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

Bhalki Taluk, Bidar District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु
South Western Region, Bengaluru

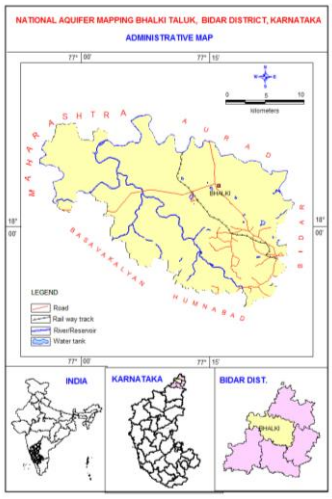
FOR OFFICIAL USE ONLY
No. SWR/RP/NQM/2022-23/16

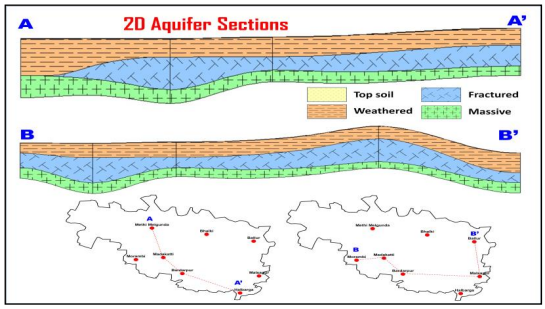
भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
एवं गंगा संरक्षण विभाग
केन्द्रीय भूमिजल बोर्ड
दक्षिण पश्चिम क्षेत्र, बेंगलुरु

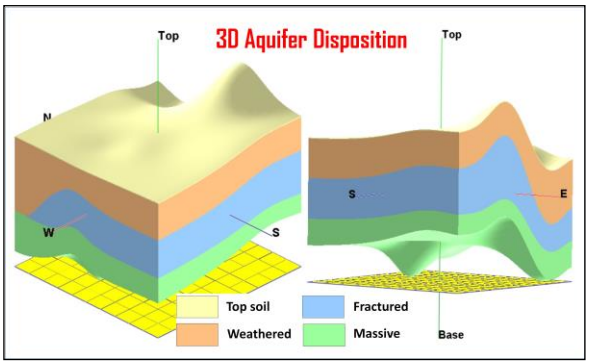
Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development &
Ganga Rejuvenation
Central Ground Water Board
South Western Region, Bengaluru

AQUIFER MAPS AND MANAGEMENT PLAN, BHALKI TALUK, BIDAR DISTRICT, KARNATAKA STATE

(AAP – 2021-2022)







By

Dr.J.DAVITHURAJ

Scientist-B, CGWB, SWR, Bengaluru

AUGUST 2022

AQUIFER MAPS AND MANAGEMENT PLAN, BHALKI TALUK, BIDAR DISTRICT, KARNATAKA STATE

(AAP – 2021-2022)

Contents

1 SALIENT FEATURES 1
1.1 Study Area 1
1.4 Agriculture & Irrigation 4
1.5 Geomorphology, Physiography & Drainage 5
1.6 Soil 6
1.7 Ground water resource availability and extraction 6
1.8 Existing and future water demands (as per GEC-2017 and 2020) 7
1.9 Water level behavior 7
2 AQUIFERDISPOSITION.....10
2.1 Aquifer types 10
3 Ground water resource, extraction, contamination and other issues 13
3.1 Comparison of Ground Water Resource and Extraction 13
3.2 Chemical quality of ground water and contamination 14
4 GROUND WATER RESOURCE ENHANCEMENT 16
4.1 Resource Enhancement by Supply Side Interventions 16
4.2 DEMAND SIDE INTERVENTIONS 18
4.2.1 Water Use Efficiency by Micro Irrigation Practices 18
4.2.2 Change in cropping pattern 19
4.2.3 Regulation and Control 19
5.0 Summary and Recommendations 20

AQUIFER MAPS AND MANAGEMENT PLAN OF BHALKI TALUK, BIDAR DISTRICT, KARNATAKA STATE

1 SALIENT FEATURES

Name of the taluk: **BHALKI**

District: **BIDAR**

State: Karnataka

Area: 1092.59 sq.km.

Population: 2,77,350

Annual Normal Rainfall: 872 mm

1.1 Study Area

Aquifer Mapping Studies have been carried out in Bhalki taluk, Bidar district of Karnataka, covering an area of 1092.59 sq.kms under National Aquifer Mapping programme. The Bhalki taluk is located between North Latitudes 17°51'16.2'' and 18°12'24.48" and East Longitudes between 76° 55' 11.64" to 77°24'054.72" and is falling in Survey of India Toposheets No forms parts of 56G/1, 56G/5, 56F/4 56F/8 and 56B/16. The study area is bounded on the North by Aurad taluk, on the South by Basvakalyan and Humnabad taluks, on the East by Bidar taluk, on the West by Mahrastra state. Location map of Bhalki taluk of Bidar district is presented in **Fig-1**. Bhalki is taluk head quarter. There are 133 villages and 40 gram panchayats in this taluk.

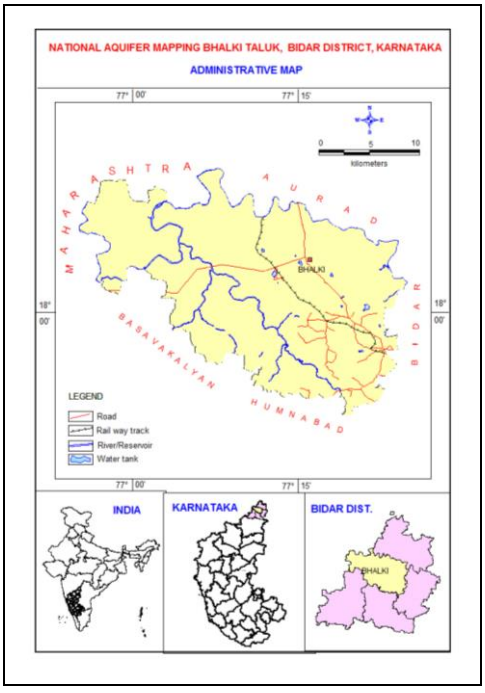


Fig-1: Location map

1.2 Population

According to 2011 census, the population in Bhalki taluk is 2,77,350. Out of which 1,41,603 are males while 1,35,747are females. The average sex ratio of Bhalki taluk is 959. The Bhalki taluk has an overall population density of 248 persons per sq.km. The decadal variation in population from 2001-2011 is 7.90% in Bhalki taluk. Details of Population of Bhalki taluk is given in **Table-1**.

Table-1.Details of Population of Bhalki taluk, Bidar district

Male	Female	SC	ST	TOTAL	No. of Villges	No. of GPs	Literacy %	Density
141603	135747	70166	29009	277350	133	40	71.56	248

Source: Bidar District website, Govt. of Karnataka

1.3 Rainfall

Bhalki taluk experiences semi arid climate with extreme summer and falls under North-East Transitional Agro-Climatic Zone. The dust storms and severe heat waves are common in the taluk between April and May. The normal annual rainfall in Bhalki taluk for the period 1981 to 2010 is 872 mm. Seasonal rainfall pattern indicates that, major amount of 716 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 82% of the annual normal rainfall, followed by North-East Monsoon season (129 mm) constituting 15% and remaining (70 mm) 3% in Pre-Monsoon season **(Table-2).**

Computations were carried out for the 30 year blocks of 1981-2010, the mean monthly rainfall at Bhalki taluk is ranging between 4 mm during Feburary to 213 mm during August. The coefficient of variation percent for pre-monsoon, monsoon and post-monsoon season is 88, 28 & 78 percent respectively. Annual Co-efficient Variation at this taluk works out to be 22 percent **(Table-2).**

Table-2: Statistical Analysis of Rainfall Data of Bhalki taluk, Bidar district (1981 to 2010)

STATION		JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
BHALKI	NRM	7	4	13	19	27	70	118	171	213	170	716	102	21	6	129	872
	STDEV	16	7	23	22	49	62	85	116	109	100	198	88	36	11	101	191
	CV%	225	201	173	116	178	88	72	68	51	59	28	86	170	184	78	22

The annual rainfall data from 2009 to 2018 of the Bhalki taluk is collected from the District statistical office, Bidar and is given in Table.3. The rainfall trend for the period from 2009 to 2018 and probability occurrence of rainfall of the taluk are shown in Fig.2 & Fig-3 respectively.

Table-3 Actual Annual Rainfall of Bhalki taluk from 2009 to 2018

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall (mm)	555	920	698	711	1023	577	565	1240	794	540

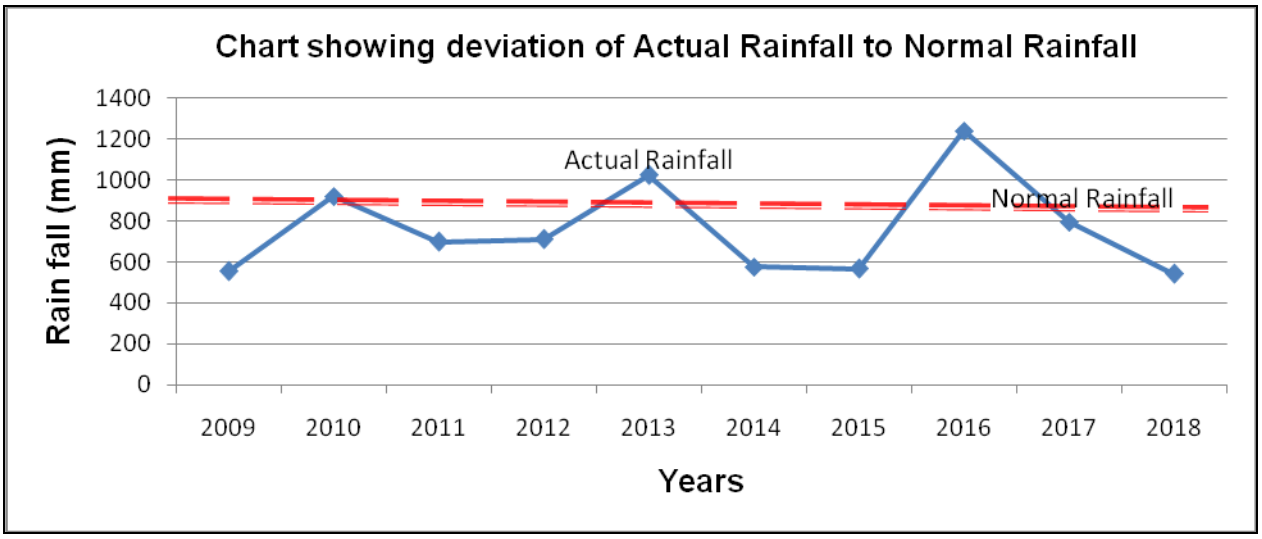


Fig-2. Rainfall trend in Bhalki taluk of Bidar district

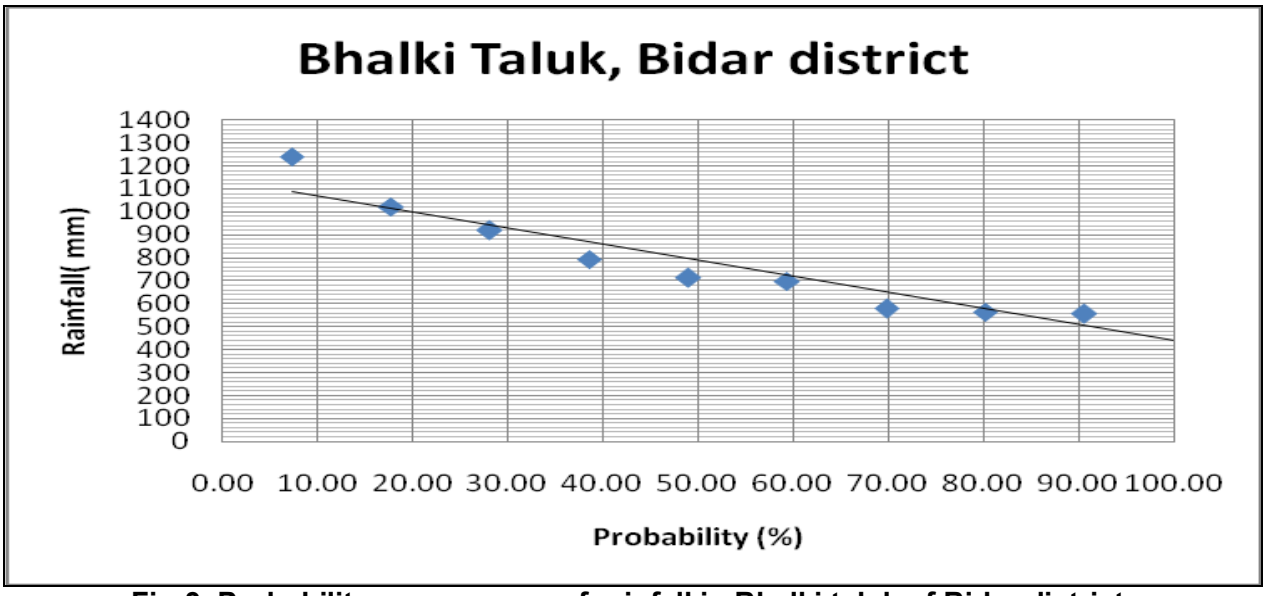


Fig-3. Probability occurrences of rainfall in Bhalki taluk of Bidar district

The rainfall pattern in the Bhalki taluk reveals the irregularity of rainfall behavior **(Fig-2)** and the rainfall varies from 540 mm to 1240 mm **(Table-3).** The normal annual rainfall of Bhalki taluk is 872mm. Bhalki taluk received rainfall above normal during the years 2010, 2013 and 2016.

Probability anlaysis of rainfall for the years from 2009 to 2019 **(Fig-3),** indicating that 680 mm rainfall is sure to occur in 70% in the taluk. The dependable rainfall of 680 mm can be used for construction of any ground water recharge structures in this taluk area.

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Bhalki taluk nearly 70% of working population is engaged in agriculture. Two cropping seasons namely, Kharif (June to September) and Rabi (October to March). Sugar Cane (water intensive crop) is the main commercial crop of the taluk and nearly 5 % of the net area sown is covered. Other principal crops are Jowar, soya beans, red gram, , Black gram, Green gram, Bengal gram, wheat, horse gram etc **(Table-4).** Jowar is grown in 10 % and oil seeds in 45% of total crop area of the taluk.

Table-4: Cropping pattern in Bhalki taluk 2018-2019 (Ha)

Year	Paddy	Jowar	Bajara	Total cereals and minor milletes	Wheat	Pulses	Fruits	Oil seeds	Sugarcane	Cotton
	Area under cultivation (in ha)									
2018-2019	5.0	8718	-	9350	627	63724	144	38271	4207	-

It is observed that net sown area accounts 76% and area sown more than once is 30% of total geographical area in Bhalki taluk **(Table-5).** Area not available for cultivation and Fallow land cover 5% &6% of total geographical area respectively. 76% of net area irrigated is from bore wells and dug wells **(Table-6).**

Table-5: Details of land use in Bhalki taluk 2018-2019 (Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Un cultivable land	Fallow land	Net sown area	Area sown more than once
Bhalki	109259	2584	5871	13946	6837	83421	32701

Source: District at a glance 2018-19, Govt. of Karnataka

Table-6: Irrigation details in Bhalki taluk

Source of Irrigation	Net area irrigated (Ha)
Canals	632
Tanks	62
Wells	1913
Bore wells	2961
Lift Irrigation	860
Other Sources	-
Total	**6428**

Source: District at a glance 2018-19, Govt. of Karnataka

1.5 Geomorphology, Physiography & Drainage

Geomorphology of Bhalki comprises of dissected Deccan plateau. The ground altitudes are varying from 540 to 684 meter above MSL. The ground surface is flat, gently sloping forming broad valleys and flat topped hills. Flat topped hills with step like sides exhibit the terraced landscape.

The taluk falls within Godavari river basin with three minor sub-basins. The important rivers are Manjara, Chulki and Karanja. The river Manjara flows in the northern part of the taluk, eastwards along the meandering course and forms the natural boundary between Bhalki and adjoining Aurad taluk. The river Karanja enters the taluk in south-eastern parts and flows in north-west direction and joins the river Manjara near Naudi Sangam, Chulki nala enters the taluk in south-western parts and joins the river Karanja, near Inchur village. Beside these, there are various minor non-perennial nalas. The drainage pattern in the taluk varies from sub-dendritic to dendritic pattern **(Fig.-5).** This has its bearing on the regional slope which is towards North West. 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.

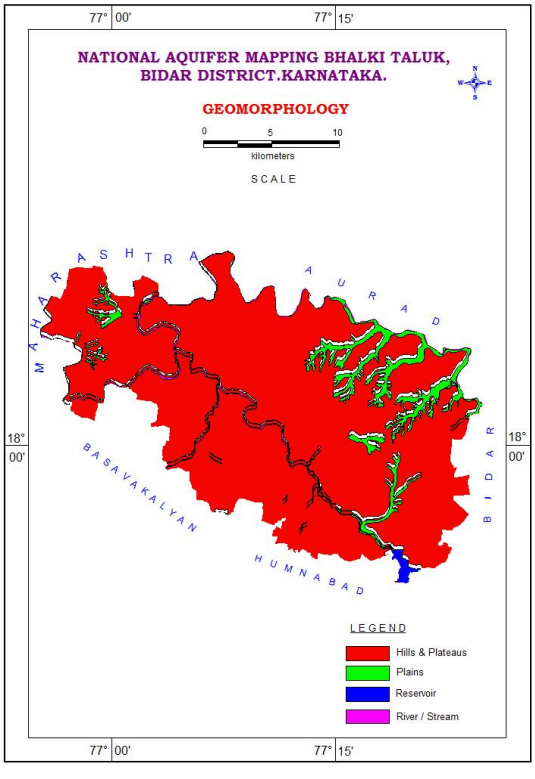


Fig-4: Geomorphology Map

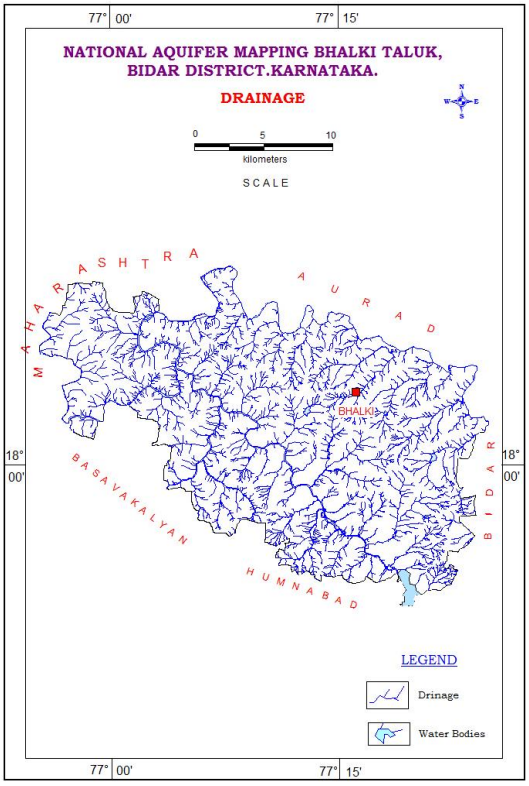


Fig-5: Drainage Map

1.6 Soil

There are three types of soils noticed in the taluk are black soils, red soils and lateritic soils. Major parts of the taluk are made up of black soils derived from Deccan traps. These are deep black in colour and their texture varies from loam to clay. Lime concentration in this soil is high resulting in poor infiltration capacities. Red soils are pale to bright red in colour and clay to clayey loam in nature. This soil has moderate to good infiltration characteristics. A lateritic soil is confined to extreme south-eastern portion of the taluk **(Fig-6).**

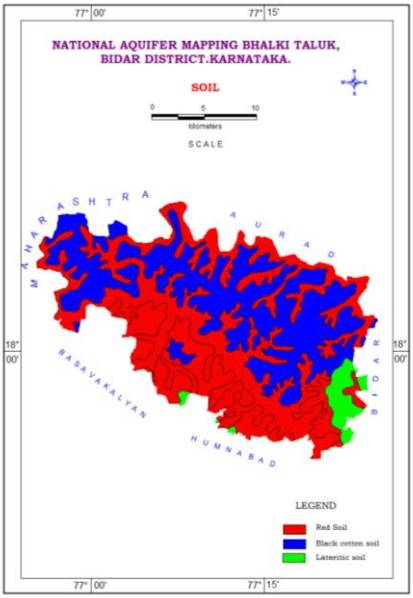


Fig-6: Soil Map

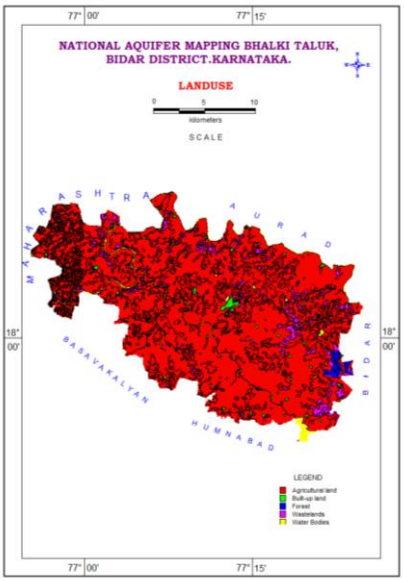


Fig-7: Land use Map

1.7 Ground water resource availability and extraction

As per the ground water resource estimation 2017 (**Table 7a**), the data on ground water resources shows that the net annual ground water availability is 11571 ham. The existing gross groundwater for irrigation is 8104 ham. The stage of groundwater development is 71% and falling under 'Semi-Critical' category.

Aquifer wise total ground water resources up to 200 m depth is given in **Table-7b** below.

Table.7a Dynamic Ground Water Resource, (March 2017 Figures in Ham)

Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross GW 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 Develop-ment	Existing Stage of Ground Water Development	Category
11571	8104	84	8188	92	3429	71	Semi-Critical

Table-7b:Total Ground Water Resources (2017) (Ham)

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
BHALKI	11571	Phreatic	Fractured (Down to 200m)	Dynamic + phreatic in-storage + fractured
		12548	3320	27439

1.8 Existing and future water demands (as per GEC-2017 and 2020)

As per the GWRA 2017, the net ground water availability is 11571 ham and the total ground water draft for all uses is 8188 ham with stage of development at 71% and the taluk falls in Semi-Critical category and there is a scope for future irrigation development @ 3429 ham. The domestic (Industrial sector) demand for next 25 years is estimated at 92 ham.

The details of dynamic ground water resources as on March 2020 is shown in **Table-7c**. It is observed that the stage of ground water extraction is almost same and only one percent decrease in stage of extraction.

Table.7c Detail of Dynamic Ground Water resource, (as on March 2020)

Annual Extractable GW Resource (Ham)	GW Extraction for Irrigation Use (Ham)	GW Extraction for Industrial Use (Ham)	GW Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net GW Availability for future use (Ham)	Stage of GW Extraction (%)	Categorization (Over-Exploited/ Critical/ Semi-critical/ Safe/Saline)
6146.84	4033.90	0.00	274.50	4308.41	295.81	1836.12	70.09	Semi-Critical

1.9 Water level behavior

(a) Depth to water level

Aquifer-I

- Pre-monsoon: 2.97 – 17.86 mbgl (Fig.-8)
- Post-monsoon: 1.94 – 15.70 mbgl (Fig.-9)

Aquifer-II

- Pre-monsoon: 18.80 – 54.80 mbgl
- Post-monsoon: 13.45 – 47.0 mbgl

(b) Water level fluctuation

Aquifer-I

- Seasonal Fluctuation: Rise ranges 1.03 – 7.95 m (Fig.-10).

Aquifer-II

- Seasonal Fluctuation: Rise ranges 5.05 – 7.8 m.

(c) Long-Term Water level trend

- Pre-monsoon: Falling ranges 0.001 – 0.4178 m (Fig-11)

  Rising ranges 0.070 – 0.439 m

- Post-monsoon: Falling ranges 0.0139 – 0.8021 m (Fig-12)

  Rising ranges 0.2713 – 1.4404 m

Table-8: Depth to water level for pre-monsoon and post-monsoon

Sr. No	Village	Source	Pre-monsoon Depth to water May-2019 (mbgl)	Post-monsoon Depth to water Nov-2019 (mbgl)	Water level Fluctuation
	Aquifer-I				
1	Bhalki	Dug Well	13.62	8.82	4.8
2	Bhatambra	Dug Well	15.19	7.24	7.95
3	Halburga	Dug Well	8.79	7.39	1.4
4	Helsi	Dug Well	6.75	5.10	1.65
5	Saigaon	Dug Well	2.97	1.94	1.03
6	Inchur	Dug Well	9.90	5.75	4.15
7	Jamakhandi	Dug Well	17.50	13.00	4.5
8	Khanapur	Dug Well	17.86	15.70	2.16
9	Kotagaiwadi	Dug Well	6.88	2.56	4.32
Aquifer-II					
10	Byalahalli	Bore well	21.70	16.65	5.05
11	Halbarga	Bore well	22.80	16.00	6.8
12	Bhalki	Bore well	54.80	47.00	7.8
13	Kotgyal	Bore well	18.80	13.45	5.35

Table–9 Long Term Water Level Trends (Based on CGWB's National Hydrograph Stations).

Sl. No.	Location	Period of observation	Water level trend m/year				Aquifer
			Pre monsoon		Post monsoon		
			Fall	Rise	Fall	Rise	
1	Bhalki(pz)	2010-2019	0.4178	-	0.8021	-	Basalt
2	Bhalki	2010-2019	-	0.439	-	1.4401	Basalt
3	Bhatambra	2010-2019	-	0.070	-	0.3834	Basalt
4	Halburga	2010-2019	0.001	-	-	0.2713	Basalt
5	Helsi	2010-2019	0.0058	-	0.2775	-	Basalt
6	Saigaon	2010-2019	0.2991	-	0.0139	-	Basalt
7	Kotagaiwadi	2010-2019	0.0064	-	0.2061	-	Basalt
8	Khanapur	2010-2019	0.1300	-	0.1903	-	Laterite

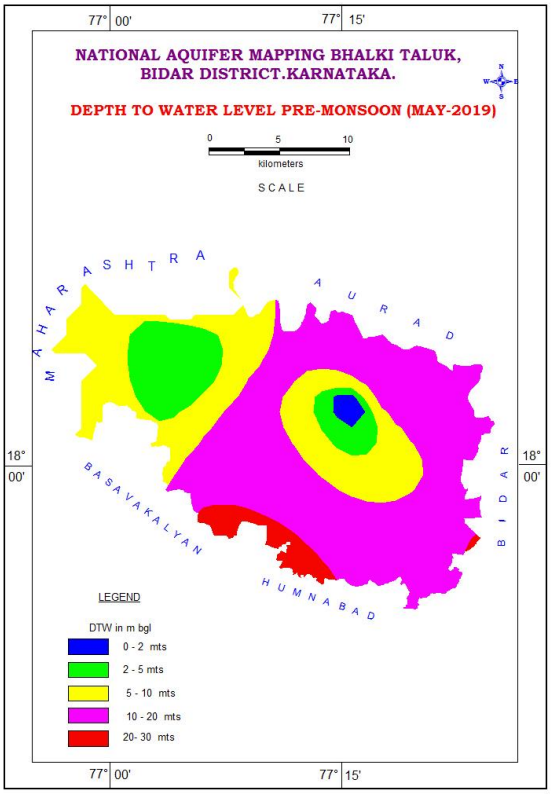


Fig-8: Pre-monsoon Depth to Water Level

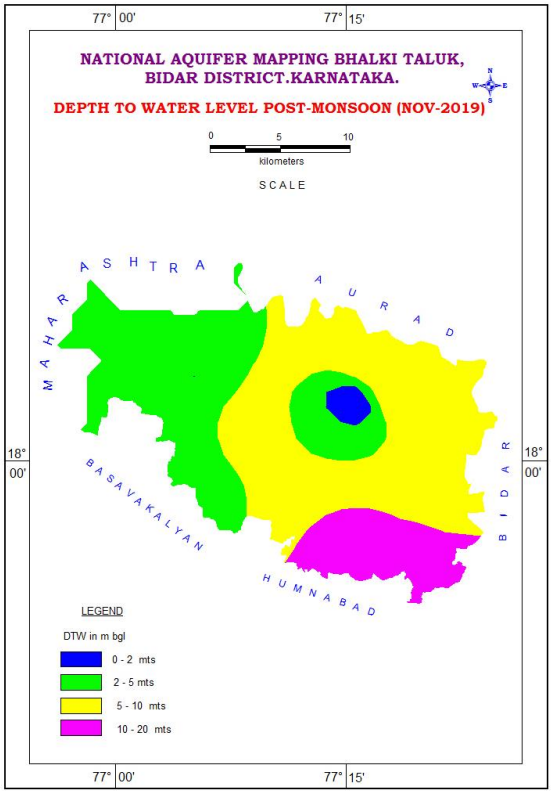


Fig-9: Post-monsoon Depth to Water Level

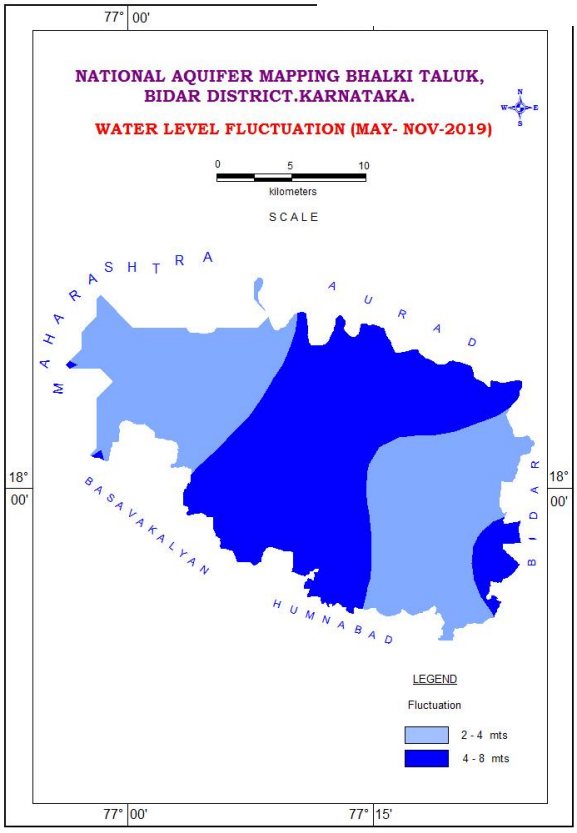


Fig-10: Water Level Fluctuation (Aq-I)

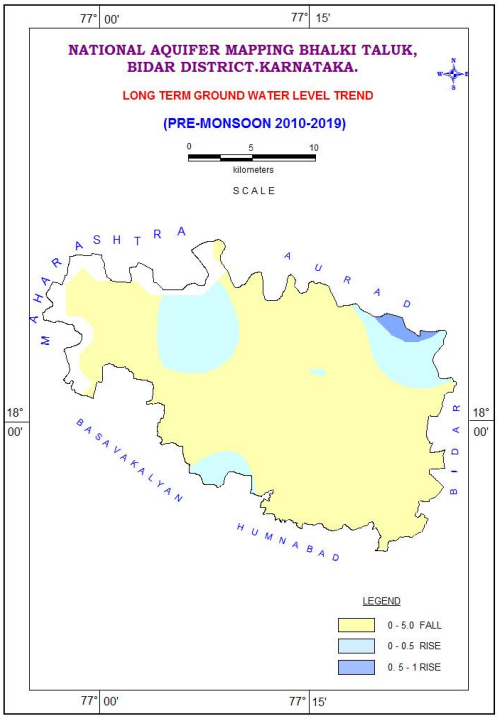


Fig-11: Pre-monsoon Long-Term Water Level Trend(m/year)

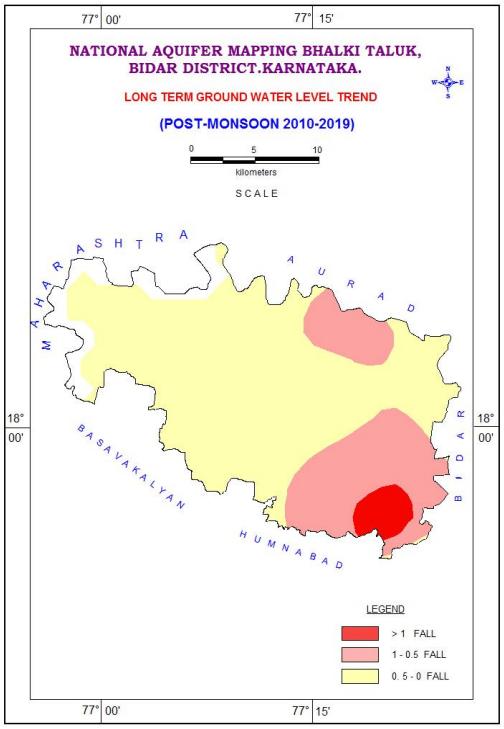


Fig-12: Post-monsoon Long-Term Water Level Trend(m/year)

2 AQUIFER DISPOSITION

2.1 Aquifer types

In Bhalki taluk, there are two types of Basaltic aquifer systems;

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

Bhalki taluk is mainly composed of Deccan Trap. In the eastern parts a thick spread of laterite forms an elevated plateau, 600 m above MSL. Deccan Traps consist of successive lava flows, mainly basaltic in composition (Massive basalt and Vesicular basalt). Basalt and laterite are the main water bearing formations **(Fig-13).** Ground water occurs within the weathered and fractured basalt under water table condition and semi-confined condition. The size and inter connectivity of vesicles, the joint patterns and intertrappean beds control occurrence and movement of water in Basalts. The porous laterite capping generally as shallow aquifer (dug wells) and yield good quantity of water for short duration.

In Bhalki taluk bore wells were drilled from a minimum depth of 58.45 mbgl to a maximum of 300 mbgl. Depth of weathered zone ranges from 6.0 mbgl to 18 mbgl. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depths of 40 to 260

mbgl. Yield ranges from 0.20 to 11.0 lps. The basic characteristics of each aquifer are summarized in **Table-11.**

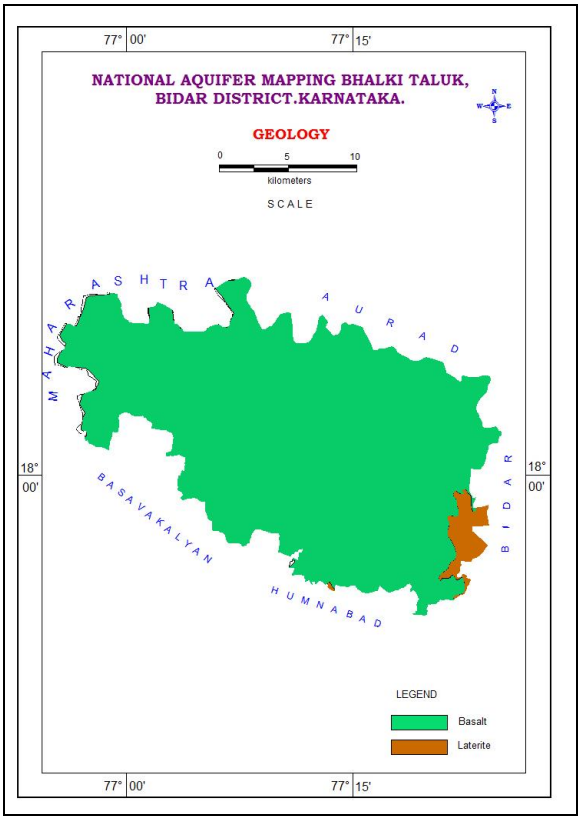


Fig-13: Geology Map

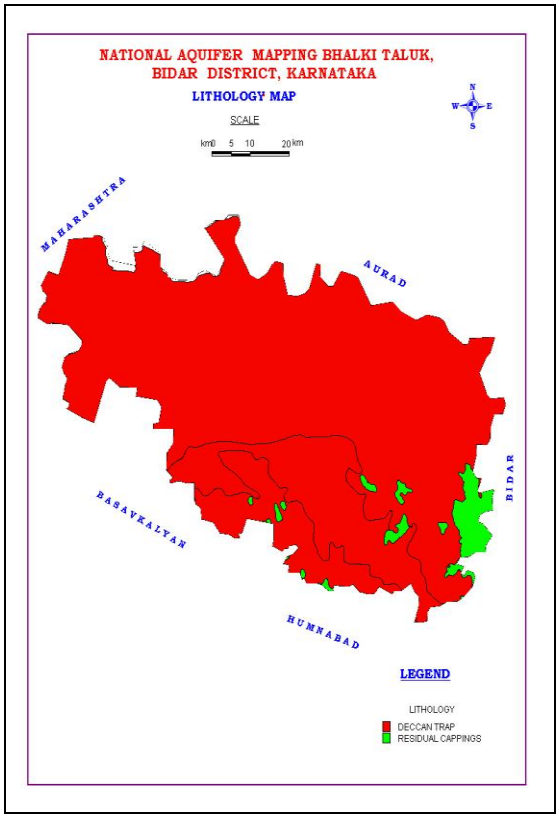


Fig-14: Lithology Map

Table-10: Details of Ground Water Exploration

S.No	Location	Lat &Long	Depth m bgl	Casing (m)	Lithology	SWL (mbgl)	Q (lps)	DD (m)	T (m^2/day)
1	Ballur-EW	18°03'05" 77° 21' 45"	202.2	16.0	Basalt/ Pink Granite	27.62	4.97	14.13	12.68
2	Ballur-OW	18°03'05" 77° 21' 45"	142.5	6.00	Basalt	29.53	4.58	10.13	17.25
3	Methi Melgunda-EW	18°05'45" 77° 07'30"	190.0	6.0	Basalt	35.58	4.15	6.55	21.28
4	Methi Melgunda-OW	17°05'45" 77° 07'30"	186.7	6.00	Basalt	35.64	4.55	10.03	12.81
5	Madakatti	17°59'45" 77° 09' 05"	300.2	14.6	Basalt/ Pink Granite	47.81	0.43	-	-
6	Malsapur	17° 56' 00" 77° 22' 30"	242.3	18.0	Basalt	79.94	1.19	-	5.77
7	Bardarpur	17^0 56' 30" 77^0 11' 45"	178.2	11.6	Basalt	2.70	2.07	34.2	-
8	Halbarga-EW	17^0 49' 30" 77^0 19' 32"	202.5	15.0	Basalt	5.82	3.77	23.55	-

9	Halbarga-OW	17^0 49' 30'' 77^0 19' 32''	117.0	15.0	Basalt	5.63	3.75	8.81	-
10	Morambi-EW	17^0 59' 30'' 77^0 05' 15''	57.15	16.0	Basalt	1.84	20.0	2.68	
11	Morambi-OW	17^0 59' 30'' 77^0 05' 15''	58.45	16.4	Basalt	0.59	11.0	1.51	-
12	Bhalki	18°02'30'' 77° 12'00''	98.6	12.0	Basalt	40.50	0.07	-	-

Table-11: Basic characteristics of each aquifer

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Laterite and Weathered Basalt	Fractured / Jointed Basalt and Granite
Thickness range (mbgl)	3-10	Fractures upto 260 mbgl
Depth range of occurrence of fractures (mbgl)	-	17-260
Range of yield potential (lps)	<1-3	<1 – 8
Specific Yield	2%	0.2%
T (m^2/day)	-	5.77-21.28
Quality Suitability for Domestic &Irrigation	Suitable	Suitable

2.2 3 D aquifer disposition and Cross-Sections

(A) Aquifer disposition – Rockworks output (Fig.-15 to Fig.-17)

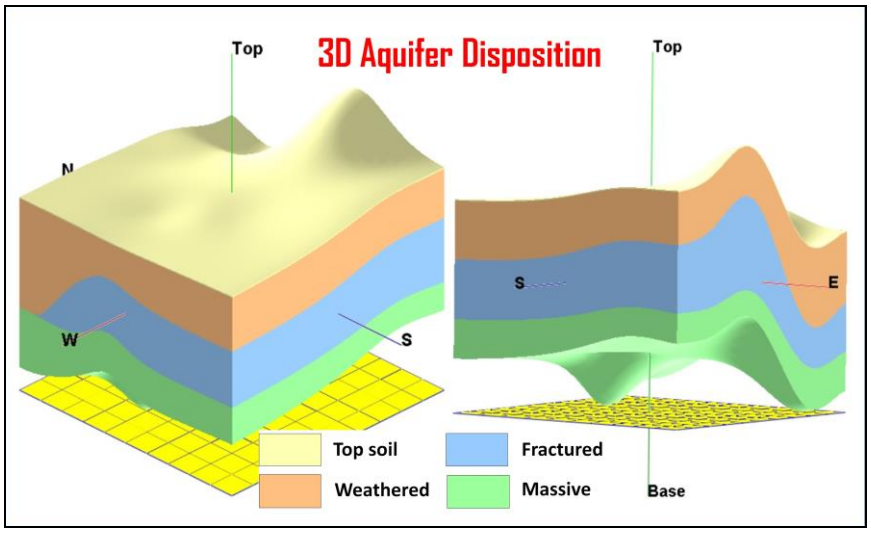


Fig-15: 3D aquifer Disposition

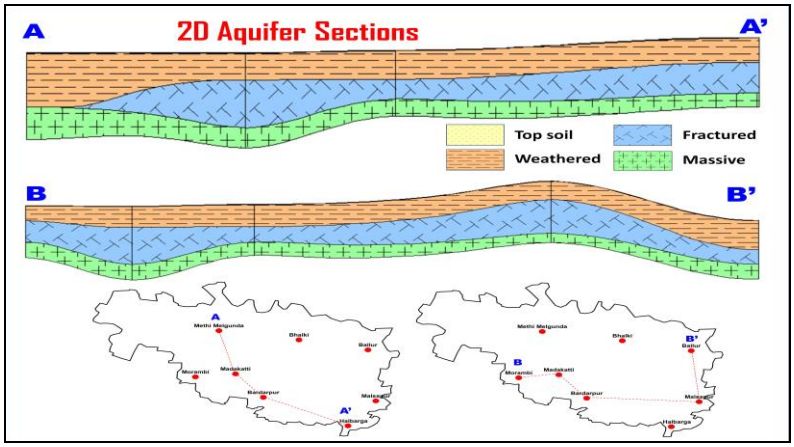


Fig-16: Cross sections in different directions

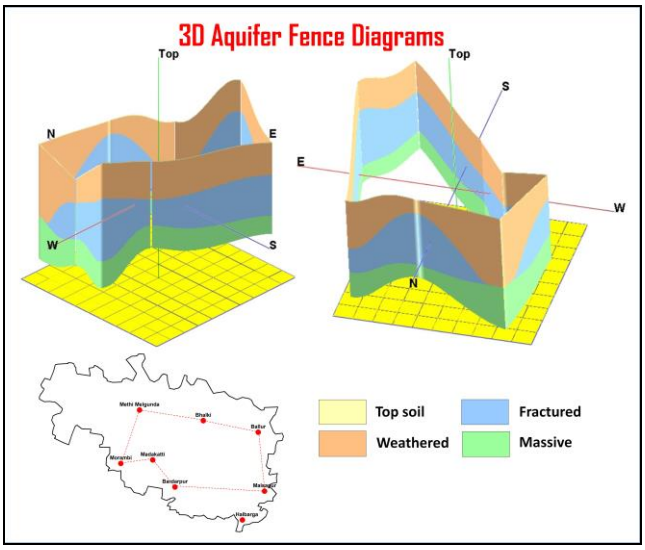


Fig-17: 3D Aquifer Fence Diagram

3 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.

3.1 Comparison of Ground Water Resource and Extraction

The Dynamic Ground Water Resource 2017 and as on 2020 have already been summarised above and are shown in **Table 12**. It is observed that the ground water availability in 2020 and in 2017 is not much difference. 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 12:Comparison of ground water availability and draft scenario in Bhalki taluk

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 (%)
	2011			2013			2017			2020		
BHALKI	9262	7515	81	9378	8125	87	11571	8188	71	6146.84	4308.11	70.09

3.2 Chemical quality of ground water and contamination

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

ELECTRICAL CONDUCTIVITY: In general, EC values range from 727 to 1637 µ/mhos/cm in the aquifer-I at 25ºC (Fig-18) and range from 140 to 760 µ/mhos/cm in the aquifer-II.

CHLORIDE: Chloride concentration in ground water ranges between 64 and 214 mg/l in the aquifer-I (Fig-19))and ranges between 14 and 142 mg/l in the aquifer-II.

NITRATE: Nitrate concentration in ground water ranges from 9.0 and 147.0 mg/l in the Aquifer – I (Fig-20) and ranges from 7.0 and 26.0 mg/l in the Aquifer –II .

FLUORIDE: Fluoride concentration in ground water ranges between 0.45 and 0.94 mg/l in the aquifer-I (Fig-21) and ranges between 0.10 and 2.7 mg/l in the aquifer-II .

Table-13: Quality of ground water in Bhalki taluk of Bidar district

Sr_No	LOCATION	PH	EC	Cl	NO3	F
Aquifer-I						
1	Bhalki	7.94	1127	214	39	0.453
2	Bhatambra	8.13	1047	178	25	0.560
3	Halburga	7.93	727	64	44	0.730
4	Helsi	7.50	1637	88	*147*	0.604
5	Saigaon	7.77	761	92	9	0.943
6	Kotagawadi	8.40	603	85	7.18	*2.14*
7	Khanapur	8.03	573	51	*62*	0.96
Aquifer-II						
8	Ballur	7.6	630	128	7	1.25
9	Methi Melgunda	7.7	680	142	9	0.6
10	Madakatti	8.2	760	106	26	2.7
11	Malsapur	7.8	140	14	22	0.1

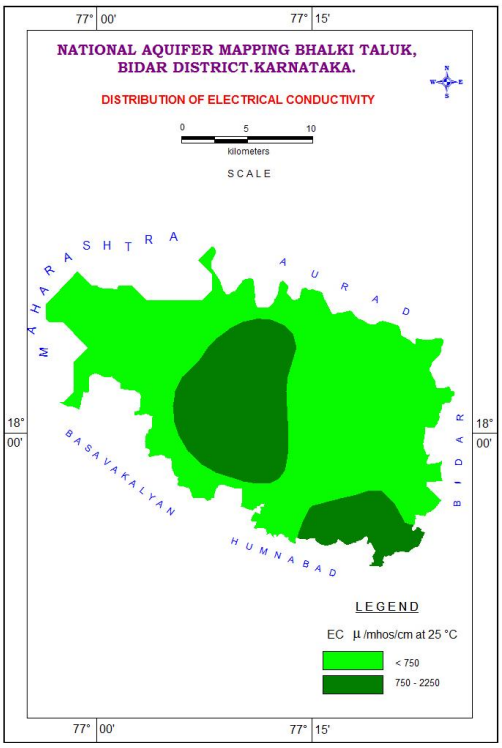


Fig-18 Distribution of Electrical Conductivity

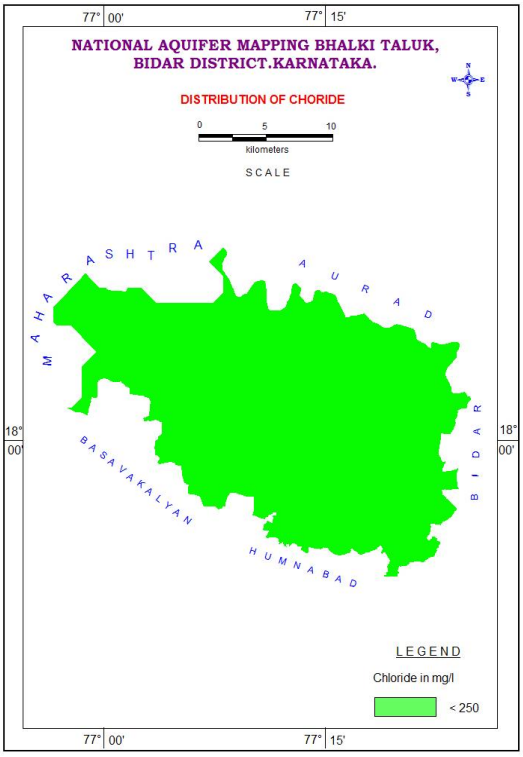


Fig-19 Distribution of Chloride Conductivity

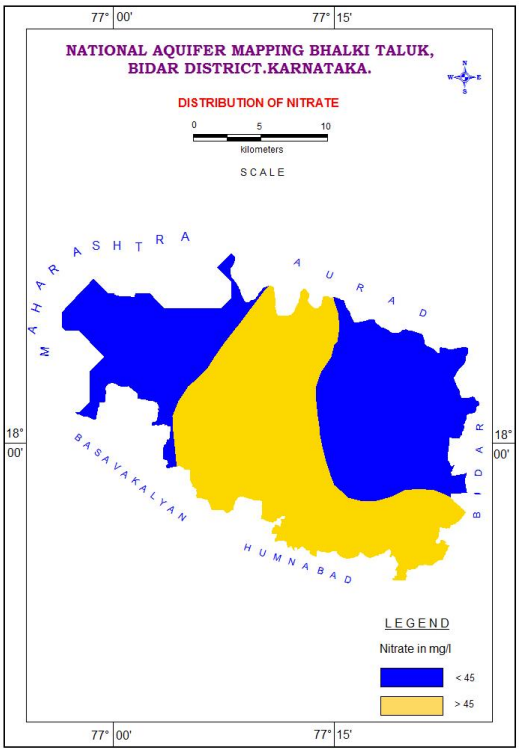


Fig-20 Distribution of Nitrate

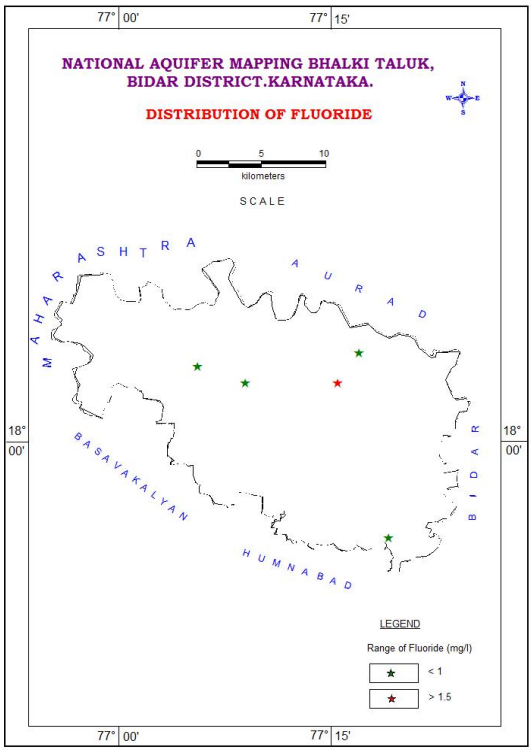


Fig-21 Distribution of Fluoride

4 GROUND WATER RESOURCE ENHANCEMENT

4.1 Resource Enhancement by Supply Side Interventions

The overall stage of ground water development is 70.09% as per GEC 2020. Considering the long-term water level trend(Table 9) and seasonal water level, seasonal fluctuation **(Fig-8,9,10),** it is proposed to construct artificial recharge (AR) structures to enhance the ground water resources and to arrest the decline in long term ground water level **(Table-14).** The area feasible for recharge in Bhalki taluk is worked out as 981 sq.km. and the surface surplus non-committed runoff availability is 78.52 MCM, which is considered for planning of AR structures. For this, a total of 2 sub-surface dykes and 67 percolation tanks are proposed. The volume of water expected to be recharged is 14.67 MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 1375.251 Lakhs. The additional area which can be brought under assured ground water irrigation will be about 0.071 lakh hectares. However, the figures given are tentative and pre-field studies / DPR are recommended prior to implementation of these recharge structures.

The details pertaining to proposed recharge structures, cost estimates and likely Recharge benefits for Bhalki taluk, Bidar district have been given in below Table 13. The tentative locations of artificial recharge structures is shown in **Fig.24** and locations mentioned in **Annexure-1.**

Table-14: Quantity of non-committed surface runoff & expected recharge through AR structures

Area feasible for Artificial Recharge Structures	981 sq.km
Non committed monsoon runoff available (MCM)	78.52
Total no. of existing Artificial Recharge Structures	1493
Number of Check Dams	-
Number of Percolation Tanks	67
Number of Sub surface dyke	2
Tentative total cost of the project (Rs. in lakhs)	1375.251Lakhs
Additional area that can be brought under irrigation(lakh hectares)	0.071
Expected recharge (MCM)	14.67
Cost Benefit Ratio (Rupees/ cu.m. of water harvested)	Percolation Tank-2.02 Sub-surface dyke-1.35

Table-15 Improvement in GW availability due to Recharge, Bhalki 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	%	%
BHALKI	6146.84	4308.41	70.09	1467	13	57

After implementation of Artificial Recharge structures for GW recharge, the annual ground water availability will increase from 6146.84 to 7613.84 ham and the expected improvement in stage of development is 13% from 70.09% to 57% that comes under Safe category.

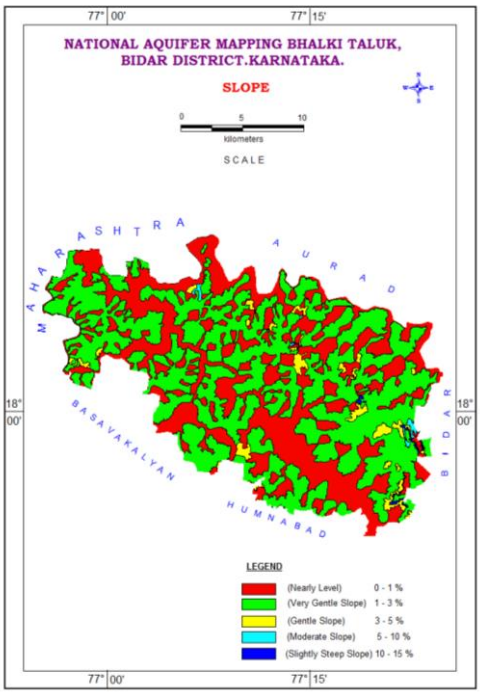


Fig. 22: Slope Map

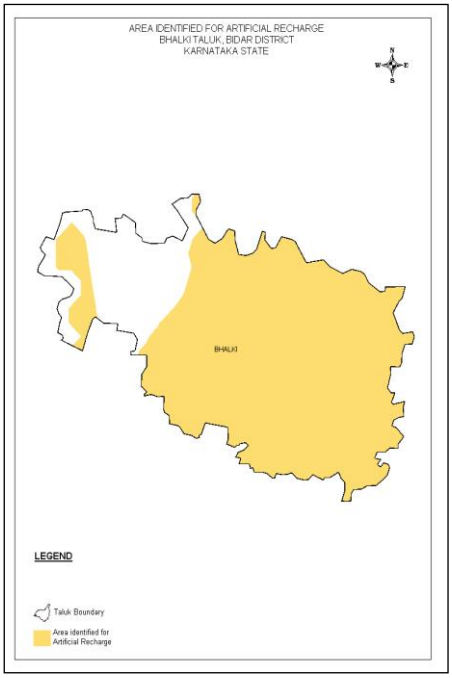


Fig.23: Artificial Recharge Feasibility Map

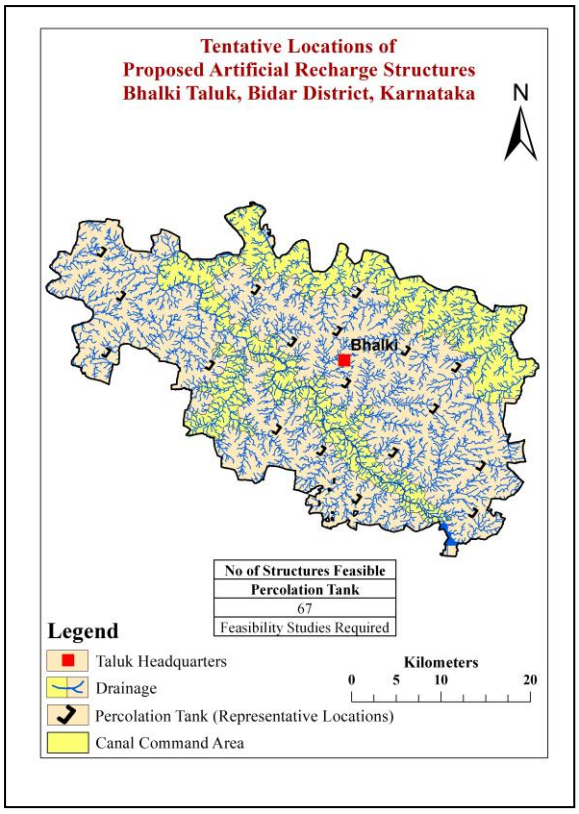


Fig.24: Map showing tentative locations of proposed artificial recharge structures

4.2 DEMAND SIDE INTERVENTIONS

4.2.1 Water Use Efficiency by Micro Irrigation Practices

Efficient irrigation practices like Drip irrigation & sprinkler needs to be adopted by the farmers in the existing 4874 ha of net irrigated area by wells & bore wells. At present (2020), the irrigation draft is 4033.90 ham.

The water efficient methodology may be applied for growing sugarcane which is grown in 4207 ha and is largely ground water dependent as compared to the other crops which are mainly grown during kharif. Efficient irrigation techniques will contribute in saving ground water by 631.05 ham considering 50% of the sugarcane area is dependent on ground water irrigation and thus will improve stage of development marginally. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent. **(Table-16).**

Table-16: Improvement in GW availability due to saving by adopting water use efficiency

Taluk	Cumulative annual ground water availability after implementing ar structures & irrigation development schemes	Existing gross ground water draft for all uses	Stage of ground water development after implementing AR structures	Saving due to adopting WUE measures	Cumulative annual ground water availability	Expected improvement in stage of ground water development after adopting WUE measures and implementation of the project	Expected improvement in overall stage of ground water development
Bhalki	HAM	HAM	%	HAM	HAM	%	%
	7613.84	4308.41	56.6	631.05	8244.89	52.2	4.4

4.2.2 Change in cropping pattern

Water intensive crop like sugarcane is grown in 4207 ha area. At present (2020), the stage of ground water extraction is also on higher side @ 70.09% and taluk has been categorised as Semi-Critical. However, the supply side and demand side interventions will definitely help in improving the situation, thus change in cropping pattern has not been suggested.

4.2.3 Regulation and Control

The taluk has been categorized as Semi-Critical, since the Stage of ground water development has reached 70.09% (GEC 2017). Hence, ground water regulation by including the industries, bulk water consumers etc under the ambit of NOC needs to be taken up by Karnataka State 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.

4.2.4 Other interventions proposed

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Excess nitrate concentration is found in ground water samples require remedial measures viz.
- Dilution of nitrate rich ground water through artificial recharge & water conservation.

- Roof top rain water harvesting.
- Improving quality by proper drainage and limited usage of Nitrogenous fertilizers
- Excess fluoride concentration is found in ground water samples require remedial measures viz. Alternate source and Removal technology

5.0 Summary and Recommendations

The main ground water issues are Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, Deeper Water Levels particularly in Aquifer-II in some parts, hilly and plateau areas which are all inter-related or inter dependent and Inferior Ground Water Quality due to nitrate contamination in some locations. The summary of ground water management plan of Bhalki taluk is given in Table-16.

The summary of Management plan of Bhalki taluk is given in Table-17.

Table-17: Summary of Management plan of Bhalki taluk

Bhalki taluk is Semi-Critical & present stage of Ground water Extraction as per GEC-2020(%)	70.09
Annual Extractable Ground Water Availability (MCM)	61.4684
Existing Gross Ground Water Extraction for all uses(MCM)	43.08
Area Feasible for Artificial Recharge (Sq.Km)	981
Expected additional recharge from monsoon surplus runoff (MCM)	14.67
Expected improvement in stage of ground water extraction after the implementation of the project (%)	70.09 to 56.6
Expected Saving due to adopting WUE measures (MCM)	4.4
Expected improvement in stage of ground water extraction after adopting WUE measures and implementation of the project (%)	56.6 to 52.2
Excess Nitrate concentration	• Dilution of nitrate rich ground water through artificial recharge & water conservation. • Roof top rain water harvesting • Improving quality by controlling usage of Nitrogenous fertilizers in agriculture field and maintaining the proper domestic drainage network system
Excess Fluoride concentration	• Alternate source • Removal technology
Water Use efficiency measures	• Government to take initiative to encourage at least 70% farmers to adopt water use efficiency irrigations practices like dip & sprinkler irrigation

As per the resource estimation – 2020, Bhalki taluk falls under Semi-Critical category with the stage of ground water extraction is 70.09 %. Thus, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk in the coming days to avoid water crisis in the future. It is suggested to adopt a scientific and multi-pronged ground water management strategy covering supply side interventions, demand side interventions, ground water development interventions and ground water quality protection aspects as mentioned in the management plan suggested above

Ground water resource enhancement by supply side interventions: The area feasible for recharge in Bhalki taluk is worked out as 981 sq.km.and the surface surplus non-committed runoff availability is 78.52 MCM, which is considered for planning of AR structures. For this, a total of 2 sub-surface dykes and 67 percolation tanks are proposed. The volume of water expected to be recharged is 14.67 MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 1375.251 Lakhs. The additional area which can be brought under assured ground water irrigation will be about 0.071 lakh hectares. 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: Efficient irrigation practices like drip irrigation & sprinkler needs to be adopted by the farmers in the existing 4874 ha of net irrigated area by wells & bore wells. At present (2020), the irrigation draft is 4033.90 ham.The water efficient methodology may be applied for growing sugarcane which is grown in 4207 ha and is largely ground water dependent as compared to the other crops which are mainly grown during kharif. Efficient irrigation techniques will contribute in saving ground water by 631.05 ham considering 50% of the sugarcane area is dependent on ground water irrigation and thus will improve stage of development marginally. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent.

Change in cropping pattern: Not suggested at present.

ANNEXURE-1

S.No	Longitude	Latitude	Village	Grama Panchayat	Taluk	District
1	77.26955	17.88641	Chalakapura	Chalkapur	Bhalki	Bidar
2	77.34794	17.89512	Nirmanahalli	Byalhalli	Bhalki	Bidar
3	77.23274	17.90868	Sikindrabadh	Khatakchincholi	Bhalki	Bidar
4	77.36686	17.92760	Malachapura	Malchapur	Bhalki	Bidar
5	77.33830	17.93438	Dhannura	Dhanura	Bhalki	Bidar
6	77.12219	17.93676	Varavatti	Varvatti	Bhalki	Bidar
7	77.35731	17.94277	Sevanagar	Dhanura	Bhalki	Bidar
8	77.30081	17.94676	Janathi	Janthi	Bhalki	Bidar
9	77.13783	17.94924	Navadhagi	Enikoora	Bhalki	Bidar
10	77.16921	17.95205	Navadhagi	Enikoora	Bhalki	Bidar
11	77.26870	17.95508	Joladhabaka	Joldabka	Bhalki	Bidar
12	77.10553	17.95936	Varavatti	Varvatti	Bhalki	Bidar
13	77.19757	17.96018	Kuruba Belagi	Kurubkhelgi	Bhalki	Bidar
14	77.37052	17.96436	Sevanagar	Dhanura	Bhalki	Bidar
15	77.15771	17.96732	Navadhagi	Enikoora	Bhalki	Bidar
16	77.10477	17.97208	Varavatti	Varvatti	Bhalki	Bidar
17	77.27549	17.97386	Siddeshwara	Siddeshwar	Bhalki	Bidar
18	77.29869	17.97471	Tharanahalli	Halbarga	Bhalki	Bidar
19	77.25273	17.97703	Siddeshwara	Siddeshwar	Bhalki	Bidar
20	77.33732	17.97846	Dhannura	Dhanura	Bhalki	Bidar
21	77.15244	17.97971	Mavinahalli	Varvatti	Bhalki	Bidar
22	77.36234	17.98278	Hala Hipparagi	Kosam	Bhalki	Bidar
23	77.13451	17.98457	Uchha	Morambi	Bhalki	Bidar
24	77.30020	17.99024	Kona Melakundha	Konmelkunda	Bhalki	Bidar
25	77.27700	17.99702	Kona Melakundha	Konmelkunda	Bhalki	Bidar
26	77.12516	18.00100	Kotagera	Gorchincholi	Bhalki	Bidar
27	77.31020	18.00130	Kona Melakundha	Konmelkunda	Bhalki	Bidar
28	77.06931	18.00560	Kesara Javalaga	Saigaon	Bhalki	Bidar
29	77.33320	18.01253	Pygampura	Halbarga	Bhalki	Bidar
30	77.30163	18.01665	Kona Melakundha	Konmelkunda	Bhalki	Bidar
31	77.28382	18.01788	Kona Melakundha	Konmelkunda	Bhalki	Bidar
32	77.22213	18.02807	Bhalki	Bhalki	Bhalki	Bidar
33	77.12725	18.03134	Gowra-Chincholi	Gorchincholi	Bhalki	Bidar
34	77.26115	18.03705	Karadiyyala	Talwad (K)	Bhalki	Bidar
35	77.27772	18.04092	Karadiyyala	Talwad (K)	Bhalki	Bidar
36	77.31091	18.04092	Hupala	Ambesanghvi	Bhalki	Bidar
37	77.33201	18.04346	Kerura	Beeri (K)	Bhalki	Bidar
38	77.08375	18.04504	Sayagaov	Saigaon	Bhalki	Bidar
39	77.25111	18.04822	Dharajawadi	Talwad (K)	Bhalki	Bidar
40	77.18548	18.05424	Bhalki	Bhalki	Bhalki	Bidar
41	76.98044	18.05595	Kongali	Wanjarkhed	Bhalki	Bidar

42	77.23382	18.05698	Ganeshapura	Ambesanghvi	Bhalki	Bidar
43	76.95573	18.05727	Vanjara Kheda	Wanjarkhed	Bhalki	Bidar
44	77.28173	18.05841	Ara Ambesangi	Ambesanghvi	Bhalki	Bidar
45	77.31876	18.06091	Kerura	Beeri (K)	Bhalki	Bidar
46	77.16604	18.06606	Bhathamba	Bhatambra	Bhalki	Bidar
47	77.22846	18.07590	Bhalki	Bhalki	Bhalki	Bidar
48	77.19100	18.07660	Siddapurawadi	Telgaon	Bhalki	Bidar
49	77.21182	18.07809	Shamasherapura	Telgaon	Bhalki	Bidar
50	76.97627	18.07975	Vanjara Kheda	Wanjarkhed	Bhalki	Bidar
51	77.26003	18.08213	Kotagyalawadi	Beeri (B)	Bhalki	Bidar
52	76.99796	18.09177	Mehakara	Mehkar	Bhalki	Bidar
53	77.17996	18.09245	Thelagaov	Telgaon	Bhalki	Bidar
54	77.14462	18.09581	Bhathamba	Bhatambra	Bhalki	Bidar
55	77.21363	18.09700	Donigapura	Dongapur	Bhalki	Bidar
56	77.16423	18.10039	Bhathamba	Bhatambra	Bhalki	Bidar
57	77.14371	18.11199	Lanjawada	Lanjawada	Bhalki	Bidar
58	76.99410	18.11527	Mehakara	Mehkar	Bhalki	Bidar
59	77.23204	18.11764	Donigapura	Dongapur	Bhalki	Bidar
60	76.95784	18.11782	H.Thugaov	Tugaon (H)	Bhalki	Bidar
61	77.13035	18.12258	Kakanala	Lanjawada	Bhalki	Bidar
62	76.93015	18.12538	H.Thugaov	Tugaon (H)	Bhalki	Bidar
63	76.97655	18.13162	H.Thugaov	Tugaon (H)	Bhalki	Bidar
64	76.94799	18.13846	H.Thugaov	Tugaon (H)	Bhalki	Bidar
65	76.96911	18.14709	Alavayi	Alwai	Bhalki	Bidar
66	76.97536	18.15899	Alavayi	Alwai	Bhalki	Bidar
67	76.95427	18.16719	Alavayi	Alwai	Bhalki	Bidar