ACCESS TO DOMESTIC WATER SUPPLY VIA MECHANICAL AND NON MECHANICAL ENERGY SYSTEM BY HOUSEHOLD IN USIN IKOLE LOCAL GOVERNMENT AREA EKITI STATE NIGERIA.

BY

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(CVE/12/0943)

A project submitted to the department of Civil Engineering, Federal University Oye-Ekiti in partial fulfillment of the Requirement for the Award of Bachelor of Engineering Degree in Civil Engineering

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ABSTRACT

This project is designed to determine households' access to domestic water supply via mechanical and non-mechanical energy system in Usin,Ikole local government area Ekiti State Nigeria, in terms of quality and quantity as the importance of adequate safe water supply to human health cannot be over emphasized. However, safe/improve water supply to most Nigerian cities is still inadequate. In the study area the relationship between water quality, the degree of water source protection and quantity. This aim was achieved by collecting water samples from different sources of water that are majorly used by community, a total of twelve water were collected for laboratory analysis from which four samples were from hand dug well, and another one sample were from bore-hole and three samples from pumping machine and four sample from rain water harvest. In addition, the samples were collected basically from both mechanized water source and non-mechanized nearby alternative water sources current used as a main sources for house hold consumption. However the distance covered between this source and houses where the water are been consumed range from 4om-450m the samples collected from hand dug wells boreholes, pumping machine water and rain water harvest which were taking to laboratory for analysis. Based on the water quality of the sample investigated, the status of the existing water quality was compared with the standard of World Health Organization (WHO, 2004). Results showed that all the rain water samples collected do not meet up with the WHO and NSDWQ standard. The pH for samples 1,2,3,4 are 5.8, 5.9, 5.7, 5.6 respectively. Also, all the samples gotten from the hand dug well do not meet up with the WHO and NSDWQ standard except for sample 2 which have a pH of 6.8. For the hand pump and borehole samples, all the samples collected are within permissible recommended limit except for sample 3 which have a pH of 6.4. It was concluded that sanitation around all domestic water source requires improvement to eliminate possibility of contamination of water from the source and was recommended that the water source can be decontaminated by chlorination and a lot of awareness creation activities should be done on sanitation and hygiene through extension workers.

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My profound gratitude goes to Almighty God, who made my existence a possibility and has so far been in the control of my life and has been protecting me from all unseen evil. My acknowledgement also goes to my parents Mr. and Mrs. Fatanmi. I pray they live to reap the fruit of their labour.

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DEDICATION

This Project is solely dedicated to Almighty God for the wisdom and strength he gave to me during the research period

CERTIFICATION

This is to certify that this Project was prepared by FATANMI, Adewale Johnson (CVE/12/0943) under my supervision, in partial fulfillment of the requirement for the award of Bachelor of Engineering (B.Eng.) in Civil Engineering, Federal University Oye- Ekiti, Ekiti State, Nigeria.

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CHAPTER ONE

INTRODUCTION

1.0 Historical background

While water resources are valued for human health and for sustaining food production, the energy contained in moving water such as rivers or tides can also be harnessed to do work through mechanical devices, or to create energy in small scale or large scale hydropower schemes. Globally, 1.4 billion people lack access to electricity, with an additional 1 billion having only intermittent access (UNDP 2012). As running water is a resource that is globally available and renewable, harnessing its power for mechanical uses can improve livelihoods and increase working productivity even in rural or developing areas where no local electricity source is available.

Domestic water supplies are one of the fundamental requirements for human life. Without water, life cannot be sustained beyond a few days and the lack of access to adequate water supplies leads to the spread of disease.

Children bear the greatest health burden associated with poor water and sanitation. Diarrhea diseases attributed to poor water supply, sanitation and hygiene account for 1.73 million deaths each year and contribute over 54 million Disability Adjusted Life Years, a total equivalent to 3.7% of the global burden of disease.

Lack of access to safe and clean water is locked in the heart of the poverty. Even though the issue of water is observed as a general problem for both the urban and the rural population, women bear the greatest burden because of their social gender roles including collecting water for their households (Rose, 2009).

Relationship between energy sources and their impact on prosperity and development, as compared to their technical complexity. Source: BATES et al. (2009)

Water Supply

Having a clean and reliable source of drinking water is essential in improving the health of a community. In rural areas, water collection is often the responsibility of women, and consumes a great deal of time and energy. Mechanized water pumps can reduce the time and physical strain of water collection for women, allowing them to focus more on other activities, such as caring for children or taking care of their own health.

Lifting

Water can also be used for transport purposes. In countries such as Switzerland and France, water has historically been used for powering cable cars, using natural gradients and counter weights to drive cars up and down hills. These technologies are still in use today, but many have been replaced with designs that are powered by engines (DE DECKER 2009).

Mechanical water use is a non-consumptive water use. Therefore, there are possibilities to link mechanical water use to other uses, such as irrigation in agriculture. This can reduce the investment costs for individual users, thus expanding the possibilities for income generation and development.

In Guidelines for Drinking-Water Quality, World Health Organization (WHO) defines domestic water as being 'water used for all usual domestic purposes including consumption, bathing and food preparation' (WHO, 1993). This implies that the requirements with regard to the adequacy of water apply across all these uses and not solely in relation to consumption of water. Although this broad definition provides an overall framework for domestic water usage in the context of quality requirements, it is less useful when considering quantities required for domestic supply.

Sub-dividing uses of domestic water is useful in understanding minimum quantities of domestic water required and to inform management options. In the 'Drawers of Water' study on water use patterns in East Africa, White et al. (1972) suggested that three types of use could be defined in relation to normal domestic sup

Consumption (drinking and cooking)

1. Hygiene (including basic needs for personal and domestic cleanliness)
2. Amenity use (for instance car washing, lawn watering).

In updating the Drawers of Water study, Thompson et al. (2001) suggest a fourth category can be included of 'productive use' which was of particular relevance to poor households in developing countries. Productive use of water includes uses such as brewing, animal watering, construction and small-scale horticulture.

The first two categories identified by White et al. (1972): 'consumption' and 'hygiene', have direct consequences for health both in relation to physiological needs and in the control of diverse infectious and non-infectious water-related disease. The third category: 'amenity' may not directly affect health in many circumstances. Productive water may be critical among the urban poor in sustaining livelihoods and avoiding poverty and therefore has considerable indirect influence on human health.

Creating community awareness of their water supply and sanitation services is one of the options for improving sustainable access (Mtinda, 2007). Improving the water supply coverage and quality has a number of consequences in addition to the fact that investigating the socioeconomic and other factors affecting household water consumption patterns provides guidance for policy makers and those in various agencies implementing projects. It also ensures the projects capture the major points to be considered before installation begins and ensures the ongoing provision of a service that is fundamental to improve health, reducing the burden of women and children carrying water long distances, and enabling users to live a life of dignity. Water supply and sanitation services should not be seen as isolated factors (Water Aid, 2009).

Furthermore to achieve the MDGs of access to improved water sources is better to incorporate each element to understand and recommend the major factors which hinder the vision of the long term programs for the provision of safe or quality water and sanitation services is very crucial.

Lack of access to safe and clean water is locked in the heart of the poverty. Even though the issue of water is observed as a general problem for both the urban and the rural population, women bear the greatest burden because of their social gender roles including collecting water for their households (Rose, 2009). Because of their task of water provision at the households, women and children suffer from disease have limited participation in education, and both income generating activities and engagement in cultural and political issues are often compromised. Several studies have been carried sout to analyze people's perception and attitude about the drinking water source quality and accessibility. Creating good community awareness about water quality issues and the associated problems like sanitation and hygiene services is important to alleviate health effects but it remains below the expected rate of coverage. Inadequate access to safe and adequate water supplies contributes to ongoing poverty both through the economic costs of poor health and in the high proportion of household expenditure on water supplies in many poor communities, arising from the need to purchase water and/or time and energy expended in collection.

The use of unimproved drinking water sources is a major challenge coupled with uncontrolled siting of latrines. Sanitation facilities which are appropriate to meet the needs and demands of communities at affordable cost both at construction and operation and maintenance for end users are viable options to the control of contamination of domestic water sources. Factors such as the presence of uncapped wells and poor sanitary completion of the wells are as important as subsurface leaching of microbial contamination.

Sources of water used in Usin Ikole Ekiti.

1) Hand dug wells,

2) Bore-holes (pumped by powered machines and hand pump),

3) Rain water harvesting

1.1 Aims

The main aim of this project is to conduct comprehensive analysis on access to domestic water supply via mechanical and non-mechanical energy system by households in Usin, Ikole Ekiti, Ekiti State, Nigeria.

1.2 Objectives

1) To assess the presence of alternative water sources used.
2) To determine the water quality parameters from each selected sources.
3) To assess the time required and distance individuals must travel to access water sources for households.
4) To carried out the key factors contributing to the continued use of unimproved water source.
5) To determine the quantity of water consumed per capita per day.
6) To carried out sanitary analysis around mechanized water source.

CHAPTER TWO

LITERATURE REVIEW

2.0 Domestic Water Supply

Basically, domestic water refers to water consumed by the household and it uses varies with the climate and the stage of sophistication of the urban community Pereira (1973). It includes water for cooking, personal cleaning, drinking, flushing of lavatory, water of lawns and flowers, car washing and general house cleaning. Ayoade (1988), in his work posits that the human body is 60% water and an average daily water intake of 2.25 liters is required by every person. Generally, there had been lack of information on the components of domestic water particularly in the tropics. But however, personal washing and flushing of closets account for almost 30% of water used by the households.

Isaac (1965) stipulates that an average man is entitled to 115 liters of water per day in the temperate region while Ayoade and Oyebande (1978) in their study of water situation in Nigeria states that an average individual requires 46 liters of water per day

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Water is needed for the maintenance of health. Its importance is not only related to the quantity, but also the quality. Access to water in the required quantity is needed to achieve good personal and domestic hygiene practice Huttly et al (1997), while good quality water ensures that ingested water does not constitute a health hazard, even in a life time of consumption Ezzati et al (2003). It is however estimated that as much as 1.1 billion people do not have access to safe drinking water UNICEF 2000, while the drinking of contaminated water is responsible for 88% of the over four billion cases of diarrhea diseases that occur in the world every year, and the 1.8 million deaths that result from them. It is also indirectly responsible for the 50% of childhood malnutrition that is linked to diarrhoral diseases, and the 860, 000 deaths that result from them each year Prüss-Üstün et al (2008)

Therefore, meeting the water needs of Nigerians would be scores of ladder closer to attaining the overall MDGs. According to the African Water Development Report (AWDR 2006), in Africa, poor access to water and the attendant water scarcity affect women and girls disproportionately, the situation is worse in rural areas due to institutional and cultural barriers, including those of disparities in rights, decision-making power, tasks and responsibilities over water for productive and domestic activities.

Infectious diarrhea is mainly responsible for the burden caused by water-borne and water washed diseases.

The realization of these and several other actual and potential benefits of water are hinged on an accessible water infrastructure. According to Adeyemo et al (2006), accessibility is the balance between the demand for and the supply of consumer services over a geographic space and narrowing or bridging the gap between geographic spaces is the all significance of transport. Access to vital resources and services has come to be recognized as positively related to development such that inaccessibility or lack of access is cited as lack of development or symptom of underdevelopment (Ayeni 1987). To the extent that, improved access to essential services has become an accepted part of the rubrics or measure of development and standard of living. Accessibility therefore establishes the extent to which factors like distance, time and cost have shrunk.

In urban areas the water source may be a public fountain or a stand pipe not more than 200 meters away. An adequate amount of water is that which is needed to satisfy metabolic, hygienic and domestic requirements usually about, at least 20 liters of safe water per person per day (UN-HABITAT 2003; World Bank 1997 in Meseret 2008). This minimum quantity, however, vary depending on whether it's an urban location or rural and whether warm or hot climate. Perhaps this is why the AWDR (2006), described basic water need of human beings to be 20 to 50 liters of uncontaminated water daily. The basic indicators for measuring water accessibility according to the WHO revolve around distance and time indices. These indicators show 4 paramount levels of accessibility; No access, for the worst scenario; Basic access; Intermediate access and Optimal access allow the basis of Time and Distance. The indicators as shown in table 2.2 would be a major basis for interpreting and assessing the level of water accessibility in the study area. Realistic measure of water accessibility is that which captures the three key indicators of, distance and time.

2.1.1 Consumption

Water is a basic nutrient of the human body and is critical to human life. It supports the digestion of food, adsorption, transportation and use of nutrients and the elimination of toxins and wastes from the body (Kleiner, 1999). Water is also essential for the preparation of foodstuffs and requirements for food preparation are included in the discussion of consumption requirements.

2.1.1.1 Adequate Hydration Requirements

The human body requires a minimum intake of water in order to be able to sustain life before mild and then severe dehydration occurs. Adverse health effects have been noted from both mild and severe dehydration and the latter can be fatal.

The US National Institutes of Health (2002) provide a definition of mild dehydration as being a loss of 3-5% of body weight, moderate dehydration as being 6-10% loss of body weight and severe dehydration (classed as a medical emergency) 9-15% loss of body weight. In a recent review Kleiner (1999) defined mild dehydration as being the equivalent of 1-2% loss of body weight through fluid losses and over 2% loss as severe dehydration, whilst noting that there is no universally applied index of hydration status. Mild dehydration can be reversed by increased fluid intake and this may be enhanced through the use of salt replacement solutions. Severe dehydration will require rehydration strategies involving more than simple fluid replacement, and often food or other osmolar intake is needed; the process may take up to 24 hours (Kleiner, 1999).

2.1.1.2 Quality of Water for Consumption

The quality of water that consumed is well-recognized as an important transmission route for infectious diarrheal and other diseases (WHO, 1993). The importance of water quality continues to be emphasized by its role in epidemics and contribution to endemic disease from pathogens (Ford, 1999; Payment and Hunter, 2001). This affects both developed and developing countries, although the majority of the health burden is carried by children in developing countries (Prüss et al., 2002). However, recent outbreaks such as that of cryptosporidiosis in Milwaukee and E.coli O157:H7 and Campylobacter jejuni in Walkerton, Ontario illustrate that the developed world also remains at risk (Mackenzie et al., 1994).

Disease may also result from consumption of water containing toxic levels of chemicals. The health burden is most significant for two chemicals: arsenic and fluoride. Arsenic contamination of drinking water sources is being found in increasing numbers of water supplies world-wide and in Asia in particular. The total disease burden is as yet unknown, but in Bangladesh, the country with the most widely reported problem, between 35 and 77 million people are at potential risk (Smith et al., 2000). Fluoride is also a significant global problem and WHO (1999) suggest that over 60 million people are affected by fluorosis in India and China and suggest the total global population affected as being 70 million. Nitrate is also of concern although there remains uncertainty about the scale of adverse health effects from nitrate as few countries include methemaglobinaemia as a notifiable disease (Saywell, 1999).

Water provided for direct consumption and ingestion via food should be of a quality that does not represent a significant risk to human health. A 'zero-risk' scenario for public supplies is not achievable and evidence points to the need to define tolerable risks, commonly based on estimates of numbers of excess cases per defined population size. This approach underpins much risk assessment thinking within the water sector for both microbial and chemical contaminants (Fewtrell and Bartram, 2001; Haas et al., 1999; WHO, 1996).

2.2.0 Quantities of Adequate Water Requirement for Cooking

Water is essential as a medium for preparing food. One study noted that the volume of cooking water available may be an important determinant for diarrhea incidence in children over 3 years of age, although this was less important than water quality for the under 3 years age group (Herbert, 1985).

Defining the requirements for water for cooking is difficult, as this depends on the diet and the role of water in food preparation. However, most cultures have a staple foodstuff, which is usually some form of carbohydrate-rich vegetable or cereal. A minimum requirement for water supplies would therefore also include sufficient water to be able to prepare an adequate quantity of the staple food for the average family to provide nutritional benefit.

It is difficult to be precise about volumes required to prepare staples as this depends on the staple itself. However, an example can be provided for rice, which probably represents the most widely used staple food worldwide. Recommendations for nutrition usually deal with the intake of nutrients rather than specific food stuffs. Most food pyramids give a suggest an intake for cereals of 6 to 11 servings per day, or 600 – 1100 grams per day. To prepare rice using the adsorption method (i.e. only sufficient water to cook the rice is added), 1.6 litres is required for 600g per capita per day. More water may be required to ensure that other foodstuffs can be cooked, although defining minimum quantities is difficult as this depends on the nature of the food being prepared. Taking into account drinking needs, this suggests that between 1.5 and 2 litres per capita per day is used for cooking.

1.2.1 Water Quantity Requirements for Hygiene

The need for domestic water supplies for basic health protection exceeds the minimum required for consumption (drinking and cooking). Additional volumes are required for maintaining food and personal hygiene through hand and food washing, bathing and laundry. Poor hygiene may in part be caused by a lack of sufficient quantity of domestic water supply (Cairncross and Feachem, 1993).

The diseases linked to poor hygiene include diarrheal and other diseases transmitted through the faecal-oral route; skin and eye diseases, in particular trachoma and diseases related to infestations, for instance louse and tick-borne typhus (Bradley, 1977; Cairncross and Feachem, 1993).

The relative influence of consumption of contaminated water, poor hygiene and lack of sanitation on diarrhoeal disease in particular has been the topic of significant discussion. This has mirrored a broader debate within the health sector worldwide regarding the need for quantifiable evidence in reducing health burdens. The desire for evidence-based health interventions is driven by the need to maximize benefits from limited resources (a critical factor both for governments and their populations). It is also 10 driven by the desire to ensure that populations benefit from the interventions that deliver the greatest improvement in their health.

2.3.0 The Interrelationship between Water Supply, Hygiene and Disease

Classifying diseases by causative agent such as microbe type for infectious disease has a value in terms of understanding etiology of infection. However, a more effective way to inform decision-making is to categorize pathogens /diseases in relation to the broad mode of transmission.

According to Bradley (1977), he suggested that there are four principal categories that relate to water and which are not mutually exclusive:

1. water-borne - caused through consumption of contaminated water (for instance diarrhoeal diseases, infectious hepatitis, typhoid, guinea worm);
2. water-washed - caused through the use of inadequate volumes for personal hygiene (for instance diarrhoeal disease, infectious hepatitis, typhoid, trachoma, skin and eye infections);
3. water-based - where an intermediate aquatic host is required (for instance guinea worm, schistosomiasis);
4. Water-related vector - spread through insect vectors associated with water (for instance malaria, dengue fever).

Other workers have suggested a change in this classification system to replace the waterborne category with faecal-oral (to reflect multiple routes of transmission) and to restrict the water-washed diseases to only as those skin and eye infections that solely relate to the quantity of water used for hygiene (Cairncross and Feachem, 1993).

The original Bradley (1977) system has particular value as its focus is on the potential impact of different interventions. The occurrence of particular diseases in more than one group is a legitimate outcome where distinct interventions may contribute to control. Thus guinea worm for example is classified as both a water-based disease and water-borne disease.

2.4 .0 The Need for Water Supply

Access to water is a prerequisite for health and livelihood, which is why the MDG target is formulated in terms of sustainable access to affordable drinking water supply.The availability of improved and quality water supply and sanitation infrastructures are widely recognized as an essential component of human rights, social and economic development (ADF, 2005). The poor and marginalized people living-in rural and peril urban settlements are most in need for improved and safe drinking water, appropriate forms of sanitation and access to water for other domestic purposes (Crow, 2001).

Table 2.2 below shows the percent coverage of improved and unimproved water supply sources in the developing country.

Water sources	Urban (%)	Rural (%)
Household connection	61.6	3.0
Public stand post/pipe	33.2	20.9
Protected borehole or tube well	0.4	4.5
Protected spring or dud well	1.2	11
Collected rain water	0.0	0.3
Unprotected spring or dug well	1.5	31.7
Directly used from pond water	2.0	28.6
Provided by ranker	0.0	0.0
Total	100	100

Even though improved water sources are available, they are often far away from the beneficiary households and are located at inconvenient locations. The management system of stakeholders coupled with water quality problems and inaccessible water sources are some of the basic problems (Demeke, 2009; Bhandari and Grant, 2007). In addition to that, the lack of safe water supply has other series negative consequences such as the workload in fetching unsafe water from mostly distant unimproved or traditional water points make them vulnerable to health problems. As a result, most of the children miss the opportunity of attending school, while women spend 10-50% of their daytime fetching water from polluted water points, losing time on productive activities (Water Resources Management Policy, 1999; Crow, 2001). According to WHO, basic access can be defined as the availability of drinking water at least 20 liters per day per person, a distance of not more than 1 km from the source to the house and a maximum time taken to collect round trip of 30 minutes. The UNDP (2008) says the minimum absolute daily water need per person per day is 50 liters (13.2 gallons) which include: 5 liters for drinking, 20 for sanitation and hygiene, 15 for bathing and 10 for preparing food.

However, because of scarcity of drinking water, millions of people try to exist on 10 liters (2.6 gallons) a day (ADF, 2005). In densely populated areas, a water hauling trip of 30 minutes or less, including queuing time would be a more appropriate indicator of access.

As indicated by ADF (2005), over one third of women in some of the regions spent more than two hours for each water collection trip.

2.4 .1 Sources of water

Water Source is potential raw water, i.e, it is natural fresh water that could be abstracted and processed for domestic purposes. The chemical composition of natural fresh water is the end result of rainwater that has fallen on to the land and interacted with the soil, the material in or on the soil, and rocks as it moves down rivers, or into lakes, or percolates underground. Its overall quality is further modified by run-off from various land uses (non-point or diffuse sources) and by discharges (point source). The quality is modified further by biological activity, wind-blown material and evaporation. DWSNZ (2015) the sources of water is basically two namely surface and underground source of Water. Surface freshwaters (rivers, streams, lakes and impoundments) comprise those natural waters that are open to the atmosphere and contain only relatively small quantities of dissolved materials; generally, much less than 1000 mg/L (Harding et al 2004).

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The convenience of having readily available and accessible sources of water rapidly renewed by rainfall is offset somewhat by the susceptibility of surface waters to pollution from a variety of diffuse and point sources. Point sources are clearly identifiable, have specific locations, and are typically pipes and drains discharging wastes (Davies-Colley and Wilcock 2004).

In most catchments used for water supply, pollution will be from diffuse sources, arising from land-use activities (urban and rural) that are dispersed across a catchment (Novotny 2003). Diffuse sources include surface runoff, as well as subsurface drainage, resulting from activities on land. The main categories of diffuse pollutants are sediment, nutrients and pathogenic micro-organisms. Other categories of diffuse pollutants are heavy metals (principally from urban land) and pesticides (mainly from agriculture and horticulture). Water UK (2012) summarizes helpful ideas for catchment protection.

A summary of human activities that impinge on the suitability of freshwaters for potable water is given in Table 2.3 Note that birds may be a significant source of faecal pollution in surface waters as indicated by standard faecal indicators (eg, E. coli), and shed pathogens (eg, Giardia cysts, Salmonellae and Campylobacter) (McBride et al 2002).

Activity	**Contaminants**	**Health risks**
Agriculture and horticulture	Sediments Nutrients Pesticides and other toxic chemicals and metals Faecal microbial contaminants	Immune and endocrine disruption Retarded physical and cognitive development, blue baby syndrome
Industry	Nutrients Toxic chemicals and metals Oils	Foetal malformation and death
Mining	Sediments Toxic chemicals and metals	
Urbanisation, infrastructure and development	Sediment Pesticides and other toxic chemicals and metals Oils Faecal microbial contaminants	Nervous system and reproductive dysfunction Behavioural changes Cancers Waterborne disease
Recreation	Oils and fuel Toxic chemicals	

Modified after Slaney and Weinstein 2004.

Table 2.3: human activities and associated inputs into fresh water ecosystems with health risks

2.5.0 Water Quality Test
Testing procedures and parameters are grouped into physical, chemical and bacteriological.

1. Physical Test

Include Temperature, colour, odour and taste, turbidity, dissolved solids, total solids and suspended solid are recorded.

i. Temperature: Temperature has implications on the usefulness of water for various purposes. Generally, users prefer water of uniformly low temperature plays a very important role in physical-chemical and biological behavior of aquatic system. It can also impact on palatability of water (WHO, 2006). Higher temperatures have encroached growth of microorganism and may increase taste, odour, colour and corrosion problems.

ii. Turbidity: The raw water samples are commonly coloured due to the presence of colloidal substance, inorganic impurity, aquatic growth and decomposition of vegetation. Turbidity can also indicate problems associated with treatment processes especially with coagulation/sedimentation and filtration.

iii. Total Dissolve Solid (TDS): indicates the general nature of salinity of water. Water with high TDS have salty taste and produce scales on cooking vessels and boilers. The palatability of water with a total dissolved solids (TDS) level of less than about 500 mg/l is generally considered to be good (WHO, 2006).

2. Chemical Test

Include PH, chlorides, hardness, acidity, iron, manganese, dissolved oxygen, biochemical oxygen demand

i. PH: The PH plays a very crucial part in waste water treatment and for fixing alum dose in water supply.

According to Kumar (2002), he reported that higher values of pH hasten the scale formation in water heating apparatus and reduce germicidal potential of chlorine. Water generally becomes more corrosive with decreasing PH. However, excessively alkaline water also may be corrosive (USEPA, 1994).

ii. Chloride: Large concentrations increase the corrosiveness of water and, in combination with sodium, give water a salty taste (USEPA 1994). WHO (2006) recommended that when chloride exist in excess of 200-300mg/l, it impacts salty taste to water and people who are not accustomed to high chloride are subjected to laxative effect.

iii. Hardness: The total hardness has been attributed mainly due to Calcium and Magnesium (Patel and Sinha, 1998; WHO, 2006). The water containing excess hardness is not desirable for potable water as it forms scales on water heater and utensils when used for cooking and can result to excessive consumption of more soap during washing of clothes.

iv. Magnesium: The sources of Magnesium (Mg) in natural water are as a result of weathering of various types of rocks, industrial waste and sewage (Samantara*et al.* 2015).

v. Iron: The primary concern about iron in drinking water is its objectionable taste. Kidney stone related problem may develop if iron contents are high (WHO,2006). The presence of iron can also stain laundry and plumbing fixtures.

vi. Biochemical Oxygen Demand (BOD): This is the amount of oxygen required by bacteria to completely stabilize organic matter into Carbon-dioxide (CO_2) and Water (H_2O) under aerobic conditions. A high BOD is the presence of a large amount of organic pollution.

3. Bacteriological Test: this Total Bacteria Counts, Total Coliform Count, Enterobactersp, Thermo Tolerant Coliform or E. coli, Faecal Streptococcus, Clostridium Perfringens spore among others, are the most common bacteriological parameters found in ground water sources. However, the universal indicator organisms have been the Coliforms, specifically Escherichia coli, which normally originate from human and animal faeces.

2.6.0 Ground Water source

Groundwater is fresh water (from rain or melting ice and snow) that soaks into the soil and is stored in the tiny spaces (pores) between rocks and particles of soil. Groundwater accounts for nearly 95 percent of the nation's fresh water resources. It can stay underground for hundreds of thousands of years, or it can come to the surface and help Fill Rivers, streams, lakes, ponds, and wetlands. Groundwater can also come to the surface as a spring or be pumped from a well. Both of these are common ways we get groundwater to drink.

In the original planning of ground water supplies, little can be done about determining the chemical quality of the water because the water will be obtained from several well-defied and different water bearing geological layers or strata. The chemical or mineral quality of the water contributed from each of these water-bearing formations or aquifers will be dependent on the dissolution of material within the formation. Therefore, water withdrawn from any ground water source will be a composite of these individual aquifers.

Before the 1970s, the study of life in groundwater habitats was relatively limited. In the 1970s, however, it became increasingly obvious that certain waste disposal practices were contaminating subsurface environments (Schaffter and Parriaux, 2002). There has also been an increasing interest in demonstrating that various shallow and deep environments contain substantial numbers of viable microorganisms to degrade potential pollutants, i.e. in bioremediation. Subsurface microbiological research to study microbial community structure, microbial activities and the geochemical properties of groundwater environments has progressed with the development of aseptic sampling techniques (Obuobie, and Barry, 2010).

In a hydrogeological sense, groundwater refers to water that is easily extractable from saturated, highly permeable strata known as aquifers (Pritchard, Mkandawire& O'Neil, 2008). For saturated environments, a rigorous distinction between local, intermediate, and regional flow systems, related to the topography of recharge and discharge areas has been long recognized by hydrologists. One can thus define several underground aquifers that serve as source of potable water in the world which can be classified as shallow aquifers, intermediate and deep aquifers (Morita, 1997).

Shallow aquifers are characterized by active flow strongly influenced by local precipitation events. Intermediate aquifers within 300 m of the surface soil are separated from shallow aquifers by confining layers; they have much slower flow rates, of the order of meters per year. Deep aquifers are also confined, but more than 300 m below the subsurface soil and they are characterized by extremely slow flow rates (meters per century, Obuobie, and Barry, 2010).

Groundwater is a key water resource in much of the world. Many major cities and small towns in the world depend on groundwater for their water supplies, mainly because of its abundance, stable quality and also because it is inexpensive to exploit. In developing countries, use of shallow groundwater sources for drinking and other domestic purposes is a common feature of many low-income communities (Howard *et al.,* 1999). The communities relying on such sources tend to be poor and live in polluted environments with associated high health risks (WHO and UNICEF, 2000). Such communities occur in most cities in developing countries, for example in Asia, Africa, Latin America and the Caribbean. Their occurrence is attributed to rapid urbanization where urban growth is associated with rapid expansion of small, unplanned urban centres and peri-urban settlements. Advantages of Groundwater

a. Rocks act as a natural filter

b. No loss of water through evaporation

c. No requirement for expensive and environmentally damaging dams

d. Pumping costs low

Disadvantages

2 Sedimentary rocks and presence of aquifers

3 Surface subsidence

4 Pollutants have long residence time

5 Groundwater not always suitable for drinking

Example of groundwater are wells and springs.

1. Wells

Dug wells

Open or poorly covered well heads pose the commonest risk to well-water quality, since the water may then be contaminated by the use of inappropriate water-lifting devices by consumers. The most serious source of pollution is contamination by human and animal waste from latrines, septic tanks, and farm manure, resulting in increased levels of microorganisms, including pathogens.

Contamination of drinking-water by agrochemicals such as pesticides and nitrates is an additional and increasing problem for small-community supplies.

Dug wells are generally the worst groundwater sources in terms of faecal contamination, and bacteriological analysis serves primarily to demonstrate the intensity of contamination and hence the level of the risk to the consumer.

Various types of hand-dug wells are (shown in Fig. 2.1) ranging from poorly protected to well protect. The upgrading of unprotected wells and the construction of protected wells for community use should be strongly promoted.Many tens of millions of families worldwide still depend on private and public dug wells; technical assessment and improvement of these wells is therefore very important. The commonest physical defects leading to faecal contamination of dug wells are associated with damage to, or lack of, a concrete plinth, and with breaks in the parapet wall and in the drainage channel.

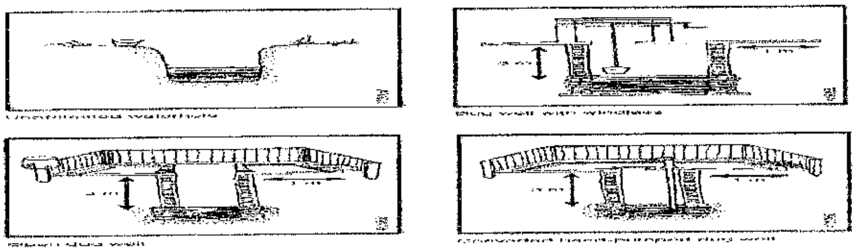


Figure. 2.1: Various types of hand-dug wells

An open dug well is little better than an unprotected hole in the ground if the above-mentioned physical barriers to surface-water contamination are not regularly maintained. The majority of open dug wells are contaminated, with levels of at least 100 faecal coliforms per 100ml, unless very strict measures are taken to ensure that contamination is not introduced by the bucket.

2. Springs

A spring is any natural situation where water flows from an aquifer to the earth surface. A spring may be the result of karst topography where surface water has infiltrated the earth surface (recharge area), becoming part of the area groundwater. The forcing of the spring to the surface can be the result of a confined aquifer in which the recharge area of the spring water table rests at a higher elevation than that of the outlet.

If a spring is to be used as a source of domestic water:

1. It should be of adequate capacity to provide the required quantity and quality of water for its intended use throughout the year
2. It should be protected to preserve its quality.

Exposed springs are vulnerable to contamination from human and animal activities. The usual method of protecting springs is to collect the water where it rises by enclosing the eye of the spring in a covered chamber or box with an outlet near the bottom to allow water to flow away from the original site of the spring; in this way the natural spring is disturbed as little as possible.

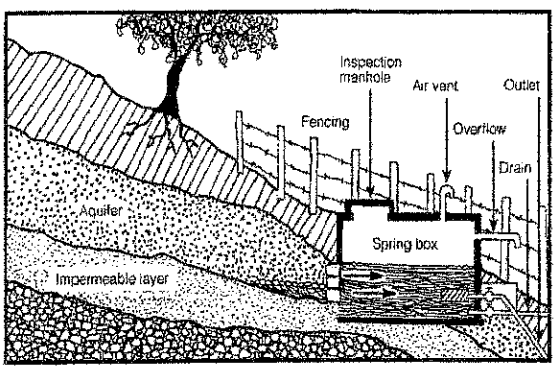


Figure 2.2: Protected gravity spring

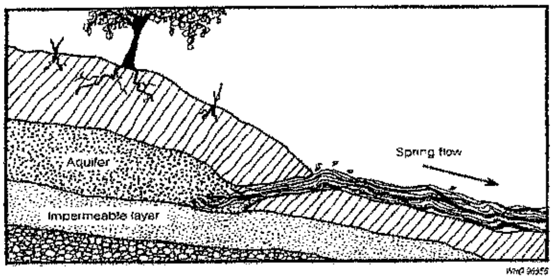


Figure 2.3: Unprotected gravity spring

2.6.1 Sources of Contamination of Groundwater

Groundwater is an important source of drinking water in many nations and may be heavily contaminated in many industrialized nations by industrial waste pits, septic tanks, oil wells, landfills, etc. Aquifers supply drinking water for about 120 million Americans and supply a quarter of the annual water demands in the United States. They are also a major supplier of water in many other countries. United States groundwater, scientists are now reporting, is increasingly threatened by pollution. Many pollutants are present at much higher concentrations in groundwater than they are in most contaminated surface supplies (Moyer and Morita, 2000). Also, many contaminants are tasteless and odourless at concentrations thought to be threatening human health.

According to Miller (1997), about 4500 billion litres of contaminated water seeps into the ground in the United States every day from septic tanks, cesspools, oil wells, landfills, agriculture, and ponds holding hazardous wastes. Unfortunately, very little is known about the extent of groundwater contamination. The Environmental Protection Agency of the United States of America (USEPA) estimates one percent (1%) of the drinking water wells in the United States has contaminants that exceed the standard designed to protect human health. Although that may seem small, 1% of hundreds of thousands of wells is a large number. In fact, one study reported that at least 8000 private, public and industrial wells in the U.S are contaminated (Miller, 1997).

2.6.2 Effects of Microbial Contaminants in Ground Water Quality

Groundwater quality can be influenced directly and indirectly by microbiological processes, which can transform both inorganic and organic constituents of groundwater. According to Mathess (1982), single and multi-celled organisms have become adapted to using the dissolved materials and suspended solids in the water and solid matter in the aquifer of their metabolism, and then releasing the metabolic products back into the water. There is practically no geological environment at or near, the earth's surface where the PH condition will not support some form of organic life (Chilton and West, 1992). In addition to groups tolerating extremes of PH, there are groups of microbes which prefer low temperatures (thermophiles), and yet others which are tolerant of high pressures. However, the most biologically favourable environments generally occur in warm, humid conditions.

Sulphides, for example, can be oxidized without microbial help, but microbial processes can greatly speed up oxidation to the extent that, under optimum moisture and temperature conditions, they become dominant over physical and chemical factors. All organic compounds can act as potential sources of energy for organisms. Most organisms require oxygen for respiration (aerobic respiration) and the breakdown of organic matter, but when oxygen concentrations are depleted some bacteria can use alternatives, such as nitrate, sulphate and carbon dioxide (anaerobic respiration).

According to Chiroma (2008), he stated that organisms which can live in the presence of oxygen (or without it) are known as facultative anaerobes. In contrast, obligate anaerobes are organisms which do not like oxygen. He presence or absence of oxygen is, therefore one of the most important factors affecting microbial activity, but not the only one.

2.7.0 Mechanized water supply

While water resources are valued for human health and for sustaining food production, the energy contained in moving water such as rivers or tides can also be harnessed to do work through mechanical devices, or to create energy in small scale or large scale hydropower schemes. Globally, 1.4 billion people lack access to electricity, with an additional 1 billion having only intermittent access (UNDP 2012). As running water is a resource that is globally available and renewable, harnessing its power for mechanical uses can improve livelihoods and increase working productivity even in rural or developing areas where no local electricity source is available.Relationship between energy sources and their impact on prosperity and development, as compared to their technical complexity. Source: BATES et al. (2009)"Noria" water wheel. Source: MACHINERY CORPORATION (2012).Scheme of an improved water mill used for cereal grinding in Nepal. Source: SHRETHA & SHRESTHA (1999)

Regardless of the technology used to use water for mechanical power, the principle of mechanical water use is the same: that the kinetic energy contained in flowing water can be harnessed and converted into mechanical energy in order to do work. The amount of energy that can be harvested depends on both the quantity of water flowing, and the velocity (speed) at which it flows.

There are many devices that can be implemented to use water for mechanical purposes. Some of the most important technologies are summarised below:

2.7.1 Water Wheels

Adapted from TRYENGINEERING (2011) A water mill is a structure that uses a water wheel or turbine to drive a mechanical process. A water mill works by diverting water from a river or pond to a water wheel, usually along a channel or pipe. The water's force drives or pushes the blades of the wheel (or turbine), which then turns or rotates an axle that drives machinery that is attached to it to do work. This machinery performs a specific task, such as transporting water or milling flour. Waterwheels can either be horizontal or vertical with respect to water flow. Horizontal water wheels are simpler, but require high water velocities to work well. There are many types of water wheel. One type, called a noria (pictured right) is used to transport water from a running stream into a trough for local water supply.

2.7.2 Water Mills and Improved Water Mills

A water mill is a water wheel or turbine that is connected to a device that drives a mechanical process. Water mills can be used for such purposes as grinding flour or agricultural produce, cutting up materials such as pulp or timber, or metal shaping. Traditional water mills are made from a wheel or turbine with wooden blades that turn when water runs through. The turbine or wheel then turns a grinder shaft, which is connected to a grinding stone.

Recently, improved water mills have been designed which replace wooden blades with metal, cup-shaped blades. This modification has led to a doubling of efficiency and operational capacity by over 100%. Improved water mills have been successfully used as a cereal grinder, paddy huller, oil expeller, saw mill, as well as to produce electricity when coupled with an electric generator (GORKHALI 2010).

Tide Mills

Tide mills are made with a water wheel that is either placed across a tidal inlet or a section of an estuary made into a reservoir. Rising tides enter the mill pond through a one-way gate that closes automatically when the tide begins to fall. The stored water can then be used to turn a water wheel.

River Turbines

River turbines are turbines placed in a flowing river or canal, which are tethered to one side, and pump water to the shore. Output depends on river speed and depth.

2.7.3 **Hydraulic Ram Pumps**

Also known as "hydrams", hydraulic rams are automatic pumping devices that use a large flow of falling water through a small head (low elevation) at an inlet in order to lift a small flow of water through a much higher head (high elevation) at an outlet, thus lifting the water (PRACTICAL ACTION 2002).

The dominant uses of mechanical power include water supply, agriculture, agro-processing, natural resource extraction, small-scale manufacturing, and lifting and crossing.

Water Supply

Having a clean and reliable source of drinking water is essential in improving the health of a community. In rural areas, water collection is often the responsibility of women, and consumes a great deal of time and energy. Mechanised water pumps can reduce the time and physical strain of water collection for women, allowing them to focus more on other activities, such as caring for children or taking care of their own health.

Service Typical Technology Mechanical power alternative

Drinking, irrigation, livestock watering Container (bucket) for lifting / carrying water Hydraulic ram, water wheel, river turbine mechanical power at point of use. Source: BATES et al. (2009)

2.7.4. **Applicability of Agro-Processing**

Post-harvest activity can be critical in helping farmers increase their income. For activities like milling, pressing, cutting, and shredding, improved water mills can have an 80–90% increase in power use and efficiency compared to a traditional water mill. They can also have multiple uses such as for both agro-processing and power generation, which can increase the load of the mill and make such installations more sustainable.

Service Typical Technology Mechanical power alternatives

Milling, pressing Hand ground, flail Water mill

Cutting, shredding Knife Water-powered saw mills

Applicability of mechanical power at point of use. Source: BATES et al. (2009)

Natural Resource Extraction

Artisanal and small-scale mining may be the only livelihood opportunity for some people, or may be their source of income during the agricultural off-season. There are many technologies that can reduce the effort needed for mining mentioned below.

1. Service Typical Technology Mechanical power alternative
2. Minerals Washing Hand washed Water powered water jet
3. Grading Hand screen Water powered shaker
4. Timber Sawing Hand saw Powered saw (sawmill, chainsaw)
5. Applicability of mechanical power at point of use. Source: BATES et al. (2009)
6. Small-Scale Manufacturing

Mechanical power technologies allow micro-enterprises to produce goods consistently at the same quality and at a faster production rate. This, in turn, will directly affect their income for the same time spent on labour.

Services Typical Technology Mechanical power alternative

Wood working, carpentry Hand saw Saw mill

Applicability of mechanical power at point of use. Source: BATES et al. (2009)

Lifting

Water can also be used for transport purposes. In countries such as Switzerland and France, water has historically been used for powering cable cars, using natural gradients and counter weights to drive cars up and down hills. These technologies are still in use today, but many have been replaced with designs that are powered by engines (DE DECKER 2009).

Mechanical water use is a non-consumptive water use. Therefore, there are possibilities to link mechanical water use to other uses, such as irrigation in agriculture. This can reduce the investment costs for individual users, thus expanding the possibilities for income generation and development.

Water for Energy and the Millennium Development Goals

The Sustainable Development Goals (SDGs), with their 169 targets, form the core of the 2030 Agenda. They balance the economic, social and ecological dimensions of sustainable development, and place the fight against poverty and sustainable development on the same agenda for the first time.

The SDGs are to be achieved around the world, and by all UN member states, by 2030. This means that all states are called upon equally to play their part in finding shared solutions to the world's urgent challenges. Switzerland is also required to implement the Goals on a national basis. In addition, incentives are to be created to encourage non-governmental actors to make an increasingly active contribution to sustainable development.

Mechanical uses of water have many positive development impacts, which can be regarded for each of the Millennium Development Goals:

Goal 1: Eradication extreme poverty and hunger growing more food and accessing sufficient water can improve food security.

Pumping water to irrigate crops can prolong the growing season and reduce vulnerability to drought (see Optimization in Agriculture). Increased quantity, quality, and uniformity of manufactured goods/produce increases income for the producer.

Goal 2: Achieve universal primary education Reduced burden on children to help with physical tasks (e.g.. fetching water) so they can attend school (see Human Powered Distribution). Better nutrition for children reduces sick days.

Additional income may allow parents to pay for school fees.

Goal 3: Promote gender equality and empower women Reduced burden on women to perform tasks such as fetching water and growing food (see Human Powered Distribution).

Goal 4: Reduce child mortality Improved food security reduces death of children due to malnutrition. Clean water pumps can reduce deaths due to diarrhea (see Pathogens and Contaminants).

Goal 5: Improve maternal health Mechanization of physical tasks reduces work strain on pregnant women. Better food security during pregnancy reduces anemia in women and low birth weight in babies (see Water Sanitation and Health).

Goal 6: Combat HIV/AIDS, malaria, and other diseases Deaths caused by anemia due to malaria will decrease with better nutrition (see Water Sanitation and Health) Improved water supply reduces vulnerability of HIV/AIDS infected people to waterborne diseases (see Pathogens and Contaminants)

Goal 7: Ensure environmental sustainability Using water for energy reduces pressure on other sources (firewood from forests).

Slash-and-burn agriculture may decrease if farming efficiency and productivity is improved.

Cost

Because of the large increases in working productivity and efficiency, mechanical water use is considered to be one of the most cost-effective ways of supporting poor people.

Mechanical devices are generally low-investment. However, the upfront capital needed is a key barrier in rural areas where investment capital is scarce. Microfinance institutions have been successful in overcoming this barrier.

When investment capital is available, mechanical water use can nearly double revenue due to increased productivity.

When multiple users are involved (for example when coupling mechanical water use with irrigation), investment costs are decreased for all users, and there may be greater opportunities for income generation. 27 April 2018

Author/Compiled by Jose Carrasco (aquasis/cewas, International Centre for Water Management Services) Andrea Pain (seecon international gmbh) Adapted

The force of water has been used for centuries to produce mechanical power. In remote villages and among low-income regions around the world, daily activities such as agro/food processing and water pumping are possible due to mechanical power. Today, mechanical power contributes to increase the efficiency and effectiveness of productive activities aiming to meet basic human needs such as water supply access, natural resource extraction and small-scale manufacturing. Mechanical power can be considered as a sustainable source of energy services for low-income people since it does not require high investment costs.

Mechanical water use relies on flowing water. Technologies can be implemented wherever there is enough force by moving water to drive the device. This force is dependent on the quantity of water, as well as the velocity (speed) at which it is flowing. Therefore, mechanical water use is most applicable where there is a steady source of flowing water (i.e. rivers, streams) to drive the machinery.

2.8.1 Identifying microbial hazards in drinking water

A large variety of bacterial, viral and protozoan pathogens are capable of initiating waterborne infections. Some are primarily the enteric bacterial pathogens including classic agents such as Vibrio cholerae, Salmonella spp., Shigellaspp., and newly recognized pathogens from faecal sources like Campylobacter jejuniand enterohemorrhagic E.coli. The survival potential of these bacteria increases in biofilms and due to their stages as VBNC (viable but non-culturable) cells (Wilson et al, 1983).

Several new bacterial pathogens such as Legionella spp., Aeromonasspp., P. aeruginosa and Mycobacterium aviumhave a natural reservoir in the aquatic environment and soil. These organisms are introduced from the surface water into the drinking water system usually in low numbers. They may survive and grow within the distribution system biofilm (Wilson et al, opcit.).

Again, more than 15 different groups of viruses, encompassing more than 140 distinct types, can be found in the human gut. These enteric viruses are excreted by patients and find their way into sewage. Hepatitis A and E viruses cause illness (hepatitis) unrelated with gut epithelium. Another specific group of viruses has been incriminated as a cause of acute gastroenteritis in humans; it includes rotavirus, calicivirus, the most notorious being Norwalk virus, astrovirus and some enteric adenovirus. These viruses cannot grow in the receiving water and may only remain in small number or die off (Szywecket al, 2000).

In addition, protozoa like Cyclospora, Isospora and many microsporidian species are emerging as opportunist pathogens and may have waterborne routes of transmission (Szywecket al, op cit.). Like viruses, protozoa cannot multiply in the receiving waters. With the exception of Salmonella, Shigellaand hepatitis A virus, all the other organisms can be so-called 'new or emerging pathogens'. There are a number of reasons for the emergence of these new pathogens. They include high resistance of viruses and protozoan cysts, a lack of identification methods for viruses, change in habit of water use (Legionella) and subpopulations at risk.

Another striking epidemiological feature is the low number of bacteria that can trigger disease. The infectious dose of Salmonella is in the range of 107–108 cells while only around 100 cells are required to cause clinical illness with E. coli 0157:H7 and Campylobacter. The infective dose of enteric viruses is low, typically in the range of 1 – 10 infectious units; it is about 10 – 100 oocysts for Cryptosporidium (Szewzyck et al, 2000).

2.8.2 Faecal Coliform Organisms

Faecal coliforms are one of the most important parameters to consider when assessing the suitability of drinking water because of the infectious disease risk. Faecal coliforms indicate contamination by mammals and birds' waste (faeces) and signify the possible presence of pathogenic bacteria and viruses which are responsible for water-related diseases such as cholera, typhoid and other diarrhoeal-related illnesses. One gram of faeces is reported to contain 10,000,000 viruses; 1,000,000 bacteria; 1000 parasite cysts; and 100 parasite eggs (UNESCO, 2007). Zero faecalcfu/100 ml is considered uncontaminated (WHO, 2006; MBS, 2005); 50 faecalcfu/100 ml is regarded suitable by MoWD (2003) for untreated water.

2.8.3 Total Coliforms

The most commonly measured indicators of water quality are the coliform organisms. Gram negative bacteria are cytochrome oxidate negative, non-spore forming, and ferment lactose at 35^{0}C–37^{0}C, within 24–48 hours (Morita, *op cit.*) this defines total coliforms. The group is as diversified as their habits from which they originate. Thus the total coliform group should not be regarded as an indicator of organisms exclusively from faecal origins especially in hot countries where coliforms of non-faecal origins are common. In the presence of organic material and under suitable conditions, coliforms multiply. Measurement of faecal coliforms is a better indicator of general contamination of faecal origin. Faecal coliforms differ from the other members of the total coliform groups on the grounds that they tolerate and grow at higher temperatures of 44-45°C. Presumptive *Escherichia coli* convert tryptophan to indole. They are permanent species among the faecal coliforms (Szyweck*et al, op cit.*).

2.8.4 Assessment of Microbial Risks

The view on the microbiological safety of drinking water is changing. The demand for the total absence of any pathogenic organism is no longer significant in light of the new pathogens, some of which are capable of growing in drinking water systems. According to the new European Union Council directive 98/83/EC, water for human consumption must be free from any microorganisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health (European Union Council, 1998). To deal with this issue, the U.S. Environmental Protection Agency for the first time used a microbial risk assessment approach. It has been defined that an annual risk of 1, 034 (one infection per 10 000 consumers per year) should be acceptable for diseases acquired through potable water, this value being close to the annual risk of infection from waterborne disease outbreaks in the United States.

Microbiological risk assessment is a major tool for decision making in the regulatory area. The problem is, however, that the key data to perform this assessment are mostly missing. Few epidemiological studies associating the incidence of disease to the pathogen densities have been reported. Several outcomes, from asymptomatic infection to death, a possible through exposure to microbes (Szyweck*et al*, *op cit.*). The issue of dose-response relationships is particularly striking: these relationships are only available for a few pathogens; when infectious doses are low as is the case for some viruses and protozoan cysts, the calculated tolerable concentrations are also low and monitoring of these pathogens in drinking water becomes impracticable (Miller, 1997).

CHAPTER THREE

METHODOLOGY

3.1 Description of area

Usin-Ekiti community is situated in Ikole-Ekiti, Ekiti, Nigeria. It is located in south-western Nigeria on longitude7° 47′ 0″ North and latitude 5° 31′ 0″ East. The predominant mother tongue spoken in Usin-ekiti of Ikole, Ekiti State is Yoruba. It has an area of 321 km^2 and a population of 168,436 at the 2006 census. Usin-Ekiti of Ikole Local Government Area is situated in the deciduous forest area of the State. Rainfall is about 70 inches per annum. Rain starts in March and peters out in November. The good drainage of the land makes it very suitable for agricultural pursuits. It is a common feature that trees shed their leaves every year during the dry season which begins in November and ends in February. The two seasons – Dry Season (November - February) and Rainy Season (early March – mid November) are quite distinct and they are very important to the agricultural pursuits of the people.

Study area

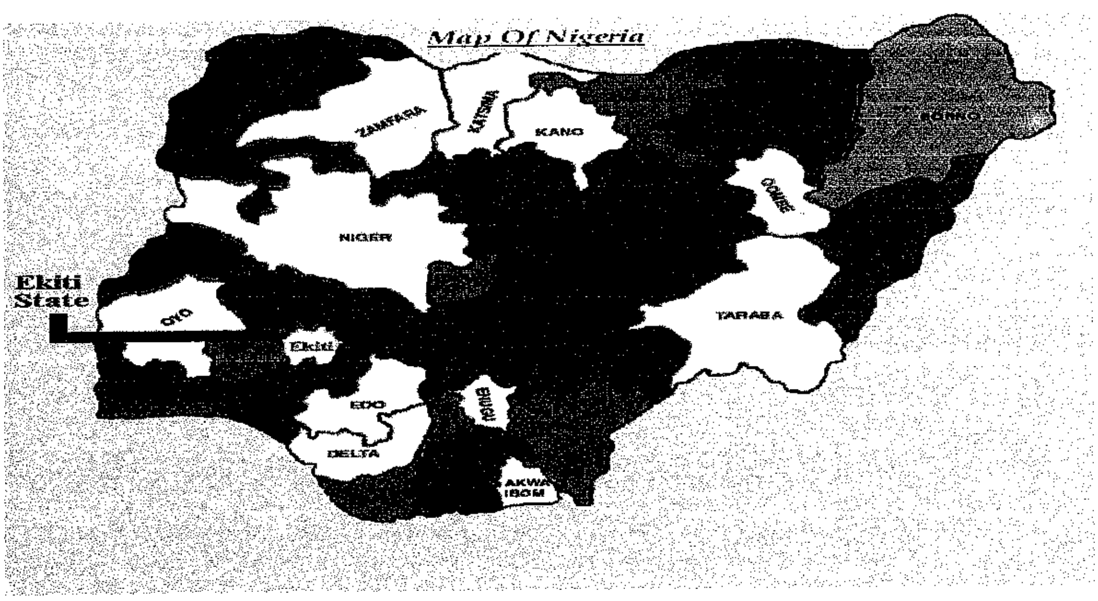


Figure 3.1: Map of Nigeria showing Ekiti State

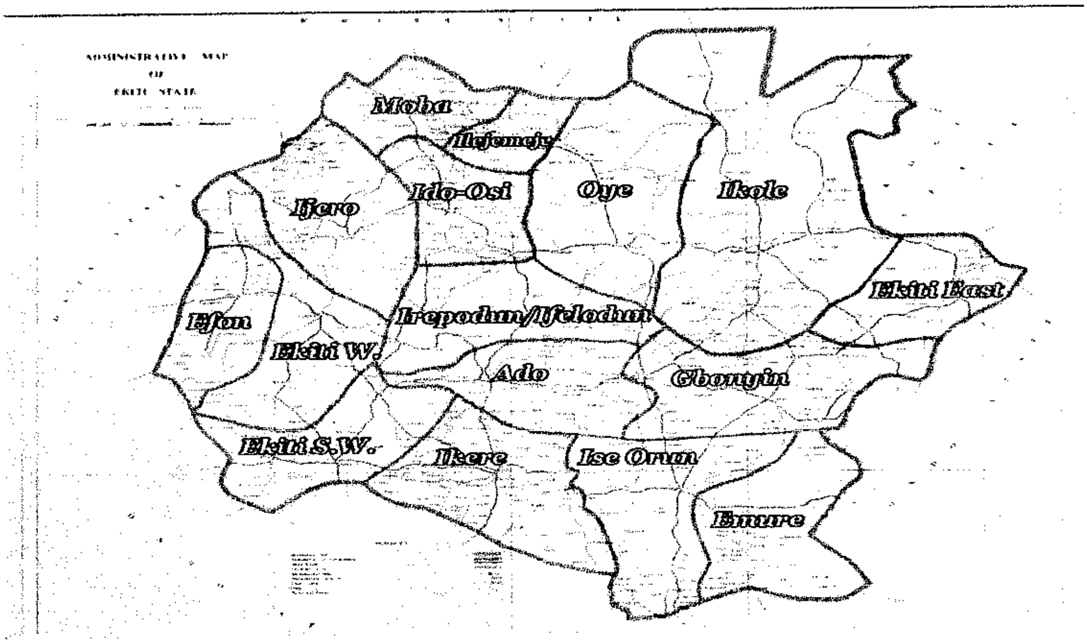


Figure 3.2: Map of Ekiti State showing all Local Government Area of the State

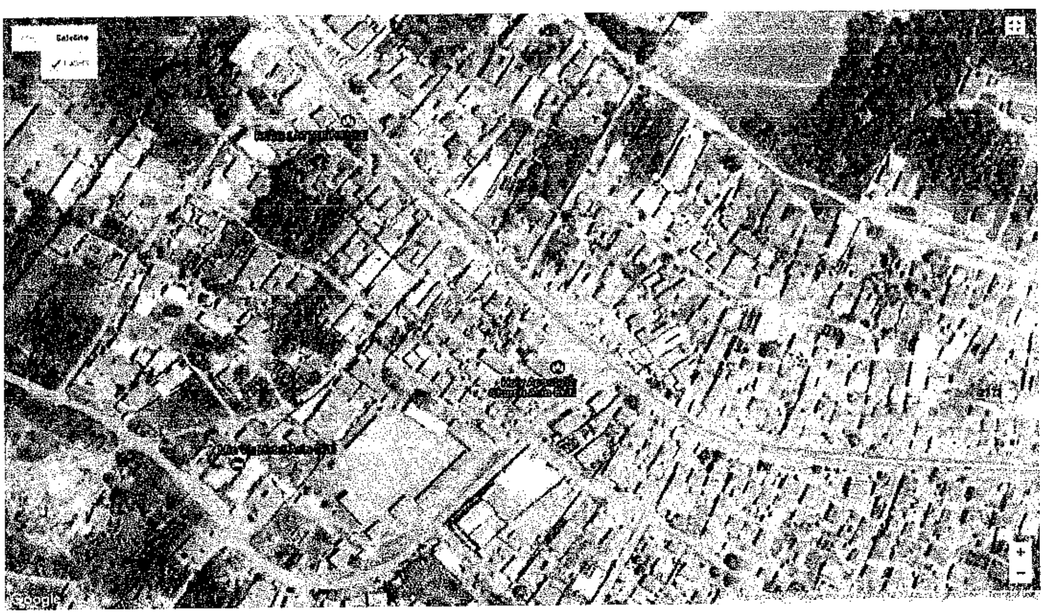


Figure 3.3: Map of Usin-Ekiti of Ikole LGA showing some street on google map

3.2 Data collection.

A random sampling technique was adopted to select areas for the sample needed for the study. In the selection of household for interview to know their perspective based on selected area of study.

3.3 Water sampling method

Water samples were collected from different sources of water that are majorly used by the community. A total of twelve water samples were collected for laboratory analysis from which four samples were from hand dug well, and another one samples were from bore-hole and three samples from pumping machine and four sample from rainwater harvest. In addition, the samples were collected basically from both mechanized water sources and non-mechanized nearby alternative water sources currently used as main sources for household consumptions. However the distance covered between these sources and the houses where the water are been consumed ranged from 40 meters to 450 meters. The samples collected from hand dug wells, Bore-holes and pumping machine water and rainwater harvest which were taken to the laboratory for analysis. Based on the water quality of the samples investigated, the status of the existing water quality was compared with the standards of the world health organization (WHO, 2004).

Table 3.0: Water source characterization

S/N	Location of Water Source	Sample Code	Type of Water Source	Protected/ Not Protected (Description of the Water Source)	Distance From soak away (Metres)	Physical appearance	GPS Location of Water Sources	
							Latitude	Longitude
1	ADANAOGUN COMPOUND	PM1	PUMPING MACHINE	WELL PROTECTED	150	Colourless and odourless	7^0 47' 32''N	5^0 30' 2''E

2	MR BAYO AYENI COMPOUND	PM2	PUMPING MACHINE	WELL PROTECTED	180	Colourless and odourless	7^0 47' 33''N	5^0 30' 4''E
3	PASTOR OLONIBUA HOUSE	PM3	PUMPING MACHINE	WELL PROTECTED	80	Colourless and odourless	7^0 47' 40''N	5^0 30' 1''E
4	OPPOSITE ALAYEROGUN HOUSE	BH1	BORE HOLE	WELL PROTECTED	150	Colourless and odourless	7^0 47' 22''N	5^0 30' 2''E
5	Mpado Hostel	HDW 1	Hand-Dug well	Well protected	120	Colourless and odourless	$7^0$47' 53.17'' N	5^0 29' 15.99''E
6	Gigonu House	HDW 2	Hand-dug well	Not Well protected	180	Slightly cloudy and odourless	$7^0$47' 44.84'' N	5^0 28' 24.85''E
7	Olamide House	HDW 3	Hand-dug well	Not Well protected	150	Slightly cloudy and unpleasant	$7^0$47' 51.92'' N	$7^0$29' 18.35''E
8	CAC Ibudo	HDW 4	Hand-dug well	Not Well protected	180	Slightly cloudy and unpleasant	$7^0$47' 48.08'' N	$7^0$29' 18.35''E
9	Mpado Hostel	RWH 1	Rain water harvest	Well protected		Colourless and odourless	$7^0$47' 53.17'' N	5^0 29' 15.99''E

10	Ootunja; FILANI'S compound	RWH 2	Rain water harvest	well protected	Colourless and odourless		
11	Usin; AYENI's compound	RWH 3	Rain water harvest	Well protected	Colourless and odourless	7^0 47' 33''N	5^0 30' 2''E
12	Ilotin	RWH 4	Rain water harvest	Not well protected	Colourless and odourless		

Method of analysis of samples

Domestic Water Samples are to be collected from four hand-dug well,three pumping machine, and one boreholes and four rainwater harvest respectively within usin community area of Ikole L.G.A different locations and these samples serve as representation of both the mechanized and non-mechanized energy system use by household. Sterilized sample bottles are used for collection. The following water quality parameters is going to be analyze in the laboratory base on physical, chemical and biological test comparing it with Nigeria Standard for Drinking Water Quality (NSDWQ) and World Health Organization (WHO). Water quality analysis was used to present the household perception of water quality following the results of the laboratory tests as compared with the WHO standards.

Table 3.1: Physical chemical and bacteriological parameters (NSDWQ/WHO)

S/N	Parameters	Unit	NSWQ	W.H.O	Health
1	Temperature	°C	25	25	None
2	Appearance	U	Clear	Clear	None
3	Odour	U	odourless	Odourless	None
4	Total dissolved Solid	Mg/l	500	500	None
5	Turbidity	NTU	0 – 5	6	None
6	E. Conductivity	υS/cm	1200	1000	None
	pH Value		6.5 – 8.5	6.5	None
7	Nitrate (NO_4)	Mg/l	30	30	Cyanosis and asphyxia(blue-

					baby syndrome in infant under three months)
8	Total Alkalinity	Mg/l	250	250	None
9	Chloride Cl^{-2}	Mg/l	250	250	None
10	Magnesium Hardness (Mg^{2+})	Mg/l	50	50	Consumer acceptability
11	Calcium Hardness(Ca^{2+})	Mg/l	50	50	None
12	Iron (Fe^{2+})	Mg/l	0.3	0.3	None
13	Sulphate(SO_4)	Mg/l	300	200	None
14	Dissolved Oxygen	Mg/l			None
15	B.O.D	Mg/l			None
16	Bacterial Count	Cfu/l	0	0	Indication of feacial contamination

3.3 Hazard Analysis

Hazards analysis is based on identifying potential risks in systems and preferring solutions to eliminate/ manage the risks accordingly. The following tables are used to monitor the various types and sources of hazards and how they can be identified (from catchment to consumer point of use)

Table 3.2: Identification of Sources of Hazards

Hazardous event	Associated hazards (and issues to consider)
Poor Water Quality	Contaminants in vicinity of water source
Location of septic tanks	Microbial contamination
Well/borehole headwork not water tight	Surface water intrusion
Flooding around water source	Water Quality compromised

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 RESULTS

The study focused on the physical, chemical and biological parameter of domestic water supply from four hand-dug well, four rain water harvest and three pumping machine and a bore hole respectively in Usin-Ekiti Community of Ikole Local Government Area.

Table 4.1.1Physical, chemical and biological analysis of rain water sample.

S/N	Parameters	UNIT	Raw sample ODI-OLOWO	Raw sample OOTUNJA	Raw sample USIN	Raw sample ILOTIN	W.H.O	NSDWQ
1	Temperature	^{O}C	24.2	25.4	22.4	22.7	25	25
2	Appearance	U	Clear	Clear	Clear	Clear	Clear	Clear
3	Odour	U	Odour Less	Odour Less	Odour less	Odour Less	Odourless	Odourless
4	Total Solid	Mg/l	4.50	3.20	14.20	3.20	500	500
5	Turbidity	NTU	0.00	1.00	0.00	0.00	6.0	0 - 5
6	E. Conductivity	υS/cm	400.00	500.00	400.00	700.00	1000	1200
7	pH Value		5.80	5.90	5.70	5.60	6.5	6.5 – 8.5
8	Nitrate (NO_4)	Mg/l	0.00	0.00	0.00	0.00	30	30
9	Total Alkalinity	Mg/l	73.20	48.8	73.2	73.2	250	250
10	Chloride Cl^{-2}	Mg/l	220.00	709.00	652.00	148.00	250	250
11	Magnesium Hardness Mg^{2+}	Mg/l	52.00	30.00	32.00	14.00	50	50
12	Calcium Hardness(Ca^{2+})	Mg/l	36.00	38.00	22.00	32.00	50	50
13	Iron (Fe^{2+})	Mg/l	0.04	0.01	0.04	0.03	0.3	0.3
14	Sulphate (SO_4)	Mg/l	0.00	0.00	0.00	0.00	200	300
15	Dissolved Oxygen	Mg/l	18.20	15.00	17.00	13.1	_	_
16	B.O.D	Mg/l	12.70	10.58	11.9	9.17	_	_
17	Bacterial Count	Cfu/l	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.1.2 **Physical, chemical and biological analysis of rain water sample.**

S/N	Parameters	UNIT	Raw sample IYA-IBO HOUSE	Raw sample ALAYE ROGUN STREET	Raw sample AYENI VILLA	Raw sample CODED VILLA	W.H.O	NSDWQ
1	Temperature	^oC	24.2	25.1	24.5	26.2	25	25
2	Appearance	U	Clear	Clear	Clear	Clear	Clear	Clear
3	Odour	U	Odourless	Odour Less	Odour less	Odour less	Odourless	Odourless
4	Total Solid	Mg/l	2.50	5.00	6.00	3.00	500	500
5	Turbidity	NTU	0.00	1.00	9.00	4.50	6.0	0 – 5
6	E. Conductivity	υS/cm	1000	820.00	1400	460	1000	1200
7	pH Value		6.5	6.80	6.4	6.8	6.5	6.5 – 8.5
8	Nitrate (NO_4)	Mg/l	0.30	0.00	0.11	0.00	30	30
9	Total Alkalinity	Mg/l	97.6	97.60	48.8	85.50	250	250
10	Chloride Cl^{-2}	Mg/l	354.5	860.5	194.0	194.00	250	250
11	Magnesium Hardness Mg^{2+}	Mg/l	42.0	84.00	60.00	52.00	50	50
12	Calcium Hardness(Ca^{2+})	Mg/l	61.00	32.00	56.00	52.00	50	50
13	Iron (Fe^{2+})	Mg/l	0.00	0.03	0.00	0.00	0.3	0.3
14	Sulphate (SO_4)	Mg/l	0.36	0.00	0.00	0.00	200	300
15	Dissolved Oxygen	Mg/l	9.20	15.00	16.20	10.20	_	_
16	B.O.D	Mg/l	6.43	10.58	11.63	7.13	_	_
17	Bacterial Count	Cfu/l	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.1.3 Physical, chemical and biological analysis of bore hole

S/N	Parameters	UNIT	Raw sample ODI-OLOWO	Raw sample OOTUNJA	Raw sample USIN	Raw sample ILOTIN	W.H.O	NSDWQ
1	Temperature	^{O}C	25.7	25.9	26.3	27.1	25	25
2	Appearance	U	Slightly Cloudy	Slightly Cloudy	Slightly Cloudy	Slightly Cloudy	Clear	Clear
3	Odour	U	Unpleasant	Odour Less	Unpleasant	Unpleasant	Odourless	Odourless
4	Total Solid	Mg/l	8.00	6.00	5.00	15.00	500	500
5	Turbidity	NTU	9.00	8.00	9.00	11.00	6.0	0 - 5
6	E. Conductivity	υS/cm	1600	1300.00	2100	1500	1000	1200
7	pH Value	-	6.0	6.80	6.10	6.40	6.5	6.5 – 8.5
8	Nitrate (NO_4)	Mg/l	4.25	6.30	0.45	0.33	30	30
9	TotalAlkalinity	Mg/l	97.6	61.00	140.4	97.6	250	250
10	Chloride Cl^{-2}	Mg/l	453.76	652.28	581.26	446.7	250	250
11	Magnesium Hardness Mg^{2+}	Mg/l	50.00	84.00	42.00	92.00	50	50
12	Calcium Hardness(Ca^{2+})	Mg/l	30.00	136.00	156.00	75.00	50	50
13	Iron (Fe^{2+})	Mg/l	0.00	0.03	0.06	0.00	0.3	0.3
14	Sulphate (SO_4)	Mg/l	0.40	0.00	0.22	0.65	200	300
15	Dissolved Oxygen	Mg/l	7.50	15.00	11.15	8.5	–	–
16	B.O.D	Mg/l	5.70	10.58	8.05	5.95	–	–
17	Bacterial Count	Cfu/l	14.00	7.00	15.00	12.00	0.00	0.00

Table 4.2: Rain water harvest samples

S/N	TESTS	RESULT				RECOMMENDED LIMITS	
		RWH1	RWH2	RWH3	RWH4	NSDWQ	WHO
1	Colour (TCU)	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
2	Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
3	Total solid	4.5	3.2	14.2	3.2	500	500
4	Temperature °C	24.2	25.4	22.4	22.7	25	25
5	Turbidity	0	1	0	0	4	6

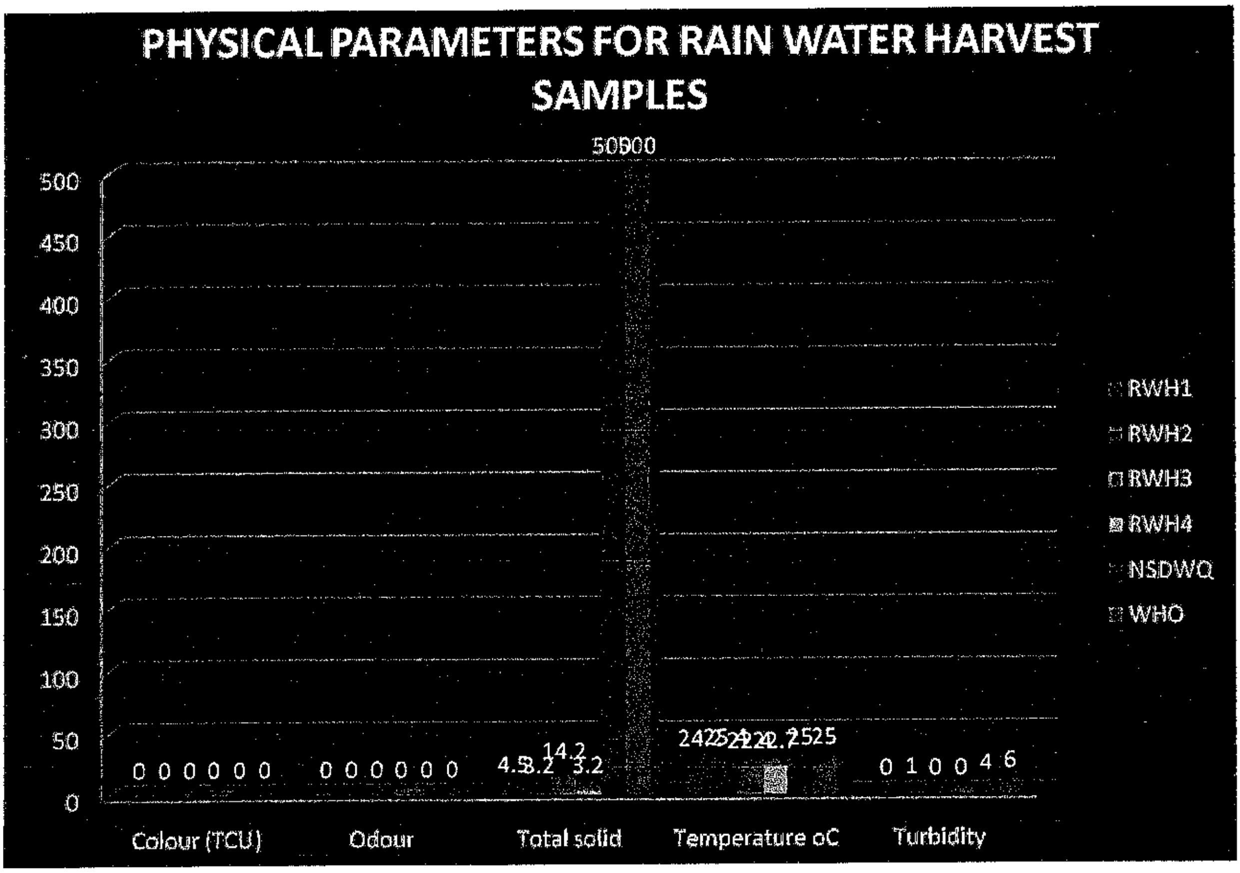


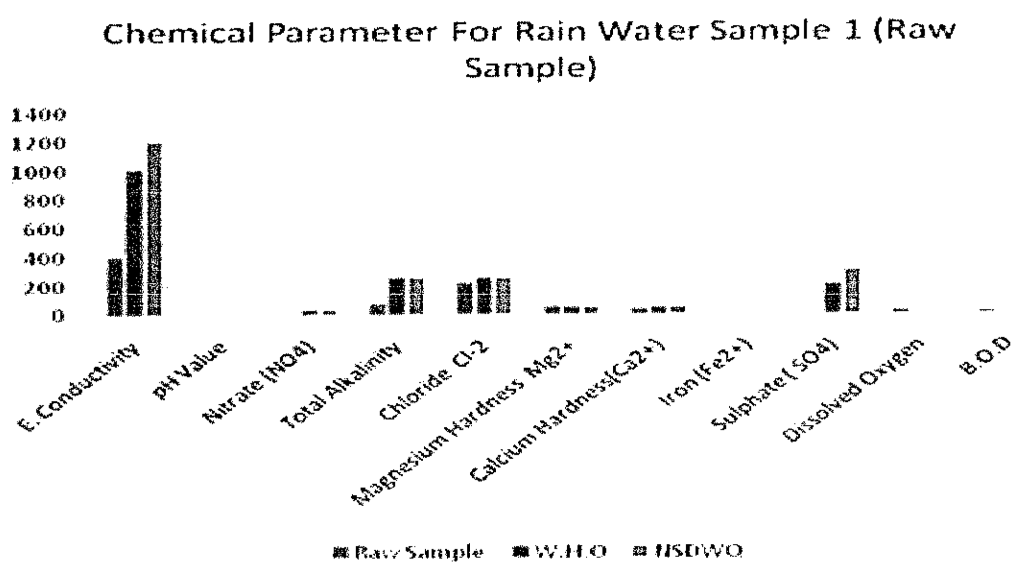
Figure 4.1 Physical parameters for rainwater harvest samples

Table 4.3: Chemical and bacteriological parameters for rain water harvest samples

S/N	TESTS	RESULT				RECOMMENDED LIMIT	
		RWH1	RWH2	RWH3	RWH4	NSDWQ	WHO
1	E. conductivity	400	500	400	700	1200	1000
2	pH value	5.8	5.9	5.7	5.6	6.5-8.5	6.5
3	Nitrate (NO_4)	0	0	0	0	30	30
4	Total Alkalinity	73.2	48.8	73.2	73.2	250	250
5	Chloride Cl^{-2}	220	709	652	148	250	250
6	Magnesium hardness (Mg^{2+})	52	30	32	14	50	50
7	calcium hardness (Ca^{2+})	36	38	22	32	50	50
8	Iron (Fe^{2+})	0.04	0.01	0.04	0.03	0.3	0.3
9	Sulphate (SO_4)	0	0	0	0	300	200
10	Dissolved oxygen	18.2	15	17	13.1		
11	B.O.D	12.7	10.58	11.9	9.17		
12	Bacteria count	0	0	0	0	0	0

Table 4.4 ***Chemical and bacteriological parameters for rain water harvest samples***

S/N	TESTS	RESULT	RECOMMENDED LIMIT	
		RWH1	NSDWQ	WHO
1	E. conductivity	400	1200	1000
2	pH value	5.8	6.5-8.5	6.5
3	Nitrate (NO_4)	0	30	30
4	Total Alkalinity	73.2	250	250
5	Chloride Cl^{-2}	220	250	250
6	Magnesium hardness (Mg^{2+})	52	50	50
7	calcium hardness (Ca^{2+})	36	50	50
8	Iron (Fe^{2+})	0.04	0.3	0.3
9	Sulphate (SO_4)	0	300	200
10	Dissolved oxygen	18.2		
11	B.O.D	12.7		
12	Bacteria count	0	0	0



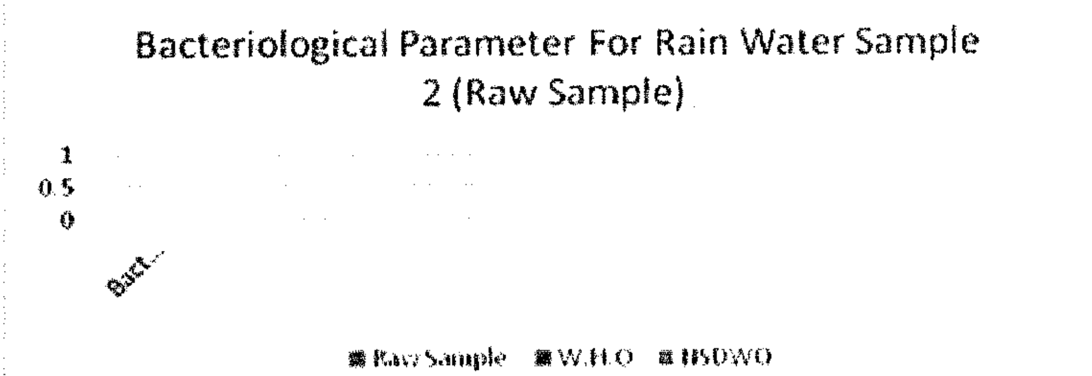
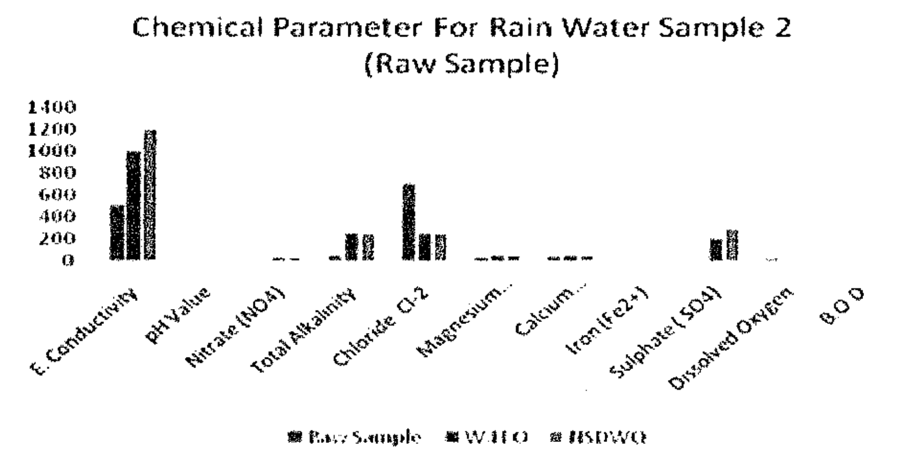


Figure 4.2: Bacteriological parameter for rainwater sample 1

Table 4.5 Chemical and bacteriological parameters for rain water harvest samples

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		RWH2	NSDWQ	WHO
1	E. conductivity	500	1200	1000
2	pH value	5.9	6.5-8.5	6.5
3	Nitrate (NO_4)	0	30	30
4	Total Alkalinity	48.8	250	250
5	Chloride Cl^{-2}	709	250	250
6	Magnesium hardness (Mg^{2+})	30	50	50
7	calcium hardness (Ca^{2+})	38	50	50
8	Iron (Fe^{2+})	0.01	0.3	0.3
9	Sulphate (SO_4)	0	300	200
10	Dissolved oxygen	15		
11	B.O.D	10.58		
12	Bacteria count	0	0	0



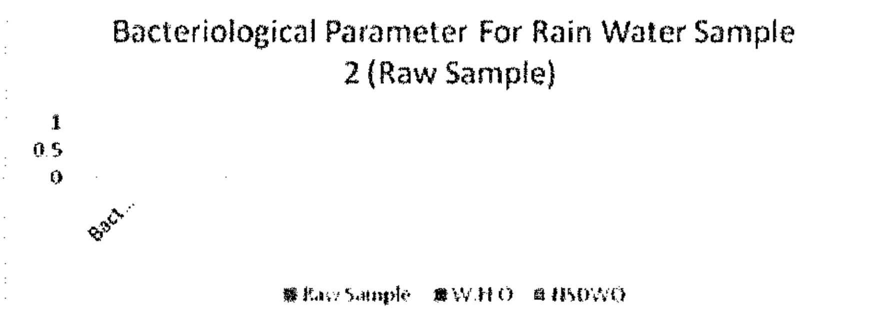
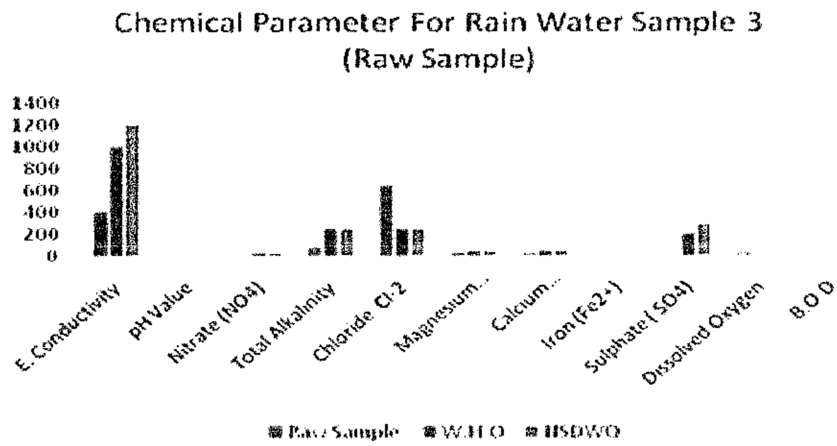


Figure 4.3: Bacteriological parameter for rainwater sample 2

Table 4.6 Chemical and bacteriological parameters for rain water harvest samples

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		RWH3	NSDWQ	WHO
1	E. conductivity	400	1200	1000
2	pH value	5.7	6.5-8.5	6.5
3	Nitrate (NO_4)	0	30	30
4	Total Alkalinity	73.2	250	250
5	Chloride Cl^{-2}	652	250	250
6	Magnesium hardness (Mg^{2+})	32	50	50
7	calcium hardness (Ca^{2+})	22	50	50
8	Iron (Fe^{2+})	0.04	0.3	0.3
9	Sulphate (SO_4)	0	300	200
10	Dissolved oxygen	17		
11	B.O.D	11.9		
12	Bacteria count	0	0	0



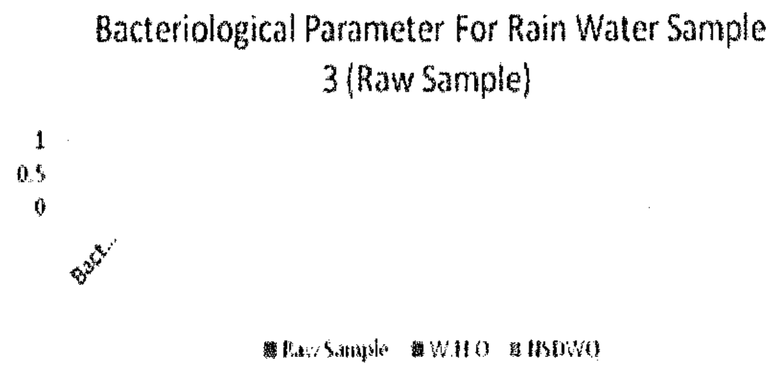


Figure 4.4: Bacteriological parameter for rainwater sample3

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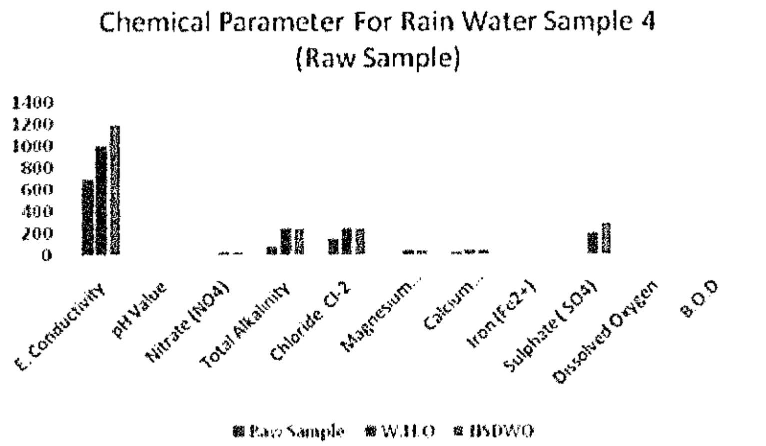
Table 4.7 Chemical and Bacteriological Parameters for Rain Water Harvest Samples 4

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		RWH4	NSDWQ	WHO
1	E. conductivity	700	1200	1000
2	pH value	5.6	6.5-8.5	6.5
3	Nitrate (NO_4)	0	30	30
4	Total Alkalinity	73.2	250	250
5	Chloride Cl^{-2}	148	250	250
6	Magnesium hardness (Mg^{2+})	14	50	50
7	calcium hardness (Ca^{2+})	32	50	50
8	Iron (Fe^{2+})	0.03	0.3	0.3
9	Sulphate (SO_4)	0	300	200
10	Dissolved oxygen	13.1		
11	B.O.D	9.17		
12	Bacteria count	0	0	0



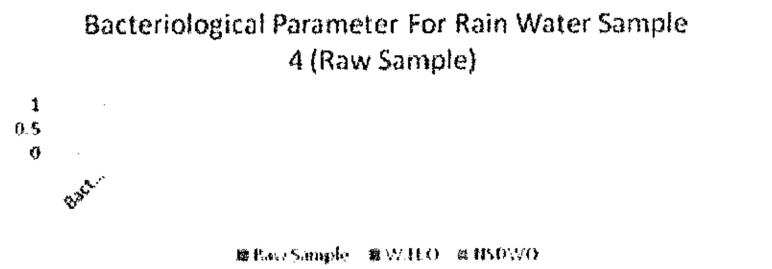


Figure 4.5 Bacteriological parameter for rainwater sample 4

Table 4.8 Chemical and bacteriolagical parameters for hand dug well

S/N	TESTS	RESULT				RECOMMENDED LIMITS	
		HDW1	HDW2	HDW3	HDW4	NSDWQ	WHO
1	Colour (TCU)	Colourless	Slightly cloudy	Slightly cloudy	Slightly cloudy	Colourless	Colourless
2	Odour	Odourless	Odourless	unpleasant	Unpleasant	Odourless	Odourless
3	Total solid	8	5	18.2	18.1	500	500
4	Temperature °C	25.7	25.9	27.1	26.3	25	25
5	Turbidity	9	9	7	14.7	4	6

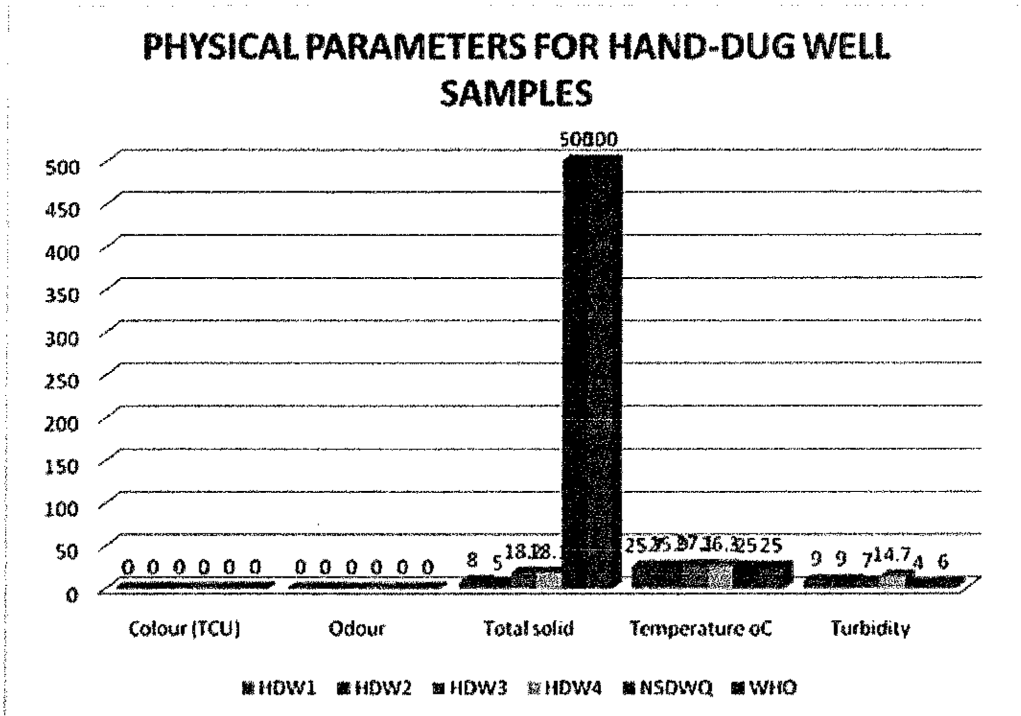


Figure 4.6 :Physical parameters for hand dug well sample

Table 4.9 Chemical and bacteriological parameters for hand dug well

S/N	TESTS	RESULT				RECOMMENDED LIMIT	
		HDW1	HDW 2	HDW 3	HDW4	NSDWQ	WHO
1	E. conductivity	1600	1300	2100	1500	1200	1000
2	pH value	6	6.8	6.1	6.4	6.5-8.5	6.5
3	Nitrate (NO_4)	4.25	6.3	0.45	0.33	30	30
4	Total Alkalinity	97.6	61	140.4	97.6	250	250
5	Chloride Cl^{-2}	453.76	652.28	581.26	446.7	250	250
6	Magnesium hardness (Mg^{2+})	50	84	42	92	50	50
7	calcium hardness (Ca^{2+})	30	136	156	75	50	50
8	Iron (Fe^{2+})	0	0.03	0.06	0	0.3	0.3
9	Sulphate (SO_4)	0.4	0	0.22	0.65	300	200
10	Dissolved oxygen	7.5	15	11.15	8.5		
11	B.O.D	5.7	10.58	8.05	5.95		
12	Bacteria count	14	7	15	12	0	0

Table 4.10 Chemical and bacteriological parameters for hand dug well 1

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		HDW1	NSDWQ	WHO
1	E. conductivity	1600	1200	1000
2	pH value	6	6.5-8.5	6.5
3	Nitrate (NO_4)	4.25	30	30
4	Total Alkalinity	97.6	250	250
5	Chloride Cl^{-2}	453.76	250	250
6	Magnesium hardness (Mg^{2+})	50	50	50
7	calcium hardness (Ca^{2+})	30	50	50
8	Iron (Fe^{2+})	0	0.3	0.3
9	Sulphate (SO_4)	0.4	300	200
10	Dissolved oxygen	7.5		
11	B.O.D	5.7		
12	Bacteria count	14	0	0

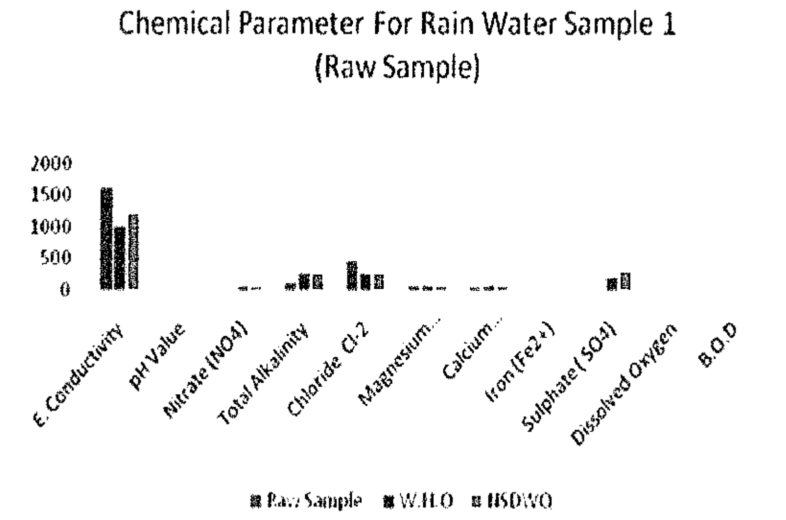


Figure 4.7: Chemical parameter for rain water sample 1

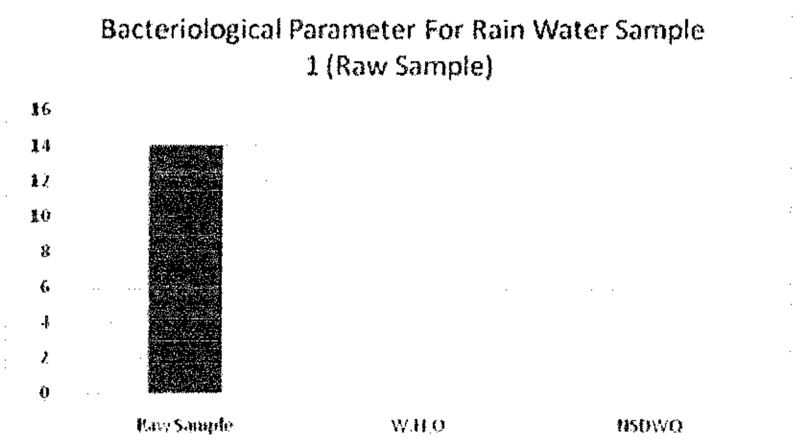


Figure 4.8: bacteriological parameter for rain water sample 1

Table 4.11 Chemical and bacteriological parameters for hand dug well 2

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		HDW2	NSDWQ	WHO
1	E. conductivity	1300	1200	1000
2	pH value	6.8	6.5-8.5	6.5
3	Nitrate (NO_4)	6.3	30	30
4	Total Alkalinity	61	250	250
5	Chloride Cl^{-2}	652.28	250	250
6	Magnesium hardness (Mg^{2+})	84	50	50
7	calcium hardness (Ca^{2+})	136	50	50
8	Iron (Fe^{2+})	0.03	0.3	0.3
9	Sulphate (SO_4)	0	300	200
10	Dissolved oxygen	15		
11	B.O.D	10.58		
12	Bacteria count	7	0	0

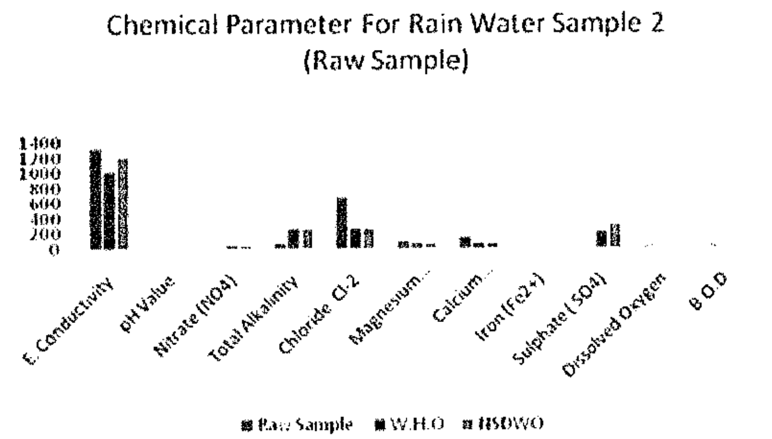


Figure 4.9: Chemical parameter for rain water sample 2

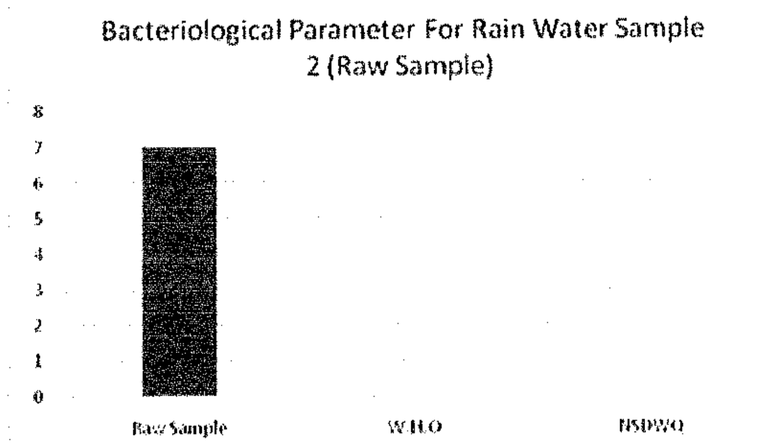


Figure 4.10: Bacteriological parameter for rain water sample 2

Table 4.12 Chemical and bacteriolagical parameters for hand dug well 3

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		HDW3	NSDWQ	WHO
1	E. conductivity	2100	1200	1000
2	pH value	6.1	6.5-8.5	6.5
3	Nitrate (NO_4)	0.45	30	30
4	Total Alkalinity	140.4	250	250
5	Chloride Cl^{-2}	581.26	250	250
6	Magnesium hardness (Mg^{2+})	42	50	50
7	calcium hardness (Ca^{2+})	156	50	50
8	Iron (Fe^{2+})	0.06	0.3	0.3
9	Sulphate (SO_4)	0.22	300	200
10	Dissolved oxygen	11.15		
11	B.O.D	8.05		
12	Bacteria count	15	0	0

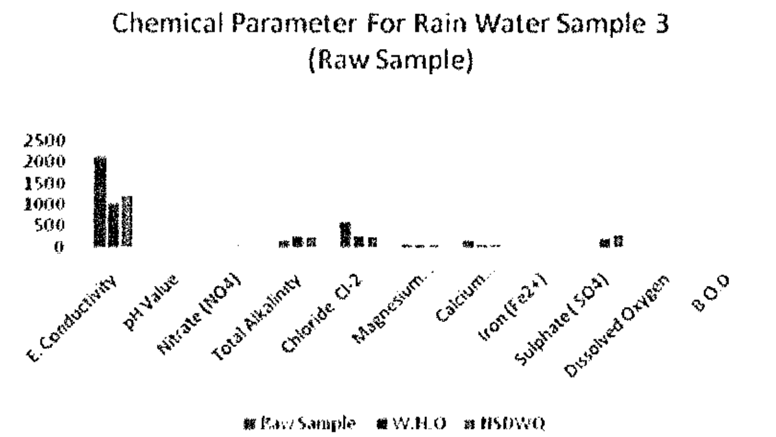


Figure 4.11: Chemical parameter for rain water sample 3

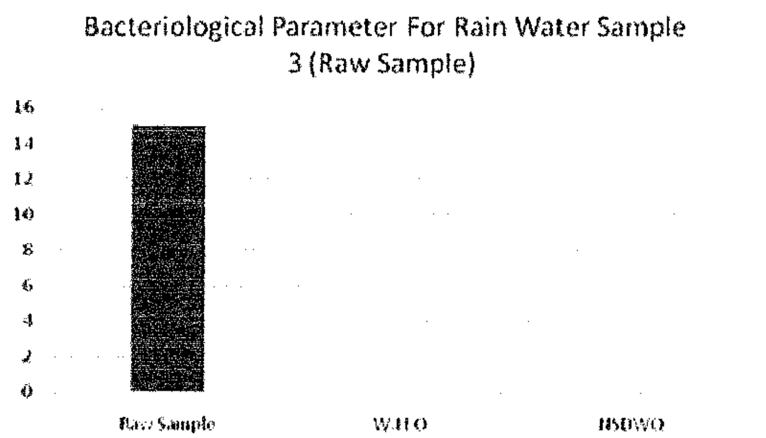


Figure 4.12: Bacteriological parameter for rain water sample 3

Table 4.12 Chemical and bacteriological parameters for hand dug well 4

S/N	TESTS	RESULTS		RECOMMENDED LIMITS
		HDW4	NSDWQ	WHO
1	E. conductivity	1500	1200	1000
2	pH value	6.4	6.5-8.5	6.5
3	Nitrate (NO_4)	0.33	30	30
4	Total Alkalinity	97.6	250	250
5	Chloride Cl^{-2}	446.7	250	250
6	Magnesium hardness (Mg^{2+})	92	50	50
7	calcium hardness (Ca^{2+})	75	50	50
8	Iron (Fe^{2+})	0	0.3	0.3
9	Sulphate (SO_4)	0.65	300	200
10	Dissolved oxygen	8.5		
11	B.O.D	5.95		
12	Bacteria count	12	0	0

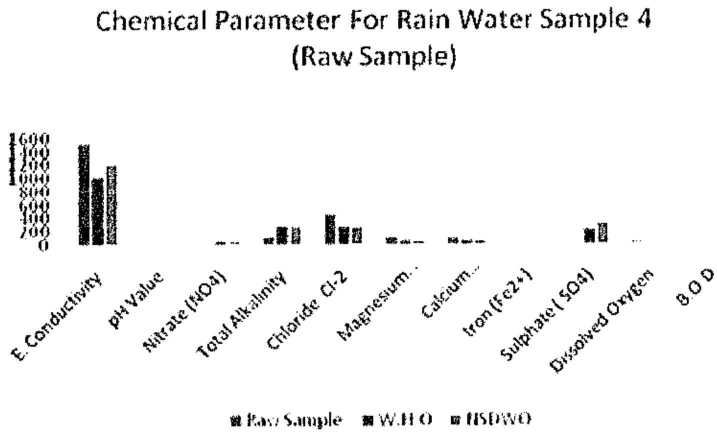


Figure 4.13: Chemical parameter for rain water sample 4

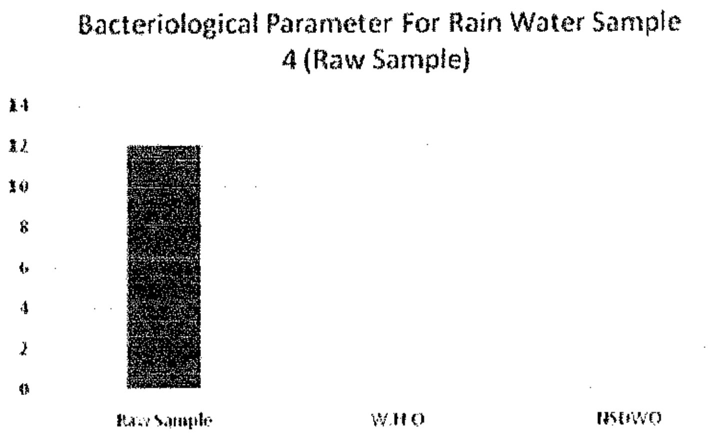


Figure 4.14: Chemical parameter for rain water sample 4

Table 4.13 Mechanical energy device

S/N	TESTS	RESULT				RECOMMENDED LIMITS	
		PM1	PM2	PM3	BH1	NSDWQ	WHO
1	Colour (TCU)	Colourless	Slightly cloudy	Slightly cloudy	Slightly cloudy	Colourless	Colourless
2	Odour	Odourless	Odourless	unpleasant	unpleasant	Odourless	Odourless
3	Total solid	2.5	6	3	5	500	500
4	Temperature ^oC	24.2	24.5	25.1	26.2	25	25
5	Turbidity	0	9	4.5	1	4	6

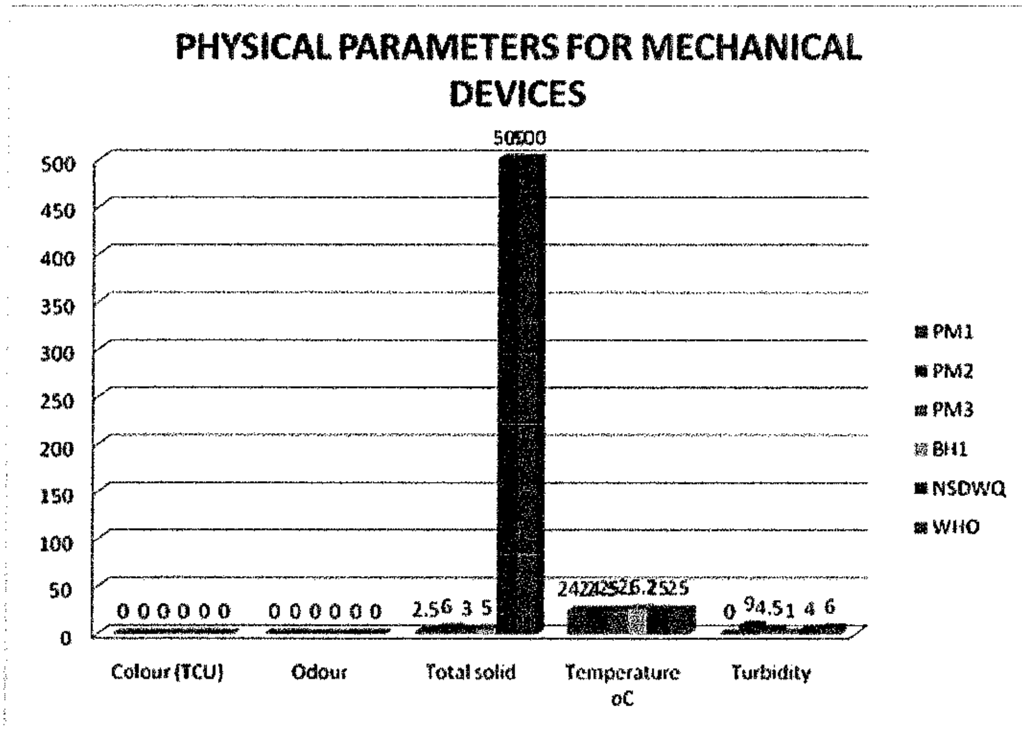


Figure 4.15: Physical parameter for mechanical devices

Table 4.14 Mechanical energy device

S/N	TESTS			RESULT		RECOMMENDED LIMIT	
		PM1	PM2	PM3	BH1	NSDWQ	WHO
1	E. conductivity	1000	1400	460	820	1200	1000
2	pH value	6.5	6.4	6.8	6.8	6.5-8.5	6.5
3	Nitrate (NO_4)	0.3	0.11	0	0	30	30
4	Total Alkalinity	97.6	48.8	85.5	97.6	250	250
5	Chloride Cl^{-2}	354.5	194	194	460	250	250
6	Magnesium hardness (Mg^{2+})	42	60	52	68	50	50
7	calcium hardness (Ca^{2+})	61	56	52	32	50	50
8	Iron (Fe^{2+})	0	0	0	0.03	0.3	0.3
9	Sulphate (SO_4)	0.36	0	0	0	300	200
10	Dissolved oxygen	9.2	16.2	10.2	15		
11	B.O.D	6.43	11.63	7.45	10.58		
12	Bacteria count	0	0	0	0	0	0

Table 4.15 Chemical and bacteriological parameters for mechanical energy device sample

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		PM1	NSDWQ	WHO
1	E. conductivity	1000	1200	1000
2	pH value	6.5	6.5-8.5	6.5
3	Nitrate (NO_4)	0.3	30	30
4	Total Alkalinity	97.6	250	250
5	Chloride Cl^{-2}	354.5	250	250
6	Magnesium hardness (Mg^{2+})	42	50	50
7	calcium hardness (Ca^{2+})	61	50	50
8	Iron (Fe^{2+})	0	0.3	0.3
9	Sulphate (SO_4)	0.36	300	200
10	Dissolved oxygen	9.2		
11	B.O.D	6.43		
12	Bacteria count	0	0	0

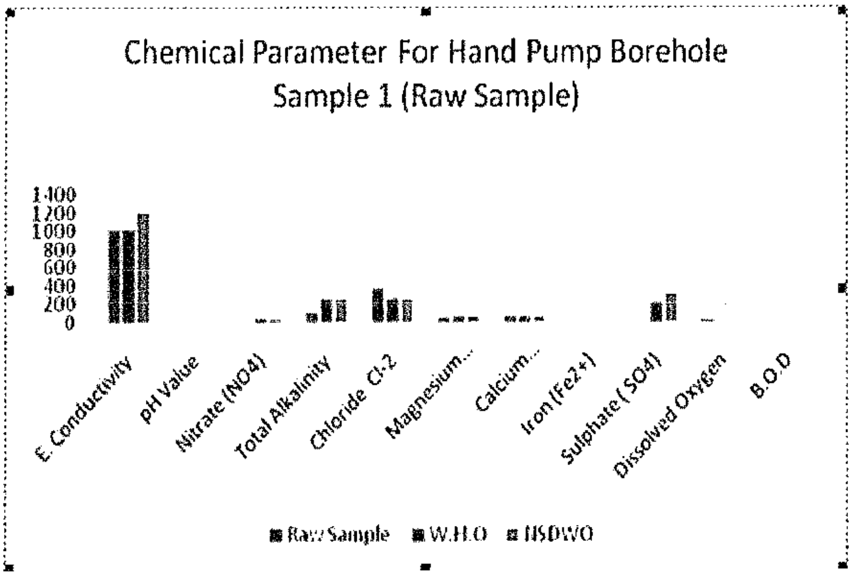


Figure 4.16: Chemical parameter for Hand pump Borehole

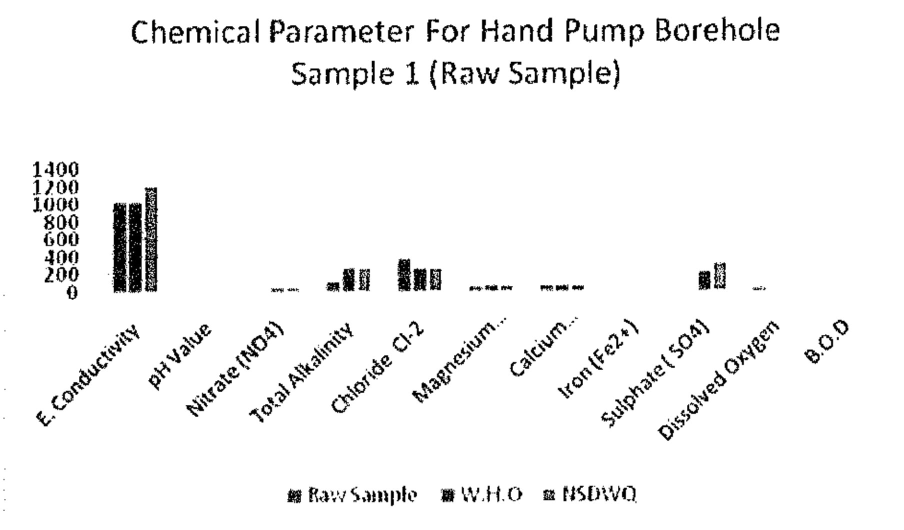


Figure 4.17: Chemical parameter for Hand pump Borehole sample 1

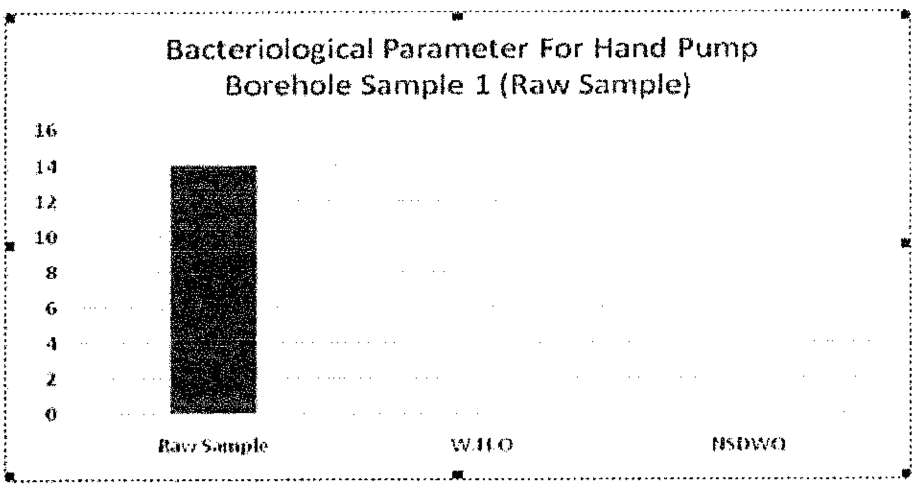


Figure 4.18: Bacteriological parameter for hand pump borehole sample 1

Table 4.16 Hand pump borehole sample 2

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		PM2	NSDWQ	WHO
S1	E. conductivity	1400	1200	1000
2	pH value	6.4	6.5-8.5	6.5
3	Nitrate (NO_4)	0.11	30	30
4	Total Alkalinity	48.8	250	250
5	Chloride Cl^{-2}	194	250	250
6	Magnesium hardness (Mg^{2+})	60	50	50
7	calcium hardness (Ca^{2+})	56	50	50
8	Iron (Fe^{2+})	0	0.3	0.3
9	Sulphate (SO_4)	0	300	200
10	Dissolved oxygen	16.2		
11	B.O.D	11.63		
12	Bacteria count	0	0	0

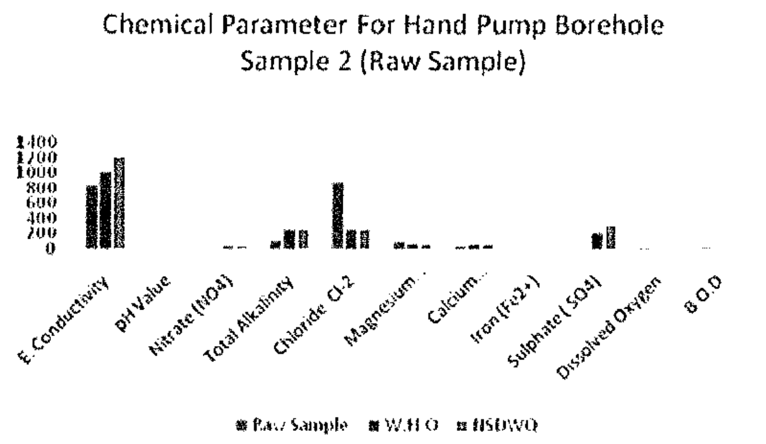


Figure 4.19: Chemical parameter for hand pump borehole sample 2

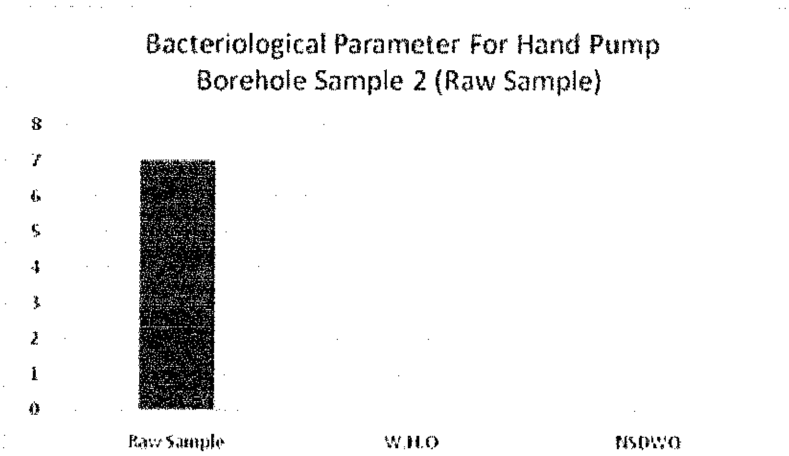


Figure 4.20: Bacteriological parameter for Hand pump Borehole sample 2

Table 4.17 Hand pump borehole sample 3

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		PM3	NSDWQ	WHO
1	E. conductivity	460	1200	1000
2	pH value	6.8	6.5-8.5	6.5
3	Nitrate (NO_4)	0	30	30
4	Total Alkalinity	85.5	250	250
5	Chloride Cl^{-2}	194	250	250
6	Magnesium hardness (Mg^{2+})	52	50	50
7	calcium hardness (Ca^{2+})	52	50	50
8	Iron (Fe^{2+})	0	0.3	0.3
9	Sulphate (SO_4)	0	300	200
10	Dissolved oxygen	10.2		
11	B.O.D	7.45		
12	Bacteria count	0	0	0

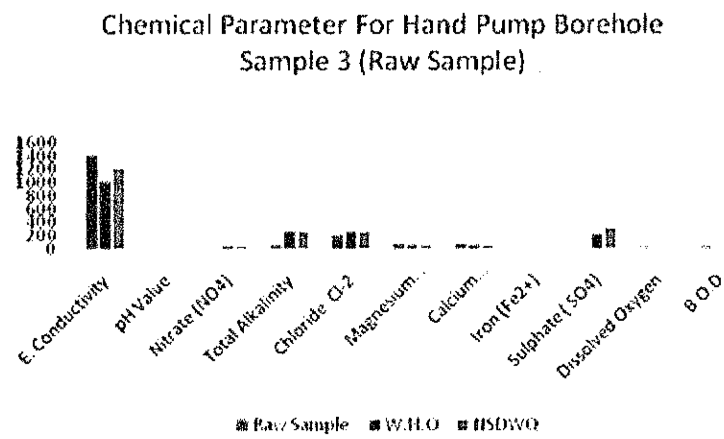


Figure 4.21: Chemical parameter for hand pump borehole sample 3

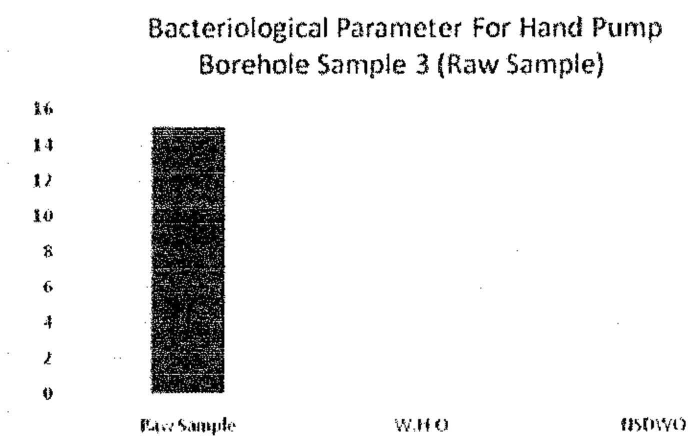


Figure 4.22: Bacteriological parameter for hand pump borehole sample 3

Table 4:18 Hand pump borehole sample 4

S/N	TESTS	RESULTS	RECOMMENDED LIMITS	
		BH1	NSDWQ	WHO
1	E. conductivity	820	1200	1000
2	pH value	6.8	6.5-8.5	6.5
3	Nitrate (NO_4)	0	30	30
4	Total Alkalinity	97.6	250	250
5	Chloride Cl^{-2}	460	250	250
6	Magnesium hardness (Mg^{2+})	68	50	50
7	calcium hardness (Ca^{2+})	32	50	50
8	Iron (Fe^{2+})	0.03	0.3	0.3
9	Sulphate (SO_4)	0	300	200
10	Dissolved oxygen	15		
11	B.O.D	10.58		
12	Bacteria count	0	0	0

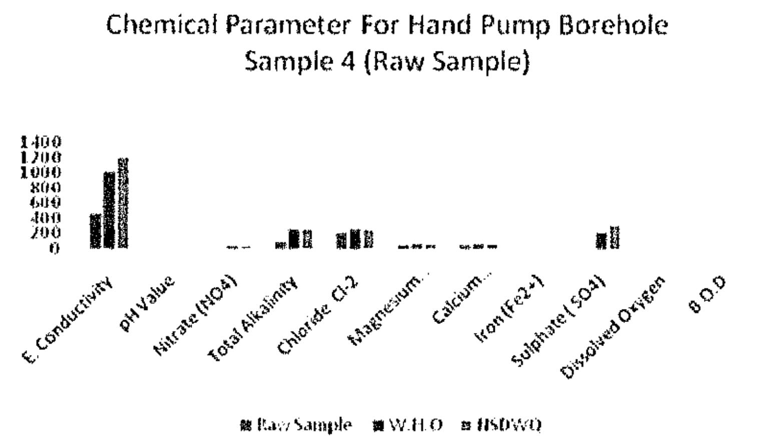


Figure 4.23: Chemical parameter for hand pump borehole sample 4

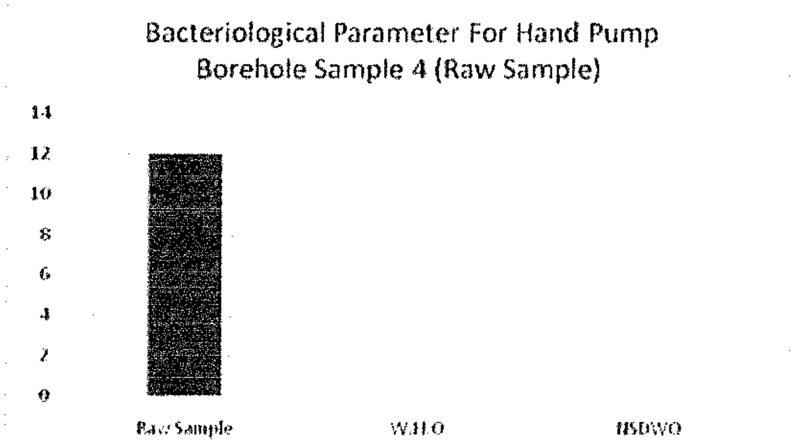


Figure 4.24: Bacteriological parameter for hand pump borehole sample 4

4.2 Analysis of Results and Discussion

4.2.1 Temperature

The temperatures of water samples obtained from the twelve water sample in Usin-ekiti of Ikole LGA ranged between 22.4°C and 27.1°C, respectively. Although, both NSDWQ and WHO have not defined temperature values for drinking water, all the values exceeded the normal room temperature of 22°C.

4.2.2 Odour

Odour in drinking-water may be indicative of some form of pollution or of a malfunction during water treatment or distribution. It may therefore be an indication of the presence of potentially harmful substances. The cause should be investigated and the appropriate health authorities should be consulted, particularly if there is a sudden or substantial change.

Moreover, Odour may also be developing during and distribution as a result of microbial activity which can originate from natural inorganic and organic chemical contaminants and biological sources or processes (e.g. aquatic microorganisms), from contamination by synthetic chemicals, from corrosion or as a result of problems with water treatment (e.g. chlorination).

It can be observed that all the samples from the rain water, hand pump and borehole sources are odourless and they conformed with the WHO and NSDWQ standards.

4.2.3 Total solids

The total solids for the rain water samples ranged between 3.2-14.2 mg/l for the four samples. The values are 4.5mg/l, 3.2mg/l, 14.2mg/l, and 3.2mg/l for sample 1 sample 2 sample 3 and sample 4 respectively. Although the four samples fall within the WHO and NSDWQ permissible limits.

For the hand dug well samples, the total solids for the raw water are 8mg/l, 6mg/l, 5mg/l and 15mg/l for samples 1,2,3,4 respectively. The samples also fall within the WHO and NSDWQ standard. Also, for the hand pump and borehole samples, the total solids of the water samples were reduced accordingly.

4.2.4 Turbidity

Turbidity simply refers to the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through water. It is caused by suspended and colloidal matter such as clay, silt, finely divided organic matter and microscopic organism. The four rain water samples are not turbid. Samples 1, 3, 4 have 0 NTU while sample 2 have 1 NTU. The four samples fall within accepted limits.

The four samples gotten from the hand dug well were all turbid. They do not fall within WHO standard which is 6 NTU and NSDWQ standard which is 5 NTU. The turbidity for the hand dug well fell between the ranges of 8 to 11 NTU respectively.

For the Hand pump and borehole, all the samples gotten are not turbid except for sample 3 which have a value of 9 NTU.

4.2.5 Electrical conductivity

The electrical conductivity values for the rain water samples are 400, 500, 400, and 700us/cm for samples 1,2,3,4 respectively. The four rainwater samples meet up with the WHO and NSDWQ standard which is 1000 and 1200vS/cm respectively.

Conductivity is a measure of water's capability to pass electrical flow. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds. Compounds that dissolve into ions are also known as electrolytes. The more ions that are present, the higher the conductivity of water. Likewise, the fewer ions that are in the water, the less conductive it is.

The results gotten from the hand dug well samples indicated that all the samples do not meet up with the WHO and NSDWQ permissible limit.

In the samples gotten from hand pump and borehole, the electrical conductivity of the raw water are 1000, 820, 1400 and 400vS/cm for samples 1,2,3 and 4 respectively.

4.2.6 PH VALUE

All the rain water samples collected do not meet up with the WHO and NSDWQ standard. The pH for samples 1,2,3,4 are 5.8, 5.9, 5.7, 5.6 respectively.Also, all the samples gotten from the hand dug well do not meet up with the WHO and NSDWQ standard except for sample 2 which have a pH of 6.8.For the hand pump and borehole samples, all the samples collected are within permissible recommended limit except for sample 3 which have a pH of 6.4.

4.2.7 Nitrate

Nitrate in groundwater originates primarily from fertilizers, septic systems, and manure storage or spreading operations. Fertilizer nitrogen that is not taken up by plants, volatilized, or carried away by surface runoff leaches to the groundwater in the form of nitrate. This not only makes the nitrogen unavailable to crops, but also can elevate the concentration in groundwater above the levels acceptable for drinking water quality. All the rain water samples collected have no nitrate contamination. For the hand dug well samples, the nitrate level for sample 1, 2, 3 and 4 are 4.25, 6.3, 0.45, and 0.33 mg/l respectively.

4.2.8 Total alkalinity

Alkalinity was observed during the research work was within the limits of WHO and NSDWQ.

4.2.9 Chloride

Chloride in drinking water is not harmful, and most concerns are related to the frequent association of high chloride levels with elevated sodium levels. There is no health based drinking water guideline for chloride however the Guidelines for Nigerian Standard for Drinking Water Quality and World Health Organisation recommend and aesthetic objective for chloride levels of 250 mg/L, based on the potential for undesirable tastes at concentrations above this level, and the increased risk of corrosion of pipes.

The chlorides were present in the range of 142-709 mg/l in the rain water samples. The chloride is well above the WHO and NSDWQ permissible limit. Also, the Hand dug well samples have chloride ions in the range of 446.7-652.28 mg/l. The four samples taken from the Hand dug well source did not meet up with the acceptable limits.

4.2.10 Magnesium and calcium hardness

Water described as "hard" is high in dissolved minerals, specifically calcium and magnesium. Hard water is not a health risk, when water is combined with carbon dioxide to form very weak carbonic acid, an

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even better solvent results. As water moves through soil and rock, it dissolves very small amounts of minerals and holds them in solution. Calcium and magnesium dissolved in water are the two most common minerals that make water "hard." The degree of hardness becomes greater as the calcium and magnesium content increases and is related to the concentration of multivalent cations dissolved in the water.

The magnesium and calcium ions present in the rain water samples are within the WHO and NSDWQ permissible limit except for the magnesium ion in sample 1 which is 52 mg/l. Most of the samples from the hand dug well source contain calcium and magnesium ions above the WHO and NSDWQ standards which is 50 mg/l.

4.2.11 Iron

Iron is one of the earth's most plentiful resources. Rainwater as it infiltrates the soil and underlying geologic formations dissolves iron, causing it to seep into aquifers that serve as sources of groundwater for wells. Although present in drinking water, iron is seldom found at concentrations greater than 10 milligrams per liter (mg/L) or 10 parts per million.

All the samples gotten from the rain water source are within the WHO and NSDWQ permissible limit which is 0.3 mg/l. The iron ions are in the range of 0.01-0.04 mg/l.

It was also observed that samples 1, 2, 3 and 4 of the hand pump and borehole samples have 0 mg/l, 0.03 mg/l, 0 mg/l, and 0 mg/l number of iron ions respectively, and they are within permissible limit.

4.2.12 Sulphate

High concentrations of sulphate in the water we drink can have a laxative effect when combined with calcium and magnesium, the two most common constituents of hardness. Bacteria, which attack and reduce sulphates, form hydrogen sulphide gas. The maximum level of sulphate suggested by the World Health Organization (WHO) in the Guidelines for Drinking-water Quality is 200. As for the hand dug well samples, the level of sulphate present are in the range of 0-0.65 mg/l. This is well below the WHO and NSDWQ standards. Also, for the hand pump and borehole samples, the sulphate level are well below the WHO and NSDWQ permissible limit. Their sulphate level are in the range of 0-0.36 mg/l.

4.2.13 Dissolved oxygen

The amount of oxygen dissolved in water depends on the rate of aeration from the atmosphere, temperature, air pressure and salinity. While the actual amount of oxygen that can be dissolved in water depends on the relative rates of respiration by all organisms and of photosynthesis by plants, oxygen levels are actually low where organic matter accumulates because aerobic decomposers require and consume oxygen. The dissolved oxygen level of the rain water samples are in the range of 13.1-18.2 mg/l

Also, for the hand dug well samples, the dissolved oxygen was in the range of 7.5-15 mg/l. Lastly, the dissolved oxygen level of the hand pump and borehole samples are in the range of 9.2-16.2 mg/l. There is no limiting values given for dissolved oxygen in drinking water by WHO and NSDWQ.

4.2.14 B.O.D

Biochemical Oxygen Demand (BOD) is used for detecting the amount of decomposing organic materials as well as the rate of biological activities that occurs in water. This is because oxygen is required for respiration by microorganisms involved in the decomposition of organic materials.The initial BOD for the rain water samples was in the range of 9.17- 12.17 mg/l.The raw water BOD for the hand dug well samples are in the range of 5.7-10.58 mg/l. Also, for the hand pump and borehole samples, the BOD level was in the range of 6.43- 11.63.mg/l

4.2.15 Bacteria count

The presence of bacteria and pathogenic (disease-causing) organisms is a concern when considering the safety of drinking water. Pathogenic organisms can cause intestinal infections, dysentery, hepatitis, typhoid fever, cholera, and other illnesses. Human and animal wastes are a primary source of bacteria in water. These sources of bacterial contamination include runoff from feedlots, pastures, dog runs, and other land areas where animal wastes are deposited. Additional sources include seepage or discharge from septic tanks, sewage treatment facilities, and natural soil/plant bacteria. Bacteria from these sources can enter wells that are either open at the land surface or do not have water-tight casings or caps.

For the rain water, hand pump and borehole samples, the bacteria count is 0 cfu/l. The samples meet up with the WHO and NSDWQ permissible limit which is 0cfu/l. But all the samples in the hand dug well source, do not meet up with the WHO and NSDWQ standards which is 0cfu/l.

4.5 THE RESULT OF HARZARD ANALYSIS ARE GIVEN IN TABLE BELOW

Table 4.19: Hazard Event - Septic Tank Location

Hazard Event	Water source	Associated Hazard	Cause	Risk	Critical Limits		Corrective Action	Monitoring		
					Current Situation	Target		What	When	Who
Location of Septic Tank from Water Source	PM_1	Well Protected		No observed risk	Acceptable		None			
	PM_2			No observed risk	Acceptable		None			
	PM_3			No observed risk	Acceptable		None			
	PM_4			No observed risk	Acceptable		None			

	HDW1			No observed Risk	Acceptable		None			
	HDW2	Microbial Contamination Well protect ted	Facility Location	No observed risk	Acceptable		None	Location of New Sanitary Facilities	Bi-annually	Designated Personnel
	HDW3			No observed risk	Acceptable		None			
	HDW4			No observed risk	Acceptable		None			
	RWH1			No observed risk	Acceptable		None			
	RWH2			No observed risk	Acceptable		None			
	RWH3			No observed risk	Acceptable		None			
	RWH4			No observed risk	Acceptable		None			

Table 4.20: Hazard Event - Poor Water Quality

Hazard Event	Water Source	Associated Hazard	Cause	Risk	Critical Limits		Corrective Action	Monitoring		
					Current Situation	Target		What	When	Who

Poor Water Quality	PM_1	Well protected	Not Applicable	No Observed Risk	Acceptable		Ensuring the vicinity of the water source is clean	Water Quality	Weekly	Designated Personnel
	PM_2		Not Applicable	No Observed Risk	Acceptable					
	PM_3		Not Applicable	No Observed Risk	Acceptable					
	PM_4		Not Applicable	No Observed Risk	Acceptable					
	HDW_1	Contaminant in Vicinity of Water Source	Microbial Contamination	Low Risk	Not well covered	Protected Water Source	Install hand pump on water source	Water Quality	Weekly	Designated Personnel
	HDW_2		Microbial Contamination	Low Risk	Clearing of bushes around the source	Protected Water Source				
	HDW_3		Microbial Contamination	Low Risk	Vicinity not clean	Protected Water Source				
	HDW_4		Microbial Contamination	Low Risk	Vicinity not clean	Protected Water Source				
	RWH_1	Well protected	Not Applicable	No Observed Risk	Acceptable					
	RWH_2		Not Applicable	No Observer	Acceptable		Ensuring adequa			

				ved Risk			te washing of the water tank	Water Quality	Weekly	Designated Personnel
	RWH_3		Not Applicable	No Observed Risk	Acceptable					
	RWH_4		Not Applicable	No Observed Risk	Acceptable					

Table 4.21: Hazard Event--Well head not Water Tight

Hazard Event	Water source	Associated Hazard	Cause	Risk	Critical Limits		Corrective Action	Monitoring		
					Current Situation	Target		What	When	Who
Well head not water tight	PM_1	Surface Water Intrusion	Use of rope and bucket for abstraction	High Risk	Use of rope and bucket for abstraction	Protected Water Source	Install hand pump on water source	Protection of Well	Bi-annually	Designated
	PM_2									
	PM_3									
	PM_4									
	HDW_1									
	HDW_2									
	HDW_3									
	HDW_4									
	RWH_1									
	RWH_2									

	RWH3									Personnel
	RWH4									

Table 4.22: Hazard Event--Flooding around water source

	Water source	Associated Hazard	Cause	Risk	Critical Limits		Corrective Action	Monitoring		
					Current Situation	Target		What	When	Who
Flooding around water source	PM_1	Water Quality Compromised	Not Applicable	No Observed Risk	Protected Well	Protected Water Source	None			
	PM_2									
	PM_3									
	PM_4									
	HDW_1									
	HDW_2									
	HDW_3									
	HDW_4									
	RWH_1									

	RW H_2									
	RW H_3									
	RW H_4									

4.3.1 Hazard Analysis Discussion

4.3.1.1 Septic Tank Location

All the water sources monitored met the minimum requirement of a distance of at least 30m from a septic tank location except for HDW3 and HDW4 where the distance is not up to 30m.

4.3.1.2 Well head not Water Tight

Water sources HDW2, HDW3, HDW4 are not well covered. All other water source has protected water head tight and corrective measured were proffered as seen in the above table

4.3.1.3 Flooding around water source

All the twelve water sources were not located in flood zones as analyze in the above table.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the research, it was found that:

1. Based on the test result obtained for Bacterial count samples from the rainwater and borehole fell within the acceptable range of WHO and NSDQW in which states that the bacterial count should be at 0.00cfu/l and 0.00cfu/l respectively.
2. The magnesium content of all samples was above NSDWQ recommended limit.
3. The total hardness of all water samples were within acceptable limit
4. The water sample were all contaminated with aerobic mesophilic organism and coliform organism.
5. Hazard Analysis proffered corrective measures for water sources with high risks
6. Sanitation around all domestic water source requires improvement to eliminate possibility of contamination of water from the source.
7. The use of plastic container which is bucket and Jeri cans which reduces the heavy load and contamination are the major collection water material.
8. There is a positive relationship between collection time, distance, quality, quantity from sources of domestic used for individual household when compared with WHO standard of 60l/Cap/day and water sources distance on average which is between 200 to 250 meters.

5.2 Recommendation

It is recommended that;

1. A lot awareness creation activity should be done on sanitation and hygiene through extension workers.
2. Government should supplement the provision of drinking water rather than creating competition between household with more water consuming activities such as area around the palace with underlay rock which prevent individual from sinking boreholes and hand dug wells.
3. The pH of water samples that are below acceptable limit can be increased by using neutralizing filters through the addition of neutralizing materials.

4. The magnesium content of water sample can be reduce using Packaged water softener.
5. The water source can be decontaminated by chlorination.
6. Regular monitoring of domestic water quality should be maintained for all the domestic water sources.
7. Strict adherence to basic environmental sanitation rules should be observed around all the domestic water sources.
8. Continuous follow up on already installed schemes will give a better chance to sustain the water scheme.
9. The community should treat their drinking water adequately before consumption.

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