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COMPARATIVE ANALYSIS OF WATER QUALITY AND ASSESSMENT IN GROUND WATER, POND WATER, LAKE WATER OF HYDERABAD

Pharmacy

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ABSTRACT

Water is the most important in shaping the land and regulating the climate. It is one of the most important compounds that profoundly influence life. The quality of water usually described according to its physical, chemical and biological characteristics. Rapid industrialization and indiscriminate use of chemical fertilizers and pesticides in agriculture are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota. Due to use of contaminated water, human population suffers from water borne diseases. It is therefore necessary to check the water quality at regular interval of time. Parameters that may be tested include pH, turbidity, salinity, nitrates and phosphates, TDS (Total Dissolved Solids), TSS (Total Suspended Solids), alkalinity and chloride. The results obtained from the water quality criteria parameter are within the drinking water standard.

KEYWORDS

Water quality, pH, total solids, total suspended solids, chlorine, Alkalinity, turbidity, fluorides

INTRODUCTION

Water (chemical formula: H_2O) is a transparent fluid which forms the world's streams, lakes, oceans and rain, and is the major constituent of the fluids of organisms. As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds. Water is a liquid at standard ambient temperature and pressure, but it often co-exists on Earth with its solid state, ice; and gaseous state, steam (water vapor). It also exists as snow, fog, dew and cloud.

Water covers 71% of the Earth's surface.[1] It is vital for all known forms of life. On Earth, 96.5% of the planet's crust water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapor, clouds (formed of ice and liquid water suspended in air), and precipitation.[2][3] Only 2.5% of this water is freshwater, and 98.8% of that water is in ice (excepting ice in clouds) and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products.[2] A greater quantity of water is found in the earth's interior.[4]

Safe drinking water is essential to humans and other lifeforms even though it provides no calories or organic nutrients. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation.[5] There is a clear correlation between access to safe water and gross domestic product per capita.[6] However, some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability.[7] A report, issued in November 2009, suggests that by 2030, in some developing regions of the world, water demand will exceed supply by 50%[8]. Water plays an important role in the world economy, as it functions as a solvent for a wide variety of chemical substances and facilitates industrial cooling and transportation. Approximately 70% of the freshwater used by humans goes to agriculture[9].

MATERIALS

Water was obtained as a gift sample from Startech Labs Pvt. Ltd., Madinaguda, in Hyderabad. Ultra-pure water was obtained from ELGA (Bucks, UK) water purification unit. Waters total recovery vials (Waters, Milford, MA, USA) were of glass type 1, class A with 20 µL maximal injectable volumes. All other chemicals were of analytical reagent grade.

Experimental Work

This mainly includes water quality monitoring, standards and treatment. This further includes sampling of water from various sources like bore wells, municipal mains, water tanks and reservoirs and harbor basin water, and testing procedures, investigative analysis and water treatment methods.

Water sampling and analysis should be done by ISO-certified laboratories. Wherever laboratories available locally are not ISO-certified, it is advisable to get their quality assessed by an ISO-certified laboratory by carrying out collaborative tests to ensure that variation in the accuracy of results is sufficiently small. Unreliable results exacerbate problems of pollution when corrective action cannot be taken in time. Sampling and monitoring tests should be carried out by qualified technicians. Depending on the actual state of the fishing harbor infrastructure and environmental conditions in and around the harbor, monitoring should be carried out according to a specific program for each source of water supply.

Testing Procedures[1,2,3,4,5]

Testing procedures and parameters may be grouped into physical, chemical, bacteriological and microscopic categories.

- Physical tests indicate properties detectable by the senses.
- Chemical tests determine the mineral and organic substances that affect water quality.
- Bacteriological tests show the presence of bacteria, characteristic of faecal pollution.

Physical Tests

Color, turbidity, total solids, dissolved solids, suspended solids, odor and taste are recorded.

Color in water may be caused by the presence of minerals such as iron and manganese or by substances of vegetable origin such as algae and weeds. Color tests indicate the efficacy of the water treatment system.

Turbidity in water is because of suspended solids and colloidal matter.

It may be due to eroded soil caused by dredging or due to the growth of micro-organisms. High turbidity makes filtration expensive. If sewage solids are present, pathogens may be encased in the particles and escape the action of chlorine during disinfection.

Odor and taste are associated with the presence of living microscopic organisms; or decaying organic matter including weeds, algae; or industrial wastes containing ammonia, phenols, halogens, hydrocarbons. This taste is imparted to fish, rendering them unpalatable. While chlorination dilutes odor and taste caused by some contaminants, it generates a foul odor itself when added to waters polluted with detergents, algae and some other wastes.

Chemical Tests

pH, hardness, presence of a selected group of chemical parameters, biocides, highly toxic chemicals, and B.O.D are estimated.

pH is a measure of hydrogen ion concentration. It is an indicator of relative acidity or alkalinity of water. Values of 9.5 and above indicate high alkalinity while values of 3 and below indicate acidity. Low pH values help in effective chlorination but cause problems with corrosion. Values below 4 generally do not support living organisms in the marine environment. Drinking water should have a pH between 6.5 and 8.5. Harbor basin water can vary between 6 and 9.

B.O.D.: It denotes the amount of oxygen needed by micro-organisms for stabilization of decomposable organic matter under aerobic conditions. High B.O.D. means that there is less of oxygen to support life and indicates organic pollution.

Bacteriological Tests

For technical and economic reasons, analytical procedures for the detection of harmful organisms are impractical for routine water quality surveillance. It must be appreciated that all that bacteriological analysis can prove is that, at the time of examination, contamination or bacteria indicative of fecal pollution, could or could not be demonstrated in a given sample of water using specified culture methods. In addition, the results of routine bacteriological examination must always be interpreted in the light of a thorough knowledge of the water supplies, including their source, treatment, and distribution.

Whenever changes in conditions lead to deterioration in the quality of the water supplied, or even if they should suggest an increased possibility of contamination, the frequency of bacteriological examination should be increased, so that a series of samples from well-chosen locations may identify the hazard and allow remedial action to be taken. Whenever a sanitary survey, including visual inspection, indicates that a water supply is obviously subject to pollution, remedial action must be taken, irrespective of the results of bacteriological examination. For unzipped rural supplies, sanitary surveys may often be the only form of examination that can be undertaken regularly.

The recognition that microbial infections can be waterborne has led to the development of methods for routine examination to ensure that water intended for human consumption is free from excremental pollution. Although it is now possible to detect the presence of many pathogens in water, the methods of isolation and enumeration are often complex and time-consuming. It is therefore impractical to monitor drinking water for every possible microbial pathogen that might occur with contamination. A more logical approach is the detection of organisms normally present in the faeces of man and other warm-blooded animals as indicators of excremental pollution, as well as of the efficacy of water treatment and disinfection. The presence of such organisms indicates the presence of faecal material and thus of intestinal pathogens. The intestinal tract of man contains countless rod-shaped bacteria known as coliform organisms and each person discharges from 100 to 400 billion coliform organisms per day in addition to other kinds of bacteria. Conversely, the absence of faecal communal organisms indicates that pathogens are probably also absent.

The use of normal intestinal organisms as indicators of faecal pollution rather than the pathogens themselves is a universally accepted principle for monitoring and assessing the microbial safety of water supplies. Ideally, the finding of such indicator bacteria should denote the possible presence of all relevant pathogens.

Indicator organisms should be abundant in excrement but absent, or present only in small numbers, in other sources; they should be easily isolated, identified and enumerated and should be unable to grow in water. They should also survive longer than pathogens in water and be more resistant to disinfectants, such as chlorine. In practice, these criteria cannot all be met by any one organism, although many of them are fulfilled by coliform organisms, especially Escherichia coli as the essential indicator of pollution by faecal material of human or animal origin.

Investigative Analysis

A harbor master's knowledge of the state of the environment in and around the fishing harbor goes a long way toward preventing outbreaks of contamination or disease with subsequent loss of resources and income. This is particularly so for the many small-to-mediums fishing ports scattered around coastlines in developing countries, where, more often than not, environmental help and support from central bodies is meager and very time-consuming. The following is a true-life example of an investigative analysis carried out in an Asian country in a harbor that was experiencing problems with cleanliness (coli form contaminated fish).

Test Case

The town's water supply cannot provide the port with potable water and the port draws groundwater from a series of boreholes in and around the port area. The port's storage infrastructure consists of only one elevated concrete tank which cannot be taken out of service for cleaning. Ice is supplied by outside contractors.

Current laboratory test results were examined and found to be too consistent to reflect natural changes in the environment, pointing a finger of suspicion at the laboratory's Quality Assurance. A new laboratory with I.S.O. certification was selected to carry out the new tests.

Water samples were taken by external technicians from the port's borehole, the auction hall's water taps, each and every one of the external ice suppliers and the harbor basin.

A sample report from the laboratory is shown in Table 1.

Table 1: Analysis of water samples by different techniques

Physical & Chemical Parameters	Unit	Test Remarks	Require ment	Methods
Color	Pt. Co scale	3	15	Colorimetric
Odor	Pt. Co scale	negative	odorless	Organoleptic
pH	Pt. Co scale	6.50	6.5-8.5	Electrometric
Taste	Pt. Co scale	normal	tasteless	Organoleptic
Turbidity	FTU	1	5	Turbidimetric
Aluminum	mg/L	below 0.20	0.2	*AAS
Copper	mg/L	below 0.03	1.0	*AAS
Iron Total	mg/L	below 0.04	0.3	*AAS
Manganese	mg/L	0.06	0.1	*AAS
Sodium	mg/L	96.93	200	*AAS
Zinc	mg/L	0.047	5	*AAS
Chloride	mg/L	140.41	250	Argentometric
Fluoride	mg/L	0.09	1.5	Colorimetric
Nitrate	mg/L	below 0.11	10	Colorimetric
Nitrite	mg/L	0.96	1	Colorimetric
Sulphate	mg/L	below 0.94	400	Turbidimetric
Arsenic	mg/L	below 0.001	0.05	*AAS
Barium	mg/L	below 0.10	1	*AAS
Cadmium	mg/L	below 0.005	0.005	*AAS
Cyanide	mg/L	below 0.01	0.1	Colorimetric
Chrome Hexavalent	mg/L	below 0.006	0.05	Colorimetric
Lead	mg/L	below 0.01	0.05	*AAS
Mercury	mg/L	below 0.001	0.001	*AAS
Selenium	mg/L	below 0.007	0.01	*AAS
Organic Matter by $KMnO_4$	mg/L	3.06	10	Permanganant ometric
Dissolved Solid	mg/L	431	1000	Gravimetric
Hydrogen Sulphide as H_2S	mg/L	below 0.01	0.05	Colorimetric
Total Hardness	mg $CaCO_3$	95.49	500	*AAS
Bacteriological Parameters				
Total Bacteria	per mL	6.9×10^2	1.0×10^2	Pour Plate
Coli form	per 100 mL	nil	nil	Filtration

*AAS-Atomic absorption spectroscopy

Standard Methods

A. Examination of the port's deep borehole test report revealed that whereas the iron and manganese levels were over the limit, indicating vegetable matter in the aquifer, the sodium and chloride levels were low, indicating that the pump was not overdrawing. Both the nitrate and nitrite levels were low indicating that sewage intrusion into the borehole casing was not a problem. The total bacterial count, however, was very high, indicating that the water has to be chlorinated to lower the count.

B. Examination of the auction hall's tap water test report (comparing them to the borehole water) indicates that the bacterial count is slightly lower but not enough to be considered sanitary and fit for drinking. The turbidity also dropped dramatically between borehole and tap, indicating deposition of solids inside the port's only storage tank. The nitrate level also drops as the nitrates are further converted to nitrites indicating bacteriological activity inside the overhead tank as well. As it turned out, chlorinating equipment was not installed.

C. Examination of the ice test reports reveals that both sodium and chlorides are over the limit indicating either leaking cans at the ice plants (dirty brine water enters the ice water during the chilling operation) or overdrawing at the plant's borehole. Closer examination also revealed that the nitrite levels are very high (indicating decomposed sewage) and that coliforms were present in the ice. This pointed a finger at the borehole of one particular plant, which in fact was found to be overdrawing water to meet an increase in demand. The presence of the coliforms also indicated that the ice plant's own chlorinating equipment was not functioning properly.

D. A close look at the river basin water indicated heavy contamination by sewage of the water course.

The conclusions to be drawn from the above exercise are that:
1). The most likely source of contamination was the ice supplied to the fishermen, which in turn contaminated the fish in the holds;
2). The port's own water supply and storage system was in need of an overhaul;
3). The port's river water was not to be used in any of the fish handling processes.

Table 2: W.H.O. drinking water standards

Parameter	Unit	Limit
Aluminum	mg Al/L	0.2
Arsenic	mg As/L	0.05
Barium	mg Ba/L	0.05
Beryllium	ug Be/L	0.2
Cadmium	ug Cd/L	5.0
Calcium	mg Ca/L	200.0
Chromium	mg Cr/L	0.05
Copper	mg Cu/l	1.0
Iron Total	mg Fe/l	0.3
Lead	mg Pb/L	0.01
Magnesium	mg Mg/L	150.0
Manganese	mg Mn/L	0.1
Mercury	ug Hg/L	1.0
Selenium	mg Se/L	0.01
Sodium	mg Na/L	200.0
Zinc	mg Zn/L	5.0
Chlorides	mg Cl/L	250.0
Cyanide	mg Cn/L	0.1
Fluorides	mg F/L	1.5
Nitrates	mg NO3/L	10.0
Nitrites	mg NO2/L	-
Sulphates	mg SO4/l	400.0
Suphides	mg H2S/l	0
Total "drins"	ug/L	0.03
Total "ddt"	ug/L	1.0
Hydrocarbons	mg/L	0.1
Anionic Detergents	mg/L	0
pH		9.2
Total dissolved solids	mg/L	1500
Total hardness	mg/L	500
Alkalinity	mg/L	500

Microbiological Parameters		
Total Bacteria	Count/mL	100
Coliform	Count/100mL	0
E. Coli	Count/100mL	0
Salmonella	Count/100mL	0

Water Treatment Method

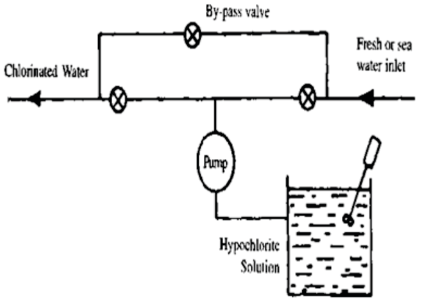
Treatment of raw water to produce water of potable quality can be expensive. It is advisable to determine the quantity of water needing treatment, as not all water used in a fishery harbor or processing plant needs to be of potable quality. Sizing of the equipment is crucial to produce acceptable water at reasonable cost.

The main point to remember is that separate systems and pipelines are required for potable and non-potable water to avoid cross contamination. Each system must be clearly identified by contrasting colored pipelines. Water used for drinking, cleaning fish and ice-making must be free from pathogenic bacteria and may require secondary treatment or even complete treatment depending on chemical elements that need to be removed. Water for other needs like general cleaning may perhaps need only primary treatment.

1. Primary Treatment

There are four methods of primary treatment: chlorination; ozone treatment; ultraviolet treatment; and membrane filtration.

a.Chlorination[6,7,8]: Fresh or sea water can be chlorinated using either chlorine gas or hypochlorite. Chlorinated water minimizes slime development on working surfaces and helps control odor.



Chlorination process

The main advantages of using chlorine gas are:
- It is the most efficient method of making free chlorine available to raw water.
- It lowers the pH of the water slightly.
- Control is simple; testing simple; and it is not an expensive method.

The main disadvantages are:
- Chlorine gas is toxic and can combine with other chemicals to form combustible and explosive materials.
- Automatic control systems are expensive.
- Chlorine cylinders may not be readily available at small centers.
- Chlorine expands rapidly on heating and hence the cylinders must have fusible plugs set at 70°C. It also reacts with water, releasing heat. Water should not therefore be sprayed on a leaking cylinder.

Table 5: Percentage of available chlorine by weight

Compound	Chemical Composition	% Chlorine By Weight
Chlorine gas	Cl_2	100.0
Monochloramine	NH_2Cl	138.0
Diochloramine	NH_4Cl_2	165.0
Hypochlorous Acid	HOCl	135.4
Calcium hypochlorite	$Ca(OCl_2)$	99.2

Hypochlorites are generally available in two forms - sodium hypochlorite solution normally available at 10% concentration and calcium hypochlorite available as a powder.

The main disadvantages of using hypochlorites are:
- Calcium hypochlorite is not stable and must be stored in air-tight drums.
- Sodium hypochlorite is quite corrosive and cannot be stored in metal containers
- Sodium hypochlorite must be stored in light proof containers.
- It is difficult to control the rate of addition of hypochlorite in proportion to water flow.

- Hypochlorite raises the pH in water.
- They are more expensive than chlorine gas.

It is important to understand the manner in which chlorine or chlorine-releasing substances behave when added to water, depending on other substances present.

- When water contains reducing substances like ferrous salts or hydrogen sulphide, these will reduce part of the added chlorine to chloride ions.
- When water contains ammonia, organic matter, bacteria and other substances capable of reacting with chlorine, the level of free chlorine will be reduced.
- If the quantity of chlorine added is sufficiently large to ensure that it is not all reduced or combined, a portion of it will remain free in the water. This is termed as residual free chlorine or free chlorine.

When chlorine reacts chemically as in the first two cases, it loses its oxidizing power and consequently its disinfecting properties. Some ammonia chlorides however still retain some disinfecting properties. Chlorine present in this form is termed residual combined chlorine or combined chlorine.

From the stand point of disinfection, the most important form is free chlorine. Routine analysis always aims at determining at least the free chlorine level.

b. Ozone treatment[9, 10, 11, 12, 13]: This method needs special equipment, supply of pure oxygen and trained operators. Ozone is generated by passing pure oxygen through an ozone generator. It is then bubbled through a gas diffuser at the bottom of an absorption column, in a direction opposite to the flow of raw water. Retention or contact time is critical and the size of the absorption column depends on the water flow.

The main advantages of ozone treatment are:

- Ozone is a much more powerful germicide than chlorine especially for faecal bacteria.
- It reduces turbidity of water by breaking down organic constituents.
- The process is easily controlled.

The disadvantages are:

- Pure oxygen may not be readily available locally.
- Ozonized water is corrosive to metal piping.
- Ozone decomposes rapidly into oxygen

c. Ultraviolet irradiation treatment[14, 15, 16, 17]: This method is often used to treat drinking water. Successful commercial installations have been made to purify sea water in large fish processing plants.

The main advantages of U-V treatment are:

- U-V rays in the range of 2500-2600 Angstrom units are lethal to all types of bacteria.
- There is no organoleptic, chemical or physical change to the water quality.
- Overexposure does not have any ill effects.

The main disadvantages are:

- Electricity supply should be reliable
- Turbidity reduces efficiency
- Water may require prior treatment like filtration.
- The unit requires regular inspection and maintenance.
- Thickness of the water film should not exceed 7.5 cm.

d. Membrane filtration [18, 19]: Osmotic membrane treatment methods are generally expensive for commercial scale installations. Combinations of membrane treatment with U-V treatment units are available for domestic use.

2. Secondary Treatment

Secondary treatment of water consists of sedimentation and filtration followed by chlorination. Sedimentation can be carried out by holding the raw water in ponds or tanks. The four basic types of filtration are cartridge filtration, rapid sand filtration, multimedia sand filtration, and up-flow filtration.

a. Cartridge filtration: This system is designed to handle waters of low turbidity and will remove solids in the 5 to 100 micron range.

The main advantages are:

- Low cost and 'in-line' installation.
- Change of cartridge is simple.
- Operation is fool-proof. Once the cartridge is clogged, flow simply stops.

The main disadvantages are:

- Sudden increase in turbidity overloads the system.
- Cartridges may not be readily available and large stocks may be required.

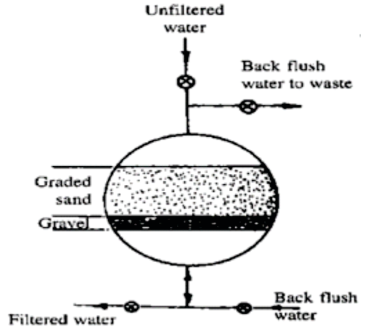
Rapid sand filtration [20, 21]: This system consists of a layer of gravel with layers of sand of decreasing coarseness above the gravel. As solids build up on top, flow decreases until it stops. This is corrected by back-flushing the system to remove the solid build up on top,

The main advantages are:

- Cost of filtration media is negligible.
- Operation is simple.

The main disadvantages are:

- A holding tank for filtered water is required to provide clear water back flushing.
- Pumping loads increase as sediments build up.



Rapid sand filtration

3. Complete Treatment[22]

Complete treatment consists of flocculation, coagulation, sedimentation and filtration followed by disinfection. Flocculation and coagulation will assist in removing contaminants in the water, causing turbidity, color odor and taste which cannot be removed by sedimentation alone. This can be achieved by the addition of lime to make the water slightly alkaline, followed by the addition of coagulants like Alum (aluminium sulphate), ferric sulphate or ferric chloride. The resultant precipitate can be removed by sedimentation and filtration.

Chemical treatment may be required to reduce excessive levels of iron, manganese, chalk, and organic matter. Such treatment is usually followed by clarification. Iron may be removed by aeration or chlorination to produce a flocculent which can be removed by filtration. Manganese may be removed by aeration followed by adjustment of pH and up-flow filtration. Most colors can be removed by treatment with ferric sulphate to precipitate the colors.

RESULTS AND DISCUSSION

S. No	Parameter	W.H.O Standards	Ground Water	Pond Water	Lake Water
1.	pH	9.2	7.32	6.44	7.14
2.	Color(Hazen)	15	1	1	5
3.	Odor	Odorless	Odorless	Odorless	Odorless
4.	Taste	Tasteless	Nil	Nil	Nil
5.	Turbidity(NTU)	5	Nil	8.8	23.2
6.	Conductivity (ms/cm)	-	1296	490	1590
7.	Total solids(mg/L)	-	835	328	1104
8.	Total dissolved solids(mg/L)	1500	824	310	1028
9.	TSS(mg/L)	-	8	18	76
10.	Total Hardness(mg/L)	500	272	136	364
11.	Calcium(mg/L)	200	84.8	40	124.8

12.	Magnesium (mg/L)	150	14.6	8.7	12.6
13.	Alkalinity(P)	500	Nil	Nil	Nil
14.	Alkalinity(M)	500	272	180	384
15.	Iron	0.3	0.14	0.08	0.08
16.	Sulphates(mg/L)	400	64.2	36.2	179.5
17.	Chlorine(mg/L)	250	102	52	259.9
18.	Nitrates(mg/L)	10	2.14	6.10	3.84
19.	Sodium(mg/L)	200	49.1	29.6	89.4
20.	Potassium(mg/L)	-	0.8	0.4	2.1
21.	Fluorides(mg/L)	1.5	0.09	Nil	0.21

CONCLUSION

Water is essential to our body. Neither we nor every living thing can't survive without water. And so therefore, we should keep, protect, save, and help prevent our waters from being polluted, we should act as early as now, we should save rivers, seas and oceans, another bodies of water because we will also bear the burden of this problem. Water was sampled from different areas of Hyderabad like ground water, pond water and lake water for which physical–chemical data were collected to analyze the water quality.

We have observed that pond water is more acidic that that of lake and ground water. We have also found that Lake Water has Turbidity of 23.2 NTU and Pond Water has Turbidity of 8.8 NTU whereas, the Standard value is 5 NTU.

The expected value of:
Calcium (200mg/L), Magnesium (150mg/L), Iron (0.3), Sulphates (400mg/L), Chlorine (250mg/), Nitrates (10mg/L) and Sodium (200mg/L), Fluorides (1.5mg/L) are as per WHO Standards.

The Observed values for ground water are:
Calcium (84.8mg/L), Magnesium (14.6mg/L), Iron (0.14), Sulphates (64.2mg/L), Chlorine (102mg/), Nitrates (2.14mg/L) and Sodium (49.1mg/L), Fluorides (0.09mg/L).

The Observed Values for pond water are:
Calcium (40mg/L), Magnesium (8.7mg/L), Iron (0.08), Sulphates (36.2mg/L), Chlorine (52mg/), Nitrates (6.10mg/L) and Sodium (29.6mg/L), Fluorides (NIL).

The Observed Values for lake water are:
Calcium (124.8mg/L), Magnesium (12.6mg/L), Iron (0.08), Sulphates (179.5mg/L), Chlorine (259.9mg/), Nitrates (3.84mg/L) and Sodium (89.4mg/L), Fluorides (0.21mg/L).

The expected Alkalinity was500mg/L as per WHO Standards.
Alkalinity using Phenolphthalein indicator was found to be NIL in ground water, pond water and lake water.

Alkalinity using Methylene red indicator was found to be 272mg/L, 180mg/L, 384mg/L for ground water, pond water and lake water respectively.

Based upon these results we conclude that ground water, pond water and lake water cannot be used directly for drinking purpose, hence has to be purified.

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