ASSESSMENT OF GROUNDWATER QUALITY IN ASARI VILLAGE, WAMAKKO, SOKOTO STATE

[1]Abdullahi, A. and [2]Yanda, M.
Civil Engineering Department
Umaru Ali Shinkafi Polytechnic Sokoto

ABSTRACT

This research presents an assessment of groundwater quality in Asari village, Wamakko, Sokoto State. The Physico-chemical and Bacteriological parameters of water from 40 boreholes drilled at Asari village for water extension, and the combined water of these boreholes supplied to different communities in Sokoto were determined within dry and wet season periods to investigate their quality. Analyses were done on water samples for: Turbidity, Total Dissolve Solids, Sulphate, pH, hardness, Nitrate, Iron, Chloride, Total coliform, Thermo-tolerant coli form for all the 40-boreholes and combined water of these boreholes using standard procedures, and evaluated with the Nigerian Standard for Drinking Water Quality approved by Standard Organization of Nigeria (SON). All physico-chemical and bacteriological parameters analyzed in the water samples were within recommended standards, except the following: turbidity had 7.9NTU in dry season and 7.3NTU in wet season, and iron had 0.5mg/l in dry season and 0.6mg/l in wet season for combined water; all generally above NSDWQ maximum permissible limit respectively. These results indicated that the combined water sources supplies to the communities were unfit for human consumption in terms of turbidity and iron respectively. Appropriate measures for treatment against these pollutants are of great importance before consumption of these waters by the populace. As a preventive measure to minimize the health threat associated with consumption of iron-contaminated water, it is recommended that the combined boreholes water at Asari being supplied to consumers should be used for bathing, washing and other domestic needs. The public should be enlightened on the need to allow debris and other particles to settle down at the bottom of the water container before use. Also there is need for frequent cleaning of the storage tank and new pipes should replace the existing old ones used in the supply of water to the users.

Keywords: Groundwater quality, Borehole, NSDWQ, Physico-chemical, Bacteriological

1. INTRODUCTION

In all of creation, water is one of the most important resources necessary for the sustenance of human life. Water exists and flows above, below and on the surface of the earth. People use it in many ways, it is perhaps unrealistic to expect it to meet all the demands they make on it. Still, with the right treatment, water can and does meet all its obligations. Public health authorities, industrial firms, commercial firms, hospitals and institutions, farmers and homemakers, each has special requirements in terms of water quality. It is almost impossible to find a source of water that will meet basic requirements for a public water supply without requiring some form of treatment. In general, the requirements for a public water supply are as follows:

1. That it shall contain no disease-producing organisms
2. That it be colourless and clear
3. That it be good-tasting, free from odours, and preferably cool
4. That it be non-corrosive
5. That it be free from objectionable gases, such as hydrogen sulphide, and objectionable staining minerals, such as iron and manganese
6. That it be plentiful and low in cost. (Lawford, 2003).

The National Water Supply Policy developed in the year 2000 has the following objectives: Increase coverage from 40% to 60% by 2003; Extend service coverage to 80% by 2007; and extend service coverage to 100% by 2011. Ten years after the adoption of this policy (2011), these policy objectives are still been pursued. Water Aid (2006) had indicated that the average water supply coverage in the country was only 60%. Thus more still needs to be done (Bichi, 2013).

While the presence of coliform bacteria and toxic chemical content in water supply would cause a water to be classified as unsafe to drink, other factors such as taste, odor, colour and mineral content have a certain aesthetic effect which can cause a water to be rejected as a usable supply thereby necessitating its being subjected to treatment. The acute water shortage forced many people to drink untreated water obtained from surface and underground sources thereby exposing them to hazardous chemicals and infectious agents. This has made many researchers to focus their attention towards evaluation of physiochemical and microbial characteristics of water supplies (Ahmed et al, 2013).

2. METHODOLOGY

2.1 Description of the Study Area

The area of the study is Asari Village in Wamakko Local Government of Sokoto State. The adjoining areas extended with groundwater supply from boreholes are part of Wamakko and Sokoto South Local Governments. It is a generally arid region that gradually merges into the desert across the border in Niger Republic. It has limited rainfall from mid May to mid September and is subjected to the Sahara's Harmattan (dry, dust-laden wind) from November to March (Raji and Ibrahim, 2011). Asari village in Wamakko Local Government area is 5km ahead to Wamakko town from Sokoto and 21 km away from Sokoto main city, located at dispersal Settlement with different villages around its vicinity. The Wamakko Local government share border with Sokoto town (East), Kware local government (North-East), Silame local government (West) and Bodinga local government (South).

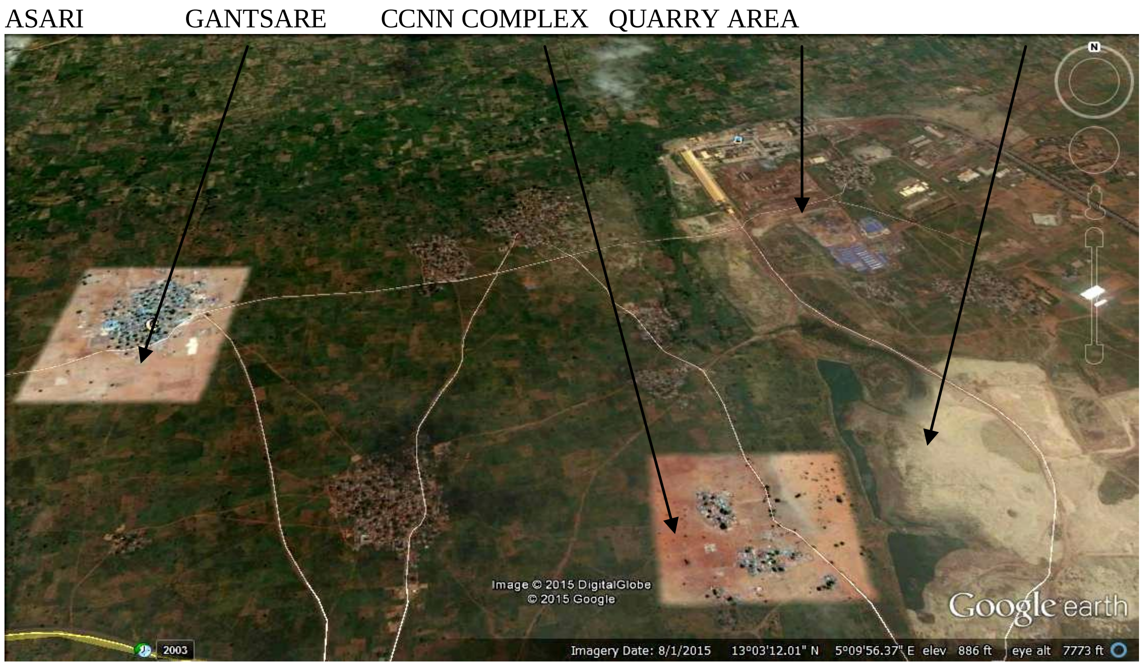

Figure2.1Map showing Asari village and neighboring villages and Cement Company

2.2 Sample Collections

Groundwater samples from tap of forty different boreholes in Asari village were collected and taken to the laboratory for analysis. The water containers used were previously washed and later rinsed with distilled water after which they were dried and labeled (BH1 – BH40) before they were used for sample collection.

The sample of combined boreholes water that are distributed to the users from the overhead reservoir by gravity, was also collected from consumers' tap in the study area and carried to the laboratory for analysis.

2.3 Sampling Method

The sampling method employed for this analysis was based on the boreholes existing within the research area (i.e. forty boreholes at Asari village) in Wamakko Local Government area, Sokoto, in accordance with Nigerian Standard for Drinking Water Quality i.e based on ISO guidelines (SON, 2007). For combined water, the sampling point was selected from the public tap within the study area for analysis. Water sampling was carried out at weekly intervals for a period of four weeks between the forty boreholes. Analysis was carried out on ten boreholes within a week for both dry and wet season period respectively. Samples of water were taken from boreholes tap in week 1 for analysis in the laboratory. The samples were labeled: BH1, BH2, BH3, BH4, BH5, BH6, BH7, BH8, BH9, and BH10 for easy identification. The samples were taken in to sterilized bottles/container by trained personnel and transported immediately to the laboratory for physicochemical and bacteriological analysis. The same sampling method and laboratory analysis were carried out on weekly basis for all the remaining boreholes labeled: BH11, BH12, BH13, BH14, BH15, BH16, BH17, BH18, BH19, BH20, and BH21, BH22, BH23, BH24, BH25, BH26, BH27, BH28, BH29, BH30, and BH31, BH32, BH33, BH34, BH35, BH36, BH37, BH38, BH39, BH40.

3. RESULTS AND DISCUSSION

A summary of the results of the 40-Boreholes, and the combined waters carried out for Physico-chemical and Bacteriological analysis in the dry and wet seasons are shown in Figures 3.1 to 3.37.

3.1 BOREHOLES WATER

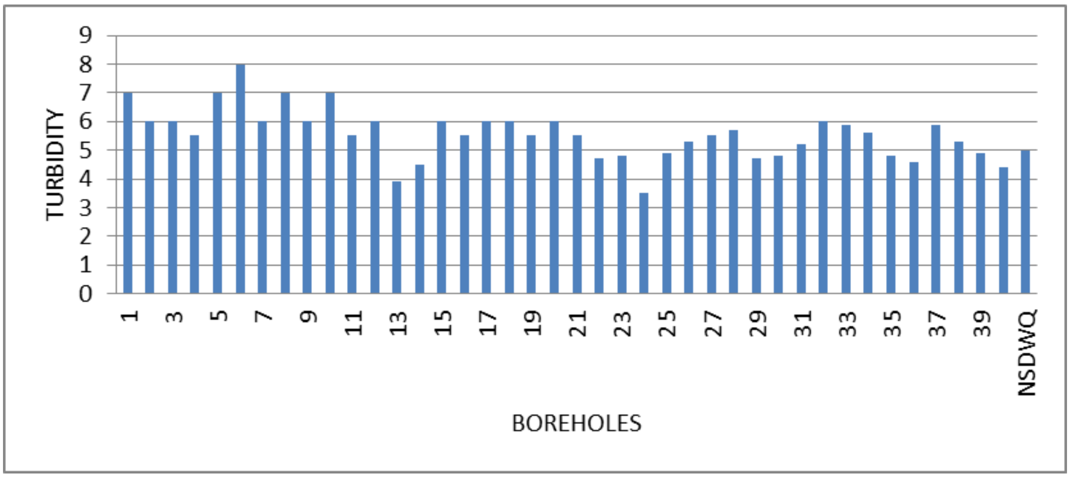

Figure 3.1: Chart showing water quality for Turbidity from 40-boreholes in Dry Season

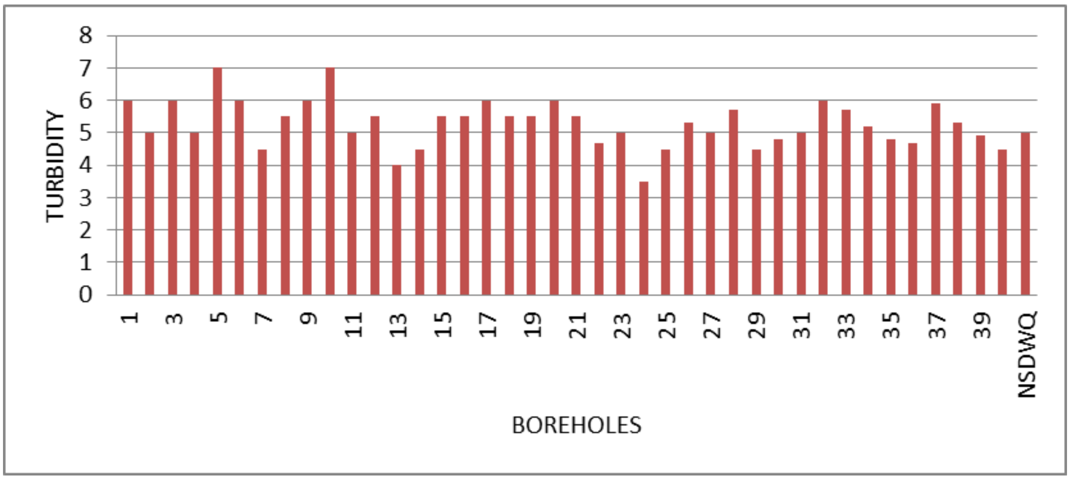

Figure 3.2: Chart showing water quality for Turbidity from 40-boreholes in Wet Season

The values for turbidity for all the forty boreholes in dry season lies in the range of least turbid water from BH24 at 3.5NTU and most turbid of BH6 at 8NTU respectively. More so, the values recorded in wet season had least turbidity content from BH24 at 3.5NTU and most turbid from BH5, and BH10 which recorded 7NTU respectively from the 40-borehole water samples.

Over half of the borehole waters are turbid. Although this varies from place to place depending on local circumstances, sometimes, high levels of turbidity tend to protect microorganisms from the effects of disinfection, stimulate the growth of bacteria and give rise to a significant chlorine demand (Adejo et al., 2013). In terms of acceptability standard, only 12 out of 40 of the water samples namely BH no. 13, 14, 22, 23, 24, 25, 29, 30, 35, 36, 39 and 40 fall beyond 5NTU limit as specified by

NSDWQ. Turbidity need to be checked, for optimal disinfection process where necessary. Therefore, the problem of waterborne infections such as diarrhea and gastroenteritis in the area might be attributed to the turbid waters that are supplied to the users for consumption from Asari boreholes. The turbidity in the water might be as a result of pumping with little quantities of mud and silt; this may result in usual damage of valves and taps and frequent washing of tank.

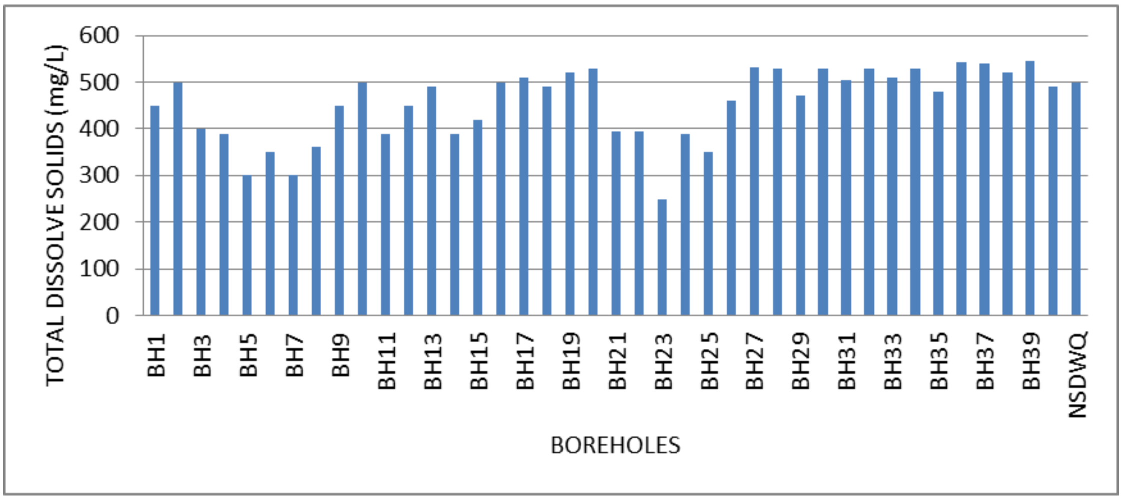

Figure 3.3: Chart showing water quality for TDS from 40-boreholes in Dry Season

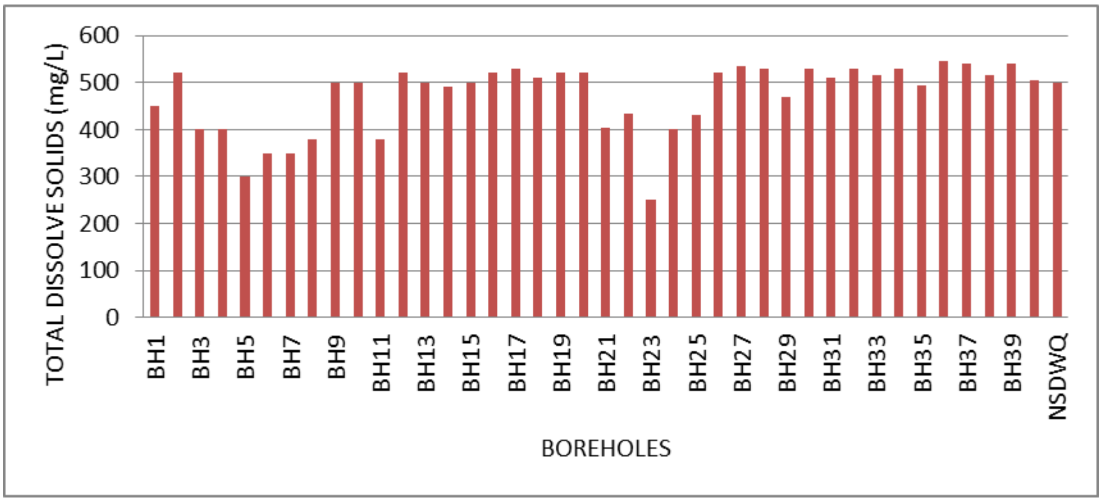

Figure 3.4: Chart showing water quality for TDS from 40-boreholes in Wet Season

The range value for Total Dissolve Solids (TDS) determination is between the range of 250 to 545mg/L for the 40-boreholes both in dry and wet season respectively. Borehole no. 1,3,4,5,6,7,8,9,11,12,13,14,15,18,21,22,23,24,25,26,29,35,40 in dry season and BH1,3,4,5,6,7,21,22,23,24,25,29,35 in wet season are below the maximum limit specified by NSDWQ standards of 500mg/L approved by SON. The remaining number of boreholes outreaches the standard. The Total Dissolve Solids values are high in the wet season periods; thus it might be due to intrusion of some dissolve substances in to the ground during rainfall.

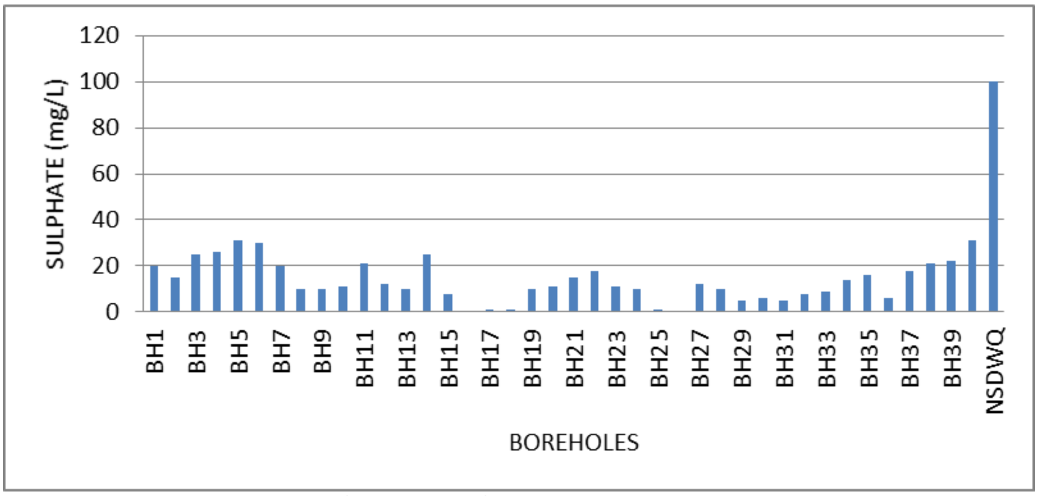

Figure 3.5: Chart showing water quality for Sulphate from 40-boreholes in Dry Season

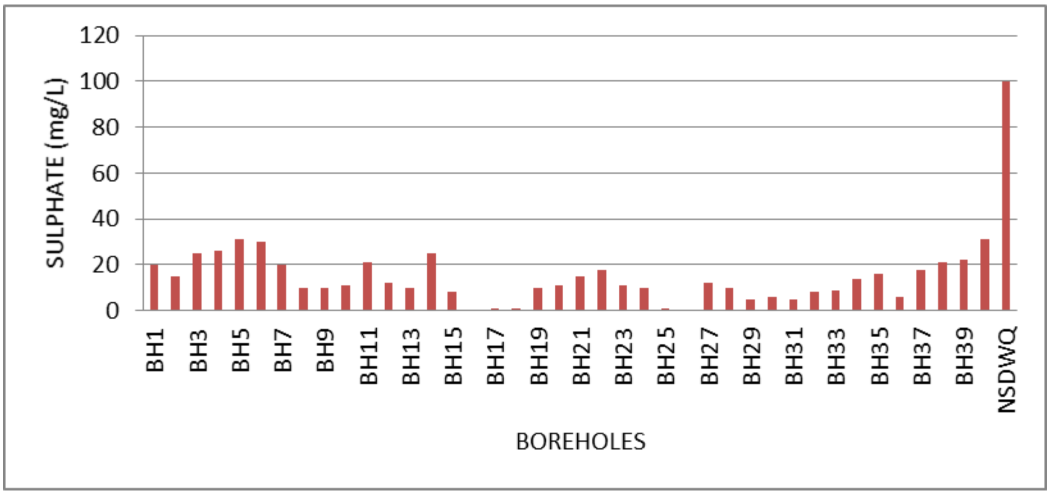

Figure 3.6: Chart of water quality for Sulphate from 40-boreholes in Wet Season

The relative value of sulphate for all the samples in dry season was lies between zero in BH16 and 31mg/L from BH5 and BH40 respectively. In wet season it was ranged between 0.1mg/L of BH25 and 31mg/L in BH40 respectively. The sulphate values in water samples collected from 40-boreholes in both dry and wet seasons were quiet below 100mg/l recommended limits set by both national and international drinking water regulatory authorities.

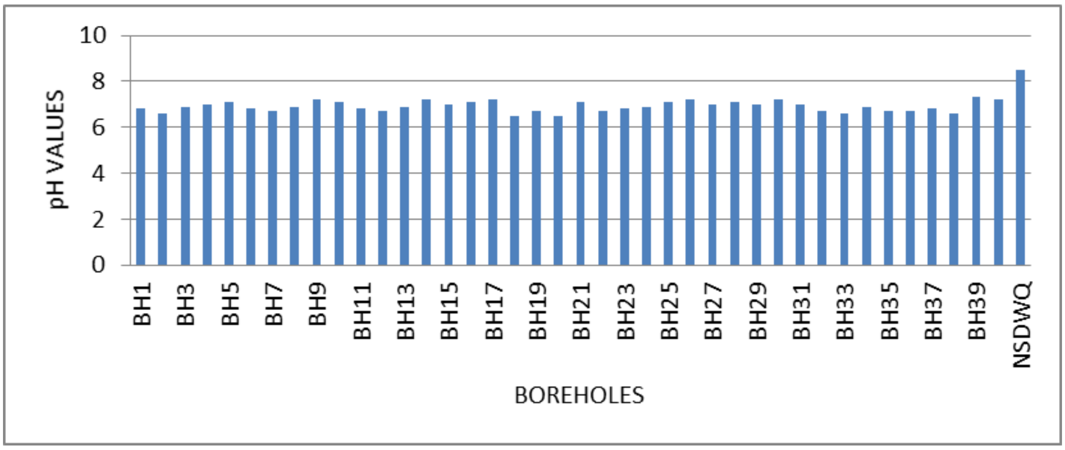

Figure 3.7: Chart showing water quality for pH from 40-boreholes in Dry Season

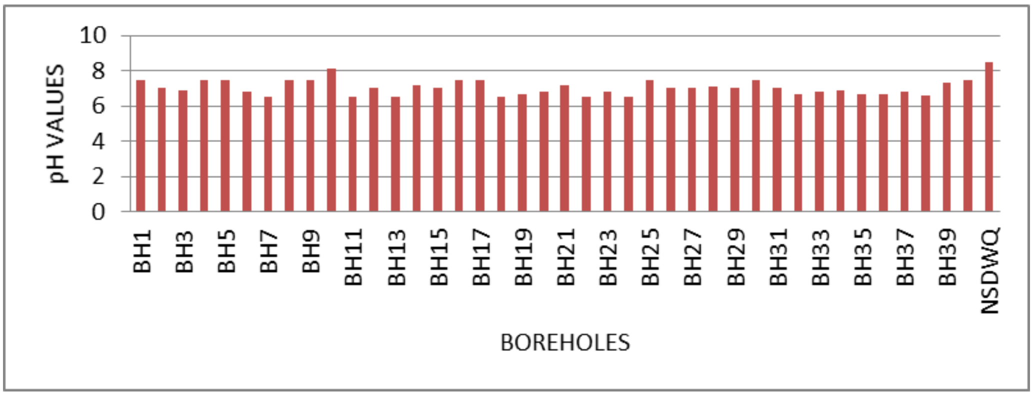

Figure 3.8: Chart showing water quality for pH from 40-boreholes in Wet Season

From the results of this study, the level of pH recorded lies from 6.5 to 7.3. Water with a low pH is regarded as acidic, soft and corrosive and could leach metals such as copper, iron, lead, manganese, and zinc from pipes and fixtures. It can also cause damage to metals pipes and brings about aesthetic problems such as a metallic sour taste, laundry staining or blue-green stains in sinks and drains (Ahmed et al., 2013). All the pH values recorded in this investigation however fall within the maximum limits of 6.5 – 8.5 as recommended by NSDWQ (SON, 2007).

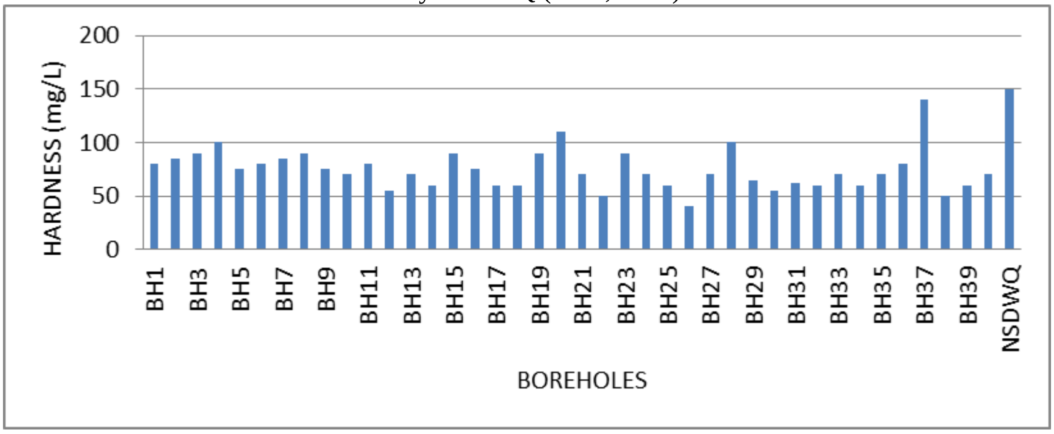

Figure 3.9: Chart showing water quality for Hardness from 40-boreholes in Dry Season

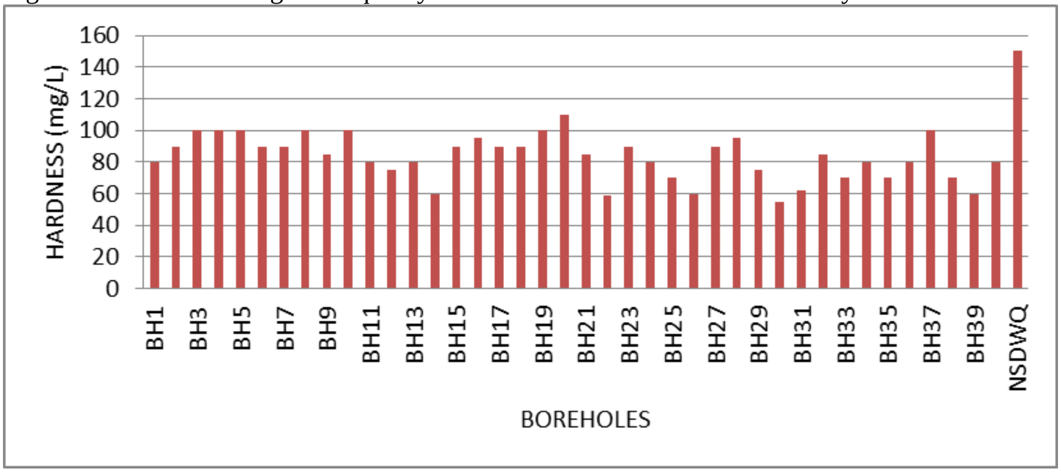

Figure 3.10: Chart showing water quality for Hardness from 40-boreholes in Wet Season

The hardness of drinking water is determined largely by its content of calcium and magnesium. It is expressed as the equivalent amount of calcium carbonate that could be formed from the calcium and magnesium in solution. Both waters showed their suitability for drinking for two seasons, as their values were below the recommended maximum permissible limits given by NSDWQ as 150mg/l.

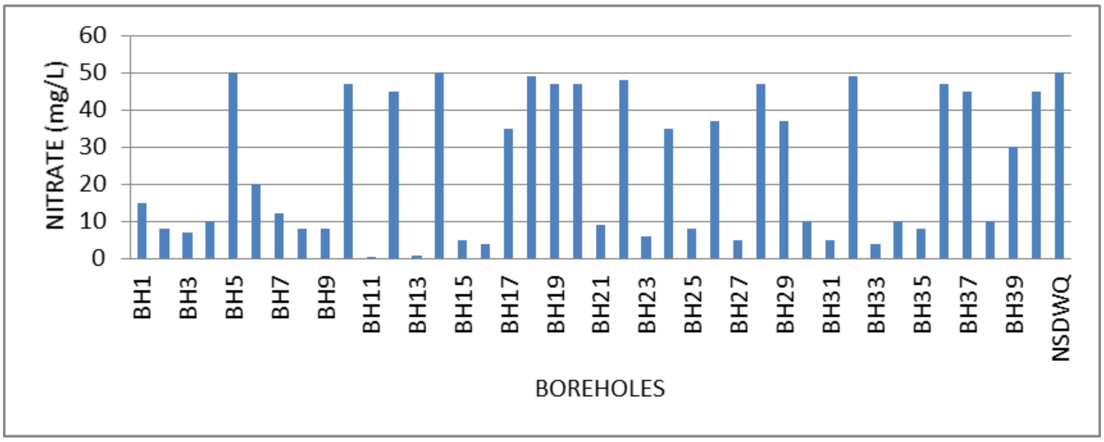

Figure 3.11: Chart showing water quality for Nitrate from 40-boreholes in Dry Season

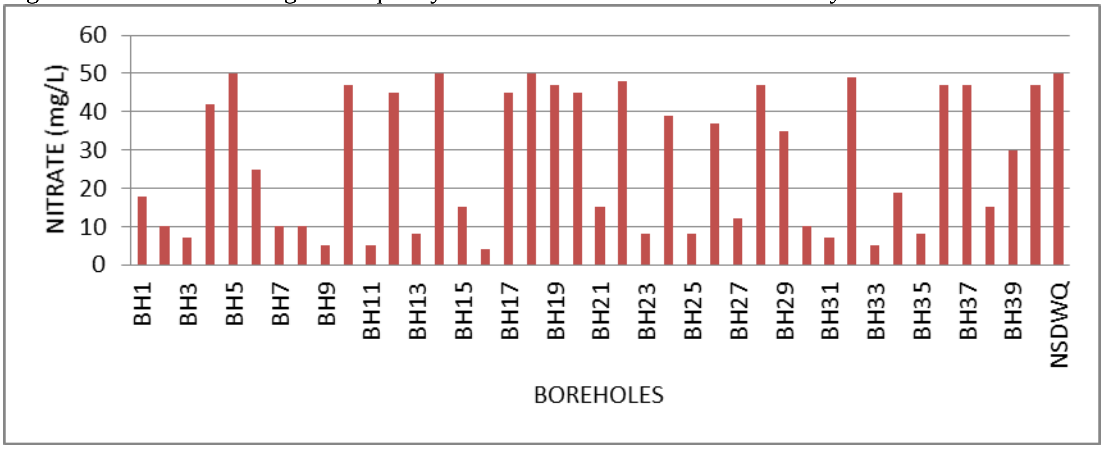

Figure 3.12: Chart showing water quality for Nitrate from 40-boreholes in Wet Season

The levels of nitrate detected in all the seasons are within maximum permissible limit set by NSDWQ of 50mg/L. Only BH5; BH14, and BH18 have met the peak level for both dry and wet season period respectively

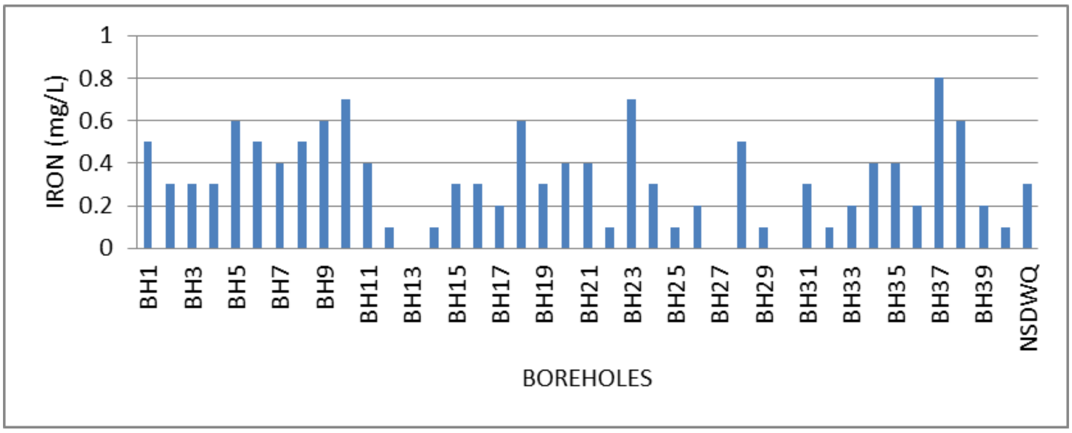

Figure 3.13: Chart showing water quality for Iron from 40-boreholes in Dry Season

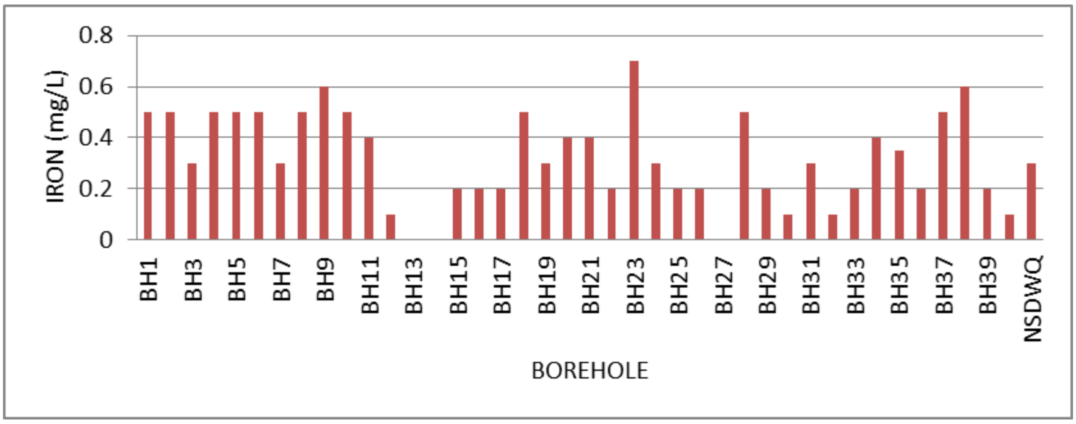

Figure 3.14: Chart showing water quality for Iron from 40-boreholes in Wet Season

The undesirable effects of iron in water are impart color, staining plumbing laundry, and stimulate growth of iron bacteria. The level of iron contents found in the water samples of 40-boreholes started with zero content for BH13, BH27, and BH30, to the highest content of 0.8 from BH37. This have indicated the presence of iron contaminants in most of the boreholes except BH12, BH13, BH14, BH22, BH25, BH27, BH29, BH30, BH32, and BH40 that had fall within the maximum permissible limit of 0.3mg/l as recommended by NSDWQ. The effect of the presence of an excessive content of iron in water is toxic and it causes nausea, vomiting, and hyperglycemia.

The WHO stipulates that all water that is to be deemed safe should not have an iron content of up to 0.3mg/l (Lawford and Denise, 2003). The iron content in the area is as a result of natural mineral content in the soil. Therefore this might possibly be attributed to the problems encountered by the users of this water in the study area, Iron is to be checked and treat accordingly.

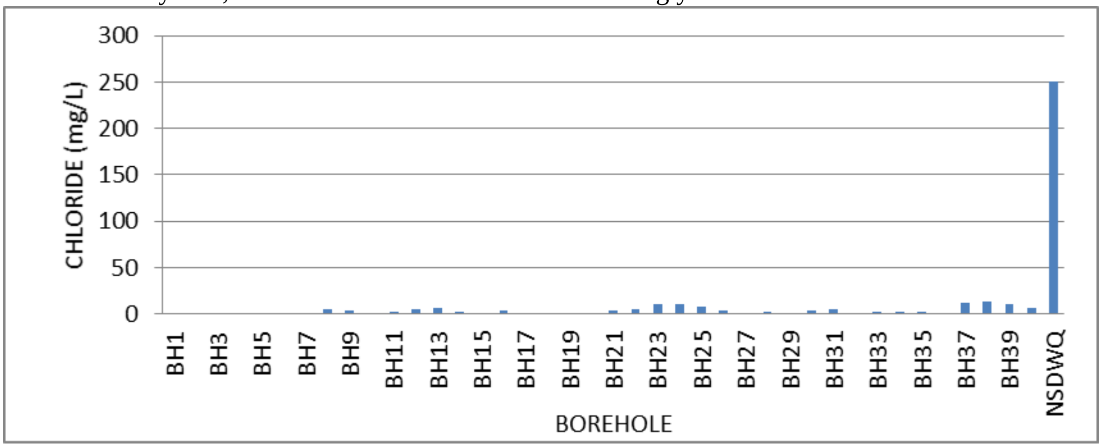

Figure 3.15: Chart showing water quality for Chloride from 40-boreholes in Dry Season

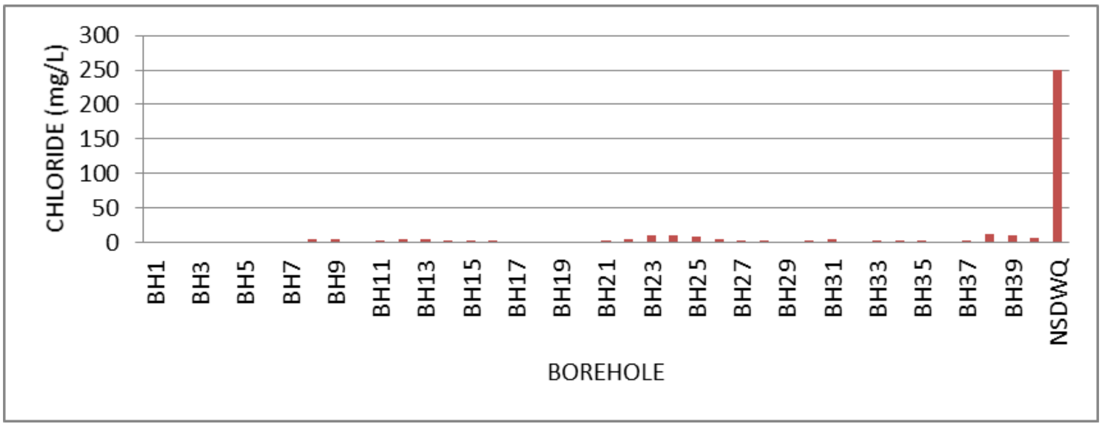

Figure 3.16: Chart showing water quality for Chloride from 40-boreholes in Wet Season

Chloride range level was investigated for all the samples and it was observed that this element was less detected in almost all the water samples. This could be attributed to the geological composition of the area, which can be said to be low in this element during dry and wet season.

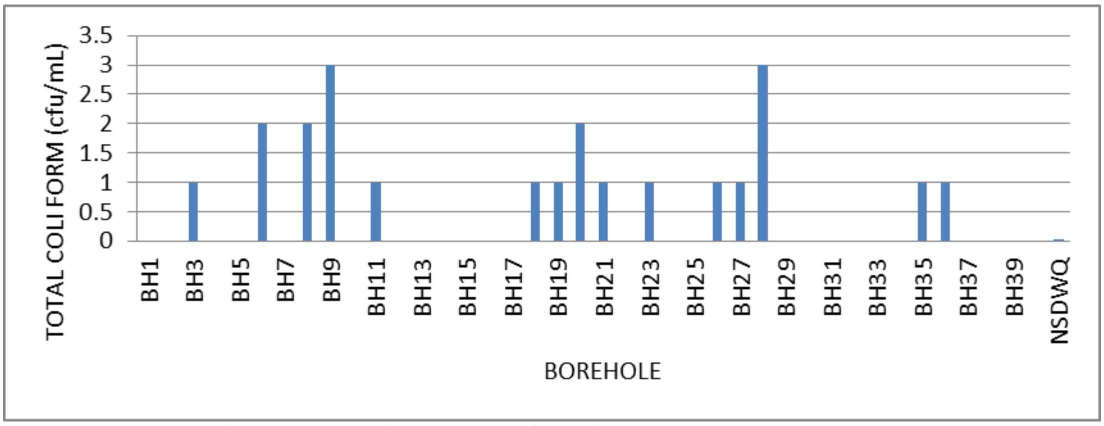

Figure 3.17: Chart of water quality for Total Coliform from 40-boreholes in Dry Season

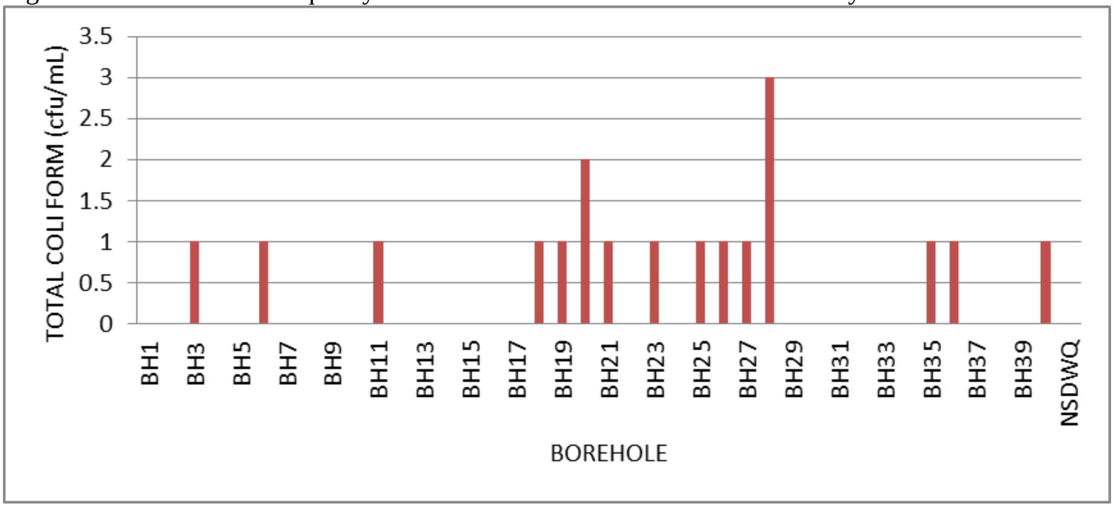

Figure 3.18: Chart of water quality for Total Coliform from 40-boreholes in Wet Season

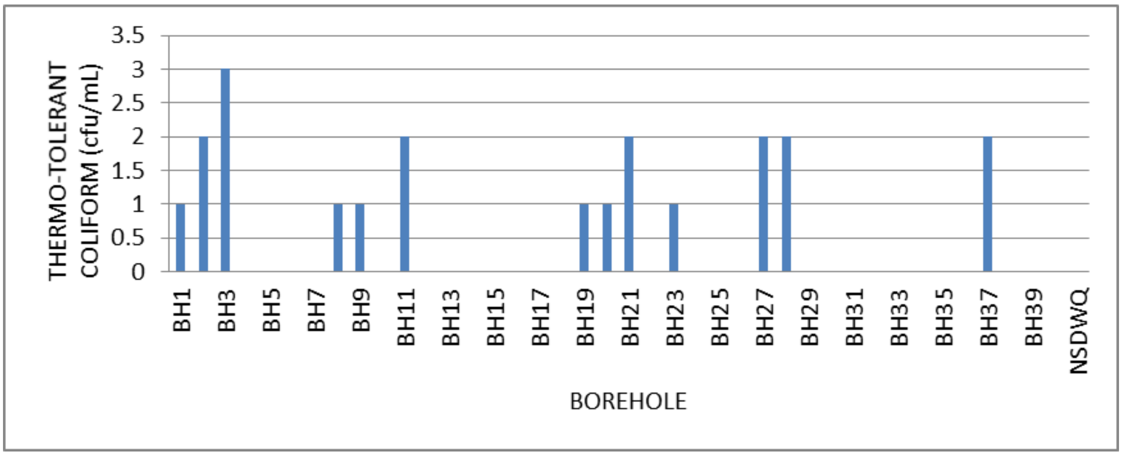

Figure 3.19: Chart of water quality for Thermo-tolerant Coli 40-boreholes in Dry Season

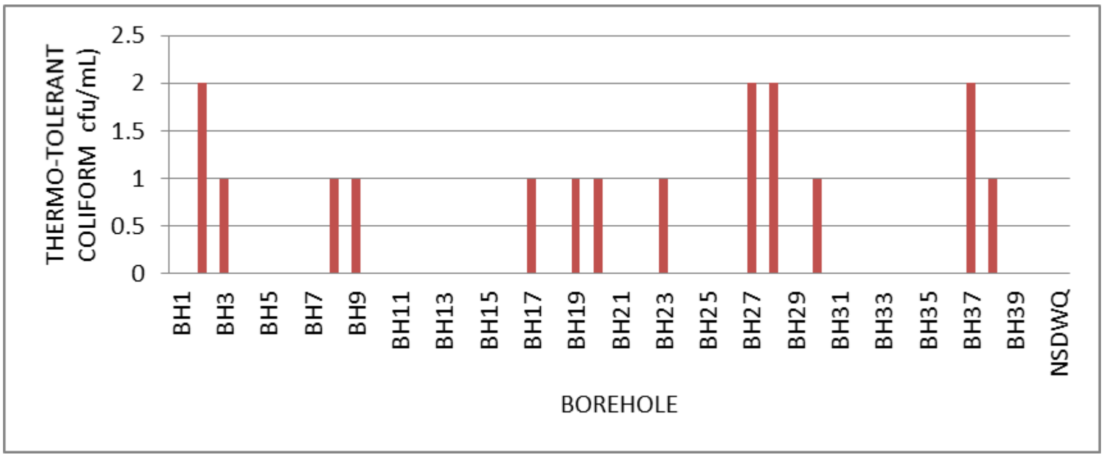

Figure 3.20: Chart of water quality for Thermo-tolerant Coli 40-boreholes in Wet Season

Coliforms are indicators of pathogens that cause various health problems. Its sources may include human and other animal faecal matter as well as hospital wastes etc. Microorganisms are commonly present in surface water and are usually absent in most groundwater because of natural filtration that took place before percolation. However shallow groundwater sources are subject to microbial contamination from pit-latrine sock away, stagnant gutter, refuse dump etc, as a result of inability to keep 100meters separation between the dug well and sources of the contaminants. The level of Total coliforms and Thermo-tolerant coliform in the water samples implies that BH1, BH2, BH3, BH6, BH8, BH9, BH11, BH18, BH19, BH20, BH21, BH23, BH26, BH27, BH28, BH35, BH36, and BH37 are carriers of either of these pathogenic organisms. An indication of too much turbidity in the water contributes in the number of bacteriological lives in water and interferes with disinfection effect in the course of treatment.

4.2 COMBINED WATER

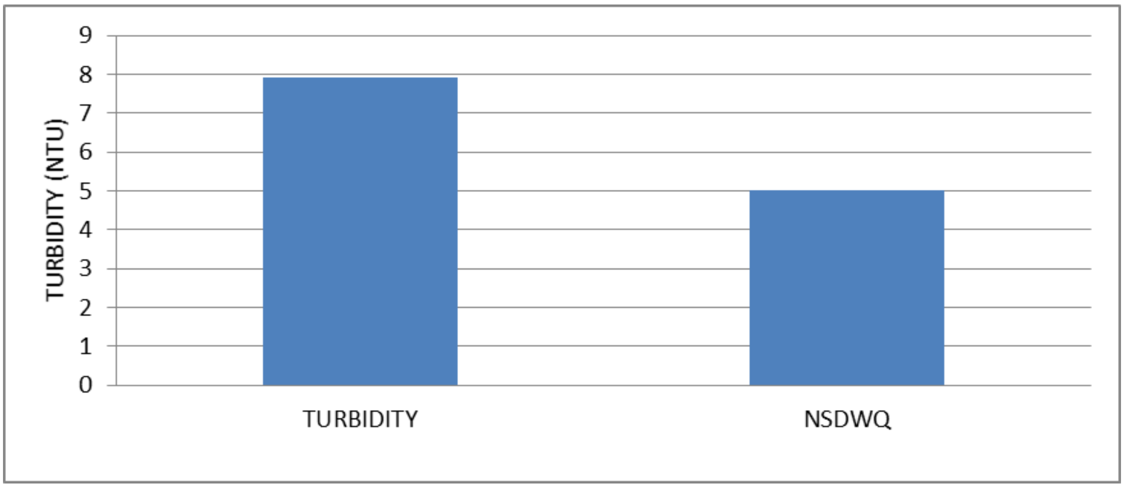

Figure 3.21: Chart of water quality for Turbidity from Combined water in Dry Season

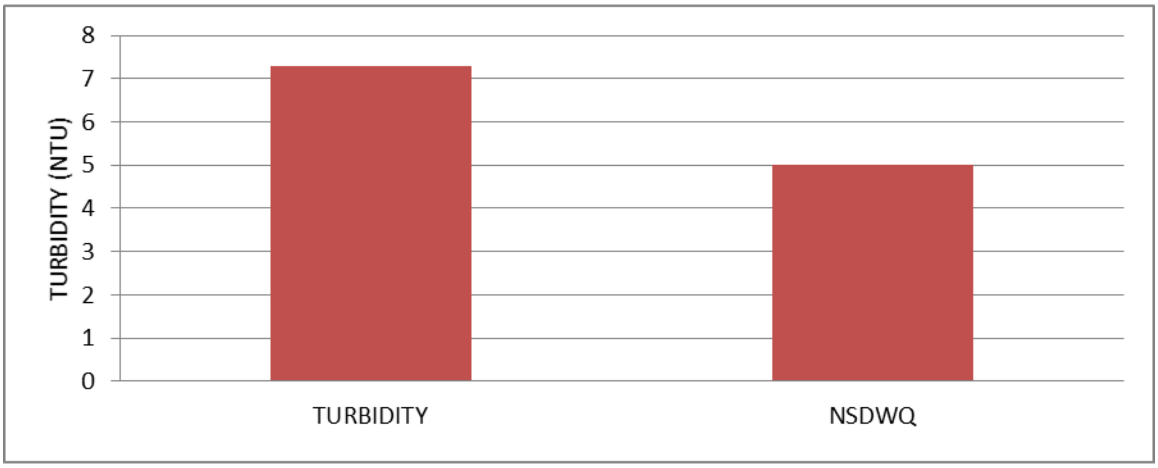

Figure 3.22: Chart of water quality for Turbidity from Combined water in Wet Season

The results showed that 7.9NTU and 7.3NTU were discovered from the combined waters in the dry and wet season periods respectively. The turbidity is needed to be checked as SON approved for 5.0NTU as maximum permissible limits for water to be safe for drinking. The turbidity increase in the water might be due to pumping with little quantities of mud and silt; this may result in usual damage of valves and taps and frequent washing of tank. The deposition of small/tiny suspended solids (mud) settled in the tank could give rise to high level of turbidity thus: when the tank is cleaned the turbidity remain the same but when it takes time turbidity increase over a long period settlement in the tank. There were several incidences of bursting of sub mains distribution pipes which might be as a result of pumping through the long term used Asbestos and Clay (AC) pipes which may attributes to increase in turbidity in the water.

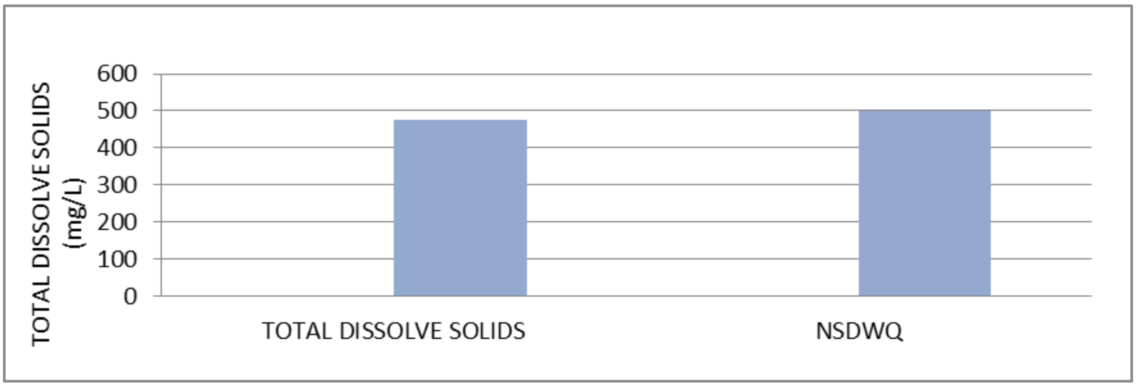

Figure 3.23: Chart of water quality for TDS combined boreholes water in Dry Season

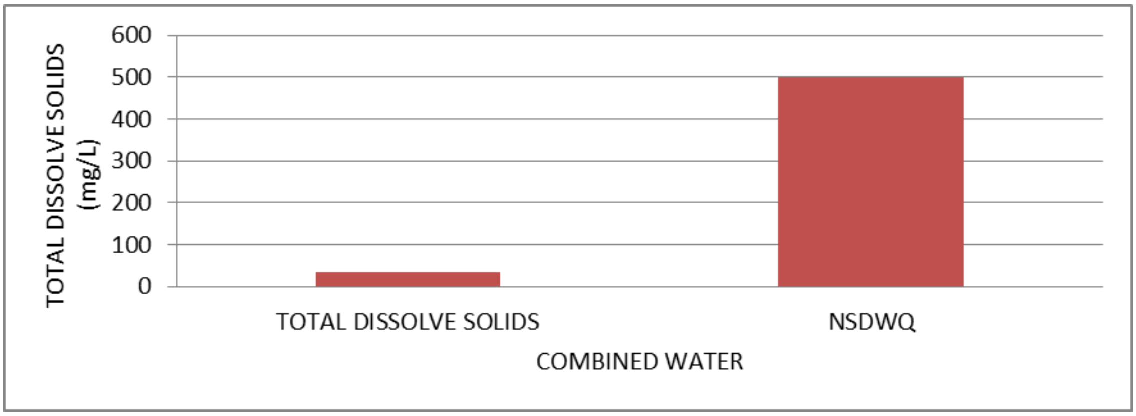

Figure 3.24: Chart for water quality for TDS from combined water in Wet Season

The level of Total Dissolved Solids detected for dry and wet season fall within the NSDWQ maximum permissible level of 500mg/L. A health based TDS value has not been proposed by the WHO. However, a value above 1200mg/l may be objectionable to consumers, as May a too low value of 475mg/L and 485mg/L recorded in combined waters of the two seasons (Adejo et al., 2013).

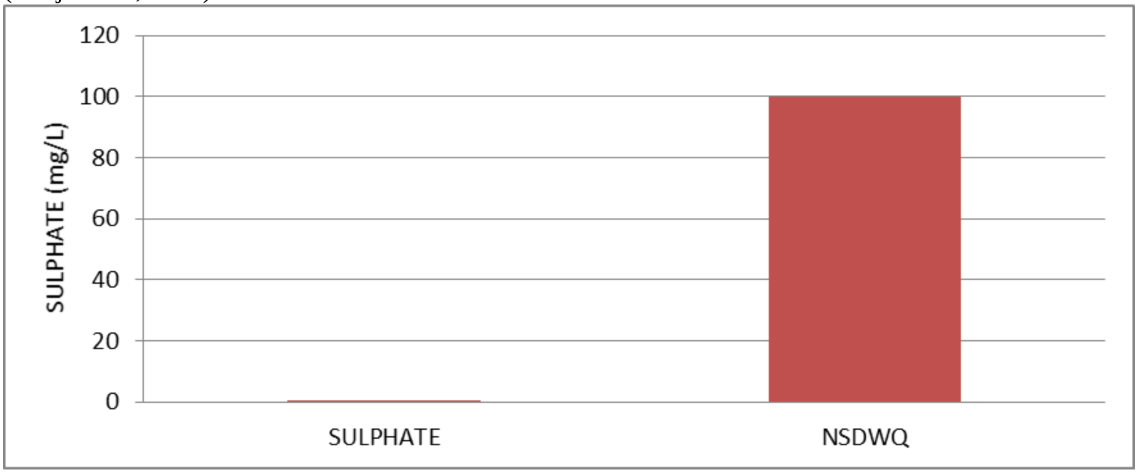

Figure 3.25: Chart for water quality for sulphate from combined water in Wet Season

The level of sulphate presence in the combined waters recorded negligible amount of 0.01mg/L in wet season far below the NSDWQ maximum permissible limits of 100mg/L and in the dry season no amount was ascertained in the water.

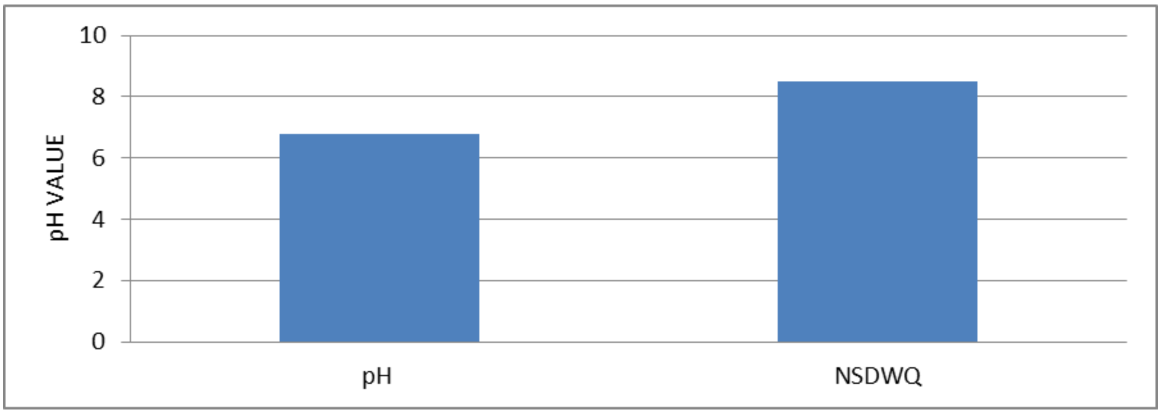

Figure 3.26: Chart for water quality for pH combined boreholes water in Dry Season

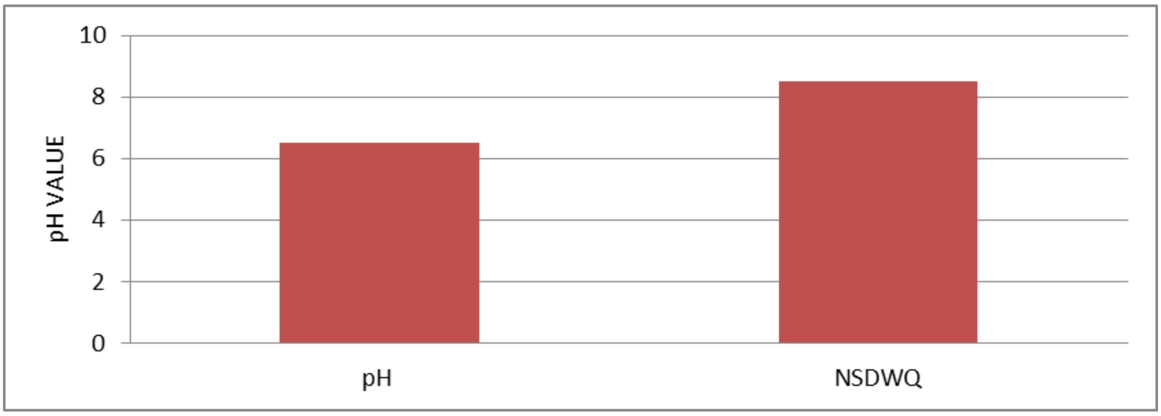

Figure 3.27: Chart for water quality for pH combined boreholes water in Wet Season

The level of pH recorded in dry and wet season was 6.8 and 6.5 from the combined water. All the pH values recorded in this investigation however fall within the permissible limits of 6.5 – 8.5 as specified by NSDWQ.

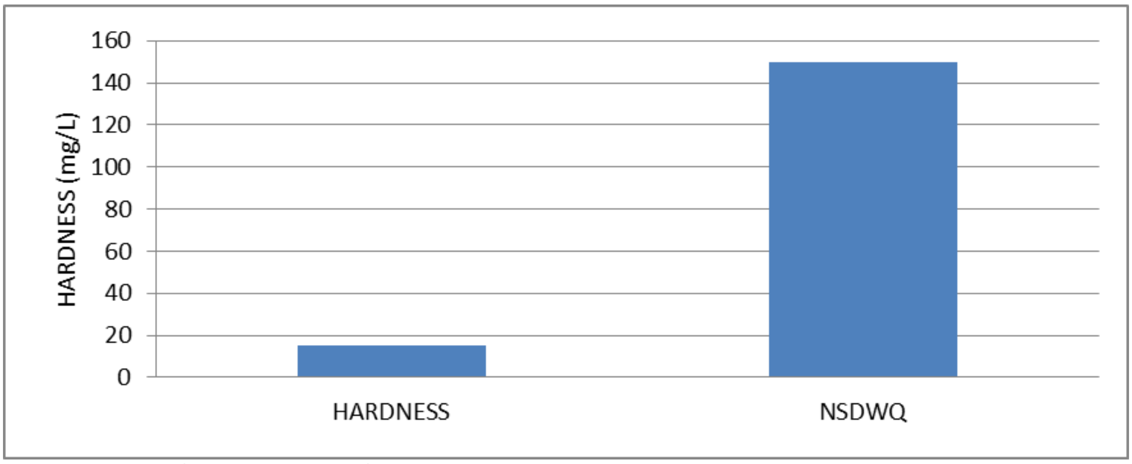

Figure 3.28: Chart for water quality for Hardness combined boreholes water in Dry Season

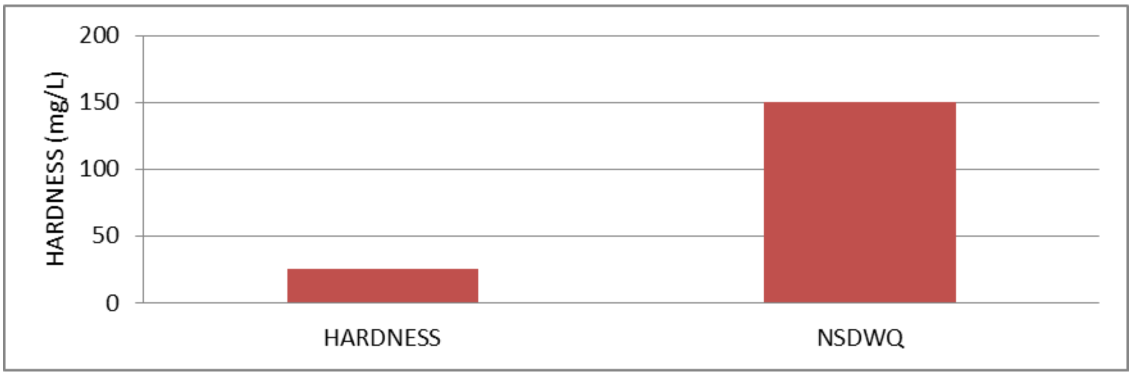

Figure 3.29: Chart for water quality for Hardness from combined water in Wet Season

The combined waters showed their suitability for drinking for two seasons, as their values were below the recommended limits given by NSDWQ as 150mg/l. It was shown that 15mg/L and 25mg/L were recorded in dry and wet season periods.

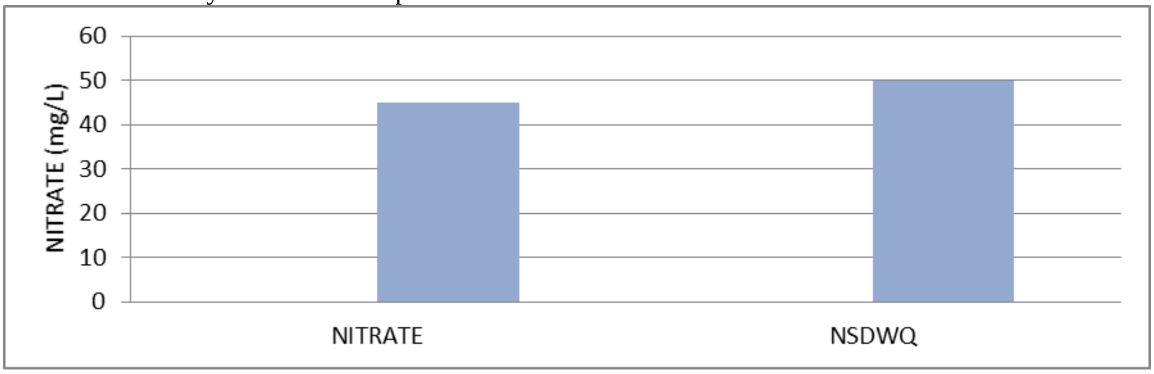

Figure 3.30: Chart for water quality for Nitrate combined boreholes water in Dry Season

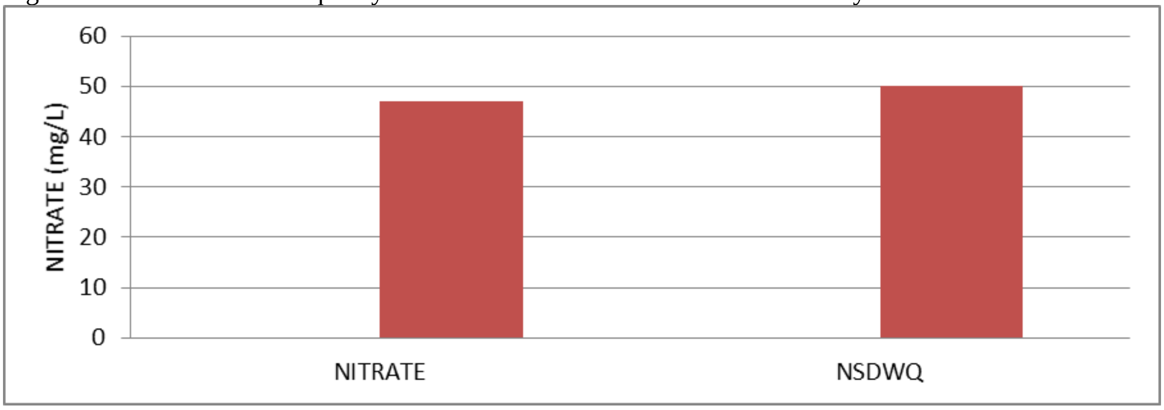

Figure 3.31: Chart for water quality for Nitrate from combined water in Wet Season

The nitrate content recorded for dry and wet season periods are 45mg/l and 47mg/l all are within the maximum permissible limit set by NSDWQ of 50mg/l.

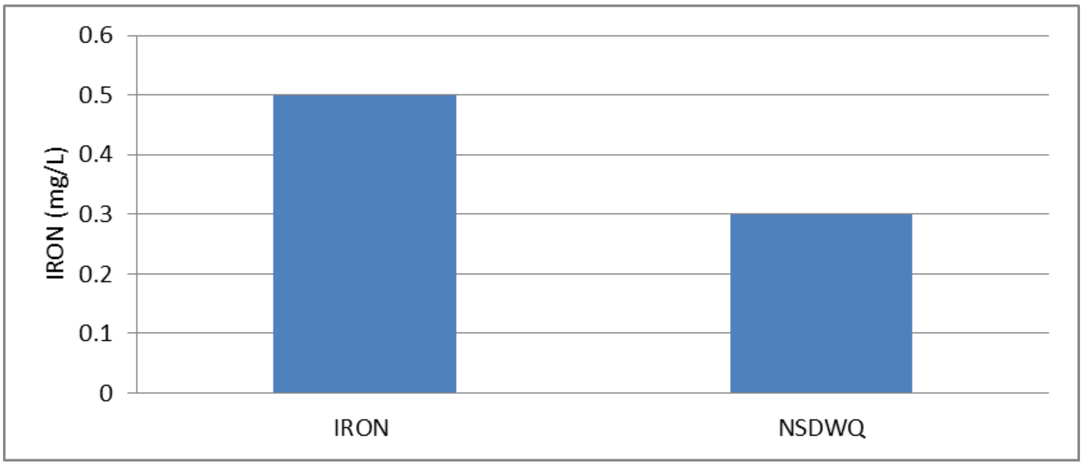

Figure 3.32: Chart showing water quality for Iron from combined water in Dry Season

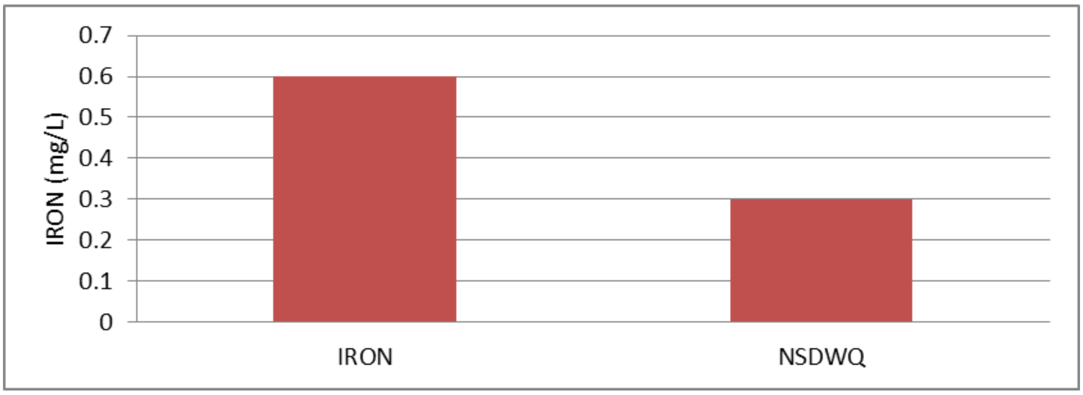

Figure 3.33: Chart showing water quality for Iron from combined water in Wet Season

The combined water falls under unacceptable limits of iron content; having up to 0.5mg/L and 0.6mg/L for dry and wet season. The iron content in the area is as a result of natural mineral content in the soil. Therefore this might possibly be attributed to the problems that encountered by the users of this water in the study area, therefore iron need to be checked and treat accordingly.

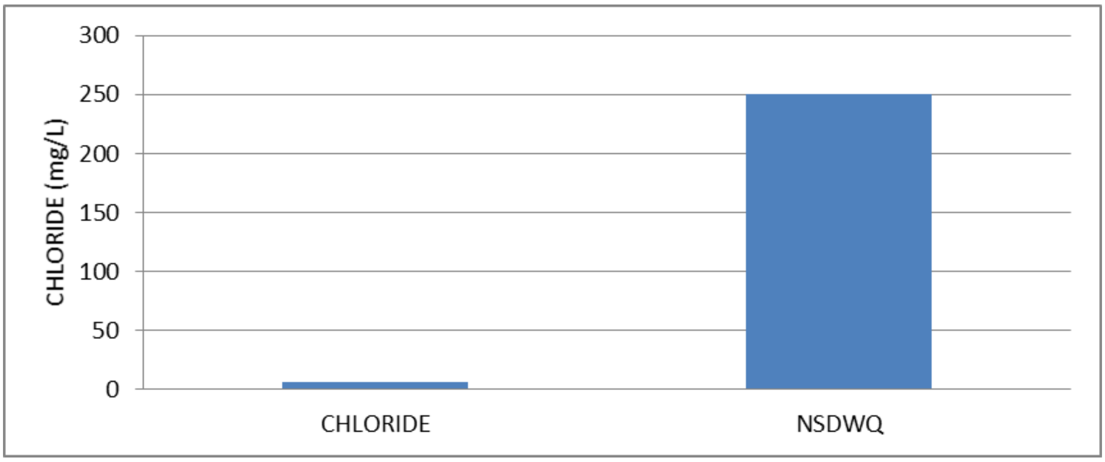

Figure 3.34: Chart of water quality for Chloride from combined water in Dry Season

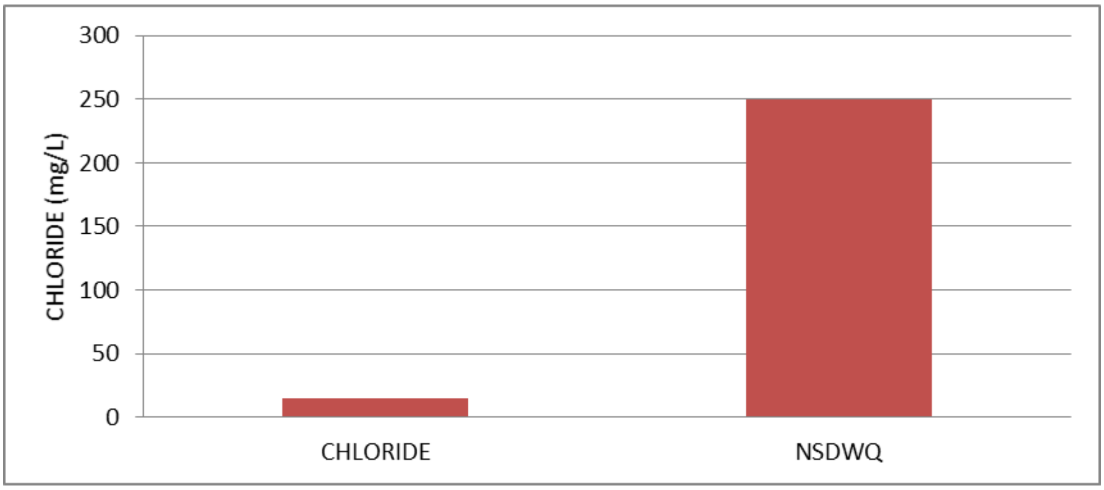

Figure 3.35: Chart of water quality for Chloride from combined water in Wet Season

Chloride level was investigated for all the samples and it was observed that this element was less detected in almost all the water samples. This could be attributed to the geological composition of the area, which can be said to be low in this element during dry and wet season. It was stipulated that the maximum level approved by SON for chloride in water to be safe for drinking should not outreached 250mg/L. Only 6mg/l and 15mg/l were detected in the combined water for both dry and rainy season periods respectively.

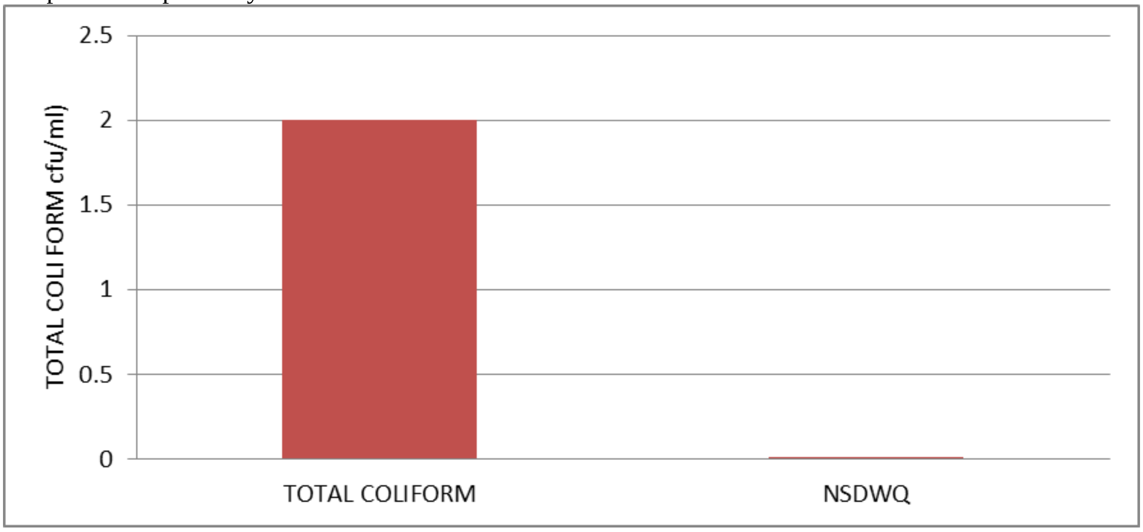

Figure 3.36: Chart of water quality for Total Coliform from combined water in Wet Season

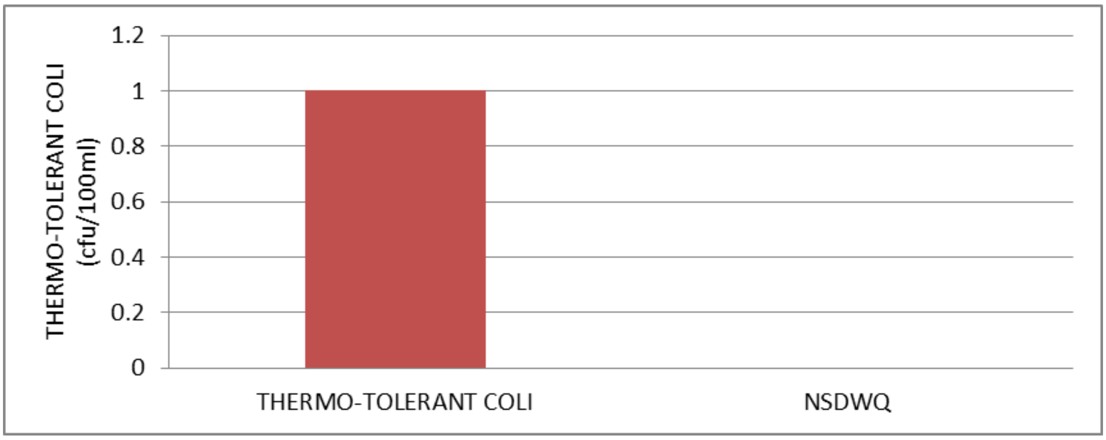

Figure 3.37: Water quality for Thermo-tolerant Coli from combined water in Wet Season

Coliforms are indicators of pathogens that cause various health problems. The combined water that distributed to the consumers was safe from coliform group as in dry season and it was detected in minute amount in the wet season that requires some disinfection treatment. This is quite related to the fact that: turbidity may indicate the presence of disease causing organisms which include bacteria, viruses, and parasites that can cause symptoms such as nausea, cramps, diarrhea, and associated illnesses (Regina, 2009).

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The physico-chemical and bacteriological analysis carried out for 40-boreholes and combined waters in the dry and wet season periods revealed that quite a number of parameters tested fall within the maximum permissible limits set by Nigerian regulatory authority (NSDWQ) that approved by SON in 2007.

The selection of parameters and the determination of maximum allowable limits have been conducted taking in to consideration the WHO guideline for drinking water quality (SON, 2007). However, the waters obtained from some of boreholes and combined borehole waters if used for drinking purpose could bring about some health problems. Findings showed that; all physico-chemical and bacteriological parameters analyzed in the combined water samples were within recommended standards except the following: turbidity had 7.9NTU in dry season and 7.3NTU in wet season and iron had 0.5mg/l in dry season and 0.6mg/l in wet season for combined water all generally above NSDWQ maximum permissible limit respectively. From forty boreholes, the most turbidity recorded from BH6 in dry season is 8NTU and in wet season BH5 and BH10 recorded 7NTU respectively. The iron recorded about 0.8mg/L from BH37 and 7mg/L from BH23 in dry and wet season respectively. Water for drinking should be safe from pollutants of these kinds, and NSDWQ stipulates that before a quantity of water can be declared safe and healthy it should not have any thermo-tolerant coliform bacteria at all. The combined water samples tested in wet season have some content of coli form bacteria.

The possible effects to the quality of these groundwaters may occur due to intrusion of contaminated water from the top of the boreholes during flooding which usually occur in the area during rainy season. Therefore the public should be properly educated on the dangers associated with drinking turbid water, water containing iron and coliform organisms.

4.2 RECOMMENDATIONS

Based on the results of the analysis carried out the following recommendations have been made:

- As a preventive measure to minimize the health threat associated with consumption of iron contaminated water, it is recommended that the combined boreholes water at Asari being supplied to consumers should be used for bathing, washing and other domestic needs.
- Alternatively, measures for treatment against turbidity and iron pollutants from these waters should be made before supplying to the public for use.
- The public should be enlightened on the need to allow debris and other particles to settle down at the bottom of the water container before use.
- The people should be enlightened to the method of simple water purification technology such as the use of local plant moringa olifera (Mangale et al, 2012) which speed up sedimentation of particles in water before drinking.
- Also there is need for frequent cleaning of the storage tank and new pipes should replaced the existing old ones used in the supply of water to the users.

1. REFERENCES

Adejo, Y., Bagudo, B.U., Tsafe, A. I., and Itodo, A.U. (2013). Physico-chemical Quality Assessment of Groundwater within Gusau Metropolis. *International Journal of Modern Analytical and* *separation Sciences*, 2013, 2(1): 1-19, ISSN: 2167-7778, Modern Scientific Press, Florida. USA.

Ahmed, S., Haruna, A. and Abubakar, U.Y. (2013). Assessment of Wash-Borehole Water Quality in Gombe Metropolis, Gombe State, Nigeria. *Journal of Environment and Earth Science*, ISSN. 2224-3216 (paper), Vol.3, No.1.

Bichi, M.H. (2013). Assessment Of Customer's Affordability and Willingness-To-Pay for water supply services in Dutse, Northern Nigeria. *Journal of the Faculty of Engineering Bayero University, Kano, Nigeria*, Vol.8-No.1, ISSN-1597-5835, pp.40-53.

Lawford, R.G. and Denise, D. F. (2003). *Water science, Policy and Management American Geophysical Union*, Washington D.C.

Mangale, S.M., Chonde, S.G. and Raut, P.D. (2012). Use of Moringa oleifera (Drumstick) seed as natural absorbent and an antimicrobial agent for groundwater treatment, Res. J. Recent Sci. 1(3) 31-40.

Raji, M.I.O and Ibrahim, Y.K.E. (2011). Prevalence of Waterborne Infections in Northwest Nigeria: A retrospective study. *Journal of Public Health and Epidemiology*, vol. 3(8), pp. 382 – 385, August 2011.

Regina. (2009). Saskatchewan Disease Control Laboratory. 1-866-450-0000. Website: http:/www.health.gov.sk.ca/lab, www.Sask$H_2$0.ca.

SON, (2007) Nigerian Industrial Standard (NIS 554:2007), Nigerian Standard for Drinking Water Quality (NSDWQ), ICS 13.060.20. Approved by SON governing council.