GROUND AND SURFACE WATER QUALITY ASSESSMENT WITHIN SOUTHWESTERN PART OF NIGERIA

BY

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LSC2010830

(B.Sc. IN GEOLOGY & MINING TECHNIQUES OPTION)

DEPARTMENT OF SCIENCE LABORATORY TECHNOLOGY
FACULTY OF LIFE SCIENCES
UNIVERSITY OF BENIN, BENIN CITY.

FEBUARY, 2025

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IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE (B.Sc. IN GEOLOGY & MINING TECHNIQUES OPTION) HONOURS IN SCIENCE LABORATORY TECHNOLOGY

FEBRARY, 2025

CERTIFICATION

This is to certify that this project was carried out by Happiness AUGUSTINE (Miss) with Matriculation Number, LSC 2010830, of the Department of Science Laboratory Technology, Faculty of Life Sciences, University of Benin, Benin City, Edo State.

Mr. P. BASSEY **DATE**

Project Supervisor

DR. P. O. ALONGE **DATE**

(Project Coordinator)

PROF. E. O. OSHOMOH **DATE**

(Head of Department)

External Examiner **DATE**

DEDICATION

I dedicate this work to Almighty God for the strength and grace for me to be able to complete this project and also to my dear mother.

ACKNOWLEDGEMENTS

I will first of all thank God Almighty for giving me the grace and capacity to prepare this work. It is by His mercies I am among the favoured.

Special acknowledgements to my wonderful parents, Mr. and Mrs. Augustine. To all my siblings, friends and acquaintances for their moral support.

I want to appreciate my esteemed Project Supervisor, Mr. Peter Bassey, whose immense assistance had helped to have a smooth final year project work. His constructive criticism as well as correction of write-ups and suggestions that made this research work an impeccable success.

I also want to appreciate the Head of Department, Dr. E.O. Oshomoh, and the entire Science Laboratory Technology Staff. Special appreciation to Geology and Mining Techniques Option Staff, University of Benin.

I also want to acknowledge and appreciate Dr. Ken Ojeaga, Mr Ekhator, Mr Oscar and Mr Uzama for their advise throughout my pursuit.

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ABSTRACT

This study was carried out in the southwestern part of Nigeria in Ondo State which lies within Latitude 7° 09' 50.1" and 7° 12' 20.6"N, and Longitude 5° 13' 30.5"E and 5° 14' 30.1", with the aim of assessing the physical, microbial and chemical parameters of the groundwater. Random sampling technique was employed in obtaining water samples from both the surface and groundwater in the study area. A sterilized one liter plastic bottle was used to collect water samples and were immediately transported to the laboratory for physico-chemical and microbial analysis. A total of ten (10) water samples were collected; seven (7) groundwater samples and three (3) river samples. The physicochemical parameters determined and values obtained are as follows: Electrical conductivity ranged 300 and 960us/cm, Temperature 25.00 to 25.01℃, pH of 6.6-9.2 with a mean value of 6.9, TDS shows a mean valve of 25.69mg/l, COD from 5-18.4 mg/liter with mean value of 10.65mg/liter, Turbidity ranged 1.5 to 6.0 NTU with mean valve of 1.03NTU, Cl^- 106.50 to 426.00mg/l, SO_4^{2-} 0.41 to 2.87 mg/l, TSS shows a mean value of 0.411mg/l, TS 1.33 to 4.33 mg/l, NO_3^- 23.73 to 41.48mg/l, Mg ranged from 0.42 to 0.67 mg/liter which is within the WHO limit with mean valve of 0.41mg/l, Ca 0.10 to 0.41 mg/l, HCO_3^- 7.00 to 22.00mg/l, Na ranged from 2.8 to 3.9 mg/liter with mean value of 1.47mg/litre, K 0.41 to 1.20 mg/l, Mn 0.01 to 0.11 mg/l, Fe 0.01 to 0.02 mg/l, Zn 0.01 to 0.65 mg/l, PO_4^- 0.07 mg/l for all locations. Pb showed a mean value of 0. 011mg/litre. Result of analysis revealed that the ground and surface water in the study area appears to be generally potable, due to concentration of heavy metals being mostly under/within the WHO standard regulation. The pH, salinity and electrical conductivity in the study area was moderate. The colour for some samples were brownish – colourless. The presence of microbial organisms in water is from sewages, septic tanks, and animal faeces. The surface water found within the study area is Ofuso River. The water quality in the study area is generally potable.

CHAPTER ONE

INTRODUCTION

1.2 GENERAL INTRODUCTION

The typical person's body weight is made up of 65-75% water (Annan, 2005 & Idiata; 2006 & Fox, 1996). Even though the importance of having access to pure water for human health cannot be emphasized, it is estimated that more than 25,000 people pass away every day from diseases that are transmitted through water (Train, 1976; Davis and Cornwell, 1991). Only 0.3% of the water on Earth is actually fit for human consumption. According to Adekoya et al. (2003), useless water includes things like ice, salinity, and atmospheric water vapor.

Groundwater pollution a simply a deviation from the normal, of the physico-chemical and bacteriological parameters. However, there are activities that can cause public health hazards, but does adversely affect such water for domestic, farm, municipal or industrial use (Akhilesh *et al.*, 2009; Weiss, 1974 and Ogbonna *et al.*, 2006). Natural water system generally contains trace elements in small concentrations. Yahaya *et al*. (2009) had reported that their occurrence in groundwater and surface water can be due to natural sources such as dissolution of naturally occurring minerals that contain trace elements within the soil or the aquifer material or to anthropogenic activities such as fuels, mining, smelting of ores and illicit waste disposal. According to Yahaya *et al*. (2009), investigation of heavy metals is very essential since slight changes in their concentration above the acceptable levels, whether due to natural or anthropogenic factors, can result in serious environmental and subsequent health problems.

The importance of water to life will never be over-emphasized, as water is precious and necessary for a sustainable economic development of an area. Over the years, groundwater had served many purposes to the human existence as it has been intensively exploited for private, domestic and industrial uses. Ajibade *et al*. (2011) reported that 90% of the population depend largely on hand-dug wells. They further informed that rapid growth in industrial activities, urban populations, agricultural and commercial developments result in increase in the search and uses of potable water.

It is worthy of note that trace amount of some heavy metals are required by living organisms, any excess amount of these metals can be detrimental to life (Berti and Jacobs, 1996; Akhilesh *et al*., 2009). Martinez and Motto (2000) had reported that the solubility of these metals in soils and groundwater is largely controlled by cation exchange capacity, organic carbon content and pH amount of metal (Elliot *et al*., 1986) and the redox potential of the system as well as the oxidation state of mineral components (Connell and Miller, 1984).

According to Martinez and Motto (2000), underground water has served as a useful source of water supply to man via through hand dug wells, springs and boreholes, over the years. It becomes necessary to access critically their quality and portability for human consumption, due to their increasing popularity as a veritable source of water supply. It is on this premise that this investigation was carried out to access and evaluate the amount of contamination of groundwater in the study area.

1.3 SCOPE OF STUDY

The scope of this study include water samples collection from the study area, samples analysis and interpretation of data.

1.3 LOCATION OF STUDY

This study area is within the city of Akure in Ondo State, which lies within Latitude 7° 09’ 50.1” and 7° 12’ 20.6”N, and Longitude 5° 13’ 30.5”E and 5° 14’ 30.1”.

1.4 AIM AND OBJECTIVES

AIM

The aim of this study is to access the groundwater quality in the study area via examining the physico-chemical and bacteriological parameters.

OBJECTIVES

For the aim to be achieved, the following objectives are employed:

a) Sampling the study area
b) Examine water samples from the area
c) Examine environmental and health implications.

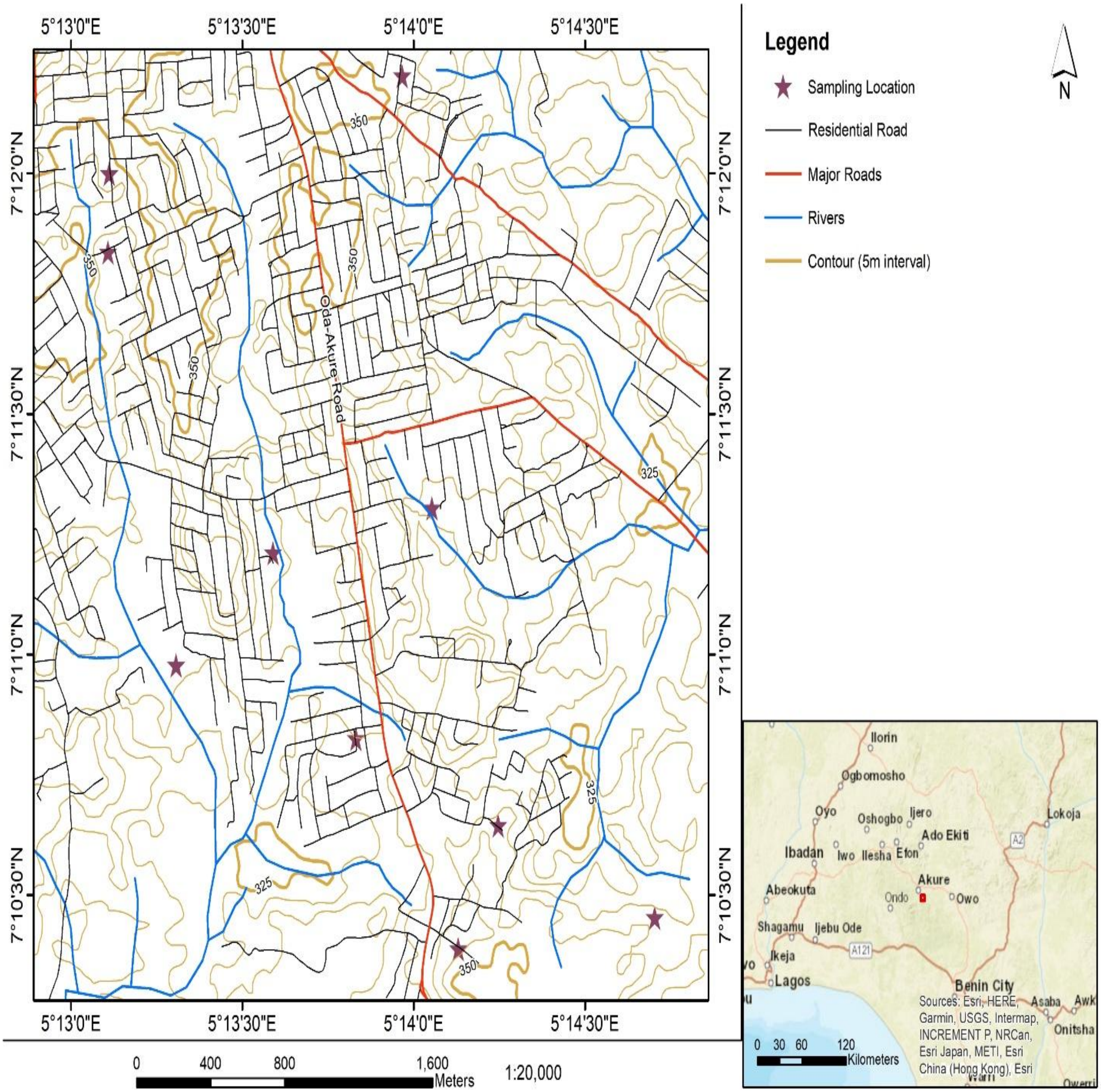

Fig. 1: Map showing sampled locations

CHAPTER TWO

2.0 LITERATURE REVIEW

The provision of potable and adequate water supply to the rapidly growing urban population is increasingly becoming a problem for world leaders throughout the world. This situation have threatened the available water resources due to the ever increasing demand for potable water by the increasing population but also through diminishing quality caused by pollution and saline intrusion (Idiata, 2006). According to Idiata (2006), similar research carried in Edo South area of the state it shows that the groundwater in the area needs minimal treatment to be fit for drinking. Henley (2000) also informed that the Nigerian Government has long considered the provision of water supply and sanitation services to be the domain of the local, state and federal governments.

According to Wright (1992), Basement Complex rocks of the southwestern Nigeria and groundwater in this environment is usually contained in the weathered and/or fractured basement rocks or alluvial deposits within flood plains. Mogaji *et al*., (2011) stated that Basement Complex rocks are known for their characteristic low porosity and negligible permeability except in cases of heavy weathering. As such, good permeability development in the form of interconnected network of joints and fractures usually presents a favorable hydrogeological setting.

Toxic metals are usually present in urban, industrial and municipal runoff, which can be harmful to humans and biotic life. Increased industrialization and urbanization are to be blamed for the spike in the level of trace metals, in water system.

According to Bayode *et al*. (2006), groundwater in a typical basement complex area is contained in two major aquifer units, namely fractured basement and weathered aquifers, and the latter is derived from chemical alteration processes while the former is as a result of tectonic activities. However, in some cases, the fractured aquifer may occur singly or in combination with the weathered layer aquifer.

2.1 REGIONAL GEOLOGY

The Precambrian Basement Complex of Southwestern Nigeria underlies Ondo State, which is also makes up the Basement Complex Rocks of Nigeria. This Basement Complex, importantly, is one of the three major litho-petrological components that consistute the geology of Nigeria.

The Basement Complex of Nigeria forms a part of the Pan – African Mobile belt and lies between the Congo Cratons and West African Cratons (Black, 1980). It is intruded by the Mesozoic Calc-Alkaline ring complexes (Younger granites) of the Jos plateau and it unconformably underlies the younger and cretaceous sediments. Dada (2006) had earlier reported that the Nigerian basement complex was affected by the 600 Ma Pan African Orogeny and it occupies the reactivated region which resulted from Plate collision between the active Pharusian continental margin and the passive continental margin of the West African craton. The Basement rocks are believed to be the results of at least four major Orogenic cycles of deformation, metamorphism and remobilization, corresponding to the Liberian (2,700 Ma), the Eburrnean (2500 Ma), The Kibaran (1,100 Ma), and the Pan-African cycles (600 Ma). The first three cycles had been characterized by intense deformation that resulted in isoclinals folding accompanied by regional metamorphism, which was immediately followed by extensive and intense migmatization. A regional meta-induced syntectonic granites and homogenous gneisses accompanied the Pan-African deformation. The End stages of this last deformation was accompanied by Late tectonic emplacement of granites and granodiorites and associated contact metamorphism accompanied. According to Gandu *et al*. (1986), the end of the orogeny was marked by faulting and fracturing. Anifowose (2004) was of the opinion that the Granitic emplacement was probably controlled by fractures within the Basement, and also showed outcrop pattern indicating that the older Granite cut across all other structures with sharp and chilled contact. Rahaman (1976) had earlier informed that within the basement complex of Nigeria, four major petro-lithological Units are distinguishable namely:

I. Medium to Coarse Granite,
II. The Charnockitic rock
III. The Undifferentiated Granite,
IV. The Migmatite – Gneiss Complex.

2.2 LOCAL GEOLOGY

The Migmatite–Gneiss Complex of the Precambrian Basement Complex of southwestern Nigeria underlies the study area. Migmatite–Gneiss Complex have metamorphosed from pre-existing igneous rocks, however, the migmatite which appears to be a mixed rock, containing both igneous and metamorphic features (Dada, 2006), was found in many parts of the area as outcrops.

2.2.1 MIGMATITE – GNEISS COMPLEX

The most widespread and presumably, the oldest group of rocks found in the study area he migmatite-gneiss complex is presumably. Although, its occurrence is not restricted since it is found in the entire study area. The structures observed on the outcrop in the study area include joints, folds, cracks and veins, while the texture of the migmatite-gneiss-quartzite complex in the study area varies from fine grained to medium grained. Mica, quartz, plagioclase, and hornblende dominate the mineral assemblages. Prominent foliation were found on the migmatite - gneiss rocks which are extensively weathered and fractured in the study area. The migmatite - gneiss complex is composed of grey gneiss, granite gneiss and quartzite. Although, granite gneiss occurs as slightly elevated to hilly outcrops, the rock units generally occur as low-lying outcrops in the study area.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 MATERIALS

From the study area, random sampling technique was employed in obtaining water samples from both the surface and groundwater in the study area. A sterilized one liter plastic bottle was used to collect water samples and were immediately transported to the laboratory for physico-chemical and microbial analysis. A total of ten (10) water samples were collected; seven (7) groundwater samples and three (3) river samples.

3.1.1 SAMPLING

A total of 10 samples were collected from the study area, 6 well samples, 1 borehole samples and 3 rivers. Samples were taken to the laboratory for physico-chemical and microbial analysis.

Plate 1: Storage water samples collected in the study area

3.2 METHODS

3.2.1 DETERMINATION OF PHOSPHORUS

Procedure

From the samples collected, 50 ml of the water sample was pipetted into a 500 ml volumetric flask, 3 ml of ascorbic acid and 5 ml of Ammonium Molybdate solution were added with stirring. Then, the mixture was diluted to the mark with deionized water and was allowed to stand for 30 mins so as to allow for maximum color development. Thereafter, the absorbance was read at 660nm including the blank.

Calculation

$$\textbf{P (ppm)} = \frac{\text{Instr.Reading x Slop Recip.x Colour Vol.}}{\text{Aliquot Taken)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{Eqn. 1}$$

3.2.2 DETERMINATION OF TOTAL HYDROCARBONS

Measure 50ml of the water sample into 150ml separating funnel. Add 10ml of Hexane; shake for 2 minutes manually, remove the stopper and allow settling for 20minutes.Drain off the water layer and collecting the Hexane layer and reading at 460nm.Use the Hexane as the Blank.

THC Standard Stock, 1000ppm

Pipette 1.18ml of Forcados Blend Crude Oil and make to 1 litre with n-Hexane. From this prepare 0, 10, 20, 40, 60, 80 and 100ppm working standards.

Calculation

THC (mg/l) = Instr.Reading x Slope Reciprocal x 25 x 20………………………………….. Eqn.2

3.2.3 DETERMINATION OF AMMONIUM NITROGEN

5 ml of the filtrate from the Sodium Acetate extract were pippetted, and 2.5 ml of Alkaline Phenol added. 1 ml Sodium Potassium Tartrate and 2.5ml of Sodium Hypochlorite or Bleach, while shaking properly in between each addition. The standard was also treated similarly and read colorimetrically against the ppm as blank at 636nm.

Calculation

NH_4N (ppm as mg/l) = $\frac{\text{IR x SR x Colour Vol}}{\text{Aliquot taken}}$………………………………………….…….. Eqn.3

3.2.4 DETERMINATION OF NITRATE (NO_3)

Into a 50 ml volumetric flask, 10 ml of the water sample was pipetted. 10 ml of 13N sulphuric acid was then added and mixed with stirring. The flask was allowed to come to a thermal equilibrium in cold water bath (0 - 10) °C. Moreover, 0.5 ml of brocine-sulfanilic acid was introduced and diluted to the mark with deionized water and the solution placed on the 100 °C hot water bath for about 25 minutes so as to allow for maximum color development. Thereafter, the flask was cooled to room temperature and the absorbance read at 410nm, including the blank.

3.2.5 DETERMINATION OF SULPHATE $(SO_4)^{-2}$

Procedure

10 ml of the filtrate was pippetted into a 50 ml flask and water added to raise the volume to 20 ml. Then, 1 ml of the Gelatine – $BaCl_2$ reagent was added and allowed to stand for 30 minutes, and made to mark with water. The solution was properly stirred to allow homogeneity and the standard treated similarly. The turbidity was read at 420nm in a spectrophotometer.

3.2.6 DETERMINATION OF CHLORIDE BY SILVER NITRATE TITRATION

Procedure

50ml aliquot, then add 2 drops of phenolphthalein indicator. 2 drops methyl orange, 3 drops of 0.025M H_2SO_4 (to bring it to methyl orange endpoint). 1ml 2% Potassium Chromate. Then titrate with the 0.05M $AgNO_3$ solution, to obtain deep brown as end point.

(0.05 x T x 35.5 x 1000/50 mg/L = 1775/50 = 35.5T)

Calculations

Cl (mg/for water) = $\frac{\text{Molarity} \times \text{Titre} \times \text{Mol. Wt.} \times 1000}{\text{Aliquot taken}}$………………..…………………..….. Eqn. 4

3.2.7 DETERMINATION OF CHEMICAL OXYGEN DEMAND (COD)

Procedure

50 ml of water sample was pippetted into a conical flask and 10 ml of the 0.00833 K_2CrO_7 solution. Add 1g of HgSO4 and 80ml of Ag2SO4 – H2SO4 solution and a few beads. A reflux greaseless condenser was fit and gently heated to boiling and then boil for exactly 10 minutes, and cooling was allowed. The condenser was properly rinsed with 50 ml of water and cool the flask under running tap. Two drops of Ferroin indicator was added and titrated with 0.025 M $Fe(NH_2)_2(SO_4)_2.6H_2O$ until the color changes from blue-green to red-brown. A Blank Determination was also done as above on 50 ml of water

Calculation

The Titre value of the sample was obtained from the difference in value between the two Titres. That is to say, if a 50 ml sample is taken, then 1 ml of difference = 0.2mgDO or 4mgDO/L.

If 25ml is used T x 8mg/l O2/l

3.2.8 DETERMINATION OF TURBIDITY

Procedure

25 ml of the water sample was introduced into the curvette and read at zero in the spectrophotometer at 450nm.

Then 25 ml of the water sample was introduced into another curvette and read in the meter

Calculation

Turbidity (FTU) = Slope Recip x Instrument Reading. ………………………………….. Eqn. 5

3.2.9 DETERMINATION OF COLOUR

Procedure

The filter was properly rinsed by pouring 50 ml of water through it and the water used for rinsing was discarded. Another 50 ml of water sample was introduced through the filter and a cuvette was filled with 25 ml of the filtered water and read the colour at 455nm. 50 ml of the water sample was introduced through the filter. Fill a second cuvette with 25 ml of the filtered water sample and read at 455nm.

Calculation

Colour of water in mg/l Pt.Co = Sample Colour – Water Colour……………………….... Eqn. 6

3.2.10 DETERMINATION OF SUSPENDED SOLIDS BY GRAVIMETRY

Procedure

A 15 ml Whatman Filter Paper No. 1 was dried at 50 °C to constant weight (X1g). 100ml of water sample was filtered through the weighed paper, and then dried in the same oven to constant weight at 50 °C. Thereafter, the filter paper was weighed with its content (X2g)

Calculation

Weight of Suspended solid = (X2 –X1)

Suspended solid (mg/l) = 1000x10 x (X2 – X1).

3.2.11 DETERMINATION OF CONDUCTIVITY/TOTAL DISSOLVED SOLIDS BY A METER

Procedure

The instrument was switched on by pressing power button, and allowed to stabilize for 10 minutes. The conductivity was calibrated by pressing CND and immersing the Probe in the KCl solutions above. The TDS was calibrated by pressing TDS and immersing the Probe in the KCl solution above. The probe was rinsed and immersed in the sample solution:

The Conductivity was read by pressing CND

The TDS was read by pressing TDS

Calculation

The meter is able to read the Conductivity and TDS directly in ms/cm or (s/cm and mg/l) respectively.

3.2.12 DETERMINATION OF BICARBONATE

Procedure

50 ml of the water sample was pippetted and 3 drops of 0.25% phenolphthalein indicator was added. If a pink colour is obtained, it will be titrated with 0.025 M H_2SO_4 until colourless.

However, to the colourless solution from the titration or to the original solution (if no colour is produced on adding phenolphthalein), 3 drops of 0.1% Methyl orange endpoint will be added. The solution may be reserved for chloride determination. Blank Determination was run with the reagents and CO_2-free water with corrections made if found necessary.

Calculation

$$(\mathbf{HCO3})^{2-} = \frac{\text{Molarity} \times \text{Titre} \times \text{Mol. Wt.} \times 18000\text{mg/litre}}{\text{Aliquot}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eqn. 7}$$

3.2.13 DETERMINATION OF SALINITY

The term soluble salts, as applied to any aqueous solution or water, refer to major dissolved inorganic solutes. The salinity (in g/l) of water/solution can thus be evaluated and characterised in terms of the concentrations of soluble salts.

The determination of salinity can be made by using electrical signals from various sensors or probes such as salinity meter. The salinity can also be determined by measuring electrical conductivity (in us/cm or ms/cm). Salinity increases with a responding increase in electrical conductivity. This relationship was employed to obtain the table below using differing concentrations of NaCl in distilled water. A good curve of conductivity against salinity can be easily drawn. The salinity of any desired sample may be deduced by extrapolation.

3.2.14 ATOMIC ABSORPTION SPECTROPHOTOMETER (AAS)

Atomic Absorption Spectrometry (AAS) has been widely used for the determination of Heavy Metals and some cations in environmental analysis. It has a hallow lamp as its source of radiation. This lamp contains a cathode constructed of same metals as that being analyzed. Their source emit the wavelength that is characteristic of the metal; and thus, a different lamp is required for each metal. The light from the hallow lamp is directed to pass through a flame and onto the monochromator, which in turn determines the preferred analytical wavelength. The photomultiplier tube detects the light from the monochromator and converts to an electrical signal. Thereafter, the sample is aspirated in the flame where the solution is evaporated and the metal contain these compounds are volatilized and dissociated into ground state atoms. The radiation from the hallow lamp is absorbed by the ground state atoms and excited to higher energy levels. Some atoms are also thermally excited but their fraction is so small that it causes no error in the analysis and acetylene-air flame used.

CHAPTER FOUR

RESULTS AND DISUCUSSION

4.1 RESULTS

Sample code	pH	EC	Sal.	Col.	Turb.	TSS	TDS	COD	$HC0^{3-}$	Na^{+}	K^{+}	Ca^{2+}	Mg^{2+}	Cl^{-}	PO^{3-}	NO^{2-}	NO^{3-}
		µS/cm	g/l	Pt.Co	NTU	mg/l											
LOC 1	**7.2**	**300**	**0.95**	**ND**	**ND**	**ND**	**0.02**	**ND**	**33.2**	**3.6**	**0.5**	**0.70**	**0.62**	**78.10**	**ND**	**ND**	**ND**
LOC 2	**6.9**	**287**	**0.129**	**ND**	**ND**	**ND**	**144**	**18.4**	**61.0**	**0.21**	**0.01**	**0.1**	**0.03**	**90.4**	**ND**	**ND**	**ND**
LOC 3	**7.1**	**16.4**	**0.007**	**ND**	**ND**	**ND**	**8.3**	**12.8**	**24.4**	**0.19**	**0.11**	**0.98**	**0.09**	**39.5**	**ND**	**ND**	**ND**
LOC 4	**6.9**	**115.7**	**0.052**	**ND**	**1.5**	**ND**	**57.9**	**17.1**	**48.1**	**0.20**	**0.5**	**3.73**	**1.22**	**97.5**	**ND**	**ND**	**ND**
LOC 5	**6.6**	**32.6**	**0.015**	**ND**	**ND**	**ND**	**16.3**	**16.0**	**42.7**	**0.17**	**0.12**	**1.88**	**0.16**	**87.1**	**ND**	**ND**	**ND**
LOC 6	**7.2**	**31.1**	**0.014**	**ND**	**ND**	**ND**	**15.5**	**16.8**	**30.5**	**0.22**	**0.08**	**1.51**	**0.20**	**102.2**	**0.8**	**0.08**	**ND**
LOC 7	**7.2**	**29.3**	**0.013**	**ND**	**ND**	**ND**	**14.8**	**15.2**	**24.4**	**0.14**	**0.05**	**1.74**	**0.19**	**98.2**	**0.5**	**ND**	**ND**
LOC 8	**7.1**	**930**	**1.10**	**ND**	**ND**	**ND**	**0.04**	**ND**	**30.5**	**3.4**	**1.6**	**0.41**	**0.96**	**113.6**	**ND**	**ND**	**ND**
LOC 9	**6.9**	**710**	**1.05**	**10**	**5**	**ND**	**0.04**	**5**	**32.4**	**2.8**	**1.2**	**0.70**	**0.57**	**156.20**	**ND**	**ND**	**ND**
LOC 10	**6.8**	**834**	**2.05**	**10**	**3.8**	**4.1**	**0.03**	**5**	**30.1**	**3.8**	**2.0**	**0.79**	**0.60**	**130.64**	**0.8**	**ND**	**ND**
WHO	**6.6-9.2**	**1200**	**1000 mg/l**	**5-50**	**5-25**	**500**	**1000 mg/l**	**10**	**100**	**75**	**5**	**100**	**30**	**250**	**5**	**--**	**--**

TABLE 1: PHYSICO-CHEMICAL PARAMETERS OF WATER SAMPLES

TABLE 2: HEAVY METALS PARAMETERS OF WATER SAMPLES

Sample code	Fe	Mn	Zn	Cu	Cr	Cd	Ni	Pb	V	THC
LOC 1	0.1	0.04	0.9	ND	ND	ND	ND	ND	ND	ND
LOC 2	0.1	0.02	0.7	ND	ND	ND	ND	ND	ND	ND
LOC 3	0.2	0.04	0.9	ND	ND	ND	ND	ND	ND	ND
LOC 4	0.1	0.06	5.0	ND	ND	ND	ND	ND	ND	ND
LOC 5	0.6	0.09	9.2	0.4	0.4	ND	ND	0.01	ND	ND
LOC 6	0.2	0.04	1.4	ND	0.1	ND	ND	ND	ND	ND
LOC 7	0.3	0.04	3.2	0.1	ND	ND	0.1	0.1	ND	ND
LOC 8	0.1	0.01	4.7	0.1	0.2	ND	ND	ND	ND	ND
LOC 9	0.1	0.02	2.1	ND	ND	ND	ND	ND	ND	ND
LOC 10	0.4	0.05	5.5	0.2	0.2	ND	ND	ND	ND	ND
WHO	0.1 - 1	0.05 –0.5	5 - 15	0.05-1.5	0.05-0.2µg/l	0.003	0.02	0.01	N/G	N/G

ND - Not Detected

TABLE 3: MICROBIAL PARAMETERS OF WATER SAMPLES

S/N	SAMPLE	TOTAL HETEROTROPHIC BACTERIAL COUNTS (CFU/ML)	TOTAL COLIFORM COUNTS (CFU/ML)	TOTAL E. coli COUNTS (CFU/ML)	TENTATIVE ISOLATES
1	LOC 1	0.1×10^4	0.1×10^5	0×10^5	*Salmonella sp.*
2	LOC 2	4.9×10^4	1.5×10^5	0×10^5	*S. aureus.*
3	LOC 3	1.5×10^4	1.4×10^5	0×10^5	*B. subtilis*
4	LOC 4	2.0×10^4	0.5×10^5	1×10^5	*B. subtilis*
5	LOC 5	1.5×10^4	1.9×10^5	1.9×10^5	*E. coli*
6	LOC 6	0×10^4	0×10^5	0×10^5	______
7	LOC 7	1×10^4	4×10^5	0.5×10^5	*S. aureus*
8	LOC 8	1×10^4	1.5×10^5	5×10^5	*E. coli*
9	LOC 9	2×10^3	1.4×10^3	0×10^5	*B. Subtilis*
10	LOC 10	1.1×10^4	1.6×10^5	1.5×10^5	*E. coli*

4.2 DISCUSSION

Physico-chemical properties of water vary according to seasons, and in addition anthropological activities such as urbanization, agriculture, domestic sewage in catchment areas result in deterioration in water quality. Hardness, temperature, alkalinity, turbidity, nutrients, dissolved oxygen and presences of some minerals are some of the factors that determine the growth of organism in water bodies. Water quality reveals the relation of all hydrogeological properties including chemical, biological and physical properties of water bodies.

4.2.1 pH

pH has been referred to as the intensity of acidic or basic nature of a solution at a given temperature. It determines the solubility and biological availability of chemical constituents such as nutrients and heavy metals. pH less than 6.5 or greater than 9.2 would markedly impair the potability of the water (WHO, 1958). The 1963 and 1971 International Standards, however, retained the pH range of 6.5–9.2 as the allowable or permissible range. It is worthy of note that pH usually has no direct impact on consumers, however, it serves as one of the most important operational parameters for water quality; moreover, the optimum pH required had often being in the range of 6.5– 9.5. The pH of water samples are collected ranges from 6.6-9.2 with a mean value of 6.9. The samples collected are within the WHO standard for pH. (Table3).

4.2.2 ELECTRICAL CONDUCTIVITY

WHO standard maximum permissible limit for conductivity is 1200us/cm. All the values of the ten samples from the ten locations have their conductivity ranges between 300 and 960us/cm. That is, the highest Conductivity value is 960us/cm and the lowest 300us/cm with mean value of 334.6µs/cm. It is a direct reflection of the salinity, which is also a function of the salt content of the samples. The electrical conductivity of all the samples were within the Permissible limits of (NAFDAC, WHO, 2003).This is due to the lower concentrations of cations and anions in the water samples analyzed. Since electrical conductivity is an indicator of how salt- free, ion-free, impurity free a water sample is (Aktar *et al*., 2010).

4.2.3 SALINITY

The W.H.O standard for the salinity values are less than 1000 mg/L set by the World Health Organization (WHO, 1979) and Standard Organization of Nigeria (SON). This implies that the waters are not saline. The salinity for sampled locations ranges from 0.51 to 2.45 mg/l with mean valve of 0.538mg/l, location five have the highest and location two have the lowest salinity. (Table3).

4.2.4 COLOUR

Pure water should ideally have no visible colour. True color is caused by dissolved compounds in water. It can be natural or anthropocentric. Dissolved and suspended solids (together) cause apparent color. For example, brown colored water could be the result of dissolved byproducts of plant biodegradation (true color) or suspended clay particles (apparent color) or both (also apparent color). The mean value is 2 Pt-Co with 10Pt-Co has its units. Color is measured in Platinum-Cobalt units (Pt-Co). Colour is also strongly influence by the presence of iron and other metals, either as natural impurities or as corrosion product. (Table3).

4.2.5 TURBIDITY

Turbidity in drinking-water is caused by particulate matter that may be present from source water as a consequence of inadequate filtration or from suspension of sediment in the distribution system. It may also be due to the presence of inorganic particulate matter in some groundwater or sloughing of biofilm within the distribution system. The appearance of water with a turbidity of less than 5 NTU is usually acceptable to consumers, although this may vary with local circumstances. Particulates can protect micro-organisms from the effects of disinfection and can stimulate bacterial growth. In all cases where water is disinfected, the turbidity must be low so that disinfection can be effective. The W.H.O standard for turbidity is 5 NTU and maximum of 25 NTU. The turbidity range for sampled waters ranges from 1.5 to 6.0 NTU with mean valve of 1.03NTU.

4.2.6 TOTAL SUSPENDED SOLIDS

Solids refer to the suspended and dissolved matter in water. They are very useful parameters describing the chemical constituents of water. Location five has total suspended solids of 5.8mg/l with W. H. O. standard being 500mg/l for drinking water and mean value of 0.411mg/l. (Table3).

4.2.7 TOTAL DISSOLVED SOLIDS

The palatability of water with a TDS level of less than 600 mg/litre is generally considered to be good; water becomes significantly and increasingly unpalatable at TDS levels greater than about 1000 mg/litre with mean valve of 25.69mg/l. The presence of high levels of TDS may also be objectionable to consumers, owing to excessive scaling in water pipes and household appliances. The TDS for samples is both within and above the WHO limit at some locations. (Table3).

4.2.8 DISSOLVED OXYGEN

The dissolved oxygen content of water is influenced by the source, raw water temperature, treatment and chemical or biological processes taking place in the distribution system. It can cause an increase in the concentration of ferrous iron in solution. The W.H.O standard for dissolved oxygen is 5mg/litre.

4.2.9 CHEMICAL OXYGEN ON DEMAND

According to W.H.O. the standard for chemical oxygen on demand is 10 mg/liter. The COD for samples ranges from 5-18.4 mg/liter with mean value of 10.65mg/liter. The samples are within the WHO limit. (Table 3)

4.2.10 SODIUM, POTASSIUM, CALCIUM, MAGNESIUM, CHLORIDE AND PHOSPHOROUS

Calcium is the most abundant ion in fresh water; magnesium is often associated with calcium. Chloride in water originates from natural sources, sewage and industrial effluents, urban runoff containing de-icing salt and salt intrusions. These ions when in the right proportion are healthy for the human body. The taste threshold concentration of sodium in water depends on the associated anion and the temperature of the solution. At room temperature for sodium is about 75 to 200 mg/litre. The sodium value for samples ranges from 2.8 to 3.9 mg/liter with mean value of 1.47mg/litre, hence is within the WHO limit. The threshold concentration of potassium is 20mg/liter. The potassium value for samples ranges from 0.5 to 3 mg/litre with mean value of 0.61mg/litre, therefore is within the WHO limit. The threshold concentration for magnesium is 30 to 150 mg/liter. The magnesium value for samples is 0.42 to 0.67 mg/liter, therefore is within the WHO limit with mean valve of 0.41mg/l.

Concentration of chloride greater than 600 mg/litre would markedly impair the portability of the water. The 1963 and 1971 International Standards retained this value as a maximum allowable or permissible concentration. Chloride concentrations in excess of about 250 mg/litre can give rise to detectable taste in water. The chloride value foe samples range from 78.10 to 177.5 mg/liter, therefore is within the WHO limit with mean valve of 99.34mg/l. The phosphorus value for samples range from 0.5 to 0.8mg/liter and it is within the WHO standard of 5 mg/liter with mean valve of 0.21mg/l. (Table3).

4.2.11 NITRITE, NITRATE, AMMONIA AND SULPHATE

Nitrate and nitrite are naturally occurring ions that are part of the nitrogen cycle. Nitrate is used mainly in inorganic fertilizers, and sodium nitrite is used as a food preservative, especially in cured meats. The nitrate concentration in groundwater and surface water is normally low but can reach high levels as a result of leaching or run off from agricultural land or contamination from human or animal wastes as a consequence of the oxidation of ammonia and similar sources. Anaerobic conditions may result in the formation and persistence of nitrite. Chlorination may give rise to the formation of nitrite within the distribution system if the formation of chloramine is not sufficiently controlled. The formation of nitrite is as a consequence of microbial activity and may be intermittent. Nitrification in distribution systems can increase nitrite level is 0.08mg/litre with mean valve of 0.008mg/l. The WHO standard for nitrate and nitrite is 45 and 3 mg/litre respectively. In the 1993 Guidelines, no health based guideline value was recommended, but the Guidelines stated that ammonia could cause taste and odor problems at concentrations above 35 and 1.5mg/liter respectively.

4.2.12 HEAVY METALS

Copper in a drinking-water supply usually arises from the corrosive action of water leaching copper from copper pipes. Concentrations can vary significantly with the period of time the water has been standing in contact with the pipes. High concentrations can interfere with the intended domestic uses of the water. Copper in drinking-water may increase the corrosion of galvanized iron and steel fittings. Staining of laundry and sanitary ware occurs at copper concentrations above 1 mg/litre. At levels above 5 mg/litre, copper also imparts a colour and an undesirable bitter taste to water. The WHO standard for copper is 2 mg/litre, the value range of copper in samples collected is 0.1 to 0.4 mg/litre, which is within limit and mean valve of 0.08. Anaerobic groundwater may contain ferrous iron at concentrations of up to several milligrams per litre without discoloration or turbidity in the water when directly pumped from a well. On exposure to the atmosphere, however, the ferrous iron oxidizes to ferric iron, giving an objectionable reddish-brown colour to the water. Iron also promotes the growth of "iron bacteria," which derive their energy from the oxidation of ferrous iron to ferric iron and in the process deposit a slimy coating on the piping. The WHO standard for iron is 1 mg/litre, the value range of iron in collected samples is 0.1 to 0.6mg/litre which are within limit with mean valve of 0.22. There is usually no noticeable taste at iron concentrations below 0.3mg/litre.

At levels exceeding 0.1mg/litre, manganese in water supplies causes an undesirable taste in beverages and stains sanitary ware and laundry. The presence of manganese in drinking-water, like that of iron, may lead to the accumulation of deposits in the distribution system. Concentrations below 0.1 mg/litre are usually acceptable to consumers. Even at a concentration of 0.2 mg/litre, manganese will often form a coating on pipes, which may slough off as a black precipitate. The value range for manganese in collected samples is 0.01 to 0.09 mg/litre which are within the WHO limit for manganese with mean of 0.041.

Zinc imparts an undesirable astringent taste to water at a taste threshold concentration of 4 mg/litre (as zinc sulfate). Water containing zinc at concentrations in excess of 3–5 mg/litre may appear opalescent and develop a greasy film on boiling. Although drinking-water seldom contains zinc at concentrations above 0.1 mg/litre, levels in tap water can be considerably higher because of the zinc used in older galvanized plumbing materials. The WHO guideline for zinc is 5 mg/litre, the value range for zinc in samples collected ranges between 0.9 to 5.0 mg/litre which is within limit with mean of 3.36.

Cadmium metal is used in the steel industry and in plastics. Cadmium compounds are widely used in batteries. Cadmium is released to the environment in wastewater, and diffuse pollution is caused by contamination from fertilizers and local air pollution. Food is the main source of daily exposure to cadmium. The daily oral intake is 10–35mg. Smoking is a significant additional source of cadmium exposure. Guideline value is 0.003 mg/litre.

Chromium is widely distributed in the Earth's crust. It can exist in valences of +2 to+6. In general, food appears to be the major source of intake. Provisional guideline is 0.05-0.2 µg/litre for total chromium with mean valve of 0.09.

Lead is used principally in the production of lead-acid batteries, solder and alloys. The organolead compounds tetraethyl and tetra methyl lead have also been used extensively as antiknock and lubricating agents in petrol, although their use for these purposes in many countries is being phased out. Owing to the decreasing use of lead containing additives in petrol and of lead-containing solder in the food processing industry, concentrations in air and food are declining, and intake from drinking-water constitutes a greater proportion of total intake. Lead is rarely present in tap water as a result of its dissolution from natural sources; rather, its presence is primarily from household plumbing systems containing lead in pipes, solder, fittings or the service connections to homes. The amount of lead dissolved from the plumbing system depends on several factors, including pH, temperature, and water hardness and standing time of the water, with soft acidic water. Guideline value 0.01 mg/litre, the value for lead in samples is 0.01mg/litre with mean of 0.011.

Provisional guideline for nickel is 0.02 mg/litre value .The guideline value is considered provisional owing to uncertainties about the effect level for prenatal mortality with mean of 0.01 There is no provisional guideline for vanadium. There seemed to be no detection of concentration of vanadium in the analysis samples. (Table4).

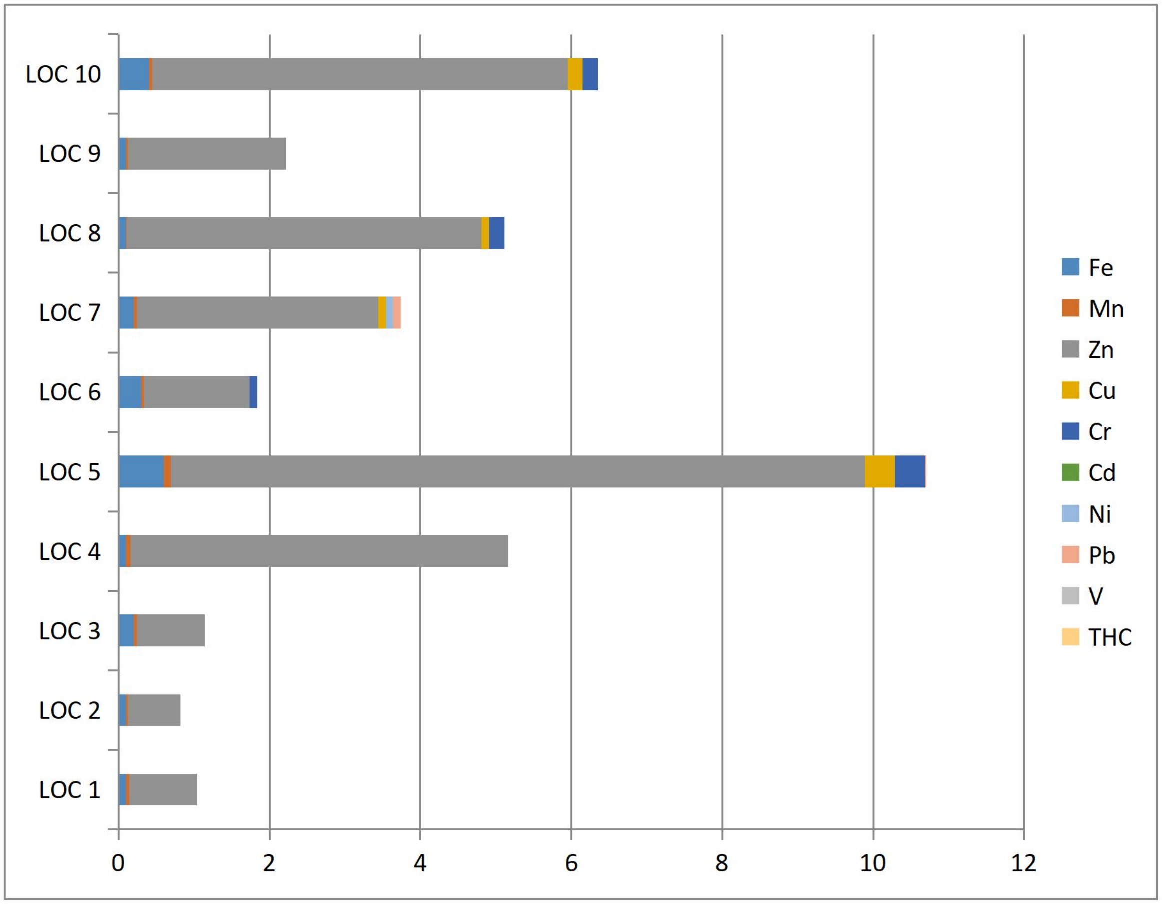

Plate 2: Chart showing the heavy metal distribution in the study area.

4.2.13 TOTAL HYDROCARBON

Aromatic hydrocarbons are used as solvents; they are found in petrol and diesel. They are not normally found in drinking-water except as a consequence of spills and or leaking storage facilities. Aromatic hydrocarbons are usually detected by taste and odour at concentrations well below the health-based guideline value. Styrene is sometimes found due to the use of certain pipeline materials (e.g. glass-reinforced plastic) that have not been cured properly. Routine monitoring is normally unnecessary, unless a potential problem has been recognized. Aromatic hydrocarbons are sometimes found, having leached from polyethylene pipes. Thus, monitoring in response to an incident or problem may be more effective at the tap rather than at the treatment works. Polycyclic aromatic hydrocarbons (PAHs) are usually only found in drinking-water as a consequence of leaching from coal-tar linings on cast-iron water mains. Total Hydrocarbon was not detected(Table4).

4.2.14 MICROBIAL ANALYSIS/RESULT

Escherichia coli occur in human and animal faeces, sewage and water subject to recent faecal pollution. Water temperatures and nutrient conditions present in drinking-water distribution systems are highly unlikely to support the growth of these organisms.

S. aureus has long been recognized as one of the most important bacteria that cause disease in humans. It is the leading cause of skin and soft tissue infections such as abscesses (boils), furuncles, and cellulitis. Although most staph infections are not serious*, S. Aureus* can cause serious infections such as bloodstream infections, pneumonia, or bone and joint infections.

Salmonella species are intracellular pathogens with certain serotypes causing illness which can be transferred from animal-to-human and from human-to-human. They usually invade only the gastrointestinal tract and cause salmonellosis, the symptoms of which can be resolved without antibiotics.

Bacillus subtilis is a ubiquitous bacterium commonly recovered from water, soil, air, and decomposing plant residue. The bacterium produces an endospore that allows it to endure extreme conditions of heat and desiccation in the environment. B. subtilis produces a variety of proteases and other enzymes that enable it to degrade a variety of natural substrates and contribute to nutrient cycling. However, under most conditions the organism is not biologically active but exists in the spore form (Alexander, 1977). *B. Subtilis* is considered a benign organism as it does not possess traits that cause disease. It is not considered pathogenic or toxigenic to humans, animals, or plants.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This study was carried out in the southwestern part of Nigeria, and falls within longitudes 5 13′ 30″ and 5 14′ 30.7″ E and latitudes 7 9′ 50″ and 7 12′ 20″ N and shows secondary porosity due to the region underlain by the Precambraian Basement Complex as a result limiting degree of porosity and permeability.

From the results obtained, it can be concluded that the ground and surface water in the study area showed the water quality in this area to be generally potable, due to concentration of heavy metals being mostly under/within the WHO standard regulation. Zinc is released to the environment through the use of zinc galvanized pipe, the presence of Manganese in water samples is primarily from household plumbing systems. The pH, salinity and electrical conductivity in the study area was moderate. The colour for the some samples was brownish – colourless. Turbidity and TSS only occurred in river samples. The presence of microbial organisms in water is from sewages, septic tanks, and animal faeces.

5.2 RECOMMENDATIONS

1. Sanitary landfills and secured landfills should be used in this area.
2. Water from this area should be treated before use, by the application of absorptions and osmosis filter method.
3. Health surveys should be carried out to show the extent of exposure and health impact.
4. Drillers and contractors should be encouraged to drill deeper so as to obtain clean and potable water.

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