UNIVERSITY OF NAIROBI

AN EVALUATION OF EFFECTIVENESS OF ALTERNATIVE WATER SUPPLY: A CASE STUDY OF NAIROBI WATER CENTRAL REGION, ZONE 1

BY

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DECLARATION

This research project is my original work and has not been presented for a degree in any other University

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DEDICATION

To my husband Mburu Githuka you have been a well of encouragement throughout my studies. To Mburu and Wanjiku, from whom I derive my motivation, to continue seeking knowledge to offer a positive contribution in the world.

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ABSTRACT

The Kenya Government through the local government is charged with responsibility of providing water and sanitation services. The delivery of these services has faced a number of challenges and bottlenecks prompting the introduction of commercialization which was expected to do away with the problems related to water and sanitation. These challenges facing water supply by the government has led to the development of alternative water supply enterprises that supply water to the formal and informal sector of Nairobi, therefore this study seeks to analyze causes of alternative water supply. The study was conducted in Nairobi city majorly focusing on Starehe constituency. The overall objective of the study was to assess the approaches used by the private sector in the provision of water services in the city of Nairobi where the following specific objectives were obtained: (i) To establish the influence of infrastructure on alternative approaches in the provision of water and sewerage services in Starehe constituency (ii) To find out the influence of institutional capacity on alternative approaches in the provision of water and sewerage services in Starehe constituency (iii) To examine the influence of urban sprawl on alternative approaches in the provision of water and sewerage services in Starehe constituency and (iv) To determine the influence of government policy on alternative approaches in the provision of water and sewerage services in Starehe constituency and (v) To investigate the level of satisfaction, efficiency, reliability and quality on approaches to alternative water provision in Starehe Constituency. The study adopted cross-sectional design method as the form of research design where respondents were expected to answer questions administered through the questionnaire. The data used both quantitative and qualitative data obtained from the questionnaire. The study population was focused on the on the business community and the residents of Starehe constituency. These formed the target

population used in the study. The study therefore targets a total of 66,108 (KNBS, 2019) conventional household of Starehe constituency and 12,540 business communities in the CBD. The study embraced a stratified sampling technique for the selection of the study respondents to participate in the study. It was appropriate for the study since the population was grouped and distributed as per the geographical locations of the election wards. The sample size was determined by Yamane (1967) formula whereby by using the formula the study discovered 399 respondents as the sample size that will be used. Data collected was primary data obtained from the original sources using self-administered questionnaires. The research also used secondary data from all available resources related to the study. The data was then analyzed where both qualitative and quantitative data analysis was used. The analyzed data was then presented in in forms of graphs and charts. There was a pilot test conducted on the 10% (n=34) of the sample population where the reliability test, KMO and Bartlett's Test, Normality Test, Multicollinearity Test and Homoscedasticity Test was conducted as test for assumptions of regression. The researcher then conducted cross-sectional design statistics such as percentages and frequency of responses after which regression analysis was conducted to give the relationship between the dependent and the independent variables. The study found out that infrastructure was the main factor that affects alternative water supply followed by institutional capacity then urban sprawl. The study established that age of the infrastructure, technological advancement and vandalism is the main reason why most residents resort to alternative water supply. The study also established that weak institutional capacity; conflicts among the existing institutions and inadequacy of the institutions were the main reasons why residents of Starehe constituency resort to alternative water supply. This means that good provision of services is not merely

about infrastructure; it includes the local capacity to innovate and make appropriate choices with regard to governance and the institutional forms for building and managing it.

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LIST OF ABBREVIATIONS

AWSB	Athi Water Service Board
BOO	Build Operate Own
BOOT	Build Operate and Transfer
CBD	Centarl Business District
CCN	County Council of Nairobi
CBD	Central Business District
GDP	Gross Domestice Product
SDG's	Sustainable Development Goals
ENSO	Southern Oscillation
KNBS	Kenya National Bureu of Statistics
NCWSC	Nairobi City Water Sewerage Company
NCBDA	Nairobi City Business District Association
NWCPC	National Water Conservation Pipeline Cooporation
WASREB	Water Service Regulatory Board
WRMA	Water Resource Management Authority
WSRB	Water Service Regulatory Board
M^3	Cubic Meter

CHAPTER ONE: INTRODUCTION

1.1: Background of the Study

Water supply is essential for growth, as well as for social well-being. It is probably the most difficult of all infrastructure services to substitute, and its absence or deficiency represents a particular burden. In the developing world, 2 out of every 10 people lack access to a safe water supply, and 5 out of 10 have inadequate sanitation (Wellman & Spiller, 2012), where this means that worldwide, more than 1.1 billion people do not have access to safe drinking water, and roughly 2.4 billion are without adequate sanitation. Yet even these estimates understate the extent of the access gap. Service is poor, even in many countries that have water supply systems. For many consumers, piped water is often intermittent, and, when available, it is unsafe for drinking. In addition, sanitation facilities are often inadequate, overloaded, in disrepair, or unused (Bakker, 2013).

To improve the situation as specified in the Sustainable Development Goals (SDG's), which aim to reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation by 2030. To achieve these goals, annual investments in water supply and sanitation in developing countries would likely need to double from the historical level of US$15 billion to US$30 billion per year.

The delivery of basic water and sanitation services to all remains as an indispensable and urgent undertaking in Kenya. Kenya's government is dedicated to decreasing the buildup in the provision of services by 2030, in accordance with the objectives set by the Sustainable Development Goals (SDGs). This particular objective has proved obscure predominantly in the informal settlements that are home to more than half of Nairobi city's population, which are

characterized by poverty, punitive living environments, high population concentrations, sub-standard accommodation, and deplorable levels of services.

Water supply and sanitation exhibit performance problems characterized by: low service coverage, high physical water losses, and the generally unreliable quality of drinking water. Many WSP's are poorly managed, operate with tariffs well below cost-recovery levels and are therefore, struggling financially, and lack the governance and resources to improve performance and grow. Even more have not even begun to address the huge financing difficulties in water and sanitation.

Private sector resources are proving to be progressively more significant in helping developing countries to satisfy the mounting demand for public services, especially now that national government funds are becoming scarce. The lack of proper governance has also made it very difficult to set up effective regulatory oversight that can be sustained over time. The time testing of regulatory oversight and other reforms is essential for providing private participation, lenders and sponsors with the assurance and investor confidence leading to sustained capital flows.

But, the private sector has been providing some level of service informally and it is only recently that the private sector has been encouraged to take a share in water supply and sanitation services. Of all municipal services, the delivery of piped water is the one with which the private sector is least involved.

The exchange of private for municipal provision of various products and services has become a global tendency, an aspect that can be construed to be encouraged by the perceptible benefits from appropriately implemented privatization in South America, Asia, and Africa as well as in the developed countries. Denationalization worked to improve local wellbeing in 12 of 13 case studies examined by the World Bank in Argentina, Singapore, Panama, and France. Productivity

went up in 10 of the 13 nations studied and exhibited no reduction in the other 4 countries. Numerous firms the appraised could demonstrate an increase in production and investment. Generally, employment was not less well-off despite the presence of redundancies and early retirements; consumers were satisfied for the most part; an aspect that was characterized by investors in the enterprises making profits in the delivery of these services. Thus, most of the interested parties in the process gained from private sector activities and involvement in the provision of water and sanitary services.

The favorable evidence that is characteristic of interventions by the private sector emanates mainly from involvement in the competitive business world such as manufacturing, agriculture, and retail operations that produce consumer goods and services. It is increasingly difficult to elicit substantiation from prosperous private ownership of businesses that function as normal monopolies for example; water provision, energy or power, and telecommunications and that cover the majority of infrastructure divisions. These businesses tend to be bigger, foreign investment that are more complicated, with capital markets demonstrating waning interest in providing finance or funding such initiatives. Importantly, just like other sectors of the infrastructure, water and sewerage systems in most unindustrialized nations are going through operational, management, and fiscal challenges. They must deal with derelict and leaky water supply infrastructure such as pipes, the inability to fund service upgrades or system extension to fulfill unfulfilled demand and must contend with the prospect of amplified costs levied by strict environmental standards.

The preferences for private sector involvement highlighted can aid the municipal water and sewerage agencies encounter these challenges by fortifying their institutional and management performance. Consequently, this may generate proficiency advances and improved use of

existing resources. The primary private sector mechanisms for direct capital development is characterized by concession arrangements and the BOO (build, operate, and own) and BOT (build, operate, and transfer) models that can be through joint undertakings or independent investments and divestiture procedures. However, denationalization confers certain costs and risks, for example, the risk of capital participation and asset proprietorship by a private capitalist in a BOT arrangement. Additionally, another issue facing private participation is the issue of natural domination or monopoly. The provision of water supply and sewerage services confer natural monopolies that tend to become more effective as they become larger. However, these economies of scale leave behind a little scope for rivalry and customarily led to the public delivery and regulation of these services. In privatizing water and sewerage services, public agencies must strive ensure that they do not rescind their duties to the consumer. Increased private sector activity often demands for augmented public oversight and regulation.

The three main players in the private sector responsible for the provision of water and sanitation services include the private sector, government, and the consumer; the private sector is the newest and most dynamic. Consequently, this research study provides significant consideration to investigating the private sector's approach in the provision of water services, its risk and reward structure, and their specific fiscal requirements. The private sector is perceived by some as a panacea for ending the apparent shortages of investment capital and inefficient operations in water and sewerage services delivery. The private sector can contribute in these areas, but it is important for decision makers to understand the opportunities and constraints that govern the private sector's willingness to participate. To enable the private sector to make a profit, the main and legitimate motivation for its interest in the sector, public managers must create an environment that lowers risks and offers a high probability of a reasonable return on investment.

Private sector capital is fungible across a range of investments by types and by countries and will be attracted by the prospect of the highest returns.

According to Triche (2002), water lubricates capital circulation, a necessary, and yet often invisible precondition to life in modern, industrialized societies. The emergence of an industry dedicated to the mass production of water, and the concurrent conversion of water from an artisanal to an industrial product, tends to occur in urban areas during periods of rapid urbanization. In rapidly urbanizing areas, the limited availability of clean water supplies leads to widespread concerns over water quality and access, as artisanal water sources such as wells, rivers, ponds, streams become increasingly polluted (Triche, 2002). To meet growing demand, water production becomes gradually industrialized, with artisanal methods of collecting and distributing water such as water vendors moving on foot through city streets being replaced by networks of pipes leading from reservoirs to consumers' taps, achieving economies of scale and scope, and enabling higher consumption levels. Surface watercourses, which typically support a multiplicity of uses including transport, trade, drinking water, and effluent disposal are filled in, or covered over in the sense the sense that the water network is, in part, an artifact of urbanization.

Majority of the Nairobi residents being the target group consume piped water, but service delivery varies. Approximately 24 % of residents have a household connection, while an estimated 73 % purchase their water from resellers at water kiosks operated by community groups or individual entrepreneurs, and in some cases from 'mkokoteni' or pushcart vendors (Central Bureau of Statistics, 2005). Water kiosks are the main water sources that are characterized by vendors selling water in 20-liter jerry cans at 2 to 5 KShs each or approximately KShs 100 to 250 per ever meter cubed (m^3). This price is well above NCWSC's average price of

KShs 45/m^3, which includes the lower block tariff of 12 KShs/m^3 applicable to households consuming under 10 m^3 per month. NCWSC's official price for water in informal settlements is a subsidized KShs10/15m^3, although resellers add their own margins and this rate is not always billed accurately. Consequently, informal settlement residents are the highest-paying consumers in the city per cubic meter (m^3). On average, poor non-connected households spend a higher share of their monthly income on water. In Nairobi, as in most African cities, lack of access to modern water services is a contributing factor to poverty since households spend their limited income on expensive water. It is behind this background that this research study seeks to establish private sector approach in provision of water services in the city of Nairobi.

1.2: Alternative Water Supply in Nairobi

Alternative water supply refers to the other multi-actor water operators involved in water supplies in the settlement. The multi actors are small water enterprises that are private operators providing water services in the informal settlements. Oenga & Kuria (2006), argues that alternative water actors would continue to play a significant role in immediate and long-term water services in the settlements. Nairobi County Water and Sewerage Company mainly distribute water services to formal and planned settlements in Nairobi through individual connections. The informal settlements with an approximate 60 percent of the city population are not directly connected to NCWSC water services (Oenga & Kuria, 2006). Water service in informal settlements is delivered by alternative water actors who are mainly connected to the NCWSC water services or source their water from boreholes, wells located in the areas. NWSC has experienced challenges in water connections made to alternative water actors in the informal settlements, with an estimated 50 percent of water pumped by NCWSC into their pipeline going

unaccounted mainly caused by illegal connection, leakages this leads to water shortages and huge revenue losses for the Water company (NCWSC report, 2007).

The capacity to provide water and sanitation by the various actors is already in place as established in the study of (Oenga & Kuria, 2006). Where up to 86% of water in informal settlements is provided by the small water vendors and other alternative water actors. However, challenges still exist in partnership, co-ordination and participation. When water and sanitation service delivery are not well coordinated in informal settlement, accessibility and cost remain high. A need therefore arises on the importance of recognizing the alternative actors, coordination of their efforts and establishment of a collaborative, participation framework for the promotion of partnership, good governance that enhances the delivery of water and sanitation to the residents of informal settlements. Increase in the actors providing water and sanitation in informal settlements does not necessarily lead to increased coverage, competitive prices, good quality services, however increased community participation in the management of water and sanitation services would yield higher benefits for the slum dwellers (Oenga & Kuria, 2006).

A large number of Nairobi dwellers get unsatisfactory, unreliable service from the utility, a number of alternative water suppliers have emerged to address these shortfalls, they include community-based water providers, individual Kiosk operators, well owners, cart pushers among others. The alternative water actors have the ability to supply water in difficult informal areas however their interventions are not well coordinated leading to a vicious spiral of weak performance, limited coordination, duplication wastage, conflict of interest and insufficient funding for maintenance, deterioration of assets, lack of accessibility hence an increase in water costs (K'Akumu, 2011).

The local alternative water actors in settlements are not just passive institutions, however in most instances they are solving their own problems and only require governments to recognize their efforts, harness their energy and encourage the poor to participate in the improvement of their own living conditions and provision of water supplies. Towards this end water service development should entail partnership among the public, private sector and civil society as water, sanitation and human settlements create opportunities for many other creative forms of partnerships. In this endeavor communal action should not be substituted for effective public policy; governments need to take the lead in achieving the commitments that they have pledged to undertake in water supplies. Schwartz and Kariuki (2005) indicates that Small scale private providers of water play a vital role in low coverage areas, especially in difficult-to-access informal settlements which deserve greater attention in terms of regulation and financing.

1.3: Problem Statement

The main problem being addressed by the study is that of poor water supply to the urban residents that is caused by the ageing infrastructure, low equipment capacity to serve the growing population of urban dwellers, low technological advancement levels by the institutions charged by water supply to the residents that rely on very old system of water supply management and vandalism of water pipes by unscrupulous metal vendors. The other problem that negatively affects water supply to the residents is that of institutional capacity where the existing institutions are inadequate to address the water problems and the existence of conflict among institutions on regulations and control of water supply where institutions rivalry make it difficult for certain water policies to be implemented.

Institutional capacity poses a great challenge to the water supply system to the urban centers where weak institutional setting, for example, in the absence of secure land tenure, may make it

difficult to obtain necessary permits to build infrastructure. In some instances, quality information cadastral surveys in newer and particularly informal settlements are often lacking, which confounds the creation of a potential customer base and renders cost recovery more difficult. In bid to counter some of the institutional challenges, communities often have strong internal organizational structures with groups that do not have formal status and thus are often not recognized by the water company or the municipality as legitimate stakeholders. In addition to technical difficulties and institutional weaknesses, logic of rent-seeking and patronage on the part of urban elites often underlies the failure to expand urban services (Triche, 2002).

The distribution of urban population from more densely populated areas to less densely populated areas has made it difficult for the supply of water to certain parts of the urban centers. Some regions with sparse population settlement have made it difficult for water supply due to cost benefit analysis where the water providers avoid less populated areas due to high running cost as opposed to the little benefits that will be obtained. The urban sprawl thus makes it difficult for the water institutions to supply water to new settlement areas due to the geographical coverage cost of the new settlement areas.

Poor implementation of government policies and lack of good will among the stakeholders in the implementation of the existing policies make it difficult for certain part of urban centers to receive adequate water supply. In most cases, the existing water policies are irrelevant and do not address the current needs of the changing world owing to the age of the policy as some were reviewed in more than two decades ago. Due to the changing nature of urban population settlements, some of the policies that exist with the water institutions are not adequate to address water supply issues thus the need for constant review of the existing policies to solve water

supply problems. It is against this background that the study seeks to assess the alternative approaches in the provision of water supply in Starehe Constituency.

1.4: Objectives of the Study

1.4.1: General Objectives

The general objectives of the research study entail assessing the effectiveness of alternative approaches in the provision of water supply in central supply region, zone 1 within Starehe Constituency

1.4.2: Specific Objectives

i. To establish factors influencing the effectiveness of alternative water supply in central supply region, zone 1 within Starehe Constituency
ii. To investigate the level of satisfaction in terms of efficiency, reliability and quality on alternative water supply in central supply region, zone 1 within Starehe Constituency.

1.5: Research Questions

i. What factors influence the effectiveness of alternative water supply in central supply region, zone 1 within Starehe Constituency
ii. What is the level of satisfaction in terms of efficiency, reliability and quality on alternative water supply in central supply region, zone 1 within Starehe Constituency.

1.6: Justification

Nairobi County is the engine of development in Kenya since it holds 5% of her population with production capacity of at least 20%. Hence, there is need to harness access to basic amenities. Yet access to basic services in Nairobi County is still low particularly for water and wastewater.

In this context of increasing the access for water and sanitation, there is a pressing need to prioritize the sector as its resilience directly impacts the county's growth toward the achievement of SDG's, particularly those relating GDP growth, poverty, health, education and gender. Vital methodologies used by the private sectors in bridging water gaps specifically in the city of Nairobi offer solutions to NCWSCo by generating and sustaining various alternative approaches.

Figure 1: Growth Towards Achieving SDG No. 6

To improve quality of services provided, should there be direction in privatization of these utilities by the government through a series of strategies and policy frameworks.

The primary focus of this research was to clearly provide evidence that can guide private institutions especially in emerging organizations in water supply to potentially create the economic, institutional, and policy framework factors for the success in Starehe constituency and

other parts of Nairobi city. This study may be useful for any organization with the intention of indulging itself in the provision of these services. This may provide information on optimal management to be adapted by the organization, challenges and the mitigation measures to be deployed. The information attained may help the organizations involved in water and sanitation in strategic planning and implementation.

1.7: Scope and Limitations of the Study

The study geographically focused on water supply in central supply region, zone 1 within Starehe Constituency in Nairobi County with a total area of approximately 20Sq.KM. Starehe constituency was ideal for this study because it forms the Nairobi Central Business District and demand of water in Nairobi County. The study covered both the informal and formal settlements so as to capture a clear scope to the study

1.7.1: Limitations of the Study

i. Collection of reliable data on the water and sewerage sector is difficult because reporting is often incomplete. These data only assess the availability of water and sewerage infrastructure within the country and its progress towards achievement of the SDG'S and does not necessarily assess key factors affecting the provision of the service such as, efficiency, quality, affordability and reliability.

ii. The inability of residents to easily volunteer information especially on the rampant incidences of illegal water connections. The residents of the informal settlements have experienced research fatigue due to many research activities carried out in the

settlements. This proved to be quite a challenge as most of them demand for payment in exchange for information.

1.8: Operational Definition of the Terms Used in the Study

Alternative Sources: refers to the other form of sources as compared to the normal ones

Alternative water supply: refers to the other multi-actor water operators who are the private sectors involved in water supplies in the settlement.

Water Supply: refers to a means of distributing of water through reservoirs, tunnels and pipelines to households, industries or institutions.

Water Kiosks: These are booths for the sale of tap water. They mostly receive treated water from utilities through a piped distribution network and act as access points for water users in areas without individual housing water service

IWRM: is a process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

CHAPTER TWO: BACKGROUND INFORMATION ON THE STUDY AREA

2.1: Introduction

This chapter examined the background information of Nairobi city water system and its operation and management. It will focus on the water resources, the access to Nairobi water, the supply of water, sewerage system, responsible arrangements for water and sewerage, service provision, policy formulation and sector coordination and the financial aspects. These will provide necessary information of the Nairobi city water and sewerage system that have been studied by other researchers and scholars. Its aim is to providing necessary information about Nairobi city water and sewerage system that aids in the study.

2.2: Locations and Size of the Study Area

The study site is Nairobi where the study focused on Nairobi residents in Starehe Constituency. Starehe constituency is a high - low-income area with both formal and informal settlements in central Nairobi. It has an estimated population of two hundred and ten thousand, four hundred and eleven (210,411) (KNBS, 2019) out of the total population of 47.6 million. It is centrally located in Nairobi with five locations, namely: Ngara, Kariokor, Central, Mathare, and Huruma. The same locations are equally represented by Members of County Assembly (MCA). Her neighbors to the north, Kasarani, to the west Westlands, Kamkunji in the east and, to the south by Makadara Constituencies; all being urban administration regions characterized by both commercial and residential population. All these are served by provincial and civic boundaries, which influence the allocation of CDF funds as the criteria being the poverty index of each area.

2.2.1: Climate

Nairobi has a subtropical highlands climate. It is located close to the eastern edge of the East African Rift Valley at an altitude of roughly 1800 M above sea level which strongly influences its climate. Nairobi receives just over 610 mm of rainfall a year occurring primarily in two rainfall seasons. The long rains from March and May, which generally records around 310 mm, and the short rains during November – December, where around 200 mm is recorded. Rainfall does also occur during January and February but is much less than the two core seasons (80 mm). A relatively dry period lasts from June – October (Urban Africa Risk Knowledge, 2017)

Rainfall varies quite strongly from year to year. The annual (July-June) total rainfall varies from around 300 – 900 mm/year, though during the extreme years it can be much higher, such as the 1997/8 year which recorded 1400mm of rainfall. Rainfall over Nairobi exhibits variability on the multi-year timescale. Some of which is related to large scale remote forces such as the El Nino Southern Oscillation (ENSO), with El Nino conditions generally being associated with above average rainfall and La Nina conditions to below average rainfall during the short rains. There is little evidence of clear or statistically significant trends in the rainfall over the last 30 years.

Temperature at Nairobi displays variability at a number of time-scales. The most obvious being the daily diurnal cycles where temperature varies by almost 12 °C. Temperature also changes though the year, but because of Nairobi's location just south of the equator, the seasonal cycle is relatively small with daily maximum temperature varying by about 6 °C and daily minimum temperature varying by around 5 °C. The long term (1981-2010) average daily maximum temperature is warmest during January – March (27.5 °C) with a secondary peak during September – November (26 °C), which corresponds to the start of the rainy seasons. Daily maximum temperature is coolest during June – August (22.5 °C). The seasonality of long-term

(1981-2010) average daily minimum temperature generally follows that of rainfall, with warmest night-time temperatures occurring during March – May (15 °C) and November – December (14.5 °C) and coldest night-time temperatures occurring during July (11.4 °C) (Urban Africa Risk Knowledge, 2017)

2.2.2: Geology

The rocks of the Nairobi area mainly comprise a succession of lava sand pyroclastics of Cainozoic age overlying a foundation of folded Precambrian schists and gneisses of the Mozambique Belt. The crystalline rocks are rarely exposed but occasionally fragments are found in agglomerates derived from the former Ngong volcano. For the period between late Precambrian and Tertiary times no geological record exists in central Kenya except that the area is known to have undergone pen planation on more than one occasion. Volcanicity is genetically associated with tectonic movements attendant upon rifting. Doming, linear warping and erosion of the sub-Miocene erosion surface had taken place prior to the extrusion of the first lava flows which flooded the eastern plains during mid-Miocene time. Subsequently volcanicity continued intermittently until recent time, the area being covered by lavas and pyroclastics from fissure eruptions during the development of the Rift Valley. Two central volcanoes, Ngong and 01 Esayeiti, were also active during this period (Saggerson, 1991)

These rocks form part of a wider East African alkaline suite characterized by a dominance of soda over potash which distinguishes them from the potash-rich alkaline rocks of the Western Rift Valley. Strongly and mildly alkaline series are recognized. The former series is represented by feldspathoid -bearing phonolites, basanites, tephrites and more basic varieties, while the latter includes feldspathoid-free rocks containing soda-rich amphiboles and pyroxenes. Both series

show an increase in silica content with differentiation and include trachytes, rhyolites and obsidians. All formations are covered by deep soils and gravels of Quaternary age. Within the Rift, loess and lacustrine deposits, some containing diatomaceous beds, reflect major changes in climatic conditions. Faulting has affected the western part of the area on at least three occasions, resulting in spectacular topography (Saggerson, 1991)

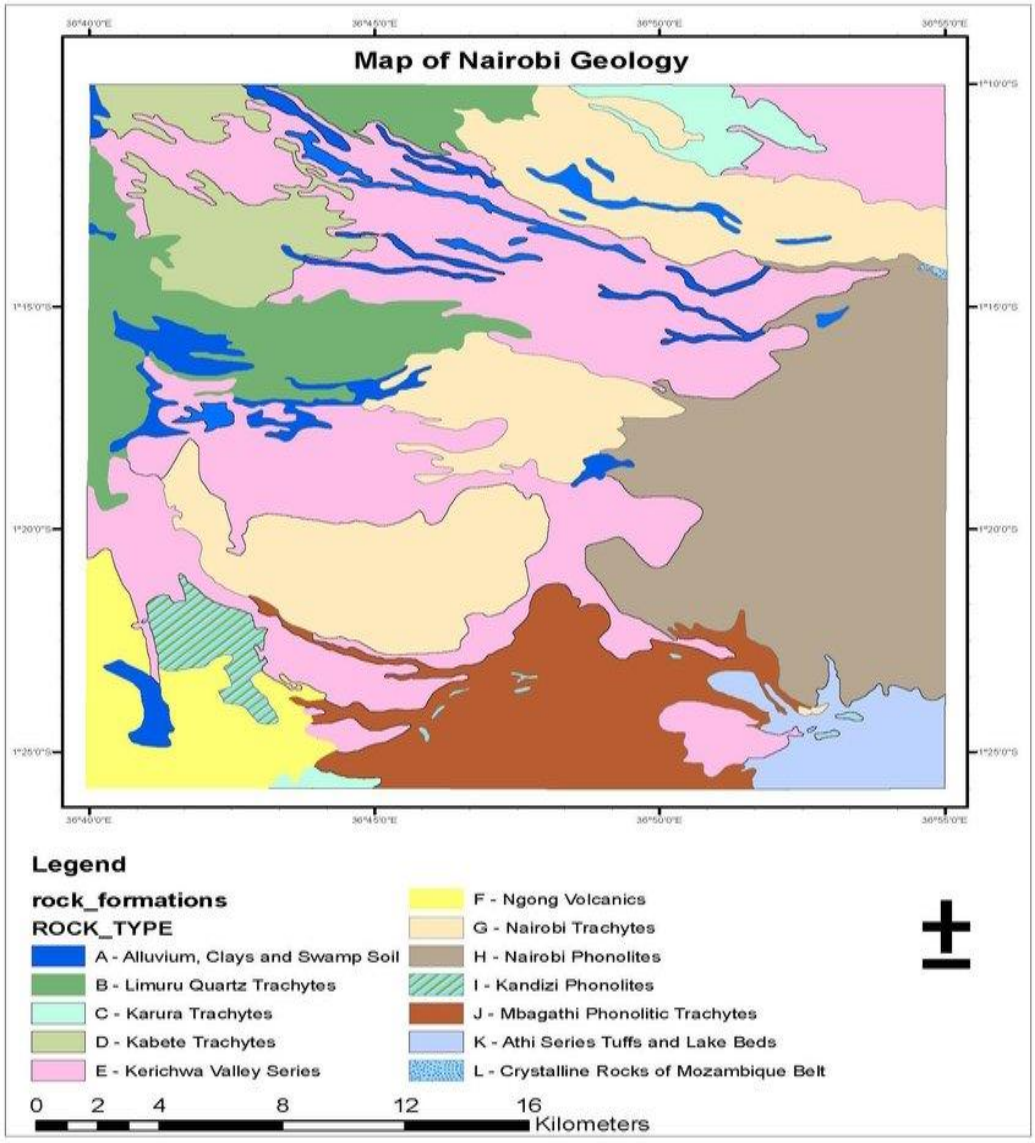


Figure 2: Nairobi Geology

2.2.3: Soils.

Nairobi City is mainly underlain by pyroclastic volcanic rocks that were deposited during the formation of the East African Rift Valley. Some of the volcanic rocks were deposited in aqueous conditions over a long period of time and are therefore intercalated with lacustrine sediments. River valleys and other depressions that existed during the periods of intermittent inactivity were filled with alluvium and clays. At building sites, the alluvium, clays as well as decomposed volcanic tuffs are found to have variable thicknesses and sensitive to moisture. The topography and surface geology of the city are largely the result of the Cenozoic volcanic processes (Onyancha, 2011).

The population of Nairobi has been steadily increasing; human activities have caused large-scale landscape modifications. Formerly sloping grounds have been levelled with fill from construction sites and sold to unsuspecting developers. The increase in population has also caused developers to move to sites with poorer subsoil characteristics such as river valleys, swamps, former springs and dump sites. Due to inadequate knowledge of the geotechnical conditions, constructors are faced with a challenge of change in assumed subsurface conditions revealed during excavation. In some cases, project construction increases underground erosion, disturbs moisture-sensitive soils, and produces construction-related vibration causing distress in some structures (Onyancha, 2011).

2.3: Historical Background of Nairobi

Nairobi is the capital city of Kenya. It is situated in the south-central part of the country, in the highlands at an elevation of about 5,500 feet (1,680 meters). The city lies 300 miles (480 KM) northwest of Mombasa, Kenya's major port on the Indian Ocean. The city originated in the late

1890s as a colonial railway settlement, taking its name from a water hole known to the Maasai people as Enkare Nairobi ("Cold Water"). When the railhead arrived there in 1899, the British colonial capital of Ukamba province was transferred from Machakos (now Masaku) to the site, and in 1905 Nairobi became the capital of the British East Africa Protectorate. From about 1900 onward, when a small Indian bazaar was established at Nairobi, the city was also a trading center.

After independence, Nairobi grew rapidly and this growth put pressure on the city's infrastructure. Power cuts and water shortages were a common occurrence, though in the past few years better city planning has helped to put some of these problems in check. In 1975 Nairobi was the host city of the 5th Assembly of the World Council of Churches. The U.S. embassy in the heart of Nairobi was bombed on August 7, 1998 by Al-Qaida, as one of a series of U.S. embassy bombings. Over two hundred civilians were killed in the embassy and another 213 persons in the surrounding area with more than 5,000 people injured. The effects were widespread and devastating. The embassy was completely destroyed and another forty buildings severely damaged. A seven-story building collapsed killing at least 60 people

As a governmental center, Nairobi subsequently attracted a stream of migrants from rural Kenya that made it one of the largest cities in tropical Africa. It was declared a municipality in 1919 and was granted city status in 1954. When Kenya gained independence in 1963, Nairobi remained the capital. The new country's constitution expanded the city's municipal area; the enlarged municipality is an independent unit administered by the Nairobi City Council. Nairobi is the principal industrial center of the country. The railways are the largest single industrial employer. Light-manufacturing industries produce beverages, cigarettes, and processed food. Tourism is also important. The city is located near eastern Africa's agricultural heartland, and a number of

primary products are routed through Nairobi before being exported via Mombasa. Nairobi also plays an important role in the community of eastern African states; it is the headquarters of important regional railways, harbors, and airways corporations.

The city is well served by roads and railways. The main routes are southeast and south to Mombasa and Tanzania and northwest via the highlands to Lake Victoria and Uganda. Jomo Kenyatta International Airport, 9 miles (15 KM) to the southwest, is one of the chief international airports in Africa. Among the city's architectural landmarks are the Kenyatta International Conference Centre, the Parliament Building and city hall, the law courts, the Roman Catholic cathedral, and the Jamia Mosque. There is also a well-planned commercial center. Nairobi is home to several educational institutions, including the University of Nairobi (founded in 1956 as the Royal Technical College of East Africa), Kenyatta University College (founded in 1972 as a constituent part of the University of Nairobi), Kenya Polytechnic University College (1961), and Kenya Institute of Administration (1961). Other institutions include the Kenya National Archives, the National Museum of Kenya (natural history), the McMillan Memorial Library, and the Kenya National Theatre. Nairobi National Park, a large reserve for numerous mammals, reptiles, and birds, is a popular tourist attraction.

2.4: Recent Developments

Kenya's capital city has risen in a single century from a brackish uninhabited swampland to a thriving modern capital. Modern Nairobi is still the safari capital of the Africa, but the modern world has quickly caught up with the city. A frontier town no more, Nairobi has become one of Africa's largest, and most interesting cities. Nairobi is a city that never seems to sleep. The entire town has a boundless energy and is thriving place where all of human life can be found. This is a place of great contrasts where race, tribe and origin all become facets of a unique Nairobi

character. The city has not lost its sense of the past, with an excellent museum and the historical home of Karen Blixen.

There is a positive correlation between development in the physical, social and policy and regulation aspects of infrastructure and economic development in Nairobi. The synergetic development of these components creates smart city systems which promote smart mobility, smart environments, smart living; sets the platform for smart people and smart governance; and ultimately results in smart economic growth. The emergent smart systems further promote inclusive growth, reduce natural disaster vulnerability and exposure, and improve resilience among the urban poor. Infrastructure development in Nairobi, particularly investments in information communication technologies (ICTs), electricity, and transport infrastructure have been in rapid positive transition. These developments, which have been promoted by a friendly policy framework and hugely benefited from foreign assistance, have largely been beneficial for Nairobi, Kenya's capital. In just under two decades, Nairobi has grown to near universal mobile phone penetration and Internet connectivity is above 60 %. The city is now one of the most important ICT innovation cities in Africa, with several incubation centres, a growing number of ICT professionals and a youthful population that is technology savvy. These developments have opened Nairobi to many economic growth opportunities.

Infrastructure development is a key consideration in the development process. It drives enterprise development in all sectors of the economy. In developing economies, roads, water and electricity form the bulk of public infrastructural needs. According to the Kenya National Bureau of Statistics (KNBS) Economic Survey 2018, the development expenditure on roads grew by 19.2% to Kshs 134.9 bn in 2017/18 from Kshs 109.0 bn 2016/17. The report highlights the state of

infrastructure in Nairobi metropolitan Area, showing that demand for infrastructure in the Nairobi Metropolitan Area has constantly outstripped supply due to the high population growth rate in the capital.

According to the KNBS, Nairobi County has the highest population density at 6,474 people per Sq.KM and growing at 4.1% p.a. followed by Kiambu County with a density of 818 people per Sq.KM and growing at 2.8% p.a. In recent years, the government has increased efforts to enhance infrastructural development throughout the country as shown by the significant National Budget allocation, which recorded a 6-year CAGR of 7.7% from 2012 to 2019.

For the year 2018/2019, the budget allocation to infrastructure came in at Kshs 418.8 bn, which is 13.6% of the national budget. For the Nairobi Metropolitan Area, the total budget allocation increased by a 6-year CAGR of 73.1% over the same period. The government has also created incentives to encourage private sector investments. For instance, the 25.0% tax exemption which allows investors in commercial property who spend on social infrastructure such as power, water, sewer lines, and roads to recover their expenses within 4-years, according to the Finance Bill of 2012. The analysis revealed that a large number of infrastructure projects are concentrated in Nairobi County followed by Kiambu County. With the exclusion of Nairobi County, Kiambu County had the highest percentage of paved roads at 16.0%, Murang'a at 9.7%, Machakos at 6.9% and Kajiado had the lowest at 5.9%.

With the increased disbursements of funds for roads development, construction of over 1000 KM of roads within the Nairobi Metropolitan Area has been underway, with Murang'a County having the longest kilometres of roads under construction at 29.0% of the total road projects. In terms of value, Nairobi has the highest value of investments in roads at 53.2% of the total

amount investments, as most of the roads under construction are class 'A' roads. A total of 1,839.6KM of roads are currently under construction within various counties in the Nairobi Metropolitan Area.

On rail transport, the report shows that use of rail transport is still low in Kenya accounting for only 0.5% of the value of output from the transport sector in 2017 compared to roads at 62.9%. The total Nairobi Metropolitan Area railway network coverage is 206 KM, consisting of 75 KM and 15 railway stations within Nairobi County, and 131 KM and 5 railway stations within Kiambu County. On sewerage connectivity, statistics from the World Health Organization shows that only 3% of Kenya's population had a sewer line connection by the end 2016. Nairobi City, with the highest sewer connectivity, currently has 162.7 KM of sewer lines covering its area of 695 Sq.KM.

However, the existing sewer infrastructure in Nairobi serves areas such as Kilimani, Kileleshwa, and the CBD, leaving a majority of the city residents who live in low-end areas such as in the informal settlements with no access to sewer lines. Kiambu County only has 11KM of sewer line serving its total area of 2,543.4 Sq.KM, while Mavoko sub-county currently has only 31.1KM of sewer lines serving its 963 Sq.KM total jurisdiction. Kajiado County also suffers from the same predicament, with none of its towns having sewerage connections, a situation that in September 2018 led residents of Kitengela to unveil plans to build their own sewer line.

In Murang'a County, only Murang'a town has access to a sewer, with other towns such as Kangema, Kenol and Maragua lacking sewer connectivity. Average sewer coverage in Nairobi Metro Area is 17% while in Nairobi it is 50%. With the growing population, and urbanization particularly in satellite towns in Kiambu, Machakos and Kajiado Counties, concerted efforts

have been made to improve sewer connectivity, with various projects being initiated mainly by the Athi Water and Sewerage Services Board. Kiambu and Machakos Counties have the largest share of proposed sewer projects at 65.5% and 23.9%

According to the Kenya Power Financial Report (2017), the Nairobi Metropolitan Area consumes more than 50.0% of Kenya's electricity supply. Nairobi Region which includes Nairobi, Kiambu, Machakos, Makueni and Kajiado, recorded the highest electricity consumption in 2017, accounting for 55.0% of the total Kenya Power purchases according to Kenya Power. Infrastructural development has been the tool for opening up previously inaccessible areas and improving connectivity which attracts investment. Investment in infrastructure has been proven to increase demand for property prices. For instance, land in areas along major highways registered consistent price appreciation, with an average 5-Year CAGR of 15.8%, signalling increased demand for the properties. The Centre for Affordable Housing Finance in a report, states that infrastructural costs in Kenya account for approximately 25.6% of construction costs. By providing infrastructure, therefore, the government provides an impetus for real estate developers to develop more affordable units, as the cost of construction reduces considerably.

2.5: Population and Demographics

Nairobi is the capital of Kenya, which is located in Africa. In addition to being the capital, Nairobi is also the country's largest city by population. The last official population was taken in 2009 and at that time was 3,138,369 in the city proper. That number has since grown to approximately 3.5 million. The metro area has over 6.5 million residents. This "Green City in the Sun" has a history dating back to 1899 and continues to grow as rural residents make their way to this big city for employment opportunities. The city of Nairobi is growing consistently and

currently sprawls over a surface area of 696 Sq.KM. This area size - in combination with the total number of residents - brings us the current population density which is now approximately 4,850 residents per Sq.KM (12,600 people living per square mile).

Nairobi is one of the fastest growing cities in Africa, quickly becoming the second largest city of the African Great Lakes. The city is growing at a rate of over 4% annually, primarily because of the high birth rates and immigrants that come to Nairobi searching for employment opportunities. It is estimated that the city will continue on its upward trajectory in terms of population, reaching 5 million in 2025. Nairobi's 2019 population is now estimated at 4,556,381. In 1950, the population of Nairobi was 137,456. Nairobi has grown by 642,869 since 2015, which represents a 3.88% annual change. These population estimates and projections come from the latest revision of the UN World Urbanization Prospects. These estimates represent the urban agglomeration of Nairobi, which typically includes Nairobi's population in addition to adjacent suburban areas.

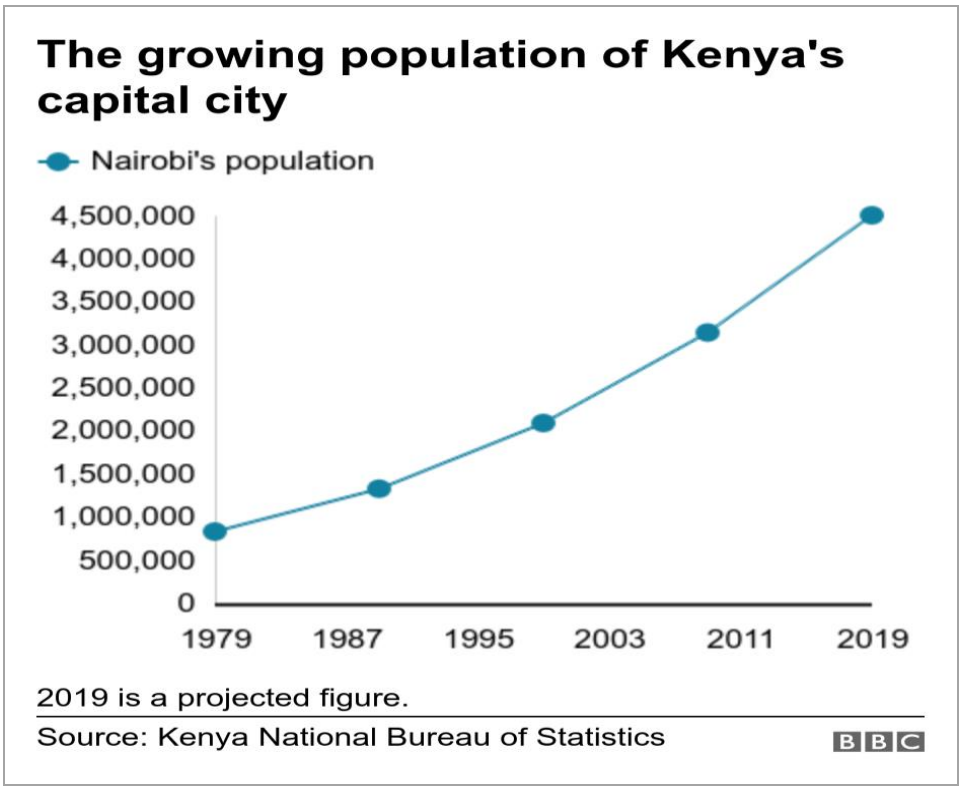


Figure 3: Nairobi Population

2.6: Water Demand in Population

Nairobi City Water and Sewerage Company (NCWSC), owned by the Kenyan Government, provide sewerage and water services in Nairobi. Nairobi's daily water supply is currently estimated at 580,000 cubic meters per day, against a daily demand of 750,000 cubic meters. Less than 50 per cent of Nairobi's residents have direct access to piped water, of which only 40 per cent have daily access to running water. Only 22 per cent of residents of the informal settlement, home to 60 per cent of Nairobi's residents, have access to piped water. Urban water demand modeling plays an important role in efficient planning, design and development of water supply systems. In order to ensure reliable water supply to the resident s of a city, an accurate estimate of future water demand is necessary. This estimate can help in planning a cost effective and

reliable infrastructure expansion, developing alternative water supply sources and incorporating water demand management programs (House-Peters & Chang, 2011).

Different households with different life-style, and different access to water, have different water needs. Hence, it is "normal" that water supply is designed in a way that provides more water to certain than others. However, in Nairobi, the better off consume more than designed for and the poor are delivered less than their designed level. 40% of the distributed water is supplied to the 7% biggest consumers and the 45% smallest consumers share 15% of water available. In other terms it seems that in Nairobi, the wealthy have such a demand that it creates a water shortage of which the cost is mainly born by the less privileged people.

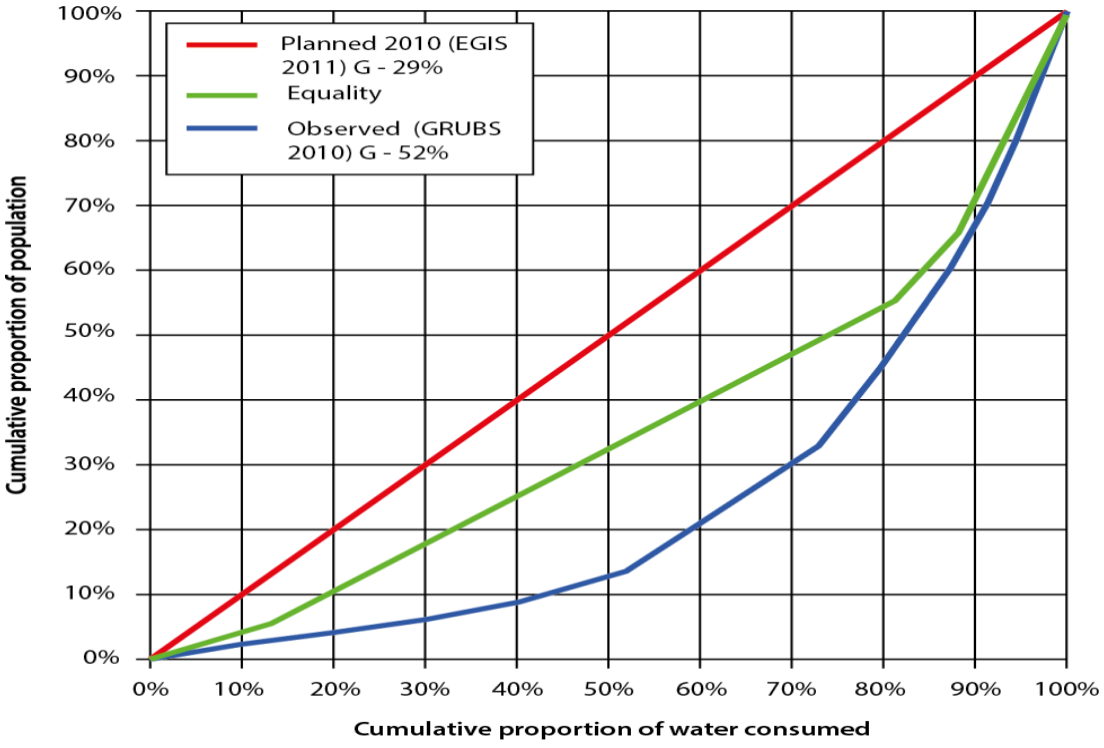


Figure 4: Nairobi Water Demand

2.7: Water Resources

Water shortage in Kenya and in many other African countries is not a new phenomenon. Despite the wealth of natural resources in Africa, the continent is the world's second – driest continent. In Kenya, 17.3 million people lack access to safe water, with 32.7 million lacking access to improved sanitation. The Nairobi water utility NCWSC says it has stringent water quality monitoring programs to ensure the water they supply the city is safe for drinking. However, due to high leakage in the network and intermittent supply treated water is sometimes re-contaminated before it reaches the tap (GoK 2007). According to the Water Sector Regulatory Board, in 2009/10 only 76% of drinking water samples complied with standards for bacteriological quality, a level deemed unacceptable by the regulator. This was the case despite a high level of chlorination that was deemed acceptable by the regulator with 91% of samples complying with the norms for residual chlorine. Also, sometimes water is contaminated because of pipe bursts. For instance, over 10 fatalities from water borne diseases were experienced in the slum Mukuru kwa Njenga in 2009. Those who can afford it boil or filter water before drinking it or buy bottled water. Those who cannot afford this are forced to take their chances with tap water (GoK 2007). Nairobi residents receive water through the piped network and pump water from their own deep wells. Water supply from both sources is about 570,000 m^3/day. If one considers that the population of Nairobi swells to 5 million during daytime, this corresponds to less than 120 litres per capita per day before distribution losses. However, water is not equally distributed: Wealthier users with access to piped water use much more than average, while those without access to piped water receive much less. Half of Nairobi's population lives in slums, and consume 34,500 m^3/day corresponding to less than 20 liters per capita per day. The heavily

polluted and relatively small Nairobi River that flows through the city is not used for drinking water supply (Jamah, 2010).

Following the reports by NCWSC (2019), the flow into certain City estates and particularly the Eastlands areas is affected by the different water supply challenges encountered during the Company's operations. This include; Nairobi Water demand is 790,000 m^3 against the installed production capacity of 525,000 m^3 /day, leakages due to old infrastructure and pipe interference, illegal connections, vandalism and catchment degradation among others. As a long-term solution to the water shortage and to meet the ever-growing demand, the utility is banking on Implementation of Northern Collector Tunnel (NCT) that will inject an additional 140,000 m^3 /day to the city by 2020 and Karimeno dam which is anticipated to produce 230,000 m^3 /day. Other measures include renewal & upgrade of old water supply infrastructure, encourage rainwater harvesting, reduction of Non-Revenue Water as well as catchment protection.

The Nairobi utility receives 94% of its water from the Tana River basin north of the city through three reservoirs: the Sasumua Dam on the Chania River, the Thika Dam and the Chania-B Dam. The Thika Dam is the largest, supplying 225,000 m^3/day. Water from the reservoirs is treated in two treatment plants, including the largest one in Ngethu. The remaining 6% comes from local sources: The Kikuyu Springs and the Ruiru Dam are both located at the Athi River Basin and whose water is treated in two smaller treatment plants. The spillway of the Sasumua Dam has been badly damaged during the 2003 El Nino floods. The spillway was rehabilitated between 2009 and 2011 with financing from the French Development Agency at a cost of 65m Euro (AWSB 2010).

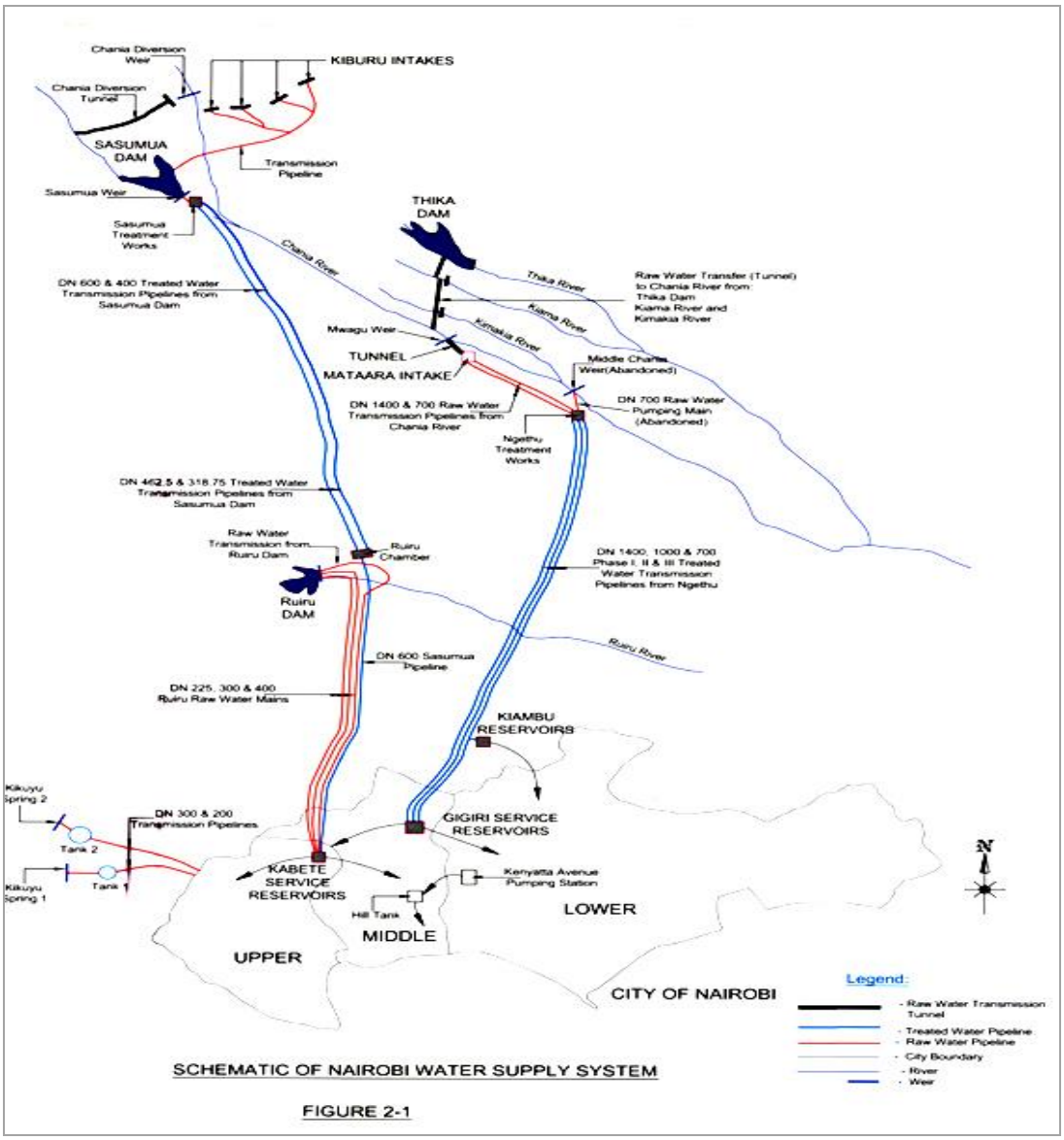


Figure 5 : Schematic of Nairobi Water Supply System

Groundwater supplies an additional 85.000 m^3 per day or more from an estimated 3000 boreholes, up from an estimated 2250 boreholes in 2001. The groundwater table has declined; in one well it declined by 40 meters between 1958 and 1996. The average depth of new wells in 2001 was 238 meters. In that year 97 new wells were drilled because of a drought (Kariuki and Schwarz 2005). Most wells are operated by industrial enterprises, hotels, farms for flower

production in greenhouses, and private houses in parts of the city that receive only intermittent supply (e.g. Langata and Karen). Groundwater is also used to irrigate gardens and to supply tankers that resell the water. Many private well owners are also connected to the mains water supply network and use groundwater as a back-up supply. Natural groundwater quality is good. There are few data on whether the aquifer has been polluted or not. At the height of another drought in 2008/2009, Athi Water Services Board drilled over 40 emergency boreholes in various parts of the city and connected them to the distribution network (NCWSC, 2017).

2.8: Access and Demand

The Kenya government development plan, 1974 sought to ensure safe water to all households by the year 2000. The government established many different plans along the way to manage water effectively, such as the National Water Conservation and Pipeline Corporation (NWCPC). By the year 2000 the NWCPC was managing piped water systems in Kenya which served about 3.8 million people. But the government experienced budget problems along with poor managements and it could not be able to meet its goals by the year 2000. Related to the government's mismanagement is a problem of private investors not willing to provide water services in Kenya (Marshall, 2011).

Water supply in Kenyan cities is highly inequitable. Over 50% of the urban poor, living in slums, have no access to safe drinking water and end up paying vastly more for municipal piped water. Autonomous quasi-government water companies provide water in towns, but their water supply capacity is insufficient to cover the urban needs. These water providers have been privatized to increase resource mobilization and investments (WASREB, 2008). As per Kenya's National Water Services Strategy for 2007-2015, only 60% of households in urban areas have access to safe water. In the low-income settlements where a majority of the urban poor live, only 20% of

the population have access to safe water, exposing them to relatively high tariffs charged by water vendors. These settlements are also bedeviled by poor hygienic conditions owing to low coverage and the dilapidated state of sanitation facilities. The poor state of sanitation poses risk of pollution to water sources from which most of the informal settlements draw water (WASREB 2008):

In the slums of Nairobi, water is frequently scarce, sometimes costly, and its supply uncertain. On good days, collecting water for household people spend about an hour going to a nearby vendor with water, queuing up, and then walking home with 44 lb containers carrying water on their heads (Brocklehurst *et al.* 2005). They make multiple trips to get sufficient water, particularly for laundry. On bad days, collecting water can take several hours. One estimate suggests that households spend 20% of their income on water (UNDP 2006). Women interviewed say they frequently curtail clothes-washing, often postpone baths, and sometimes have fewer meals, when water is unavailable or unaffordable. One corner, wall or under-table space of each 10 ft by 10 ft, mud wall and tin-roof dwelling have multiple containers in which water can be stored. With uncertain access to water, each household has to store water within the house.

Private water vendors - also known as the "other" private sector (Solo, 1999) - are informal and/or small-scale operators who provide water (and sanitation) services in mostly low- and middle-income neighbor hoods. They operate apart from the government and may even be illegal. They have a generally negative image, usually cast as "the 'bad guys' who charge usurious rates". However, there are many types of small-scale entrepreneurs in the water and sanitation sector other than the young men transporting two or more 20-litre jerry-cans of water on their bicycles and selling it at high prices during the dry season (Ahlers, 2013)

2.9: Water Supply

The bulk of water supply for Nairobi comes from Thika, Sasumua and Ruiru Dams, as well as the Kikuyu Springs. Over time water supply for the city has failed to meet demand. The current estimated water demand for Nairobi is 650 000 m^3/day compared to the production of 482 940 m^3/day (WRMA 2010). The difference between production and demand has been widening over time due to population growth, inadequacy of the carrying capacity of the distribution network and climate shocks. Water supply and sanitation in Nairobi is characterised by achievements and challenges. Among the achievements is the expansion of infrastructure to keep pace with population growth, in particular through the construction of the Thika Dam and associated water treatment plant and pipelines during the 1990s; the transformation of the municipal water department into an autonomous utility in 2003; and the more recent reduction of water losses – technically called non-revenue water – from 50 to 40% (WRMA 2010).

Challenges in water supply include poor quality and intermittent water supply (only 40% of those with house connections receive water continuously), the loss of storage capacity in reservoirs behind dams through siltation accelerated by erosion in the Aberdare Range, lack of access to adequate sanitation in slums where half the population of the city lives, blockages of sewers resulting in overflows, and unused capacity in the city's largest wastewater treatment plant in Dandora. Another problem is political infighting and corruption, leading to the firing of the entire Board of the Nairobi Water Company in 2009 (UNHABITAT 2010). The source of the first piped water system of Nairobi was the Kikuyu springs and the Kabete treatment plant developed in 1906. This was followed by the Ruiru dam in 1936 and the Sasumua Dam on the Chania River in 1945, both located in the Aberdare Range north of Nairobi, as well as local deep wells. In the 1970s these sources were not any more sufficient to supply the growing city during

the dry season and financing for a new and larger dam, the Thika Dam, was mobilised to alleviate growing water shortages. The dam and the associated pipeline and water treatment plant were financed by the World Bank, the African Development Bank, the European Investment Bank and the Japanese OECF. Gross water availability increased from 165 litres per capita and day in 1976 to 200 in 1995. When the Thika dam came on stream the last wellfield used by the city for piped water supply was closed down so that the city began to rely exclusively on surface water (UNHABITAT 2010).

In parallel with the tapping of new water sources, efforts were undertaken to reduce water distribution losses by introducing a metered zoning system. According to a World Bank evaluation the system allowed to "significantly reduce water losses". In 1998 non-revenue water, which includes physical losses as well as administrative losses such as illegal water use and under metering, had thus been reduced to 27–30%. However, water losses subsequently must have increased again, because in 2010 the Nairobi Water and Sewer Company declared that it had successfully achieved a reduction of non-revenue water from 50 to 40%. The regulatory agency WASREB estimated non-revenue water in Nairobi at 40% in 2008/09 and at 42% in 2009/10 (UNHABITAT 2010)

A particular challenge in Nairobi has been and still is how to provide sufficient and affordable water to half its population living in slums. Since the 1970s slum residents with piped water connections have built water kiosks where they resell water to other residents in buckets. The number of water kiosks in slums increased from about 150 in 1978 to nearly 1,500 in 1994. The municipal water department recommended a resale price but could not enforce it so that the poorest end up paying much more than those fortunate enough to have a tap in their house. Another challenge is sanitation. A sewer system for the central district was built in the late

colonial period and the first wastewater treatment plant was completed at Kariobangi just east of the city in 1961, shortly before independence. A second wastewater treatment plant was commissioned in 1980 in Dandora further East and further downstream on the Nairobi River (UNDP, 2006).

In 1994 a substantial expansion of the plant was completed, making it the largest plant of its kind – a stabilization pond plant – in Africa. In parallel, an effort was made to expand the sewerage system. With the new infrastructure the discharge of liquid waste in open drains declined considerably and for a period between 1987 and 1995 the water quality of the Nairobi River improved. However, the discharge of untreated wastewater in non-sewer areas continued. Because of inadequate garbage collection and poor maintenance sewers became clogged and overflowed, so that the benefits of the sewerage were less than expected. Furthermore, the Kariobangi plant was poorly maintained and stopped functioning so that the wastewater bypassed it and was discharged without treatment to the Nairobi River (AWSB, 2009).

2.91: Sewerage

According to WASREB's Model Water Services Regulation, sewerage consists of structures, pipes, valve, meters sewers or other accessories used in the conveyance through the sewer reticulation system and treatment at the treatment plant. Provision of sewerage services in Kenya dates back to the colonial period, the time during which most sewerage, currently in use, were designed and developed. The provision of sewerage services has been however, characterized by such challenges as lack of legal framework, disjointed and overlapping policies, old and inadequate infrastructure, lack of connection networks and the poor performance of utilities. Further, the capacity of sewerage service provision has been stretched by rapid population growth and urbanization that has affected major towns. (WASREB, 2011)

The Nairobi City Water and Sewerage Company (NCWSC) was incorporated in December 2003 under the companies Act, Cap 486. It is a wholly owned subsidiary of the City Council of Nairobi (CCN). It has its headquarters at Kampala Road, Industrial Area with five Regional centers at Karen- Western, Nairobi Dam – Southern, Eastleigh – Northern, Kariobangi – Eastern and Charan Centre – Central. The Company's formation arose from the enactment of the new Water Act 2002, created new institutions to manage water resources and services in Kenya.

The Company took over the provision of water and sewerage services within Nairobi and its environs hitherto provided by the Water and Sewerage Department of the CCN. The company was appointed by Athi Water Services Board (AWSB) provide Water and Sewerage services to its residents under the terms of the service provision agreement (SPA) with the aim of ensuring adequate and quality supply of water, affordable tariffs, maintenance and improvement of water and sewerage infrastructure. There was also a tripartite agreement between the CCN, AWSB and NCWSC by which 8 AWSB leased assets of CCN in line with the requirements of the Water Act 2002 which AWSB the right to acquire the full use of those assets. Other agreements include those for agency and operational assets between the CCN and NCWSC.

2.10: Responsible Arrangements for Water and Sewerage

The existing sewer network of a total length of about 163 KM only covers an area of about 208KM^2, which is less than 30% of the 696 KM^2 area of the city. It is unclear what share of the population is connected to the sewerage system: Estimates vary from 10 to 48%. There are two wastewater treatment plants in Nairobi: The Dandora stabilisation ponds treat industrial and domestic sewage and have a design capacity of 80,000M^3 per day. The Kariobangi wastewater treatment plant has a capacity of 32,000 m3 per day and uses the trickling filter technology. The

effluent from both plants is discharged into the Nairobi River (Karanja, 2011). The responsibility for water supply and sewerage in Nairobi is shared between an asset holding company, AWSB, and an operating company, NCWSC that operates under contract with the AWSB. 10 other Water Service Providers (WSPs) operate under the AWSB in localities near Nairobi that are located outside of Nairobi county. Service standards are set and monitored by a national water regulatory agency called Water Services Regulatory Board (WASREB) (Water Services Regulatory Board, 2012). The 10 WSPs under contract with the AWSB operate water and in some cases, sewer systems in towns around Nairobi. They are the Kiambu Water & Sewerage Company, Gatundu South Water & Sanitation Company, Karimenu Community Water & Sanitation Company, Gatanga Community Water Project, Limuru Water & Sewerage Company, Kikuyu Water Company, Ruiru Juja Water & Sewerage Company, Runda Water & Sewerage Company and Githunguri Water and Sanitation Company. Some of them are private, such as Runda Water and Sewerage Company that provides piped water to the housing estate of Runda (UNHABITAT 2010)

2.10.1: Policy Formulation and Sector Coordination

The Government of Kenya is committed to ensuring the realization of the constitutional requirement to the right to water according to national water policy 2012. Nevertheless, through this policy and the collective commitment of water sector stakeholders, the government is determined to meet its obligations. This policy also considers obligations of the country with regard to regional and international arrangements related to water resources management and environment. The country has only five water towers (GOK 2012) which are faced with severe degradation due to anthropogenic activities. Without their protection and conservation, the ecosystem services and water security in the country would worsen having a negative effect on

the economic development of Kenya and the living conditions of its population. The government regulations on water include environmental which is administered by NEMA (NEMA, 2012)

The National Policy on Water Resources Management and Development Sessional Paper No. 1 of 1999 and the Water Act of 2002 spearheaded these water sector reforms. One of the main objectives of the National Water Policy of 1999 was preservation, conservation and protection of available water resources and allocation in a sustainable, rational and economical way. It also sought to enhance the supply of good quality water in sufficient quantities to meet various needs and alleviate poverty while ensuring safe disposal of waste water and environment protection. The Policy was also meant to establish an efficient and effective institutional framework to guide development and management of the water sector as well as develop sustainable financing system for effective water resources management, water supply and sanitation development. (Water act, 2002)

The policy advocated for decentralization of operational activities from the central Government to other actors, including local authorities, the private sector and increased involvement of communities in order to improve efficiency and sustainability in service delivery. The Sessional paper further addressed water supply and sanitation development, the institutional framework and financing of the water sector thereby proposing the amendment of the Water Act Cap 372 to enable it to be consistent with the provisions. It was clear that with the passing of the Water Act (2002) and consequent water sector reforms, the Government committed itself to adopting a human rights-based approach in the water sector. (Water Act 2002)

The new water policy redefines the role of government to focus on policy and regulatory functions while delegating the implementation and provision of water resources to private sectors

and community-based groups such as water resources user associations and self-help groups. To substantiate the fundamental role played by water in development, various developmental goals and plans have also had it included for instance, the Millennium Development Goal target 7c, intends to halve the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015.

2.10.2: Regulation

Appropriate regulatory frameworks and institutions at national level to oversee water and sanitation services provision are essential to operationalize national policies, protect property rights, and generate equitable returns on private investments through efficient tariff structures and levels, service standards, and expansion targets. When responsibility is delegated to local bodies for provision of services, an appropriate distribution of roles between national and local authorities is essential and should be clearly defined. Also, partnering with private sector will entail a stable and predictable regulatory regime that promotes essential values, such as independence in legislation, accountability, transparency and professionalism in the process. One of the main tasks of the regulator is to nationally standardize operations of water utilities to ensure fair competition and guard against monopolies and cartels. Access to information for monitoring quality and levels of service is a key area of concern for regulatory agencies (Crow & Odaba, 2010)

The Water Services Regulatory Board (WASREB) was created to set standards and regulate the sub-sector while the Water Appeal Board (WAB) was mandated to adjudicate on arising disputes. Seven Water Services Boards (WSBs) were also created to be responsible for the efficient and economical provision of water services. Water supply regulations have recently been reviewed in the Water Act 2002. The New Act provides for the establishment of a Water

Services Regulatory Board (WSRB), which in effect paves way for private sector participation in water sector as Water Supply Providers (WSPs). WSRB will be responsible for licensing WSPs for setting and enforcing water supply standards and giving guidelines on setting the prices of water. The main thrust of establishing the WSRB is the empowerment of water consumers and creation of opportunities for private sector participation in the water sector, either as partners or as principal agents. Through the WSRB, water consumers can lounge a complainant against WSPs and penalties levied to the WSPs. Depending on the nature of the offence, WSRB can transfer the license to another WSP (Water Act, 2002). Selection of most suitable contender for water supply provision will be based on competitive bidding criteria. (WASREB, 2009)

Water in Nairobi is rationed. Traders in Nairobi were told by the water company some years ago to expect water supply for three days out of seven. Different estates of Nairobi expect to have water on different sets of days. When there are shortages in the reservoirs supplying Nairobi, this may be reduced further. For example, in August 2008, the Director of Nairobi Water Company told the Standard (2008) that low water levels at Ndakaini dam, due to the failure of the rains, were to blame for shortage at that time. Traders have responded to rationing in at least one way which tends to reduce the scarcity. Larger water traders interviewed described without hesitation their connections to several of the mains pipes going through or adjacent to Nairobi town. (Interview, August 2008).

2.10.3: Asset management

The Water Resource Management Authority (WRMA) is a state corporation under the Ministry of Water and Irrigation established under the Water Act 2002 and charged with being the lead agency in water resources management. Gazetting water schemes to be state and community owned, establishing Catchment Management Strategies (CMS) and Collecting water use and

effluent discharges. In order for WRMA to undertake its stipulated responsibilities, the Act provides for decentralized and stakeholder involvement. This will be implemented through regional offices of the Authority based on drainage basins (catchment areas) assisted by Catchment Area Advisory Committees (CAACs). At the grassroots level, stakeholder engagement will be through Water Resource User Associations (WRUAs). Duties of WRMA include catchment protection and conservation, gazetting water protected areas and delineation of catchment areas.

In Nairobi, the Water Act of 2002 recognizes the need to promote integrated water resource management through the involvement of various stakeholders. In pursuant to Section 15(5) of the Act, the Catchment Management Strategy is meant to encourage and facilitate the establishment and operation of Water Resource Users Associations (WRUAs) for co-operative management of water resources. The involvement of stakeholders in water resources conservation is supported by Cremers *et al* (2005) who considered this action to be central in improving access, development and use of water resources. In spite of the rising demand for water, very little is being done to conserve water especially in the urban areas of Kenya due to financial constraints, lack of knowledge and lack of technology (Ngigi *et al*., 2008). To avoid this situation there is need to educate people in various water conservation techniques and also conservation of the environment in general. (Mwangi *et al.,* 2015) established that the first priority any community needs is accessing clean drinking water followed by water for livestock, then water for crop production and finally water for other activities like pottery, recreation and transport, among others.

2.10.4: Service Provision

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 (WHO, 1999). The mandate of the company is to provide clean water services to the residents of Nairobi county in a finically sustainable way within the laid government regulations. By the end of 2015, NCWSC had 280,000 connections, this is projected to increase to 400,000 by 2018/19, (NCWSC strategic plan 2014/15). The Nairobi county has a measured area of about 7000KM^2 at the south eastern end of Kenya's agricultural heartland. The city enjoys tolerable temperatures year around two distinct rainfall seasons, the long-term and short-term rainfall (CBS 2001, Mitullah 2003).

Treatment and maintenance are also key factors for the safety of water supply. Common challenges that face many piped water supply systems include contamination of source by industry, agriculture and municipal activities, old and deteriorating treatment works and distribution systems, demand for water outstripping supply, the increasingly recognized problem of treatment-resistant pathogens such as Cryptosporidium and fear over toxicity of disinfection by-products. A further factor is the development of bio-films within the distribution network. These are nutrient rich collections of micro-organisms which provide an environment favorable to pathogen survival inside pipes. Intermittent water supplies can result in water being effectively unavailable for hygiene purposes. Often households need to store water. Domestic water storage vessels are the main breeding sites for vectors (Gemon, 2008).

Intermittence is also associated with changes in pressure within distribution networks which can lead to materials being drawn in through fractures in the pipes. This can then lead to secondary contamination of the water supply, depending on levels of residual chlorine. Similarly, where water is collected from non-piped sources, the nature of water storage and treatment are both important. Pathogens from outside the immediate household are more hazardous than those routinely found within the household. Therefore, it is more important for water quality interventions to safeguard the quality of the water source rather than to attempt to improve domestic water storage (WHO, 2015). There are suggestions for treatment of water within the household to improve quality of often contaminated source water. Routine household treatment of water in many cases often involves boiling. It kills off most pathogens but can be expensive and time consuming. It has been estimated that one kilogram of wood is needed to boil one litre of water for one minute. This may not be a choice for lower-income households where resources are limited (Sobsey, 2007).

2.10.5: Financial Aspects

For water supply, financial allocations to the main sector ministry have increased six-fold since 2003/04, while development partner contributions have almost quadrupled since 2006/07. Estimates for required and anticipated capital investment suggest that urban water supply has sufficient funds for water supply infrastructure, but additional funding needs for urgent water storage and bulk transfer schemes will require consideration. Anticipated capital investment for rural water supply falls short of requirements and is highly fragmented, making it difficult to manage and report on. For sanitation, though anticipated capital investments are close to requirements, this assumes households will meet a substantial share of costs. However, there is

currently no clear policy on promotion and marketing to encourage households to invest in sanitation

The Kenya Water Sector Strategic Plan budget is US$ 627 million to be used from 2010 to 2015 as guided by the Vision 2030. In 2010/11 budget, Kenya shillings 25 32.8 billion was committed which was a 31.7% increment from Kenya shillings 24.7 billion in 2009/10. The water budget's compound growth rate for the last 10 years was 20.

Despite the fact that a bulk rate has been incorporated into the tariff policy of NCWSC (Appendix IV), this has not been effective in bringing down costs for consumers. Kiosks are usually registered as domestic connections due to the requirements of obtaining a bulk connection and additional costs (such as a deposit which doubles that of a domestic connection). Kiosks are usually charged tariffs according to the increasing block tariff and end up pay high retail rates. At the highest block of the tariff, each additional cubic meter purchased by the operator costs Ksh35 or Ksh7 per jerry can.

With the adoption of the Water Act 2002, The social and political considerations outweigh the economic considerations in the setting of tariffs such that water is largely considered a social good. The need to have a different view on the pricing of water becomes urgent, so increasingly, water is now/also viewed as an economic good. This necessitates the development of appropriate tariff structures and cost recovery measures. In order to gain acceptance, the water pricing systems are developed with the full consultation of water users (Section 57 of the Water Act - 2002). The Act also directs the management of the demand of water in a sustainable way. This includes market-based and technology-based strategies. The two major market-based strategies are water pricing ("the user pays" principle, with special treatment of low-income users) and

effluent charges ("the polluter pays" principle). One of the 16 technology-based strategies as per the Act concerns the reduction of unaccounted-for-water (Republic of Kenya, 2002)

The tariff structure in force in Nairobi City is an increasing block tariff. The official water tariff provides little indication of what people are actually paying. Despite low average water use, estimated at only 40 liters per capita per day, households are paying remarkably high unit prices for water. However, the actual average water cost is estimated to be Ksh297 per cubic meter in Nairobi's informal settlements. The main reason behind the high prices is that poor households are buying water from informal on-sellers such as tankers, kiosks and water delivery services (Pamoja & UC Berkeley, 2009).

Despite the NCWSC's attempts to deliver a subsidy through their tariff, there could be evidence that the poor, who are more likely to rely on water sold by third parties, pay more per unit of water. In an attempt to partially address the problem, the water utility has established a flat rate of Kshl3 per cubic meter for bulk supply to water kiosks serving informal settlements. However, this has not been effective in bringing down costs to consumers as few kiosk operators are actually billed at this rate as they often end up being charged the regular domestic tariff. As consumption is high, this pushes the price of water into the highest blocks of the tariff. These costs, as well as the investment costs and overheads incurred by the kiosk operators, translate into very high prices at kiosks.

No matter what they are compared to, prices that most water kiosks in slums charge is high. Although WASREB and the water utility has recommended that water be sold for Ksh2 per jerry can, this is not usually observed because of the costs associated with establishing and running water kiosks. A more common price is Ksh 5 per jerry can prevails, which is eight times more the lowest block of the tariff at domestic connections and four times the average recommended

tariff for Nairobi. During water shortages, the prices soar to KShs 10 or as much as KShs 20 for a 20-litre jerry can. The unit cost of water in Nairobi's slums can thus rise above the average price of water at household connections in other African countries (KNBS, 2018)

CHAPTER THREE: LITERATURE REVIEW

3.1: Introduction

This chapter examined the literature on water governance issues, privatization, and alternative sources of water for urban dwellers especially in the cities of the developing world. In particular, the review will concentrate on the availability or lack of policy and regulatory framework to ensure provision of water in major urban areas in Kenya. There was keen concern on the various types of these alternatives that are available in Nairobi city Kenya as they have been explored by other researchers and scholars. The aim is to identify the gaps in the available literature to help in making viable recommendations on approaches to provide safe drinking and sustainable water in Kenya's urban areas using the alternative sources of water.

3.2: The Concept of Alternative Water Supply

According to Kahinda *et al.* (2007), a significant number of people in the world have poor access to quality and sustainable water. The authors also recognize that inadequate safe drinking water and poor sanitation characterize most places around the world. One of the SDG's is to ensure sustainable and safe drinking water to people globally. The issue has necessitated the need to seek alternative water sources aside from water sourced from fresh surface water or ground water. There several examples of alternative water sources including harvested rainwater. Kahinda, *et al. (*2007) examines rainwater harvesting as an appropriate option to ensure quality water supply in South Africa. The authors identify that rainwater offers this important resource to many households in areas where conventional technologies are not applicable. In line with the realization of the (SDG's) Sustainable Development Goals goal, the South African government offered financial assistance to ensure poor households can purchase storage tanks.

In examining the concept of alternative water supply for Chilean coastal desert villages, Cereceda *et al.* (1992) observed that villagers in Chungungo and Los Hornos spend close to 10 percent and 6% of their family income on water respectively. The high costs necessitated the establishment of a water project to help in reducing the costs of water supply within the region. The completion of the project led to supply of quality water in a reliable manner. Crane (1994) observes that close to eight million people in Jakarta get water from the municipal council. In addition, the municipality authority supplies water to street vendors, although most of the water comes from contaminated sources. The author notes that the local authorities are seeking means to ensure more people get connected with the available water supply.

Manzungu *et al.* (2016) undertook study on the bulk water suppliers in the city of Harare in Zimbabwe. The bulk water suppliers started their trade following challenges encountered in delivery of domestic water. They supplied to middle and high-income neighborhoods; hence, cutting out a significant mark in the country's urban waterscape. It is also noteworthy that poor regulatory regime undermined access to safe water by the urban dwellers. The government introduced regulations on bulk water suppliers in 2013 – an indicator of laxity within the government agencies. The operations of the private actors in Zimbabwe are significant to supplement urban water supply systems. The authors underscore the significance of creating regulations that consider the local interests and needs.

Figure 6: Minimum supply standard for water

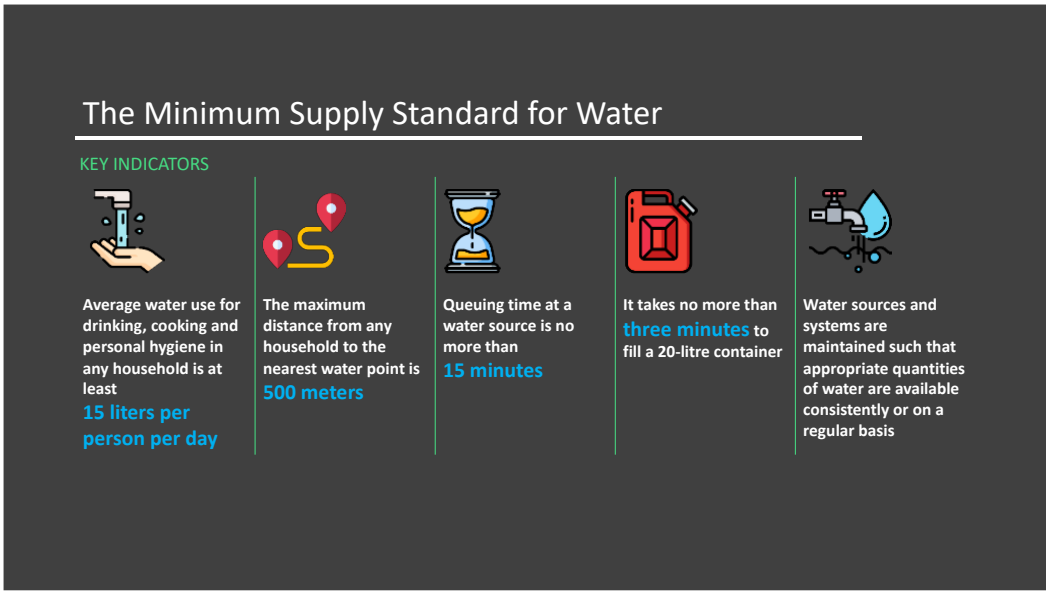


Figure 7: Minimum supply standard for water

2.7.1: Types of Alternative Water Providers

The types of water providers discussed under the study are grouped into two, the fixed-point water suppliers, which includes the tap vendors, water kiosks and borehole water vendors; the mobile suppliers which includes the push cart vendors and tanker tracks.

2.7.1.1: Tap Water Vendors and Water Kiosks

The services offered by the tap water vendors and water kiosks are very similar. tap water vendors are private entrepreneurs relying on a single piped connection, usually selling water from their dwellings or from a separate legal connection in a strategic location within the community. Households that engage in water reselling are another type of tap water vendor. these vendors are unregulated and consist mainly of landlords supplying tenants, sometimes through a small piped network.

Water kiosks tend to be formally licensed providers and are distinguished by their better infrastructure. They are distributed across the area of service and offer services in official opening hours. on average, vendors operate at least six days a week. Kiosks can usually serve more than one customer at a time from two or more taps, thus speeding up the service rate. These attributes contribute to the ability of water kiosks to sell significantly more water than tap water vendors. Most fixed vendors depend on the reliability of supply from the utility. they complain of supply disruptions caused by rationing by the utility company. Water kiosk operators also complain of weak water pressure and its negative impact on the service rate and the time spent in line by consumers.

2.7.1.2: Borehole Water Vendors

The typical borehole vendor operates as a family business. initially, the borehole may have been constructed to serve the household and possibly a cluster of tenants (Kariuki *et al* 2005). However, in the face of mounting community demands, it has been transformed into a water vending business. a number of privately-owned boreholes, in the vicinity of Dagoretti in Nairobi, supply a fleet of tanker trucks. Boreholes comprise an essential water source for households not connected to the utility's network.

Borehole construction is expensive and involves sunk costs associated with digging and construction, as well as the purchase of pumps and storage tanks. Some vendors are able to finance construction through revolving fund schemes. Before construction can begin, an official authorization is required. this may explain why boreholes are found only in the formalized settlements of Kangemi village, Kinoo and Olepolos WASREB (2010). Concerns over water quality and quantity are decisive factors in the regulator's decisions to authorize borehole construction. But quality testing is carried out only at the time of licensing, with no subsequent monitoring. This, as we shall see later, has serious implications for the quality of the water distributed. In contrast to the fixed-point vendors discussed above, who are dependent on a reliable supply provided by the utility company's piped network, borehole vendors are better positioned to take advantage of negative water supply shocks in the network.

2.7.1.3: Pushcart Vendors

Operators of manual and donkey-pulled pushcarts obtain water mostly from boreholes, water kiosks or through an illegal connection to the piped network. They resell water to end users in 20-litre jerry cans. A typical pushcart water vendor is a man in his mid-thirties with two family dependents (UNDP 2001), earning an average monthly per capita household income of Kshs

9,948 (US$ 4.12 per day). Pushcart vendors deliver water to households in urban informal settlements by manual pushcarts or by donkey-pulled carts in peri-urban areas. The initial investment cost consists of buying 15 to 30 jerri can containers at Kshs 200 per unit, and acquiring the pushcart (about Kshs 5,000) or renting it (UNDP 2011). Operating costs include cart maintenance as well as animal feed and care. According to Kariuki, *et al* (2005) competitive advantage of mobile vendors lies primarily in their ability to reduce the time cost for households associated with obtaining water by offering door-to-door vending. these vendors also play a larger role where kiosks and tap vendors either are absent or are too few to provide an adequate supply of water. They may either walk house to house offering services or, more efficiently, deliver in response.

2.7.1.4: Tanker Trucks

Privately operated tanker trucks supply water in bulk to end users who can afford storage tanks. tanker trucks obtain water either from private boreholes or directly from the utility company. Borehole water vendors supply water to mobile vendors for resale, but also sell water directly to end users. a fleet of tanker trucks and exhauster vehicles gather daily at their collection point which is usually a location on the outskirts of Nairobi city that has strategic access to a number of borehole water vendors. Exhauster vehicles service households that are not connected to a sewer line and empty pit latrines when they are full. Tanker trucks deliver water to private homes or firms, where they replenish storage tanks. They do so in response to mobile phone calls, covering all of Nairobi. Some tanker trucks operate 24 hours a day. Some vendors purchase their own truck, while others rent a vehicle from the Nairobi County Council. All tanker truck operators require a business permit, issued by NCC for a fee. truck operators incur recurrent costs associated with truck maintenance, parking fees, and operational equipment such as gloves,

piping and pumps. Some government officials allege that the truck operators are sometimes involved in disrupting the piped supply network in order to boost demand. There are also allegations of exhauster vehicles being refurbished into water tankers in response to soaring demand at the peak of water shortage.

2.7.1.5: CBO-Run Water Projects (Kiosks)

Water and sanitation services are also provided by community-based organizations (CBO's) These groups are sometimes made up of residents who together manage, operate and maintain a number of sanitation blocks and associated water kiosks. CBO-managed water projects are usually funded by the government's community development Fund (CDF) or by non-governmental organizations (NGO's). CBO's rely on a formal connection to the utility's Nairobi County Water and Sanitation Company (NCWSCo) piped network, paying a subsidized water tariff of Kshs 15 (uS$0.19) per m^3. this rate is lower than the company's commercial and residential rates the price charged per jerry can of water by the CBO is set by the utility at a uniform rate of Kshs 2 per 20-litre jerry can (AWSB 2011). The group of residents running the water and sanitation blocks are called "members". they hold frequent meetings that serve as forums for elections and decision making on all matters related to block operation and the general welfare of community members. Having discounted the monthly operational and bulk water costs, the profit is reinvested or saved. Dividends are shared periodically among the members according to a set formula. CBO-managed projects are good examples of participatory management and community empowerment.

2.7.2: Supply and Distribution by Alternative Water Suppliers

The price-setting behavior of alternative water providers indicates substantial levels of extraction in response to excess demand (UNDP 2011). Among the small-scale providers surveyed by UNDP for a study on small-scale water providers in Kenya, the majority of water kiosks (59.5 percent), pushcart vendors (47.1 percent) and tap water vendors (36.1 percent) set water prices on the basis of the price charged by competitors. And about a third of tap water vendors and pushcart vendors declared that they set prices on the basis of a cost mark-up. Another indication of the significant extraction levels is the relatively high share of tap water vendors (23 percent) and borehole water vendors (22 percent) who set prices on the basis of what they believe the costumer is able to pay.

Kiosk, tap and borehole operators push up prices in times of limited supply and excess demand. But kiosks offer lower prices and one explanation for their lower price is higher degree of official tariff compliance by fixed-point vendors, and especially by licensed kiosks buying water at the subsidized bulk water rate from the utility company. The presence of water kiosks generally seems to be putting downward pressure on the prices charged by individual tap water vendors. The declared price setting strategy of tanker trucks could be taken to suggest a high degree of market competition, with prices being based mainly on the cost of provision (operational and bulk water costs) and distance (transport costs).

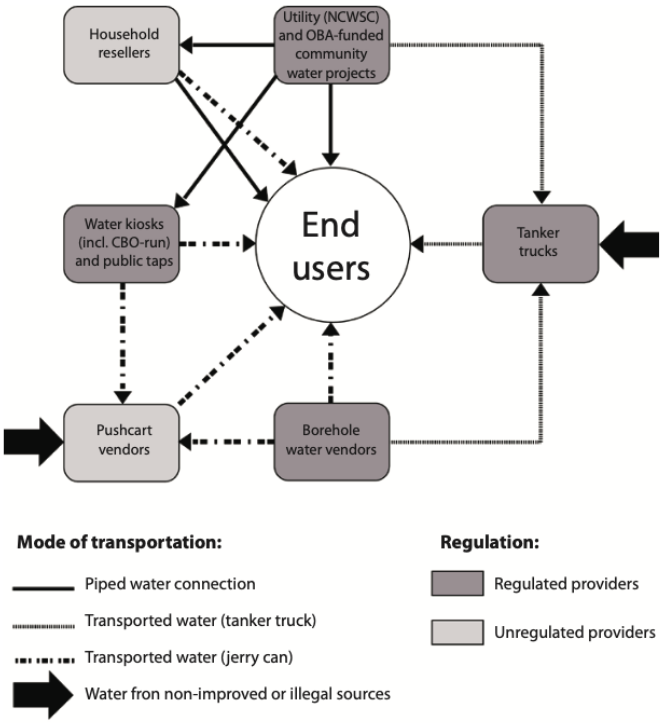


Figure 8: Water Supply Chain in Nairobi City

3.3: Private Participation and Water Regulation in Kenya

Privatization in Kenya began with a divestiture exercise that saw the government sell proportions of its shares in the public enterprises to cooperatives or dispose of public enterprises assets through receivership or winding up Goldman *et al.*, (2005). Privatization of the water utility is one of the earlier privatization initiatives that took place in Kenya outside the provision of a national policy framework. Yet in the water sector itself, privatization had begun earlier on before a sectorial policy framework was put in place. The sector framework came into being in the name of the Water Act of 2002 (K'akumu, 2004). The new Act was enacted to repeal the erstwhile Water Act chapter 372 of the laws of Kenya that had been in operation since 1962. This was done in order to usher in reforms in the water sector. The reforms are entrenched in the new Act in two main aspects; the management of water resources and the management of water

services. The latter is considered under Part IV of the Act covering water supply and sewerage (K'akumu, 2004).

The new Act establishes a regulator in the name of the Water Services Regulatory Board (WSRB) to regulate the water market. The WSRB is responsible for the fixing of tariffs, ensuring cost-effective and efficient operations, and promoting water conservation and demand management measures, among other things, with these functions point to the market-oriented paradigm of service provision (K'Akumu, 2007). The Act also makes provision for the creation of Water Services Boards (WSBs). The WSB as a statutory creation is therefore incorporated as a public enterprise. In implementing the Act, the ministers in charge of water services gazette seven WSBs as regional bodies in charge of water provision. The WSB is to be licensed by the WSRB, a fellow public body, for the purposes of providing "efficient and economical" water services.

Private companies have been in the water sector as long as it has been in existence. Existing literature is very much conversant with this fact. Wells *et al.* (2001) acknowledge the long history of private sector participation in water management both in the developed and developing world Bartram, *et al* (2005) also notes the fact that the first water and sanitation services were provided by the private sector to well to do communities who were able and willing to pay. But in the near past, private sector players have been confined to peripheral roles, away from the ownership and operation of main systems. In developed countries, according to Bartram *et al.* (2005), the sector has been responsible for technological innovations and solutions for water management and for the provision of commercial or bottled water. In developing countries, the sector has been responsible mainly for tanked water to unconnected or shortage-prone communities. Private provision in developing countries has been hampered by shortage of local

capital and an underdeveloped private sector, among other things (Rakodi, 2000). It was not until recently that thinking on private provision took center stage.

The other reason cited by the proponents of private sector approach is the obvious failure of the public sector to provide an adequate and sustainable supply for the urban population. This is in spite of the donor support that was available for it in the early days (Budds & McGranahan, 2003). Failure of the public sector is marked by: inability to extend services to the poor, inability to rehabilitate existing infrastructure, inability to recover cost for self-sustenance and dependence on the exchequer which has limited funds, among others. Donor funding is no longer available to address the enormous problems afflicting the sector hence the need to turn to private financing and control.

Those who support private initiative as a sustainable approach to service provision would rather see water as an economic good that can be exchanged in the market at a price. It does not mean that under public provision water has not been sold at a price. In practice it has been sold at a price that is not the market price (Society for International Development, 2004). The market price is determined by demand and supply. The market price would allocate water according to competing uses, considering the opportunity cost. Water is a scarce resource nowadays and should therefore be used in a sustainable and economical way. By paying for water at market price, consumers within a particular use will face a situation where they only consume the amount of water for which they can pay. This would cut down on wastage that was rampant within the supply management approach under public provision. The current focus in demand management therefore has potential for conservation (Yarrow, 2010).

3.4: Government Policy

Governance challenges in Kenya are multi-faceted although most water and sanitation services (WSS) governance assessments have, over the years, considered the rights and needs of the individuals, households and settlements in rural and urban settings that have no relationship with these formal agencies (Roth, 2007). With these skewed approaches, in interventions, it becomes difficult to develop mechanisms specific to the needs of the poor groups, particularly in addressing the demands of marginalized groups and areas including urban informal settlements. Effective water governance however goes beyond ensuring that policies and institutions are in place, and captures issues of access to resources, information and affordable technology while participating in the decision- making processes, that affect the management and effectiveness of service provision. This analysis of water resources and supply and sanitation services governance in the Kenyan sector focuses on the current situation of service provision and looks at the state actors operating at all levels.

In analyzing the water supply and sanitation services governance in the Kenyan sector, therefore, the focus is on the current situation of services provision by looking at all actors on all levels and what policies and strategies are governing their activities, the existing challenges and gaps in WSS service provision-on and define interventions for ensuring better provision for those who are currently un-served or inadequately served (Kameri-Mbote, 2011). At the level of interventions, it therefore becomes difficult to develop mechanisms specific to the needs of the poor groups particularly in addressing the demands of marginalized groups and areas including urban informal settlements. Enhancing water governance goes beyond ensuring that policies and institutions are in place, and captures issues of access to water resources, information and affordable technology while participating in the decision-making processes that affect the

management and effectiveness of service provision. This means that good provision of services is not merely about infrastructure; it includes the local capacity to innovate and make appropriate choices with regard to technology and the institutional forms for building and managing it.

Government policies and regulations often pose constraints to provision of services to both the rural and urban poor. K'akumu and Appida (2006) observe that this has been the case in Kenya, where deliberate marginalization of communities particularly in rural areas and in informal settlements has resulted in poor sanitation conditions due to poor or often non-existent infrastructure for accessing clean water and in handling wastewater, garbage and human solid waste. Both legal and policy arrangements have an important role to play in improved access to WSS and ensuring adequate provision of service (World Bank, 2007). Most water legislation does not have a proper definition of what constitutes equitable access of provision to the urban poor, hence overlook the needs and rights of the poor particularly those residing in unplanned settlements. Such settlements suffer under the lack of clarity between different policies, for instance, land tenure policies which influence the security of tenure and the right to provision of basic service. As a result, and short of the necessary legal provision, the poor cannot articulate the human rights issues surrounding access to adequate WSS. This makes legislation and policy reforms vital when setting up the legal and institutional frameworks that will facilitate pro-poor governance and to ensure long-term sustainability of WSS interventions.

In Kenya, the development in the water sector has been guided by various policies and laws related to water developed both in the pre and post-independence periods. The first law was the Water Ordinance in 1927 and followed by the Water Act Cap 372. The National Water Master Plan of July 1992 recommended that the revision of the Water Act Cap 372, the principal law for water development and use in Kenya. This has resulted to enactment and implementation of

Water Act 2002. The Water Act Cap 372, the principal law for water development and use in Kenya. This has resulted to enactment and implementation of the Water Act, 2002. The Water Act 2002 clearly sets out the legal implementation framework for the water sector policy decentralizing functions to lower public institutions although ultimate decision-making remains centralized (Ministry of Water and Irrigation, 2012). The legal and institutional framework for implementing the defined policies in the water sector, under the Water Act 2002, is captured in the arrangements for the management, conservation, use and control of water resources; the acquisition and regulation of rights to use water, and in the regulation and management of water supply and sewerage. The policy changes in the water sector are therefore linked to the implementation of the Water Act 2002, as an enabling legislation that provides for an increased and deliberate focus on two key sub-sectors. The Water Act, 2002 has introduced comprehensive and, in many instances, radical changes to the legal framework for the management of the water sector in Kenya. These reforms revolve around the following four themes: The separation of the management of water resources from the provision of water services, which is explained further below: The separation of policy making from day-today administration and regulation: Decentralization of functions to lower-level state organs and the involvement of nongovernment entities in both the management of water resources and the provision of water services.

In efforts to enhance the efficiency, accessibility and sustainability of water and sanitation services, President Moi's Government promulgated a new policy called the National Policy on Water Resources Management and Development (Water Policy), which sought to deal comprehensively with the problems confronting water and sanitation services. The Water Policy identified the problems which have constrained the development of the water sector as including:

The shortage of funds for development, operation and maintenance of water supplies and management of water resources. The over centralization of decision making: Fragmentation of water resource management responsibilities: Lack of proper co-ordination of the various actors in the sector and lack of proper inter-linkages with other water related sectors (Wambua, 2004). The Water Policy established four specific principles that would guide efforts to address these problems, namely: The sustainable, rational and economical allocation of water resources. The supply of sufficient quantities of water of good quality while ensuring safe disposal of wastewater and environmental protection. The establishment of an efficient and effective institutional framework and the development of a sound and sustainable financing system for effective water resources management, water supply and sanitation development is the core aim of the policy.

3.5: Quality Assessment

The quality of any body of surface or ground water is a function of either both natural influences and human influences. Without human influences water quality would be determined by the weathering of bedrock minerals, by the atmospheric processes of evapotranspiration and the deposition of dust and salt by wind, by the natural leaching of organic matter and nutrients from soil, by hydrological factors that lead to runoff, and by biological processes within the aquatic environment that can alter the physical and chemical composition of water. One of the key challenges to the developing countries is increasing access to safe water supply to the rapidly growing urban population, consequently, billions of dollars have been invested in pursuit of the goal of 'universal service' and yet the realization of that goal is still elusive. The goal of the 'universal service' is to achieve self-sufficiency in water supply with increased access to safe water of adequate quantity and acceptable quality in sustainable way. The main challenges of

increased water self-sufficiency for water managers are: controlling energy demands; controlling environmental impacts; ensuring high quality water and avoiding negative impacts on human health; ensuring public trust in the water supply; and ensuring cost effectiveness (Schertenleib & Triche, 2009). The quality of any body of surface or ground water is a function of either both natural influences and human influences (Kenya National Commission on Human Rights, 2006). Without human influences water quality would be determined by the weathering of bedrock minerals, by the atmospheric processes of evapotranspiration and the deposition of dust and salt by wind, by the natural leaching of organic matter and nutrients from soil, by hydrological factors that lead to runoff, and by biological processes within the aquatic environment that can alter the physical and chemical composition of water.

Water quality standards in Kenya follow the WHO guidelines on drinking water quality. Several agencies have a mandate to deal with water quality. The Ministry of Water and Irrigation has a division that deals with water quality and pollution. There is insufficient water quality monitoring for informal and small-scale provision, either by government actors or by users. The media has reported serious consequences including death resulting from consumption of unsafe water from rivers and other informal sources. Water quality monitoring by government bodies is not sufficient because it is difficult to enforce standards for informal provision. There must also be public educational campaigns on the dangers of poor-quality water, how to identify it and on simple household level treatment methods, including boiling and use of purification tablets. Water quality standards in Kenya comply with international standards (Goldman *et al.*, 2005). In regard to formalized water supply, water quality monitoring has been improved by the reforms. Further improvements, including an obligation to inform consumers of water quality are expected due to the requirements set out in Service Performance Agreements ('SPAs').

Challenges remain in water quality monitoring for the informal sources used by a large sector of the population. The adoption of the 'polluter pays' principle by the Water Resource Management Authority ('WRMA') and the increase in its enforcement powers relating to pollution control are a positive development. The Ministry of Health (MoH) carries out insufficient education of users on hygiene, water testing, purification and storage.

3.6: Decentralized Water Systems

Tucker *et al.* (2010) observes that when populations in cities grow bigger, it is not only expensive to aggregate the services over a large region and size the systems to accommodate future demand, but also requires considerable pumping energy to transport water over longer distances and the systems are more vulnerable to contaminant transport like salt loads, drought or legal constraints. Decentralized wastewater management systems are stand-alone systems in which small wastewater flows are collected, treated and dispersed at or near the point of generation. Decentralized water systems have less conveyance energy and more integrated resource management such as local system-wide reuse opportunities. Accordingly, this leads to more flexibility, more utility optimization and community independence. Decentralized systems allow the communities to phase-in added sewer capacity as growth occurs, for example, and avoid the upfront financial burden of long-term demand projections in centralized systems where the current users bear the cost of future use. The networks of decentralized subsystems provide the necessary redundancy and flexibility responsive to potential weather changes or other system disruptions. When one decentralized system fails, the other ones provide the auxiliary connections and can redirect resources in the event of an emergency. This will increase resource exchange among systems, optimal resource throughput and minimization of wastes. It is also

easier to reach an equilibrium point between water, energy, and land use where improvements in one aspect does not signify cost in others (Muturi, 2013).

The tradeoff of decentralized systems is the increased complexity within the clusters of independent, yet interconnected networks. In centralized systems, the system configuration and operations are much simpler, but costly (Kahariri, 2014). The efficiency of decentralized systems is achieved through complex information management that allows system exchange, and more diverse technology to achieve resource recovery and sharing, instead of extensive energy-driven technologies. The modern development of digital and communications technology can provide systematic communication between decentralized water systems like smart grid technology in electricity networks (Tucker *et al.*, 2010). Networks such as the Smart Water System use the automated and integrated remote sensing network to provide better efficiency, reliability and security, resulting in a more resilient system. Ma *et al*. (2015) observe that compared with a wealth of knowledge about conventional systems, decentralized systems have been shown conceptually promising. Although significant progress has been made, Muturi (2013) observes that the decentralization concept is still in its relative infancy. It is not a simple downscale of the centralized version; otherwise the economy of scale in microeconomics would determine that the cost generally decreases with increasing scale (Ma *et al.*, 2015). It should be effectively linked to other alternative options such as dual water quality, energy and material recovery, fit-for-purpose, etc. In reality, new system architectures can be configured in different designs, including hybrid systems which reconfigure the current systems and incorporate centralized and decentralized elements and transformative systems that overcome the system inertia with new system designs (Ma *et al*., 2015). The focus of system optimization certainly involves a general matter of scale that deserves more research.

3.7: Green/Natural Infrastructure

To develop effective storm water management and build cost-effective solutions with physical and operational resilience, it is suggested that hard urban surfaces are replaced by vegetated or permeable surfaces to retain runoff and natural shoreline features such as wetlands and sand dunes to mitigate the effects of storm surges. According to Kahariri (2014), green infrastructure incorporates natural capitals like vegetation and soil to manage rainwater near where it falls. Instead of diverting storm water outside the watershed as much and as fast as possible with extensive piping system and transport energy, the available potential energy from the rain should be used to encourage maximum productivity and native biodiversity within the watershed. Water system management should also collaborate with city zoning and land use management. Most metropolitan cities in US and around the world have experienced the massive flooding in severe storm and urban heat island (UHI) effects in hot summer due to the replacement of natural open and vegetated land surfaces with artificial concrete infrastructure and impermeable, dry surfaces (Kahariri, 2014). Solar energy is converted to more sensible heat, rather than latent heat. Excess water is disposed as quick as possible before it returns to its natural cycle through evapotranspiration (ET) and infiltration. Ma *et al*. (2015) propose that to overcome these issues, cities should implement strategies that encourage more ET and infiltration with urban forests, urban agriculture, trees, and vegetation, green roof and cool roof, and cool and permeable pavements and surfaces.

A study conducted by Owuor and Foeken (2009) on eco-hydrologic effects of urbanization on ET illustrated that loamy soils can sustain vegetation transpiration more than sandy soils; mature tree covers with deep root structures have higher annual ET rates than shallow rooted covers such as grass, which may reduce runoff and mitigate against UHI effects. Although urbanization

necessarily comes with a certain degree of impervious surface at the expense of vegetated cover, it was shown that impacts to annual ET fluxes can be mitigated by strategies like eliminating directly connected impervious area (Ma *et al.*, 2015). The natural ground cover would only have 10% runoff with 40% via ET and 50% through infiltration while the impervious cover would have 55% runoff with 30% ET and 15% infiltration (Ma *et al*., 2015). The basic principle of low-impact development (LID) practices as storm water management alternative is to mimic pre-development hydrologic regime and detain runoff close to its source (Tucker *et al.*, 2010). At the watershed level, if the efforts are focused on targeting the fundamental problem by making acyclic hydrologic process become more cyclic and restoring natural hydrologic cycle, the storm water runoff will be alleviated and the more balanced natural hydrologic cycle will in turn provide resilient support for urban water systems in the long run (Owuor & Foeken, 2009). Constructed wetlands will also increase ET and potentially infiltration. Large bodies of water greatly moderate land climates because of the high latent heat of evaporation and melting characteristic of water. If possible and necessary, other underground and above-ground water storage bodies, like quarry reservoirs, can serve as water bank and environmental buffer to store excess water for later use, flood control, energy storage of potential hydroelectric power, emergency water supply and groundwater recharge. For example, the numerous quarries found in Nairobi and within the outskirts of the city can be used to store excess runoff storm water that can be used for irrigation and run the numerous car wash businesses that litter the city's estates.

3.8: Fit for Purpose and Rainwater Reuse

Repurposing waste water and reuse of rainwater is only possible where there is an existent dual water system, which according to Ma *et al*. (2015) is none existent in Kenyan cities. The witnessed population explosions in recent decades and increased rural to urban migration alludes

to the fact that a majority of Kenyan cities will have to undergo major infrastructural changes to accommodate the heightened need for more and efficient amenities. Owuor & Foeken (2009) have identified the use of dual water systems as an effective approach towards the repurposing of waste waters and reuse of rainwater. It is important to note that the initial intention of dual water systems was to conserve high-quality natural waters for drinking and use reclaimed wastewater for non-portable purposes. Dual systems in a new community/system would be built simultaneously. For existing systems, dual systems can be retrofitted a new drinking water system, with smaller pipes and rely on the existing system, with larger pipes to serve as the non-potable supply. Ma *et al*. (2015) observe in a study that if the majority of the domestic water use, for example, 93% is for non-potable purposes, the treatment strategy should adopt "fit-for-purpose" practice, in which the treated water, called "clean water", is for non-potable use, like toilet flush, clothes washing, firefighting and landscape irrigation.

A survey conducted in the US established that no major public health problems from the use of reclaimed water. The source of clean water can be treated greywater and rainwater, in which the water quality standard is not as high as drinking water, but safe for its purpose. Unlike blackwater that is composed of feces without urine, which is rich in organic matter, greywater is domestic non-sewage water which generates larger volumes with lower concentrations of contaminants, such as that from showers, sinks, and laundry (Tucker *et al.*, 2010). Due to the evaporation and condensation processes as parts of the water cycle, rainwater is generally considered clean and the quality is better than surface water. It is when rainwater comes in to contact with the catchment area such as roof and road surfaces, contaminants like pathogens, VOC and road salts are introduced. The harvested rainwater can serve as an independent water source for clean water as well as for storage and other purposes such as landscape irrigation

(Kahariri, 2014). The treatment of combined greywater and storm water can employ less energy-intensive technology and with lower capital expenditure.

Constructed wetlands can serve as one such option. The natural wetland system is one of the most productive primary production systems on terrestrial biomes. Although wetlands occupy only about 2% of the global surface area, they contain 10%–14% of the carbon [95]. Wetland soils, such as histosols, may contain up to 20% carbon by weight. The peats are even more carboniferous. The aerobic-anaerobic stratification of wetland sediment columns involving vegetation, microbial and soil community is uniquely important in the global cycling of sulfur, nitrogen, and phosphorus as well as carbon [96]. An open-water wetland with land area of 6 × 104 m2 (15 ha) can achieve 90% removal of most compounds in nitrified wastewater effluent receiving 3.8 × 103 m^3 /d (1 million gallon per day mg/d or flow) (Tucker *et al.*, 2010). The treatment efficiency would be higher for lower strength greywater and storm water. This efficient ecological and evolutionary machinery from natural systems provides enormous natural capitals that often are not appreciated by market capitals. Moreover, the benefits beyond water purification can be food chain support, biodiversity conservation, storm water and erosion control, flood conveyance, water storage and buffering, local climate control, reduction of wild fire, and downstream ecosystem improvement (Mwamburi, 2013). Constructed wetlands are designed to simulate natural wetlands and use renewable energy to replace fossil fuel energy used in conventional treatment technologies to achieve the same water purification purpose. The carbon sequestration of wetlands is not limited to simply carbon fixation by photosynthesis within the wetland. It is also the sinks of carbon from inflow water such as greywater from domestic use (Owuor, & Foeken, 2009). The aquatic vegetation and organisms in wetlands also play an active role in taking up nitrogen, phosphorus and other compounds from inflow water.

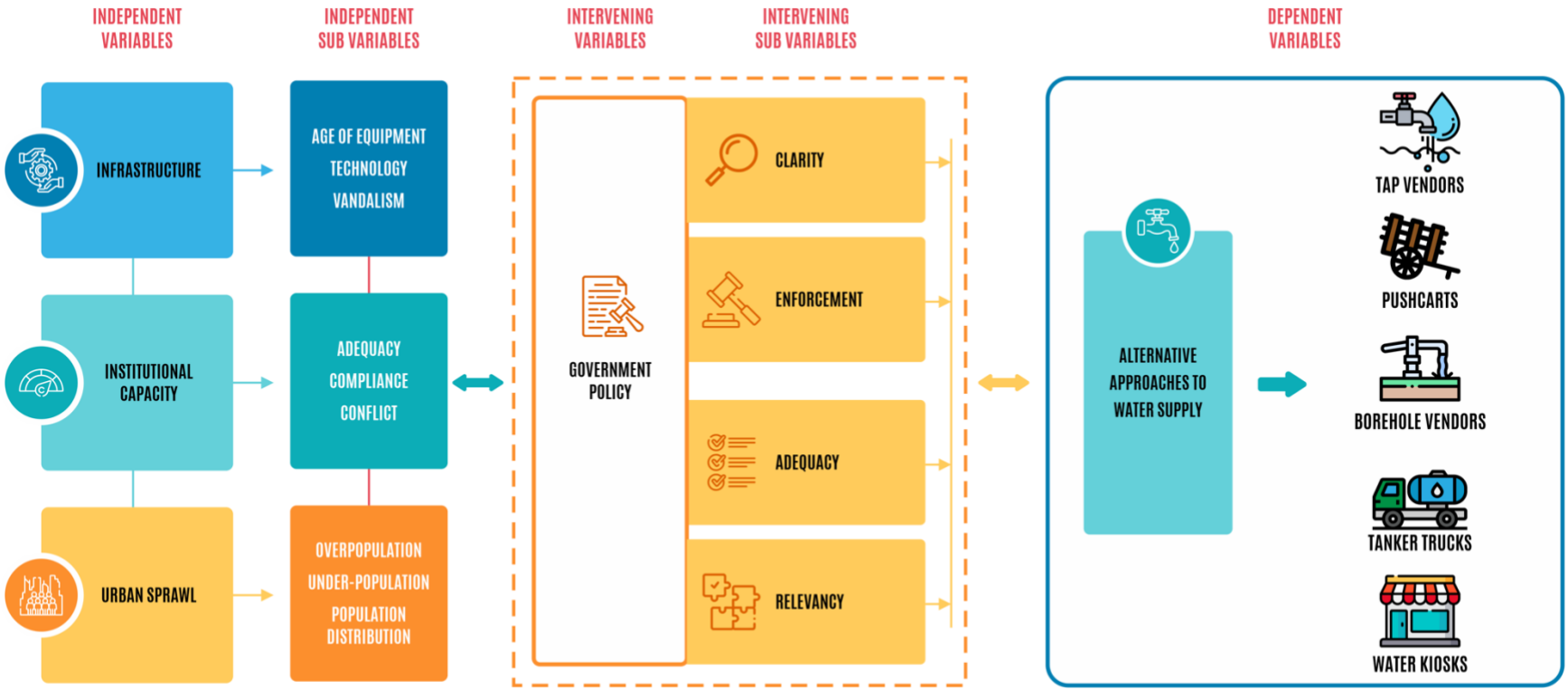
Muturi (2013) states that the rising temperature and imbalanced water cycle has been and will continue to cause more severe climate related events. It has been estimated that the frequency of such severe events has increased by 20% in the US since the beginning of the century as illustrated by the ongoing rainstorm in the state of Texas and in India. In the areas with decreased precipitation, constructed wetland and its storage function will provide additional supply during drier months or drought periods because of its relative constant flow from domestic water use. In the areas with increased precipitation, the constructed wetland will provide water quality buffering, storm water runoff treatment and erosion control. The integration of constructed wetland with urban living as a part of aesthetic co-design of water functioning services and urban landscape will not only provide a financially viable option because the water purification is done by natural capital instead of market capital, but also offers numerous ecological services as mentioned above and additional urban design function such as more public spaces to promote social interactions, physical health and fitness, diminished crime and increased wellness, resulting in improving the quality of life within the livable, regenerative community (Kahariri, 2014). Although the wetland treatment efficiency for lower strength greywater and storm water would be higher than for traditional wastewater, the technology still requires extensive land occupation that captures renewable energy in the form of vegetation, soil and microbes to treat wastewater. In areas where land is not available such as in the densely populated communities, the treatment can instead employ technologies with smaller footprint, but driven by purchased inputs and fossil fuels to treat greywater and storm water. Even so, the overall system efficiency may still outweigh the ones in centralized systems (Tucker *et al.*, 2010).

3.9: Emerging Interventions in Water Reforms in urban Kenya

A study conducted on five major urban centers of Kisumu, Kisii, Nakuru, Homa Bay, and Eldoret by Mwamburi (2013) established that water sector reforms in Kenya are intended to address the weaknesses in policy, regulation and service provision characteristic in the previous Water Act Cap 327.The following aspects were observed:

i. Minimal network extension with efforts towards rehabilitation and water kiosks
ii. Significant reduction in unaccounted-for-water
iii. Improved metering, billing and revenue
iv. Addressing the plight of low-income neighborhoods through pro-poor programs
v. Attraction of donor funding and interventions
vi. Providing an opportunity for other water service provider

3.10: Conceptual Framework



CHAPTER FOUR: STUDY METHODS AND MATERIALS

4.1: Introduction

This chapter covers the methods and techniques used in It covers the research design, population and sampling design, data collection methods, research procedures and data analysis methods. It gives the methods that will be used in conducting an analysis of causes of demand of alternative water supply in Nairobi.

4.2: Research Design

The research design employed in the study was a survey cross-sectional design method and the research method used is quantitative tools in data collection exercise. The survey cross- sectional design was appropriate for the study since the respondents in this study are expected to answer questions administered through questionnaires after which the researcher describes the responses given. The cross-sectional design method used in the study is designed to collect data that describe the characteristics of persons, events, or situations. The cross-sectional design research in this study were both quantitative and qualitative in nature. It involved the collection of quantitative data such as satisfaction ratings and structured response of 'Yes' and 'No'. It involved the collection of both quantitative and qualitative information like in the situation where the researcher is interested in associations among variables to describe populations, events or situations.

A cross-sectional design research design is a scheme, outline or plan that is used to generate answers to research problems that describe the characteristics of a phenomenon (Oradho, 2008). It is the conceptual structure within which research is conducted. It creates roadmap for the

collection, measurement and analysis of data, based on research questions (Kothari, 2008). A cross-sectional design research design also shows how all of the major parts of the research study work together in an attempt to address the research questions. It gives directions from the underlying philosophical assumptions to research data collection process (Creswell, 2013).

4.3 Study Area

The study site was Starehe Constituency in Nairobi County. Starehe Constituency is an electoral constituency in Kenya. It is one of seventeen constituencies in Nairobi County. It consists of central and central to north areas of Nairobi. The entire constituency is located within Nairobi City county area. The Starehe constituency electoral wards are Nairobi Central, Ngara, Pangani, Landimawe and Nairobi South (South B). The constituency covers an area in Sq.KM (Approx.): 20.00 with a population of 210,423 with a total number of 104,980 households having a population density of 10,205 persons per Sq.KM. (KNBS, 2019). The Starehe constituency was selected for the study due to its cosmopolitan nature; it has a varied land use with a population of people with different ethnic background. The land use in the constituency is that of the residential and the commercial such as the ones in the central business district. It also has two main markets in Nairobi which is Muthurwa market and Gikomba market thus making Starehe constituency to be a good study site for alternative water supply in Nairobi since different land uses have different demands for water supply.

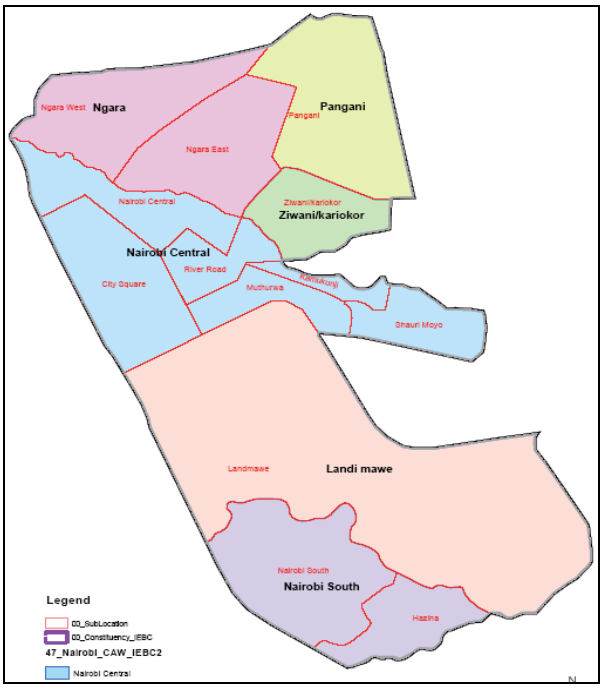


Figure 9: Map of Starehe Constituency

4.4: Population and Sampling

4.4.1: Population

Sekaran and Bougie (2013) state that a population is a group of people events or things of interest that the researcher wishes to investigate and make inferences based on the sample statistics. The study population was the business community and the residents of Starehe constituency. The business community involved small traders at the open market in Gikomba and Muthurwa as well as those operating formal businesses in the central business district (CBD). The study population shall also consist of the residents of Ngara area, Pangani, Ziwani, Landmawe and Nairobi South (B). Cooper and Schindler (2014) consider a population as the group of components a researcher would wish to make inferences over. The target population is

the complete rudiments of the specific population components relevant to the research study (ZiKMund, 2003).

4.4.2: Target Population

The target population was residents of Starehe constituency as well as the business community. The target population is defined in terms of elements of geographical boundaries and time. The research objective and the scope of the study play a crucial role in defining the target population (Sekaran *et al*., 2013). The study therefore targets a total of 66,108 (KNBS, 2019) conventional household of Starehe constituency and 12,540 business communities in the CBD.

4.4.3: Sampling Frame

The sampling frame for the study is the business community and residents in Starehe constituency as given by the KNBS (2019). The sample frame is taken to represent everyone that does business and resides in the constituency since they need constant supply of water for their daily chores. The sample frame is adequate representative of all the general population of Nairobi County due to its diverse profile composition and the varied land use in Starehe constituency. In this study, the sample frame is the 66,108 conventional households and 12,540 business community of Starehe constituency. A sampling frame is an index of items from which a sample can be selected or a physical representation of items in the population from which the sample is drawn (Kothari, 2004; Sekaran & Bougie, 2013).

4.4.4: Sampling Design

This study embraced a stratified random sampling technique for the selection of the study respondents to participate in the study. Stratified random sampling is appropriate for the study

since the population is grouped and distributed as per the geographical locations of the election wards by the IEBC (2012). Random sampling was then used in identifying the respondents since this gave equal chances to the respondents to participate in the study without any biasness. According to Swanborn (2010), stratified random sampling is a method where the population is divided into subcategories and then a separate sample element is selected from each subcategory. It has the advantage of reducing sampling errors by giving the researcher a greater power over the composition of the sample. It also ensures that a subcategory within the population is adequately represented in a sample to enable comparative analysis with the larger sample.

The study divides the population into different wards to form the strata from where the respondents are selected. After the stratification, a random sampling method was used to select the respondents to participate in the study based on their availability and accessibility. Stratified random sampling technique is preferred because the respondents are of different localities separated by roads as the main demarcation. Singleton and Straits (2010) noted that stratified random sampling technique also enabled the researcher to avoid the sampling bias. According to Adejimi *et al.* (2010), stratified random technique is advantageous as it samples each sector (stratum) independently by grouping members of the population into relatively homogeneous sub-groups before sampling. This improves the representativeness of the sample by reducing sampling error.

Sampling is a deliberate choice of a number of people who provided the data from which conclusions were drawn and generalized on the sample it represents (Jankowicz, 2002). Sampling design could either be a probability or a nonprobability sampling. In probability sampling, every element of the study population has a probability of being chosen as a sample unit. It generalizes the findings from the sample to the whole population. In non-probability

sampling, the units of the population do not have a predetermined chance of being chosen as subjects. It is more suited when other factors other than time is more important than generalizability (Sekaran & Bougie, 2013).

4.4.5: Sample Size

Orodho and Kombo (2002) view a sample as a finite and representative number of individuals or objects in a population to be studied. On the other hand, Kothari (2004) describes a sample size as a collection of units chosen from the universe to represent it and it should not be too large or too small. Gerstman (2003) state that a sample size is needed because a study that is insufficiently precise is a waste of time and money.

The sample size for the study was determined using Yamane (1967) formula, which is a central scientific method for calculating sample populations from a larger population. The sample size is then calculated as below:

$$n = \frac{N}{1 + Ne^2}$$

- Where n = the desired sample size
- N= the total population (target population)
- e = the degree of accuracy given at 0.05 testing at 95% Confidence Level

$$\frac{66{,}108}{1 + 67{,}358 \quad (0.05)2}$$

The study sought to sample more respondents to 399

4.5: Methods of Data Collection

Burns and Grove (2003) define data collection as the precise, systematic gathering of information relevant to the research sub-problems, using methods such as interviews, participant observations, focus group discussion, narratives and case histories.

4.5.1 The influence of infrastructure on alternative approaches to the provision of water supply in Starehe constituency

Primary data pertaining to the objective was obtained from the original sources using a self – administered questionnaire. The questionnaires were distributed randomly to the sampled respondents for filling. Some additional data was obtained from the records and reports of earlier researches done by the NCWSC on similar problem. Secondary data was collected from all the available sources like newspaper and articles.

4.5.2 The influence of institutional capacity on alternative approaches to the provision of water supply in Starehe constituency

According to Kothari (2008), primary data refers to information that a researcher gathers from the field. This primary data was obtained from the respondent's answered questionnaire which was distributed for filling. Additional secondary data was obtained from the records and reports of earlier studies in done by the NCWSC on related topics and data was obtained from the NCWSC website.

4.5.3 The influence of urban sprawl on alternative approaches to the provision of water supply in Starehe constituency

Primary data concerning this objective was obtained from the questionnaire administered to the respondents. Secondary information on the objective was also available for the study which was obtained from the latest records and reports of the KNBS. Other additional data was obtained from newspapers and publications on the topic of urban sprawl.

4.5.4 The influence of government policy on alternative approaches to the provision of water supply in Starehe constituency

The primary data concerning the influence of government policies on the integration of alternative supplies into the mainstream was collected through self-administered questionnaires that were given out to the respondents for study and filling. Secondary data was obtained from the ministry of water in Nairobi County on the government policies and the reports and records done by the NCWSC.

4.5.5 The level of satisfaction in terms of efficiency, reliability and quality on alternative water provision in Starehe Constituency

The sampled respondents were the original sources of the primary data obtained through the distribution of self-administered questionnaires. Cooper and Schindler (2014) argued that the questionnaire is definite, concrete and already determined questions, which are presented with exactly the same phrasing or language and also in the same order to all the respondents. Some extra data was obtained from every available source published and reports done by the NCWSC. Secondary data was obtained from every available document and also in NCWSC website for records and reports of related research problem

4.6: Research Procedures

The researcher informed the respondents that the instruments being administered are for the research purposes only and the responses from the respondents were kept confidential. The researcher then obtained an introductory letter from the University of Nairobi, School of Built Environment, Department of Building Science in order to collect data from the field. The study respondents were informed of their rights to refuse to participate in the study without giving reasons where the researcher assured them of the confidentiality of the data given. The respondents were assured of anonymity where the results of the findings shall be availed to the interested respondent upon request to the researcher. Before the questionnaire administration, the researcher tested the data collection tools for reliability and validity where the validity was done by the university supervisors who examined the questions against the study objectives to confirm if the questions have captured the objectives correctly. The reliability test was conducted by the use of a pilot test.

Pilot studies are important in detecting ambiguity, evaluating the type of answers given to determine whether they help the researcher to achieve the laid down objectives (Robson, 2007). After being developed, the draft questionnaires were presented pre-tested. The main purpose of conducting a pilot study is to detect and remedy any possible errors in questionnaire design prior to administering the main survey (Cavana *et al.,* 2001) and typically, to refine and revise the questionnaire to help ensure the validity and reliability of the measures, as well as making it more user-friendly.

Mugenda and Mugenda (2003) reported that a pre-test sample should be between 1% and 10% depending on the sample size. In terms of a pilot sample, Hunt, ParKMan and Wilcox (1982) and Green *et al.* (1988) share the opinion that pre-test subjects should be as similar as possible to the final group, representative but with extreme as well as typical respondents, or more succinctly,

should mirror the composition of the main survey. However, convenience sampling is also often used to generate a sample for the pilot study (Calder *et al.,* 1981) with a recommended sample size of between 12 and 30 (Hunt *et al.,* 1982) or between 25 and 100 (Emory & Cooper 1991).

The pilot test of the study was conducted using a percentage of 10 percent of the sample size that is 40 respondents on other wards other than those in Starehe constituency such as Upper Savanna Ward, before starting the data collection exercise. This is done to ensure that there is instrument reliability and instrument validity. The pilot study data was then be analyzed using SPSS version 22 where the results that indicate a Cronbach's alpha of 0.7 and above gives good reliability statistics hence the questionnaires can be used for the data collection exercise. The results from the pilot study was then be used to improve and strengthen the data collection exercise.

The researches participants were protected from harm, given informed consent, rights to privacy, and honesty with professional colleagues (Leedy & Ormrod, 2005). Participants were not exposed to undue physical or psychological harm. Steps were taken to ensure participants are not subjected to unusual stress, embarrassment, or loss of self-esteem. Informed consent is critical in the research study. Participants were informed of the nature of the study and given the option to participate or not. The informed consent form contained details about the study that is involved in such type of activity and duration of participation, nature of participation and the option to withdraw without penalty, guarantee of anonymity and confidentiality.

In this research to ensure anonymity of the respondents, names were not necessary to be known to the researcher. The participants were assured that the data was only going to be used for the study purposes and that no other person would be having access to the research data (Bless & Higson-Smith, 2000).

Researchers have an obligation to report findings completely and honestly without misrepresentation or misleading others regarding the findings (Leedy & Ormrod, 2005). According to Kombo and Tromp (2009), data collection is important in research because it allows for the dissemination of accurate information and development of meaningful programmes.

4.7: Data Analysis Methods

Objective 1: To establish the influence of infrastructure on alternative approaches to the provision of water supply in Starehe constituency

Collected data was checked for completeness then coded into SPSS version 22 for the purposes of analysis. Data relating to infrastructure was coded from the likert scale of 1-5 into the SPSS data sheet where analysis was then conducted to make deductions from the coded data. There was a pilot test conducted on the 10% (n=34) of the sample population where the reliability test, KMO and Bartlett's Test, Normality Test, Multicollinearity Test and Homoscedasticity Test was conducted as test for assumptions of regression. The researcher then conducted cross-sectional design statistics such as percentages and frequency of responses after which regression analysis was conducted to give the relationship between the dependent and the independent variables. The regression had the output for ANOVA Test where the F-values was obtained to test the significance of the model, the model summary gave the overall representation of the variables and the coefficients gave the contribution of each dependent variable to the independent variable of the study.

Objective 2: To find out the influence of institutional capacity on alternative approaches to the provision of water supply in Starehe constituency

Collected data was checked for completeness then coded into SPSS version 22 for the purposes of analysis. Data relating to institutional capacity was coded from the likert scale of 1-5 into the SPSS data sheet where analysis was then conducted to make deductions from the coded data. There was a pilot test conducted on the 10% (n=34) of the sample population where the reliability test, KMO and Bartlett's Test, Normality Test, Multicollinearity Test and Homoscedasticity Test was conducted as test for assumptions of regression. The researcher then conducted cross-sectional design statistics such as percentages and frequency of responses after which regression analysis was conducted to give the relationship between the dependent and the independent variables. The regression had the output for ANOVA Test where the F-values was obtained to test the significance of the model, the model summary gave the overall representation of the variables and the coefficients gave the contribution of each dependent variable to the independent variable of the study.

Objective 3: To examine the influence of urban sprawl on alternative approaches to the provision of water supply in Starehe constituency

Collected data was checked for completeness then coded into SPSS version 22 for the purposes of analysis. Data relating to urban sprawl was coded from the likert scale of 1-5 into the SPSS data sheet where analysis was then conducted to make deductions from the coded data. There was a pilot test conducted on the 10% (n=34) of the sample population where the reliability test, KMO and Bartlett's Test, Normality Test, Multicollinearity Test and Homoscedasticity Test was conducted as test for assumptions of regression. The researcher then conducted cross-sectional design statistics such as percentages and frequency of responses after which regression analysis was conducted to give the relationship between the dependent and the independent variables. The regression had the output for ANOVA Test where the F-values was obtained to test the

significance of the model, the model summary gave the overall representation of the variables and the coefficients gave the contribution of each dependent variable to the independent variable of the study.

Objective 4: To determine the influence of government policy on alternative approaches to the provision of water supply in Starehe constituency

Collected data was checked for completeness then coded into SPSS version 22 for the purposes of analysis. Data relating to government policy was coded from the likert scale of 1-5 into the SPSS data sheet where analysis was then conducted to make deductions from the coded data. There was a pilot test conducted on the 10% (n=34) of the sample population where the reliability test, KMO and Bartlett's Test, Normality Test, Multicollinearity Test and Homoscedasticity Test was conducted as test for assumptions of regression. The study then conducted cross-sectional design statistics such as percentages and frequency of responses after which regression analysis was conducted to give the relationship between the dependent and the independent variables. The regression had the output for ANOVA Test where the F-values was obtained to test the significance of the model, the model summary gave the overall representation of the variables and the coefficients gave the contribution of each dependent variable to the independent variable of the study.

Objective 5: To investigate the level of satisfaction in terms of efficiency, reliability and quality on alternative water provision in Starehe constituency

Collected data was checked for completeness then coded into SPSS version 22 for the purposes of analysis. Data was coded from the likert scale of 1-5 into the SPSS data sheet where analysis was then conducted to make deductions from the coded data. There was a pilot test conducted on

the 10% (n=34) of the sample population where the reliability test, KMO and Bartlett's Test, Normality Test, Multicollinearity Test and Homoscedasticity Test was conducted as test for assumptions of regression. The researcher then conducted cross-sectional design statistics such as percentages and frequency of responses after which regression analysis was conducted to give the relationship between the dependent and the independent variables. The regression had the output for ANOVA Test where the F-values was obtained to test the significance of the model, the model summary gave the overall representation of the variables and the coefficients gave the contribution of each dependent variable to the independent variable of the study.

The following regression analysis was then tested:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_3 X_4 + €$$

Where Y = dependent variable (alternative water supply)

α = constant

β_1, $\beta 2$, β_3 and β_4 are coefficients of independent variable variables

X_1, X_2, X_3 and X4= are independent variables (Infrastructure, Institutional capacity, urban sprawl and government policy

€ is the error term which captures the unexplained variations in the model.

CHAPTER FIVE: DATA ANALYSIS AND PRESENTATION

5.1: Introduction

Chapter four gives result of the analyzed data using SPSS. The results are presented inform of tables and graphs for ease of understanding and interpretation. The results are organized under the following sub-thematic areas: demographic information of the respondent, levels of satisfaction, efficiency, reliability and quality on alternative water provision and government policy.

5.2 Demographic Information

5.2.1 Gender

The study findings in figure 5.1 indicate that majority of the respondents are male (55%, n=218) followed by the female respondents (45%, n=181). The small merging between the male and female respondents indicate that the study was not gender biased thus the findings obtained for the study represent contributions from all genders regarding the study objectives.

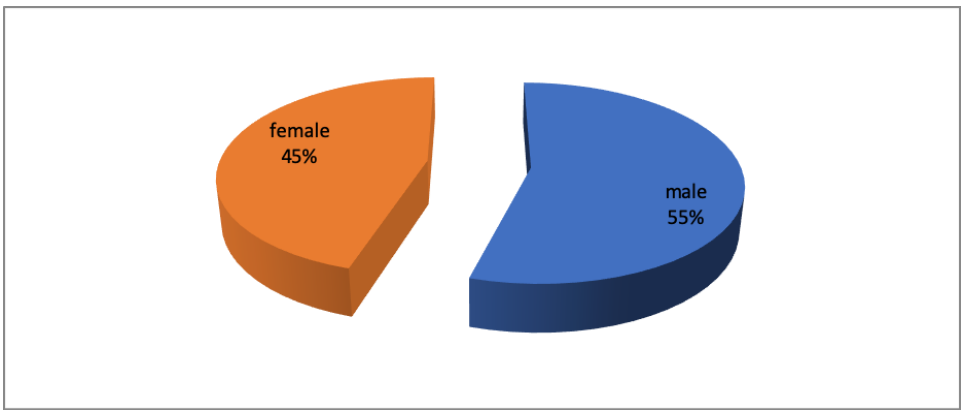


Figure 10: Gender

5.2.2 Level of Education

The study findings in figure 5.2 indicate that majority of the respondents had primary level of education (35%, n=141), followed by those with secondary level of education (24%, n=95) while post-graduate level of education was the least with 9% (n=39). The levels of education did not affect the study findings since the respondents were carefully selected using a scientific method of sampling to ensure objectivity of the data collected. For the illiterate respondents who had primary level of education, the researcher administered the questionnaires to them by the help of research assistants who were able to read interpret to them the content of the questionnaire.

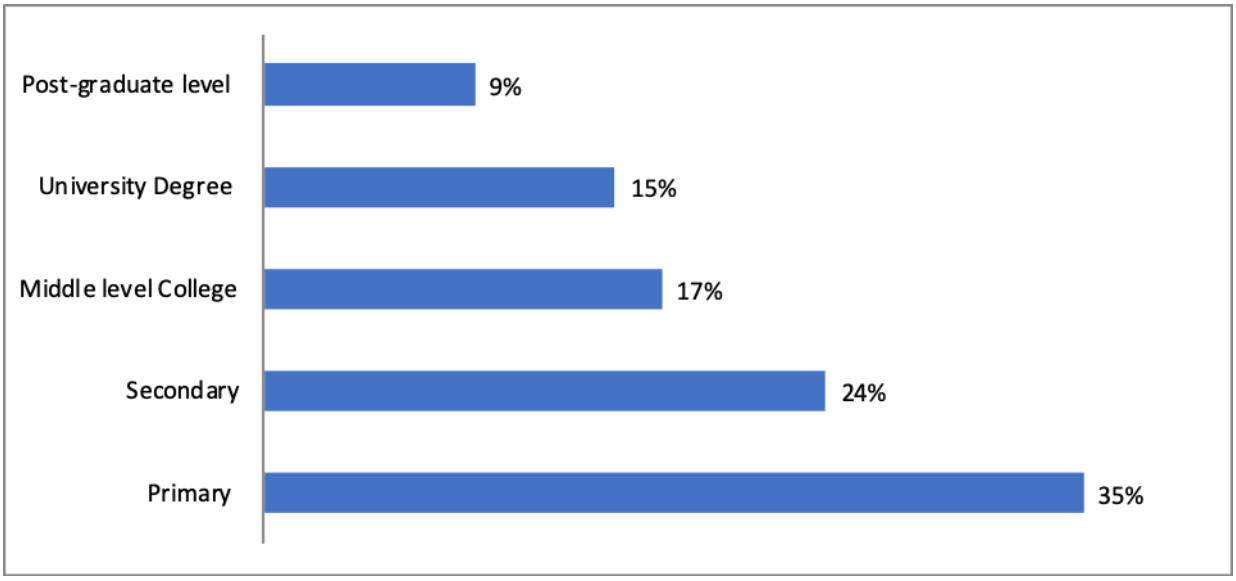


Figure 9: Level of Education

5.2.3 Employer

The study findings in figure 5.3 indicate that majority of the respondents are self-employed as given by 64% (n=257) of the response followed by those working for the NGO as given by 20% of the response (n=81). The study did not target any specific characteristic of individuals with respect to employment status thus the high number of self-employed respondents was as a result

of the demographic of Starehe constituency which contains the CBD, Muthurwa Market, Marigiti market and Gikomba market.

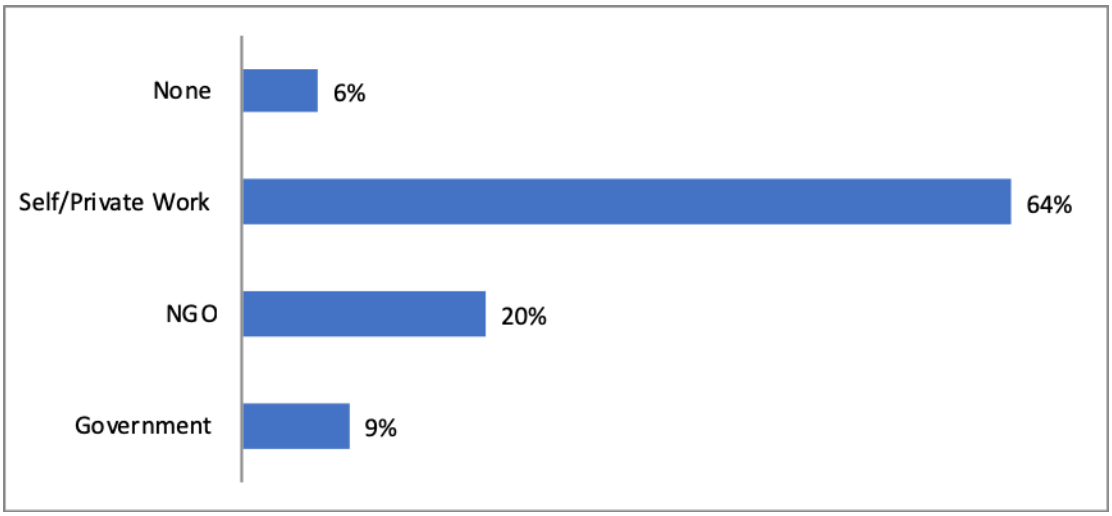


Figure 11: Employer

5.3: The Influence of Infrastructure on Alternative Approaches to the Provision of Water Supply

The study established the influence of infrastructure on alternative water provision in Starehe constituency where the respondents were requested to respond to the following statements in a scale of 1-5 where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1] as given in table 5.1.

Table 1: The Influence of Infrastructure on Alternative Approaches to the Provision of Water Supply

NO	Statement		1	2	3	4	5	Totals
1	There is poor water infrastructure used in the water supply in urban centers	%	11	13	9	38	29	100%
		f	38	45	31	130	99	343
2	The existing infrastructure capacity is able to supply enough water to the residents of Starehe constituency	%	16	20	7	32	25	100%
		f	55	69	24	110	85	343
3	There is adequate infrastructure for the supply of water to residents of Starehe constituency	%	12	18	7	35	28	100%
		f	41	62	24	120	96	343
4	There is vandalism to the water supply equipment's that affects water supply to the residents of Starehe constituency	%	13	19	6	33	29	100%
		f	45	65	21	113	99	343
5	The slow pace of replacement of water systems of the aging equipment's affects the water supply	%	16	22	5	31	26	100%
		f	55	75	17	106	89	343
6	The existence of modern technology in the infrastructure development of water equipment's supports water supply to the residents of Starehe constituency	%	27	41	4	15	13	100%
		f	92	141	14	51	45	343
7	There is no aged equipment in the supply of water system due to constant replacements in Starehe constituency	%	31	44	6	12	7	100%
		f	106	153	20	41	24	343

5.4: The Influence of Institutional Capacity on Alternative Approaches to the Provision of Water Supply

The respondents were asked to use a rating-scale of 1-5 where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2] and Strongly Disagree [1] to give the extent of agreement with the following statements on the influence of institutional capacity on alternative approaches to the provision of water supply.

Table 2: The Influence of Institutional Capacity on Alternative Approaches to the Provision of Water Supply

NO	Statement		1	2	3	4	5	Totals
1	The existing institutions have adequate capacity for the alternative approaches to the provision of water supply	%	40	32	2	10	16	100%
		f	137	110	7	34	55	343
2	The existing institutions are adequate to support the management of alternative approaches to the provision of water supply	%	42	34	5	9	10	100%
		f	144	117	17	31	34	343
3	There is a conflict of interest among the institutions charged with the management of alternative approaches to the provision of water supply	%	38	31	7	14	10	100%
		f	130	107	24	48	34	343
4	The existing institutions are able to effectively manage compliance for the alternative approaches to the provision of water supply	%	30	37	7	15	11	100%
		f	103	127	24	51	38	343
5	The existing water institutions conduct their duties within the mandate and they are effective in water management	%	36	27	1	14	22	100%
		f	123	93	3	48	76	343

The study results in Table 5.2 indicate that majority of the respondents observed that the existing institutions have no adequate capacity for the alternative approaches to the provision of water supply as given by 40% (n=137) of the respondents that strongly agreed followed by 32% (n=110) of the respondents who strongly disagreed. The study also indicated that the existing institutions are not adequate to support the management of alternative approaches to the provision of water supply as given by 42% (n=144) for strongly disagree and 32% (n=117) for disagree of the response obtained. Further, the study indicated that there is a conflict of interest among the institutions charged with the management of alternative approaches to the provision of water supply as given by 38% (n=130) for strongly disagree and 31% (n=107) for agree.

5.5 The Influence of Urban Sprawl on Alternative Approaches to the Provision of Water Supply

The respondents were asked to give the extent of agreement with the following statements regarding urban sprawl on alternative water provision using the rating-scale of 1-5 where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2] and Strongly Disagree [1]. The study results are as given in Table 5.3.

Table 3: Influence of Urban Sprawl on Alternative Approaches to the Provision of Water Supply

NO	Statement		1	2	3	4	5	Totals
1	The movement of population settlement from crowded urban centers to less dense areas has affected alternative approaches to the provision of water supply	%	20	25	3	29	23	100%
		f	69	86	10	99	79	343
2	The existence of low-density settlement has negatively affected the alternative	%	21	10	9	35	25	100%
		f	72	34	31	120	86	343

	approaches to the provision of water supply							
3	The crowding of population settlements has negatively affected the alternative approaches to the provision of water supply	%	15	16	5	30	34	100%
		f	51	55	17	103	117	343
4	The culture of settlement away from urban centers has negatively affected the alternative approaches to the provision of water supply	%	13	17	3	29	38	100%
		f	45	58	10	99	131	343

The study findings in Table 5.3 indicate that the movement of population settlement from crowded urban centers to less dense areas has affected alternative approaches to the provision of water supply as given by 29% (n=99) for agree and 23% (n=79) for strongly agree. The study also established that the existence of low-density settlement has negatively affected the alternative approaches to the provision of water supply as given by 35% (n=120) for agree and 25% (n=86) for strongly agree. The study also indicated that the crowding of population settlements has negatively affected the alternative approaches to the provision of water supply as given by 30% (n=103) for agree and 34% (n=117) for strongly agree.

5.6 The Influence of Government Policy on Alternative Approaches to The Provision of Water Supply

The respondents were asked to give the extent of agreement with the following statements regarding government policy and recommendations on alternative water provision using the

rating-scale of 1-5 where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2] and Strongly Disagree [1].

Table 4: The Influence of Government Policy on Alternative Approaches to the Provision of Water Supply

NO	Statement		1	2	3	4	5	Totals
1	Government has increased its supply of water to the informal sectors of the city through the private sectors	%	27	25	6	22	20	100%
		f	92	86	21	75	69	343
2	Government has put in place adequate policies to ensure that households have good alternative water supply	%	21	38	8	15	18	100%
		f	72	130	27	52	62	343
3	The existing government policies are able to adequately address issues of efficiency in alternative water supply	%	25	36	9	17	13	100%
		f	86	123	31	58	45	343
4	The existing government policies enhances reliability of alternative water supply in the area	%	23	47	7	15	8	100%
		f	79	162	24	51	27	343
5	The existing government policies ensures quality on alternative water supply to the public	%	28	46	4	16	6	100%
		f	96	158	14	55	20	343
6	The existing government policies are comprehensive enough to cover alternative water supply in the area	%	26	32	5	21	16	100%
		f	89	109	17	72	56	343

The study findings in Table 5.4 indicate that the Government has not increased its supply of water to the informal sectors of the city through the private sectors as given by 27% (n=92) for strongly disagree and 25% (n=86) for disagree. The study also indicated that the Government has not put in place adequate policies to ensure that households have good alternative water supply as given by 21% (n=72) for strongly disagree and 38% (n=130) for disagree. The study also

indicated that the existing government policies are able to adequately address issues of efficiency in alternative water supply as given by 25% (n=86) for strongly disagree and 36% (n=123) for disagree.

5.7 The Level of Satisfaction, Efficiency, Reliability and Quality on Alternative Water Provision

The respondents were asked to state the influence of institutional capacity on alternative water provision in Starehe constituency using a scale of 1-5 where [5] strongly Agree, Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1] as given in Table 5.5 below:

Table 5: Levels of Satisfaction, Efficiency, Reliability and Quality on Alternative Water Provision

NO	Statement		1	2	3	4	5	Totals
1	Water supplied by the private sector satisfies the needs of the residents	%	39	28	6	12	15	100%
		f	134	96	21	41	51	343
2	There is an increased efficiency in the provision of water in the private sector has increased the bond between households and suppliers	%	40	36	6	8	10	100%
		f	137	123	21	28	34	343
3	The alternative water provision is very reliable with respect to the quality of water supplied	%	38	29	9	11	13	100%
		f	130	99	31	38	45	343
4	The alternative water provision is very reliable with respect to the timely delivery upon demand	%	32	35	7	16	10	100%
		f	109	121	24	56	34	343
5	There is easy access of alternative water supply in Starehe constituency	%	35	28	3	12	22	100%
		f	120	96	10	41	76	343
6	Clear structure of management of the	%	33	29	6	13	19	100%

	water supply by the private sector has increased the revenues of the private institutions.	f	113	99	21	46	64	343
7	There is good efficiency in supply of alternative water supply	%	39	36	5	9	11	100%
		f	134	123	17	31	38	343

The study findings in Table 4.5 indicate that water supplied by the private sector does not satisfy the needs of the residents as given by 39% (n=134) for strongly disagree and 28% (n=96) for disagree. The study also indicates that there is no efficiency in the provision of water in the private sector has increased the bond between households and suppliers as given by 40% (n=137) for strongly disagree and 36% (n=123) for disagree. Further, the study indicates that the alternative water provision is not reliable with respect to the quality of water supplied as given by 38% (n=130) for strongly disagree and 29% (n=99) for disagree.

5.8 Alternative Water Supply

The respondents were asked to give the extent of agreement with the following statement on alternative water supply using a scale of 1-5 where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2] and Strongly Disagree [1].

Table 6 Alternative Water Supply

NO	Statement		1	2	3	4	5	Totals
1	We regularly use alternative water supply whenever the supply from Nairobi water fails	%	7	12	6	44	31	100%
		f	24	41	21	151	106	343
2	We get our water from the tap water vendors	%	6	16	5	43	30	100%
		f	21	55	17	147	103	343
3	We always buy water from Water kiosks	%	4	14	5	42	35	100%
		f	14	48	17	144	120	343
4	We do buy water from borehole water vendors	%	11	14	6	38	31	100%
		f	38	48	21	130	106	343
5	We regularly buy water from pushcart vendors	%	14	21	8	28	29	100%
		f	48	72	27	97	99	343
6	We always buy water from tanker trucks	%	5	10	16	33	36	100%
		f	17	34	55	113	124	343

The respondents observed that they regularly use alternative water supply whenever the supply from Nairobi water fails as given by 44% (n=151) for agree and 31% (n=106) for strongly agree. The study respondents also indicated that they get their water from the tap water vendors as given by 43% (n=147) for agree and 30% (n=103) for strongly agree. Further, the study indicated that the respondents always buy water from water kiosks as given by 42% (n=144) for agree and 35% (n=120) for strongly agree.

5.9 Diagnostic Statistics

5.9.1 Reliability Analysis

Table 7: Cronbach's Alpha

Variables	Cronbach's Alpha	No. of Items
Infrastructure	.855	34
Institutional capacity	.792	34
Urban sprawl	.815	34
Government policy	.814	34
Alternative water supply	.832	34

Reliability of this instrument was evaluated through Cronbach Alpha which measures the internal consistency. Cronbach Alpha value is widely used to verify the reliability of the construct. The study findings in Table 4.7 on the pilot test shows that 'Infrastructure' factor had a Cronbach's reliability alpha of 0.855, 'institutional capacity' had an Alpha value of 0.792, 'Urban sprawl' factor had an Alpha value of 0.815, 'Government policy' factor had a reliability value of 0.826 and alternative water supply factor had a reliability of 0.832. The pilot test showed that the scales measuring the objectives had a very high reliability and therefore no amendment on the objectives was necessary. This implied that the research instruments were adequate, objective and had reasonable internal consistency to give very reliable results. Zinbarg (2005) states that an alpha coefficient of 0.80 or higher indicates that the gathered data are reliable as they have a relatively high internal consistency and can be generalized to reflect opinions of all respondents in the target population about the study problem.

5.9.2 KMO and Bartlett's Test

Table 8: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.002
Bartlett's Test of Sphericity	Approx. Chi-Square	370.416
	df	32
	Sig.	.000

Kaiser-Meyer-Olkin Measure (KMO) of sampling adequacy and Bartlett's Test of Sphericity tests were conducted to establish data's sampling adequacy on to determine if there is a need for factor reduction in the study. The obtained Kaiser-Meyer-Olkin measures of sampling adequacy indicates that the value of test statistic is 0.002 which is less than 0.05 implying that factor analysis will not yield distinct and reliable factors hence there is no need of conducting factor analysis in the study. Bartlett's test of sphericity is used to test whether the data is statistically significant or not. With the value of test statistic and the associated significance level, it shows that there is a relationship among variables since the significance value is less than 0.05 testing at 5% significance level using a one tail test ($p<0.05$) implying that the sample size used was adequate for the study.

According to Cerny and Kaiser (1977), Kaiser-Meyer-Olkin (KMO) Test is a measure of how suited your data is for factor analysis. The test measures sampling adequacy for each variable in the model and for the complete model. The statistic is a measure of the proportion of variance among variables that might be common variance. Williams, Brown and Onsman (2012) stated

that KMO of 0.50 is acceptable degree for sampling adequacy and KMO measure that varies between 0 and 1, and values closer to 1 are better with a threshold of 0.5.

5.9.3 Normality Test

Table 9: Shapiro-Wilk

Variables	Statistic	Df	Sig.
Infrastructure	.969	32	.000
Institutional capacity	.744	32	.000
Urban sprawl	.848	32	.000
Government policy	.978	32	.000
Alternative water supply	.875	32	.000

The normality was tested using the Shapiro-Wilk test, which also has power to detect departure from normality due to either skewness or kurtosis or both. The findings in table 4.9 indicate that since the significance value is less than the alpha value (0.05 testing at 5% one tail test), then one concludes that all the results of the Shapiro-Wilk test are normally distributed (Sig 0.000 <0.05). Normality tests are done to determine whether the sample data has been drawn from a normally distributed population. Normality assessment can be done by using a graphical or numerical procedure. The numerical procedures include inferential statistics such as Kolmogorov-Smirnov and Shapiro-Wilk. According to Razali and Wah (2011), Shapiro-Wilk test assesses whether data is normally distributed against hypothesis whereby if statistic ranges from 0 to 1 and figures higher than 0.05 indicate the data is normally distributed. He further observed that Kolmogorov-Smirnov test is considered appropriate for samples larger than 2000 while Shapiro-Wilk test is deemed appropriate for samples ranging from 50 to 2000. In this study, the usable response rate was 310 and hence Shapiro-Wilk test was used.

5.9.4 Multicollinearity Test

Table 10: Multicollinearity

	Tolerance	**VIF**
Infrastructure	.768	1.656
Institutional capacity	.694	1.710
Urban sprawl	.972	1.433
Government policy	.843	1.225

To confirm that there was non-multicollinearity in the model, all the independent variables were shown to have tolerances of values above 0.2 and VIFs of below 5.0 as given in table 5.4, this is supported by the findings of Ringle *et al*., (2015) who observed that the maximum level for the VIF range is 5 while Hair *et al*., 2010 observed that the tolerance value for multicollinearity should be below 0.2. Multicollinearity is exhibited if one or more independent variables can be expressed in terms of the other independent variables. That would imply that the independent variables are not truly independent of each other as assumed by fitting the OLS model. The fitted OLS model assumed that the independent variables do not exhibit multicollinearity.

Mugenda and Mugenda (2012), posit that multicollinearity can occur in multiple regression models in which some of the independent variables are significantly correlated among themselves. Multicollinearity is a situation that occurs when the independent variables are highly correlated (Martz, 2013). If an independent variable has a tolerance of less than 0.2, it implies that the independent variable shares more than 80% of its variance with another independent variable in the model.

5.9.5 Homoscedasticity Test

Table 11: Homoscedasticity Test Results

Variable	Levene Statistic	df1	df2	Sig.
Infrastructure	14.845	32	341	.000
Institutional capacity	49.740	32	341	.000
Urban sprawl	38.110	32	341	.000
Government policy	73.396	32	341	.000

The results given in Table 5.11 gives the findings of test for homogeneity where the probability associated with the Levene Statistic is more than the level of significance (0.05) testing at 5% significance level for all variables (P>0.05); the researcher therefore concludes that the variance is homogeneous. Knaub, J. (2007) observed that if the level of Leven Statistics is more than 0.05 then the data is homogenous. The study findings had the homoscedasticity test evaluated for pairs of variables using the levene statistic for the test of homogeneity of variances.

5.10 General Regression Analysis

The study found out that the independent variable in the study explained a significant proportion of variance in dependent variable R^2= 0.783 which implies that 78.3% of the proportion in alternative water supply can be explained by the independent variable variables while other variables not covered by this study contributes to 21.7% of the variance as indicated in table 5.11.

Table 12: Model Summary for Variables

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.783[a]	.613	.657	1.743
a. Independent variables: (Constant), Infrastructure, Institutional capacity, Urban sprawl and Government policy.				

Table 13: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.654	4	8.654	71.175	.000[b]
	Residual	4.978	9	.365		
	Total	13.632	13			
a. Dependent Variable: alternative water supply						
b. Independent variables: (Constant), Independent variables: (Constant), Infrastructure, Institutional capacity, Urban sprawl and Government policy						

The findings in table 5.12 indicate that the significance value in testing the reliability of the model for the relationship between independent variable variables and alternative water supply was $F(1, 13) = 71.175$, $p = 0.000$; therefore, the model is statistically significant in predicting the relationship between the study variables.

Table 14: Regression Coefficients for all the Variables

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	.952	.290	.332	1.356	.000
	Infrastructure	.425	.336	.754	1.124	.000
	Institutional capacity	.346	.373	.375	1.497	.000

	Urban sprawl	.248	.665	.788	1.647	.000
	Government policy	.102	.498	.354	1.543	.000
a. Dependent Variable: alternative water supply						

Based on the linear regression model, $Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + u$, the model therefore becomes; $Y = 0.952 + 0.425\ X_1 + 0.346X_2 + 0.248X_3 + 0.102X_4 + u$

Where Y = dependent variable (alternative water supply)

α = constant

$\beta_1, \beta_2, \beta_3$ and β_4 are coefficients of independent variable variables

X_1, X_2, X_3 and X4= are independent variables (Infrastructure, Institutional capacity, urban sprawl and government policy)

Testing at 5% significant level, the regression analysis in table 4.33 is significant since all the p-values (Sig. $p<0.025$) testing at 2 tail tests. The findings indicate that that every increase in Infrastructure by 42.5%, increase in institutional capacity by 34.6%, increase in urban sprawl by 24.8% and increase of government policy by 10.2% would increase alternative water supply by 100% taking into considerations the constant value and the value for the standard error.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATION

6.1: Introduction

This chapter presents summary of the findings, conclusions and recommendations of results of the study that sought to assess the alternative approaches in the provision of water and sewerage services in Starehe Constituency. This is in line with the objectives of the study and the study suggests further areas of research.

6.2: Summary

6.2.1: The influence of infrastructure on alternative approaches to the provision of water supply in Starehe constituency

The study discovered that there is poor water infrastructure set up used for water supply in urban centers. Although the existing infrastructure capacity is able to supply enough water to the residents of Starehe Constituency and the neighboring Constituency in the county. The study also indicates that there is adequate infrastructure necessary for the supply of water to the residents of Starehe Constituency to their satisfaction.

The study discovers that there are high rates of vandalism to the water supply equipment's that affects water supply to the residents of Starehe constituency while other respondents disagree to that indicating that it occurs in certain sections of the constituency. After vandalism there is slow pace of replacement of damaged or aging equipment's this in turn may lead to water leakage hence shortages.

The study indicates that there is limited use of modern technology in the infrastructure development of water equipment's that supports water supply to the residents of Starehe

Constituency. The study indicates that the supply equipment's are aged due to lack of replacements by the water board since installation.

6.2.2 The influence of institutional capacity on alternative approaches to the provision of water supply in Starehe constituency

The study results indicate that majority of the respondents observed that the existing institutions have not adequate capacity for the alternative approaches to the provision of water supply. The study also indicate that the existing institutions are not adequate to support the management of alternative approaches to the provision of water supply. Further, the study indicated that there is a conflict of interest among the institutions charged with the management of alternative approaches to the provision of water supply.

The study indicates that institutions charged with the management of alternative provision of water supply have a common goal of interest are closing working together in provision. Although the institutions are not able to effectively manage compliance for the alternative approaches to the provision of water supply. According to the respondents the institutions have failed to conduct their duties within the mandate are poor in management of water.

6.2.3 The influence of urban sprawl on alternative approaches to the provision of water supply in Starehe constituency

The study findings indicate that the movement of population settlement from crowded urban centers to less dense areas has affected alternative approaches to the provision of water supply. The study also established that the existence of low-density settlement has negatively affected the alternative approaches to the provision of water supply. The study also indicated that the

overpopulated settlements have negatively affected the alternative approaches to the provision of water supply.

The study discovers that the culture of settlement away from urban center has negatively affected the alternative approaches to the provision by increasing distance hence increasing the cost of equipment's used for alternative supply

6.2.4 The influence of government policy on alternative approaches to the provision of water supply in Starehe constituency

The study indicate that the Government has not increased its supply of water to the informal sectors of the city through the private sectors. The study also indicated that the Government has not put in place adequate policies to ensure that households have good alternative water supply. The study also indicated that the existing government policies are able to adequately address issues of efficiency in alternative water supply.

The study indicates that government policies does not enhance reliability of water supply in the area. The government policies available are not able to comprehensively cover alternative water supply in the area.

6.2.5 The level of satisfaction in terms of efficiency, reliability and quality on alternative water provision in Starehe Constituency

The study findings indicate that water supplied by the private sector does not satisfy the needs of the residents. The study also indicates that there is no efficiency in the provision of water in the private sector has increased the bond between households and suppliers. Further, the study indicates that the alternative water provision is not reliable with respect to the quality of water supplied.

According to the finding there is difficulty in accessing of alternative water supply in Starehe Constituency. The study also indicates that there is no clear structure of management of water supply by the private sector has increased the revenues of the private institutions. The study further indicates that there is poor efficiency in supply of alternative water supply in the area. The study discovered that residents of Starehe constituency have no easy access to alternative water supply.

6.2.6 Alternative Water Supply

The respondents observed that they regularly use alternative water supply whenever the supply from Nairobi water fails. The study respondents also indicated that they get their water from the tap water vendors. Further, the study indicated that the respondents always buy water from water vendors, borehole water vendors, pushcarts vendors and tanker trucks.

6.3 Conclusion

From the study findings it was found that alternative water supply in Starehe constituency is dependent on infrastructure, institutional capacity, urban sprawl and government policies. Hence there is need for development of infrastructure aimed at ensuring that there is continuous supply of water. This will be possible through institutional capacity building and compliance with government policies aimed at supporting alternative modes of water supply that is dependent on population demand. The study concludes that the level of satisfaction, efficiency and quality on model of water supply is in response to demand. It also concludes that there is no clear structure of management of water supply by the private sector and this is the cause of all the problems related to alternative water supply.

The first objective of the study investigated the influence of infrastructure in alternative water supply in Starehe constituency. The study documented positive and significant influence of infrastructure in alternative models of water supply in Starehe constituency. It can be concluded that there is need for provision of reliable infrastructure to enhance water supply. This would be possible through technological adoption to minimize odds of vandalism.

Secondly, there was a positive and significant influence of institutional capacity on alternative water supply in Starehe constituency. This implies that there is need for capacity building and advocacy on compliance with laid down procedures. This would be possible through management of conflicts via win-win model.

Urban sprawl had positive and significant influence on alternative water supply in Starehe constituency. There is need for matching water supply models with the rates of population changes in Starehe constituency. Starehe being densely populated with some areas being slums, there is need for adoption of water supply model that would be consistent and reliable. Further, pricing models adopted may deter water access thus there is need to adopt blended approach to minimize odds of lacking water.

Government policy had positive and significant influence on alternative approaches to water supply. This implies that there is need for adoption of water supply policies that are clear, enforceable and responds adequately to people's needs. The government policies should be flexible to demand of water supply in different parts of the country.

6.4 Recommendations

The study recommends for the review of the existing government policy regarding water use and strengthening of existing institution for efficient regulation and control of water use among urban residents. The study further recommends for the institutions involved in alternative supply of water to take into serious consideration of the customer satisfaction, efficiency in supply, reliability and the quality of water supplied to the households and business sectors. They should improve and maintain high level of services provided during the provision.

The study recommends for the frequent monitoring of water quality by the private sector also frequent monitoring of maintenance and good conditions of the systems. This will improve the quality of water a necessary factor in the demand for alternative supply.

The study also recommends the government in association with the Nairobi City Water and Sewerage Company to subcontracting of specialized maintenance jobs to the private sector and also connections to the informal sector of the constituency. This will increase the supply and access of households to water supply.

The study recommends that the private sectors should come up with better and clear structures of management to be able to handle all the issues and maintain efficient water supply to all the informal sectors making sure every household has access to clean water supply.

6.5 Management Framework

What this study has highlighted is that a wide consultation process involving a range of stakeholders can operate effectively to enable informed participation. It is often argued that beneficiaries need to contribute to a project in order to achieve 'ownership', and that without local contributions there is no way of ensuring that the project really is serving local needs.

Moreover, it is commonly held that local knowledge is critical to good project design, and that local participation gives the beneficiaries more control over local development. Key lessons from the study shows that principles such as more participation from the government, private sector, civil society, residents and stakeholder consultation, cooperation, collaboration and coordination are critical ingredients to the solution of provision of water to underserved areas of Nairobi through alternative water supply methods. From the study the identified stakeholders engaged in the implementation as agency responsible for provision of infrastruture and delivery of services to the residents and business owners of Starehe are: -

i. Government - Nairobi County Water and Sewerage Services, Nairobi County, Water Regulatory Services Board, Athi Water Services Board;

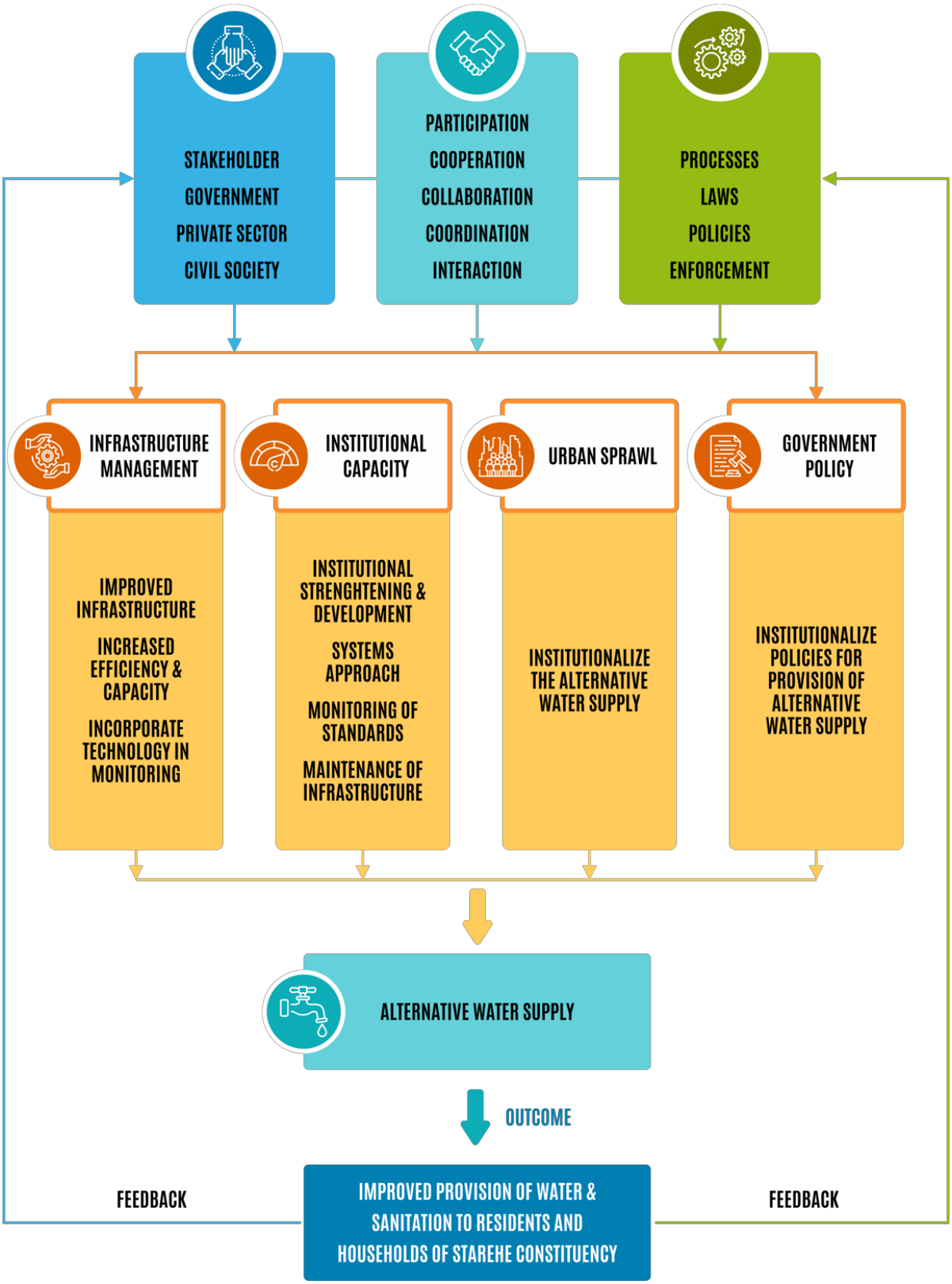
ii. Private Sector – Water Vendors;

iii. Civil Societies - CBOs and Religious-based organizations helping local residents with water provision and

iv. Residents and. Business Owners - The final consumers of water, who had a stake in an affordable, safe, sufficient and reliable water supply.

The study recommends the realignment of the water sector reforms to regularize a framework for alternative water supply where the framework is embedded in the management and operation of the water system into the sector's regulatory framework so as to guarantee the protection of the interests and the rights of the consumers and to ensure that water services are provided according to the national standards. These measures can include the development of point sources (boreholes), small scale piped systems and stand pipes which meets the standards by the Regulatory Board and may be managed by community associations, public benefits

organizations or a private person under a contract by the county government. The monitoring and evaluation system to be able to track progress and take stock of valuable lessons and good practices form the partnerships formed which can then be replicated in other underserved areas.


STAKEHOLDER
GOVERNMENT
PRIVATE SECTOR
CIVIL SOCIETY
PARTICIPATION
COOPERATION
COLLABORATION
COORDINATION
INTERACTION
PROCESSES
LAWS
POLICIES
ENFORCEMENT
INFRASTRUCTURE MANAGEMENT
INSTITUTIONAL CAPACITY
URBAN SPRAWL
GOVERNMENT POLICY
IMPROVED INFRASTRUCTURE
INCREASED EFFICIENCY & CAPACITY
INCORPORATE TECHNOLOGY IN MONITORING
INSTITUTIONAL STRENGHTENING & DEVELOPMENT
SYSTEMS APPROACH
MONITORING OF STANDARDS
MAINTENANCE OF INFRASTRUCTURE
INSTITUTIONALIZE THE ALTERNATIVE WATER SUPPLY
INSTITUTIONALIZE POLICIES FOR PROVISION OF ALTERNATIVE WATER SUPPLY
ALTERNATIVE WATER SUPPLY
OUTCOME
FEEDBACK
IMPROVED PROVISION OF WATER & SANITATION TO RESIDENTS AND HOUSEHOLDS OF STAREHE CONSTITUENCY
FEEDBACK

6.6 Recommendation for Further Research

Further research can be conducted on:

The process of regularization of a framework for alternative water supply in Nairobi and how it can be integrated into the sector policy as a sustainable approach to provision of water in underserved and informal settlements in Nairobi.

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APPENDIX 1: COVER LETTER

Elizabeth Wambui Mungai

University of Nairobi

Department of Architecture and Building Science

P.O Box 30197-00100 Nairobi

3rd September 2019

Dear Respondent,

I am Carrying out research on the causes of demand of alternative water supply: A case study of Starehe Constituency in Nairobi City. This study is a requirement for the partial fulfilment of the Masters of Urban Management Degree Program at the University of Nairobi, School of Built Environment.

This study seeks information from stakeholders whose water supply is from by alternative vendors or sources, and how the service affects the residents, and business owners. You have been selected as key stakeholders of this study.

This is an academic research and confidentiality is strictly emphasized, your name and details will not appear anywhere in the report. Kindly spare some time to complete the questionnaire attached.

Thank you in advance

Yours Sincerely

Elizabeth Mungai

APPENDIX 2: QUESTIONNAIRE

Section A: Demographic Details

Please tick (√) your perceived relevant response to each of the questions below

1. **In which year were you born?.....**
2. **Sex**

   Male ☐

   Female ☐
3. **Highest Level of Education**

   Primary ☐

   Secondary ☐

   Middle level College ☐

   University Degree ☐

   Post-graduate level ☐
4. **Employer**

   Government ☐

   NGO ☐

   Self/Private Work ☐

   None ☐
5. **For how many years have you lived in this area?**

   .....
6. **Marital Status** ☐

   Single ☐

   Married ☐

Widow/widower ☐

Separated

Divorced ☐

7. **What is the number of people living in your house?**

   .....

8. **Do you have tap water system in your house?**

   ……...

Section B: The Influence of Infrastructure on Alternative Approaches to the Provision of Water Supply

Use the rating-scale where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1], and kindly tick (√) the degree of agreement with the statements provided below:

NO	Statement	1	2	3	4	5
1	There is poor water infrastructure used in the water supply in urban centers					
2	The existing infrastructure capacity is able to supply enough water to the residents of Starehe constituency					
3	There is adequate infrastructure for the supply of					

	water to residents of Starehe constituency					
4	There is vandalism to the water supply equipment's that affects water supply to the residents of Starehe constituency					
5	The slow pace of replacement of water systems of the aging equipment's affects the water supply					
6	The existence of modern technology in the infrastructure development of water equipment's supports water supply to the residents of Starehe constituency					
7	There is no aged equipment in the supply of water system due to constant replacements in Starehe constituency					

Section C: The Influence of Institutional Capacity on Alternative Approaches to the Provision of Water Supply

Use the rating-scale where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1], and kindly tick (√) the degree of agreement with the statements provided below:

NO	Statement	1	2	3	4	5
1	The existing institutions have adequate capacity for the alternative approaches to the provision of water supply					
2	The existing institutions are adequate to support the management of alternative approaches to the provision of water supply					
3	There is a conflict of interest among the institutions charged with the management of alternative approaches to the provision of water supply					
4	The existing institutions are able to effectively manage compliance for the alternative approaches to the provision of water supply					
5	The existing water institutions conduct their duties within the mandate and they are effective in water management					

Section D: The Influence of Urban Sprawl on Alternative Approaches to the Provision of Water Supply

Use the rating-scale where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1], and kindly tick (√) the degree of agreement with the statements provided below:

NO	Statement	1	2	3	4	5
1	The movement of population settlement from crowded urban centers to less dense areas has affected alternative approaches to the provision of water supply					
2	The existence of low-density settlement has negatively affected the alternative approaches to the provision of water supply					
3	The crowding of population settlements have negatively affected the alternative approaches to the provision of water supply					
4	The culture of settlement away from urban centers has negatively affected the alternative approaches to the provision of water supply					

Section E: The Influence of Government Policy on Alternative Approaches to the Provision of Water Supply

Use the rating-scale where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1], and kindly tick (√) the degree of agreement with the statements provided below

NO	Statement	1	2	3	4	5
1	Government has increased its supply of water to the informal sectors of the city through the private sectors					
2	Government has put in place adequate policies to ensure that households have good alternative water supply					
3	The existing government policies are able to adequately address issues of efficiency in alternative water supply					
4	The existing government policies enhances reliability of alternative water supply in the area					
5	The existing government policies ensures quality on alternative water supply to the public					
6	The existing government policies are comprehensive enough to cover alternative water supply in the area					

Section F: The Level of Satisfaction, Efficiency, Reliability and Quality on Alternative Water Provision in Starehe Constituency

Use the rating-scale where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1], and kindly tick (√) the degree of agreement with the statements provided below

NO	Statement	1	2	3	4	5
1	Water supplied by the private sector satisfies the needs of the residents					
2	There is an increased efficiency in the provision of water in the private sector has increased the bond between households and suppliers					
3	The alternative water provision is very reliable with respect to the quality of water supplied					
4	The alternative water provision is very reliable with respect to the timely delivery upon demand					
5	There is easy access of alternative water supply in Starehe constituency					
6	Clear structure of management of the water supply by the private sector has increased the revenues of the private institutions.					

7	There is good efficiency in supply of alternative water supply					

Section G: Alternative Water Supply

Use the rating-scale where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1], and kindly tick (√) the degree of agreement with the statements provided below

NO	**Statement**	**1**	**2**	**3**	**4**	**5**
1	We regularly use alternative water supply whenever the supply from NCWSC water fails					
2	We get our water from the tap water vendors					
3	We always buy water from Water kiosks					
4	We do buy water from borehole water vendors					
5	We regularly buy water from push-cart vendors					
6	We always buy water from water bowsers					

SECTION B: The level of satisfaction, efficiency, reliability and quality on alternative water provision in Starehe Constituency

Use the rating-scale where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1], and kindly tick (√) the degree of agreement with the statements provided below

NO	Statement	1	2	3	4	5
1	Water supplied by the private sector satisfies the needs of the residents					
2	There is an increased efficiency in the provision of water in the private sector has increased the bond between households and suppliers					
3	The alternative water provision is very reliable with respect to the quality of water supplied					
4	The alternative water provision is very reliable with respect to the timely delivery upon demand					
5	There is easy access of alternative water supply in Starehe constituency					
6	Clear structure of management of the water supply by the private sector has increased the revenues of the private institutions.					
7	There is good efficiency in supply of alternative water supply					

SECTION C: The government policies and recommendation put in place for the integration of alternative supplies into the mainstream

Use the rating-scale where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1], and kindly tick (√) the degree of agreement with the statements provided below

NO	Statement	1	2	3	4	5
1	Government has increased its supply of water to the informal sectors of the city through the private sectors					
2	Government has put in place adequate policies to ensure that households have good alternative water supply					
3	The existing government policies are able to adequately address issues of efficiency in alternative water supply					
4	The existing government policies enhances reliability of alternative water supply in the area					
5	The existing government policies ensures quality on alternative water supply to the public					
6	The existing government policies are comprehensive enough to cover alternative water supply in the area					

SECTION D: Alternative water supply

Use the rating-scale where strongly Agree [5], Agree [4], Neither Agree nor Disagree [3], Disagree [2], Strongly Disagree [1], and kindly tick (√) the degree of agreement with the statements provided below

NO	Statement	1	2	3	4	5
1	We regularly use alternative water supply whenever the supply from Nairobi water fails					
2	We get our water from the tap water vendors					
3	We always buy water from Water kiosks					
4	We do buy water from borehole water vendors					
5	We regularly buy water from pushcart vendors					
6	We always buy water from tunkers					

APPENDIX 3: INTERVIEW

Consumers with Water Connection

1. Would you please tell me your name, place of residence and the duration under which you have operated in Starehe constituency?

2. How is your water supply like?

3. What do you think are the main causes of alternative water provision in Starehe constituency?

4. What is the level of satisfaction on the service rendered by alternative water vendors in your area?

5. In your opinion what should the Nairobi City County do alleviate the problem?

APPENDIX 4: FOCUS GROUP WITH NCWSC DISCUSSION GUIDE

Name: .....
Department: .....
Designation: .....

1. Has the supply of water to the underserved sectors of the city through the private sectors?
2. Has government has put in place adequate policies to ensure that households have good alternative water supply
3. What policies are able to adequately address issues of efficiency in alternative water supply?
4. Are existing government policies enhancing reliability of alternative water supply in the area?
5. Are the existing government policies ensuring quality on alternative water supply to the public?
6. Are the existing government policies comprehensive enough to allow alternative water supply in the area?