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SCHOOL OF THE BUILT ENVIRONMENT

DEPARTMENT OF ARCHITECTURE AND BUILDING SCIENCE

IMPACT OF ZONING REGULATIONS ON SUSTAINABLE URBAN DEVELOPMENT: A CASE OF RIVERSIDE NEIGHBOURHOOD OF NAIROBI, KENYA

BY

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A Project Report submitted in partial fulfillment of the requirements for the Award of the Degree of Master of Urban Management in the Department of Architecture and Building Science, University of Nairobi

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Declaration

This Project Report is my original work and has not been presented for the award of a degree in any other University or any institution of higher learning. No part or whole of this work may be reproduced or transmitted in any other form without prior permission of the author and/or the University of Nairobi.

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Dedication

This work is dedicated to my dear wife Maureen and our two lovely daughters Michelle and Maya.

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This work would not have been possible were it not for all of you who played a role in shaping up the study. My special thanks go to my supervisors for their constructive comments and guidance. I am specifically indebted to my supervisors Dr. Maurice O. Oyugi and Prof. Laban U. Shihembetsa whose patience, immense knowledge, encouragement and positive criticisms aided completion of this report. Special thanks go to Mr. Walter Ogana and Ms. Judy Balla my Research Assistants, whose efforts led to timely collection and analysis of field data.

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Abbreviations and Acronyms

^{o}C	Degrees Celsius
CBD	Central Business District
CBS	Central Bureau of Statistics
CCN	City Council of Nairobi
CoK	Constitution of Kenya
DU/ha	Dwelling Unit per Hectare
GIS	Geographical Information System
Ha	Hectare
JICA	Japan International Cooperation Agency
Km^2	Square Kilometers
KNBS	Kenya National Bureau of statistics
NCCG	Nairobi City County Government
NCWSCo	Nairobi City Water and Sewerage Company
NMGS	Nairobi Metropolitan Growth Strategy
NMT	Non-motorized transport
NUSG	Nairobi Urban Study Group
PPA	Physical Planning Act
PM	Particulate Matter
SSA	Sub-Saharan Africa
SDG	Sustainable Development Goals
UN	United Nations
UN-DESA	United Nations Department of Economic and Social Affairs

WCED World Commission of Economic Development

WHO World Health Organization

Operational Definition of Terms

Density: According to the physical planning Act CAP 286, density means the maximum amount of development permitted or the maximum number of persons permitted to reside, as the case may be, on any area of land.

Development: This is carrying out any works on land or making any material change in the use of any structures on the land.

Ground Coverage: This refers to the total area covered by a building on the ground floor expressed as a ratio of the land size usually in percentage.

Neighborhood: This is an area of the city's development zone or sub-zone that is developed.

Plot Ratio: This refers to the total plinth area expressed as a ratio of the land size.

Sustainable Development: Sustainable development was first defined by the World Commission on Environment and Development (WCED) as development, which meets the needs of the present without compromising the ability of the future generations to meet their own needs.

Urban Development: This refers to the improvements of an urban area by carrying out works on land or making any material change in the use of any structures on the urban land.

Zoning Regulations: This refers to the development parameters set on each of the city's development zones and consist of the minimum area per plot, land use of the plot, plot ratio, ground coverage and a maximum height of developments.

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Abstract

This research investigates the impacts of zoning regulation on urban sustainability with specific case of Riverside neighbourhood of Nairobi. The objectives of the study were to document land uses and development densities occasioned by changes in zoning regulations for the neighbourhood, to establish the impacts of zoning regulations on water supply, sewer system, parking and road capacities and then evolve an alternative policy framework to guide developments in the neighbourhood. The study set out to answer three questions namely; how has zoning regulations impacted on the neighbourhood's land uses?, how has the zoning regulations impacted on water supply, sewer systems, roads and parking facilities in the neighbourhood? and what measures should be put in place for sustainable development of the neighbourhood? Likewise, the study made an assumption that an increase in development density devoid of infrastructure expansion erodes the sustainability of a neighbourhood.

The nature of the study dictated that both qualitative and quantitative approaches be adopted with data collected from the target population which was the properties. It therefore meant that different actors for the properties in the study area were involved for data collection.

The study establishes that zoning regulations have changed three times from the year 2006 with minimal infrastructural investments. Whereas densification has been fronted as a strategy towards urban sustainability, the study establishes that densification devoid of infrastructural growth coupled by mix of land use activities creates further urban challenges that hinder a neighbourhood's sustainability. The study found out that Riverside neighbourhood is experiencing densification with minimal infrastructural

investments hence stands at higher risk of veering off the sustainability path. In order to ameliorate the situation and embrace sustainability for the neighbourhood the study came up with four recommendations notably; Appraisal of the infrastructural requirement, planning and implementation, enactment of zoning policy a shift from ad hoc zoning regulations, land use integration, neighbourhood greenery policy.

CHAPTER ONE: INTRODUCTION

1.1 Background Information

Nairobi is the commercial, industrial, financial, educational and communication hub of Eastern and Central Africa. With an intercensal population growth rate of about 4.5%, Nairobi city's population is projected at 5,852,736 by the year 2020 (Oyugi and K'akumu, 2007). This underscores the fact that the city's population will subsequently lead to an increased demand for services such as residential facilities, commercial, educational as well as employment opportunities consequently leading to urban expansion at a time when the urban infrastructure is already constrained. To mitigate this, the city's planning authority has over the years revised zoning policies operational in the city. Zoning policy is an instrument used to balance population growth and infrastructure services. According to Fischel (1999), zoning regulations are the most common regulatory tools used by planning authorities to control urban development. However, Nairobi city's zoning regulations has not kept pace with the rapid growth of the city thus making the planning policies outdated in some zones of the city. In effect, ad hoc policies have been adopted to guide developments.

Nairobi City County Government has divided the city into 20 development zones and 10 sub-zones with varying development densities and land uses. Riverside neighborhood is situated in Zone 4C of the city's development zones and like most of the zones, its development regulations have been revised several times over the years. In the years 1979, 1987, 2006, 2012 and 2015 the city's zoning regulations were revised to allow for higher density developments in areas that were previously zoned for low density developments. Prior to the year 2006, development regulations for zone 4C allowed for single dwelling units.

In the year 2006, a policy review for Zones 3,4 and 5 was commissioned by the then City Council of Nairobi (CCN) to make recommendations on new zoning regulations. According to Mwaura (2006), zone 4C was recommended to maintain the low-density residential development status. The recommended development regulations for zone 4C was ground coverage of 35%, plot ratio of 75%, minimum plot size of 0.2 Ha with dominant land use being residential. The year 2006 zoning regulations was as a result of a zoning policy review that aimed to balance the city's growth with infrastructure development. The trunk sewer only covered few properties in the neighborhood but following the recommendations of the zoning review of 2006, the sewer infrastructure was expanded to cover more properties in the year 2009.

As would be expected following the sewer infrastructure development, the land values went up significantly making the zoning regulations set in the year 2006 not economically viable for real estate investments. The developers then adopted a planning justification supported by planning gains model to negotiate for higher plot ratio and different land uses in an effort to maintain marginal profits for real estate ventures in the neighborhood. By the year 2012, there were pockets of higher development densities as a result of the bonus plot ratios that necessitated the formulation of an ad hoc zoning policy. The year 2012's ad hoc zoning regulations for the Riverside neighborhood was not legally adopted as a bylaw hence it has been changed over the years with the recent developments adopting a new set of standards different from their neighbors'.

The year 2012, ad hoc policy increased ground coverage to 40% and plot ratio to 200%. The minimum plot size and dominant land use remained the same. Today, the neighborhood's physical setup is different from what was envisaged by the year 2012

policy that limited the skyline to four levels. The new developments have far surpassed the zoning regulations a situation that if not checked will have dire consequences on the neighborhood's sustainability.

The ad hoc regulations operational in Riverside area have been justified that it promotes the compact development of the neighborhood, which consequently creates opportunities for efficient resource utilization by allowing for urban utilities and amenities to be shared as well as enhancing the environmental and social sustainability of such neighborhoods. Contrary to this, low-density development allows for uneconomical developments as this lead to expensive infrastructure expansion. Indeed, zoning regulations should be tied to infrastructure capacity (UN-Habitat, 2004). This realization has made many city managers to make attempts at reconciling urban development with infrastructure capacity for sustainable development which manifest through environmental quality parameters of thermal comforts and good air quality among others. In this regard, this study sought to establish the impact of development zoning regulations of the year 2012 on the development of the Riverside neighborhood of Nairobi city, Kenya.

1.2 Problem Statement

Nairobi zoning ordinance has 20 zones with 10 sub-zones with each zone defining unique development density, land use, plot ratios, ground coverage and the skyline. However, most zones in the city have not adhered to the set development standards rendering the zoning regulations obsolete and not responsive to the realities on the ground. In effect, ad hoc policies have been adopted to guide the development of neighborhoods. According to Mwathi (2016) this situation has led to environmental degradation and negative impacts on neighborhoods' sustainability.

The year 2012 ad hoc zoning regulations for the Riverside neighborhood was not legally adopted as a bylaw hence it has been changed over the years with recent developments adopting a new set of standards different from their neighbors'. Although it has been argued that the current zoning policy operational in the neighborhood has an average plot ratio of 200% and ground coverage of 40% with a minimum plot size of half an acre, there exist higher development densities per hectare. The high-density residential developments are no longer limited to plots served by trunk sewer because developers have adopted alternative eco-friendly sewerage systems. The higher development densities approved after the year 2012 have not been accompanied by minimal infrastructural expansion, consequently leading to adverse transformation of the neighborhood. This has made policymakers and urban managers grapple with how to ameliorate the situation and adopt a set of regulations that are in harmony with the infrastructure provision for sustainability. The aforementioned necessitated an investigation on the impact of zoning regulations on the neighborhood's development with a view of evolving an alternative policy in consideration of the available infrastructure.

1.3 Objectives of the Study

1.3.1 General Objectives

The aim of the study was to investigate the impact of zoning regulations on sustainable development of Riverside neighborhood development with a view of evolving an alternative policy in consideration of infrastructure in the neighborhood.

1.3.2 Specific Objectives

i. To document land uses and development densities occasioned by changes in zoning regulations for the neighborhood

ii. To establish the impacts of zoning regulations on water supply, sewer system, parking and road capacities.

iii. To evolve an alternative policy framework to guide developments in the neighborhood

1.4 Research Questions

The study answered the following questions:

i. How has the zoning regulations impacted on the neighborhood's land uses?

ii. How has the zoning regulations impacted on water supply, sewer system, roads and parking facilities in the neighborhood?

iii. What measures should be put in place for the sustainable development of the neighborhood?

1.5 Research Assumptions

This study made the following assumptions:

i. An increase in development density devoid of infrastructure expansion erodes the sustainability gains of a neighborhood.

ii. There will be no changes in the zoning policy during the study period;

iii. There will be no infrastructure expansions in the neighborhood in the near future;

iv. The neighborhood will continue experiencing sustained urbanization, which will be sustained by increased densification.

1.6 Significance of the Study

The study aimed at evolving an alternative set of zoning regulations for the neighborhood in harmony with available infrastructure. Therefore, the study is significant because it grants a basis for formulation and implementation of a zoning policy for an urban neighborhood in view of the available infrastructure. The study was also based on the

optimal utilization of available infrastructure. This study is also imperative in granting indicators for urban managers and policymaker on infrastructure requirements and capacity accompanying changes in the zoning regulations. Furthermore, the study is significant because it has broadened the investment portfolio to inform future zoning regulations for sustainable neighbourhood development.

1.7 Scope of the Study

This study covered the stretch of Riverside drive and the plots accessed through lanes or roads named after Riverside starting from Ring Road Parklands ending at Mzima Springs road. The study area covered approximately one square kilometer and about two hundred plots within zone 4C of the Nairobi city's development zones. The variables considered by this study included land uses, plot ratio, ground coverage and infrastructure notably water supply, sewer system, roads and parking facilities all measured using the best applicable standards.

1.8 Limitations of the Study

The study considered water supply, sewer, road and parking facilities and their existing capacities in supporting the existing development densities and land uses in the neighborhood. This left other infrastructure elements such as energy and stormwater drainage among others, which are equally imperative in sustainable neighborhood development.

1.9 Organization of the Study

The study is organized in six chapters of which chapter one forms the introduction of the study by highlighting the problem the study aims at solving, the objectives as well as the justification of the study. Chapter two provides detailed information on the study area while chapter three is the literature review. Chapter four draws a path on how the study

will be conducted and spells out the methods for which the research questions will be answered in order to fulfill the objectives of the study. Chapter five is the analysis and presentation of the study findings while chapter six is a summary of the study finding in respect to the study objectives and concludes the study by making recommendations in view of providing solutions to the problems the study had earlier envisaged to answer.

CHAPTER TWO: THE STUDY AREA

2.1 Introduction

This chapter highlights the historical growth of the city, the geographical scope, physiographic factors, infrastructure, and population projections as well as the location of the study area.

2.2 Location of the Study Area

Nairobi is located on the Southern part of Kiambu County, Western of Machakos County and North Eastern part of Kajiado County. The Riverside neighborhood is located within the Dagoretti North Sub-County of Nairobi City between the boundary of Kileleshwa and Muthangari Wards in Kileleshwa location. This neighborhood is rapidly growing and is in proximity to the Central Business District (CBD) of the city. The study area lies between longitudes 36^0 41' 0.75" E to 36^0 48' 51.5"E and latitudes 1^0 15' 51.71"S to 1^0 16' 20.14"S and is covering an area of approximately $1km^2$.

Figure 2.1: Nairobi in Africa and National Context

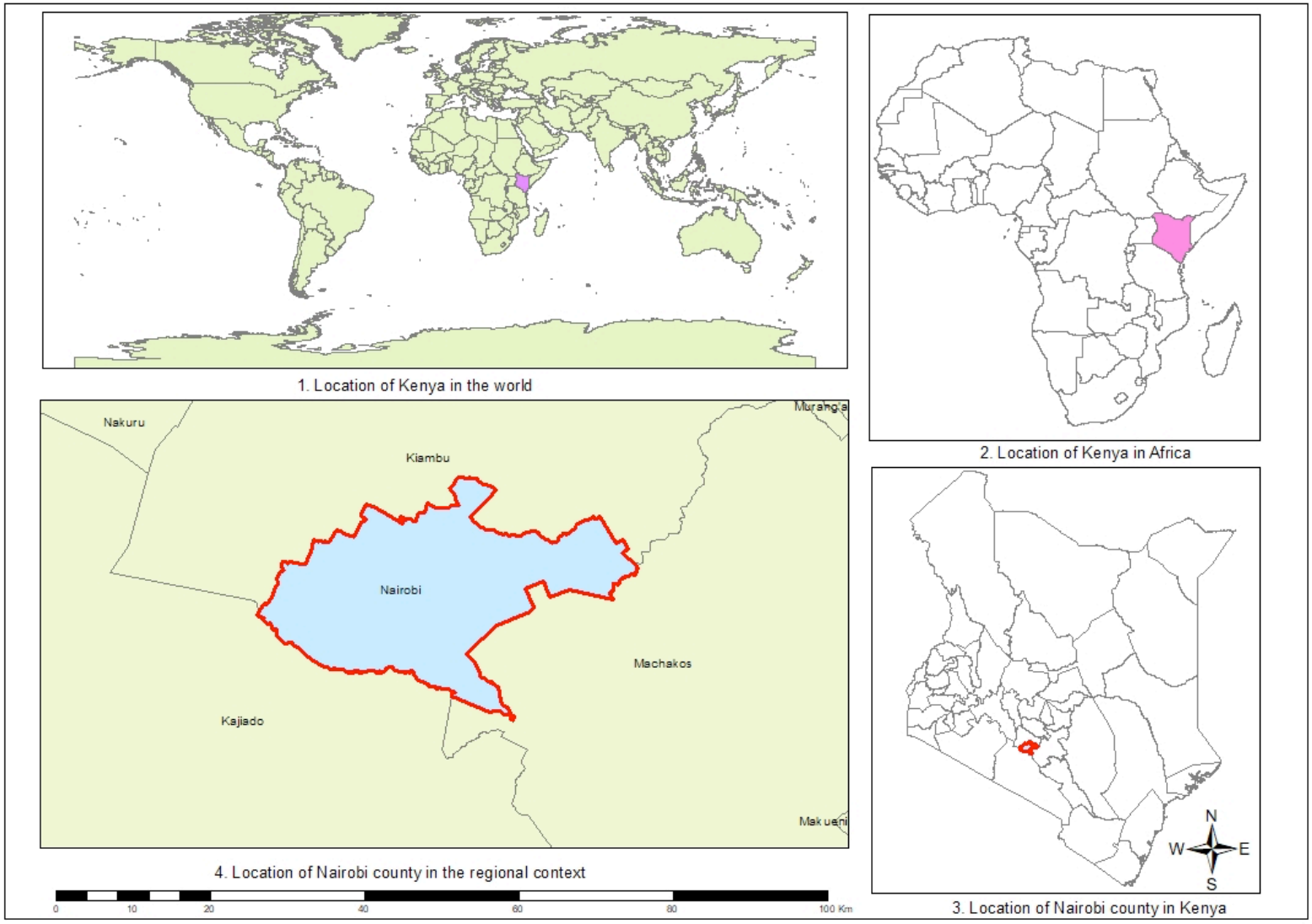
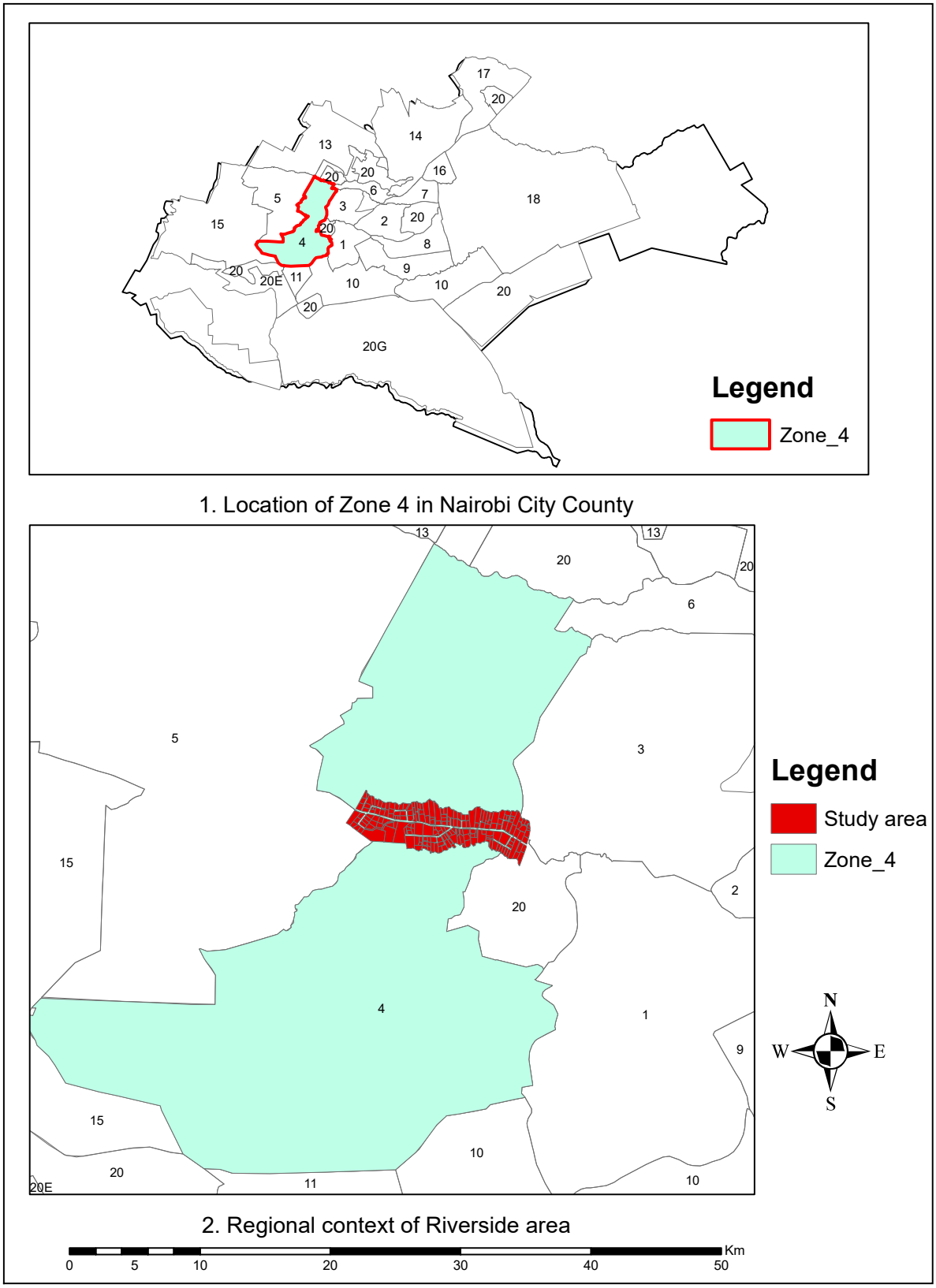


Figure 2.2: Riverside neighborhood in the Local Context



2.3 Population Dynamics and Historical Growth of the City

The city of Nairobi is among the key urban areas in Kenya that have continued to experience high population growth rates occasioned by rural-urban migration and natural population increase. With an intercensal population growth rate of about 4.5%, Nairobi city's population is projected at 5,852,736 by the year 2020. According to the Kenya National Bureau of Statistics (KNBS) data of 2009 census, Kileleshwa area in which Riverside neighborhood is part of had a population of 27,202 people. The population growth is expected to grow steadily hence the demands for housing and supportive infrastructure are inevitable.

Nairobi's spatial expansion has over the years been influenced by infrastructure and population expansion. Upon inception as capital city of Kenya in the year 1900, the boundary of the city kept on being expanded. In the year 1906, the city covered an area of 18km^2. Table 2.1 and Figure 2.3 corroborates that Nairobi has experienced both demographic and spatial expansion. Despite the size of the city not expanding after the year 1963, the population has increased with an average rate of 4.5% every year in the last two decades. Also, from the year 1963, the city's functions expanded such that it has achieved dominance in the political, social, cultural and economic life of the people of Kenya and the whole eastern and central Africa region (Mitullah, 2003).

The expanding population post-independence led to the demand for space for various land uses, which necessitated that policymakers come up with plans to guide the growth. Towards this endeavor, the city has had four plans developed at different stages of her growth trajectory. In the year 1948, South African and British consultants prepared a master plan for the city. Despite the planning having been adopted, the years between

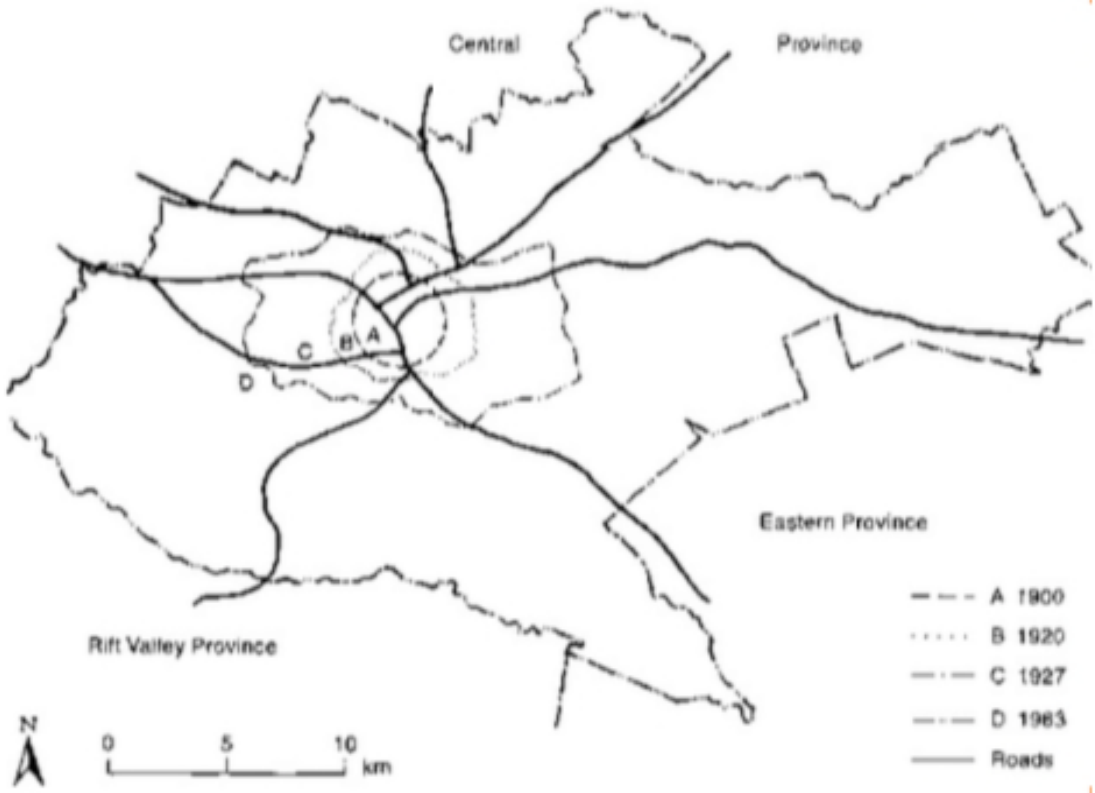
1962 and 1967 witnessed increased population in the city which further complicated the urban problems and challenges. In the year 1967, a number of ad hoc study groups were set up to deal with specific aspects of the city growth which in the year 1973 culminated into the Nairobi Urban Study Group (NUSG). The study led to a policy document known as Nairobi Metropolitan Growth Strategy (NMGS) that was to guide development of the city up to the year 2000. Unfortunately, these plans were never fully implemented and the city authority has over the years used zoning regulations to control development and to accommodate the increasing population in the city.

Table 2.1: Land and Population Changes in Nairobi

Year	Area (Hectares)	Population	% Increase of population	Density (Person per Hectare)
1906	1813	11512	-	6
1928	2537	29864	159.4	12
1931	2537	47919	60.5	19
1936	2537	49600	3.5	20
1944	2537	108900	119.6	43
1948	8315	118976	9.3	14
1963	68945	342764	188.1	5
1969	68945	509286	48.6	7
1979	68945	827735	62.5	12
1989	68945	1324570	60	19
1999	68945	2143254	61.8	31
2009	68945	3,273,783	52.7	47

Source: (Mitullah, 2003; Ngayu, 2011)

Figure 2.3: Changes of Nairobi City Boundaries



Source: (Mitullah, 2003)

2.4 Physiographic Factors

Nairobi city's main drainage follows the regional slope of the volcanic rock towards the east while subsidiary internal drainage into the Rift region is confined to the western part. Ruiru-Nairobi-Ngong are underlain by a succession of lava flows alternating with lakebeds, streams, deposits, tuff and volcanic ash. These plains comprising mainly of the Athi plains nad northern section of Kapiti plain extend westwards rising from 4900 feet (1493m) at the Athi River to 6000 feet (1829m) above sea level in the faulted region near Ngong. Water drainage eastwards from the hill area accumulates on the low-lying ground between parklands in the north and Nairobi south estate forming a perched water table above the Nairobi phonolite. The Kirichwa valley tuff to the east of the highway

function like a sponge nad the contact between them and the underlying impermeable phonolite thus forms a perfect aquifer so much so that a number of channels containing water occur beneath Nairobi. The terrain of the study area is undulating with some sections relatively flat while others are sloppy. On the northern part the study area covers the Nairobi River while on the southern part it covers Kirichwa Kubwa River. The rocks in Nairobi area mainly comprise a succession of lavas and pyroclastics of the cainozoic age and overlying the foundation of folded Precambrian schist. The soils of the Nairobi area are products of weathering of mainly volcanic rocks. Weathering has produced red soils that reach more than 50 feet (15m) in thickness.

Nairobi has a temperate tropical climate with two rainy seasons. The highest rainfall is received between March and May while the short rainy season is between October and December. The mean annual rainfall ranges between 850mm to1050mm. The mean daily temperature ranges between 12^{o}C to 26^{o}C. It is usually dry and cold between July and August but hot and dry in January to March (CBS, 2003). The mean monthly relative humidity varies between 36% to 55%. The mean daily sunshine hours varies between 3.4 and 9.5 hours.

2.5 Infrastructure

The study area is connected by water supply from NCWSCo. However some properties have sunk boreholes to supplement the Nairobi City's Water and Sewerage Company supply. The study area is covered by network of tarmacked roads. The main spine is Riverside drive, which is 21 metres wide. Some of the roads are not in good condition a situation exacerbated by heavy trucks frequenting the neighbourhood. The study area is

covered by NWSCo trunk sewer system and properties that are not covered use septic tanks for liquid waste management.

2.6 Environment

Wetlands and rivers in the study area are faced with challenges namely; encroachment, pollution and failure to observe riparian reserves. Water pollution carries both environmental degradation and water borne diseases and is manifested through floods and health risks to the area residents. The study area is on the Western side of the Nairobi CBD and is well endowed with favourable climatic conditions. Over the years the neighbourhood was zoned for low- density residential developments with abundant vegetation cover. The built versus un-built sections of the neighbourhood show that the vegetation cover hold up to 50% of the land size consisting of trees, shrubs and well-lawn grassland.

CHAPTER THREE: LITERATURE REVIEW

3.1 Introduction

This chapter reviews the existing literature related to urban neighborhood development and sustainability by examining the theories on urban spatial structure, the concept of urban sustainability as well as the role of development regulations and allied factors on urban sustainability. This is imperative in drawing a conceptual model for urban neighborhood sustainability, which encompasses sets of regulations balancing developments and infrastructure standards for the attainment of sustainability of urban neighborhoods.

3.2 Theories of Urban Land Uses and Spatial Structure

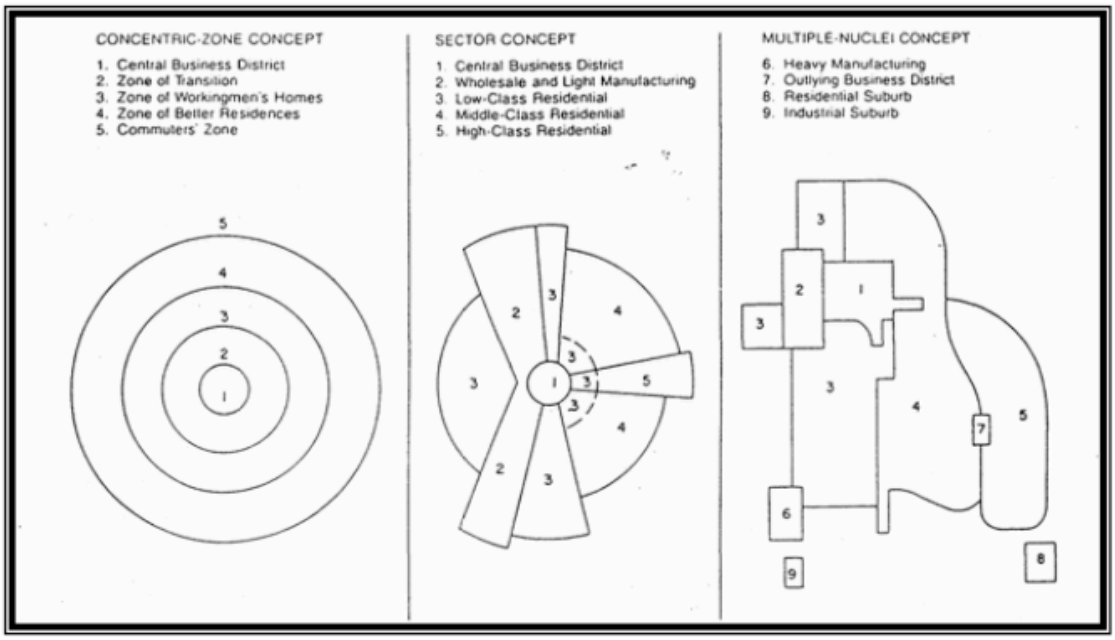
The *Concentric-Model*, which was postulated by Burgess (1925), consists of five series of concentric zones namely; the Central Business District (CBD), Zone of Transition, Working Men's Homes, Residential Zone and the Commuters' Zone. Burgess notes that while the CBD has facilities such as shopping areas, theatres, hotels, offices and banks among others, the zone of transition is characterized by mixed land uses such as the co-existence of high-rise residential developments with commercial developments. The zone of working men's homes is home to factory workers while the residential zone is where the white-collar workers and middle-income families reside. The fifth ring being the commuters' zone is a suburban community where the upper-income group having private modes of transport resides. Burgess (1925) further observes that with increased urbanization, inner zones invade the next outer zones similar to ecological succession. In contrast, when urban decay occurs, the outer zones remains stationary while the inner fringe of the transitional zone recedes into the CBD. While the model provides a useful

explanation to urban land use patterns, it is an oversimplification of urban morphological reality.

Hoyt (1939) postulated *Sector Model* which posits that different urban land uses locate in distinct neighborhoods in a star-shaped manner centred on a single CBD which is the most accessible part of a city. Rents then graduate downwards from the CBD as determined by transportation network. In this case, high-income residential areas developing along the highways pull high order commercial activities to the neighborhoods to form an agglomeration of compatible land uses. Despite the simplicity of the model and its emphasis on residential developments, it provides a profound explanation to urban land use differentiations than the concentric model.

Harris and Ullman (1945) formulated *Multi-Nucleic Model*, which posits that rather than a single CBD as postulated by the other models, there exist series of nuclei patterning urban land uses. The nuclei may take the form of industrial or wholesaling centres where specialized complementary economic activities have gravitated over the years. Harris and Ullman (1945) further notes that factors responsible for multi-nucleic patterning of urban land uses are inter-dependence of certain activities that find it mutually profitable to cluster, some activities having specific site requirements which must be fulfilled for them to locate, presence of activities which are offensive to other users and rents which either attract or repel users. Despite the model satisfactorily explaining the metropolitan land use differentiation, it needs modification before it can be utilized in explaining the land use and land cover differentiations in cities with a colonial origin which has continued to influence land uses post the era.

Figure 3.1: Urban Land Use Models



Source: (Hartshon, 1980)

As noted by the 19th century Scholars such as Ruskin, Geddes, Carlyle, Dickens, Engels and Disraeli, urban land use differentiations is occasioned by land value speculations and environmental considerations (Gallion, 1963). This informed Ebenezer Howard (1898) to envisage a town with communal land ownership where residential facilities and civic buildings are distributed along a large central court with shopping centres and industrial land uses located on the edges. Howard's utopian city envisaged a population of 58,000 people within 1,000 acres surrounded by 5,000 acres of agricultural land.

Alonzo (1964) gives an account of urban morphological differentiation based on land values by detailing out how individual households faced with the desire to buy land is equally faced with the dilemma of deciding on the size of land to purchase and how close it should be to the city centre. Alonzo's theory assumes a city of single employment and

shopping zone with equal transportation costs and opportunities in all directions, making the cost of commuting to the city centre a function of the distance. The theory also assumes that the households and/or firms have perfect knowledge of the prices of land within different locations of the city and that the cost of land drops as one moves away from the city centre. Therefore, the household's locational equilibrium is achieved through a selective combination of the desired quantity of land and distance from the city centre. He further uses the concept of bid rent curve to arrive at distances from the city centre at which different land uses will viably locate. The theory observes that the most accessible sites in the city go to the users with the steepest bid rent-curve notably the high order commercial activities with the second steepest bid rent-curve locating on the next ring outward from the city centre. This compels land uses such as residential developments whose bid-rent curves are gentle to locate in the urban peripheries.

Wingo (1961) postulated *Transportation-Oriented Theory* to explain the distribution of urban residential development densities. The theory posits that higher residential development densities within cities positively correlate with accessibility. On the other hand, Webber (1929) posits that spatial interactions (the flow of people, goods and services) as aided by transportation network are significant determinants of urban activities and spatial structure. Guttenberg (1960) advances the concept further by acknowledging that accessibility influences urban morphology by promoting interactions and land use clustering. However, Firey (1974), in his study of Boston city observes that socially rooted values and ethnicity exert causative influence on urban land use patterns and that infrastructure and market forces are only secondary factors. Therefore, failure to recognize the role of cultural values in determining urban land use

and land cover differentiation by Wingo (1961), Alonzo (1964), Webber (1929) and Guttenberg (1960) was an omission.

Bourne (1976) further postulates that population increase alone is no longer the main stimulus of urban land use dynamics. This debate has metamorphosed into sustainable urban development agenda of the 21st century, which incorporates multiple-variables such as natural ecology, socio-economic, political and legal factors in explaining the land use and land cover differentiations within a city. De Groot *et al.* (2002) advances the debate on sustainable urban development by noting that urban land use and land cover equilibrium is achieved through perceptions among the urban residents as to whether an urban neighborhood provides a healthy environment for interactions and establishment of economic activities. If the perception is negative, then there is a likelihood of migration and establishment of the activities in other neighborhoods, which are positively perceived. This ultimately leads to urban land use and land cover changes. De Groot *et al.* (2002) further states that urban vibrancy depends on its ability to provide goods and services to its inhabitants, which ultimately triggers land use and land cover changes. Other sentiments expressed by De Groot *et al.* (2002) on the same is that legal, statutory regulations, political decisions on land use and technological advancements in the society accelerate the urban land use and land cover changes. Together with the above, globalization which facilitates movement of people, goods and services between nations also determine the urban morphological changes depending on a city's location, internal site opportunities and the stage of national economic development (Martin, 1986).

3.3 The Role of Development Regulations in Urban Sustainability

There have been concerns of changes in zoning regulations attributed to the scarcity of serviced land in urban areas. The changes in the zoning regulations have been fronted to optimize utilization of land amongst competing land uses. The regulations have been constantly revised towards intensification and densification a process that is usually lengthy, participatory and political. The past studies indicate that densification of the city's neighborhood is one of the key factors in achieving urban sustainability. Towards this endeavor, Nairobi city since independence has embarked on periodic revisions of zoning policy to support the increase in population.

Urbanization in the developing countries is linked to unsustainable growth as a result of failures of planning authorities to enforce planning regulations. In this regard, Antar and Alshihri (2015) posits that in order to adhere to the principles of sustainable urbanization, urban development densities should be increased. This view is supported by Moos (2017) who argues that densification of the built environment has become a key variable in attaining urban sustainability for such a move lead to the reduction of carbon emissions and slows the dependence on the utility of motorized mode of transportation hence sustainability.

According to Fragkou (2009), a city is a complex system, which is a culmination of social, economic, environmental conditions, relations and processes. As the population grows the urbanization which is often positively correlated to socioeconomic becomes inevitable (Huang et al, 2015). Indeed, sustainable urban development requires the evolution of physical infrastructure and socio-economic processes. The aim of sustainable urban development is to create the smallest possible ecological footprint and

to produce the lowest quantity of pollution possible, to efficiently use land, compost used materials, recycle it or convert waste to energy and to make the city's overall contribution to climate change minimal (Larijani, 2016).

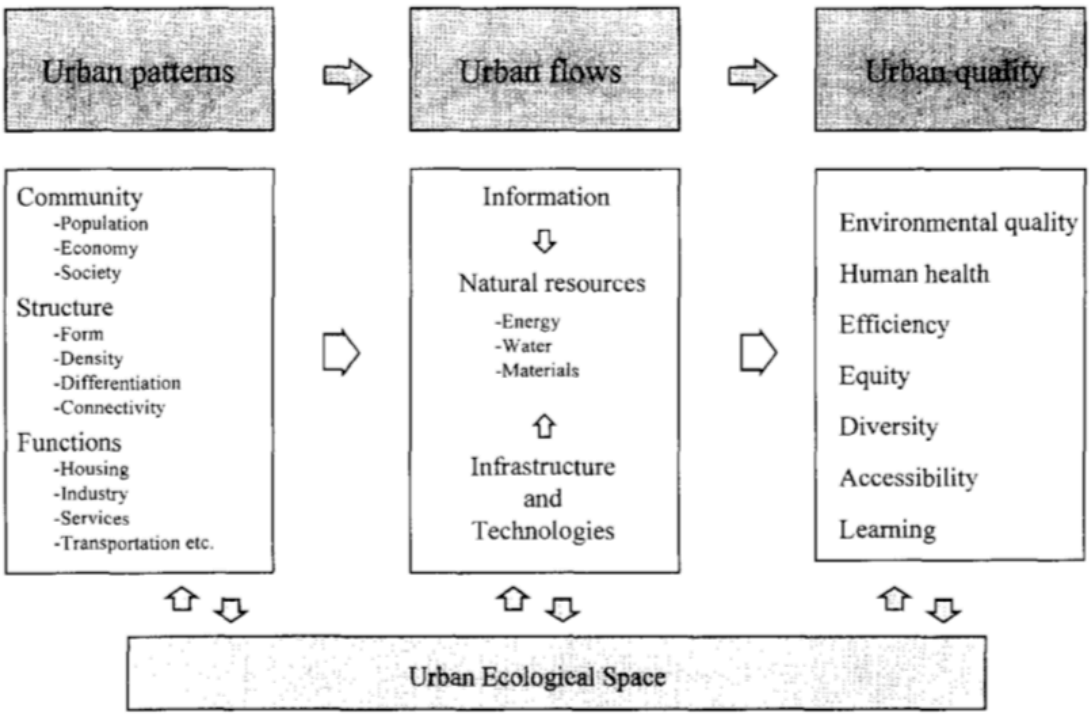
According to Fenton (2014) urban sustainability focuses on human settlement as a multi-dimensional space, shaping and influencing sustainable development both locally and in the wider global context; a space that is manifested not just in the form of physical infrastructure, but also in terms of social, economic and environmental systems situated in settlements as well as the administrative, institutional, political and cultural contexts influencing such systems. In order to promote and achieve sustainable urban development, zoning regulations have been formulated and applied in the cities. Fenton (2014) argues that since sustainable urban development is critical to the future of human activities, municipal organization or city authorities have a vital role to play in the attainment of urban sustainability. Fenton (2014) concludes by providing a conceptual framework comprising of five key factors that inform the processes of attaining urban sustainability notably: the capacity of municipalities and others to act for urban sustainability, the mandate of municipalities, resources available, the scope of processes and intended outcomes and the individual and collective goodwill.

Weingaertner (2010) in a study on identification of the strategic initiatives to promote urban sustainability postulates that strategic urban development decisions and initiatives including zoning regulations should be promoted to positively influence the ability of a city to promote sustainable patterns of development. He further explores cities trajectory and management strategies by arguing that cities at their infant stages are easy to manage sustainably. He concludes that holistic strategies for sustainability are required

for future urban development with consideration on the social dimension of sustainability.

Larijani (2016) notes that social, economic and environmental problems faced by the cities are best ameliorated through the application of sustainability principles and that emphasis for the achievement of sustainability should be placed on sustainability of land use planning, buildings, urban form and energy, transportation and density. He concludes by noting that a sustainable city is a basis for attaining citizenry welfare, social justice and human development as well as improvement of environmental quality and optimal distribution of urban services for social satisfaction. On similar note, Alberti et al (1996) observes that while measuring the sustainability of a city three dimensions have to be considered notably: urban patterns, urban flows and urban quality as shown in the Figure 3.2. He further notes that the above is achieved through enactment of proactive zoning regulations. He also notes that urban quality is as a result of carefully organized urban patterns (in the form of communities, structures and land use activities) and urban flows as occasioned by infrastructure and sustainable use of natural resources. The urban patterns and urban flow interact in urban ecological spaces denoted by zoning regulation leading to urban sustainability manifested by environmental quality, human health, efficiency, equity, accessibility amongst others.

Figure 3.2: Sustainability Dimensions



Source: (Alberti et al, 1996)

Laakso (2011) observes that in measuring urban sustainability, there are six parameters to be used notably; harmony with nature, livable built environment, place-based economy, equity, polluters' pay and responsible regionalism. The argument here is that developments that are in harmony with nature interact with ecosystems in minimally destructive way without altering natural processes. On the other hand, Lankao *et al* (2016), notes that urban environmental degradation manifested through deforestation, poor air quality, water and soil pollutions as well as increased urban surface thermal values all of which can be mitigated through proactive zoning regulations. On the other hand, livable built environments facilitate access among land uses and foster a sense of place.

Towards this end mixed land uses, higher densities and ability to choose transit transportation or access through cycling and walking as accentuated by zoning regulations supports livable environment (Laakso, 2011). According to Berke and Conroy (2000), zoning regulations ensure equity which is the ability of the low-income population to access basics such as a healthy environment and human dignity. Therefore, proactive planning of community infrastructure promotes both equity and urban sustainability.

According to Mitullah (2003), Nairobi city has been expanding, spatially as a result of infrastructure expansion and population growth since the year 1901 when the initial boundary was established. Mitullah (2003) further points out that by 1980s Riverside neighborhood was a low density, a high-income residential zone with a population density of 2 to 25 people per hectare. Currently, largely because of high rates of urbanization the development has intensified and manifest through increased plot coverage and skylines.

Oyugi and K'akumu (2007), notes that land use challenges of Nairobi city and other African cities are rooted to their historic, socio-economic and physical development, therefore redirecting sustainable growth of these cities necessitates re-examining the existing policies to enable decision-makers and development partners to explore short and long-term strategies for sustainable urban development. Oyugi and K'akumu (2007), further posits that urbanization being inevitable, there is a need for managing the resultant problems and utilizing the opportunities arising from the same. They further note that land use planning framework alone is inadequate in addressing the challenges of urbanization. Therefore, there is a need for stakeholders' participation and a robust

management policy framework to mitigate the ravages of urbanization. On the same note, Gitau (2011), postulates that governance and legal framework affect the management of cities thus there is a need for instituting an integrated and participatory urban management approach to achieve sustainability and livable urban areas.

Reed (2013) conducted a study on how land use regulations inform sustainable development. The study came up with a checklist (indicators) on urban sustainability notably the urban centre's walkability, ability to accommodate mixed land uses, efficient off-street parking, alternative transportation, energy conservation and efficiency in reducing urban runoffs. Upon undertaking the study Reed (2013) concludes that land use regulations are not sufficient in directing urban growth towards sustainability.

Antar *et al* (2015) in a paper on urbanization and sustainability in Saudi Arabia, argues that rapid urbanization has created many demographic, socio-economic, environmental and institutional challenges that contradict the principles of sustainability. They note that the situation is aggravated by inadequate planning and management tools operational in developing countries, population increase and physical developments promoted by rapid expansion of the economy, speculative real estate market and limited capacity of urban planning departments in devising and imposing development regulations. In conclusion, the paper argues that sustainable urbanization policy should focus on environmental protection through conservation of urban peripheral land for future uses.

Jaeger (2006), in his paper on the effects of land use regulations on property values, notes that land use regulations affect market property values both positively and negatively. He argues that values can be increased when the land and property supply is limited as a result of regulations and vice versa. He further argues that since regulations

determine the availability of land and the surrounding environment, communities are often pushed to revise zoning regulations to ease land for development and conserve the environment so as to either maintain or increase the property values. This necessitates the need to include the infrastructure availability as a sustainability agenda in urban development and management. Indeed, infrastructural changes have a direct correlation with changes in the zoning regulations. Nairobi like other cities has followed the same path of infrastructure investments inviting development and thus increased dwelling units per hectare. This is responsible for the development of typological differentiations in the city and subsequently the property values and availability (Jaeger, 2006). Infrastructure provision thus has link with development typologies and the resultant land uses of which are further linked to development regulations (Jaeger, 2006). Therefore, in order to attain compact urban developments, which integrate community amenities, pedestrianization of movements thus enhancing sustainability, zoning regulations should be used to guide and contain urban sprawl.

3.4 Roles of Other Factors in Urban Sustainability

Land use regulations play a role in urban sustainability by determining the spatial location of different land uses in the city and setting parameters for development in a specific zone. In this regard sustainability is achieved if the development policies adopted are proactive entailing encouragement of mixed land uses and discouragement of reliance on motorized transportation which compromise air quality or the deliberate regulations supportive of compact and high-density developments. Naeg (2015) notes that the political global agenda is a concept that calls for inclusivity in urban policy formulation and implementation, a development, which has both positive and negative impacts on urban sustainability. Govender et al (2015) argued that where the political

will is compromised, the developments are not aligned with the sustainability principles. According to Neag (2015), the economic and social pillars of urban sustainability dictates that urban areas should be balanced to avoid over maximization of profits at the expense of natural resources. Together with the above, rapid population in the cities create pressure on land whose supply is inelastic (Striker, 2011). The response to the above has been the revision of development regulations to intensify land use, subsequently affecting the city's sustainability.

Zoning regulations tools are tied to both legislation and policy foundations. In Kenya, the zoning regulations applicable are spelled out and anchored in a legal framework. In Nairobi, the zoning policy stipulates plot ratio, ground coverage and land use of a plot. The Physical Planning Act (PPA) Cap 286 mandates the county governments to exercise development control within their jurisdictions. Section 24 of the Act provides for the development and enforcement of local physical development plans to guide and coordinate development and infrastructure provisions within a town. Section 29 of the PPA gives County Government powers to prohibit and control the use of land, building, and subdivision of land in the interest of proper and orderly development of its area. On zoning, the PPA empowers Counties to formulate by-laws in respect to use and density of development.

The Constitution of Kenya, 2010 (CoK) gave provisions for the enactment of the County Government Act, (2012) which empowers counties to prepare plans and make legislation in respect to all such matters as are necessary or desirable for the maintenance of health, safety and well-being of the inhabitants of the area within the

county. These include among others the infrastructure management (construction and maintenance of water supply, sewerage and solid waste systems).

It is within this framework that Nairobi city enacted the Nairobi Integrated Urban Development Master Plan (NIUPLAN) as the overall planning and management framework for the city in line with Kenya Vision 2030. This master plan was prepared through collaboration between the Nairobi City County Government (NCCG) and Japan International Cooperation Agency (JICA) to give effect to a planning framework since the expiry of 1973 NMGS in the year 2000. The NIUPLAN is premised on four pillars notably; Economy, Environment, Governance and Social cultural attribute enhancement. The NIUPLAN gives strategies and recommendations for review of the existing zoning policy to be in harmony with changing population, infrastructure and economic dynamics in an effort towards the attainment of sustainable urban development. Towards this end, the NIUPLAN aims at achieving the compact urban development with mixed land use and higher density in most neighborhoods that is key for neighborhood sustainability.

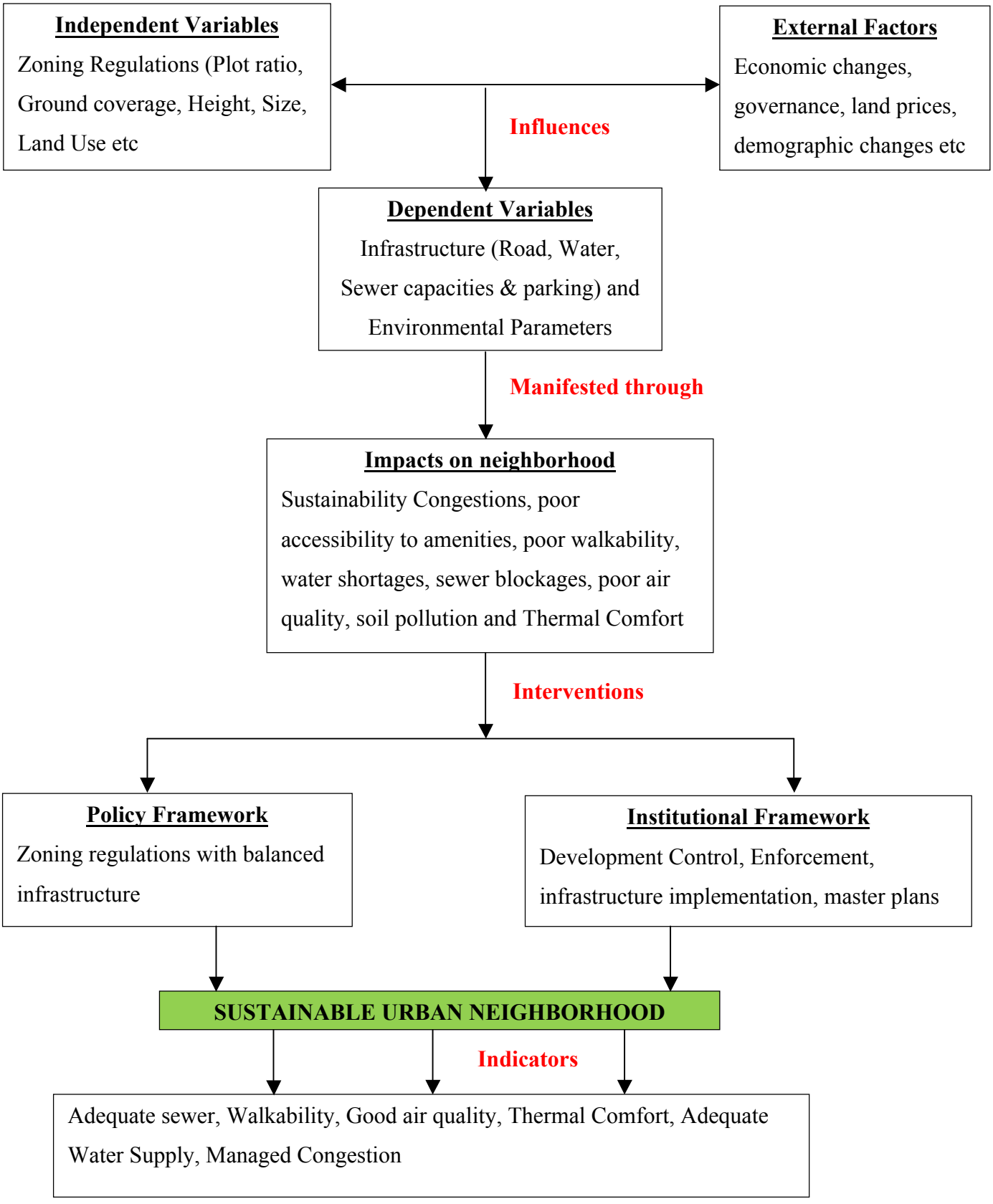
The SDGs is 15-year strategies that came into force on the first day of January 2016 with an aim of alleviating poverty, fighting inequality and promoting sustainable development through continuous development and protection of the planet through a multi-sectoral approach. While goal 11 of the SDGs aspires to make cities inclusive, safe, resilient and sustainable goal 13 aspires to combat climate change and its impacts.

3.5 Conceptual Model for Urban Neighborhood Sustainability

Zoning regulations coupled with external factors such as demographic and economic changes, land prices and governance influences urban form in terms of character, development densities, land uses and vegetation cover. These characteristics influence the environmental parameter and infrastructure requirements for a neighborhood. The environmental parameters often influenced by the urban form include air quality, thermal comforts, water and soil quality. Therefore, both environmental parameters and infrastructure have impact on neighborhood sustainability.

The adverse effects of neighborhood development can be ameliorated through policy and institutional framework encompassing reviewing and enforcing zoning regulations to be in tandem with the available infrastructure. The conceptual model as outlined in Figure 3.3 assumes that urban sustainability is dynamic and aims at providing for needs of the current generations optimally and preserving for the future generation. Therefore if the factors influencing the revisions of zoning regulations change then the authorities will be required to adjust the zoning regulations to enhance sustainability.

Figure 3.3: Conceptual Model for Sustainable Urban Neighborhood Development



CHAPTER FOUR: STUDY METHODS AND MATERIALS

4.1 Introduction

This chapter describes the tools and approaches, which were employed in the study towards meeting the goal and objectives of the study. It further highlights the materials and types of data used in the study, the data processing techniques as well as how the findings of the study are presented.

4.2 Target Population

The target population for the study was all the properties situated within the study area both built and un-built.

4.3 Sampling Design

Whereas the target population was all properties, the study used the *Yamane method* of estimating samples for known population, which was calculated as follows;

The study area comprises of a total of two hundred (200) plots of varying sizes ranging from quarter acre (0.1Ha) to two acres (0.8Ha). A sample size of 133 respondents was considered out of a population of 200 from the Yamane formula.

$ny = N/ (1+Ne2)$

where N is the known population size and e is the marginal error.

Assuming that the confidence level is 95% then e = 0.05

Therefore $ny = 200/ (1+200*0.0025)$

$ny = 133$

A total of 133 questionnaires were administered within the properties in the study area and only 106 questionnaires were filled and returned. This translated to a response rate of 80% which is considered a representative sample. The study employed Purposive sampling for quantitative data collection to ensure that out of 133 respondents all segments of the target population were captured. The properties in the study area are a

reflection of the zoning regulations applicable at the time of the development and the purposive sampling was to ensure that all existing development typologies and land uses are well represented.

The key informant's selection method was also purposively informed by the study objectives. The key informants were chosen from two departments of Nairobi City County (department of roads and department of urban planning of Nairobi City County) as well as the NWSCo to provide information on infrastructure. NEMA, WRA and NCA were also selected and interviewed to provide information on compliance, coordination and enforcement of any illegal development in the neighborhood.

4.4 Research Instruments

The study employed two types of questionnaires, one for the key informant's interviews and another for households. The questionnaire was confidential, clear, comprehensive and brief to gather more information within a short period. Qualitative data instrument employed a designed checklist tool as well as a photography checklist to guide specified data requirements for the study.

4.5 Sources of Data

The data for the study were obtained from both secondary and primary sources. Secondary data was collected obtained from previous studies, journals, zoning policies, and other case studies. Secondary data contributed towards building a background to the study and establishment of the knowledge gap, which the study was to fill. Details of the neighborhood zoning regulations and the changes thereof were obtained from the Nairobi City County.

The primary data were collected from the key informant interviews and household questionnaires. The study also employed mapping, observation, as well as photography and observation checklist to capture qualitative primary data which was an enabler to the meeting the study objectives. In order to understand the impacts of zoning regulations on available infrastructure data on the capacity of the existing infrastructure was obtained from the institution for example on sewer and water infrastructure and supply, data was obtained from NCWSCo.

4.6 Data Collection Process

In order to ensure that the study meets all the objectives, data was collected with the aim of answering all the research questions. Therefore, the research questions were answered in view of the laid out research objectives:

a) **To Document the Land Uses and Densities Occasioned by the Changes in Zoning Regulations**

The data needed to meet this objective is a mapping exercise of the land uses within the study area. The cadastral map of the area was obtained from Survey of Kenya (SoK) and data was collected on zoning regulations (height of the existing building, type of land use, and land coverage, typology of the house).

b) **To Examine the Impacts of Zoning Regulations on Water, Sewer, Road and Parking facilities**

Zoning regulations are known to have a correlation to infrastructural need. As such the study sought out to investigate the impact of zoning regulation on transportation (roads & parking), water and sewer capacities, which in turn affect the neighborhood sustainability. In consideration of the overall goal of the research that is to attain a sustainable neighbourhood the infrastructure was measured against the best applicable

standards. The capacities of water and sewer, roads and parking facilities were measured against the best management standards and linked to the zoning regulations. Data on water and sewer infrastructure sizes and coverage was obtained from the Forward Planning section of Nairobi City County and NCWSCo while information on Road infrastructure was acquired from department of roads at NCC. The aim was to create a set of zoning regulations that are in harmony with the available infrastructure. The information for the two objectives aided in answering the third objective as well as the third research question, which was the main goal of the investigation. Ultimately, following the analysis of the data collected from the household questionnaires coupled by information from the key informants, a zoning policy framework for the study area was developed with a management framework aligned to the available and standard infrastructure need.

4.6 Method of Data Analysis

The data collected was analyzed using various methods. The spatial data were analyzed using ArcGIS 10.5 while household data were analyzed using SPSS and MS Excel. Most of the qualitative data were analyzed from observation and photography while quantitative data was analyzed from questionnaires.

The collected data was keyed into a spreadsheet, which together with the unique code assigned to each building by using GIS, allowed for analysis of the various attributes such as percentage ground coverage and building height.

4.7 Information Presentation

The study findings are presented in the form of a report, maps, infographics, tables and pie charts that are easy to understand.

4.8 Ethical Considerations

The research was premised on ethical considerations by first seeking necessary permits before any primary data collection. The permits were obtained from the University of Nairobi, NACOSTI, Nairobi City County, NWSCo and a clearance was sought from the provincial administrations for security issues. The questionnaires were not personalized and all responses were confidential.

Table 4.1: Data Needs Matrix

Research Objective	**Data need (type of data)**	**Source of Data**	**Method of Data collection**	**Method of data Presentation**
To document land uses and development densities occasioned by changes in zoning regulations for the neighborhood	Type and distribution of land uses, Housing typologies, Ground coverage's and plot ratio Parking types and standards Height	Field survey NCC NWSCo Literature review	Literature review Interview Photography Mapping	Written reports Graphs Maps
To establish the impacts of zoning regulations on water, sewer systems, road and parking facilities	Parking standards Road reserve Public transport, NMTs Water infrastructure capacity Sewer infrastructure capacity Distribution of water and sewer	NCC Other institutions Literature review Field Survey	Mapping Observation Photography Interview Literature review	Maps Written report Photographs
To evolve an alternative policy framework to guide developments in the neighborhood	Standards of infrastructure demand Climate (wind direction, sun) Densities, compactness of neighborhood, Vegetation cover	Survey Other institutions	Literature Mapping Literature review	Table Graphs Formulae Report

CHAPTER FIVE: FINDINGS AND DISCUSSIONS

5.1 Introduction

This chapter aims to present the research findings as derived from the respondents and field observations.

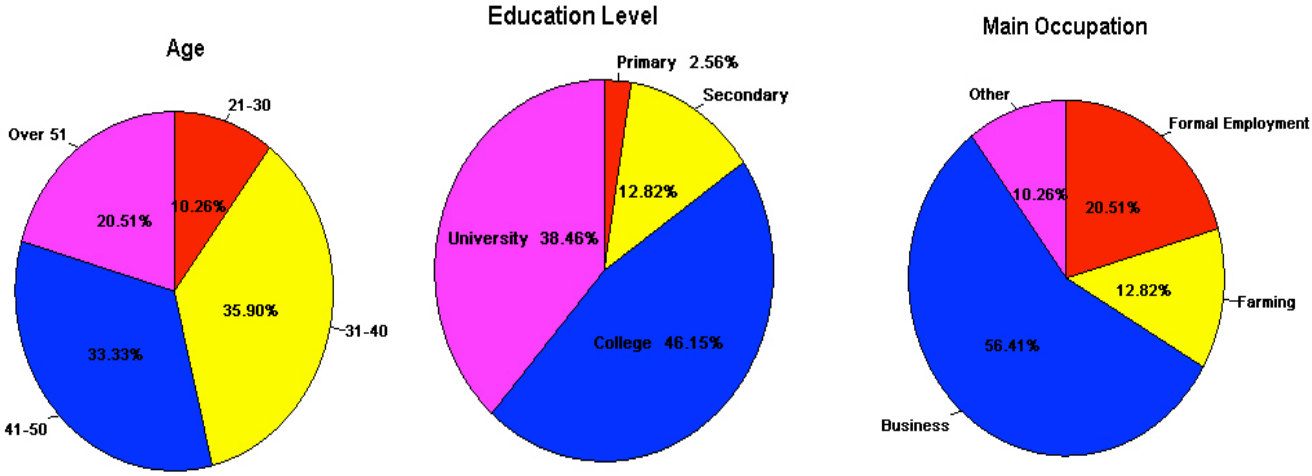
5.2 Response Rate

Mugenda and Mugenda (2003) note that response rate is the percentage of subjects who respond to questionnaires. A response rate of 80% is considered favourable, and is interpreted to show that the respondents were representative of the total target population.

5.3 General Information

Majority of the respondents about 90% were aged above 30 years representing a group of working class out of which 85% had either a college certificate or a university degree. About 77% of this group had their sources of livelihood either from formal employment or in business ventures. More than half (56%) of the respondents who were business entrepreneurs had a monthly income of more than Kshs. 150,000. This translates that this group can afford a mortgage, rent or land in the upper middle income zone like in the study area.

Figure 5.1: Age, Education level and Occupation

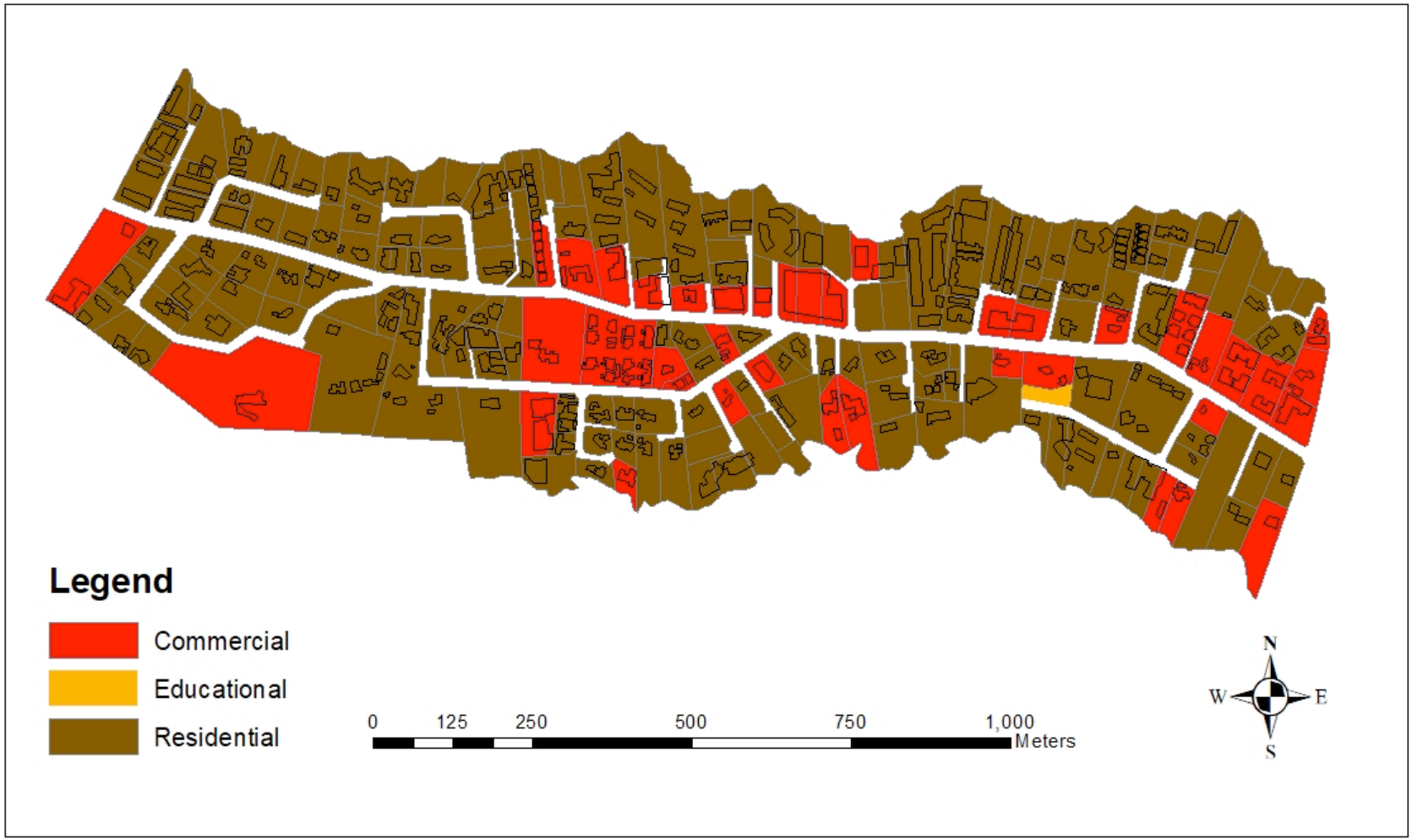


5.4 Changes in Land Uses and Development Densities in Riverside Neighborhood from 2006

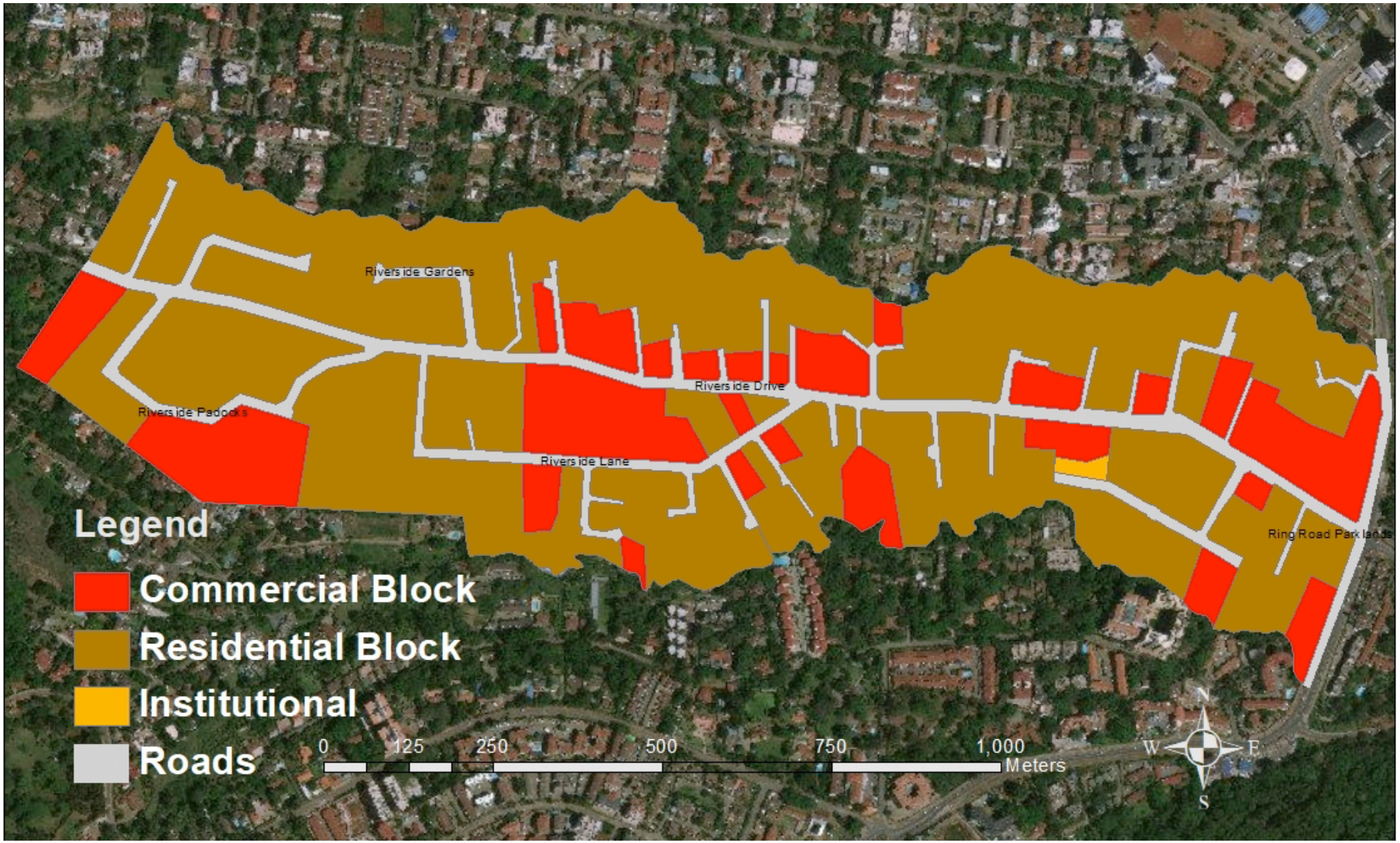
There are a number of factors linked to why people choose to live in a given neighborhood. The respondents had varying reasons that attracted them to live in the neighborhood notably; the proximity to work and amenities, serenity of the neighborhood, accessibility of the neighborhood and some being born in the neighbourhood. The existing land uses at the time of our field survey are as a result of varying zoning regulations informed by different set of zoning policy framework applicable in the area since the Country's independence. The year 1979 and the year 1987 rezoning policies of Nairobi city did not affect the Riverside neighbourhood, as the applicable zoning regulations remained the same. The land uses and the development densities also remained the same during that period up until early 2000 when some infrastructure development were initiated necessitating the review of the zoning regulations. In the year 2006 the zoning regulations for the area were reviewed to allow

for medium density developments in light of the existing infrastructure. The properties that were served by trunk sewer were allowed to develop apartment but with limitation of the skyline. The dominant land use was residential (single dwelling and apartments) of up to four floors. Since then the zoning regulation have been revised to cater for the increasing population as well as demand for housing and office spaces in the area. The study establishes that the existing land uses in the area are residential (bungalows, mansionattes, townhouses and apartments), commercial (offices, hotel and retail), embassies, transportation (roads) and institutional (schools). Map 5.1 below shows the types and the distribution of land uses in the study area.

Map 5.1: Existing Land Uses with existing Buildings



Map 5.2: Land Uses in the Study Area



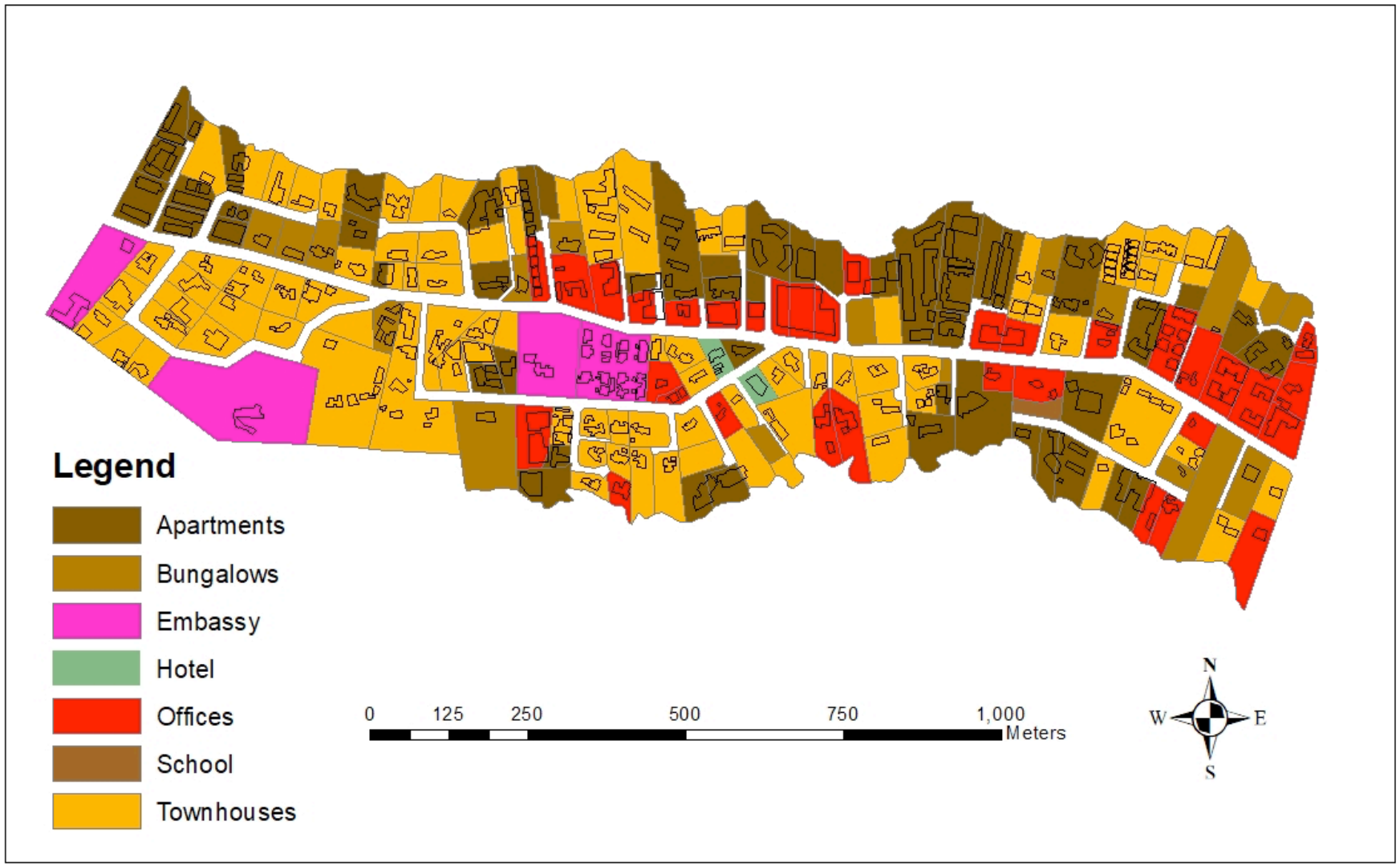
The field survey observes that the changes in the applicable zoning regulations for the area have not influenced the change of the dominant land use, as residential use is still the dominant land use. The offices development as a result of change of user is noticeable and in line with the principles of urban sustainability. Most respondents who still reside in the townhouses and bungalows are open to the possibility of high rises in the future. They however, urged the city authorities to come up with effective development control measures to align developmental growth with a sense of adequate infrastructure and services.

The study found that the existing land uses and development densities are a reflection of changes in zoning regulations over the years. In 2006 all plots in the study area were to be used for single dwelling residential land use. This meant that most of the developments were of residential use with three types of typologies notably bungalow, townhouses and apartments with a maximum skyline of twelve (12) metres or four floors. The existing land use documented during the field survey established that about 50% of these plots have changed the development category to either apartments or offices with a skyline higher than 12 metres or four levels. The study also established that the skyline or development height have changed over the years while responding to changes in the zoning regulations. It was noted that commercial land use conformed to a skyline of 3 metres per floor while residential land use adhered to a height of 2.7 metres per floor. The skylines, plot ratio and the ground coverage have also changed in a way to illuminate the development characteristics that define the zoning regulations of NCCG. The ad hoc zoning regulations operational in the study area were noted to compromise the adequacy of the available infrastructure. The NCCG department of roads notes that

the structure plan and road surrenders in the area did not envisage such high densities hence they foresee increased traffic congestions when the neighbourhood is fully developed.

Plate 5.1: Existing Housing Typologies

Map 5.3: Existing Development Typologies



5.4.1 Zoning Regulations and Development Changes in Riverside Neighborhood

All respondents (100%) acknowledged that the Riverside neighborhood has changed since they started residing there. On average the respondents have lived in the neighborhood for about 13 years. The main changes that were observed are inclusion of commercial developments and high rise residential developments. 54% of the respondents reside in single dwelling residential unit (townhouses or bungalow) while 46% live in multiple dwelling residential units (apartments). The respondents noted that in 2006 zoning regulations for zone 4C allowed ground coverage of 35%, plot ratio of 75%, minimum plot size of 0.2 Ha with dominant land use being residential. Developments informed by 2006 zoning regulations have either maintained the townhouses or medium density residential development character with a skyline ranging from 3m to 16m or one (1) level to six (6) levels. These zoning regulations allowed developments with a skyline of five floors but developers prompted by higher values of land negotiated with the city authorities using the planning gain rationale to get an extra floor. The study notes that the varying skyline using the same zoning regulations is as a result of policy makers not recognizing the development height in metres but rather in the number of floors.

In 2012, ad hoc policy increased ground coverage to 40% and plot ratio to 200%. The 2012 ad hoc zoning regulations saw the skylines change from five to eight or nine floors and land use from residential to mixed-use developments. This was necessitated by the infrastructural development that expanded the coverage of trunk sewer and water supply infrastructure by City Council of Nairobi in 2009 following recommendations of zoning

review of 2006. The land values skyrocketed making 2006 set of zoning regulations not economically viable.

In 2015, again because of the higher land values and proximity to Nairobi CBD there was an increased demand for housing and office spaces necessitating adoption of a new ad hoc zoning regulations. This change in the applicable zoning regulations necessitated a shift of the skylines from 9 floors to 12 floors for all allowable land uses

The study establishes that Northern side of Riverside Drive has fully accepted developmental changes set by zoning regulations of 2012 and 2015 evidenced by new high rise mixed developments taking place. The Northern side of Riverside drive was also found to be well endowed with wider coverage of both water and sewer infrastructure compared to the southern side.

5.4.2 Triggers to Zoning Regulations and Development Changes in Riverside Neighborhood

Whereas there has been changes in the study area attributed by varying zoning regulations, it was noted that there is an area that has strictly maintained the prior 2006 development character. The study also established that the residents' groups played a role in shaping the neighbourhood character through public participation to the proposed development. The resident group pointed out that their collaboration with the approving authority resulted to successful objections of proposed change of use. It was also noted that the north western side of the study area, the property owners are politicians, senior government official and diplomats who have a say in policy implementation. Therefore, political power and influence was noted as a trigger to changes in zoning regulations.

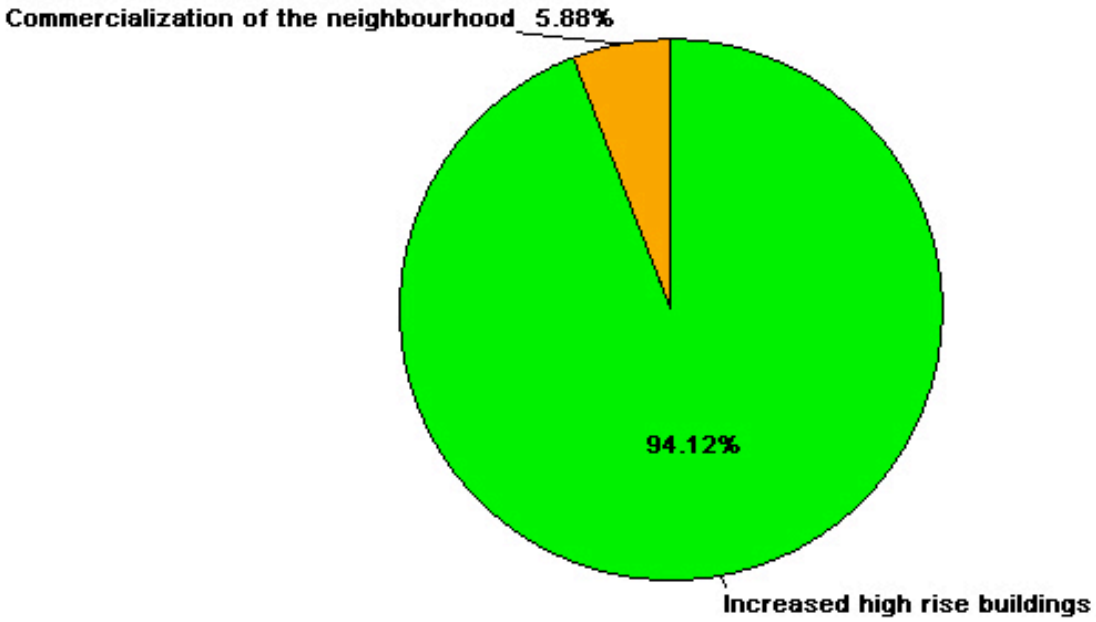
As observed the land values skyrocketed upon expansion of infrastructure in 2009 rendering the existing zoning regulations not economically sound. It has been noted that

ad hoc zoning regulations have been adopted to conform to the prevailing economics. The demand and supply of both commercial and residential spaces and locations in the study area are the key drivers that have triggered policy shift through revision of zoning regulations. The economic equilibrium has been enhanced by the purchasing power by both the developer and the home owners as well as tenants. If investments in real estate in the area were faced by voids, then the zoning regulations and changes would be minimal. Economics therefore has played a key role in the changes of the zoning regulations.

Population growth in the city has been postulated to trigger urbanization which is often correlated to socioeconomics (Huang et al, 2015). The population growth of the study area has indeed led to a shift in the zoning policy.

As a result of the ad hoc zoning regulation, infrastructure coverage and the residents' active participation, the study observes that the developments in zone 4C has been further delineated into three unique sub-zones. The respondents noted that the key causes of the changes in the neighbourhood were commercialization of the plots (either by conversion of the existing dwelling or complete redevelopment of offices or commercial enterprise) and a shift from medium density to high rise development in the neighbourhood triggered by economics, population growth, infrastructural changes and policy changes.

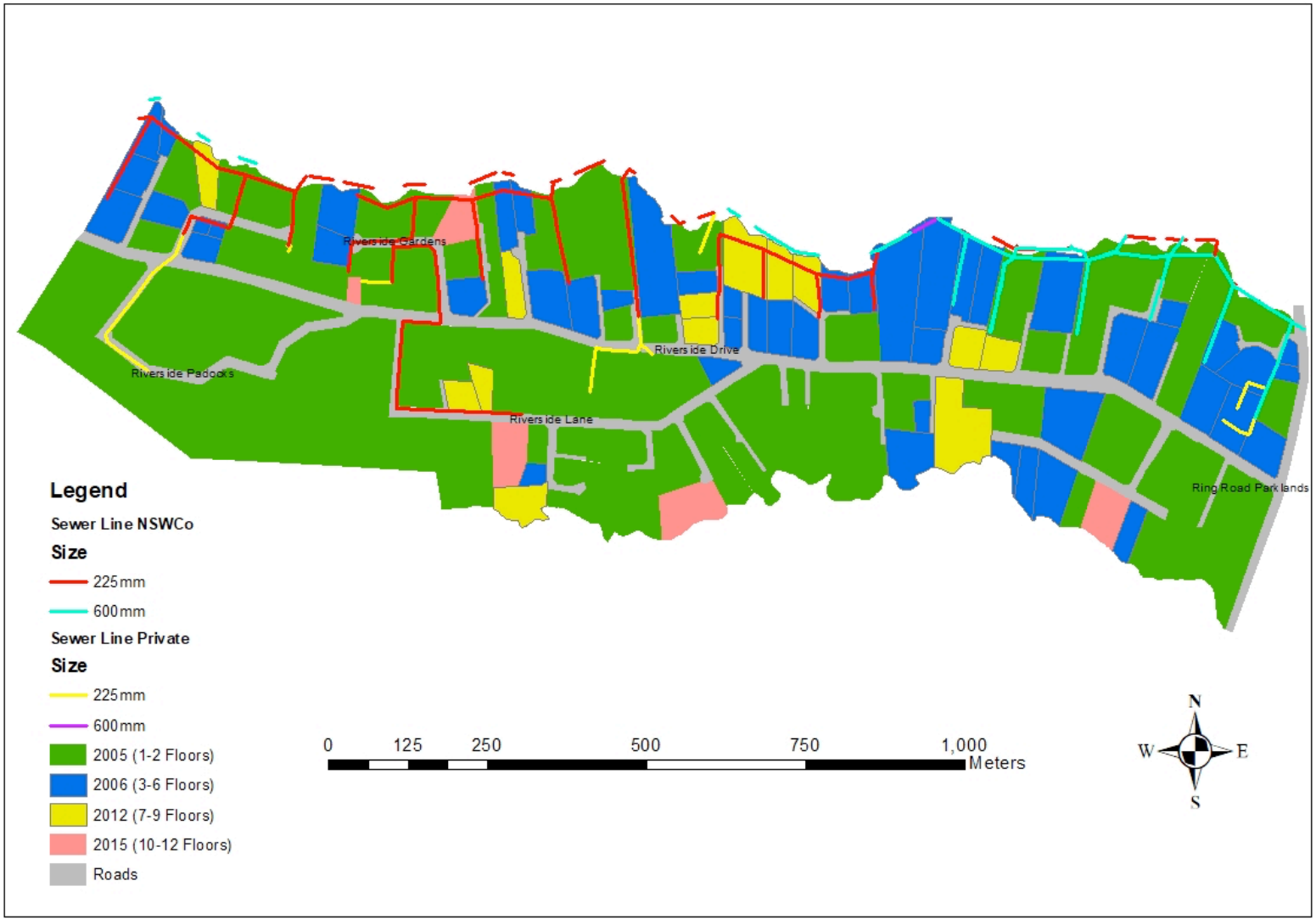
Figure 5.2: Causes of Neighbourhood Changes



Whereas there are other factors attributed to the changes in the neighbourhood the two were the main cause of the noticeable changes as observed by the respondents.

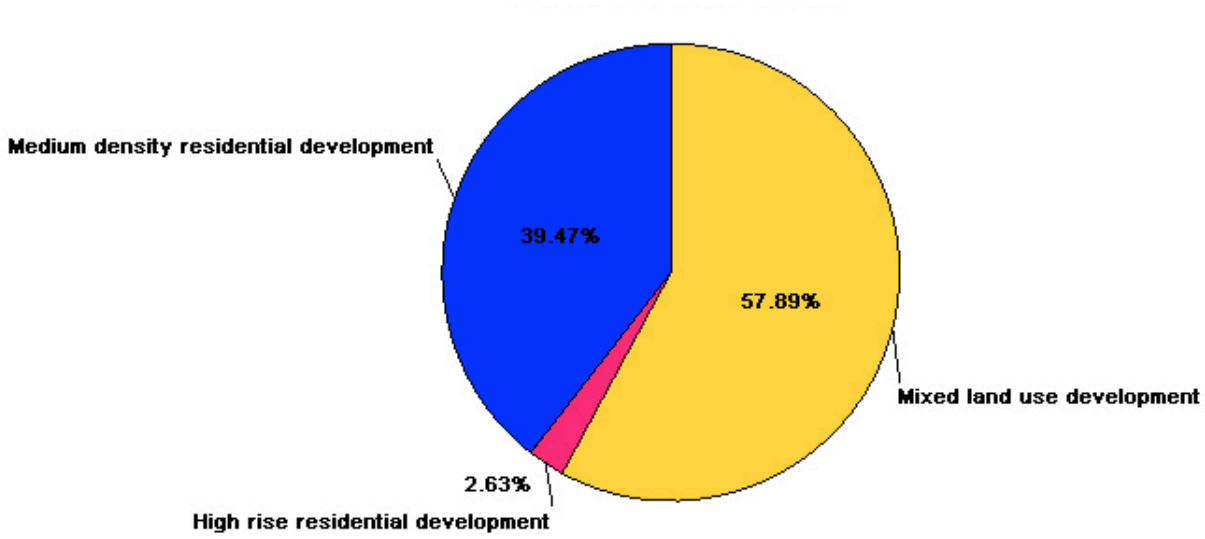
The study found out that some property owners came together to privately extend the trunk sewer connection to enable them develop the high rises which were limited to availability of trunk sewer by the applicable zoning regulations. The study also established that almost all plots that have high rises are covered by trunk sewer infrastructure connected either by the authority or privately by the developers. Map 5.4 below shows the development skyline and sewer coverage by different actors.

Map 5.4: Development Height in Relationship with Zoning Regulations Year and Sewer Availability



Despite the changes in zoning regulations, no major infrastructure expansions have been done in the neighborhood since the year 2009. Some of the respondents 39% still prefer the year 2006 zoning regulations to be considered because they were aligned to available infrastructure hence neighborhood sustainability was certain. The reasons they supported the medium density as the preferred development option was the fact that the available infrastructure in the neighborhood is already constrained and if no infrastructure interventions by the NCCG the neighborhood sustainability will be eroded. The study established that both sewer and water infrastructure did not cover some properties in the study area and the property owners relied on septic tanks for liquid waste disposal and either borehole or water bowsers for water supply.

Figure 5.3: Preferred future development



However, more than half 57% of the respondents believe that the current development scenario of mixed land use development is the best as it leads to sustainability because all activities are concentrated at walking distance. They however noted that mixed

development should be accompanied by adequate infrastructure and services for it to work.

The ground coverage of a development is an important element of zoning regulations. The study found that the ground coverage's have changed as the applicable zoning regulations change. The year 2006 zoning regulations allowed a ground coverage of 35% while the 2012 and 2015 ad hoc zoning regulations changed to 40% and 50% respectively. The net effect of ground coverage is the balance of both hard and soft space of a development, which in turn affects the neighbourhood sustainability.

The study found out that as result of changes in the applicable zoning both the height of the building and ground coverage changed. It was observed that the ground coverage increment meant depletion of the existing tree cover thereby compromising the sustainability by impacting the air quality and the thermal comforts of a development. Map 5.5 below shows that the existing development ground coverage in relation to height of the building.

Map 5.5: Ground Coverage in Relation to the Building Height

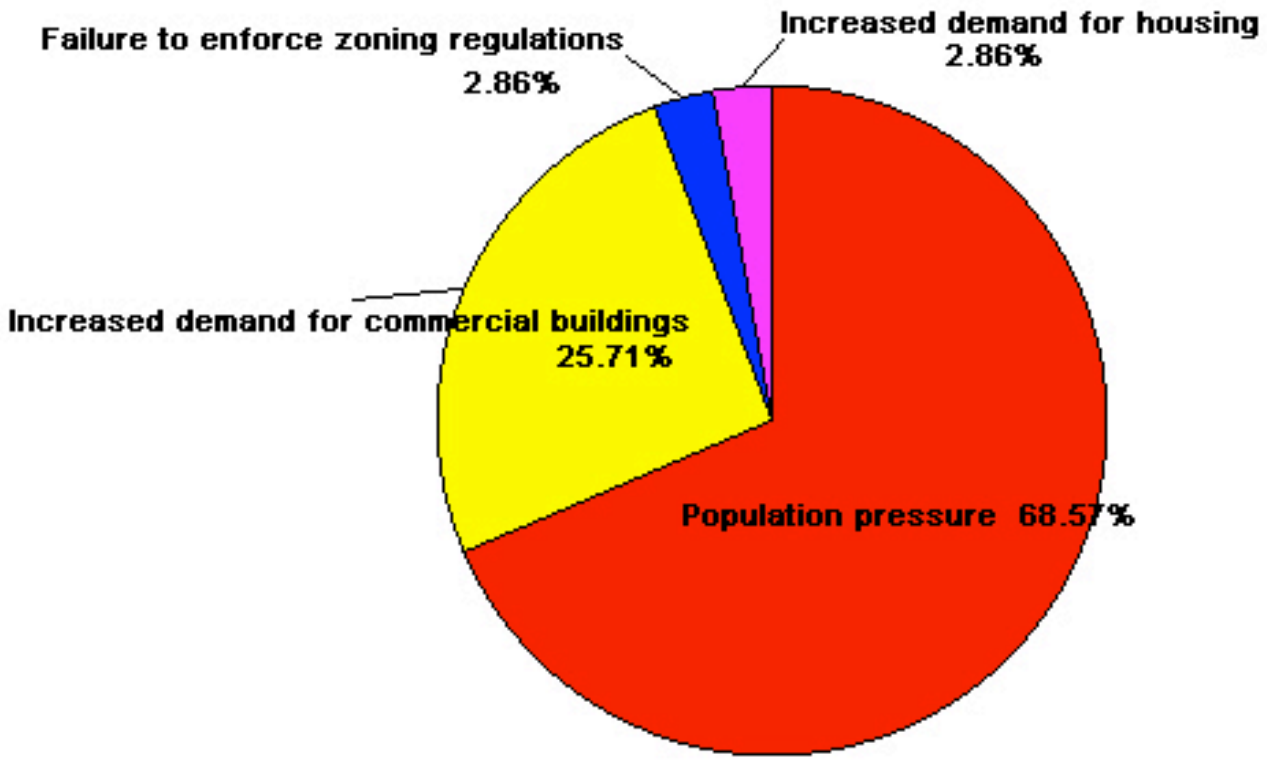
5.5 Impacts of Zoning Regulations on Infrastructure

Changes in zoning regulations for the neighbourhoods closer to the Central Business Districts (CBD) have enhanced development densities through a shift in both ground coverage's and plot ratios. The development densities in many jurisdictions of such areas at close proximity to the CBD are revised upwards to take care of the growing and varying needs of the city residents. The respondents to the study noted that there have been significant changes in density within the neighborhood necessitated by population pressure, increased demand for commercial spaces, failure to enforce the applicable zoning regulations and increased demand for housing.

Riverside neighborhood is at a proximity to Nairobi CBD and majority of the respondents' perception on the main causes of the changes in the neighborhood were population pressure and the increased demand for commercial spaces. These changes in the development densities, land uses and development heights have necessitated revisions in zoning regulations applicable in the area as earlier noted leading to water rationing, sewer burst, traffic congestion amongst other impacts. Policymakers recommend that developments should follow infrastructure growth and this position was not supported by the years 2012 and 2015 ad hoc zoning regulations. Some of the respondents also noted that the city enforcement mechanisms have played a role in the change of development density over the years through corrupt dealings manifested by inconsistent development permissions.

The respondents have argued that some developers would stretch the densities beyond the approval and regularize later after development completion, which in effect has created wrong precedence culminating to adoption of ad hoc regulations.

Figure 5.4: Drivers of Neighbourhood Changes



5.5.1 Impacts of Zoning Regulation on Water Supply

Ground and surface water both play an important role in water supply for Nairobi city. The principal source of water for Nairobi is surface water from the Tana River drainage basin. Fresh water is also found in the three main rivers notably Nairobi, Mathare and Ngong Rivers that flow through the city but their quality is compromised as a result of pollution. Nairobi River is a boundary to the study area and indeed it is very polluted making the water not usable.

Water demand and its supply in a residential neighborhood is a sustainability ingredient for a well-functioning urban system. The water demand per household is depended on the size of housing unit and number of people residing therein. This was confirmed as the study establishes that there is a direct correlation between household size and water demand. The study found out that daily water usage per household ranges from 100 litres to 1000 litres depending on the size of the household. Majority of the respondents relied on water supply from NCWSCo and a mix of NCWSCo and water bowsers. These two sources accounted for 92% of the water supply in the study area. It was also noted that the southern part of the study area is not well served by infrastructure and some plots we neither connected by NCWSCo nor boreholes but relied on water bowsers. The neighborhood has not tapped in to ground water evidenced by less than 3% of the respondents who indicated they use borehole water. Water Resources Authority (WRA) formerly Water Resource and Management Authority (WRMA) in an interview with their representative confirmed that the study area has potential for underground water and that the future of water supply for the neighborhood would be boreholes. They noted that only a few boreholes had been sunk but they have issued several permits for the up coming developments. The records provided were for only eight boreholes which have been completed and the proponents issued with completion certificates. The WRA official noted that the borehole water quality were tested and found fit for human consumption. The extraction permits for the boreholes in the area were for domestic purposes hence limited to the standards of 280 cubic metres (m^3) per day.

The table below shows the depth of boreholes and their respective yields over the years.

Table 5.1: Existing Boreholes in Riverside Neighbourhood

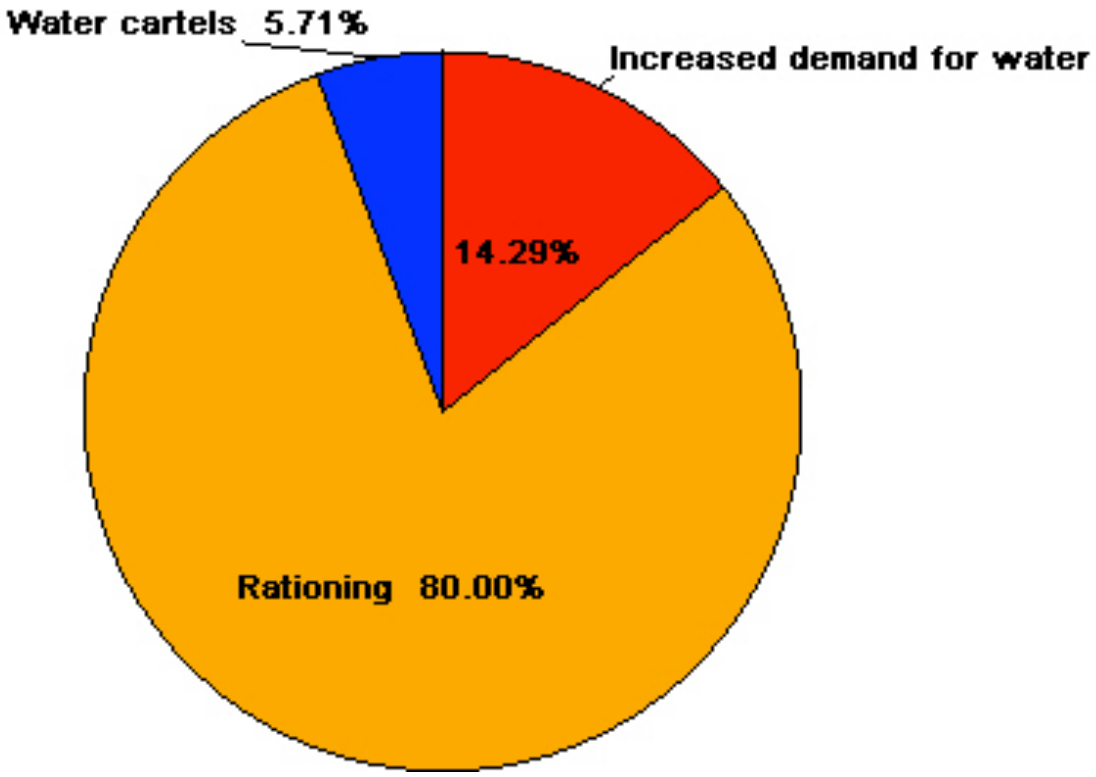
Borehole Id	Depth(M)	Yield (M^3/hr)	Year of Borehole Completion
2752	97.5	-	1958
9685	130	0.99	1991
10281	160	7.92	1992
13009	265	10	2000
12948	275	10.02	2000
14539	280	10	2004
1176	278	15.65	2010
994	290	25	2011

From the table above, it can be concluded that the aquifers have been depleted in the city over the years. In the year 1958 the aquifer in the neighbourhood was just below 100M deep, while in the year 2011 it is almost three times deeper at 290M. Based on the same information it can be argued that the deeper the aquifers the more the water yields because the 1958 aquifer yield was below 1 cubic meter per hour (M^3/hr) while in the year 2011 the yields were 25M^3/hr. It can also be argued that over the years the water table has been depleted causing water table to go lower. The study suggests measures on environmental conservations to form part and parcel of protection and conservation of underground water sources.

On adequacy of water, 97% of the respondents noted that water commodity is not adequate and the supply by NWSCo is not reliable. The study establishes that the coverage of the NWSCo infrastructure was not 100% with some properties relying on borehole water and water bowsers. The residents who lived in the neighborhood prior to the year 2010 noted that water supply was adequate and reliable in sites that the infrastructure had reached. It was observed that there were few plots on the southern part of the study area that were which explains partly why the coverage of water infrastructure is not 100%.

It was noted that the inadequate water supply at household level is as a result of varying factors including; NWSCo rationing, increased demand for water while the supply has gone down, water cartel who want to supply the commodity in the neighborhood colluding with the authorities. Majority of the respondents 80% noted that the supply was limited through rationing which was a direct impact of revising the zoning regulations without due consideration of water infrastructure and supply of the commodity to the residents in neighborhood. The study further established that the rationing was a temporary solution to a worse situation if the neighbourhood development trend persists without investment on the infrastructure.

Figure 5.5: Reasons for Insufficient water supply



Currently, the NCWSCo supply is about 10% of their water requirement per household and water in the neighborhood is supplied once or twice a week. They supplement this by purchasing water and providing bigger underground storage tanks for their households.

The study establishes that water supply by NCWSCo prior to the year 2010 was on a daily basis but currently it is supplied once a week and the pressure of the commodity is low. This is attributed to the infrastructure, which anticipated six floors, and currently in some properties the levels are double.

Figure 5.6: Daily water consumption and sources per household

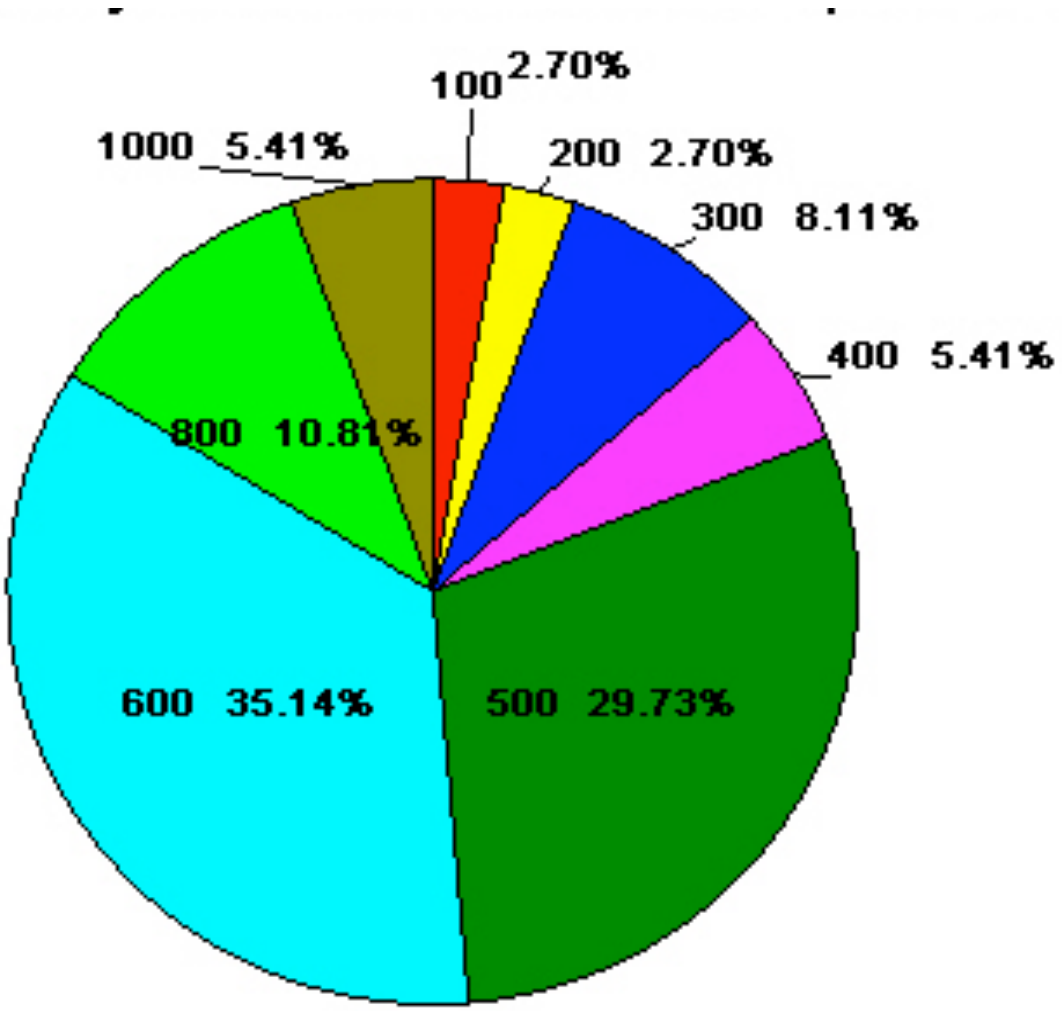
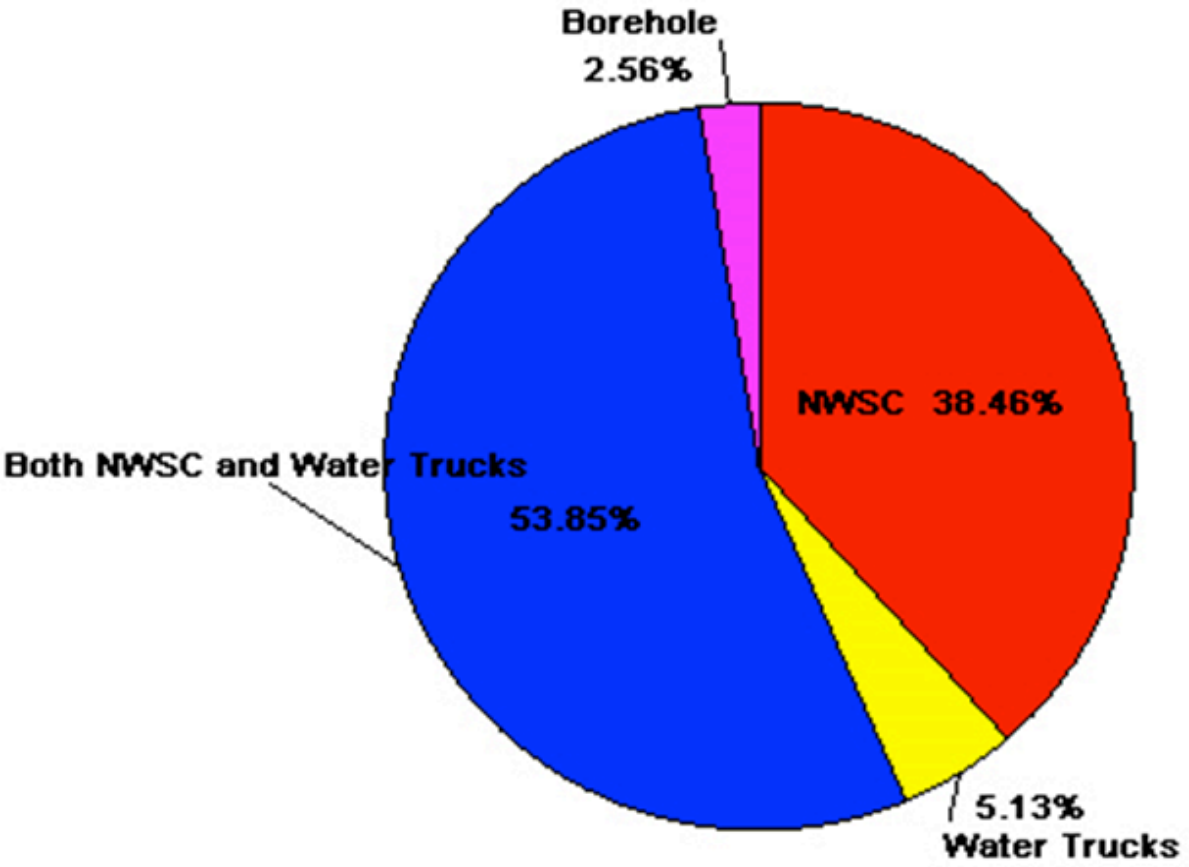


Figure 5.7: Sources of Water

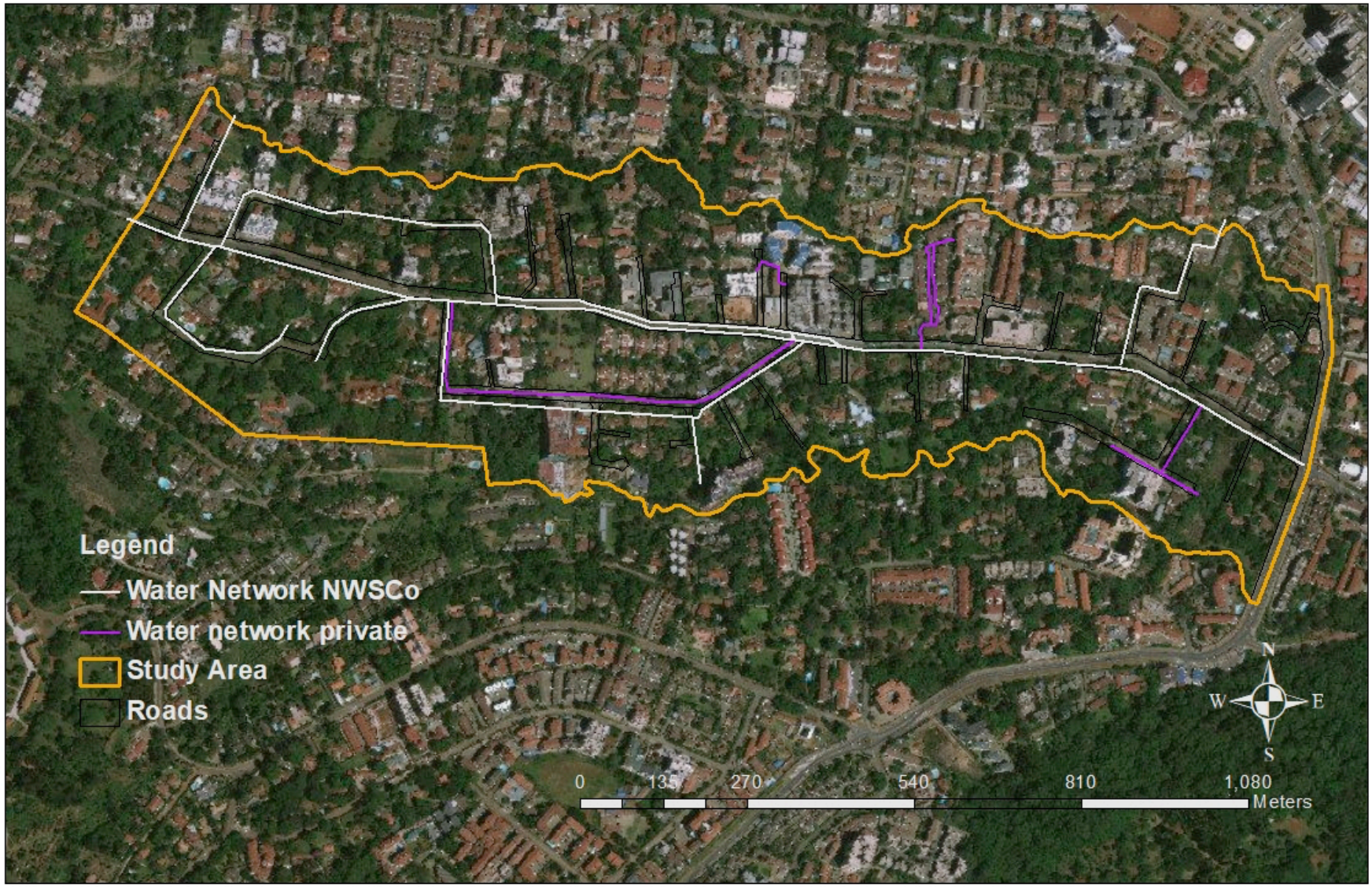


boreholes. It was observed that some plots had both private line and NCWSCo line. This was as a result of the plot owners sinking boreholes to supplement the existing supply upon densification. The increased densities as a result of changes in the applicable zoning regulations have led to an increase in population. Riverside neighbourhood and indeed zone 4C is situated in Kileleshwa location or ward. As of the year 2013, KNBS estimated the Kileleshwa ward's population to be 27,202 people. The study assumed that the development and the population distribution to be homogeneous. While considering the total area of Kileleshwa ward which is approximately $9KM^2$ and the study area approximately $1KM^2$, then the population of the study area was approximately to be 3023 persons in the year 2013. The projected current population during the study period

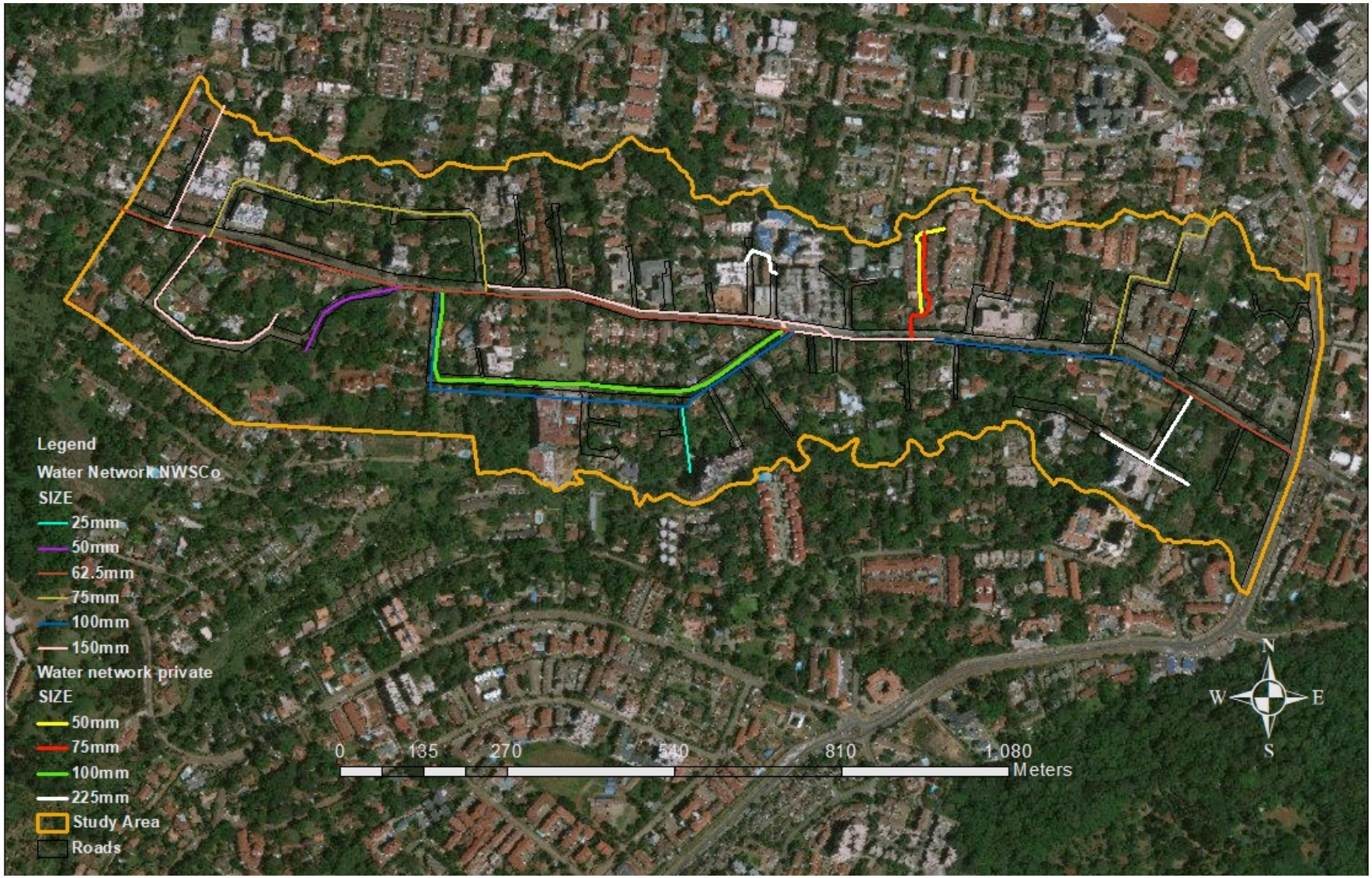
is 3,937 people assuming a constant growth rate of 4.5% per annum. According to the Water Design Manual formulated by the Ministry of Water and Natural Resources (MoWNR), Riverside neighbourhood's usage is indicated as 250 litres per person per day because it lies in a high class housing location of the city. The daily water consumption is therefore 250*3937=984,250 litres ($984M^3$). The actual supply of water is from NCWSCo is estimated at 50% of the total daily water requirement thus a shortage of $492M^3$.

The borehole water supply and water bowsers supplement the existing deficit. While assuming a sustained population growth of 4.5%, in the year 2033, which is fifteen (15) years after this study the population is projected to be 7620 people. Therefore the daily water requirement for the neighbourhood is projected at $1905M^3$.

Map 5.6: Water Reticulation in the Study Area



Map 5.7: Size of Water Reticulation Pipes in the Study Area

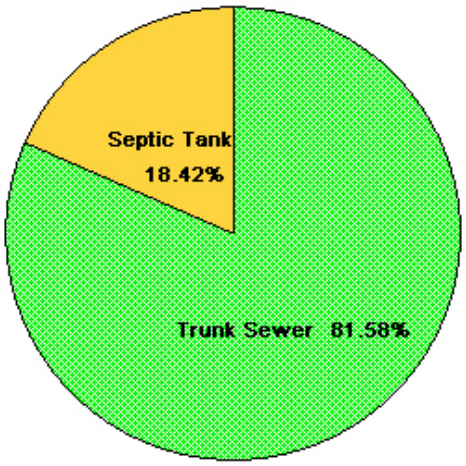


5.5.2 Impact of Zoning Regulation on Sewer System

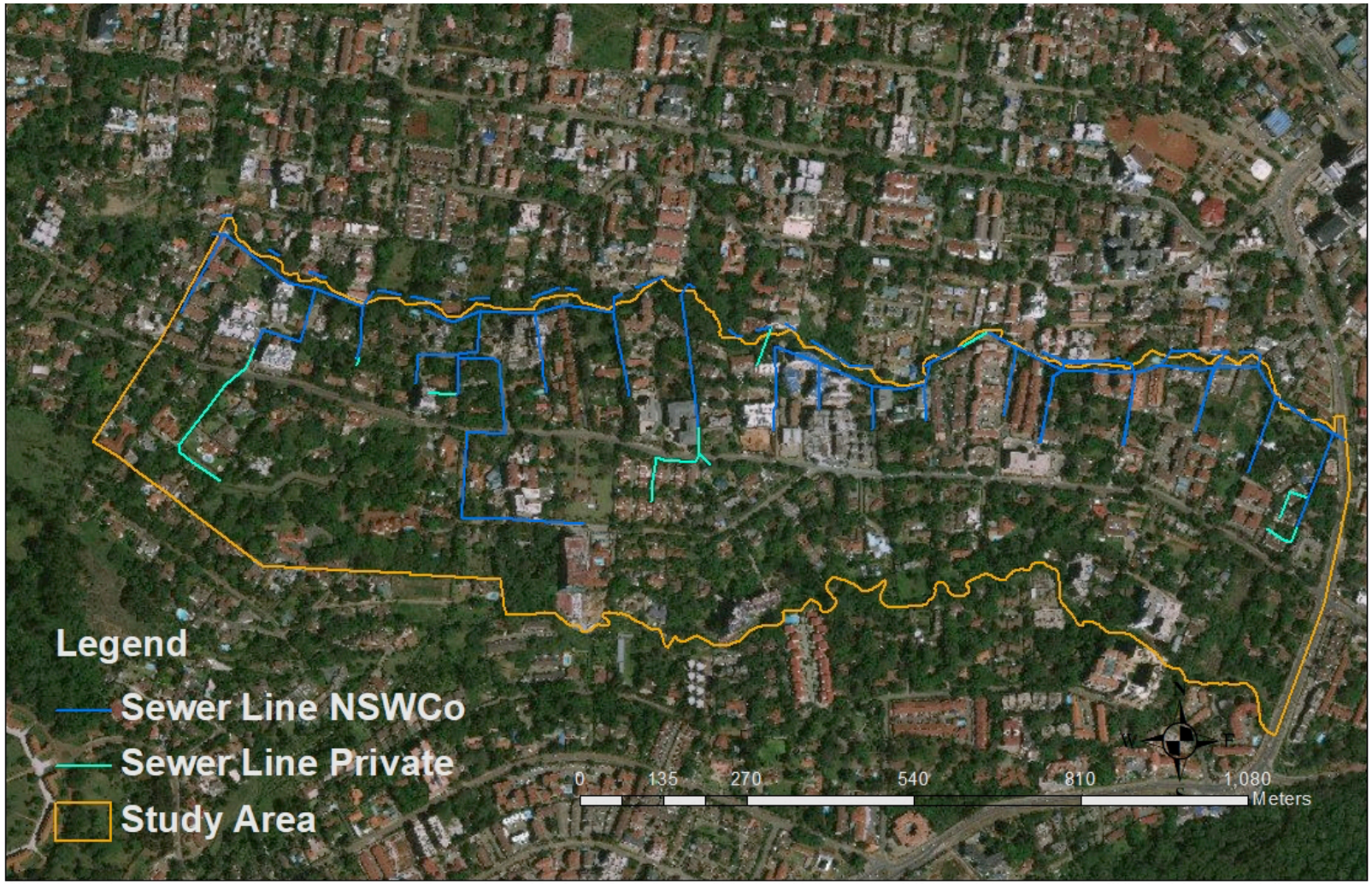
Liquid waste management in Riverside neighbourhood is through both the trunk sewer system by NWSCo and septic tanks. The zoning regulations for the neighbourhood were tied to the trunk sewer availability for higher densities. The properties served by sewer in 2006 were allowed to develop apartments while the rest were zoned for townhouses development. The study establishes that sewer expansion done post rezoning of the year 2006 covered most properties on the Northern side of the study area while most of the properties on the Southern side were not covered. The respondents were picked from apartments development and townhouses development. Some of the respondents who live in townhouse developments had intentions of redevelopments in the near future and had already procured the change of user to either apartments or office or a mix of apartments and offices from NCCG planning department.

This demonstrates that the development densities and number of dwelling units per hectare will increase in the near future. The study also found that trunk sewer covered about 82% of the properties in the neighbourhood while 18% used septic tanks for liquid waste management.

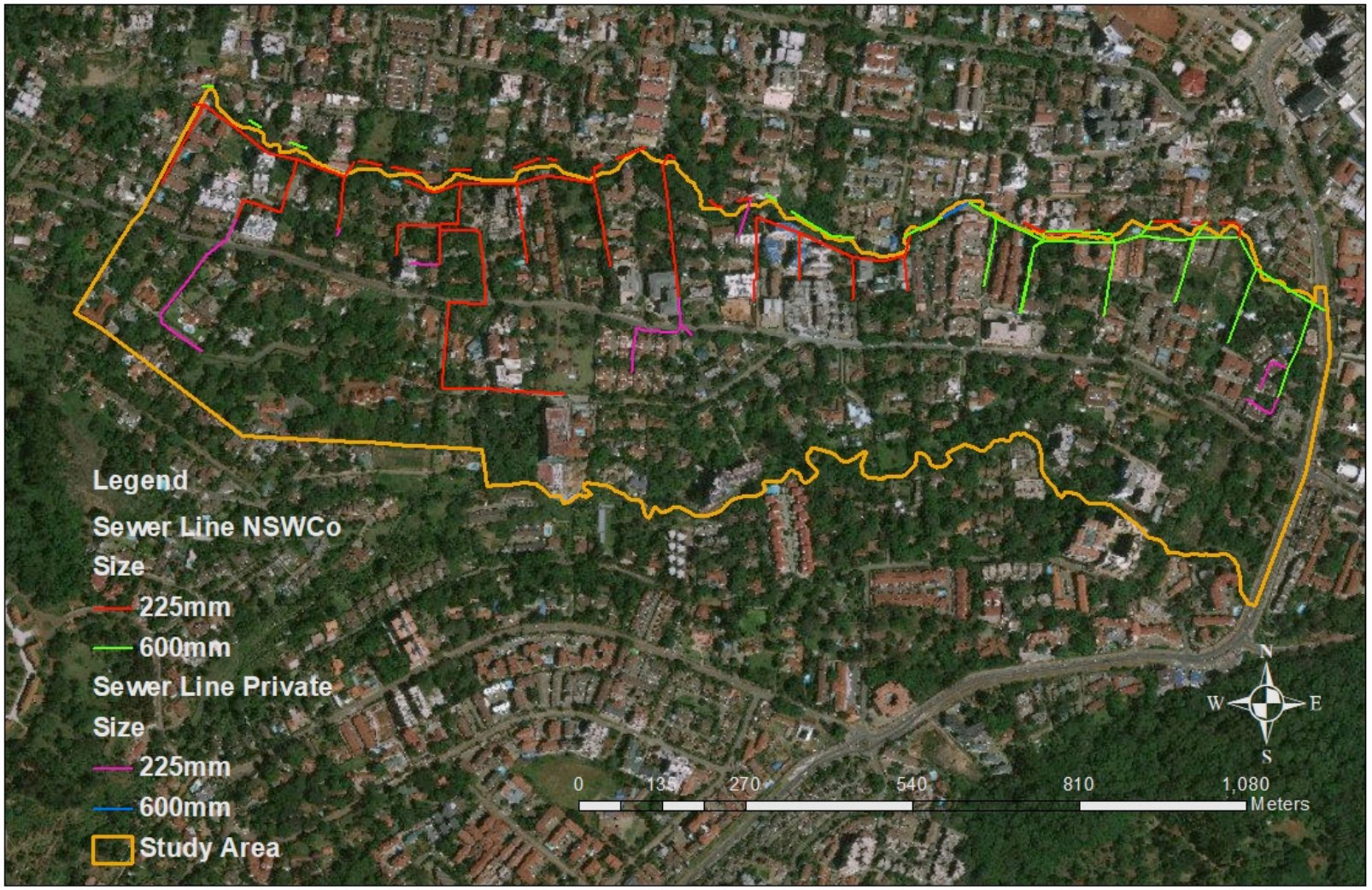
Figure 5.8: Waste Disposal



Map 5.8: Sewer Reticulation in the Study Area



Map 5.9: Size of Trunk Sewer in the Study Area



About 91% of the respondents note that the sewer network was sufficient for the changes in development densities in the area with a small number (8%) cautioning the authorities on the sustainability of the infrastructure. The trunk sewer does not serve about 20% of the area. The sewer infrastructure coverage comprises of 225mm diameter and 600mm diameter pipes.

The projected current population during the study period is 3,937 with an estimated daily water consumption of $984M^3$. The sewer demand per day is 75% of daily water usage. Therefore the sewer demand was estimated to be $738M^3$ during the day. In the year 2033, fifteen years from the study period the sewer demand will increase to a projected $1429M^3$.

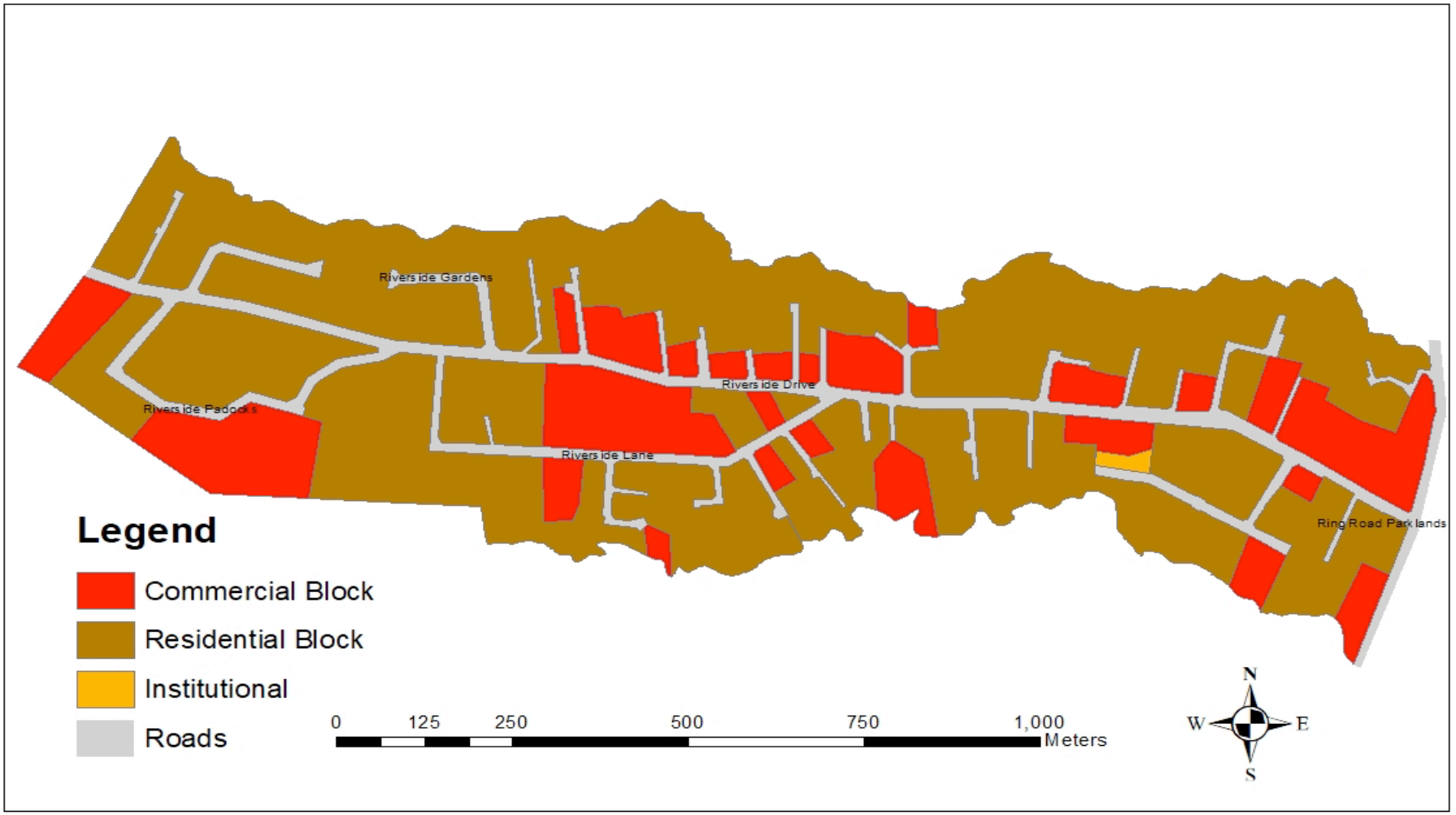
5.5.3 Impact of Zoning Regulation on Road

The study established that riverside neighbourhood is served by one spine road (Riverside Drive), which was initially 15 metres wide. The NCCG road department structure plan on road proposed expansion of the spine road to 21 metres. In order to achieve this there collaboration between road and urban planning departments to enforce road surrenders before any proposed development permission is granted. In effect all owners of properties abutting Riverside drive are required to surrender 3 metres prior to any development permission being granted by the city planning authority. The study established that there is traffic congestion as a result of increased densification brought about by changes in zoning regulations. All the respondents confirmed that traffic congestion was a direct impact of the changes in zoning regulations. On causes of traffic congestion, the respondents attributed them to increased number of private cars,

increased population, commercialization of plots, lack of traffic law enforcement, narrow roads and increased high-density developments.

Plate 5.1: Section of Roads with Storms Drains

Map 5.10: Land uses and Road Coverage

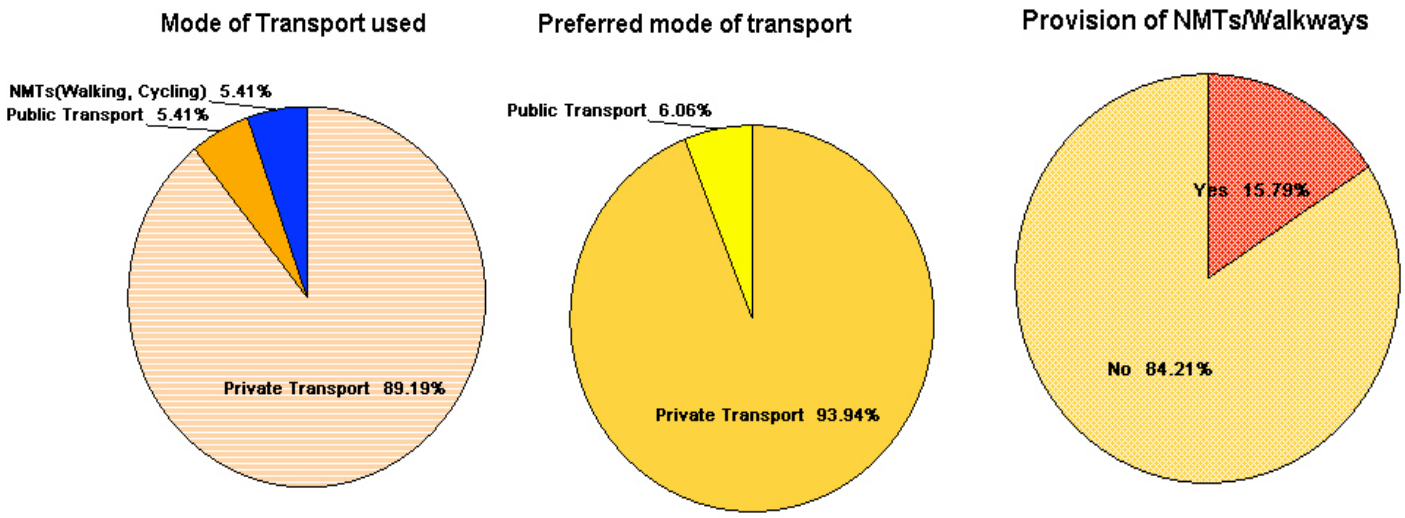


Despite the changes in development densities the respondents noted that the provision of Non Motorised Transport (NMT) infrastructure was still not elaborate with only 16% confirming that it was provided for on the roads serving their properties. The study established that only a small portion of Riverside Drive was served by NMTs which is very risky considering the first row of the same road has attracted commercial offices and retail developments which in effect attract both human and vehicular traffic. It was observed that all other feeder roads in the neighborhood have no attempts in provision of NMTs.

Plate 5.2: Access Road in Riverside Neighbourhood

The study found that the changes in land uses and development densities are towards compact development, intensification and densification. The study establishes that the existing development had a negative impact on infrastructure i.e. water supply (attested by frequent rationing), traffic congestions, lack of NMTs, flooding and lack of trunk sewer coverage in some plots.

Figure 5.8: Modes of Transport

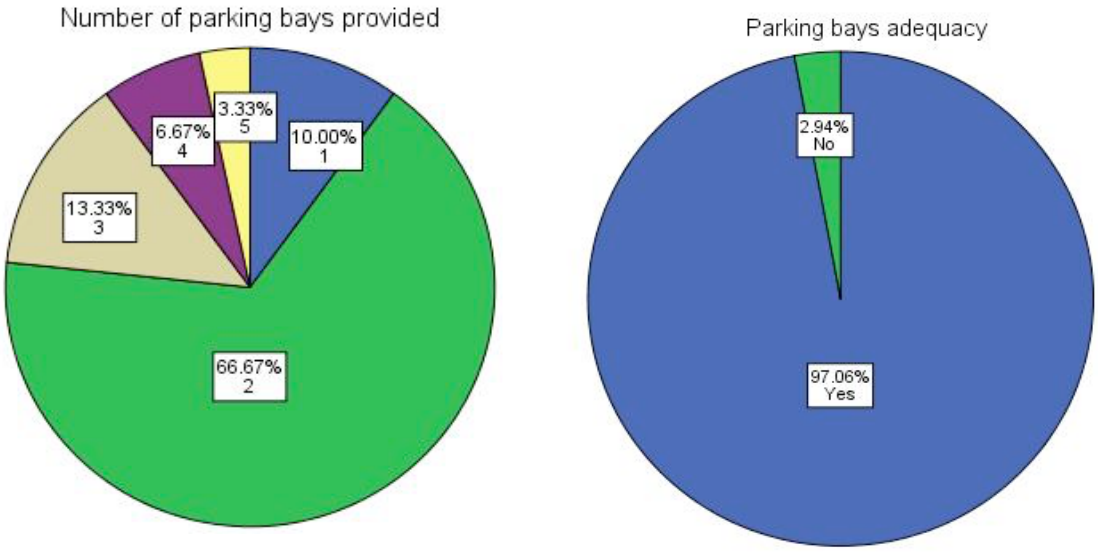


The study established that majority of residents (90%) who live in the neighbourhood used private transport means while a small proportion of 10% used both public transport and NMTs for some trips. The study also established that trips were generated to access schools for children, health facility, gyms hotel and shopping centre. These facilities were situated on average distance of 1 kilometre to 6 kilometres; the schools are located about 3.5Km from the residents, health facility are situated about 5Km, while shopping centre and hotels are located about 6Km and 1Km respectively. The average distances from the facilities were acceptable distances to the residences apart from shopping centre and a gym, which they wished could be planned or proposed within the neighbourhood.

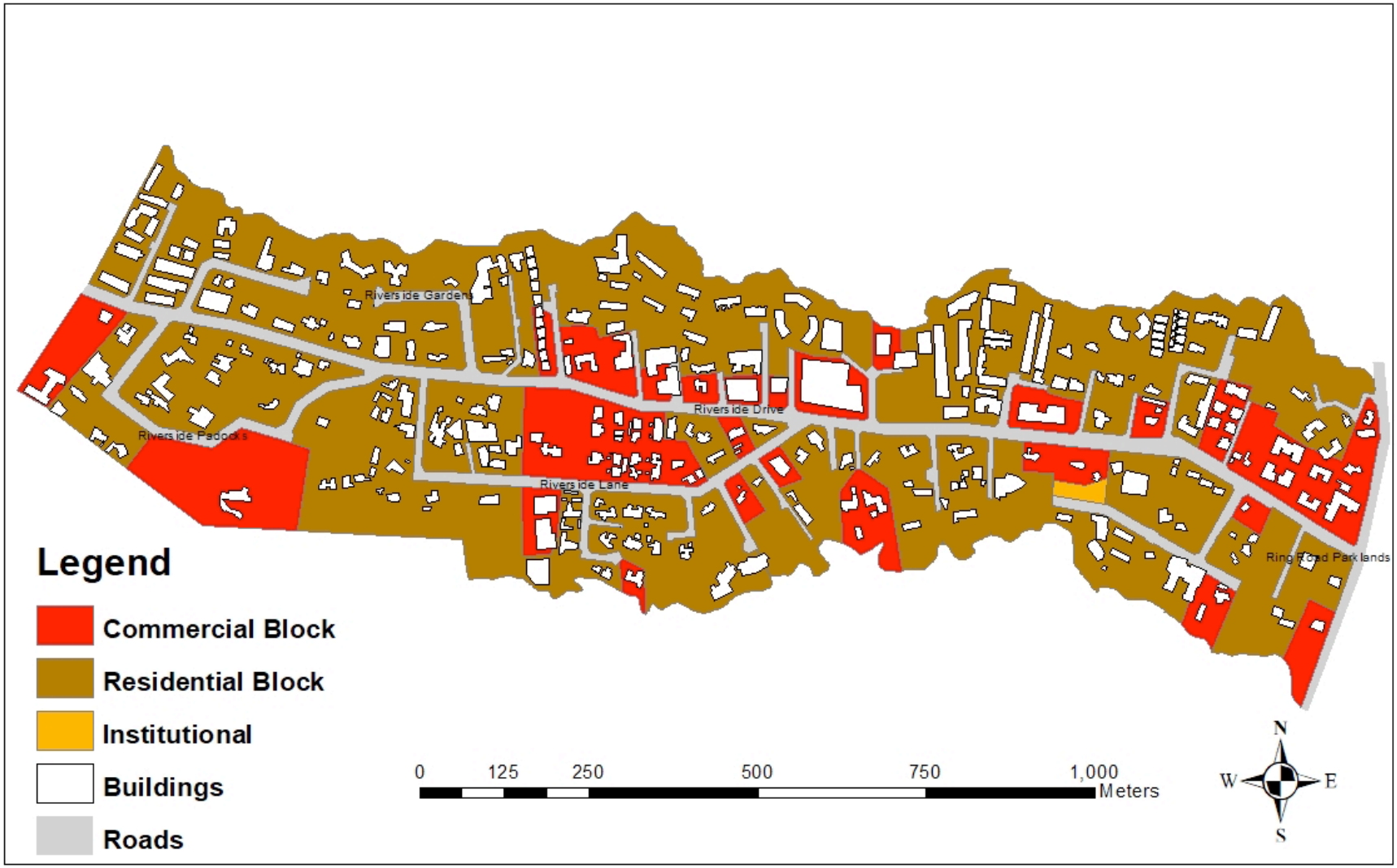
5.5.4 Impact of Zoning Regulations on Parking

Any changes in zoning regulations shift the parking requirements per plot as indicated in the NCCG bylaws. The parking standards for residential land uses is different from those of commercial developments. Whereas the residential parking are considered per residential unit those of commercial are considered and provided per net lettable area of the commercial development. All respondents confirmed they had parking provided for their dwellings and they ranged from one to five bays. On adequacy about 97% confirmed that the parking provided was adequate and functional. The parking bays were provided depending on the sizes of the residences as per the standards and hence compliance to the standards was observed.

Figure 5.9: Parking Adequacy



Map 5.11: Land Uses and Buildings

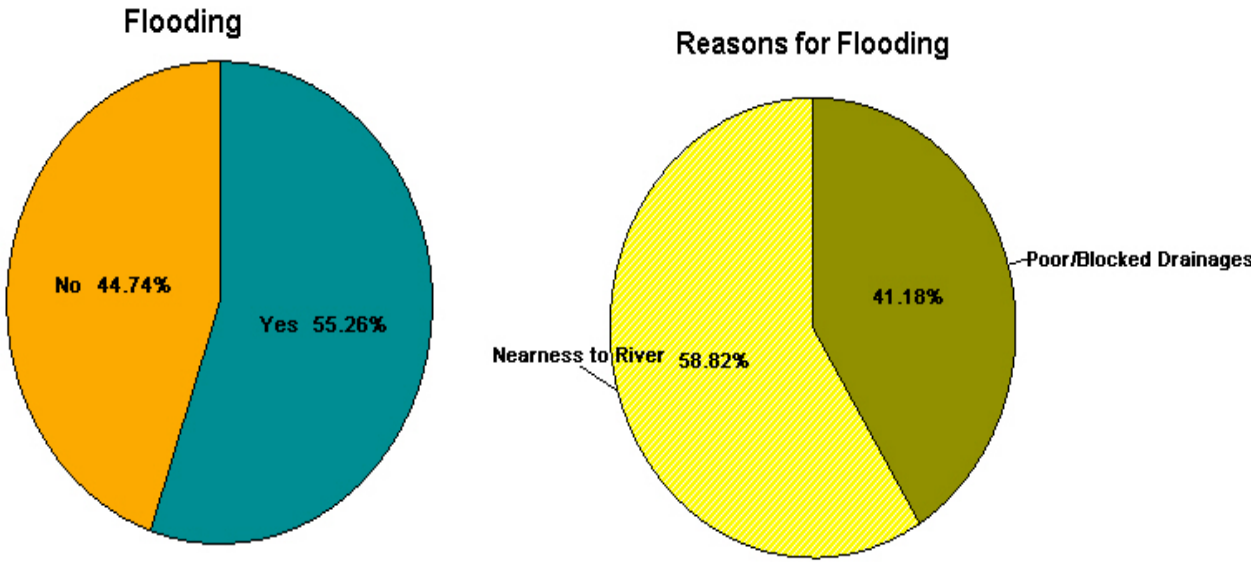


5.5.5 Impacts of Zoning Regulation on Environment

The neighborhood developments prior to the year 2006 had ground coverage of 25%, in the year 2006 zoning regulations it was enhanced to 35% while the year 2012 it moved to 40%. Currently the applicable ad hoc zoning regulation of the year 2015 has enhanced the ground coverage to an average of 50%. The net effect of this zoning regulation has been the fact that developments deprive environment sustainability through depletion of the vegetation cover.

The respondents observed that recently Riverside neighborhood has started to experience floods during the rainy seasons. They linked the floods to the developments at proximity of river without consideration of riparian as well as poor and unmanaged drainage systems along the roads. Of concern to the respondents was that the original plan never provided adequate drainage wayleaves and when the landowners put up perimeter wall then water cannot find their way to the river. About 55% of the respondents experienced flooding in their premises whenever it rains.

Figure 5.10: Floods Occurrences



5.5.6 Impacts of Zoning Regulation on Energy

The respondents observed that the changes in zoning regulations have had an effect on the demand for energy causing power blackouts. It was noted that whereas the densities have increased over the years as a result of these changes in zoning regulations, the energy infrastructure has not been upgraded. The respondents noted that some of the measures that developers have employed are use of the solar water heaters, adopting green designs (conforming to natural lighting and ventilation) as well as the use of Light Emitting Diode (LEDs) for lighting.

In line with Energy and Petroleum Regulatory Authority (EPRA) regulation of 10% use of renewable energy, the respondents suggested that zoning regulations should adopt some regulations to the zoning policy to enhance the energy sustainability of the city and the country at large.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter answers the study's research questions posed as a guide to the study main objective which was to investigate the impact of zoning regulations on sustainable urban development: a case study of Riverside neighbourhood of Nairobi. Therefore, this chapter is a summary of findings, conclusion and recommendations.

6.2 Summary of Findings

The study established that there are changes in development densities and land uses in Riverside neighborhood occasioned by applicable zoning regulations. This is evidenced by a shift from single residential dwelling to multiple dwelling apartments or/and commercial offices. The change in development density and land uses has impacted negatively on the existing infrastructure. As earlier discussed the study area existing developments have been delineated into three sub-zones which for purposes of this study will be referred as zone 4Ci, zone 4Cii and zone 4Ciii as shown on map 6.1 below.

6.3 Conclusion

The study notes that zoning regulations have direct impact on urban sustainability. Further the study has established that ad hoc zoning regulations are neither sustainable nor enforceable in a rapid growing city's neighbourhood. In the study area for example the applicable zoning regulations are tied to height and ground coverage, which then dictates the plot ratio. Depending on the plot size the regulation will make the same sub zone or neighbourhood to have a varying plot ratio with a range of 3 to 7. The implication is that when you narrow down to density for infrastructure planning it is not easy to determine the supply and adequacy of services hence affecting the urban sustainability. The study also establishes that ad hoc zoning regulations are not stable and are likely to change in the short term.

The applicable zoning regulations since 2012 have kept on changing every three years. In consideration to the infrastructure planning and implementation that are long term and stretch through a period of ten (10) to twenty (20) years the net effect is that the urban neighborhood sustainability has been compromised over the years. The densification and intensification as a result of changes in the zoning regulations has impacted the infrastructure components notably; road network, sewerage systems, water and parking. The study notes that whereas densification allows for compact development, which is sustainable, the land use integration has to be considered in neighborhood.

6.4 The Study Recommendation

The study establishes that applicable zoning regulations have impacted on the neighborhood's sustainability. The respondents observed that there is still hope for restoration of the neighborhood sustainability and made the following consideration to attain the attractiveness of the neighbourhood. They noted that there is need to limit the high-rises buildings and commercial development, strict adherence to planning regulations, replanting trees, improvement of drainage, provision of walkways and rehabilitation of the existing road as well as zero tolerance on corruption.

This was further echoed by different authorities which included National Environment Management Authority (NEMA), Water Resource Authority (WRA), National Construction Authority (NCA), Nairobi City Water and sewerage company (NCWSCo) and enforcement section of NCCG planning department. The authorities in one accord noted that whereas there is need for developments of higher densities to cater for the growing demand for housing and related auxiliary facilities there was need for the supply to be regulated and measured against infrastructure development. They argued that the NCCG whose mandate is to regulate development should only approve developments that are fully supported by infrastructure and services and in line with the zoning policy. The following recommendation will make the neighborhood attractive as well as sustainable in line with the principles of urban sustainability:

6.4.1 Enactment of Zoning Policy a Shift from Ad hoc Regulations

Ad hoc zoning regulations applicable since the year 2012 are bound to change and abused since it is discretionary to the approving authority. The net effect is a neighbourhood that has no order on housing typologies, the skylines and land uses

causing imbalances on the infrastructure. The study observes that the changes in zoning regulations are inconsistent as a result of outdated policy framework. It is therefore recommended that a policy framework be tailored from the existing ad hoc policy and adopted as a bylaw for the neighbourhood in strict consideration of the infrastructure requirements.

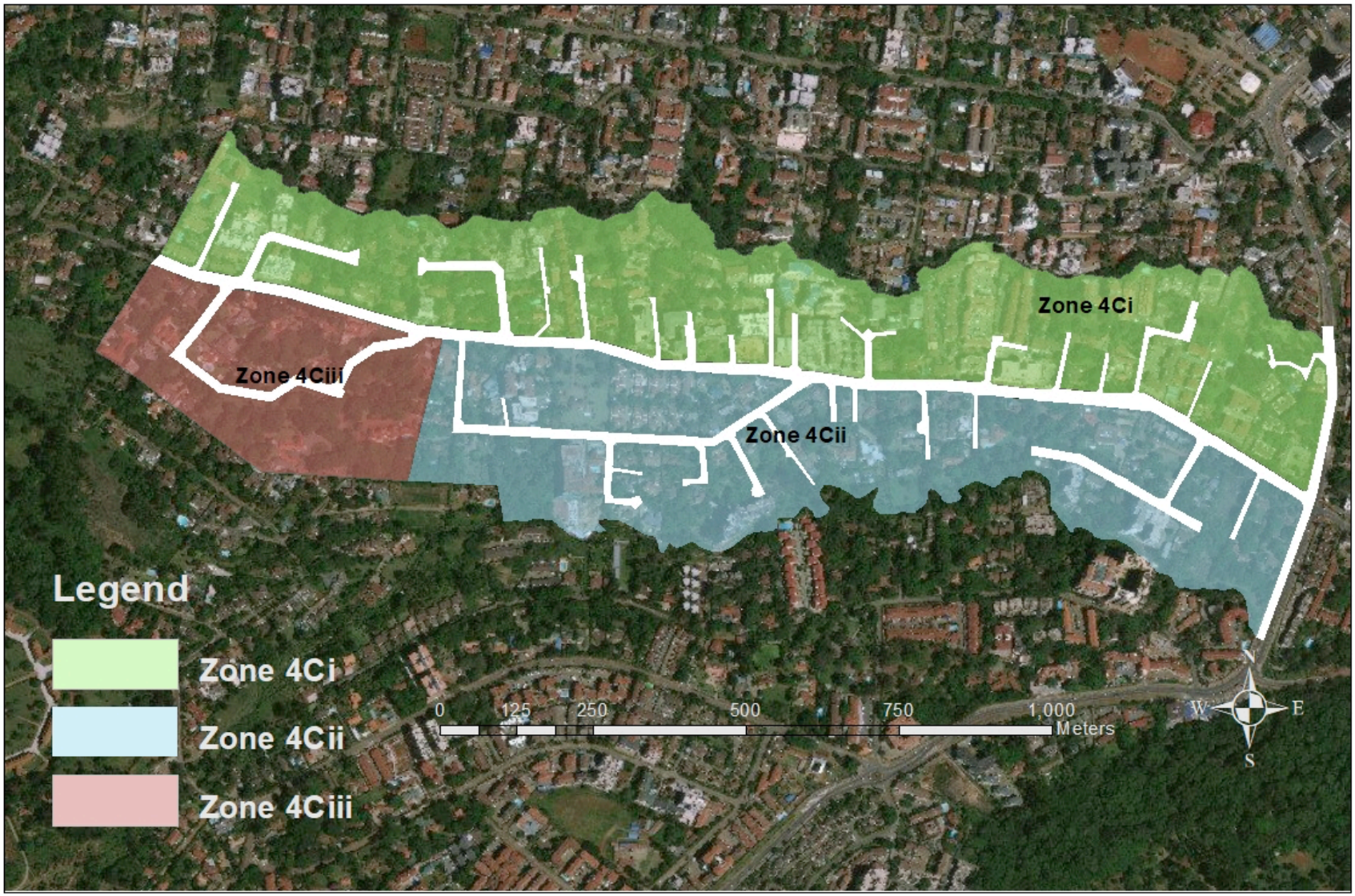
The study further notes that the unit of measurement for the skyline in the applicable zoning policy is the number of floors as opposed to height in metres. The study recommends the use of both number of floors and height in metres to restrict developers who take advantage of the slope to negotiate for higher skylines. Therefore, a floor of a residential land use (apartment) will have a maximum of 2.8M floor from ground slab to beam while a commercial land use will have a maximum of 3.0M.

The current zoning regulations adopted in 2006, 2012 and 2015 have not been consistent with the infrastructure growth. Whereas the NIUPLAN and population projections have anticipated densification of the city, the supportive infrastructure is paramount for sustainable neighborhoods. Riverside neighbourhood has revised the zoning regulations after very few years largely influenced by wrong precedence and usually devoid of infrastructure growth. The sustainability of the neighbourhood is at risk and this is manifested by inefficient standards of infrastructure, poor air quality, soft scape versus hard scape, surface water pollution, thermal discomforts, soil quality amongst others.

Therefore, there is an urgent need for an alternative integrated policy framework to guide developments that is anchored to the existing infrastructure. The zoning review of the year 2006 anticipated an infrastructure led development and made recommendation for expansion of infrastructure especially the trunk sewer system. Whereas this was

partly implemented in the year 2009, it created a problem in that the land values skyrocketed making the planned densities uneconomically viable for real estate investment. The land values coupled by other factors have again influenced the ad hoc zoning regulations applicable in the neighbourhood that are not cognizance of infrastructural planning and implementation. The study recommends a zoning policy that is aligned to the existing development trends. As earlier observed the development trends have delineated the study area into three sub-zones which for the purposes of this study will be referred as zone 4Ci, zone 4Cii and zone 4Ciii as shown on map 6.1 below.

Map 6.1: Proposed Zones in the Study Area

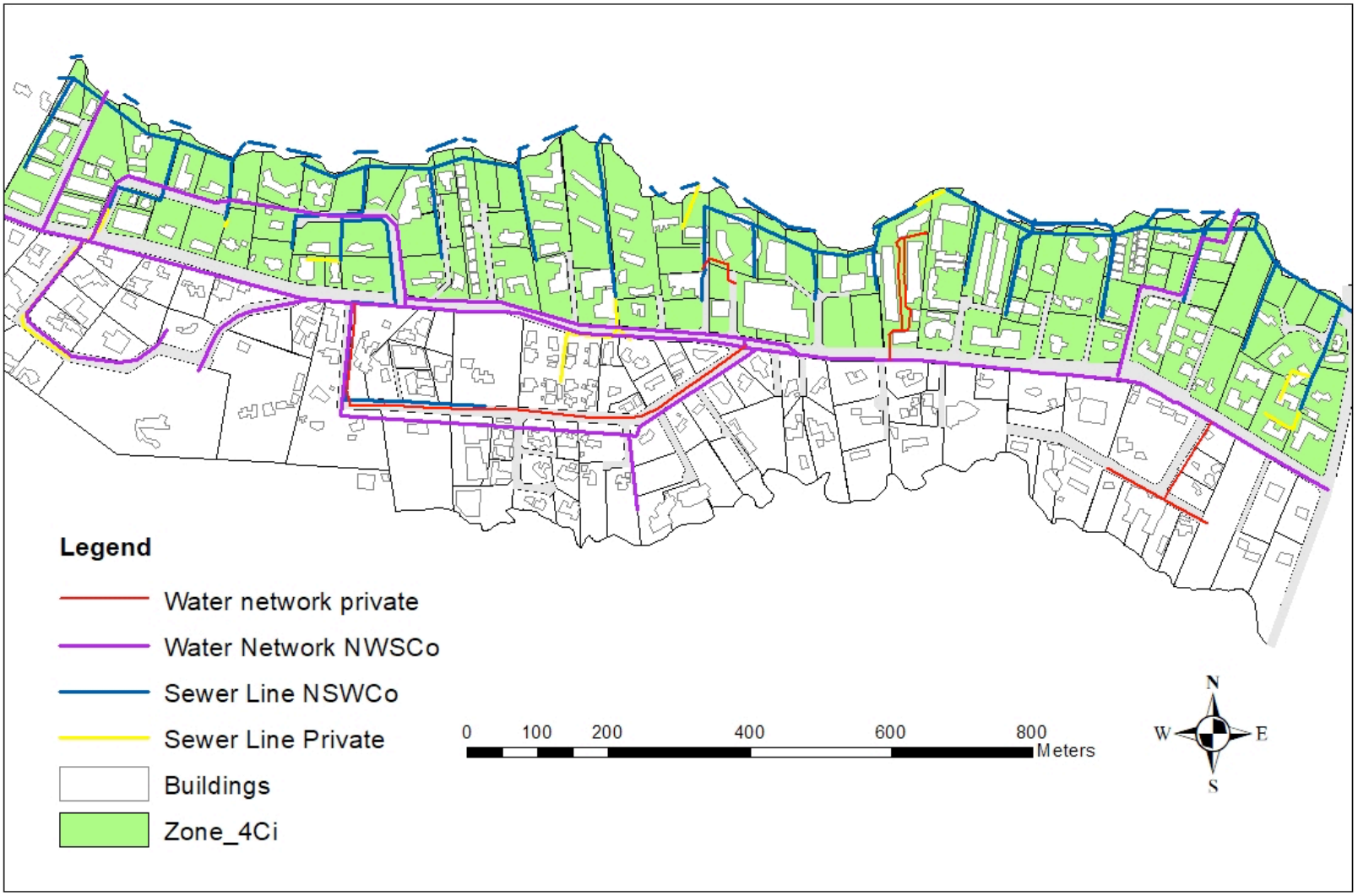


Zone 4Ci

The proposed zone is situated on the northern side of the study area, north of Riverside Drive as shown on Map 6.2 below. It is characterized by different land uses (commercial and residential) as well as different development typologies notably; offices, bungalows, townhouses, apartments and restaurants informed by the changing zoning regulations over the years. Offices and apartments developments dominate the existing development typologies with pockets of the old bungalows and townhouses. The apartments and offices height range from four (4) levels (11.2 m and 12m for apartments and offices respectively) to twelve (12) levels (34m and 36m for apartments and offices respectively). These are informed by the applicable zoning regulations during the time of their inception.

The proposed zone is fully covered by the sewer infrastructure comprising of 225mm and 600mm diameter. The sewer reticulation is a product of both public and private initiatives with 90% being public contribution. This therefore means that the proposed zone is well endowed with sewer infrastructure. The water infrastructure is also well distributed in the proposed zone 4Ci. The main pipe runs through Riverside Drive, which is the highest position of the study area for ease of distribution of the water through gravity. The plots tap from this main either through direct connection by NCWSCo or private connection approved and supervised by NCWSCo. The water reticulation pipe diameters range from 25mm to 225mm. The study proposes that zone 4Ci observes the development trends but also sticks to the set proposed zoning regulations that include ground coverage of 40%, plot ratio 400% with minimum plot size of 0.1 hectares.

Map 6.2: Proposed Zone 4Ci in the Study Area

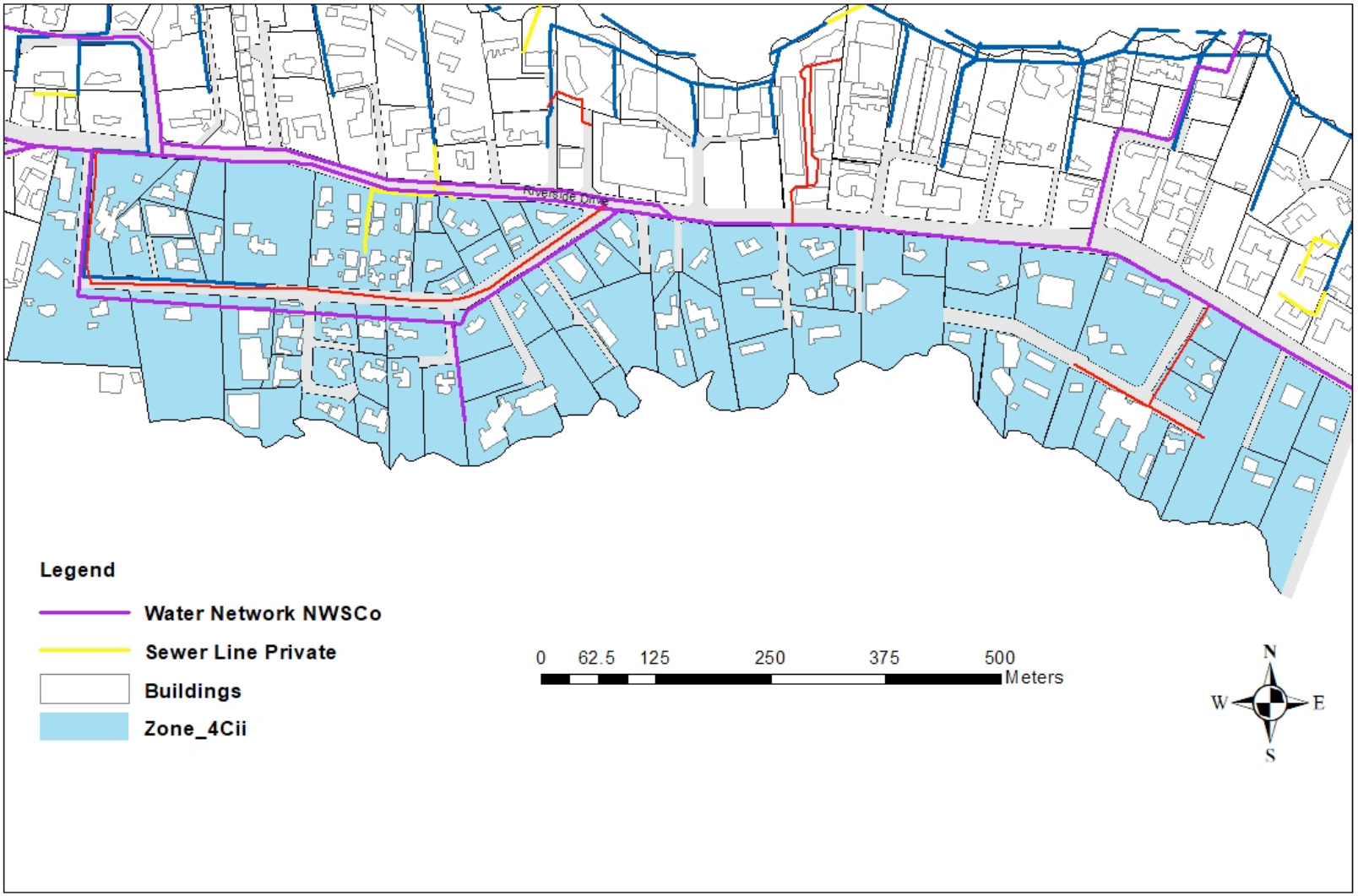


Zone 4Cii

The proposed zone is situated on the South Eastern side of the study area, South of Riverside Drive as shown on Map 6.3 below. It is characterized by different land uses (commercial and residential) as well as different development typologies notably; bungalows, townhouses, apartments, embassies and hotels. The residential land use is the dominant land use with typologies of old bungalows, townhouses and pockets of new developments comprising of apartments and some office. The apartments and offices heights range from four levels to twelve levels similar to the proposed zone 4ci.

However, as earlier established zone 4cii is not well endowed with infrastructure services and therefore the study recommends that the zoning regulation should follow an investment on infrastructure development for sustainability. There is however about 20% sewer coverage (225mm diameter) an investment by both private and public sector. About 60% of the proposed zone is covered by water reticulation infrastructure ranging from 25mm to 225mm diameter. The study recommends that proposed zone 4cii adopted similar zoning regulations to those of zone 4ci. Indeed, the proposed zone 4cii is recommended to adopt ground coverage of 40%, plot ratio of 400%, minimum plot size of 0.1Ha and maximum height of 10 levels anchored on the set of zoning regulations.

Map 6.3: **Proposed Zone 4Cii in the Study Area**



Zone 4Ciii

The proposed zone is situated on the south Western side of the study area, south of Riverside Drive as shown on Map 6.4 below. It is characterized by residential land uses of varying typologies notably; bungalows, townhouses, and embassies. This area has maintained the typology and the zoning regulation that existed before the year 2006. The respondents from the proposed zone supported the authorities retaining the low-density residential character that they argued is more sustainable. The zone is well endowed by both sewer and water infrastructure with coverage of 100%. The sewer system is privately provided by way of sewer connection by private entities. The sewer has a diameter of 225mm. Water coverage is also 100% and the water infrastructure ranges from 50mm to 150 mm done by the NCWSCo.

The study proposes that zone 4Ciii maintains the residential character of low-rise developments of bungalow, townhouses typologies. The zone 4Ciii is therefore recommended to adopt ground coverage of 35%, plot ratio of 75%, minimum plot size of 0.05 hectare per dwelling.

Map 6.4: **Proposed Zone 4Ciii in the Study Area**

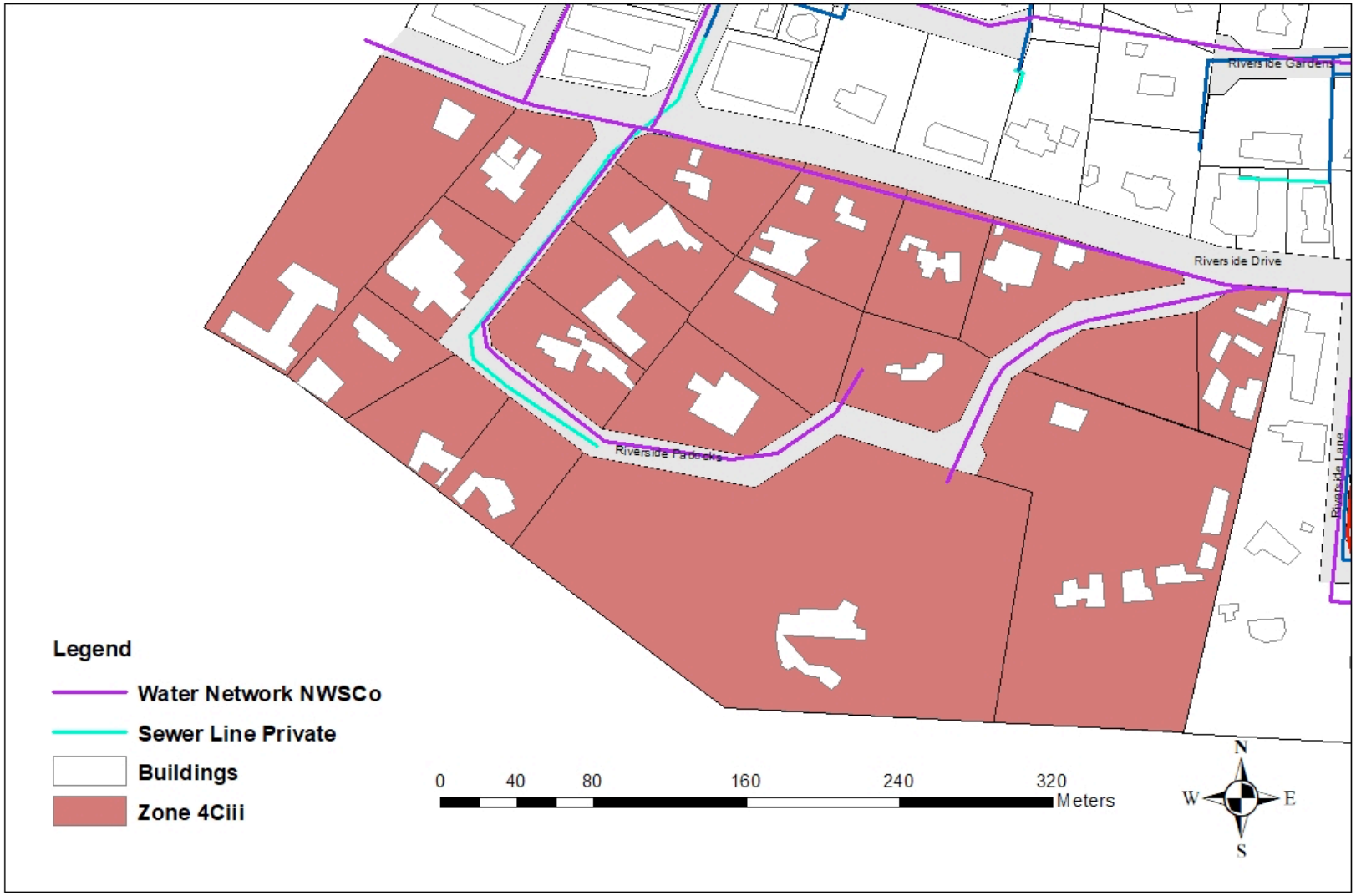


Table 6.1: Summary of Zoning Regulation for the Proposed Zones 4Ci, 4Cii and 4Ciii

Proposed zone	Proposed GC and PR	Minimum Plot Size (Ha)	Recommendations/Remarks
Zone 4Ci	GC-40% PR-400%	0.1	• Apartments and offices allowed on sewer and on minimum • Townhouses allowed each on 0.05Ha • Sewer size to be upgraded to 600mm • Maximum height limited to 10 floors (28M height for apartment and 30M height for offices) • Water mains to be upgraded to 225mm • Water reticulation design to be per standards
Zone 4Cii	GC-40% PR-400%	0.1	• Apartments and offices allowed on sewer and on minimum 0.1 Ha • Townhouses allowed each on 0.05Ha • Sewer line of 600mm to be constructed alongside the southern stream. • Maximum height limited to 10 floors (28M height for apartment and 30M height for offices) • Water mains to be upgraded to 225mm • Water reticulation design to be per standards
Zone 4Ciii	GC-35% PR-75%	0.05	• Only townhouses allowed each on 0.05Ha • Maximum height limited to 3 levels (8.4M) • Water mains to be upgraded to 225mm

6.4.2 Appraisal of Infrastructure Requirements, Planning and Implementation

The neighbourhood infrastructure development has lagged behind largely as a result of ad hoc zoning regulation which have kept on changing the densities from those anticipated in the year 2006 zoning regulations. However, there has been a justification from the authority on the need for higher densities to take care of the increased urban population growth rate in Nairobi estimated at 4.4% per annum, which is higher than the average global growth rate of 2.1% per annum. Densities informed by zoning regulations should follow infrastructural development for urban sustainability. The roads networks, the sewer systems, the water infrastructure and supply are strained hence the desire to appraise the need versus the applicable densities as well as the putting in place adequate measures to enhance sustainability of the neighbourhood.

6.4.2.1 Road Infrastructure

It was noted in the study that the upgrading of the link road that connects Riverside drive has been instrumental in supporting the high-rise developments in the neighbourhood. The respondents were of the view that the NCCG in collaboration with KURA should plan for expansion, rehabilitation and upgrading of the feeder roads serving the study area. The study recommends that the road design should encourage different users and activities to reduce the conflicts. The NMTs, which encourage walkability and cycling in neighbourhood and are viewed as key ingredients towards urban neighbourhood sustainability are missing in the study area. The study recommends provision of NMTS as well as a clear drainage infrastructure along the feeder roads and the main spine road. Traffic congestion will be eased by a number of measures, which may include reducing the trips through provision of services within the neighbourhood, expansion of the

feeder roads as well as encouraging walkability and cycling. The study recommends the following key actions for sustainable road infrastructure in the neighbourhood:

The NCCG to ensure that the surrenders for road widening are enforced and achieved in the neighbourhood to get adequate reserves for road expansion. The roads departments to design as well implement the walkways and cycling lanes along the main spine and key feeder roads while protecting them from potential use by rogue matatus. The conflict as a result of encroachments by other road users on NMTS can be reduced by use of 450mm curbs as buffers on the edges of the driveways.

6.4.2.2 Sewer and Infrastructure

Trunk sewer system is known to be the most efficient and effective liquid waste management system. The study observes whereas there is growth towards densification, the trunk system has not covered the entire area. It is recommended that a study be conducted in view of the anticipated volumes to aid upgrading and expansion of the infrastructure before the area is fully developed. This can be done in line with the zoning review for the area. The proposed zoning regulations recommends the adoption of the 2015 ad hoc regulations, which allowed high densities. In line with the sewer demand and capacity the study recommends that the southern side of the study, a trunk sewer (600mm) is designed and implemented. Both Zone 4Ci and 4Cii to have an upgrading of sewer reticulation of 600mm diameter to take care of anticipated population and indeed the liquid waste volumes. The study recommends that Zone 4Ciii maintain the existing sewer infrastructure.

While considering that the trunk sewer investment takes a huge capital outlay, the study recommends that all new developments proposed in zone 4Ci where the sewer is 225mm, the developer be made to come with a Waste Water Treatment Plant (WWTP),

as a short term measure to ensure that the waste is release in the trunk system as fluid. This will ensure that the blockages and bursting of the sewer system is managed.

6.4.2.3 Water Infrastructure

Water supply for the city at large has gradually declined at the sources attributed to myriads of factors. The study recommends underground water tapping, water recycling, expansion of the existing infrastructure, rainwater harvesting and the use of water efficient fixtures in the designs. The existing infrastructure should be redesigned and implemented. The reticulation of water is inconsistent to the standards for example the main supply along Riverside drive has varying sizes and some feeders have bigger diameter than the mains creating inconsistences of the supply pressure.

6.4.2.4 Storm Water Drainage System

The clearing of trees due to increased ground coverage as a result of changes in zoning regulations result to increased surface run off since the natural drainage of the storm water is compromised. This problem can be managed through policies and programs that advocate for increase in green cover. The study proposed a zoning policy that will take in to consideration the holistic storm water management. The study recommends that the ground coverage be maintained at most 40% with at least 10% of the ground coverage being left for green. The study further recommends that the policy instrument to ensure that developers are subject to demonstrating how to achieve 10% on their proposed site plan layouts for greenery as well as the tree planting at 5 metre interval at the boundary lines. This will ensure smooth management of the storm water. These actions must be coupled by provision of drainage wayleaves and opening of the existing ones to ease flooding in the area.

6.4.3 Land Use Integration

Densification and intensification of urban neighbourhood have been fronted as key ingredient towards sustainability. The study observes that Riverside has supported densification of residential use and some offices devoid of other supportive land uses. This form of densification of one land use is detrimental to sustainability because it is a trip generator as well as trip origin to other activities leading to reliance of automobile hence air pollution consequently affecting air quality and leading to road congestions. The study recommends strategic apportionment of various activities (land uses) that support residential land use e.g. shopping centers, recreational facilities, schools as well as health facilities at walking distances to enhance neighbourhood sustainability.

6.4.4 Neighbourhood Greenery Policy

The study observes that while developments solve the social need for housing, they also cause destruction on environment through cutting down of trees hence impacting on the neighbourhood sustainability. The developers argued that trees were affecting the foundation of the developments hence the wanton cut down. Currently there exists a policy on tree cutting that dictates every one-tree cut to be replaced by three seedlings on the same local area. The study observes non-adherence to the policy and recommends an enforcement mechanism be employed to ensure that trees are replanted. One of the ways this can be achieved is inspection prior to the issuance of completion or occupation certificates to the developers. The study further recommends that a policy of tree planting be reviewed to ensure that trees are replanted along the boundary line at five (5) metres interval. This will be achieved if it is tied as an approval condition for architectural plans.

6.5 Implementation Framework for Sustainable Neighbourhood

The study underscores that Riverside neighbourhood will drift further from neighbourhood sustainability if the recommendations outlined are not implemented fully. The implementation strategy comprises of short, medium and long-term measures designed for management of the sustainability goals of the neighbourhood. The study assumes that the short-term measures will be implemented within the first five (5) years, medium term measures in ten (10) years and long-term measures in fifteen (15) years. The study establishes several key actors towards implementation of the measures notably; the Nairobi City County, Nairobi Water and Sewerage Company, Water Resource Authority, Property Owners, Kenya Urban Roads Authority, Kenya Forest Department, National Environment Management Authority and Resident Groups.

Formulation and adoption of the zoning policy is the starting point for other key actions that will be activated towards urban sustainability. The study recommends that rezoning of the study area by the NCCG be done in the first 2-3 years. This will open up the area for further management of actions and programs.

The road infrastructure in the study area will need a traffic impact assessment conducted by NCCG in collaboration with KURA in line with adopted zoning policy and the recommended actions thereon implemented. Some of the obvious notable actions are expansion of the roads, enforcing road surrenders as prescribed in the NCCG road structure plan, provision of NMTs and protection of the NMTs through the use of 450mm curbs. The action on the road infrastructure will be both short and medium term actions.

Water infrastructure and supply will require boreholes drilled at strategic sites and reticulation lines laid for private supply. The NCWSCo will issue the drilling and

extraction permits while the NCCG and developers will drill and do the reticulation trunk for the supply. These actions will be achieved within the first five years. The existing NCWSCo trunk infrastructure to be appraised and rehabilitated towards resolving the inconsistencies of supply and flow rates in the neighbourhood. The deficit of supply require a few boreholes sharing the commodity which will ease the over exploitation of ground water aquifers.

NCWSCo will undertake sewer rehabilitation, upgrading and connection through out the study area progressively for the next fifteen years. On liquid waste further action by developers, which will aid towards achievement of results of sustainability at short term. This will involve the adoption of policy on areas covered with 225mm trunk sewer to use onsite wastewater treatment plant for ease of flow of the waste hence sustainability. A condition on the architectural plans approval will enhance the enforcement and compliance towards sustainable liquid waste management.

Indeed, the study foresees that the envisaged plan of infrastructure management will go along way towards making Riverside neighbourhood sustainable and a case for emulation.

Table 6.1: Summary of Implementation Measures

Duration	Management Measures	Actors	Outcome
Short Term (0-5 Years)	▪ Zoning Review ▪ Water and Sewer Area Master Plan ▪ Greening policy ▪ Sewer Rehabilitation ▪ Road surrenders ▪ Water infrastructure rehabilitation ▪ Sewer connection in Zone 4Cii along Kirichwa ndogo river ▪ Opening up of drainage way leaves ▪ Proposition of new drainage wayleaves	GoK NCCG NCWSCo WRA KFS NEMA Residents Groups	▪ 100% coverage of trunk sewer ▪ 100% water trunk system ▪ Updated Zoning Regulations ▪ Tree cover policy framework ▪ Borehole water sharing framework
Medium Term (6-10 years)	▪ Upgrading of Riverside Drive ▪ Expansion of sewer trunk system ▪ Expansion of water trunk system ▪ Construction of NMT on the feeder roads ▪ Enforcement and compliance to the Zoning regulations	GoK KURA NCCG NCWSCo	▪ Upgraded road, sewer and water systems ▪ Zero flooding ▪ Walkability ▪ Dedicated bus terminals
Long Term (11-15 years)	▪ Upgrading of other feeder roads ▪ Monitoring and Evaluation of the Zoning Regulations ▪ Monitoring of infrastructure performance	NCCG Residents Groups	▪ Consistent Neighborhood form ▪ Review of the Zoning Regulations ▪ Upgrading of the infrastructure

6.6 Areas of Further Research

In conclusion, the study recommends further research in the following areas that will enhance urban neighbourhood sustainability:

1. The impact of zoning regulation on neighbourhood environmental management
2. The roles of development control authority in urban sustainability
3. Urban sustainability in growing mixed use neighbourhoods

The above stated recommendations strengthen the imperative role of stakeholders in efforts to achieve sustainable neighbourhood development.

REFERENCES

Alonzo, W (1964), **Location and Land Use.** Harvard University Press, Cambridge, MA

Alberti, M. and Susskind L. (1996), **Managing Urban Sustainability** an Introduction to the Special Issue, Centre for Conservation Biology, Stanford University 1996; 16: 213-221

Antar A. A and Alshihri F. (2015), **Rapid Urbanization and Sustainability in Saudi Arabia: The case of Dammam Metropolitan Area**, *Journal of Sustainable Development; Vol. 8, No. 9; 2015,* Canadian Center of Science and Education, Canada.

Berke P. R. and Conroy M.M (2000), **Are we planning for sustainable development?** An evaluation of 30 comprehensive plans, Journal of the American Planning Association, Researchgate

Bourne, L. S (1976). **Urban Structure and Land Use Decisions.** *Annals of the Association of American Geographers*,66(4):531-535

Burgess, E.W (1925). **The Growth of the City: An Introduction to a Research Project**. *American Sociological Society*, **18**:85-97

CBS (2003), **Population and Housing Census**, Counting our People for Development Vol 1, Central Bureau of Statistics, Nairobi.

De Groot, R. S., Wilson, M.A and Boumans, R.M (2002). **A Typology for the Classification, Description and Valuation of Ecosystem Functions** - Goods and Services *Ecological Economics***,** 41(2): 393-408.

Faga B. (2014), Formers versus Zoners. **How and why communities shift to form based zoning**, Phd Thesis, Georgia Institute of Technology

Fenton P. (2014), **Five Factors for Urban Sustainability Exploring Influences on Municipal Strategic Planning**, Maters Thesis, Linkoping. University.

Firey, H. M (1974), **The Political Economy of Ethnic Change**. *American Journal of Sociology* **79:**1151-78

Fischel W. A. (1999), **Zoning and land use regulations**, Dartmouth College, 2200: 403-442

Fragkou M. C. (2009), **Evaluation of urban sustainability through a metabolic perspective**, PHD Thesis, University of Autonoma, Bercelona.

Gallion, P (1963). **Urban Pattern,** Columbia University Press, New York

Gitau F.P (2011), **Urban Management challenges facing emerging towns in Kenya: A case study of Kiserian Market center in Kajiado County**, Masters research Project, University of Nairobi, Unpublished.

Govender K. and Makasi A. (2015), **Globalization and Sustainable Development: A Conceptual Model**, *Mediterenean Journal of social science, Vol. 6, No. 9; 2015*. MCSER, Rome Italy.

Guttenberg, A. Z (1960). **Urban Structure and Growth**. *Journal of the American Institute of Planners,* **26:** 104-110.

Hartshon, T. A (1980). **Interpreting the City: An Urban Geography.** London, John Wiley & Sons.

Harris, C. D and Ullman, E. L (1945), **The Nature of Cities.** Annals of the American Academy of Political and Social Science 242: 7-19

Howard, E (1898), Originally published in 1898 as To-Morrow: A Peaceful Path to Real Reform and reissued in 1902 under its present title, **Garden Cities of Tomorrow.** London, Routledge.

Hoyt, H (1939). **The Structure and Growth of Residential Neighborhoods in American Cities.** Washington DC; Federal Housing Administration

Huang L. Wu J. and Yan L (2015), **Defining and Measuring Urban Sustainability**: a review of indicators, Article in the Landscape Ecol (2015), 30:1175-1193

Jaeger W.K. (2006), **The Effects of Land Use Regulations on Property Values**, Article in the Environmental law, 2006, 36:105

Laakso S. (2011), **A comparison of Sustainability in Greenfield Development under Form-based Codes and Euclidean Zoning Regulations**: A case study of St. Lucie County, Florida, Masters Thesis submitted at University of Florida.

Lankao P. Gnazt D. and Hayden M. (2016), **Urban Sustainability and Resilience**: from Theory to Practice, Article in the Sustainability Journal 2016, 8: 1224

Larijani A. H. (2016), **Sustainable Urban Development, Concepts, Features, and indicators**, International Academic Journal of Science and Engineering, 3 (6): 9-14

Martin, L.R.G (1986). **Change Detection in the Urban Fringe Employing Landsat Satellite** Imagery. *Plan Canada* 26(7): 182-190.

Miller, G (1994). **Living in the Environment**. Wadsworth, Belmont, CA

Mitullah W. (2003), **Understanding slums: Case Studies for Global Report on Human Settlements 2003;** The case of Nairobi City, Kenya, UNHABITAT, Nairobi

Moos M. (2017), **The Velocity of Density, can we Build more Sustainable Cities fast enough?;** Article in Sustainability Journal 2017, 9: 2326.

Mugenda O. M. and Mugenda A. G, (2003), **Research Methods-Quantitative and Qualitative Approaches**; ACTS Press, Nairobi

Mwaura A. M. (2006), **Policy Review for Zones 3, 4 and 5, Nairobi Kenya**, A paper presented at the 42nd Isocarp Congress on 16, September 2006 Instabul, Turkey.

Mwathi P.M (2016), **Effects of land use and land cover dynamics on environmental quality of Nairobi city and its environs**, Masters Research Project, University of Nairobi.

Ngayu M.N (2011), **Sustainable Urban Communities: Challenges and opportunities in Kenya's Urban Sector**, International Journal of Humanities and Social Science, 1 (4), 70-76

Naeg M. M. and Bucata G. (2015), **Globalization and sustainable Development** *Article in the Journal of Military Art and Science* 1(77), 1-4

Oyugi M. O and Kakumu O. A (2007), **Land Use Management Challenges for the city of Nairobi**, *Article in Urban forum* 2007, 17(3)

Reed M. D (2013), **How Land Use Regulations Inform Sustainable Development**: A look at commercial development in Bakersfield, California, Masters Research Project, California Polytechnic State University.

Striker M. (2011), **Intensification, Compact City Development and Sustainability**, A paper presented at 47th ISOCARP Congress, 24-28 October, 2011, Wuhan, China.

The Republic of Kenya (1996), **Physical Planning Act Cap 286**, Government Printers, Nairobi.

The Republic of Kenya (2010), **Constitution of Kenya**, Government Printers, Nairobi.

UN-Habitat (2004), **Urban Patterns for a Green Economy**, Optimizing Infrastructure, UNON publishing services section, Nairobi.

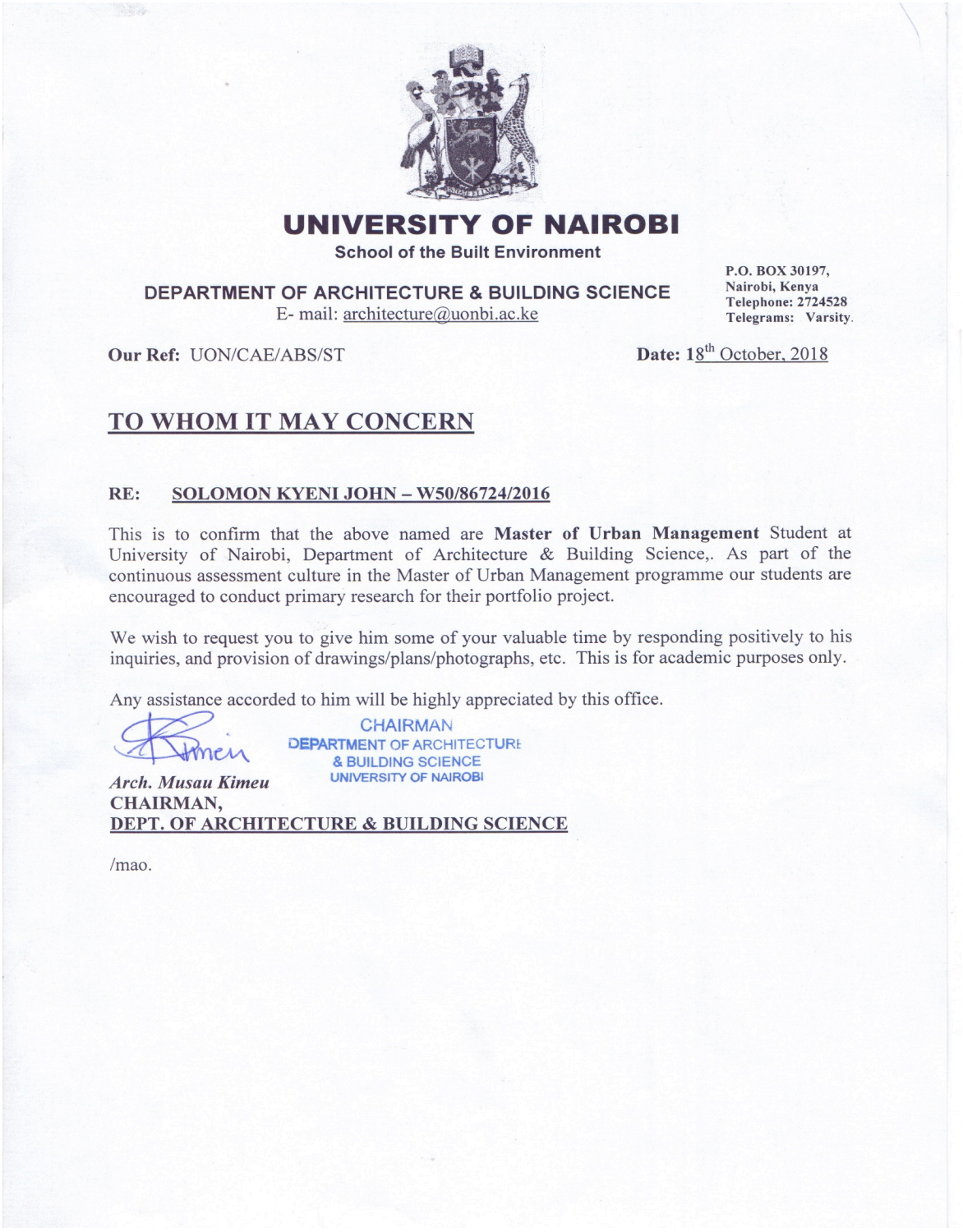
Webber, A (1929), **Theory of the Location of Industries** (Translated by Carl J. Friedrich from Weber's 1909 book) Chicago, the University of Chicago Press.

Weingaertner C. (2010), **Identifying Strategic Initiatives to Promote Urban Sustainability**, PHD Thesis, Royal Institute of Technology, Sweden.

Wingo, L (1961), **Transportation and Urban Land Use**. The Johns Hopkins Press, Baltimore

APPENDIXES

Appendix 1: Letter from University of Nairobi



UNIVERSITY OF NAIROBI

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Our Ref: UON/CAE/ABS/ST **Date:** 18th October, 2018

TO WHOM IT MAY CONCERN

RE: SOLOMON KYENI JOHN – W50/86724/2016

This is to confirm that the above named are **Master of Urban Management** Student at University of Nairobi, Department of Architecture & Building Science,. As part of the continuous assessment culture in the Master of Urban Management programme our students are encouraged to conduct primary research for their portfolio project.

We wish to request you to give him some of your valuable time by responding positively to his inquiries, and provision of drawings/plans/photographs, etc. This is for academic purposes only.

Any assistance accorded to him will be highly appreciated by this office.

CHAIRMAN
DEPARTMENT OF ARCHITECTURE
& BUILDING SCIENCE
UNIVERSITY OF NAIROBI

Arch. Musau Kimeu
CHAIRMAN,
DEPT. OF ARCHITECTURE & BUILDING SCIENCE

/mao.

Appendix 2: Letter from the National Commission for Science, Technology and Innovation

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No **NACOSTI/P/18/57894/27107**

Date: **27th November, 2018**

Solomon Kyeni John
University of Nairobi
Po Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Impact of zoning regulations on sustainable urban development: A case study of riverside neighbourhood of Nairobi, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for the period ending **26th November, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

DR. STEPHEN K. KIBIRU, PHD
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nairobi County

The County Director of Education
Nairobi County

Appendix 3: Household Questionnaire

The purpose of this questionnaire is to collect data in view to investigate the impacts of zoning regulations on neighbourhood sustainability. The information provided through this questionnaire will be used purely and exclusively for academic purpose and will be treated confidential and your right to participate or not is also respected.

Section I: Population & Demography

1. (a) Age 103 Less than 20

(b) Gender 103 Male

(c) Marital status 103Married

(d) Education level None

(e) Household head 103 Father

(f) Household size.....

2. (a) Respondents' main occupation (Economic Activities).

Formal employment 103 Farming 103Business 103 Others (Specify).....

(b) What is your monthly income? Less than Kshs 30,000 103 Kshs (30,001 - 50,000) 103 Kshs (50,001 - 80,000) 103 Kshs (80,001-150,000) 103 Kshs (above 150,000) 103

(c) Type of house

Townhouse 103 Apartment 103

(d)Size of the house.....

3. (a)How long have you lived in this neighbourhood?.....

(b) What factors led you to choose this neighbourhood?.....

.....

4. Has there been any changes in lands uses, development densities and building heights during the period you've stayed here? Yes 103 No 103 if yes explain

10321-30 103 31-40 103 Female

10341-50 103 Over 51

103 Single 103Divorced

103 Primary 103Secondary 103College

103 Widower/widow 103 University

103Mother 103Others.....

.....

.....

5. In your opinion what do you think has necessitated these changes in land use, development densities and building heights?

.....

.....

6. What impacts have the changes in land uses; development densities and building height have on the following:

Road infrastructure.....

Sewer system.....

Parking facilities.....

Water supply.....

7. In your opinion what measures should be put in place to mitigate the above stated impacts on the infrastructure.

Road infrastructure.....

Sewer system.....

Parking facilities.....

Water supply.....

8.(a)What is your household daily water demand?.....

(b) What are the sources of your water supply?.....

(c) Is the water supply adequate? Yes 104No 104

(d) Give reasons.....

9 (a)Is there reliable public transport in this area Yes 104 No 104

(b) Do you experience traffic congestions in the neighbourhood Yes 104 No 104

(c) If yes what causes the traffic congestions.....

.....

(d) Is there provision of NMTs/ walkways or cycling lane on the roads? Yes 104 No 104 why?.....

.....

e) Do you experience flooding in the neighbourhood Yes 105No 105 why? .....

.....

10. (a) How do you dispose your liquid waste?

Trunk Sewer 105Septic Tanks 105Other Specify 105 If through sewer ask (b) below

(b) Is the existing sewerage network adequate to support the changes in development densities? Y es.....NO.....

(c)Please give reasons.....

11(a) How many parking bays are you served with.....

(b) Are the parking adequate and functional.....

12. In your opinion what measures do you think should be put in place to ensure there is harmony between infrastructure and development densities?.....

.....

13. (a) What type of development do you prefer for the neighbourhood?

Mixed land use development 105

High Rise residential development 105

Medium density residential development 105

Other Specify.....

(b) Please give reasons.....

14. (a) How far from your property are these facilities and what distances would you propose these facilities be located?

Facility	**Distance from your Property (KM)**	**Proposed distance (KM)**
Schools		
Health Facility		
Shopping Center		
Gym		
Hotel/Restaurant		
Other specify		

(c) What mode of transport do you use to access these facilities? Why?

105Private transport.....

106Public transport.....

106NMTs (Cycling, walking).....

106Others Specify.....

15. What mode would you prefer to use, give reasons why you don't use it?

.....

.....

16. What do you recommend to be put in place to retain the neighbourhood attractiveness to you? .....

.....

THANK YOU

Appendix 4: NEMA, NCA & WRA Questionnaire

Agency I Questionnaire (NEMA, NCA & WRA)

The purpose of this questionnaire is to collect data in view to investigate the impacts of zoning regulations on neighbourhood sustainability. The information provided through this questionnaire will be used purely and exclusively for academic purpose and will be treated confidential and your right to participate or not is also respected.

1. What role does your agency play in ensuring that developments are compliant? Probe
2. How do you enforce in cases of non-compliance?
3. What challenges do you face in execution of you roles?
4. What measure do you think if put in place will ensure 100% compliance?
5. How do you coordinate with other enforcement agencies to ensure total compliance?
6. Are there any gaps in coordination and how can they be addressed?
7. In your opinion do you think the rates and magnitude of developments in Riverside neighbourhood are at sustainable levels? Probe
8. What measure would you recommend to be put in place to ensure a sustainable neighbourhood development in Riverside area?

Appendix 5: NCC Planning Department Questionnaire

Agency II Questionnaire (NCC Planning Department)

The purpose of this questionnaire is to collect data in view to investigate the impacts of zoning regulations on neighbourhood sustainability. The information provided through this questionnaire will be used purely and exclusively for academic purpose and will be treated confidential and your right to participate or not is also respected.

1. What role does your department play in development of city neighbourhoods? Probe
2. What challenges do you face as a department in executing your mandate?
3. What are the current zoning regulations applicable for the Riverside area?
4. What has led to changes in the zoning regulations for Riverside area? Probe
5. Are zoning regulations tied to availability of infrastructure?
6. What impacts does the changes in zoning have on the land uses and development density?
7. Are all developments compliant to the zoning regulations applicable in the area? Probe
8. Which departments or agencies do you coordinate with to achieve sustainable urban developments in the city? Probe
9. In your opinion do you think the rates and magnitude of developments in Riverside neighbourhood are at sustainable levels? Probe
10. What measure would you recommend to be put in place to attain urban sustainable neighbourhood development in Riverside area?

Appendix 6: NWSCO & NCC Roads Questionnaire

Agency III Questionnaire -(NWSCO &NCC Roads)

The purpose of this questionnaire is to collect data in view to investigate the impacts of zoning regulations on neighbourhood sustainability. The information provided through this questionnaire will be used purely and exclusively for academic purpose and will be treated confidential and your right to participate or not is also respected.

1. What role does your department play in development of city neighbourhoods? Probe
2. Does the city have an integrated infrastructure plan for Riverside area?
3. Are there any infrastructure developments in Riverside Area?
4. What informs/has informed these infrastructure developments in the neighbourhood?
5. In your opinion do you think that zoning regulations is tied to infrastructure provision?
6. What impacts does the changes in zoning have on the land uses and development density?
7. In your opinion do you think the rates and magnitude of developments in Riverside neighbourhood are at sustainable levels? Probe
8. What measure would you recommend to be put in place to ensure that there is harmony between developments and infrastructure?