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Assessment of Groundwater Quality in Rewari Industrial Area, Haryana and Its Suitability for Domestic and Irrigation Use

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Abstract- The present study evaluates the groundwater quality of the Rewari industrial and peri-urban region of Haryana and assesses its suitability for domestic purposes. Groundwater samples were collected from seven representative locations, including industrial, residential, and semi-urban zones during the pre-monsoon season of 2024. Physico-chemical and microbial parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), nitrate, fluoride, fecal coliform, and total coliform were analyzed using standard APHA methods. The results indicated that groundwater pH ranged from 7.1 to 8.0, showing neutral to slightly alkaline conditions. EC values varied between 1210 and 1780 µS/cm, while TDS concentrations ranged from 680 to 828 mg/L, indicating moderate salinity and mineralization. The highest EC value (1780 µS/cm) was observed at Haily Mandi and HSIIDC Sector-37, reflecting stronger ionic concentration due to industrial and urban influences. Fluoride concentration remained constant at 0.2 mg/L and nitrate levels ranged from 0.0 to 0.3 mg/L, both within permissible drinking water limits. BOD values remained low at 1 mg/L, indicating negligible organic contamination. Microbial analysis showed low fecal and total coliform counts (~1.8 MPN/100 ml) at most monitoring locations. Temporal analysis from 2021–2024 revealed increasing salinity trends at several industrial locations due to industrial discharge and excessive groundwater abstraction. The study concludes that groundwater in the Rewari industrial region is moderately mineralized and requires treatment before drinking purposes. Sustainable groundwater management, pollution control measures, and periodic monitoring are essential to protect groundwater resources and ensure long-term water quality sustainability.

Keywords- Groundwater quality, Rewari industrial area, Haryana, physicochemical parameters, drinking water suitability, irrigation suitability, Electrical Conductivity (EC), Total Dissolved Solids (TDS).

1. Introduction

Groundwater is one of the most significant natural resources that supports human life, agricultural development, and industrial growth. In many parts of India, particularly semi-arid regions such as Haryana, groundwater serves as the primary source of drinking water, irrigation, and industrial consumption. Rapid urbanization, industrial expansion, and population growth have increased the dependence on groundwater resources, leading to concerns regarding both quantity and quality. Rewari district, located in the southern part of Haryana, has experienced substantial industrial development over the past few decades. The establishment of industrial units, expansion of urban settlements, and intensive agricultural practices have considerably influenced the groundwater environment of the region. As a result, continuous monitoring and assessment of groundwater quality have become essential to ensure its safe utilization for domestic and irrigation purposes(Fallatah & Khattab, 2023; Kumari et al., 2023; Lingayat & Rai, 2023; Pande et al., 2023).

The Rewari industrial area is characterized by diverse industrial activities including metal processing, manufacturing, automobile components, chemical handling, and other small- and medium-scale industries. These industrial operations generate various liquid and solid wastes that may infiltrate into the soil and groundwater system. In addition, excessive extraction of groundwater for industrial and agricultural activities has further aggravated the groundwater stress in the region. The improper disposal of industrial effluents, sewage discharge, and agricultural runoff containing fertilizers and pesticides contribute significantly to groundwater contamination(Di et al., 2023; Hosseininia & Hassanzadeh, 2023). Such contamination may alter the physico-chemical characteristics of groundwater, making it unsuitable for human consumption and agricultural use. Therefore, scientific evaluation of groundwater quality is necessary to understand the extent of contamination and its potential impacts on public health and agricultural productivity.

Groundwater quality is generally assessed through the analysis of various physico-chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), total hardness, calcium, magnesium, chloride, sulphate, nitrate, fluoride, sodium, potassium, and bicarbonate. These parameters provide important information regarding the chemical composition and suitability of water for different purposes(Alghamdi et al., 2023; Study, 2023; Tekile, 2023). The suitability of groundwater for drinking is usually evaluated based on standards prescribed by organizations such as the World Health Organization (WHO), Bureau of Indian Standards (BIS), and Indian Council of Medical Research (ICMR). Similarly, irrigation suitability is determined using indices such as Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC), Permeability Index (PI), and Kelly’s Ratio (KR). Poor-quality groundwater may adversely affect soil fertility, crop productivity, and human health by causing diseases related to excessive salinity, hardness, nitrate, or fluoride contamination.

In recent years, several studies conducted in different industrial regions of India have reported deterioration in groundwater quality due to anthropogenic activities. Industrial areas are particularly vulnerable because contaminants can easily percolate through the soil and accumulate in aquifers over time. Rewari district is no exception, as increasing industrialization and urban pressure have raised concerns regarding groundwater pollution. Hence, there is a

pressing need to systematically investigate the groundwater quality status of the Rewari industrial area and evaluate its suitability for domestic and irrigation purposes.
The present study aims to assess the groundwater quality in the Rewari industrial area through detailed physico-chemical analysis and comparison with standard permissible limits. The study also evaluates the suitability of groundwater for irrigation using various water quality indices. The findings of this research will help in understanding the current groundwater quality scenario, identifying potential contamination sources, and suggesting suitable management strategies for sustainable groundwater utilization in the region(Purposes & Study, 2023; Sunkari et al., 2023).

2. Literature Review

(Deep & Kumar, 2025) evaluates the spatio-temporal variation of groundwater levels in Kurukshetra district using GIS techniques and data from ninety-seven observation wells collected between 1985 and 2020. Inverse Distance Weighted interpolation and Vertical Electrical Sounding (VES) methods were used to analyze groundwater depth and subsurface conditions. Results reveal a severe decline in groundwater levels, with large areas shifting from 10–20 m depth in 1990 to 40–45 m below ground level in 2020. Intensive wheat and paddy cultivation was identified as the major cause of depletion. The study recommends efficient irrigation, crop diversification, rainwater harvesting, and government initiatives for sustainable groundwater management.
(A. Yadav et al., 2025) focuses on municipal solid waste management and landfill site selection in Rewari using GIS, Analytical Hierarchy Process (AHP), and Weighted Linear Combination (WLC) techniques. Data were collected through FAO resources, ALOS PALSAR DEM, Sentinel-2B imagery, Google Earth Pro, and field interviews. Results show that Land Use Land Cover (LULC) contributed 35.4% importance in landfill suitability analysis, followed by road networks with 24.0% weight. The WLC analysis identified 4.65 km² as unsuitable and 0.11 km² as highly suitable for landfill development. The study supports sustainable waste management and assists policymakers in scientifically selecting environmentally safe landfill sites.
(Wani et al., 2024) presents a comparative hydrochemical and groundwater quality assessment of karst aquifers in the Altinova using GIS-based analysis. Twenty-five groundwater wells were monitored seasonally for one year to evaluate relationships among groundwater quality, geology, and climate. Irrigation suitability was assessed using EC, SAR, sodium percentage, magnesium hazard, permeability index, Kelly's ratio, and IWQ index. Results showed dominance of Ca^{2+} and HCO_3^- ions, while non-karstic areas exhibited higher TDS, hardness, and sulphate concentrations. SAR values indicated medium to high salinity risk with low sodium hazard. Overall, groundwater was found suitable for irrigation, with salinization mainly controlled by geological and ionic interactions.

(Singh et al., 2023) evaluated human health risks associated with poor groundwater quality in the Lucknow region of the Central Ganga alluvial plain, India. A total of 27 groundwater samples were analyzed, revealing that silicate and carbonate weathering, along with cation exchange and sulfide oxidation, controlled groundwater chemistry. Most water samples belonged to the Ca–Na–HCO_3 type and were within WHO permissible limits, except for elevated iron and nitrate concentrations. Water Quality Index (WQI) analysis showed that about 98.52% of the urban area had well to excellent water quality. However, nearly 35% of the west-central region exhibited moderate to high human health risks due to iron and nitrate contamination

(Walia et al., 2023) evaluated the performance and profitability of wheat cultivation under sprinkler irrigation systems in Southern Haryana, particularly in Rewari and Bhiwani districts. A multistage random sampling technique was adopted, and primary data were collected from 120 wheat farmers during 2021–22. The analysis revealed that total cultivation costs were slightly higher in Rewari (₹86136.85) than in Bhiwani (₹85178.89). Farmers in Rewari obtained marginally higher net returns (₹18665.70) compared to Bhiwani (₹18547.61). The benefit-cost ratio over total cost was found to be 1.21 in Rewari, 1.22 in Bhiwani, and 1.21 overall, indicating that wheat cultivation under sprinkler irrigation was economically profitable in both districts.

Table 1: Literature Summary

Authors/Year	Methodology	Research Gap	Findings
(Saleh et al., 2023)	Groundwater hydrochemical and trace analysis.	Limited multi-aquifer contamination assessment studies.	High salinity and heavy metal contamination.
(P. Yadav & Pandey, 2022)	Groundwater pollution source identification and evaluation.	Limited regional health impact assessment studies.	Natural and anthropogenic pollution severely affected groundwater.
(Ige et al., 2022)	Groundwater physicochemical and bacteriological quality assessment.	Limited dumpsite impact studies on nearby aquifers.	Groundwater remained suitable for drinking and irrigation.
(Ravish et al., 2021)	Literature-based groundwater quality status review.	Limited integrated groundwater quality assessment studies.	Urbanization and pollution degraded groundwater quality.
(Ali et al., 2021)	Spatio-temporal groundwater	Limited long-term NCR groundwater monitoring studies.	Industrialization significantly affected

	variation analysis in NCR.		groundwater quality and availability.

3. Research Methodology

The study was conducted in the industrial and peri-urban regions of Rewari, Haryana, near NH-8 to assess groundwater quality influenced by rapid industrialization and land-use changes. A purposive sampling design was used to collect 11 groundwater samples from hand pumps and bore wells across industrial, residential, and agricultural zones during the pre-monsoon season. Field parameters such as pH, EC, and TDS were measured using a portable digital water analyzer, while laboratory analysis followed APHA standards for major ions. Drinking and irrigation suitability were evaluated using BIS, WHO, and ICMR guidelines, and statistical tools were applied for data interpretation and spatial variation analysis.

3.1 Selection of Study Area

The study was conducted in the industrial and peri-urban regions of Rewari, Haryana, located near the Delhi–Jaipur National Highway (NH-8). The area was selected because rapid industrialization, urban growth, and groundwater extraction have significantly affected groundwater quality. Geological formations such as quartzite, slate, and alluvial deposits influence groundwater chemistry. The study area includes industrial zones, residential settlements, and agricultural land to examine the impact of different land-use patterns on groundwater contamination and suitability for domestic purposes.

3.2 Research Objectives

a) To analyze the physico-chemical characteristics of groundwater in the Rewari industrial area.
b) To evaluate groundwater suitability for drinking and domestic purposes using standard guidelines (BIS, WHO, ICMR).
c) To assess groundwater suitability for irrigation based on salinity, sodium hazard, and hydrochemical parameters.

3.3 Hypothesis

H1: There is a significant variation in the physico-chemical characteristics of groundwater in the Rewari industrial area

H0: There is no significant variation in the physico-chemical characteristics of groundwater in the Rewari industrial area.

H2: The groundwater in the Rewari industrial area is not fully suitable for drinking and domestic purposes as per BIS, WHO, and ICMR guidelines.

H0: The groundwater in the Rewari industrial area is suitable for drinking and domestic purposes as per BIS, WHO, and ICMR guidelines.

H3: The groundwater in the Rewari industrial area shows significant irrigation suitability limitations based on salinity, sodium hazard, and hydrochemical parameters.

H0: The groundwater in the Rewari industrial area is suitable for irrigation without significant limitations based on salinity, sodium hazard, and hydrochemical parameters.

3.3 Sampling Design and Selection of Sampling Sites

A purposive sampling technique was adopted to select representative groundwater sampling locations. Eleven sampling points were identified from industrial, residential, and agricultural zones based on pollution vulnerability, groundwater usage intensity, and proximity to contamination sources. Groundwater samples were collected from hand pumps and bore wells actively used for drinking and domestic purposes. Sampling was conducted during the pre-monsoon season (April–June 2022) to avoid dilution effects caused by rainfall recharge and to obtain stable groundwater conditions.

3.4 Groundwater Sample Collection

Groundwater samples were collected in one-litre pre-cleaned polyethylene bottles following standard hydrogeological protocols. Before sample collection, bottles were rinsed multiple times with groundwater from the same source to prevent contamination. Each sample was labelled with location name, sample code, source type, and date of collection. During sampling, precautions were taken to avoid exposure to sunlight, air bubbles, or external impurities. The collected samples were transported carefully to the laboratory under controlled conditions to maintain their original physicochemical properties.

3.5 Field Measurement of Water Quality Parameters

On-site field measurements were carried out immediately after sample collection using a portable digital water analyzer (CENTURY–CK–710). Important parameters such as pH, Electrical Conductivity (EC), and Total Dissolved Solids (TDS) were measured directly in the field to avoid changes caused by transportation or environmental exposure. Instruments were calibrated before use to ensure data accuracy and reliability. These parameters provided initial information regarding groundwater salinity, mineralization, and acidity–alkalinity characteristics in the study area.

3.6 Laboratory Analysis of Groundwater Samples

Detailed laboratory analysis was conducted using APHA (1985) standard procedures. Major cations and anions such as calcium, magnesium, sodium, chloride, bicarbonate, sulphate, and fluoride were analyzed using volumetric titration and flame photometry techniques. AnalR grade chemicals and double-distilled water were used to ensure analytical precision. Laboratory analysis helped in determining the hydrochemical composition of groundwater and identifying dissolved ionic concentrations responsible for groundwater mineralization and contamination in industrial regions.

3.7 Drinking Water Suitability Assessment

The suitability of groundwater for domestic and drinking purposes was assessed by comparing observed physicochemical values with standard permissible limits prescribed by BIS (1999), WHO (2003), and ICMR (1975). Parameters such as pH, TDS, fluoride, nitrate, and EC were evaluated to determine whether groundwater was safe, marginal, or unsuitable for

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consumption. Locations showing elevated TDS and EC values were categorized as requiring treatment before domestic use. This comparison provided a clear understanding of groundwater quality status in the Rewari industrial area.

3.8 Statistical Analysis and Interpretation

All laboratory and field data were organized systematically into tables for interpretation and comparison. Descriptive statistical methods including minimum, maximum, and mean values were used to analyze groundwater quality variations across locations. The analysis helped identify spatial trends, salinity patterns, and contamination hotspots. Hydrochemical interpretations were further supported using comparative assessments and standard classifications. This systematic analysis enabled scientific conclusions regarding groundwater quality deterioration and domestic water suitability in industrial regions of Rewari.

4. Results and Discussion

4.1 Analysis of Groundwater Physico-Chemical Parameters

The groundwater samples collected from industrial and peri-urban locations of Rewari showed neutral to slightly alkaline pH values ranging between 7.1 and 8.0, indicating chemically stable groundwater conditions. Electrical Conductivity (EC) values ranged from 1210–1780 µS/cm, while Total Dissolved Solids (TDS) varied between 680–828 mg/L, indicating moderate mineralization and salinity influence. Fluoride and nitrate concentrations remained within permissible drinking limits. These findings suggest that groundwater quality is mainly affected by dissolved ionic salts rather than toxic contaminants.

Table 4. 1 Groundwater Quality Parameters at Selected Monitoring Locations in Haryana, 2024

STN Code	Monitoring Location	Temp (°C)	pH	EC	BOD	Nitrate	Fecal Coliform	Total Coliform	TDS	Fluoride
4845	Borewell, HSIIDC Park, Sector-1, IMT Manesar	26.8	7.2	1610	1	0.3	1.8	1.8	816	0.2
4846	Tubewell No. 6, HSIIDC, Sector-8	28.1	7.8	1620	1	0.3	1.8	1.8	828	0.2
4847	Tubewell No. 4, Haily	27.1	7.4	1780	1	0.3	1.8	1.8	784	0.2

Kavya Setu
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	Mandi, Pataudi									
4848	Tubewell HSIIDC, Sector-37	27.4	7.4	1780	1	0.0	–	–	784	0.2
4849	Borewell, Ansal Pioneer Industrial Park	27.6	7.3	1210	1	0.3	1.8	1.8	680	0.2
4850	Borewell, Water Works, Sector-35	26.8	8.0	1350	1	0.3	1.8	1.8	712	0.2
4851	Borewell, PHED Office, Pataudi	27.1	7.1	1410	1	0.3	1.8	1.8	732	0.2

The groundwater quality data from selected monitoring locations indicate neutral to slightly alkaline conditions, with pH values ranging from 7.2 to 8.0. Electrical Conductivity (EC) values between 1210 and 1780 µS/cm reveal moderate to high salinity levels, while TDS values (680–828 mg/L) indicate mineralized groundwater. BOD remained low at 1 mg/L, suggesting minimal organic pollution. Nitrate and fluoride concentrations were within safe limits at most locations. Fecal and total coliform counts were low, indicating limited microbial contamination. Haily Mandi and HSIIDC Sector-37 recorded the highest EC values, reflecting stronger dissolved ionic concentration likely influenced by industrial activities.

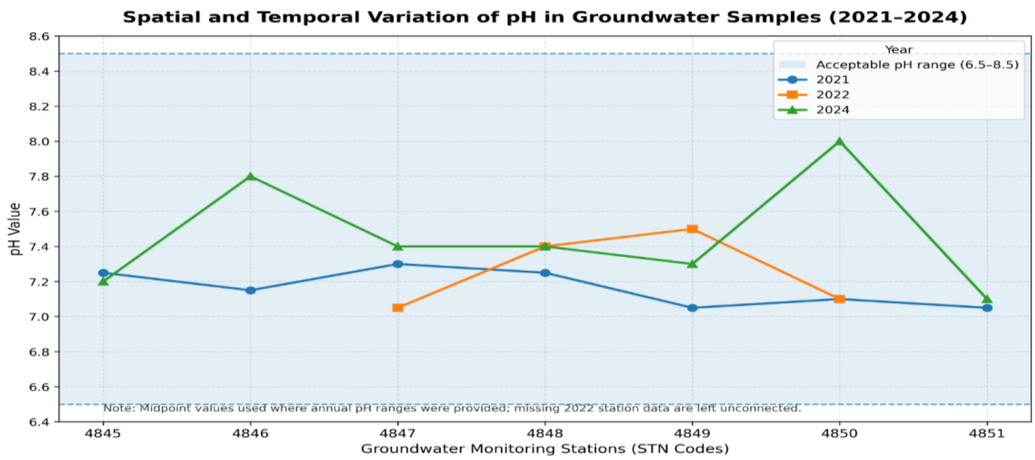

Figure 4. 1 Lab-Based Groundwater Quality Results, 2024

Kavya Setu

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Presents the laboratory-based groundwater quality analysis of selected monitoring locations in the Rewari industrial area during 2024. The figure shows variations in pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), nitrate, fluoride, and BOD levels. Results indicate moderate mineralization and salinity in groundwater, particularly at Haily Mandi and HSIIDC Sector-37, while fluoride and nitrate concentrations remained within permissible drinking water limits.

Table 4. 2 Statistical Summary of Groundwater Parameters, 2024

Parameter	Minimum	Maximum	Mean	Result Interpretation
Temperature °C	26.8	28.1	27.27	Normal groundwater temperature
pH	7.1	8.0	7.46	Neutral to slightly alkaline
EC µS/cm	1210	1780	1537.14	Moderately high salinity
BOD mg/L	1.0	1.0	1.0	Low organic load
Nitrate mg/L	0.0	0.3	0.26	Very low nitrate contamination
TDS mg/L	680	828	762.29	Above desirable drinking limit
Fluoride mg/L	0.2	0.2	0.2	Safe fluoride level

The mean EC value of 1537.14 µS/cm indicates that the aquifer contains a considerable dissolved ionic load. The mean TDS value of 762.29 mg/L confirms that groundwater is not ideal for direct drinking use based on desirable limits, although it may still fall within the permissible range where no alternative source is available.

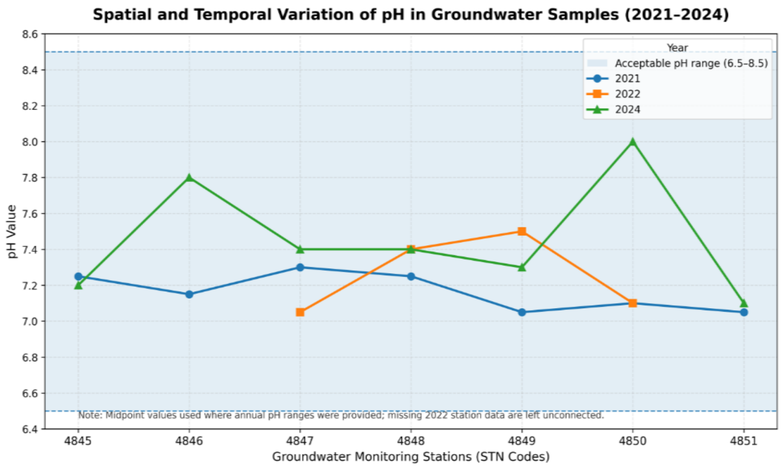

Figure 4. 2 Spatial and temporal variation of pH in groundwater samples

A more critical parameter is Electrical Conductivity (EC), which reflects the concentration of dissolved salts. The data show that EC values frequently exceed recommended limits (1400 µS/cm in many standards). For example, in 2021, EC values reached up to 2320 µS/cm, while in 2024 several locations recorded values between 1610 and 1780 µS/cm. This indicates moderate to high salinity levels, likely due to geological formations, industrial discharge, and evapotranspiration effects.

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Similarly, Total Dissolved Solids (TDS) values ranged between 520 and 1440 mg/L, with several stations exceeding desirable limits for drinking water (500–600 mg/L). Elevated TDS indicates the presence of dissolved inorganic salts such as calcium, magnesium, sodium, and chlorides. High TDS water may not be immediately harmful but can lead to long-term health issues and affects palatability. Fluoride concentrations remained within safe limits (0.2–1.1 mg/L), indicating no significant fluoride contamination risk in the monitored areas. Nitrate levels were also consistently low (around 0.3 mg/L), suggesting limited agricultural runoff or nitrogen pollution.

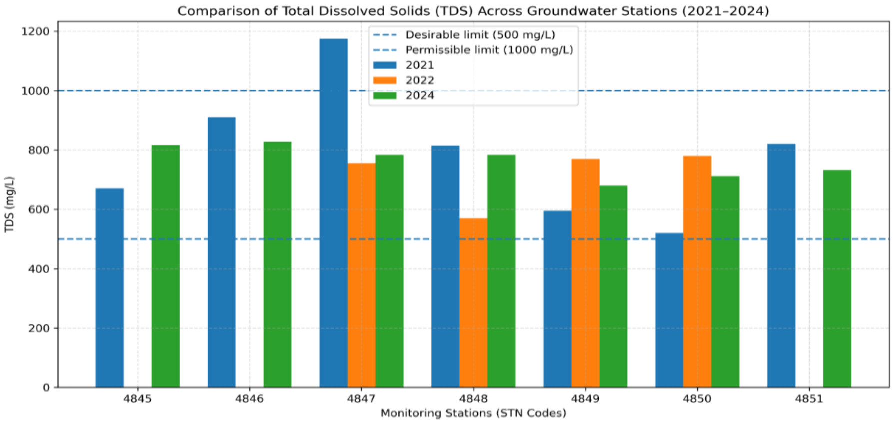

Figure 4. 3 Comparison of total dissolved solids across groundwater monitoring locations

Illustrates the spatial variation in total dissolved solids (TDS) across different groundwater monitoring locations. The results indicate significant differences among sampling sites, reflecting varying degrees of mineralization and anthropogenic influence on groundwater quality and overall suitability for use assessment.

4.2 Statistical Interpretation of Groundwater Quality

Descriptive statistical analysis revealed that the mean EC value was 1537.14 µS/cm and the mean TDS value was 762.29 mg/L. These values exceed desirable drinking water standards, indicating increased dissolved mineral content in groundwater. The relatively low standard variation in pH demonstrates stable hydrochemical conditions across sampling sites, whereas EC and TDS variations indicate spatial differences in salinity caused by industrial discharge and groundwater mineral dissolution. Statistical interpretation confirmed moderate groundwater degradation in industrial regions.

Table 4. 3 EC–TDS Relationship and Salinity Assessment

Monitoring Location	**EC µS/cm**	**TDS mg/L**	**TDS/EC Ratio**	**Salinity Interpretation**
Borewell, HSIIDC Park, Sector-1, IMT Manesar	1610	816	0.507	Moderately saline
Tubewell No. 6, HSIIDC, Sector-8, IMT Manesar	1620	828	0.511	Moderately saline

Kavya Setu
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Tubewell No. 4, Haily Mandi, Pataudi	1780	784	0.440	High ionic concentration
Tubewell HSIIDC, Sector-37	1780	784	0.440	High ionic concentration
Borewell, Ansal Pioneer Industrial Park, Pathreri	1210	680	0.562	Moderate mineralization
Borewell, Water Works, Sector-35, NH-8	1350	712	0.527	Moderate mineralization
Borewell, PHED Office, Pataudi	1410	732	0.519	Moderate mineralization

The EC–TDS ratio remains mostly between 0.44 and 0.56, showing that dissolved ionic salts are the major contributors to conductivity. The highest EC values were observed at Tubewell No. 4, Haily Mandi, Pataudi and Tubewell HSIIDC, Sector-37, both at 1780 µS/cm, suggesting stronger salinity influence, likely due to industrial and urban land-use impact.

4.3 Drinking Water Suitability Assessment

Groundwater suitability for drinking purposes was evaluated using BIS, WHO, and ICMR standards. Results showed that pH, nitrate, fluoride, and BOD values remained within safe limits at all monitoring locations. However, TDS concentrations exceeded desirable limits in all groundwater samples, indicating saline taste and mineralization problems. Therefore, groundwater was categorized as “Requires Treatment” before domestic consumption. Reverse osmosis (RO), filtration, and blending methods were recommended for safe household use.

Table 4. 4 Lab-Based Groundwater Quality Results, 2024

Monitoring Location	Temp °C	pH	EC µS/cm	BOD mg/L	Nitrate mg/L	TDS mg/L	Fluoride mg/L	Lab Interpretation
Borewell, HSIIDC Park, Sector-1, IMT Manesar	26.8	7.2	1610	1.0	0.3	816	0.2	High mineral load
Tubewell No. 6, HSIIDC, Sector-8, IMT Manesar	28.1	7.8	1620	1.0	0.3	828	0.2	Highest TDS

Kavya Setu

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Tubewell No. 4, Haily Mandi, Pataudi	27.1	7.4	1780	1.0	0.3	784	0.2	Highest EC
Tubewell HSIIDC, Sector-37	27.4	7.4	1780	1.0	0.0	784	0.2	Highest EC, nitrate absent
Borewell, Ansal Pioneer Industrial Park, Pathreri	27.6	7.3	1210	1.0	0.3	680	0.2	Lowest EC and TDS
Borewell, Water Works, Sector-35, NH-8	26.8	8.0	1350	1.0	0.3	712	0.2	Highest pH
Borewell, PHED Office, Pataudi	27.1	7.1	1410	1.0	0.3	732	0.2	Acceptable but mineralized

4.4 Microbial Water Quality Analysis

Microbiological analysis indicated low fecal coliform and total coliform counts (~1.8 MPN/100 ml) at most groundwater locations. Although contamination levels were relatively low, drinking water standards ideally require zero fecal coliform presence. This suggests occasional microbial infiltration from sewage leakage or poor sanitation practices. Hence, groundwater disinfection through chlorination or UV treatment is necessary before drinking purposes.

Table 4. 5 Microbial Suitability of Groundwater

Monitoring Location	Fecal Coliform	Total Coliform	Microbial Status
Borewell, HSIIDC Park, Sector-1, IMT Manesar	1.8	1.8	Low contamination, disinfection required
Tubewell No. 6, HSIIDC, Sector-8, IMT Manesar	1.8	1.8	Low contamination, disinfection required
Tubewell No. 4, Haily Mandi, Pataudi	1.8	1.8	Low contamination, disinfection required
Tubewell HSIIDC, Sector-37	Not available	Not available	Further testing required

Borewell, Ansal Pioneer Industrial Park, Pathreri	1.8	1.8	Low contamination, disinfection required
Borewell, Water Works, Sector-35, NH-8	1.8	1.8	Low contamination, disinfection required
Borewell, PHED Office, Pataudi	1.8	1.8	Low contamination, disinfection required

4.5 Temporal Trend Analysis (2021–2024)

Comparative analysis from 2021–2024 revealed increasing EC and TDS values at several monitoring stations, especially HSIIDC Park Sector-1, Sector-37, and Water Works Sector-35. This trend indicates long-term accumulation of dissolved salts due to industrial discharge, urbanization, and excessive groundwater abstraction. Some locations such as Haily Mandi showed slight improvement, suggesting localized recharge or reduced contamination impacts.

Table 4. 6 Groundwater Temporal Change at Common Locations

Location	2021 EC Range	2024 EC	2021 TDS Range	2024 TDS	Trend
Borewell, HSIIDC Park, Sector-1, IMT Manesar	1340–1520	1610	670	816	EC and TDS increased
Tubewell No. 6, HSIIDC, Sector-8, IMT Manesar	1280–2010	1620	610–1210	828	Moderate, variable
Tubewell No. 4, Haily Mandi, Pataudi	1940–2320	1780	910–1440	784	Improved from 2021
Tubewell HSIIDC, Sector-37	1430–1540	1780	710–920	784	EC increased
Borewell, Ansal Pioneer Industrial Park, Pathreri	1040–1120	1210	560–630	680	Slight increase
Borewell, Water Works, Sector-35, NH-8	1010–1210	1350	520	712	Increased
Borewell, PHED Office, Pataudi	1490–1580	1410	710–930	732	Slight improvement

The trend suggests that several locations show increasing salinity and dissolved solids from 2021 to 2024. This is especially visible at HSIIDC Park Sector-1, HSIIDC Sector-37, Ansal Pioneer Industrial Park, and Water Works Sector-35 NH-8. These increases may be associated

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with industrial discharge, urban expansion, poor recharge quality, and long-term groundwater abstraction.

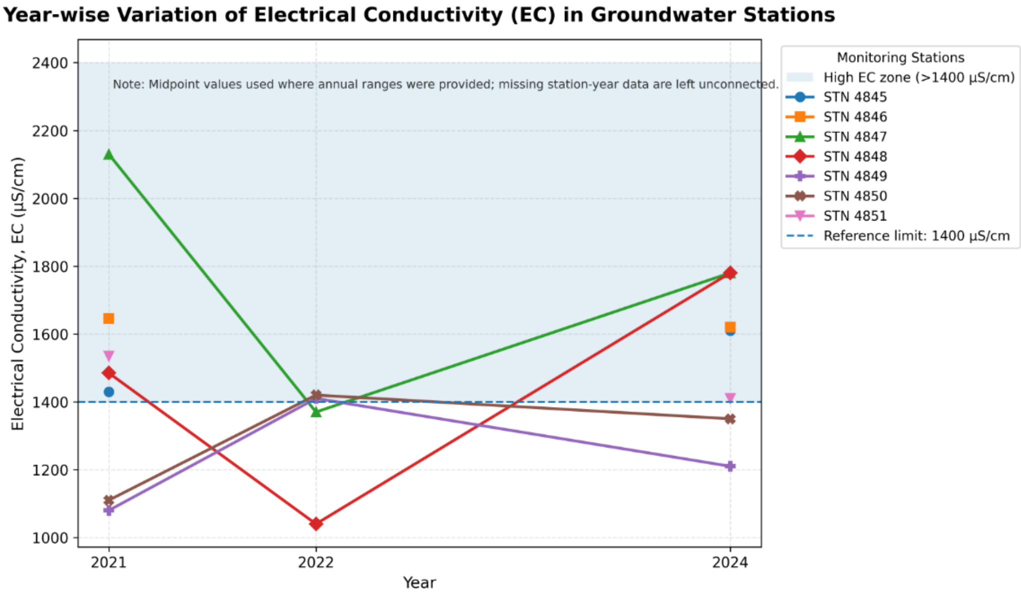

Figure 4. 4 Spatial and temporal variation of pH in groundwater samples

Illustrates the spatial and temporal variation of pH values in groundwater samples collected from different monitoring locations during the study period. The figure indicates that groundwater remains neutral to slightly alkaline across most sites, with minor yearly fluctuations. These variations reflect hydrochemical stability and the influence of geological and anthropogenic factors.

5. Conclusion

The present study evaluated the groundwater quality of the Rewari industrial and peri-urban region of Haryana to determine its suitability for domestic use based on physico-chemical and microbial characteristics. The results revealed that groundwater in the study area is generally neutral to slightly alkaline, with pH values ranging from 7.1 to 8.0 and an average value of 7.46, indicating stable hydrochemical conditions. Electrical Conductivity (EC) values varied between 1210 and 1780 µS/cm, while Total Dissolved Solids (TDS) ranged from 680 to 828 mg/L, with mean values of 1537.14 µS/cm and 762.29 mg/L respectively, reflecting moderate to high mineralization and salinity levels in groundwater. The highest EC value of 1780 µS/cm was recorded at Haily Mandi and HSIIDC Sector-37, whereas the lowest EC value of 1210 µS/cm was observed at Ansal Pioneer Industrial Park. Similarly, the maximum TDS value of 828 mg/L was recorded at Tubewell No. 6, HSIIDC Sector-8. Fluoride concentration remained constant at 0.2 mg/L, nitrate values ranged between 0.0 and 0.3 mg/L, and BOD remained low at 1 mg/L, indicating low chemical and organic contamination. Microbial analysis showed low fecal and total coliform counts of about 1.8 MPN/100 ml at most locations, though disinfection is still recommended before consumption. Temporal analysis from 2021–2024 indicated increasing EC and TDS trends at several industrial locations due to industrial discharge, urbanization, and excessive groundwater extraction. Overall, the groundwater is moderately mineralized and requires treatment before domestic use, while sustainable groundwater management and industrial pollution control are necessary to prevent further groundwater deterioration in the Rewari industrial region.

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