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YEAR BOOK
ON
GROUND WATER QUALITY IN SHALLOW AQUIFERS OF NCT OF DELHI DURING 2023

GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
CENTRAL GROUND WATER BOARD
STATE UNIT OFFICE, NEW DELHI

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Government of India
Ministry of Jal Shakti
CENTRAL GROUND WATER BOARD

REPORT
ON

GROUND WATER QUALITY IN SHALLOW AQUIFERS OF NCT OF DELHI (2023)

(AAP: 2024-25)

CENTRAL GROUND WATER BOARD,
STATE UNIT OFFICE, NEW DELHI

REPORT
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GROUND WATER QUALITY IN SHALLOW AQUIFER OF NCT OF INDIA DURING 2023

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Govt. of India
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Government of India
Ministry of Jal Shakti
Department of Water Resources,
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FOREWARD

Water is an indispensable resource for sustaining life and fostering growth, and the quality of our groundwater is paramount in ensuring the well-being of our communities. The NCT of Delhi, being a densely populated region with a burgeoning urban landscape, faces unique challenges in maintaining the quality of its water resources. Recognizing the significance of the shallow aquifer, this report delves into a thorough analysis to provide a comprehensive understanding of the ground water quality in the region.

This report provides an extensive analysis of groundwater quality, based on comprehensive sampling carried out during both the pre-monsoon and post-monsoon seasons. By analyzing groundwater samples from these two distinct periods, the study aims to capture the temporal variations in water quality. This approach offers valuable insights into the changes that occur as a result of natural recharge during the monsoon, as well as the influence of anthropogenic activities. The findings contained in this report are expected to provide vital information for water resource managers, policymakers, researchers, and environmentalists working to secure the future of groundwater in the region. By identifying both the strengths and areas of concern, this report seeks to contribute to more informed decision-making regarding groundwater conservation and management.

I extend my heartfelt gratitude to the dedicated team members who contributed to this endeavour. It is my sincere belief that this report will serve as a valuable reference and guide for all those committed to preserving and enhancing the groundwater quality in the National Capital Territory of Delhi.

14/10/24

S.K Mohiddin
Regional Director, SUO, New Delhi

1.0 INTRODUCTION

The quality of groundwater is a very sensitive issue. Groundwater is never pure and contains varying amounts of dissolved solids, the type and concentration depend on its source, surface and sub-surface environment, rate of groundwater movement, the residence time, the solubility of minerals present and the amount of dissolved carbon dioxide. In addition to the natural changes, anthropogenic activities such as sewage disposal, agricultural practices, industrial pollution etc. also contribute significantly to changes in groundwater quality. Once the contaminants have entered to the sub-surfacegeological environment, they may remain concealed for many years and may get dispersed over wide areas. Weathering of rock and mineral solubility controls the major ion composition of groundwaters. With increasing anthropogenic activities, a substantial amount of dissolved matter is added to groundwater. The ground water resources are being utilized for drinking, irrigation and industrial purposes. However, due to rapid growth of population, urbanization, industrialization and agriculture activities, ground water resources are under stress. There is growing concern on the deterioration of ground water quality due to geogenic and anthropogenic activities.

NCT of Delhi has varied hydrogeological situations resulting from diversified geological and topographic settings. Water-bearing rock formations (aquifers), range in age from Archaean to Recent. The natural chemical composition of ground water is influenced predominantly by type & depth of soils and subsurface geological formations through which ground water passes. Ground water quality is also influenced by contribution from the atmosphere and surface water bodies. Quality of ground water is also influenced by anthropogenic factors.

A diverse range of dissolved inorganic compounds present in different concentrations characterizes groundwater. These compounds originate from the chemical and biochemical interactions between water and geological substances. Inorganic impurities such as salinity, chloride, fluoride, nitrate, iron, and arsenic play a crucial role in assessing the suitability of groundwater for drinking purposes.

2.0 HYDROGEOLOGY

Behaviour of ground water in NCT of Delhi is highly complicated due to the occurrence of diversified geological formations with considerable lithological and chronological variations, and various hydrochemical conditions. Broadly two groups of rock formations have been identified, on the basis of Ground Water hydraulics viz. Alluvium Deposits and Hard Rock Formations.

2.1 Alluvium Deposits

In NCT Delhi region, exposures of the oldest lithostratigraphic unit, the Delhi Quartzite ridge acts as main recharge zone to subsurface aquifer system. The Quaternary deposits in the form of aeolian and alluvial deposits constitute the major repository of ground water in the area. In the East of the ridge, the thickness of unconsolidated sediments gradually increases away from the ridge, with the maximum reported thickness being 170 m. In the Southwestern, Western and Northern parts of the area, the thickness of sediments is more than 300 m except at Dhansa where the bedrock has been encountered at 297 m below land surface. In Chhattarpur basin, the maximum thickness of sediments is 116 m. The aeolian deposits of South Delhi are mainly comprised of loam, silty loam and sandy loam. The bedrock is overlain by these deposits. Older alluvial deposits consist mostly of inter-bedded, lenticular and inter fingering deposits of clay, silt, and sand along with kankar. These deposits are overlain by the newer alluvium, which occurs mostly in the flood plains of river Yamuna.

2.2 Hard Rock Formation

Quartzite is one of the most physically durable and chemically resistant rocks found in NCT of Delhi. The suits of quartzite and associated mica schist /phyllite bands of Delhi system have undergone multiple folding and different phases of metamorphism. When the mountain ranges are worn down by weathering and erosion, less-resistant and less-durable rocks are destroyed, but the quartzite remains. Therefore, Delhi Quartzite is so often the rock found as linear ridges ranges and covering their flanks as a litter of scree. One of the research study on weathering of Proterozoic quartzite in the semi-arid conditions around Delhi suggested that Quartzite being a resistant rock, dissolution of small amount of pyrites presence, by moving water produced a sulphate-bearing acidic solution and ferrous iron which reacted with alumino-silicate minerals and quartz respectively and has made the Delhi Quartzite porous and subsequent friable. The coupled weathering mechanism, from the core outward and also proceeded initially from fractures towards the inside, produced weathering rinds and subsequent physical erosion of loose sand, produced during rind development in the outermost zones, has given rise to features like tors, spheroids, gullies, cavities and small-scale caves on these quartzites. Thus, the terrain has acquired ruggedness in semi-arid conditions.

In one of the studies of GSI, it is reported three generations of folding in the rocks of Delhi. The fold axes of first-generation folds follow the trend of main ridge i.e. NNE-SSW, the second-generation folds trending NE-SW are observed at Tughlaqabad - Mehrauli area, and third generation fold trending NW-SE is observed at Anand Parbat. The rocks are highly jointed and two sets of conjugate vertical to sub-vertical joints have been reported. Another study of GSI has inferred several faults trending NNE-SSW, NE-SW and WNW-ESE.

3.0 HYDROCHEMISTRY

The water that falls as rain and snow infiltrates into the subsurface soil and rock. Some water remains in the shallow soil layer whereas large portion infiltrate deeper and becomes part of groundwater system. The chemical characteristics of groundwater are mainly based on the surface and subsurface environment, such as the chemical composition of rain, composition of infiltrating surface water, properties of soil and rock in which the groundwater moves. It varies as per duration of contact time and contact surface between groundwater and geological material along its flow path, rate of geochemical (oxidation/reduction ion exchange, dissolution, evaporation, precipitation) process and microbiological process.

3.1 Chemistry of Rainwater

The atmosphere is composed of water vapors, dust particles and various gaseous components such as N_2, O_2, CO_2, CH_4, CO, SO_4, NO_3 etc. Pollutants in the atmosphere can be transported long distances by the wind. These pollutants are mostly washed down by precipitation and partly as dry fall out. Composition of rainwater is determined by the source of water vapors and by the ion, which are taken up during transport through the atmosphere. In general, chemical composition of rainwater shows that rainwater is only slightly mineralized with specific electrical conductance (EC) generally below 50 μS/cm, chloride below 5 mg/l and HCO_3 below 10 mg/l. Among the cations, concentration of Ca, Mg, Na & K vary considerably but the total cations content is generally below 15 mg/l except in samples contaminated with dust. The concentration of sulphates and nitrates in rainwater may be high in areas near industrial hubs.

3.2 Chemistry of Surface Water

Surface water is found extremely variable in its chemical composition due to variations in relative contributions of ground water and surface water sources. The mineral content in river water usually bears an inverse relationship to discharge. The mineral content of river water tends to increase from source to mouth, although the increase may not be continuous or uniform. Other factors like discharge of city wastewater, industrial waste and mixing of waters can also affect the nature and concentration of minerals in surface water. Among anions, bicarbonates are the most important and constitute over 50% of the total anions in terms of milli equivalent per liter (meq/l). In case of cations, alkaline earths or normally calcium predominates but with increasing salinity the hydrochemical facies tends to change to mixed cations or even to Na-HCO_3 type.

3.3 Chemistry of Ground Water

The downward percolating water is not inactive, and it is enriched in CO_2. It can also act as a strong weathering agent apart from general solution effect. Consequently, the chemical composition of ground water will vary depending upon several factors like frequency of rain, which will leach out the salts, time of stay of rain water in the root-zone and intermediate zone, presence of organic matter etc. It may also be pointed out that the water front does not move in a uniform manner as the soil strata are generally quite heterogeneous. The movement of percolating water through larger pores is much more rapid than through the finer pores. The overall effect of all these factors is that the composition of ground water varies from time to time and from place to place.

Before reaching the saturated zone, percolating water is charged with oxygen and carbon dioxide and is most aggressive in the initial stages. This water gradually loses its aggressiveness, as free CO_2 associated with the percolating water gets gradually exhausted through interaction of water with minerals.

$$CO_2 + H_2O \longleftrightarrow H_2CO_3 \longleftrightarrow H^+ + HCO_3^-$$

$$H^+ + \text{Feldspar} + H_2O \longrightarrow \text{Clay} + H_4SiO_4 + \text{Cation}$$

The oxygen present in this water is used for the oxidation of organic matter that subsequently generates CO_2 to form H_2CO_3. This process goes on until oxygen is fully consumed.

$$CH_2O + O_2 = CO_2 + H_2O$$
(Organic matter)

Apart from these reactions, there are several other reactions including microbiological mediated reactions, which tend to alter the chemical composition of the percolating water. For example, the bicarbonate present in most waters is derived mostly from CO_2 that has been extracted from the air and liberated in the soil through biochemical activity. Some rocks serve as sources of chloride and sulphate through direct solution. The circulation of sulphur, however, may be greatly influenced by biologically mediated oxidation and reduction reactions. Chloride circulation may be a significant factor influencing the anion content in natural water.

3.4 Hydrogeochemistry of NCT of Delhi

The diverse physiographic, topographic and geologic conditions have given rise to diversified groundwater situations and groundwater quality of NCT of Delhi and it varies with depth and space. It is mainly influenced by local geology and inherent salinity, and uneven development of groundwater.

In alluvial formations, in general, the quality of ground water deteriorates with depth, which is variable in different areas. The fresh ground water aquifers mainly exist up to a depth of 25 to 35 m in North West, West and parts of South west districts and in minor patches in North and Central districts. In South, Southeast & Southwest district, especially in Najafgarh *Jheel* area the fresh water occurs up to a depth of 30 to 45 mbgl. A localized area located just north of Kamala Nehru Ridge (part of Delhi ridge falling in Central District) covering area of Dhirpur, Wazirabad and Jagatpur are characterized by shallow depth of fresh water aquifers that is in the range of 22 to 28mbgl, regardless of proximity to River Yamuna. In the flood plains of Yamuna, in general, fresh water aquifers exist down to depth of 30-45mbgl and especially in Palla it reaches to the depth of 60 to 75mbgl below which brackish and saline water exists. The ground water is fresh at all depths in the areas around the ridge falling in Central, New Delhi, South and eastern part (Ridge Area) of South-West districts and also in Chattarpur basin. In the areas west of the ridge, in general, the thickness of fresh water aquifers decreases towards North-West, the thickness of fresh water zone is limited in most parts of west and southwest districts.

4.0 WATER QUALITY CRITERIA

The available quality of groundwater is the resultant of all the processes and reactions, which taken place since the condensation of water in the atmosphere to the time it is retrieved in the form of groundwater from its source. The water has excellent capability to accumulate substances in soluble form as it moves over and into the land resource, from the biological processes and from human activities. Urbanization, agricultural development and discharges of municipal and industrial residues significantly alter characteristics of groundwater resource. The prevailing climatic conditions, topography, geological formations and use and abuse of this vital resource have significant effect on the characteristics of the water, because of which its quality varies with locations.

The definition of criteria and standards for water quality vary with the type of use. The characteristic of water required for human consumption, livestock, irrigation, industriesetc., have different water quality requirements. The term water quality criteria may be defined as the "Scientific data evaluated to derive recommendations for characteristics of water for specific use'. The term standard applies to any definite rule, principle or measure established by any statutory Authority. The distinction between criteria and standards is important, as the two are neither interchangeable nor they become synonyms for the objective or goal. Realistic standards are dependent on criteria, designated uses and implementation as well as identification and monitoringprocedure. The changes in all these factors may provide a basis for alteration instandards. In formulation of water quality criteria, the selection of water quality parameters depends on its use. Sayers, et. al. (1976 as quoted in CGWB & CPCB2000) identified the key water quality parameters according to its various uses **(Table 4.0).**

Table 4.0: Water quality criteria parameters for various uses (Sayers et.al., 1976)

Public Water supply	Industrial Water supply	Agricultural water supply	Aquatic life & wild life water supply	Recreation and Aesthetics
Coliform bacteria Turbidity colour, Taste, Odour TDS, CI, F, SO_4 NO_3, CN, Trace Metals, Trace Organics Radioactive substances	**Processing** pH, Turbidity Colour, Alkalinity, Acidity, TDS, Suspended solids, Trace metals, Trace Organics **Cooling** PH, Temp, Silica, AI, Fe, Mg, Total hardness, Alkalinity/ Acidity Suspended solids, Salinity	Farmstead Same as for public supply Live-stock Same as for public supply Irrigation TDS, EC, Na, Ca, Mg, K, B, CI and Trace metals	Temp, DO, pH, Alkalinity, Acidity, TDS Salinity, pH, DCOs, Turbidity Colour, Settleable materials, Toxic substances, Nutrients, Floating materials	Recreations Tem, Turbidity, Colour, Odour, Floating Materials, Settable Materials Nutrients, Coliforms Aesthetics Same as for Recreation and Substances adversely affecting wild life

4.1 Water Quality Criteria for Drinking Purpose

With the objective of safeguarding water from degradation and to establish a basis forimprovement in water quality, standards / guide lines / regulations have been laid downby various national and international organizations such as; Bureau of Indian Standards(BIS), World Health Organization (WHO), European Economic Community (EEC), Environmental Protection Agency (EPA), United States, and Inland Waters Directorate, Canada. The Bureau of Indian Standards (BIS) earlier known as Indian Standards Institutions (ISI) has laid down the standard specification for drinking water during 1983, which have been revised and updated from time to time. In order to enable the users, to exercise their discretion towards water quality criteria, the maximum permissible limit has been prescribed especially where no alternative sources are available. The national water quality standards describe essential and desirable characteristics required to be evaluated to assess suitability of water for drinking purposes. The important water quality characteristics as laid down in BIS standard (IS 10500: 2012) are summarized in **Table – 4.1**

Table 4.1: Drinking Water Characteristics (IS 10500: 2012)

S. No.	Parameters	Desirable Limits (mg/L)	Permissible limits (mg/L)
Essential Characteristics			
1	Colour Hazen Unit	5	15
2	Odour	Unobjectionable	-
3	Taste	Agreeable	-
4	Turbidity (NTU)	1	5
5	pH	6.5-8.5	No relaxation
6	Total Hardness, $CaCO_3$	200	600
7	Iron (Fe)	1.0	No relaxation
8	Chloride (Cl)	250	1000
9	Residual Free Chlorine	0.2	1
10	Fluoride (F)	1.0	1.5
Desirable Characteristics			
11	Dissolved Solids	500	2000
12	Calcium (Ca)	75	200
13	Magnesium (Mg)	30	100
14	Copper (Cu)	0.05	1.5
15	Manganese (Mn)	0.1	0.3
16	Sulphate (SO_4)	200	400
17	Nitrate (NO_3)	45	No relaxation
18	Phenolic Compounds	0.001	0.002
19	Mercury (Hg)	0.001	No relaxation
20	Cadmium (Cd)	0.003	No relaxation
21	Selenium (Se)	0.01	No relaxation
22	Arsenic (As)	0.01	No relaxation
23	Cyanide (CN)	0.05	No relaxation
24	Lead (Pb)	0.01	No relaxation
25	Zinc (Zn)	5.0	15
26	Hexavalent Chromium	0.05	No relaxation
27	Alkalinity	200	600
28	Aluminum (Al)	0.03	0.2
29	Boron (B)	0.5	2.4
30	Pesticides	Absent	0.001
31	Uranium	0.03	No relaxation

NTU- Nephelometric Turbidity Unit.

N.B. The fluoride limits vary with average annual temperature of the areas. Similarly, the limits for magnesium are based on sulphate contents of water. When sulphate content is 250 mg/L or above, the magnesium should be between 30 and 50 mg/L but ifsulphate is lower, higher content of magnesium is permissible.

4.2 Water Quality Criteria for Irrigation Purpose

Water quality plays a significant role in irrigated agriculture. Many problems originate due to inefficient management of water for agriculture use, especially when it carries high salt loads. The effect of total dissolved salts in irrigation water (measured in terms of electrical conductance) on crop growth is extremely important. Soil water passes in to the plant through the root zone due to osmotic pressure and the plants root able to assimilate water and nutrients. Thus, the dissolved solid contents of the residual water in the root zone also have to be maintained within limits by proper leaching. These effects are visible in plants by their stunted growth, low yield, discoloration and even leaf burns at margin or top. The safe limits of electrical conductivity for crops of different degrees of salt tolerances under varying soil textures and drainage conditions are presented in **Table - 4.2.**

Table 4.2: Safe Limits for electrical conductivity for irrigation water (IS:11624-1986)

S. No.	Nature of soil	Crop Growth	Upper permissible safe limit of electrical conductivity in water µs/cm at 25°C
1	Deep black soil and alluvial soils having clay content more than 30%; soils that are fairly to moderately well Drained	Semi-tolerant	1500
		Tolerant	2000
2	Textured soils having clay contents of 20-30%; soils that are well drained internally and have good surface drainage system	Semi-tolerant	2000
		Tolerant	4000
3	Medium textured soils having clay 10-20%; internally very well drained and having good surface drainage system	Semi-tolerant	4000
		Tolerant	6000

4	Light textured soils having clay lessthan 10%; soils that have excellent internal and surface drainage system.	Semi-tolerant	6000
		Tolerant	8000

In addition to problems caused by total amount of salts, some of the specific ions like sodium, boron and trace elements, if present in water in excess, also render it unsuitable for agricultural use.

4.2.1 SODIUM ADSORPTION RATIO (SAR) & RESIDUAL SODIUM CARBONATE (RSC)

The clay minerals in the soil adsorb divalent cations like calcium and magnesium ions from irrigation water. Whenever the exchange sites in clay are filled by divalent cations, the soil texture is conducive for plant growth. Sodium reacts with soil to reduce its permeability. In case the irrigation water is sodium dominant, the clay lattice is filled with sodium ions due to ion exchange. Such soils become impermeable and sticky and as such the cultivation becomes difficult to support plant growth. However, the cation exchange process is reversible and can be controlled either by adjusting the composition of water or by soil amendment by application of gypsum, which releases cations (Calcium) to occupy the exchange position. The tendency of water to replace adsorbed calcium and magnesium with sodium can be expressed by the Sodium Adsorption Ratio (SAR), where all the ion concentrations are in milli-equivalents per litre (meq/L).

$$\mathbf{SAR} = \frac{\mathbf{Na}}{\sqrt{(\mathbf{Ca} + \mathbf{Mg})/2}}$$

When, water having high bicarbonates and low calcium and magnesium is used for irrigation purpose, precipitation of calcium and magnesium as carbonate takes place, changing the residual water to high sodium water with sodium bicarbonate in solution. It is termed as Residual Sodium Carbonate (RSC) which is expressed as;

$$\mathbf{RSC} = (\mathbf{HCO3} + \mathbf{CO3}) - (\mathbf{Ca} + \mathbf{Mg})$$

(Where all the ions' concentrations are in milli equivalents / litre).

Percentage sodium (%Na):

Percentage sodium (%Na) is an indication of the soluble sodium content of the groundwater and also used to evaluate Na hazard. In all natural waters, %Na is a common parameter to assess its suitability for irrigation purposes since sodium reacts with the soil to reduce permeability.

$$\%\mathbf{Na} = \frac{(\mathbf{Na} + \mathbf{K})}{(\mathbf{Ca} + \mathbf{Mg} + \mathbf{Na} + \mathbf{K})} * \mathbf{100}$$

The quality of water is commonly expressed by classes of relative suitability for irrigation with reference to salinity levels. The recommended classification with respect to Electrical Conductivity, Sodium content, Sodium Adsorption Ratio, and Residual Sodium Carbonate, under customary irrigation conditions has been depicted in **Table - 4.2.1.**

Table 4.2.1: Guidelines for evaluation of quality of irrigation water

Water Class	Alkalinity hazards		
	SAR IS:11624-1986	RSC (meq/L) IS:11624-1986	%Na Wilcox
Low	< 10	< 1.5	< 20
Medium	>10 – 18	1.5 – 3	20 - 60
High	>18 – 26	3 - 6	> 60
Very High	> 26	> 6	

4.3 Effects of Water Quality Parameters on Human Health and Distribution for Various Users

It is essential to ensure that various constituents are within prescribed limits in drinking water supplies to avoid impact on human health **(Table – 4.3.1)**. Man, life forms and domestic animals are affected by alteration in water quality due to natural or anthropogenic reasons. The effect of these substances depends on the quantity of water consumed per day and their concentration in water.

Table 4.3.1: Effects of water quality parameters on human health when used for drinking Purpose

S. No.	Parameters	Prescribed limits IS:10500, 2012		Probable Effects
		Desirable Limit	Permissible Limit	
1	Colour (Hazen unit)	5	15	Makes water aesthetically undesirable
2	Odour	Essentially free from objectionable odour		Makes water aesthetically undesirable
3	Taste	Agreeable		Makes water aesthetically undesirable
4	Turbidity (NTU)	1	5	High turbidity indicates contamination / Pollution.
5	pH	6.5	8.5	Indicative of acidic or alkalinewaters, affects taste, corrosivity and the water supply system
6	Hardness as $CaCO_3$ (mg/L)	200	600	Affects water supply system (Scaling), Excessive soap consumption, and calcification of arteries. There is no conclusiveproof but it may cause urinary concretions, diseases of kidney or bladder and stomach disorder.

S. No.	Parameters	Prescribed limits IS:10500, 2012 Desirable Limit	Permissible Limit	Probable Effects
7	Iron (mg/L)	1.0	No relaxation	Gives bitter sweet astringenttaste, causes staining of laundry and porcelain. In traces it isessential for nutrition.
8	Chloride (mg/L)	250	1000	May be injurious to some people suffering from diseases of heart or kidneys. Taste, indigestion, corrosion and palatability are affected.
9	Residual Chlorine (mg/L) Only when water is Chlorinated	0.20	-	Excessive chlorination of drinking water may cause asthma,colitis and eczema.
10	Total Dissolved Solids-TDS (mg/L)	500	2000	Palatability decreases and may cause gastro intestinal irritation in human, may have laxative effect particularly upon transits and corrosion, may damage water system.
11	Calcium (Ca) (mg/L)	75	200	Causes encrustation in water supply system. While in sufficiency causes a severe type of rickets, excess causesconcretions in the body such as kidney or bladder stones and irritation in urinary passages.
12	Magnesium (mg) (mg/L)	30	100	Its salts are cathartics and diuretic. High concentration may have laxative effect particularly on new users. Magnesium deficiency is associated with structural and functional changes. It is essential as an activator of many enzyme systems.
13	Copper (Cu) (mg/L)	0.5	1.50	Astringent taste but essential and beneficial element in human metabolism. Deficiency results in nutritional anemia in infants. Large amount may result in liver damage, cause central nervous system irritation and depression. In water supply it enhance corrosion of aluminum in particular
14	Sulphate (SO_4) (mg/L)	200	400	Causes gastro intestinal irritation along with Mg or Na, can have a cathartic effect on users, concentration more than 750 mg/L may have laxative effect along with Magnesium.
15	Nitrate (NO_3) (mg/L)	45	No relaxation	Cause infant methaemoglobinaemia (blue babies) at very high concentration, causes gastriccancer and affects adversely central nervous system and cardiovascular system.
16	Fluoride (F) (mg/L)	1.0	1.50	Reduce dental carries, very high concentration may cause crippling skeletal fluorosis.

S. No.	Parameters	Prescribed limits IS:10500, 2012		Probable Effects
		Desirable Limit	Permissible Limit	
17	Cadmium (Cd) (mg/L)	0.003	No relaxation	Acute toxicity may be associated with renal, arterial hypertension, itai-itai disease, (a bone disease).Cadmium salt causes cramps, nausea, vomiting and diarrhea.
18	Lead (Pb) (mg/L)	0.01	No relaxation	Toxic in both acute and chronic exposures. Burning in the mouth, severe inflammation of the gastro-intestinal tract withvomiting and diarrhoea, chronictoxicity produces nausea, severe abdominal pain, paralysis, mental confusion, visual disturbances, anaemia etc.
19	Zinc (Zn) (mg/L)	5	15	An essential and beneficial element in human metabolism. Taste threshold for Zn occurs at about 5 mg/L imparts astringent taste to water.
20	Chromium (Cr^6) (mg/L)	0.05	No relaxation	Hexavalent state of Chromium produces lung tumors can produce cutaneous and nasal mucous membrane ulcers and dermatitis.
21	Boron (B) (mg/L)	0.5	2.4	Affects central nervous system itssalt may cause nausea, cramps, convulsions, coma etc.
22	Alkalinity (mg/L) as $CaCO_3$	200	600	Impart distinctly unpleasant taste may be deleterious to human being in presence of high pH, hardness and total dissolved solids.
23	Pesticides: (m g/l)	Absent	0.001	Imparts toxicity and accumulated in different organs of human body affecting immune and nervous systems may be carcinogenic.
24	Phosphate (PO_4) (mg/L)	No guideline		High concentration may causevomiting and diarrhea, stimulate secondary hyperthyroidism andbone loss
25	Sodium (Na) (mg/L)	No guidelines		Harmful to persons suffering From cardiac, renal andcirculatory diseases.
26	Potassium (K) (mg/L)	No guidelines		An essential nutritional elementbut its excessive amounts is cathartic
27	Silica (SiO_2) (mg/L)	No guidelines		-
28	Nickel (Ni) (mg/L)	0.02		Non-toxic element but may becarcinogenic in animals, can react with DNA resulting in DNAdamage in animals.
29	Pathogens (a) Total coliform (per100ml) (b) Faecal Coliform (per 100ml)	nil		Cause water borne diseases like coliform Jaundice, Typhoid, Cholera etc. produce infections involving skin mucous membrane of eyes, ears and throat.

S. No.	Parameters	Prescribed limits IS:10500, 2012		Probable Effects
		Desirable Limit	Permissible Limit	
30	Arsenic	0.01	**No relaxation**	Various skin diseases, Carcinogenic
31	Uranium	0.03	**No relaxation**	Kidney disease, Carcinogenic

5.0 GROUND WATER QUALITY MONITORING

The International Standard Organization (ISO) has defined monitoring as," The programmed process of samplings, measurements and subsequent recording or signaling or both, of various water characteristics, often with the aim of assessing, conformity to specified objectives". A systematic plan for conducting water quality monitoring is called Monitoring Programme, which includes monitoring network design, preliminary survey, resource estimation, sampling, analysis, data management & reporting.

Monitoring of ground water quality is an effort to obtain information on chemical quality through representative sampling in different hydrogeological units. Ground Water is commonly tapped from phreatic aquifers through dugwells in a major part of the country and through springs and hand pumps in hilly areas. The main objective of ground water quality monitoring programme is to get information on the distribution of water quality on a regional scale as well as lattice is to create a background data bank of different chemical constituents in ground water.

One of the main objectives of the ground water quality monitoring is to assess the suitability of ground water for drinking purpose. The quality of drinking water is a powerful environmental determinant of the health of a community. The problem of the quality of water resources in general, and groundwater resources in particular, is becoming increasingly important in both industrialized and developing nation. In developing countries like India, the essential concerns as regards water resources are their quantity, availability, sustainability and suitability. Groundwater plays a leading role because it has of fundamental importance to all living beings.

Even though water is the most frequently occurring substance on earth, lack of safe drinking water is more prominent in the developing countries. Due to increasing world population, extraction of groundwater is also increasing for irrigations, industries, municipalities and urban and rural households' day by day. During dry season extensive withdrawal of groundwater for irrigation purpose is lowering the water table in the aquifer and also changing the chemical composition of water.

The physical and chemical quality of ground water is important in deciding its suitability for drinking purposes. Bureau of Indian Standards (BIS) formally known as Indian Standard Institute (ISI) vide its document IS: 10500:2012, Edition 3.2 (2012-15) has recommended the quality standards for drinking water. On this basis of classification, the natural ground water of India has been categorized as desirable, permissible and unfit for human consumption.

From the analytical results, it is seen that majority of water samples collected from observation / monitoring wells of CGWB in a major part of the country fall under desirable or permissible category and hence are suitable for drinking purposes. However, a small percentage of well waters are found to have concentrations of some constituents beyond the permissible limits. Such waters are not fit for human consumption and are likely to be harmful to health on continuous use.

5.1 Data Validation / Data Quality Control

Groundwater quality data validation is an essential step in ensuring the reliability and accuracy of the data. Here are some of the main steps for groundwater quality data validation.

a. Checking of Data Consistency: Checking of the data for consistency by comparing the measurements of a particular parameter over time. This will help identify any changes in the groundwater quality due to measurement methodology or equipment

b. Checking the correlation between EC and TDS:
    a. The relationship between the two parameters is often described by a constant (commonly between 0.55 and 0.95 for freshwaters).
    b. Thus: TDS (mg/l) ~ (0.55 to 0.95) x EC (mS/cm).
    c. The value of the constant varies according to the chemical composition of the water. For freshwaters, the normal range of TDS can be calculated from the following relationship:
    d. 0.55 conductivity (mS/cm) < TDS (mg/l) < 0.95 conductivity (mS/cm).
    e. Typically the constant is high for chloride rich waters and low for sulphate rich waters.

c. Checking the cation-anion balance

When a water quality sample has been analysed for the major ionic species, one of the most important validation tests can be conducted: the cation-anion balance.

Sum of cations = sum of anions

where:
cations = positively charged species in solution (meq/l)
anions = negatively charged species in solution (meq/l)

The Electronic charge balance is expressed as follows:

$$\text{Electronic Charge Balance (ECB \%)} = \frac{[\sum \text{cations} - \sum \text{anions}]}{[\sum \text{cations} + \sum \text{anions}]} \times 100$$

All concentrations should be in epm. Error charge balance has been computed for the chemical results of 2022-23 and analysis showing more than 10% ECB has not been accepted as it indicates that there has been an error made in at least one of the major cation/anion analyses.

6.0 GROUND WATER QUALITY SCENARIO IN NCT OF DELHI

The quality of groundwater in NCT of Delhi has been evaluated by sampling and analysis of water samples collected from Groundwater Monitoring wells.About **103** Groundwater Monitoring wells were monitored for water quality during May 2023 representing pre-monsoon water quality. The district-wise chemical analysis data of the samples are given in the Annexure – 1 & 2. The summarized results of groundwater quality ranges are given in **Table – 6.1.**

Table - 6.1. Summarized results of groundwater quality ranges, (May 2023)

S. No	Parameters		Range	No. of sample	Percentage
1	Electrical Conductivity µs/cm at 25ºC	Fresh	< 750	19	18.45
		Moderate	750- 2250	45	43.69
		Slightly mineralized	2251- 3000	15	14.56
		Highly mineralized	> 3000	24	23.3
2	Chloride mg/L	Desirable limit	< 250	52	50.49
		Permissible limit	251-1000	33	32.04
		Beyond permissible limit	> 1000	18	17.48
3	Fluoride mg/L	Desirable limit	< 1.0	65	63.11
		Permissible limit	1.0 - 1.5	21	20.39
		Beyond permissible limit	>1.5	17	16.5
4	Nitrate mg/L	Permissible limit	< 45	82	79.6
		Beyond permissible limit	> 45	21	20.4

The groundwater samples collected from submersible pumps and hand pumps tapping phreatic aquifers are analyzed for all the major inorganic parameters. Based on the results, it is found that ground water in the NCT of Delhi is mostly of calcium bicarbonate (Ca-Mg-HCO_3) type when the total dissolved solids of water is below 500 mg/L (corresponding to electrical conductance of 750 µS/cm at 25^{0}C). They are of mixed cations and mixed anion type when the electrical conductance is between 750 and 3000 µS/cm and waters with electrical conductance above 3000 µS/cm are of sodium chloride (Na-Cl) type. However, other types of water are also found among these general classifications, which may be due to the local variations in hydro-chemical environments due to anthropogenic activities. Nevertheless, occurrence of high concentrations of some water quality parameters such as salinity, chloride, fluoride, iron, arsenic and nitrate have been observed in some pockets in few districts of Delhi.

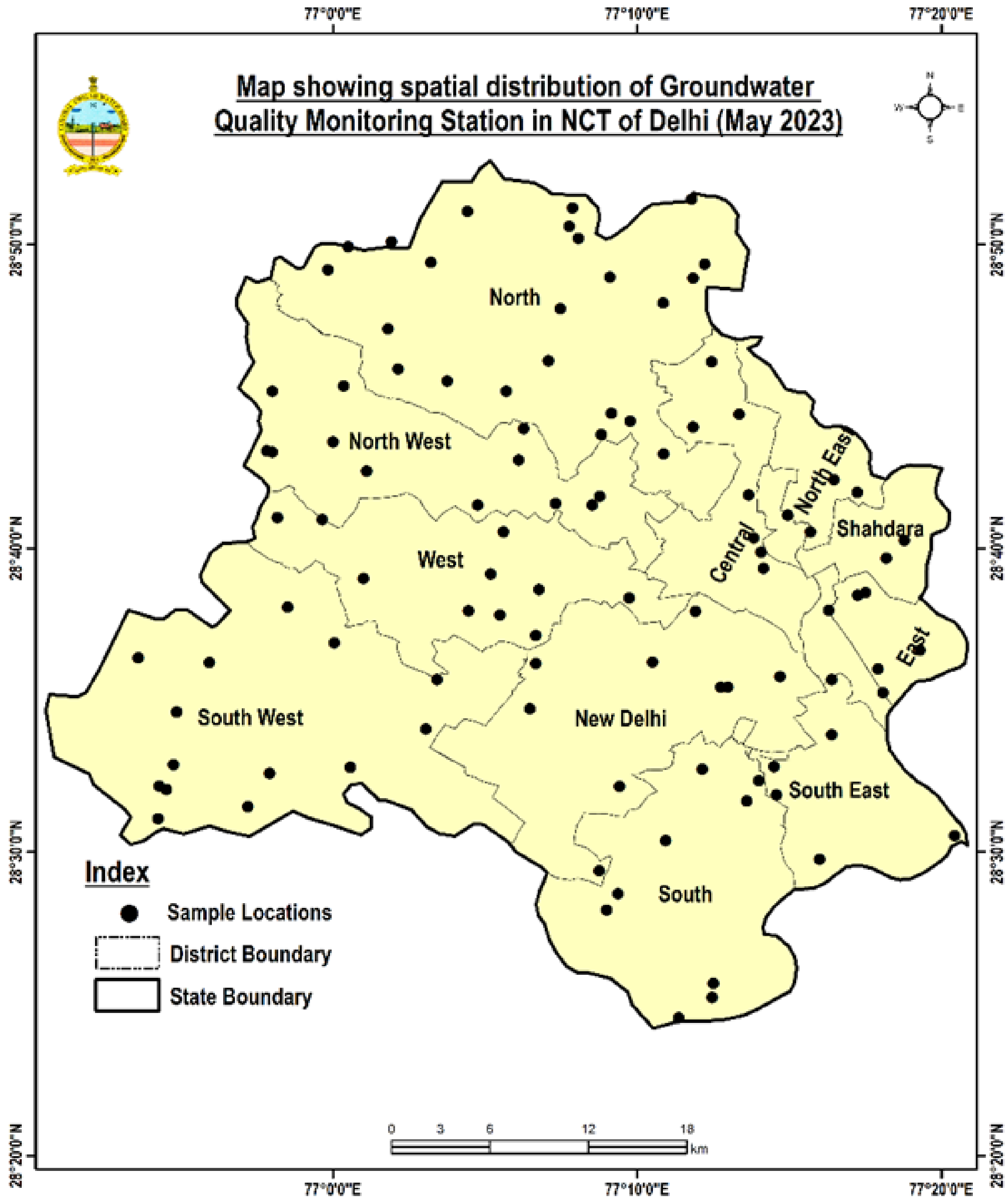


Fig 6.1.1 Map showing location of Sampling Stations in NCT of Delhi (May 2023)

7.0 PRE-MONSOON GROUND WATER QUALITY HOT SPOTS IN UNCONFINED AQUIFERS OF NCT OF DELHI

Unconfined aquifers are extensively tapped for water supply across the State therefore; its quality is of paramount importance. The chemical parameters like TDS, Chloride, Fluoride, Iron, Arsenic and Nitrate etc. are main constituents defining the quality of ground water in unconfined aquifers. Therefore, presence of these parameters in ground water beyond the permissible limit in the absence of alternate source has been considered as groundwater quality hotspots.

Groundwater quality hot spot maps of the NCT of Delhi have been prepared depicting seven main parameters based on their distribution shown on the separate maps. These maps depict the spatial distribution of the following constituents in ground water tapping the unconfined aquifers.

I. Electrical Conductivity
II. Chloride (> 1000 mg/L)
III. Fluoride (>1.5 mg/L)
IV. Nitrate (>45mg/L)
V. Iron (>1.0mg/L)
VI. Arsenic (>0.01 mg/L)
VII. Uranium (>0.03 mg/L)

7.1 Electrical Conductivity

Conductivity measurements are used routinely in many industrial and environmental applications as a fast, inexpensive and reliable way of measuring the ionic content in a solution. For example, the measurement of product conductivity is a typical way to monitor and continuously trend the performance of water purification systems. In many cases, conductivity is linked directly to the total dissolved solids (TDS).

Salinity is the saltiness or dissolved salt contents of a water body. Salt content is an important factor in water use. Salinity can be technically defined as the total mass in grams of all the dissolved substances per Kilogram of water. Different substances dissolve in water giving it taste and odour. In fact, humans and other animals have developed senses which are, to a degree, able to evaluate the potability of water, avoiding water that is too salty or putrid.

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, and quantity of rainfall and above all, the climate of the area. The salinity of groundwater in coastal areas in addition to the above may be due to air borne salts originating from air water interface over the sea and also due to over pumping of fresh water which overlays saline water in coastal aquifer systems.

BIS has recommended a drinking water standard for total dissolved solids a limit of 500 mg/L (corresponding to EC of about 750 μS/cm at 25^0C) that can be extended to a TDS of 2000 mg/L (corresponding to EC of about 3000 μS/cm at 25^0C) in case of no alternate source. Water having TDS more than 2000 mg/L is not suitable for drinking purpose. In Fig 7.1.2, the EC values (in μS/cm at

25^{0}C) of ground water from observation/monitoring wells have been used to show distribution patterns of electrical conductivity in different ranges of suitability for drinking purposes. It is apparent from the map that majority of the waters having EC values less than 750µS/cm at 25^{0}C occur throughout the state in patches.

Groundwater with EC ranging between 750 and 3000µS/cm at 25^{0}C falling under 'permissible' range are confined mainly to Central and South-Eastern part of the State. These include South, South-East, East, Shahdara, North-East, Central and New Delhi districts of the State. However, in some cases, relatively high values of EC in excess of 3000 µS/cm are observed in many parts of the State, especially Nort and Western parts of the State. Table 7.1.1 shows the list of districts affected by high EC water (EC > 3000 µS/cm) and these areas are water quality hot spots from salinity point of view.

District-wise percentage of wells having EC >3000 µS/cm is shown as a bar diagram in Fig 7.1.1 and the occurrences of Electrical Conductivity in ground water beyond permissible limit (>3000 µS/cm) have been shown on the contour map as Fig 7.1.2, the percentage groundwater samples in various EC range is also illustrated in Fig 7.1.3. Locations details are given in Annexure-3.

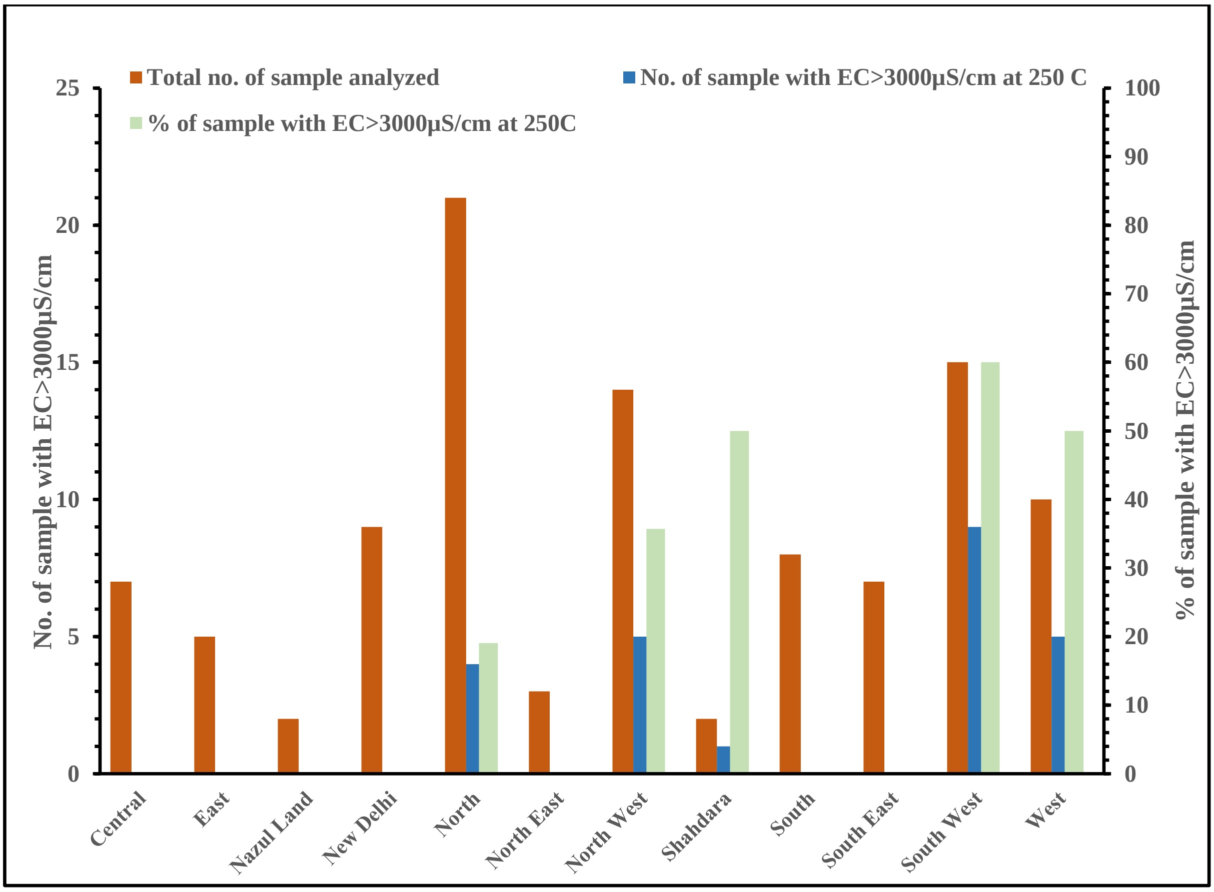


Fig 7.1.1 District-wise percentage of wells having EC >3000 µS/cm.

Table 7.1.1 District-wise percentage of samples having EC >3000 µS/cm

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with EC>3000µS/cm at 25^0 C	(%) Samples with EC>3000µS/cm at 25^0C
1.	Central	7	0	0.0
2.	East	5	0	0.0
3.	Nazul Land	2	0	0.0
4.	New Delhi	9	0	0.0
5.	North	21	4	19.0
6.	North East	3	0	0.0
7.	North West	14	5	35.7
8.	Shahdara	2	1	50.0
9.	South	8	0	0.0
10.	South East	7	0	0.0
11.	South West	15	9	60.0
12.	West	10	5	50.0
	Total	**103**	**24**	**23.3**

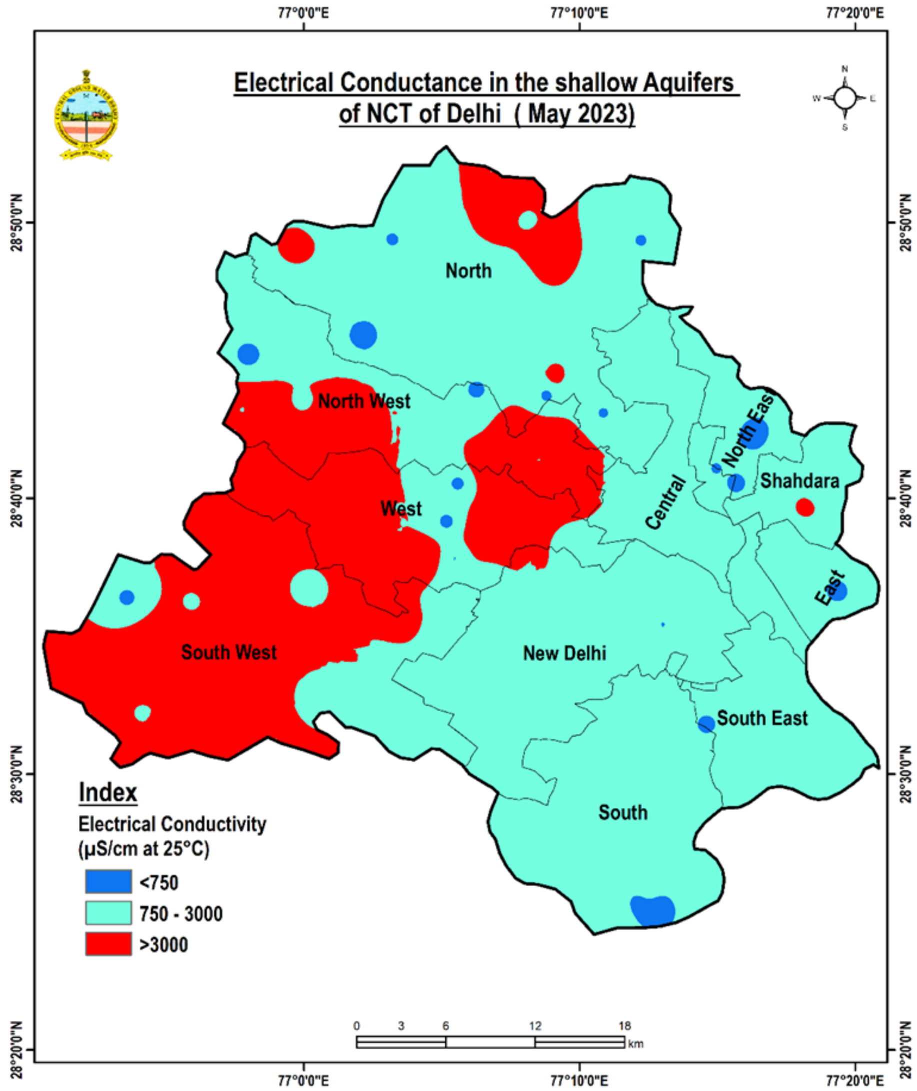


Fig 7.1.2 Spatial distribution of Electrical Conductivity during May 2023.

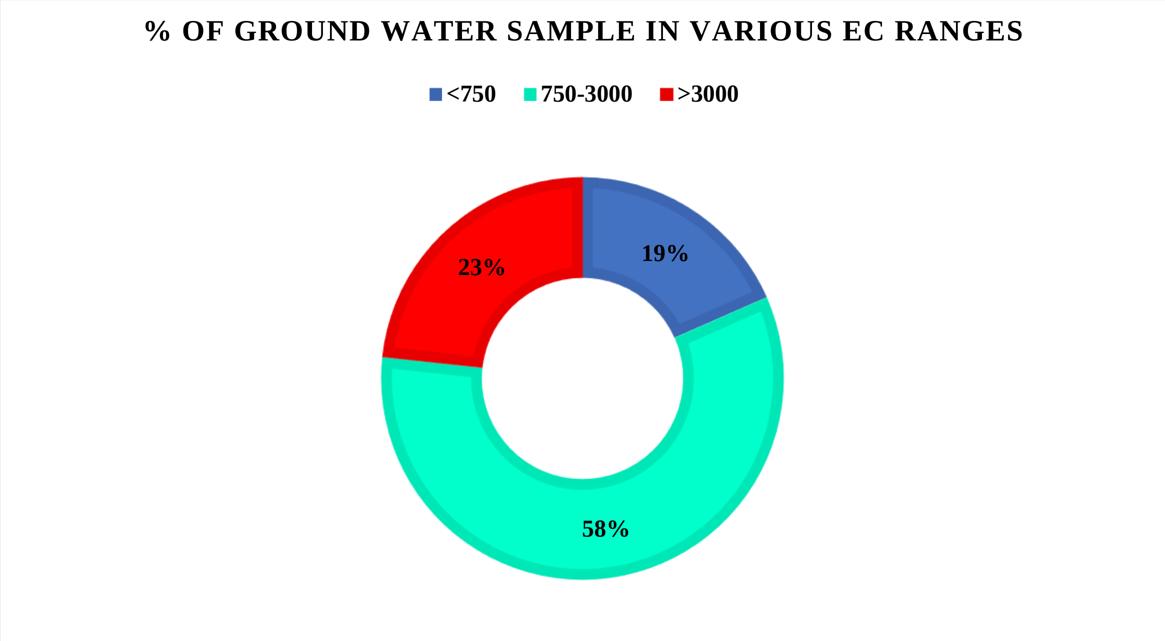


Fig 7.1.3 Percentage groundwater samples in various EC range (NCT of Delhi).

Table 7.1.2: Comparative change in number of districts having EC > 3000 µS/cm in various states.

S. No.	District	Nos. of locations having EC > 3000 µS/cm.		
		2017	2023	Increase/Decrease
1.	Central	0	0	0
2.	East	0	0	0
3.	New Delhi	0	0	0
4.	North	4	4	0
5.	North East	0	0	0
6.	North West	3	5	2
7.	South	1	0	-1
8.	South East	0	0	0
9.	South West	5	9	4
10.	West	4	5	1
11.	Nazulland	0	0	0
12.	Shahdara	0	1	1
	Total	**17**	**24**	**7**

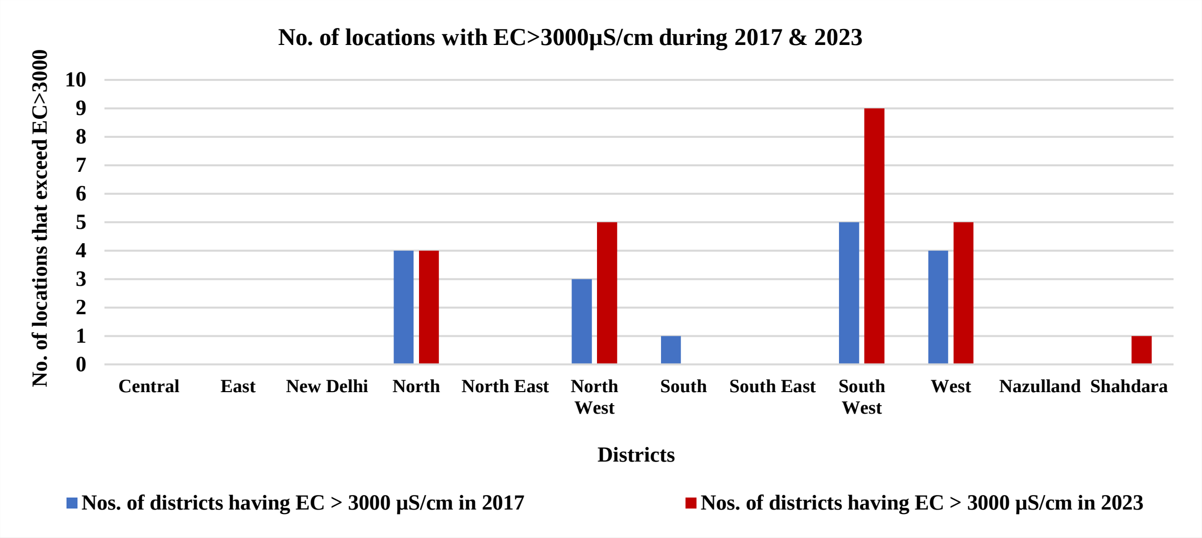


Fig. 7.1.4 Comparison on No. of locations with EC >3000 µS/cm during 2017 and 2023.

In comparison to 2017 (Table 7.1.2), it has been observed that the no. of districts having EC more than 3000 µS/cm in various States has increased in 2023 by 41.17 %. In North West, South West & West districts, the increase in the no. of location is a matter of concern.

7.1.1 TREND ON ELECTRICAL CONDUCTIVITY

Trend analysis determines whether the measured values of the water quality variables increase or decrease during a time period. The Electrical Conductivity (EC) of groundwater is contributed by all the dissolved ionic constituents. Therefore, it is a measure of the total ionic content of the water. It could be used as a source of inorganic pollution indicator as most of the inorganic compounds are present as ions in water. Hence, EC was taken to assess the trend of ground water quality in NCT of Delhi. The percentage of well exceeds the electrical conductivity more than 3000 µS/cm for the period of 2017 to 2023 were compared and presented in the Table 7.1.3 and observed that the percentage of samples exceed the permissible limit of 3000 µS/cm were ranging between 26 - 32 % and no significant trend was noticed. Trend on water quality for Electrical conductivity (EC) prepared for the NCT of Delhi is showing a slightly decreasing trend (Fig. 7.1.5 & 7.1.5a). This may be attributed to dilution factor.

Table 7.1.3: Percentage of wells Exceed EC>3000 µS/cm during the period of 2017-2023

Year	Total Number of samples analysed	No. of districts affected by EC	Total No of locations affected by EC	% of locations affected by EC (EC>3000 µS/cm
2017	64	5	17	**26.56**
2018	65	4	20	**30.77**
2019	64	5	20	**31.25**
2020	66	7	21	**31.82**
2021	79	6	22	**27.85**
2022	95	4	24	**25.26**
2023	103	5	24	**23.3**

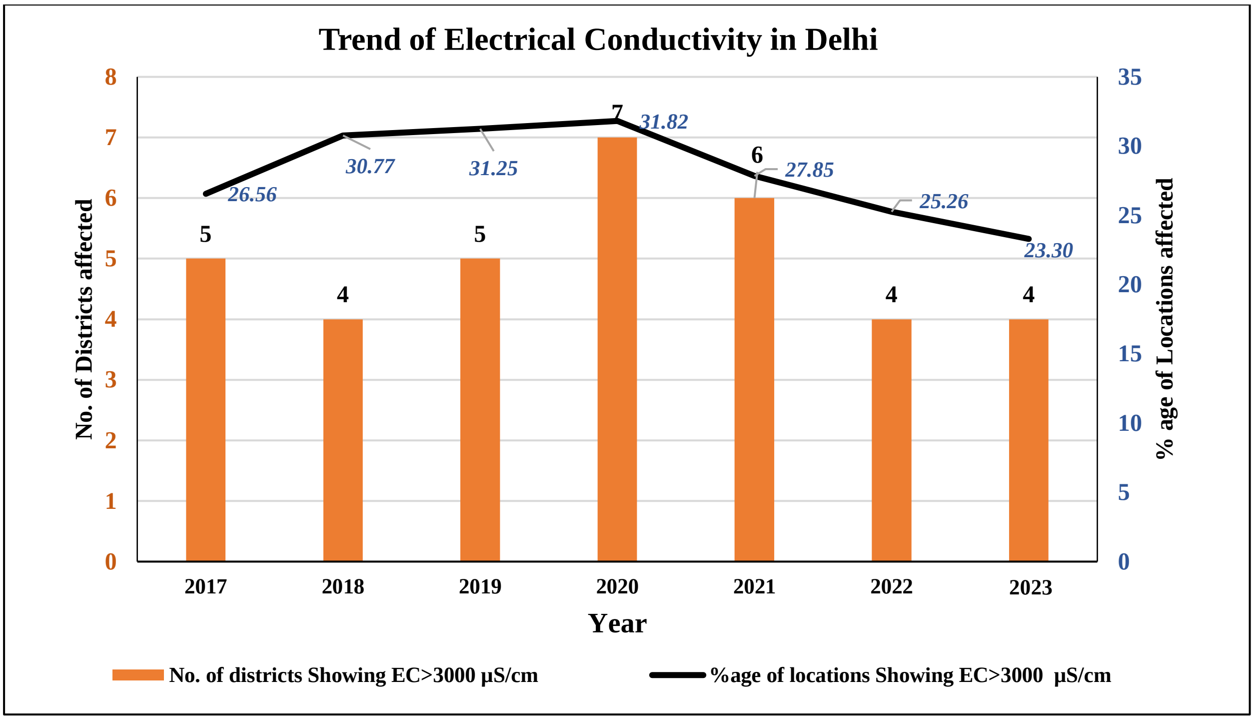


Fig. 7.1.5 Trend of Electrical Conductivity in NCT of Delhi

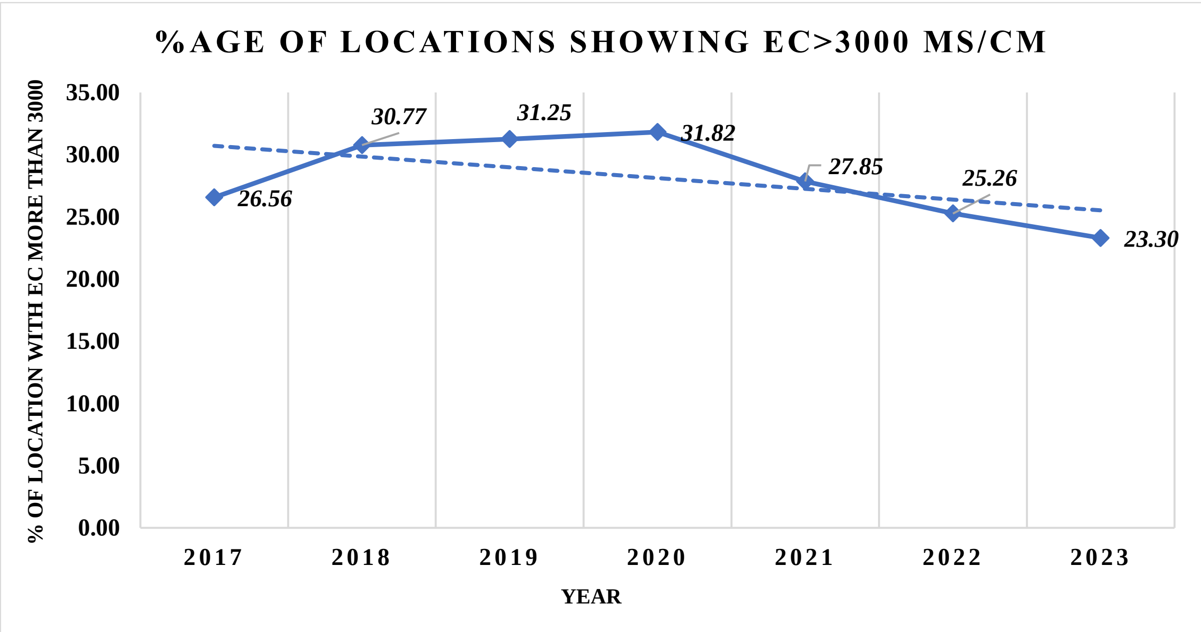


Fig. 7.1.5(a) Trend on Electrical Conductivity in NCT of Delhi for the period of 2017-2023

7.2 CHLORIDE

Chloride is present in all-natural waters, mostly at low concentrations. It is highly soluble in water and moves freely with water through soil and rock. In ground water the chloride content is mostly below 250 mg/L except in cases where inland salinity is prevalent and in coastal areas.

BIS (Bureau of Indian Standard) have recommended a desirable limit of 250 mg /L of chloride in drinking water; this concentration limit can be extended to 1000 mg/L of chloride in case no alternative source of water with desirable concentration is available. However, ground water having concentration of chloride more than 1000 mg /L are not suitable for drinking purposes.

In Fig 7.2.1, the concentration of chloride (in mg/L) in ground water from observation wells have been used to show distribution patterns of chloride in different ranges of suitability. It is apparent from the map that majority of the samples having chloride values less than 250 mg/L are found mostly along South and Eastern parts of State viz., South, South East, North East, East, Central, New Delhi and Shahdara districts.

Water with chloride ranging between 250 and 1000 mg/L falling under 'permissible' range are confined mostly to parts of North, North West, West, and South West districts.

Relatively high values of Chloride (>1000 mg/L) are observed in patches in the North, North West, West, and South West districts. Table 7.2.1 shows the district-wise list of locations affected by high chloride water (>1000 mg/L) and these areas are water quality hot spots from high chloride point of view.

The occurrences of chloride in ground water beyond permissible limit (1000 mg/L) have been shown on the contour map as Fig 7.2.1, District-wise percentage of wells having chloride >1000 mg/L is shown as a bar diagram in Fig 7.2.2 and also given location details in Annexure-3.

Table 7.2.1 District-wise percentage of samples having Chloride >1000mg/L

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with Cl>1000 mg/L	(%) Samples with Cl>1000 mg/L
1.	Central	7	0	0
2.	East	5	0	0
3.	Nazul Land	2	0	0
4.	New Delhi	9	0	0
5.	North	21	3	14.29
6.	North East	3	0	0
7.	North West	14	4	28.57
8.	Shahdara	2	0	0
9.	South	8	0	0
10.	South East	7	0	0
11.	South West	15	8	53.3
12.	West	10	3	30
	Total	**103**	**18**	**17.48**

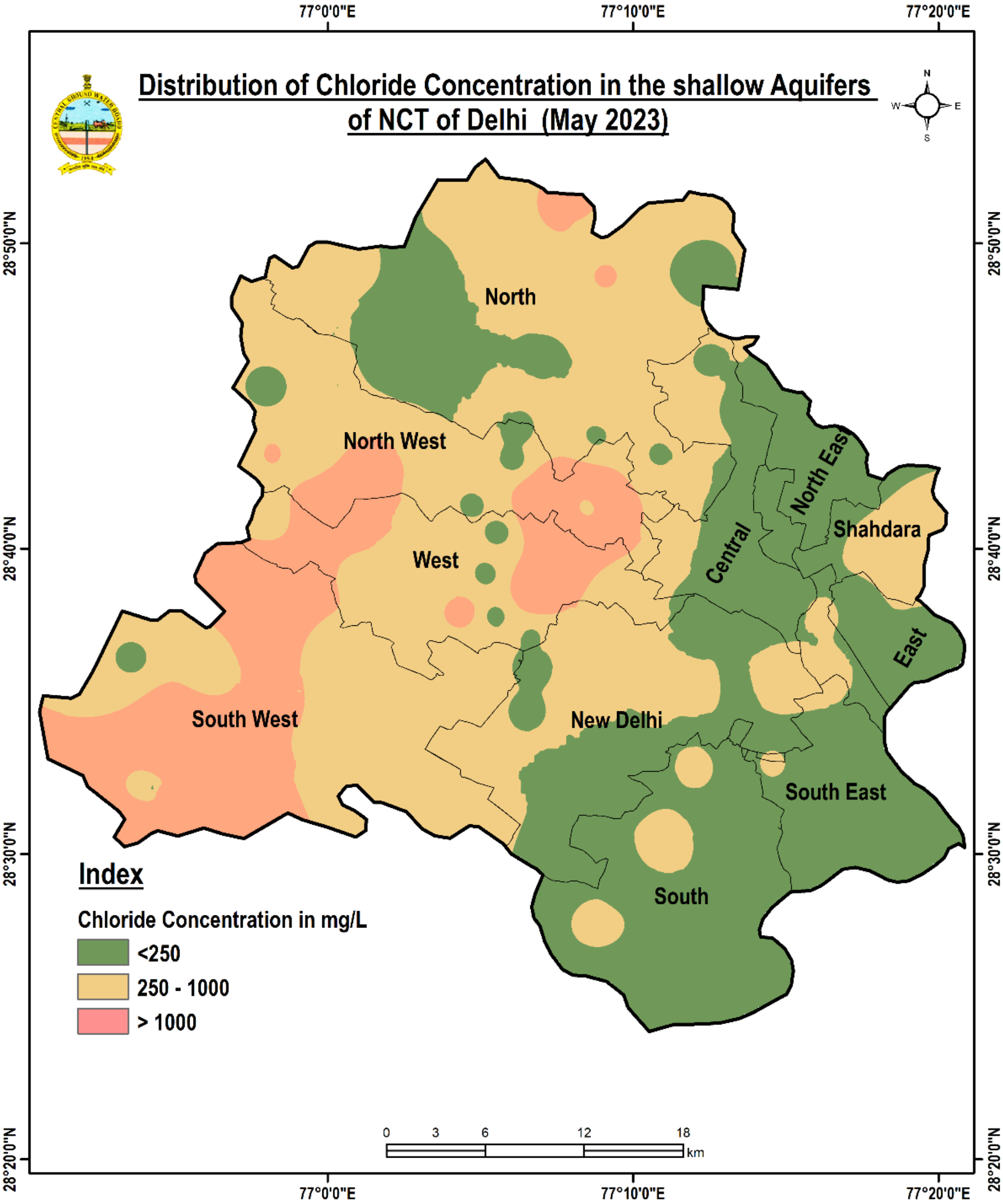


Fig 7.2.1 Spatial Distribution of Chloride during May 2023

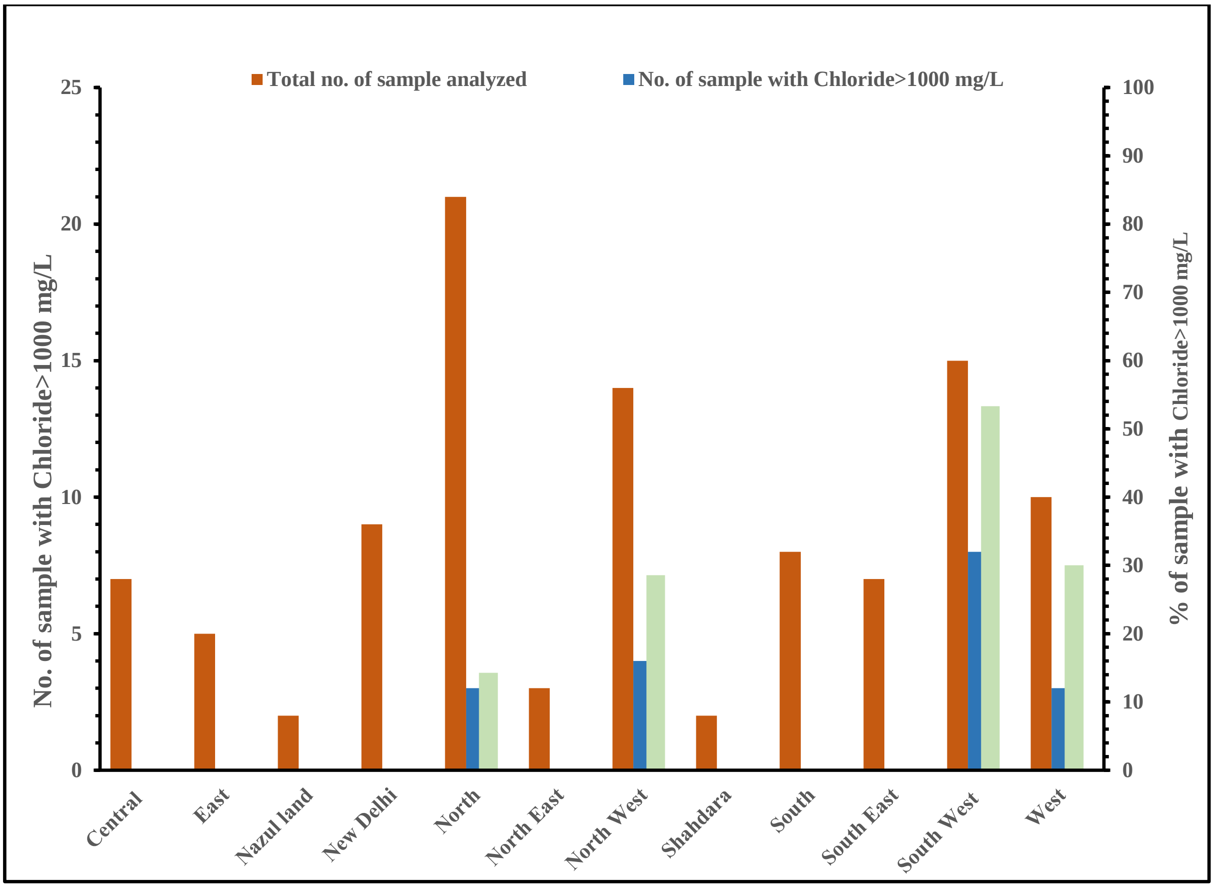


Fig 7.2.2 District-wise percentage of wells having Chloride > 1000 mg/L.

Table-7.2.2: Comparative Change in number of locations having Cl > 1000 mg/L in various districts of NCT of Delhi

S. No.	District	Nos. of locations having Cl>1000 mg/L.		
		2017	**2023**	**Increase/Decrease**
1.	Central	0	0	0
2.	East	0	0	0
3.	New Delhi	0	0	0
4.	North	2	3	1
5.	North East	0	0	0
6.	North West	2	4	2
7.	South	0	0	0
8.	South East	0	0	0
9.	South West	5	8	3
10.	West	2	3	1
11.	Nazulland	0	0	0
12.	Shahdara	0	0	0
13.	Central	0	0	0
14.	East	0	0	0
	Total	**11**	**18**	**7**

In comparison to 2017, it has been observed that the no. of districts having chloride more than 1000 mg/L in various districts has increased. (Table 7.2.3 & Fig.7.2.3). In North, North West, South West and West districts, the increase in the no. of location is a matter of concern.

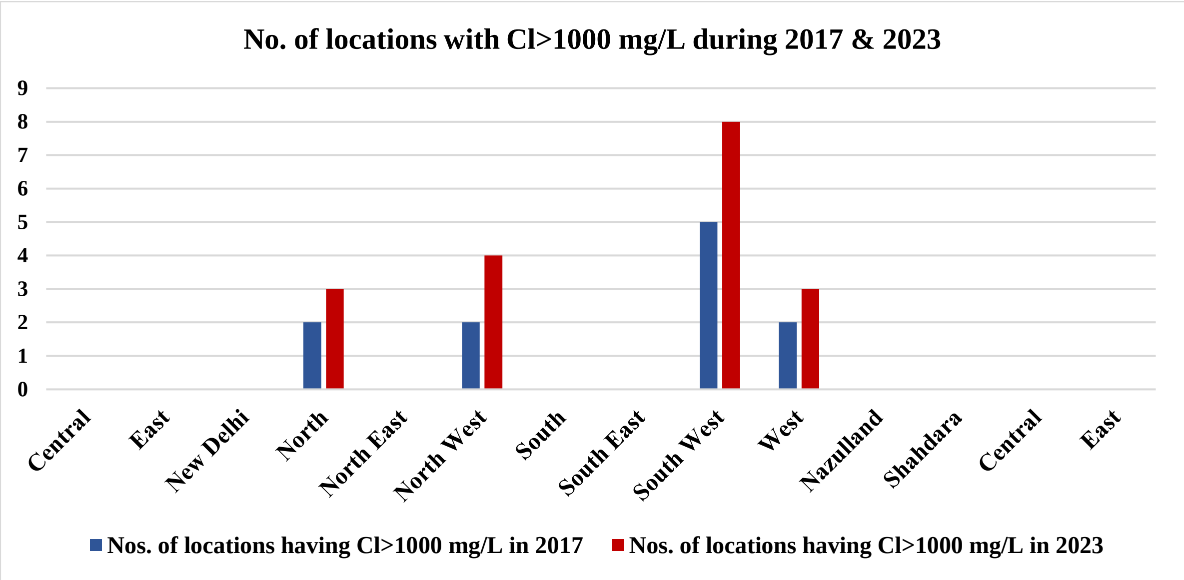


Fig. 7.2.3 Comparison on No of locations exceeding Chloride >1000 mg/L during 2017 and 2023.

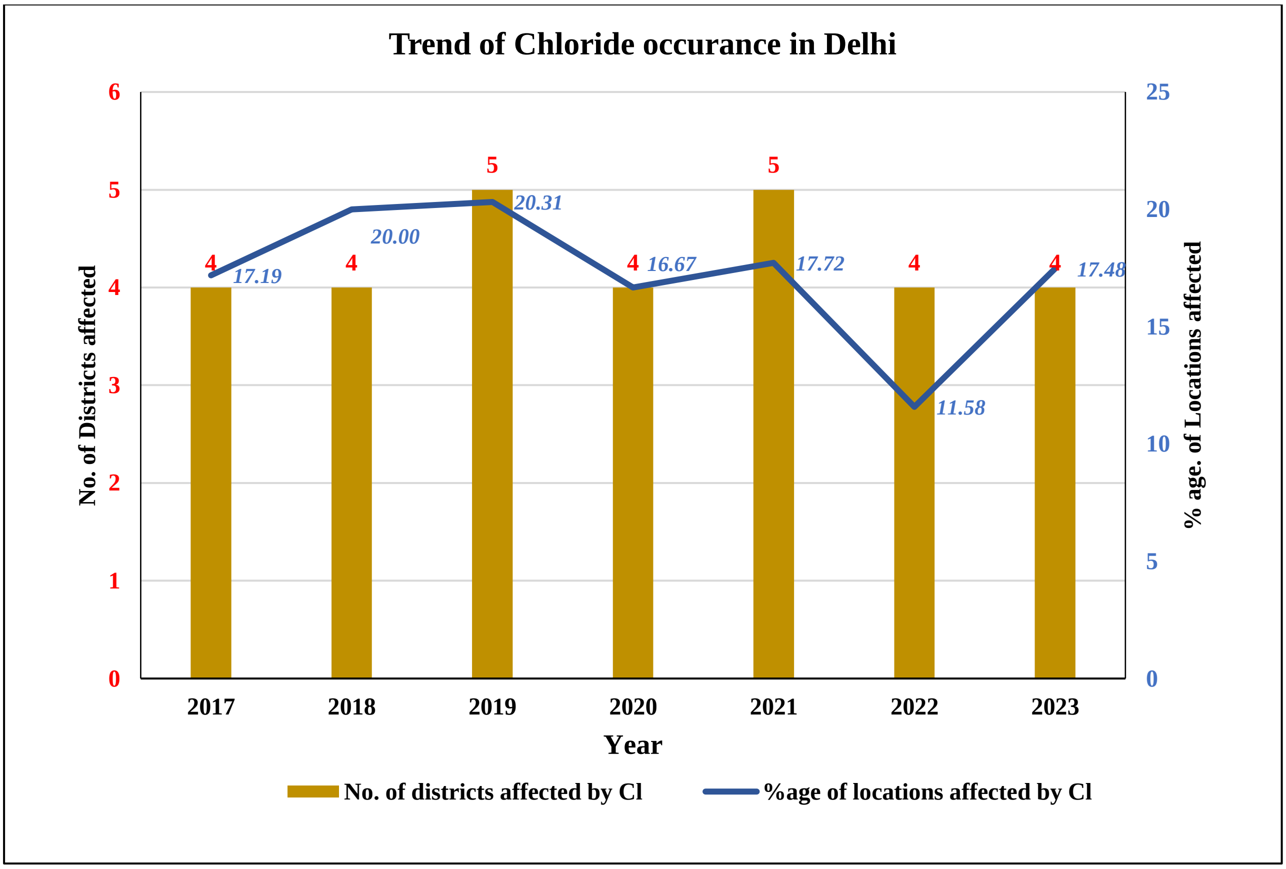


Fig. 7.2.4 Trend of Chloride occurrence in NCT of Delhi

7.3 FLUORIDE

Fluorine is a fairly common element but it does not occur in the elemental state in nature because of its high reactivity. Fluorine is the most electronegative and reactive of all elements that occur naturally within many types of rock. It exists in the form of fluorides in a number of minerals of which fluorspar, cryolite, fluorite and fluorapatite are the most common. Fluorite (CaF_2) is a common fluoride mineral.

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 ground water in small amounts. The occurrence of fluoride in natural water is affected by the type of rocks, climatic conditions, nature of hydrogeological strata and time of contact between rock and the circulating ground water. Presence of other ions, particularly bicarbonate and calcium ions also affect the concentration of fluoride in ground water.

It is well known that small amounts of fluoride (less than 1.0 mg/L) have proven to be beneficial in reducing tooth decay. Community water supplies commonly are treated with NaF or fluorosilicates to maintain fluoride levels ranging from 0.8 to 1.2 mg/L to reduce the incidence of *dental carries*. However, high concentrations such as 1.5 mg/L of F and above have resulted in staining of tooth enamel while at still higher levels of fluoride ranging between 5.0 and 10 mg/L, further pathological changes such as stiffness of the back and difficulty in performing natural movements may take place.

BIS has recommended an upper desirable limit of 1.0 mg/L of F^- as desirable concentration of fluoride in drinking water, which can be extended to 1.5 mg/L of F in case no alternative source of water is available. Water having fluoride concentration of more than 1.5 mg/L are not suitable for drinking purposes.

The fluoride content in groundwater from observation wells in a major part of the State is found to be less than 1.0 mg/L. The distribution of ground water samples with fluoride concentration more than 1.5 mg/L have been depicted on the map as Fig. 7.3.1. It is observed that there are several locations in the districts of North, North West and South West where the fluoride in ground water exceeds 1.5 mg/L. The details of locations where fluoride concentration more than 1.5 mg/l is given in Annexure-3. The details of districts showing localized occurrence of fluoride in ground water in excess of 1.5mg/L is given in table 7.3.1

The occurrences of fluoride in groundwater beyond permissible limit (1.5 mg/L) have also been shown on the map as Fig. 7.3.1, District-wise percentage of wells having fluoride >1.5mg/L is shown as a bar diagram in Fig 7.3.2.

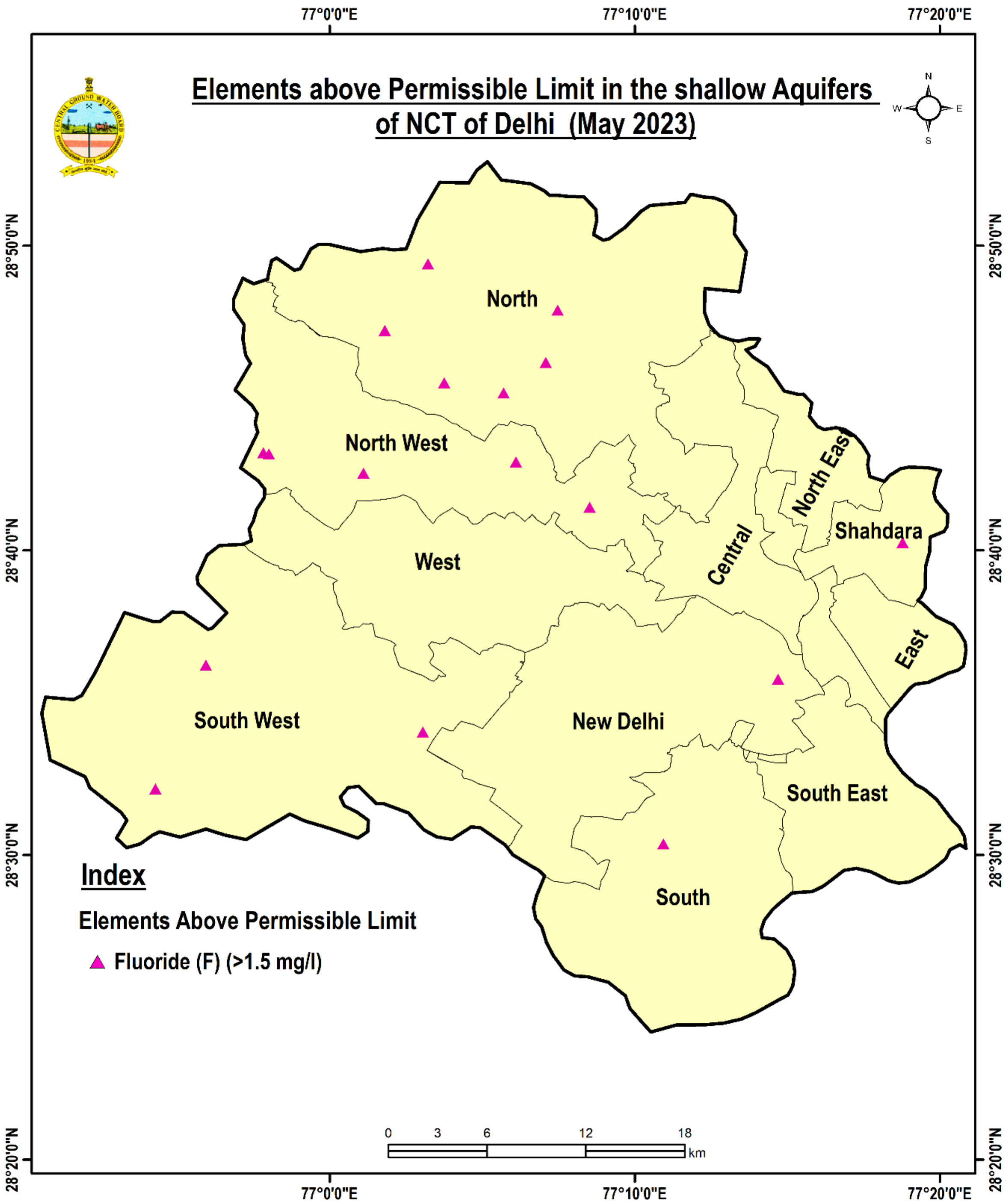


Fig 7.3.1 Locations having Fluoride concentration > 1.5 mg/L during May 2023.

Table 7.3.1 District-wise percentage of wells having fluoride >1.5mg/L

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with F>1.5 mg/L	(%) Samples with F>1.5 mg/L
1.	Central	7	0	0.0
2.	East	5	0	0.0
3.	Nazul Land	2	0	0.0
4.	New Delhi	9	1	11.1
5.	North	21	6	28.6
6.	North East	3	0	0.0
7.	North West	14	5	35.7
8.	Shahdara	2	1	50.0
9.	South	8	1	12.5
10.	South East	7	0	0.0
11.	South West	15	3	20.0
12.	West	10	0	0.0
	Total	**103**	**17**	**16.5**

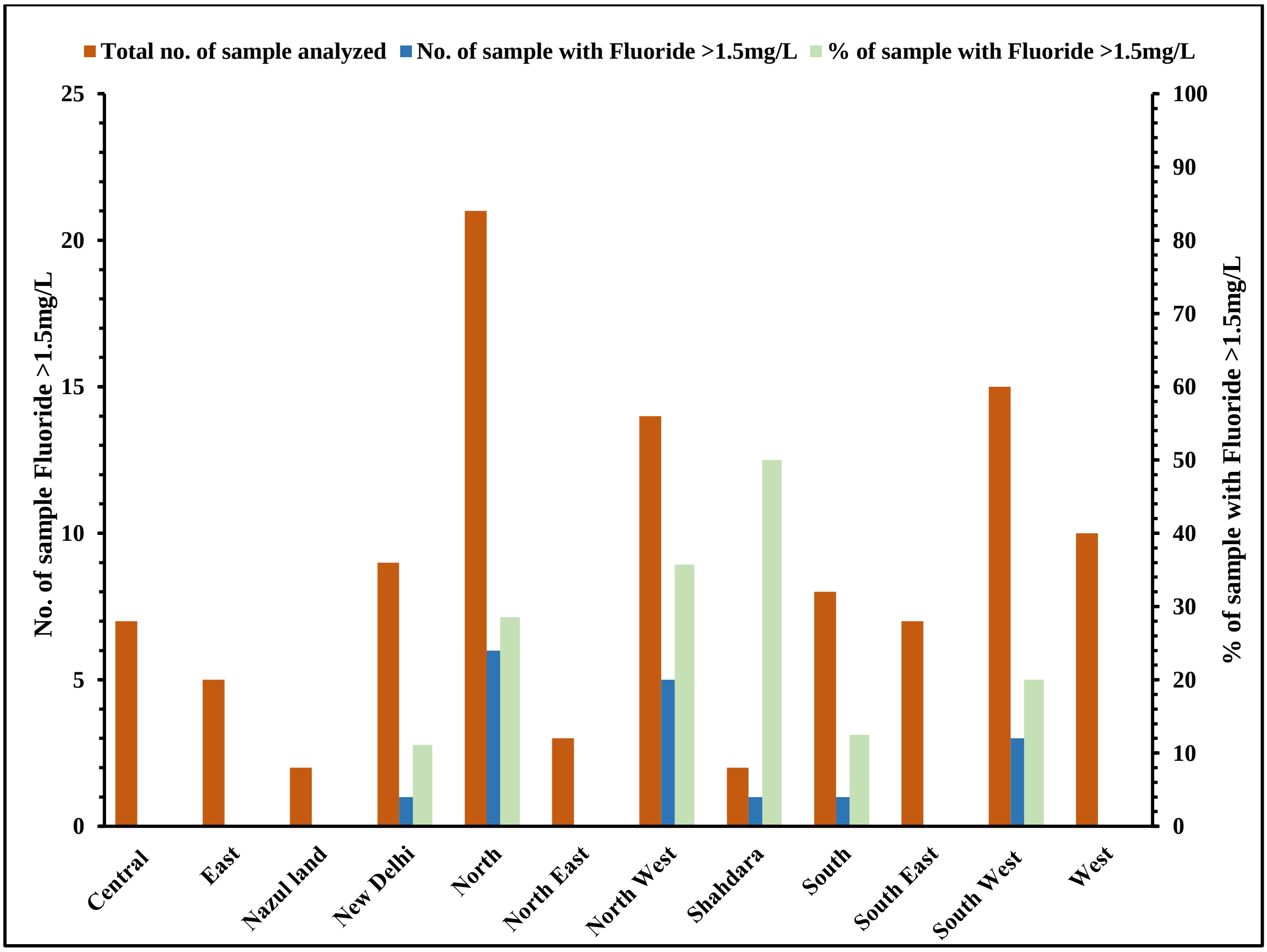


Fig 7.3.2 District-wise percentage of wells having fluoride >1.5 mg/L

Table-7.3.2: Comparative Change in number of locations having F > 1.5 mg/L in various districts.

S. No.	District	Nos. of locations having F> 1.5 mg/L.		
		2017	**2023**	**Increase/Decrease**
1.	Central	0	0	0
2.	East	0	0	0
3.	Nazul Land	0	0	0
4.	New Delhi	1	1	0
5.	North	2	6	4
6.	North East	0	0	0
7.	North West	3	5	2
8.	Shahdara	0	1	1
9.	South	1	1	0
10.	South East	0	0	0
11.	South West	1	3	2
12.	West	3	0	-3
	Total	**11**	**17**	**06**

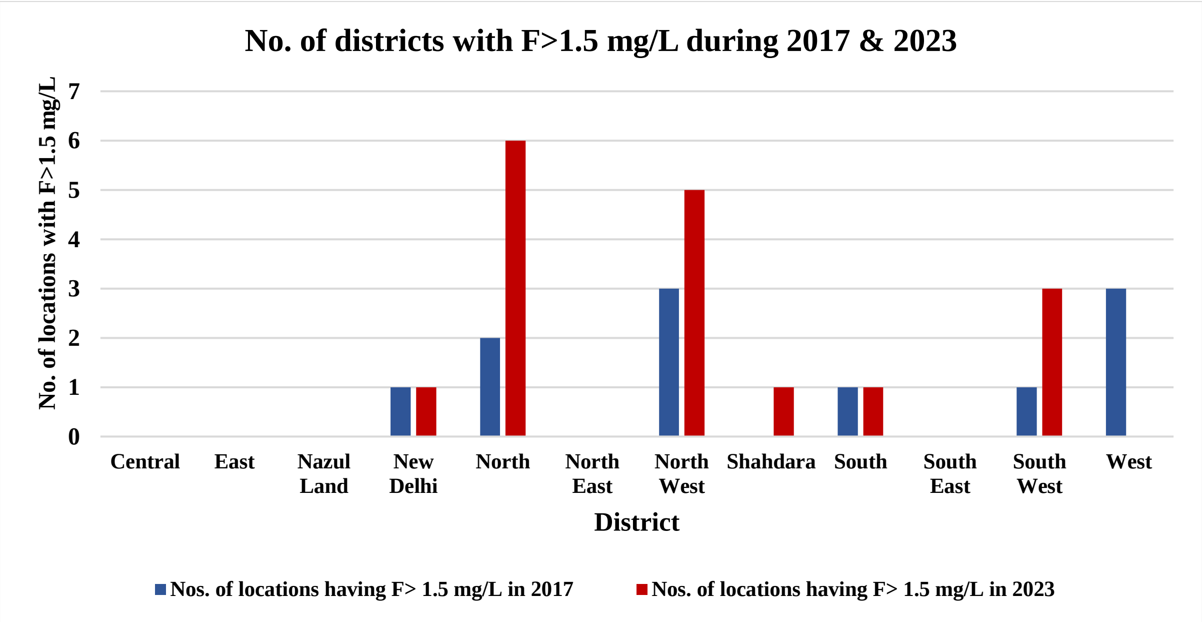


Fig 7.3.3 Comparison on No of districts exceed Fluoride >1.5 during 2017 and 2023

It has been observed (Table 7.3.3) that total number of districts affected by high fluoride in different States has increased by 54.54 % in 2023 as compared to the data available in 2017.

7.3.1 TREND ON FLUORIDE

The occurrence of fluoride in groundwater is mainly due to weathering and leaching of fluoride bearing minerals from rocks and sediments. To assess the trend of ground water pollution due to geogenic activity, the percentage of well exceeds the permissible limit of 1.5mg/L for the period of 2017 to 2023 were compared and presented in the Table 7.3.3 and observed that the percentage of samples exceed the permissible limit of fluoride 1.5 mg/L were ranging between 9 - 17 % and no significant trend was noticed. The number of fluoride affected location has increased in the year 2023. Trend on water quality for fluoride was prepared for the NCT of Delhi is shown in Fig 7.3.4. Trend on fluoride in NCT of Delhi shows (Fig 7.3.5) almost constant trend.

Table 7.3.3: Percentage of wells Exceed fluoride >1.5 mg/L during the period of 2017-2023

Year	Total Number of samples analysed	No. of districts affected by Fluoride	No. of locations affected by Fluoride	% of locations affected by Fluoride (F >1.5mg/L)
2017	64	6	11	17.19
2018	65	5	11	16.92
2019	64	2	6	9.38
2020	66	4	6	9.09
2021	79	6	13	16.46
2022	95	6	15	15.79
2023	103	6	17	16.5

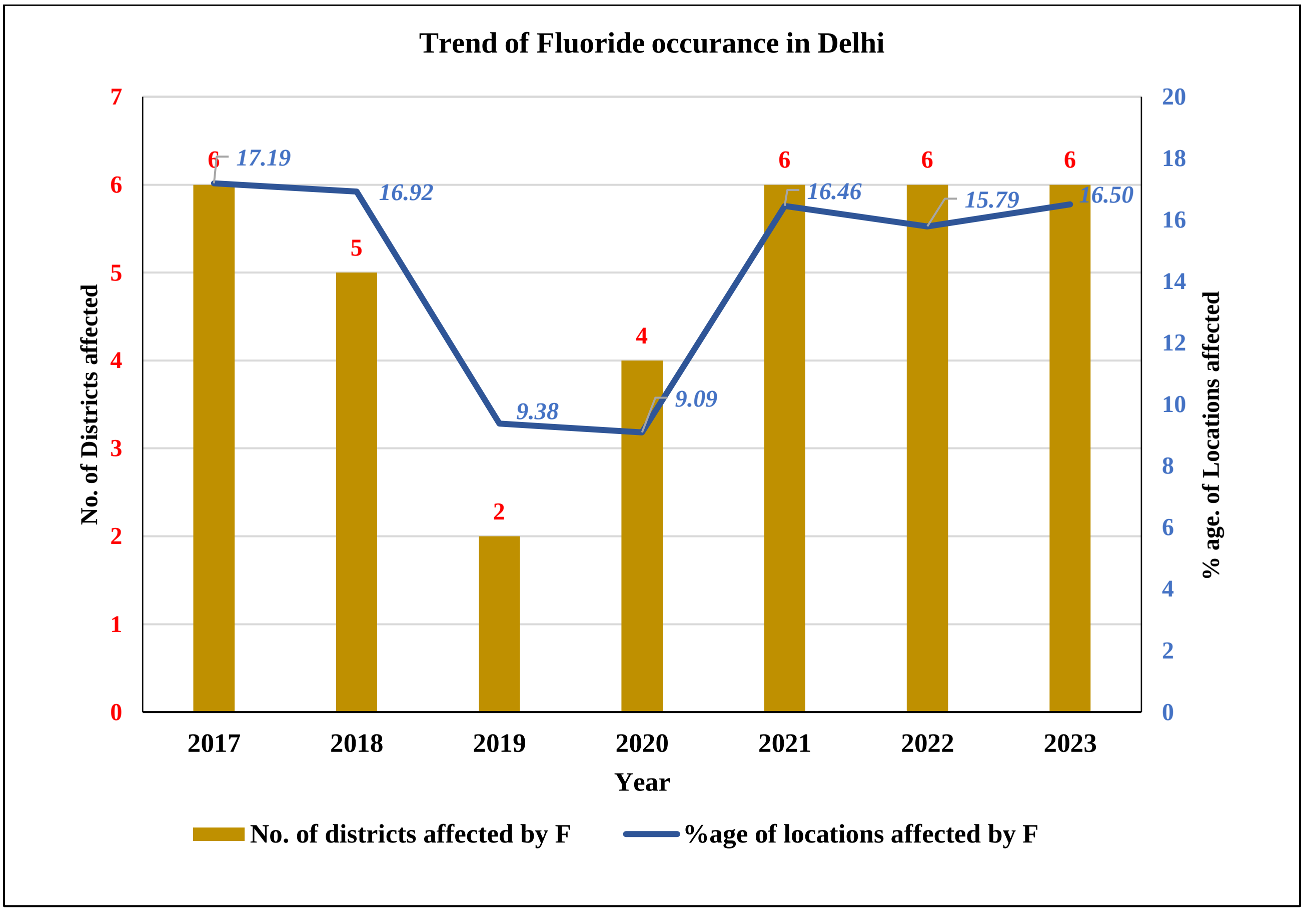


Fig. 7.3.4 Trend of Fluoride occurrence in NCT of Delhi

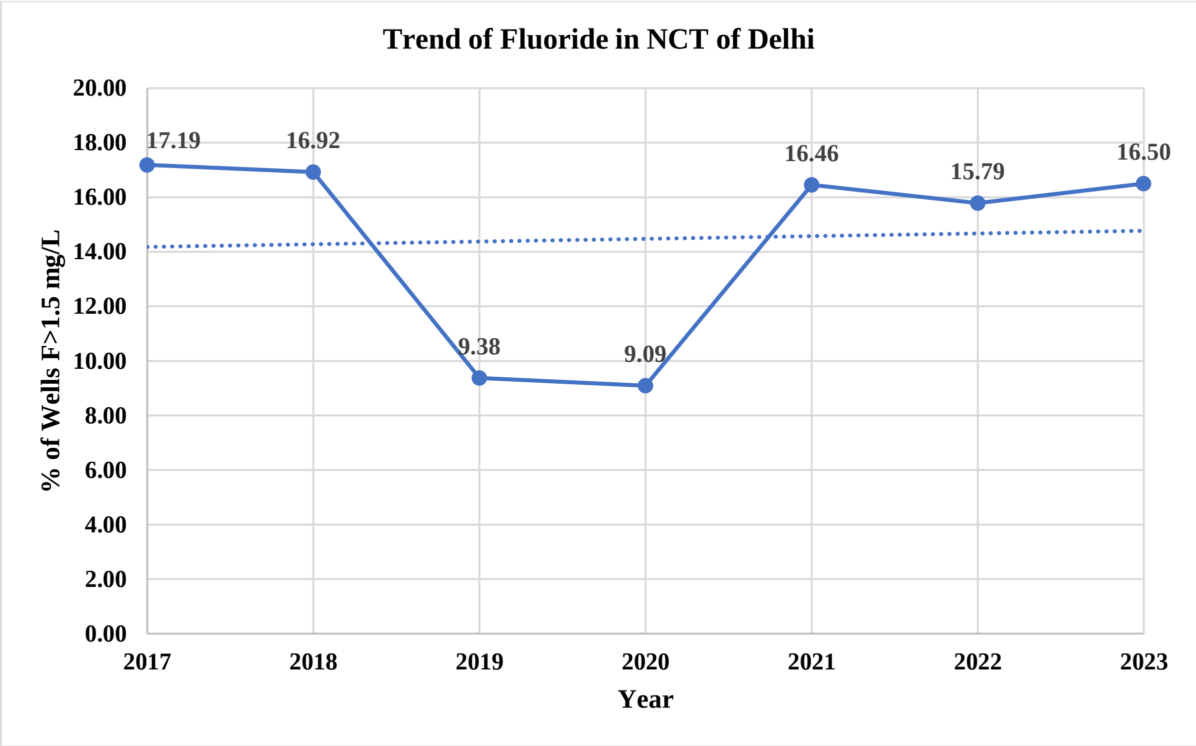


Fig 7.3.5 Trend on Fluoride in NCT of Delhi for the period of 2017-2023

7.4 NITRATE

Nitrate is a naturally occurring compound that is formed in the soil when nitrogen and oxygen combine. The primary source of all nitrates is atmospheric nitrogen gas. This is converted into organic nitrogen by some plants by a process called nitrogen fixation. Dissolved Nitrogen in the form of Nitrate is the most common contaminant of ground water. Nitrate in groundwater generally originates from non-point sources such as leaching of chemical fertilizers & animal manure, groundwater pollution from septic and sewage discharges etc. It is difficult to identify the natural and man-made sources of nitrogen contamination of ground water. Some chemical and micro-biological processes such as nitrification and denitrification also influence the nitrate concentration in ground water.

As per the BIS Standard for drinking water the maximum desirable limit of Nitrate concentration in ground water is 45 mg/L with no relaxation. Though, Nitrate is considered relatively non-toxic, a high nitrate concentration in drinking water is an environmental health concern arising from increased risks of methemoglobinemia particularly to infants. Adults can tolerate little higher concentrations. The specified limits are not to be exceeded in public water supply. If the limit is exceeded, water is considered to be unfit for human consumption.

The occurrences of Nitrate in ground water beyond permissible limit (45 mg /L) have been shown on the map as a point source Fig 7.4.1 and also given in Annexure-3. Table-7.4.1 shows the districts where nitrate has been found in excess of 45 mg/L in groundwater.

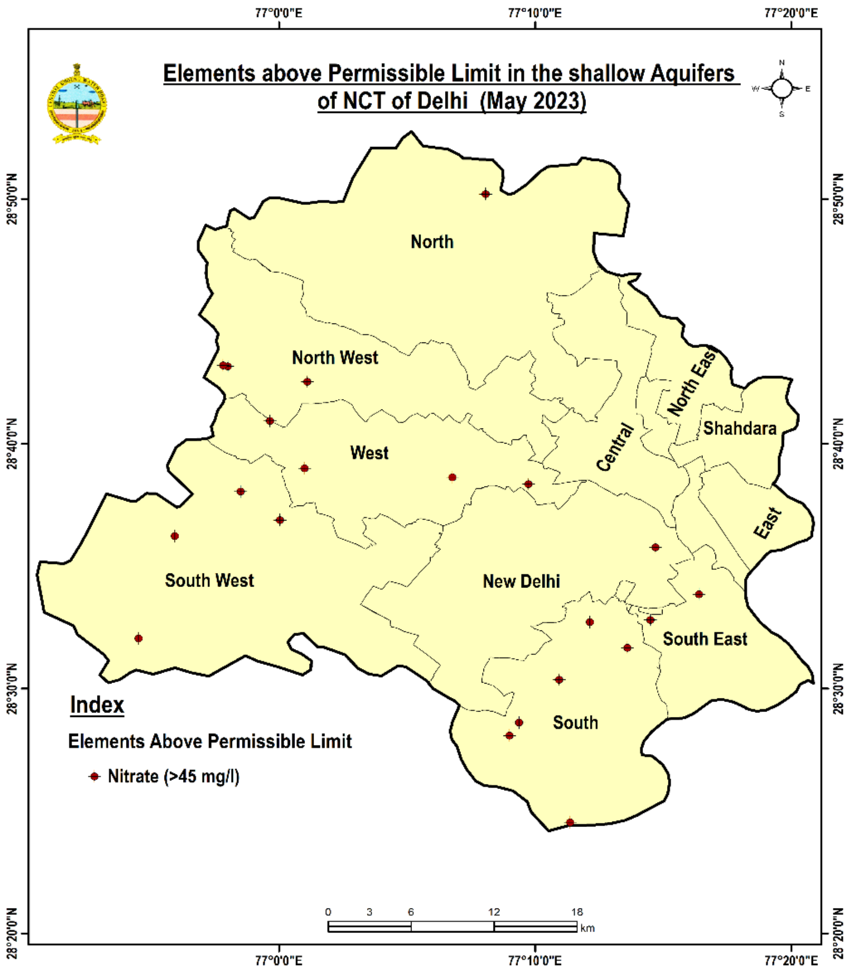


Fig 7.4.1 Locations having Nitrate concentration > 45 mg/L during May 2023

Table 7.4.1: District-wise percentage of wells having Nitrate > 45 mg/L

Sr. No	Name of Districts	Total no. of Sample Analyzed	No. of Sample with Nitrate>45 mg/L	(%) Samples with Nitrate>45 mg/L
1.	Central	7	0	0.00
2.	East	5	0	0.00
3.	Nazul land	2	0	0.00
4.	New Delhi	9	1	11.11
5.	North	21	1	4.76
6.	North East	3	0	0.00
7.	North West	14	3	21.43
8.	Shahdara	2	0	0.00
9.	South	8	6	75.00
10.	South East	7	2	28.57
11.	South West	15	4	26.67
12.	West	10	4	40.00
	Total	**103**	**21**	**20.39**

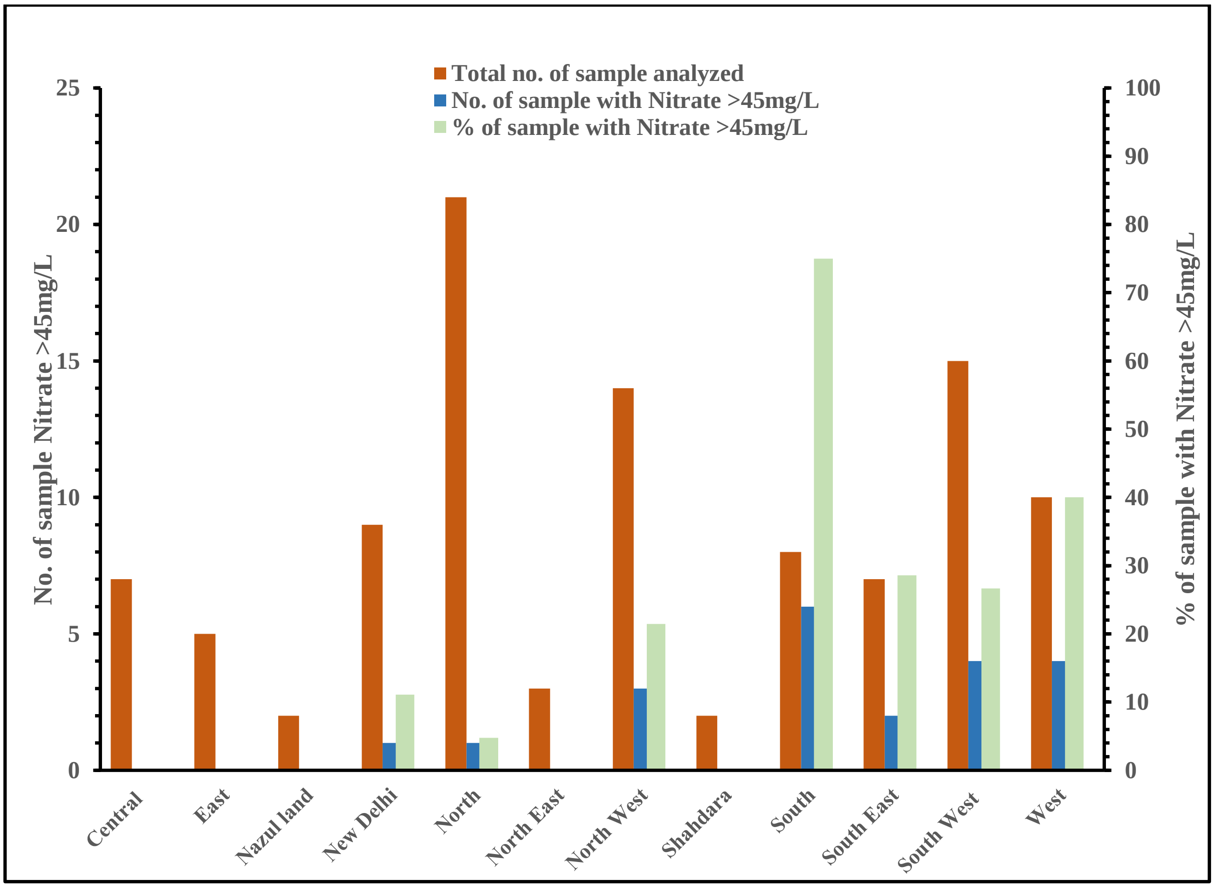


Fig 7.4.2 District-wise samples exceed Nitrate 45 mg/L (May 2023)

Table-7.4.2: Comparative Change in number of Districts having Nitrate > 45 mg/L in various districts

S. No.	District	Nos. of locations having NO_3> 45 mg/L.		
		2017	2023	Increase/ Decrease
1.	Central	1	0	-1
2.	East	1	0	-1
3.	New Delhi	3	1	-2
4.	North	1	1	0
5.	North East	0	0	0
6.	North West	2	3	1
7.	South	3	6	3
8.	South East	1	2	1
9.	South West	5	4	-1
10.	West	2	4	2
11.	Nazul land	0	0	0
12.	Shahdara	0	0	0
	Total	**19**	**21**	**02**

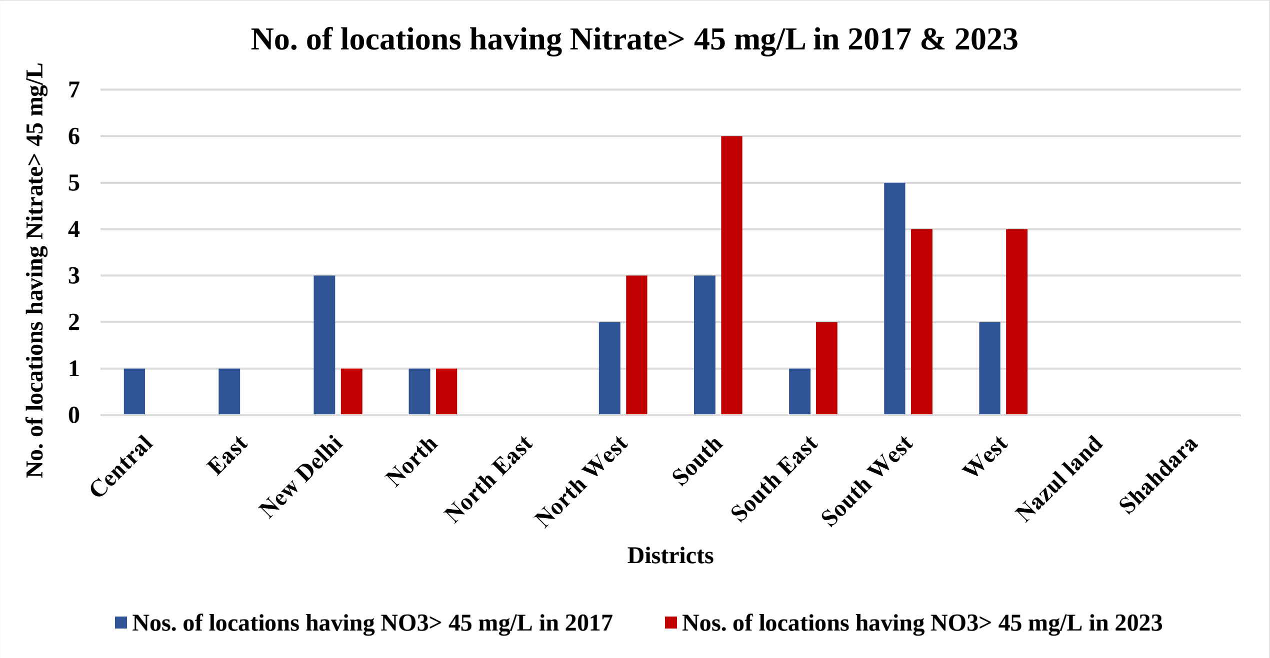


Fig. 7.4.3 Bar diagram comparing no. of Nitrate contaminated (45 mg/L) locations in various districts during year 2017 and 2023

It has been observed (Table 7.4.3) that No. of districts in various States having high Nitrate (more than 45 mg/l) content in ground water has increased by 10.52% in year 2023 as compared to the data available in year 2017.

7.4.1 TREND ON NITRATE

Trend analysis determines whether the measured values of the water quality variables increase or decrease during a time period. Nitrate is one of the major indicators of anthropogenic sources of pollution. Nitrate is the ultimate oxidized product of all nitrogen containing matter and its occurrence in groundwater can be fairly attributed to infiltration of water through soil containing domestic waste, animal waste, fertilizer and industrial pollution. As the lithogenic sources of nitrogen are very rare, its presence in ground water is almost due to anthropogenic activity. Hence, nitrate was taken to assess the trend of ground water quality in Delhi is due to anthropogenic activity. The percentage of well exceeds the permissible limit of 45mg/L for the period of 2017 to 2023 were compared and presented in the Table 7.4.3 and Fig 7.4.4 and observed that the percentage of samples exceed the permissible limit of nitrate (> 45 mg/L) were ranging between 15 - 37 % and increase in the trend was noticed. The number of nitrate affected district has decreased in the year 2023 in comparison to 2017; this may be attributed to dilution. It is also observed that the type of waste generated is important in causing the nitrate pollution and also indicates that domestic waste leads to more nitrate problem. This could be due to the leaching of nitrate from the open sewerage lines. Trend on water quality for Nitrate prepared for the NCT of Delhi is shown in (Fig 7.4.5).

Table 7.4.3: Percentage of wells Exceed Nitrate >1.5 mg/L during the period of 2017-2023

Year	Total Number of samples analysed	No. of districts affected by Nitrate	No. of locations affected by Nitrate	% age of samples affected by Nitrate (NO_3 >45 mg/L)
2017	64	9	19	29.69
2018	65	9	24	36.92
2019	64	6	10	15.63
2020	66	5	10	15.15
2021	79	7	17	21.52
2022	95	10	33	34.7
2023	103	7	21	20.39

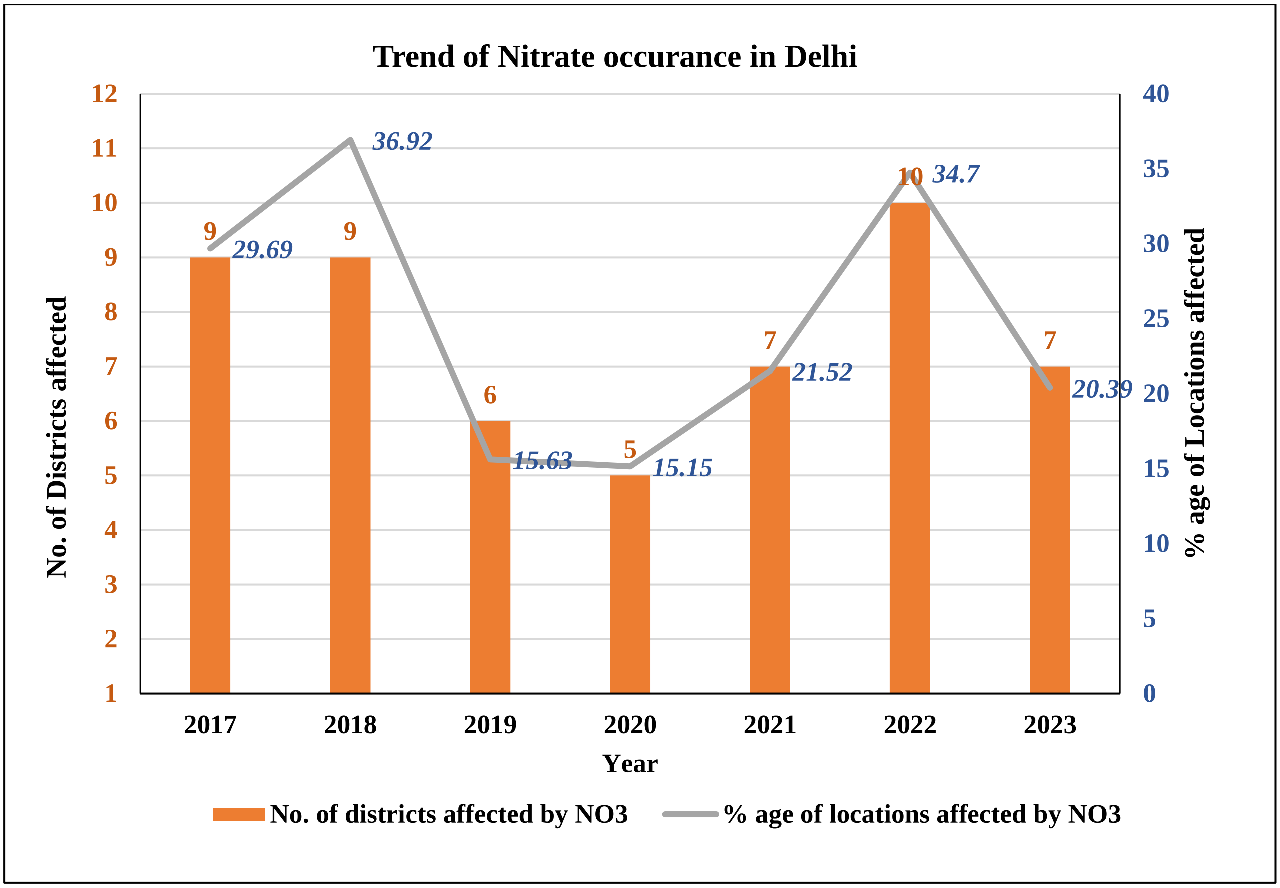


Fig. 7.4.4 Trend of Nitrate occurrence in Delhi

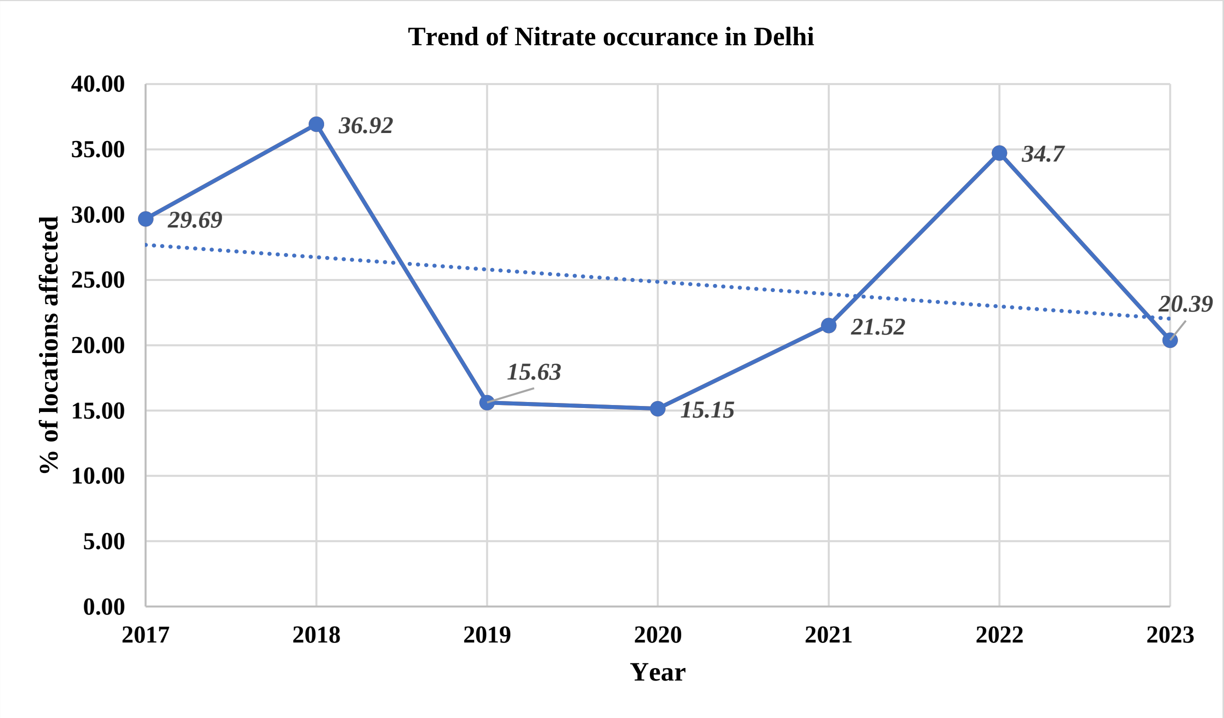


Fig. 7.4.5 Trend of Nitrate occurrence in NCT of Delhi for the period of 2017-2023

7.5 IRON

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 groundwater 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 1.0 mg/L as per the BIS Standard for drinking water. The occurrences of iron in ground water beyond permissible limit (> 1.0 mg /litre) have been shown on the maps as point sources (Fig 7.5.1). It is based on the chemical analysis of water samples mostly collected from the groundwater observation wells/ springs/ hand pumps. The details of the sampling sources are given in Annexure-3. The iron point value map indicates that the shallow aquifers in the NCT of Delhi is generally free from Fe contamination. Only four locations in the district namely South East, East and Nazul Land show iron values beyond the permissible limits for drinking water.

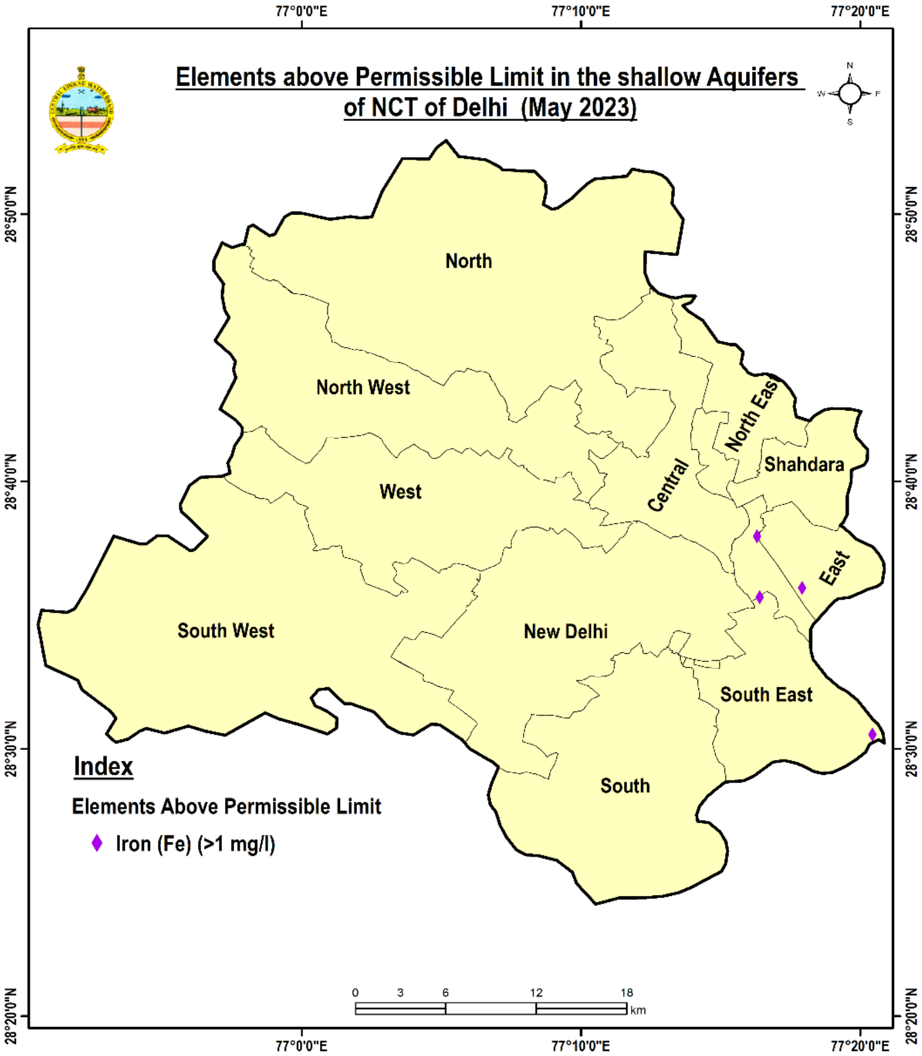


Fig 7.5.1 Map showing areas of Iron contaminated (> 1.0mg/L) groundwater in NCT of Delhi

Table 7.5.1: District-wise percentage of wells having Iron > 1mg/L

Sr. No	Name of Districts	Total no. of Sample Analyzed	No. of Sample with Iron>1 mg/L	(%) Samples with Iron>1 mg/L
1.	Central	7	0	0.0
2.	East	5	1	20.0
3.	Nazul land	2	1	50.0
4.	New Delhi	9	0	0.0
5.	North	21	0	0.0
6.	North East	3	0	0.0
7.	North West	14	0	0.0
8.	Shahdara	2	0	0.0
9.	South	8	0	0.0
10.	South East	7	2	28.6
11.	South West	15	0	0.0
12.	West	10	0	0.0
	Total	**103**	**4**	**3.9**

Table-7.5.2: Comparative Change in number of Districts having Iron > 1 mg/L in NCT of Delhi

S. No.	District	Nos. of locations having Fe>1 mg/L.		
		2019	2023	Increase/ Decrease
1.	Central	0	0	0
2.	East	0	1	1
3.	New Delhi	0	0	0
4.	North	0	0	0
5.	North East	0	0	0
6.	North West	1	0	-1
7.	South	0	0	0
8.	South East	0	2	2
9.	South West	0	0	0
10.	West	0	0	0
11.	Nazulland	0	1	1
12.	Shahdara	0	0	0
	Total	**1**	**4**	**3**

Table 7.5.3: Percentage of wells Exceed Iron >1 mg/L during the period of 2019-2023

Year	Total Number of samples analysed	No. of districts affected by Iron	No. of locations affected by Iron	% age of samples affected by Iron (Fe>1 mg/L)
2019	64	1	1	1.56
2020	66	3	4	6.06
2021	79	4	4	5.06
2022	95	2	2	2.10
2023	103	3	4	3.9

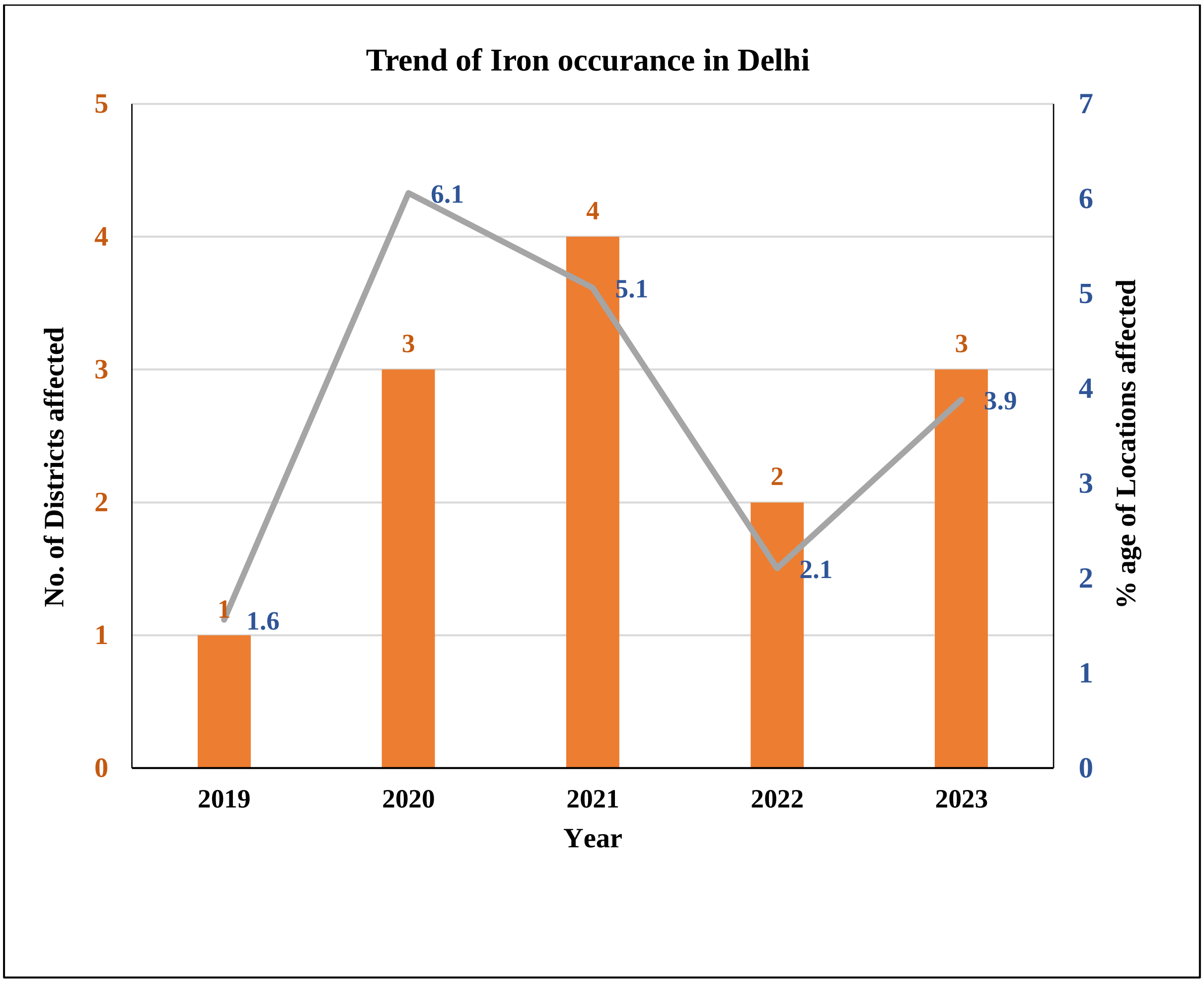


Fig. 7.5.2 Trend of Iron occurrence in NCT of Delhi

As compared to the data available in year 2019, the number of districts having Iron more than 1.0 mg/L in ground water samples has only increased in 2 districts.

7.6 Arsenic

Arsenic is a naturally occurring trace element found in rocks, soils and the water in contact with them. Arsenic has been recognized as a toxic element and is considered a human health hazard.

Arsenic is a metalloid. The common valancy of arsenic in unpolluted ground water of geogenic origin are +III & +V as hydrolysis species. The dissociation constant of As (III) and As (V) acids are quite different. The fact that dominant dissolved species are either uncharged or negatively charged suggests that adsorption and ion exchange will cause little retardation as these species are transported along ground water flow path. Organic arsenic compounds such as methyl arsenic acid and dimethyl arsenic acid are not common in ground water. The occurrence of Arsenic in ground water was first reported in 1980 in West Bengal in India.

The map showing distribution of Arsenic in ground water in NCT of Delhi (Fig 7.6.1) has been generated from the data on arsenic concentration in water samples mostly collected from the groundwater observation wells. Arsenic contaminated areas have been shown as points based on findings of Central Ground Water Board. The point sources are plotted on the map (Fig 7.6.1). Districts having Arsenic > 0.01 mg/L in Ground Water in NCT of Delhi is shown in Table-7.6.1.

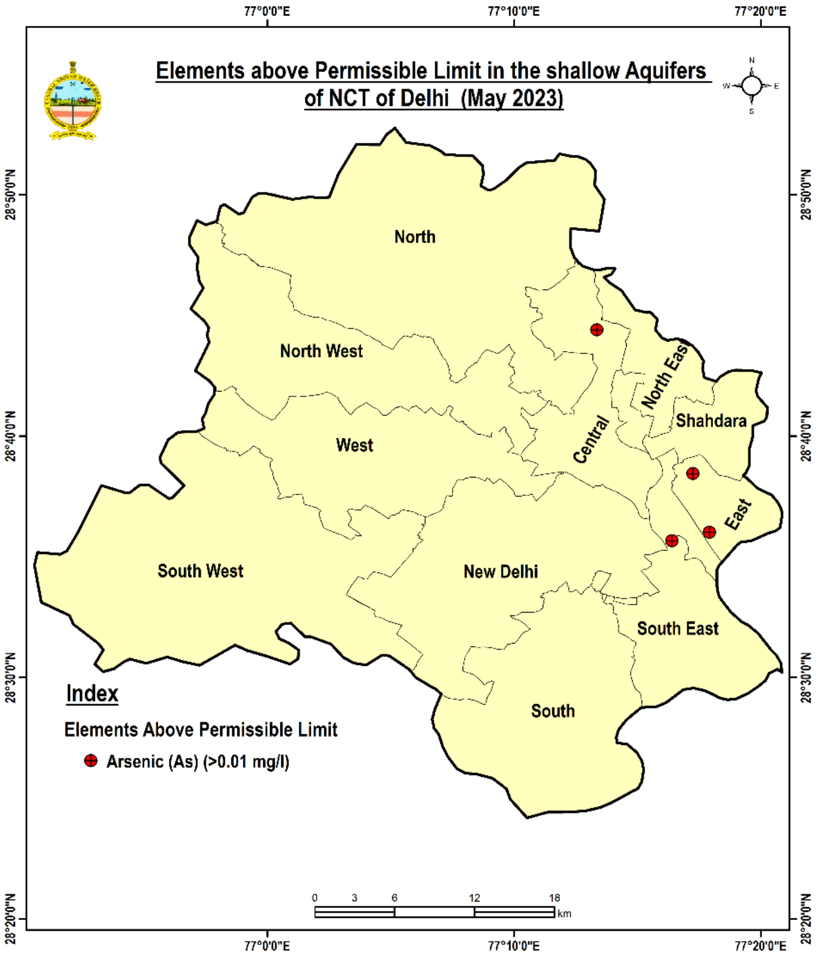


Fig 7.6.1 Map showing areas of Arsenic contaminated (> 0.01 mg/L) groundwater in NCT of Delhi

Table 7.6.1: District-wise percentage of wells having Arsenic > 0.01 mg/L

Sr. No	Name of Districts	Total no. of Sample Analyzed	No. of Sample with Arsenic>0.01 mg/L	(%) Samples with Arsenic>0.01 mg/L
1.	Central	7	1	14.3
2.	East	5	2	40.0
3.	Nazul land	2	0	0.0
4.	New Delhi	9	0	0.0
5.	North	21	0	0.0
6.	North East	3	0	0.0
7.	North West	14	0	0.0
8.	Shahdara	2	0	0.0
9.	South	8	0	0.0
10.	South East	7	1	14.3
11.	South West	15	0	0.0
12.	West	10	0	0.0
	Total	**103**	**4**	**3.9**

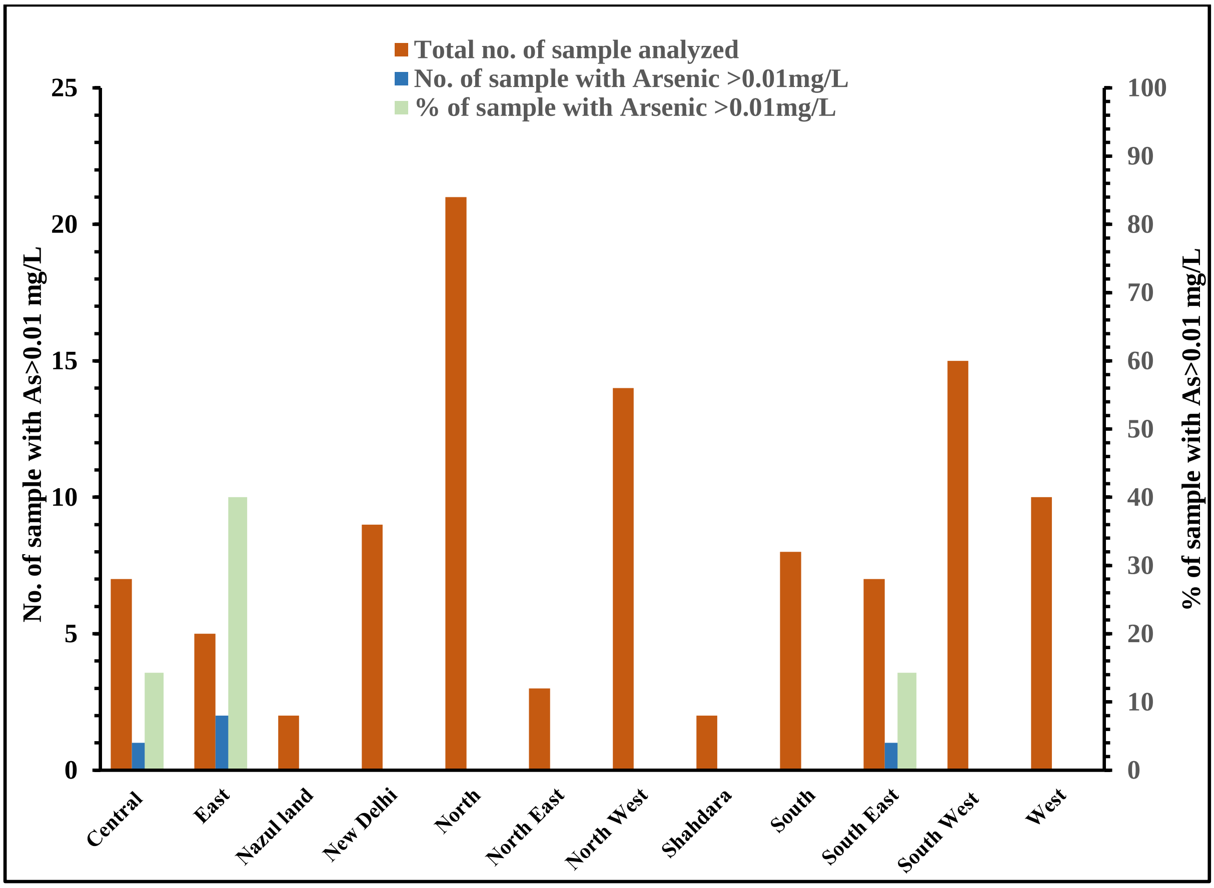


Fig 7.6.2 District-wise samples exceeding Arsenic 0.01 mg/L (May 2023)

Table-7.6.2: Comparative Change in number of locations having Arsenic > 0.01 mg/L in districts of NCT of Delhi

S. No.	District	Nos. of locations having As > 0.01 mg/L.		
		2019	2023	Increase/ Decrease
1.	Central	0	1	1
2.	East	0	2	2
3.	New Delhi	0	0	0
4.	North	0	0	0
5.	North East	0	0	0
6.	North West	0	0	0
7.	South	0	0	0
8.	South East	0	1	1
9.	South West	0	0	0
10.	West	0	0	0
11.	Nazulland	1	0	-1
12.	Shahdara	0	0	0
	Total	**1**	**4**	**3**

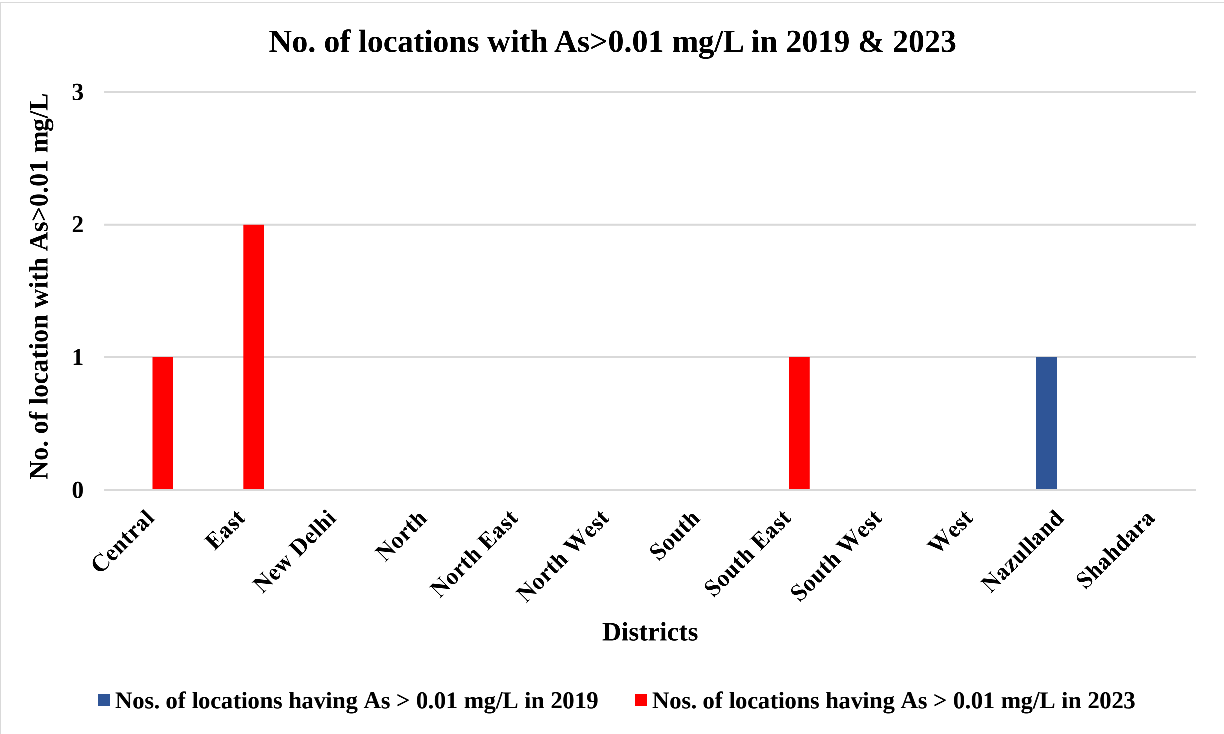


Fig. 7.6.3 Bar diagram comparing no. of Arsenic contaminated (0.01 mg/L) locations in various districts during year 2019 and 2023

It has been observed (Table 7.6.2) that No. of districts in various States having high Arsenic (more than 0.01 mg/l) content in ground water has been reported in three more districts in year 2023 as compared to the data available in year 2019.

7.7 URANIUM

Uranium occurs naturally in groundwater and surface water. Being a radioactive mineral, high uranium concentration can cause impact on water, soil and health. Uranium has both natural and anthropogenic source that could lead to the aquifer. These sources include leaching from natural deposits, release in mill tailings, and emissions from the nuclear industry, combustion of coal and other fuels and the use of phosphate fertilizers that contains uranium and contribute to ground water pollution. Uranium enters in human tissues mainly through drinking water, food, air and other occupational and accidental exposures. Intake of uranium through air and water is normally low, but in circumstances in which uranium is present in a drinking water source, the majority of intake can be through drinking water.

Water with uranium concentration above the recommended maximum permissible concentration of 30 ppb (BIS,10500:2012) is not safe for drinking purposes as it can cause damage to internal organs, on continuous intake. Elevated uranium concentrations in drinking water have been associated with many epidemiological studies such as urinary track cancer as well as kidney toxicity. A recent study, found a strong correlation between uranium concentration in drinking water and uranium in bone, suggesting that bones are good indicators of uranium exposed via ingestion of drinking water. Therefore, such studies trigger further assessment of uranium's adverse health effects on humans and/or the environment for countries where elevated uranium concentration in drinking water has been observed. Hence, it becomes important to study the level of uranium in drinking water for health risk assessment.

Uranium concentration in the shallow ground water varies primarily due to recharge and discharge, which would have dissolved or leached the uranium from the weathered soil to groundwater zone. High uranium concentrations observed in groundwater may be due to local geology, anthropogenic activities, urbanization and use of phosphate fertilizers in huge quantity for agriculture purpose. Studies have shown that phosphate fertilizer possess uranium concentration ranging from 1 mg/kg to 68.5 mg/kg (Brindha K et al., 2011). Hence, the phosphate fertilizers manufactured from phosphate rocks may also contribute uranium to ground water in agriculture region. In ores, uranium is found as uranite (UO_2^{2+}) and pitchblende ($U_3O_8^{2+}$) or in the form of secondary minerals (complex oxides, silicates, phosphates, vanadates).

Table 7.7.1 Summary of uranium concentrations in different types of rocks

Rocks	Range(mg/kg)
Granite	3.4
Limestone/dolomite	2.2
Argillaceous shale	3.7
Sediments	1.4-53
Phosphates	30-100

Table 7.7.2 Standards and guidelines for uranium in drinking water in various countries.

Sl. No	Country / agency	guideline value (μg/L)	Reference
1	Australia	GV 17	NHMRC, Australia (2011)
2	Bulgaria	ML 60	European Food Safety Authority (2009)
3	Canada	MAC 20	Health Canada (2019)
4	Finland	RV 100	European Food Safety Authority (2009)
5	India	RBL 60	AERB, India (2004)
6	India	PL 30	BIS,2012
7	Malaysia	MAV 2	Ministry of Health Malaysia (2004)
8	USA	MCL 30	USEPA (2011)
9	WHO	PGV 30	WHO 2011

GV, Guideline value; ML, Maximum limit; MAC, Most acceptable concentration; RV, Recommended value; RBL, Radiological based limit; PL, Permissible Limit; MAV, Maximum acceptable value; MCL, Maximum contaminant level; PGV, Provisional guideline value

To assess the Uranium concentration and distribution in the ground water, Uranium sampling of its National Hydrograph Network Stations (NHNS) for the State was carried out during Pre-monsoon monitoring (May,2023). The sample collection and storage were done according to the standard protocols prescribed by APHA (2017). The groundwater samples were collected in plastic bottles after having been filtered through 0.45-μm filter paper. For the cations and uranium analyses, groundwater samples were immediately acidified below pH 2 by adding nitric acid to prevent precipitation and adsorption to the container walls. Uranium (U) was detected using Inductively Coupled Plasma Mass-spectrometry. To ensure quality control, duplicate and standard checks were performed on every ten samples. In addition, a trace element standard reference material was examined. District wise no. of locations affected by Uranium (>30 ppb) and maximum value observed is given in Table 7.7.4.

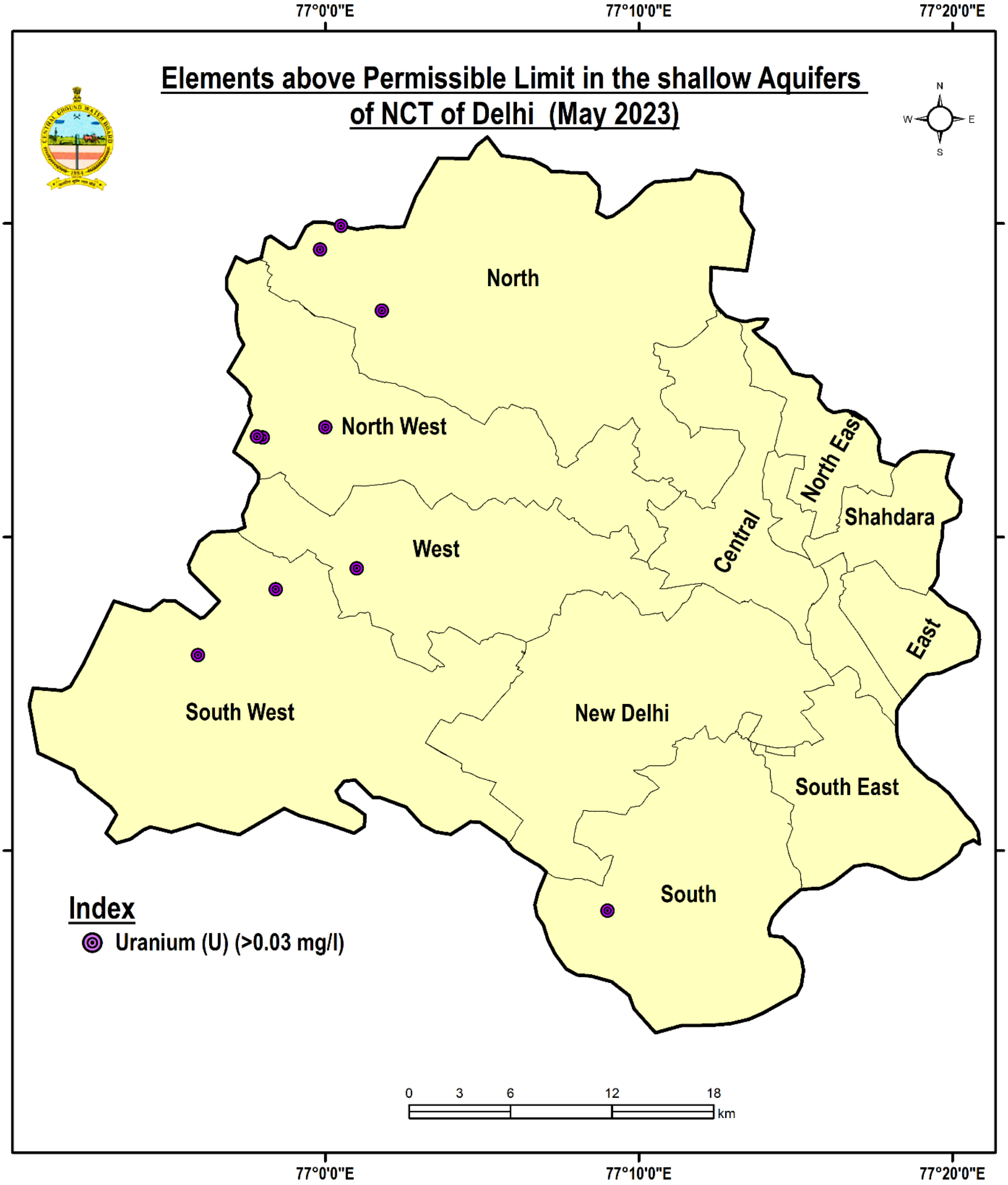


Fig 7.7.1 Map showing areas of Uranium contaminated (> 0.03 mg/l) groundwater in NCT of Delhi

Table 7.7.3: District-wise percentage of wells having Uranium > 30 ppb

Sr. No	Name of Districts	Total no. of Sample Analyzed	No. of Sample with Uranium>30 ppb	(%) Samples with Uranium>30 ppb
1.	Central	7	0	0.0
2.	East	5	0	0.0
3.	Nazul land	2	0	0.0
4.	New Delhi	9	0	0.0
5.	North	21	3	14.3
6.	North East	3	0	0.0
7.	North West	14	3	21.4
8.	Shahdara	2	0	0.0
9.	South	8	1	12.5
10.	South East	7	0	0.0
11.	South West	15	2	13.3
12.	West	10	1	10.0
	Total	**103**	**10**	**9.7**

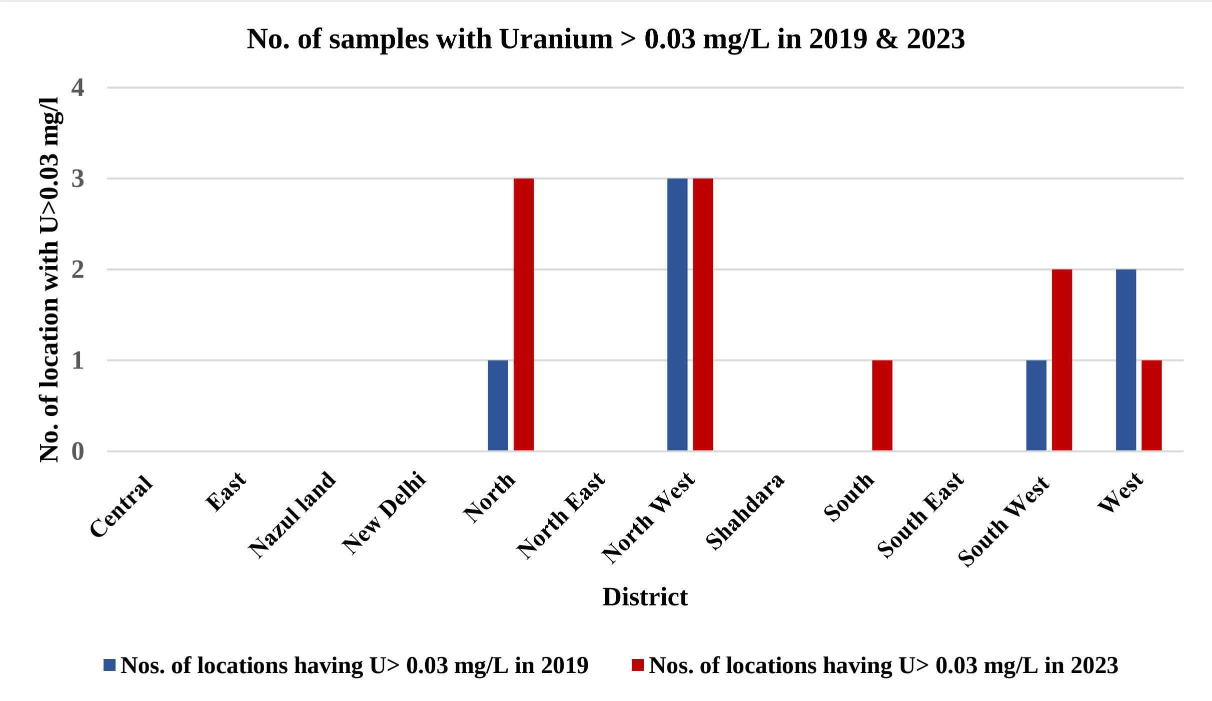


Fig. 7.7.3 Bar diagram comparing no. of Uranium contaminated (30 ppb) locations in various districts during year 2019 and 2022

Table 7.7.4 shows the number of districts partly affected in NCT of Delhi with maximum values recorded. It is observed that North, North West, West and South West are observed to have Uranium concentration above the permissible level of 30 µg/L in some localized pockets.

Uranium concentration varied from 0.0 to 0.122 mg/L in NCT of Delhi during Pre-monsoon monitoring, indicating that uranium concentrations in groundwater vary by some orders of magnitude. Slight variations seen in Uranium concentrations could be due to the wide variation of geographical locations or regional differences in the hydrogeochemical characteristics of groundwater.

Table 7.7.4: Details of number of districts partly affected with Uranium > 0.03 mg/L (>30ppb) and the maximum values of Uranium in districts of NCT of Delhi

Sl. No.	Districts	No. of location partly affected with U > 0.03 mg/L	Maximum value of Uranium observed (in mg/L)
1.	**North**	03	0.053
2.	**North West**	03	0.122
3.	**West**	01	0.04
4.	**South West**	02	0.04
5.	**South**	01	0.031

Table 7.7.5: Percentage of wells Exceed Uranium > 0.03 mg/L during the period of 2019-2023

Year	Total Number of samples analysed	No. of districts affected by Uranium	No. of locations affected by Uranium	% age of samples affected by Uranium (U >0.03 mg/L)
2019	64	4	7	11.67
2020	66	5	5	6.85
2021	79	1	3	3.90
2022	95	4	8	8.42
2023	103	05	10	9.71

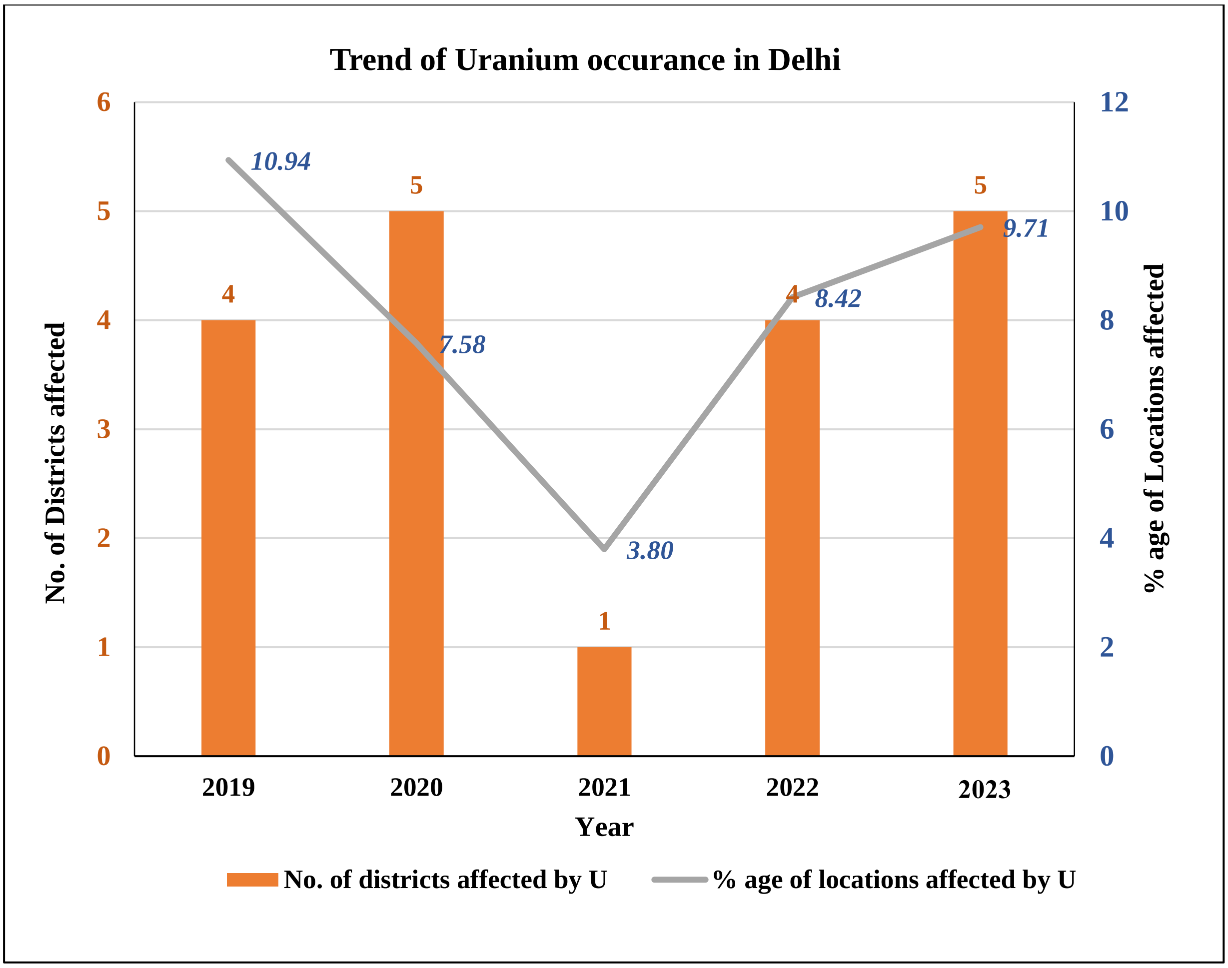


Fig. 7.7.4 Trend of Uranium occurrence in NCT of Delhi

8.0 SUITABILITY OF GROUNDWATER FOR IRRIGATION PURPOSE

The chemical quality of water is an important factor to be considered in evaluating its usefulness for irrigation purposes. Plants grown by irrigation absorb and transpire water but leave nearly all the salts behind in the soil, where they accumulate and eventually prevent plant growth. Excessive concentrations of solute interfere with the osmotic process by which plant root membranes are able to assimilate water and nutrients. In areas where natural drainage is inadequate, the irrigation water infiltrating the root zone will cause water table to rise excessively. In addition to problems caused by excessive concentration of dissolved solids, certain constituents in irrigation water are especially undesirable and some may be damaging even when present in small concentrations. Irrigation indices viz. Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) have been evaluated to assess the suitability of ground water for irrigation purposes.

8.1 Alkali Hazard

In the irrigation water, it is characterized by absolute and relative concentrations of cations. If the sodium concentrations are high, the alkali hazard is high and if the calcium & magnesium levels are high, this hazard is low. The alkali soils are formed by the accumulation of exchangeable sodium and are characterized by poor tilt and low permeability. The U.S. Salinity laboratory has recommended the use of sodium adsorption ratio (SAR) as it is closely related to adsorption of sodium by the soil.

SAR is derived by the following equation:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+} Mg^{2+}}{2}}}$$

The water with regard to SAR is classified into four categories

- **S_1 – Low Sodium Water** (SAR <10)

Such waters can be used on practically all kinds of soils without any risk or increase in exchangeable sodium.

- **S_2 – Medium Sodium Water** (SAR 10-18)

Such waters may produce an appreciable sodium hazard in fine textured soil having high cation exchange capacity under low leaching.

- **S_3 – High Sodium Water** (SAR >18-26)

Such waters indicate harmful concentrations of exchangeable sodium in most of the soil and would require special management, good drainage, high leaching and addition of organic matter to the soil. If such waters are used on gypsiferrous soils the exchangeable sodium could not produce harmful effects.

- **S_4 – Very High Sodium Waters** (SAR >26)

Generally, such waters are unsatisfactory for irrigation purposes except at low or perhaps at medium salinity where the solution of calcium from the soil or addition of gypsum or other amendments makes the use of such waters feasible.

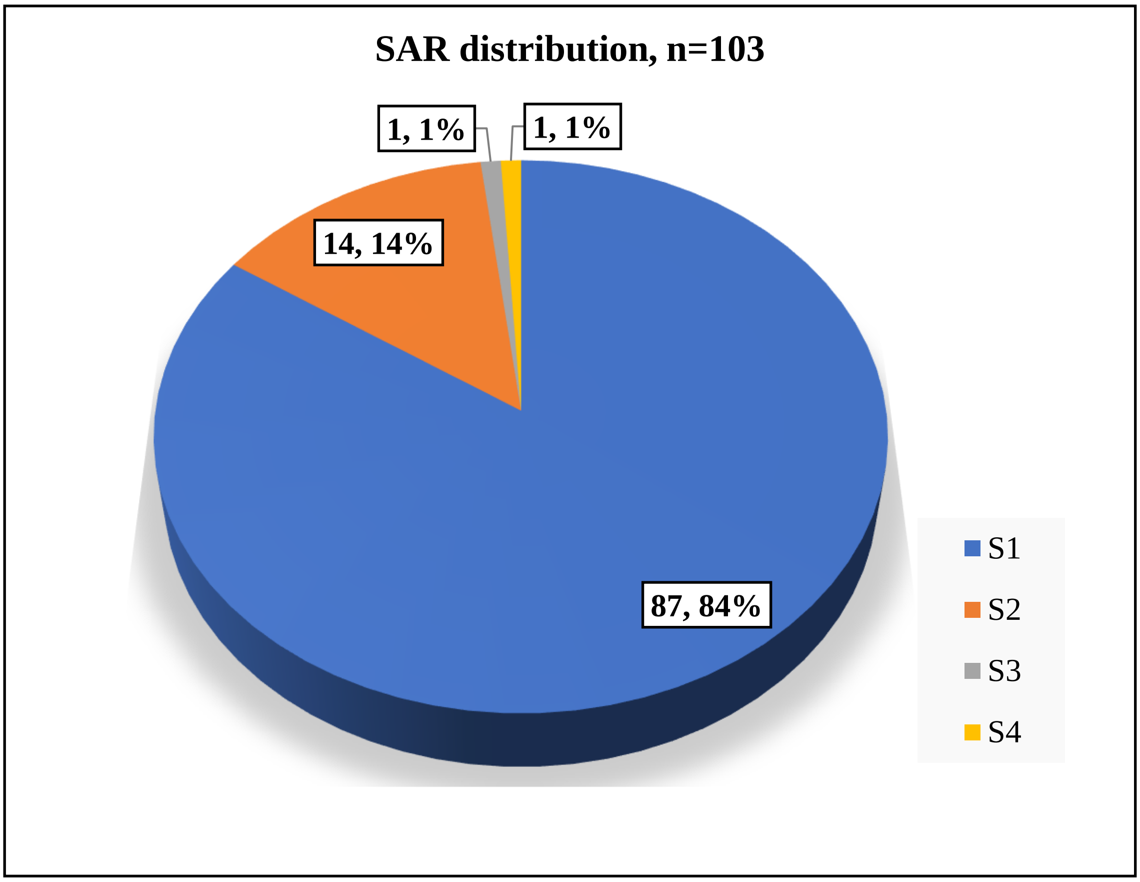


Figure 8.1: Percentage of groundwater samples according to SAR classifications (n=103).

The computed SAR values ranges from 0.15 to 31.89. The maximum SAR value has been found at Nangli Rajapur piezometer in South West district. It is apparent from Fig. 8.1 that 84.47% samples belong to excellent category (S_1) and only one ground water sample is associated with very high sodium category (S_4).

According to SAR classification, 100% of water samples in Central, East, North East, South East and West Delhi districts fall in excellent category (S_1). (Table 8.1)

It was found that in Shahdara and Nazul land total 50 % sample fall in S2 categories.

Table 8.1(a): Summary of irrigation quality of the groundwater samples in various districts based on SAR classifications.

District	Number of samples in various SAR range				
	(low Sodium <10)	(medium Sodium 10-18)	(high Sodium 18-26)	(very high Sodium >26)	Total
Central	7	0	0	0	7
East	5	0	0	0	5
New Delhi	7	2	1	0	10

North	17	4	0	0	21
North East	2	0	0	0	2
North West	13	1	0	0	14
Shahdara	1	1	0	0	2
South	6	2	0	0	8
South East	7	0	0	0	7
South West	11	3	0	1	15
West	10	0	0	0	10
Nazulland	1	1	0	0	2
Total	**87**	**14**	**1**	**1**	**103**

Table 8.1(b): Summary of irrigation quality of the groundwater samples in various districts based on SAR classifications.

District	**%. of samples in various SAR range**			
	(low Sodium <10)	**(medium Sodium 10-18)**	**(high Sodium 18-26)**	**(very high Sodium >26)**
Central	100.00	0.00	0.00	0.00
East	100.00	0.00	0.00	0.00
New Delhi	70.00	20.00	10.00	0.00
North	80.95	19.05	0.00	0.00
North East	100.00	0.00	0.00	0.00
North West	92.86	7.14	0.00	0.00
Shahdara	50.00	50.00	0.00	0.00
South	75.00	25.00	0.00	0.00
South East	100.00	0.00	0.00	0.00
South West	73.33	20.00	0.00	6.67
West	100.00	0.00	0.00	0.00
Nazulland	50.00	50.00	0.00	0.00
Total	**13.59**	**0.97**	**0.97**	**13.59**

8.2 Residual Sodium Carbonate (RSC)

If the enriched carbonate (residual) concentration becomes relatively high, carbonates get together with calcium and magnesium to form precipitates. The relative abundance of sodium in comparison to alkaline earths and the quantity of bicarbonate and carbonate in excess of alkaline earths also influences the suitability of water for irrigation. This excess is represented in terms of "Residual Sodium Carbonate" (RSC). The highly soluble sodium carbonate known as residual sodium carbonate (RSC) is defined as;

$$\boldsymbol{RSC} = (\boldsymbol{HCO_3^-} + \boldsymbol{CO_3^-}) - (\boldsymbol{Ca^{2+}} + \boldsymbol{Mg^{2+}})$$

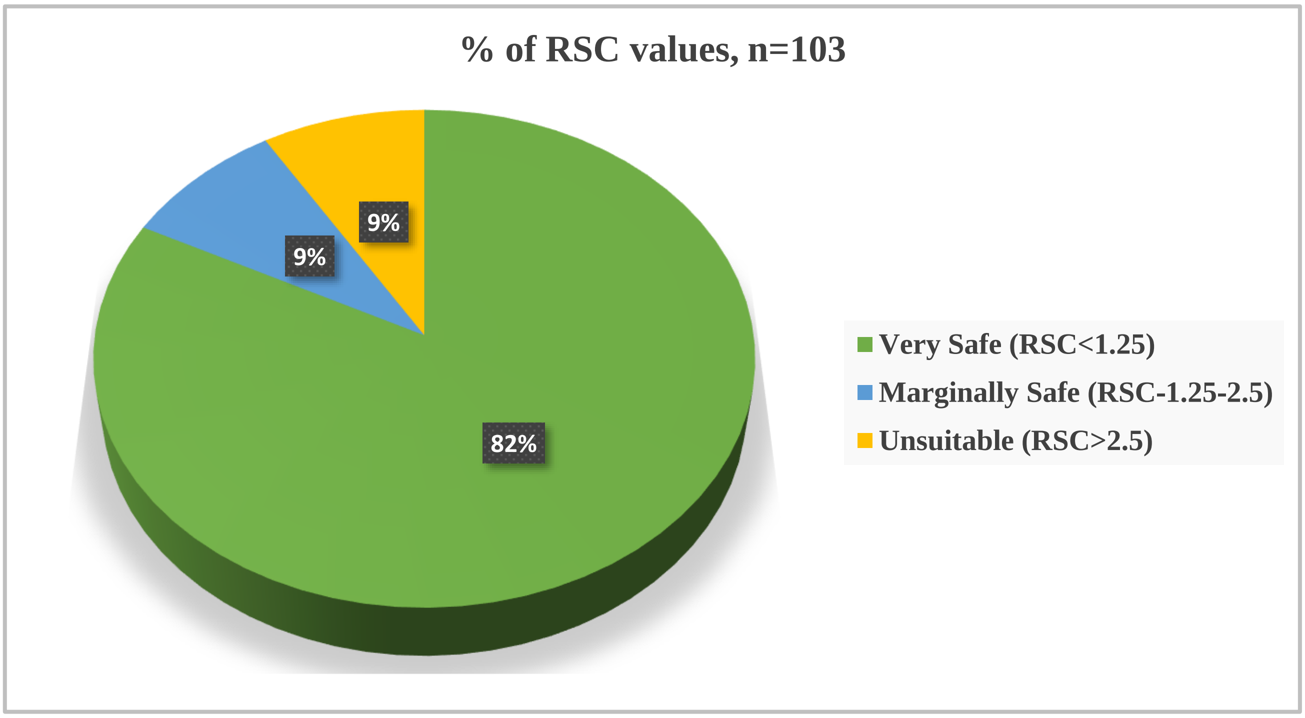


Figure 8.2a: Percentage of groundwater samples in various categories according to RSC classifications (n=103) (Wilcox et al.,1954).

Waters with high RSC produces harmful effects on plant development and is not suitable for irrigation. Waters associated with RSC < 1.25 are of excellent irrigation quality and can be safely applied for irrigation for almost all crops without the risks associated with residual sodium carbonate (Wilcox et al.,1954). If the RSC values lie between 1.25 and 2.5, the water is of an acceptable quality for irrigation. Waters associated with RSC values higher than 2.5 are not acceptable for irrigation. In fig 8.2a. it can be seen that in National Capital Territory of Delhi. 82.5% collected water samples are associated with RSC values less than 1.25 and are safe for use in irrigation practices. Only 8.7% water samples are associated with RSC values more than 2.5 and are unsuitable for irrigation. The water with high RSC values if applied for irrigation causes soil to become infertile owing to deposition of sodium. Table 8.2 summarizes the irrigation quality of the groundwater samples in various districts based on RSC values.

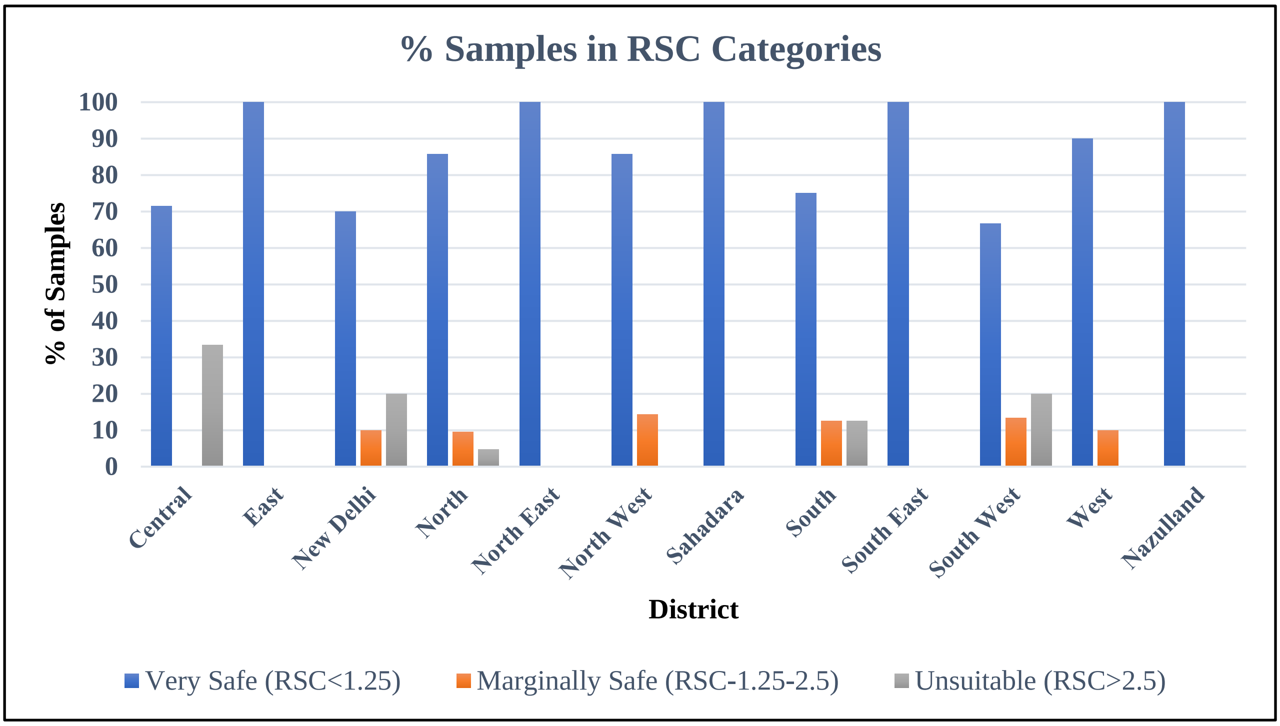


Figure 8.2b: Percentage of samples with respect to RSC values.

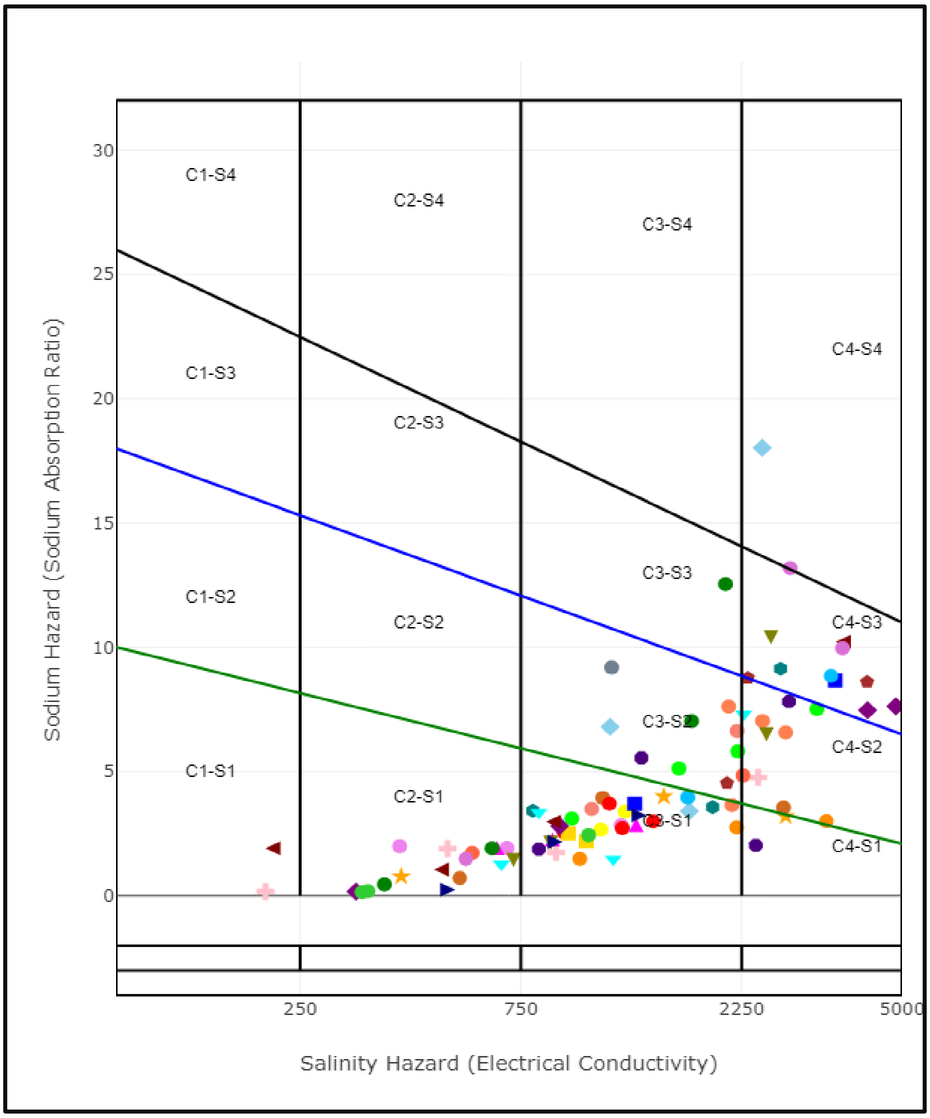
According to RSC classification 100% of water samples in East, North East, Shahdara, South East Districts and Nazul land fall in very safe category with RSC values less than 1.25.

Table 8.2: Summary of irrigation quality of the groundwater samples in various states based on RSC values.

District	Very Safe (RSC<1.25)	Marginally Safe (RSC- 1.25-2.5)	Unsuitable (RSC>2.5)
Central	71.4	0.0	33.3
East	100.0	0.0	0.0
New Delhi	70.0	10.0	20.0
North	85.7	9.5	4.8
North East	100.0	0.0	0.0
North West	85.7	14.3	0.0
Shahdara	100.0	0.0	0.0
South	75.0	12.5	12.5
South East	100.0	0.0	0.0
South West	66.7	13.3	20.0
West	90.0	10.0	0.0
Nazulland	100.0	0.0	0.0
Total	**82.5**	**8.7**	**8.7**

8.3 Wilcox diagram

EC and sodium concentration are very important in classifying irrigation water. The Wilcox diagram (Wilcox 1948) relating EC and SAR shows (fig. 8.3) that most of the samples are plotted in C2S1, C3S1 and C3S2 showing medium to high salinity and low to medium alkali hazard and suitable for irrigation. Samples falling in C4S2, C4S3, C4S4 are very high salinity with medium to very high alkalinity hazard and are not suitable for irrigation.



Sodium (Alkali) Hazard
S1- Low
S2- Medium
S3- High
S4- Very High

Salinity Hazard
C1- Low
C2- Medium
C3- High
C4- Very High

Fig.8.3: Plots of SAR verses electrical conductivity (after Wilcox 1955) in groundwater samples of NCT Delhi.

8.4 Piper Diagram:

Piper diagram (Piper 1944) describes the process responsible for the evolution of hydrogeochemical parameter in groundwater. Based on the major cation and major anion content in the water samples and plotting them in the trilinear diagram, hydrochemical facies could be identified. Hydro-chemical facies are very useful in investigating diagnostic chemical character of water in hydrologic systems. Different types of facies within the same group formations are due to characteristic ground water flow through the aquifer system and effect of local recharge. The types of facies are inter-linked with the geology of the area and distribution of facies with the hydrogeological controls. Hydrochemical facies are delineated by plotting percentage reacting value of major ions on tri-linear diagrams know as Piper Diagram.

In NCT Delhi, cation chemistry is dominated by sodium and potassium followed by magnesium. In anion side chloride is dominating anion followed by sulphate and bicabonate.

The facies mapping shows (Fig.8.4) that NaK-Cl is the dominant hydrogeochemical facies followed by mixed chemical character of hydrogeochemical facies.

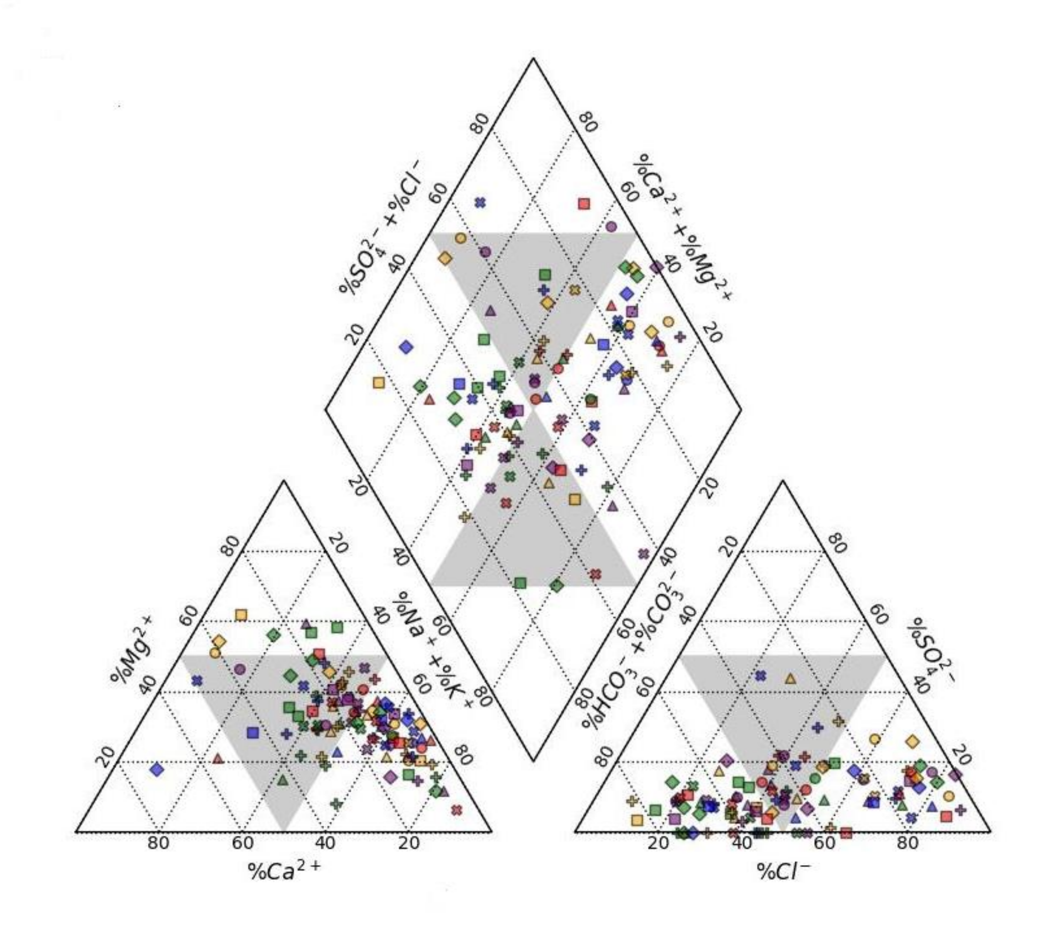


Fig- 8.4 Piper diagram of groundwater of NCT Delhi.

8.5 X-Y Plot:

If halite dissolution is responsible for the sodium, the Na+/Cl- ratio is approximately one, whereas a ratio greater than one, it is typically interpretated as Na+ released from Silicate weathering reaction. In the water samples of the shallow aquifers of Delhi, Only one sample fall along the equilibrium in the Na+/Cl- plot, indicating common source of halite for both the ions (Fig.8.5). In the water samples of the shallow aquifers of Delhi, 55.3% of the samples have molar ratio greater than one indicating ion exchange is the major process. It is where Na montmorillonite clay reacts with calcium and magnesium and releases sodium (sometimes called natural softening).

$$2Na^{+} - clay + Ca^{2+} = Ca^{2+} - clay + Na^{+}$$

The observed Na+/Cl-< 1 in 43.7% samples, may be attributed to Cl- enrichment from anthropogenic sources such as irrigation return flows or domestic waste disposal. Bivariant plot of NCT Delhi is shown in Fig.8.5.

Na^{+}/Cl^{-}	No of Samples	% Sample
>1	57	55.3
1	1	1
<1	45	43.7

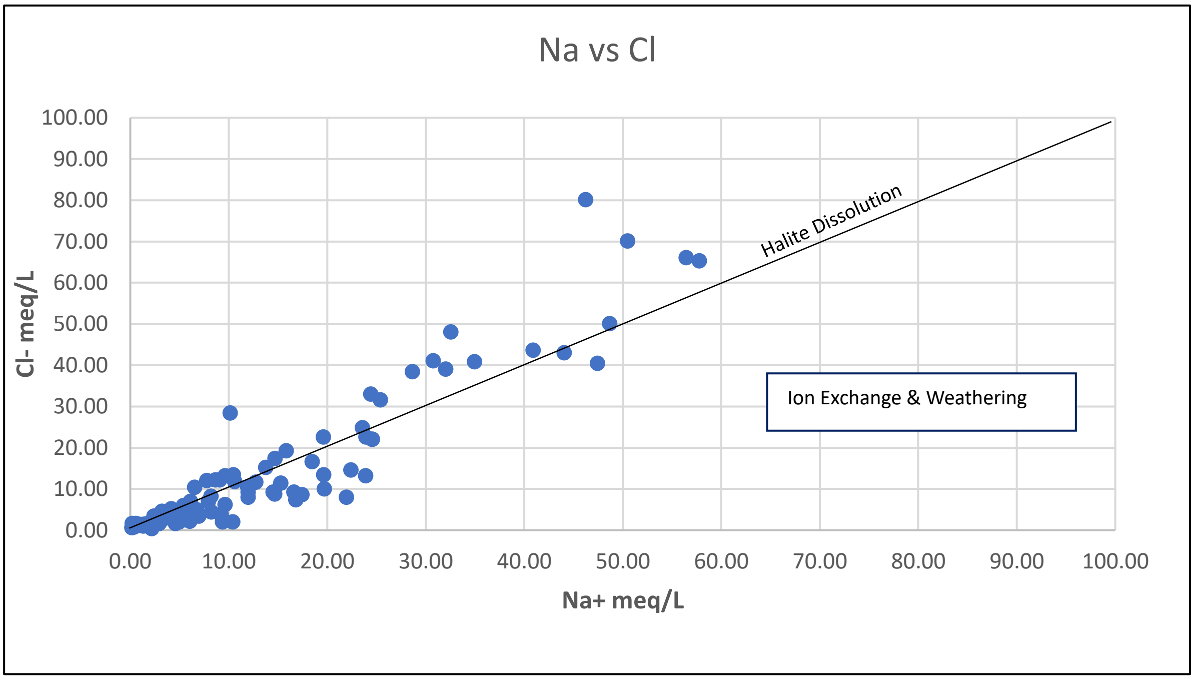


Fig. 8.5: The plot for Na versus Cl in groundwater samples of NCT of Delhi

9. POST MONSOON GROUND WATER QUALITY HOT SPOTS IN UNCONFINED AQUIFERS OF NCT OF DELHI

The Pre-Monsoon Data of 2022 revealed that several locations exhibited groundwater contamination levels exceeding the permissible limits outlined in the IS 10500:2012 drinking water standards. Notably, elevated concentrations of hazardous contaminants such as Arsenic, Uranium, Fluoride, among others, were detected in these areas, posing potential risks to public health and environmental sustainability.

In light of these findings, and to assess the influence of monsoonal recharge on contaminant levels, groundwater samples were collected from the identified locations in November 2023. These post-monsoon samples have been systematically analyzed to determine any changes in the presence and concentration of these contaminants. This part of the report aims to present the outcomes of this analysis and provide insights into the groundwater quality status following the monsoon season.

About **25** Groundwater Monitoring wells were monitored for water quality during November 2023 representing post-monsoon water quality. The district wise distribution of samples is presented in **Table 9.1**.

Table - 9.1. District wise distribution of samples for Post-Monsoon

District	**Total Sample**
Central	2
North	7
North West	7
South East	1
South West	4
West	4
Total	25

However, due to leakage during transportation, one sample from Majnu Ka Tila (Central District) could only be analyzed for basic parameters. As a result, 24 samples were analyzed for basic parameters, while all 25 samples analysed for heavy elements. The district-wise chemical analysis data of the samples are given in the Annexure – 5 & 6. The summarized results of groundwater quality ranges are given in **Table – 9.2 & 9.3.**

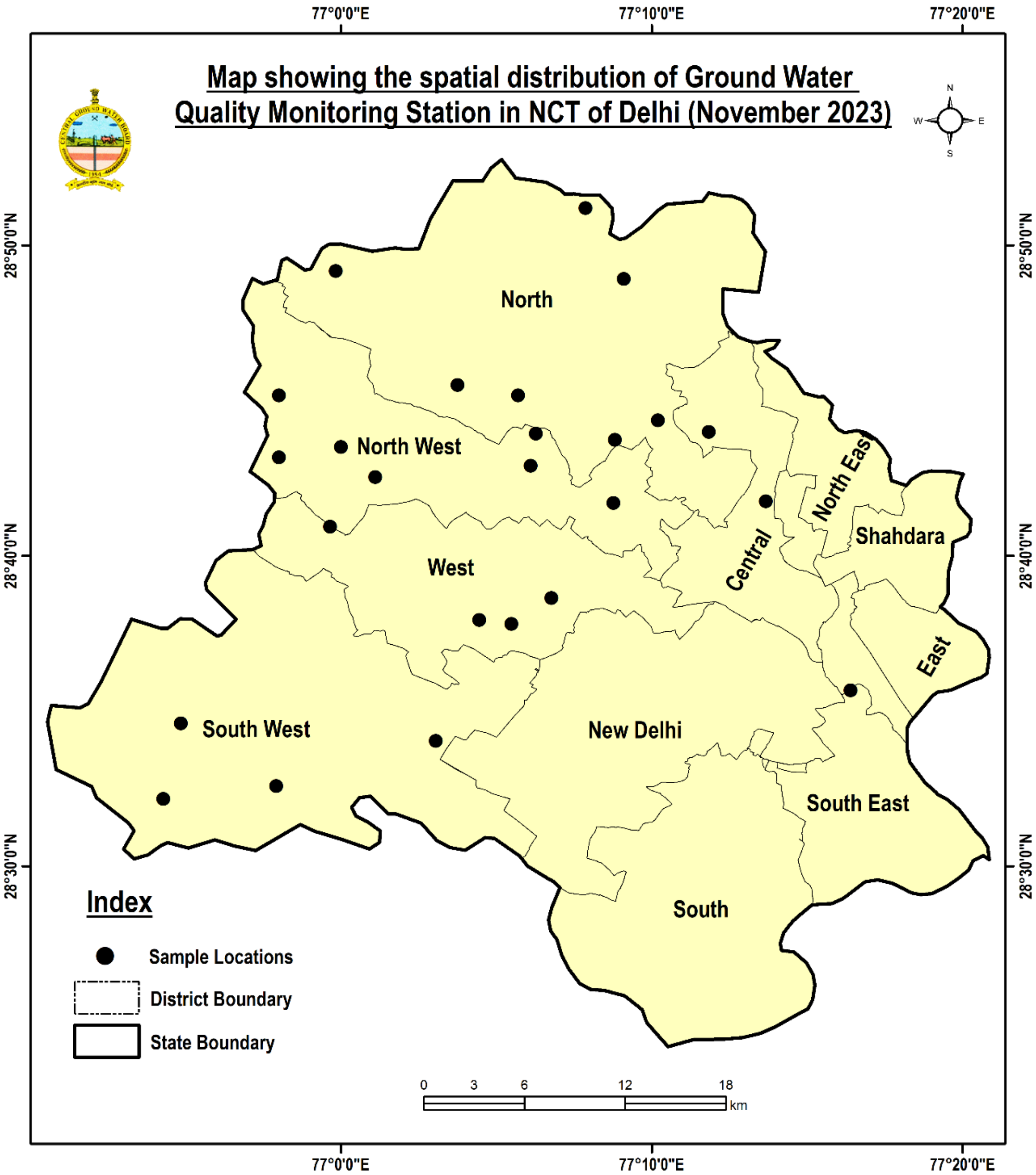


Fig 9.1 Map showing location of Sampling Stations in NCT of Delhi (November 2023)

Table - 9.2. Summarized results of groundwater quality ranges for basic parameters (n=24), (November 2023)

S. No	Parameters		Range	No. of sample	Percentage
1	Electrical Conductivity µs/cm at 25°C	Fresh	< 750	1	4.17
		Moderate	750- 2250	7	29.17
		Slightly mineralized	2251- 3000	3	12.50
		Highly mineralized	> 3000	13	54.17

S. No	Parameters		Range	No. of sample	Percentage
2	Chloride mg/L	Desirable limit	< 250	9	37.50
		Permissible limit	251-1000	4	16.67
		Beyond permissible limit	> 1000	11	45.83
3	Fluoride mg/L	Desirable limit	< 1.0	13	54.17
		Permissible limit	1.0 - 1.5	2	8.33
		Beyond permissible limit	>1.5	9	37.50
4	Nitrate mg/L	Permissible limit	< 45	18	75.0
		Beyond permissible limit	> 45	6	25.0

Table - 9.3. Summarized results of groundwater quality ranges for heavy elements (n=25), (November 2023)

S. No	Parameters		Range	No. of sample	Percentage
1	Iron Mg/L	Permissible limit	< 1.0	23	92.0
		Beyond permissible limit	> 1.0	2	8.0
2	Arsenic mg/L	Permissible limit	< 0.01	24	96.0
		Beyond permissible limit	>0.01	1	4.0
3	Uranium mg/L	Permissible limit	< 0.03	23	92.0
		Beyond permissible limit	> 0.03	2	8.0

Groundwater quality hot spot maps of the NCT of Delhi during post-monsoon have been prepared depicting seven main parameters based on their distribution shown on the separate maps. These maps depict the spatial distribution of the following constituents in ground water tapping the unconfined aquifers.

I. Electrical Conductivity
II. Chloride (> 1000 mg/L)
III. Fluoride (>1.5 mg/L)
IV. Nitrate (>45mg/L)
V. Iron (>1.0mg/L)
VI. Arsenic (>0.01 mg/L)
VII. Uranium (>0.03 mg/L)

9.1 Electrical Conductivity

Groundwater with EC ranging between 750 and 3000µS/cm at 25^{0}C falling under 'permissible' range are majorly confined in West &North West of the State. However, in some cases, relatively high values of EC in excess of 3000 µS/cm are observed in many parts of the State, especially North and South West parts of the State. Table 9.1.1 shows the list of districts affected by high EC water (EC > 3000 µS/cm) and these areas are water quality hot spots from salinity point of view.

The percentage groundwater samples in various EC range is illustrated in Fig 9.1.1. District-wise occurrences of Electrical Conductivity in ground water beyond permissible limit (>3000 µS/cm) have been shown Fig 9.1.2.

Table 9.1.1 District-wise percentage of samples having EC >3000 µS/cm

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with EC>3000µS/cm at 25^0 C	(%) Samples with EC>3000µS/cm at 25^0C
1.	Central	1	1	4.17
2.	North	7	5	20.83
3.	North West	7	2	8.33
4.	South East	1	0	0.00
5.	South West	4	3	12.50
6.	West	4	2	8.33
	Total	**24**	**13**	**54.17**

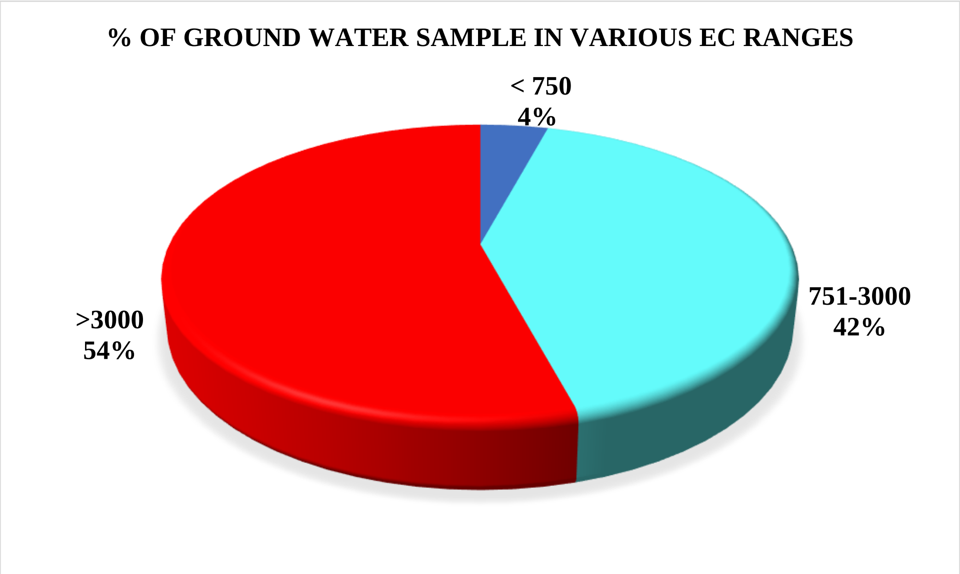


Fig 9.1.1 Percentage groundwater samples in various EC range (NCT of Delhi).

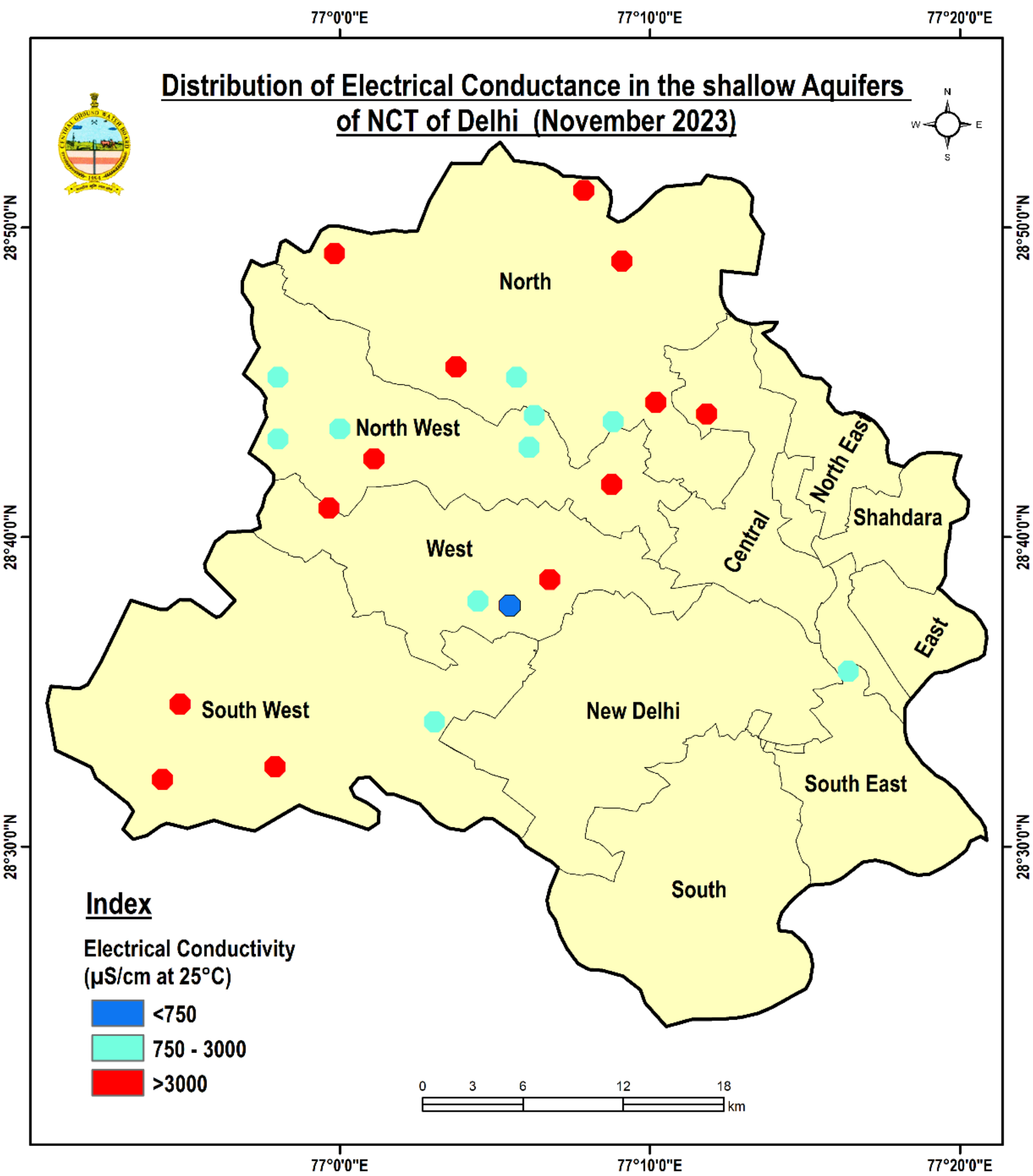


Fig 9.1.2 Spatial distribution of Electrical Conductivity during November 2023.

Table 9.1.2 District-Wise Temporal Variation in EC during May 2023 & November 2023

Sr. No	Name of districts	No. of Sample with EC>3000µS/cm at 25⁰ C		
		May 2023	Nov 2023	Increase/Decrease
1.	Central	0	1	1
2.	North	4	5	1
3.	North West	5	2	-3
4.	South East	0	0	0
5.	South West	9	3	-6
6.	West	5	2	-3
	Total	**23**	**13**	**-10**

The total number of samples with EC values exceeding 3000 µS/cm decreased from 23 in May 2023 to 13 in November 2023. This suggests that the monsoonal recharge generally improved groundwater quality by diluting dissolved solids, resulting in lower salinity levels across most regions. The substantial reduction in high EC levels in the majority of samples indicates that the monsoon had a positive effect on groundwater quality.

Despite the general improvement, there were localized increases in EC levels, particularly in one sample from the Central district and a slight rise in the North district (from 4 to 5 samples). These areas may be experiencing factors such as contamination, saline intrusion, or reduced effectiveness of recharge.

9.2 CHLORIDE

In Fig 9.2.1, the concentration of chloride (in mg/L) in ground water from observation wells have been used to show distribution of chloride in different ranges of suitability. It is apparent from the map that majority of the samples having chloride values less than 250 mg/L are found mostly along South and Eastern parts of State viz., South, South East, North East, East, Central, New Delhi and Shahdara districts.

Water with chloride ranging between 250 and 1000 mg/L falling under 'permissible' range are confined mostly to parts of North West and West districts.

Relatively high values of Chloride (>1000 mg/L) are observed in patches in the North and South West districts. Table 9.2.1 shows the district-wise list of locations affected by high chloride water (>1000 mg/L) and these areas are water quality hot spots from high chloride point of view.
The occurrences of chloride in ground water beyond permissible limit (1000 mg/L) have been shown on map as Fig 9.2.1.

Table 9.2.1 District-wise percentage of samples having Chloride >1000mg/L

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with Cl>1000 mg/L	(%) Samples with Cl>1000 mg/L
1.	Central	1	1	4.17
2.	North	7	3	12.50
3.	North West	7	2	8.33
4.	South East	1	0	0.00
5.	South West	4	3	12.50
6.	West	4	2	8.33
	Total	**24**	**11**	**45.83**

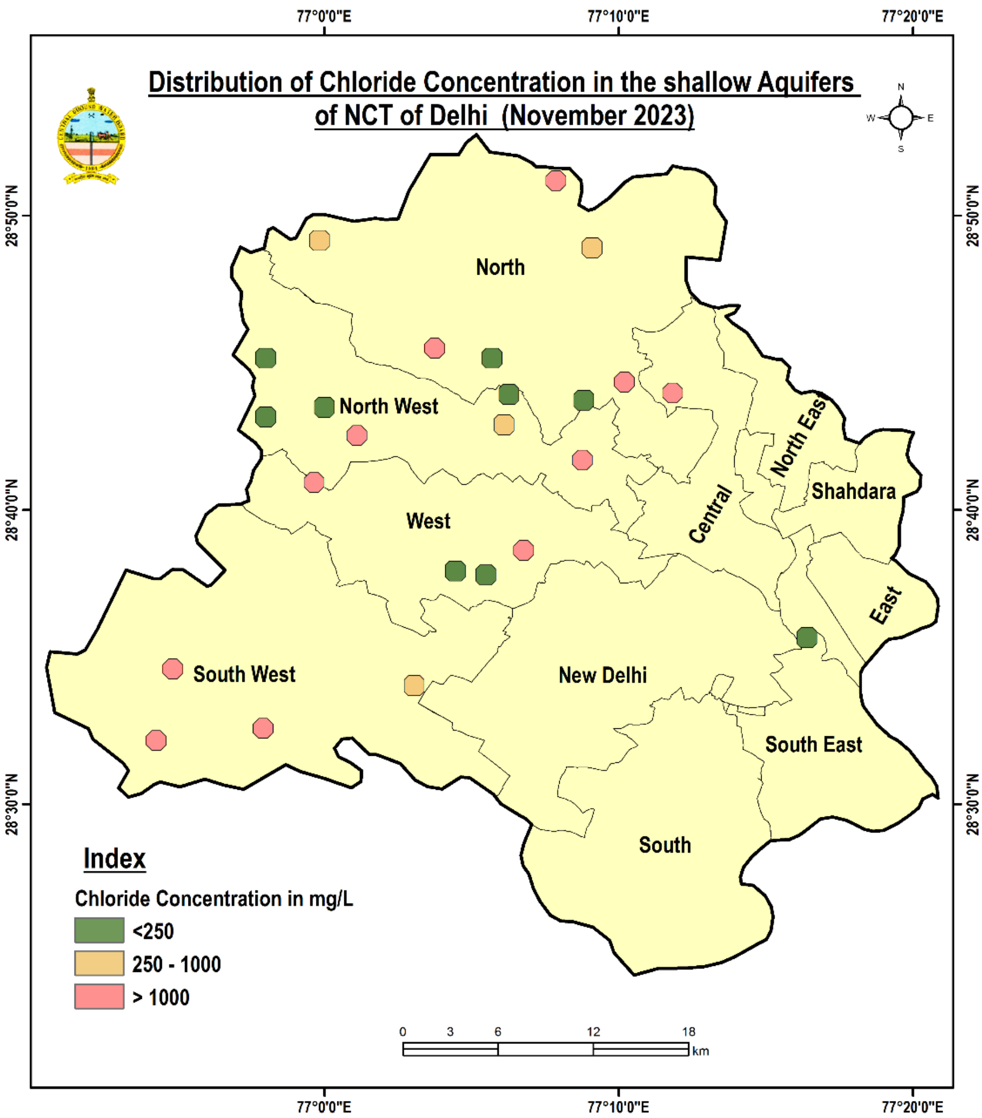


Fig 9.2.1 Spatial Distribution of Chloride during November 2023

Table 9.2.2 District-Wise Temporal Variation in Chloride Concentration during May 2023 & November 2023

Sr. No	Name of districts	No. of Sample with Cl>1000 mg/L		
		May 2023	Nov 2023	Increase/Decrease
1.	Central	0	1	1
2.	North	3	3	0
3.	North West	4	2	-2
4.	South East	0	0	0
5.	South West	8	3	-5
6.	West	3	2	-1
	Total	**18**	**11**	**-7**

Across nearly all districts, the total number of samples with chloride concentrations exceeding 1000 mg/L has decreased, except in the Central district, where one sample showed an increase post-monsoon.

This rise in chloride levels may indicate localized factors such as contamination sources or insufficient dilution from rainfall in that area.

In the North district, the number of samples with elevated chloride levels remained constant, suggesting that chloride contamination in this area is persistent and not significantly influenced by monsoonal recharge.

Overall, the data indicates that the monsoon had a generally positive effect on reducing chloride concentrations in groundwater, particularly in most regions, except for the localized issues observed in the Central and North districts.

9.3 FLUORIDE

The fluoride content in groundwater from observation wells in post monsoon samples is found to be less than 1.0 mg/L. The distribution of ground water samples with fluoride concentration more than 1.5 mg/L have been depicted on the map as Fig. 9.3.1. It is observed that there are several locations in the districts of North, North West and South West where the fluoride in ground water exceeds 1.5 mg/L. The details of districts showing localized occurrence of fluoride in ground water in excess of 1.5mg/L is given in table 9.3.1

The occurrences of fluoride in groundwater beyond permissible limit (1.5 mg/L) have also been shown on the map as Fig. 9.3.1.

Table 9.3.1 District-wise percentage of wells having fluoride >1.5mg/L

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with F>1.5 mg/L	(%) Samples with F>1.5 mg/L
1.	Central	1	0	0.00
2.	North	7	2	8.33
3.	North West	7	5	20.83
4.	South East	1	0	0.00
5.	South West	4	1	4.17
6.	West	4	1	4.17
	Total	**24**	**9**	**37.50**

Table 9.3.2 District-Wise Temporal Variation in Fluoride Concentration during May 2023 & November 2023

Sr. No	Name of districts	No. of Sample with F>1.5 mg/L		
		May 2023	Nov 2023	Increase/Decrease
1.	Central	0	0	0
2.	North	6	2	-4
3.	North West	5	5	0
4.	South East	0	0	0
5.	South West	3	1	-2
6.	West	0	1	1
	Total	**14**	**9**	**-5**

The total number of samples with fluoride concentrations greater than 1.5 mg/L decreased from 14 in May 2023 to 9 in November 2023. This decline indicates an overall improvement in groundwater quality, potentially influenced by the dilution effects of monsoonal recharge.

While many areas experienced reductions in fluoride levels, the North district showed a notable decline from 6 samples in May to 2 in November, and the South West district decreased from 3 to 1 sample. However, the North West district maintained a consistent count of 5 samples exceeding the threshold, indicating persistent fluoride issues in this area. Additionally, one sample in the West district exceeded the limit for the first time in November.

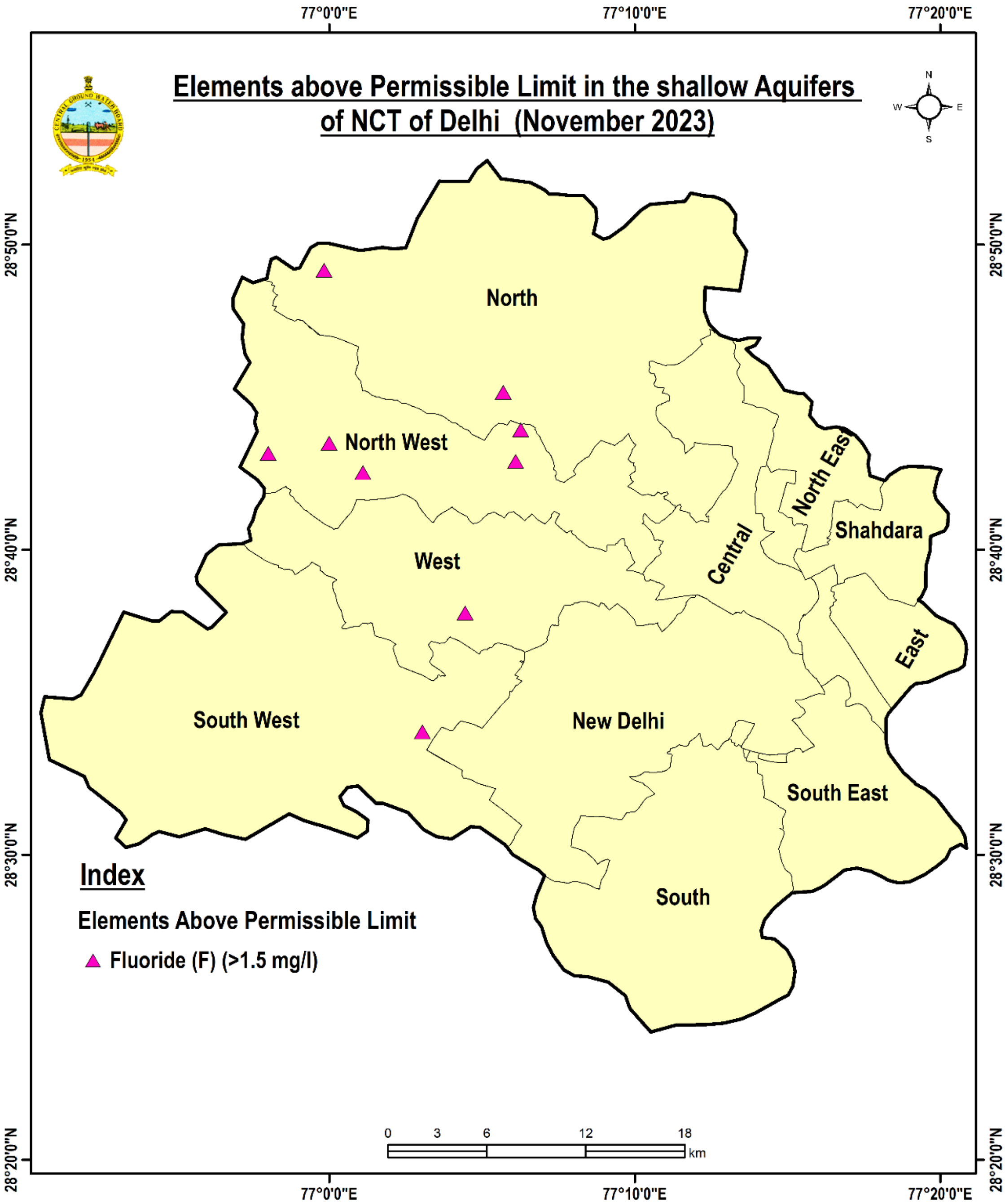


Fig 9.3.1 Locations having Fluoride concentration > 1.5 mg/L during November 2023.

9.4 NITRATE

The occurrences of Nitrate in ground water beyond permissible limit (45 mg /L) have been shown on the map as a point source Fig 9.4.1. Table-9.4.1 shows the districts where nitrate has been found in excess of 45 mg/L in groundwater during post-monsoon sampling.

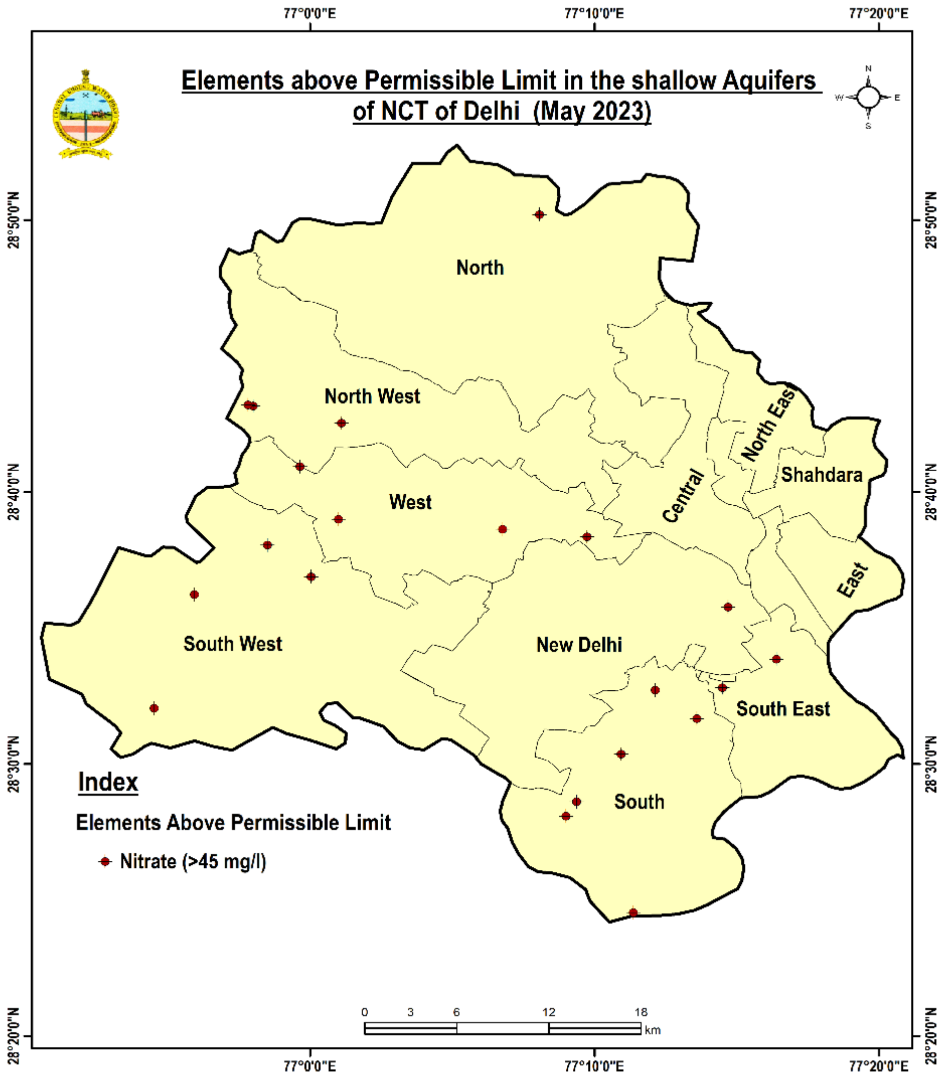


Fig 9.4.1 Locations having Nitrate concentration > 45 mg/L during May 2023

Table 9.4.1: District-wise percentage of wells having Nitrate > 45 mg/L

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with Nitrate>45 mg/L	(%) Samples with Nitrate>45 mg/L
1.	Central	1	0	0.00
2.	North	7	2	8.33
3.	North West	7	2	8.33
4.	South East	1	0	0.00
5.	South West	4	0	0.00
6.	West	4	2	8.33
	Total	**24**	**6**	**25.00**

Table 9.4.2 District-Wise Temporal Variation in Nitrate Concentration during May 2023 & November 2023

Sr. No	Name of districts	No. of Sample with Nitrate>45 mg/L		
		May 2023	Nov 2023	Increase/Decrease
1.	Central	0	0	0
2.	North	1	2	1
3.	North West	3	2	-1
4.	South East	2	0	-2
5.	South West	4	0	-4
6.	West	4	2	-2
	Total	**14**	**6**	**-8**

The total number of samples with nitrate concentrations in the 6 districts exceeding 45 mg/L decreased from 14 in May 2023 to 6 in November 2023. This significant decline indicates an overall improvement in groundwater quality, likely influenced by monsoonal dilution and recharge effects.

While several districts showed improvements, the North district experienced an increase in the number of samples exceeding the nitrate threshold, rising from 1 in May to 2 in November. The increase in nitrate levels in the North district highlights the need for ongoing monitoring and management to address potential sources of contamination.

9.5 IRON

The iron point value map indicates that the shallow aquifers in the NCT of Delhi is generally free from Fe contamination. Only two locations in the district namely South East and North show iron values beyond the permissible limits for drinking water.

Table 9.5.1: District-wise percentage of wells having Iron > 1mg/L

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with Iron>1 mg/L	(%) Samples with Iron>1 mg/L
1.	Central	2	0	0.0
2.	North	7	1	4.0
3.	North West	7	0	0.0
4.	South East	1	1	4.0
5.	South West	4	0	0.0
6.	West	4	0	0.0
	Total	**25**	**2**	**8.0**

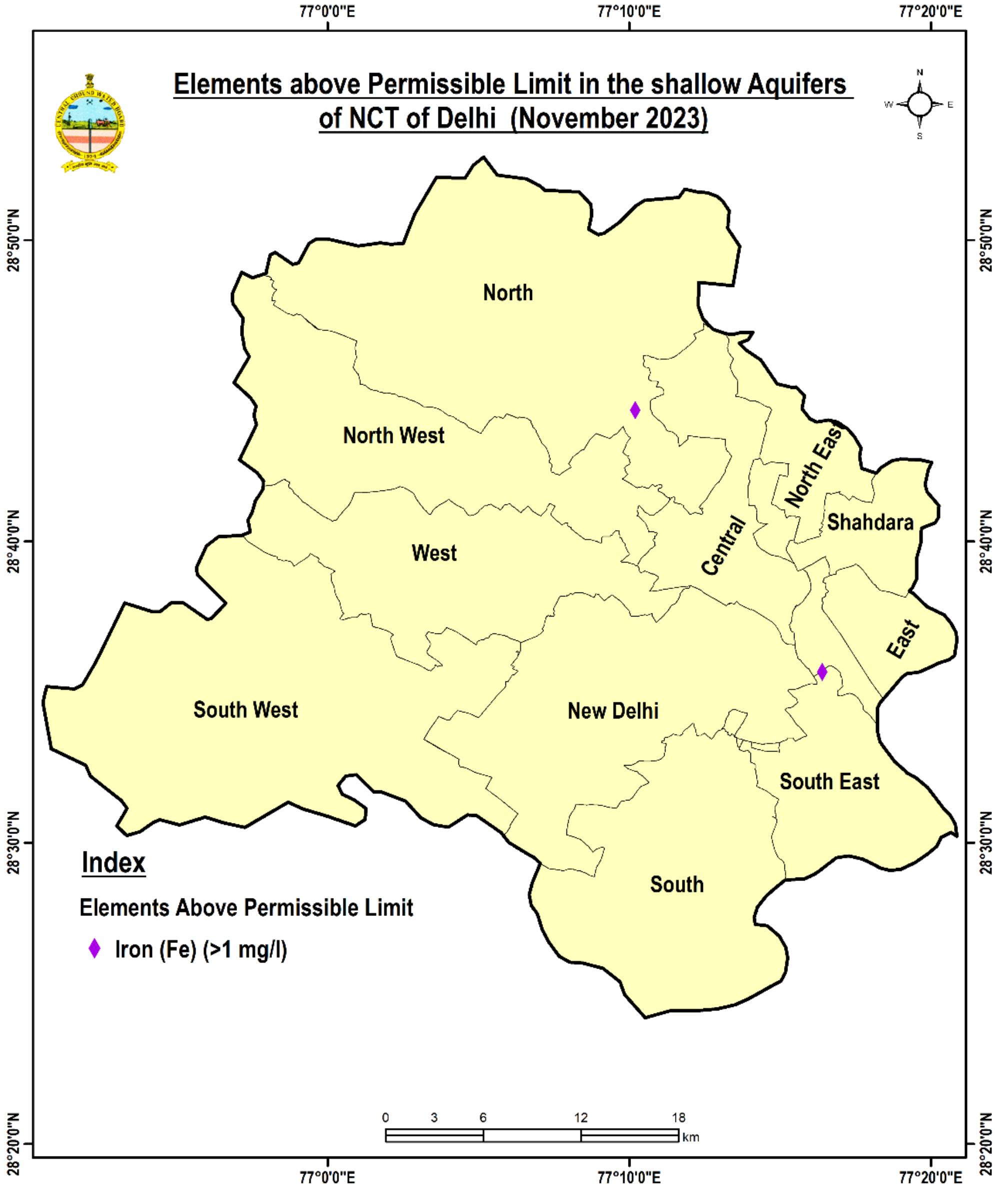


Fig 9.5.1 Map showing areas of Iron contaminated (> 1.0mg/L) groundwater in NCT of Delhi

Table 9.5.2 District-Wise Temporal Variation in Iron Concentration during May 2023 & November 2023

Sr. No	Name of districts	No. of Sample with Iron>1 mg/L		
		May 2023	Nov 2023	Increase/Decrease
1.	Central	0	0	0
2.	North	0	1	1
3.	North West	0	0	0
4.	South East	2	1	-1
5.	South West	0	0	0
6.	West	0	0	0
	Total	**2**	**2**	**0**

The North district recorded an increase, with one sample exceeding the iron threshold in November 2023, which was not observed in May. Conversely, the South East district saw a decrease in samples exceeding the threshold, dropping from 2 to 1. The increase of Iron in North district may be attributed to either to changes in land use pattern/anthropogenic factors or sampling variability or localized hydrological changes which might mobilize iron from sediment or surrounding soil into the groundwater.

9.6 Arsenic

The map showing distribution of Arsenic (Post-Monsoon) in ground water in NCT of Delhi have been shown as points. The point sources are plotted on the map (Fig 9.6.1). Districts having Arsenic > 0.01 mg/L in Post-monsoon sampling Ground Water in NCT of Delhi is shown in Table-9.6.1.

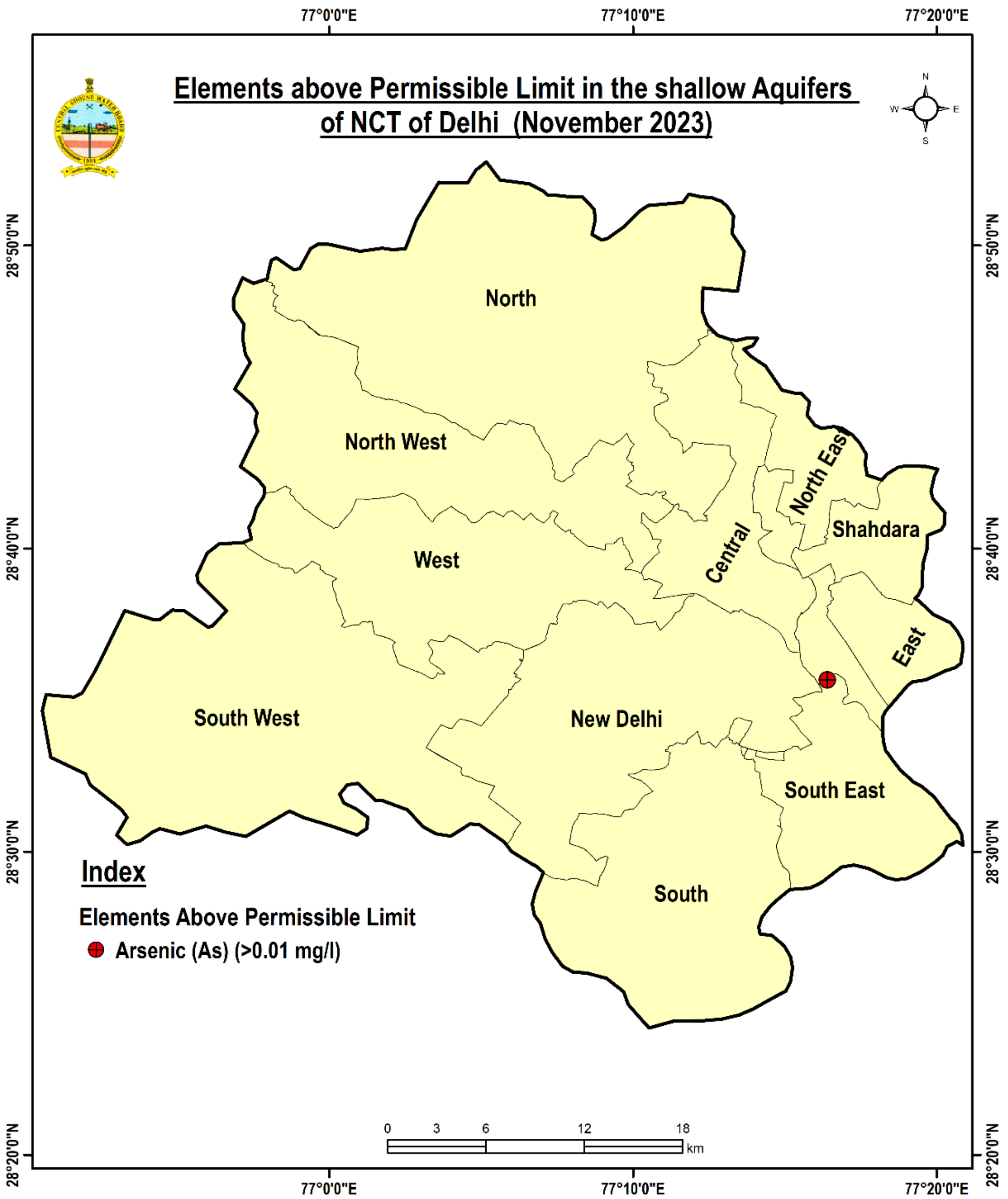


Fig 9.6.1 Map showing areas of Arsenic contaminated (> 0.01 mg/L) groundwater in NCT of Delhi

Table 9.6.1: District-wise percentage of wells having Arsenic > 0.01 mg/L

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with Arsenic>0.01 mg/L	(%) Samples with Arsenic>0.01 mg/L
1.	Central	2	0	0.0
2.	North	7	0	0.0
3.	North West	7	0	0.0
4.	South East	1	1	4.0
5.	South West	4	0	0.0
6.	West	4	0	0.0
	Total	**25**	**1**	**4.0**

Table 9.6.2 District-Wise Temporal Variation in Arsenic Concentration during May 2023 & November 2023

Sr. No	Name of districts	No. of Sample with Arsenic>0.01 mg/L		
		May 2023	Nov 2023	Increase/Decrease
1.	Central	1	0	-1
2.	North	0	0	0
3.	North West	0	0	0
4.	South East	1	1	0
5.	South West	0	0	0
6.	West	0	0	0
	Total	**2**	**1**	**-1**

The total number of samples with arsenic concentrations exceeding 0.01 mg/L decreased from 2 in May 2023 to 1 in November 2023. This reduction suggests an overall improvement in groundwater quality, likely influenced by factors such as monsoonal recharge and dilution. The overall decrease in arsenic levels, particularly the reduction observed in the Central district, indicates an improvement in groundwater quality in some areas. However, the persistence of elevated arsenic in the South East district highlights the need for continued monitoring and mitigation efforts to address long-term contamination risks.

9.7 URANIUM

District wise no. of locations affected by Uranium (>30 ppb) and maximum value observed is given in Table 9.7.1.

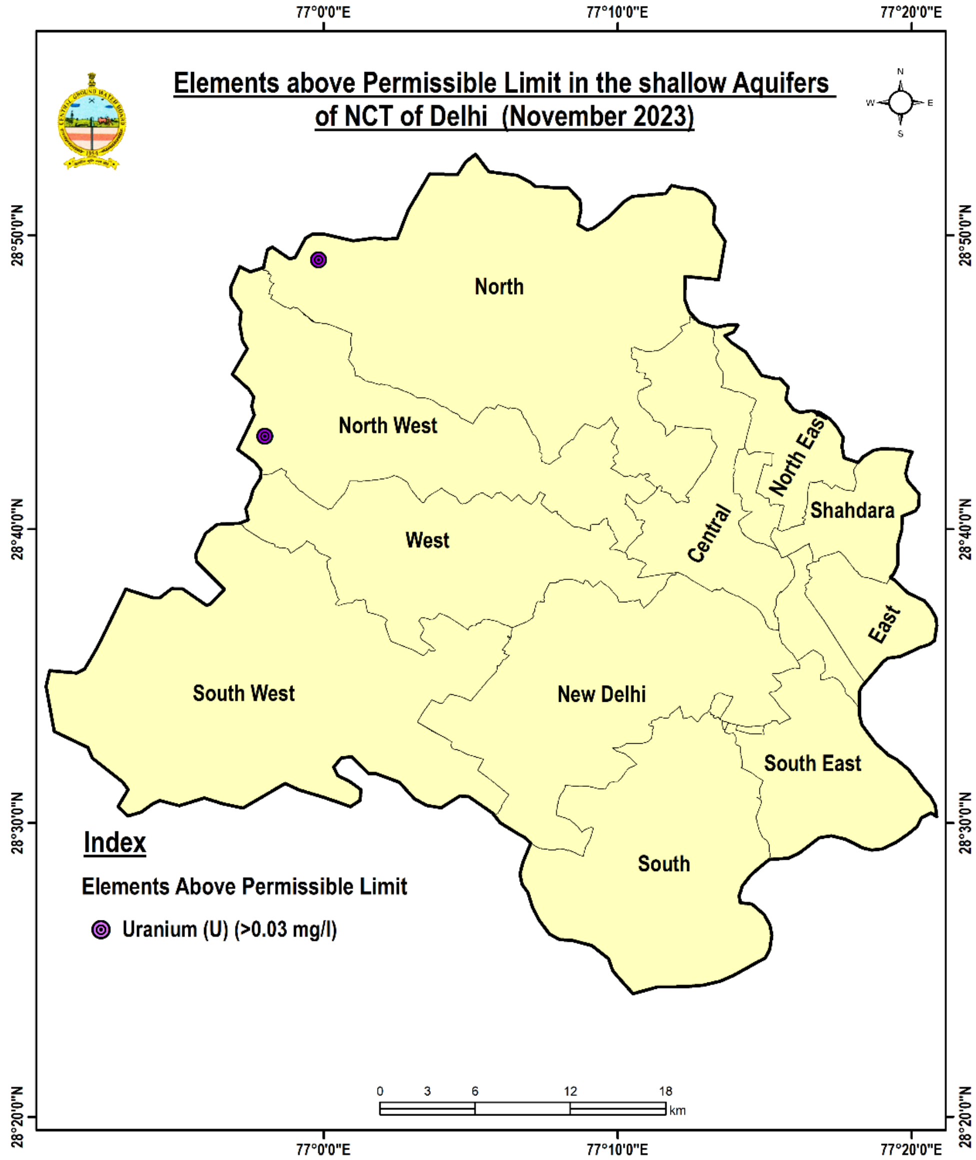


Fig 7.7.1 Map showing areas of Uranium contaminated (> 0.03 mg/L) groundwater in NCT of Delhi

Table 9.7.1: District-wise percentage of wells having Uranium > 0.03 mg/L

Sr. No	Name of districts	Total no. of Sample Analyzed	No. of Sample with Uranium>0.03 mg/L	(%) Samples with Uranium>0.03 mg/L
1.	Central	2	0	0.00
2.	North	7	1	4.00
3.	North West	7	1	4.00
4.	South East	1	0	0.00
5.	South West	4	0	0.00
6.	West	4	0	0.00
	Total	**25**	**2**	**8.00**

Table 9.7.2 District-Wise Temporal Variation in Uranium Concentration during May 2023 & November 2023

Sr. No	Name of districts	No. of Sample with Uranium>0.03 mg/L		
		May 2023	Nov 2023	Increase/Decrease
1.	Central	0	0	0
2.	North	3	1	-2
3.	North West	3	1	-2
4.	South East	0	0	0
5.	South West	2	0	-2
6.	West	1	0	-1
	Total	**9**	**2**	**-7**

The total number of samples with uranium concentrations exceeding 0.03 mg/L decreased significantly, from 9 samples in May 2023 to just 2 samples in November 2023. This sharp decline indicates a notable improvement in groundwater quality with respect to uranium contamination, likely due to the natural dilution effects of monsoonal recharge.

10.0 SUMMARY

Groundwater quality in the National Capital Territory (NCT) of Delhi is subject to seasonal variations, particularly influenced by the monsoon rains. This chapter focuses on the summary of groundwater contamination data collected during the pre-monsoon and post-monsoon periods. The post-monsoon sampling was conducted in areas identified with elevated contaminant levels during the pre-monsoon season of the Year 2022, offering a targeted comparison. Understanding these seasonal changes is crucial for designing effective groundwater management strategies and mitigating risks related to water quality, particularly in regions with known contamination issues. The Pre-Monsoon Contamination Overview and the Post-Monsoon Contamination overview is presented in Table 10.1 & Tale 10.2 respectively.

Table 10.1: Pre-Monsoon Summary of Groundwater Quality in NCT of Delhi: Samples Collected and Contamination Percentage

<table>
<tr><td rowspan="7">NCT of Delhi Summary (Pre-Monsoon)</td><td rowspan="2">Total no. of Basic samples</td><td colspan="3">Number of samples contaminated (%age of samples contaminated)</td></tr>
<tr><td>EC</td><td>NO$_3$</td><td>F</td></tr>
<tr><td>103</td><td>24 (23.3%)</td><td>21 (20.4%)</td><td>17 (16.5%)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Total no. of HM samples</td><td>As</td><td>Fe</td><td>U</td></tr>
<tr><td>103</td><td>4 (3.9%)</td><td>4 (3.9%)</td><td>10 (9.7%)</td></tr>
</table>

Table 10.2: Post-Monsoon Summary of Groundwater Quality in NCT of Delhi: Samples Collected and Contamination Percentage

<table>
<tr><td rowspan="6">NCT of Delhi Summary (Post-Monsoon)</td><td rowspan="2">Total no. of Basic samples</td><td colspan="3">Number of samples contaminated (%age of samples contaminated)</td></tr>
<tr><td>EC</td><td>NO3</td><td>F</td></tr>
<tr><td>24</td><td>13 (54.17%)</td><td>6 (25.0%)</td><td>9 (37.5%)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Total no. of HM samples</td><td>As</td><td>Fe</td><td>U</td></tr>
<tr><td>25</td><td>1 (4.0%)</td><td>2 (8.0%)</td><td>2 (8.0%)</td></tr>
</table>

The post-monsoon data, collected from areas with pre-existing contamination, underscores the dynamic nature of groundwater quality in the NCT of Delhi. While some contaminants, like Electrical Conductivity and Fluoride, showed slight increase post-monsoon. Stable levels of Arsenic and the slight reduction in Uranium contamination post-monsoon suggest that groundwater quality in terms of heavy metals remains largely consistent, with seasonal changes having only a modest impact.

11.0 Bibliography

- APHA (2017), “Standard Methods for the Examination of Water and Wastewater (22th Ed.)”.Washington, Dc: American Public Association.
- CGWB (2018), “Ground Water Quality In Shallow Aquifers of India”. Faridabad: Central Ground Water Board, Ministry of water Resources, Government of India.
- Drinking water standards of BIS 10500: 2012.
- Karanth K.R. (1997), „Groundwater Assessment, Development and Management. New Delhi, India‟: Tata Mcgraw-Hill Publishing Company Limited.
- Todd D.K., Groundwater Hydrology. John Wiley and sons Inc. Newyork, 1976
- USSL (1954), Diagnosis and improvement of saline and alkali soils. USDA Agr. Handbook No. 60,Washington DC.
- Freeze, R.A., and Cherry, J.A., 1979, Groundwater: New Jersey, Prentice Hall.
- Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3rd ed.): U.S. Geological Survey, Water Supply Paper.2254.
- L.V. Wilcox, (1955), “Classification and Use of Irrigation Waters”, U.S. Department of Agriculture Circle, Amer. J. of Science, Vol,8, No.3, pp. 123128.
- N. Manivasagam (1984), Physico-Chemical Examination of Water, Sewage And Industrial Effluents, PragatiPrakashan, Meerut.
- Piper, A.M., 1944, A graphical procedure in the geochemical interpretation of water analysis: American Geophysical Union Trans., v. 25, p. 914-923.

ANNEXURE-1: LIST OF GROUNDWATER SAMPLES & CHEMICAL ANALYSIS (BASIC ELEMENTS): MAY 2022

Longitude	Latitude	Block	Location	pH	EC in µS/cm at 25^0 C	CO_3	HCO_3	Cl	SO_4	NO_3	F	PO_4	Ca	Mg	Na	K	SiO_2	TH as $CaCO_3$
						mg/L												
77.1244	28.7981	Alipur	Alipur Garhi Pz	8.20	2077	0	537	263	168	0.53	3.7	ND	24	29	386	3.3	12	180
77.2667	28.4958	Kalkaji	Asola Pz	7.55	931	0	354	156	BDL	18	0.77	ND	56	36	99	4.4	25	290
76.9972	28.8194	Narela	Auchandi Pz	8.86	3585	96	439	518	480	18	1.3	ND	24	148	515	16	13	670
77.1517	28.8153	Alipur	Bakoli	8.25	4850	0	171	1122	576	1	0.52	ND	112	202	584	14	15	1110
77.2078	28.4200	Saket	Balbir Nagar DW	7.42	413	0	207	43	BDL	3.1	0.62	ND	52	12	24	1.8	20	180
77.2875	28.6408	Preet Vihar	Bank Enclave Pz	7.85	893	0	342	114	24	38	0.92	ND	64	44	74	7	11	340
77.0736	28.8514	Narela	Bankner Pz	8.03	2730	0	366	476	432	5.6	1.50	ND	56	78	451	7.7	15	460
77.0167	28.6500	Punjabi Bagh	Baprola Dw	8.15	4206	0	342	781	480	166	1.20	ND	68	156	564	33	18	810
77.0625	28.7583	Narela	Barwala Pz	8.18	1365	0	476	135	144	12	2.80	ND	36	46	213	5.4	11	280
77.0300	28.7869	Narela	Bawana JE Store	8.01	1116	0	451	121	BDL	39	2.80	ND	28	66	113	5.3	12	340
77.0536	28.8233	Narela	Bawana WTP	7.96	681	0	305	71	19	3.5	2.20	ND	40	41	48	4.1	19	270
77.1628	28.7364	Model Town	Bhalaswa Lake Pz	8.95	2208	84	464	412	BDL	21	1.50	2.1	84	66	293	22	13	480
77.2083	28.4278	Saket	Bhatti Pz	7.38	877	0	451	85	BDL	14	1.40	ND	72	27	100	1.5	27	290
77.1986	28.6319	Chanakyapuri	Birla Mandir DW	7.68	870	0	281	128	BDL	3.7	1.00	ND	60	29	70	2.1	10	270
77.2075	28.7689	Civil Lines	Burari Augur Pz	8.01	1234	0	317	213	58	0.8	0.92	ND	52	56	124	6.6	18	360
77.1972	28.7331	Civil Lines	Burari DJB Ex.Engg Office Pz	7.79	2800	0	293	682	125	3.4	1.20	ND	84	90	364	9.2	19	580
77.3031	28.6611	Shahdara	CBD Shahdara	7.78	3600	0	525	802	144	6.9	1.10	ND	68	92	550	9.2	21	550
77.2358	28.6556	Kotwali	Chandini Chowk DW	7.95	923	0	329	114	48	22	0.90	ND	44	39	82	54	13	270
77.0094	28.5464	Kapeshera	Chhawla Pz	8.55	2200	36	171	540	120	1.6	0.62	ND	60	68	316	5.5	12	430
77.3014	28.5872	Mayur Vihar	Chilla Regulator	7.62	1038	0	390	185	BDL	1	0.59	ND	52	54	95	10	15	350
77.2986	28.6003	Mayur Vihar	Chilla Saroda Pz	7.37	1736	0	451	249	192	0	0.70	ND	104	68	182	9.0	15	540
77.1111	28.6033	Delhi Cantonment	Cvd Depot Cant (Deep)	7.97	1050	0	488	78	48	26	0.65	ND	56	54	107	1.9	21	360

Longitude	Latitude	Block	Location	pH	EC in µS/cm at 25⁰ C	CO_3	HCO_3	Cl	SO_4	NO_3	F	PO_4	Ca	Mg	Na	K	SiO_2	TH as $CaCO_3$
						mg/L												
76.9086	28.5342	Najafgarh	Daryapur Khurd PZ	8.25	5200	0	146	1448	240	81.2	0.29	ND	100	124	803	4.8	15	760
76.9653	28.5431	Kapeshera	Daulatpur Pz	8.22	3431	0	171	1008	72	40.6	0.74	ND	112	209	233	39	13	1140
76.9750	28.6342	Najafgarh	Dichaon Kalan DW	8.53	11008	84	244	2840	864	316	0.59	0.4	344	569	1063	38	16	3200
77.0508	28.5672	Dwarka	Dwarka Sec-23 DDA Park	8.12	2863	0	781	469	168	16	2.60	ND	36	58	549	4.4	19	330
77.0569	28.5944	Dwarka	Dwarka Sec-5 DDA Park	7.66	3511	0	817	880	BDL	25	1.10	ND	80	124	542	8.5	18	710
77.1561	28.4769	Mehrauli	Gadaipur Pz	7.76	1126	0	183	121	240	86	0.95	ND	36	54	160	5.5	23	310
77.2744	28.7042	Karawal Nagar	Gokulpuri EW	7.74	380	0	98	57	43	2.8	0.45	ND	32	24	14	2.6	8	180
77.2917	28.6422	Preet Vihar	Gujarat Vihar Pz	7.45	1241	0	476	170	BDL	16	0.50	ND	52	58	120	11	19	370
76.9125	28.5478	Najafgarh	Gummanhera DW	8.21	6038	0	220	1704	408	22	0.41	ND	120	250	748	35	15	1330
77.1469	28.7289	Alipur	Haiderpur Pz	8.12	330	0	73	28	77	4.0	0.36	ND	36	19	5.0	2.2	11	170
77.0083	28.8319	Narela	Hareoli DW	7.72	2800	0	488	469	240	45	0.70	ND	92	163	221	10	18	900
77.2022	28.5453	Hauz Khas	Hauz Khas Pz	8.09	2442	0	622	284	144	199	1.10	ND	52	122	275	1.1	22	630
76.9942	28.6822	Punjabi Bagh	Hiran Kudna DW	7.43	5569	0	561	1385	192	132	0.65	ND	128	204	736	7.2	21	1160
77.1808	28.8011	Alipur	Hiranki Village Pz	7.67	2092	0	464	419	96	1.1	0.57	ND	68	92	244	10	20	550
77.2306	28.6722	Civil Lines	ISBT (Kasmiri Gate) DW	8.51	820	18	317	78	34	41	0.52	1.9	80	17	71	32	18	270
77.1569	28.5358	Vasant Vihar	J N U Pz (Upstream)	7.79	1258	0	458	156	34	39	0.72	ND	60	49	146	2.2	26	350
77.2225	28.7400	Civil Lines	Jagatpur Pz 2	7.65	1187	0	415	163	82	6.2	0.43	ND	40	92	74	20	17	480
77.2333	28.5389	Kalkaji	Jahapana Park	8.12	966	0	366	99	38	33	1.00	ND	64	24	115	8.8	19	260
77.3406	28.5089	Sarita Vihar	Jaitpur Khadar RD3500 Pz	7.30	1330	0	366	213	58	0.8	0.41	ND	20	78	139	8.5	21	370

Longitude	Latitude	Block	Location	pH	EC in µS/cm at 25^0 C	CO_3	HCO_3	Cl	SO_4	NO_3	F	PO_4	Ca	Mg	Na	K	SiO_2	TH as $CaCO_3$
						mg/L												
77.1822	28.5061	Mehrauli	Jamali Kamali DW	7.68	2603	0	805	355	86	111	2.00	ND	40	68	453	10	17	380
77.0914	28.6300	Patel Nagar	Janakpuri Pz	8.39	700	30	293	57	14	0.3	1.30	ND	28	39	67	14	13	230
77.1500	28.4681	Mehrauli	Jaunapur DJB TW	7.71	2496	0	488	405	168	72	1.30	ND	52	83	351	4.4	18	470
76.9667	28.7528	Kanjhawala	Jaunti DW	7.06	210	0	73	36	BDL	6	0.30	ND	16	2.4	31	1.9	8	50
76.97361	28.63888	Najafagarh	Jharoda Kalan	8.15	12057	0	24	3550	960	30	0.49	ND	268	445	1636	43	20	2500
77.1894	28.4089	Mehrauli	Jheel Khoh	7.70	1066	0	488	78	48	51	1.10	ND	44	46	139	1.7	24	300
76.9047	28.5361	Najafgarh	Jhuljhuli Dw	8.65	950	30	305	135	38	1.3	2.10	ND	40	49	100	17	15	300
77.0000	28.7250	Kanjhawala	Kanjhawala Pz	8.26	2492	0	854	284	96	8.1	1.3	ND	28	19	504	6.1	13	150
77.0864	28.6525	Patel Nagar	Keshopur DJB WTP	8.05	340	0	110	57	10	1	0.37	ND	28	24	4.5	2.3	8	170
77.1811	28.7183	Model Town	Kewal Park Pz	7.63	589	0	183	121	BDL	2.2	0.35	ND	40	24	56	6.6	8	200
77.2344	28.6644	Civil Lines	Khela Ghat Bhela road	7.97	1005	0	390	107	34	25	0.55	0.2	52	54	64	31	21	350
77.1181	28.7694	Alipur	Khera Kalan Pz	8.95	1177	30	488	71	86	0	2.50	ND	20	19	239	5.9	18	130
77.3217	28.6106	Mayur Vihar	Kondli DJB WTP	7.82	570	0	183	64	38	20	0.53	ND	36	24	47	5.7	10	190
77.2717	28.6325	Nazul Land	Lalitha Park (Pz)	7.74	1722	0	390	291	96	26	0.46	ND	56	71	189	13	17	430
77.2164	28.5903	Chanakyapuri	Lodhi Garden (D)	8.00	553	0	244	50	BDL	6.2	0.51	ND	28	39	25	0.6	19	230
77.1750	28.6042	Chanakyapuri	Mahabir Vansth.	7.69	1755	0	439	327	58	8	0.88	ND	60	34	275	2.4	25	290
77.0058	28.7556	Saraswati Vihar	Majara Dabas	7.71	1450	0	427	249	58	16	0.72	ND	48	73	141	43	19	420
77.2278	28.6958	Civil Lines	Majnu Ka Tila DW	8.16	1320	0	488	128	120	29	1.10	ND	44	39	140	134	22	270
77.0792	28.6903	Rohini	Mangolpur Pz	7.97	909	0	342	121	19	6	0.79	ND	48	34	104	1.5	15	260
77.1111	28.6186	Rajouri Garden	Mayapuri Pz	7.97	1529	0	641	156	72	4	0.64	ND	48	75	190	2.1	25	430
76.8933	28.6064	Najafgarh	Mundela Kalan Pz	8.41	520	60	98	71	10	3.4	0.28	ND	32	22	57	2.7	9	170
77.0006	28.6147	Najafgarh	Najafgarh Town	8.11	1948	0	256	433	91	101	0.45	ND	64	105	199	7.4	20	590

Longitude	Latitude	Block	Location	pH	EC in µS/cm at 25^0 C	CO_3	HCO_3	Cl	SO_4	NO_3	F	PO_4	Ca	Mg	Na	K	SiO_2	TH as $CaCO_3$
						mg/L												
77.2733	28.5944	Defence Colony	Nangli Rajapur Pz	7.47	1772	0	512	305	96	33	0.65	0.3	80	-41	401	42	16	30
77.1344	28.8367	Narela	Narela DJB WTP	7.61	2414	0	732	369	168	52	0.48	ND	84	199	150	19	20	1030
76.9667	28.7194	Kanjhawala	Nizampur EW	8.01	6793	0	939	1434	480	130	2.20	ND	92	216	1090	18	17	1120
76.9636	28.7200	Kanjhawala	Nizampur Mandir Dw	8.26	2273	0	634	312	38	140	3.50	ND	44	71	337	6.2	10	400
77.2733	28.5642	Kalkaji	Okhla DJB WTP Pz	7.69	1648	0	427	220	86	72	0.66	ND	52	54	221	4.3	18	350
77.2036	28.8225	Alipur	Palla Temple	8.02	666	0	244	85	34	4.0	0.95	ND	36	27	72	4.1	11	200
77.1964	28.8581	Alipur	Palla Zero RD	7.52	2545	0	378	618	106	4.8	0.55	ND	56	102	338	9.0	16	560
77.0933	28.6756	Punjabi Bagh	Peeragarhi DW	8.08	410	0	220	14	19	3	0.32	ND	28	12	50	2.2	9	120
77.1622	28.6392	Patel Nagar	PUSA (NRL) Pz	7.94	2144	0	464	433	14	48	0.75	ND	64	112	209	2.1	22	620
77.2267	28.5278	Hauz Khas	Pusp Vihar Pz	8.21	850	0	195	128	14	83	0.30	ND	44	24	99	2.4	21	210
77.0331	28.8503	Narela	Qatlupur Dw	8.18	540	0	305	28	10	0.8	0.84	ND	36	46	9.4	5.0	14	280
77.0183	28.7089	Rohini	Rani Khera DW	7.98	11074	0	647	2315	768	994	1.70	ND	112	260	1328	1043	12	1350
76.9042	28.5181	Kapeshera	Raota Dw	8.67	7353	42	397	1775	576	9	0.81	0.5	68	207	1119	55	14	1020
77.2417	28.5467	Kalkaji	R-Block, GK-1	7.67	2087	0	537	327	96	94	0.96	ND	44	63	333	1.6	14	370
77.1017	28.7150	Rohini	Rithala Pz Sec5 Rohini	7.67	1168	0	598	71	38	26	1.90	ND	32	27	216	6.0	11	190
77.1044	28.7322	Rohini	Rohini Sec 11 Pz	8.19	350	0	98	50	34	4	0.32	ND	32	24	5.8	2.1	8	180
77.0950	28.7528	Alipur	Rohini Sector 28	8.06	2265	0	488	369	240	5	2.60	ND	32	129	275	8.3	19	610
77.2125	28.5903	Chanakyapuri	Safdarjung tomb	7.54	2195	0	390	426	216	27	0.35	ND	40	170	179	9.2	21	800
77.1219	28.6911	Saraswati Vihar	Sainik Vihar(Pz)	7.59	14500	0	390	4601	432	3.3	0.60	ND	312	265	2507	37.2	11	1870
77.1525	28.7406	Rohini	Samaypur Badli Pz	7.99	3722	0	500	781	264	22	1.20	ND	56	114	565	9.7	14	610
77.1461	28.6950	Saraswati Vihar	Sandesh Vihar Pz	7.83	8380	0	525	2343	288	11	1.20	ND	60	270	1297	28.5	8	1260
77.1419	28.6903	Saraswati Vihar	Sanjay Van Pz	7.81	2770	0	512	476	240	15	1.70	ND	92	156	241	8.0	12	870

Longitude	Latitude	Block	Location	pH	EC in µS/cm at 25^0 C	CO_3	HCO_3	Cl	SO_4	NO_3	F	PO_4	Ca	Mg	Na	K	SiO_2	TH as $CaCO_3$
						mg/L												
77.2617	28.6756	Nazul Land	Shastri Park (Pz)	8.00	650	0	305	57	38	5.5	0.52	ND	40	32	67	4.2	9	230
77.1078	28.5783	Delhi Cantonment	Shekhawati Lines	8.21	1164	0	464	178	19	0.6	0.48	ND	40	56	155	2.4	17	330
76.9533	28.5247	Kapeshera	Shikarpur Shallow Pz	8.78	5855	72	293	1527	432	8.2	0.77	ND	20	195	1012	13.8	19	850
77.1294	28.8433	Alipur	Singhola Pz	7.98	4215	0	464	1172	240	6.6	0.66	ND	84	209	561	10.1	15	1070
77.1311	28.8533	Alipur	Singhu Village Pz	8.09	5423	0	366	1456	336	21	0.68	ND	84	248	707	14.7	18	1230
77.0356	28.7650	Rohini	Sultanpur Dabas	8.20	210	0	92	21	BDL	3.1	0.40	ND	32	4.9	4.1	2.1	8	100
77.1458	28.4894	Vasant Vihar	Sultanpur IMS Pz	7.88	796	0	342	57	38	9.5	1.00	ND	20	32	106	2.9	19	180
77.2450	28.5961	Chanakyapuri	Sunder Nursery Pz	7.89	2320	0	610	327	96	130	1.60	ND	40	63	382	5.7	18	360
76.9322	28.6039	Najafgarh	Surheda	8.48	2846	36	378	589	240	66	1.60	ND	28	119	425	41.7	13	560
77.1128	28.6439	Rajouri Garden	Tagore Garden	7.92	9514	0	439	2485	864	71	0.88	ND	332	377	1161	23.8	14	2380
77.1972	28.8147	Alipur	Tiggipur Deep Pz	7.90	820	0	366	71	58	1	0.80	ND	32	34	114	4.7	18	220
76.9694	28.6833	Punjabi Bagh	Tikri Kalan Pz	8.41	3270	90	122	802	216	30	0.65	ND	44	139	451	19.1	11	680
76.9142	28.5767	Najafgarh	Ujwah Pz	8.03	5901	0	378	1548	432	30	0.90	ND	24	229	940	15.1	17	1000
77.2492	28.6847	Seelam Pur	Ushmanpur Pz	7.77	723	0	305	57	24	1	0.80	ND	28	44	42	22.1	12	250
77.0742	28.6322	Patel Nagar	Vikashpuri Pz	7.92	5150	0	512	1363	96	26	0.90	ND	72	219	658	9.9	15	1080
77.3131	28.6708	Vivek Vihar	Vivek Vihar (Pz)	7.88	2110	0	488	327	192	30	1.70	ND	20	78	337	6.9	18	370
77.2430	28.5312	Kalkaji	W Park GK_1	7.86	486	0	207	53	19	4.6	1.40	ND	48	19	34	3.2	20	200
77.2872	28.6972	Yamuna Vihar	Yamuna Vihar DJB WTP	7.68	1400	0	427	185	38	30	1.40	ND	44	63	143	5.4	19	370

ANNEXURE-2: LIST OF GROUNDWATER SAMPLES & CHEMICAL ANALYSIS (HEAVY METALS): MAY 2023

Longitude	Latitude	Block	Location	Cr (mg/l)	Fe (mg/l)	Mn (mg/l)	Cu (mg/l)	Zn (mg/l)	As (mg/l)	Pb (mg/l)	U (mg/l)
77.12444	28.79806	Alipur	Alipur Garhi Pz	BDL	0.166	BDL	BDL	0.258	0.001	0.003	0.025
77.26667	28.49583	Kalkaji	Asola Pz	BDL	0.068	BDL	BDL	0.195	0.000	0.003	0.000
76.99722	28.81944	Narela	Auchandi Pz	BDL	0.229	BDL	BDL	1.540	0.000	0.006	0.053
77.15167	28.81528	Alipur	Bakoli	BDL	0.000	0.060	BDL	0.277	0.000	0.002	0.010
77.20778	28.42	Saket	Balbir Nagar DW	BDL	0.000	BDL	BDL	0.183	0.000	0.002	0.000
77.2875	28.64083	Preet Vihar	Bank Enclave Pz	BDL	0.169	0.202	BDL	0.118	0.011	0.002	0.004
77.07361	28.85139	Narela	Bankner Pz	BDL	0.133	BDL	BDL	1.272	0.000	0.006	0.015
77.01667	28.65	Punjabi Bagh	Baprola Dw	BDL	0.026	0.059	BDL	BDL	0.000	0.000	0.040
77.0625	28.75833	Narela	Barwala Pz	BDL	0.051	BDL	BDL	0.181	0.001	0.002	0.014
77.03	28.78694	Narela	Bawana JE Store	0.002	0.041	BDL	BDL	0.165	0.000	0.004	0.034
77.05361	28.82333	Narela	Bawana WTP	BDL	0.083	BDL	BDL	0.165	0.001	0.002	0.012
77.16278	28.73639	Model Town	Bhalaswa Lake Pz	BDL	0.195	0.512	BDL	0.162	0.007	0.005	0.004
77.20833	28.42778	Saket	Bhatti Pz	BDL	0.032	BDL	BDL	0.139	0.000	0.003	0.009
77.19861	28.63194	Chanakyapuri	Birla Mandir DW	BDL	0.092	0.238	BDL	0.335	0.000	0.002	0.000
77.2075	28.76889	Civil Lines	Burari Augur Pz	BDL	0.051	BDL	BDL	0.368	0.002	0.002	0.007
77.19722	28.73306	Civil Lines	Burari DJB Ex.Engg Office Pz	BDL	0.074	1.149	BDL	0.218	0.006	0.004	0.000
77.30306	28.66111	Shahdara	CBD Shahdara	BDL	0.000	BDL	BDL	0.195	0.000	0.002	0.013

Longitude	Latitude	Block	Location	Cr (mg/l)	Fe (mg/l)	Mn (mg/l)	Cu (mg/l)	Zn (mg/l)	As (mg/l)	Pb (mg/l)	U (mg/l)
77.23583	28.65556	Kotwali	Chandini Chowk DW	0.001	0.050	BDL	BDL	0.075	0.000	0.002	0.000
77.00944	28.54639	Kapeshera	Chhawla Pz	BDL	0.057	BDL	BDL	0.153	0.000	0.002	0.010
77.30139	28.58722	Mayur Vihar	Chilla Regulator	BDL	0.067	0.079	BDL	0.131	0.000	0.002	0.006
77.29861	28.60028	Mayur Vihar	Chilla Saroda Pz	BDL	1.777	0.524	BDL	0.105	0.011	0.002	0.004
77.11111	28.60333	Delhi Cantonment	Cvd Depot Cant (Deep)	BDL	0.000	BDL	BDL	0.219	0.000	0.002	0.009
76.90861	28.53417	Najafgarh	Daryapur Khurd PZ	BDL	0.068	BDL	BDL	BDL	0.000	0.001	0.010
76.96528	28.54306	Kapeshera	Daulatpur Pz	BDL	0.109	BDL	BDL	0.053	0.000	0.000	0.007
76.975	28.63417	Najafgarh	Dichaon Kalan DW	0.002	0.104	BDL	BDL	BDL	0.000	0.000	0.012
77.05083	28.56722	Dwarka	Dwarka Sec-23 DDA Park	BDL	0.000	BDL	BDL	BDL	0.000	0.000	0.014
77.05694	28.59444	Dwarka	Dwarka Sec-5 DDA Park	BDL	0.000	BDL	BDL	0.122	0.000	0.001	0.006
77.15611	28.47694	Mehrauli	Gadaipur Pz	BDL	0.000	BDL	BDL	0.243	0.000	0.001	0.000
77.27444	28.70417	Karawal Nagar	Gokulpuri EW	BDL	0.241	BDL	BDL	0.528	0.002	0.002	0.000
77.29167	28.64222	Preet Vihar	Gujarat Vihar Pz	BDL	0.131	0.313	BDL	0.107	0.000	0.003	0.009

Longitude	Latitude	Block	Location	Cr (mg/l)	Fe (mg/l)	Mn (mg/l)	Cu (mg/l)	Zn (mg/l)	As (mg/l)	Pb (mg/l)	U (mg/l)
76.9125	28.54778	Najafgarh	Gummanhera DW	BDL	0.000	0.610	BDL	BDL	0.002	0.000	0.005
77.14694	28.72889	Alipur	Haiderpur Pz	BDL	0.195	BDL	BDL	2.623	0.000	0.008	0.000
77.00833	28.83194	Narela	Hareoli DW	0.003	0.149	BDL	BDL	0.178	0.000	0.001	0.037
77.20222	28.54528	Hauz Khas	Hauz Khas Pz	0.002	0.000	BDL	BDL	0.186	0.000	0.000	0.016
76.99417	28.68222	Punjabi Bagh	Hiran Kudna DW	BDL	0.000	0.089	BDL	0.097	0.000	0.002	0.017
77.18083	28.80111	Alipur	Hiranki Village Pz	BDL	0.301	0.376	BDL	0.273	0.000	0.002	0.022
77.23056	28.67222	Civil Lines	ISBT (Kasmiri Gate) DW	0.002	0.372	0.229	BDL	0.075	0.002	0.003	0.000
77.15694	28.53583	Vasant Vihar	J N U Pz (Upstream)	BDL	0.000	BDL	BDL	0.092	0.000	0.001	0.010
77.2225	28.74	Civil Lines	Jagatpur Pz 2	BDL	0.896	1.352	BDL	0.472	0.035	0.002	0.000
77.23333	28.53889	Kalkaji	Jahapana Park	BDL	0.069	BDL	BDL	0.340	0.000	0.002	0.009
77.34056	28.50889	Sarita Vihar	Jaitpur Khadar RD3500 Pz	BDL	1.698	0.289	BDL	0.158	0.000	0.006	0.007
77.18222	28.50611	Mehrauli	Jamali Kamali DW	0.004	0.000	BDL	BDL	0.120	0.000	0.002	0.015
77.09139	28.63	Patel Nagar	Janakpuri Pz	BDL	0.174	BDL	BDL	0.503	0.000	0.003	0.015
77.15	28.46806	Mehrauli	Jaunapur DJB TW	0.001	0.000	BDL	BDL	0.730	0.000	0.003	0.031

Longitude	Latitude	Block	Location	Cr (mg/l)	Fe (mg/l)	Mn (mg/l)	Cu (mg/l)	Zn (mg/l)	As (mg/l)	Pb (mg/l)	U (mg/l)
76.96667	28.75278	Kanjhawala	Jaunti DW	BDL	0.079	BDL	BDL	0.240	0.000	0.003	0.000
76.97361	28.63888	Najafagarh	Jharoda Kalan	BDL	0.078	0.313	BDL	0.053	0.000	0.000	0.031
77.18944	28.40889	Mehrauli	Jheel Khoh	0.001	0.000	BDL	BDL	0.158	0.000	0.002	0.009
76.90472	28.53611	Najafgarh	Jhuljhuli Dw	0.001	0.000	BDL	BDL	0.062	0.003	0.002	0.000
77.00	28.725	Kanjhawala	Kanjhawala Pz	BDL	0.000	BDL	BDL	0.109	0.002	0.002	0.056
77.08639	28.6525	Patel Nagar	Keshopur DJB WTP	BDL	0.050	BDL	0.031	0.538	0.000	0.003	0.000
77.18111	28.71833	Model Town	Kewal Park Pz	BDL	0.106	BDL	BDL	0.120	0.002	0.004	0.000
77.23444	28.66444	Civil Lines	Khela Ghat Bhela road	0.001	0.000	BDL	BDL	0.064	0.002	0.002	0.006
77.11806	28.76944	Alipur	Khera Kalan Pz	BDL	0.000	BDL	BDL	0.263	0.002	0.004	0.030
77.32167	28.61056	Mayur Vihar	Kondli DJB WTP	BDL	0.000	BDL	BDL	0.096	0.000	0.002	0.018
77.27167	28.6325	Nazul Land	Lalitha Park (Pz)	BDL	2.546	0.368	BDL	0.133	0.003	0.002	0.006
77.21639	28.59028	Chanakyapuri	Lodhi Garden (D)	BDL	0.000	BDL	BDL	0.267	0.000	0.004	0.000
77.175	28.60417	Chanakyapuri	Mahabir Vansth.	BDL	0.000	BDL	BDL	0.142	0.000	0.002	0.004
77.00583	28.75556	Saraswati Vihar	Majara Dabas	BDL	0.798	BDL	BDL	0.163	0.000	0.002	0.027
77.22778	28.69583	Civil Lines	Majnu Ka Tila DW	0.002	0.195	BDL	BDL	0.192	0.000	0.002	0.009

Longitude	Latitude	Block	Location	Cr (mg/l)	Fe (mg/l)	Mn (mg/l)	Cu (mg/l)	Zn (mg/l)	As (mg/l)	Pb (mg/l)	U (mg/l)
77.07917	28.69028	Rohini	Mangolpur Pz	BDL	0.000	0.080	BDL	0.221	0.000	0.002	0.000
77.11111	28.61861	Rajouri Garden	Mayapuri Pz	0.002	0.102	BDL	BDL	0.793	0.000	0.005	0.009
76.89333	28.60639	Najafgarh	Mundela Kalan Pz	BDL	0.000	BDL	BDL	0.077	0.000	0.003	0.000
77.00056	28.61472	Najafgarh	Najafgarh Town	BDL	0.132	BDL	BDL	0.113	0.000	0.002	0.018
77.27333	28.59444	Defence Colony	Nangli Rajapur Pz	BDL	6.183	0.889	BDL	0.118	0.074	0.002	0.000
77.13444	28.83667	Narela	Narela DJB WTP	BDL	0.061	0.122	BDL	0.338	0.000	0.002	0.023
76.96667	28.71944	Kanjhawala	Nizampur EW	BDL	0.148	BDL	BDL	0.137	0.000	0.000	0.122
76.96361	28.72	Kanjhawala	Nizampur Mandir Dw	BDL	0.344	BDL	BDL	0.406	0.000	0.002	0.073
77.27333	28.56417	Kalkaji	Okhla DJB WTP Pz	0.002	0.000	BDL	BDL	0.077	0.000	0.001	0.004
77.20361	28.8225	Alipur	Palla Temple	BDL	0.084	BDL	BDL	0.288	0.001	0.003	0.006
77.19639	28.85806	Alipur	Palla Zero RD	BDL	0.498	0.377	BDL	0.062	0.009	0.001	0.011
77.09333	28.67556	Punjabi Bagh	Peeragarhi DW	BDL	0.000	BDL	BDL	0.234	0.001	0.003	0.000
77.16222	28.63917	Patel Nagar	PUSA (NRL) Pz	0.001	0.096	BDL	BDL	0.194	0.000	0.002	0.009
77.22667	28.52778	Hauz Khas	Pusp Vihar Pz	0.002	0.000	BDL	BDL	BDL	0.000	0.000	0.013
77.03306	28.85028	Narela	Qatlupur Dw	BDL	0.098	BDL	BDL	0.242	0.000	0.002	0.022

Longitude	Latitude	Block	Location	Cr (mg/l)	Fe (mg/l)	Mn (mg/l)	Cu (mg/l)	Zn (mg/l)	As (mg/l)	Pb (mg/l)	U (mg/l)
77.01833	28.70889	Rohini	Rani Khera DW	0.003	0.481	0.057	BDL	0.066	0.000	0.000	0.021
76.90417	28.51806	Kapeshera	Raota Dw	BDL	0.000	BDL	BDL	BDL	0.000	0.000	0.000
77.24167	28.54667	Kalkaji	R-Block, GK-1	BDL	0.000	BDL	BDL	0.090	0.000	0.001	0.008
77.10167	28.715	Rohini	Rithala Pz Sec5 Rohini	BDL	0.000	BDL	BDL	0.195	0.000	0.003	0.011
77.10444	28.73222	Rohini	Rohini Sec 11 Pz	BDL	0.213	BDL	BDL	2.835	0.001	0.010	0.000
77.095	28.75278	Alipur	Rohini Sector 28	BDL	0.147	0.164	BDL	0.190	0.000	0.002	0.028
77.2125	28.59028	Chanakyapuri	Safdarjung tomb	BDL	0.000	BDL	BDL	0.121	0.000	0.001	0.018
77.12194	28.69111	Saraswati Vihar	Sainik Vihar(Pz)	BDL	0.248	BDL	BDL	0.072	0.000	0.000	0.006
77.1525	28.74056	Rohini	Samaypur Badli Pz	BDL	0.063	0.055	BDL	0.310	0.000	0.001	0.008
77.14611	28.695	Saraswati Vihar	Sandesh Vihar Pz	BDL	0.000	BDL	BDL	BDL	0.000	0.000	0.012
77.14194	28.69028	Saraswati Vihar	Sanjay Van Pz	BDL	0.068	0.054	BDL	0.350	0.000	0.002	0.021
77.26167	28.67556	Nazul Land	Shastri Park (Pz)	BDL	0.103	0.576	BDL	0.141	0.000	0.002	0.004
77.10778	28.57833	Delhi Cantonment	Shekhawati Lines	0.001	0.000	BDL	BDL	0.234	0.000	0.002	0.007
76.95333	28.52472	Kapeshera	Shikarpur Shallow Pz	BDL	0.066	BDL	BDL	BDL	0.000	0.001	0.021
77.12944	28.84333	Alipur	Singhola Pz	0.008	0.158	0.092	BDL	3.426	0.000	0.000	0.010

Longitude	Latitude	Block	Location	Cr (mg/l)	Fe (mg/l)	Mn (mg/l)	Cu (mg/l)	Zn (mg/l)	As (mg/l)	Pb (mg/l)	U (mg/l)
77.13111	28.85333	Alipur	Singhu Village Pz	BDL	0.052	BDL	0.025	0.280	0.000	0.000	0.006
77.03556	28.765	Rohini	Sultanpur Dabas	BDL	0.000	BDL	BDL	0.120	0.001	0.002	0.000
77.14583	28.48944	Vasant Vihar	Sultanpur IMS Pz	0.014	0.000	BDL	BDL	0.168	0.000	0.002	0.007
77.245	28.59611	Chanakyapuri	Sunder Nursery Pz	BDL	0.000	BDL	BDL	0.089	0.000	0.001	0.015
76.93222	28.60389	Najafgarh	Surheda	BDL	0.000	0.148	BDL	BDL	0.000	0.001	0.040
77.11278	28.64389	Rajouri Garden	Tagore Garden	BDL	0.228	BDL	BDL	0.381	0.000	0.000	0.010
77.19722	28.81472	Alipur	Tiggipur Deep Pz	BDL	0.117	0.152	BDL	0.200	0.002	0.002	0.005
76.96944	28.68333	Punjabi Bagh	Tikri Kalan Pz	BDL	0.000	BDL	BDL	0.108	0.000	0.002	0.007
76.91417	28.57667	Najafgarh	Ujwah Pz	BDL	0.000	BDL	BDL	0.051	0.000	0.000	0.023
77.24917	28.68472	Seelam Pur	Ushmanpur Pz	BDL	0.389	0.977	BDL	0.223	0.000	0.002	0.005
77.07417	28.63222	Patel Nagar	Vikashpuri Pz	BDL	0.000	BDL	BDL	1.421	0.000	0.002	0.020
77.31306	28.67083	Vivek Vihar	Vivek Vihar (Pz)	BDL	0.058	BDL	BDL	0.162	0.000	0.002	0.012
77.24299	28.53123	Kalkaji	W Park GK_1	BDL	0.072	BDL	BDL	0.121	0.000	0.002	0.000
77.28722	28.69722	Yamuna Vihar	Yamuna Vihar DJB WTP	BDL	0.070	BDL	BDL	0.118	0.000	0.002	0.000

ANNEXURE-3: ASSESSMENT FOR SUITABILITY OF WATER FOR DRINKING PURPOSES AS PER INDIAN STANDARD DRINKING WATER - SPECIFICATION - IS 10500 : 2012.

S.No.	Location	pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	NO_3^{-}	F^{-}	Iron (as Fe)	Total arsenic (as As)
			μ S/cm		mg/L												
1	Alipur Garhi Pz	8.20	2077	1329.28	180	24	29	386	3.3	0	537	263	168	0.53	3.7	0.166	0.001
2	Asola Pz	7.55	931	595.84	290	56	36	99	4.4	0	354	156	0	18	0.77	0.068	0.000
3	Auchandi Pz	8.86	3585	2294.4	670	24	148	515	16	96	439	518	480	18	1.3	0.229	0.000
4	Bakoli	8.25	4850	3104	1110	112	202	584	14	0	171	1122	576	1	0.52	0.000	0.000
5	Balbir Nagar DW	7.42	413	264.32	180	52	12	24	1.8	0	207	43	0	3.1	0.62	0.000	0.000
6	Bank Enclave Pz	7.85	893	571.52	340	64	44	74	7	0	342	114	24	38	0.92	0.169	0.011
7	Bankner Pz	8.03	2730	1747.2	460	56	78	451	7.7	0	366	476	432	5.6	1.50	0.133	0.000
8	Baprola Dw	8.15	4206	2691.84	810	68	156	564	33	0	342	781	480	166	1.20	0.026	0.000
9	Barwala Pz	8.18	1365	873.6	280	36	46	213	5.4	0	476	135	144	12	2.80	0.051	0.001
10	Bawana JE Store	8.01	1116	714.24	340	28	66	113	5.3	0	451	121	0	39	2.80	0.041	0.000
11	Bawana WTP	7.96	681	435.84	270	40	41	48	4.1	0	305	71	19	3.5	2.20	0.083	0.001
12	Bhalaswa Lake Pz	8.95	2208	1413.12	480	84	66	293	22	84	464	412	0	21	1.50	0.195	0.007
13	Bhatti Pz	7.38	877	561.28	290	72	27	100	1.5	0	451	85	0	14	1.40	0.032	0.000
14	Birla Mandir DW	7.68	870	556.8	270	60	29	70	2.1	0	281	128	0	3.7	1.00	0.092	0.000
15	Burari Augur Pz	8.01	1234	789.76	360	52	56	124	6.6	0	317	213	58	0.8	0.92	0.051	0.002
16	Burari DJB Ex.Engg Office Pz	7.79	2800	1792	580	84	90	364	9.2	0	293	682	125	3.4	1.20	0.074	0.006
17	CBD Shahdara	7.78	3600	2304	550	68	92	550	9.2	0	525	802	144	6.9	1.10	0.000	0.000
18	Chandini Chowk DW	7.95	923	590.72	270	44	39	82	54	0	329	114	48	22	0.90	0.050	0.000
19	Chhawla Pz	8.55	2200	1408	430	60	68	316	5.5	36	171	540	120	1.6	0.62	0.057	0.000
20	Chilla Regulator	7.62	1038	664.32	350	52	54	95	10	0	390	185	0	1	0.59	0.067	0.000

S.No.	Location	pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	NO_3^{-}	F^{-}	Iron (as Fe)	Total arsenic (as As)
21	Chilla Saroda Pz	7.37	1736	1111.04	540	104	68	182	9.0	0	451	249	192	0	0.70	1.777	0.011
22	Cvd Depot Cant (Deep)	7.97	1050	672	360	56	54	107	1.9	0	488	78	48	26	0.65	0.000	0.000
23	Daryapur Khurd PZ	8.25	5200	3328	760	100	124	803	4.8	0	146	1448	240	81.2	0.29	0.068	0.000
24	Daulatpur Pz	8.22	3431	2195.84	1140	112	209	233	39	0	171	1008	72	40.6	0.74	0.109	0.000
25	Dichaon Kalan DW	8.53	11008	7045.12	3200	344	569	1063	38	84	244	2840	864	316	0.59	0.104	0.000
26	Dwarka Sec-23 DDA Park	8.12	2863	1832.32	330	36	58	549	4.4	0	781	469	168	16	2.60	0.000	0.000
27	Dwarka Sec-5 DDA Park	7.66	3511	2247.04	710	80	124	542	8.5	0	817	880	0	25	1.10	0.000	0.000
28	Gadaipur Pz	7.76	1126	720.64	310	36	54	160	5.5	0	183	121	240	86	0.95	0.000	0.000
29	Gokulpuri EW	7.74	380	243.2	180	32	24	14	2.6	0	98	57	43	2.8	0.45	0.241	0.002
30	Gujarat Vihar Pz	7.45	1241	794.24	370	52	58	120	11	0	476	170	0	16	0.50	0.131	0.000
31	Gummanhera DW	8.21	6038	3864.32	1330	120	250	748	35	0	220	1704	408	22	0.41	0.000	0.002
32	Haiderpur Pz	8.12	330	211.2	170	36	19	5.0	2.2	0	73	28	77	4.0	0.36	0.195	0.000
33	Hareoli DW	7.72	2800	1792	900	92	163	221	10	0	488	469	240	45	0.70	0.149	0.000
34	Hauz Khas Pz	8.09	2442	1562.88	630	52	122	275	1.1	0	622	284	144	199	1.10	0.000	0.000
35	Hiran Kudna DW	7.43	5569	3564.16	1160	128	204	736	7.2	0	561	1385	192	132	0.65	0.000	0.000
36	Hiranki Village Pz	7.67	2092	1338.88	550	68	92	244	10	0	464	419	96	1.1	0.57	0.301	0.000
37	ISBT (Kasmiri Gate) DW	8.51	820	524.8	270	80	17	71	32	18	317	78	34	41	0.52	0.372	0.002
38	J N U Pz (Upstream)	7.79	1258	805.12	350	60	49	146	2.2	0	458	156	34	39	0.72	0.000	0.000
39	Jagatpur Pz 2	7.65	1187	759.68	480	40	92	74	20	0	415	163	82	6.2	0.43	0.896	0.035
40	Jahapana Park	8.12	966	618.24	260	64	24	115	8.8	0	366	99	38	33	1.00	0.069	0.000
41	Jaitpur Khadar RD3500 Pz	7.30	1330	851.2	370	20	78	139	8.5	0	366	213	58	0.8	0.41	1.698	0.000

S.No.	Location	pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	NO_3^{-}	F^{-}	Iron (as Fe)	Total arsenic (as As)
42	Jamali Kamali DW	7.68	2603	1665.92	380	40	68	453	10	0	805	355	86	111	2.00	0.000	0.000
43	Janakpuri Pz	8.39	700	448	230	28	39	67	14	30	293	57	14	0.3	1.30	0.174	0.000
44	Jaunapur DJB TW	7.71	2496	1597.44	470	52	83	351	4.4	0	488	405	168	72	1.30	0.000	0.000
45	Jaunti DW	7.06	210	134.4	50	16	2.4	31	1.9	0	73	36	0	6	0.30	0.079	0.000
46	Jharoda Kalan	8.15	12057	7716.48	2500	268	445	1636	43	0	24	3550	960	30	0.49	0.078	0.000
47	Jheel Khoh	7.70	1066	682.24	300	44	46	139	1.7	0	488	78	48	51	1.10	0.000	0.000
48	Jhuljhuli Dw	8.65	950	608	300	40	49	100	17	30	305	135	38	1.3	2.10	0.000	0.003
49	Kanjhawala Pz	8.26	2492	1594.88	150	28	19	504	6.1	0	854	284	96	8.1	1.3	0.000	0.002
50	Keshopur DJB WTP	8.05	340	217.6	170	28	24	4.5	2.3	0	110	57	10	1	0.37	0.050	0.000
51	Kewal Park Pz	7.63	589	376.96	200	40	24	56	6.6	0	183	121	0	2.2	0.35	0.106	0.002
52	Khela Ghat Bhela road	7.97	1005	643.2	350	52	54	64	31	0	390	107	34	25	0.55	0.000	0.002
53	Khera Kalan Pz	8.95	1177	753.28	130	20	19	239	5.9	30	488	71	86	0	2.50	0.000	0.002
54	Kondli DJB WTP	7.82	570	364.8	190	36	24	47	5.7	0	183	64	38	20	0.53	0.000	0.000
55	Lalitha Park (Pz)	7.74	1722	1102.08	430	56	71	189	13	0	390	291	96	26	0.46	2.546	0.003
56	Lodhi Garden (D)	8.00	553	353.92	230	28	39	25	0.6	0	244	50	0	6.2	0.51	0.000	0.000
57	Mahabir Vansth.	7.69	1755	1123.2	290	60	34	275	2.4	0	439	327	58	8	0.88	0.000	0.000
58	Majara Dabas	7.71	1450	928	420	48	73	141	43	0	427	249	58	16	0.72	0.798	0.000
59	Majnu Ka Tila DW	8.16	1320	844.8	270	44	39	140	134	0	488	128	120	29	1.10	0.195	0.000
60	Mangolpur Pz	7.97	909	581.76	260	48	34	104	1.5	0	342	121	19	6	0.79	0.000	0.000
61	Mayapuri Pz	7.97	1529	978.56	430	48	75	190	2.1	0	641	156	72	4	0.64	0.102	0.000
62	Mundela Kalan Pz	8.41	520	332.8	170	32	22	57	2.7	60	98	71	10	3.4	0.28	0.000	0.000
63	Najafgarh Town	8.11	1948	1246.72	590	64	105	199	7.4	0	256	433	91	101	0.45	0.132	0.000
64	Nangli Rajapur Pz	7.47	1772	1134.08	30	80	-41	401	42	0	512	305	96	33	0.65	6.183	0.074
65	Narela DJB WTP	7.61	2414	1544.96	1030	84	199	150	19	0	732	369	168	52	0.48	0.061	0.000

S.No.	Location	pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	NO_3^{-}	F^{-}	Iron (as Fe)	Total arsenic (as As)
66	Nizampur EW	8.01	6793	4347.52	1120	92	216	1090	18	0	939	1434	480	130	2.20	0.148	0.000
67	Nizampur Mandir Dw	8.26	2273	1454.72	400	44	71	337	6.2	0	634	312	38	140	3.50	0.344	0.000
68	Okhla DJB WTP Pz	7.69	1648	1054.72	350	52	54	221	4.3	0	427	220	86	72	0.66	0.000	0.000
69	Palla Temple	8.02	666	426.24	200	36	27	72	4.1	0	244	85	34	4.0	0.95	0.084	0.001
70	Palla Zero RD	7.52	2545	1628.8	560	56	102	338	9.0	0	378	618	106	4.8	0.55	0.498	0.009
71	Peeragarhi DW	8.08	410	262.4	120	28	12	50	2.2	0	220	14	19	3	0.32	0.000	0.001
72	PUSA (NRL) Pz	7.94	2144	1372.16	620	64	112	209	2.1	0	464	433	14	48	0.75	0.096	0.000
73	Pusp Vihar Pz	8.21	850	544	210	44	24	99	2.4	0	195	128	14	83	0.30	0.000	0.000
74	Qatlupur Dw	8.18	540	345.6	280	36	46	9.4	5.0	0	305	28	10	0.8	0.84	0.098	0.000
75	Rani Khera DW	7.98	11074	7087.36	1350	112	260	1328	1043	0	647	2315	768	994	1.70	0.481	0.000
76	Raota Dw	8.67	7353	4705.92	1020	68	207	1119	55	42	397	1775	576	9	0.81	0.000	0.000
77	R-Block, GK-1	7.67	2087	1335.68	370	44	63	333	1.6	0	537	327	96	94	0.96	0.000	0.000
78	Rithala Pz Sec5 Rohini	7.67	1168	747.52	190	32	27	216	6.0	0	598	71	38	26	1.90	0.000	0.000
79	Rohini Sec 11 Pz	8.19	350	224	180	32	24	5.8	2.1	0	98	50	34	4	0.32	0.213	0.001
80	Rohini Sector 28	8.06	2265	1449.6	610	32	129	275	8.3	0	488	369	240	5	2.60	0.147	0.000
81	Safdarjung tomb	7.54	2195	1404.8	800	40	170	179	9.2	0	390	426	216	27	0.35	0.000	0.000
82	Sainik Vihar(Pz)	7.59	14500	9280	1870	312	265	2507	37.2	0	390	4601	432	3.3	0.60	0.248	0.000
83	Samaypur Badli Pz	7.99	3722	2382.08	610	56	114	565	9.7	0	500	781	264	22	1.20	0.063	0.000
84	Sandesh Vihar Pz	7.83	8380	5363.2	1260	60	270	1297	28.5	0	525	2343	288	11	1.20	0.000	0.000
85	Sanjay Van Pz	7.81	2770	1772.8	870	92	156	241	8.0	0	512	476	240	15	1.70	0.068	0.000
86	Shastri Park (Pz)	8.00	650	416	230	40	32	67	4.2	0	305	57	38	5.5	0.52	0.103	0.000
87	Shekhawati Lines	8.21	1164	744.96	330	40	56	155	2.4	0	464	178	19	0.6	0.48	0.000	0.000
88	Shikarpur Shallow Pz	8.78	5855	3747.2	850	20	195	1012	13.8	72	293	1527	432	8.2	0.77	0.066	0.000
89	Singhola Pz	7.98	4215	2697.6	1070	84	209	561	10.1	0	464	1172	240	6.6	0.66	0.158	0.000

S.No.	Location	pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	F^-	Iron (as Fe)	Total arsenic (as As)
90	Singhu Village Pz	8.09	5423	3470.72	1230	84	248	707	14.7	0	366	1456	336	21	0.68	0.052	0.000
91	Sultanpur Dabas	8.20	210	134.4	100	32	4.9	4.1	2.1	0	92	21	0	3.1	0.40	0.000	0.001
92	Sultanpur IMS Pz	7.88	796	509.44	180	20	32	106	2.9	0	342	57	38	9.5	1.00	0.000	0.000
93	Sunder Nursery Pz	7.89	2320	1484.8	360	40	63	382	5.7	0	610	327	96	130	1.60	0.000	0.000
94	Surheda	8.48	2846	1821.44	560	28	119	425	41.7	36	378	589	240	66	1.60	0.000	0.000
95	Tagore Garden	7.92	9514	6088.96	2380	332	377	1161	23.8	0	439	2485	864	71	0.88	0.228	0.000
96	Tiggipur Deep Pz	7.90	820	524.8	220	32	34	114	4.7	0	366	71	58	1	0.80	0.117	0.002
97	Tikri Kalan Pz	8.41	3270	2092.8	680	44	139	451	19.1	90	122	802	216	30	0.65	0.000	0.000
98	Ujwah Pz	8.03	5901	3776.64	1000	24	229	940	15.1	0	378	1548	432	30	0.90	0.000	0.000
99	Ushmanpur Pz	7.77	723	462.72	250	28	44	42	22.1	0	305	57	24	1	0.80	0.389	0.000
100	Vikashpuri Pz	7.92	5150	3296	1080	72	219	658	9.9	0	512	1363	96	26	0.90	0.000	0.000
101	Vivek Vihar (Pz)	7.88	2110	1350.4	370	20	78	337	6.9	0	488	327	192	30	1.70	0.058	0.000
102	W Park GK_1	7.86	486	311.04	200	48	19	34	3.2	0	207	53	19	4.6	1.40	0.072	0.000
103	Yamuna Vihar DJB WTP	7.68	1400	896	370	44	63	143	5.4	0	427	185	38	30	1.40	0.070	0.000
No. of samples; >Permissible limit)		**9**	**24**	**24**	**30**	**4**	**33**					**18**	**14**	**21**	**17**	**4**	**4**
% of samples; >Permissible limit)		**8.7**	**23.3**	**23.3**	**29.1**	**3.9**	**32.0**	**0.0**	**0.0**	**0.0**	**0.0**	**17.5**	**13.6**	**20.4**	**16.5**	**3.9**	**3.9**

BIS DWS-IS 10500 : 2013	Permissible Limit	<6.5->8.6		2000	600	200	100	N/A	N/A	N/A	N/A	1000	400	45	1.5	1	10

ANNEXURE-4: ASSESSMENT FOR SUITABILITY OF WATER FOR IRRIGATION PURPOSE.

Sl No.	Block	Well Name	TDS	S S P%	SAR	Percent Sodium	Residual Carbonate
			(EC* 0.64)	Na*100/ Ca+Mg+Na	Na / √ (Ca+Mg) / 2	((Na+K) / (Ca+Mg+Na+K))*100	(HCO3 + CO3) – (Ca + Mg)
1	Alipur	Alipur Garhi Pz	1329.280	82.346	12.520	82.419	5.197
2	Kalkaji	Asola Pz	595.840	42.570	2.525	43.207	-0.003
3	Narela	Auchandi Pz	2294.400	62.573	8.658	63.006	-3.011
4	Alipur	Bakoli	3104.000	53.351	7.623	53.701	-19.414
5	Saket	Balbir Nagar DW	264.320	22.837	0.794	23.571	-0.201
6	Preet Vihar	Bank Enclave Pz	571.520	32.163	1.749	33.335	-1.204
7	Narela	Bankner Pz	1747.200	68.076	9.150	68.293	-3.206
8	Punjabi Bagh	Baprola Dw	2691.840	60.232	8.624	61.044	-10.611
9	Narela	Barwala Pz	873.600	62.286	5.529	62.632	2.196
10	Narela	Bawana JE Store	714.240	41.968	2.668	42.635	0.594
11	Narela	Bawana WTP	435.840	28.082	1.284	29.072	-0.404
12	Model Town	Bhalaswa Lake Pz	1413.120	57.044	5.820	58.107	0.794
13	Saket	Bhatti Pz	561.280	42.859	2.555	43.074	1.597
14	Chanakyapuri	Birla Mandir DW	556.800	36.077	1.855	36.480	-0.803
15	Civil Lines	Burari Augur Pz	789.760	42.866	2.848	43.625	-2.005
16	Civil Lines	Burari DJB Ex.Engg Office Pz	1792.000	57.700	6.572	58.060	-6.807
17	Shahdara	CBD Shahdara	2304.000	68.496	10.201	68.706	-2.408

Sl No.	Block	Well Name	TDS	S S P%	SAR	Percent Sodium	Residual Carbonate
			(EC* 0.64)	Na*100/ Ca+Mg+Na	Na / √ (Ca+Mg) / 2	((Na+K) / (Ca+Mg+Na+K))*100	(HCO3 + CO3) – (Ca + Mg)
18	Kotwali	Chandini Chowk DW	590.720	39.794	2.173	47.839	-0.004
19	Kapeshera	Chhawla Pz	1408.000	61.503	6.627	61.745	-4.605
20	Mayur Vihar	Chilla Regulator	664.320	37.238	2.221	38.673	-0.605
21	Mayur Vihar	Chilla Saroda Pz	1111.040	42.337	3.413	43.034	-3.406
22	Delhi Cantonment	Cvd Depot Cant (Deep)	672.000	39.260	2.453	39.502	0.795
23	Najafgarh	Daryapur Khurd PZ	3328.000	69.675	12.672	69.749	-12.809
24	Kapeshera	Daulatpur Pz	2195.840	30.787	3.005	32.798	-20.015
25	Najafgarh	Dichaon Kalan DW	7045.120	41.937	8.174	42.444	-57.239
26	Dwarka	Dwarka Sec-23 DDA Park	1832.320	78.345	13.148	78.426	6.194
27	Dwarka	Dwarka Sec-5 DDA Park	2247.040	62.406	8.849	62.620	-0.811
28	Mehrauli	Gadaipur Pz	720.640	52.882	3.953	53.384	-3.204
29	Karawal Nagar	Gokulpuri EW	243.200	14.371	0.450	15.688	-2.002
30	Preet Vihar	Gujarat Vihar Pz	794.240	41.363	2.714	42.675	0.395
31	Najafgarh	Gummanhera DW	3864.320	55.014	8.923	55.678	-23.018
32	Alipur	Haiderpur Pz	211.200	6.024	0.167	7.469	-2.202
33	Narela	Hareoli DW	1792.000	34.838	3.209	35.439	-10.012
34	Hauz Khas	Hauz Khas Pz	1562.880	48.732	4.773	48.792	-2.410

Sl No.	Block	Well Name	TDS (EC* 0.64)	S S P% Na*100/ Ca+Mg+Na	SAR Na / √ (Ca+Mg) / 2	Percent Sodium ((Na+K) / (Ca+Mg+Na+K))*100	Residual Carbonate (HCO3 + CO3) – (Ca + Mg)
35	Punjabi Bagh	Hiran Kudna DW	3564.160	57.974	9.399	58.114	-14.015
36	Alipur	Hiranki Village Pz	1338.880	49.061	4.519	49.654	-3.408
37	Civil Lines	ISBT (Kasmiri Gate) DW	524.800	36.382	1.880	42.018	0.398
38	Vasant Vihar	J N U Pz (Upstream)	805.120	47.499	3.386	47.721	0.495
39	Civil Lines	Jagatpur Pz 2	759.680	25.055	1.465	27.964	-2.807
40	Kalkaji	Jahapana Park	618.240	49.023	3.102	50.121	0.797
41	Sarita Vihar	Jaitpur Khadar RD3500 Pz	851.200	44.941	3.141	45.820	-1.406
42	Mehrauli	Jamali Kamali DW	1665.920	72.144	10.100	72.409	5.593
43	Patel Nagar	Janakpuri Pz	448.000	38.897	1.931	41.617	1.197
44	Mehrauli	Jaunapur DJB TW	1597.440	61.889	7.043	62.064	-1.407
45	Kanjhawala	Jaunti DW	134.400	57.067	1.880	57.922	0.200
46	Najafagarh	Jharoda Kalan	7716.480	58.728	14.234	59.099	-49.630
47	Mehrauli	Jheel Khoh	682.240	50.275	3.503	50.451	1.996
48	Najafgarh	Jhuljhuli Dw	608.000	42.022	2.511	44.375	-0.004
49	Kanjhawala	Kanjhawala Pz	1594.880	87.970	17.916	88.045	10.996
50	Patel Nagar	Keshopur DJB WTP	217.600	5.398	0.149	6.888	-1.602

Sl No.	Block	Well Name	TDS	S S P%	SAR	Percent Sodium	Residual Carbonate
			(EC* 0.64)	Na*100/ Ca+Mg+Na	Na / √ (Ca+Mg) / 2	((Na+K) / (Ca+Mg+Na+K))*100	(HCO3 + CO3) – (Ca + Mg)
51	Model Town	Kewal Park Pz	376.960	37.697	1.712	39.293	-1.002
52	Civil Lines	Khela Ghat Bhela road	643.200	28.458	1.489	33.869	-0.605
53	Alipur	Khera Kalan Pz	753.280	80.002	9.125	80.231	6.397
54	Mayur Vihar	Kondli DJB WTP	364.800	35.135	1.494	36.720	-0.802
55	Nazul Land	Lalitha Park (Pz)	1102.080	48.824	3.958	49.805	-2.206
56	Chanakyapuri	Lodhi Garden (D)	353.920	19.087	0.716	19.301	-0.603
57	Chanakyapuri	Mahabir Vansth.	1123.200	67.347	7.026	67.460	1.397
58	Saraswati Vihar	Majara Dabas	928.000	42.180	2.991	46.204	-1.406
59	Civil Lines	Majnu Ka Tila DW	844.800	53.053	3.715	63.806	2.596
60	Rohini	Mangolpur Pz	581.760	46.412	2.794	46.622	0.397
61	Rajouri Garden	Mayapuri Pz	978.560	48.942	3.977	49.103	1.893
62	Najafgarh	Mundela Kalan Pz	332.800	42.239	1.907	42.896	0.198
63	Najafgarh	Najafgarh Town	1246.720	42.329	3.567	42.860	-7.608
64	Defence Colony	Nangli Rajapur Pz	1134.080	96.687	31.894	96.874	7.801
65	Narela	Narela DJB WTP	1544.960	24.056	2.034	25.364	-8.615
66	Kanjhawala	Nizampur EW	4347.520	67.917	14.174	68.128	-7.017
67	Kanjhawala	Nizampur Mandir Dw	1454.720	64.717	7.339	64.962	2.394

Sl No.	Block	Well Name	TDS	S S P%	SAR	Percent Sodium	Residual Carbonate
			(EC* 0.64)	Na*100/ Ca+Mg+Na	Na / √ (Ca+Mg) / 2	((Na+K) / (Ca+Mg+Na+K))*100	(HCO3 + CO3) – (Ca + Mg)
68	Kalkaji	Okhla DJB WTP Pz	1054.720	57.884	5.144	58.163	-0.005
69	Alipur	Palla Temple	426.240	43.988	2.222	44.798	-0.002
70	Alipur	Palla Zero RD	1628.800	56.759	6.214	57.141	-5.008
71	Punjabi Bagh	Peeragarhi DW	262.400	47.552	1.987	48.194	1.199
72	Patel Nagar	PUSA (NRL) Pz	1372.160	42.268	3.647	42.409	-4.809
73	Hauz Khas	Pusp Vihar Pz	544.000	50.560	2.964	50.920	-1.002
74	Narela	Qatlupur Dw	345.600	6.824	0.245	8.772	-0.604
75	Rohini	Rani Khera DW	7087.360	68.134	15.717	75.762	-16.419
76	Kapeshera	Raota Dw	4705.920	70.452	15.235	71.038	-12.515
77	Kalkaji	R-Block, GK-1	1335.680	66.207	7.539	66.269	1.394
78	Rohini	Rithala Pz Sec5 Rohini	747.520	71.154	6.802	71.487	5.997
79	Rohini	Rohini Sec 11 Pz	224.000	6.517	0.187	7.779	-2.002
80	Alipur	Rohini Sector 28	1449.600	49.468	4.837	49.906	-4.210
81	Chanakyapuri	Safdarjung tomb	1404.800	32.721	2.752	33.383	-9.613
82	Saraswati Vihar	Sainik Vihar(Pz)	9280.000	74.459	25.219	74.624	-31.019

Sl No.	Block	Well Name	TDS	S S P%	SAR	Percent Sodium	Residual Carbonate
			(EC* 0.64)	Na*100/ Ca+Mg+Na	Na / √ (Ca+Mg) / 2	((Na+K) / (Ca+Mg+Na+K))*100	(HCO3 + CO3) – (Ca + Mg)
83	Rohini	Samaypur Badli Pz	2382.080	66.808	9.946	67.031	-4.009
84	Saraswati Vihar	Sandesh Vihar Pz	5363.200	69.122	15.898	69.395	-16.620
85	Saraswati Vihar	Sanjay Van Pz	1772.800	37.597	3.555	38.053	-9.012
86	Nazul Land	Shastri Park (Pz)	416.000	38.722	1.917	39.595	0.397
87	Delhi Cantonment	Shekhawati Lines	744.960	50.539	3.713	50.769	0.995
88	Kapeshera	Shikarpur Shallow Pz	3747.200	72.141	15.105	72.301	-9.814
89	Alipur	Singhola Pz	2697.600	53.267	7.459	53.530	-13.815
90	Alipur	Singhu Village Pz	3470.720	55.541	8.766	55.840	-18.618
91	Rohini	Sultanpur Dabas	134.400	8.097	0.176	10.270	-0.501
92	Vasant Vihar	Sultanpur IMS Pz	509.440	56.093	3.429	56.481	1.997
93	Chanakyapuri	Sunder Nursery Pz	1484.800	69.776	8.763	69.960	2.794
94	Najafgarh	Surheda	1821.440	62.246	7.806	63.555	-3.809
95	Rajouri Garden	Tagore Garden	6088.960	51.465	10.349	51.764	-40.427
96	Alipur	Tiggipur Deep Pz	524.800	53.026	3.350	53.626	1.597

Sl No.	Block	Well Name	TDS	S S P%	SAR	Percent Sodium	Residual Carbonate
			(EC* 0.64)	Na*100/ Ca+Mg+Na	Na / √ (Ca+Mg) / 2	((Na+K) / (Ca+Mg+Na+K))*100	(HCO3 + CO3) – (Ca + Mg)
97	Punjabi Bagh	Tikri Kalan Pz	2092.800	59.024	7.515	59.619	-8.610
98	Najafgarh	Ujwah Pz	3776.640	67.138	12.926	67.345	-13.816
99	Seelam Pur	Ushmanpur Pz	462.720	26.589	1.146	32.219	-0.004
100	Patel Nagar	Vikashpuri Pz	3296.000	56.999	8.715	57.215	-13.216
101	Vivek Vihar	Vivek Vihar (Pz)	1350.400	66.424	7.613	66.688	0.593
102	Kalkaji	W Park GK_1	311.040	26.745	1.033	27.810	-0.602
103	Yamuna Vihar	Yamuna Vihar DJB WTP	896.000	45.613	3.227	46.162	-0.405

ANNEXURE-5: LIST OF GROUNDWATER SAMPLES & CHEMICAL ANALYSIS (BASIC ELEMENTS): NOVEMBER 2023

Longitude	Latitude	Block	Location	pH	EC (us/cm)	CO3 (mg/L)	HCO3 (mg/L)	Cl	SO4	NO3	PO4	F	TH	Ca	Mg	Na	K
77.15166667	28.81527778	Alipur	Bakoli	7.78	4950	Nil	390.4	935.88	820	1	0.26	0.48	1140	188	162.944	620	11.1
77.0625	28.75833333	Narela	Barwala Pz	7.23	11000	Nil	256.2	3722	620	70	0.98	0.25	4320	1080	394	850	8
76.96527778	28.54305556	Kapeshera	Daulatpur Pz	7.7	3510	Nil	268.4	1049.32	40	36	0.65	0.95	1240	160	204.288	230	28
76.99416667	28.68222222	Punjabi Bagh	Hiran Kudna DW	7.3	4785	Nil	793	1120.22	265	130	0.66	0.9	1070	176	153.216	710	5
76.96666667	28.75277778	Kanjhawala	Jaunti DW	7.5	978	Nil	268.4	120.53	160	26	0.02	0.45	390	92	38.912	86	4
76.90472222	28.53611111	Najafgarh	Jhuljhuli Dw	7.17	5167	Nil	475.8	1389.64	250	18	0.45	0.44	990	208	114.304	750	8.6
77.27333333	28.59444444	Defence Colony	Nangli Rajapur Pz	7.16	1150	Nil	340	198.52	20	2	0.11	0.75	150	40	12	192	10.1
77.13111111	28.85333333	Alipur	Singhu Village Pz	7.55	5270	Nil	366	1106.04	755	95	0.03	0.8	1410	248	192.128	600	12
77.11277778	28.64388889	Rajouri Garden	Tagore Garden	7.5	8820	Nil	366	1134.4	2750	110	0.01	0.65	2330	424	308.864	1150	20
76.91416667	28.57666667	Najafgarh	Ujwah Pz	7.59	5590	Nil	488	1503.08	475	31	0.87	0.9	1250	120	231.04	820	11.1
77.19722222	28.73305556	Civil Lines	Burari DJB Ex.Engg Office Pz	7.46	5150	Nil	329.4	1347.1	490	4	0.11	0.45	970	272	70.528	780	17.9
77.14694444	28.72888889	Alipur	Haiderpur	7.84	1080	Nil	402.6	35.45	220	16.8	0.13	0.78	530	104	65.664	42	4.2
77.17	28.73929	Model Town	Bhalaswa Lake	7.32	5620	Nil	85.4	1573.98	683.04	1.25	0.01	0.41	1320	176	214.016	770	9
77.09138889	28.63	Patel Nagar	Janakpuri Pz	7.6	625	Nil	402.6	42.54	14	6.6	0.1	1.23	370	88	36.48	16	9.75
77.14611111	28.695	Saraswati Vihar	Sandesh Vihar	7.66	8610	Nil	524.6	2623	320	4	0.13	1.1	1440	224	214.016	1380	22.9
76.99722222	28.81944444	Narela	Auchandi Pz	7.73	4270	Nil	744.2	694.82	490	36	0.25	1.65	1120	116	201.856	460	13
77.05083333	28.56722222	Dwarka	Dwarka Sec-23 DDA Park	7.7	2982	Nil	760	567.2	60	16	0.32	2.65	380	64	53.504	520	4
77	28.725	Kanjhawala	Kanjhawala Pz	7.46	2290	Nil	305	205.61	525	60	0.11	4.59	460	160	15	310	12.8
76.96666667	28.71944444	Kanjhawala	Nizampur EW	7.12	1080	Nil	536.8	141.8	12	10	0.1	4.6	240	44	31.616	198	3.19
77.01833333	28.70888889	Rohini	Rani Khera DW	7.74	9770	Nil	378.2	2197.9	1502	135	0.56	2.15	1400	156	245.632	950	1280
77.10166667	28.715	Rohini	Rithala Pz Sec5 Rohini	7.78	2910	Nil	597.8	446.67	385	30	0.11	3.5	460	64	72.96	500	7.5

Longitude	Latitude	Block	Location	pH	EC (us/cm)	CO3 (mg/L)	HCO3 (mg/L)	Cl	SO4	NO3	PO4	F	TH	Ca	Mg	Na	K
77.095	28.75277778	Alipur	Rohini Sector 28	7.99	1970	Nil	585.6	191.43	455	5	0.05	2.2	400	40	72.96	380	6.13
77.07416667	28.63222222	Patel Nagar	Vikashpuri Pz	7.91	1420	Nil	463.6	184.34	132	30	0.05	1.99	370	60	53.504	200	5.7
77.10444444	28.73222222	Rohini	Rohini Sec 11	8.18	1280	Nil	561.2	35.45	75	11	0.52	5.2	90	24	7.296	240	3.6

ANNEXURE-6: LIST OF GROUNDWATER SAMPLES & CHEMICAL ANALYSIS (HEAVY METALS): NOVEMBER 2023

Longitude	Latitude	Block	Location	Cr	Fe	Mn	Cu	Zn	As	Pb	U
76.9972222	28.81944	Narela	Auchandi Pz	0	0.467874	0	0	0.050508	0	0	0.039619
77.1516667	28.81528	Alipur	Bakoli	0	0.161737	0	0	0.601945	0	0.001476	0.006799
77.0625	28.75833	Narela	Barwala Pz	0	0.112053	1.196082	0	0	0	0	0
76.9652778	28.54306	Kapeshera	Daulatpur Pz	0	0.097617	0.062852	0	0.050368	0	0	0.005609
77.0508333	28.56722	Dwarka	Dwarka Sec-23 DDA Park	0	0.1706	0	0.025722	0.657317	0	0.002526	0.013067
76.9941667	28.68222	Punjabi Bagh	Hiran Kudna DW	0	0.155585	0.082175	0	0	0	0	0.011585
77.0913889	28.63	Patel Nagar	Janakpuri Pz	0	0.174314	0	0	0	0.003108	0.002186	0.006734
76.9666667	28.75278	Kanjhawala	Jaunti DW	0	0.108563	0	0	0.075422	0	0.001565	0.00919
76.9047222	28.53611	Najafgarh	Jhuljhuli Dw	0	0.067337	0.236373	0	0	0	0	0.026238
77	28.725	Kanjhawala	Kanjhawala Pz	0	0.100859	0.305101	0	0.069651	0	0	0.0282
77.2277778	28.69583	Civil Lines	Majnu Ka Tila DW	0.001962	0.140521	0	0	0.618324	0	0.003843	0.007146
77.2733333	28.59444	Defence Colony	Nangli Rajapur Pz	0	6.696919	0.798459	0	0.279162	0.070375	0.002233	0
76.9666667	28.71944	Kanjhawala	Nizampur EW	0	0.226162	0	0	0.107574	0	0.00155	0.054281
77.0183333	28.70889	Rohini	Rani Khera DW	0	0.318869	0	0	0.29039	0	0	0.007491
77.1016667	28.715	Rohini	Rithala Pz Sec5 Rohini	0	0.600689	0.05285	0	0.260196	0	0.001886	0.012845
77.095	28.75278	Alipur	Rohini Sector 28	0	0.104801	0	0	0	0	0	0.010781
77.1311111	28.85333	Alipur	Singhu Village Pz	0	0	0	0	0.118317	0	0	0.004797
77.1127778	28.64389	Rajouri Garden	Tagore Garden	0	0.264948	0.066686	0	0	0	0	0.007075
77.0741667	28.63222	Patel Nagar	Vikashpuri Pz	0	0.14402	0	0	0.074078	0	0.001889	0.020017
76.9141667	28.57667	Najafgarh	Ujwah Pz	0	0.078139	0	0	0	0	0	0.012518
77.1461111	28.695	Saraswati Vihar	Sandesh Vihar	0	0.11923	0	0	0	0	0	0.008029
77.1972222	28.73306	Civil Lines	Burari DJB Ex.Engg Office Pz	0	0.920321	0.841149	0	0.357457	0.003826	0.002837	0
77.1469444	28.72889	Alipur	Haiderpur	0	0.155779	0	0	0.270735	0	0.003491	0.012312
77.1044444	28.73222	Rohini	Rohini Sec 11	0	0.08432	0	0	0.05352	0.002549	0.001254	0.009136
77.17	28.73929	Model Town	Bhalaswa Lake	0	3.220075	0.36949	0	2.740444	0	0.010596	0

ANNEXURE-7 PRE-MONSOON & POST-MONSOON COMPARATIVE ANALYSIS OF SELECTED SAMPLES

Long	Lat	District	Block	Location	EC (µS/cm at 25 C)		F (ppm)		NO3 (ppm)		Fe (ppm)		As (ppm)		U (ppm)	
					PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
76.997222	28.819444	North	Narela	Auchandi	3585	4270	1.3	1.65	18.4	36	0.229	0.468	BDL	BDL	0.053	0.040
77.151667	28.815278	North	Alipur	Bakoli	4850	4950	0.52	0.48	0.9	1	BDL	0.162	BDL	BDL	0.010	0.007
77.062500	28.758333	North	Narela	Barwala	1365	11000	2.80	0.25	12.1	70	0.051	0.112	0.001	BDL	0.014	0.000
76.965278	28.543056	North	Kapeshera	Daulatpur	3431	3510	0.74	0.95	40.6	36	0.109	0.098	BDL	BDL	0.007	0.006
77.050833	28.567222	South West	Dwarka	Dwarka Sec-23 DDA Park	2863	2982	2.60	2.65	15.7	16	BDL	0.171	BDL	BDL	0.014	0.013
76.994167	28.682222	West	Punjabi Bagh	Hiran Kudna	5569	4785	0.65	0.9	131.9	130	BDL	0.156	BDL	BDL	0.017	0.012
77.091389	28.630000	West	Patel Nagar	Janakpuri	700	625	1.30	1.23	0.3	6.6	0.174	0.174	BDL	0.003108	0.015	0.007
76.966667	28.752778	North West	Kanjhawala	Jaunti	210	978	0.30	0.45	6.3	26	0.079	0.109	BDL	BDL	BDL	0.009
76.904722	28.536111	South West	Najafgarh	Jhuljhuli	950	5167	2.10	0.44	1.3	18	BDL	0.067	0.003	BDL	BDL	0.026
77.000000	28.725000	North West	Kanjhawala	Kanjhawala	2492	2290	1.3	4.59	8.1	60	BDL	0.101	0.002	BDL	0.056	0.028
77.227778	28.695833	Central	Civil Lines	Majnu Ka Tila	1320	Blank	1.10	Blank	29.0	Blank	0.195	0.141	BDL	BDL	0.009	0.007
77.273333	28.594444	South East	Defence Colony	Nangli Rajapur	1772	1150	0.65	0.75	33.0	2	6.183	6.697	0.074	0.070	BDL	0.000
76.966667	28.719444	North West	Kanjhawala	Nizampur	6793	1080	2.20	4.6	129.5	10	0.148	0.226	BDL	BDL	0.122	0.054
77.018333	28.708889	North West	Rohini	Rani Khera	11074	9770	1.70	2.15	994.0	135	0.481	0.319	BDL	BDL	0.021	0.007

Long	Lat	District	Block	Location	EC (µS/cm at 25 C)		F (ppm)		NO3 (ppm)		Fe (ppm)		As (ppm)		U (ppm)	
					PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
77.101667	28.715000	North	Rohini	Rithala Pz Sec5 Rohini	1168	2910	1.90	3.5	25.8	30	BDL	0.601	BDL	BDL	0.011	0.013
77.095000	28.752778	North	Alipur	Rohini Sector 28	2265	1970	2.60	2.2	5.3	5	0.147	0.105	BDL	BDL	0.028	0.011
77.131111	28.853333	North	Alipur	Singhu Village	5423	5270	0.68	0.8	20.8	95	0.052	0.000	BDL	BDL	0.006	0.005
77.112778	28.643889	West	Rajouri Garden	Tagore Garden	9514	8820	0.88	0.65	71.2	110	0.228	0.265	BDL	BDL	0.010	0.007
77.074167	28.632222	West	Patel Nagar	Vikashpuri	5150	1420	0.90	1.99	26.1	30	BDL	0.144	BDL	BDL	0.023	0.020
76.914167	28.576667	South West	Najafgarh	Ujwah	5901	5590	0.90	0.9	29.5	31	BDL	0.078	BDL	BDL	0.020	0.013
77.19722	28.73305556	Central	Civil Lines	Burari DJB Ex.Engg Office	2800	5150	1.20	0.45	3.4	4	0.074	0.920	0.006	0.003826	BDL	0.000
77.14694	28.72888889	North	Alipur	Haiderpur	330	1080	0.36	0.78	4.0	16.8	0.195	0.156	BDL	BDL	BDL	0.012
77.10444	28.73222222	North West	Rohini	Rohini Sec 11	350	1280	0.32	5.2	4.4	11	0.213	0.084	0.001	0.002549	BDL	0.009
77.14611	28.695	North West	Saraswati Vihar	Sandesh Vihar	8380	8610	1.20	1.1	10.7	4	BDL	0.119	BDL	BDL	0.012	0.008
77.17	28.73929	North	Model Town	Bhalaswa Lake	2208	5620	1.50	0.41	20.7	1.25	0.195	3.220	0.007	BDL	0.004	0.000

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