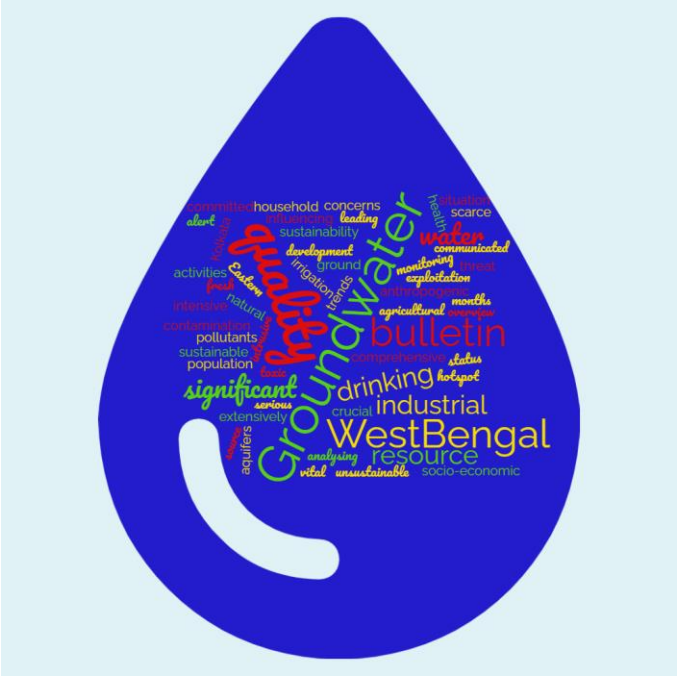

GROUNDWATER QUALITY BULLETIN: 2024 (PRE-MONSOON)

Central Ground Water Board

Eastern Region, Kolkata

ABSTRACT

Periodic ground water quality assessment (2024-25 Premonsoon) highlighting the findings, significant trends and groundwater contamination status of West Bengal

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1.0 INTRODUCTION

Groundwater is a critical resource that supports drinking water supply, irrigation for agriculture, and numerous industrial processes. Its role is particularly significant in regions where fresh surface water is scarce, driving an increasing reliance on groundwater to meet basic and economic needs. Groundwater sustains not only individual households but also entire economies, making it vital for sustainable socio-economic development.

In West Bengal, a large segment of the rural population relies directly on groundwater as their primary source for drinking, cooking, and various household needs. However, the overexploitation of this resource has severely strained many aquifers, pushing them to the brink of unsustainability. Additionally, the quality of groundwater is being compromised by the infiltration of toxic pollutants from a variety of sources (Fig. 1). These contaminants originate either from natural processes, such as mineralization, or human activities, including agricultural runoff, industrial effluents, and improper waste disposal. The growing intrusion of pollutants poses a serious risk to public health and the environment, demanding urgent attention and strategic intervention.

To address this concern, Central Ground Water Board (CGWB), Eastern Region, Kolkata, is actively engaged in the systematic monitoring of groundwater quality across West Bengal. In response to the need for timely and transparent information, CGWB will publish a comprehensive bulletin every six months. This bulletin will serve as a critical tool for stakeholders, policymakers, government departments, and other concerned organizations, enabling them to stay informed about emerging issues, trends, and priorities in groundwater management.

The bulletin will offer an in-depth overview of the current groundwater scenario in West Bengal. It will analyze a range of critical aspects, such as factors influencing groundwater quality, primary sources of contamination, pollution hotspots, and the broader trends impacting groundwater resources. By identifying areas of concern and offering insights into sustainability challenges, the bulletin aims to foster informed decision-making, support the implementation of corrective measures, and ultimately promote the sustainable use and management of groundwater resources in the region.

Supported by the latest water quality data from West Bengal, the bulletin aims to:

1. Present the current groundwater quality scenario for each district, detailing parameters individually.

2. Identify current hotspots of poor groundwater quality by analysing spatial variations in the latest 2024 quality data.

3. Assess the temporal changes in groundwater quality from 2020 to 2024, highlighting areas of improvement or deterioration to provide insights for effective water quality management strategies.

Up-to-date groundwater quality information through this bulletin will support stakeholders and related departments in making timely and effective decisions.

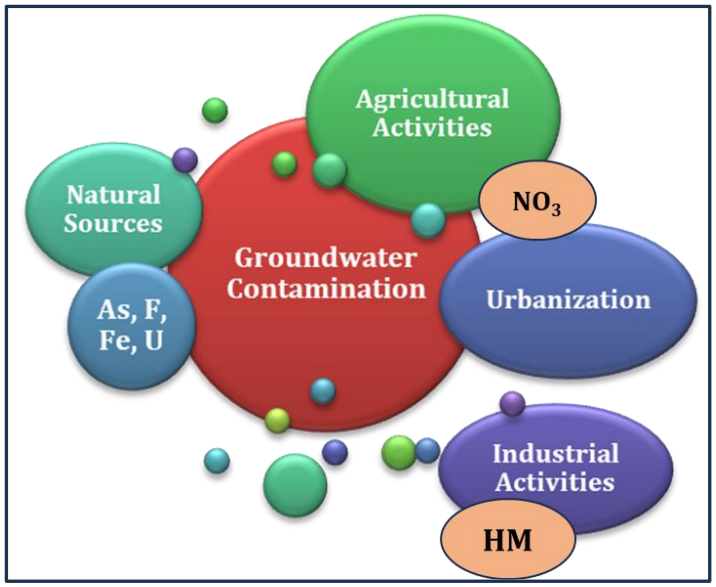


Fig. 1 Sources of Groundwater Contamination

2.0 STUDY AREA

West Bengal, located in Eastern India, borders Bangladesh and Assam to the East, Bhutan and Sikkim to the North, and Nepal, Bihar, Jharkhand, and Odisha to the West. To the South, it is bounded by the Bay of Bengal. West Bengal spans a Latitude of 21°10′N and 27°38′N and a Longitude of 85°50′E and 89°50′E.

The state of West Bengal has been divided into two broad hydrogeological units – hard consolidated to semi - consolidated formation and alluvial (unconsolidated) formation. Alluvial formation occupies about two - third of the state area while the remaining one - third is occupied by hard consolidated formation (Archaean crystalline & Gondwana Sedimentaries).

The state can be broadly divided into four distinct physiographical divisions i.e. (i) Himalayan Region comprising districts of Darjeeling, Jalpaiguri and Coachbihar, (ii) Eastern fringe of Chotanagpur Plateau comprising districts of Purullia, western part of Barddhaman, Medinipur (old), Birbhum and northern and western part of Bankura, (iii) Deltaic areas of Sundarbans comprising districts of South 24 Parganas and small part of North 24 Parganas forming deltaic zone, and (iv) Flat land areas.

In general, West Bengal is a flat plain crisscrossed with rivers except the Himalayan foot hills in the north and Chotanagpur plateau in the south - west. The state is principally drained by the southern flowing the Ganga River and its numerous distributaries. The Ganga River system encompasses the catchment areas of the Mahananda, Jalangi, Bhairab etc., in the eastern part and the Mayurakshi, Ajoy, Damodar, Dwarakeswar and Kasai in the western part. The Teesta Torsa and Jaldhaka streams of the Brahmaputra River system originate in the Himalayas and drain the northern part of the state. Besides them, there is a small independent river basin, the Subarnarekha basin covering south western part of the state in Purba and Paschim Medinipur district.

Table 1. District wise distribution of water Quality Monitoring Stations

Sr no	District	No. of Water Quality Monitoring Station				
		2020	2021	2022	2023	2024
1	Alipurduar	19	2	17	20	20
2	Bankura	62	59	48	76	85
3	Birbhum	55	14	41	38	40
4	Cooch Behar	28	2	24	30	31
5	Dakshin Dinajpur	21	18	17	35	39

6	Darjeeling	37	35	45	38	39
7	Howrah	24	13	24	17	21
8	Hughli	33	16	36	29	41
9	Jalpaiguri	37	29	39	46	47
10	Jhargram	18	4	7	30	29
11	Kolkata	13	16	7	16	16
12	Malda	23	17	22	50	51
13	Murshidabad	36	40	44	64	66
14	Nadia	38	23	20	54	60
15	North 24 PGS	53	31	63	83	92
16	Paschim Barddhaman	57	2	44	57	58
17	Paschim Medinipur	41	18	34	66	66
18	Purba Barddhaman	54	44	40	47	50
19	Purba Medinipur	13	0	25	36	38
20	Purulia	39	44	35	22	32
21	South 24 PGS	61	86	90	84	90
22	Uttar Dinajpur	9	2	15	21	22
	Total	**771**	**515**	**737**	**959**	**1033**

3.0 GROUNDWATER QUALITY MONITORING

In West Bengal, ground water level monitoring is being carried out by Central Ground Water Board, Eastern Region, Kolkata from 1810 Ground Water Monitoring Stations (GWMS) covering all districts of West Bengal encompassing various hydrogeological and agro-climatic zones during the month of January (from 1st to 10th), April (from 20th to 30th), August (from 20th to 30th) and November (from 1st to 10th). Periodical monitoring of ground water regime is conducted to acquire information on behavior of ground water levels, chemical quality and temperature of formation water through representative sampling.

The chemical quality of ground water is being monitored by Central Ground Water Board twice in a year (Pre-monsoon and Post-monsoon) since 2024 through 1033 locations located all over the state **(Fig. 2)**.

The present bulletin has been prepared on the Water quality data (analyzed in Regional Chemical Laboratory, Eastern Region, Kolkata) for the groundwater samples of West Bengal, collected during Pre-monsoon 2024. The primary goal of a groundwater quality monitoring program is to assess water quality distribution on a regional scale and establish a baseline data bank of the different chemical components in groundwater.

The district-wise distribution of water Quality Monitoring Stations of CGWB is given in **Table 1**. This bulletin is based on the changing scenario of water quality in network observation wells of West Bengal in year 2020 and 2024.

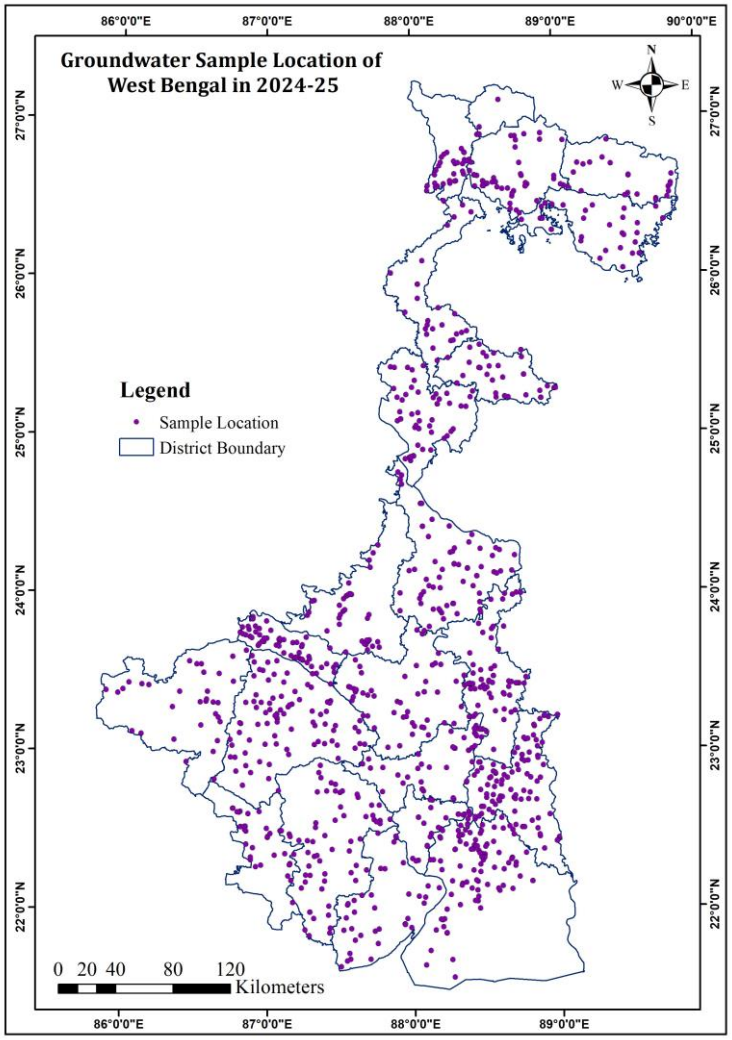


Fig. 2 Map showing Spatial Distribution of 1033 Groundwater Quality Monitoring Stations in West Bengal based on 2024 NHS (Pre-monsoon)

4.0 GROUNDWATER QUALITY SCENARIO

The primary objective of groundwater quality monitoring is to evaluate the suitability of groundwater for drinking purposes. The quality of drinking water is a critical environmental factor influencing the health of communities.

The Bureau of Indian Standards (BIS), through IS: 10500:2012, Edition 3.2 (2012-15), has set the recommended quality standards for drinking water in India. These standards serve as a benchmark for assessing groundwater quality.

Groundwater samples, collected from Phreatic and Confined aquifers are analyzed for major inorganic parameters. The analysis aimed to identify the chemical composition of groundwater in West Bengal, its suitability and to classify the water types based on salinity and Electrical Conductance.

Based on Geographical Locations of the districts, Principal aquifer Systems of West Bengal, Major Aquifers, Geology, Lithology and existing River Systems the districts have been divided into four sub groups and hydrochemical features of concerned subgroup have been discussed separately (**Table 2**). The Subgroups are as follows –

1. **Northern Region** comprising Darjeeling, Jalpaiguri, Alipurduar, Kochbehar, Uttar Dinajpur, Dakshin Dinajpur and Malda Districts.
2. **South Western Region** comprising Bankura, Purulia and Birbhum Districts.
3. **South Central Region** comprising Purba Bardhaman, Paschim Bardhaman, Howrah, Hooghly, Purba Medinipur, Paschim Medinipur and Jhargram Districts.
4. **South Eastern Region** comprising Murshidabad, Nadia, North 24 Parganas, South 24 Parganas and Kolkata Districts.

Table 2. Facies distribution in different Geographical section of West Bengal

Geographical Section	Ca-HCO_3	Mg-HCO_3	Na-HCO_3	Ca-Cl	Mg-Cl	Na-Cl
	% sample					
Northern Region	38	26	7	10	8	10
South Eastern Region	27	35	22	-	4	12
South Western Region	17	19	13	9	21	20
South Central Region	20	16	40	4	5	16

From the Table 2, this is evident that for Northern Region, comprising districts of North Bengal, the dominant facies is Ca-HCO_3. In case of South Eastern Zone, South Western Zone and South-Central Zone, the dominant facies is Mg-HCO_3, Mg-Cl and Na-HCO_3 respectively.

Nevertheless, occurrence of high concentrations of some water quality parameters such as Salinity (EC), Fluoride, Nitrate, Iron, and Arsenic and the changes in water quality based on these parameters have been observed in the various parts of West Bengal. These changes in water quality are significant and warrant continuous investigation and monitoring.

4.1 QUALITY ASSESSMENT OF GROUNDWATER IN WEST BENGAL

To establish the ground water chemistry of the state, samples from different corners of West Bengal (23 Districts) both from confined and unconfined aquifer have been collected during the month of April/May (2024-25), which is generally a dry period, leading to maximum concentration of elements in the water samples.

In an unconfined aquifer, there is no overlying impermeable layer, like clay, to block water flow from above. This allows the aquifer to freely recharge from precipitation, surface water, and other sources. This makes the aquifer more vulnerable to accumulating contaminants, leading to significant impacts on its water quality.

The chemical parameters such as TDS, Fluoride, Nitrate, Iron, and Arsenic are key indicators of groundwater quality. Therefore, the presence of these parameters and any changes in their chemical composition are discussed as under:

1. Electrical Conductivity (> 3000 µS/cm)

2 Fluoride (>1.5 mg/litre)

3. Nitrate (>45 mg/litre)

4. Iron (>1.0 mg/litre)

5. Arsenic (>0.01 mg/litre)

4.1.1 ELECTRICAL CONDUCTIVITY

Electrical conductivity or Total dissolved solids or Salinity is the dissolved salt content in a water body. Different substances dissolve in water giving it taste and odour. Electrical conductivity represents total number of cations and anions present in groundwater, indicating ionic mobility of different ions, total dissolved solids and saline nature of water.

In general water having EC < 1500 µS/cm, is considered as fresh water, EC 1500 –15000 µS/cm is considered as brackish water and >15000 µS/cm is considered as saline water. Salinity always exists in ground water but in variable amounts. It is mostly influenced by aquifer material, solubility of minerals, duration of contact and factors such as the permeability of soil, drainage facilities, quantity of rainfall and above all, the climate of the area. BIS has recommended a drinking water standard for total dissolved solids a limit of 500mg/I corresponding to EC of about 750 µS/cm at 25°C) that can be extended to a TDS of 2000 mg/L (corresponding to EC of about 3000 µS/cm at 25°C) in case of no alternate source. Water having TDS more than 2000 mg/litre are not suitable for drinking purposes.

SCENARIO OF WEST BENGAL W. R.T ELECTRICAL CONDUCTIVITY (EC)

Distribution of Electrical Conductivity (EC)

The EC value of ground waters in the State varies from 44 µS/cm at Rangamati Overbridge, Mal block of Jalpaiguri district to 5534 µS/cm at Balarampur, Indpur block of Bankura district at 25°C. Grouping water samples based on EC values, it is found that 60.4 % of them have EC less than 750 µS/cm, 38.5% have between 750 and 3000 µS/cm and the remaining 1.1% of the samples have EC above 3000µS/cm. The map showing aerial distribution of EC **(Fig. 3)** with intervals corresponding to limits as above indicates that less than 750 class of water occur throughout the state in patches but in high proportion is in Southern, Western and Eastern parts of the State. The ground water occurring in the Southern, Central and some part in West comprising of parts of South 24 Pgs., Howrah, Malda, Purulia and Bankura districts are mostly saline and is not suitable for drinking purpose in terms of Electrical Conductance.

Table 3 provides the number of samples analyzed per district, along with their minimum, maximum, and mean EC values based on NHS 2024 pre-monsoon Data.

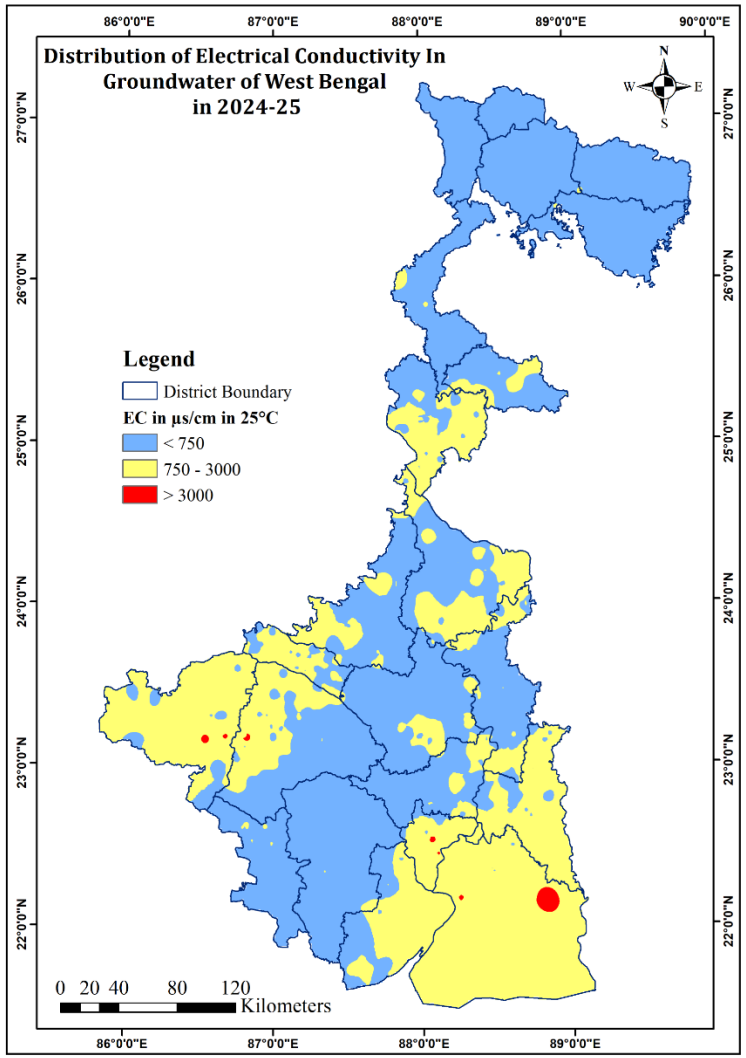


Fig. 3 Map showing distribution of Electrical Conductivity in West Bengal based on NHS 2024 Data

Table 3. District wise distribution of EC in GW of West Bengal

District	No. of sample analysed	permissible limit	max	min	mean	No. of samples(%)		
						<750	750-3000	>3000
Alipurduar	20	3000	700	103	307	100	0	0
Bankura	85	3000	5534	60	765	61.2	37.6	1.2
Birbhum	40	3000	2166	169	718	60	40	0
Cooch Behar	31	3000	1089	82	379	93.5	6.5	0
Dakshin Dinajpur	39	3000	1684	186	527	84.6	15.4	0
Darjeeling	39	3000	709	62	282	100	0	0
Howrah	21	3000	3684	452	1476	33.3	47.6	19
Hughli	41	3000	2558	268	695	68.3	31.7	0
Jalpaiguri	47	3000	1037	44	318	97.9	2.1	0
Jhargram	29	3000	1312	64	425	82.8	17.2	0
Kolkata	16	3000	2003	461	1102	18.8	81.3	0
Malda	51	3000	3371	310	904	52.9	45.1	2
Murshidabad	66	3000	2680	170	837	53	47	0
Nadia	60	3000	1470	329	592	85	15	0
North 24 PGS	92	3000	2985	370	918	30.4	69.6	0
Paschim Barddhaman	58	3000	2850	96	915	41.4	58.6	0
Paschim Medinipur	66	3000	907	60	405	92.4	7.6	0
Purba Barddhaman	50	3000	1647	240	609	84	16	0
Purba Medinipur	38	3000	2166	320	857	44.7	55.3	0
purulia	32	3000	3572	205	1210	25	68.8	6.3
South 24 PGS	90	3000	5484	400	1354	5.6	91.1	3.3
Uttar Dinajpur	22	3000	1029	118	353	95.5	4.5	0

TEMPORAL VARIATION OF EC IN GROUND WATER DURING THE PERIOD FROM 2020 TO 2024

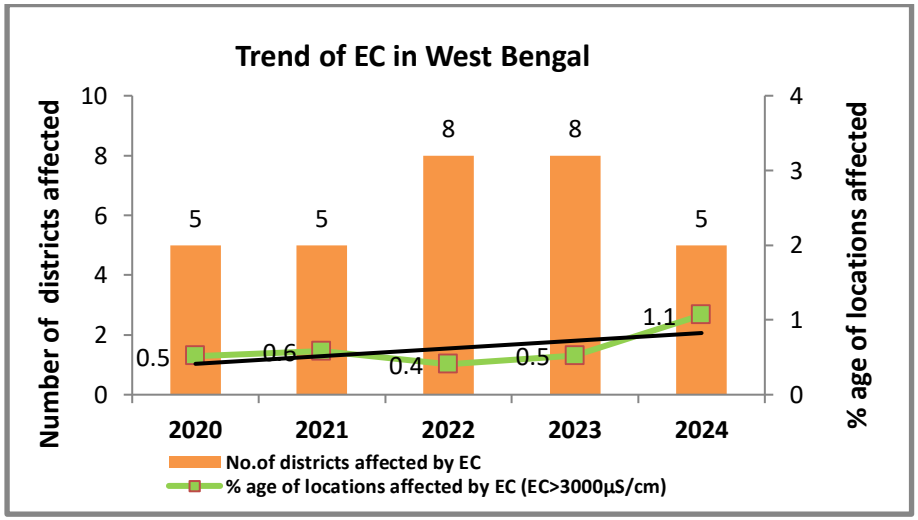
In comparison to 2020 (**Table 4**), it has been observed that there is marginal increase in the no. of Districts having EC more than 3000 µS/cm in 2024.

Table 4. Comparative change in number of locations having EC > 3000 µS/cm in various Districts

Sr. No	District	No. of locations >3000				
		2020	**2021**	**2022**	**2023**	**2024**
1	**Alipurduar**	0	0	0	0	0
2	**Bankura**	0	0	0	1	1
3	**Birbhum**	1	0	0	0	0
4	**Cooch Behar**	0	0	0	0	0
5	**Dakshin Dinajpur**	0	0	0	0	0
6	**Darjeeling**	0	0	0	0	0
7	**Howrah**	2	3	5	2	4
8	**Hughli**	1	0	0	0	0
9	**Jalpaiguri**	0	0	0	0	0
10	**Jhargram**	0	0	0	0	0
11	**Kolkata**	0	0	0	0	0
12	**Malda**	0	0	0	1	1
13	**Murshidabad**	0	0	0	0	0
14	**Nadia**	0	0	0	0	0
15	**North 24 PGS**	0	0	0	0	0
16	**Paschim Barddhaman**	0	0	0	0	0
17	**Paschim Medinipur**	0	0	0	0	0
18	**Purba Barddhaman**	0	0	0	0	0
19	**Purba Medinipur**	0	0	0	0	0
20	**Purulia**	0	1	2	1	2
21	**South 24 PGS**	1	1	1	3	3
22	**Uttar Dinajpur**	0	0	0	0	0
	Total	**5**	**5**	**8**	**8**	**11**

Table 5. Periodic variation in suitability Classes of groundwater Electrical Conductivity (EC) of West Bengal

Parameter	Class	Percentage of samples					Periodic Variation 2020-2023
		2020 (n=771)	2021 (n=515)	2022 (n=737)	2023 (n=959)	2024 (n=1033)	
Salinity as EC	< 750 mg/L	67.7	56.5	60.2	64.0	60.4	-7.3
	750-3000	32.9	44.5	38.7	35.0	38.5	5.6
	>3000	0.6	1.0	1.1	0.8	1.1	0.5



4.1.2 NITRATE

Naturally occurring nitrate forms when nitrogen and oxygen combine in soil, primarily sourced from atmospheric nitrogen. Groundwater nitrate mainly comes from chemical fertilizers, animal manure leaching, and sewage discharge. Identifying natural vs. man- made sources is challenging. Chemical and microbiological processes like nitrification and denitrification also affect groundwater nitrate levels.

As per the BIS standard for drinking water the maximum desirable limit of nitrate concentration in groundwater is 45 mg/L. Though nitrate is considered relatively non-toxic, a high nitrate concentration in drinking water is an environmental health concern arising from increased risks of methaemoglobonaemia particularly to infants. Adults can tolerate little higher concentration.

SCENARIO OF WEST BENGAL W. R. T NITRATE (NO_3^-)

Distribution of Nitrate (NO_3)

The probable sources of nitrate contamination of ground water are through excessive application of fertilizers, bacterial nitrification of organic nitrogen, and seepage from animal and human wastes and atmospheric inputs. In the State, nitrate in ground water samples varies from BDL to 161 mg/L. BIS permits a maximum concentration of 45 mg/L nitrate in drinking water. Considering this limit, it is found that 91.9% of the samples, spread over the entire State, have nitrate below 45 and 8.03 % have more than 45 mg/L. Spatial distribution of Nitrate (**Fig. 4**) indicates a considerable area of the western and southern part of state have Nitrate concentration exceeding 45 mg/L.

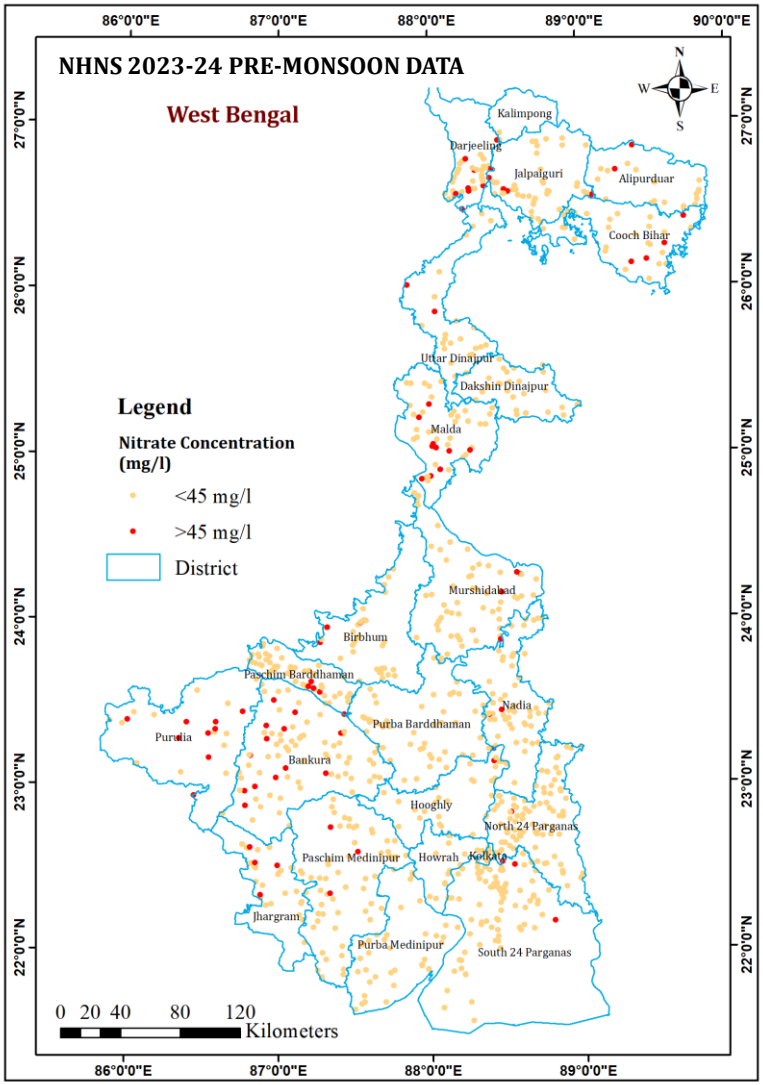


Fig. 4 Map showing distribution of Nitrate in West Bengal based on NHS 2024 Data

Table 6 given below provides for the number of samples analyzed per district, along with their minimum, maximum, and mean Nitrate values based on NHS 2024 Data.

Table 6. District wise Range and distribution of Nitrate in shallow GW of West Bengal

S.No.	District	No.of.samples analysed	Permissible limit	Desirable limit	Min	Max	Mean	No.of samples(%)	
								< 45 mg/L	>45 mg/L
1	Alipurdaur	20	45.00		0.0	96.6	18.2	90.0	10.0
2	Bankura	85	45.00		0.0	52.0	15.1	92.9	7.1
3	Birbhum	40	45.00		0.0	52.6	17.0	90.0	10.0
4	Coachbehar	31	45.00		0.0	96.6	19.0	87.1	12.9
5	Dakshin Dinajpur	39	45.00		0.0	52.1	3.6	97.4	2.6
6	Darjeeling	39	45.00		0.0	82.6	26.6	66.7	33.3
7	Howrah	21	45.00		0.0	45.1	14.9	100.0	0.0
8	Hughli	41	45.00		0.0	160.5	13.3	92.7	7.3
9	Jalpaiguri	47	45.00		0.4	103.1	18.8	93.6	6.4
10	Jhargram	29	45.00		0.0	54.0	16.4	86.2	13.8
11	Kolkata	16	45.00		0.0	42.4	6.6	100.0	0.0
12	Malda	51	45.00		0.0	59.0	12.9	80.4	19.6
13	Murshidabad	66	45.00		0.0	53.5	10.0	93.9	6.1
14	Nadia	60	45.00		0.0	52.0	5.9	96.7	3.3
15	North 24 PGS	92	45.00		0.0	51.0	6.1	98.9	1.1
16	Paschim Medinipur	66	45.00		0.0	50.9	6.1	95.5	4.5
17	Paschim Barddhaman	58	45.00		0.0	137.9	27.7	79.3	20.7

18	purulia	32	45.00	0.0	53.0	21.5	84.4	15.6
19	Purba Barddhaman	50	45.00	0.0	47.5	5.8	98.0	2.0
20	Purba Medinipur	38	45.00	0.0	25.8	1.5	100.0	0.0
21	South 24 PGS	90	45.00	0.0	53.0	7.0	95.6	4.4
22	Uttar Dinajpur	22	45.00	0.0	48.5	8.1	95.5	4.5

TEMPORAL VARIATION OF NO_3 IN GROUND WATER DURING THE PERIOD FROM 2020 TO 2024

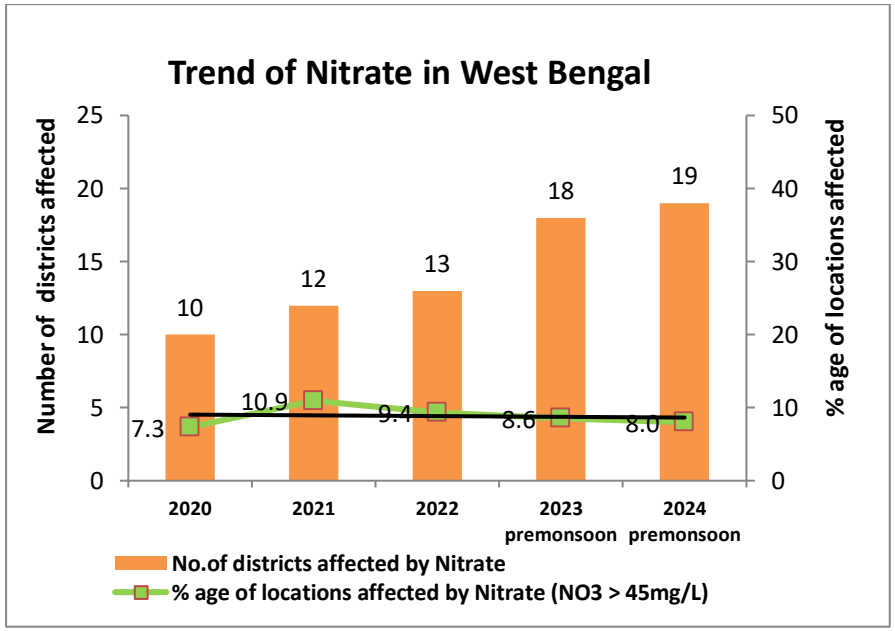
It has been observed (**Table 7**) that No. of locations in various Districts having high Nitrate (more than 45 mg/l) content in ground water has increased from **60** in year 2020 to **83** in the year 2024.

Table 7. Comparative Change in number of locations having Nitrate > 45 mg/I

S.no.	District	No.of Locations having Nitrate > 45.0 mg/L				
		2020	2021	2022	2023	2024
1	Alipurdaur	0	0	1	2	2
2	Bankura	23	16	13	14	6
3	Birbhum	0	0	7	3	4
4	Coachbehar	5	0	3	2	4
5	Dakshin Dinajpur	1	1	0	1	1
6	Darjeeling	12	9	6	10	13
7	Howrah	0	1	0	0	0
8	Hughli	1	1	3	2	3
9	Jalpaiguri	4	2	4	4	3
10	Jhargram	0	0	0	4	4
11	Kolkata	0	0	0	0	0
12	Malda	1	3	0	10	10
13	Murshidabad	0	5	2	6	4
14	Nadia	2	2	2	2	2
15	North 24 PGS	0	0	0	1	1
16	Paschim Medinipur	0	0	0	3	3
17	Paschim Barddhaman	0	1	10	5	12
18	Purulia	10	14	16	9	5
19	Purba Barddhaman	0	2	1	0	1
20	Purba Medinipur	0	0	0	0	0
21	South 24 PGS	0	0	1	3	4
22	Uttar Dinajpur	1	0	0	1	1
	Total	**60**	**57**	**69**	**82**	**83**

Table 8. Periodic variation in suitability Classes of Nitrate in groundwater of West Bengal

Parameter	Class	Percentage of samples					Periodic Variation 2020-2024
		2020 (n=818)	2021 (n=521)	2022 (n=737)	2023 (n=959)	2024 (n=1033)	
Nitrate as NO3-	< 45 mg/L	92.6	89.1	90.7	91.4	91.9	-0.7
	> 45 mg/L	7.3	10.9	9.2	8.5	8.03	0.7



4.1.3 FLUORIDE

Fluorine does not occur in the elemental state in nature because of its high reactivity. It exists in the form of fluorides in a number of minerals of which Fluorspar, Cryolite, Fluorite & Fluorapatite are the most common.

Most of the fluoride found in groundwater is naturally occurring from the breakdown of rocks and soils or weathering and deposition of atmospheric particles. Most of the fluorides are sparingly soluble and are present in groundwater in small amount. The type of rocks, climatic conditions, nature of hydro geological strata and time of contact between rock and the circulating groundwater affect the occurrence of fluoride in natural water.

BIS has recommended a desirable limit of 1.0 mg/l of fluoride concentration in drinking water and maximum permissible limit of 1.5 mg/l in case no alternative source of drinking water is available. It is well known that small amount of fluoride (upto1.0 mg/l) have proven to be beneficial in reducing tooth decay. However, high concentrations (>1.5mg/l) have resulted in staining of tooth enamel while at still higher levels of fluoride (> 5.0 mg/l) further critical problems such as stiffness of bones occur. Water having fluoride concentration more than 1.5mg/l is not suitable for drinking purposes. High Fluoride >1.5mg/l is mainly attributed due to geogenic conditions. The fluoride content in ground water from observation wells in a major part of the State is found to be less than 1.0 mg/l.

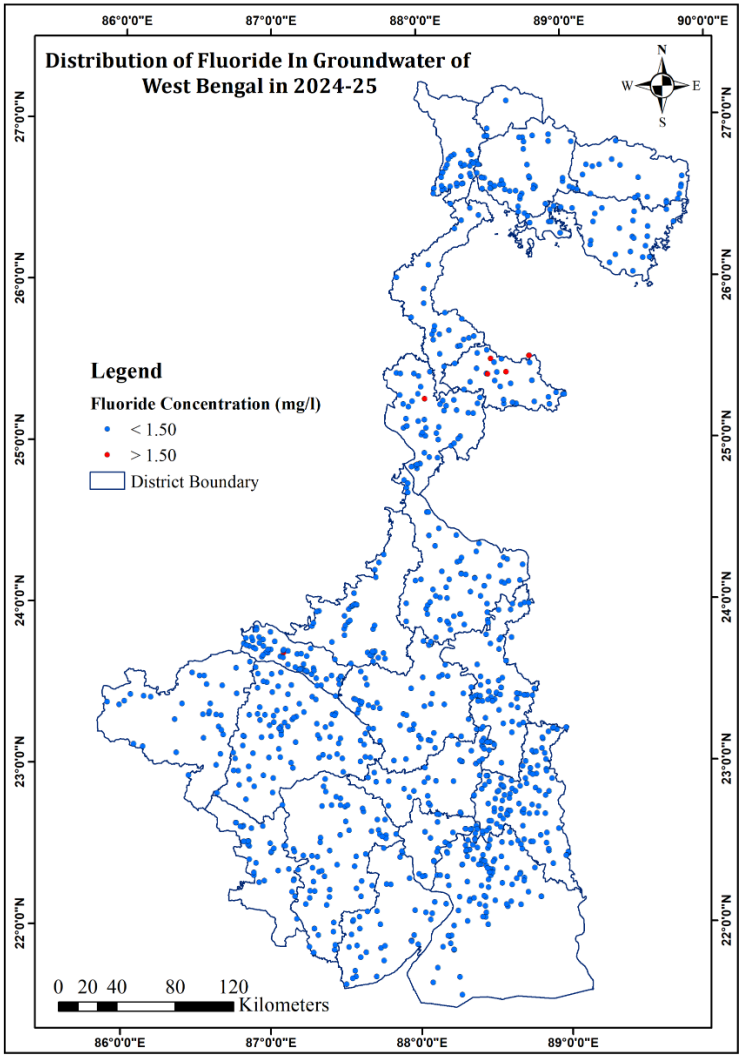


Fig. 5 Map showing distribution of Fluoride in West Bengal based on NHS 2024 Data

SCENARIO OF WEST BENGAL W. R. T Fluoride

Distribution of Fluoride (F)

Fluoride in small amounts in drinking water is beneficial for the dental health while in large amounts it is injurious. The fluoride content in ground water ranges from 0.00 to 3.5 mg/L. BIS recommends that fluoride concentration up to 1.0 mg/L in drinking water is desirable, up to 1.50 mg/L it is permitted and above 1.50 mg/L is injurious. Classification of samples based on this recommendation, it is found that 96 % samples have fluoride in desirable range, 3.2 % in the permissible and the remaining 0.8 % have fluoride above 1.50 mg/L.

Map showing spatial distribution **(Fig. 5)** of fluoride contents in ground water indicates that ground waters with fluoride above 1.50 mg/L are found mainly in Birbhum, Dakshin Dinajpur and Paschim Bardhaman and Malda districts of the State. It is worth mentioning that high fluoride waters are encountered in areas where high salinity is encountered.

Table 9 given below provides for the number of samples analyzed per district, along with their minimum, maximum, and mean Fluoride values based on NHS 2024 Data.

Table 9. District wise Range and distribution of Fluoride in shallow GW of West Bengal

Fluoride (F-)									
S. No.	District	No. of samples analysed	Permissible limit	Desirable limit	Min	Max	Mean	No. of samples (%)	
								<=1.5	>1.5
1	Alipurdaur	20	1.5		0.0	1.4	0.6	100.0	0.0
2	Bankura	85	1.5		0.0	1.0	0.2	100.0	0.0
3	Birbhum	40	1.5		0.0	1.6	0.3	97.5	2.5
4	Coachbehar	31	1.5		0.1	1.0	0.2	100.0	0.0
5	Dakshin Dinajpur	39	1.5		0.0	3.5	0.7	87.2	12.8
6	Darjeeling	39	1.5		0.0	0.8	0.2	100.0	0.0
7	Howrah	21	1.5		0.1	1.0	0.4	100.0	0.0
8	Hughli	41	1.5		0.1	0.9	0.3	100.0	0.0
9	Jalpaiguri	47	1.5		0.0	1.5	0.6	100.0	0.0
10	Jhargram	29	1.5		0.0	0.4	0.1	100.0	0.0
11	Kolkata	16	1.5		0.2	0.5	0.3	100.0	0.0
12	Malda	51	1.5		0.1	2.0	0.3	98.0	2.0
13	Murshidabad	66	1.5		0.0	1.1	0.2	100.0	0.0
14	Nadia	60	1.5		0.0	1.1	0.4	100.0	0.0
15	North 24 PGS	92	1.5		0.0	1.2	0.3	100.0	0.0
16	Paschim Medinipur	66	1.5		0.0	0.4	0.2	100.0	0.0
17	Paschim Barddhaman	58	1.5		0.0	1.6	0.5	98.5	1.5
18	purulia	32	1.5		0.0	1.3	0.3	100.0	0.0
19	Purba Barddhaman	50	1.5		0.0	0.5	0.2	100.0	0.0
20	Purba Medinipur	38	1.5		0.1	0.5	0.2	100.0	0.0
21	South 24 PGS	90	1.5		0.1	0.6	0.2	100.0	0.0
22	Uttar Dinajpur	22	1.5		0.0	0.6	0.2	100.0	0.0
		1033							

TEMPORAL VARIATION OF FLUORIDE IN GROUND WATER DURING THE PERIOD FROM 2020 TO 2024

It has been observed (**Table 10**) that total number of districts affected by high fluoride has decreased from 28 in 2020 to 07 in 2023.

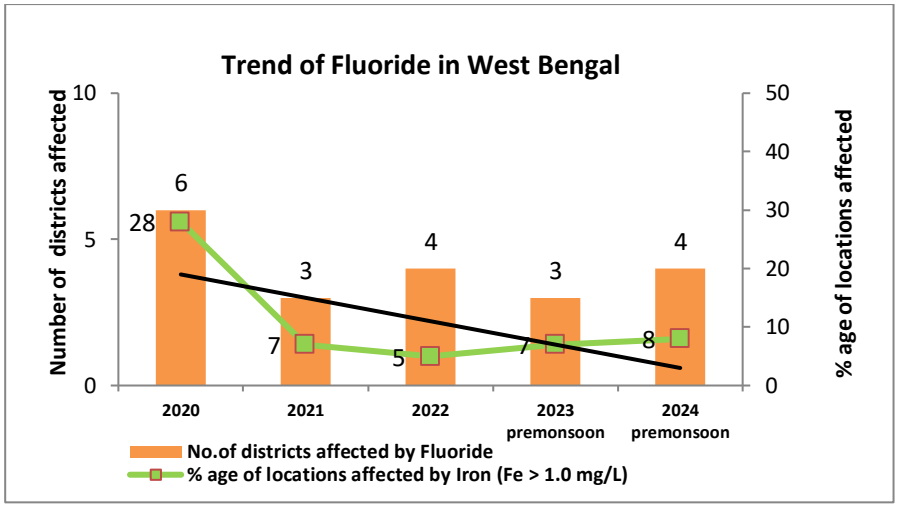
Table 10. Comparative Change in number of Locations having F > 1.5 mg/L

S. No.	District	No.of Locations having Fluoride > 1.5ppm				
		2020	2021	2022	2023	2024
1	Alipurdaur	0	0	0	0	0
2	Bankura	10	1	0	0	0
3	Birbhum	3	0	1	1	1
4	Coachbehar	0	0	0	0	0
5	Dakshin Dinajpur	0	5	2	5	5
6	Darjeeling	0	0	0	0	0
7	Howrah	0	0	0	0	0
8	Hughli	0	0	0	0	0
9	Jalpaiguri	0	0	0	0	0
10	Jhargram	1	0	0	0	0
11	Kolkata	0	0	0	0	0
12	Malda	0	1	1	0	1
13	Murshidabad	3	0	1	0	0
14	Nadia	0	0	0	0	0
15	North 24 PGS	0	0	0	0	0
16	Paschim Medinipur	0	0	0	0	0
17	Paschim Barddhaman	3	0	0	1	1

18	purulia	0	0	0	0	0
19	Purba Barddhaman	0	0	0	0	0
20	Purba Medinipur	0	0	0	0	0
21	South 24 PGS	8	0	0	0	0
22	Uttar Dinajpur	0	0	0	0	0
	Total	**28**	**7**	**5**	**7**	**8**

Table 11. Periodic variation in suitability Classes of Fluoride in groundwater of West Bengal

Parameter	Class	Percentage of samples				
		2020 (n=771)	2021 (n=515)	2022 (n=737)	2023 (n=959)	2024 (n=1033)
Fluoride as F-	< 1.0 mg/L	91.3	91.6	98.5	95.8	96
	1.0-1.5mg/L	5.1	7.4	0.8	3.5	3.2
	> 1.5 mg/L	3.6	1	0.7	0.7	0.8



4.1.4 Arsenic

Arsenic, a naturally occurring element, is widely distributed throughout the Earth's crust and can be found in various environmental mediums such as water, air, food, and soil. It exists in two primary forms: organic and inorganic. While natural processes like biological activities, weathering reactions, and volcanic emissions contribute to arsenic release, human activities also play a significant role. Anthropogenic sources include mining activities, fossil fuel combustion, the use of arsenical pesticides, herbicides, and crop desiccants, as well as arsenic additives in livestock feed, especially poultry feed. Although the use of arsenical products like pesticides and herbicides has declined over recent decades, their use in wood preservation remains common. The maximum permissible limit for arsenic according to the Bureau of Indian Standards (BIS) is 10 parts per billion (ppb).

SCENARIO OF WEST BENGAL W. R. T Arsenic

Distribution of Arsenic (As) The arsenic content in ground water ranges from BDL to 242.4 µg/L. BIS recommends that arsenic concentration up to 10 µg/L in drinking water is acceptable. Classification of samples based on this recommendation, it is found that 8.6% samples have arsenic above 10 µg/L. Map showing spatial distribution **(Fig. 6)** of arsenic content in ground water (2024) indicates that ground water with arsenic above 10 µg/L are found mainly in Malda, Murshidabad, Nadia, North 24 and South 24 Paraganas districts of the State.

Table-12 Provides for the number of samples analyzed per district, along with their minimum, maximum, mean Arsenic values based on NHS 2024 Data.

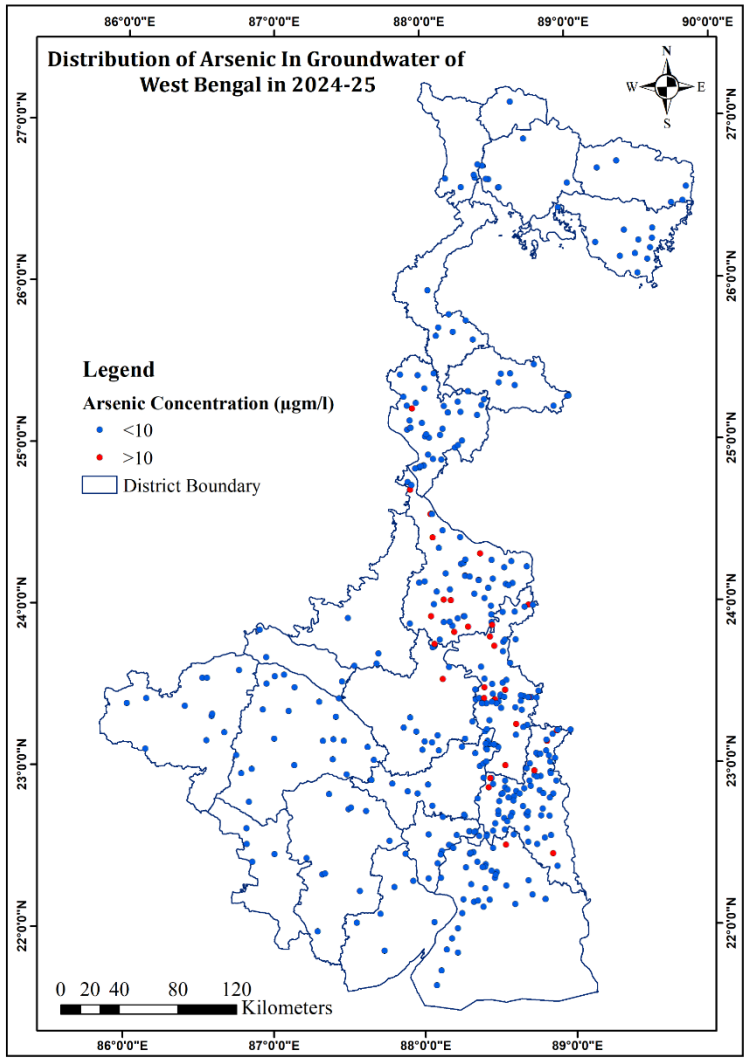


Fig. 6 Map showing distribution of Arsenic in West Bengal based on NHS 2023 Data

Table 12. District wise Range and distribution of Arsenic in West Bengal

S. no.	District	No.of.samples analysed	Permissible limit(ppb)	Min	Max	Mean	No. of samples (%)	
							<=10ppb	>10ppb
1	Alipurdaur	20	10.0	0.0	2.3	0.3	100.0	0.0
2	Bankura	85	10.0	0.0	3.1	0.3	100.0	0.0
3	Birbhum	40	10.0	0.0	1.9	0.1	100.0	0.0
4	Coachbehar	31	10.0	0.0	4.7	0.7	100.0	0.0
5	Dakshin Dinajpur	39	10.0	0.0	5.6	0.6	100.0	0.0
6	Darjeeling	39	10.0	0.0	2.0	0.1	100.0	0.0
7	Howrah	21	10.0	0.0	9.2	2.2	100.0	0.0
8	Hughli	41	10.0	0.0	9.1	1.9	100.0	0.0
9	Jalpaiguri	47	10.0	0.0	6.1	0.3	100.0	0.0
10	Jhargram	29	10.0	0.0	2.5	0.2	100.0	0.0
11	Kolkata	16	10.0	0.0	7.1	1.4	100.0	0.0
12	Malda	51	10.0	0.0	14.9	3.8	96.1	3.9
13	Murshidabad	66	10.0	0.0	242.4	16.3	78.8	21.2
14	Nadia	60	10.0	0.0	90.8	8.9	80.0	20.0
15	North 24 PGS	92	10.0	0.0	125.9	4.1	93.5	6.5
16	Paschim Medinipur	66	10.0	0.0	3.4	0.2	100.0	0.0
17	Paschim Barddhaman	58	10.0	0.0	5.1	0.1	100.0	0.0
18	purulia	32	10.0	0.0	2.7	0.1	100.0	0.0
19	Purba Barddhaman	50	10.0	0.0	8.3	1.0	100.0	0.0
20	Purba Medinipur	38	10.0	0.0	4.3	0.3	100.0	0.0
21	South 24 PGS	90	10.0	0.0	14.3	1.4	98.9	1.1
22	Uttar Dinajpur	22	10.0	0.0	6.4	0.9	100.0	0.0

TEMPORAL VARIATION OF ARSENIC IN GROUND WATER DURING THE PERIOD FROM 2020 TO 2024

As compared to the data available in year 2019, the number of locations having Arsenic more than 10 µg/L in ground water samples has slightly decreased (**Table 13**) during the year 2024.

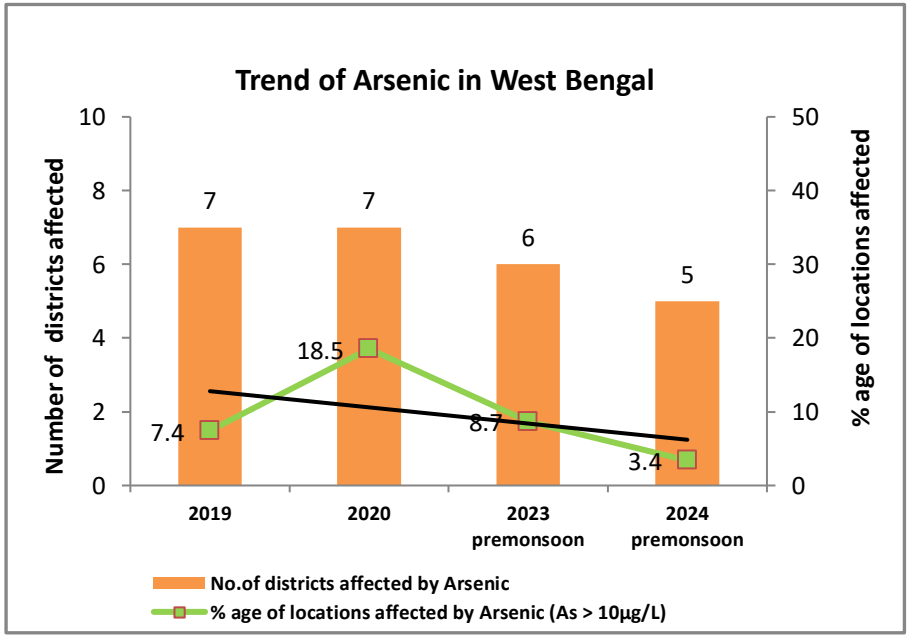
Table 13. Comparative Change in number of Locations having As > 10 µg/L

S.no.	District	No.of Locations having Arsenic > 10ppb			
		2019	2020	2023	2024
1	Alipurdaur	0	0	0	0
2	Bankura	0	0	0	0
3	Birbhum	0	0	0	0
4	Coachbehar	0	0	0	0
5	Dakshin Dinajpur	0	0	0	0
6	Darjeeling	0	0	0	0
7	Howrah	1	1	2	0
8	Hughli	2	11	0	0
9	Jalpaiguri	0	0	0	0
10	Jhargram	0	0	0	0
11	Kolkata	0	0	0	0
12	Malda	4	9	4	2
13	Murshidabad	20	15	29	14
14	Nadia	17	18	23	12
15	North 24 PGS	22	17	22	6
16	Paschim Medinipur	0	0	0	0
17	Paschim Barddhaman	0	0	0	0
18	purulia	0	0	0	0
19	Purba Barddhaman	0	2	0	0
20	Purba Medinipur	0	0	0	0
21	South 24 PGS	3	5	3	1

4.1.5 IRON

Table 14. Periodic variation in suitability Classes of Arsenic in groundwater of West Bengal

Parameter	Class	Percentage of samples				Periodic Variation 2019-2024
		2019 (n=930)	2020 (n=421)	2023 (n=959)	2024 (n=1033)	
Arsenic as As	< 10µg/L	92.5	81.4	91.3	96.6	-4.1
	> 10µg/L	7.4	18.5	8.6	3.3	4.1



Iron is a common constituent in soil and ground water. It is present in water either as soluble ferrous iron or the insoluble ferric iron. Water containing ferrous iron is clear and colorless because the iron is completely dissolved. When exposed to air, the water turns cloudy due to oxidation of ferrous iron into reddish brown ferric oxide.

The concentration of iron in natural water is controlled by both physico-chemical and microbiological factors. It is contributed to ground water mainly from weathering of ferruginous minerals of igneous rocks such as hematite, magnetite and sulphide ores of sedimentary and metamorphic rocks. The permissible Iron concentration in ground water is less than 1.0 mg/litre as per the BIS Standard for drinking water.

SCENARIO OF WEST BENGAL W. R. T IRON

Distribution of Iron (Fe)

The iron content in ground water ranges from BDL to 30.6 mg/L. BIS recommends that iron concentration up to 1.0 mg/L in drinking water is acceptable. Classification of samples based on this recommendation, it is found that 34.7 % samples have iron above 1.0 mg/L. Map showing spatial distribution (**Fig. 7**) of ground water (2024) indicates that ground waters with iron above iron content in 1.0 mg/L are found mainly in Bankura, Nadia, North 24 Paraganas, Malda, Murshidabad, dakshin and Uttar Dinajpur districts of the State

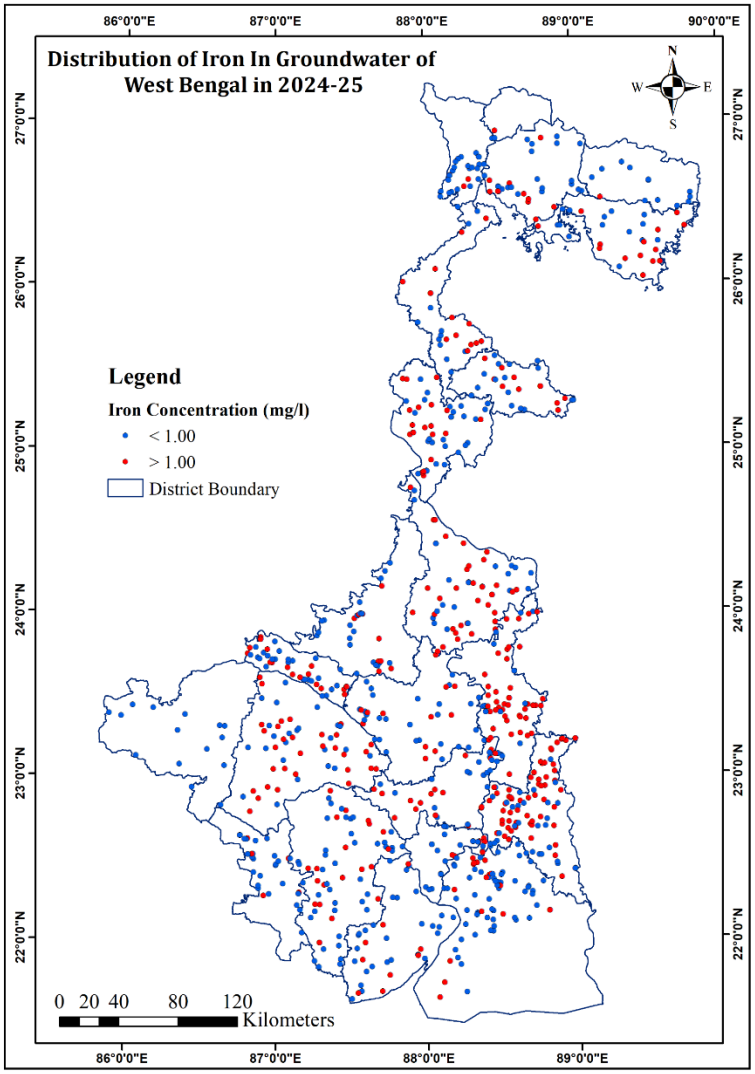


Fig. 7 Map showing distribution of Iron in West Bengal based on NHS 2024 Data

Table 15 given below provides for the number of samples analyzed per district, along with their minimum, maximum, mean Iron values based on NHS 2024 Data.

Table 15. District wise Range and distribution of Iron in West Bengal

Iron (Fe)									
S.no.	District	No.of.samples analysed	Permissible limit	Desirable limit	Min	Max	Mean	No.of samples(%)	
								<=1.0 ppm	>1.0ppm
1	Alipurdaur	20	1.00		0.00	3.40	0.43	95.0	5.0
2	Bankura	85	1.00		0.00	30.55	3.55	63.5	36.5
3	Birbhum	40	1.00		0.00	19.47	1.91	72.5	27.5
4	Coachbehar	31	1.00		0.00	17.61	3.80	51.6	48.4
5	Dakshin Dinajpur	39	1.00		0.00	16.84	2.60	59.0	41.0
6	Darjeeling	39	1.00		0.00	12.87	0.71	89.7	10.3
7	Howrah	21	1.00		0.00	8.64	0.88	85.7	14.3
8	Hughli	41	1.00		0.02	12.65	1.68	65.0	35.0
9	Jalpaiguri	47	1.00		0.00	10.05	0.81	78.7	21.3
10	Jhargram	29	1.00		0.02	1.34	0.45	89.7	10.3
11	Kolkata	16	1.00		0.26	11.56	2.11	62.5	37.5
12	Malda	51	1.00		0.03	18.90	2.40	60.8	39.2
13	Murshidabad	66	1.00		0.00	16.36	3.21	43.9	56.1

14	Nadia	60	1.00		0.00	22.46	3.51	25.0	75.0
15	North 24 PGS	92	1.00		0.00	24.69	3.36	30.4	69.6
16	Paschim Medinipur	66	1.00		0.14	29.47	2.19	68.2	31.8
17	Paschim Barddhaman	58	1.00		0.00	5.08	0.75	82.8	17.2
18	purulia	32	1.00		0.00	0.65	0.14	100.0	0.0
19	Purba Barddhaman	50	1.00		0.00	24.82	1.49	74.0	26.0
20	Purba Medinipur	38	1.00		0.21	12.90	1.96	73.7	26.3
21	South 24 PGS	90	1.00		0.00	12.92	0.94	83.3	16.7
22	Uttar Dinajpur	22	1.00		0.01	17.07	3.18	59.1	40.9

TEMPORAL VARIATION OF IRON IN GROUND WATER DURING THE PERIOD FROM 2020 TO 2024

As compared to the data available in year 2020, the number of districts having Iron more than 1.0 mg/l in ground water samples has marginally Increased (**Table-16**) during the year 2024.

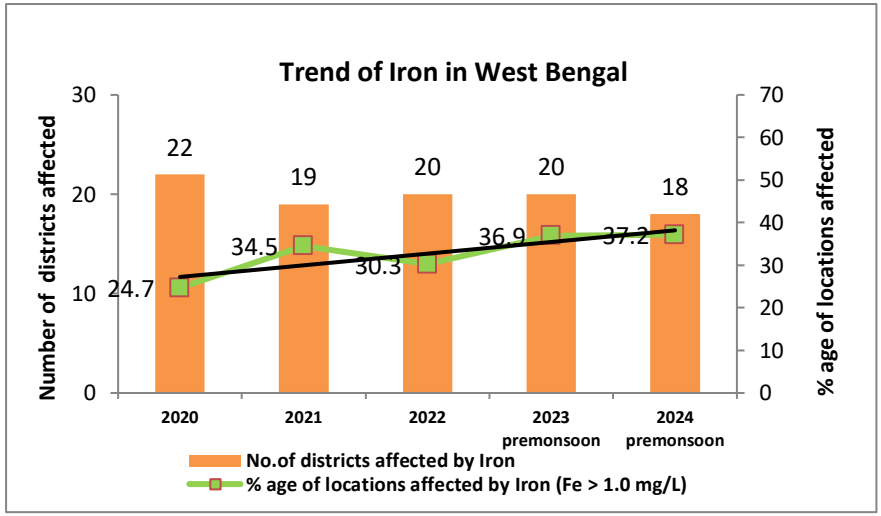
Table 16. Comparative Change in number of Locations having Fe > 1.0 mg/L

S.no.	District	No.of Locations having Iron > 1.0 mg/L				
		2020	2021	2022	2023	2024
1	Alipurdaur	4	0	0	0	1
2	Bankura	11	8	6	32	31
3	Birbhum	5	6	10	9	11
4	Coachbehar	6	0	0	15	15
5	Dakshin Dinajpur	5	10	8	11	16
6	Darjeeling	8	8	5	2	4
7	Howrah	8	4	10	2	3
8	Hughli	10	5	8	14	14
9	Jalpaiguri	2	4	2	8	10
10	Jhargram	4	1	2	5	3
11	Kolkata	8	10	2	6	6
12	Malda	5	2	5	20	20
13	Murshidabad	19	34	26	36	37
14	Nadia	20	13	15	42	45
15	North 24 PGS	32	17	46	59	64
16	Paschim Medinipur	9	5	11	21	21
17	Paschim Barddhaman	10	1	1	14	10
18	purulia	1	1	0	14	0
19	Purba Barddhaman	4	18	18	18	13
20	Purba Medinipur	6	0	9	7	10
21	South 24 PGS	21	32	37	5	15
22	Uttar Dinajpur	4	1	2	14	9
	Total	**202**	**180**	**223**	**354**	**358**

Table 17. Periodic variation in suitability Classes of Iron in groundwater of West Bengal

Parameter	Class	Percentage of samples					Periodic Variation 2020-2024
		2020 (n=818)	2021 (n=521)	2022 (n=737)	2023 (n=959)	2024 (n=1033)	
Iron as Fe	< 1.0 mg/L	75.3	65.4	69.7	63.1	65.3	-10

	> 1.0 mg/L	24.6	34.5	30.2	36.9	34.6	10



5.0 SUMMARY

The analytical results show a concerning trend: compared to 2020, more districts in West Bengal had groundwater samples exceeding permissible limits for Nitrate, Arsenic and Iron by 2024. This decline in water quality may stem from geogenic or anthropogenic sources. While most samples from Central Ground Water Board observation wells meet drinking water standards for basic parameters and heavy metals, some exceed permissible limits, posing health risks with prolonged use.

DISTRICT WISE CONTAMINANT WISE STATUS SUMMARY BASED ON NHS 2024 PRE- MONSOON DATA

Table 18 provides a detailed summary of groundwater quality across various districts in West Bengal, focusing on basic parameters (Electrical Conductivity, Nitrate, Fluoride) and heavy metals (Iron, Arsenic).

Table 18. Summary of Groundwater Quality in Various Districts of Haryana, Highlighting Basic Parameters (Electrical Conductivity, Nitrate, Fluoride) and Heavy Metals (Iron, Arsenic)

District	Total No. of basic samples	EC	NO_3	F	Total No. of HM samples	Fe	As
		µS/cm at 25°C	mg/L	mg/L		mg/L	µg/L
Alipurdaur	20	0(0%)	2(10%)	0 (0%)	20	1(5%)	0(0%)
Birbhum	40	0(0%)	4(10%)	1(2.6%)	40	31(36.5%)	0(0%)
Coachbehar	31	0(0%)	4(12.9%)	0 (0%)	31	15(48.4%)	0(0%)
Dakshin Dinajpur	39	0(0%)	1(2.6%)	5 (14.3%)	39	16(41%)	0(0%)
Darjeeling	39	0(0%)	13(33.3%)	0 (0%)	39	4(10.3%)	0(0%)
Howrah	21	4(19%)	0(0%)	0 (0%)	21	3(14.3%)	0(0%)
Hughli	41	0(0%)	3(7.3%)	0 (0%)	41	14(34.1%)	0(0%)
Jalpaiguri	47	0(0%)	3(6.4%)	0 (0%)	47	10(21.3%)	0(0%)
Jhargram	29	0(0%)	4(13.8%)	0 (0%)	29	3(10.3%)	0(0%)
Kolkata	16	0(0%)	0(0%)	0 (0%)	16	6(37.5%)	0(0%)

Malda	51	1(2%)	10(19.6%)	1(1.7%)	51	20(39.2%)	2(2%)
Murshidabad	66	0(0%)	4(6.1%)	0 (0%)	66	37(56.1%)	14(14%)
Nadia	60	0(0%)	2(3.3%)	0 (0%)	60	45(75%)	12(12%)
North 24 PGS	92	0(0%)	1(1.1%)	0 (0%)	92	64(69.6%)	6(6%)
Paschim Medinipur	66	0(0%)	3(4.5%)	0 (0%)	66	21(31.8%)	0(0%)
Paschim Barddhaman	58	0(0%)	12(20.7%)	1(1.8%)	58	10(17.2%)	0(0%)
Purulia	32	0(0%)	5(15.6%)	0 (0%)	32	0(0%)	0(0%)
Purba Barddhaman	50	0(0%)	1(2%)	0 (0%)	50	13(26%)	0(0%)
Purba Medinipur	38	2(6.3%)	0(0%)	0 (0%)	38	10(26.3%)	0(0%)
South 24 PGS	90	3(3.3%)	4(4.4%)	0 (0%)	90	15(16.7%)	1(1%)
Uttar Dinajpur	22	0(0%)	1(4.5%)	0 (0%)	22	9(40.9%)	0(0%)
Total	**1033**	**11(1.1%)**	**83(8.03%)**	**8(0.8%)**	**1033**	**358(34.6%)**	**35(3.3%)**

Basic Parameters

- **Electrical Conductivity (EC)**
  1.1% of samples exceed permissible limits, with higher occurrences in districts like Bakura, Howrah, South 24 Paraganas and Purulia.
- **Nitrate (NO_3)**
  8.03% of samples exceed limits, with notable levels in Bankura, Darjeeling, Malda, Murshidabad and Purulia districts.
- **Fluoride (F)**
  Overall 0.8% of samples surpass permissible levels, with varying percentages across Dakshin Dinajpur, Birbhum and Paschim Bardaman,Malda districts

Heavy Metals

- **Iron (Fe)**
  Detected in 34.6% of samples, notably in all districts except purulia district of west Bengal.
- **Arsenic (As)**
  Detected in 3.3% of samples, with minimal occurrences across in Malda and South 24 Paraganas districts. Whereas high occurrence was reported in Murshidabad, Nadia and North 24 Paraganas districts.

Table 19. Summary of Groundwater Quality in West Bengal: Samples Collected and Contamination Percentage

	Total No. of Basic Samples	No. of Samples Contaminated (% of samples contaminated)		
		EC	NO_3	F
West Bengal State Summary	1033	11(1.1%)	83(8.03%)	8(0.8%)
	Total No. of HM samples	Fe	As	
	1033	358(34.6%)	35(3.3%)	

Table 19 provides a summary of groundwater quality in the state of West Bengal, broken down by the number of samples collected and the

percentage of those samples that are contaminated with various parameters.

Graphical representation of the same is depicted hereunder:

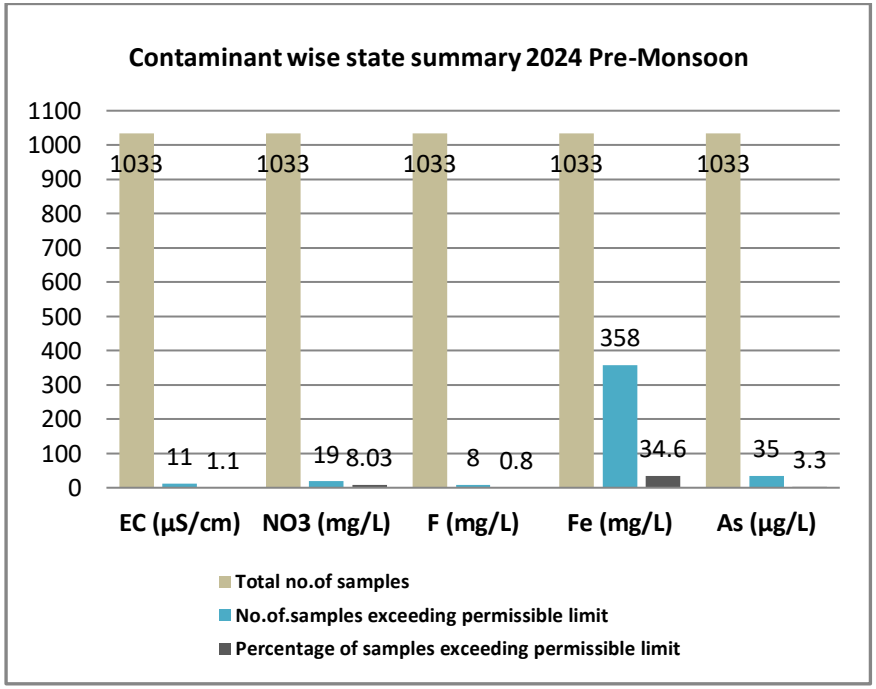


Fig. 7 State summary w.r.t. various contaminant in West Bengal

The groundwater quality assessment in West Bengal revealed notable levels of contamination across various parameters. Iron (Fe) emerged as the predominant contaminant, with 34.6% of samples surpassing permissible limits, followed by Nitrate (NO_3) in 8.03%, Arsenic (As) contamination was observed in 3.3% of samples, while electrical conductivity (EC) and Fluoride (F) exhibited lower levels of contamination, with 1.1% and 0.8% of samples exceeding permissible limits, respectively.

National Accreditation Board for Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

REGIONAL CHEMICAL LABORATORY, CENTRAL GROUND WATER BOARD, EASTERN REGION, KOLKATA

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

BHUJALIKA, CENTRAL GROUND WATER BOARD,24 PARAGANAS NORTH, KOLKATA, WEST BENGAL, INDIA

in the field of

TESTING

Certificate Number: TC-13873

Issue Date: 12/06/2024 Valid Until: 11/06/2026

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of thislaboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Entity: Central Ground Water Board

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

Save water, Save Life

Central Ground Water Board, Eastern Region, Kolkata

Bhujalika, Block CP6, Salt Lake, Sector- V,
Kolkata- 700091, West Bengal

सत्यमेव जयते

Ministry of Jal Shakti
Department of Water Resources, River Development and Ganga Rejuvenation
GOVERNMENT OF INDIA