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# Physicochemical Analysis of Groundwater Quality in the Vicinity of Bhalswa Lake in North West Delhi, India

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## ABSTRACT

The different physicochemical parameters, including pH, total dissolved solids (TDS), alkalinity, chloride, total hardness, sulphate, and nitrate, were used to analyse ground water samples near Bhalswa Lake in the North West Delhi area of India. water samples were obtained from locations across Bhalswalake, such as: In order to determine the groundwater quality surrounding Bhalswa Lake, the concentration of pH, electrical conductivity, total dissolved solids (TDS), hardness, alkalinity, chloride, sulphate, nitrate, and phosphate was measured in groundwater samples. Bhalswa Lake is both a residential neighbourhood and a trash dump. Effects of this analysis revealed that groundwater is heavily polluted and unsafe for drinking and household operations since it includes strong chemical contaminants. Water Quality Index of groundwater at various locations around Bhalswa Lake was also found to be unsuitable, reflecting extremely polluted groundwater status at almost all sampling sites.

**Keywords:** Bhalswa lake; Groundwater quality; Water quality assessment; Groundwater pollution.

## INTRODUCTION

Among various natural water resources, ground water is most desirable fresh water resource in rural as well as urban areas throughout the world. Existence of life is only possible due to presence of water on earth surface. While 97% of the earth's surface is protected by water, just 1% of the earth's surface is accessible as fresh water. A large amount of ground water is used for irrigation purposes. Besides this, it is widely used in domestic, industrial and ecological processes. Increased population and expansion of economic growth further hiked the demand of water for various activities.Inrecent years, increased social process, improper recycling of waste, severe water pollution alongwithreduction annual drizzle rate have drastically distressed the available fresh water resources for human utilizing and their endurance. Excessive use of groundwater has resulted in lowering of ground water table causing depression in ground surface. The loss and destruction of water supplies is a subject of considerable concern in India at present. Rising demand for fresh water has been caused by rapid industrialization and increased population and has placed immense strain on numerous water supplies.

Waste water generated from various industries have been discharged on land surface as well as in various water bodies viz. rivers, lakes and streams which leads to severe environmental pollution. Also increased anthropogenic activities have significantly altered ground water quality by contaminated with toxic chemicals and heavy metal which percolates down the earth suface and cause contamination of subsurface aquifers.. Major sources of ground water pollution are fluoride, salinity, iron nitrate, arsenic and heavy metal contamination.

Also polluted ground water have also harmful effects on human health. It is very difficult to restore the ground water quality once it is contaminated. The only way to prevent of ground water contamination is reduction of pollutants at their emission sources. In current scenario it is highly necessary to identify and assess the ground water polluting sources and their remediation. Continuous analysis of the condition of groundwater and the production of reliable and scientific approaches to preserve it are also quite important.

Although in developing countries like in India, it is technically feasible to clean aquifers but economically not feasible. Different metrics have been established to assess the water quality of different water supplies. Among them, along with a single amount, WQI is the most powerful method to assess the water quality status of the water body concerned.

The WQI has been an efficient and effective criterion for groundwater evaluation and control in the last few decades. The water quality index of groundwater around Bhalswa Lake was calculated in the present report, suggesting its extremely contaminated status with organic and inorganic impurities. Water has also been shown to be unsuitable for consumption and household use. WQI assessed the overall consistency of different water sources, showing the suitability of water for numerous uses, such as drinking, washing, swimming, ecosystem for marine organisms, usage of agriculture and animals, leisure and water supply. The present thesis is focused on the study of different physiochemical characteristics of samples of groundwater obtained from different locations around Bhalswa Lake. The key benefit of this index is its capacity to equip a single number by composite measures of a range of different parameters in a single unit and its usefulness as a coordination method.

## METHODOLOGY

### Study area

Total twelve samples from different regions around Bhalswalake have been collected for studying various physicochemical parameters.The groundwater samples were collected During monsoon season in month of September,2018. In Table-1, along with Latitude (N) and Longitude (E) of the locations found using the google map, the details of all sampling locations from which groundwater samples were collected are given. Fig 1. Also shows the sampling locations near and around the Bhalswalake district. Bhalswa's lake complex area is 92 hectares. The lake's 350 meters wide (dda.org.in). Also near the shore is Bhalswa farm, and residential areas cover half of the lake perimeter. The primary cause of pollution is the Bhalswa dairy and surrounding residential area. In the study area, groundwater is primarily used for domestic and milk usage.

**Table 1.** Location details of collected ground water samples around Bhalswalake

| **Sample Code** | LATITUDE (N) | LONGITUDE (E) |
|---|---|---|
| **GW1** | 28.7399 | 77.17206 |
| **GW2** | 28.7362 | 77.171 |
| **GW3** | 28.7469 | 77.1713 |
| **GW4** | 28.7441 | 77.1761 |
| **GW5** | 28.7466 | 77.1802 |
| **GW6** | 28.7358 | 77.183 |
| **GW7** | 28.7405 | 77.1658 |
| **GW8** | 28.7427 | 77.18 |
| **GW9** | 28.7469 | 77.1711 |
| **GW10** | 28.7561 | 77.1747 |
| **GW11** | 28.7611 | 77.1863 |
| **GW12** | 28.7544 | 77.1722 |

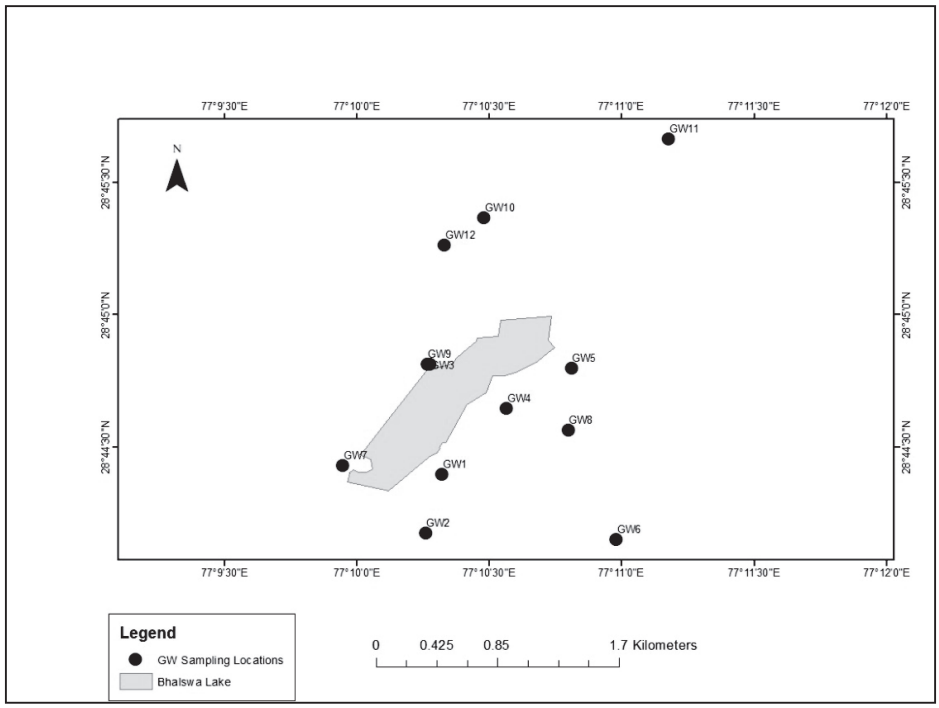


**Figure.1.** Ground water sampling locations around Bhalswa lake.


**Figure. 2.** Google Map of Groundwater sample taken around Bhalswa Lake

## EXPERIMENTAL ANALYSIS

The present research approach is based on the protocol suggested in the water quality recommendations of APHA (1992) and NEERI (1991). The physical and chemical properties of groundwater were calculated at various locations around Bhalswa Lake. Both samples obtained are subsequently placed in a dark sterile box and shipped for numerous physical and chemical tests to the laboratory (Table 2). Twelve samples were obtained from different locations, Bhalswa dairy, residential area and near Bhalswa Shore Lake landfill area in this report. Various physicochemical parameters, viz. pH, EC, salinity, TDS, chloride, alkalinity,hardness, sulphate, nitrate, phosphate, calcium have been studied to determine the groundwater quality near Bhalswalake. Only pH, EC, TDS, alkalinity, complete hardness, chloride, sulphate, nitrate and phosphate were used among all parameters to assess the groundwater water quality index.

**Table 2.** Various methods and instruments used for determination of physicochemical parameters of ground water samples.

| S.NO | Parameters | Methods | Instruments/Equipments |
|---|---|---|---|
| 1 | pH | Electrometric | pHmeter |
| 2 | EC | Electrometric | Conductivity meter |
| 3 | TDS | Electrometric | Conductivity meter/TDS Meter |
| 4 | Alkalinity | Titration | _ |
| 5 | Hardness | EDTA | _ |
| 6 | Chloride | Silver Nitrate | _ |
| 7 | Sulphate | _ | UV Spectrophotometer |
| 8 | Nitrate | _ | UV Spectrophotometer |
| 9 | Phosphate | _ | UV Spectrophotometer |

## RESULTS AND DISCUSSION

### Physicochemical characteristics of ground water

Acidity and alkalinity of ground water samples may be evaluated by measuring the pH of water samples. A significant impact on the toxicity of materials present in water bodies is the pH of the water. This is what has been reported by these authors (Pondhe and Jadhav, 2000; Shinde et al., 2010; Shinde et al., 2010). In the current research, the pH of groundwater near Bhalswa Lake ranged between 7.8 and 9.0. (Fig.1). It suggests that ground water in the natural world is a simple substance. This may be due to alkaline chemicals being diluted during the rainy season, which would explain the high pH value (Shaikh and Yeragi, 2003).

**Table 3.** Standards of Water given by BIS and WHO for Drinking Water.

| S. No. | Parameter | BIS, Indian Standards (IS 10500:1991) | | World Health Organization (WHO Guideline) |
|---|---|---|---|---|
| | | Desirable Limit | Permissible Limit | Maximum allowable concentration |
| 1 | Colour | 5 Hazen Units | 25 Hazen Units | 15 True Colour Units |
| 2 | Turbidity | 5.0 NTU | 10 NTU | 5.0 NTU |
| 3 | PH | 6.5-8.5 | No relaxation | 6.5-8.5 |
| 4 | Total Hardness (as $CaCO_3$) | 300 mg/L | 600 mg/L | 500 mg/L |
| 5 | Chlorides (as Cl) | 250 mg/L | 1000 mg/L | 250 mg/L |
| 6 | Residual Free Chlorine (When Protection against viral infection is required it should be Min 0.5 mg/L) | 0.2 mg/L | - | - |
| 7 | Dissolved Solids | 500 mg/L | 2000 mg/L | 1000 mg/L |
| 8 | Calcium (as Ca) | 75 mg/L | 200 mg/L | - |
| 9 | Sulphate (as $SO_4^{2-}$) | 200 mg/L | 400 mg/L | 400 mg/L |
| 10 | Nitrate (as $NO_3$) | 45 mg/L | 100 mg/L | 10 mg/L |
| 11 | Fluoride (as $F^-$) | 1.0 mg/L | 1.5 mg/L | 1.5 mg/L |
| 12 | Phenolic Compounds (as $C_6H_5OH$) | 0.001mg/L | 0.002 mg/L | - |
| 13 | Anionic Detergent (as MBAS) | 0.2 mg/L | 1.0 mg/L | - |
| 14 | Mineral Oil | 0. 01 mg/L | 0.03 mg/L | - |
| 15 | Alkalinity | 200 mg/L | 600 mg/L | - |
| 16 | Boron | 1.0 mg/L | 5.0 mg/L | - |
| | Micro Pollutants (Heavy Metals & Pesticides) | | | |
| 17 | Zinc (as Zn) | 5.0 mg/L | 15 mg/L | 5.0 mg/L |
| 18 | Iron (as Fe) | 0.3 mg/L | 1.0 mg/L | 0.3 mg/L |
| 19 | Manganese (as Mn) | 0.1 mg/L | 0.3 mg/L | 0.1 mg/L |
| 20 | Copper (as Cu) | 0.05 mg/L | 1.5 mg/L | 1.0 mg/L |

| S. No. | Parameter | BIS, Indian Standards (IS 10500:1991) | | World Health Organization (WHO Guideline) |
|---|---|---|---|---|
| | | Desirable Limit | Permissible Limit | Maximum allowable concentration |
| 21 | Arsenic (as As) | 0.05 mg/L | No relaxation | 0.05 mg/L |
| 22 | Cyanide (as CN) | 0.05 mg/L | No relaxation | 0.1 mg/L |
| 23 | Lead (as Pb) | 0.05 mg/L | No relaxation | 0.05 mg/L |
| 24 | Chromium (as $Cr^{++}$) | 0.05 mg/L | No relaxation | 0.05 mg/L |
| 25 | Aluminium (as Al) | 0.03 mg/L | 0.2 mg/L | 0.2 mg/L |
| 26 | Cadmium (as Cd) | 0.01 mg/L | No relaxation | 0.005 mg/L |
| 27 | Selenium (as Se) | 0.01 mg/L | No relaxation | 0.01 mg/L |
| 28 | Mercury (as Hg) | 0.001 mg/L | No relaxation | 0.001 mg/L |
| 29 | Total Pesticides | Absent | 0.001 mg/L | - |

| S. No. | Parameter | BIS, Indian Standards (IS 10500:1991) | | World Health Organization, (WHO Guideline) |
|---|---|---|---|---|
| | | Desirable Limit | Permissible Limit | Maximum allowable concentration |
| 1 | Sodium | - | - | 200 mg/L |
| 2 | Aldrin &dieldrin | - | - | 0.03 µg/L |
| 3 | DDT | - | - | 1.0 µg/L |
| 4 | Lindane | - | - | 3.0 µg/L |
| 5 | Methoxychlor | - | - | 30.0 µg/L |
| 6 | Benzene | - | - | 10.0 µg/L |
| 7 | Hexachlorobenzene | - | - | 0.01 µg/L |
| 8 | Pentachlorophenol | - | - | 10.0 µg/L |

**Table 4.** Physicochemical parameters of ground water around Bhalasalake.

| Sample no / Parameter | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | GW7 | GW8 | GW9 | GW10 | GW11 | GW12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **pH** | 8.5 | 8.7 | 8.5 | 8.6 | 8.6 | 8.5 | 7.8 | 8.4 | 8.6 | 8.5 | 9 | 8.6 |
| **EC (µS/cm)** | 1960 | 2630 | 2770 | 2670 | 2300 | 2410 | 2290 | 2420 | 2370 | 1303 | 1980 | 2040 |
| **TDS (mg/l)** | 1313 | 1762 | 1855 | 1788 | 1541 | 1614 | 1534 | 1621 | 1587 | 873 | 1326 | 1366 |
| **Alkalinity (mg/l)** | 125 | 189 | 195 | 193 | 194.5 | 135 | 225 | 250 | 180 | 183 | 135 | 185 |
| **Chloride (mg/l)** | 244 | 188 | 194 | 202 | 223 | 195 | 252 | 269 | 280 | 294 | 197 | 231 |
| **Hardness (mg/l)** | 820 | 950 | 710 | 580 | 510 | 640 | 1040 | 900 | 850 | 1080 | 670 | 700 |
| **Phosphate (mg/l)** | 2.13 | 4.87 | 2.37 | 2.93 | 5.78 | 3.11 | 6.13 | 3.46 | 3.68 | 3.07 | 3.06 | 3.15 |
| **Sulphate (mg/l)** | 6.39 | 14.64 | 2.59 | 13.74 | 5.92 | 4.31 | 7.69 | 56.7 | 56.24 | 58.83 | 55.6 | 6.27 |
| **Nitrate (mg/l)** | 0 | 9.04 | 0 | 19.86 | 16.07 | 53.1 | 0 | 23.46 | 4.86 | 0.47 | 0 | 7.75 |

**Graph & discussions of different physiochemical parameters which are taken during study**

**pH**

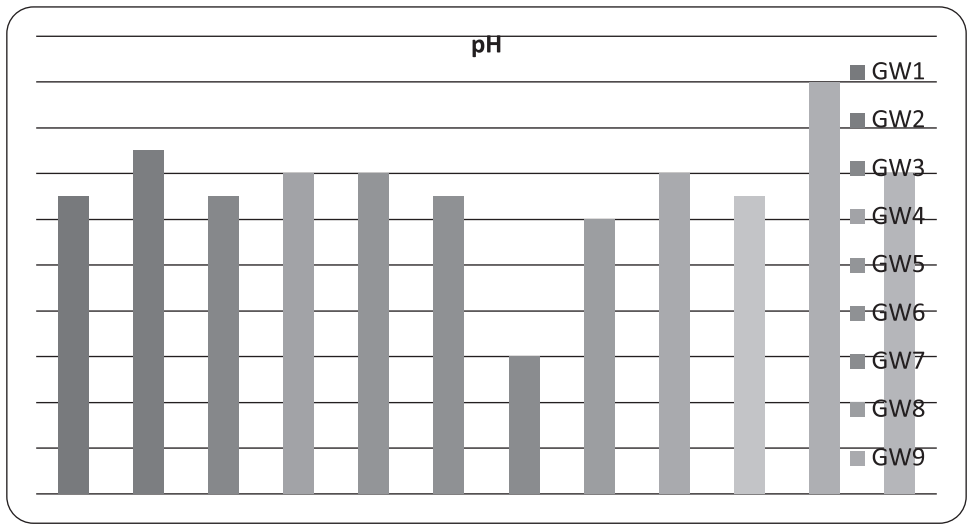


**Figure. 3.** Graphical representation pH of ground water at different locations around Bhalswalake

**Electrical Conductivity**

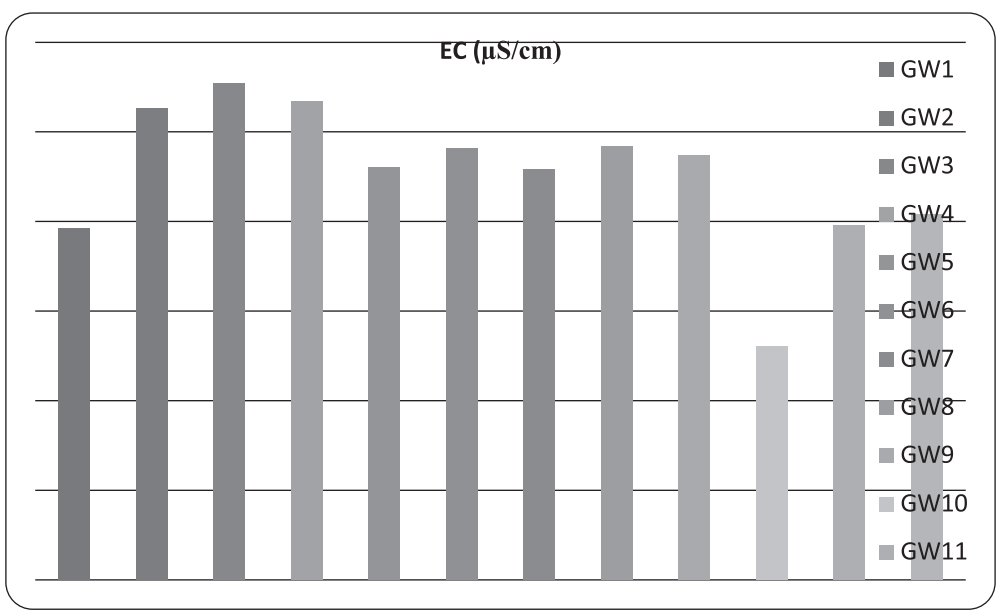


**Figure. 4.** Graphical representation TDS (mg/l) of ground water at different locations around Bhalswalake

TDS falls from rock breakup, surface degradation and lime dissolution, gypsum, etc. In this analysis, the minimum TDS value of 873 mg/L was observed in groundwater. Total value was 1855 mg/l (Fig.4). The benefit of TDS may be strong by combining rainwater with dissolved salts.

**Alkalinity**

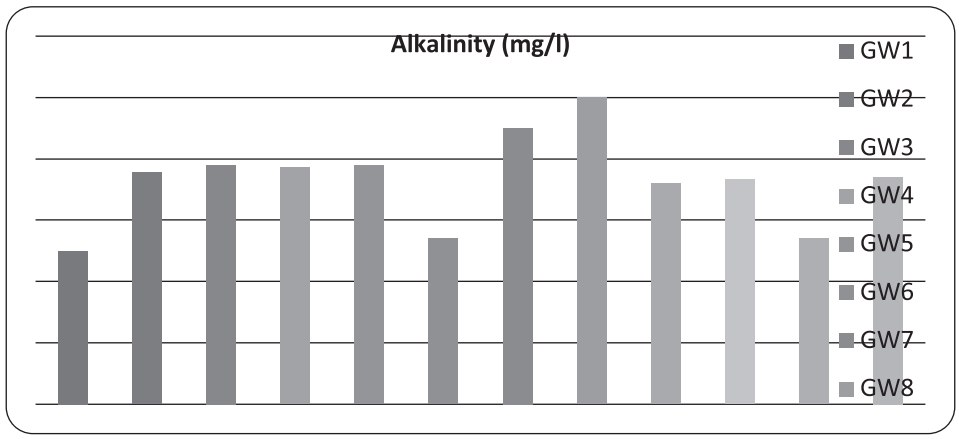


**Figure. 5.** Graphical representation alkalinity (mg/l) of ground water at different locationsaround Bhalswa lake

The total alkalinity of the water body is increased as a result of the higher pH. the high pH of water is influenced by the presence of hydrogen oxide, carbonates, and bicarbonates (Khare and Jadhav, 2008). Total alkalinity of the solution is an indicator of water's capacity to neutralise strong acids (Gayathri et al., 2013). Measurements of the alkalinity of groundwater samples may vary greatly, ranging from 125 to 250 mg/l (Fig. 5). The allowable level of 200 mg/l is more than the legal limit (IS: 10500).

**Chloride**

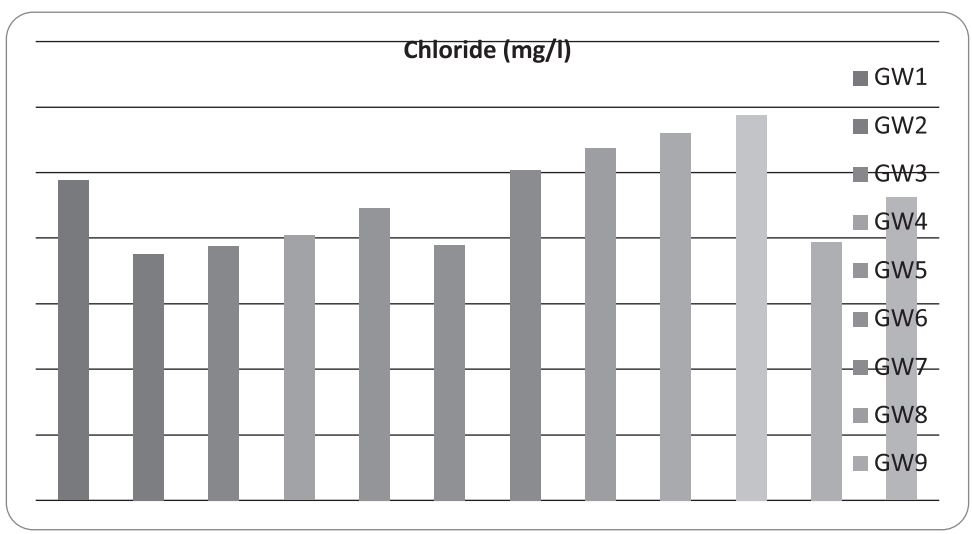


**Figure. 6.** Graphical representation chloride (mg/l) of ground water at different locations around Bhalswa lake

To prevent contamination, the SMCL for chloride is 250 mg/l, and this is the point at which water is judged unsuitable for human consumption. Home plumbing, water radiators, and municipal water supplies may be compromised by high chloride levels. When there is chloride in ground water, there occurs sodium fixation. The presence of greater levels of chloride in water sources confirms the presence of household waste garbage.

**Total Hardness**

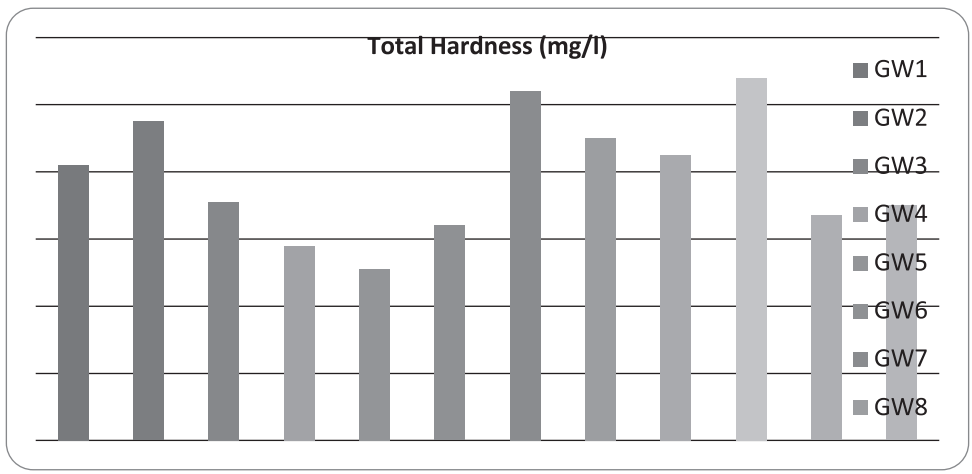


**Figure. 7.** Graphical representation Total Hardness (mg/l) of ground water at different locations around Bhalswa lake

Ca and Mg fixation limits Water usage is an essential segment of the exoskeleton of arthropods and shells, although inmollusca (Piska, 2000). In this study the maximum hardness was observed 1080 mg/L and lowest 510 mg/l (Fig. 7).

**Phosphate**

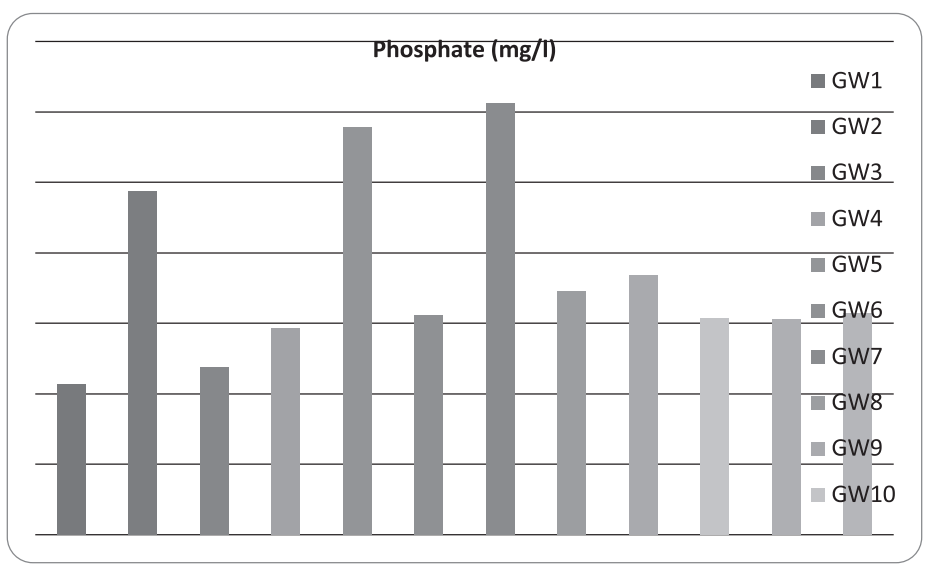


**Figure. 8.** Graphical representation of phosphate (mg/l) of ground water at different locations around Bhalswa lake

Phosphate value varied from 2.1 to 6.1 mg/l (Fig. 8). High phosphate value can result from mixing rain with phosphate fertilizers (from agricultural fields) and their percolation down the earth's surface. This indicates the strong phosphate in the groundwater sample.

**Sulphate**

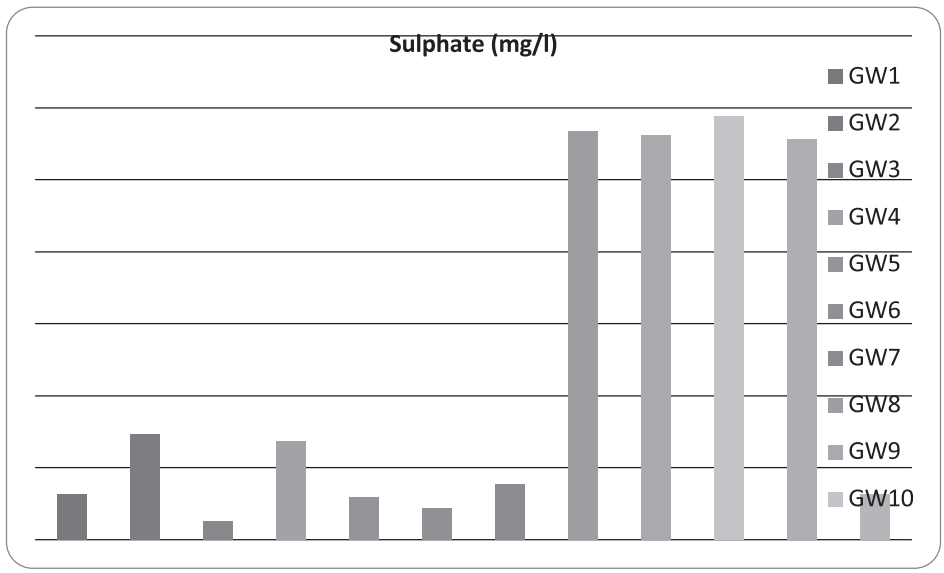


**Figure 9.** Graphical representation sulphate (mg/l) of ground water at different locations around Bhalswa lake

Sulfate can't promptly be expelled from drinking water, with the exception of by costly procedure, for example, refining, turn around assimilation or electro dialysis. Maximum sulfate concentration could be attributed to earth surface percolation. In this study, sulphate concentration was 2.59 to 58.83 mg/l (Fig 9).

**Nitrate**

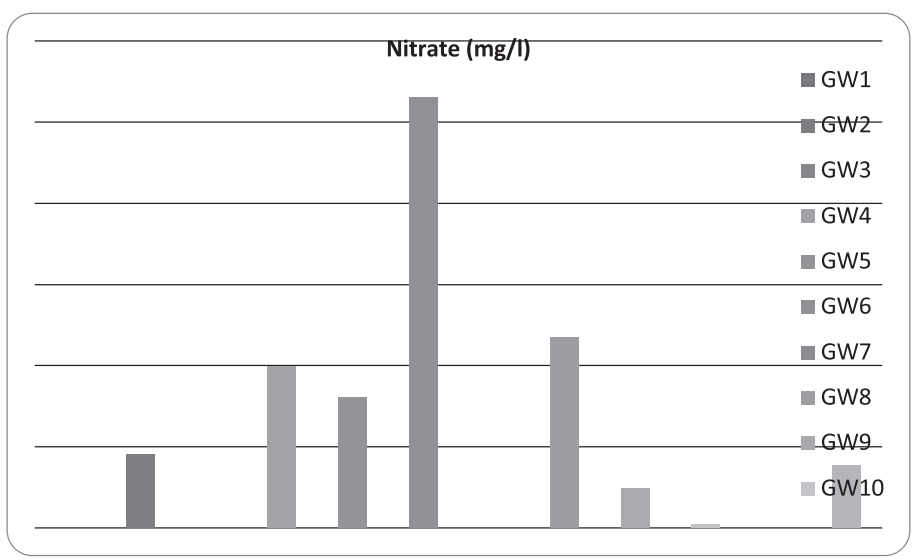


**Figure 10.** Graphical representation nitrate (mg/l) of ground water at different locations around Bhalswa lake

The nitrate concentration of ground water samples were found in the range between 0 to 53.1 mg/l in this study (Fig. 10).High concentration of nitrate in ground water samples cause methanoglobenemia in infants . Permissible limit in water samples should be below 45 mg/l.Nitrate concentration is higher at sample location 6 and lowest at sample location 1, 3 and 11.

**Water Quality Index (WQI) of ground water**

The WQI of the water body was determined in the current research using the weighted arithmetic index technique (Brown et. al.). The quality rating is calculated first in this approach, and it may also be written as a sub index in certain cases. It is computed with the help of the following expression:

$$Q_n = 100*[V_n - V_{io}] / [S_n - V_{io}] \quad (1)$$

As an example, if there are n water quality parameters that have been measured, and the quality rating or sub index (Qn) associated with the nth parameter is a number, the result could be that the Qn value can be added to numbers to create a higher numerical value. The relevant value of the nth parameter in the contaminated water body is compared to the standard allowed value of that parameter, which may be found in this value or number. When discussing the parameters of water quality, the phrase "Qn" is used to reference the parameter quality rating of the nth parameter. The nth observed parameter at the sample station is known as vn. Sn = the value that is the standard for a parameter's allowed range For DO and pH, the ideally expected values are 14.6 mg/l and 7, respectively. Other parameters should be set to 0 as well.

Determining the unit weight of the water quality parameter after the computation of the quality rating yields the results below. The standard value is the ratio of the nth parameter's coefficient of proportionality to the nth parameter itself. The measure's weight has been referred to as the relative weight in some circles.

$$W_n = K_p / S_n \quad (2)$$

$W_n$ = relative weight of parameter,
$S_n$ = Standard value of parameter within permissible limit
$K_p$ = Coefficient for proportionality.

$$K_p = 1/\sum (1/S_n) \quad (3)$$

Finally the Water Quality Index of water body can be calculated by the following equation:

$$WQI = Q_n W_n / \Sigma W_n \quad (4)$$

**Table 4:** WQI Range and water quality on the basis of range

| Water Quality Index Range | Water quality |
|---|---|
| 0-25 | Excellent water quality |
| 26-50 | Good water quality |
| 51-75 | Poor water quality |
| 76-100 | Very poor water quality |
| >100 | Not fit for drinking |

**Table 5:** Water Quality Index of ground water around Bhalswalake

| Sampling Locations | WQI | Inference |
|---|---|---|
| GW1 | 235 | Not fit for drinking |
| GW2 | 269 | Not fit for drinking |
| GW3 | 236 | Not fit for drinking |
| GW4 | 256 | Not fit for drinking |
| GW5 | 255 | Not fit for drinking |
| GW6 | 247 | Not fit for drinking |
| GW7 | 131 | Not fit for drinking |
| GW8 | 228 | Not fit for drinking |
| GW9 | 253 | Not fit for drinking |
| GW10 | 237 | Not fit for drinking |
| GW11 | 311 | Not fit for drinking |
| GW12 | 253 | Not fit for drinking |

After estimation of WQI of Bhalswa Lake, compare it with the standard WQI values given by Chatterji and Raziuddin, 2002 and fix the status of Water Quality on the basis of estimated WQI.

After calculating the water quality of all the locations we conclude that water quality is worst and not fit for drinking purposes. The water quality index greater than 100 is not fit for drinking as per WHO standards and here we can see that all the locations have water quality greater than 100. Sampling location 11possess maximum Water Quality Index . Therefore we can say that at that point water quality is worst and at sampling location number 7 water qualities is minimum among all the sampling locations.

## CONCLUSION

This investigation was carried out in order to determine the physio-chemical characteristics of ground water in the area of Bhalswalake. The water quality is getting detrioted due to leachate from Bhalswa landfill and other waste water being disposed in the area.

The high WQI in all ground water samples indicates that there is high water contamination due to untreated waste disposal on land surface from domestic and dairy effluent. Also the waste from landfill site near study area is major polluting source of ground water during monsoon. Study shows that the underground water has high magnesium hardness. The other parameters are relatively within or close to permissible limits. The high values of some parameters can be due to dumping site close to the Bhalswalake and Bhalswa landfill site.

## REFERENCES

**P. Li, H. Qian, and J. Wu,** "Assessment of groundwater quality for irrigation purposes and identification of hydrogeo chemical evolution mechanisms in Pengyang County, China," Environ. Earth Sci., Online first, doi:10.1007/s 12665-012-2049-5

**Jianhua Wu1, 2, Peiyue Li1, 2*, Hui Qian1, 2, Jie Chen1, 2, Groundwater Pollution in and Around a Paper Waste water-Irrigated Area, Northwest China, 2013** Fourth International Conference on Digital Manufacturing & Automation

**A. M. Aenab, C. Needs, S. Foundation, and S. K. Singh, 'Al-Masab Al-Aam River ( Third River ) and Surface Water Pollution Within Baghdad Division Al-Masab Al-Aam River ( Third River ) and Surface Water Pollution Within Baghdad Division', no. February, 2015.**

**IS 10500 Indian Standard and D. W. — SPECIFICATION, 'Wq Standards', no. May, 2012.**

**G. J. Chakrapani, 'Water and sediment geochemistry of major Kumaun Himalayan lakes, India', Environ. Geol.,** vol. 43, no. 1–2, pp. 99–107, 2002.

**X. yuan MA, S. guang LI, and W. shen ZHU, 'A New Method in Groundwater Flow Modeling', J. Hydrodyn.,** vol. 21, no. 2, pp. 245–254, 2009.

**B. Jhamnani and S. K. Singh, 'Groundwater Contamination due to Bhalswa Landfill Site in New Delhi', Int. J. Civ. Environ. Eng.,** vol. 1, no. 3, pp. 121–125, 2009.

**T. Poonam, B. Tanushree, C. Sukalyan, E. Science, and E. Group, 'Water Quality Indices - Important Toolsfor Water Quality assessment: a Review',** vol. 1, no. 1, pp. 15–29, 2015.

**M. E. Goher, A. M. Hassan, I. A. Abdel-Moniem, A. H. Fahmy, and S. M. El-Sayed, 'Evaluation of surface water quality and heavy metal indices of Ismailia Canal, Nile River, Egypt', Egypt. J. Aquat. Res.,** vol. 40, no. 3, pp. 225–233, 2014.

**I. C. Nnorom, U. Ewuzie, and S. O. Eze, 'Multivariate statistical approach and water quality assessment of natural springs and other drinking water sources in Southeastern Nigeria', Heliyon,** vol. 5, no. 1, p. e01123, 2019.

**S. K. Singh, N. Delhi, and N. Delhi, 'Water quality index assessment of bhalswa lake, new delhi', Int. J. Adv. Res.,** vol. 3, no. 5, pp. 1052–1059, 2015.

**S. K. Singh and N. A. Deepika, 'Assessment of water quality parameters of Bhalswa Lake in New Delhi', Int. J. Environ. Eng.,** vol. 9, no. 1, p. 52, 2017.

**K. Yogendra and E. T. Puttaiah, 'Determination of Water Quality Index and Suitability of an Urban Waterbody in Shimoga Town, Karnataka', Proc. Taal 2007,** no. 12, pp. 342–346, 2008.

**I.S.Sn,'An International Research Journal of Biological Sciences (NAAS RATING: 3.4) Scientists Unique Researchers Yare Ass ociation Website: www.floraandfauna.org',** vol. 20, no. 2, 2014.

**Hutchinson and G. E., 'Introduction to lake biology and the limnoplankton.', A Treatise Limnol., p. 1115p, 1967.**

**J. D. Desai and S. K. Tank, 'Water Quality Index (WQI) of River Tapti-Surat, Gujarat, India', Linnaeus Eco-Tech,** pp. 390–399, 2017.

**S. Town, 'Determination of Water Quality Index and Suitability of an Urban Waterbody in Determination of Water Quality Index and Suitability of an Urban Waterbody in Shimoga Town , Karnataka', no. January 2008, 2015.**

**S. S. Gaikwad and N. A. Kamble, 'Qualitative Analysis of Surface Water of Panchganga River, India',** vol. 2, no. 3, 2014.

**V. B. Pawar, 'Physico Chemical analysis of Lonar Lake with reference to Bacteriological Study',** vol. 3, no. 7, pp. 15–22, 2016.

**M. C. Shah, P. G. Shilpkar, and P. B. Acharya, 'Ground water quality of Gandhinagar Taluka, Gujarat, India', E-Journal Chem.,** vol. 5, no. 3, pp. 435–446, 2008.

**J. N. Sharma, R. S. Kanakiya, and S. K. Singh, 'Limnological Study of Water Quality Parameters of Dal Lake, India', Int. J. Innov. Res. Sci. Eng. Technol.,** vol. 4, no. 2, pp. 380–386, 2015.