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PHYSICO-CHEMICAL EVALUATION OF GROUNDWATER QUALITY IN LAWYER HAMMED STREET, STADIUM AREA, OGBOMOSO, NIGERIA

ADEDAYO ADEGBOLA, ALAO OLUWATOSIN, JINADU AKEEM, ALADE ADEWALE & ALADE OPEYEMI

Department of Civil Engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria

ABSTRACT

This article presents results of groundwater quality assessment based on some physic-chemical parameters such as Total Dissolved Solids (TDS), Total Suspended Solids (TSS), pH, Zinc, Iron, Copper, Temperature, Lead, Nitrate, Sulphate, Phosphate, Total Alkalinity carried out on wells around Lawyer Hammed Street in Ogbomoso. Fifteen (15) wells within the street were sampled and analyzed using standard laboratories techniques. The results were then compared with the World Health Organization (WHO) standard. The pH values ranged from 6.1 – 7.3 during the rainy season and ranged from 4.27 – 5.11 highest value of 7.3(basic) during the rainy season Total dissolved solids concentration ranged from 140mg/l – 975mg/l during the rainy season and ranged from 168mg/l – 1170mg/l during the dry season. Coli form count ranged from l.0 x 10^5 – 9.7 x 10^6 during the rainy season and ranged from 2.0 x 10^5 – 10.4 x 10^6 during the dry season. Samples 2 and 20 showed the lowest concentration of l.0 x 10^5 while Sample 4 showed the highest concentration of 9.7 x 10^6 during the rainy season. Sample 10 showed the lowest count of 9.5 x 10^5 while sample 20 showed the highest count of 2.0 x 10^8 during the dry season. USEPA and WHO standards do not allow any number of coli forms as they play major roles in the contributions and spread of so many diseases Recommendations include periodic groundwater assessment and treatment.

KEYWORDS: Results of Groundwater, Diseases Recommendations

INTRODUCTION

As the popular African saying goes “water has no enemy’’. Thisconfirms the necessity of water as one of the most essential needs of humans. Water is involved in the day to day activities of humans either for industrial or domestic purpose. Of the two sources of water available in the study area: groundwater and surface water, the groundwater is the most preferable source because of its relative resistance to contamination. Groundwater constitutes over 90% of the world’s readily available freshwater with remaining 10% in lakes, reservoirs, rivers and wetlands. [1]

Ground-water supplies are obtained from aquifers, which are subsurface units of rock and unconsolidated sediments capable of yielding water in usable quantities to wells and springs. The hydrologic characteristics of aquifers and natural chemistry of ground water determine the availability and suitability of ground-water resources for specific uses. Ground water is the part of precipitation that enters the ground and percolates downward through unconsolidated materials and openings in bedrock until it reaches the water table. The water table is the surface below which all openings in the rock or unconsolidated materials are filled with water. Water entering this zone of saturation is called recharge.

The geochemistry of ground water may influence the utility of aquifer systems as sources of water. The types and concentrations of dissolved constituents in the water of an aquifer system determine whether the resource, without prior treatment, is suitable for drinking-water supplies, industrial purposes, irrigation, livestock watering, or other uses. Changes in the concentrations of certain constituents in the water of an aquifer system, either because of natural or anthropogenic causes, may alter the suitability of the aquifer system as a source of water. Groundwater quality can affect not only health, but also our societal and economic values. Groundwater contamination can adversely affect property values, the image of the community, economic development and the overall quality of life. Once contaminated, it is usually very difficult to clean.

For many years, groundwater was thought to be protected from contamination by layers of rock and soil that has filters but contaminants do make their way into the groundwater and affect its quality. Since groundwater moves through rocks and sub surfaces, it has a lot of opportunities to dissolve substances as it moves. This property in turn affects the physic-chemical attributes of water gotten from this source. Hence, the need for concise assessment of the physical and chemical properties of water obtained and distributed from this source. For that reason, groundwater will often have more dissolved substances than surface water will. This fact is candidly supported by Adegbola and Adewoye (2012) which states that the chemistry of groundwater is a reflection of the composition of both man made materials and country rocks through it has come in contact with.

Lawyer Hammed Street is located within the Ogbomoso South Local government of Oyo State with coordinates **N8^{0} 8$'$ 36.7”** to **N8^{0} 8’ 40.92”** and **E4^{0} 15’ 17.64”** to **E4^{0} 15’ 21.24”**. It is bounded by Stadium road to the north and Kuye road to the south. It mainly comprises of the Yoruba speaking populace makingYoruba language the official language. It is served by a polluted stream which flows within the area. The only means of refuse disposal is by dumping them on the parcel of land and burning it. There are no sanitary landfills within the area (**Figure 1**)

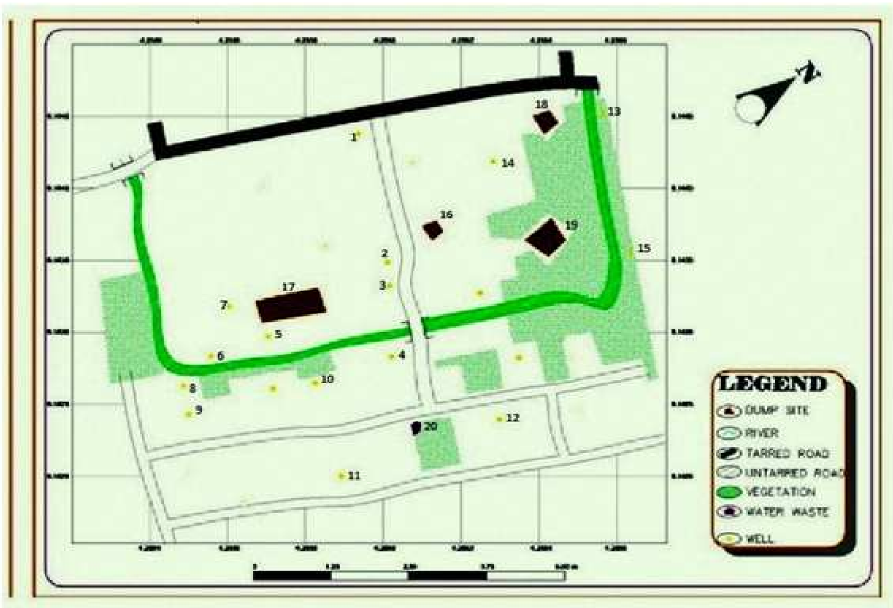

Figure 1: Detailed Map Showing the Sample Water Location and Dumpsite

MATERIALS AND METHODS

Twenty samples were collected from twenty different wells labelled from W01 0to W20. Sampling protocols described by Classen [2] and Barcelona et al [3] were strictly followed during sample collection: the sampling bottles were conditioned by washing with detergent, then with ten percent (10%) nitric acid, and finally rinsing several times with distilled water. This was carried out to ensure that the sample bottles were free from contamination, which could affect the concentration of various ions in the water samples. The samples were collected in a litre bottle. After collection, samples were immediately corked under water to prevent oxidation. Parameters analyzed on site include pH. Temperature, Total Dissolved Solids (TDS) and Dissolved Oxygen (DO) using digital meters. Others were analyzed in the laboratory. Bacteriological analysis was carried out with Standard Plate Counts, while major cations and anions were analyzed using the Flame Atomic Absorption Spectrometer (FAAS).

RESULTS AND DISCUSSIONS

Colour

Colour ranged from 0unit – 16.7units. Samples 15 and 17 showed the lowest concentration of 0unit while Sample 20 showed the highest concentration of 16.7units. The permissible concentration of colour according to USEPA and WHO standards are 15units and 5units respectively. **Figure 2** shows the effects of colour on analyzed water samples.All samples except Samples 16 and 20 conformed to both the USEPA and WHO standards. Samples 15 and 17 showed the lowest value which is an indicator of clear water while Samples 16 and 20 showed the highest value, a greenish colour which is an indication of the presence of copper in the water, large amount of organic chemical compounds and high disinfection methods. Sources of copper in the study area include septic waste animal waste. This is as a result of leachate migration from the dumpsite to wells in which Samples 16 and 20 were taken due to the proximity of the wells to the dumpsite.

pH

The pH values ranged from 6.1 – 7.3. Sample 12 showed the lowest value of 4.27(acidic) while Sample 17 showed the highest value of 5.11(acidic) during the dry season. The values of pH according to USEPA and WHO standards ranged from 6.5 - 8.5. All samples are within the range of USEPA and WHO standard except Samples 2, 10 and 12 which are not within range. **Figure 3** shows the effects of pH on the analyzed water samples.Samples 2, 10 and 12 showed pH out of range of the specified range of 6.5 – 8.5 and are likely to experience metallic or sour taste. This is as a result of leaching of metals from the surrounding to the wells which are likely to leave blue – green stains on sinks and drains.

Temperature

The temperature values ranged from 26^{o}C – 35^{o}C. Sample 20 showed the highest value of 35^{o}C and Sample 6 showed the lowest values of 26^{o}C. There is no permissible limit or value for temperature for both the USEPA and WHO standards. **Figure 4** shows the effects of temperature on the analyzed water samples.

Chemical Parameters

Copper

The result obtained ranged from 0.2797mg/l – 0.5910mg/l. Sample 1 shows the highest value of 0.591mg/l while Sample 15 shows the minimum value of 0.2797mg/l. All test results are still within the WHO and USEPA standards of 2mg/l and 1.3mg/l respectively. High copper concentration in Sample 1 is as a result of septic waste contamination as they are the major source of copper within the area. Research has shown that people who drink water containing copper in excess of the action level may, with short term exposure, experience gastrointestinal distress and with long term exposure may experience liver or kidney damage. **Figure 5** shows the effects of copper concentrations on analyzed samples.

Lead

The obtained results ranged from 0.1652mg/l -1.9375mg/l. Sample 14 exhibited the highest value of 1.9375mg/l while sample 17 showed the lowest value of 0.1652mg/l. The permissible concentrations of lead according to USEPA and WHO standards are 0.015mg/l and 0.01mg/l respectively. All sample concentrations are above the specified standards except for sample 19 which conforms with the standards. Lead can cause a variety of adverse health effect. High concentration of Lead in the samples generally are due to the presence of common sources of lead like used batteries, burnt tyres carelessly disposed without considering their adverse effects on the surrounding and groundwater. In babies and children, exposure to lead in drinking water above the action level can result in delays in physical and mental development, along with slight deficits in attention span and learning abilities while in adults, it may cause increase in blood pressure and adult who drinks this water over many years could develop kidney problems. **Figure 6** shows the effects of lead concentration on the sampled well water.

Zinc

The values of the samples ranged from 0.0242mg/l-0.0613mg/l. Sample 16 showed the highest concentration of 0.0613mg/l while sample 14 showed the lowest value of 0.0242mg/l. The permissible concentrations according to USEPA and WHO standards are 5mg/l. All samples analyzed are within the permissible range of the considered standards. **Figure 7** shows the effects of Zinc concentration on the sampled well water. Though all analyzed samples are still within range of the standards, common sources of zinc includes human activities like washing, combustion of household waste. Zinc shortages can cause birth defects. Although human can handle proportionally large concentration of zinc, too much zinc can cause eminent health problems such as stomach cramps, skin irritation, vomiting, nausea and anaemia. Very high level of zinc can damage the pancreas and disturb the protein metabolism, and cause arteriosclerosis.

Iron

The obtained values of concentration ranged from 0.0788mg/l - 1.8153mg/l. Sample 19 showed the highest level of concentration with 1.8153mg/l while sample 19 showed the lowest concentration with 0.0788mg/l. All values of concentration conforms to both the USEPA and WHO permissible concentration of 0.3mg/l and 0.12mg/l respectively. Iron promotes undesirable bacteria growth within waterworks and distribution system. The human body requires approximately 1-3 mg of iron per day. With the analyzed results, the water can hardly produce a milligram which indicates the iron content in the water is below par. **Figure 8** shows the effects of iron concentrations on the sampled well water. Samples 1, 2, 5, 6, 16 and 18 showed concentrations above the USEPA standard while other samples conformed to it. Samples 15 and 19 showed concentrations above the WHO standard while others conformed to it. Samples 1, 2 5, 6, 16 and 18 whose iron concentrations are above standard may be caused by known sources which are of increase within their surroundings. Known sources of Iron includes leaching from corrosion of roofing sheets, rust of metal scraps being dumped indiscriminately.

Potassium

The results obtained ranged from 0.8701mg/l - 15.2623mg/l. Sample 16 showed the highest concentration with 15.2623mg/l while sample 5 showed the lowest concentration with 0.8701mg/l. Sample 16 which shows the highest value of potassium is attributed to the presence of clay within its surrounding which is a rich source of potassium. Vital functions of potassium include its role in nerve stimulus, muscle contractions, blood pressure regulation and protein dissolution. Shortages of potassium may lead to depression, muscle weakness, heart rhythm disorder and confusion. Potassium loss may be a consequence of a chronic diarrhea or kidney disease because the physical potassium balance is regulated by the kidneys. **Figure 9** shows the detailed relationship between the potassium concentrations in the analyzed samples and the standard considered. There is no permissible concentration for potassium for both the WHO and USEPA standards.

Nitrate

The nitrate concentration ranged from 0.3mg/l - 10.6mg/l. Sample 20 showed the highest concentration with 10.6mg/l while Sample 1 showed the lowest concentrations with0.3mg/l. All samples except Sample 20 conforms to both USEPA and WHO concentrations of 10mg/l and 15mg/l respectively. Nitrate is absorbed in the blood, and hemoglobin the oxygen carrying component of blood is converted to methemoglobin which does not carry oxygen efficiently.

Methemoglobin in infant blood cannot change back to hemoglobin, which normally occurs in adults. Several Methemoglobinemia can result in brain damage. **Figure 10** shows the effect of nitrate concentration on the analyzed samples. Sample 20 shows a concentration of 10.6mg/l which is above the USEPA standard. Sample 20 which showed the highest concentration of nitrate may be due to dumping of water and excretion by erosion into the shallow water. Water from Sample 20 is not suitable for drinking purpose. It is mainly use for agricultural purpose though on a small scale. High concentration of nitrate in this area may be attributed to fertilizers and pesticides being applied on the subsistence farm being cultivate.

Sulphate

Sulphate concentration ranged from 0mg/l – 9.9mg/l. Samples 1 and 3 showed the lowest concentration of 0mg/l while Sample 20 showed the highest concentration of 9.9mg/l. The permissible concentration of sulphate according to USEPA and WHO standards are 250mg/l and 200mg/l respectively. High sulphate levels may also corrode plumbing particularly copper piping. People unaccustomed to drinking with elevated levels of sulphate can experience diarrhea and dehydration. All analyzed samples conform to both USEPA and WHO standards of 250mg/l and 200mg/l respectively. **Figure 11** shows the effect of sulphate concentration on analyzed water samples. High concentration of sulphate in Sample 20 may be attributed to small rocks sited around the area as they are major sources of minerals and salts which sulphate is a vital example of.

Phosphate

Phosphate concentration ranged from 0.5mg/l - 27.4mg/l. Samples 5 showed the lowest concentration of 0.5mg/l while Sample 20 showed the highest concentration of 9.9mg/l. The permissible concentration of Phosphate according to USEPA and WHO standards are 1.0mg/l and 5mg/l respectively. Phosphate itself does not have any notable adverse effects. However, phosphate levels greater than 1.0 may interfere with coagulation in water treatments. As a result, inorganic particles that harbor microorganisms may not be completely removed before distribution thereby indirectly causing much disease which includes malaria, diarrhea to mention a few. **Figure 12** shows the effects of Phosphate concentrations on the analyzed water samples. Samples 1, 3, 5, 6 and 8 conformed to the USEPA standard while all samples except Samples 16 and 20 conforms to the WHO standard. Samples 16 and 20 with high phosphates concentration may be attributed to presence of rock which harbors minerals and salts such as phosphates, sulphates and nitrates in its surrounding.

Total alkalinity

It ranged from 0.1mg/l – 7.2mg/l. Samples 3 and 5 showed the lowest concentration of 0.1mg/l while Sample 20 showed the highest concentration of 7.2mg/l. There is no specific standard according to WHO and USEPA for total alkalinity. **Figure 13** shows the effects of total alkalinity on the analyzed samples. Alkalinity is a measure of the capacity of water or any solution to neutralize or buffer acids. The common source of alkalinity is calcium carbonate which is dissolved in water flowing through geology that has limestone and/or marble. High alkalinity in Sample 20 may be attributed to presence of rock which harbors minerals and salts such as phosphates, sulphates and nitrates in its surrounding.

Total hardness

It concentration ranged from 59.9mg/l – 78.3mg/l. Samples 8 showed the lowest concentration of 59.9mg/l while Sample 20 showed the highest concentration of 78.3mg/l. The permissible concentration of total hardness according to

USEPA and WHO standards are 500mg/l.All samples conformed to both the USEPA and WHO standards. A high value of hardness in sample 20 is attributed to the deposits of calcium and magnesium which are mainly found in minerals like limestone, chalk and dolomite. **Figure 14** shows the effects of hardness on the analyzed samples. Hard drinking water is generally not harmful to one's health, but can pose serious problems in industrial settings, where water hardness is monitored to avoid costly breakdowns in boilers, cooling towers and other equipment that handles water.

Total Dissolved Solids

Total dissolved solids concentration ranged from 140mg/l – 975mg/l. Samples 5 showed the lowest concentration of 140mg/l while Sample 20 showed the highest concentration of 975mg/l. The permissible concentration of sulphate according to USEPA and WHO standards are 500mg/l. All samples except Sample 15, 16, 17, 18, 19 and 20 conformed to the USEPA and WHO standard of 500mg/l. **Figure 15** shows the effect of total dissolved solids on the analyzed water samples. High values of TDS in Samples 15, 16,17,18,19 and 20 is attributed to the presence of salt and metals naturally occurring and as a result of urban storm water runoff, domestic wastewater discharge and farming.

Total Suspended Solids

Total suspended solids ranged from 1150mg/l – 2865mg/l. Sample 1 showed the lowest concentration of 1150mg/l while Sample 20 showed the highest concentration of 2865mg/l. The permissible value of total suspended solids according to USEPA and WHO standards are 1000mg/l and 1000mg/l. None of the samples conformed to both the USEPA and WHO standards. **Figure 16** shows the effects of total suspended solids on analyzed water samples. Total suspended solids are solids in water that can be trapped by a filter. High value of TSS can be attributed to a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentration of suspended solids can cause many problems for stream health and aquatic life.

CONCLUSIONS

The data indicated that the groundwater of the study area is highly contaminated as it is polluted with high amount of solids, phosphates, sulphates and nitrates. Most of the water quality parameters are above the permissible limit. It can be inferred from the above statement that the lives of the residents of Lawyer Hammed Street are in danger. Urgent remedial measures must be taken to address this situation.

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APPENDICES

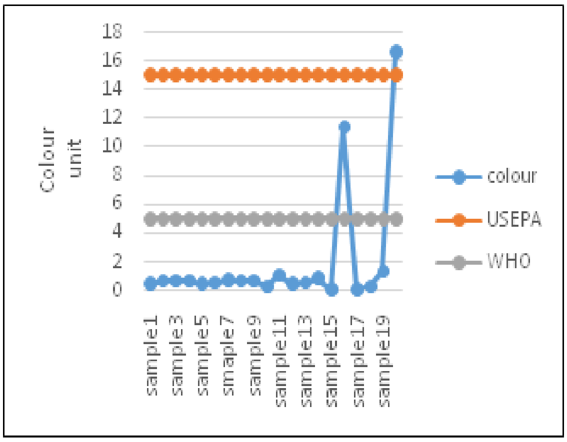

Figure 2: Effect of Colour on Analyzed Samples

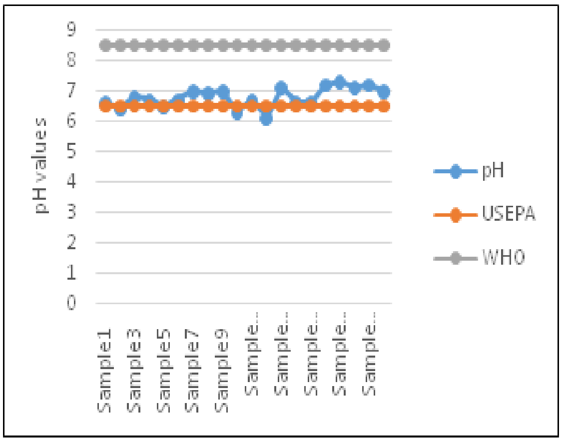

Figure 3: Effect of pH on Analyzed Samples

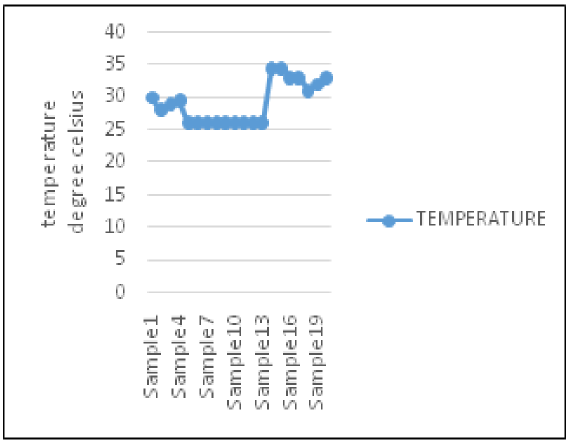

Figure 4: Effect of Temperature on Analyzed Samples

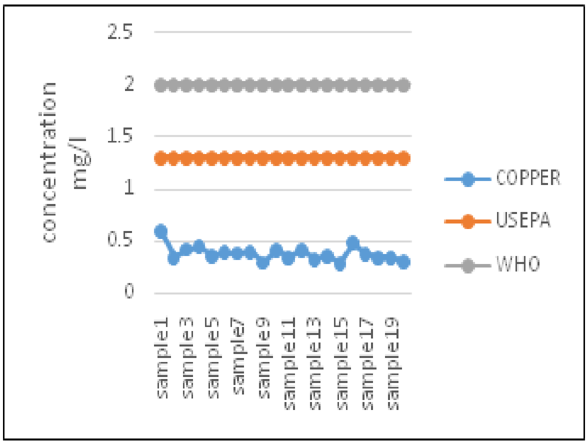

Figure 5: Effect of Copper on Analyzed Samples

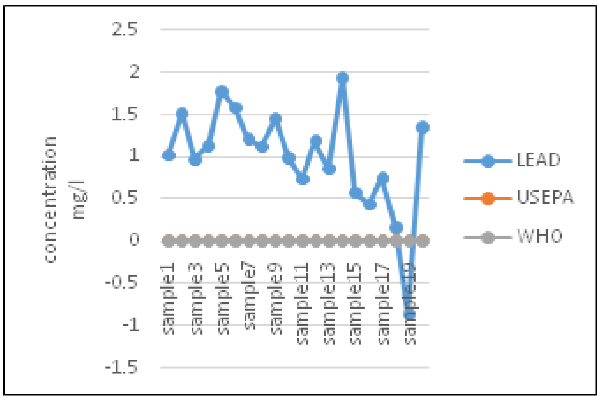

Figure 6: Effect of Lead on Analyzed Samples

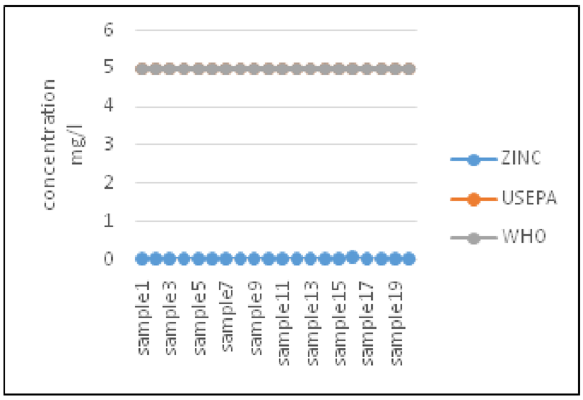

Figure 7: Effect of Zinc on Analyzed Samples

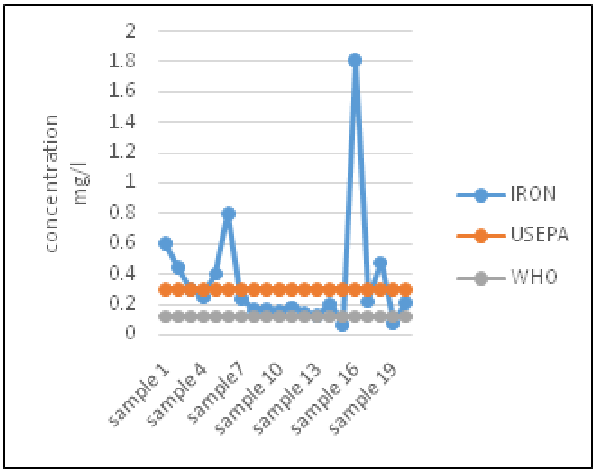

Figure 8: Effect of Iron on Analyzed Samples

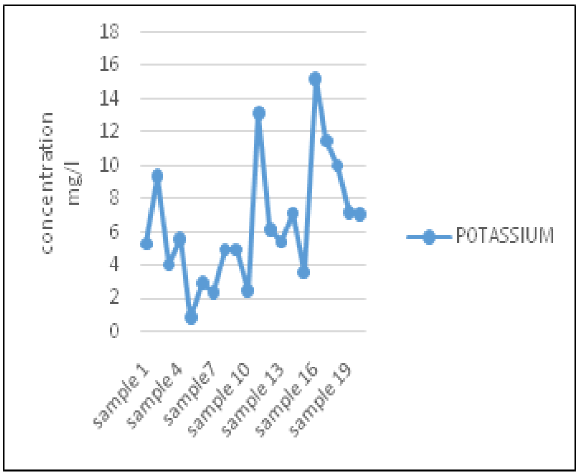

Figure 9: Effect of Potassium on Analyzed Samples

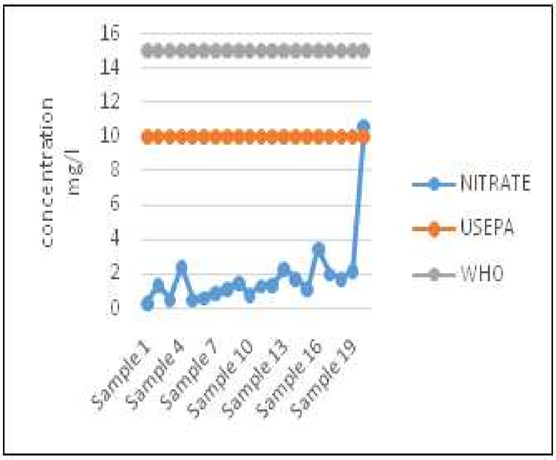

Figure 10: Effect of Nitrate on Analyzed Samples

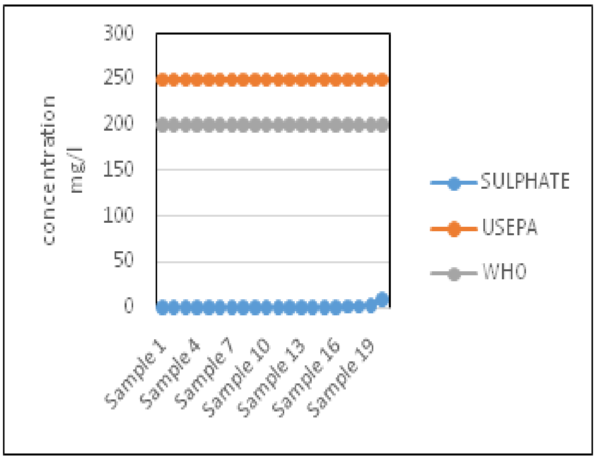

Figure 11: Effect of Sulphate on Analyzed Samples

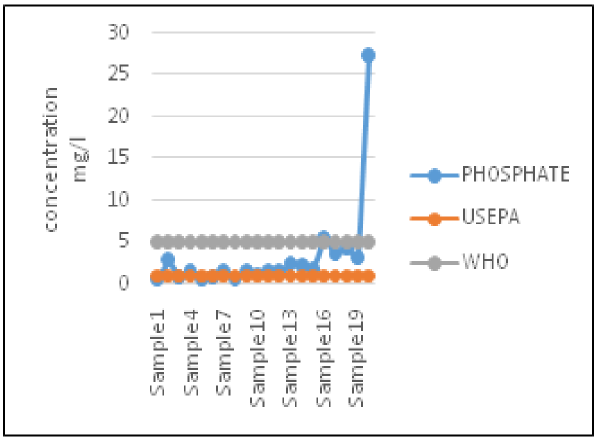

Figure 12: Effect of Phosphate on Analyzed Samples

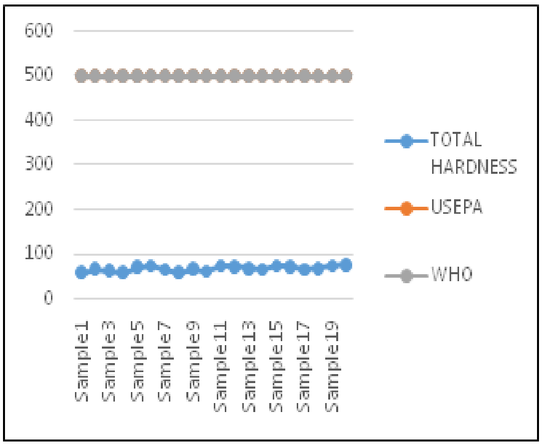

Figure 13: Effect of Total Alkalinity on Analyzed Samples

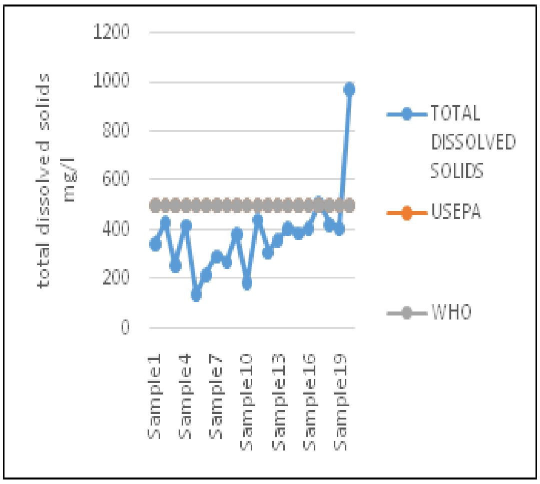

Figure 14: Effect of Total Hardness on Analyzed Samples

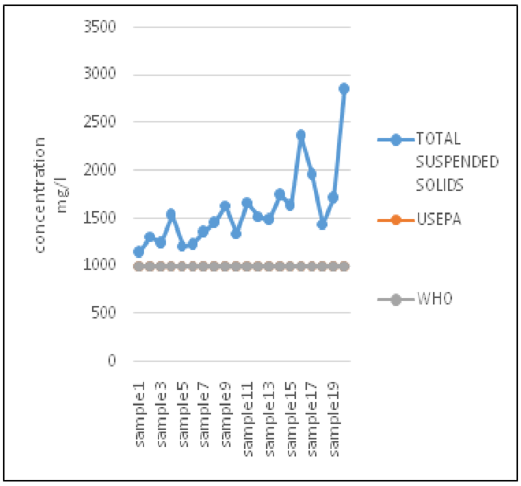

Figure 15: Effect of TDS on Analyzed Samples

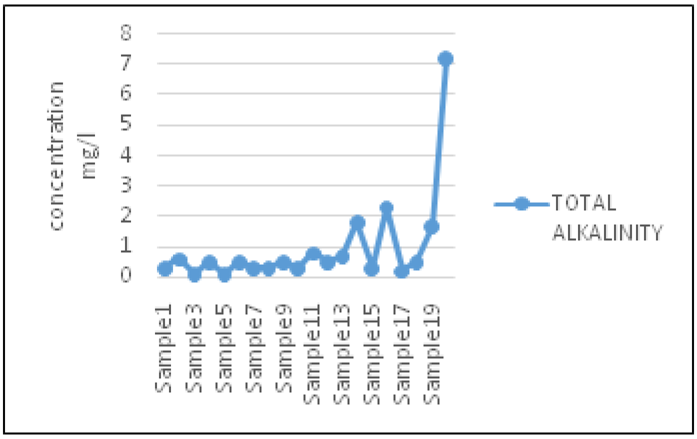

Figure 16: Effect of TSS on Analyzed Samples