# Assessment of Drinking Water Quality and Its Effects on Residents District Mandi, Himachal Pradesh

**Er. Manisha Thakur[1], Er. Chetan Kumar[2], Dr. Devender Sharma[3]**

[1]M. Tech Student, Department of Civil Engineering, Abhilashi University, Mandi, India;
[2]Assistant Professor, Department of Civil Engineering, TRAMIET Tanda, Mandi, India;
[3]Dean, Associate Professor, Department of Civil Engineering, Abhilashi University, Mandi, India;

**Abstract**

Drinking water quality is the great public health concern. This study was carried out to assess the quality of drinking water from different natural sources, reservoirs. A cross –sectional study was carried out using random sampling method in Mandi district Himachal Pradesh. The Mandi area has a population of approximately 36000, an area of 3950 km2, and a population density of 250 per km2 as of the year 2023. Sites for Sample Collection in the Mandi Area. Mandi is located at 31°42'29"N and 76°55'52"E longitude and latitude. The purpose of this paper was to categories the various water sources in Mandi based to their quality. The water samples taken from the villages conducted a number of testing, including physical, chemical, and microbiological examinations. Water samples have been collected from each of the 31 sample sites selected close to the Mandi area. The analysis of water samples in the lab serves as the basis for data collection. The study was conducted from July 2022 to June 2023 for a period of 12 months.

**Keywords**: Physical Parameter, Chemical Parameter, Biological Parameter, Water Quality Testing, Effects on Residents, Water Contamination

## 1. INTRODUCTION

The study was conducted to investigate the drinking water quality parameters from different sources and hygienic conditions of people living around Mandi district. The summary of the literature shows that experts in the field of Physico-Chemical and Biological Analysis of Water and the Effect of Contamination on Residents do a significant amount of research. Water is necessary for everyone to survive. There are many different sources of water, including lakes, reservoirs, and rivers. Not all water sources, nevertheless, are suitable for consumption. The usage of water in different situations depends on its quality. Water's physical, chemical, and microbiological properties all have an effect on its quality. Due to waste product disposal, the discharge of untreated sewage, and the release of hazardous chemicals from industry into water bodies, water pollution is becoming a growing concern. In order to get water for domestic usage, this problem had to be face. This research proposes a workable classification model for categorized water quality based on machine learning methods. In this case study, five classification models are developed and analyzed. This study aims to investigate the connections between human health and longevity and the quality of drinking water.

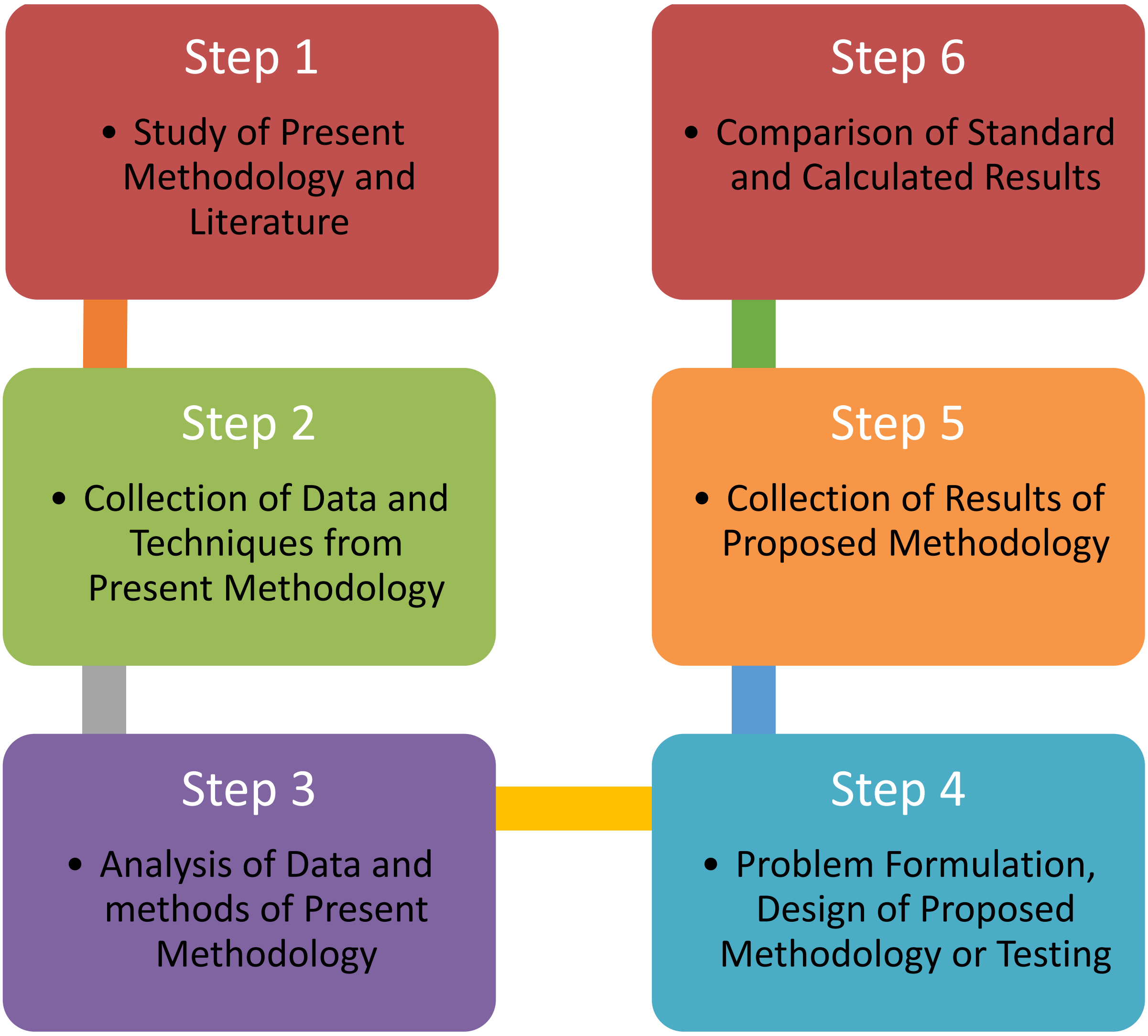
## 2. LITERATURE SURVEY

**Nandini Thakur et al.(2017)** It determined the water quality and any potential geochemical processes that may be affecting in the Kullu valley of the Himachal Himalayas **.Aniqa Batool et al. (2018)** because local geological conditions have an impact on the area's drinking water quality, quality differs from place to location. Drinking water quality of salt range has not been monitored on a routine basis and no reliable data are available in this respect. **AzzaDaghara et al. (2019)** it is examined that the physical and chemical properties of spring water that were within the permissible standard limits, with the exception of turbidity and chloride and nitrate concentrations. **Sunali Mahajan et al. (2020)** Ten different Physico-chemical parameters viz. pH, alkalinity, conductivity, total dissolved solids, total hardness, nitrate, sulfate, phosphate, DO, and BOD were analyzed in the laboratory by adopting standard methods suggested by the American Public Health Association (APHA).**Hemant Pathak (2020**) used a variety of chemometric methodologies to assess and analyse water quality data derived from the drinking water resources. 15 sample stations were used to check the district's water quality. **Motuma Shiferaw et al. (2021)** with WHO criteria in order to evaluate and analyse the water quality of Nekemte Town's water supply and to offer appropriate remedies to the problem.**J.K. Ondieki et al. (2021)** determined that Kisii Town's household water met the WHO's recommended levels for TDS and EC. 91.9% and 69.4% of the drinking water samples, respectively, met the requirements for turbidity and pH. **DulamsurenGanpurev et al. (2021)** shown that a reasonably cohesive picture of a positive association between nitrate ion content and bacteriological contamination of the water has been created from the findings of the microbiological and nitrate ion assays. **Maqbul Hussain et al. (2021)** examined the state of the drinking water quality from four different water sources that were around a Nagaland University campus, paying particular attention to the detection of trace heavy metal ions.**O. K. Jean-Eudes et al. (2022)** the quality and mobility of the hills' subterranean water supplies were accessed. They examined 21 sources of drinking water with regard to cations and anions as well as physical (temperature, pH, and electrical conductivity) and chemical (pH) factors. **Meseret B Addisie et al. (2022)** The water quality indicators measured using the water quality index (WQI) tools were combined with user impressions in the study. Two bacteriological analyses and nine physicochemical analyses were completed. **Farhat Abbas et al. (2023**) studied the water dimensions, security, and governance for two distinct regions like non-arid region countries. It is focused on managing future climate change impacts and policymakers have to consider factors that predict perceptions of risks associated with global climate change.

## METHDOLOGY

Based on the study and the writings of other experts and authors, it has been concluded that in order to anticipate the quality of the water and the impact of contaminants on human health, if any, a comprehensive study of physical, chemical, and biological elements must be conducted. The following methodology has been used for this work. Some of the steps followed for carrying out the combined analysis are given in the following figure:

International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com




**Various steps used for Analysis**

**Examination of water samples**

Determination of pH: The pH of the water samples was tested using the pH meter. Use deionized water to thoroughly rinse the measurement cylinder. In a clean beaker, dispense 70 ml of the water sample. Activate the pH metre.

Using DW solution, clean the electrode of the pH metre. Place a beaker with a water sample close to the device, and insert an electrode into it to the appropriate depth. Write down the stable PH value from the digital display after 3-5 minutes. For a different sample, repeat the procedure.

Determination of total dissolved solids (TDS): this was measured using digital turbidity Method. Deionized water should be used to thoroughly rinse the measurement cylinder. In a tidy beaker, add 70 ml of the water sample. Set the TDS metre to on. Utilise DW solution to clean the TDS metre electrode. Put the water sample beaker close to the TDS metre and insert the TDS electrode into it to the proper height.

Determination of conductivity: This was done using a conductivity meter. The probe was dipped into the container of the samples until a stable reading will be obtained and recorded.

Measurement of temperature: This was conducted out at the site of sample collection using a digital thermometer. The sample was placed into the thermometer, which was then dipped into it, and the stable recording was recorded.

**Table 1.1: Mean values of water sample taken and Standard value of drinking water parameters as per Indian standards**

| Water quality | Mean Value | Permissible Value as per Indian Standard |
|---|---|---|
| Turbidity (NTU) | 1.45 | 10 |
| pH | 7.5 | 6.5-8.5 |
| TDS | 183.78 | 250 |
| Total alkanity | 91.43 | 200 |
| Chloride | 29.15 | 250 |
| Total hardness | 92.4 | 300 |
| Ca | 17.9 | 75 |
| Mg | 6.65 | 30 |

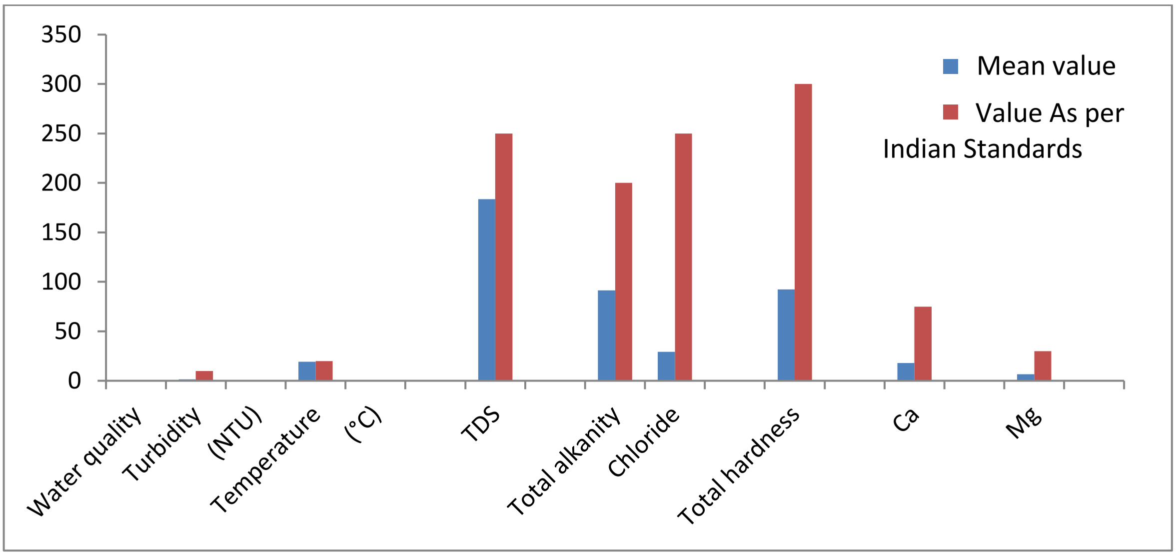



**Fig.1.1: Showing Comparison of water quality parameters of drinking water of District Mandi H.P. with Indian standards of drinking water**

**Table 1.2: pH and turbidity values for various water samples**

| Sr. No. | Samples | pH | Turbidity(NTU) | Sr. No. | Samples | pH | Turbidity(NTU) |
|---|---|---|---|---|---|---|---|
| **1.** | S1 | 7.53 | 1.0 | **17.** | S17 | 8.31 | 0.48 |
| **2.** | S2 | 7.37 | 1.0 | **18.** | S18 | 8.15 | 0.43 |
| **3.** | S3 | 7.38 | 1.0 | **19.** | S19 | 7.41 | 1.6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **4.** | S4 | 7.45 | 1.1 | **20.** | S20 | 7.82 | 0.86 |
| **5.** | S5 | 7.83 | 2.3 | **21.** | S21 | 7.34 | 0.44 |
| **6.** | S6 | 7.83 | 2.3 | **22.** | S22 | 7.65 | 0.54 |
| **7.** | S7 | 7.43 | 1.3 | **23.** | S23 | 7.45 | 1.10 |
| **8.** | S8 | 7.21 | 1.1 | **24.** | S24 | 7.27 | 0.98 |
| **9.** | S9 | 7.32 | 1.0 | **25.** | S25 | 6.89 | 2.12 |
| **10.** | S10 | 7.49 | 1.0 | **26.** | S26 | 7.32 | 0.84 |
| **11.** | S11 | 6.98 | 0.16 | **27.** | S27 | 7.62 | 0.69 |
| **12.** | S12 | 7.1 | 0.15 | **28.** | S28 | 7.46 | 1.88 |
| **13.** | S13 | 8.2 | 2.81 | **29.** | S29 | 8.12 | 7.41 |
| **14.** | S14 | 7.21 | 0.66 | **30.** | S30 | 8.31 | 1.36 |
| **15.** | S15 | 7.12 | 2.16 | **31.** | S31 | 8.1 | 3.57 |
| **16.** | S16 | 6.92 | 2.12 | **32.** | S32 | 7.1 | 1.45 |

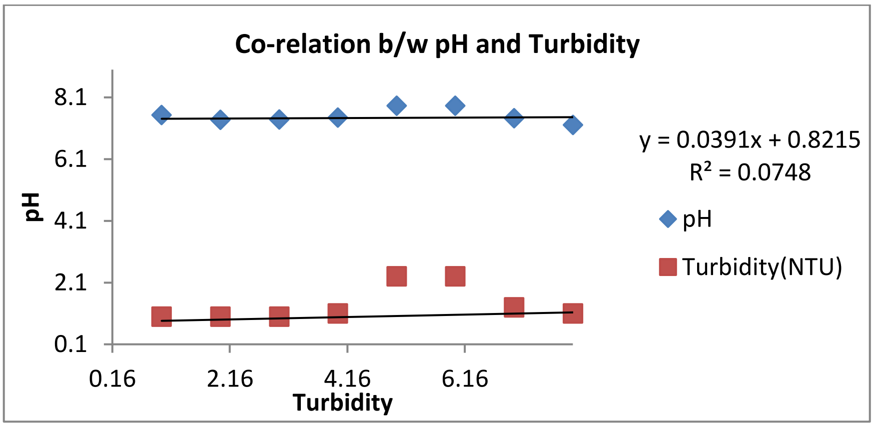



**Fig.1.2: Co-relation b/w pH and Turbidity**

The relationship between the results of the turbidity and pH tests is depicted in Figure 1.2. The turbidity test value and pH value showed a weak connection, with an $R^2$ value of 0.0748<<0.7.The developed equation is invalid**.**

**Table 1.3: TDS and pH values for Various Water Samples**

| **Sr. No.** | **Samples** | **TDS(ppm)** | pH | **Sr. No.** | **Samples** | **TDS(ppm)** | pH |
|---|---|---|---|---|---|---|---|
| **1.** | S1 | 120 | 7.53 | **17.** | S17 | 151 | 8.31 |
| **2.** | S2 | 115 | 7.37 | **18.** | S18 | 210 | 8.15 |
| **3.** | S3 | 125 | 7.38 | **19.** | S19 | 182 | 7.41 |
| **4.** | S4 | 135 | 7.45 | **20.** | S20 | 180.4 | 7.82 |
| **5.** | S5 | 240 | 7.83 | **21.** | S21 | 250.1 | 7.34 |
| **6.** | S6 | 230 | 7.83 | **22.** | S22 | 191.2 | 7.65 |
| **7.** | S7 | 130 | 7.43 | **23.** | S23 | 275.5 | 7.45 |
| **8.** | S8 | 115 | 7.21 | **24.** | S24 | 204.2 | 7.27 |
| **9.** | S9 | 125 | 7.32 | **25.** | S25 | 261.3 | 6.89 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **10.** | S10 | 120 | 7.49 | **26.** | S26 | 211.3 | 7.32 |
| **11.** | S11 | 74.2 | 6.98 | **27.** | S27 | 212.4 | 7.62 |
| **12.** | S12 | 80.8 | 7.1 | **28.** | S28 | 215.8 | 7.46 |
| **13.** | S13 | 110 | 8.2 | **29.** | S29 | 270 | 8.12 |
| **14.** | S14 | 78.5 | 7.21 | **30.** | S30 | 209 | 8.31 |
| **15.** | S15 | 238 | 7.12 | **31.** | S31 | 337 | 8.1 |
| **16.** | S16 | 252 | 6.92 | **32.** | S32 | 212 | 7.1 |

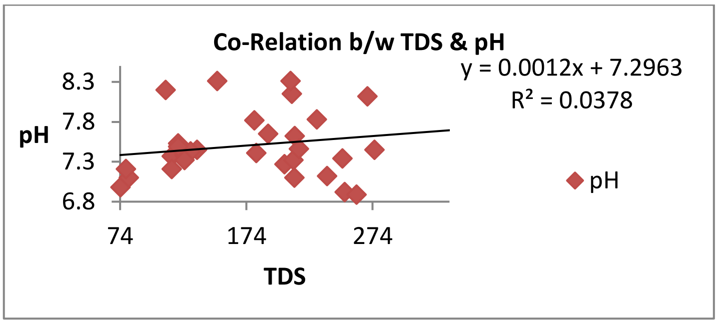



**Fig.1.3: Co-relation b/w TDS and pH**

.

The relationship between the results of the TDS and pH tests is depicted in Figure 1.3. The TDS test value and pH value showed a good connection, with an $R^2$ value of 0.0378 .

**Results and discussions**

**pH Water**

When assessing the drinking water quality, pH is a key factor. Additionally, it shows if the water is acidic or alkaline. The maximum pH allowed range, according to Indian Standards, is between 6.5 and 8.5. The current investigation's ranges fell between 6.89 and 7.5, which is within Indian Standards criteria.

**Temperature**

The study area's water samples had an average temperature of 19.4 °C, which was below 20°C. The temperature in this investigation was found to be within the Indian Standard permitted range (20 °C).

**Turbidity**

Turbidity the amount of solid stuff present in the suspended state determines how turbid the water is. The test is used to determine the quality of waste discharge with regard to colloidal matter and measures the light-emitting capabilities of water. The Indian Standard recommended limit of 10 NTU and the average value of samples lies below this limit.

**TDS**

TDS, or total dissolved solids Numerous inorganic and some organic minerals or salts, including potassium, calcium, sodium, bicarbonates, chlorides, magnesium, sulphates, and others, can be dissolved by water. These minerals gave the water an undesirable flavor and diminished colour. Water with a high TDS rating is one that has a high mineral content. The recommended TDS level for drinking purposes is

250 mg/l, with a maximum limit of 500 mg/l. In the current investigation, TDS content was found to be 183.78 mg/l, which lies within permissible range.

**Chloride**

Chloride is mostly created when hydrochloric acid salts, such as table salt (NaCl) and $NaCO_2$, dissolve and are then added to other substances including sea water, sewage, and industrial waste. Chloride concentrations in surface water bodies are frequently lower than those in subsurface water. The content of chloride should not be more than 250 mg/l, as per Indian Standards guidelines. The average chloride level in the study regions is 29.15 mg/l, which lies within the permissible limit.

**Calcium**

Calcium is the most abundant element in the earth's crust. In the human body, bones and teeth store about 95% of the calcium. In humans, a significant calcium deficit can lead to rickets, poor blood clotting, bone fractures, etc., while a calcium intake that is too high can result in cardiovascular illnesses. Its permitted range in drinking water is 75 mg/l, as per Indian Standards guidelines. The average calcium level in the study regions is 17.9 mg/l, which lies within the permissible limit.

**Magnesium**

Water naturally contains magnesium, which is the eighth most common element in the crust of the earth. It is a requirement for the proper operation of living things and is present in minerals like dolomite and magnetite, among others. Magnesium makes up around 25% of the human body, with 60% of that amount found in bones and 40% in muscles and tissues. Magnesium levels in water should not exceed 30 mg/l, as per Indian Standards guidelines. The average magnesium level in the study regions is 6.65mg/l, which lies within the permissible limit.

**Total Hardness**

The WHO states that there are no known negative effects of hard water on health. Particularly very hard water may significantly increase the amount of calcium and magnesium that is consumed. The detrimental effects of hard water on one's health are mostly caused by the effects of the salts dissolved in it, especially calcium and magnesium. Total hardness levels in water should not exceed 250mg/l, as per Indian Standards guidelines. The average total hardness level in the study regions is 183.78 mg/l, which lies within the permissible limit.

**Alkalinity**

Due to high alkalinity drinking water may taste chalky, salty, or carbonated, dry out skin, or cause the production of a chemical precipitate that would block pipes and build up on filters and other heat exchange devices. Alkalinity levels in water should not exceed 200mg/l, as per Indian Standards guidelines. The average alkalinity level in the study regions is 91.43 mg/l, which lies within the permissible limit.

**Conclusion**

In this study, good quality water is not only safe for public consumption but also good for our health, as well as that of animals and plants, as it provide irreplaceable nutrients and benefits needed to survive.

Based on the results ,it was determined that the drinking water of the research areas was that all physico–chemical parameters in the drinking water sampling sides were consistent with world Health Organization (WHO) drinking water standards. It showed that there were no harmful problems and that all of the results for calcium (Ca), magnesium (Mg), chloride (Cl), TDS were within the acceptable.

**REFERENCES**

1. Alam, M. F., Dafader, N. C., Sultana, S., Rahman, N., & Taheri, T. (2017). Physico-Chemical Analysis of the Bottled Drinking Water available in the Dhaka City of Bangladesh. Journal of Materials and Environmental Sciences, 8(6), 2076–2083.
2. Aydın, N., Tanrıverdi, M., Özçırpıcı, B., Cüce, C., Alben, F., Erceylan, S., & Tas, M. (2018). Microbiological and physico-chemical properties of packaged, residential treatment device and tap water drinking water and their possible effects on human health Neriman Journal of Water, Sanitation and Hygiene for Development, 8(4), 767–776. https://doi.org/10.2166/washdev.2018.056
3. Ali, G., Bashir, M. K., Abbas, S., & Murtaza, M. (2021). Drinking-water efficiency, cost of illness, and peri-urban society: An economic household analysis. *PLoS ONE*, *16*(9 September), 1–13. https://doi.org/10.1371/journal.pone.0257509
4. Addisie, M. B. (2022). Evaluating Drinking Water Quality Using Water Quality Parameters and Esthetic Attributes. *Air, Soil and Water Research*, *15*. https://doi.org/10.1177/11786221221075005
5. Bhateria, R., & Jain, D. (2016). Water quality assessment of lake water: a review. Sustainable Water Resources Management, 2(2), 161–173. https://doi.org/10.1007/s40899-015-0014-7
6. Cabral, J. P. S. (2010). Water Microbiology. Bacterial Pathogens and Water. International Journal of Environmental Research and Public Health, 7(10), 3657–3703. https://doi.org/10.3390/ijerph7103657
7. Choubey, V. K., Singh, O., Durbude, D. G., & Singh, R. (2013). *Impact of Sewage Effluent on Drinking Water Sources of Shimla City and Suggesting Ameliorative Measures*. *April*, 184.
8. Clune, J. W., & Charles A. Cravotta, I. I. I. (2019). *Drinking water health standards comparison and chemical analysis of groundwater for 72 domestic wells in Bradford County, Pennsylvania, 2016*. *May*. https://doi.org/10.3133/sir20185170
9. Deshpande, L. (2012). Water Quality Analysis Laboratory Methods. *Council of Scientific & Industrial Research, New Delhi, Govt. of India*, 68. http://mpcb.gov.in/envtdata/LSD-NEERI- Water Quality Analysis.pdf
10. Extension, U. G. A., Testing, W., Public, F. O. R., & Supplies, W. (2009). Testing for water quality.
11. Edition, F. (2011). Guidelines for Drinking-water Quality. World Health, 1(3), 104–108. https://doi.org/10.1016/S1462-0758(00)00006-6
12. **“**FINAL PROJECT REPORT Assessment of Ground Water Quality of the First Industrial-Residential Confluence Area of Visakhapatnam,” 2014.
13. Fong, K., Grainger, E., Melanson, R., & Salisbury, D. (n.d.). *Improving Water Quality Treatment and Monitoring Techniques in Rural Himachal Pradesh Villages*. 8–19.
14. FAO. (2023, June 1). *WATER QUALITY MONITORING, STANDARDS AND TREATMENT*. Www.fao.org. https://www.fao.org/3/X5624E/x5624e05.htm
15. G. Ali, M. K. Bashir, S. Abbas, and M. Murtaza, “Drinking-water efficiency, cost of illness, and peri-urban society: An economic household analysis,” *PLoS ONE*, vol. 16, no. 9 September, Sep. 2021, doi: 10.1371/journal.pone.0257509.
16. Gajjar, H. (2022). *Analytical Study of TDS and Sulphate Concentration in Ground Water: A Case Study of Vatva Region of Ahmedabad District, Gujarat*. Www.ijraset.com; IJRASET. https://www.ijraset.com/research-paper/analytical-study-of-tds-and-sulphate-concentration-in-ground-water

17. Lenntech.et al (2023) *what causes turbidity?* Www.lenntech.com. https://www.lenntech.com/turbidity.htm#:~:text=%2D%20Urban%20runoff.
18. Rahmanian, N., Ali, S. H. B., Homayoonfard, M., Ali, N. J., Rehan, M., Sadef, Y., & Nizami, A. S. (2015). Analysis of physiochemical parameters to evaluate the drinking water quality in the state of perak, Malaysia. *Journal of Chemistry*, *2015*(Cd). https://doi.org/10.1155/2015/716125
19. S. Mahajan and A. Gupta, "Seasonal Assessment of Drinking Water Quality for Anions, Biological Oxygen Demand, Chemical Oxygen Demand and Dissolved Oxygen of Tehsil Balh, Distt Mandi ,Himachal Pradesh, India," vol. 11, 2020, [Online]. Available: www.jespublication.com
20. World Health Organization. (2022). *Drinking water*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/drinking-water