Bulletin of Pure and Applied Sciences
Geology (Geological Science), Vol.43F, No.1,
January-June 2024: P.12-22
Original Research Article

Print version ISSN 0970 4639
Online version ISSN 2320 3234
DOI: https://doi.org/10.52710/bpas-geo.4
Available online at www.bpasjournals.com

Assessment and Analysis of Drinking Water Quality Parameters and Standards Suitable for Human

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Received on 05.01.2024, Revised on 24.03.2024, Accepted on 05.04.2024

How to cite this article: Pearl, Deepmala, Sandhya, and Kumar S. (2024). Assessment and Analysis of Drinking Water Quality Parameters and Standards Suitable for Human. *Bulletin of Pure and Applied Sciences- Geology*, 43F (1), 12-22.

Abstract:
The "Elixir of Life" is a term used to describe one of the most valuable natural resources: water. Although it is a renewable resource, excessive water use can result in severe shortages. Depletion of this natural resource is caused by a variety of factors, including population growth, industry, urbanisation, pollution, deforestation, climate change, etc. Ajmer's Sophia Girls' College believes that managing and conserving water, the most vital and pervasive element of life is its top priority. Providing clean and safe drinking water is the primary duty of every organisation. This is accomplished through effective management and conservation of the campus's water resources. As part of the campus's annual environment and energy assessment, regular water management audits are undertaken. The study of water management audit is periodically conducted and is based on estimation and analysis of many parameters of water quality evaluation, including pH of water, Turbidity, Alkaline methyl orange, Total hardness (as CaCO3), Chlorides, Nitrates, and Total Dissolved Salt (T.D.S).The college's drinking water has a pH of 7.8, a turbidity of 0.7, an alkaline methyl orange value of 120, a total hardness value of 130 (CaCO3), a chloride level of 60 or less, and an insignificant 2 ppm nitrate content. All indicators are well below the allowable level. A clean and secure supply of drinking water is guaranteed on campus by routine evaluation of water quality criteria.

Keywords: *Sophia, Ajmer, Water, Environment And Energy Audit, pH, Turbidity, Alkalinity, Color, Odor*

INTRODUCTION

Water quality assessment can be defined "as the evaluation of physical, chemical and biological state of the water in relation with the natural state, anthropogenic outcomes and future uses" (Chapman, 1996).

Good water quality is essential for the survival of living beings as well as for a sustainable ecosystem. Still, it's a big challenge now, to ensure sufficient healthy water to everyone. About 70% of surface water resources in India are polluted. The major factors contributing to water pollution are wastewater from different sources, intensive agriculture, industrial production, infrastructure development, untreated urban runoff and wastewater. According to WHO half of India's morbidity is water related (Murty and Kumar 2011).

The assessment of water quality is very significant to both public health and aquatic life. (Ouyang Y, 2005). The understanding and monitoring of sources and quality of water used for water supply is of utmost importance since per capita water demand is increasing while accessibility to freshwater availability is continuously declining. The assessment of water quality is carried out by determining its physical, chemical and biological properties or parameters against a set of standards. Drinking water requires a higher standard compared to the standard used for agricultural and industrial use and therefore water for domestic purposes should be free from toxic substances and organisms in order to prevent waterborne diseases.Drinking water is typically defined as water that is utilized for domestic purpose and for human consumption. Drinking water should ideally be clean, colourless, and tasteless or odourless. It must not contain pathogenic bacteria that could be hazardous to human health or dangerous chemicals. Water contaminant levels have a significant impact on human health. Water quality varies greatly depending on the source of water like lakes, reservoirs, and rivers as well as groundwater sources. The qualities of the source, applicable drinking water standards, and the features of the distribution system all affect the necessary treatment to attain potability (Chow et al., 2005).

Testing for water quality is a crucial component of environmental monitoring. The aquatic life and surrounding ecology are affected by substandard water quality. In order to maintain the source of water safe and free from potential health hazards, it must be assessed periodically, regardless of its usage for agricultural, commercial, domestic, or other reasons by public municipalities or by private homes. By testing the water quality parameters information is obtained that is needed to treat the issue currently affecting the water quality. Further, it will make sure that the treatment system is operating properly and that the water quality is safeguarded from any potential sources of contamination. Before using water, it is essential to ensure that it is suitable for usage. It may be used for various purposes like drinking, irrigation, spraying, or hydrating livestock. It will additionally help you in deciding how to use the water and what needs to be done to ensure its cleanliness.

The economic, physical, and social well-being of people worldwide depends primarily on the availability of good-quality water. Regular water testing is needed to monitor presence any potential health hazard associated with water contamination. To comply with legal standards and uphold the safety protocols required for contaminant-free water, water testing is done. This is a wide conception that entails a number of methods for analysing and rating the water quality.

Unclean water when used for drinking, domestic usage, or even enjoyment can make people sick. Drinking water contaminated with microorganisms is a major cause of water-borne diseases like typhoid, diarrhoea, cholera, dysentery, hepatitis A etc., which are all major contributors to the worldwide burden of disease. Pollutants like pesticides and heavy metals contaminating water sources pose a greater risk to human health. A long-term exposure to heavy metals such lead, mercury, arsenic, chromium and cadmium can cause damage to vital organs like lungs, liver, kidney, and urinary bladder leading to cancer, genetic disorders and other dreadful conditions. The flora, fauna as well as abiotic components of an ecosystem are also affected by the quality of water in that particular ecosystem. The morphology and physiology of plants and animals is also altered due to presence of adulterants in irrigation and drinking water.

The information and data collected through water testing is used to support choices about how to manage water quality now and in the future. This informs us of the issues that are present, ongoing, and likely to arise so that we can assess take measures to safeguard and maintain the standard water quality parameters.

In the conclusion, maintaining a healthy and sustainable planet requires regular monitoring of the quality of the world's water supplies. Monitoring water quality becomes more crucial as humans continue to develop towns, clear land for farming, and alter other aspects of nature. It's

important to recognise the effects of anthropogenic activities on water systems and how they affect waterbodies both above and below ground.

The following is a table of indicators (physical, chemical and biological) that are often measured to assess the quality of water. (Ruth Olubukola 2021)

Table 1: Water quality assessment indicators

Physical Indicators	Chemical Indicators	Biological Indicators
Temperature Electrical Conductivity Taste TotalSuspended Solids (TSS) Turbidity Odor Color Total Dissolved Solids (TDS)	pH Biochemical Oxygen Demand (BOD) ChemicalOxygen Demand (COD) Dissolved Oxygen (DO) Total Hardness Phosphates Pesticides Nitrates Surfactants Heavy metals	Bacteria Viruses Fungi Protozoa Parasitic worms – *Pimephalespromelas*(fathead minnow) -*Americamysisbahia* (Mysid shrimp) Benthic macro-invertebrates

Water quality issues are complex and diverse, requiring urgent global attention and action (Chand & Chauhan, 2012). The decline in water quality has become a global issue of concern because of its inherent ability to cause major alterations to the hydrological cycle.

REVIEW OF LITERATURE

The progressive and continuous degradation of natural resources is the result of an anomalous increase in the population and rapid rate of urbanization along with expansion of agricultural practices. The consequence of imprudent interference of man in nature can be interpreted in terms of major climate changes and frequent occurrence of natural disasters.

Polluted water is an important cause of outbreak of water-borne diseases. The intake of water containing pathogenic organisms or poisonous chemical compounds and the usage of insufficient volumes of water, ensuing in terrible hygiene, pose severe dangers to human health. In addition, the physical parameters of water (colour, flavor and odour) may render it undrinkable. For this reason, periodic water testing and quality assessment are of significant importance (UNICEF). According to Bullard, detrimental water quality results in an unhealthy socio-economic environment (Bullard, 1972).

In an area the local water quality can serve as an important parameter to identify the sources and results of harmful contaminants and pollutants from ecology, geology and anthropogenic activities (Chapman, 1996). This will be helpful in minimizing potential public health risks by developing appropriate management strategies (Carroll et al.2006). The data obtained by assessment of water quality will also contribute in environmental decision making and improving public health by providing clean and safe drinking water (Cambers, 2005).

Water quality values are useful and sensitive indicators of changes in the physical, chemical and biological composition of water. The water quality parameters viz. temperature, turbidity, conductivity, pH, BOD etc. can be used to derive water quality index (WQI) of a water body (Kankal-2012). The WQI provides a mechanism for presenting a cumulatively derived numerical expression for defining water quality (Miller, 1986).

A fundamental human right is the availability and access to safe and high-quality potable water .One of the most important resources for

agriculture, industry, and human sustenance is water. This outstanding resource serves as the foundation for and sustains social and economic progress (Taiwo, et al., 2012).

The criteria used to describe water's quality and assess its suitability for various uses, including the preservation of human health and the aquatic ecosystem, are its physical, chemical, biological, and aesthetic characteristics. Majority of these characteristics are affected by substances that are suspended or dissolved in water, and both natural and artificial processes can have an impact on water quality. (Hubert, E. &Wolkersdorfer, and Department of Water Affairs (DWA). Groundwater Strategy. Department of Water Affairs: Pretoria, South Africa. 64 (2010))

The national drinking water quality standards created by the federal governments and other relevant agencies are to be used as a benchmark for the municipality's water supply (Patil, P. et al., 2012). According to these guidelines, some characteristics are crucial to the drinking water's quality while others are only slightly more significant. Ideally, faecal indicator bacteria (FIB), notably *Escherichia coli* (*E. coli*) or temperature tolerant coliform (TTC), should not be discovered in any 100 mL of drinking water sample (WHO. *Guidelines for Drinking Water Quality* 4th Edn (World Health Organization, Geneva, Switzerland), 2011], according to the recommendations for drinking water quality.

Despite the existence of these standards and recommendations, faecal contamination of drinking water sources, including improved sources of water like pipe water, has been documented in numerous WHO and United Nations International Children Emergency Fund (UNICEF) reports, particularly in low-income countries (Bain, R. et al.). Worldwide, water-related illnesses continue to be the leading factor in the high mortality rate among children under the age of five. Particularly in emerging nations' rural areas, these issues are present. In addition, people in both developed and developing nations have been linked to chronic health issues by new pollutants and disinfection byproducts (Younos, & Grady). Due to the inability of water delivery infrastructures to be sustained, efforts by both governmental and non-governmental organisations to provide water security and safety in recent years have failed in many areas (Tigabu, A. D. et. al.).

Table 2 presents some of the established standards of some water quality assessment parameters (Ashok-2006). The water quality index can be calculated for three different uses:

1. ***Drinking Water Quality Index*** which includes drinking, recreation, irrigation, and livestock watering use.
2. ***Aquatic Water Quality Index*** which includes aquatic life protection and use.
3. ***Overall Water Quality Index*** which includes the protection of human health, aquatic ecosystems and wildlife.

Table 2: Sets of some established standards

Parameters	WHO	CCME
pH (mg/l)	6.5–8.5	8.5
DO (mg/l)	–	5
Temperature (°C)	25	15
Turbidity (NTU)	5	5
TDS (mg/l)	500	500
Ammonia (mg/l)	0.2	1.37
Nitrate (mg/l)	50	48.2
Lead (mg/l)	0.01	0.01
Iron (mg/l)	0.3	0.3
Chromium (mg/l)	0.05	0.05

Water is a vital commodity for sustenance of life and for global economy. However, due to impact of both natural and anthropogenic factors, water quality is declining gradually (Vadde-2018). Water quality assessment focuses on identification of sources of water contamination and accordingly development of a plan of action for sustainable water resource management. This in turn would be helpful in maintenance and promotion of human health and socio-economic growth (Carroll-2006)

MATERIALS & METHODS

In the present study, for the assessment of water quality parameters of Sophia Girls' College, Ajmer, water samples were collected from different sources in the month of October in 2018. The sources are as follows:

1. Source 1- Drinking tap water
2. Source 2- Well 1
3. Source 3- Well 2

For collection of samples, plastic bottles of 1.5 litre capacity were used. The bottles were washed with 2% nitric acid and then rinsed three times with distilled water. The bottles were filled with full capacity leaving no air space and sealed properly to prevent any leakage. The bottles were appropriately labelled with source name and date of sample collection. Physico-chemical analysis of water samples was done following standard procedures mentioned in "Standard Methods for Examination of Water and Wastewater" 20th edition (1998) published by APHA. (APHA 1998)

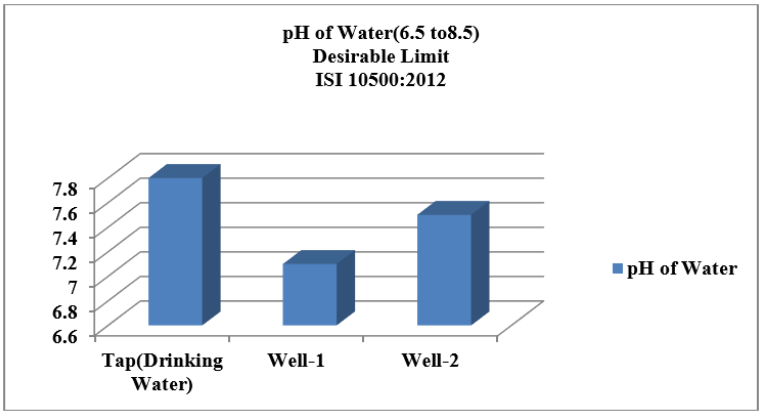
RESULTS AND DISCUSSIONS

Water is a liquid having a high dielectric constant and due to this reason, it is the best solvent for most of the substances. Survival of living beings totallydepends on quality of drinking water available. Water makes up 60% of an adult's body weight. Itcontains essential nutrients and plays a key role in functioning of the human body. We can survive up to several weeks without food, but only a few days without water. Every system in the body, from cells and tissues, to vital organs, requires water to function properly. The human body cannot store water. Replenishing the lost fluidand keeping our body correctly hydrated is essential for good health. Safe drinking water is made available by the management of SophiaGirls' College for its staff and students. pH, Turbidity, Alkalinity Methyl Orange,Total Hardness (As $CaCO_3$), Chlorides, Nitrates, Total Dissolved Solids and Fluorides are some elements having concentrations in the water will decide the quality of water. Minimum amount of some elements are even necessity in water to live healthy. First of all sample collected was given to PHED lab Ajmer for testing of sample of water.

Table 3: Standard Parameters and comparison of these parameters of Sophia College and ISI

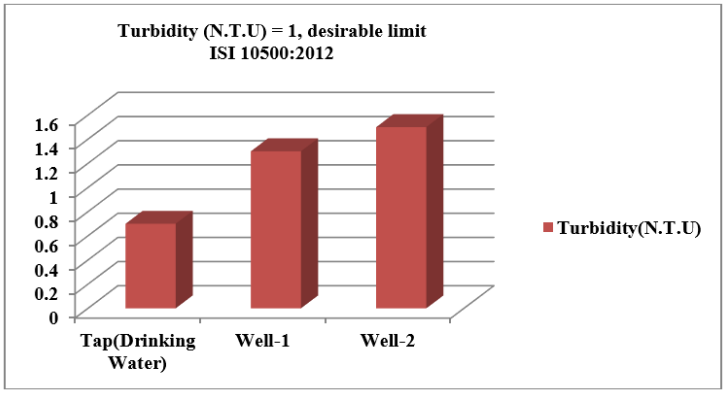
S. No.	Parameters	Tap (Drinking Water)	Well-1	Well-2	Desirable Limit ISI 10500:2012	Permissible Limit in the absence of alternate Source
1.	pH	7.8	7.1	7.5	6.5 to 8.5	6.5 to 8.5
2.	Turbidity (N.T.U)	0.7	1.3	1.5	1	5
3.	Alkalinity Methyl Orange	120	420	540	<200	600
4.	Total Hardness (As $CaCO_3$)	130	630	390	<200	600
5.	Chlorides (mg/l)	60	420	590	<250	1000
6.	Nitrates	2	230	260	<45	No relaxation
7.	Total Dissolved Solids (T.D.S)	318	1930	2680	500	2000
8.	Fluorides (ppm)	0.3	1.5	2.8	1	1.5

Table-3 represents pH of water, Turbidity, Alkaline methyl orange, total hardness (as $CaCO_3$), Chlorides, Nitrates and Total Dissolved Salt (T.D.S) in different samples at Sophia Girls' College, Ajmer (Rajasthan). In table-3 these parameters are also compared with ISI 10500:2012 and with WHO standards. According to ISI 10500:2012 rules pH of water should lie between 6.5 to 8.5. If pH of water is not in this range, then ecological balance and acid-base equilibrium will be disturbed. pH is a measure of Hydrogen ion concentration. If pH>7 water is said to be alkaline and if pH< 7 then it is acidic. pH of drinking water should be slightly greater than 7 because alkaline nature of water can detox our body. pH of drinking water in the College is 7.8 which indicates that quality of water is very good and fit for drinking purposes.



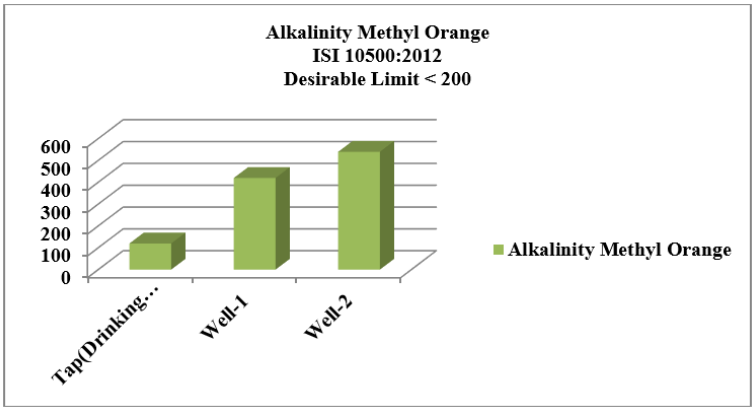
Graphs 1: pH of Drinking Water

Turbidity refers to the "Clarity of Liquid". When light falls on a liquid, its intensity after scattering measures the turbidity. If water has less turbidity then it is safer for drinking purpose as it contains less suspended particles. According to ISI 10500:2012 rules turbidity of water should be less than one. According to Asrafuzzamann (2011) *Cicer arietinum* can reduce turbidity of a water sample upto 95.89% and it is as effective as Alum. *Moringa oleifera* can reduce turbidity up to 94.1%. Turbidity of water at Sophia Girls' College, Ajmer (Rajasthan) is 0.7 which is much less than permissible limit of ISI 10500:2012



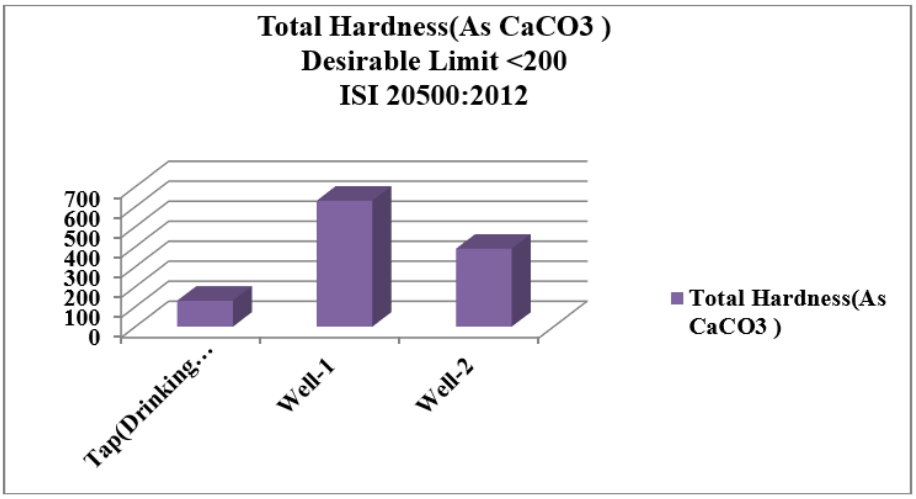
Graphs 2: Turbidity of Drinking Water

According to ISI 10500:2012 rules alkalinity of water should less than 200. Alkaline methyl orange is a water soluble azo-dye known as, pH indicator. Alkalinity of water acts as a buffer reagent against rapid pH changes. The sources of alkalinity in water are rocks as water flows through rocky areas; it contains carbonates, bicarbonates, silicates and phosphates etc. $CaCO_3$ accounts for most of alkalinity of water. Excess alkalinity in water causes nutritional imbalance in humans.



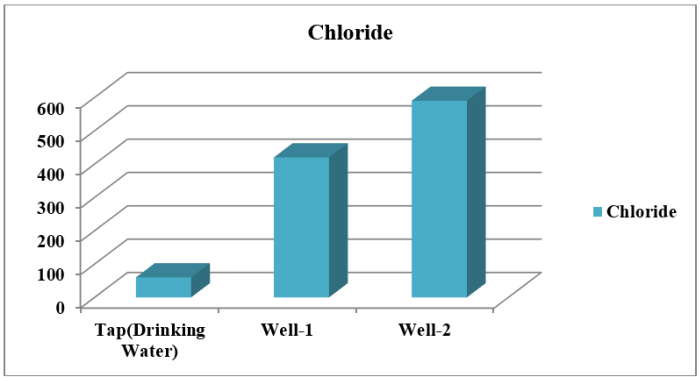
Graphs 3: Alkalinity of Drinking Water

Total hardness of water is due to multivalent metal ions such as calcium and magnesium. Excess intake of these metals leads to osteoporosis, kidney stone, colon cancer, high BP, obesity etc. According to ISI 10500:2012 rules alkalinity of water should be less than 200.Drinking water of Sophia College has less than permissible limit of carbonates and thus is safe and fit for consumption.



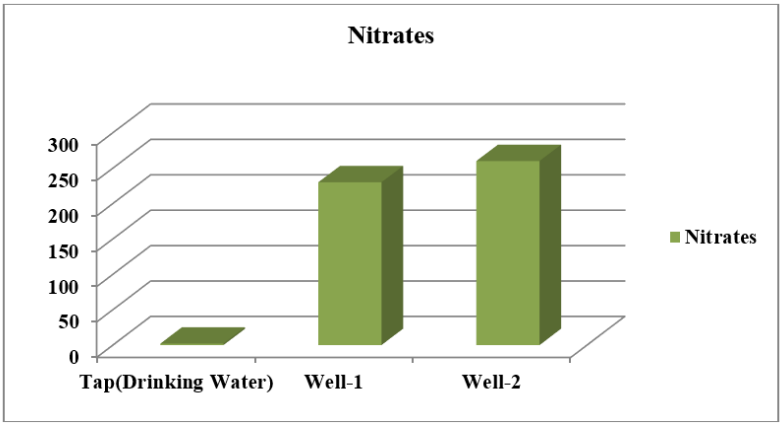
Graphs 4: Total Hardness of Drinking Water

According to ISI 10500:2012 rules Chlorides in water should less than 250mg/l. Sodium Chloride is a vital component in the production of sodium carbonate, caustic soda, soda ash and sodium hypo chloride. In drinking water chloride is due to dissolution of salt deposits, waste from chemical industries, sewage and volcanic eruptions, urban runoff etc. These are the factors responsible for the local contamination of surface and ground water. Reverse Osmosis (RO), Distillation, De-ionization are some methods with which we can reduce Chloride content. In Sophia Girls' College, Ajmer (Rajasthan), Chloride level is much less than permissible limit. Chloride concentration also disturbs the osmotic balance of cells.



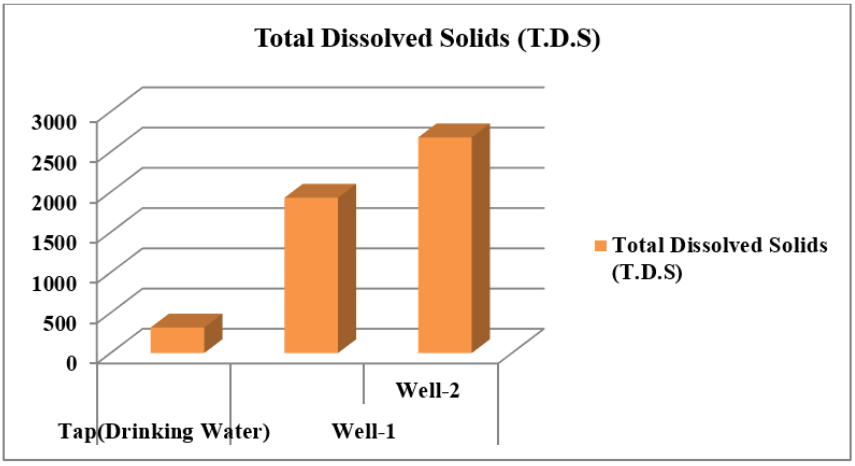
Graphs 5: Chloride Concentration of Drinking Water

According to US Geological Survey *"Nitrate was the most common inorganic contaminant derived from man-made sources – such as from fertilizer applications and septic tanks – that was found at concentrations greater than the Federal drinking water standard for public water supplies (10 mg/L).* According to ISI 10500:2012 rules Nitrate concentration should be less than 45. Inorganic fertilizer and animal manure are the two main sources for Nitrate level in water. Due to formation of N-nitroso compounds Nitrate level in water is very harmful and it causes certain cancers and also produces birth related problems (Ward-2018).



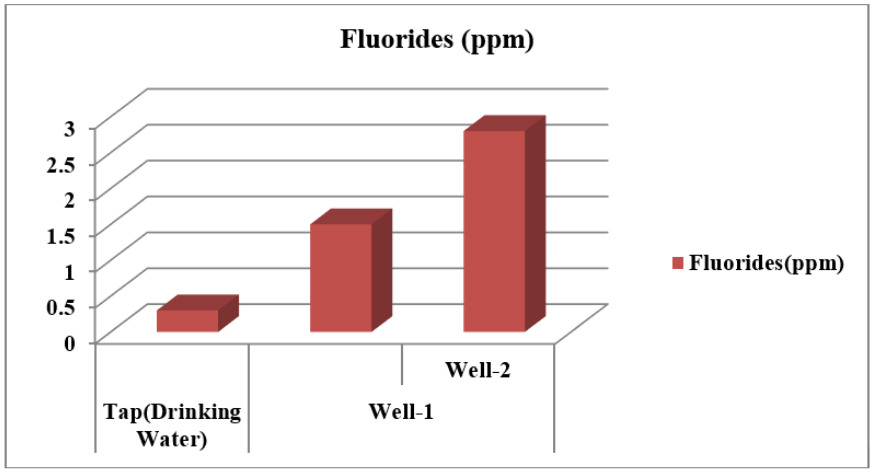
Graphs 6: Nitrates Concentration of Drinking Water

T.D.S. may be organic or inorganic found in water but when it crosses the saturation level, it is harmful for human beings. It results in turbidity and sedimentation in water and is also responsible for bacteria and virus. T.D.S. of water is mainly due to urban and agriculture run-off, sewage, water treatment chemicals etc. T.D.S. between 50-100 ppm is a safer range. Calcium, magnesium, strontium, potassium, carbonates, hydrogen carbonates, chloride, sulphate and nitrate anions are the major constituents of T.D.S. According to ISI 10500:2012 rules it should not cross 500.In Sophia Girls' College, Ajmer it is much below that is 318.



Graphs 7: Total Dissolved Solids (TDS) of Drinking Water

According to ISI 10500:2012 rules Fluorides concentration should be less than 1.According to Mahipal Singh Sankhla1& Rajeev Kumar (2018), Water contaminated by the Fluoride causes dental and skeletal fluoridise. Excess of Sodium Fluoride also causes death. Fluoride contents in water if crosses the permissible range 1.5ppm then it will create a health problem. Fluoride in water is mainly due to usage of pesticides, brick kilns and industrial waste.



Graphs 8: Fluorides Concentration of Drinking Water

CONCLUSION AND FINDINGS

Sophia Girls' College (Autonomous), Ajmer understands its responsibility towards the environment to ensure its ecological balance. It is essential to take up measures to conserve and augment the natural water resources. It becomes our duty to use the resources wisely and Rain water harvesting is one of the measures which is useful for water conservation to meet out daily water requirements. The rain-water harvesting mechanism of the College is modern and has a mammoth capacity of 1, 00,000 litres. The total storage area is 10m*3.60m*2.90m.pH of drinking water in the College is 7.8 which is within the WHO permissible limits and is fit for drinking purpose. Drinking water turbidity at Sophia Girls' College, Ajmer (Rajasthan) is 0.7 which is much less than permissible range of ISI 10500:2012. Alkaline methyl orange value is 120 in drinking water again a safer number for drinking purpose. Total hardness as $CaCO_3$ is 130 which further makes water fit for potable purpose. The chloride content of College water is also below the permissible limit i.e. 60. The nitrate level in College drinking water is negligible viz. only 2 ppm which is very good as it is a cause of cancer and many birth related problems.

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