

**EFFECT OF DOMESTIC WASTE ON QUALITY PARAMETERS OF GROUND AND
SURFACE WATER IN GWAZANGO EXTENSION KUBWA FEDERAL CAPITAL
TERRITORY ABUJA, NIGERIA.**

BY

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MATRIC NO. 2004/18393EA

**DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.**

FEBRUARY, 2010

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**BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL
FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF
ENGINEERING (B. ENG.) DEGREE IN AGRICULTURAL & BIORESOURCES
ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER
STATE.**

FEBRUARY, 2010

DECLARATION

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.


Obi, Samson Nzubechukwu

17/02/2010
Date

CERTIFICATION

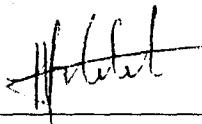
This project entitled "Effect of Domestic Waste on Quality Parameters of Ground and Surface Water in Gwazango Extention Kubwa Federal Capital Territory Abuja, Nigeria. " by Obi, Samson Nzubechukwu, meets the regulations governing the award of the degree of Bachelor of Engineering (B.ENG.) of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.



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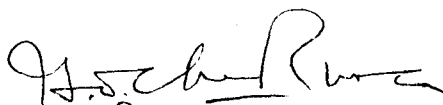
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DEDICATION

This project work is dedicated to the Glory of Almighty God, who made it possible for me to conduct the project work and achieve my goal without hindrance.

AKNOWLEDGEMENTS

All praises and glory are to God almighty, beside which there is no other god, the most merciful, the creator who in his infinite mercy inspired, guided and directed me throughout the period of my studies and in carrying out this work.

I am indebted to my supervisor, Mr. Musa, J. Jiya for taken his time to go through this project, despite other academic works at his disposal. Particularly the constructive criticisms offered.

Special thanks to officer in charge of laboratory, Mohammed Jiya and other staff of Niger state water board through whom the laboratory analysis was made possible.

I owe a word of appreciation to the head of the department Dr. A.A. Balami and other staff members of the department which include; Dr. O. Chukwu, Dr. N.A. Egharevba, Dr. B.A. Alabadan, Dr. D. Adgidzi, Dr G. Agidi, Engr. P.A Idah, Engr. P. Adeoye, Mr. M. Sadeeq, Mrs. H. I. Mustapha, Mr. H. Adamu, Mrs. B. Orhevba, and Mr. Dauda for their contributions to my knowledge during my study.

To my father Mr. Obi, Godwin and my mother Mrs. Obi, Helen, I owe a million of gratitude for your love, care and supports. I also thank my brothers; Arinze Obi, Ikechukwu Obi, Tochukwu Obi, Okechukwu Obi and my beloved sisters; Chinyere Amatu and Florence Obi, And to the rest of my siblings for there patience, prayers and supports.

I express immeasurable appreciations to my course mate and friend Ojukwu Henry who assisted me in organizing this work, I also appreciate Micheal Jacob, Bello Goro, Fadiji Samuel Tobi and the rest of my course mates too numerous to mention. May the sky be your starting point. You all made my stay in the campus a memorable one.

ABSTRACT

Household water supply problems remain one of the major challenges facing developing countries. In Nigeria, there is lack of documentation on the levels and causes of water pollution particularly in sub-urban areas so that meaningful interventions can be adopted. However, contamination free ground and surface water is essential for sustainable life and improved agricultural productivity. This projects deals with the effects of domestic waste on quality parameter of ground and surface water in kubwa federal capital territory Abuja. Water samples were collected using 50Cl plastic containers from two sources (ground and surface water) at different time intervals for each source. The physical and chemical parameter of these samples was analysed. Water samples collected from the major sources of domestic water supply showed that there are variations in the levels of water pollution between ground water and surface water sources. For instance the turbidity for sample "B" morning surface water is 74.0 which is far above WHO limits while turbidity for sample "B" morning ground water is 5.0 which conforms to WHO limits The results indicate that the water resources have been polluted by indiscriminate disposal of domestic waste in the area which reduces the quality of water for both human and agricultural productivity. The study recommends proper monitoring of the indiscriminate dumping of domestic waste in area close to water source or area liable to be flooded by runoff.

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List of Abbreviations

CWA	-	Clean Water Act
DBPs	-	disinfection by-products
DWAF	-	Department Of Water Affairs And Forestry
EC	-	Electrical conductivity
mg/L	-	milligrams per Liter
MCLG	-	Maximum Contaminant Level
MCL	-	Maximum Contaminant Level
NPS	-	Non Point Source
NT	-	nephelometric turbidity unit
N/S	-	Not Stated
NSDWRs	-	National Secondary Drinking Water Regulations
Ppm	-	parts per million
SS	-	Suspended solid
TT	-	special treatment techniques required
TACs	-	toxic air contaminants

TDS	-	Total dissolved solid
USEPA	-	United States Environmental Protection Agency
UNEP	-	United Nation Environmental protection Agency
USGS	-	United States Geological Survey
VOCs	-	volatile organic compounds
WHO	-	World Health Organisation

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Access to safe clean water and adequate sanitation is a fundamental right and a condition for basic health (UNEP 1998). However, in the developing world, one person in three lacks safe drinking water and sanitation. The lack of safe drinking water and adequate sanitation measures lead to a number of diseases such as cholera, dysentery, salmonellosis and typhoid, and every year millions of lives are claimed in developing countries. Diarrhoea is the major cause for the death of more than 2 million people per year world-wide, mostly children under the age of five. It is a symptom of infection or the result of a combination of a variety of enteric pathogens (Anon 2000). Water-borne pathogens infect around 250 million people each year resulting in 10 to 20 million deaths world-wide (Dwaf 1996). This highlights the potential of infection due to water - borne pathogens.

However, within the urban areas there are disparities in the provision of some basic services such as electricity, tap water. Nevertheless, where population density is high, pollution may result because these are often located in close proximity with utilised water resources. The situation may be worsening by the hydrogeology of the area, which permit persistence, and mobility of the pollutants. Lack of solid waste disposal systems is also threatening water resources in urban areas.

The poor collection of waste in kubwa urban areas leads to indiscriminate refuse dumping close to resident. In the peri-urban areas, domestic waste collection is not done at all.

Thus, disposing of wastes can give rise to serious pollution of ground and surface water resources especially where there is uncontrolled tipping of waste. As such, lack of adequate sanitation facilities continues to threaten water resources in urban areas. Water supply systems and sanitation facilities are directly linked to behavioural practices in major cities around Nigeria most especially Kubwa a satellite town in the federal capital territory Abuja.

1.1.1 Water Pollution Categories

Surface water and groundwater have often been studied and managed as separate resources, although they are interrelated. (USGS 1998). Sources of surface water pollution are generally grouped into two categories based on their origin.

Water pollution can come from number of different sources. If the pollution comes from single sources, such as an oil spill, it is called point-source pollution. Point source pollution refers to contaminants that enter a waterway through a discrete conveyance, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain. The U.S. Clean Water Act (CWA) defines point source for regulatory enforcement purposes. If the pollution comes from many sources it is called non-point source pollution. Non-point source (NPS) pollution refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often a cumulative effect of small amounts of contaminants gathered from a large area. Nutrient run-off in storm water from "sheet flow" over an agricultural field or a forest are sometimes cited as examples of NPS pollution. Contaminated storm water washed off of parking lots, roads and highways, called urban runoff, is sometimes included under the category of NPS pollution. However, this runoff is typically channeled into storm drain systems and discharged through pipes to local surface waters, hence becoming a point source. The CWA definition of point source was amended in 1987 to include

municipal storm sewer systems, as well as industrial storm water, such as from construction sites.

1.1.2 Types of Water Pollution

Most types of pollution affect the immediate area surrounding the sources. Sometimes the pollution may affect the environment hundreds of miles away from the source, such as nuclear waste, this is called trans-boundary pollution. (CWA)

1.1.2a Surface Waters Pollution

Surface waters are the natural water resources of the earth. They found on the exterior of the earth's crust and include: Oceans; Rivers; Lakes. These waters can be come polluted in a number of ways, and this is called surface water pollution.

1.1.2b Ground Water Pollution

A lot of the earth's water is found underground in soil or under rock structures called aquifers. Humans often use aquifer as a means to obtain drinking water and build wells to access it. When this water becomes polluted it is called ground water pollution. Ground water pollution is often caused by pesticide contamination from the soil this can infect our drinking water and cause huge problems. (CWA) however, management agencies must define and use appropriate timeframes in groundwater planning (Sophocleous, M 2002).

1.1.2c Microbiological Water Pollution

Microbiological water pollution is usually a natural form of water pollution caused by microorganisms many types of microorganism's lives in water and causes fish, land animals and humans to become ill. Microorganisms such as: Bacteria; Viruses; Protozoa. A serious disease

such as cholera comes from microorganisms that live in water. These diseases usually affect the health of people in poorer countries as they do not have the facilities to treat polluted water.

(CWA)

1.2 Statement of Problem

There is a broad range of environmental concerns that encompass the solid waste management world wide, contamination to the atmosphere, soil and water, which puts the entire ecosystem of an area in danger. The contamination of waste causes sever problems for human and animal alike. The major environmental effect includes Air pollution which includes odour, smoke, noise and dust.

However there health effects are numerous on man, the Flora or Fauna of the environment in form of health problems ranges from convulsion, dermatitis, irritation of nose/throat, a plastic anaemia, skin burns, chest pains, blood disorders, stomach aches, vomiting diarrhoea, and lung cancer to death

1.3 Objective of the Study

The main objective of the study was to determine extent of water quality available to residents in Kubwa Township, and to see how domestic waste affects the quality parameters of ground and surface water sources in the area.

1.4 Justification

In the rural and peri-urban (kubwa) area where ground and surface water are being consumed without prior examination on the consumable quality of the water. The understanding and knowledge of the quality of the water consumed (WHO Standard) will help individuals or dwellers to plan on how waste can be adequately managed. This will go along way to help

sanitary agents or environmental protection agencies on having better understanding of the impact of indiscriminate waste disposal on ground and surface water.

1.5 Scope of Study

This study would involve series of analysis to be carried out on the ground and surface water, making reference to different locations. Analyzing the properties of ground and surface water is necessary in order to measure the content of the water and this in turn is used to determine its effect on human.

Ground and surface water sampling is to be collected in small quantity weighing about 50cl each that will represent the ground and surface water in the area. The main objective of the study was to determine extent of water quality available to residents in Kubwa Township, and to see how these contaminated water sources affect the quality parameters of domestic water sources in the area.

CHAPTER TWO

2.0 LITRATURE REVIEW

Palamuleni, (2001) Stated that Household water supply problems remain one of the major challenges facing developing countries. In Malawi, there is lack of documentation on the levels and causes of water pollution particularly in peri-urban areas so that meaningful interventions can be adopted. Therefore, a study was carried out in South Lunzu Township a peri-urban area in the City of Blantyre. The study revealed that the major form of sewerage disposal is the on-site sanitation system where about 58.8% of the respondents use traditional pit latrine while in terms of solid waste disposal, the Blantyre City Assembly which is responsible for solid waste collection, has only two collection vans to cater for more than half a million residents BCA, (1999) hence indiscriminate disposal rampant in the area. Water samples collected from the major sources of domestic water supply showed that there are variations in the levels of water pollution between ground water and surface water sources and between the wet and the dry season. For instance, physically, the ground water turbidity levels were in the range of 2mg/l to 12mg/l during the dry season but increased to a maximum of 114mg/l during the wet season while for surface water the turbidity increased from 4mg/l to 408mg/l over the seasons compared to the WHO standard set at 5mg/l and the Water Department standard set at 25mg/l. Chemical pollution for surface water sources show seasonal variations with an increase in the concentration during the wet season, for instance, iron levels ranged from 2.3 mg/l to 4.03mg/l. This is above the WHO and Water Department drinking water standards, which are 1mg/l and

3mg/l respectively. However, bacteriologically, both the ground water and the surface water sources are grossly polluted. Ground water spring coliform count ranged from 90/100ml to 9,500/100ml; and the well 3,500/100ml to 11,000/100ml having the maximum during the wet season. Surface water results also indicated the coliform count ranging from 2,900/100ml to 4,600/100ml way higher than the WHO, MBS standard for drinking water which is 0 and the Water Department standard for untreated water of which range from 10-50 coliforms/100ml. The results indicate that water resources have been polluted by lack of sanitation facilities, indiscriminate disposal of waste and the institutional set-up governing the provision of services in the area, Levels and identifying the factors which have led to the degradation of water resources.

Access to adequate and safe drinking water still remains a challenge in developing countries. Some people especially in the rural areas use untreated surface and groundwater. An assessment of groundwater quality from shallow wells was carried out in nine villages in Blantyre district of Malawi. Water samples from nine randomly selected shallow wells (7 covered or protected and 2 open) were analysed for biological (total and faecal coliforms), chemical (hardness, nitrate, nitrite, sulphate, ammonia, pH, electrical conductivity and arsenic) and physical (total dissolved solids and turbidity) parameters of water using a portable water testing kit (Paqualab 50). Sampling was carried out four times during the year, i.e. twice in the dry season (August and October) and twice in the wet season (February and April) to find out if the quality of water changes with season (Palamuleni, 2001).

Results indicate that drinking water from shallow wells is heavily polluted by both total and faecal coliforms. The pollution level was higher in the wet season compared to the dry season. All the samples tested in the wet season did not meet the guideline value of 50 total coliforms (colony forming units) per 100 ml of the sample water (50 cfu/100 ml) set by the

Malawi Ministry of Water Development (MoWD) for untreated water for drinking purposes (e.g. groundwater), while 22% of the samples met the guideline during the dry season. The difference in the contamination level between the dry and wet season was not significant for total coliforms ($p = 0.13 > 0.05$). All chemical (hardness, nitrate, nitrite, sulphate, ammonia, pH, electrical conductivity and arsenic) and physical (total dissolved solids and turbidity) parameters tested except for turbidity were within the guideline values set by MoWD for untreated water. About 11% of the wells tested failed to meet the turbidity guideline value for the Ministry of Water Development of 25 NTU while about 22% failed to meet the World Health Organisation (WHO) and Malawi Bureau of Standards (MBS) for treated water of 5 NTU in both the dry and wet season. There is need to carry out a further analysis of quality of water from shallow wells in Blantyre and other districts, (Palamuleni, 2001).

2.1 Domestic Waste

World Health organization (WHO, 2000). defined waste as “Something, which the owner no longer wants at a given time and place and which has no current or perceived market value”. There has been an increasing concern about the environment in which man lives. Solid wastes, mount of rubbish, garbage and sewage are being produced everyday by our urban society. In an attempt to dispose of these materials, man has carelessly polluted the environment. In a traditional underdeveloped world, a fact that partly reflects the sampling locations considered in the present work, household wastes are completely biodegradable and homogenous. Consequently, both biodegradable and non-biodegradable materials now constitute household wastes. In the past, men thought the environment had an infinite capacity to devour his waste without any ill effects. More recently, however, man’s health and welfare are being affected by environmental pollution.

Types waste includes Solid waste; Liquid waste; Gaseous waste.

2.1.1 Solid Waste

A solid waste does not flow like water or gas. Examples include paper, wood, metals, glass, plastic, and contaminated soil. Solid wastes can be hazardous or nonhazardous. Problems associated with nonhazardous solid waste include aesthetic problems (litter and odors), leachate from the infiltration of water through the waste, and off-gases resulting from biodegradation. Nonhazardous solid wastes are commonly handled by recycling, combustion, land-filling, and composting. (Davis and Cornwell 1998).

2.1.2 Liquid Wastes

Siegel, (1993). Stated that, Liquid wastes must be transported in containers or through pipes. Examples include sewage, contaminated groundwater, and industrial liquid discharges. In some cases, direct discharge to the environment may be allowed. However, depending on the waste's characteristics, direct discharge may cause unacceptable environmental harm. For example, large amounts of sewage discharged into a stream can result in fish kills. Liquid wastes containing excreta can contain pathogenic organisms. Other liquid wastes may be toxic. Liquid wastes are often handled at wastewater treatment plants, followed by discharge to the environment.

Sludge contain various ratios of liquid and solid material. They generally result from liquid waste-treatment operations, such as sedimentation tanks. Depending on the percent of solids, sludge may have the characteristics of a liquid or solid. Biological sludge can contain pathogenic organisms. Some sludge's contain heavy metals or other toxins. Sludge's are commonly handled with treatment, combustion, land filling, and land application, (Siegel, 1993).

2.1.3 Gaseous Wastes

Davis and Cornwell (1998). Gaseous wastes, of course, consist of gases. They are primarily generated by combustion (e.g., internal combustion engines, incinerators, coal-fired electrical generating plants) and industrial processes. Depending on their characteristics, gaseous wastes can be odiferous or toxic. Some are implicated in global warming, ozone depletion, and smog. Gaseous wastes may be released to the atmosphere or captured/treated with pollution control equipment.

2.2 Water Sources

The availability of portable water is an indispensable feature for preventing diseases and improving the quality of life (Oluduro and Aderiye 2007). Natural water contains some types of impurities whose nature and amount vary with source of water. Metals are introduced into aquatic system through several ways which includes weathering of rocks and leaching soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and the use of metal based materials (Ipinmoroti and Oshodi, 1993; Adeyeye, 1994; Asaolu et al., 1997). Metals after entering the water may be precipitated, adsorbed on solid surface, remains soluble, suspended in water or may be taken up by fauna and flora and eventually, accumulated in marine organisms that are consumed by human being (Asaolu et al, 1997).

In order to understand drinking water contamination, it is necessary to first understand from where our drinking water comes. For most urban residents, relying upon municipal water systems, drinking water comes from two major sources: groundwater and surface water. These two sources of drinking water will be referenced throughout this guide to water contamination.

2.2.1 Ground Water Source

Groundwater refers to any subsurface water that occurs beneath the water table in soil and other geologic forms (Rail 2000). Scientists estimate that groundwater makes up 95% of all freshwater available for drinking. Groundwater is a significant source of water for many municipal water systems in the United States. Rural residents, withdrawing their water from wells, also rely upon groundwater. Groundwater is generally stored in aqueducts, underground layers of porous rocks that are saturated with water. These aqueducts receive water as soil becomes saturated with precipitation or through stream and river runoff. As the aqueducts exceed their capacity for water storage, they will bleed water back into streams or rivers. The aqueducts maintain a natural balance of water, alternately receiving or giving water as their saturation levels oscillate. Throughout this process, water constantly moves between surface and groundwater sources, sharing contaminants. (Xie and Yuefeng F. 2004). Another cause for concern is that groundwater drawdown from over-allocated aquifers has the potential to cause severe damage to both terrestrial and aquatic ecosystems – in some cases very conspicuously but in others quite imperceptibly because of the extended period over which the damage occurs. (Zektser, and *etal*, 2005).

2.2.1.1 Ground Water Extraction

Groundwater is derived principally from surface water (sources include rainfall, waterways, irrigation and water storages) that percolates through the soil until it reaches the water table. The water table is the level below which all the spaces between soil/rock materials are saturated with water. Groundwater is also found in layers of porous rock called aquifers.

Groundwater is an important part of the water cycle and is fundamentally linked to surface water. When groundwater is discharged into springs, wetlands, rivers and other waterways it is once again considered surface water. The physical properties of groundwater can vary greatly, particularly the dissolved mineral concentrations. Groundwater is usually extracted via bores either by pumping or under natural pressure for a variety of purposes, i.e. drinking and irrigating, (Department of Environment and Resource Management, 2009).

Deterioration in water quality in pumped groundwater results either from changes in the quality of water in the aquifer or changes in the well. These changes may affect the biological, chemical and or physical quality of water. Deterioration in biological and chemical quality generally results from conditions in the aquifer, whereas changes in physical quality result from changes in the well. Both the biological and the chemical quality of water from new public-supply wells must be analyzed before the wells are placed in use to determine water-quality standards and, if not, water treatment may be necessary.

2.2.2 Surface Water Source

Surface water refers to water occurring in lakes, rivers, streams, or other fresh water sources used for drinking water supplies. While most drinking water in the United States is withdrawn from groundwater sources, surface water remains a significant water resource. Each source of water has a unique set of contaminants; groundwater stores pesticide chemicals and nitrate while surface water contains most bacteria and other microorganisms. Because of the interconnectedness of groundwater and surface water, these contaminants may be shared between the two sources. Neither water source can ever be entirely free from water contaminants. Due to the cycle of water (hydrology), the two sources of drinking water feed each other, sharing contaminants. (Lingreddy, Srinivasa, 2002).

2.2.2.1 Surface Water Extraction

Surface water refers to water that exists above the ground including lakes, dams, rivers, streams, and the ocean. For the purpose of this guide, only land-based surface water supplies are considered – the ocean has been excluded. Surface water is extracted for a range of domestic and industrial purposes. The impact of surface water extraction depends on the volume of water removed, e.g. through pumping. The greater the volume of water removed the greater the impact, (Department of Environment and Resource Management, 2009).

2.3 Water Pollution

Water pollution is the contamination of water bodies such as lakes, rivers, oceans, and groundwater caused by human activities, which can be harmful to organisms and plants that live in these water bodies. It occurs when pollutants (domestic waste) are discharged directly into water bodies without treating it first.

Pollution of ground water is receiving increased attention from both the regulatory agencies and from water users. As a result, pollution has been found to be much more widespread than we had believed only a few years ago. This attention has also resulted in widespread recognition that polluted ground water may pose a serious threat to health that is often not apparent to those affected and that purification of polluted ground-water systems may require centuries or the expenditure of huge sums of money. These facts alone make it imperative that the pollution of ground water by harmful substances be avoided to the maximum possible extent.

Pollution of ground water refers to any deterioration in the quality of the water resulting from the activities of man. This definition also includes apparently natural processes like saltwater encroachment into freshwater-bearing aquifers in coastal areas resulting from the artificial lowering of ground-water heads. Most pollution of ground water results from the disposal of domestic, municipal and industrial wastes on the land surface, in shallow excavations including septic tanks, or through deep wells and mines; the use of fertilizers and other agricultural chemicals; leaks in sewers, storage tanks, and pipelines; and animal feedlots. The magnitude of a pollution problem depends on the size of the affected area, the amount of the pollutant involved, the solubility, toxicity, and density of the pollutant, the mineral composition and hydraulic characteristics of the soils and rocks through which the pollutant moves, and the effect or potential effect on ground-water use.

Interactions between groundwater and surface water are complex. Consequently, groundwater pollution, sometimes referred to as groundwater contamination, is not as easily classified as surface water pollution. United States Geological Survey (USGS). (Denver, CO. 1998). By its very nature, groundwater aquifers are susceptible to contamination from sources that may not directly affect surface water bodies, and the distinction of point vs. nonpoint source may be irrelevant. A spill of a chemical contaminant on soil, located away from a surface water body, may not necessarily create point source or non-point source pollution, but nonetheless may contaminate the aquifer below. Analysis of groundwater contamination may focus on soil characteristics and hydrology, as well as the nature of the contaminant itself.

It is good practice to periodically determine the biological and chemical quality of water from all wells, especially those that supply domestic needs, in order to determine if changes in quality are occurring. Deterioration in *biological quality* refers to the appearance in the water of bacteria and (or) viruses associated with human or animal wastes. Such deterioration indicates, in

nearly all cases, a connection between the land surface or a near-surface zone and the open section of the well. Deterioration in *chemical quality* refers to the arrival at a supply well of water containing dissolved chemicals in an undesirably large concentration. The most commonly observed increases in concentration involve NaCl (sodium chloride or common salt) and NO₃ (nitrate), but, if the well is near a sanitary landfill or other waste-disposal site, the increase may involve almost any substance commonly used by man. Nitrate is an important constituent in fertilizers and is present in relatively large concentrations in human and animal wastes. Therefore, nitrate concentrations in excess of a few milligrams per liter almost invariably indicate that water is arriving at the well from shallow aquifers that are polluted by septic tanks or animal feedlots or that are contaminated by excess nitrates used in farming operations. Other pollutants in water supply wells may include herbicides, pesticides and other complex organics, petroleum products, industrial contaminants containing trace concentrations of metals. In the nuclear word, contamination of water with radioactive materials can have far reaching consequences.

Water pollution is a major problem in the global context. It has been suggested that it is the leading worldwide cause of deaths and diseases, (Pink, Daniel H. 2006).and that it accounts for the deaths of more than 14,000 people daily. West, (Larry 2006). In addition to the acute problems of water pollution in developing countries, industrialized countries continue to struggle with pollution problems as well. In the most recent national report on water quality in the United States, 45 percent of assessed stream miles, 47 percent of assessed lake acres, and 32 percent of assessed bay and estuarine square miles were classified as polluted (USEPA. Washington, DC October 2007). Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, like serving as drinking water, and/or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish.

changes in water quality and the ecological status of water. Water pollution has many causes and characteristics.

2.3.1 Causes of Water Pollution

The specific contaminants leading to pollution in water include a wide spectrum of chemicals, pathogens, and physical or sensory changes such as elevated temperature and discoloration. While many of the chemicals and substances that are regulated may be naturally occurring (calcium, sodium, iron, manganese, etc.), the concentration is often the key in determining what is a natural component of water, and what is a contaminant.

Oxygen-depleting substances may be natural materials, such as plant matter (e.g. leaves and grasses) as well as man-made chemicals. Other natural and anthropogenic substances may cause turbidity (cloudiness) which blocks light and disrupts plant growth, and clogs the gills of some fish species. (U.S. EPA. 2005.)

Many of the chemical substances are toxic. Pathogens can produce waterborne diseases in either human or animal hosts. Alteration of water's physical chemistry includes acidity (change in pH), electrical conductivity, temperature, and eutrophication. Eutrophication is the fertilization of surface water by nutrients that were previously scarce.

These pollutants are substances present naturally in the environment but when released in significant amount by humans, become toxic. The World Health Organization (WHO) estimates that more than 20% of the world population (around 1.3 billion people) has no safe drinking water and that more than 40% of all populations lack adequate sanitation (Oastridge and Trent, 1999). Poor water quality is still a significant problem in many parts of the world. It can often

limit the use of these vital resources and in more extreme cases can harm human and other life (Forum and Entwicklung 2001). Water can be polluted by substances that dissolve in it or insoluble liquid droplets that become suspended in it. It's not just a bunch of fibers that are laid down and put together. It's coated, bonded and got a tremendous amount of technology built in it (Borman, 2002). Many workers have detected elevated levels of both organic and inorganic pollutants and heavy metals in surface and underground water (Ololade et al. 2000)

Generally, as a result of long retention time and natural filtering capacity of aquifers, groundwater is often unpolluted. However, leachates from wastes at a dump site, as observed in the present study, are potential sources of contamination of both groundwater and surface water (Odukoya et al., 2002).

In addition, investigations have shown that in non-arid regions, infiltrations of water through landfill have caused water table molding. This causes leachate to flow downward and outward from the land fill. Downward flow pollutes ground-water while outward flow causes leachate springs at the periphery of the landfills or seepage into streams or other surface-water (Khanbilvardi et al., 1992). Globally, people need to appreciate the fact that our environment is a delicately balanced substance and, indeed that it is a system. Consequently, the task of protecting it is not a regional issue, neither is it a continental affair, it goes beyond local initiatives. Thus, the research becomes necessary at the present location in Kubwa, Federal Capital Territory Abuja, Nigeria, where there is little or no awareness about the dangers inherent in contaminated water. It is all in an attempt to direct attention to issues of effective management of the environment and the protection of the water qualities therein.

Table 2.1: Characteristics of Water That Affect Water Quality

Characteristic	Principal cause	Significance	Remarks
Hardness	Calcium and magnesium dissolved in water	Calcium and magnesium combine with soap to form an insoluble precipitate and hamper the formation of lather. Hardness affects water use in the textile and paper industries and in steam boilers and water heaters.	Hardness (mg/L as CaCO ₃): 0-60: Soft 61-120: Moderately hard 121-180: Hard
pH (hydrogen ion activity)	Dissociation of water molecules and of acids and bases dissolved in water	pH of water is a measure of its reactive characteristics. Low values of pH, below 4, indicate corrosive water that will tend to dissolve metals. High values of pH (above 8.5), indicate alkaline water that, on heating, will tend to form scale.	PH values: Less than 7, water is acidic; Value of 7, water is neutral; More than 7, water is basic.
Special electrical conductance	Substances that form ions when dissolved in water	Most substances dissolved in water dissociate into ions that can conduct an electrical current. The larger the conductance, the more mineralized the water.	Conductance values indicate electrical conductivity, in micromhos, of 1 cm ³ Of water at a 25° C.
Total dissolved solids (TDS)	Mineral substances dissolved in water	TDS is a measure of the total amount of minerals dissolved in water. Water containing less than 500 mg/L is preferred for domestic use and for many industrial processes.	TDS (mg/L): < 1,000: Fresh 1,000-3,000: Slightly saline 3,000-10,000: Moderately saline 10,000-35,000: Very saline > 35,000: Brine

Nearly all substances are soluble to some extent in water, and many chemical wastes are highly toxic even in minute concentrations. Table 2.1 lists the maximum concentrations of inorganic substances permitted in drinking-water supplies. The density of a liquid substance, i.e. the weight per unit volume of the substance relative to that of water, affects its underground movement.

Densities range from those of petroleum products that are less dense than water to brines and other substances that are denser than water.

Table 2.2 Primary Drinking Water Standards

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Fluoride	4.0	4.0	Skeletal and dental fluorosis	Natural deposits; fertilizer, aluminium industries; water additive
Volatile organics				
Benzene	Zero	0.005	Cancer	Some foods; gas, drugs, pesticides, paint, plastic industries
Carbon Tetrachloride	Zero	0.005	Cancer	Solvents, and their degradation product
p-Dichlorobenzene	0.075	0.075	Cancer	Room and water deodorants, and "mothballs"
1,2-Dichloroethane	Zero	0.005	Cancer	Leaded gasoline, fumigant, paints
1,1-Dichloroethylene	0.007	0.007	Cancer	Plastics, dyes, perfumes, paint
Trichloroethylene	Zero	0.005	Cancer	Textiles, adhesives and metal degreasers
1,1,1-Trichloroethene	0.2	0.2	Liver, nervous system effect	Adhesives, aerosols, textiles, paints, inks, metal degreasers
Vinyl chloride	Zero	0.002	Cancer	May leach from PVC pipe; formed by solvent break down

Coliform And Surface Water Treatment

<u>Gairdia Lamblia</u>	Zero	TT	Gastroentretic disease	Human and animal fecal Waste
Legionella	Zero	TT	Legionnaire's disease	Indigenous to natural water; con grow in water heating system
<u>Standard plate count</u>	N/A	TT	Indicates water quality, effectiveness treatment	
<u>Total coliform*</u>	Zero	<5%+	Indictes gastroenteric pathogens	Human and Animal focal waste
Turbidity*	N/A	TT	Interferes with disinfection, filtration	Soil runoff
Viruses	Zero	TT	Gastroenteric disease	Human and animal focal waste

Notes: TT=special treatment technique required *Contaminant with interim standard which have been revised.
 +=less than 5% positive samples

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Inorganic				
Antimony	0.006	0.006	Cancer	Fire retardants, ceramics, electronics, fireworks, solder
Asbestos(>10m)	7MFL	7MFL	Cancer	Natural deposits; asbestos cement in water systems
Barium*	2	2	Circulatory system effects	Natural deposit, pigments, epoxy sealants, spent coal
Beryllium	0.004	0.004	Bone lung damage	Electrical, aerospace, defense industries
Cadmium*	0.005	0.005	Kidney effect	Galvanized pipe corrosion; natural deposit;

Chromium*(total)	0.1	0.1	Liver, kidney, circulatory disorders	batteries paints Natural deposit; mining, electroplating, pigments
Cyanide	0.2	0.2	Thyroid, nervous system damage	Electroplating, steel, plastic mining, fertilizer
Mercury*(inorganic)	0.002	0.002	Kidney, nervous system disorders	Crop runoff; natural deposits; batteries electrical switches
<u>Nitrate*</u>	10	10	Methemoglobinemia	Animal waste, fertilizer, natural septic tanks sewage
Nitrite	1	1	Methemoglobinemia	Same as nitrate; rapidly converted to nitrate
Selenium*	0.5	0.05	Liver damage	Natural deposit; mining, smelting, coal/oil combustion
Thallium	0.0005	0.002	Kidney, liver, brain, intestinal	Electronics, drugs, alloys Glass

Notes:*contaminants with interim standard which have been revised.

MFL=million fibers per liter.

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Organics(1of4)				
Acrylamide	Zero	TT	Cancer, nervous system effect	Polymers used In sewage/waste water treatment
Adipate; (di(2-ethylhexyl))	0.4	0.4	Decreased body weight	Synthetic rubber, food packaging, cosmetics
Alachlor	Zero	0.002	Cancer	Runoff from herbicide on corn, soybeans, other crops

Atrazine	0.003	0.003	Mammary gland Tumors	Runoff from use as herbicide on corn and non-cropland
Carbofuran	0.04	0.04	Nervous, reproductive system effects	Solid fumigant on and cotton; restricted in some areas
Chlordane*	Zero	0.002	Cancer	Leaching from soil treatment for termites
Chlorobenzene	0.1	0.1	Nervous system and liver effect	Waste solvent from metal degreasing processes
Dalapon	0.2	0.2	Liver and kidney effect	Herbicide on orchards, beans, coffee, lawns, road/railways
Dibromochloropropane	Zero	0.0002	Cancer	Soil fumigate on soybeans, cottons, pineapple, orchards
o-Dichlorobenzene	0.6	0.6	Liver, kidney, blood cell damage	Paints, engine cleaning compounds dyes, chemical wastes
Cis-1,2-Dichloroethylene	0.07	0.07	Liver, Kidney, nervous, circulatory	Waste industrial extraction solvent
Trans-1,2-Dichloroethylene	0.1	0.1	Liver, kidney, nervous, circulatory	Waste industrial extraction solvent
Dichloromethane	Zero	0.005	Cancer	Paint stripper, metal degreaser, propellant, extraction.
1,2-Dichloropropane	Zero	0.005	Liver, kidney, effects; cancer	Soil fumigant; waste industrial solvents

Notes:*Contaminants with interim standards which have been revised.

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion	Sources of Contaminant
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			of Water	in Drinking Water
Organics (2 of 4)				
Dinoseb	0.007	0.007	Thyroid, reproductive organ damage	Runoff of herbicide from crop and non crop applications
Dioxin	Zero	0.00000003	Cancer	Chemical production by-product; impurity in Herbicides
Diquat	0.02	0.02	Liver, kidney, eye effects	Runoff of herbicides On land and aquatic weeds
2,4-D*	0.07	0.07	Liver and kidney damage	Runoff from herbicide on wheat corn, rangelands, lawns
Endothall	0.1	0.1	Liver, kidney, gastrointestinal	Herbicide on crops, land/aquatic weeds; rapidly degraded
Endrin	0.002	0.002	Liver, kidney, heart damage	Pesticide on insect, rodents, birds; restricted since 1980
Epichlorohydrin	Zero	TT	Cancer	Water treatment chemicals; waste epoxy resins, coatings
Ethylbenzene	0.7	0.7	Liver, kidney, nervous system	Gasoline; insecticides; chemical manufacturing wastes
Ethylene dibromide	Zero	0.00005	Cancer	Leaded gasoline additives; leaching of soil fumigant
Glyphosate	0.7	0.7	Liver, kidney damage	Herbicide on grasses, weeds, brush
Heptachlor	Zero	0.0004	Cancer	Leaching of insecticide for

Heptachlor epoxide	Zero	0.0002	Cancer	termites, very few crops Biodegradation of heptachlor
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Notes: *contaminants with interim standard which have been revised
TT = special treatment techniques required

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Organics(3 of 4)				
Hexachlorobenzene	Zero	0.001	Cancer	Pesticide production waste by-product
Heptachlorocyclopentadiene	0.05	0.05	Kidney, stomach damage	Pesticide production intermediate
Lindane	0.0002	0.0002	Liver, kidney, nervous, immune, circulatory	Insecticide on cattle, lumber, gardens; restricted in 1983
Methoxychlor	0.04	0.04	Growth, liver, kidney, nerve effects	Insecticide for fruits, vegetables, alfalfa, livestock, pets
Oxamyl (Vydate)	0.2	0.2	Kidney damage	Insecticide on apples, potatoes, tomatoes
PAHs (benzo(a)pyrene)	Zero	0.0002	Cancer	Coal tar coatings; burning organic matter; volcanoes, fossil fuels
PCBs	Zero	0.0005	Cancer	Coolant oils from electrical transformers; plasticizers
Pentachlorophenol	Zero	0.001	Liver and kidney effects and cancer	Wood preservatives, herbicide, cooling tower wastes
Phthalate, (di (2-ethylhexyl))	Zero	0.006	Cancer	PVC and other plastics

Picloram	0.5	0.5	Kidney, liver damage	Herbicide on broadleaf and woody plants
Simazine	0.004	0.004	Cancer	Herbicide on grass sod, some crops, aquatic algae
Styrene	0.1	0.1	Liver, nervous system damage	Plastics, rubber, resin, drug industries; leachate from city landfills
Tetrachloroethylene	Zero	0.005	Cancer	Improper disposal of dry cleaning and other solvents
Toluene	1	1	Liver, kidney, nervous, circulatory	Gasoline additive; manufacturing and solvent operations

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking W
Organics (4of4)				
Toxaphene	Zero	0.003	Cancer	Insecticide on cattle, cotton, soybeans; canceled in 1982
2,4,5-TP	0.05	0.05	Liver and kidney damage	Herbicide on crops, right-of-way, golf courses; canceled in 1983
1,2,4-trichlorobenzene	0.07	0.07	Liver, kidney damage	Herbicide production, dye carrier
1,1,2-trichloroethane	0.003	0.005	Kidney, liver, nervous system	Solvent in rubber, other organic products; chemical production wastes
Xylenes(total)	10	10	Liver, kidney, nervous system	By-product of gasoline

Lead and copper				
Lead*	Zero	TT+	Kidney, nervous system damage	refining; paints, inks, detergents
Copper	1.3	TT#	Gastrointestinal irritation	Natural/industrial deposits; plumbing solder, brass alloy faucets
Other Interim Standards				
Beta/photon emitters	Zero	4mrem/yr	Cancer	Natural/industrial deposits; wood preservatives, plumbing
Alpha emitters	Zero	5pCi/L	Cancer	Decay of radionuclides in natural and man-made deposits
Combined Radium 226/228	Zero	5pCi/L	Bone cancer	Decay of radionuclides in natural deposits
Arsenic*	0.05	0.05	Skin, nervous system toxicity	Natural deposits; smelters glass, electronic wastes; orchards
Total Trihalomethanes	Zero	0.10	Cancer	Drinking water chlorination by-products

Notes: +=Action level 0.05mg/L

#=Action level 1.3mg/L

*contaminant with interim standards which have been revised.

pCi=picocuries

Source: Wilkes University Center For Environmental Quality Environmental Engineering and Earth Sciences

Secondary Drinking Water Standards

National Secondary Drinking Water Regulations (NSDWRs or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards

Table 2.3: Secondary Drinking Water Standards.

Contaminant	Secondary Standard
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

Source: Wilkes University Center for Environmental Quality Environmental Engineering and Earth Sciences

2.4 Waste Management

There has been an increasing concern about the environment in which man lives. Solid wastes, mount of rubbish, garbage and sewage are being produced everyday by our urban society. In an attempt to dispose of these materials, man has carelessly polluted the environment. (Ololade, etal 2008).

2.4.1 Effects of Waste Management

2.4.1a Health and Environmental Effect

As research into the characteristics of ground and surface water has become more expensive, as the technique for analyzing specific constituents and their potential health and environmental effects have become more comprehensive, the body of scientific knowledge has expanded significantly. Many of the new treatment methods being developed are designed to deal with health and environmental concerns associated with findings of recent research. However, the advancement in treatment technology effectiveness as not kept pace with the enhanced constituent detection capability. Pollutants can be detected at lower concentrations that can be attained by available treatment technology. Therefore careful assessment of health and environment effects and community concern about these effects becomes increasingly important in ground and surface water management. The need to establish a dialogue with the community is important to assure that health and environmental issues are being addressed.

There is a broad range of environmental concerns that encompass the solid waste management world wide, contamination to the atmosphere, soil and water, which puts the entire ecosystem of an area in danger. The contamination of waste causes severs problems for humans and animals alike. The major environmental effects includes Air pollution which includes odour,

smoke, noise, dust, etc, waste pollution –pollution from disposal site via flooding because of blocked drains and degradation.

Water quality issues arise when increasing amount of treated ground and surface water are discharged to water bodies that are eventually used as water supplies. The waters of the Mississippi River and many rivers in the eastern United States are used for municipal and industrial water supplies and as repositories for the resulting treated ground and surface water. In southern California, a semiarid region, increasing amounts of reclaimed ground and surface water are being used or are planned to be used for groundwater recharge to augment existing potable water supplies. Significant questions about the testing and level of treatment necessary to protect human health where the presence of highly treated ground and surface water with drinking water sources results in indirect potable reuse. Some professionals object in principle to indirect reuse of treated ground and surface water for potable purposes; others express concern that current techniques are inadequate for detecting all microbial and chemical contaminants of health significance (Crook et al., 1999). Among the later concerns are: the lack of sufficient information regarding the health risks posed by some microbial pathogens and chemical constituents in ground and surface water, the nature of unknown or unidentified chemical constituents and potential pathogens, and the effectiveness of treatment processes for their removal. Defining risk to the public health based on sound science is an ongoing challenge. Other health concerns relate to: the release of volatile organic compounds (VOCs) and toxic air contaminants (TACs) from collection and treatment facilities, chlorine disinfection, and disinfection by-products (DBPs) odors are the most serious environmental concerns to the public. The effects are numerous on man, the Flora or Fauna of the environment in form of health problems ranges from convulsion, dermatitis, irritation of nose/throat, a plastic anaemia, skin burns, chest pains, blood disorders, stomach aches, vomiting diarrhoea, and lung cancer to death. Obviously something still needs to be accomplished in the field of testing and linking

waste exposure to human health Other health effects includes: Flies which carry germs on their bodies and legs and also excrete them, mosquitoes, breed in stagnant water in blocked drains in favourable location and also in cars, tyres etc

New techniques for odor measurement are used to quantify the development and movement of odors that might emanate from ground and surface water facilities, and special efforts are being made to design facilities that minimize the development of odors, contain them effectively, and provide proper treatment for their destruction. (Metcalf and Eddy, 2004)

2.4.1b Social Effects and Economic Effects

A common thread that further unites people from across the globe, is their sentiment on wastes, they do not want them in their neighbourhoods, countless stories of social effects on people living near waste dumpsite have decorated the news in recent years and some incidents have been so great that whole towns have been evacuated” (Miller et al 1991). The issue of solid waste is a relatively new issue, spawned by the city land fills and the desire for other sites for dumping in distant rural areas.

“A city with a hazardous waste facility is now perceived as an undesirable place to live (Miller et al 1991).

The impact of solid waste on economic values has received limited attention. It is also presumed that its impact is a negative one, one economic effect of living near a hazardous waste site disposal maybe increased taxes. The end of the 1980s saw a radical reappraisal of our concerns over resource availability and use, the environmental consequences of resource exploitation and the relationship between the environment, poverty and economic change. This re-appraisal has given rise to a new approach to environment and development issues an approach, which seeks to reconcile human needs and the capacity of the environment to cope with the consequences of economic systems. This approach is called sustainable development.

Sustainable development is an implied development without destruction. Sustainable development can also be defined as judicious use of non-renewable resources for the present and future generations. That is, non-renewable resources must be used at a judicious rate, neither too fast nor too slow and to ensure that the natural wealth that they represent is converted into long-term wealth as they are used.

Some scholars succinctly put it that sustainable development is development without jeopardizing future development. Meaning that in our efforts to explore and exploit the natural resources to serve us, there is an obvious paradox evident in the need to ensure economic development, while protecting the environment. (US EPA, 2002)

2.4.2 Major Causes of Improper Waste Management

2.4.2a Attitude to Work

Alamieyeseigha, (2004) in his book titled "Managing employee productivity in Nigeria- A strategic Approach" noted that employee productivity of the Nigeria worker is too low, when compared with available human and natural resources. He attributed this incidence of low productivity to certain factors including sociological factors, which is fact in the manifested lack of sense of belonging in an organization and the tendency by employees to perceive a "job" as another business. Confirming the slogan "It is everybody's job and nobody's job"

This negative attribute to work has negatively impacted on the waste management effort of the community.

2.4.2b Inadequate Vehicles, Plants and Equipment and Necessary Tools

It should be noted that waste disposal or deposited at designated points of collection has to be transported either to the transfer loading station where so try is efficient collection system, there must be enough and well maintained equipment such as trucks, tippers, pay loaders, bulldozers, road sweepers, compactors and others. In Lagos State for example municipal solid waste transportation collection and disposal has been epileptic, since the state realized its

responsibility to the environment. A lot of problem such as inadequate number of vehicles, lack of spare, dearth of fund, Poor technical know – how, poor maintenance culture, insufficient funding and lack of motivation has bedevilled the various agencies responsible for effective and safe waste management in the community, (Alamieyeseigha, 2004)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Area

The project study area under investigation is Gbazango extension in Kubwa federal capital territory Abuja, Nigeria. Federal capital territory Abuja is the centre of Nigeria, It lies within the savannah region with moderate climatic condition between latitude $8^{\circ} 25^1$ N and $9^{\circ} 20^1$ N and longitude $6^{\circ} 45^1$ E and $7^{\circ} 39^1$ E of Greenwich meridian.

Kubwa is located along zuba wuse beggar express way, between dei-dei junction and gwarinpa estate in federal capital territory Abuja.

There are indiscriminate tipping of domestic waste in kubwa which is shown in the plates below:

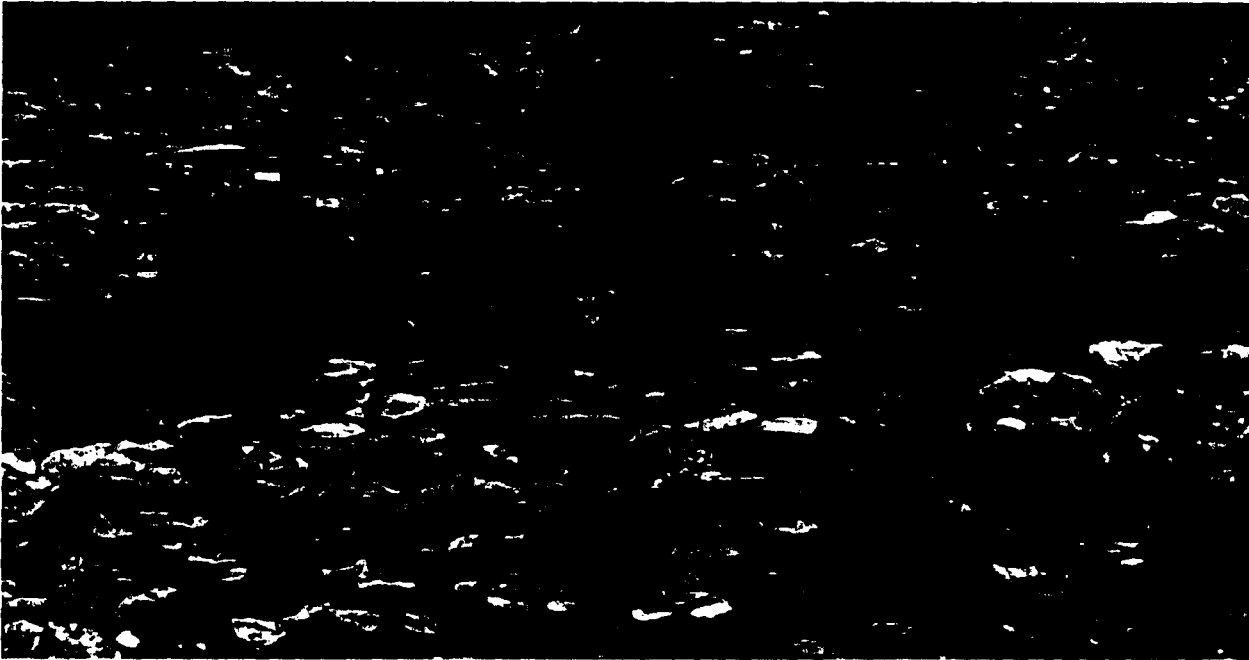


Plate 3.1a: Refuse Dump at the Entrance of Gwazango Extension Kubwa



Plate 3.1b: Refuse Dump within the Houses at Gwazango Extension Kubwa

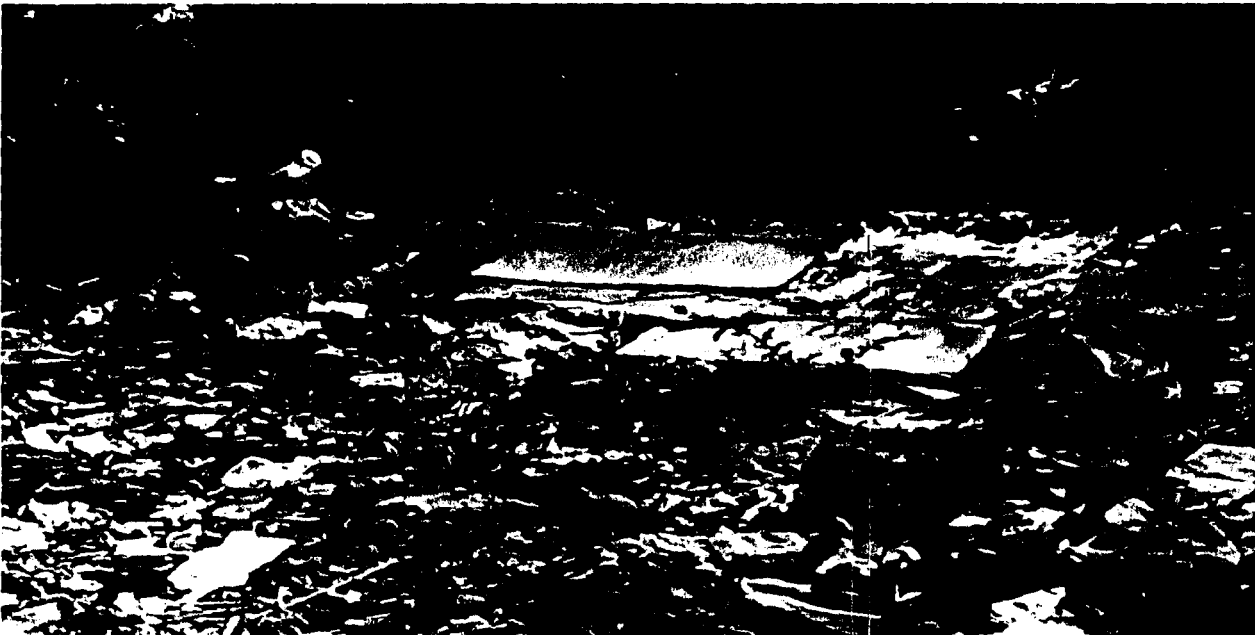


Plate3.1c: Refuse Dump very close to the River at Gwazango Extension Kubwa

3.2 Sample preparations

The sampling was carried out in January, 2009. Water samples were collected using 50Cl plastic containers. All the containers were initially washed using detergent and properly rinsed with distilled water. At the point of sampling, the containers were also rinsed using the ground and surface water respectively several times before the respective samples were taking. The samples were stored in the refrigerator at a temperature of about 4°C prior to the analysis (American Public Health Association (APHA), 1989; Campolo et al., 2002).

Samples were taken from two sources (ground and surface water)

The samples taken from the ground water source were termed:

- 1 Sample "A" morning ground water
- 2 Sample "B" morning ground water
- 3 Sample "C" evening ground water

The samples taken from surface water source were termed:

- 1 Sample "A" morning surface water
- 2 Sample "B" morning surface water
- 3 Sample "C" evening surface water

Three water samples were collected from different points of ground water source via well water, two in the morning at about 8:00am and one in the evening at about 8:00pm, and three samples from surface water along gbazango Extension stream from three sampling points.

Sample "A" surface water at the entry point of kubwa first Gate Township at about 7:30am, sample "B" surface water at the exit of the study area (gbazango extension) at about 7:45am and sample "C" surface water within the study area at about 8:20pm.

Both the ground and surface water were analyzed for physical and chemical parameters.

The physical parameters analyzed include:

- a) Total dissolved solid (mg/L)
- b) Temperature (°c)
- c) Suspended solid (mg/L)
- d) Turbidity (NTU)
- e) Colour (pt.co)

The chemical parameters include:

- a) Electrical conductivity ($\mu\text{s}/\text{cm}$)
- b) pH
- c) Iron content (mg/L)
- d) Sulphate (mg/L)
- e) Nitrate as nitrogen (mg/L)
- f) Nitrate (mg/L)
- g) Total hardness (mg/L)
- h) Hardness (Ca)
- i) Hardness (Mg)
- j) Total alkalinity (mg/L)
- k) Phosphate as phosphorus (mg/L)

3.3 Sample Analysis

The physio-chemical parameters observed in this study were determined using the standard methods. The sulphate was determined using the turbidimetric methods. For the nitrate and phosphate, the cadmium reduction method and ascorbic acid method were employed respectively. Others like total solids (TS), total dissolved solids (TDS), pH, temperature, Electrical conductivities, hardness, colour and turbidities were also determined accordingly. (See **appendix A for details**)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 presentations of results

Details of the results of some physico-chemical parameters determined in the water from the various sources are presented in the Table 4.1a, 4.1b, and 4.1c for morning ground water source A and B, morning surface water source A and B, and evening ground and surface water source C and C respectively.

Table 4.1a Physical and Chemical Parameters of Morning ground Water A and B

S/N	PARAMETERS	SAMPLE "A" MORNING GROUND WATER	SAMPLE "B" MORNING GROUND WATER	W.H.O LIMITS
1	Electrical conductivity ($\mu\text{S}/\text{cm}$)	130	30	1000
2	Total dissolved solids (mg/L)	65	10	500
3	Temperature in the laboratory ($^{\circ}\text{c}$)	26.2	26.2	N/S
4	Suspended solids (mg/L)	10	0	25
5	Turbidity (NTU)	9.0	5.0	5.0
6	Colour (pt.co)	37	5.0	15
7	Ph	6.8	6.8	6.5-8.5
8	Iron content (mg/L)	0.00	0.06	0.30
9	Sulphate (mg/L)	0.00	1.0	250
10	Nitrate as nitrogen (mg/L)	3.60	0.7	10
11	Nitrate (mg/L)	15.84	3.08	50
12	Total hardness (mg/L)	58	10	100
13	Hardness (ca) CaCO_3	23.2	4.0	N/S
14	Hardness (mg) CaCO_3	34.8	6.0	N/S
15	Total alkalinity (mg/L)	4.0	4.0	100
6	Phosphate as phosphorus (mg/L)	0.03	0.01	N/S

Table 4.1b Physical and Chemical Parameters of Morning Surface Water A and B

S/N	PARAMETERS	SAMPLE "A" MORNING SURFACE WATER	SAMPLE "B" MORNING SURFACE WATER	W.H.O LIMITS
1	Electrical conductivity ($\mu\text{S}/\text{cm}$)	340	170	1000
2	Total dissolved solids (mg/L)	170	80	500
3	Temperature in the laboratory ($^{\circ}\text{c}$)	26.4	26.4	N/S
4	Suspended solids (mg/L)	4.0	33.0	25
5	Turbidity (NTU)	7.0	74.0	5.0
6	Colour (pt.co)	41	382	15
7	pH	6.9	7.1	6.5-8.5
8	Iron content (mg/L)	1.21	3.30	0.30
9	Sulphate (mg/L)	2.0	9.0	250
10	Nitrate as nitrogen (mg/L)	1.5	8.7	10
11	Nitrate (mg/L)	6.6	38.28	50
12	Total hardness (mg/L)	98	42	100
13	Hardness (ca) CaCO_3	39.2	16.8	N/S
14	Hardness (mg) CaCO_3	58.8	25.2	N/S
15	Total alkalinity (mg/L)	10	10	100
16	Phosphate as phosphorus (mg/L)	0.3	0.24	N/S

Table 4.1c Physical and Chemical Parameters of Evening Ground and Surface Water C and C

S/N	PARAMETERS	SAMPLE "C" EVENING GROUND WATER	SAMPLE "C" EVENING SURFACE WATER	W.H.O LIMITS
1	Electrical conductivity ($\mu\text{S}/\text{cm}$)	190	130	1000
2	Total dissolved solids (mg/L)	95	60	500
3	Temperature in the laboratory ($^{\circ}\text{C}$)	27.9	27.8	N/S
4	Suspended solids (mg/L)	2.0	63.0	25
5	Turbidity (NTU)	1.0	92.0	5.0
6	Colour (pt.co)	10.0	487	15
7	pH	6.8	7.1	6.5-8.5
8	Iron content (mg/L)	0.13	3.30	0.30
9	Sulphate (mg/l)	2.0	6.0	250
10	Nitrate as nitrogen (mg/L)	5.9	5.9	10
11	Nitrate (mg/L)	25.96	25.96	50
12	Total hardness (mg/L)	76	34	100
13	Hardness (ca) CaCO_3	30.4	13.6	N/S
14	Hardness (mg) CaCO_3	45.6	20.4	N/S
15	Total alkalinity (mg/L)	4.0	10	100
16	Phosphate as phosphorus (mg/L)	0.01	0.27	N/S

4.2 Discussion of Results

4.2.1 Electrical Conductivity (EC_w), Total Dissolved Solid (TDS)

The EC values obtained for Sample "A" morning ground water, Sample "B" morning ground water, Sample "A" morning surface water, Sample "B" morning surface water, Sample "C" evening ground water, and Sample "C" evening surface water are 130, 30, 340, 170, 190 and 130 μ S/cm respectively. These values when compared to the guideline were below the 1000 μ S/cm W.H.O limits. there is no restriction on the use of the water for consumption.

The values of TDS obtained from the analyses were below the 500mg/L W.H.O limits. Hence the water does not pose any threat.

4.2.2 Temperature and pH

From the results obtained the highest was 27.9°C sample "C" evening ground water and the least was 26.2°C sample "A" morning ground water. Therefore the water temperatures will not cause harm to aquatic life and other beneficial uses.

The pH is a measure of the acidity or alkalinity of the water. In general, water with a pH < 7 is considered acidic and with a pH >7 is considered basic. The normal range for pH in surface water systems is 6.5 to 8.5 and for groundwater systems 6 to 8.5. However the pH of sample "B" morning surface water and sample "C" evening surface water are 7.1 which is slightly acidic although poses no threat since its in the range of W.H.O limits.

4.2.3 Turbidity, suspended solid (SS) and Colour

Turbidity is the degree to which water loses its transparency due to the presence of suspended particulates. From the result obtained, apart from sample "B" morning ground water and sample "C" evening ground water 5.0, 1.0 NTU respectively the rest samples has turbidity higher than

5.0 NTU W.H.O limit. The elevated levels above the permissible limit may be associated with the turbulent water flow due to heavy rains during the sampling period. This turbid nature is not good for water as it allows for microbial contamination which can cause significant damage to humans and animals. Moreover, turbid water is more expensive to treat (Ololade et al. 025).

For Suspended Solid Sample "A" morning ground water, Sample "B" morning ground water, Sample "A" morning surface water, Sample "C" morning ground water the results are 10.0, 0.0, 4.0, 2.0mg/l respectively which is below WHO standard but Sample "B" morning surface water and sample "C" evening surface water are 33.0 and 63.0mg/l which poses threat to human as they are far above WHO limit

Apart from Sample "B" morning ground water and Sample "C" morning ground water the rest of the results for colour are above 15mg/l WHO limit hence they are not fit for domestic uses.

4.2.4 Nitrogen and Nitrates

The results obtained for Nitrogen Sample "A" morning ground water, Sample "B" morning ground water, Sample "A" morning surface water, Sample "B" morning surface water, Sample "C" morning ground water and sample "C" evening surface water are 3.6, 0.7, 1.5, 8.7, 5.9, 5.9mg/l respectively which is below 10 mg/l WHO limits, the present study does not call for any adverse effects when used for domestic and recreational purposes.

For Nitrate Sample "A" morning ground water, Sample "B" morning ground water, Sample "A" morning surface water, Sample "B" morning surface water, Sample "C" morning ground water and sample "C" evening surface water are 15.84, 3.08, 6.6, 38.28, 25.96, 25.96 respectively which are less than 50mg/l WHO drinking water guideline. No adverse effects have been observed with Nitrate concentrations <20 – 30mg/L, except for methemoglobinemia in infants (Metcalf and Eddy 2004)

4.2.5 Phosphorus

The addition of phosphorus as phosphate ion, to natural waters is one of the most environmental problems because of its contribution to the eutrophication process. WHO limits was not stated to compare the results.

4.2.6 Iron Content

The results obtained was 1.21, 3.30, 0.13, 3.30 mg/l for Sample "A" morning surface water, Sample "B" morning surface water, Sample "C" morning ground water and sample "C" evening surface water respectively, WHO maximum permissible limit for iron is 0.30 mg/l. This limit was exceeded in all the water samples except in Sample "A" morning ground water and sample "B" morning ground. 0.0, 0.06mg/l respectively. This can impact an unpleasant ironish smell to drinking water and a bittersweet taste can be detected at level above 1-2mg L⁻¹

Consequently, the parameter does give concern as it renders the water unsuitable for domestic use.

4.2.7 Sulphate

The concentration of Sulphate in the water are 0.0, 1.0, 2.0, 9.0, 2.0, 6.0 mg/l for Sample "A" morning ground water, Sample "B" morning ground water, Sample "A" morning surface water, Sample "B" morning surface water, Sample "C" morning ground water and sample "C" evening surface water respectively, based on 250 mg/l WHO limit the concentrations were very low hence it would not adversely affect its use for domestic.

4.2.8 Total hardness, Hardness (Ca) and Hardness (Mg).

The total hardness measured in mg/l or ppm is the sum of Ca and Mg carbonate concentrations in the water. The results are 58, 10, 98, 42, 78, 34ppm for Sample "A" morning ground water, Sample "B" morning ground water, Sample "A" morning surface water, Sample

B” morning surface water, Sample “C” morning ground water and sample “C” evening surface water respectively, with respect to 100ppm WHO limit it poses no threats.

Hardness (Ca) is due to calcium in water only, while hardness (Mg) is due to magnesium in the water only. Water are classified according to the hardness scale

Table 4.2 Classification used for water hardness

Degree of hardness	Hardness (mg equivalent $\text{CaCO}_3 \text{ L}^{-1}$)
Soft	<50
Moderately soft	50-100
Slightly hard	100-150
Moderately hard	150-200
Hard	200-300
Very hard	>300

based on the table 4.2 all the results on Total, Calcium and Magnesium Hardness are either soft or moderately soft therefore it has no harmful effect on human.

1.2.9 Total Alkalinity

The total alkalinity concentration are 4.0, 4.0, 10.0, 10.0, 4.0, 10.0mg/l for Sample “A” morning ground water, Sample “B” morning ground water, Sample “A” morning surface water, Sample “B” morning surface water, Sample “C” morning ground water and sample “C” evening surface water respectively comparing with 100mg/l WHO limit, all the results proved no harm since it is below the maximum permissible limit.

Below shows the pictorial variation of the physiochemical properties analysed for surface and ground water in relative comparison with WHO standard for drinking water.

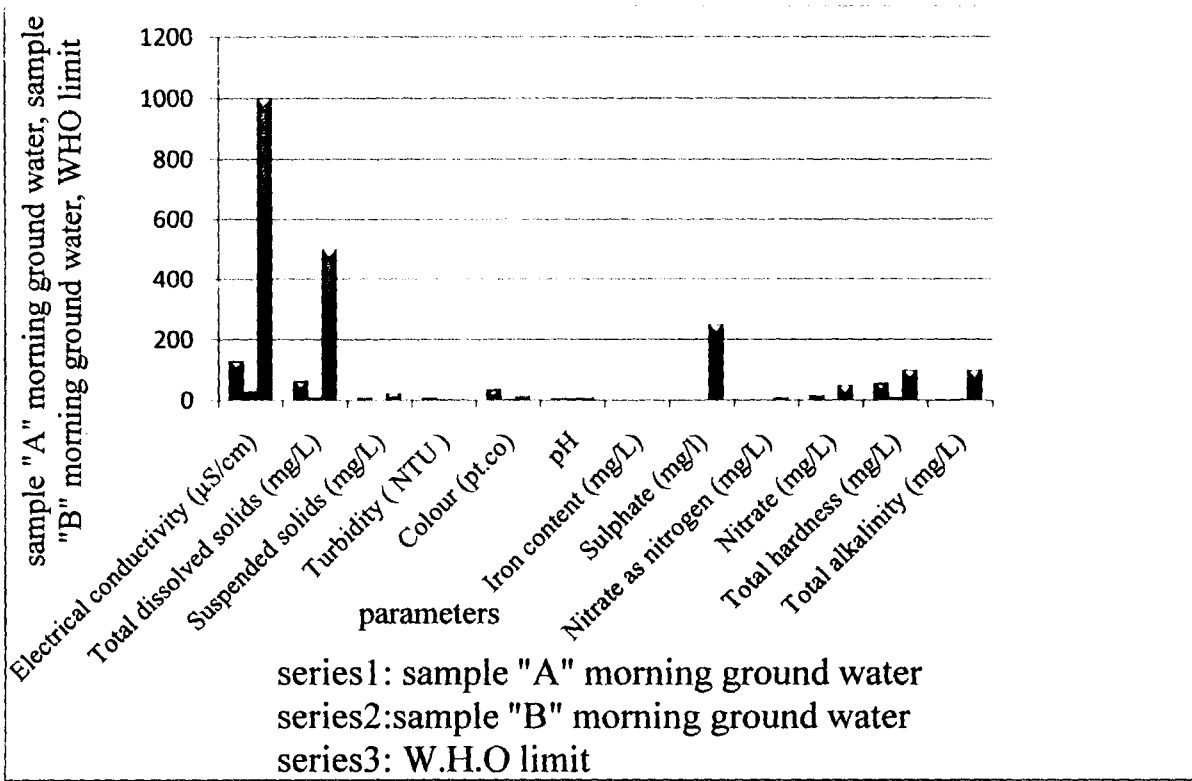


Fig. 4.2a: variation of sample A, B morning ground water and WHO guideline

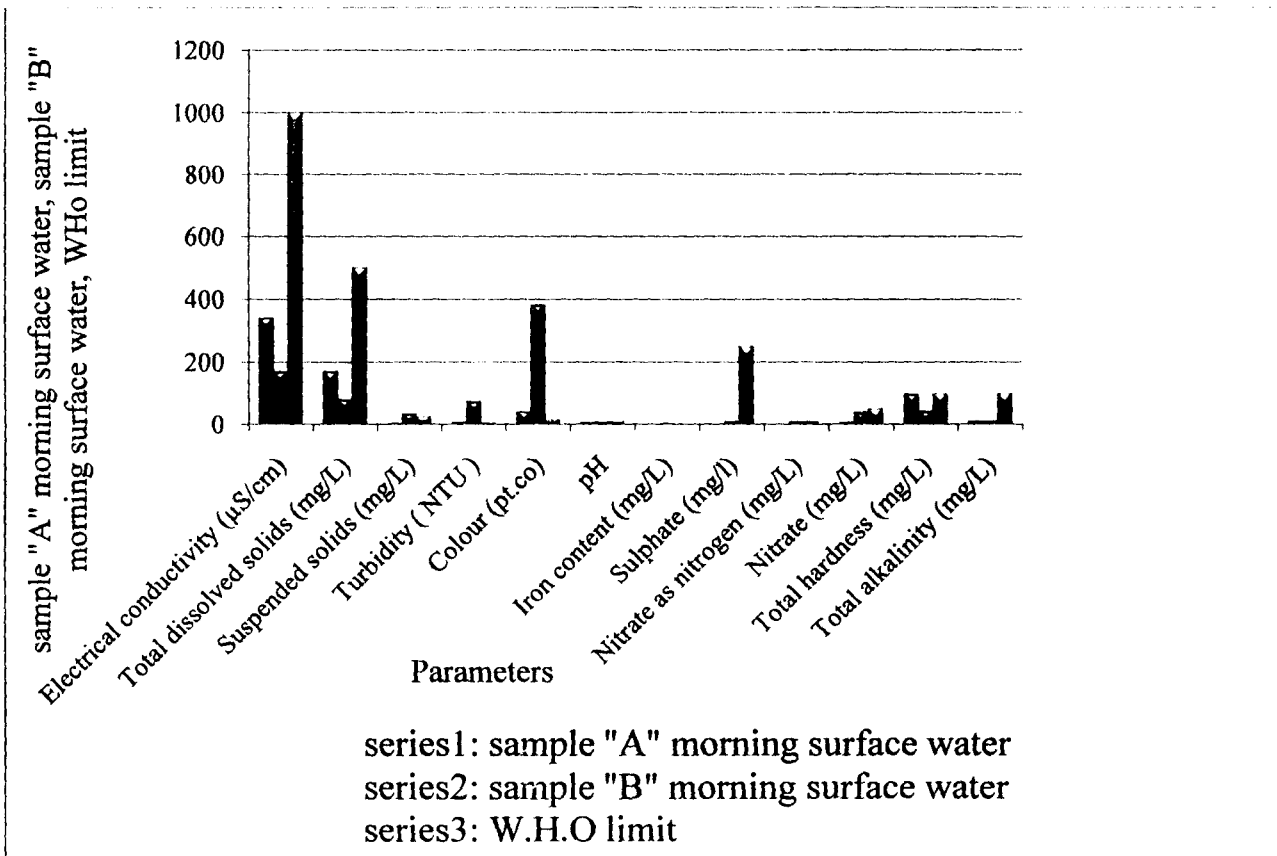


Fig. 4.2b: variation of sample A,B morning Surface water and WHO guideline

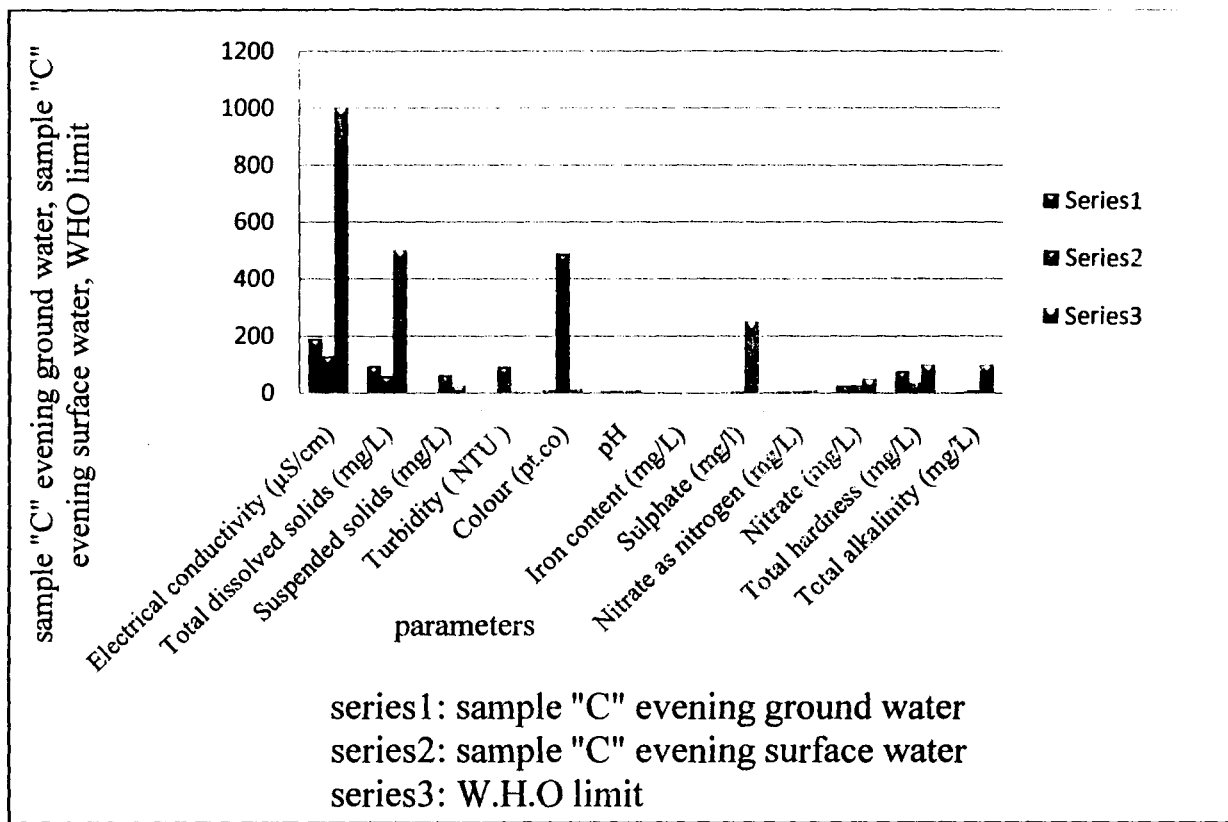


Fig. 4.2c: variation of sample "C" evening ground water, sample "C" evening Surface water and WHO guideline

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Quality parameters of ground and surface water of Gbazango Extension Kubwa Federal Capital Territory Abuja, Nigeria were analysed. The results were compared with World health organization (WHO) guidelines for interpretation of water. Variability between ground and surface water and W.H.O limits were observed with the aid of chart. Hence it leads to the following conclusions:

A. Surface water

Domestic wastes has a lot effects on surface water in Gbazango Extension since most of the physical and chemical parameters analysed such as Suspended solid (mg/L), Turbidity (NTU), Colour (pt.co), Iron content (mg/L), exceeded the guideline provided by WHO and this perhaps is due to flow of domestic waste into the surface water.

B. Ground water

Domestic waste has little or no effects on ground water in Gbazango Extension since it poses no threat on the uses except for the sample "A" where the colour and turbidity results exceeded the guideline. Therefore it is safer to consume ground water in Gbazango Extension Kubwa Abuja than surface water.

Recommendations

- a. With the consent of river purification board domestic waste must not be discharged into any water source.
- b. These analyses should be carried out time to time to always know the level at which water is been polluted in the area so as to take necessary measure.
- c. In designing well the protected walls should be raised above ground level, ringed and properly covered to prevent excess run-off from polluting the ground water.

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APPENDIX A

I pH determination using pH meter

Aim: Determination of the pH of water samples using pH meter

Apparatus: Beakers, water sample, pH buffer solution, distilled water and pH meter.

Procedure

- Standardize the activated electrode (pH) with pH buffer solution
- Rinse the electrode thoroughly with distilled water after removal from the buffer solution.
- Place the electrode in the sample and record the reading on the electronic scale
- Immerse the probe ends in a beaker of 7 buffer storage solution
- Turn meter to standby or off.

II Determination of temperature

Aim: To measure the temperature of water sample using a digital electrode thermometer

Principle of Operation: The electrode thermometer makes use of the effect of temperature on electromotive force (E.M.F). The electrode is connected to some electronic device which gives a digital display of temperature reading.

Apparatus: Water sample, beakers, and digital electrode thermometer.

Procedure:

- Collect sample in a clear beaker

- Switch on the thermometer and dip the electrode inside the beaker and allow for some minutes.
- Take the reading as soon as the display attains a steady value.

III Determination of turbidity

Aim: To determine the turbidity of water sample using a turbidimeter

Apparatus: Water sample, sample cells, turbidimeter.

Procedure:

- Wash the sample cells with sample water, discard and refill with the same sample.
- Wipe the sides of the cells with a dry cloth.
- Switch on the power source and adjust the turbidimeter to read in NTU
- Open the cell holder, place the sample cell in it and replace the lid
- Record the reading on the digital display in NTU.

IV Determination of solids (suspended solid and total dissolved solids)

Aim: to determine the total solids of water sample.

Apparatus: Filter papers (Whatman) or suitable glass, graduated measuring cylinder 100ml capacity, vacuum pump, funnel (glass), oven steam/water bath, weighing balance, evaporating dishes.

Suspended solids (SS):

Procedure:

- Mix the water sample very well and measure out 100ml of the sample into the measuring cylinder.
- Weigh the filter paper (for initial weight).
- Filter through a pre-dried and weighed filter paper for the total volume, if possible by air of a vacuum pump.
- Dry the filter in an oven of a temperature of 103⁰C for about 30 minutes.
- Cool to room temperature in a desiccator and weigh.
- Record the final weight.

Calculation:

$$\text{Suspended solids (SS)} = \frac{\text{the final weight-initial weight}}{100\text{ml}}$$

In liters = above figure obtained x 10³

$$\text{i.e., SS in liters} = \frac{\text{Difference in weight} \times 1000}{100}$$

Total dissolved solids (TDS)

From the filtrate obtained from the last experiment, a known volume usually (100ml) is evaporated from water bath continuously until all the water is removed leaving the dissolved salts.

• Like the filter paper, the dishes had been pre-weighed after drying at 180⁰C as the initial weight.

Then, the dried dish and plus the salt residue is also weighed and the final weight is obtained.

Mathematically,

$$\text{TDS (mg/l or g/l)} = \frac{(\text{final weight} - \text{initial weight}) \times 1000}{100}$$

= differential weight of initial and final.

V Determination of hardness

Aim: To determine the hardness of a sample by complexometric analysis.

Apparatus: Volumetric flask (1000ml), burette(25ml), burette support, beaker(250ml), graduated cylinder, magnetic stirrer, Erlenmeyer(500ml), funnel, flask, hot plate.

Procedure:

- Take a clean beaker and add 50ml of sample
- Add 2ml of buffer solution.
- Add 2 drops of indicator solution
- Titrate with standard EDTA solution until the last reddish tinge disappears from the solution. The solution is pure blue when the end point is reached.
- Total hardness is therefore calculated as follows;

$$\text{Hardness (mg/l) as CaCO}_3 = \frac{A \times 1000}{\text{ml of sample}}$$

Where A= titrant used (ml)

VI Determination of electrical conductivity

The conduct meter (WPA CM 25 conductivity meter) was used for the determination of electrical conductivity of water samples.

Procedure:

- Put the instrument on and allow warming up for 15 minutes
- Rinse the conductivity meter electrode with distilled water and wipe it with a tissue paper
- Put the electrode into the sample contained in the beaker, note the temperature of the sample and measure it.
- Stir the water sample with the electrode and allow standing for about 1 minute and taking note of the conductivity value
- Record the conductivity value.

VII Determination of total alkalinity

Aim: To determine the alkalinity of water samples by volumetric analysis.

Apparatus: Graduated cylinder (100ml), burette (25ml), beaker (250ml), pH meter, electrode, magnetic stirrer, analytical balance, dessicator, sodium carbonate solution (0.05), sulphuric acid (1N), and standard sulphuric acid (0.02N).

Procedure:

- Take a clean beaker and add 100ml of sample
- Place electrode of PH meter into the beaker containing sample
- Stir sample slowly (with a magnetic stirrer)
- Check the pH of sample. If the ph is 8.3 or below, then there is no phenolphthalein alkalinity present and you can use it to this point.
- If the ph is greater than 8.3 titrate very carefully to a ph of 8.3 with 0.02N H₂SO₄. Record the amount of acid used from starting point to this point.

- Continue to titrate to pH 4.5 with 0.02N H₂SO₄. Record the total amount of acid used from starting point to finish.

Calculate the total and phenolphthalein (if present) alkalinities from the formula:

(a) Phenolphthalein alkalinity in mg/l as CaCO₃

$$= \frac{A \times N \times 50,000}{\text{ml of sample}}$$

Where A = ml of titrate used to pH 8.3, N = Acid normality.

(b) Total Alkalinity, mg/l as CaCO₃

$$= \frac{B \times N \times 50,000}{\text{ml of sample}}$$

Where B = Total ml of titrant used.

VIII Nitrate

Methodology: Two moles of NO₃⁻ react with one mole of chromotropic acid to form a yellow reaction product, the absorbance of which is measured at 410nm. The method can be used to determine nitrate concentrations in the range 0.1 – 5mg NO₃⁻ - NL⁻¹. It is necessary to eliminate interference by nitrate, residual chlorine and certain oxidants which yield yellow colour when they react with chromotropic acid. Interference from residual chlorine and oxidizing agent can be eliminated by addition of sulfite. Urea eliminates nitrite interference by converting it to N₂ gas. Addition of antimony can mark up to 2000mg Cl⁻ L⁻¹.

Materials:

- Spectrophotometer
- Cooling bath
- Stock nitrate solution, $100\mu\text{g NO}_3^- \text{N mL}^{-1}$. Prepare by diluting a commercially available 1000mg L^{-1} solution. Otherwise prepare as follows dry sodium nitrate (NaNO_3) in an oven at 105°C for 24hours. Dissolve 0.607g of the dried salt in water and dilute to 100mL .
- Working nitrate solution. $10\mu\text{g NO}_3^- \text{N mL}^{-1}$. Pipette 50mL of the stock solution into a 500 mL volumetric flask and make up to the mark with water.
- Sulphite – urea reagent. Dissolve 5g urea and 4g anhydrous Na_2SO_3 in water and dilute to 100mL .
- Antimony reagent. Heat 0.5g of antimony metal in 80 mL of concentrated H_2SO_4 until all the metal has dissolved. Cool the solution and cautiously add to 20mL iced water. If crystals form after standing overnight, redissolve the heating.
- Purified chromotropic acid solution (0.1%). Boil 125 mL of water in a beaker and gradually add 15 g of 4, 5-dihydroxyl-2, 7-naphthalene-disulfonic acid disodium salt, while stirring constantly. Add 5g of decolourising activated charcoal and boil the mixture for 10minute . Add water to make up for loss due to evaporation. Filter the hot solution through cotton wool. Add 5g of activated charcoal to the filtrate and boil for 10minutes . Remove the charcoal completely from the solution by filtering, first through cotton wool and then through filtered paper. Cool and add slowly 10mL of concentrated H_2SO_4 . Boil the solution down to 100mL in a beaker and stand overnight. Transfer crystals of

chromotropic acid to a Buchner funnel and wash thoroughly with 95% ethyl alcohol until crystals are white. dry the crystals in an oven at 80°C. prepare a 0.1% solution by dissolving 100mg of the purified chromotropic acid in 100mL of concentrated H₂SO₄ and store in a brown bottle. This solution is stable for two weeks. If the sulphuric acid is free from nitrate impurities the solution should be colourless.

- Sulphuric acid, concentrated high purity.

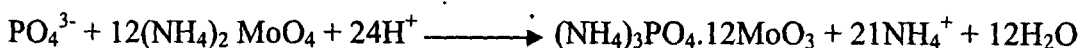
Experimental procedure: (a) *storage of samples;* result form most reliable when nitrate ion is determined in fresh samples. For short term preservation of up to 1day, samples can be stored in refrigerator at 4°C. if it is not possible to carry out the analysis promptly, samples can be preserved by adding 0.5-1.0mL of concentrated H₂SO₄ per litre of sample and store at 4°C.

(b) *Analyses;* prepare nitrate standards in the range 0.1-5 mg NO₃⁻ NL⁻¹ by pipetting 1, 5, 10, 20, 40 and 50mL of the working nitrate solution into a series of 100mL volumetric flasks and making up to the mark with water. Filter the sample if significant amounts of suspended matter are present. Pipette 2mL aliquots of samples, standards and a urea reagent to each flask. Place flasks in a tray of cool water with a temperature between 10-20°C and add 2mL of the antimony reagent swirl the flasks when adding to each reagent. After the flasks have stood in the bath for about 4 minute. Add 1 mL of the antimony reagent. Swirl the flasks again and allow to stand in the cooling bath for another 3 minute. Make up to the mark concentrated H₂SO₄ . stop and mix with contents by inverting them 4 times. Allow the flasks to stand at room temperature for 45 minute and again adjust the volume to 10mL with concentrated H₂SO₄. Finally, mix very gently to avoid introducing gas bubbles. Allow the flasks to stand for at least 15 minutes before measuring the absorbance at 410 nm using a 1cm cell with water in the reference cell. Subtract the absorbance reading of the water blank from the absorbances of samples and standard. Prepare

a calibration graph of net absorbance against $\text{mg NO}_3^- \cdot \text{NL}^{-1}$ based on the standard measured and read off directly the concentration of NO_3^- (expressed as $\text{mg} \cdot \text{NL}^{-1}$) in the samples.

IX Phosphorus

Methodology: Phosphate reacts with ammonium molybdate under acidic conditions to form an ammonium phosphomolybdate complex:



The molybdenum in the ammonium phosphomolybdate complex is reduced by ascorbic acid to produce a blue-coloured compound known as molybdenum blue. The absorbance of molybdenum blue is measured using a spectrophotometer at 880nm.

Orthophosphates are determined by analyzing samples without preliminary hydrolysis. Some condensed phosphates are also analysed at the experimental conditions. Owing to this slight interference, the term reactive phosphorus is sometimes used to define phosphates that are determined without preliminary hydrolysis. Condensed phosphates are converted into orthophosphates by hydrolysis and the total inorganic phosphates (orthophosphate + condensed phosphate) determined. Some organic phosphorus may also be released during the treatment and interfere in the analysis. Condensed phosphates are determined by differences. The term "acid hydrolysable phosphorus" is sometimes used instead of "condensed phosphate" to describe this fraction. Organic phosphorus is oxidized to orthophosphate and the total phosphate determined. Organic phosphorus is determined difference.

Samples are filtered through a $4.5\mu\text{m}$ filter prior to analysis if only dissolved phosphorus compounds are to be analysed. Unfiltered samples can also be analysed to give total phosphorus (dissolved + suspended) and the phosphorus in suspended matter calculated by difference.

Materials

- Spectrophotometer
- Potassium antimony tartrate solution prepared by dissolving 2.7g K (SbO)C₄H₄O₆·5H₂O in water and diluting to 1 L
- Ammonium molybdate solution prepared by dissolving 40g (NH₄)₆Mo₇O₂₄·4H₂O in water and diluting to 1L
- Ascorbic acid, 0.01 M, prepared by dissolving 1.76 g ascorbic acid in water and diluting to 100mL. Store in a refrigerator at 4°C. This solution can be used for up to one week.
- Sulfuric acid. Dilute 70mL concentrated H₂SO₄ to 500mL with water.
- Reaction mixture. Add 100mL of above sulfuric acid solution, 10mL potassium antimony tartrate solution, 30mL ammonium molybdate solution and 60mL ascorbic acid solution to 250mL bottle. Mix after addition of each reagent and allow to cool to room temperature before adding the next reagent. If the final solution becomes clear. This reagent is stable for only 4 hour so prepare when required.
- Stock phosphate solution, 100mg P L⁻¹. Dissolve 439.0 mg anhydrogen phosphate (KH₂PO₄) in water and dilute to 1L; 1 mL = 100µg.
- Working phosphate solution, 10 mg P L⁻¹. Dilute 10.0mL stock phosphate solution to 100mL with water; 1 mL = 10µg P.

Experiment procedure: (a) sampling and storage. Analysis of P should be carried out as soon as possible after sample collection. If this is not possible, samples can be stored by deep- freezing at temperatures lower than -10°C after adding 40 mg HgCl₂ per litter of sample. Neither acid nor

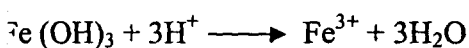
CHCl_3 should be used as a preservative when phosphorus is to be determined. If only dissolved phosphorus compounds are to be analysed filter sample immediately through pre-washed 0.45 μm membrane filters. Filters should be pre-washed by soaking in water for 24 hours to remove any phosphorus from the filters. As they could contribute significantly to samples with low levels of phosphate. Preferably use glass bottles for sampling. Plastic bottles may be used for storing frozen samples. Glass sampling bottles should be washed with hot dilute HCl and rinsed several times with water. Commercial detergents containing phosphate should never be used for cleaning glassware used in phosphate analysis.

(b) Analysis. Prepare calibration standard by adding volumes of standard phosphate solution ($10\mu\text{gP mL}^{-1}$) corresponding to between 5 and $60\mu\text{g P}$ (i.e. 0.5-6 mL of standard solution) to a series of 50 mL volumetric flasks. Pipette 40 mL of sample into 50 mL volumetric flasks. To each flask, add 8 mL of the reaction mixture and make up to the mark with water. Prepare a water blank by pipetting 8 mL of the reaction mixture into a 50 mL flask and making up to the mark with water. Mix the solution thoroughly and allow to stand for at least 10 minutes. But no longer than 30 minutes. Use the water blank prepared above in the reference cell of the spectrophotometer rather than the customary water. Measure the absorbance of each solution at 880 nm in a 1 cm cell. Plot a calibration graph of absorbance against $\mu\text{g P}$. This should be a straight line going through the origin. Read off the amount of phosphorus in the sample and calculate the concentration as: $\text{mgP L}^{-1} = \mu\text{gP}/V$

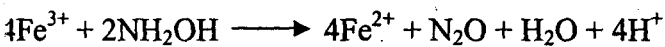
X Iron Content

Methodology: the method is based on the reaction between ferrous Fe (II) ion and 1, 10-phenanthroline to form an orange-red complex ion. As some iron in the sample may be present

As precipitated ferric hydroxide, Fe is first brought into solution and reduced to the ferrous state by boiling with hydrochloric acid:



Ferric Fe(III) is reduced to the ferrous state by reaction with hydroxylamine:



Each ferrous ion reacts with three molecules of 1, 10-phenanthroline to form a complex ion which is orange-red in colour. The pH is kept at pH 3.2 – 3.3 to ensure rapid colour development. The colour solution obeys Beer's law and can be measured using a spectrophotometer.

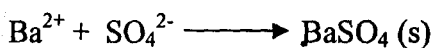
Materials

- Spectrophotometer
- Filtration apparatus
- Filter paper, 0.45µm
- Hot plate
- Concentrated hydrochloric acid
- Hydroxylamine solution (10%) prepared by dissolving 10 g $\text{NH}_2\text{OH}\cdot\text{HCl}$ in 100mL water
- Ammonium acetate buffer solution. Dissolve 250 g $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$ in 150 mL water and add 700mL of concentrated glacial acetic acid.

- Phenanthroline solution prepared by dissolving 100mL of 1, 10-phenanthroline monohydrate, $C_{12}H_8N_2 \cdot H_2O$, in 100mL water and adding two drops concentrated HCl. The solution should be discarded if it darkens.
- Stock iron solution, 1000 mg L^{-1} . Commercially available. This can also be prepared as follows. Dissolve 1.00 g iron wire in 50 mL 1:1 HNO_3 and dilute to 1 L.
- Working iron solution, 10 mg L^{-1} , prepared by dilution of the stock solution
- Standard iron solution, 1 mg L^{-1} , prepared by further dilution

XI Sulphate

An excess of barium chloride ($BaCl_2$) is added to the sample. The barium ion reacts with the sulphate to precipitate barium sulphate crystals of uniform size:



The colloidal suspension is measured using a spectrophotometer and the sulphate concentration determinate by comparison with standards. Suspended particles present in large amounts will interfere and these can be removed by filtration. Highly coloured samples may give erroneous results.

Materials

- Magnetic stirrer and bar
- Spectrophotometer and absorption cells (2 – 10cm)
- Stopwatch

- Barium chloride ($\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$), crystalline. Dry in an oven and pass through a sieve of 20 mesh sieve.
- Sodium chloride – hydrochloric acid reagent. Dissolve 60g NaCl in water, add 5mL concentrated HCl and dilute to 250mL.
- Glycerol – ethanol solution. Mix 100 mL glycerol with 200mL of ethanol in bottle.
- Standard sulphate solution, 100mg L^{-1} . Dissolve 147.9 mg anhydrous sodium sulphate and dilute to 1 L with water. $1\text{mL} = 0.1\text{ mg SO}_4^{2-}$.

Experimental procedure: sampling and storage. Store samples at 4°C to prevent biological reduction of SO_4^{2-} to S^{2-} . unpolluted sample can be stored at room temperature for 2-3 days. Filter through a $0.45\mu\text{m}$ membrane filter.

Analysis. Measure 100mL of sample into a 250 mL conical flask and place on a magnetic stirrer. While stirring add 20 mL of the NaCl – HCl solution and 20mL of the glycerol – alcohol solution. Add approximately 0.3g barium chloride. Stir for 2minutes exactly after adding barium chloride. Immediately pour some solution into an absorption cell and measure the absorbance at 250nm after exactly 3minutes. Prepare a series of calibration standards by pipetting aliquots of the standard sulphate solution corresponding between 0.5 and 5mg SO_4^{2-} (i.e 5-50mL) into a 100mL volumetric flask and making up to the mark with water. Analyse in the same way as samples. Prepare sample blanks by adding all the reagents except barium chloride to 100mL of sample and measure the absorbance. Subtract from each sample reading the blank reading obtained using the same sample to compensate for sample colour and turbidity.