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

Molkalamuru Taluk, Chitradurga District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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जल शक्ति मंत्रालय
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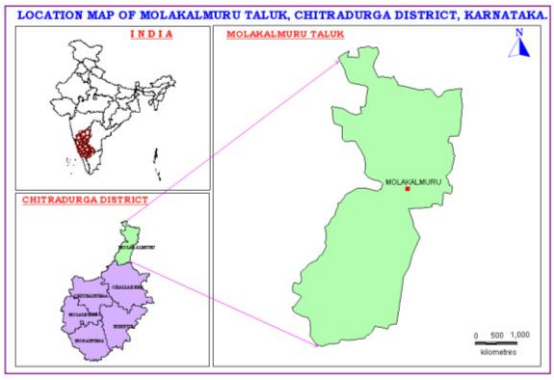
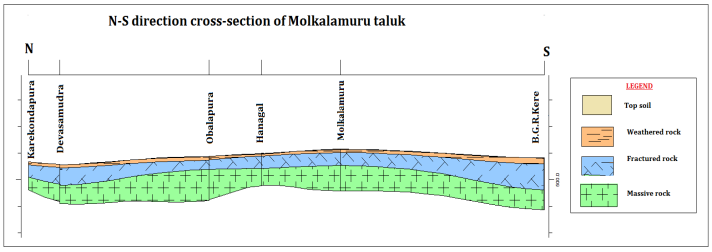
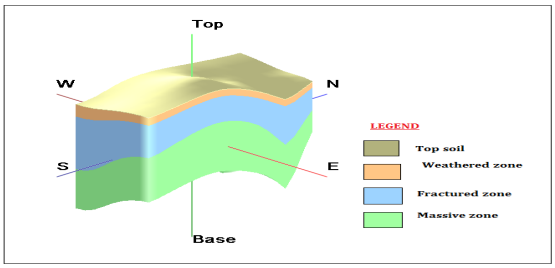
AQUIFER MAPS AND MANAGEMENT PLAN, MOLKALAMURU TALUK, CHITRADURGA DISTRICT, KARNATAKA STATE

(AAP – 2021-2022)







By

Dr.Suchetana Biswas, Scientist 'B', CGWB, SWR, Bengaluru

AUGUST 2022

AQUIFER MAPS AND MANAGEMENT PLAN, MOLKALAMURU TALUK, CHITRADURGA DISTRICT, KARNATAKA STATE

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AQUIFER MAPS AND MANAGEMENT PLAN, MOLKALAMURU TALUK, CHITRADURGA DISTRICT, KARNATAKA STATE

1 SALIENT INFORMATION

Name of the Taluk: **MOLKALAMURU**

District: Chitradurga

State:Karnataka

Area: 738sq.km

Population: 1,41,284

Annual Normal Rainfall:542mm

1.1 Study area

Aquifer mapping studies were carried out in Molkalamuru taluk, Chitradurga district of Karnataka, covering an area of 738sq.km under National Aquifer Mapping Project. Molkalamuru taluk of Chitradurga district is located between North latitude 12°18'8.28" – 12°30'6.84" & East longitude 76°33'25.92" – 76°54'27.36" and is covered in parts of Survey of India Toposheet Nos. 57B/9, 57 B/10, 57B/13 and 57B/14. Molkalamuru taluk is bounded by Bellary district on North and West, Andhra Pradesh state on East, and Challakere taluk of Chitradurga district on South side. Location map of Molkalamuru taluk of Chitradurga district is presented in **Figure 1.**

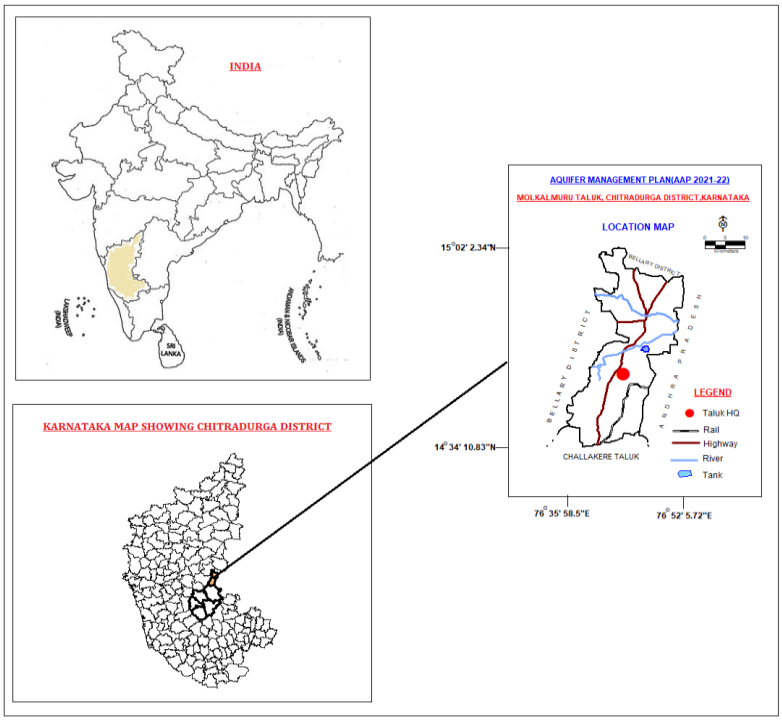

Figure 1:Location Map

Taluk administration of Molkalamuru is divided into 02 Hoblies and 16 Gram Panchayats. There are 78 inhabited and 11 uninhabited villages in the Taluk.

1.2 Population

According to 2011census, the population in Molkalamuru taluk is 1,41,284 of which 72,049 male and 69,235 female population.

1.3 Rainfall

There are five (05) rain gauge station located in Molkalamuru taluk. Normal annual rainfall is 542mm. Actual annual rainfall for 2019 was 674mm.The annual rainfall data from 2001 to 2019 is given in Table 1. Highest rainfall of 935.3 mm was received in 2010 and lowest rainfall of 226mm was received in 2016. The yearwise rainfall variability graph is given in **Figure-2.**

Molkalamuru taluk experiences semi-arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Central Dry agro-climatic zone of Karnataka state and is categorized as drought prone.

Table 1: The annual rainfall data from 2001 to 2019

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Rainfall in mm	574	551	255	584	657	422	804	661	941	935.3	319	561.4	366	650.5	546	226	428.01	331	674.4

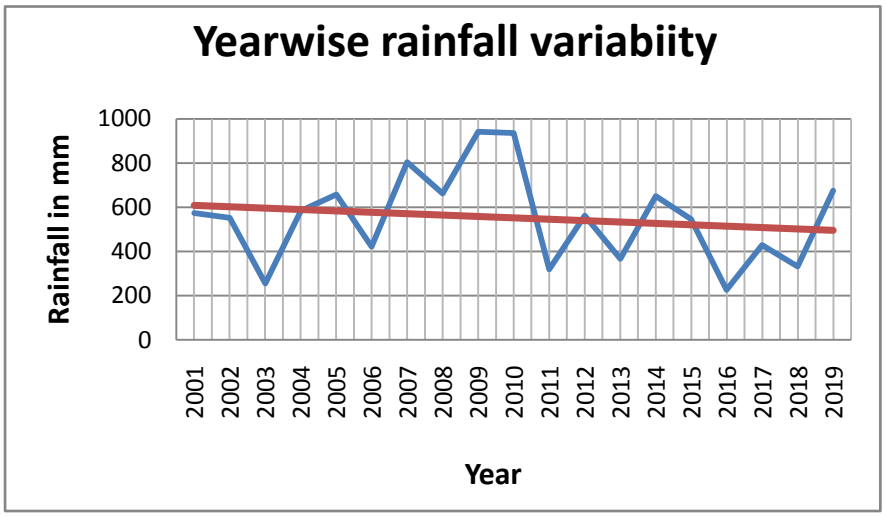

Figure 2: Yearwise annual rainfall graph

1.4 Agriculture and Irrigation

Agriculture is the main occupation in Molkalamuru taluk. Oilseedsare the major crop grown in the talukin 22871ha area, followed by millets (3476 ha), cotton (3042 ha), maize (1838ha) andvegetables (1096 ha) **(Table 2)**.

Table 2: Cropping pattern in Molkalamuru taluk 2016-2017(Ha)

Paddy	Jowar	Bajra	Maize	Ragi	Other minor millets	Pulses	Fruits	Vegetables	Oil seeds	Cotton
64	1306	1379	1838	374	417	764	597	1096	22871	3042

Source: Chitradurga District at a Glance 2016-17, Govt. of Karnataka

It is observed that net sown area accounts for about 40.3% of total geographical area, while area sown more than once is 6.8% of total geographical area in the taluk **(Table 3).** As per the data available, the talukuses 1379 dug wells and 55887 borewells for irrigation purpose. Ground water is the main source for irrigation in the taluk **(Table 4).** Landuse pattern of the taluk is represented as **Figure 3**.

Table 3: Details of landuse in Molkalamuru taluk 2016-2017(Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Molkalamuru	73800	15373	5893	8924	29712	5024

Source: Chitradurga District at a Glance 2016-17, Govt. of Karnataka

Table 4: Irrigation details in Molkalamuru taluk(Ha)

Source of Irrigation	Nos./Length	Net area irrigated (Ha)	Gross area Irrigated (Ha)
Canals	29 km	--	1113
Tanks	22	--	--
Wells	1379	--	--
Bore wells	55887	6900	7729
Lift Irrigation	--	--	--
Other Sources	--	--	--
Total		6900	8842

Source: Chitradurga District at a Glance 2016-17, Government of Karnataka

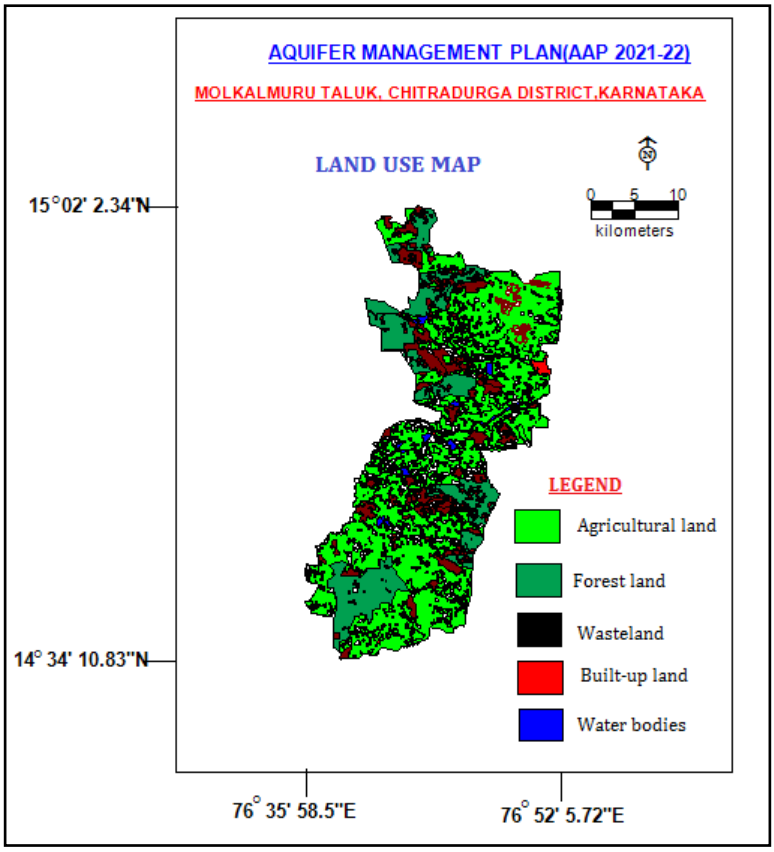

Figure 3: Landuse Map

1.5 Geomorphology, Physiography and Drainage

Physiographically, the region in which the taluk is situatedmay be classified as a maidan. The taluk, it may be observed in broad items, ischaracterized by vast stretches of undulating plainsinterspersed by low ranges of rocky hills. The southern portionof Molkalamuru taluk comprises of plains of Vedavathiriver. The northern portion of Molkalamurutaluk is predominantly hilly and the area may be called the central hilly region. An interior belt of the Eastern Ghats is running through the taluk.The surface topography is in theform of undulating plains has an average elevation of 580- 630m amsl. There are fewsporadic out crops of rocks as hills and few fertile shallow valleys **(Figure 4)**. The sheet rocks in Hire Adavi reserve forest near Molkalamuru town reach the maximum altitude of 921m amsl. The general slope in the taluk is in North-East direction.The Taluk is drained by ChinnaHagari/Janagahalla river. Two important hill streams (without any names given to them) take their rise in the range of hills in the north-west of the Molakalmuru taluk, flow into the Janagahalla about a mile beyond the taluk boundary **(Figure 5).**

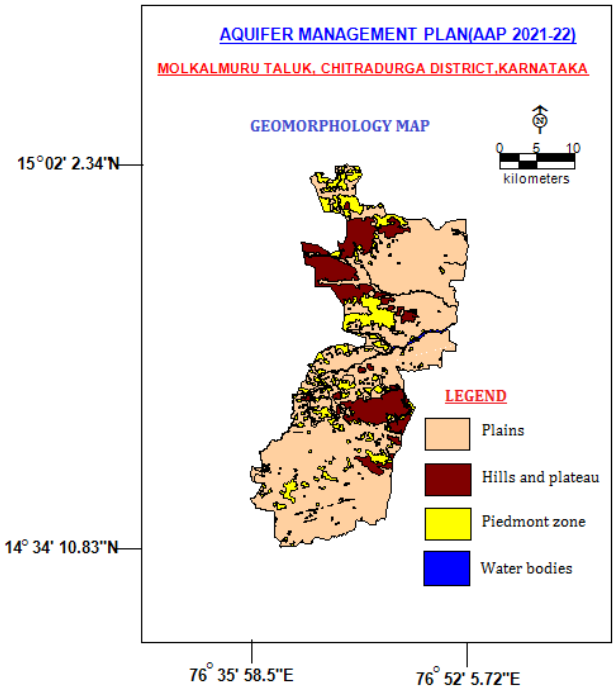

Figure 4: Geomorphology map

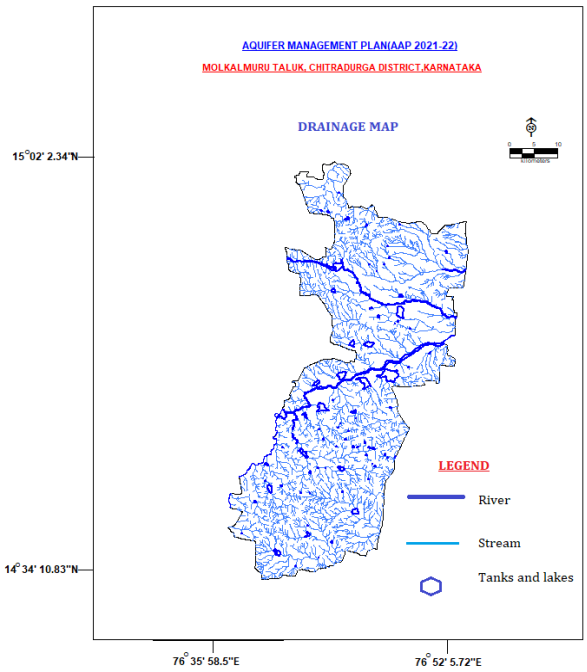

Figure 5: Drainage map

1.6 Soil

The different types of soil in the taluk are–Aridisols, rocky land,inceptisol and entisol.The soils are further characterised as rocky land, clayey-skeletal, clayey to loamy.Water deficiency and very low concentration of organic matter is the major characteristic of Aridisols **(Figure 6).**

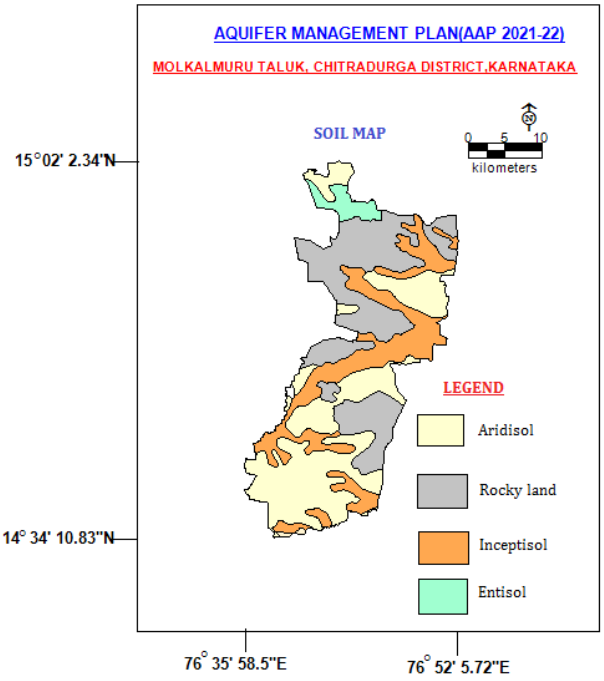

Figure 6: Soil map

1.7 Existing and future water demands (as per GWRA-2020)

The details of dynamic (Phreatic) ground water resources for Mokalamuru taluk as on March 2020 is shown in **Table.5.** The annual extractable water resource is 7165.71ham.Total groundwater extraction for irrigation and domestic use is 2223.96ham. Annual GW Allocation for domestic use as on 2025 is 1088.73ham. Net Ground Water Availability for future use is 4939.20ham.

Table.5 Detail of Dynamic Ground Water resource, Molkalamuru taluk, (as on March 2020)

Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)
7165.71	1251.62	0.00	972.34	2223.96	1088.73	4939.20	31.04

1.8 Water level behaviour

Phreatic aquifer-I represented by dugwells are mostly reported to be dry in the taluk especially during summer. The dry depth of wells vary from 10.3 to 12.5m bgl. The water level data have been monitored from the representative borewells for both pre and post-monsoon seasons. During pre-monsoon season in aquifer-II (fractured) water level ranges from 25.0 to 122.0 m bgl, whereas in post-monsoon it varies from 22.4 to 60.60 m bgl. The seasonal water level fluctuation in aquifer-II is rise in the range of 3.3 m to 82.46 m.

(a) Depth to water level

Aquifer-I

Post-monsoon: 4.5 to 7.5m bgl

Aquifer-II

Pre-monsoon: 25.0 - 122.0mbgl (May 2019)

Post-monsoon: 22.4-60.60 mbgl (Nov 2019)

(b)Water level fluctuation

Aquifer-II

Seasonal Fluctuation: Rise in the range of 3.3m to 82.46m.

The long term groundwater trend (2011-2020) for pre-monsoon period shows a fall 0.53m/year (Table 6).and for post-monsoon period also shows a fall of 0.10m/year **(Table 7).** During pre-monsoon period as well as post-monsoon period monitoring station is showing falling trend.

Table 6:Pre-monsoon Trend Of Groundwater monitoring stations(2011 to 2020)

SL_NO	TALUK	LOCATION	RISE (M/YEAR)	FALL (MYEAR)	AQUIFER_TYPE
1	Molkalamuru	Molkalamuru		0.5289	Unconfined

Table 7:Post-monsoon Trend Of Groundwater monitoring stations (2011 to 2020)

SL_NO	BLOCK_NAME	LOCATION	RISE (M/YEAR)	FALL(M/YEAR)	AQUIFER_TYPE
1	Molkalamuru	Molkalamuru		0.1025	Unconfined

2 AQUIFER DISPOSITION

2.1 Aquifer Types

In Molkalamuru taluk, there are mainly two types of aquifer systems

i. **Aquifer-I (Phreatic aquifer)** comprising of weathered granite and granitic gneiss
ii. **Aquifer-II (Fractured aquifer)** comprising fractured granite and granitic gneiss

In Molkalamuru taluk, fractured granite and granitic gneiss are the major water bearing formation. A small portion is covered with schist **(Figure 7)**. Groundwater occurs within the jointed and fractured granite and granitic gneiss under semi-confined to confined conditions. In Molkalamuru taluk borewells were drilled from a minimum depth of 55.25 mbgl to a maximum of 200.3mbgl **(Table 8)**. Depth of weathered zone (Aquifer-I) range from 3.8mbgl to 24.0mbgl. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 25 to 130m bgl **(Figure 8, 9 & 10).** Yield ranges from negligible to 3.5lps.

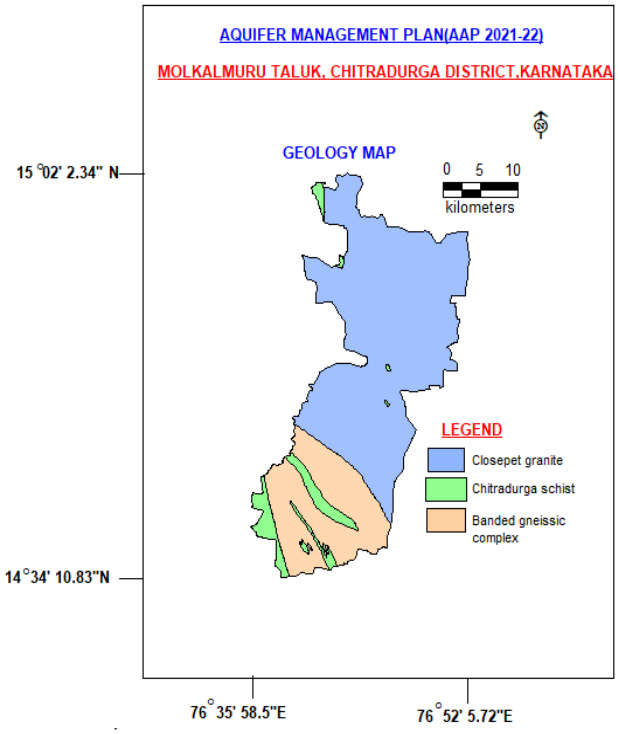

Figure 7: Geology Map

Table 8: Details of Ground water Exploration

Sl. No.	Location	Latitude (N)	Longitude (E)	Depth Drilled (m bgl)	Casing Depth (m bgl)	Fracture Zones (mbgl)	SWL (mbgl)	Q (lps)
1.	HANAGAL EW	14.74778	76.70166667	67.8	3.8	29.0-39.0, 52.0-57.0	3.5	0.8
2.	KAREKONDAPUR EW	14.88222	76.7875	55.25	10.94	20.0-35.0	9.5	1.1
3.	Molakalmuru	14.20333	75.27027778	190.1	12.3	20.5,27,63	16.8	1.5
4.	Tammenahalli EW	14.7125	76.75	133.15	14.7	44,50/,60	>50	0.7
5.	B.GR KereEW	14.5875	76.6625	200	24	45, 78, 125	14.62	3.5
6.	B.GR KereOW	14.5875	76.6625	195.15	14.7	23, 45, 129	12.68	3.5
7.	Obalapura	14.77917	76.725	200	17	19, 32, 41	11.95	0.07

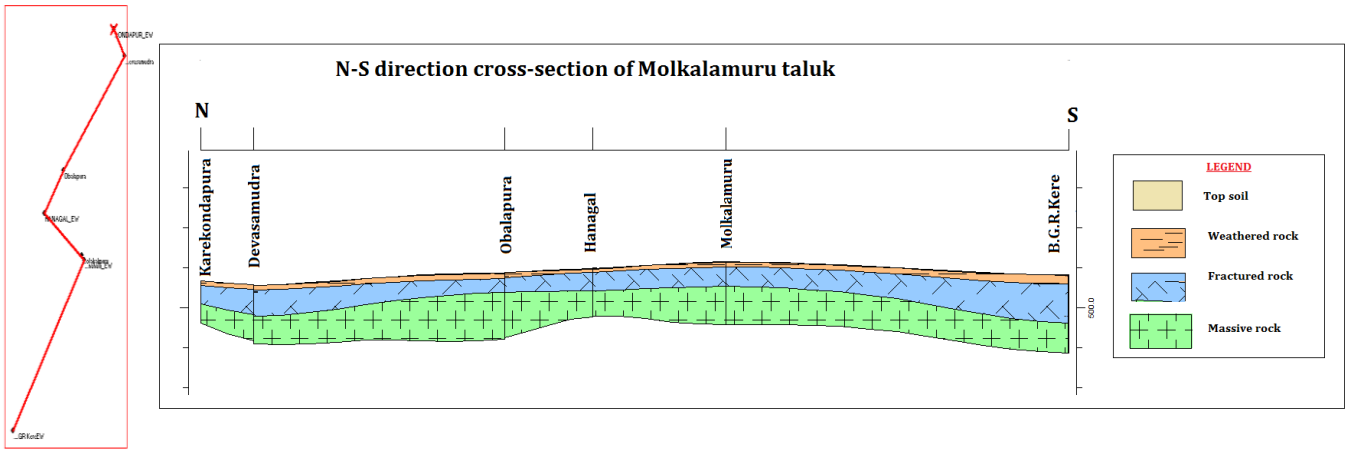

Figure 8: Cross section of exploration wells drilled in Molkalamuru taluk

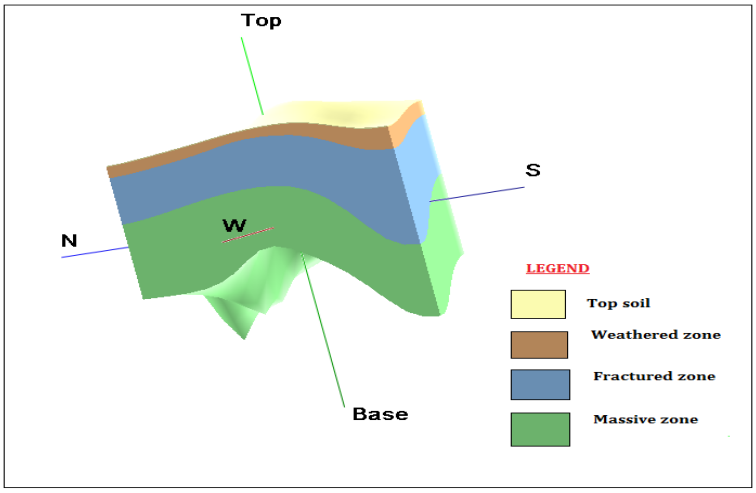

Figure 9:3D aquifer disposition

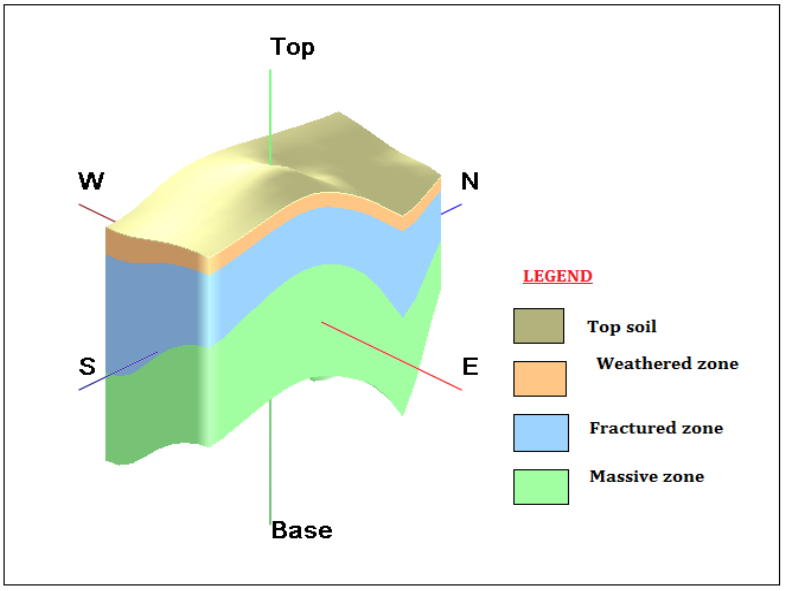

Figure 10:3D aquifer disposition

3 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

The comparison of the resource as on 2013, 2017 and 2020 are summarised below in Table 9. It is observed that the ground water availability is more during the year 2020 as compared to 2017. It is attributable to water conservation / recharge activities carried out in the taluk by various state govt. and other agencies.

Table 9: Comparison of Ground Water Availability and Draft Scenario in Molkalamuru taluk

Taluk	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development (%)	GW Availability (Ham)	GW Draft (Ham)	Stage of GW Development (%)	Annual extractable GW resource (Ham)	Total GW Extraction (Ham)	Stage of GW Extraction (%)
	2013			2017			2020		
Molkalamuru	6238	3408	55	6351	2262	36	7165.71	2223.96	31.04

3.2 Chemical Quality of Ground Water and Contamination

Ground Water Quality (May 2019)

The water samples collected from borewells and analysed for iron, fluoride, nitrate and total hardness by employing standard methods. Based on the hydro chemical data (**Table 10**), the portability of these samples has been assessed as per the standards prescribed by the Bureau of Indian Standards (IS 10500: 2012) and categorized into 'Desirable', 'Permissible' and 'Unsuitable' classes.

One of the essential elements for maintaining normal development of healthy teeth and bones is Fluoride. Lower concentrations of fluoride usually below 0.6mg/l may contribute to dental caries. However, continuing consumption of higher concentrations, above 1.2mg/l however cause dental fluorosis and in extreme cases even skeletal fluorosis. Most of the fluoride found in groundwater is of geogenic origin. Distribution of fluoride in the taluk ranges from 0.03 mg/l to 1.0 mg/l. Thus majority of samples in the taluk shows fluoride concentration of<1 mg/l rendering them suitable for drinking purpose**.**

Nitrate is a problem as a contaminant in drinking water primarily from groundwater and wells due to its harmful biological effects. High concentrations can cause methemoglobinemia, and have been cited as a risk factor in developing gastric, an intestinal cancer.The distribution of nitrate in the taluk indicated that the values are in the range of 12 mg/l to 52 mg/l. Nitrate in drinking water should not exceed 45 mg/l as per BIS (ISO: 10500: 2012) standard**.**02 samples, namely Molkalamuru and

Gowrasamudra have nitrate concentration more than 45 mg/L.Remaining samples from the taluk indicates that the groundwater is suitable for drinking purposes in those places.

Table 10: Hydro-chemical data of water samples analysed

SITE_NAME	Fe	F	NO_3	TH
Rampura	0.07	0.8	12	300
B.G.Kere	0.06	0.03	18	440
Molakalmuru	0.07	1	**52**	220
Gowrasamudra	0.02	0.02	**52**	372
Hanagal	0.08	0.03	17	380
Tammenahalli	0.03	0.8	12	300

4 GROUND WATER RESOURCE ENHANCEMENT

4.1 Resource Enhancement by Supply Side Interventions

The overall stage of ground water development is 31.04% as per GEC 2020. Considering the ever increasing demand for groundwater resource and erratic annual rainfall pattern, it is proposed to construct artificial recharge (AR) structures to recharge phreatic aquifer and enhance the ground water resources. The area feasible for recharge in the taluk is worked out as 736 sq.km and the surface surplus non-committed runoff availability is 92.406MCM, which is considered for planning of AR structures. For this, 79 check dams,83 percolation tanks and 2 subsurface dykesare proposed. The volume of water expected to be conserved/recharged @75% efficiency is 69.305MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 2500.9 Lakhs. 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 Molkalamuru taluk have been carried out and given in below Table 11.

Table 11: Quantity of non-committed surface runoff and expected recharge through AR structures

ArtificialRechargeStructures	**Molkalamuru taluk**
Area feasible for recharge	736sq.km
Non-committedmonsoonrunoffavailable(MCM)	92.406
NumberofCheckDams proposed	79
NumberofPercolationTanks	83
NumberofPointRechargestructures	0
Number of subsurface dyke	2
Tentativetotalcostoftheproject(Rs.Inlakhs)	2500.931

Expectedrecharge(MCM)	69.305
CostBenefitRatio(Rupees /cu.mofwaterharvested)	3.61

Table 12: Improvement in GW availability due to Recharge, Molkalamuru taluk

Sl.no.	Resource Details	As per GWRA 2020 Estimation
1.	Annual extractable GW resource in HAM	7165.71
2.	Total GW extraction for all uses in HAM	2223.96
3.	Existing stage of groundwater extraction in percentage	31.04
4.	Expected recharge from artificial recharge structures in HAM	6930.5
5.	Cumulative groundwater availability for extraction in HAM	14096.21
6.	Expected improved stage of groundwater extraction in percentage	15.77%

After implementation of artificial recharge structures for groundwater recharge, the net annual groundwater availability will increase from 7165.71 ham to 14096.21 ham and the expected improvement in stage of development is 15.27% from 31.04% to 15.77 % (**Table 12**).

4.1.2 Development of irrigation facilities through surface water

Small area of the taluk (1113 ha) is irrigated by water from Rangaiahnadurga dam and other small tanks. Most distributaries/ field channels are unlined and there is great scope to improve the irrigation efficiency by proper lining to these structures, and attending to other canal maintenance works timely.

4.2 Demand Side Interventions

4.2.1 Water Use Efficiency by Micro Irrigation Practices

The major source of irrigation is ground water through dug wells and borewells in the taluk. 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 8842ha of gross irrigated area. Presently, draft through irrigation is 1251.62ham. Implementation of efficient irrigation techniques will contribute in saving groundwater by 375.49ham and thus, will improve stage of development by 15.68% from 31.04%to 15.36% **(Table 13).**

Table 13: Improvement in GW availability due to saving by adopting water use efficiency

Sl.no.	Resource Details	As per GWRA 2020 Estimation
1.	Annual extractable GW resource in HAM	7165.71
2.	Total GW extraction for all uses in HAM	2223.96
3.	Existing stage of groundwater extraction in percentage	31.04
4.	Expected recharge from artificial recharge structures in HAM	6930.5
5.	Cumulative groundwater availability for extraction in HAM	14096.21
6.	Expected improved stage of groundwater extraction in percentage	15.77%
7.	Saving due to using Water Use Efficiency technique in HAM	375.49
8.	Cumulative groundwater availability for extraction in HAM	14471.696
9.	Expected improved stage of groundwater extraction after implementation of project	15.36%

4.2.2 Change in cropping pattern

Cotton, which is water intensive crop is grown in an area of 3042 hectares which is 10.23% of net sown area. Since it is a valuable commercial crop, it may not be possible for farmers to switch to other crop, hence water use efficiency practices like drip irrigation and point irrigation for cotton cultivation and plastic mulching should be adopted to prevent soil erosion and evaporation.

4.2.3 Additional area of irrigation

After adopting various water use efficiency techniques and recharge measures and its resultant savings, the stage of extraction is expected to be 15.36% in the taluk, indicates the taluk will continue to remain in safe category. Hence 0.083lakh hectare additional area may be brought under irrigation after implementing artificial recharge plan.

4.2.4 Regulation and Control

Groundwater recharge component needs to be made mandatory in the taluk to manage the aquifer.

4.2.5 Other interventions proposed:

- The rejuvenation of the existing tanks by desilting and construction of additional percolation tanks will help in recharging the phreatic zone.
- Large number of abandoned bore wells/dug well can be used to recharge the aquifer utilizing the surplus surface runoff available during rainy days.
- The existing dugwells may be deepened and deep dugwells may be converted into dug-cum-borewells to increase the yield.
- Water use efficiency practices point irrigation for cotton cultivation, plastic mulching should be adopted to prevent soil erosion and evaporation**.**
- Periodic maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Build up awareness among local village/urban community about proper disposal of sewage/runoff from chemical fertilizers contributing to nitrate.

6.0 SUMMARY AND RECOMMENDATIONS

The main ground water issues are limited ground water potential / limited aquifer thickness / sustainability, drying up of phreatic aquifer, deeper water levels particularly in aquifer-ii in some parts and inferior ground water quality due to nitrate contamination in some pockets. The summary of ground water management plan of Molkalamuru taluk is given in Table-14.

Table 14: Summary of Management plan

Molkalamuru taluk is Safe' and present stage of GW Development (2020)	31.04%
Net Annual Ground Water Availability (MCM)	71.65
Existing Gross Ground Water Draft for all uses (MCM)	22.23
Expected additional recharge from monsoon surplus runoff (MCM)	69.31
Change in Stage of GW development, %	15.77
Expected Saving due to adopting WUE measures (MCM)	3.75
Change in Stage of GW development, %	15.36

As per the resource estimation – 2020, Molkalamuru taluk falls under safe category with the stage of ground water extraction 31.04 %. But there is need to formulate management strategy to tackle the water scarcity related issues in the taluk in the summer 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 the taluk is worked out as 736 sq.km. and the surface surplus non-committed runoff availability is 92.406MCM, which is considered for planning of AR structures. For this,79 check dams,83 percolation tanks and 2 subsurface dykesare proposed. The volume of water expected to be conserved/recharged @75% efficiency is 69.305MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 2500.9 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 about irrigation is mostly by bore wells (ground water). Efficient irrigation practices like drip irrigation and sprinkler has to be adopted by the farmers in the existing 8842ha of gross irrigated area. Presently, draft through irrigation is 1251.62ham. Implementation of efficient irrigation techniques will contribute in saving groundwater by 375.49ham and thus, will improve stage of development by 15.68% from 31.04%to 15.36%

Change in cropping pattern: Cotton, which is water intensive crop is grown in an area of 3042 hectares which is 10.23% of net sown area. Since it is a valuable commercial crop, it may not be possible for farmers to switch to other crop, hence water use efficiency practices like drip irrigation and point irrigation for cotton cultivation and plastic mulching should be adopted to prevent soil erosion and evaporation.

Additional area under irrigation: After adopting various water use efficiency techniques and recharge measures and its resultant savings, the stage of extraction is expected to be 15.36% in the taluk, indicates the taluk will continue to remain in safe category. Hence 0.083lakh hectare additional area may be brought under irrigation after implementing artificial recharge plan.

Also, rejuvenation of the existing tanks by desilting and construction of additional percolation tanks , utilizing abandoned bore wells/dug well to recharge the aquifer using the surplus surface runoff available during rainy days, deepening of existing dugwells or converting them to dug-cum –borewells, Periodic maintenance of artificial recharge structures and participatory groundwater management are suggested.