	0.038 1.21	-	4.00
14	Pamaldinni EW 16° 16' 58.7" 74° 46' 35.5"	202.60	202.60	5.50	6.00	47.0 80.60	50.10 86.70	Basalt/Gr. Gneiss	8.38	1.79 5.54	17.22	10.36
15	Pamaldinni OW 16° 16' 58.7" 74° 46' 35.5"	134.50	134.50	5.50	6.00	13.0 62.0 117.0	16.0 65.0 120.0	Basalt/Gr. Gneiss	15.24	1.21 10.20 13.10	1.79	93.68

**Table-8: Basic characteristics of each aquifer**

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered Basalt/weathered sand stone/shale	Fractured / Jointed Basalt
Thickness range (mbgl)	20	Fractures upto 200 mbgl
Depth range of occurrence of fractures (mbgl)	7-15	10-191
Range of yield potential (lps)	moderate yield	0.2 – 8.5
Specific Yield	2%	0.2%
T (m <sup>2</sup> /day)	-	1 – 297
Quality Suitability for Domestic & Irrigation	Suitable	Suitable

### 3. GROUND WATER RESOURCES, EXTRACTION, CONTAMINATION AND OTHER ISSUES

#### 3.1 Aquifer wise resource availability and extraction

The details of ground water resource is given in Tables 9a, 9b and 9c

#### 9a. Present Dynamic Ground Water Resource (2017) (in ham)

Taluk	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	Allocation For Domestic And Industrial Use For Next 25 Years	Net Ground Water Availability For Future Irrigation Development	Existing Stage Of Ground Water Development	Category
Gokak	8186	5946	761	6708	1357	1397	82	SEMICRITICAL

#### 9b. Present total Ground Water Resource (2017) (in ham)

Taluk	Annual replenishable GW resources (in ham)	Fresh In-storage GW resources (in ham)		Total availability of GW resource (in ham)
		Phreatic	Fractured	
Gokak	8186	2326	2841	13353

#### 9c. Comparison of ground water availability and draft scenario (in ham)

Taluk	GW availability (in ham)	GW draft (in ham)	Stage of GW development	GW availability (in ham)	GW draft (in ham)	Stage of GW development	GW availability (in ham)	GW draft (in ham)	Stage of GW development	GW availability (in ham)	GW draft (in ham)	Stage of GW development
	2009			2011			2013			2017		
Gokak	16282	14547	89%	15124	11331	75%	15167	11644	77%	8186	6708	82%

### 3.2 Chemical quality of ground water and contamination

Interpretation from Chemical Analysis results in Gokak taluk is mentioned as under:

**Electrical conductivity:** In general, EC values range from 350 to 3180  $\mu$ /mhos/cm at 25°C in the Aquifer-I.

**Fluoride:** Fluoride concentration in ground water ranges between 0.23 -1.9 mg/l in the Aquifer-I

**Nitrate:** Nitrate value ranges from 4 and 85 mg/l in the Aquifer –I

**Table 10. Quality of ground water (Aquifer-I) in Gokak taluk**

SI.No	LOCATION	PH	EC	TH	CA	MG	NA	K	CO <sub>3</sub>	HCO <sub>3</sub>	CL	SO <sub>4</sub>	NO <sub>3</sub>	F
1	Chikkanandi	8.20	900	260	32	44	87	3	0	256	78	106	32	1.50
2	Gokak	8.30	3180	210	28	34	644	0	60	854	305	336	4	1.90
3	Arabhavi	8.20	676	190	32	27	56	22	0	146	85	52	30	0.89
4	Kundargi	8.00	660	160	28	22	67	21	0	153	85	53	35	1.80
5	Naganur	8.20	1226	460	32	92	69	3	0	201	177	178	56	0.98
6	Sangankeri	8.01	1090	440	40	83	48	1	0	189	142	51	59	0.88
7	Sindhikurbet	8.17	479	175	24	28	29	2	0	104	43	53	85	0.89
8	Ghodegeri	8.35	610	-	-	-	-	-	-	-	90	-	49	0.46
9	Khangaon	8.21	1400	-	-	-	-	-	-	-	174	-	20	0.71
10	Mammadapur	9.61	350	-	-	-	-	-	-	-	50	-	11	0.23

## 4.0 GROUND WATER RESOURCE ENHANCEMENT

### 4.1 Aquifer wise space available for recharge and proposed interventions

To enhance the ground water resources the dry phreatic aquifer (Aq-I) in the taluk to be recharged through the construction of artificial recharge structures like check dams, percolation tanks & point recharge structures (**Table-11**). The choice of recharge structures should be site specific and such structures needs to be constructed in areas already identified as feasible for artificial recharge. Improvement in Ground water availability is given in **Table-12**.

**Table-11. Quantity of non-committed surface runoff & expected recharge through AR structures (As per Master Plan for artificial recharge in Karnataka and Goa,2020)**

Artificial Recharge Structures Proposed	Gokak taluk
Non committed monsoon runoff available (MCM)	37.248
Number of Check Dams	140
Number of Percolation Tanks	34
Number of subsurface dykes	1
Tentative total cost of the project (Rs. in lakhs)	2086.887
Expected recharge (MCM)	27.936
Cost Benefit Ratio (Rupees/ cu.m. of water harvested)	7.47

**Table-12. Improvement in GW availability due to Recharge in Gokak taluk**

Taluk	Net annual ground water availability	Existing gross ground water draft for all uses	Existing stage of ground water development	Expected recharge from proposed artificial recharge structures	Expected improvement in stage of ground water development after the implementation of the project	Expected improvement in overall stage of ground water development
	HAM	HAM	%	HAM	%	%
Gokak	8186	6708	82	2793.6	61.10	20.9

#### 4.2 Regulation and Control

- Gokak taluk has been categorized as Semicritical, since the Stage of ground water development is 82% (GEC March 2017). Hence, stringent action has to be taken up through Karnataka Ground Water Authority to control further ground water exploitation in the taluk.
- Ground water recharge component needs to be made mandatory in the non-command area of the taluk for further development of ground water.

#### 4.3 Other interventions proposed

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Any excess nitrate & fluoride concentration is found in groundwater samples require remedial measures like dilution of nitrate rich groundwater through artificial recharge & water conservation and also by roof top rainwater harvesting.

### 5 Summary

The summary of Management plan of Gokak taluk is given in **Table 13**.

**Table 13. Summary of Management plan of Gokak taluk**

Gokak taluk is semicritical & present stage of GW Development (2017)	82%
Net Annual Ground Water Availability (MCM)	81.86
Existing Gross Ground Water Draft for all uses	67.08
Expected additional recharge from monsoon surplus runoff (MCM)	27.936
Change in Stage of GW development, %	82% TO 61.10%
Excess nitrate & fluoride concentration	<ul style="list-style-type: none"> <li>• Dilution of nitrate rich ground water through artificial recharge &amp; water conservation.</li> <li>• Roof top rainwater harvesting.</li> </ul>