



केन्द्रीय भूमिजल बोर्ड

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

Central Ground Water Board

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

Report on

AQUIFER MAPPING AND MANAGEMENT PLAN

**Bangalore South Taluk, Bangalore Urban
District, Karnataka**

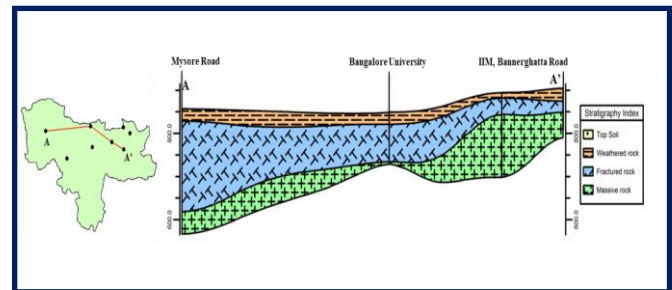
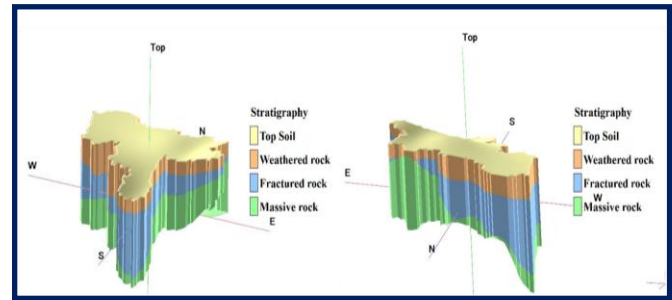
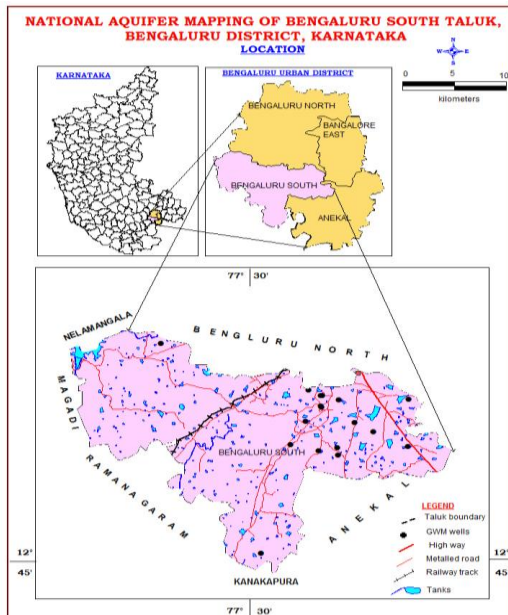
दक्षिण पश्चिमी क्षेत्र, बेंगलुरु
South Western Region, Bengaluru

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Bengaluru

Aquifer Maps and Management Plan, Bengaluru South Taluk, Bengaluru Urban District, Karnataka State (AAP: – 2020-2021)



By
Bijimol Jose, Sc-B, CGWB, SWR, Bengaluru

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1. INTRODUCTION

National Project on Aquifer Mapping (NAQUIM) initiated by Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India with a vision to identify and map the aquifers at the micro level with their characteristics, to quantify the available groundwater resources, to propose plans appropriate to the scale of demand and institutional arrangements for participatory management in order to formulate a viable strategy for the sustainable development and management of the precious resource which is subjected to depletion and contamination due to indiscriminate development in the recent past.

Groundwater is being increasingly recognized as a dependable source of supply to meet the demands of domestic, irrigation and industrial sectors of the country. The development activities over the years have adversely affected the groundwater regime in many parts of the country. Hence, there is a need for scientific planning in development of groundwater under different hydrogeological situations and to evolve effective management practices with involvement of community for better groundwater governance.

Aquifer Mapping has been taken up in Bengaluru South taluk, Bengaluru South district in a view to formulate strategies for sustainable management plan for the aquifer system in accordance with the nature of the aquifer, the stress on the groundwater resource and prevailing groundwater quality which will help in drinking water security and improved irrigation facility. It will also result in better management of vulnerable areas.

1.1 Objectives

The objectives of the aquifer mapping in Bengaluru South taluk, Bengaluru Urban district can broadly be stated as

- To define the aquifer geometry, type of aquifers and their lateral and vertical extent
- To determine the groundwater regime scenario
- To determine the hydrogeochemical characteristics of the aquifer units
- To define 2D and 3-D dispositions of the aquifer units
- To estimate the availability of groundwater resources
- To develop a sustainable groundwater management plan to meet the demand supply gap

1.2 Scope of the Study

The important aspect of the aquifer mapping programme is the synthesis of the large volume of data already generated during specific studies carried out by CGWB and various Government organizations with a new data set generated that broadly describe the aquifer system. The available generated data are assembled, analyzed, examined, synthesized and interpreted from available sources. These sources are predominantly non-computerized data, which is to be converted into computer based GIS data sets.

Data gaps have been identified after proper synthesis and analysis of the available data collected from different state organizations like GWD, Watershed Department, etc. In order to bridge the data gap, data generation programme has been formulated in an organized way in the study area. Exploration work has been carried out in different segments of the regions and aquifer parameters have been estimated. Groundwater monitoring regime has been strengthened by establishing/adding State agencies additional monitoring wells. 2D and 3D sections have been prepared to bring out more realistic as the data points are more closure to the field.

1.3 Issues of the study area

Bengaluru south has both Urban and peri urban areas with different set of issues and manifestations. The main issues pertaining to the Bengaluru South taluk is as follows

Urban areas (40% area)

- Lack of groundwater resources to meet the Demand Supply gap of 1360 MLD
- Decline in water levels and drinking water scarcity especially during lean months
- Water quality issues:
 - Fluoride
 - Heavy metals (Chromium, Zn, Mn)
 - Brackishness & Nitrate
 - Radon and Uranium
- Pollution of surface water and groundwater due to
 - Sewage and industrial effluents (Bellandur lake)
 - Improper waste disposal to water bodies (Vishrabhavathi River)
- Poor recharge to GW
 - Rapid urbanization
 - Filling up of lakes
 - Poor water WUE due to UFW (approx.40%)

Peripheral areas (60% area)

- Over exploitation due to 100% dependency on groundwater as surface water is absent
- Access for safe drinking water is a major issue, especially during summer
- Water quality issues
- Decline in water levels and unmindful drilling of borewells
- Reduced irrigation potential for field crops
- Cultivation of water intensive crops with due to the marketing and exporting facilities- Horticulture crops
- Undependable GW based irrigation due to poor sustainability of wells
- Reduced GW recharge resulted from
 - Land use changes
 - Encroachment of water bodies-lakes and ponds-GW recharge zones
 - Drying up of rivers

1.4 Approach & Methodology

Integrated multi-disciplinary approach involving geological, geophysical, hydrological and hydrogeological and hydrogeochemical components were taken up in 1:50000 scale to meet the objectives of study. Geological map of the study area has been generated based on the GSI maps, geophysical data have been generated through vertical electrical soundings and geoelectrical layers with different resistivity have been interpreted in corroboration with the litho stratigraphy of the observation wells and exploratory wells down to depths of 250 m bgl. Hydrological and Hydrometeorological data have been collected from Statistical department, Govt of Karnataka. Drainage, Soil and Geomorphology of the taluk were prepared based on the satellite data interpreted by KRSAC.

Based on the data gap analysis data generation process has been scheduled through establishing key observation wells, integrating Ground Water Directorate observation wells, pinpointing exploratory sites for drilling through in-house and outsourcing, collecting geochemical samples in order to study groundwater regime, geometry of the aquifer and aquifer parameters, and quality of the groundwater respectively. Groundwater recharge and draft have been computed through different methods and resources of the aquifer system estimated through groundwater balance method.

Based on the above studies Management strategies both on the supply side through augmentation of groundwater through artificial recharge and water conservation and on demand side through change in irrigation pattern have been formulated for sustainable management of the groundwater resource.

2. SALIENT INFORMATION

Name of the Taluk:	BENGALURU SOUTH
District:	Bengaluru Urban
State:	Karnataka
Area:	528 sq. km.
Population:	205274 (109,255 males , 96019 females (2011 Census)
Annual Normal Rainfall:	866 mm (1980-2010) 1058 mm (Actual Annual rainfall-2018)

2.1 Study area

Bengaluru South Taluk is located in South western portion of Bengaluru Urban district, Karnataka state covering an area of 528 Sq. Km. Bengaluru South is located between 12° 44' 45.24"- 12° 41' 45.6" N latitude and 77° 42' 20.61"-77° 40' 14.33" E longitude with an average elevation of 915 m (3,001 ft) above the MSL.

Bengaluru South is surrounded by Bengaluru North Taluk & Bengaluru City of Bengaluru Urban district in the north, Anekal along South and South East, Hoskote Taluk of Bengaluru Urban district along west. Location map of the Taluk is shown in **Figure-1**.

Bengaluru South taluk lies in the Southern part of the Bengaluru metropolitan area around 25 km from downtown Bengaluru. Bifurcation of Bengaluru city from all existing 4 taluks reduced the area coverage of Bengaluru South to 342 sq km. It is a part of Bengaluru revenue division with Bengaluru South as taluk head quarter. There are 8 towns, 9 Hoblis, 28 Grama Panchayaths 97 villages and 51094 houses. The Taluk is well connected with good network of roads with National Highway 4 and the Bengaluru-Chennai railway line connecting Hosakote to Bengaluru and Chennai with other district roads forming good network of transport facility.

Bengaluru South Taluk covers part of Cauvery River and Krishna River basin and has no major rivers running through the region, Shimsa, Kanva rivers of Cauvery basin drains the taluk Bengaluru South has a handful of freshwater lakes and water tanks. Sewage laden Vrishabhavathi, tributary of Arkavathi flows through Bengaluru South.

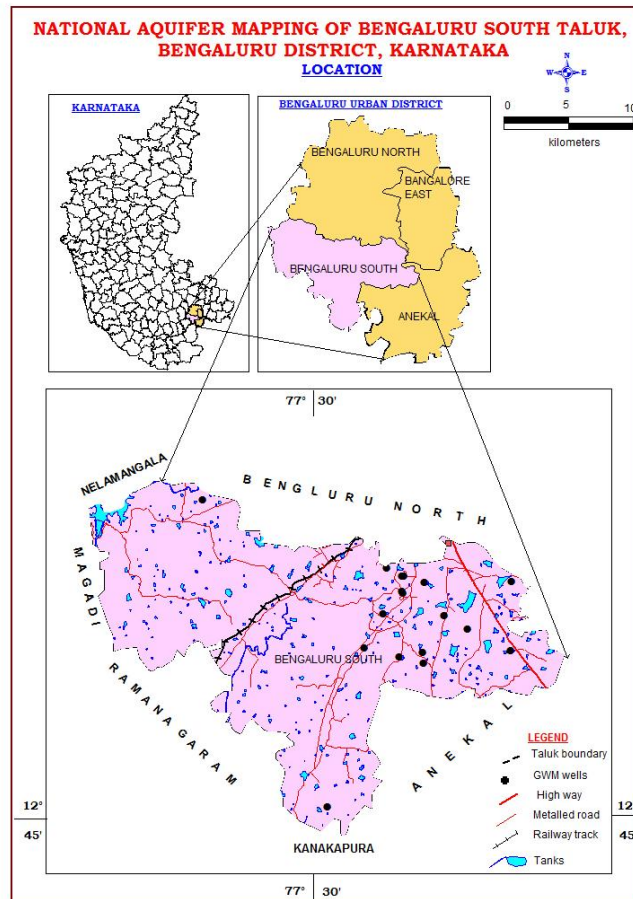


Fig.1: Location Map

2.2 Population

As per 2011 census, the total population in Bengaluru South Taluk is 205274 of which males 109,255 are males and 96019 are females (2011 Census) of which about 72% constitutes the rural population, 28 % in urban areas, 51094 households are there in Bengaluru South. The Taluk has an overall population density of 980 persons per sq.km. The decadal change is 15 % in rural and 55 % in urban population.

2.3 Rainfall

Semi arid to humid climate prevails in Bengaluru South with dryness and hot weather during major part of the year. The area falls under Eastern Dry Agro-Climatic zone of Karnataka state and is categorized as drought prone. The climate of the Taluk is quite agreeable and free from extremes. The temperature in summer is in between 26.2⁰C to 34.2⁰C and in winter it is 15.1⁰ to 21.8⁰ C with normal temperature ranging from 21.1⁰ to 28⁰C. Maximum of 33⁰C in April to lowest mean

maximum of 14°C in January. The mean monthly relative humidity is the lowest during the month of March at 44% and records highest between the months of June and October at 80 to 85%

The rainy season or South-West monsoon is from June to September followed by North-East monsoon and post-monsoon from October to December. Eastern Dry Agro-Climatic zone's characteristic of low rainfall pattern with more uniform and bi-modal distribution with average 55 rainy days is observed in Bengaluru South.

The mean monthly rainfall at Bengaluru South Taluk is ranging from 1 mm during January to 181 mm during October. The Annual Normal rainfall (1981 to 2010) in the Taluk is 866 mm and the statistical analysis of rain fall data is presented in the **Table 1**.

Table 1: Statistical Analysis of Rainfall Data of Bengaluru South Taluk, Bengaluru Urban District

STATION	Item	JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
Bengaluru South	NRM	1	4	15	40	81	141	66	78	104	180	429	181	51	12	243	813
	ST.DEV	3	14	31	43	59	88	57	58	66	104	156	118	51	18	141	256
	CV%	349	332	209	108	73	63	86	74	63	58	36	65	100	149	58	31

2.4 Assessment of Drought

Rainfall data has been analyzed to assess the drought condition using for 102 years IMD Rain fall data and the results thus obtained are listed in the **Table-2**. It is observed that the Bengaluru South Taluk has experienced alternating no drought to acute drought conditions over the years.

Table 2: Classification of drought and its periodicity (IMD,1971)

% of Deviation (Di)		>0	0 to -25	- 25 to 50	- 50 to - 75	< - 75	Probability of drought occurrences
Category		No drought	Mild (Normal)	Moderate	Severe	Acute	
		Years					
Taluk	Bengaluru South	54	24	21	3	0	Once in 4 years

Out of 102 years of analysis in Bengaluru South Taluk, "No Drought" condition is experienced in 54 years, "Mild Drought" condition is 24 years and "Moderate Drought" condition experienced in 21 years. Further it is observed that "Severe Drought" condition is experienced in 3 years ie, during 1920, 1923 and 2006. 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 4 years**.

2.4 Agriculture & Irrigation

Bengaluru South Taluk is having (68.1 %) of rural population wholly dependent on the rainfall for their agricultural activities. The land use pattern of the Taluk is presented in the **Table-3** and in **Fig.2**.

Table 3: Land use pattern of Bengaluru South Taluk (Ha)

Forest	Land not available for cultivation	Fallow Land	Area sown		
			Net Sown	Sown more than once	Total
1345	17597	3328	8155	204	8359

The only principle crop of the Taluk is Ragi which is grown in 9742 ha (39.33% to the total cropped area), followed by Fruits (2429 ha) and Vegetables (1953 ha) which are normally rain fed crops. Fruits are grown in 9.8 % of the area during Rabi season. This followed by vegetables grown in an area of 1953 ha (7.88% to the total cropped area). Pulses are grown in the principle crops and the area grown is shown in **Table 4**.

Table 4: Principle crops grown in Bengaluru South Taluk

Pulses	Food grains	Fruits	Vegetables	Oil seeds
823	5916	409	186	223

Source: District at a Glance 2017-2018, Govt. of Karnataka

In Bengaluru South Taluk, the ground water is being developed from ground water structures like 3500 tube wells (District at Glance 2017-2018) for irrigation purposes. The ground water thus developed from these structures were managed through water distribution irrigation practices by adopting- Open channel, Underground pipe, surface pipe, drip irrigation, sprinklers and others. No surface water available for irrigation lift scheme. Ground water tapped through bore wells is the main source of irrigation. The details of surface water and ground water irrigation are in the **Table 5**.

Table 5: Details of irrigation in Bengaluru South Taluk

Sl. No.	Source		No. / Length	Net area irrigated (Ha)	Gross area irrigated (Ha)
1	Surface water	Canals	0	0	0
		Tanks	300	201	0
		Lift irrigation	1	43	43
2	Ground water	Dug Wells	30	26	0
		Bore wells	4144	4154	4862
		Total	4475	4424	4905

Source: District at a Glance 2017-2018, Govt. of Karnataka

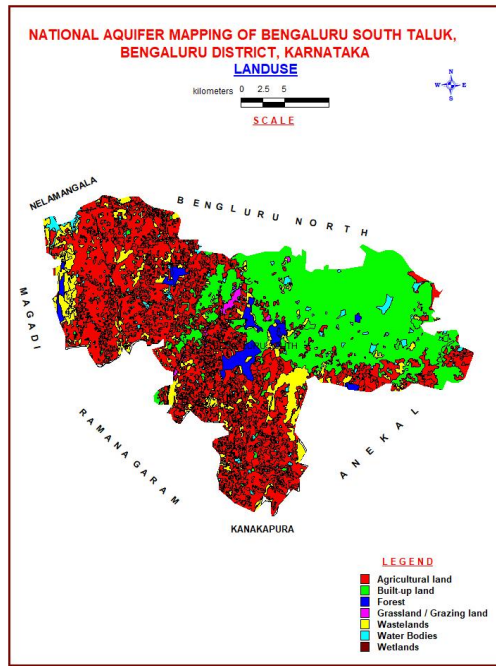


Fig.2:Land use map

2.5 Geomorphology, Physiography & Drainage

Geomorphologically Bengaluru South Taluk falls in southern maidan region. Physiographically, the area is characterized by undulating topography. It is located on a plateau and the highest elevation is observed at 940 m msl and the average elevation ranging from 600 to 900 m amsl. It has range of hills which are actually spurs of Eastern Ghats extends from east to south made up of granites with lateritic capping (Figure 3).

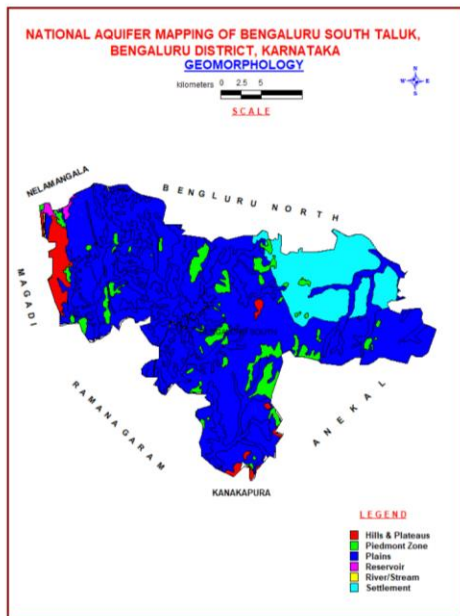


Fig.3:Geomorphology map

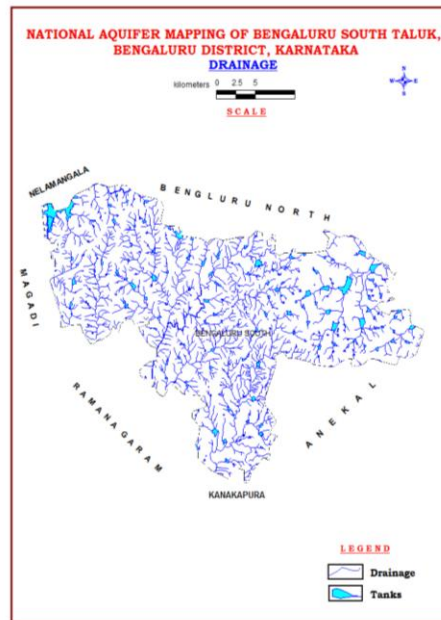


Fig.4:Drainage map

Bengaluru South Taluk is the part of South Pennar (Ponnaiyar) river basin. The main drainage of the Taluk is from north to south. The South Pennar River which rises north of Sidlaghatta Taluk at Nandi hills of Chickballapur district and after entering Bengaluru Rural district/ Hosakote towards southwards where it forms the large lake known as Janagama-Kote Kere and Hosakote-kere at Hosakote. The sewage waters of Bengaluru city enter this river via Bellandur and Varthur lakes. The general drainage pattern is of sub-rectangular (**Figure 4**) due to marked influence of geologic structures in the basin.

2.6 Geology

Bengaluru South Taluk is occupied by Banded Gneisses called as Peninsular Gneissic Complex and small patch of laterite occurs north of Bengaluru South (**Figure 5**).

2.7 Soil

The soils of the area are derived from Gneiss, Granites and Laterites. The soils are hard and poor in general. Sandy, loam, black soil are the main soil types of the Taluk (**Figure 6**).

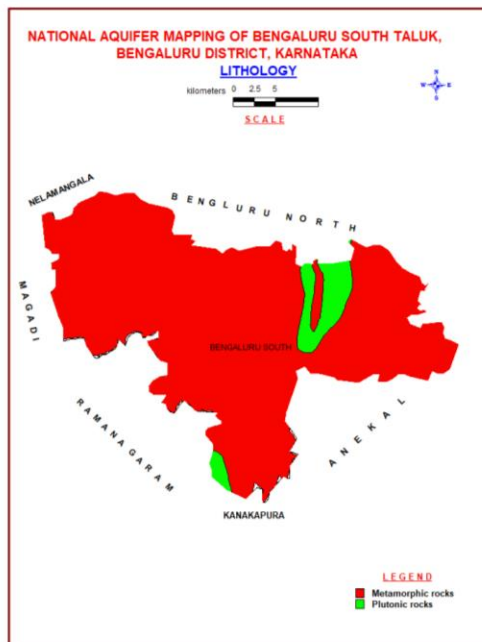


Fig.5: Geology map

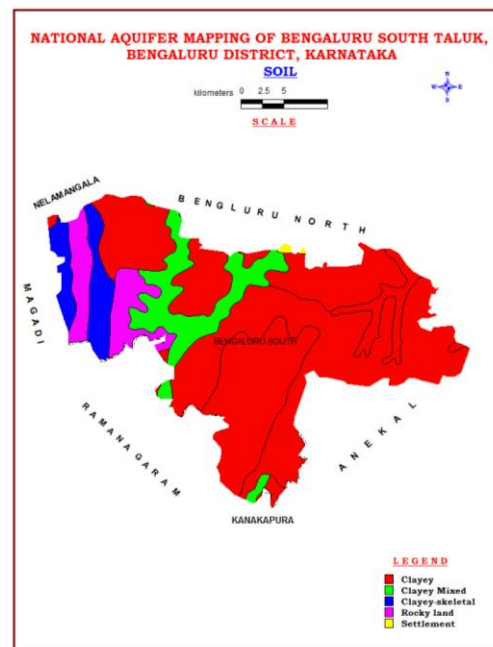


Fig.6: Soil map

2.8 Ground water resource availability and extraction

The Ground water availability as per Resource Estimation 2020 is presented in the **Table 6**.

Table 6: Ground Water Resource Estimation of Bengaluru South Taluk-2020 (Ham)

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
HAM	HAM	HAM	HAM	HAM	HAM	%	
4667.09	4652.29	148.06	4800.35	191.67	0.00	102.86	Over Exploited

As per the estimation of GEC 2020, the ground water draft (extraction) for irrigation worked out to be 4652 ham with stage of ground water development of 103%.

2.9 Existing and future water demands

As per GEC (2020), existing ground water draft for irrigation, industrial & domestic (all use) is 4800.35 ham and as the stage of ground water development already reached up to 103% having nil availability for future irrigation demands. However, allocation of ground water for industrial and domestic purposes is computed to be 148 HAM.

2.10 Water level behavior

Phreatic aquifer is desaturated in most part of the Bengaluru South Taluk. Change in average water levels in phreatic aquifer is from 2014 to 2019 furnished in table below.

Table 7: Average Depth to Water Level(m bgl)									
2015		2016		2017		2018		2019	
No of Wells	WL (m bgl)	No of Wells	WL (m bgl)	No of Wells	WL (m bgl)	No of Wells	WL (m bgl)	No of Wells	WL (m bgl)
4	6.68	4	5.44	4	6.16	4	3.04	4	6.43

The depth to water levels during pre and post monsoon and the rate of fluctuation of water level shown in the **Table 8 & 9** and depth to water level maps shown in **Figure 7 & Figure 8**.

Table 8: List of Water Level monitoring stations in Bengaluru South Taluk and DWL

SITE_NAME	DEPTH	RL (mamsl)	MP	Aquifer Type	Depth to water level (m bgl)	
					MAY2019	NOV2019
Begihalli	6.60	900.66	0.00	Unconfined	3.45	1.62
Bhaktipura	12.00	924.54	1.67	Unconfined	10.75	4.83
Haragadde-A	11.35		0.80	Unconfined	6.75	5.70
Jigani	7.55		0.90	Unconfined	4.78	2.72

Table 9: Range of Depth to Water levels in Bengaluru South Taluk

Item	Pre-monsoon		Post monsoon		Water level Fluctuation	
	Aquifer I	Aquifer II	Aquifer I	Aquifer II	Aquifer I	Aquifer II
	Range	3.45 to 10.75	2.50 to 22	1.62- 5.70	2.41 to 19.74	-
Average	-	10.5	-	7.5	-	8.2

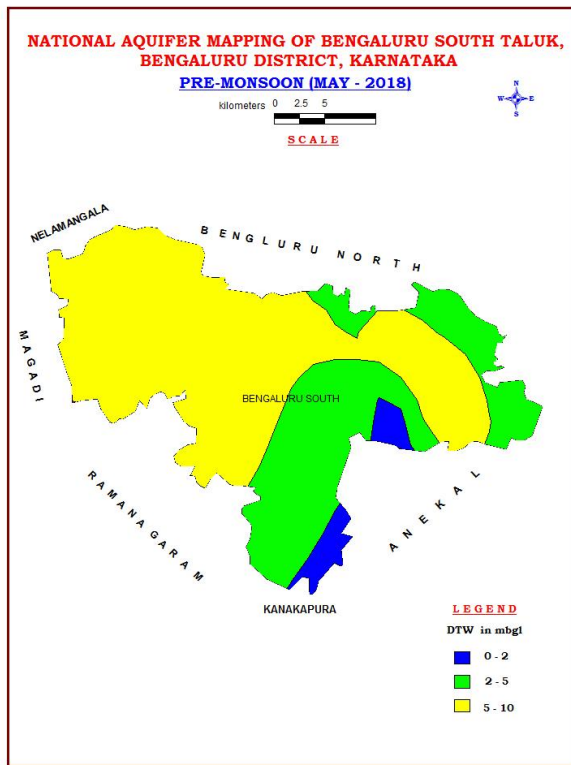


Fig.7 :Pre monsoon DTW Map

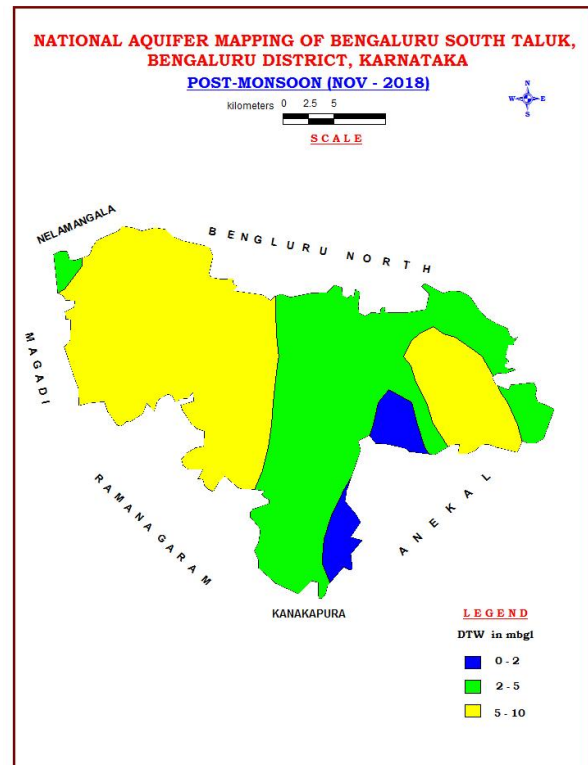


Fig.8: Post monsoon DTW map

The analysis of long-term water level trend in Aquifer-1 indicates that in pre-monsoon there is rising trend of 0.9098 m/year and falling trend of 0.0042 m/year. Similarly, during post monsoon there is a rising trend to the tune of 1.449 m/year and falling trend observed to be 1.0539 m/year. Overall trend indicates a falling trend to the tune of 1.6422 m/year.

GW Monitoring status:

Particulars	Dug wells	Piezometers
• Water level range:	1.52–12.15mbgl (May 2020)	9.25-32.60(May 2020)
	0.5- 13.7mbgl (Nov 2020)	2.03-31.16(Nov 2020)

3. AQUIFER DISPOSITION

The data collected during Geophysical investigation, Ground water exploration were made use to delineate the aquifer system, geometry and the extension of aquifer in terms of both lateral and vertical extent. The details of ground water exploration are presented in **Table 10**.

Aquifer system in Bengaluru south taluk is divided into weathered and fractured aquifers of banded gneissic complexes, granites, secondary structures like joints, fissures and faults present in them act as a porous media-the Aquifer. Ground water in the aquifer generally occurs under unconfined/phreatic and semi-confined conditions.

3.1 Aquifer types

Based on the Ground water exploration data, there are mainly two types of aquifer systems

- i. **Aquifer-I- (Phreatic aquifer)** comprising Weathered Gneiss (BGC) / Granite
- ii. **Aquifer-II- (Fractured aquifer)** comprising Fractured Gneiss (BGC) / Granite.

2D, 3D disposition and aquifer geometry is furnished in Fig 9 to 11.

Table 10: Basic characteristics of each aquifer

Aquifer Type	Formation	Thickness / fracture encountered thickness (m)	Yield (lps)	Transmissivity (m ² /day)	Groundwater quality		
					EC (µS/cm at 25°C)	F ⁻ (mg/L)	NO ₃ ⁻ (mg/L)
Aquifer I Weathered/Phreatic	Weathered granites and Gneisses	10 to 40 (Mostly desaturated)	< 1	-	400 - 2100	< 1	< 45
Aquifer II Fractured	Fractured granites and Gneisses	100 to 225	< 1 – 4	15-280	640 - 1300	< 1	1 – 92

TABLE11: Details of Exploratory wells drilled in Bengaluru South Taluk

S.No	District	Location	EW	Latitude	Longitude	Year of Drilling (FSP)	Depth Drilled (mbgl) / Casing Depth in m	Casing/ length	Lithology	Frac Zones in m	SWL in mbgl	APT Results
												Q in LPS
1	Bengaluru Urban/Bengaluru South	B'lore-GSI	PZ	12.9103	77.5681	2010-11	200.2	12	Granitic gneiss	11.2-32.12:30.48-32.12		0.51
2	Bengaluru South	Nimhans	PZ	12.9395	77.5988	2011-12	100		Granitic gneiss with pegmatite veins, dolerite dykes	47.40-51.40, 68.68-72.32	5.36	1
3	Bengaluru South	IIM, Bannerghatta Road	PZ	12.8956	77.6000	2011-12	108.52	32	Granitic gneiss , weathered	51.4-55.04	30.8	0.22
4	BENGALURU	SOMANAHALLI EW		12.7861	77.0208	1994-95	210.89	12	GRGN	14-28, 38-40, 45-50, 70-73, 95-96, 102-106, 123-126, 182.5-183.5, 203-205,		5
5	BENGALURU	SOMANAHALLI EW		12.7861	77.0208	1994-96	186.41	14	GRGN PGMT	4-16,16-28		3.2
6	BENGALURU	SOMANAHALLI EW		12.7861	77.0208	1994-97	35 / 12.26		GRGN PGMT	62-64, 74, 76, 104-113		
7	BENGALURU	KUMBLAGODU		12.8778	77.4478	1994-98	149.93	35	GRGN PGMT	25-39		0.81

8	BENGALURU	BENGALURU UNIVERSITY		12.9417	77.5111	1994-95	119.45	35	GRGN, PGMT	47-49, 54-58, 78-81, 106-112, 115-119		7.8
9	BENGALURU	BENGALURU UNIVERSITY		12.9417	77.5111	1994-96	119.45		GRGN, PGMT	15-23, 49-53, 54-60, 87-89, 110-112		8.4
10	BENGALURU	BENGALURU UNIVERSITY		12.9417	77.5111	1994-97	60	35	GRGN, PGMT, AMPL	18-21, 43-45, 52-58,		7.5
11	BENGALURU	KORAMANGALA		12.9278	77.6167	1995-96	167.17	22	WEAT, FR, GRGN	38.75-43.25, 34-43		0.13
12	BENGALURU	KORAMANGALA		12.9395	77.5988	1995-96	215		GRGN			1.2
13	BENGALURU	CAR, MYSORE ROAD		12.9586	77.5537	1995-96	264.23	31	FR, PGMT, GRGN	45-52, 75-78, 110-116, 211-213		3.5
14	BENGALURU	R.R.Nagar		12.9001	77.5158	2014	250	40	GRGN	2225-228		4

Table 12: Summary of Ground water Exploration Results, Bengaluru South Taluk

Status of GW exploration:	Particulars	CGWB	State GWD
	• No. of wells (EW,OW,PZ):	13 (3 PZs)	-
	• Depth range (m bgl):	60 to 264	-
	• Weathering (m bgl):	10 to 40	-
	• Yield (lps):	0.5 to 8.4	-
	• Transmissivity	15-280 m ² /day	-
Aquifer Characteristics:	Particulars	Exploratory wells	
	• Depth range (mbgl)	60 to 264	
	• Weathering range (mbgl)	10 to 40	
	• Yield range (lps)	>1 to 4	
	• Fractures (mbgl)	Most of the fractures encountered between the depth ranges of 100to 225mbgl	

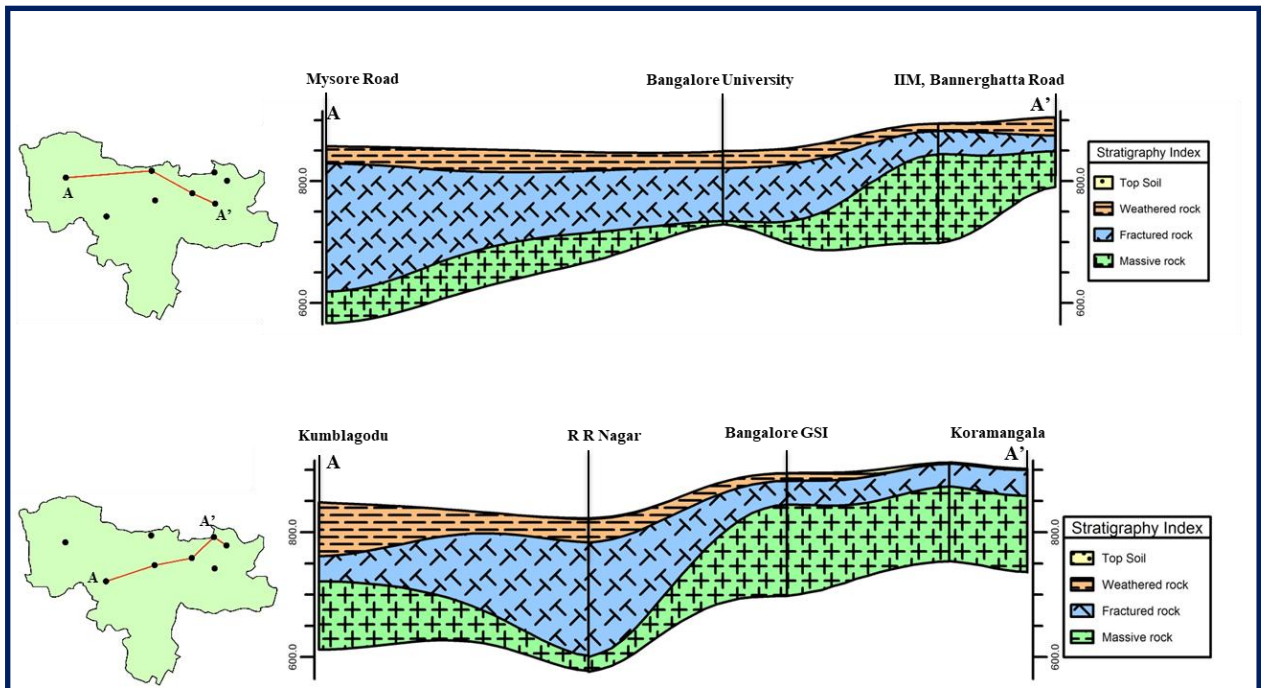


Fig.9:2D Aquifer section

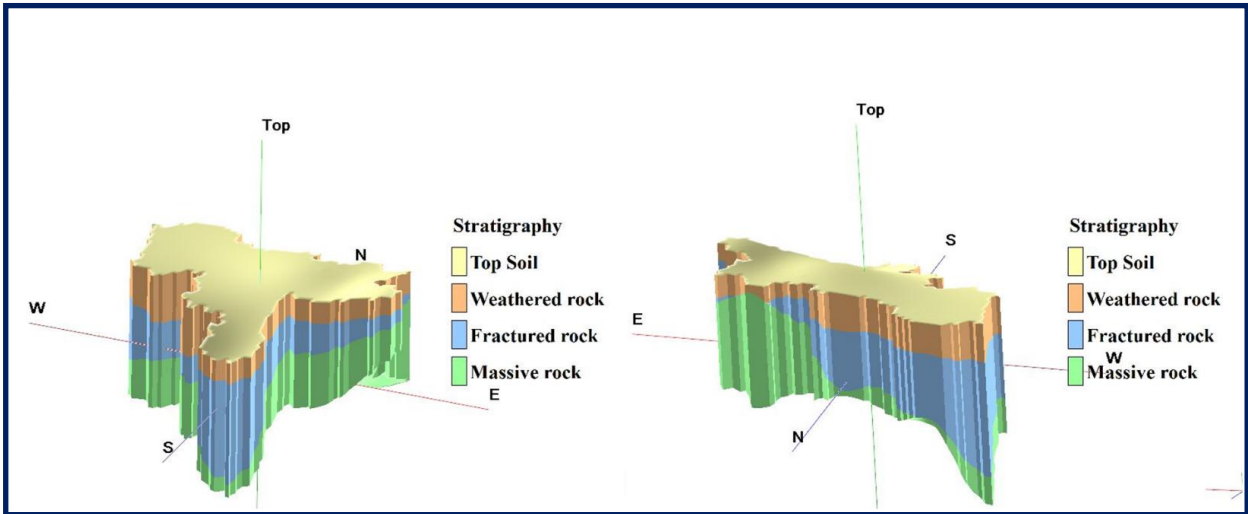


Fig.10:3D Aquifer section

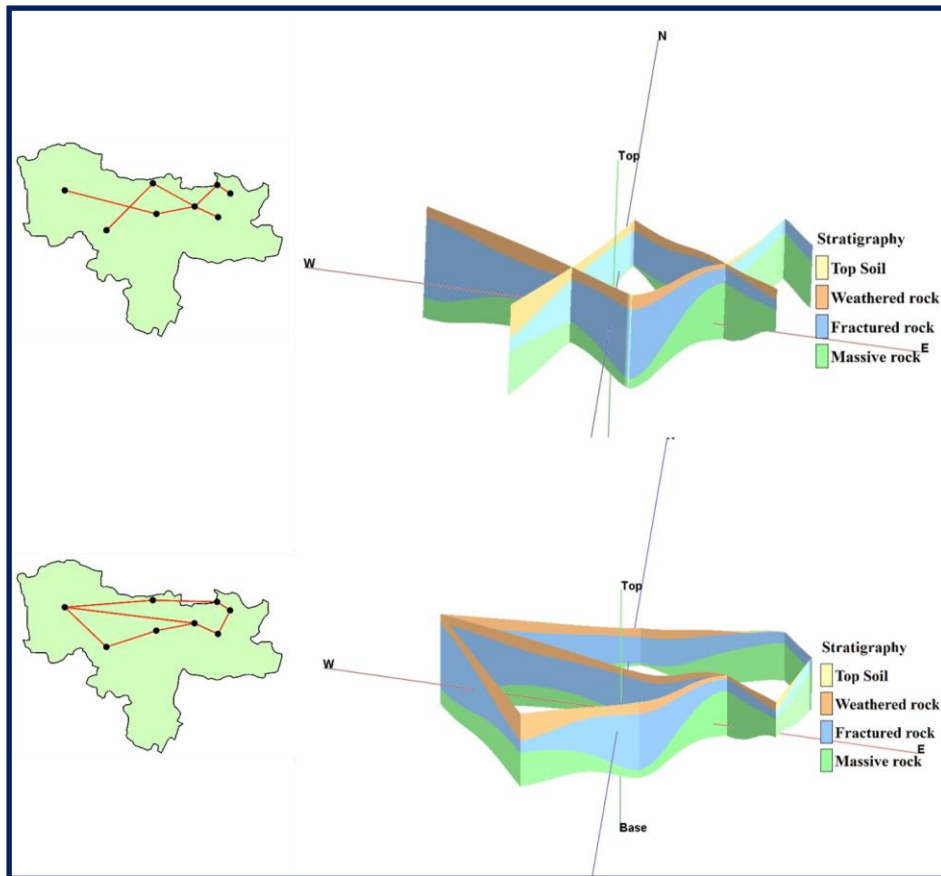


Fig.11:3D Fence Diagram of aquifer

4. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

The main ground water issues are over exploitation, Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, deeper water levels especially in Aquifer II, declining water level trend which are all inter-related or inter dependent.

4.1 Comparison of Ground Water Resource and Extraction

The Dynamic Ground Water Resource 2017 and as on 2020 have shown in **Table 14**. It is observed that the ground water availability in 2020 is more compare to 2017 due to increase in rainfall and in water table. It is attributable to the improvement in the irrigation practice, influence of command area and also due to the water conservation / recharge activities carried out in the taluk by various state govt. and other agencies.

Table 14: Comparison of groundwater availability and draft scenario (in ham)

Taluk	March 2017			March 2020		
	GW availability	GW Extraction	Stage of GW development	GW availability	GW Extraction	Stage of GW development
Bengaluru South	3354	4680	140	4667.09	4800.35	102.86

4.2 Chemical quality of ground water

In general ground water in Bengaluru South taluk is sodium Chloride type. As per analysis that the the ground water from shallow aquifers are safe and potable In Bengaluru South taluk EC varies from 1000 to 2000 micromhos /cm at 25°c except for small part in the centre of Bengaluru South taluk where salinity is more with EC> 2000 micromhos /cm at 25°. Summary of Groundwater Quality are presented in the **Table 15**.

Table 15: GW Quality

Particulars	Phreatic Aquifer (Aquifer-I)	Fractured Aquifer (Aquifer-II)
EC (μ S/cm at 25°C)	400– 2100	80 -2300
F(mg/l)	<1	<1
NO ₃ (mg/l)	9 – 144	2 -129

Groundwater Quality maps

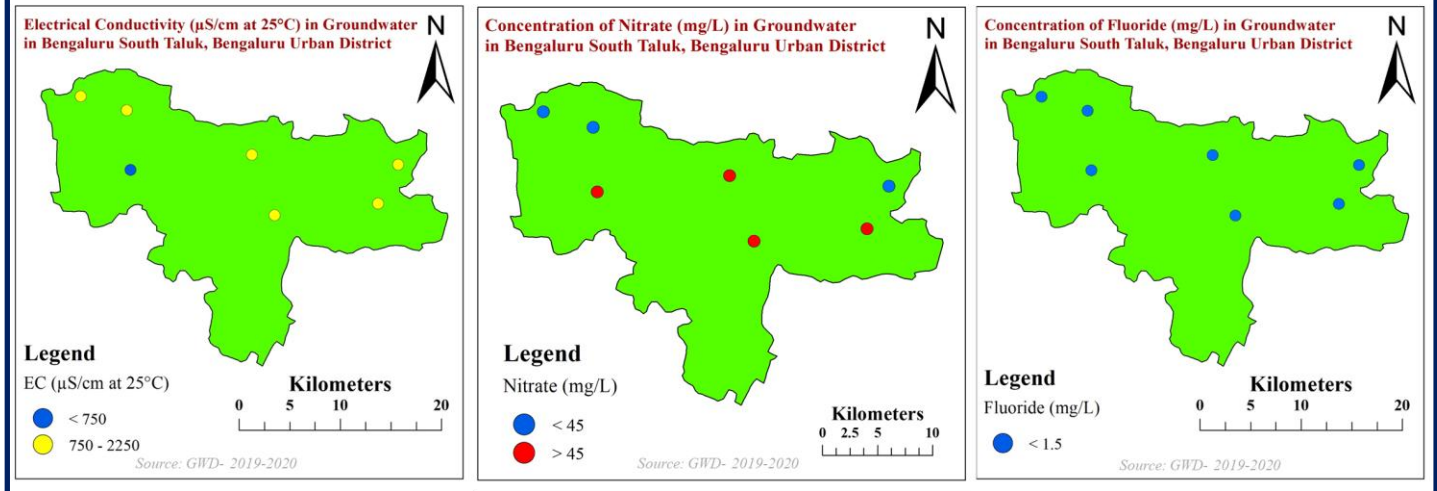


Fig-12: GW Quality Maps

4.3 Ground water contamination

As reported that the the ground water from shallow aquifers are safe and potable. How ever due to increase of usage of borewells and drawing water from greater depths resulted in contamination. Nitrate is the major ground water contamination for drinking purposes over Bengaluru SouthTaluk. This is a quite an intriguing situation facing quality problem. In addition to that contamination from the sewage effluents to Groundwater from various industries has been reported from Bengaluru South Taluk.

5. GROUND WATER RESOURCE ENHANCEMENT

5.1 Resource Enhancement by Supply Side Interventions

Continuous drought, increase in agricultural activity, subjected to excessive ground water withdrawal leading to depletion of ground water table, reduction in yield and deterioration of ground water quality etc., suggests a need for proper ground water management and enhancement of storage capacity of aquifers, protection of ground water quality and proper utilization of ground water.

To enhance the storage capacity of aquifers, the dewatered aquifers are to be recharged, for which the artificial recharge structures like Check dams, percolation tanks, point recharge structures etc have to be constructed. Tentative locations of proposed ARS shown in **Figure 13** and the location details in **Annexure 1**.

Table 16: Quantity of non-committed surface runoff & expected recharge through AR structures

Details of Artificial Recharge structures		
S.No	Artificial recharge structures available/proposed	
1	Total area (Sq km)	833
2	Area feasible for AR (Sq km)	630
3	Non committed monsoon runoff available in (MCM)	16.932
4	No of Check Dams	90
5	No of percolation tanks	15
6	No of Filter beds	2
7	Tentative total cost of the project (Rs in lakhs)	1219.964
8	Expected Recharge in (MCM)	6.25
9	Additional Irrigation Potential (Lakh hectares)	0.015

After implementation of Artificial Recharge structures for GW recharge, the annual ground water availability will increase from 4667.09 to 5292.09 ham and the expected improvement in stage of development is 12.16% from 102.86% to 90.7%.

Table 17: Improvement in GW availability due to Recharge

Details of Resource enhancement after proposed artificial recharge structures		
S.No	Resource Details	As per 2020 Estimation
1	Net Groundwater Availability in Ham	4667.09
2	Existing Gross Groundwater Draft for all use in Ham	4800.35
3	Existing stage of Ground water development in %	102.86
4	Expected recharge from Artificial recharge projects Ham	625
5	Cumulative annual groundwater availability in Ham	5292.09
7	Expected improvement in stage of ground water development after implementation of project in %	12.16
8	Expected improvement in overall stage of ground water development in %	90.7

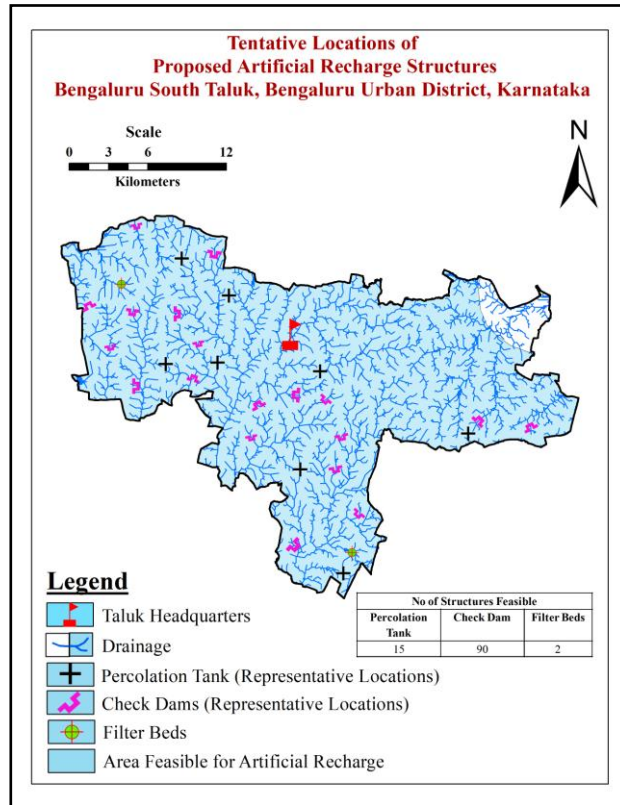


Fig-13: Tentative locations of proposed ARS

5.2 Demand Side Interventions

5.2.1 Water Use Efficiency by Micro Irrigation Practices

It is observed that presently, in the command areas, canals are the source of irrigation and in non-command areas, ground water through bore/tube wells is used for irrigation purpose. But in this taluk Groundwater is the only main source for irrigation. Water use efficiency measures have to be adopted for saving the ground water resources.

Efficient irrigation practices like Drip irrigation and sprinkler has to be adopted by the farmers in the existing 4905 ha of gross irrigated area. Presently, groundwater extraction for irrigation is 4197 ham. It is proposed to adopt micro irrigation (drip) techniques in fruits and vegetables (595 ha). It is assumed that 50% of this area i.e., 298 ha is irrigated by ground water. Implementation of efficient irrigation techniques will contribute in saving ground water by 37.25 ham and thus enhancing the cumulative net availability of ground water from 5292.09 ham to 5329.34 ham. Implementation of efficient irrigation techniques will contribute in saving ground water by 298 ham. Thus, will improve stage of extraction by 0.63% from 90.7% to 90.07% (**Table 18**).

5.2.2 Grey Water Utilization

As per data 111.52 ham of domestic grey water is available. It is suggested to put 50% of this grey water to secondary treatment and use the treated water either for irrigation or recharging the tanks and ponds. Thus 55.76 ham of treated sewage water can be utilized for gainful purposes thereby reducing the load on fresh groundwater. The resource enhancement by grey water use will bring the stage of extraction from 90.07% to 89.14%.

Table 18: Improvement in GW availability due to saving by adopting water use efficiency and Grey water

SI No.	Resource Details	As per 2020 Estimation
1	Cumulative Ground Water availability after implementation of artificial recharge schemes (ham)	5292.09
2	Existing Ground Water Extraction for all uses in ham	4800.35
3	Expected improvement in stage of Ground Water extraction after implementation of artificial recharge schemes	90.7%
4	Saving due to adopting Water Use Efficiency measures in ham a. Fruits & Vegetables irrigated by GW – 595 ha, CWR by surface flooding – 0.50m, CWR by drip irrigation – 0.375 m, Savings – 0.125	37.25 ham 37.25 ham
5	Additional saving by adopting Grey Water (50% of Available grey water) in ham	55.76
6	Cumulative Ground Water Availability after adopting WUE and Grey water in ham	5385.1
7	Expected improved stage of Ground Water extraction after implementation of all interventions (%)	89.14
8	Total water likely to be saved after all interventions (ham)	718.01

5.2.3 Regulation and Control

Bengaluru South taluk has been categorized as **Over Exploited**, since the Stage of ground water extraction has reached **102.86%** (GEC 2020). Hence, stringent action has to be taken up through Karnataka Ground Water Authority to control ground water exploitation in the taluk. Ground water recharge component needs to be made mandatory in the taluk to save the situation from deteriorating further.

6. SUMMARY

The main ground water issues are over exploitation, limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, deeper water levels particularly in Aquifer II in some parts, semi-urbanized areas which are all inter-related or inter dependent along with nitrate contamination in some parts. The summary of ground water management plan is given in **Table-19**.

Table 19: Summary of Management plan

Stage of GW Extraction and Category (2020)	102.86%, Over Exploited
Annual Extractable GW Resource (Ham)	4667.09
Total Extraction (Ham)	4800.35
Ground Water Draft for Irrigation (Ham)	4652.29
Ground Water Resource Enhancement by Supply side Interventions	
Non committed monsoon runoff available in (ham)	1693
No of Proposed AR structures	
PT	15
CD	90
FB	2
Expected Additional Recharge to GW due to AR (Ham)	625
Total Estimated Expenditure (Rs. in Lakhs.)	1219.964
Additional Irrigation Potential that can be created (Lakh Ha)	0.015
Change in Stage of GW Extraction (%)	102.86 to 90.7

Ground Water Resource Enhancement by Demand side Interventions	
Expected Saving due to adopting WUE measures (ham)	37.25
Change in Stage of GW Extraction (%)	90.7 to 90.07
Expected Saving by adopting Grey water re-use (ham)	55.76
Change in Stage of GW Extraction (%)	90.07 to 89.14
Cumulative Ground Water availability by adopting all interventions (ham)	5385.1
Change in Stage of GW extraction after adopting all interventions, %	102.86 to 89.14
Total water likely to be saved after all interventions (ham)	718.01

As per the resource estimation – 2020, Bengaluru South taluk falls under Over Exploited category with the stage of ground water extraction 102.86%. However, there is need to formulate management strategy to tackle the over exploitation, water scarcity related issues and nitrate contamination in the taluk. It is suggested to adopt a scientific and multi-pronged ground water management strategy covering supply side and demand side interventions aspects as mentioned in the management plan suggested above.

Ground water resource enhancement by supply side interventions: Quantity of surface water available through non-committed surface run-off is estimated to be 16.932 MCM. This can be used to recharge the aquifer through Percolation tanks (15), Check dams (90) and Filter beds (2). The volume of water expected to be recharged is 625ham through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 1219.964 lakhs. However, the figures given are tentative and pre-field studies / DPR are recommended prior to implementation of these recharge structures.

Ground water resource enhancement by demand side interventions: At present overall irrigation is by bore wells (ground water). It is proposed to adopt micro irrigation (drip) techniques in fruits and vegetables (595 ha). It is assumed that 50% of this area i.e., 298 ha is irrigated by ground water. Implementation of efficient irrigation techniques will contribute in saving ground water by 37.25 ham and thus enhancing the cumulative net availability of ground water from 5292.09 ham to 5329.34 ham. Implementation of efficient irrigation techniques will contribute in saving ground water by 37.25 ham.

Grey water utilization: As per data 111.52 ham of domestic grey water is available. It is suggested to put 50% of this grey water to secondary treatment and use the treated water either for irrigation or recharging the tanks and ponds. Thus 55.76 ham of treated sewage water can be utilized for gainful purposes thereby reducing the load on fresh groundwater.

Hence the stage of extraction is reduced from 102.86% to 89.14% (Over exploited to Semi-Critical) due to the implementation of all these supply side and demand side interventions.

A) Location details of Check dams

Sl.No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	77.50052	12.74423	Ravgodlu	Nelaguli	Bengaluru-South
2	77.50456	12.75292	K.G.Chunchagatta	Bengaluru-South	Bengaluru-South
3	77.50985	12.76386	Sunkadakatte	Somana Halli	Bengaluru-South
4	77.53397	12.76435	Vaddarahalli	Somana Halli	Bengaluru-South
5	77.48797	12.76765	K.G.Nelaguli	Nelaguli	Bengaluru-South
6	77.52183	12.77387	Doddakallasandra	Bengaluru-South	Bengaluru-South
7	77.50049	12.77829	Somanahalli	Somana Halli	Bengaluru-South
8	77.48397	12.78235	K.G.Choodanahalli	Nelaguli	Bengaluru-South
9	77.51513	12.78658	Puttenahalli	Bengaluru-South	Bengaluru-South
10	77.53164	12.78768	K.G.Tharalu	Tharalu	Bengaluru-South
11	77.49339	12.79013	Hongasandra	Bengaluru-South	Bengaluru-South
12	77.50366	12.80300	K.G.Kaggalipura	Kaggalipura	Bengaluru-South
13	77.52475	12.80624	K.G.Kadirenahalli	Bengaluru-South	Bengaluru-South
14	77.48872	12.80745	Uttari	Kaggalipura	Bengaluru-South
15	77.51064	12.80874	Lingadeeranahalli	Bengaluru-South	Bengaluru-South
16	77.53630	12.81488	K.G.Gulakamale	Tharalu	Bengaluru-South
17	77.47091	12.81658	Chinna Kuruchi	K. Gollahalli	Bengaluru-South
18	77.51779	12.81867	O.B.Choodahalli	Kaggalipura	Bengaluru-South
19	77.50275	12.82158	K.G.Kaggalipura	Kaggalipura	Bengaluru-South
20	77.44585	12.83567	Gonipura	K. Gollahalli	Bengaluru-South
21	77.51214	12.83583	Agara	Agara	Bengaluru-South
22	77.48791	12.83614	Agara	Agara	Bengaluru-South
23	77.52199	12.83656	Badamanavarthekeval	Agara	Bengaluru-South
24	77.45860	12.84159	K.G.Vasanthanahalli	K. Gollahalli	Bengaluru-South
25	77.57835	12.84179	Sarakki	Bengaluru-South	Bengaluru-South
26	77.52178	12.84206	J.I.Halage Vaderahalli	Bengaluru-South	Bengaluru-South
27	77.59118	12.84248	Karisandra	Bengaluru-South	Bengaluru-South
28	77.49632	12.84490	Hongasandra	Bengaluru-South	Bengaluru-South
29	77.56323	12.84689	Thurahalli	Bengaluru-South	Bengaluru-South
30	77.65357	12.84879	Doddathoguru	Dodda Thoguru	Bengaluru-South
31	77.60316	12.85073	J.I.Kammanahalli	Bengaluru-South	Bengaluru-South
32	77.50715	12.85104	Badamanavarthekeval	Agara	Bengaluru-South
33	77.61928	12.85416	Mylasandra	Dodda Thoguru	Bengaluru-South
34	77.44603	12.85432	Kumbalagodu Gollahalli	K. Gollahalli	Bengaluru-South
35	77.46978	12.85445	Devagere	K. Gollahalli	Bengaluru-South
36	77.48895	12.85517	Badamanavarthekeval	Agara	Bengaluru-South
37	77.53244	12.85869	Thalagattapura	Bengaluru-South	Bengaluru-South
38	77.46454	12.86448	Gubbalalu	Bengaluru-South	Bengaluru-South
39	77.67820	12.86469	Doddanagamangala	Konappana Agrahaara	Bengaluru-South
40	77.43573	12.86685	Bilekahalli	Bengaluru-South	Bengaluru-South

41	77.50793	12.86709	Nayandahalli	Bengaluru-South	Bengaluru-South
42	77.37711	12.87026	Dodderi	Chikkana Halli	Bengaluru-South
43	77.49079	12.87218	Varahasandra	Bengaluru-South	Bengaluru-South
44	77.35048	12.87552	Chikkanahalli	Chikkana Halli	Bengaluru-South
45	77.39114	12.87624	Dodderi	Chikkana Halli	Bengaluru-South
46	77.41412	12.87961	Koluru	Chunchana Kuppe	Bengaluru-South
47	77.37646	12.88058	A dugodi	Bengaluru-South	Bengaluru-South
48	77.44008	12.88163	Kumbalagodu	Kumbalagodu	Bengaluru-South
49	77.40215	12.88368	Gottigere	Bengaluru-South	Bengaluru-South
50	77.46781	12.88597	K.G.Kambipura	Kumbalagodu	Bengaluru-South
51	77.35762	12.88967	Beraten A Agrahara	Bengaluru-South	Bengaluru-South
52	77.41681	12.89114	Hulimavu	Bengaluru-South	Bengaluru-South
53	77.49391	12.89224	Hemmigepura	Bengaluru-South	Bengaluru-South
54	77.38904	12.89490	Chunchanakuppe	Chunchana Kuppe	Bengaluru-South
55	77.46475	12.90004	Kengeri	Bengaluru-South	Bengaluru-South
56	77.37492	12.90059	Byalalu	Ajjanahalli	Bengaluru-South
57	77.41332	12.90185	Ramohalli	Ramohalli	Bengaluru-South
58	77.40177	12.90272	Basapura	Bengaluru-South	Bengaluru-South
59	77.35952	12.90377	Soolivara	Chikkana Halli	Bengaluru-South
60	77.34706	12.90517	K.G.Kalena Agrahara	Bengaluru-South	Bengaluru-South
61	77.42034	12.90685	Ittamadu	Bengaluru-South	Bengaluru-South
62	77.43051	12.91173	Ramohalli	Ramohalli	Bengaluru-South
63	77.49485	12.91338	Mylasandra	Bengaluru-South	Bengaluru-South
64	77.40021	12.91631	Ganapathihalli	Chunchana Kuppe	Bengaluru-South
65	77.36305	12.91729	Anjanapura	Bengaluru-South	Bengaluru-South
66	77.39127	12.91787	J.I.Kembatthahalli	Bengaluru-South	Bengaluru-South
67	77.44669	12.92162	Kommagatta	Soolikere	Bengaluru-South
68	77.37797	12.92225	Ajjanapalya	Ajjanahalli	Bengaluru-South
69	77.49244	12.92775	Valagerahalli	Bengaluru-South	Bengaluru-South
70	77.40553	12.92882	Karigiripura	Chunchana Kuppe	Bengaluru-South
71	77.37594	12.92971	Byrasandra	Bengaluru-South	Bengaluru-South
72	77.36125	12.93024	Madhapatna	Ajjanahalli	Bengaluru-South
73	77.34172	12.93510	Madhapatna	Ajjanahalli	Bengaluru-South
74	77.47465	12.93754	Ramasandra	Soolikere	Bengaluru-South
75	77.43080	12.93891	Maragondanahalli Krishnasagara	Ramohalli	Bengaluru-South
76	77.39019	12.93900	Tavarekere	Thavarekere	Bengaluru-South
77	77.44981	12.94095	Sulikere	Soolikere	Bengaluru-South
78	77.40962	12.94455	Tavarekere	Thavarekere	Bengaluru-South
79	77.35586	12.94678	Cholanayakanahalli	Cholanayakana Halli	Bengaluru-South
80	77.34000	12.95004	Singasandra	Bengaluru-South	Bengaluru-South
81	77.41262	12.95419	K.G.Raghavanapalya	Bengaluru-South	Bengaluru-South
82	77.39587	12.95830	Begur	Bengaluru-South	Bengaluru-South
83	77.37688	12.96135	K.G.Ganakallu	Cholanayakana Halli	Bengaluru-South
84	77.36520	12.96139	K.G.Nyanappanashetty Palya	Bengaluru-South	Bengaluru-South

85	77.34509	12.96491	K.G.Gangappanahalli	Cholanayakana Halli	Bengaluru-South
86	77.38521	12.96577	Vittasandra	Dodda Thoguru	Bengaluru-South
87	77.43399	12.96835	Channenahalli	Channena Halli	Bengaluru-South
88	77.39586	12.97551	Konappana Agrahara	Konappana Agrahaara	Bengaluru-South
89	77.40560	12.98260	Varthuru	Cholanayakana Halli	Bengaluru-South
90	77.37860	12.98895	K.G.Gangenahalli	Cholanayakana Halli	Bengaluru-South

B) Location details of Percolation tanks

Sl.No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	77.52151	12.74910	Vaddarahalli	Somana Halli	Bengaluru-South
2	77.49214	12.82086	Uttari	Kaggalipura	Bengaluru-South
3	77.61019	12.84445	K.G.Hommadevanahalli	Dodda Thoguru	Bengaluru-South
4	77.52133	12.85134	Uttarahalli Manavarthekeval	Agara	Bengaluru-South
5	77.47041	12.86565	Badamanavarthekeval	Agara	Bengaluru-South
6	77.50659	12.88830	Hemmigepura	Bengaluru-South	Bengaluru-South
7	77.39832	12.89429	Kethohalli Ramapura	Chunchana Kuppe	Bengaluru-South
8	77.43468	12.89541	Tavarekere	Bengaluru-South	Bengaluru-South
9	77.39523	12.92904	Singasandra	Bengaluru-South	Bengaluru-South
10	77.37491	12.93849	Puradhapalya	Chunchana Kuppe	Bengaluru-South
11	77.44318	12.94069	Vaddarapalya	Bengaluru-South	Bengaluru-South
12	77.39897	12.95026	K.G.Vajarahalli	Bengaluru-South	Bengaluru-South
13	77.38661	12.95122	Kengeri	Bengaluru-South	Bengaluru-South
14	77.41022	12.96685	K.G.Kurubarahalli	Channena Halli	Bengaluru-South
15	77.37253	12.97386	Devamachanahalli	Cholanayakana Halli	Bengaluru-South

C) Location details of Filter beds

Sl.No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	77.52789	12.76306	Thurahalli	Bengaluru-South	Bengaluru-South
2	77.36774	12.94947	Puradhapalya	Chunchana Kuppe	Bengaluru-South