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The Effect of Septic Tank Locations on Borehole Water Quality in Port Harcourt, Nigeria.

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ABSTRACT

The effect of septic tank locations on borehole water quality in five locations in Port Harcourt metropolis of Rivers State, Nigeria, was investigated. The locations were Miles I and III, Old GRA, Rukpokwu and Ada George. Three boreholes and septic tanks were involve in each location. The distance between each borehole and septic tank was measured while water sample from each borehole was analysed for parameters such as appearance, taste, pH, electrical conductivity, temperature, salinity, and turbidity. Other parameters were total dissolved solid (TDS), phosphate, sulphate, nitrate, ammonium, chlorides, alkalinity, dissolved oxygen, bio-chemical oxygen demand, total heterotrophic bacteria (THB), total coliform bacteria (TCB) and faecal count bacteria (FCB). The results obtained from the various locations were compared with WHO drinking water quality standard. From the results, there was no problem with appearance and taste. However, the highest pH value was 4.4 from both Mile III and Ada George, with distance between borehole and septic tank of 6m and 9m respectively. The pH value is below that recommended by WHO (6.5-8.5), thus indicating that the water from all the locations, irrespective of distance between boreholes and septic tanks, is acidic. For Salinity, only water samples from Old GRA and Rukpokwu (0.1mg/l each) were outside WHO's specified limit of 0.05mg/l, despite the varying distances between boreholes and septic tanks. Water samples from all the other locations were also within the recommended WHO's limit for TDS, sulphate, nitrate and chloride. For total heterotrophic bacteria (THB), total coliform bacteria (TCB) and faecal count bacteria (FCB) only water samples from Ada George have values greater than that recommended by WHO. Water from Ada George, irrespective of distances between borehole and septic tank has the highest coliform contamination, thus rendering the water unsuitable for human consumption.

Key words: *septic tank, borehole, Port Harcourt, Nigeria.*

1. INTRODUCTION

Underground water being the water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations has been polluted via industrialization and urbanization that has progressively developed over time without any regard for environmental consequences which eventually result in the deterioration of physico-chemical and biological properties of water, (Longe and Balogun, 2010). Most water distribution facilities do not deliver or have failed to meet the water requirement of the served community due to corruption, lack of maintenance or increased population. The paucity of piped water has made communities to find alternative source of water, and groundwater source has been a ready source, (Adelekan, 2010). There is also no central wastewater treatment system in town. Every landlord is therefore compelled to install septic tanks and soak-aways in order to dispose of the domestic wastewater. However, in a desperate effort to obtain potable water, these landlords have also drilled boreholes to tap the groundwater, but without taking into cognizance the distances of these boreholes from septic tanks and soak-aways. Although water from boreholes can be polluted through other means,(Onunkwo and Uzoiji, 2011), the most common cause of pollution is attributable to close proximity of septic tanks to boreholes especially where the adjoining geological formation is fissured. A septic tank stores waste for a period during which it undergoes pre-treatment. About 70% of the waste contains germs and pathogens which pose real threat of contamination and diseases and is therefore very dangerous to human life (Fosse Septique , 2008). Septic tanks have been found to fail and leak profusely, causing environmental damage (Sincere et al., 2006). This can serve as a vehicle for spreading illness caused by such microorganisms as Vibrio

Cholera, Yersinia Enterocolitica, Escherichia Coli and vector borne diseases such as guinea worm, schistosomiasis, Lymphatic Filariosis, parasitic and viral infections (Mackenzie et al., 1995). When septic systems are located in a sandy or coarser soil on a property adjoining a water body, phosphate will progress beyond the treatment area and because of the limited practice surface area, pose a threat to the surface water leading to aging and saturation of soils by phosphate (Burubai, 2005) . Once polluted, ground water is very slow to clean (Sincero et al., 2006) . The main objective of this study, therefore, was to determine the extent to which the locations (in terms of distances) of septic tanks can affect the quality of borehole water.

2. MATERIALS AND METHODS

2.1 Description of Study Area:

The Project was carried out at five different locations in Port Harcourt metropolis of Nigeria. The locations are mile I, mile III, Ada George, Rukpokwu and Old GRA. Port Harcourt is characterized by high humidity (≥80%), moderately high temperature (25-30^{0}C), and predominantly southern wind except slight harmattan influence in December through February. The area is also characterised by heavy rainfall, about 370 mm per year, occurring mostly in the months of June through September.

2.2 Sampling Procedures :

For each location, two different samples were collected from the boreholes, one sample for the analysis of physical and chemical characteristics and the other for microbiological characteristics. The water was first collected in a bowl and the thermometer was placed in the bowl to read the temperatures of the water to be analysed. Then, the water from the boreholes was allowed to flow for ten seconds before collection. Distance between the boreholes and septic tanks were measured with a tape.

2.3 Laboratory Analysis

The water samples were taken to the Institute of Pollution Studies of the Rivers State University of Science and Technology, Port Harcourt, Nigeria, for analysis. The parameters analysed were appearance, taste, pH, electrical conductivity, temperature, salinity, turbidity, and total dissolved solid. Other parameters were phosphate, sulphate, nitrate, ammonium, chlorides, alkalinity, dissolved oxygen, bio-chemical oxygen demand, total heterotrophic bacteria, total coliform bacteria and faecal count bacteria.

The taste and appearance was done using organoleptic while the pH, conductivity, turbidity and salinity were measured using Horiba Water Checker (Model U-10) after calibrating the instrument with the standard Horiba solution. The total dissolved solids were measured using gravimetric method (APHA 1995) and sulphate determination was made by the turbid metric method (APHA, 1985). Phosphate was determined using the stannous chloride method (APHA, 1985) while, nitrate measurement was by the Brucine method (APHA, 1979). Also**,** ammonium-nitrogen was determined using the phenate method (APHA 1985) and chloride was determined by the Argentometric titration method (APHA, 1985). The total alkalinity determination involved the titration of 50 ml sample, containing 5 drops methyl orange indicator with 0.02N H2SO4 solution and detection limit is 1.0 mg/l as $CaCO_3$ (APHA 1985).The dissolved oxygen was determined by the Modified Azide or Winkler's method (APHA, 1985). For the bio-chemical oxygen demand, water sample was incubated at 20ºC for five days. To ensure presence of oxygen, the BOD samples were diluted before incubation and the BOD5 calculated using the following equation (Ayotamuno, et al., 2007.)

BOD5 = (A - B) x DF

Where: A = Initial DO of dilution water, B =DO after 5-day incubation and DF = is dilution factor of sample to dilution water.

The spread plate technique with Nutrient Agar was used for Total Heterotrophic Bacteria (THB) while the Most Probable Number (MPN) technique using Mac-Conkey broth in tubes and incubating at 37°C for 24 hours was used for the estimation of Total Coliform.

RESULTS AND DISCUSSION

The results obtained from the analysis are presented in Table 1.

Table 1. Water quality parameters of boreholes at various distances from septic tanks in five locations in Port Harcourt metropolis, Nigeria

PARAMETERS / Location	Mile I			Mile III			Old GRA			Rukpokwu			Ada George			W.H.O STANDARD
Distance between borehole and septic tank (m)	**3**	**6**	**9**	**3**	**6**	**9**	**3**	**6**	**9**	**3**	**6**	**9**	**3**	**6**	**9**	
APPEARANCE	clear	Clear	Clear	Clear	clear	clear	Clear	clear	clear	Clear	clear	clear	Clear	clear	clear	Clear
TASTE	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	INOFFENSIVE
pH	4.1	3.8	3.8	4.2	4.4	4.3	3.5	3.6	3.9	3.6	3.6	3.8	4.3	4.3	4.4	6.5-8.5
ELECTRICAL CONDUCTIVITY (μs/cm)	132	132	133	135	138	138	182	185	187	182	183	185	36	38	38	1000 μs/cm
TEMPERATURE ^{O}C	27.2	27.8	27.6	27.4	27.2	27.4	27.4	27.2	27.6	27.3	27.6	27.2	27.4	27.6	27.2	
SALINITY	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.05mg/l
TURBIDITY (NTU)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5 N.T.U
TOTAL DISSOLVED SOLID (mg/l)	82	88	88	89	90	86	126	126	124	121	120	120	33	30	32	600mg/l
PHOSPHATE AS PO_4 (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
SULPHATES AS SO_4 (mg/l)	1.4	1.3	1.6	2.4	2.1	2.4	5.2	5.2	5.4	5.0	5.1	5.3	2.3	2.2	2.3	250mg/l
NITRATE AS NO_3 (mg/l)	3.6	3.3	3.2	2.4	2.0	2.0	3.6	3.0	3.2	3.3	3.3	3.1	0.9	0.6	0.3	**50mg/l**
AMMONIUM AS NH_4 (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.4	1.2	1.2	0.9	0.9	0.6	<0.05	<0.05	<0.05	0.50 mg/l
CHLORIDES AS Cl (mg/l)	11.2	11.0	10.9	10.4	10.6	10.2	10.6	10.3	9.9	13.8	13.8	13.4	3.5	3.3	3.2	250 mg/l
ALKALINITY AS $CaCO_3$ (mg/l)	N.D	N.D	N.D	2.0	2.2	2.0	N.D	N.D	N.D	N.D	N.D	N.D	2.0	2.2	2.2	30-500mg/l
DISSOLVED OXYGEN (mg/l)	6.4	6.5	6.7	7.7	7.2	7.9	7.7	7.2	7.9	6.7	6.9	7.1	7.7	7.2	7.8	
BIO-CHEMICAL OXYGEN DEMAND (mg/l)	1.6	1.5	1.5	1.6	1.2	1.4	1.6	1.6	1.8	0.8	0.6	0.8	2.4	2.2	2.2	
TOTAL HETEROTROPHIC BACTERIA (cfu/ml)	52	52	50	30	28	26	79	76	70	20	20	18	120	118	114	Max of 100cfu/ml
TOTAL COLIFORM BACTERIA (mpn index/100ml)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20	19	16	0-10 MPN/100ml
FAECAL COUNT BACTERIA (mpn index/100ml)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10	10	8	0-2 MPN/100ml

Since the various sites are built-up areas, it was not feasible to embark on comparative analysis of the various results obtained from the different sites because of the inability to ascertain the actual soil formation at each site or location.

However , Table 1 indicates that all the physico-chemical properties except pH in all the locations, and ammonium in two locations (old G.R.A. and Rukpokwu) satisfy WHO standards despite the varying distances between septic tanks and boreholes.For pH, WHO recommended 6.5-8.5, but none of the water samples from the locations is within the recommended range despite the varying distances between boreholes and septic tanks. The low pH values indicate that the water in each location is acidic. It also indicates that the water from these sources has corrosive tendencies and could cause corrosion of distribution lines if such lines are metallic (Twort et al.,1979). The recommended range for alkalinity is between 30-500mg/l but all the values obtained from the locations are lower than the least value . Alkalinity in water should be sufficient to enable floc formation during coagulation but must not be high enough to cause physiological distress in humans. Conductivity is the measure of the activity of all dissolved ionised solids in water. Compared with the standard set by the WHO, the conductivity values of all the water samples are below the maximum allowable. This is also true for salinity. Turbidity, total dissolved solids, sulphate, nitrate, chloride, dissolved oxygen and biochemical oxygen demand are all within the acceptable range and therefore pose no threat to the water source, (Bond and Straub, 1972). Although there is no WHO guideline in respect of phosphate, larger amount may give rise to a bitter taste in water. (Twort et al., 1979).

For old GRA and Rukpokwu, the ammonium values ranges from 0.6 to 1.4mg/l irrespective of the distances of boreholes from septic tanks. These values are beyond the WHO recommended limits of 0.5mg/l. Twort et al., (1979) posit, however, that firm conclusions regarding the nature of any pollution can not be drawn from the ammonia figures as some well waters containing high amount of ammonia are quite wholesome.

Table 1 further shows that the variations between the various parameters and the borehole-septic tank distances do not indicate any consistent trend. For example, Figures 1-3 depict the trends for Total Dissolved Solids, Chloride and Total Heterotrophic Bacteria, and these do not indicate any form of consistency.

However bacteria count is one of the most critical parameters in water quality. Based on this premise, water samples from Mile I, Mile III, Old GRA and Rukpokwu are potable as the values of total heterotrophic bacteria , total count bacteria and faecal count bacteria are within the acceptable WHO recommended standard. It is only water from Ada George that is problematic, as each of the bacteria count is more than that recommended by WHO. The water is therefore not wholesome.

Although WHO (1997) recommended that the minimum distance between boreholes and septic tanks should be 30m, the maximum distance used in this study was 9m. This is due to the fragmented nature of individual land holdings. The plot sizes are quit small and every land lord , in order to maximize space for the main buildings, leaves very small space for septic tanks and boreholes at close proximity to the buildings.

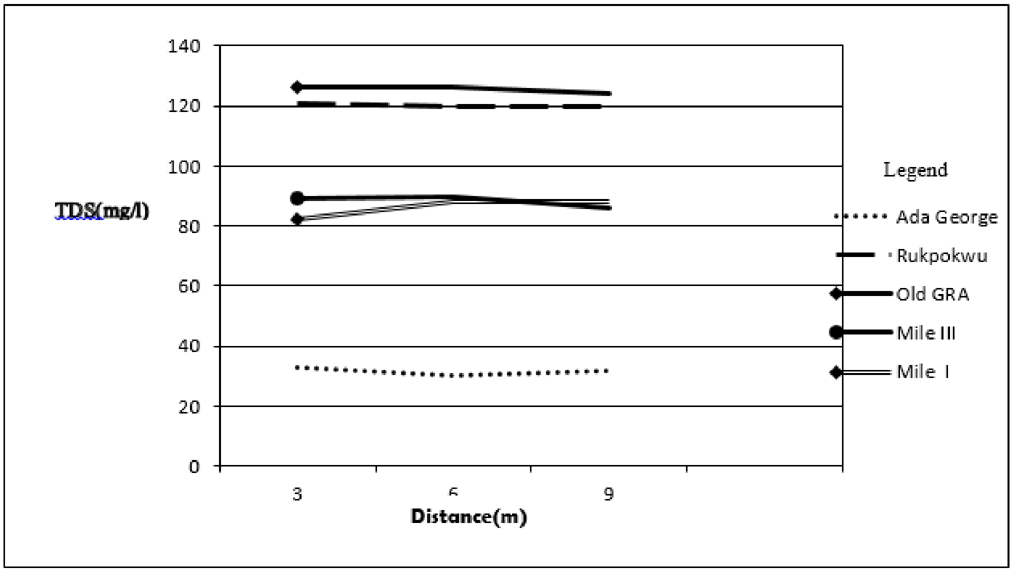

Fig 1. Total Dissolved Solids (TDS) versus distances between septic tanks and boreholes

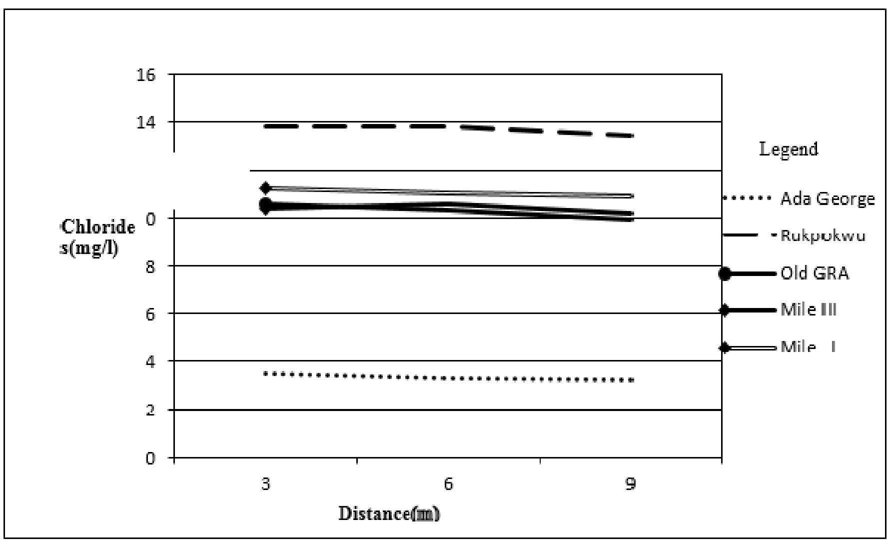

Fig 2. Chlorides versus distances between septic tanks and boreholes

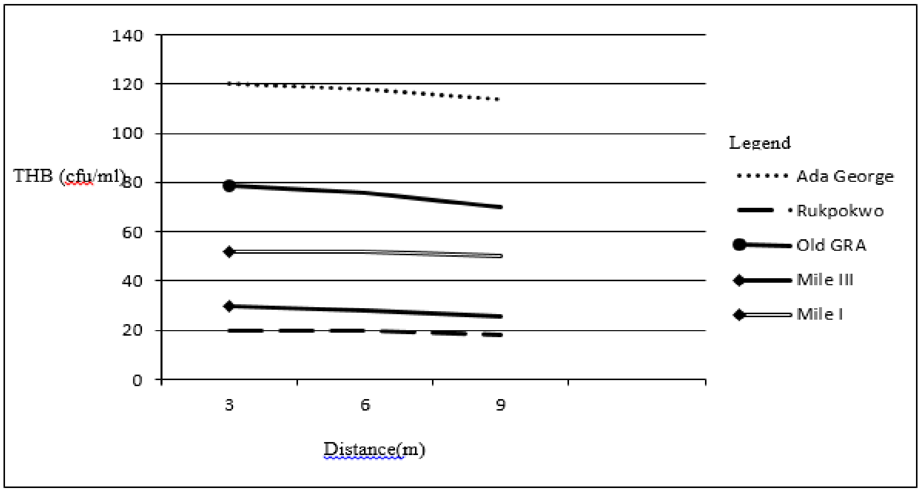

Fig 3. Total Heterotrophic Bacteria (THS) versus distances between septic tanks and boreholes

3. CONCLUSION

The study showed that all the physico-chemical parameters except pH in all the locations and ammonium in two locations (Old GRA and Rukpokwu) are within the WHO recommended limits. The pH values in all the locations are less than the allowable range, thus indicating that the water is acidic.

Furthermore, water samples from Ada George contain some level of coliform and E. coli pollution. The greatest threat posed to the public health arises from microbiological contamination of water sources, hence water from this source is unwholesome and should therefore be treated before use.
The distance of septic tanks from boreholes in the areas investigated did not conform with that recommended by WHO.

RECOMMENDATIONS

The following recommendations were made in an attempt to enhance and promote the quality and suitability of the water sources:

1. There is need to ensure continuous monitoring of our drinking water in borehole source especially as industrialization and population are on the increase in Port Harcourt.

2. A proper agency should be established to monitor the siting of borehole and provide early warning of groundwater contamination.

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