THE CHALLENGE OF PROVIDING WATER AND SANITATION SERVICES IN THE FRINGE AREAS OF NAIROBI: THE CASE OF RIRUTA

THESIS

BY

Nguah Elizabeth M K B.A (Hons) Economics,Sociology, U.O.N

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DEDICATION

To my dad
For his tireless support throughout all my life
To mum
'You showed me how to divide and multiply'
And to my family
Anthony, Brian and Wanjira
I owe you this, and much more

DECLARATION

This thesis is my original work and has not been presented for any degree in any other university

Signed..... Date...9.10.2002.....

Nguah Elizabeth M K
(Candidate)

This thesis has been submitted for examination with my approval as a university supervisor

Signed..... Date...9/10/2002...

Professor S O Akatch

(Supervisor)

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LIST OF ACRONYMS

BOD	Biochemical Oxygen Demand
CBD	Central Business District
CBO	Community Based Organizations
GOK	Government Of Kenya
HABRI	Housing and Building Research Institute
IMF	International Monetary Fund
NCC	Nairobi City Council
NGOS	Non-governmental Organizations
NHC	National Housing Corporation
NMGS	Nairobi Metropolitan Growth Strategy
NWCPC	National Water conservation and Pipeline Corporation
PHAST	Participatory Hygiene and Sanitation Transformation
PSP	Private Service Provider
RBO	Religious Based Organizations
RTPC	Rural Trade and Production Centre
RTA	Registration of Titles Act
SAPS	Structural Adjustment Programs
UNCHS	United Nations Centre for Human Settlements
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
WB	World Bank
WHO	World Health Organization
WSD	Water and Sanitation Department

ABSTRACT

Safe water and sanitary disposal of waste are central to good housing, living and health conditions (WB-UNDP 1993, 1998, UNCHS 1998, GOK-UNDP 1999). Together with other infrastructure services they enhance urban livelihood and are a lubricant to development to the extent that absence of the same curtails development.

This study therefore seeks to examine the impacts of uncontrolled developments on water and sanitation services in Riruta with a view to suggesting approaches to make it a satisfactory urban development area. The study stepped down this goal to specific tasks or objectives namely: to examine the causes of uncontrolled developments in Riruta, to examine the impacts of uncontrolled developments on the water and sanitation standards, to evaluate the existing water and sanitation standards against public health standards and environment quality standards and finally to suggest approaches necessary to improve the water and sanitation standards in order to make it a satisfactory urban development area. The study formulated hypotheses that, uncontrolled developments reduces the water and sanitation standards in Riruta and further that existing water and sanitation standards reduces the standards of public health and environment quality.

Primary and secondary data were obtained to help fulfill the objectives of the study. Secondary data was obtained from books, journals, working papers of Ministry of Water Development, World Bank and United Nations Environment Program and unpublished theses from graduate students of the University of Nairobi. Other secondary data was obtained from the Internet. This data introduced the researcher to the issues of urbanization, water and sanitation service worldwide.

Primary data was obtained by undertaking a field study of Riruta from which a sample of ninety households was taken. Interviews with key persons with information regarding the study topic such as Nairobi City Council officers were undertaken. The data collected was later cleaned and organized into qualitative and quantitative data to enable ease of analysis. Descriptive statistics such as the mode, mean and frequency distributions were then computed and presented in charts and graphs. The relationships between variables under study were tested using chi-square analysis.

The study found that the pressure of urbanization had pushed low and middle-income earners to Riruta in search of cheap housing. This has enhanced the rate of subdivisions to an average 10 subdivisions in a month. The study also found a dichotomy of planned settlements juxtaposed against unplanned/uncontrolled settlements. This pattern of water and sanitation standards hence the standards of public health and environment quality followed the pattern of settlements. In the planned/ controlled settlements there was no incidence of water and sanitation related diseases while these were rampant in the uncontrolled areas. Pollution of the environment was also intense in the uncontrolled settlements.

The study recommends a complete overhaul of the existing water and sanitation services to enable reticulation of these services. Policy review to speed up privatization of such services is necessary, since the water and sanitation department of the NCC has failed to provide them adequately. A reorganization of the settlements and enforcement of development control regulations is also recommended in order to address the core of the problem. To this end review of land use policy and the institutional and legal frameworks is necessary. Further research is recommended in the areas of water quality and pollution levels of the shallow wells in order to ascertain the effects on the population.

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CHAPTER ONE
INTRODUCTION

1.0 Introduction

Safe water and sanitary disposal of waste are central to good housing, living and health conditions (WB-UNDP 1993, 1998, UNCHS 1998, GOK-UNDP 1999). Together with other infrastructure services they enhance urban livelihood and are a lubricant to development to the extent that absence of the same curtails development.

In 1900, only 14 % of world's population lived in urban centers, but by 1950 this proportion had grown to 30%. By 1980, the figure had grown further to 39%. This figure was expected to rise to 47.5% in 2001. The main feature of this growth is that half will take place in developing countries with cities such as Jakarta and Mexico expected to double in size by 2025 and further that half of this growth will result from natural increase and expansion of urban areas to rural hinterlands (UNCHS 2000).

This scenario implies that this population will require support infrastructure services such as health, housing, roads, water and sanitation and community facilities. The rapid rate with which urbanization is taking place is overwhelming the capacities of infrastructures of urban governments in developing countries to cope with additions to urban households. This therefore, threatens the balance of the urban system to the extent that about 30-50% of urban population in developing countries has unsatisfactory water and sanitation services leading to pollution of water supplies and high incidence of diseases (Yahya et al 2000).

Unfortunately, most city migrants come to search for better opportunities, but much of the urbanization has not been accompanied by industrialization and economic growth. This being the case, then, these cities cannot cope with the rate of urbanization neither can they afford better opportunities to immigrants. This therefore means that migrants seek refuge in informal sector of the economy, hence making them incapable of affording health services or improving their infrastructure situation.

Africa has not been spared from the bandwagon of urbanization. Reports indicate that Kenya and Tanzania are among countries with highest growth rates (Syagga 1988). Sub-Saharan African cities have experienced steady population growth and increasing urbanization from 1950 to 1985. The largest cities have experienced the largest growth due to their attractiveness to migrants from rural areas in search of employment opportunities (UNDP-WB 2001). As the population in the towns has grown they have extended to incorporate neighboring areas where people were originally leading rural life drawing water from wells and rivers (UNDP-WB 2000).

After independence in Kenya, the colonial restrictions of movement were lifted opening the floodgates of rural urban migration. This trend has been enhanced by the introduction of designated growth centers and Rural Trade and Production Centres (RTPCs) through the growth center policy in order to facilitate growth of their hinterlands. In 1989, Kenya had an estimated 22.7m people, 20% of who lived in urban areas. This proportion is very high when compared with the 5.1% figure in 1948 (AID 1989). This has resulted in extension of city growth to cover rural areas but little attention has been given to organize or plan for this growth, resulting in spontaneous urban development patterns with little or no infrastructure services (UNDP-WB 2000).

The process of urbanization has been coupled with a lax on the part of local authorities in enforcement of development control regulations in recipient areas (WB 1998). Consequently, unplanned and uncontrolled settlements have emerged with very high population densities exerting pressure on existing water and sanitation services (UNDP-WB 2000).

Being the largest city in Kenya, Nairobi has received the bulk of the rural urban immigrants due to its status as a primate city and therefore attracting businesses and developments to itself. By 1999, Nairobi had a population of 2.1m growing at a rate of 4.8%. This has had serious implications in terms of demand for basic services such as housing, water and sanitation services. Owing to the structural adjustment programs (SAPs) of 1986 and consequent reduction in public spending on basic services, poor management capacity and poor revenue base collection, urban governments have been unable to supply adequate basic services to meet demand. This scenario has meant that areas that have been provided with services attract more people, hence hiking prices of housing. Consequently this has pushed middle and lower income earners to either informal settlements abutting the CBD or to the fringe areas.

The process has been enhanced by increase in land values in the center relative to the fringe areas, making developers to move to the periphery in search of cheap land to build cheap rental housing. This is in a bid to take advantage of the influx of population to these areas. This has given rise to extensive subdivision of land to very small parcels of even up to 0.09hectares.

The process has further been enhanced by failure of city fathers to implement the 1973 Nairobi Metropolitan Growth Strategy (NCC 1973), but who rather rationalized the same to allow for provision of alternative modified forms of infrastructure. They have also committed the responsibility of extension of minor

trunk sewer and domestic water connections to the private sector. In practical terms however the private sector has performed dismally. The population has been increasing without provision of sufficient infrastructure leading to massive environment degradation and overloading of existing infrastructure due to overuse. Consequently, residents are faced with falling standards of water and sanitation services leading to a high incidence of diseases such as typhoid and intestinal worms.

This situation is not likely to improve because conventional methods of provision of water and sanitation services require huge capital outlays and they have therefore remained the responsibility of Government. The government on the other hand is reducing its expenditure on these services meaning not much can be expected from it.

Community participation has been widely applied in the water sector to mobilize communities in undertaking water projects. The level of participation has varied from contribution of materials, labor to actual planning and management of projects, but in most cases communities have lacked the management skills necessary for sustaining such projects. Their existence however, is a sign of a potential that can be utilized to mobilize communities towards sustainable provision of water and sanitation services.

Small private providers have taken the initiative to provide for the shortfall created by declining quality of services by public utilities. Over 75% of urban poor get water and sanitation services directly from a range of such providers (UNDP-WB 2000). The question is whether the water is from assured sources and therefore exposing no risk to consumers.

In order to supplement the services provided by the government and local authorities, alternative approaches are required to cope with the foregoing challenges and policy therefore needs to be geared towards maximizing the potential of these private providers and communities among other approaches since they form part of the solution. Reorganization of the settlement will also be necessary since provision of water and sanitation services alone will be tantamount to addressing the symptoms without addressing the issues that are at the core of the problems.

1.1 Problem Statement

In 1962, only 7.8% of Kenya's population lived in towns (more than 2000 people). Out of this population 66% was concentrated in main towns of Nairobi and Mombasa. By 1969, the urban population had grown to 9.8% of total Kenyan population out of which 70% was in Nairobi and Mombasa. Of the estimated 1972 national population of 12m people about 650,000 lived in Nairobi (NCC 1973). According to the 1999 census, Nairobi's population had grown to 2.1m (GOK 1999). The situation in Nairobi has been enhanced by its status as the social, economic and communications hub of the country and therefore attracting both developments and rural in-migrants to itself.

This process has resulted in two main problems. Firstly there has been increased demand for land-space to accommodate this population. Consequently Nairobi's boundaries have been continually extended with the last extension having been done at independence in 1963 to include peri-urban areas of Embakasi and Dagoretti and other important features like the Jomo Kenyatta International Airport and the Nairobi National Park. Secondly the increased population has implied a rise in demand for employment opportunities, education, health,

housing and supporting infrastructure while the provision of these services has fallen short of the demand.

In the housing sector, the provision of housing units in Nairobi has not matched the rising demand for housing. The Government policy on housing in 1967 was to provide a maximum number of housing units at the lowest cost possible. In the 60s and 70s, the National Housing Corporation in collaboration with the local authorities put up a lot of houses. In the late 70s however, the emphasis shifted to site and service schemes whereby people were provided with serviced plots to develop incrementally. With the structural adjustment programs of 1986, the emphasis shifted again to facilitation of the private sector and market driven approaches with serious negative implications to production of housing stock.

Despite progress made by private agencies and individuals to increase the housing stock, existing housing stock in the center of the town has become hopelessly inadequate pushing the price of houses upwards. This has driven out low and middle-income earners either to the squatter settlements abutting the CBD or to the fringe areas of Embakasi and Dagoretti where housing is relatively cheaper.

The influx of population to the fringe area of Dagoretti and more particularly in Riruta, has triggered several forces of change and corresponding development challenges. Firstly, speculators have taken this as an opportunity to buy farms cheaply and subdivide them into plots for sale to developers of residential houses. This situation has further been enhanced by a lax in enforcement of development control regulations in the area. Secondly, investors have also taken this opportunity to escape high land values and stringent development conditions and housing standards in the city center and have bought plots cheaply for development of low cost housing structures in response to the high demand for housing. Other investors have developed well-planned housing estates with

necessary supporting facilities to serve middle income earners, making the area a dichotomy of well-planned settlements juxtaposed with unplanned-uncontrolled settlements.

Fourthly the rising population has created demand for consumer goods and other investors have taken the cue to provide commercial structures along the main roads with no supporting facilities like water and sanitation facilities.

Riruta has thus become highly urbanized with very high population densities putting pressure on existing water and sanitation services. Despite the fact that most residents are connected to piped water supply from Nairobi City Council (NCC), water shortages have become a common phenomenon forcing residents to fetch water from polluted Nairobi River or buy water of un-assured quality from private service providers. In response to this situation landowners have dug shallow wells to supplement water supplies from NCC.

Though some areas in Riruta such as Dagoretti Corner, Race Course, Santak and Suna are connected to NCC sewerage system, which is subject to frequent blockages and leakages causing inconvenience to motorists and pedestrians especially along Wanyee Road. Residents in other areas rely wholly on septic tanks and pit latrines. With rising population density, these facilities cannot cope with demand for toilet services. This means that more and more pit latrines are being dug against a situation of dwindling plot sizes. In the presence of many shallow wells there is danger of contaminating of ground water sources, which is a risk to the residents who rely on these sources.

Due to high level of usage, these facilities are often full. Due to dwindling investment in the water and sanitation sector, NCC exhauster services are no longer reliable and the residents rely on private providers to exhaust their pit

latrines and septic tanks or drain the sludge to the storm water drains and streets. This exposes children, who often play along the streets, to disease infections. During floods the sludge is swept downstream to the Nairobi River, polluting its waters.

Although the area is under the jurisdiction of NCC, residents do not receive solid waste disposal services. Initially garbage disposal was not a big problem since the plot sizes were big enough to accommodate garbage disposal pits, however this is no longer the case today. Those who cannot afford private services are forced to dump the garbage anywhere.

The general urban environment in the area therefore is extremely poor and portends a crisis, which requires urgent planning attention so as to understand the real challenges and suggest solutions. The purpose of the study therefore is to identify the causes of uncontrolled developments and their impacts on water and sanitation standards in Riruta. The study will also suggest approaches to improve provision of water and sanitation services in order to make the area a satisfactory urban development area.

1.2 Research Questions

1. What are the causes of uncontrolled developments on the fringe areas of Riruta?
2. What are the impacts of uncontrolled developments on water and sanitation services in Riruta?
3. What problems are associated with the existing standards of water and sanitation services?
4. What approaches are necessary to improve water and sanitation services in order to make the area a satisfactory urban development area?

1.3 Objectives

1. To examine the causes of uncontrolled developments on the fringe areas of Riruta
2. To examine the impacts of uncontrolled developments on the water and sanitation services in Riruta
3. To evaluate the existing standards of water and sanitation standards against public health and environmental quality standards
4. To recommend approaches necessary to improve the water and sanitation standards in order to make area a satisfactory urban development area

1.4 Hypotheses

1. Uncontrolled developments reduces the level of water and sanitation standards in Riruta
2. The existing water and sanitation standards in Riruta reduces the level of public health and environment quality standards

1.5 Justification

The water and sanitation problems in Riruta, present a unique situation. This is because the area is a result of Nairobi's expansion to originally rural areas owing to political interests at the time (NCC 1973) to the extent that planning for settlement was not done in advance of the actual settlements. It therefore requires a new policy approach. Since information is not available on the development challenges in the area, a research was necessary in order to understand the nature of the problem, look at the existing standards of water and sanitation with regard to the public health and environment quality, with a view to suggesting solutions to make the area a satisfactory urban development area.

The choice of Riruta was made in view of the fact that it is on the fringe areas of Nairobi, which have received little or no attention in terms of adequate provision of water and sanitation services. This is despite the fact that it is experiencing a lot of pressure from the overspill of population from the core of Nairobi. High-rise buildings are coming up in the area to accommodate the incoming population, without due consideration to the capacity of the existing water and sanitation services. This therefore calls for urgent planned intervention.

Against the above background, this investigation undertook a field study in Riruta to examine these issues, their scope, effects, implication to people and the environment and further to suggest possible appropriate courses of action. The results of the study will benefit Riruta residents who have had to grapple with problems of inadequate water and sanitation services. If recommendations of the study are implemented then one can expect improvements in their living conditions.

1.6 Scope

Earlier works in this area of water and sanitation were conducted to inform the study on existing situation and the gaps that need to be filled. The study examined the forces pushing and pulling population towards Riruta, impacts of the population influx on adequacy of provision of water and sanitation services and their implications on public health and environment quality. Consultation was done with the NCC and the ministry of local government to find out the policy efforts that have been put in place towards effective provision of water and sanitation facilities in the area. To get this information, a field study was undertaken and interviews and questionnaires administered to the residents of Riruta.

The study suggests policy options to tackle the problems associated with inadequate provision of water and sanitation services in Nairobi, generally and Riruta in particular. These suggestions are drawn from experiences elsewhere in the World and Kenya in particular.

The first chapter of the thesis addresses problem statement, objectives, methodology, hypotheses, scope, limitations and justification for the study. The research methodology also forms part of this chapter and outlines types of data, sources of data, methods to be employed in data collection, types of variables and finally the tools of analysis of the data to be collected.

The second chapter outlines the literature that has been written overtime in the area of water and sanitation. This includes literature from books, unpublished theses, journals, periodicals, working papers and Government publications. An analysis of the literature informs the study on the gaps to be filled by the study.

The third chapter gives the report of study in terms of historical background to the study area, its country and regional location, its physical and geological characteristics, infrastructure services and governance. It also covers demand and supply of water and sanitation services, the problems associated with inadequate provision, the effects of these problems on people and the environment and the efforts put in place to address these problems. The chapter uses frequency tables, bar charts, and pie charts to present these data.

The fourth chapter evaluates the level of water and sanitation standards in Riruta against the public health and environment quality standards. It also includes hypotheses testing of the relationship between the dependent and independent variables under study.

The fifth and final chapter gives a summary of findings in relation to the objectives of study and recommends approaches that the researcher thinks can ensure effective and sustainable provision of water and sanitation services based on the findings. It also suggests areas of further research and ends with concluding remarks.

1.7 Limitations

The study was limited by time needed for such an undertaking to the extent that only 90 households and a handful of officials were reached. The researcher required more than two research assistants and due to inadequate funds then only two were taken.

Some informants demanded payment in exchange for information given. The researcher had to therefore skip them and interview those willing to volunteer information for free. The study was undertaken after the clashes between landlords and tenants in Kibera making some landowners suspicious of the researcher's intentions and therefore unwillingness to give information.

1.8 Research Methods

1.8.1 Data Needs

The study obtained two types of data namely primary and secondary data. Secondary data On urbanization, housing, land values, population size, composition, and growth rates were obtained. Policy options in other areas or countries were looked at with a view to recommending alternative options to Riruta situation.

Primary data included the education levels, occupations, number of people connected with water, number not connected, types of connection whether house connections, communal taps, water kiosks or standpipes, number of people provided with sanitation services and those without connections were looked at in order to determine the shortfall. Efforts towards providing the shortfall were examined and the measures the community is taking to cope with the existing conditions. Data also included what the residents think is the best way to solve the water and sanitation problems. This was helpful in the choice of strategies recommended.

1.8.2 Sources of Data

Primary data was obtained by undertaking a field study of Riruta. For control purposes, the researcher chose both areas that are most affected by inadequate water and sanitation services, such as Ngando and Kinyanjui plus others that have relatively better services like Suna. These clusters also exhibit different characteristics in terms of population concentration and nature of settlements.

Secondary data was obtained from books, journals, unpublished theses from graduate students, journals, and Government publications such as policy papers, population census, World Bank reports, working papers and from the Internet.

1.8.3 Methods of Data Collection

Secondary data was obtained by undertaking library searches at the ADD, Word Bank, HABRI and UDD libraries. This was done in order to identify what has been done on the subject and the gaps that required further enquiry. It was also relevant to the researcher's preliminary understanding of the region before field study, comparison with studies in other regions of the world and preparation of a bibliography of all materials used in the study. Consultations were made with World Bank personnel for relevant literature on the subject. To this end visits were undertaken to World Bank officials and NCC officials. A frequent Internet search was undertaken to inform the study on the up-to-date information on urbanization trends and effects on water and sanitation situation in the globe.

Primary data was obtained from the field study by use of questionnaires, focused group discussions, interviews with key informants, photographs and observation sheets. Two sets of questionnaires were administered one to the landlords and another to tenants. This was done in order to identify the adequacy of water and sanitation services, types of services, problems associated with their provision and the socio-economic characteristics of the population in question such as occupation and education levels.

Interviews were made with key informants such as NCC officials; health officers of both NCC and NGO funded initiatives. Interview notes were used to conduct focused group discussions with members of a woman based CBO. This was done in order to get an overall picture of what efforts have been applied to cope with the problems faced by the community and whether there were any plans for the future.

Photographs, sketch plans, illustrative diagrams plus spatial maps of the area were used to supplement the field study by highlighting the magnitude of the problems spatially. These problems include lack of development control. Solid waste heaps and sewage pools.

1.8.4 Survey Organization

A reconnaissance survey was done on the basis of which the researcher decided to subdivide the area of study into several clusters namely Suna, Racecourse, Ngando, Kinyanjui and Satellite. The researcher then administered questionnaires to a random sample of 90 households categorized as tenants and landlords.

To supplement the findings from the sample, purposive sampling was used to collect in-depth information on history of the area from the chief and community elders. It was also used to collect data on number of households connected with water and sanitation services and plans for Riruta Satellite from NCC officers; types and incidence of diseases from health officers and efforts by stakeholders in the water and sanitation sector like the World Bank. Photographs and observation techniques were used. The researcher engaged the services of two research assistants due to limited time and funds.

1.8.5 Sample Design

The researcher used secret ballot to determine the division of study. The names of the divisions that are on the fringe areas of Nairobi were written on pieces of paper namely Langata, Kasarani, Dagoretti, and Embakasi. The papers were put in a basket and shuffled together after which one paper was picked randomly and it turned out to be Dagoretti.

Since Dagoretti division is too large to cover within the time given for the study, the researcher chose one location from Dagoretti on the basis of the one with the highest population size and density. The locations were Waithaka, Mutuini, Uthiru, Ruthimitu, Kawangware, Riruta and Kenyatta Golf course. Using the 1999 population census Kawangware had the highest population of 86,824 with a density of 21,706. However it was disqualified because it had already benefited from a World Bank program on water, sanitation, roads and street lighting in 1980s. The researcher therefore, took Riruta Satellite since it had the second highest population of 65,958 and a density of 9,035 (GOK 1999).

Using the registry index map numbers 11, 12, 13, and 15, the total number of plots was counted manually to derive 1589 plots. Out of these, a sample of 10% was taken to get 159 plots. Due to limited time however, only 90 plots were actually covered. Out of this a ratio of 1:5 was taken and 15 landlords and 75 tenants were interviewed. This is because Riruta population is made up of tenants and landlords and the tenants being the majority.

Riruta however is not homogeneous in terms of population distribution and therefore the area was subdivided into five sections namely Suna, Racecourse, Ngando, Kinyanjui and Satellite. The sample was taken on the basis of population density.

Table1-1: Ratio of Landlords to Tenants by Cluster

Area	No of Landlords	No of Tenants
Suna	2	10
Race course	2	10
Ngando	4	20
Kinyanjui	4	20
Satellite	3	15

Table 1-1 shows the distribution of the random sample between Suna, Racecourse, Ngando, Kinyanjui and Satellite.

1.8.6 Selecting the Sample

Though the area is planned, it was difficult to take a sample from Kinyanjui, Satellite, Racecourse and Ngando, since, due to a lot of subdivisions, a lot changes have taken place and the boundaries were not clear on the ground. The sample in this case was thus taken purely on simple random basis. At Suna however, the boundaries are distinct and one house was taken from each row of houses.

1.8.7 Population

The target population was Riruta Satellite population of 65,958 persons (GOK 1999 census), while the accessible population will be all landlords and tenants of Riruta Satellite.

1.8.8 Types of Variables

The types of variables observed were independent, dependent and antecedent variables. The independent variables were socio-economic characteristics such as household size, occupation and education levels, demand and supply of water and sanitation services, types of services, access to water and sanitation services, and quality of water and sanitation services. The dependent variables were the effects of the shortfall in terms of incidence of disease vectors, incidence of diseases, BOD levels of Nairobi River. Urbanization was observed as an antecedent variable, which is bringing about population pressure on existing water and sanitation services, hence resulting in inadequacy of water and sanitation services.

1.8.9 Techniques of Data Analysis

Variables

Variables of a random sample were used to generalize the results of the total population. These variables were:

1. Urbanization
2. Socio-economic characteristics
3. Demand and supply of water and sanitation services
4. Types of services
5. Access to water and sanitation services
6. Quality of water and sanitation services
7. Presence of diseases, pests and foul smell
8. Pollution of river water

Analysis of urbanization was done using level of demand for housing and the reasons for this demand. Water demand was analyzed using the water demand table from the ministry of water resources while factoring in other issues that

affect water demand such as income levels, household sizes and frequency of supply.

Presence of diseases was analyzed by looking at the levels of water and sanitation related diseases and in terms of how near the boreholes were located in relation to the pit latrines, the presence of water leakages and open drainage systems. Pollution levels were analyzed against World Health Organization (WHO) standards and research carried out by organizations such as United Nations Environment Program (UNEP) in the past.

The questionnaires were coded in advance of the study to enable analysis and this analysis was done using the SPSS for Windows programme. The data was analyzed using frequency tables, graphs, charts, mean, and mode. The relationships between the variables were tested using chi-square analysis. Figures, maps, plates were used in data presentation.

Chi-square Analysis

Hypotheses test were carried out using the chi-square (x^2) method. This was done to answer the question whether there were any relationships between the dependent (X) and independent variables (Y), under study. If there was a relationship, the observed values (O) are not equal to the expected values (E). The chi-square was used to estimate the overall difference between observed values and expected values for the whole of the data.

Table 1-2: Analytical Framework

Objective	Data Needs	Analysis
To examine the causes of uncontrolled developments in the fringe areas of Riruta	Population–size in Nairobi, size in CBD in relation to Riruta Growth rates	To identify the push factors- What is pushing population to Riruta
	Housing in CBD	Compare demand housing with supply of housing units
	Land values in C B D Land values in Riruta	Compare land values between CBD and Riruta
	Legal Administrative background of Riruta	How has the legal administrative background impacted on the land ownership pattern, and the pattern of development
	Land ownership pattern/system Typical plot layouts of planned/controlled estates and unplanned/uncontrolled settlements	How has the land ownership system changed over time and what are its impacts – dichotomy of planned estates & unplanned uncontrolled settlements

Table 1-2 Continued

	Land-use policy- Number of subdivisions per year	How comprehensive is the land policy in terms of controlling development? What is lacking– why that rate of subdivisions? In which areas are planning standards being followed?
	Enforcement of planning standards Development control guides, building standards, average plot layout, building materials Who enforces building standards?	Compare level and types of development areas where building standards are enforced and areas where building standards are not enforced. What needs to be done to ensure development control
To examine the impacts of uncontrolled developments on water and sanitation standards in Riruta	Types of services Levels of services	Asses level of demand and supply of services and the deficit
	Accessibility to sampled population, schools and nurseries	Compare the levels between planned and unplanned areas

Table 1-2 Continued

	Quality of water services	Assess quality of service in relation to population, no of Households per plot and planning standards
To evaluate the existing standards of water and sanitation against the public health standards and environment quality standards	W H O Standards on drinking water	Compare the standards of water supplied to WHO standards on drinking water
	Pollution of Nairobi river	Assess river water with WHO Biochemical Oxygen Demand level & Standards Compare quality of environment between controlled and uncontrolled settlements
	Incidence of disease related to Water & sanitation. Diseases reported in health clinics	Assess the level of diseases Compare incidence of disease to public health standards

Table 1-2 Continued

To suggest approaches to improve water and sanitation standards in Riruta to make it a satisfactory urban development area	Approaches in other countries of Africa and Asia.	Compare with methods in other regions of the world and draw what can work here.
	Provisions of public Health Act.	What is the responsibility of Government under these circumstances? What is the duty of NCC to its residents?
	Lessons from communities such as Kahawa Sukari.	Assess possibility of community mobilization to improve standards of water and sanitation. . Compare the status quo with the plan for the area. Why has the plan been ignored? Who should bring in development control-the Government or the communities? Searches for a paradigm shift to ensure plans are followed by involving communities

CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction

The events taking place in Riruta are a result of the interplay between push factors that are pushing the population from Nairobi to Riruta and pull factors that are pulling the population from Nairobi to Riruta. This chapter looks at these push and pull in order to diagnose the real problem.

2.1 Urbanization

Urbanization is the process of town formation and growth. It is a function of population increase and the spatial expansion of urban settlements to absorb this increase. The urban environment is a system of interrelated components namely the population, the space and the networks. So that if one component, is not working it distorts the equilibrium. This section looks at the push and pull forces that creates an imbalance in the urban system.

2.1. I Urbanization In The Globe

In 1900 only 14% of World's population lived in cities. By 1950 the figure had grown to 30% and by 1980 the figure had grown even further to 39%. It was estimated that by year 2001, 47.5% of world's population will be in urban areas (UNCHS 2000). The level of urbanization is expected to reach 56.7% in the current decade and almost half of this growth will be in developing countries. Cities such as Mexico, Jakarta and Bombay are expected to double their population by year 2025 (UNCHS 2000). Another feature of this growth is that it will mostly result from natural increase and expansion of urban areas to their hinterlands.

This scenario implies that a number of support facilities such as housing, roads water, sanitation and community facilities need to be built. This rapid rate of urbanization is overwhelming the capacities of infrastructure to cope with additions of new urban households. Urbanization has already threatened the balance of world's cities especially in developing countries due to their inadequacies in public infrastructure. Infrastructure has been defined as 'the sum total of basic material structures, institutional conditions and human resources available to society, needed for the functioning of the economic sector' (UNCHS 1997: 6). Material infrastructure refers to all buildings and physical networks of roads, pipelines, waterways, and sewerage systems, which, the government or quasi-government, directly or indirectly provide. About 30-50% of population in third world cities has unsatisfactory water and sanitation services (Business and Economic Research, 1999). This has resulted in pollution of water supplies leading to high incidence of disease among urban inhabitants.

Unfortunately, most city migrants come to towns in search of better opportunities but much of this urbanization is not accompanied by economic growth and industrialization. This means that the urban centers are not affording better opportunities to migrants. Since these cities cannot cope with the rate of urbanization, the migrants find refuge in informal economy hence they cannot afford health care services or improve their infrastructure situation.

Africa has not been spared from urbanization phenomenon. Its cities are experiencing rapid urbanization implying immense development challenges. In Botswana it is estimated that about 58% population will be living in urban areas by 2025.

Table 2-1: Urbanization Trends in Some African Countries

Country	Urban Population (as % of Total Population)			Urban Annual Growth Rate (%)	
	1960	1994	2000	1960/1994	1994/2000
Botswana	2	27	33	12.3	6.6
Ethiopia	6	13	15	4.7	5.2
Kenya	7	27	32	7.6	6.0
Malawi	4	13	16	6.8	5.0
Mozambique	4	33	41	9.0	7.4
Namibia	15	36	43	5.3	5.6
South Africa	47	50	53	2.8	3.1
Tanzania	5	24	28	8.2	5.9
Uganda	5	12	14	6.2	5.6
Zambia	17	43	45	6.1	3.4
Zimbabwe	13	31	36	6.0	4.6

Source: Adapted from UNCHS (1999)

Table 2-1 shows the urbanization trends in selected countries in Africa. It indicates that Tanzania, Kenya, Mozambique and Botswana have experienced the highest growth.

2.1.2 Urbanization In Kenya

Kenya has experienced rapid urbanization, especially during the period after independence, when the colonial restrictions on movement were lifted. This pace continued following the introduction of the growth center policy, which provided for the establishment of designated growth centers and Rural Trade and Production Centers (RTPCs) in which infrastructure services would be concentrated through the Integrated Transport Network Policy. It was assumed that these centers would facilitate growth of their hinterlands (GOK).

According to Malombe 1992 this has been attributed to natural population increase in urban areas, expansion of urban areas to former hinterlands and rural urban migration .The natural population increase is the excess of births over death and it results from improved health and thus increase life expectancy. In Kenya half of urban population arises from natural increase and boundary expansions. The disparity in income between urban and rural areas has contributed to rural urban migration and this accounts for the other half of urban growth in Kenya. This has serious implication in terms of demand for basic services such as shelter and supporting infrastructure owing to poor management capacity, poor revenue collection and consequent poor revenue base. Urban Governments have been unable to supply the basic services in adequate quality to meet demand for these services. This scenario has meant that areas provided with these services attract more people pushing prices of housing upwards and consequently pushing the low and middle-income earners to the informal settlements to the periphery.

2.2 Housing

'Housing is both the process and the product of creating shelter for humans' (Jorgensen 1975:12), while a household is people living together as a family or

with a common bond, eating, sleeping and spending time together under the same roof and keeping important belongings together in a place they call their dwelling. Well-planned housing with essential services and at affordable costs affords dignity, security and privacy for the individual (Jorgensen 1975).

Housing is not just the shelter but includes education and health facilities and other infrastructure services. GOK (1986) indicates that housing demand is simply housing need coupled with willingness and ability to pay. Effective demand for housing is demand at existing prices, which can be met, and which depends on household income and other factors such as cost of the house (Erkelens 1991). When people have more money to spend, they buy or build more houses in a better environment. Potential demand is that existing but hidden demand which will become effective (dreams/ hopes to own a house). This report will take demand for housing to mean effective demand for housing. This section looks at housing demand and supply in the globe, in Africa, Kenya and Nairobi in order to bring out its impacts on what is taking place in the periphery of urban centers such as Nairobi.

2.2.1 Housing in the Globe

It is estimated that half of the world's population lives in urban areas (Malombe 1992, UNCHS 2000, Yahya et al 2001). The composition of this population differs between the north and the south with Africa and Latin America having 50% of the population made up of children (Yahya et al 2001). In Europe and North America, the population is gradually aging and therefore household sizes are shrinking, hence reduction in requirements of residential space.

Urban residents in high and middle incomes in the north can afford to buy, build or rent adequate housing accommodation, but in the south the situation is worse

since majority of households are low income. At least 1 billion people in the world live in absolute poverty of which 90% are in the south (Yahya et al 2001).

Housing investment in most African cities is a non-priority issue and for this reason it often accounts for about 5% of gross domestic product and 15% of gross capital formation (Syagga 1988). This scenario is reflected in the acute shortage of housing in major cities in Africa, resulting in mushrooming of extensive informal settlements, such as Mukuru and Kibera in Kenya.

UNCHS (2000) indicates that housing is a major urban planning problem of most cities in Africa including Nairobi, Johannesburg, Harare, Dare salaam and Abuja. It further indicates that the housing deficit for Morocco was 400,000 units, Uganda 237,000 units. Zambia's deficit was estimated at between 40,000 and 60,000 units per annum (UNCHS 2000).

2.2.2 Housing in Kenya

Kenya's housing policy can be traced from the national development plan 1964-70, where the primary objective of government was to provide adequate shelter for all. The government published sessional paper number 5 of 1966/67 on Housing Policy. The emphasis of the paper was on provision of essential housing and healthy environment to the urban dweller at the lowest cost possible. In pursuance of the policy the government established the National Housing Corporation (NHC), through which the government was to channel funds to the local authorities for housing development. Consequently 41,852 housing units were provided in urban areas in form of mortgage, purchase, rentals and site and service schemes, representing 64% of total formal sector housing. The NHC however assumed the role of developer rather than facilitator so that a lot of resources in the private sector remained untapped.

The policy also established the Housing and Building Research Development Unit (HRDU), to make research on building technology and construction costs. The reports of this department were never widely applied and therefore cost of housing remained very high due to high building standards.

Meanwhile, the removal, at independence in 1963 of colonial restrictions governing rural urban migration increased urban population. Between 1976 and 1982 therefore, the public sector produced 75% of the total 6400 units per annum, while the private sector produced 25% (Syagga 1987). The production of housing stock was only able to satisfy 21% of the increase in urban household. Housing deficit for Kenya in 1987 was 280,000 units (UNCHS 2000)..

In Kenya 58.5% of housing in 1988, were regarded as indecent housing. In Nairobi 22.6% of the existing 60,232 units were in uncontrolled settlements. Kenya's urban housing development problems stem from high population growth rates, lax in urban infrastructure development that support housing development, low purchasing power for the majority of people and high building standards. A look at Kenya's housing policy reveals that it has not been comprehensive enough to translate into increased production of housing stock over the years.

The Saps of 1986 contained in sessional paper number one of 1986 on Economic Management for Renewed Growth, introduced cost sharing in provision of services between the government and the public (GOK 1986). This together with the National Housing Strategy for Kenya (1987-2000) emphasized on the role of the private sector and the market forces in determining demand and supply of housing, but ignored the human dimension of equity, distribution and access to housing. This policy shift was influenced by John Turner's (1970), thinking that people needed to be given freedom to build their own houses in order to stimulate

individual and social well-being. Access to housing therefore was only available to those who could afford to buy or construct.

The housing finance sector in Kenya comprises of a three-tier market: high-income, middle-income and low income. High-income groups can access finance easily and therefore can access the highest quality of housing available. The middle income is composed of waged and salaried workers who are not adequately covered for, so they encroach on housing targeted for low-income earners (GOK 1994). Housing supply for low-income earners is therefore, lower than the demand. Low-income people are thus displaced by middle income and move to either the informal settlements or to the fringe areas of the urban centers.

Kenya's budgetary allocation by the exchequer towards housing has been negligible and declining every year. In fact during the 2002, budget there was no mention of housing as a central focus of development financing. Kenya's contribution to UNCHS (Habitat) has been low at 0.01% of total world contribution. This means that while Habitat is doing housing contribution in other countries, there is very little being done in Kenya, yet it has its headquarters here.

Housing policy in Kenya is very weak and therefore has failed to give the necessary guidance towards increasing housing supply. Consequently housing demand in the center of towns has pushed the prices upwards. For example a house in Nairobi West will cost Ksh.20, 000 whereas the same will cost Kshs.6, 000 or less in the periphery areas. In Riruta one can even get a two-roomed house for Ksh. 2, 500.

This has consequently made middle and low-income urban dwellers to seek refuge in informal settlements and the fringe areas of the city, leading to overcrowding in the low-income settlements, with more than 3 persons living in

one habitable room (GOK-UNDP 1999). A habitable room is that which is mainly used for living and excludes stores, office, toilet and kitchens, except in cases where these are used for sleeping or entertaining guests (GOK-UNDP 1999).

This state of affairs has been enhanced by increase in land values in the center relative to land values in the fringe areas. This has resulted to property developers rusting to the fringe areas where land is cheaper relative to the city center. In turn this has attracted even more people to settle in the fringe areas where rents are cheaper. Consequently, the increased population has led to excessive pressure on existing water and sanitation services and mushrooming of poor-uncontrolled human settlements.

2.3 Land Values And Land Markets

Land values are measures of intensity of demand and competition for urban land (Malombe 1992). Land values vary with quality and access to employment, commercial and social services centers in a given area. Consequently land values decline with distance from the city center, since most employment, commercial and social services will be located at the city center. They also vary with demand for particular zones so that most businesses would want to locate in the Central Business District, a location that affords them better market for their goods and services.

High land values in the city center therefore, are pushing investors to the periphery where values are lower hence land is cheaper. It is also pushing low and middle-income residents to the fringe areas. The demand for housing in the fringe areas is in turn increasing due to influx of migrants from the city center. This increase in demand plus improved infrastructure has made land values in the eastern and western zones of Nairobi to appreciate significantly (NCC 1973). The

land values however are low relative to those in the city center. This influx of migrants from the city center is therefore likely to continue, owing to the existing differences in value of land.

Table 2-2: A Comparison of Land values

Area	Area (Hectares)	Land values (Ksh) (1989)
Riruta		
Dag/Riruta/2380	0.0116	140,000
Dag/Riruta/1671	0.1	80,000
Dag/Riruta/1647	0.08	60,000
Dag/Riruta/5490	0.23	80,000
Dag/Karadini/T30	0.0286	1,000,000
City Center& Environs		
Duruma	0.0302	3,000,000
Rd.209/138/94	0.0633	3,560,055
Accra Rd.209/2449	0.4	2,500,000
Ngong Rd.209/289/1/5	0.4489	1,050,000
Hospital Hill.209/9627	0.114	4,800,000
Kijabe 209/4360/26		
Riruta		(1990-2002)
Dag/Riruta/T77	0.13	450,000
Dag/Riruta/5248	0.23	320,000
Dag/Riruta/S 30	0.23	250,000
	0.0244	1,900,000
Santak Dag/Riruta	3.0	2,700,000
City Centre& Environs		
Upper hill .209/1270	1.922	64,600,000
Upper hill .209/6524	3.989	132,990,000
Loita street.209/10343	0.487	110,000,000
Kaunda street 209/1205	0.088	120,000,000

Source: Ministry of Lands and Settlement (1989/2002)

Table 2-2 shows a comparison between land values in Nairobi's CBD and Riruta. It indicates that land values are higher in the CBD relative to Riruta.

Figure 2-1: Cross Section of Land values

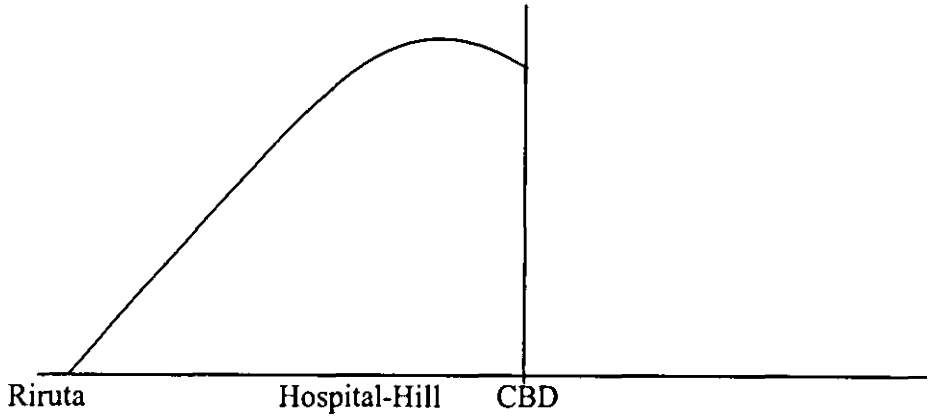


Figure 1 shows a cross-section of land values taken from the city center through hospital hill to Riruta. It indicates that land values in Nairobi and Hospital hill are higher and declining as one moves towards Riruta. This therefore pushes those who cannot afford land in the center to Riruta where land is cheaper.

2.4 Legal Administrative Background

Riruta was formerly under Kiambu county council (KCC), before it was annexed to Nairobi in 1964 (NCC 1973). The way of life of Riruta residents was basically rural. People owned land under the Kikuyu custom, which is patriarchal: land rights were passed on from father to children. These lands were on free hold certificates when the area was included to Nairobi. The system of land ownership did not change, except, the area designated townships and market centers which was to be taken over by Government under leasehold titles. The landlords were to surrender the certificates to the Government in exchange for 99-year leases, but

due to lack of enforcement, some heeded the advice while others did not (NCC 1973).

Families owned Land and after some time, some started selling the farms to private investors to build housing estates and that's how well planned estates such as Santak and Suna emerged. Others sold land to people wishing to build their own private houses. It is this latter group that has built uncontrolled human settlements to take advantage of the rising demand for housing. The area therefore has a dichotomy of two kinds for settlements, the planned and controlled estates and the unplanned and uncontrolled housing developments.

2.5 Development Control

Development control is the process involving monitoring of implementation of developments in order to ensure that developments comply with physical development plan provisions, regulations, policies and strategies (Masinde 2000). These regulations, policies and strategies are devised in order to ensure that land use is guided and controlled in the interest of efficiency, economy, safety, order, health, amenity and general welfare. The functions of development control include implementation of development plans, regulation of land use, efficient and equitable location and distribution of resources and conservation of the quality of the environment among others (ML&S 1992).

The Physical Planning Act provides that all development application must be submitted to the local authorities that after consulting with the Director of Physical Planning and other relevant authorities shall give approval or decline it. This provision is based on the fact that subdivisions, amalgamations and extension of leases forms the basis for human settlements and the physical planner

must come in and give planning guidelines before finalization of such decisions. These guidelines include provision of public utilities like water reticulation system, sanitation system, schools, access roads and social amenities. This then fosters properly planned built environment and guards against developments which are injurious to man and the environment.

The planner also gives guidance on the density of development so that for low-density multi family units, 20 to 25 dwelling units are allowed per hectare with minimum frontage of 7.5m and distance of 9m between buildings (Planning Handbook 19). This ensures that care is taken to create a spatial and functional independent system of built up area well provided with day-to-day services within distances that are conducive to the enjoyment of the residents.

Before the Physical Planning Act (1996) was enacted the NCC development control department used to carry out development control. For a long time therefore development in Nairobi has not been guided since city fathers ignored the development plan of 1973 and therefore most development have occurred without any controls. The Nairobi Metropolitan Strategy of 1973 laid emphasis on urban expansion to accommodate rapid urban growth, departing from 1948 Master plan, which segregated the town in different sectors. The plan laid a framework for infrastructure investment to facilitate expansion and incorporation of extended areas of the city, which were mainly farmlands into productive urban environs.

Due to lack of administrative, political and financial support, the plan was not implemented, leading to informal urban developments and the entry of land-buying companies and cooperative societies which mobilized peoples' savings to purchase land on the periphery. Illegal subdivisions such as Roysabu came up. By 1979 about 50 % of residential developments in Nairobi was comprised of illegal

developments (Ondiek 2001). In 1979 therefore, NCC rationalized the Nairobi Metropolitan Growth Strategy and re-directed city planning to focus on structural development of the city by use of land use and density controls and spatial development plans extended areas allowing alternative methods of sewage disposal and committed private developers to be responsible for minor extension of trunk and domestic reticulations. In practical terms however, the private sector has performed dismally. Density controls became impossible due to rising land values and high construction costs. Development has thus occurred without sufficient infrastructure capacity leading to massive environmental degradation and dilapidation of infrastructure due to overloading and overuse (Ondiek 2001).

2.6 Impacts Of Uncontrolled Developments On Access To Water And Sanitation Services

The achievement of the physical, mental and social well being of people is critical to enhancing human development (GOK-UNDP 1999). The absence of disease is one of the conditions necessary for a healthy population capable of participating in the development process. Access to clean water and adequate sanitation are a prerequisite for prevention of environment pollution, water borne and infectious diseases and therefore, forms the foundation to the improvement of community's well being (GOK-UNDP 1999).

2.6.1 Access to Water and Sanitation Services in the Globe

A lot of attention has been directed to the plight of cities particularly on environment point of view since the 1976 Vancouver conference out of which the UNCHS (Habitat) was formed (UNCHS 1996). The United Nations General Assembly proclaimed 1987 as the international year for shelter for the homeless and having recognized the role-played by infrastructure in development it laid

emphasis on infrastructure provision as an important component of the basic strategy to improve shelter (UNCHS 1996).

According to UNEP (1987), the overall goals of sanitation development in urban settlements in developing countries include reduction in excreta related health risks by providing adequate sanitation facilities, protection of the environment by adequate treatment and disposal of waste waters and provision of these services at an affordable cost.

Despite considerable progress made in Africa, Asia and Latin America by the end of the International Drinking Water Supply and Sanitation Decade, which began in 1980, 245m urban dwellers and 1bn rural dwellers had no access to water of assured quality. By 1994 the proportion for urban had increased to 280m and that for rural had decreased to 835m (UNCHS 1996).

The 1991 statistics showed that at least $^1/_3$ of urban dwellers in Africa, Asia and Latin America and more than ½ its rural population had no hygienic means of disposing excreta (UNCHS 1996: 268). Those with provision, 1bn had pit latrines, 550m had houses connected to public sewer and 220m had septic tanks. The 1994 estimates suggested that those lacking adequate sanitation had increased to 588m in urban areas and 2.28bn in rural areas (UNCHS 1996). Projections for year 2000 showed that if those rates were maintained, the people without adequate sanitation would increase to 3.31bn, which amounted to more than half of the World's population (UNCHS 1996).

Most cities in Africa and Asia have no sewers at all, yet some have over 1m people. Human waste therefore is discharged into the rivers, streams, drainage, gullies and ditches. The resultant health problems are more serious in urban areas

than in the rural areas because of higher densities, which make it difficult to protect the people from contact with excreta (Nyamwano 1994). The situation is no different in terms of water supply. Provision of water supply in urban areas will require $11-14bn per year for the next 30 years (UNDP-WB 1993: 2). Yet these are the World's poorest countries. In order to deal with water and sanitation challenges, review of best practices in other parts of the world such as Guatemala and china is handy.

Urban Environmental Sanitation in Illegal Settlements: El Meziquital settlement in Guatemala

In 1997, Guatemala had more than 2.5m people, 231,000 of whom lived in makeshift settlement on its outskirts without basic infrastructure services. Faced with critical outbreaks of typhoid fever, the settlers asked UNICEF to improve their water supplies. This resulted in the launching of an urban environmental sanitation program by UNICEF in 1984/97.

A Committee for Attention of Population in Precarious Areas (COINAPP) was formed comprising government, local public and private institutions, representatives of the community organizations to coordinate assistance to the settlements from public private sources and to help form alliances between agencies and local communities. This committee played a major role in mobilizing low-income communities and institutional resource from government and other agencies and documenting successful methodologies and experiences.

The project helped provide water and sanitation to 2000 families and helped El Meziquital gain legal status and thus entitlement to public water and sanitation services. Another 1000 families were supplied with water from Guatemala Municipal Water Enterprise.

Two different models were chosen, the single-source tank suitable for communities of less than 10,000 and a well, construction of which required community participation plus technical assistance and institutional cooperation from COINAPP. The community chose a single source tank and they created the supply network to reach each household. UNICEF provided funds for pipes and materials while each family did their own connection.

The water company issues a communal bill to the local community association, which in turn collect fees from users. The fee includes a small surcharge for maintenance of drains and sewers and a minimum fee to finance other projects like low-cost latrines. Volunteers were trained in basic environmental sanitation resulting in installation of 14 public water taps, 500 dry latrines, and improvement of 3000 existing latrines, building of sewage drains and sidewalks and sewerage treatment plants (Duarte 2000).

The lessons can be drawn from this activities are that community participation needs to be viewed as an integrated management and empowerment exercise which is important for enabling poor communities to take control of their own development in the face of declining public supplies. Municipal authorities therefore need to see this as easing their burden and not a political, economic loss. Urban Sector Network (1999) describes *Community participation* as engagement of the public in the ongoing process of policy formulation, decision-making, implementation, monitoring and evaluation. It creates opportunity for the public to influence the policy decisions of the Government.

Provision of education and training in health and sanitation, offers the people necessary tools in carrying out other project activities and therefore need to be an important component of any project. There is need to integrate the various initiatives of institutions involved in community development by establishing

links between them. This gives the projects a synergistic impact (Duarte 2000) and avoids duplication of effort.

Environmental Sanitation and Hygiene education in Rural China

An estimated 600m rural residents in China have no sanitary latrines and therefore they rely on traditional latrines comprising of a hole dug in the ground and stones placed on either side as a footrest. Excreta are regularly scooped to fertilize the fields. As a result about 530 m Chinese including 90% of children in poor areas suffer from intestinal worms. Worm infection and diarrhea contribute to stunted growth for over 39% of rural children with diarrhea claiming 140,000 children every year.

In the year 1996/ 2000 UNICEF supported a program to promote sanitation and hygiene in areas where safe water was already available. A push and pull strategy was used to gain Government commitment and to motivate communities and families to improve their own sanitation. 'Decision makers were pushed to take action through advocacy meetings with national and provincial leaders, establishing of regulations, research and development of affordable technologies and promotion of links between sanitation and hygiene education and development initiatives in water, agriculture, education, women's empowerment, poverty alleviation and environmental sectors' Communities were pulled to demand and support sanitary latrines and better hygiene, through social mobilization, communication and social marketing strategies.

Affordable technologies were demonstrated in schools, hospitals, and mass media. The double urn' and the 'three compartment' type of sanitary latrines were promoted, which have been used in China for a decade. The cost of the underground component (water proof) was $14.44 (Vathmee 2000)

This initiative shows the importance looking at what technology people have and improving on it. It also underscores the need to link sanitation with hygiene education.

2.6.2 Access to Water and Sanitation Services in Africa

In Africa over half of the population was not served with safe drinking water and of those served, only a small proportion had house connections (UNCHS 1996). Only a ratio of 1:3 urban dwellers had house connections with 32m relying on public standpipes and the rest on other sources (UNCHS 1996). In Africa, over ½ of the population had no provision for sanitation, 20% of urban population used pit-latrines, 20% were connected to public sewers and 20% had septic tanks (UNCHS 1996).

Since these countries are among the poorest in the world the situation in the continent is not expected to improve soon. Annual Gross National Product (GNP) per capita in ten African countries under study was US$120-660, with more than 80% living under one dollar per day. They thus have very little to spend on basic necessities like water US$5-20 a year per capita and sanitation US$2-10 a year per capita (UNDP-WB 2000).

The problems of sanitation are most apparent in urban areas and their high densities make cheaper and easier solutions less appropriate. Most cities in Africa have no sewers at all and most lack connections to septic tanks so that most human excreta ends up in rivers, gullies and ditches, untreated.

In sub-Saharan Africa water and sanitation has remained a government responsibility since it is considered basic services and therefore are heavily subsidized by public coffers. In urban areas, a citywide authority provides them

and many residents have no direct access. Over the last 10 years some countries such as Senegal, Guinea, and Cote D Ivories have however established joint public-private water distribution companies. In Kenya, Uganda, Mali and Benin the process is underway (UNDP-WB 2000).

Studies done on the sub-Saharan African countries in 1998 found that through recognition, regularization of their activities, and facilitation of intermediation, coordination, partnership between operators and independent providers, municipal and national authorities can improve delivery of water and sanitation services for the poor (UNDP-WB 2000).

Community Water and Sanitation Project-Ghana

An UNDP-World Bank program has promoted community-based approaches, which mobilize users and enable them to make informed decisions about the services they want and are willing to maintain (UNDP-WB 1999: 23). In Ghana, an impact study on a community water and sanitation project showed that services needed to be delivered more quickly to reduce per-capita costs and poor communities could benefit from the program if technical options were more varied and flexible (UNDP-WB 1999: 24). It also found that empowering communities to take responsibility for provision and management of basic services is essential for sustainability of projects' (UNDP-WB 1999: 24)

Solid Waste Management in Benin

With the growing problem of uncollected solid waste, which had initially been the responsibility of the Oredo County council, an ad-hoc task force called the State Environmental, sanitation Task Force was established. It identified the 2nd and last Saturdays of the month as state and national environmental days respectively and it enforced compliance using the military. This initiative did not work because it relied on volunteers to provide trucks for waste collection but never paid for

maintenance of the same. The city authorities therefore, sought to involve the private sector but this failed due to rising cost of operation and maintenance.

In 1995, the contracting method was adopted called 'commercialization' of waste services where city officials had consultations with the community traditional leaders presided over by political administration. Their support of the community was viewed as important to the cost recovery strategy. The city was divided into 12 zones, each of which was responsible for engaging the services of private operators under supervision of the city council. A fee of 50n per household per month was agreed upon. Out of 60% was to go to the private operator, 20% was retained by the council while 20% went to the community elders for organizing and ensuring collection of monthly fees (Scatterthwaite 2000).

Though not wholly successful, the contracting method is a major attempt to provide a sustainable waste management solution in Benin. The method introduced elements of community participation, decentralization and a community based service collection system (Scatterthwaite 2000:114). Its weaknesses were that it assumed that community leaders views reflected those of the community members whereas this was not the case as 58% of the residents were migrants. This therefore, calls for monitoring and evaluation to get feedback from the households. It also took for granted issues of affordability and willingness to pay resulting in lack of enthusiasm and cooperation from households (Scatterthwaite 2000: 114)

The short listed private operators were not involved in discussions on service standards and delivery. Important details of accessing certain households during rainy seasons were not taken into account. Decisions on service charges and amount payable to operators were not based on assessment of cost of operations.

Despite experiencing no apparent improvement in waste management, private sector participation is necessary in the face of dwindling public sector resources. Community/private sector partnerships can be encouraged however in low-income areas to enable them use 'sub-optimal' standards, which can also lead to improvement of the environment for example the use of neighborhood bins (114). A combination of two or more methods may help instead of relying on one method.

Institutional partnerships are ". Defined as cooperative working arrangements aimed at achieving a specific objective" (Scatterthwaite 2000: 79). Public/private partnerships therefore, can be seen as cooperative arrangements between the public sector stakeholders and the actors in the private sector with a view to achieving specific objectives e.g. improvement in water and sanitation.

2.6.3 Regional Water and Sanitation Situation

'Vast investments have been made in public water supplies in East and Southern Africa but there is still a considerable backlog with regard to coverage and easy access' (UNDP-WB: 1997: 1). Institutional and sector reforms have taken place with people's attitudes changing from viewing the government not a provider as a facilitator (UNDP-WB 1998: 25). With high population growth rates and declining quality of services coverage by utilities, small private providers have taken the initiative to provide for the shortfall. Over 75% of urban poor get water and sanitation services directly from a range of such providers (UNDP-WB 2000: 1). They therefore, form part of the solution for solving water and sanitation problems and policy needs to be geared towards maximizing their potential. In Tanzania corporitisation of urban and peri-urban water and sanitation services has been done by formation of autonomous utility companies to take charge of water and sanitation and drastic improvements have been registered in service delivery

and revenue collection (UNDP-WB 2000). In Kenya corporitisation has not succeeded due to lack of specific government policy and political will to achieve and implement policy,

A review of Participatory Hygiene and Sanitation Transformation (PHAST) program in Botswana, Kenya, Mozambique, Tanzania and Uganda showed prevalence of malaria, diarrhea, skin and eye infections resulting to high infant mortality rates (UNDP-WB 1998). PHAST together with community action has increased hygiene enabling facilities and improved water transport and storage and therefore has contributed to a reduction in water borne diseases (UNDP-WB 1998).

Communities can play a major role in management of water supply, in view of prevailing public sector constraints, by introducing payments for water services, mobilizing resources for capital investments, setting tariffs and covering operation and maintenance expenses (UNDP-WB 1997). Water and sanitation services can also be improved by transferring assets of water utility to a public trust company, owned directly by the government or indirectly through the local authority and managed by an independent board of trustees with capacity to source multilateral funds for example the Kenya Revenue Authority.

Sanitation and hygiene involve social behavior and community norms, so community participation is necessary for effectiveness and sustainability of projects aimed at improvising sanitation and hygiene (UNDP-WB 1998).

Small Enterprise Providers in Senegal

In Senegal, the long-term water supply project advocates for community-based approaches depending on the service they want to pay for which encourages small enterprise providers in delivery of services. The utilities act as institutional

anchors and communities are responsible for operation and maintenance. Private operators may be contracted to operate standpipes, pit emptying, construction and maintenance of facilities (UNDP-WB 1999: 25).

Wobulenzi water supply-Uganda

In Uganda, Wobulenzi water supply is a good example of the triple linkage between willingness to pay, demand driven technology and levels of service and locating management responsibilities on organised user groups. According to Business Economic Research (1999) the scheme was conceived as partnership between Uganda development Department and resident households, where households contributed 2% of capital cost and Department of Water Development (DWD) contributed 98% through a loan from International Development Association (IDA). Consumers were to bear the cost of operation and maintenance and fuel replacement costs. Users at each water kiosk were required to form water user groups and elect a five-member committee to be responsible for operating, managing and revenue collection through a water kiosk operator. In this way 31 user groups were created to form the Wobulenzi Water Users Association with a five-member executive.

2.6.4 Access to Water and Sanitation Services in Kenya

Over the last two decades, Kenya's urban growth has been increasing rapidly which has often been attributed to the high rate of rural-urban migration and high population growth rates (Malombe 1992). This has resulted in towns extending into areas that have been traditionally been rural without due consideration of how infrastructure services like water and sanitation are to be provided. This results in poor living conditions for the residents, who have to rely on unsafe water from streams and shallow wells and sub-optimal methods of sewage disposal.

The situation in Kenyan urban centers indicates that infrastructure provision has not been in tandem with the high population growth rates in these areas. A World Bank report estimated that less than 50% of rural population had access to safe water and 70% of urban residents had access to safe water (WB 2001: 2). In 1991, 13m people in urban areas lacked access to adequate sanitation. UNCHS (1986) estimated that only a little over half-urban resident had access to adequate sanitation. These conditions are not conducive to reasonable quality of life and provide few incentives to residents to improve their neighborhoods.

According to Karanja (1993), in 1981, the Kenya government declared its water supply coverage goals for 1990 to 100% of urban population and 75% rural population and sanitation coverage to be 90% for urban and 50% for rural population. By 1989 about 61% of urban and 10-20% of rural had access to safe water supply while 40% of urban population and 25-35% of rural population had access to sanitation. Despite high levels of investments by donors in the sector only limited success was achieved due to construction of urban type high technology schemes resulting in high maintenance costs.

Despite increasing population, hence increasing demand for water and sanitation services, the Kenya government's expenditure on these services has been declining since the policy shift (GOK 1986) from the provider principle to the facilitator principle. This policy shift would seem to contradict Kenya's goal of 100% coverage of water in urban areas and 75% of rural areas.

At the same time Kenya's gross domestic product has been declining from 4.6% in 1996 to 1.8%, 1.45, minus 0.3% in 1998, 1999 and 2000 respectively (CBK 2001). This has resulted in problems of deficit financing and debt servicing reducing drastically the finance resource availability to water and sanitation sector. In 1980/1995, Government expenditure declined from 20% 0f GDP to

13% (UNDP-GOK 1999). This is reflected in expenditure on respective basic services with water and sanitation declining from 2.4% and 0.65% to 0.4% and 0.3% respectively, during the same period (UNDP-GOK 1999).

The decline in expenditure has also been contributed partly by the shift in policy contained in the Saps of 1986 from providing to participatory management of services. This shift in policy meant that the government was to share the cost of provision of services with the public and provide an enabling environment for the private sector to provide certain services. However, the performance of the private sector has not been encouraging since strategic measures facilitating their involvement were not put in place. The trend is very disturbing as the demand for services is increasing on a daily basis.

The underlying causes of problems in water and sanitation sector are that the supply side is dominated by Government monopoly and prices are heavily regulated and heavily subsidized. Provision of urban water and sanitation services is done by state owned institutions like the Kenya Water Conservation and Pipeline Corporation (KWCPC). The NWCPC was established in 1988 to manage and operate water supply schemes previously operated by the ministry of water resources. However there is usually a conflict between NCWPC and local authorities in terms of failure by local authorities to pay dues.

The National water policy is a welcome development since it provides for the involvement of other stakeholders in water management but there is need for concrete steps to implement it. Private Sector Participation is necessary based on the separation of ownership assets from management of those assets creating and environment where private involvement can yield desired performance.

The World Bank (2001) also recommends active involvement of women, men and children in water and sanitation services provision in order for projects to be sustainable. The paper defines sustainability as the ability for a project to sustain itself in terms of functioning physical infrastructure and proficiency of users and local management committee to effectively maintain, manage, finance the service (WB 2001: 4)

2.6.5 Water and Sanitation Services in Nairobi

In Nairobi, the NCC is charged with the mandate of providing water and sanitation services to the residents. The performance of NCC however, has been below expectations and in some areas it has been lacking. According to Karanja (1993) the continued frustration with the inability of various city commissions to provide a lasting solution to problems of uncollected garbage, water shortages, potholes and poor sewage disposal, made Nairobi residents come together in the Nairobi convention and come up with several recommendations towards the 'Nairobi we want'. The convention pointed out the problem of lack of co-ordination between control of foul sewage, surface water drainage, and solid waste disposal and river pollution. This is due to shared responsibility of these issues among different government departments.

The convention's proposal was to ensure effective disposal of sewage with minimum nuisance and risk to health and upgrading of the sewage system after review of city planning. Another proposals was comprehensive plan is done to improve public health inspection of private properties in densely populated areas and make the landlords improve sanitation facilities. By 1998, the targets of this convention had not been met. We are now in the new the 21st century and adequate provision of water and sanitation services seems to be a pipe dream.

Informal settlements and businesses have increasingly dominated the urban areas and people here rely on self-help techniques, ranging from illegal tapping of urban services by low-income households to the provision of water and sewerage facilities by middle and high-income developers in the absence of public sector supplies. The traditional paradigm of urban growth of planning-servicing-building-occupation has been reversed to the extent that today people build and occupy houses before planning and servicing has been done.

Water Services Situation

Nairobi has 2.1m people (GOK 1999) and their water requirements are supposed to be provided by the Water and Sanitation Department (WSD) of NCC. Nairobi's estimated daily water production is 364,000m^3/day representing 93.3% and 96.9% of water consumed in Nairobi (Business Economic Research 1999). Areas like Karen and parts of Langata rely on boreholes (WB 1998/99). Water losses through leakage reduce the bulk by 50% and therefore NCC is unable to meet demand for safe drinking water (Business Economic Research 1999).. Residents in informal settlements don't have direct connections and obtain water from private water kiosks and standpipes. The issue is whether these private providers can be trusted to bring safe drinking water in which case then, they need to be encouraged to do so.

Table 2-3: Outputs of Water Stations in Nairobi

Source	M3/Day
Kikuyu Springs	4,000
Sasumua Dam	43,000
Ruiru	12,000
Ngethu	305,000
Total	364,000

Source: Business Economic Research (1999)

Table 2-3 shows that the Water and Sanitation Department (WSD) produces 364,000m3 of water per day from Kikuyu springs, Sasumua Dam, Ruiru and Ngethu. In 1999 however the overall production of these sources was approximately 320,000m3/day implying a shortfall of 44,000m3 per day.

Table 2-4: Nairobi-access to Drinking Water and Sanitation Services, 1999

Source	Percentage
In-home connection	71
Stand pipe water fetched by HH	1
Independent providers of traditional sources	27

Source: Bernard Collignon & Marc Vezina (2000)

Table 2-4 shows the coverage of water connections in Nairobi. It indicates that 27% of households depended on independent providers and traditional sources of streams. The table shows that the percentage of people with piped water is 71%, which does not tally with the 1999 population census figures. According to GOK (1999), 93% of residents in Nairobi had piped water while 7% accessed water

from rivers and streams. This may be due to the fact that the census figures are based on house-to-house study whereas the Collignon & Vezina (2000) figures are based on a random study. However the census figures do not show actual water supply but rather water connections.

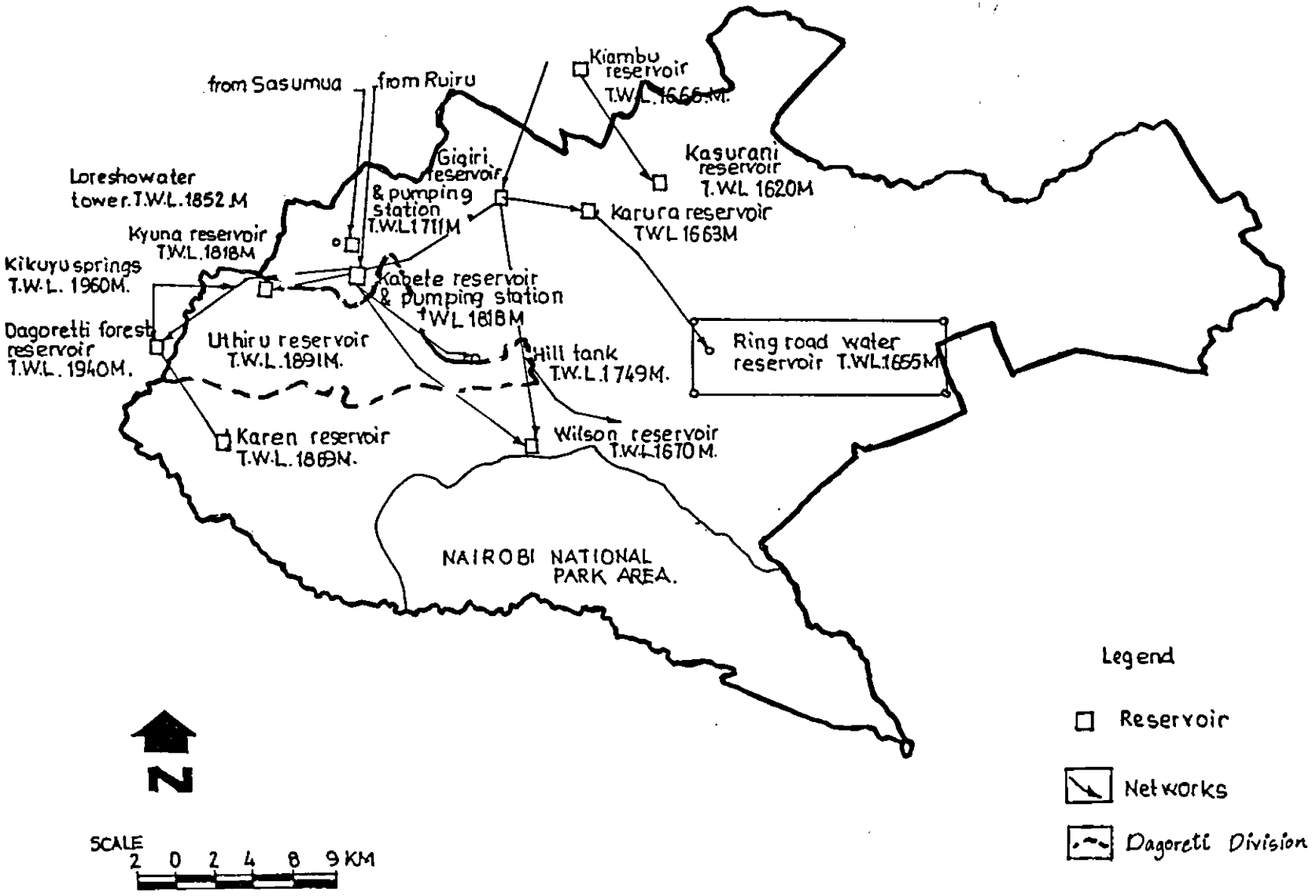
The upper supply includes Kibera, Karen and Riruta among others (Map 2-1). Its daily requirement of water is estimated at 97,000m^3. Effective daily production from Kikuyu springs and Sasumua sources are 47,000m^3/day. This gives a shortfall of 50,000m3, which requires that water must be pumped from Gigiri and Kabete daily. Currently only 32,000m^3 is transferred from the latter stations giving a shortfall of 18,000m^3 (Business Economic Research, 1999). The implication is that there occur shortages, inadequacies and interruptions of water supply to all parts of the upper supply area.

The situation of shortages is not likely to improve because WSD's performance has been very poor due to the following factors:

1. Unaccounted for water losses of between 47-51% compared to losses in other cities of developing countries at 37% and 20% in developed countries (1999)
2. Management of consumer bulk meters has collapsed with only ¼ of the meters recording any movement
3. Billing of consumers has almost ground to a halt with only 30% of total accounts being billed
4. Revenue collection has been very poor in that it takes about 800 days on average for consumer to settle a bill

There have been concerted efforts to improve water situation in areas such as Kibera by introduction of water kiosks that have gone a long way in easing water problems in the area.

MAP 2-1 WATER DISTRIBUTION NETWORKS IN NAIROBI



Source: Nairobi Master Plan for Service, Sanitation and Drainage.
1907

Water Kiosks of Kibera

The water kiosks act as a source of income and water for domestic use. About 98 % of the water kiosks are owned by community self-help groups while the remainder are owned by individuals. The cost of infrastructure to the NCC mains is borne by the operator and constitutes 89% of the initial investment. 800ksh is given to gatekeepers as informal payments, which is twice the official payment to WSD. Overall capital investment was between Ksh. 5,000-4,0000 (UNDP-WB 1997).

Kiosk owners reported delays in meter readings, late and irregular b ills, and billing fro sewerage even though they aren't connected to NCC sewer.
Source: UNDP-WB (1997)

All these efforts to alleviate the water and sanitation problems in poor communities will however encourage the council to abdicate its duties to provide services to the people who pay taxes in form of rates. Therefore mechanisms need to be put in place to ensure refund to the community for services they provide on their own initiative (UNDP-WB (1997).

Sanitation

There is need to develop water and sanitation services together with other support services. Sanitation is often ignored in favor of transport and water supply because of inadequate awareness of the dangers it poses to community well being. Nevertheless it is an essential element in promoting community health and the efficient operation of other infrastructure services (Ndegwa 1991).

Sewerage Management

About 58% of Nairobi's population is served by existing waterborne sewerage system while the remainder uses septic tanks, conservation tanks or pit latrines that pollute ground water and piped water owing to seepage.

NCC develops and maintains water borne sewerage in Nairobi. The sewage development policy of NCC is based on the 1973 structure plan, which was very broad and strives towards an ideal situation (Karanja 1993). The water and sewage department however has been unable to finance the plan proposals. Development of water borne sanitation facilities have therefore not been in tandem with population growth meaning that Nairobi faces poor health standards and increased pollution of the environment.

In many poor neighborhoods sanitation problems go unabated. A GOK-UNICEF study (1990) found that 69.2%, 15.9% and 12.9% of residents interviewed in Mukuru, Dagoretti and Korogocho respectively had no toilets at all. WHO report (1974) stated that the arrangement of sewage disposal in Kenya was unsatisfactory and cautioned that it would become serious with rapid population growth and industrialization. It recommended a positive action on the backlog in proper sanitation to forestall problems as they occur. It is important to note that despite this advice little has been done to date.

In areas like Dagoretti sewage provision has not been addressed and the facilities that exist are built through the efforts of the landowners. It is no wonder then that sewage in such areas will normally be discharged into the rivers and open drains causing a health risk to the population resident there and particularly the children.

Water and Environmental Sanitation Needs of Kibera

A rapid assessment by UNDP-WB (1997) of Kibera informal settlement revealed excreta disposal, water supply and solid waste management as the main priorities of the residents. Limited access to exhauster services made 30% of the pit-latrines to be unusable. Kenya Water for Health Organization (KWAHO) has initiated an experimental exhauster service-Vacu-Tag to alleviate this problem. It has also helped establish group water Kiosks (UNDP-WB 1997: 2).

Residents suggested that landlords provide adequate pit latrines for tenants and pay latrines for communal use, larger diameter for water distribution pipe, establishment of more water kiosks, collection points, regular collection by NCC and privatization of garbage collection. Community based organizations are involved in weekly clean up of solid waste from drains, waste recycling and community-managed water kiosks.

Most health problems cited-malaria, diarrhea, intestinal worms and vomiting-were directly related to quality of water and environmental sanitation (UNDP-WB 1997).

Solid Waste Management

Solid waste is defined as that which is perceived to be of no use to the producer, presently or in the future (Mairura 1988, Malombe 1992). Solid waste can be categorised as organic or inorganic matter. Organic matter is that which decomposes and include food remains and grass, while inorganic matter is that which does not decompose such as broken glass and metal. Solid waste is derived from organic and inorganic household wastes, commercial refuse from stores, offices and restaurants, institutional refuse from schools and hospitals and construction debris.

In industrialised countries, waste generation is between 0.7 and 1.8 kg per capita per day, while in developing countries it is between 0.4 and 0.6kg per capita per day (Malombe 1992). Since the population is also increasing, the amount of solid waste generated is enormous. These enormous amounts of waste need to be collected and disposed regularly to ensure good environment quality.

Solid waste management is the process by which waste is generated, collected, stored, transported and disposed or recycled into original forms or different forms (Malombe 1992). Management of solid waste has remained one of the challenges facing urban governments in Africa. In Tanzania urban authorities could only collect 24% of refuse produced. In Dar salaam only 16% of solid waste was collected (Malombe 1992).

In Cairo, waste is collected from neighbourhoods with donkey carts, which are advantageous because they can negotiate narrow streets where motor vehicles cannot. Other cities in Africa can borrow from this innovative solution, which can save fuel and create employment.

Solid Waste Management in Kenya

In Kenya the need for waste management is provided for by section 116 of the Public health Act, which states that local authorities have an obligation to maintain the area under its jurisdiction in cleanliness and sanitary condition (Malombe 1992). Management of solid waste is therefore a right that residents need to demand from urban governments.

Rapid population growth rates against a declining economy have strained the administrative capabilities of urban governments, which in turn have reduced service coverage and steadily diminished quality and frequency of services offered. Waste management deficiency has thus become one of the major

problems facing urban centres in Kenya today. This problem is most acute in the informal settlements of Nairobi.

In most urban centres in Kenya however the solid waste collection system is irregular leading to dumping of wastes in open spaces, access roads and along watercourses. This heaps acts as a good breeding ground for disease vectors such as flies, mosquitoes and rats. Lecheate from putrefying and decomposing garbage percolates into the soil and nearby water sources contaminating water, food and soil and is thus responsible for transmission of diseases among humans (Malombe 1992). Rotting garbage also fouls the air resulting in respiratory tract ailments among humans.

Another related problem results from scattering of waste by rodents onto the watercourses such as rivers and open storm water drains. This blocks the watercourses and results in flooding when the rains come. The waste also pollutes rivers and the environment (Malombe 1992).

Solid Waste Management in Nairobi

In Nairobi, the solid waste generated is between 800 and 1000 tons, but only a quarter of this is collected (Malombe 1992, GOK-UNDP 1999). Nairobi City Council does not give an accurate figure of the quality of waste produced in the city but only gives quantity of waste collected by its cleansing department. Studies by Ministry of Local Government however indicate waste production was 0.375kg and UNDP estimated it at 1.36kg per capita day (Mairura 1988). Syagga puts the rate of generation at 0.4 kg per capita per day (Malombe 1992).

Studies done by UNEP also indicate that household, commercial and institutional waste accounts for about 90% of all waste in urban centres in Kenya (Malombe

1992). About 76% of solid waste constitutes biodegradable matter (Malombe 1992).

Provision of solid waste disposal services in Nairobi has been declining over the years. In 1974, the amount collected was 173,983 tonnes and this declined to 108,717 tonnes in 1991 (Malombe1992). In the 80s NCC used to collect solid waste in estates such as Buruburu twice, weekly. By 1991, the collection changed to once every 7-14 days in planned settlements while in informal settlements it was once every 28 days (Malombe 1992). Today this service is very rare or inexistent. Yet the waste generated was rising due to population increase. This has been attributed to inadequate of vehicles for solid waste collection.

In Nairobi, 60% of the population lives in low-income settlements where intermediate storage collection points are lacking (Malombe 1992). A study by Syagga found that 43% of households in Dandora estate dumped garbage on the road kerbs, open spaces and back-lanes. Dandora had a population of 220,000 producing 84 tonnes of solid waste per day yet it only had 4 bulk containers of 3-ton capacity. Plains view estate had 4000 people producing 2.5 tonnes daily, but had only one bulk container (Malombe 1992). In most areas the refuse is disposed in open drains with adverse effects on health and quality of life for residents.

Private Service providers such as ROC refuse Handlers and Bins ltd have been used in some high and middle-income estate in Nairobi to offer waste collection services. This has been very successful and needs to be maintained. The community approach has also been touted as a solution to solid waste disposal based on the principle of each waste generator taking responsibility for waste generated. This means that each household should draw from its resources to ensure that waste is collected in accordance with local authority guidelines. The problem however arises because some urban dwellers cannot afford meals leave

alone money for solid waste disposal. Solid waste disposal to them therefore is not a priority and any suggestions to improve solid waste management need to recognize this fact.

Drainage

Storm water drains are used to carry rain or surface water to natural watercourses or to a body of water in such a way as to prevent flooding. According to the Physical Planning Handbook (ML&S 1992), a storm sewer system should provide for drainage of storm water in major residential areas where annual rainfall exceeds 200mm. Provision of surface drainage along the roads will however suffice for flow and drainage of storm water in dry areas of 100mm. In dispersed housing however this need not be provided.

Storm water drainage in Nairobi has been provided in areas close to the CBD and in formal housing estates such as Buruburu and Langata. The fringe areas however have not been served with drainage services and therefore depend on natural watercourses and roads for drainage to the extent that flooding have often resulted. This especially happens during heavy rains due to the compounded problem of indiscriminate dumping of solid waste. With rising populations and increased construction of housing units mean increased run-off hence need for construction of storm water drains.

2.6.6 Problems Resulting from Inadequate Water and Sanitation Services

Access to clean water and adequate sanitation are a prerequisite to prevention of environment pollution, water borne and infectious diseases. Absence of clean water and adequate sanitation therefore results in environment pollution and high incidence of water and sanitation related diseases.

Environment pollution

The environment of urban areas is fragile and requires sound management to avoid deterioration. Infrastructure services are powerful tools in this management.

Excreta chemical substances have a predisposition of taking in oxygen (high chemical oxygen demand BOD) and may slowly kill living animals and plants if drained into the rivers and on land. According to a study carried out by UNEP (2001) on Nairobi River, the western part of the river was found to have Biochemical Oxygen Demand (BOD) of between 40 and 78.5 mg/l O_2. Raw sewage has a BOD of 600 mg/l O_2 while treated sewage effluents have BOD of 10 to 100 mg/l O_2. On the western part of Nairobi River therefore BOD values are slightly higher than treated sewage i.e. between 40 and 78mg/l O_2. Unpolluted waters usually have BOD values of 2mg/l O_2 indicating that the whole river system is polluted including the watershed area, which lies in Kiambu District just next to Dagoretti Division.

Sampling was done during the dry period when runoff inputs were low and that explains why BOD levels were low. Biochemical oxygen demand (BODS) is an approximate measure of the amount of biochemical degradable organic matter present in a water sample. It is the amount of oxygen required for the aerobic microorganism in the water sample to oxidize the organic matter to a stable inorganic form (UNEP 2001).

The same study found that Nairobi River has coliforms count of between 30 and 1800mg/liters, which exceeds the limit of accepted total coliforms even in the watershed area. According to WHO total coliforms in drinking water should not exceed 10 per 100ml while faucal coliforms concentrations should be equal to zero per 100ml (UNEP 2001). Coliforms are microorganism normally found in

the human elementary canal so if the water has coliforms then this is an indication that it has been contaminated by human excreta. Nairobi River water is therefore unfit for direct human consumption since it had three times the coliforms above which water is unfit for human consumption.

Public Health

Public health was the basis on which the built environment was first regulated. This was in United Kingdom after the cholera outbreak in 1831 and further outbreak in 1848. According to WHO, man cannot live in dignity among his own waste. Mairura (1988) indicated that human excreta contain pathogens that are likely to communicate diseases such as cholera, typhoid, dysentery, poliomyelitis, infection hepatitis, and anaerobic dysentery and worm infection. The World Health Organization estimates that 4m children in developing countries die of diarrhea each year (Nyamwano 1994).

Most urban poor suffer from health problems and high mortality rates because they have to depend on unreliable public supplies or use surface and groundwater that is contaminated by human coliforms and heavy metals. Those in peri-urban areas have to buy water of unsure sources or reduce consumption.

Inadequate water and sanitation can result in pollution of water sources increasing costs of to households who have to boil water before drinking estimated at Rp96B in Jakarta in 1987 or $57m per year (Rhamesh 1993: 9). Even in formal estates of Nairobi residents are boiling water because they are not sure of the water quality from NCC.

Studies in Kajiado have shown that improvement of housing and surrounding environment conditions reduces vector-borne decease and infections of the upper respiratory tract (Yahya et al 2001).

2.7 Institutional, Policy and Legal Framework

The problem of inadequate water and sanitation services in Riruta can be seen as only a symptom of another underlying problem of uncontrolled developments. The problem of inadequate water and sanitation services cannot be adequately addressed without addressing the problem of uncontrolled developments first.

An understanding of the institutional, policy and legal frameworks within which these problems are taking place will be necessary in order to gauge the extent to which these frameworks are either facilitating or discouraging the mushrooming of uncontrolled developments. In this way then, sustainable strategies can be recommended to solve the problems, either within the laid down framework or within a suggested new framework.

Until recently, the division of urban management responsibilities in Kenya between public and private sector were clear-cut. The Public sector provided public goods such as infrastructure services and community facilities, while the private sector provided merit goods. This delineation is not clear today in that even the private sector is providing public goods at market prices. The situation has been worsened by the effects of structural adjustment Programs of International Monetary Fund (IMF) and World Bank policies that insist on charging market prices for services delivered. An understanding of the institutional policy and legal framework will shed some light into whether this new dispensation is working or otherwise.

2.7.1 Institutional Framework

Institutions are rules of society or of organization that facilitate co-ordination among people by helping them form expectations which each person can hold in

dealing with others (Kihagi 2000). In this section institutions are seen in as far as they facilitate or inhibit land use development and supply of housing, water and sanitation.

Land use

Land use in Nairobi is managed by the ministry of lands through the departments of lands, physical planning and the NCC. Before the enactment of the physical planning Act, development control used to be undertaken by the commissioner of lands, through a section called inspectorate and by the NCC development control section. These departments have however failed to control development resulting in uncoordinated developments in urban areas. The Act has now given powers to NCC to control development (Masinde 2000), but as we saw earlier, the powers are not adequate to enforce compliance.

The changes emanating from urbanization have been too rapid, while the department of physical planning has failed to cope with these changes. The department, which should formulate planning guidelines, does not have the necessary powers to enforce development control. This role has been given to the NCC, which lacks the necessary capability in terms of qualified staff to ensure development control. When approving building plans, the officer should inspect the building and give occupation certificate. This does not happen because there are no vehicles to take them to the respective sites.

The physical planning Act of 1996 does not however give powers to the NCC to prosecute in cases where development control regulations are flouted. A local Authority can only prosecute its By-laws, which are weak and give minimal penalty. The Act has rather given powers to prosecute to the Attorney General. The court process on the other hand takes a long time to adjudicate cases, yet this Act is legal framework for enforcing development control.

The process of building plan approval is time consuming since once approved by the officers they have to wait for full council meeting to ratify the approvals. This makes the decisions subject to political interference and hence delays. The applicants become impatient and therefore build their own housing without reverting to authority for approval of building plans. Meanwhile, land development in Nairobi continues to take place in a '*laissez faire*' manner.

Housing

The built environment links people and organizations in myriad ways. In Kenya, there are many public and private institutions involved such as the housing department, the physical planning department, the commissioner of lands, ministry of health, the ministry of water, responsible for policy formulation and standard setting and NCC responsible for implementation and enforcement. The private sector like housing finance institutions, architects, planners and designers and quasi-government agencies like NHC, also have a role to play. This creates confusion on which statutory body governs what and how. The many public institutions in Kenya are not able to oversee the legislative, technical and enforcement components of the built environment (Yahya et al 2001).

Housing in Kenya is managed by a housing department, which has more often than not been moving from ministry of lands and settlement to Ministry of public works. This implies that the government is not sure of where this function should fall, yet, it is a very important function for this country.

The government also established the National Housing Corporation (NHC) in pursuance of the housing policy through which the government was to channel funds to the local authorities for development of housing units. NHC however became a developer rather than a facilitator leading to confusion and duplication

of functions (Syagga 1987). The intention of policy was thus frustrated by the inability of NHC to mobilize private funds for housing development. Today all that is heard about NHC is the never-ending squabbles with the local authorities such as NCC regarding control of housing units developed through NHC.

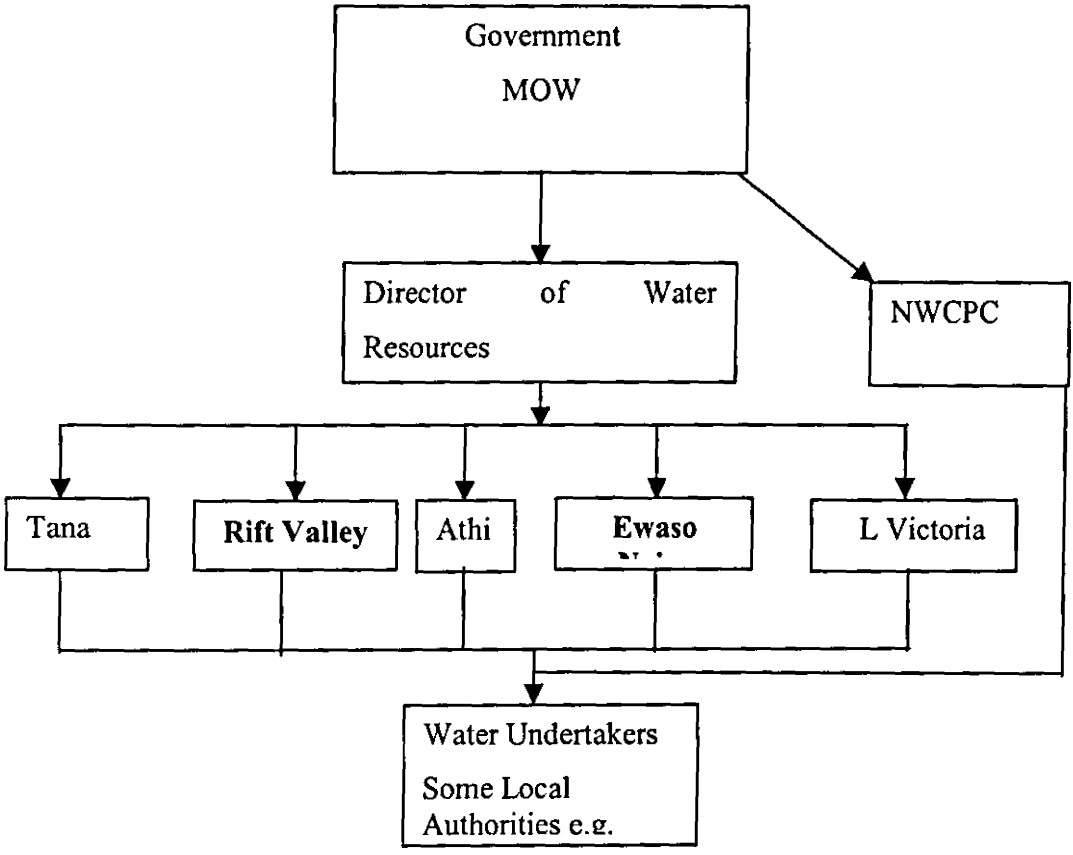
The housing policy also established the Housing and Building Research Development Unit (HRDU) to make research on building technology and construction costs (Syagga 1987).. The reports of this department have not been widely applied by the local authorities and their residents yet they can contribute to development of more housing units from low-income urban dwellers. This implies inadequate avenues within which HABRI can exchange ideas with the various local authorities.

Water

In Kenya, the Government owns all the water resources that it manages through the ministry of water Resources. The ministry has a director of water resources whose role is to advise the ministry on the state of water resources in the country. The director performs this role using catchments boards for the various catchments areas namely Tana, Athi, Ewaso Ng'iro, and Lake Victoria.

The role of the catchments boards is to apportion water to user's requests, issue licenses, sanctions and permits and to advise the minister accordingly. The catchments boards have appointed water undertakers, whose role is to secure, control, distribute water, and make regulations, tariffs and management of water supply and control pollution of water bodies.

Figure 2-2: Institutional Framework for Water Supply in Kenya



Source: Adapted

Figure shows the institutional framework for water supply in Kenya. It indicates that water is controlled by the Government whereas local authorities are just channels through which water reaches the consumer.

According to Business Economic Research 1999), water and sanitation services in Nairobi are provided by NCC, which is constituted under the Local Government Act. NCC is an undertaker under the Water Act (Cap 372). To enable it perform this function NCC has several departments including the Water and Sewage Department (WSD). When it was created in 1970, the WSD was to be

autonomous but currently this autonomy has been curtailed since the town clerk who is appointed by the Minister for Local government performs the executive functions.

A general manager heads the WSD, which has several sections, namely, operations, engineering, maintenance, sewage and commercial sections. The administration section has been decentralized to Kariobangi, Eastleigh, Nairobi Dam and Karen (Business Economic Research 1999).

Sewer

According to Malombe (1992) Water supply and sewerage systems in Kenya tend to be run jointly by either local authorities with either a department in the ministry of water development or with National Water Conservation and Pipeline Corporation (NWCPC). The local authorities are in this respect categorized as:

- Category A- Full water undertakers
- Category B- Partial water undertakers
- Category C- Sewerage undertakers
- Category D- others

Much of the sewerage works is the responsibility of the local authorities, but the financial arrangements for design and construction is supported by the central government in conjunction with the ministry of local government through the Local Government Loan Authority Fund (LGLA) and the ministry of water development. The operation and maintenance of the water supply and sewerage is split between local authorities on one hand and the ministry of water and the NWCPC on the other. This split of functions is rather confusing and is responsible for the financial and management problems in the sector (Business Economic Research 1999).

When planning for water and sanitation services, these institutions have to be harmonized to allow each local authority to manage sewage services autonomously so as to reduce duplication of effort.

2.7.2 Policy and Legal Framework

Land use Policy

Land use policy is the system of laws, rules, regulation and practices to govern rights and obligation of landowners together with appropriate guidelines to ensure maximization utilization of available land in both rural and urban areas. The Governments strategy as contained in National Development Plan (1994-1996) is to ensure that all land is planned surveyed, adjusted and registered thus providing security of tenure and encouraging investments and developments.

Kenya's urban land use policy is contained in the service centers policy, the growth center policy and the integrated Transport and communications network policy. The first two identified designated centers to become rural trade and production centers (RTPCs) and designated settled urban centers to become growth centers. The Government was to intensify investment in infrastructure in these designated caters in order to attract further investment in industry, education and health . These centers were to become alternative focus to Nairobi and Mombasa for employment and development in respective regions.

The integrated transport and communication network policy was to link these centers to each other and to different parts of the country. The policies were designed to guide the urbanization process towards desired direction. These policies have been successful in reducing migration to Nairobi and Mombasa and balancing rural and urban. They also ensured a good road network for the country but rural-urban migration still continues.

The land use policy is however silent as to the use of scarce land resources and enforcement of regulations and practices that govern rights and obligations of landowners. This has encouraged mushrooming of informal settlements even in well-planned estates such as Buruburu. This scenario has been very serious to the extent that most people claim that Kenya does not have a land use policy.

Physical Planning Act (1996)

The Physical Planning Act is one of the instruments of the land use policy. It empowers the director of physical planning to prepare local physical development plans with respect to government land, trust land and private land within the area of authority and city, municipal, town or urban council or with reference to any trading center or market. The purpose of this plan is to guide and coordinate development of infrastructure facilities and services and to control the use of land or for the provision of any land for public purpose.

Section 29 of the Act empowers local authorities to control or prohibit the use or development of land and buildings in the interest of proper and orderly development of its area, to control and prohibit subdivision of land or existing plots into smaller sizes, to control development and approve development permissions and to formulate by-laws to regulate zoning in respect of use and density of developments. These powers are however not adequate to ensure compliance. The Physical Planning Act of 1996 does not give powers to the NCC to prosecute in cases where development control regulations are flouted. The Act has rather given powers to prosecute to the Attorney General. Yet this is legal framework for enforcing development control. The act needs to be amended to allow more powers to local authorities for development control.

The act does not recognize other acts like the other previous legislations giving land rights to individuals such as the Registration of Titles Act (RTA), but rather empowers the Director of Physical Planning to prepare local physical development plans on any land (Kioko 2001). This thereby results in problems of enforcing compliance.

A review of the act will be necessary under these circumstances. The act can copy from success stories such as Kahawa-Sukari where the developers enforce development control. This will be in a bid to find out why development control has succeeded in the area and possibly incorporate communities in controlling developments in their neighborhoods.

Housing Policy

Kenya's housing policy can be traced from the national development plan 1964-70, where the primary objective of government was to provide adequate shelter for all in order to reduce the growth of informal settlements, which had started to emerge in urban areas. Sessional paper number 5 of 1966/67 on Housing Policy was then published. The emphasis of the paper was provision of essential housing and healthy environment to urban dweller at the lowest cost possible. In pursuance of this, the policy established the National Housing Corporation (NHC), through which the government was to channel funds to the local authorities. Consequently 41,852 housing units were provided in urban areas in form of mortgage, purchase, rentals and site and service schemes representing 64% of total formal sector housing (Syagga 1987). The NHC however, assumed the role of developer rather than a facilitator so that a lot of resources remained untapped in the private sector. The policy also established the Housing and Building Research Development Unit (HRDU), to make research on building technology and construction costs. The reports of this department were never widely applied. The cost of housing remained high due to high building standards.

By 1980, the housing policy had become outdated and a number of studies were done, which enabled formulation of the National Housing Strategy for Kenya (1987-2000). This strategy included the 'enablement approach' in which the government would shift from the role of a direct developer to that of working with and facilitating the private sector entities. This strategy does not seem to have taken root since NHC is still performing the role of a developer. Today policy has also moved away from institutional pool housing resulting in civil servants being given notice to move out of government houses by 31st December 2001 or pay for housing at market rates.

Housing Act (Cap 117)

The legislative framework provided for by the Housing act cap 117 covers only the operations of NHC. It is therefore not comprehensive enough since it fails to cover the operations of private individuals and companies, who are currently providing houses. The department in-charge of housing for example has no powers to compel the private sector to produce more low income housing in exchange for tax- rebates (concessions).

Building Standards

Building standards are a technical yardstick or measure that a building material, service or method must satisfy (Yahya et al 2001: 15). The current building standards have been criticized as being mere specifications instead of being performance-oriented. They therefore do not allow flexibility to suit culture and economic conditions. The build code was copied from the colonial past and reviewed in 1968 and therefore not relevant to the local situation. It needs to be reviewed on a regular/continuous basis to incorporate any technological innovations coming up for example HABRI bricks, which use intermediate technology.

Despite being aware of the shortcomings of the building standards, the relevant authorities have often dealt with the subject of housing standards with tension due to political considerations, vested interests of those responsible for legislation and application (Yahya et al 2001). In Kenya, authorities have been grappling with the issue since 1963 with bureaucracy impeding introduction of well-researched and well-intentioned changes. The building code and zoning regulations, have a direct relation in cost of housing development. The impact has been reducing housing for low income since the cost of housing is beyond their means hence the mushrooming of uncontrolled informal settlements in every available space in Nairobi.

Sectional properties act (1996)

Sectional properties act (1996) allowing ownership of shared properties is still having problems for example getting titles for Nyayo high-rise has proven very difficult. The act needs to be revisited to enable people to own shared property.

Banking Act

The Banking act restricts lending to housing development that requires long-term loans. Commercial banks therefore concentrate on short term lending making the housing very expensive for Housing Finance Institutions, who in turn transfer the expense to customers. This factor together with stringent restrictions by the banks makes it difficult for low-income earners to access credit for developing their own housing units.

A review of the housing act, sectional properties act and the banking act will be necessary to ensure increased supply of descent housing units to urban dwellers. It will also be necessary to put together some of these acts into a single legislation to

enable easy implementation e.g. in Cameroon and Rwanda all issues to do with the building standards are under one statute (Yahya et al 2001).

Water Policy

Water and Sanitation has remained a Government responsibility since they are considered as basic services and therefore heavily subsidized by public coffers. Since independence, the Government undertook to alleviate poverty, disease and ignorance under sessional paper no 10 on African Socialism and its application to planning. In the 70s, the government invested heavily in water supply and took over water supply management, previously under local communities and authorities. The economic crisis of 1980s however, led to the structural adjustment programmes and consequent reduction in public spending on basic services. Management of water supply was handed back to the local authorities, but due to mismanagement, these projects collapsed and prompting the Government to publish sessional paper no One of 1999 on National Policy on Water Resources management and development.

The policy addresses water resources management, water supply and sewerage development, institutional arrangements and sector financing for sustainable development. The policy provides for creation of an enabling environment for other actors such as Non-Governmental Organizations (NGOs), Religious Based Organizations (RBOs, communities and the private sector to play their roles in the sector with the government gradually settling to a facilitative and regulatory role.

The policy also recognizes the need for creation of awareness and training for communities to become effective and sustainable managers of these services. This policy has however not been followed by necessary action plans to implement it. Except in areas such as Kibera, where efforts of donor communities and NGOs

have involved communities in management of water kiosks, the situation in other areas indicates that management of water is still undertaken by NCC.

Water, sewage and solid waste are all managed and provided under the WSD but there seems to be an emphasis on water management, at the expense of sewage and solid waste management. Even the water policy, which should guide sanitation management, lays more emphasis on water than sewage and solid waste. This stems from lack of understanding of the benefits the sector provides, since these benefits cannot be quantified (Kilbermaten 1980). This raises the need to have a separate sanitation policy to guide sanitation management, in order to avoid the temptation of relegating sanitation to the back seat.

Water Act (cap 372)

This Act makes provision for conservation, control, apportionment and use of water resources in Kenya. Under this act, contamination of ground water and failure to provide encasement to wells and boreholes is an offence. A water undertaker has powers to make regulations providing tariffs and management of water supply and for preventing pollution. The act prohibits throwing, conveying any rubbish dirt or refuse to any body of water in a manner likely to cause pollution.

Public Health Act (Cap 242)

This act prohibits any landowner or occupier of a building to allow any nuisance or condition injurious or dangerous to health to prevail on land. Nuisance constitutes any obstruction, smell, and accumulation of wastes, refuse smoke, dirty premises without proper sanitation e.t.c.

Environment Act (Cap)

The Act provides that every person in Kenya has a right to clean and healthy environment. It gives powers to public health officers to compel persons responsible for degrading the environment to restore it to its immediate condition before damage.

2.8 Summary of Issues

The process of urbanization is expected to continue and over half of this growth will be mostly in urban areas of developing countries. This growth will be mainly as a result of natural population increase and expansion of urban areas to the hinterlands. Kenya like other developing countries is experiencing high rates of urbanization attributed to natural increase and expansion of town boundaries to former rural farmlands. Declining urban economies has meant that urban governments are unable to provide basic services such as housing and infrastructure services putting pressure on existing urban services. Under the circumstances therefore informal settlements have mushroomed with little or no infrastructure services.

The process of urbanization does not have to follow this negative path, if managed properly through enforcement of development control regulations and through anticipating and planning for its eventual occurrence.

The housing policy in Kenya has not been comprehensive enough to translate into more production of housing units to cope with rising urban population in Nairobi. This implies that housing demand will continue to outstrip supply and therefore will continue pushing prices of housing upwards thereby pushing low and middle income outwards to the fringe areas such as Riruta. An attempt needs to be made to address policy if the influx of population to Riruta is to be checked.

Attempts by NCC to rationalize the 1973 NMGS by allowing alternative methods of infrastructure provision, have meant that in Riruta the recommendations of the 1973 NMGS were largely ignored. In the advent of Saps of 1986, the private sector was expected to provide infrastructure services, but this sector has performed dismally due to absence of a development control guidance system. In Riruta however, all has not been lost, since there exist some level of private sector involvement in provision of infrastructure services that needs to be used in a bid to provide a lasting solution to the provision of infrastructure services. In Riruta, like in Kibera, there exist a number of private service providers (PSP). Though their water sources cannot be ascertained, regulations can be put in place to ensure water quality.

Unlike other informal settlements such as El Meziquital and Kibera, the issue of landownership and tenure is clear in Riruta where landlords hold land on either freehold or leasehold basis. An intervention relating to provision of infrastructure in this area would therefore be easier since landlords can be called upon to contribute towards improvement of settlements.

In Riruta as in Kibera, NCC and other institutions have performed very poorly in terms of service provision and regulation. A solution to the water and sanitation problems in Riruta however, must include the role of these institutions in order to ensure more efficient delivery of services. Nevertheless the role of WSD should be reviewed so as to allow other actors to provide services while it settles to regulation, provision of bulk water and trunk sewer. Water supply and sanitation services to end-consumer and collection of revenue needs to be left to the private sector by means of contracts or partnerships, since NCC has failed miserably in this area.

It is clear that Kenya has enough statutes to ensure adequate service delivery such as the water Act, the Public Health Act and the Environment Act, but these statutes needs to be moved from paper to implementation. There is also need for integration of these acts with other acts such as the Housing Act and the Physical Planning Act, to allow ease of administration since they are all supportive of each other. There will be need also to amend the Physical Planning Act to give more powers to local authorities to control development.

Though these acts would seem adequate to ensure satisfactory urban development, the authorities have often ignored their implementation and that is how unsanitary informal settlements have been allowed to continue. A review of the housing act, sectional properties act and the banking act will be necessary to ensure increased supply of descent housing units to urban dwellers. It will also be necessary to put together some of these acts into a single legislation to enable easy implementation for example in Cameroon and Rwanda, all issues to do with the building standards are under one statute.

The literature review has demonstrated how other communities in the World have dealt with the problems of provision of water and sanitation services, but has failed to demonstrate other important facets of dealing with the problem. Provision of these services alone within the existing spatial situation is tantamount to just treating the symptoms of the problem rather than addressing the core of the problem. A new re-organized spatial plan of the area plus enforcement of the plan will be necessary and this forms the challenge for this thesis.

2.9 Conceptual Framework

This study set out to examine the causes of uncontrolled developments and their effects on standards of water and sanitation services in Riruta with a view to suggesting approaches necessary for sustainable provision of the same. This concern stems from fact that rapid population growth rate in Nairobi has resulted deficit of housing supply. This has in turn resulted in an overspill of population from the center to the fringe areas such as Riruta, thereby putting pressure on existing water and sanitation services. This process has been enhanced by lax in enforcement of development control regulations to the extent that a dichotomy of informal and uncontrolled settlements and formal/ controlled settlements have emerged. The living conditions in these settlements have become very poor leading to a high incidence of disease and extensive pollution of the environment. A conceptual framework has been developed to explain the existing situation and to shed some light into what can be done to solve these problems.

The study has drawn from several theories namely: descriptive, explanatory and normative theories of urban spatial organization. The first theory is the ecological theory developed in the early 70s following the United Nations Stockholm Conference on environment. The theory states that the environment is the habitat of man and neither man nor the environment can be seen with the exclusion of the other. It further states that we cannot realize development without recognizing the capacity of the environment to facilitate that development and the impacts of that development on the environment. Utilization of the environment without recognizing its effects on the ecological balance will ruin man himself.

The environment is seen by the theory as an ecosystem comprising the physical environment of climate, atmosphere soils, water, flora and fauna with man and his society. The ecosystem is a complex whole with continuous interaction between

living organisms and the environment itself. This environment limits the growth of any species. This implies that rapid population growth will result in problems since this rate may be beyond the capacity of the environment to support it. Some of these negative effects are evident in poor waste management and pollution of the environment, which have endangered the survival of man himself by increasing the incidence of disease.

The theory of the urban spatial structure by Chapin and Kaiser, which has three components: the activity systems, land development systems and the environment systems, would seem to reinforce the ecological theory. The activity systems are man, institutions such as households, firms and government organize their day to day activities in order to meet human wants and by so doing interact with time and space (Maleche 1992).

The land development systems are processes, which convert space and adapt it for use by the activity systems. These are land developers, land markets, public agencies and consumers such as households. The environment systems are the biotic and abiotic state generated by natural processes. These are the flora and fauna, water, air and land. These systems provide the basis for human existence and the habitat and resources to sustain man. These environment systems function to either enhance or constrain the other systems depending on whether they are used sparingly or unsustainably.

In Riruta, the land development systems and the activity systems are functioning in a manner that is harmful to the environment systems through poor waste management. This has ignited a chain reaction to the extent that the pollution of the environment has threatened the health of man, hence his survival.

The study also draws from Alonzo's classical theory of land-use which holds that of the firms', households' preferences on the demand side and the land and location opportunities on the supply side mediate through the market mechanism to establish land-use for residential development (Maleche 1992). In Riruta however the pattern of land use that develops is not optimum in that it has been accompanied with harmful impacts on man and the environment.

In an attempt to look for a solution, the normative theory of land use is suggested to provide the basis through which an area can establish what ought to be an optimum pattern of land use. According to Maleche (1992), the theory holds that the urban spatial structure is an outcome of the functioning of both the market forces and political forces. The market forces provide the means through which households, firms and institutions pursue their self-interests and the political forces provide the government means to pursue the public interest on behalf of society through development control. The public interest includes health, safety and environment quality among other concerns. It follows then that the solution to the problems arising from this interplay will be found through the interplay of the same forces, but in the correct doses.

The public interest in Riruta provides the basis for public intervention through planning of the three systems so that they can function efficiently. The force of government will be used to guide and control land use decisions, particularly those of the private sector, through a clear statement of policy goals and objectives and establishment of relevant institutions that are designed to achieve a desired and sustainable urban development area. Sustainable development has popularly been used to mean development that meets the needs of the present generations without compromising the ability of the future generations to meet their own needs (UNCHS 1992, 2000). Once these are complete, then we can

expect to have well-planned, well-managed human settlements with enhanced economic vitality and improved socio-economic well-being of residents.

CHAPTER THREE
WATER AND SANITATION SERVICES IN RIRUTA

3.0 Introduction

This study set out to identify the causes of uncontrolled developments and their impacts on water and sanitation services in Riruta and to suggest approaches to sustainable provision of the same in order to make the area a satisfactory urban development area.

The data was organized into qualitative and quantitative data to allow for ease of analysis. Descriptive statistics were then computed such as the mode, mean, frequencies and percentages. The frequency distributions were later represented in form of bar graphs, bar charts and pie charts in order to show the magnitude of distribution much more vividly. The relationships between the variables under study were then tested using the Chi-square analysis at 95 % confidence level.

Thereafter, the researcher revisited the analytical framework by relating the research questions and objectives to the data at hand. The data collected was then grouped into the objectives it satisfied. This chapter presents the results of this analysis. This section looks at the historical backgrounds of both Nairobi and Riruta, the physical and socio-economic characteristics and the water and sanitation situation in the area.

3.1 Study Area

Riruta is located in Dagoretti division of Nairobi province at an altitude of 1650-1798m above sea level on low high ground zone. It is situated 10 km away from Nairobi city center (Maps 3-1, 3-2, 3-3, 3-4). In order to understand the forces

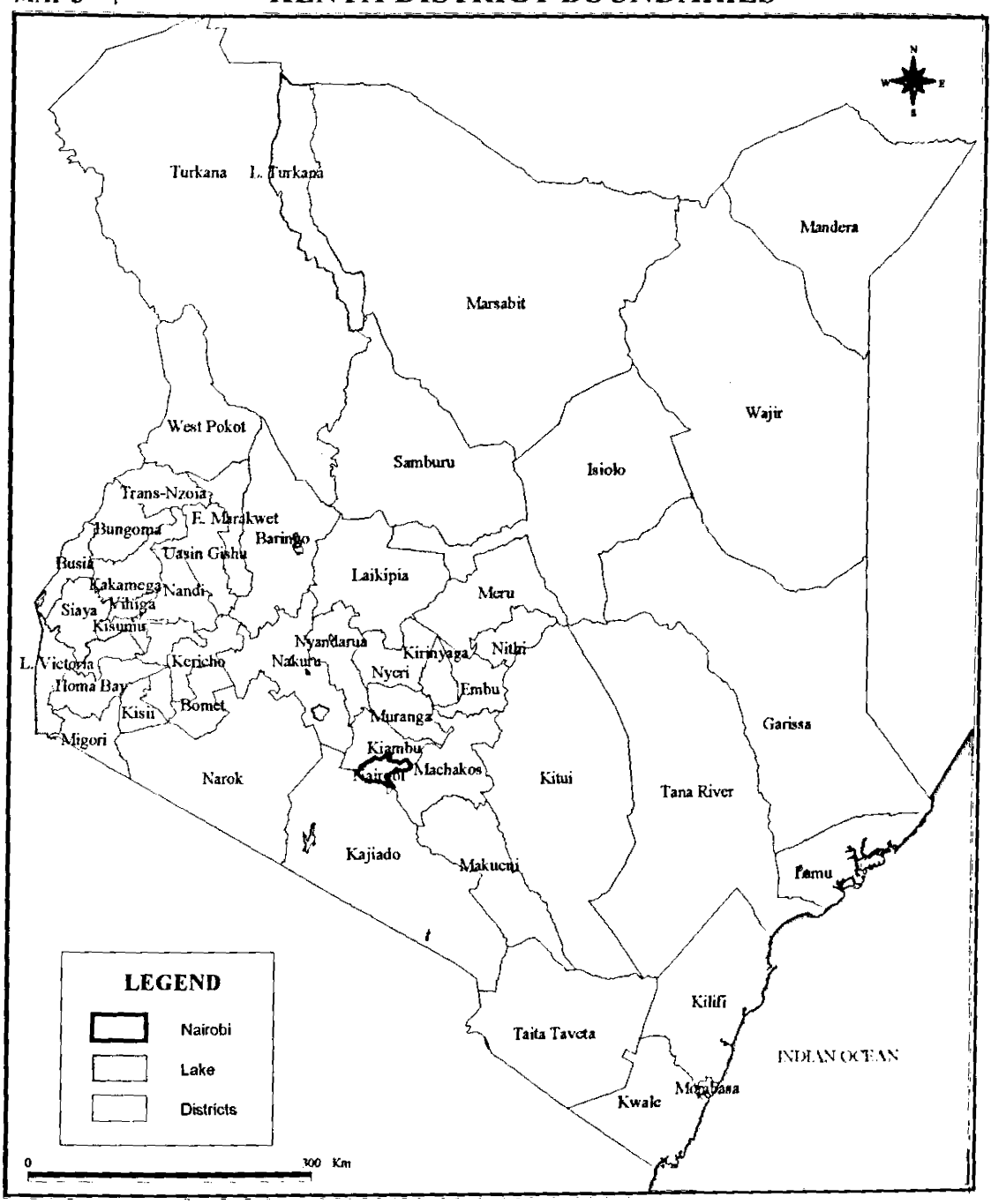
contributing to the water and sanitation situation in Riruta, it will be important to look at the historical background of Nairobi and that of Riruta.

3.1.1 Historical Background of Nairobi

Nairobi effectively started as a caravan route at Pangani. Its current site was a swampland thus making it not conducive for settlement (3-5). The current site started when Sir Sergeant Ellis established a railway depot in 1896 following which it became the headquarters of the Uganda Railway in 1899.Soon the Provincial Headquarter was moved from Machakos to Nairobi and Asian traders started moving from Mombasa and Zanzibar. It grew in importance and size and in 1919 to become an incorporated municipality with 15000 persons and its boundaries were extended to 25 Km^2 (NCC 1973, NCC-Howard 1987).

MAP 3 - 1

KENYA DISTRICT BOUNDARIES



Prepared by E.M.K NGUAH

Source: Almanac Characterisation Tools

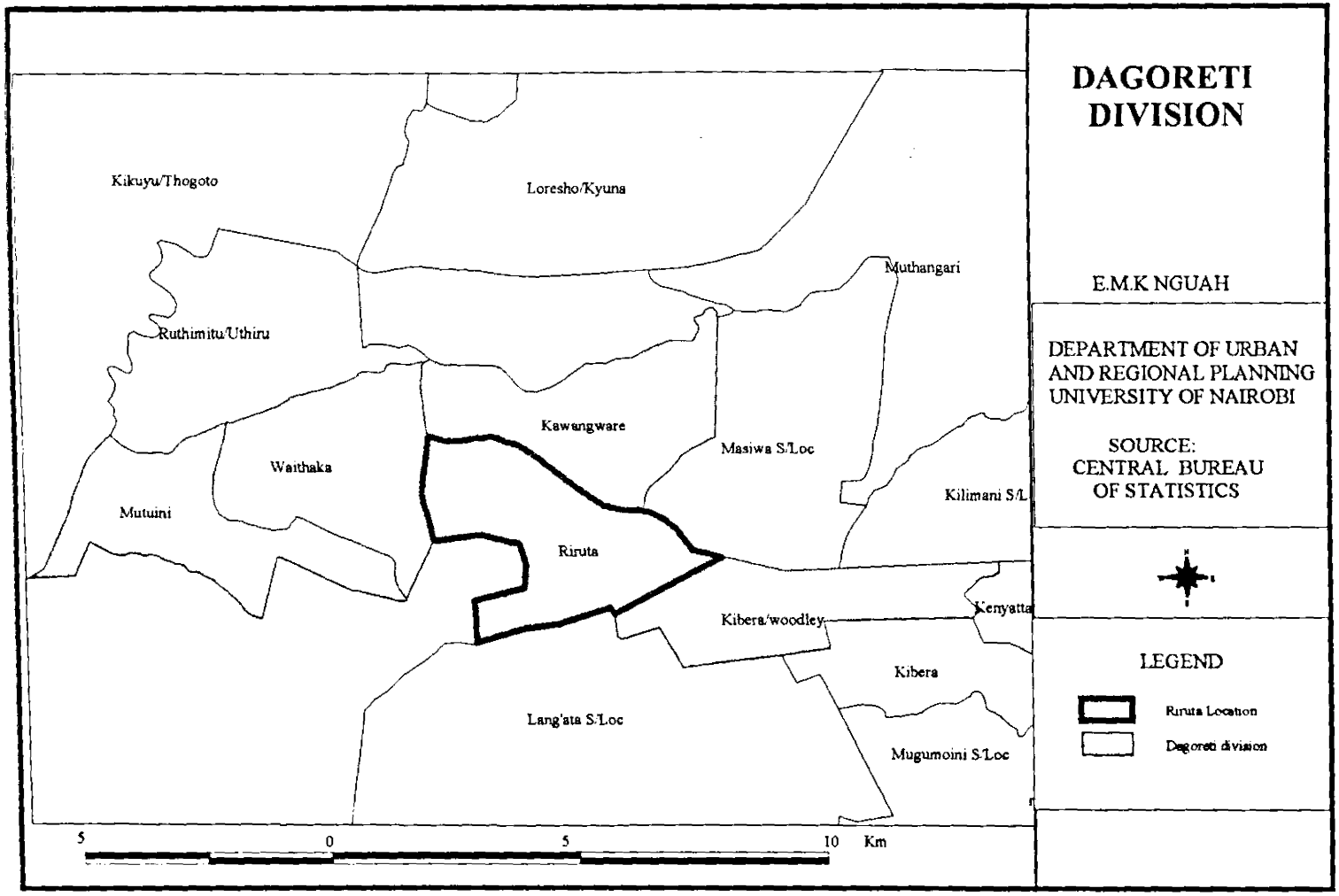
MAP33: MAP SHOWING NAIROBI DIVISIONS AND THEIR POPULATIONS

SOURCE OF POPULATION FIGURES: Kenya Population Census (1999)

DRAWN BY: Author.

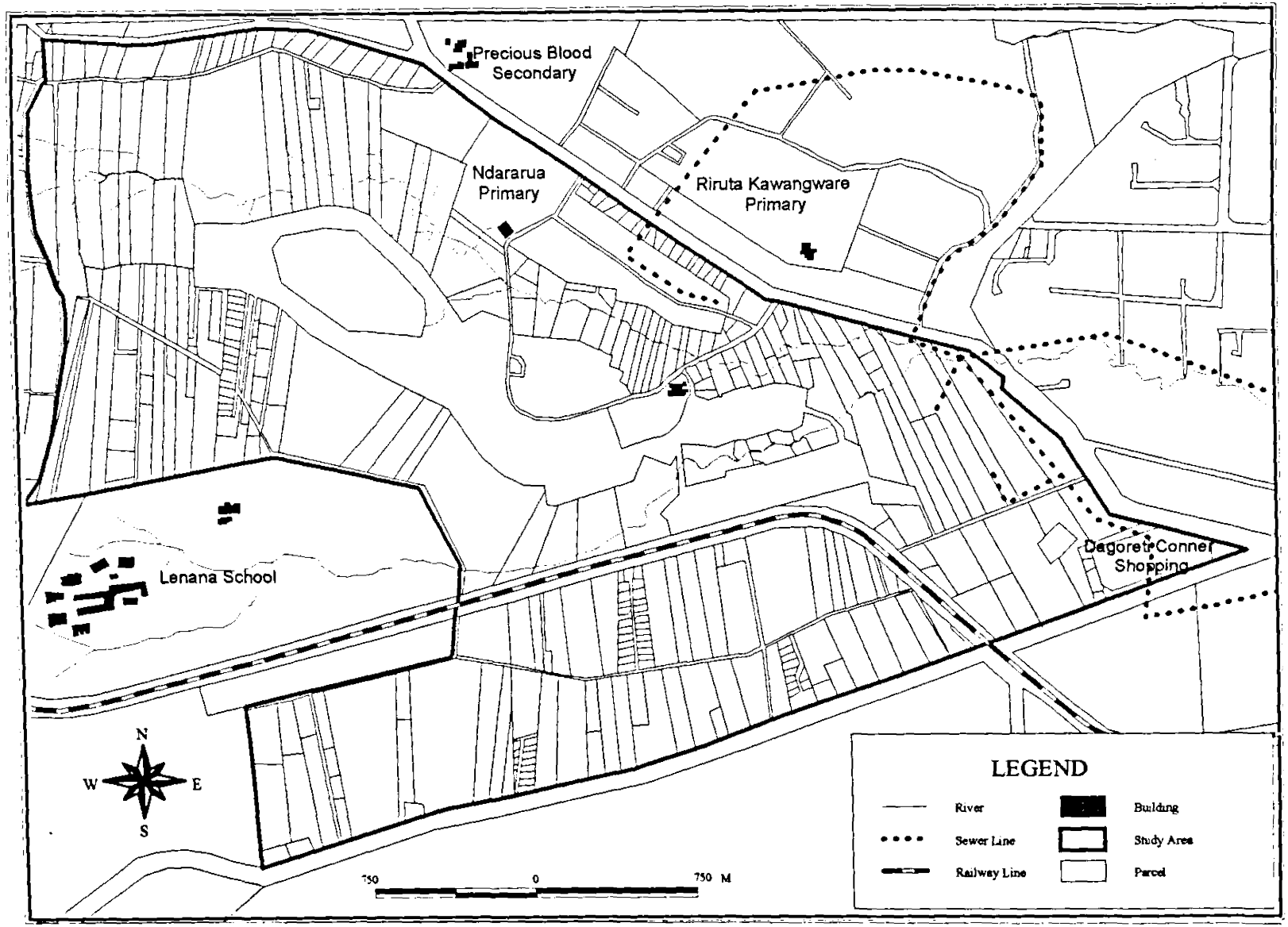
0 1 2 3 4 5 6 7 8 9
KILOMETRES

MAP 3 - 5


Kikuyu/Thogoto
Loresho/Kyuna
Muthangari
Ruthimitu/Uthiru
Kawangware
Masiwa S/Loc
Waithaka
Mutuini
Kilimani S/L
Riruta
Kenyatta
Kibera/woodley
Kibera
Lang'ata S/Loc
Mugumoini S/Loc
5
0
5
10
Km
DAGORETI DIVISION
E.M.K NGUAH
DEPARTMENT OF URBAN AND REGIONAL PLANNING UNIVERSITY OF NAIROBI
SOURCE: CENTRAL BUREAU OF STATISTICS
LEGEND
Riruta Location
Dagoreti division

MAP 3-5

RIRUTA LOCATION



Prepared by E.M.K. NGUAH

Source: Adapted from Survey of Kenya

During its early years, economic forces controlled Nairobi's growth and coordination of development was done only by the gridiron layout, currently exhibited in the city center. In 1926, a town-planning consultant was appointed to make recommendations on zoning, but due to land speculation, developments continued in an uncontrolled manner (NCC 1973). Increased population made water and sanitation become a problem. Nairobi got its first waterborne sewerage at East Leigh in 1930 (NCC-Howard 1987).

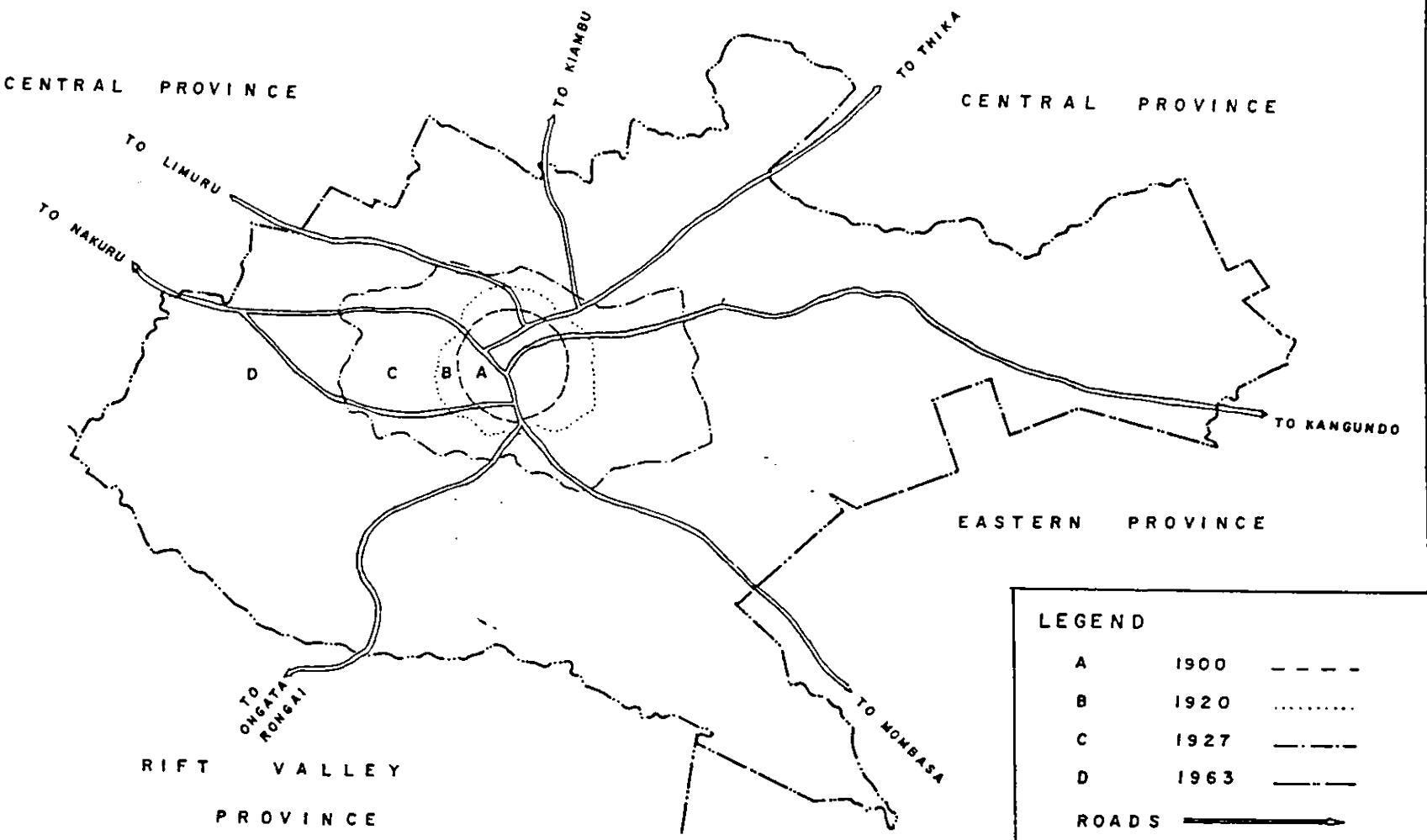
The 1948 master plan laid down guidelines for expansion of Nairobi in the next 20 years and introduced zoning (NCC 1973). This plan earmarked land for residential, industrial and commercial purposes, while extending its boundaries to 83Km^2. This plan is responsible for current planned development in Nairobi.

In 1950, Nairobi became a City by Royal charter and this was followed by an attempt to make another comprehensive plan due to prevailing problem of water, sanitation and transport. This was however not successful and following independence in 1963 its boundaries were extended to 690Km^2 to include Nairobi's peri-urban areas and other important features like Nairobi National Park, Jomo Kenyatta International Airport and ranching area to the east for future expansion of the city (NCC 1973). This extension was however highly influenced by independence political considerations with the results that the city does not constitute a cohesive planning unit (NCC 1973).

In order to arrest the continuing problems of water, sanitation and transport, the Nairobi Metropolitan Growth Strategy was done in 1973, but it has not been implemented to date, yet it expired at the turn of the century. There has been talk of attempts to prepare a new plan for Nairobi but a report on its progress is yet to be made public.

MAP 3-6

BOUNDARY CHANGES FOR THE CITY COUNCIL OF NAIROBI: 1900, 1920, 1927 & 1963.



SOURCE:

DRAWN BY: AUTHOR

3.1.2 Historical Background of Dagoretti

Dagoretti area was part of Kikuyu Reserve during the colonial era, hence original residents own the land, which they or their Kinsmen have controlled for several generations. When it was incorporated in Nairobi in 1964, it had a distinctly rural character (NCC 1973)

The proximity of its eastern sections of Dagoretti (i.e. Riruta) to Nairobi city center and availability of a reliable transport made it attractive for early development of rental housing. This fact was later enhanced by failure of the public and private agencies to provide adequate and inexpensive housing elsewhere in the city (NCC 1973) among other factors.

Up to around 1973, the NCC did not exercise control over Dagoretti through providing education and health facilities to the residents. A large proportion of the landowners did not therefore pay rates and the NCC did not inspect or control building activities in the area. After the realization that this would lead to undesirable consequences, NCC developed infrastructure development programs and began to enforce by-laws in the area (NCC 1973). The situation in the area today however indicates that by-laws are not enforced.

There has been rapid expansion of privately built rental housing by landowners introducing a large tenant population into the area who commute to employment areas in the city center.

3.1.3 Physical and Geological Characteristics

This section looks at the physical, socio-economic and political characteristics of Riruta in so far as they affect the water and sanitation situation in Riruta. The physical characteristics such as rock formations indicate how far the water table is; socio-economic characteristics indicate the quality of the population.

Physical Characteristics

Riruta is situated at an altitude of 1650-1798m above sea level on low high ground zone. This is the area where the relief of Nairobi begins to rise towards the west and this highly determines its climatic conditions.

Table 3-1: Annual and Seasonal Rainfall (mm)

	Annual	Long rains	Short rains
Mean monthly totals	1033	445.8	224.3
Min of monthly Totals	482.27	883.3	749.4
Max of Monthly Totals	1633	85	59.6

Source: Metrological Department (MOPW)

Table 3-1 shows the mean annual and seasonal rainfall in Riruta indicating very wet conditions. This implies an opportunity in terms of enhancing rain harvesting as an alternative source of water in order to cope with water shortages.

Table 3-2: Temperature (^{0}C)

Mean Max	Mean Min	Range	Highest	Lowest
23.5	12.2	11.3	30.6	2.5

Source: Metrological Department (MOPW)

Table 3-2 shows the mean maximum and minimum temperatures ranging between 23.5 and 12.2 degrees centigrade. The highest temperature experienced is at 30.6 degrees. These temperatures are conducive to breeding of disease microorganisms in areas of poor sanitation and therefore increasing the risk to public health.

Table 3-3: Relative Humidity (rh%) and Wind Speed

Hrs (gmt)	Wind Speed (knots)	Relative Humidity (rh%)
0300hrs (GMT)		93
0600hrs	5	82
1200hrs	8	50

Source: Metrological Department (MOPW)

Figure 3-3 shows the relative humidity levels in Riruta. These complement high rains and conducive temperatures to form perfect breeding grounds for bacteria microorganisms in areas of poor sanitation.

Geology and Soils

The area lies within volcanic rock zone of Nairobi with red soils in some areas and top dark swampy clay soils from kerichwa valley turfs, in others. Geologically, the area has a stratigraphical sequence of rocks with kerichwa

valley turfs, Nairobi trachytes, Ngong basalts, Kandizi phonolites, Athi tuffs and lakebeds and basement rocks at great depths.

Ground water is anticipated to have aquifers mainly at different contact zones of the above volcanic flows and on the fractures and fissures within rocks. Recharge is expected from lateral water transmission from higher grounds to the west and infiltration from annual rainfall. The area therefore has moderate ground water potential, which can be exploited to enhance water availability to the residents.

3.1.4 Social Economic and Political Characteristics

Social economic and political characteristics of Riruta will be important in understanding the quality of population, water and sanitation situation in the area and the development forces that are taking place.

Population Size and Growth

The area has experienced rapid growth of population due to availability of cheap housing for low-income earners. Between 1969 and 1979 the Dagoretti population grew at 12.2% from 41,609 to 130,902 persons, which was higher than the 5% growth rate of Nairobi as a whole (Mulinge 1986:58). According to the 1999 population census, the population of Dagoretti had almost doubled to a total of 240,509 persons with Riruta recording 65,958 persons (GOK 1999).

Table 3-4: Riruta Population (1999)

Area	Area (km^2)	Population	Density	No of Households
Riruta Sub-location	4.1	42,037	10,253	12,444
Ngando Sub-location	3.2	23,921	7,475	7747
Total	7.3	65,958	9,035	20,191

Source: GOK (1999)

Figure 3-4 shows the population size, densities and number of households in each of the two sob-locations in Riruta.

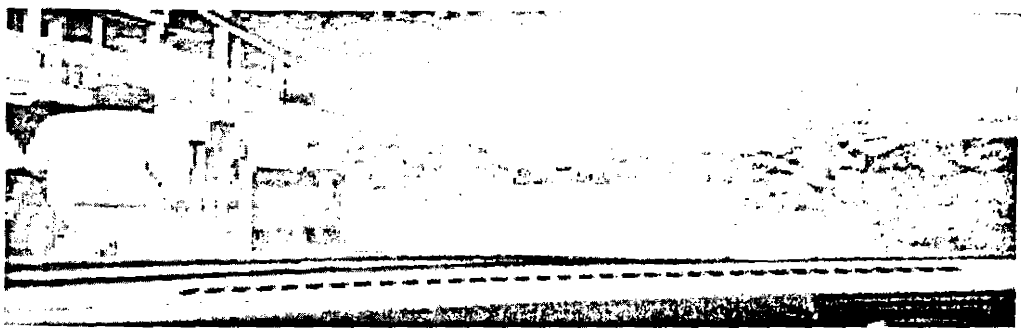
Land Tenure

Since the area was formerly under Kiambu County Council, it exhibits a rural character. The land sizes are relatively larger than those in Nairobi's C B D within minimum size being 0.09 hectare. Some plots along the river are about 3 hectares and these ones are held on freehold basis. The plots which are half hectare and below are on leasehold.

Most of the commercial plots in the townships and market centers were assigned when Dagoretti was under Kiambu county council. After NCC took over, the government took over ownership of the land and residents were to formalize their temporary certificates by getting leases for the land. However, only a handful has heeded the call.

The area is administered under a chief at Kawangware shopping Center and a sub-chief at Ngando. The chief licenses the operation of kiosks on temporary basis and allocates the common land to community groups for community purposes. Kiosks have therefore sprung up all along the main roads and at the shopping centers without regard to zoning maps and availability of water and sanitation services.

Plate 3-1: Haphazard Developments



Note the Density of developments and population along the main road-Kabiria
Source: Field Study (2002)

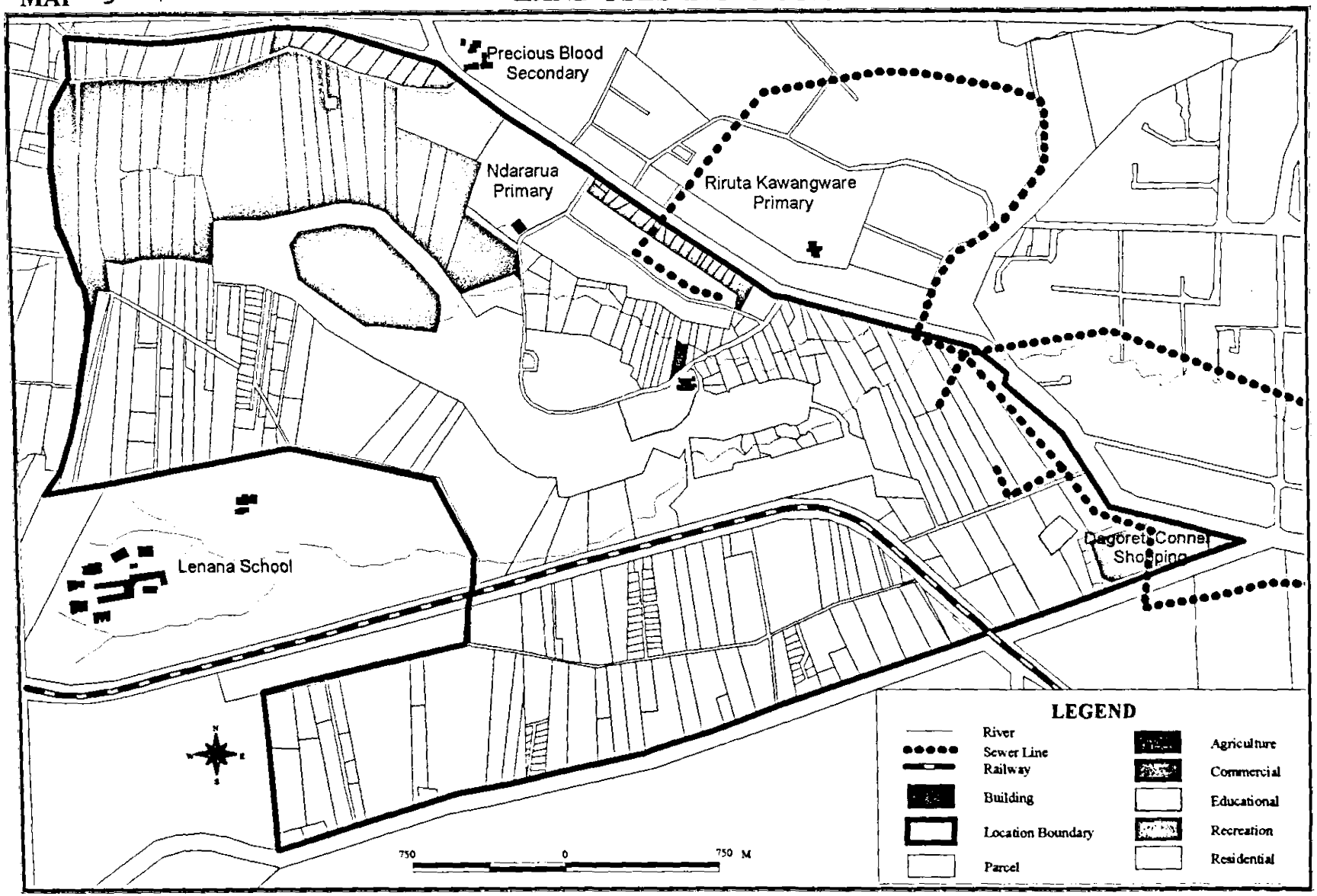
Zoning Classification in Dagoretti and Land Use

The area was initially classified into four zones namely: Market areas, Townships administered under Grade 2 building by-laws, Satellites administered under Grade 1 building by-laws and Agricultural area (NCC 1973). As early as 1973, much of the agricultural land in Dagoretti was proposed for re-zoning to residential use since the above distinction was no longer practicable or enforceable for densities had risen. Zoning in Riruta was thus changed to allow multi-family occupancy per plot in selected areas. Similar proposals were to be made in other sections of Dagoretti and were to receive priority in water and sewerage installations. Today

agriculture has almost given way to residential, commercial land and public utility users (Map 3-6).

MAP 3- 7

LAND USES IN RIRUTA



Prepared by E.M K NGUAH

Source: Adapted from Survey of Kenya

Governance

The area is administered by the provincial administration through the local chief at Kawangware and a sub chief at Ngando with divisional headquarters at Waithaka shopping center. The area is also administered by the Nairobi City Council under the name of western division of NCC. The NCC provides water and sanitation services to the residents in exchange for water and sewerage charges paid by the landowners.

3.1.5 Infrastructure Services

Housing

By 1967, areas of Kawangware, Karadini market (Dagoretti corner), Satellite and areas along Naivasha road and Ngong roads had shown a rapid rise in unofficial rental housing (NCC 1973). The NCC prepared house type 'plans' and sold them to residents. Due to lack of enforcement of building standards however, some residents have built very poor residential structures to satisfy the rising demand for housing. In Riruta, landlords are flouting the zoning maps and building by-laws with impunity. Despite some areas such as townships being administered under grade (II) by-laws, which are relaxed standards; landlords are still ignoring these standards.

In the planned estates of Santak and Suna, building materials consists of stone, walls, cement floor and tiles for roofing. In the unplanned areas however, building materials consists of Iron sheet walls and roofing and cement screen on floors. The layouts of settlements reflect the system of development control enforcement. Where there is enforcement of development control the layout of the estates is well organized and in the unplanned settlements the layout is as haphazard as their name implies.

The study selected a few clusters for sampling namely: Suna, Racecourse, Ngando, Kinyanjui and Satellite. The clusters chosen have different historical backgrounds and organizational layout and this highly determines their level of access to water and sanitation services.

Suna

Suna comprises two estates that are surrounded by sprawling informal settlements. The first to be built was by Dr Kiano who developed maissonettes in the late 1980s. The second was called Suna developed by Suna Developers in early 90s. This later development comprises bungalows. Both of the developers bought land from the late chief Wanyee family. Their distinguishing feature is that planning of the estates was done in advance of the development and the necessary infrastructure services such as water supply, sewerage system and access roads put in place. The housing units were then sold to private individuals some of whom have rented them out while others are living in them.

Ngando and Racecourse

In Ngando and Racecourse, about 60% of landowners are original residents of the area when it was under Kiambu County council. The other 40% have bought land for building private residences and for constructing rental housing units. This construction however has been done in a haphazard manner without regard to building standards such as the building line and building materials. The landlords have also failed to provide even the minimum level of services for such developments only providing makeshift pit-latrines and communal water points. Figure 3-1 and 3-2 shows the housing layout and cross section of Wanyee road at Ngando while figure 3-3 shows the housing Layout for Racecourse Note that they are almost similar.

Plate3- 2: An ongoing construction of back-to-back housing units

Source: Field Study (2002)

Kinyanjui and Satellite

Originally the area consisted of large farms. Kiambu county council had constructed a township at Satellite and same residential houses for its officers along Wanyee road. After the area was annexed to Nairobi, much of the land was subdivided into half-acre leasehold plots while the area along the river was subdivided into 3-acre farms for agricultural purposes. Most of the original owners have sold their land and left for Nyandarua where they have purchased large farms for farming. The new landowners have either built their own individual residential units or rental units. This rental housing is in stone and in sizes ranging bungalows to high-rise buildings. Kinyanjui and Satellite have almost similar housing layouts therefore one is taken to represent the other. Figure3-4 shows the housing layout for Kinyanjui.

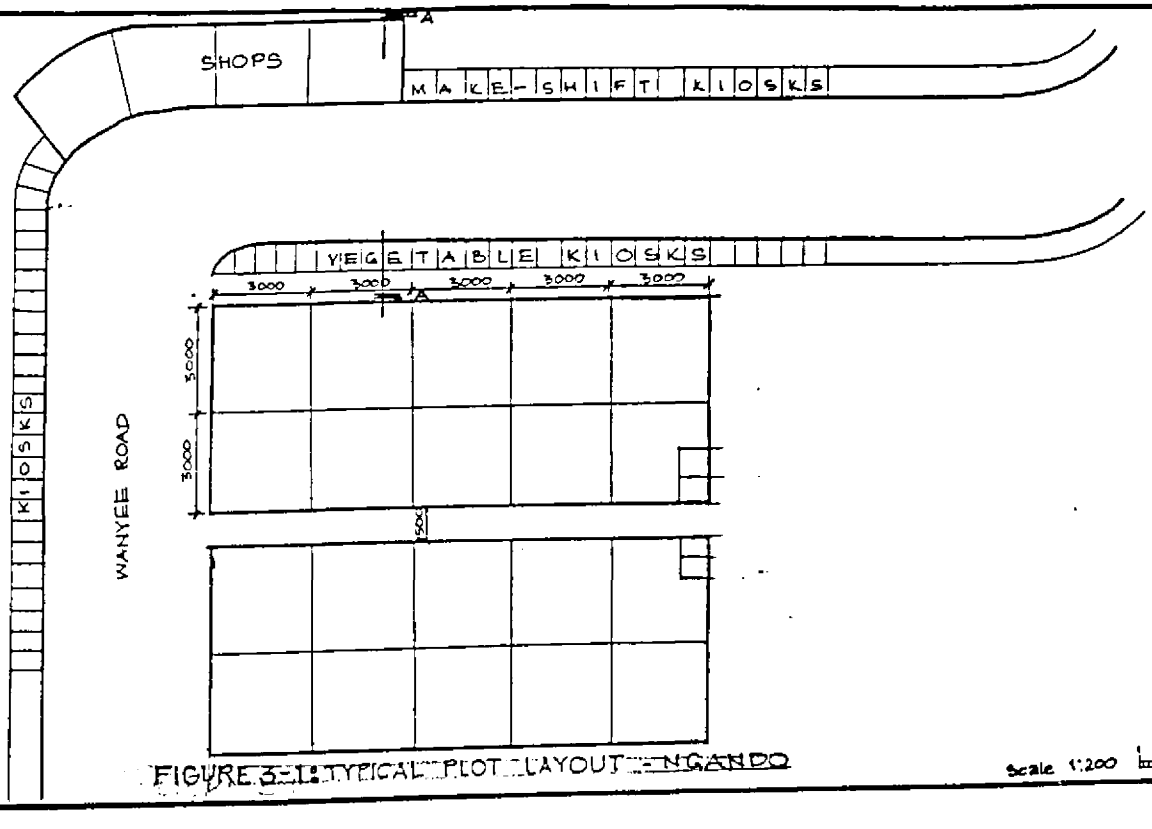


FIGURE 3-1: TYPICAL PLOT LAYOUT - NGANDO

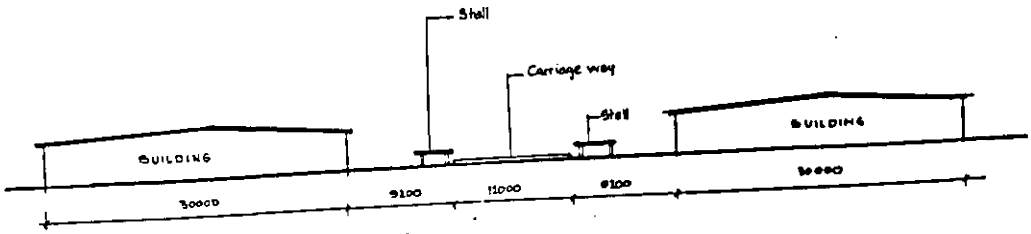


FIGURE 3-2: CROSS SECTION A-A

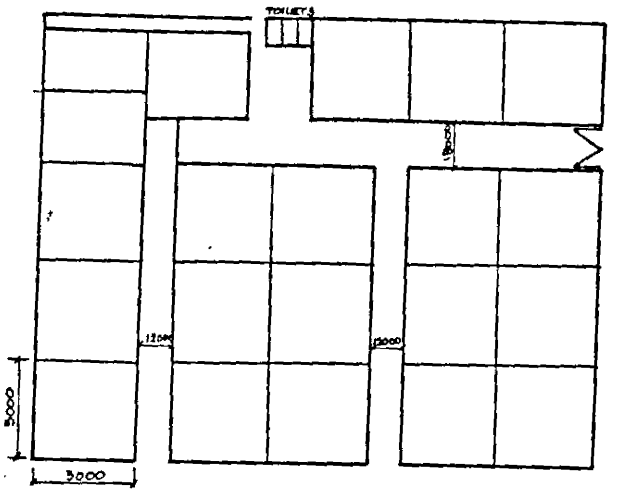


FIGURE 3-3 : TYPICAL PLOT LAYOUT - RACE COURSE Scale 1:200 1 0 1 5 M

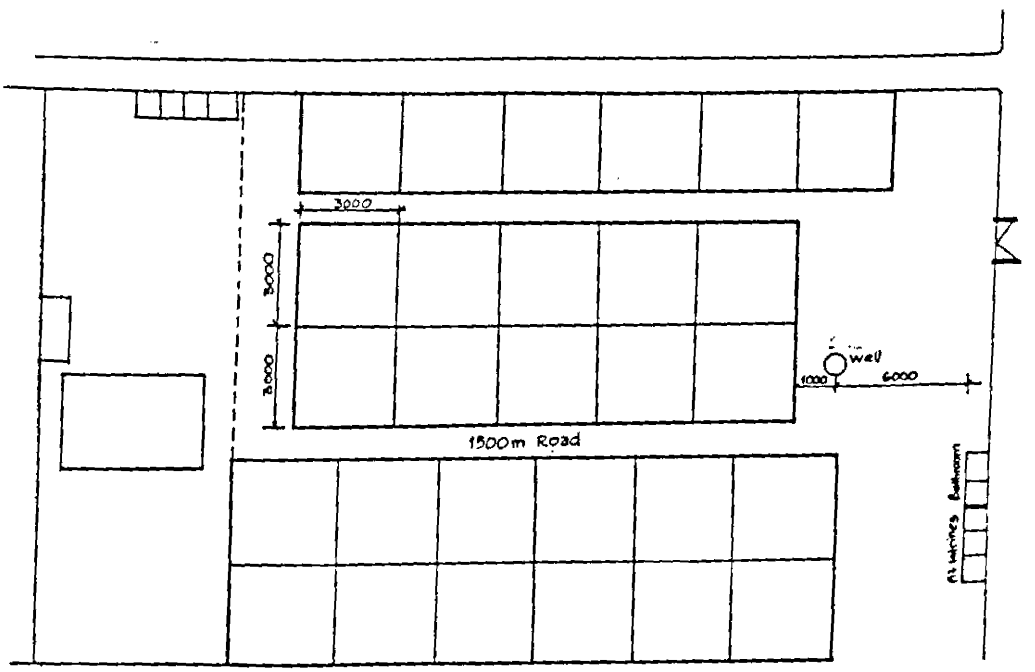


FIGURE 3-4 : TYPICAL PLOT LAYOUT - KINYANJUI Scale 1:200 1 0 1 5 M

Roads

By 1973, all the roads adopted by NCC had been graded, murramed and a few sealed. Sealed roads included Wanyee, Satellite and Kinyanjui roads. After a long period of neglect however, the roads deteriorated completely. Recently the Government and NCC have launched a program to improve the roads like Kinyanjui and Wanyee roads. It is expected that these program will include opening up of drainage channels along the roads hence result in an improvement in the drainage in Riruta.

Water Supply

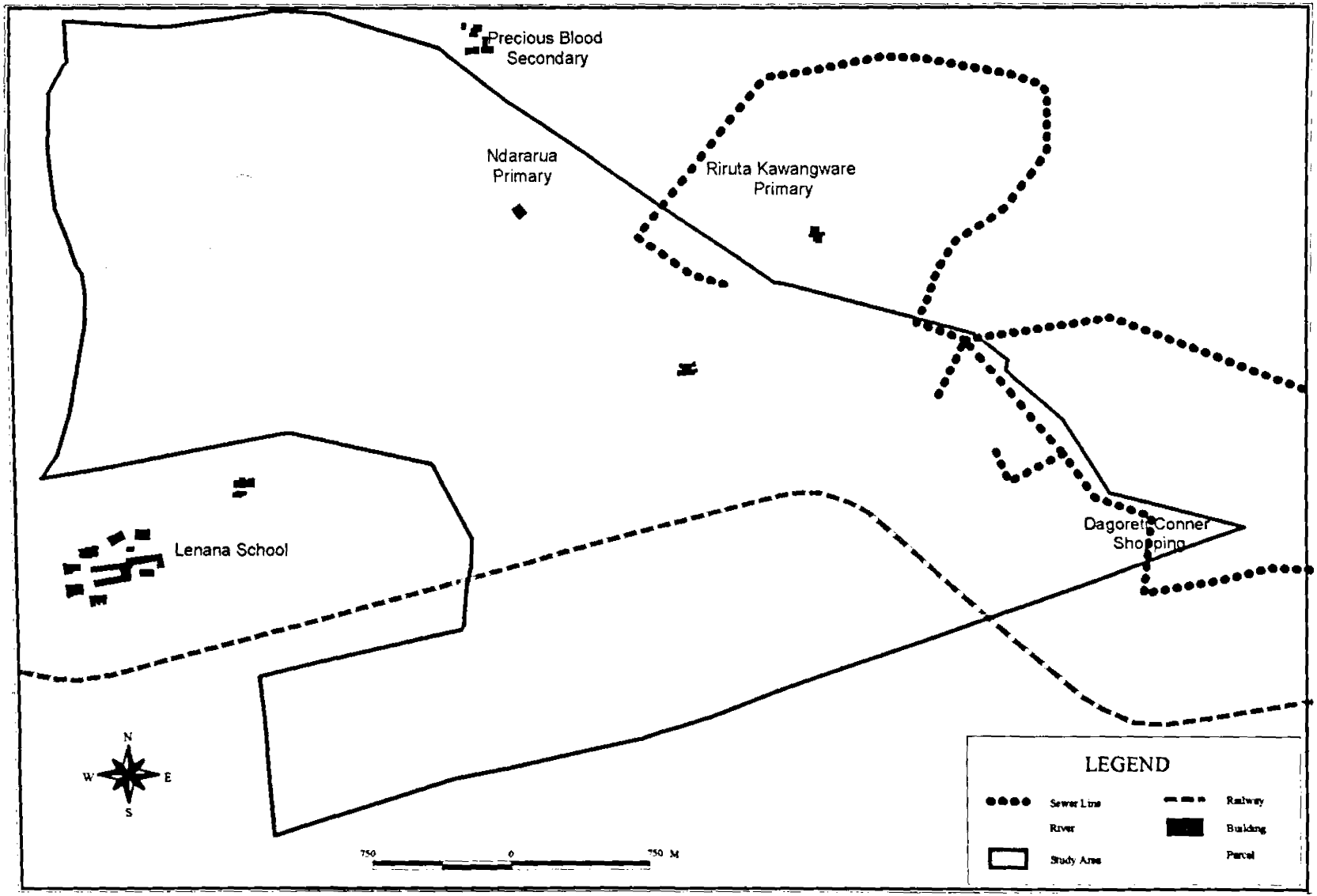
By 1973, Dagoretti was served with NCC water from Kikuyu springs. The distribution system was fairly old and small in capacity at that time. The NCC accepted recommendation, in 1973, to design and construct a new higher-pressure system oriented to new road alignments. Construction was expected at the end of 1973 but this has not been done.

Sewerage

The Kibera trunk sewer was extended to Dagoretti along Ngong road in 1972. Before this the residents relied wholly on Pit latrines and septic tanks. The NCC had accepted recommendation to provide Riruta and Kangemi with waterborne sewerage system by 1973. In Riruta this has not been constructed to date. Only parts of Riruta are connected to NCC sewerage system namely, Dagoretti corner Racecourse, Santak and Suna and parts of Kawangware (Map 3-7).

MAP 3-18

RIRUTA SEWERAGE SYSTEM COVERAGE



Prepared by E.M.K NGUAH

Source: Adapted from Survey of Kenya

3.2 Factors Pulling Population to Riruta

There are several factors pulling population to Riruta such as cheap housing, failure of authorities to enforce development control etc. This section will bring out all these factors in order to offer a clear understanding of the forces at play.

3.2.1 Cheap Housing

In the literature review, we saw that the value of land in the city center is higher relative to that in the fringe areas such as Riruta. The low values of land coupled with lack of enforcement of development control regulations in Riruta have translated into low cost of housing. This has in turn attracted people in search of cheap housing.

Table 3-5: Reason for migration

	Cheap housing	Employment	Insecurity	Water scarcity	Nearer to business	Born here	
Suna	2	6			1	1	10
Racecourse	3	5	1	1			10
Ngando	6	9	1	1		3	20
Kinyanjui	6	13		1			20
Satellite	7	7				1	15
Total	24	40	2	3	1	5	75

Source: Field Study (2002)

Table 3-5: indicates the reasons that make people move to Riruta. Out of 75 tenants interviewed 40 came to Riruta because of employment while 24 migrated to Riruta because of Cheap housing and only 5 were born in Riruta. It can be

assumed that those who chose Riruta because of employment was as a result of the cheap accommodation it provided relative to other areas in the center of Nairobi.

Of the 75 tenants interviewed 40% paid house rents of between Kshs1000 and 2000 while 32% paid between Ksh.2001 and 3000, for a three-roomed housing unit. These rates are very low compared to house rent in areas such as South-B and Nairobi West where a two bed-roomed house goes for Kshs.25, 000. A similar unit will cost Ksh15, 000 or more in Buruburu.

3.2.2 Subdivision of Land

Due to failure of NCC to enforce development control, the residents have taken advantage of the situation and subdivided land to plot sizes of even up to 0.09ha. Since the minimum plot size for an area not served by sewer is 0.1ha, the increased subdivisions have had serious implication on provision of sewage disposal services. Reports from the ministry of lands indicate that they receive two to three subdivisions from the area every week making on average ten subdivisions per month.

Table 3-6: Subdivisions of Land 2001/2002

2001	2002
Dag/Riruta/ 2405	Dag/Riruta/ 4101
Dag/Riruta/ 4367	Dag/Riruta/ 125
Dag/Riruta/ 4496	Dag/Riruta/ 2904
Dag/Riruta/ 1762	Dag/Riruta/ 138
Dag/Riruta/ 2877	Dag/Riruta/ 2405
Dag/Riruta/ 2870	Dag/Riruta/ 1899
Dag/Riruta/ 96	Karadini/50
Dag/Riruta/ 125	Dag/Riruta/ 1190
Dag/Riruta/ 117	Dag/Riruta/ 1070
Dag/Riruta/ 3962	Dag/Riruta/ 1899
Dag/Riruta/ 3932	Dag/Riruta/ 705
Dag/Riruta/ 62	Dag/Riruta/ 2405
Dag/Riruta/ 118	
Dag/Riruta/ 4102	
Dag/Riruta/ 475	
Dag/Riruta/ 86	
Dag/Riruta/ 3247	
Dag/Riruta/ 232	
Dag/Riruta/ 4103	
Dag/Riruta/ 18	
Dag/Riruta/ 4708	
Dag/Riruta/ 342	
Dag/Riruta/ 1030	
Dag/Riruta/ 1600	
Dag/Riruta/ 1250	

Table 3-6: gives an indication of subdivisions that have been approved by Ministry of Lands for Riruta since January 2001. The rate of subdivision is an indication of the continuing demand for land to develop housing units. This pressure of population resulting from increased urbanization is evident on the ground (Map 11). The subdivision approval are given subject to the following conditions among others

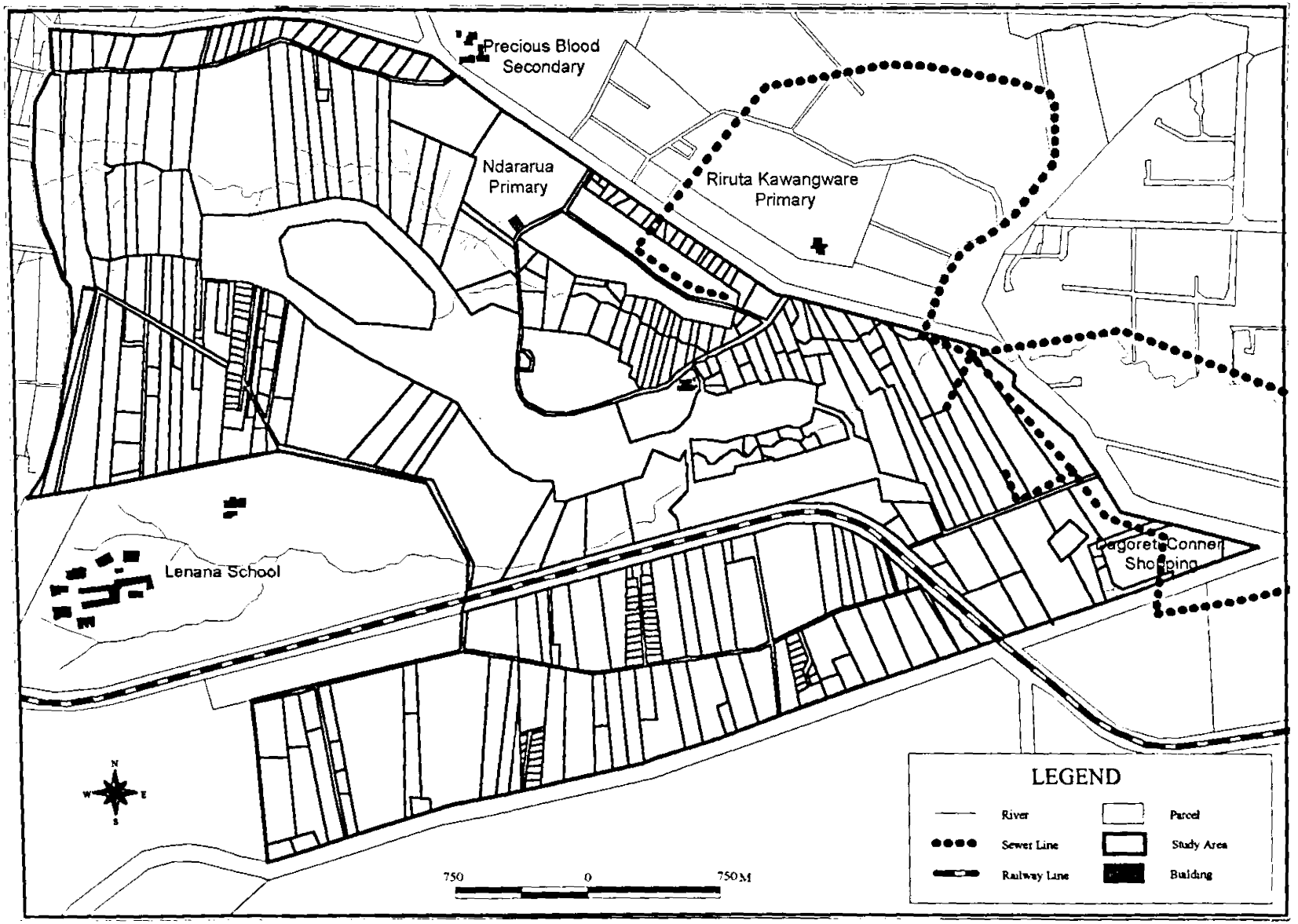
1. Connection of water supply to each sub-plot
2. Vehicular access to each subplot
3. Surrender of 3m drainage way leave to the Government

Developers often ignore these conditions since no follow up is made to ensure compliance. The study revealed that some 8 % of plots were not connected to NCC water supply. It was also evident that developers had encroached on the 3m vehicular drainage way left especially along Kabiria road, next to Satellite shopping center and along Wanyee road at Ngando area.

If 0.1ha is the minimum plot size below which one must provide sewerage system, then the situation in Riruta means that developers are ahead of the planners since development control has not been enforced (Figure 3-8).

MAP 3-'9

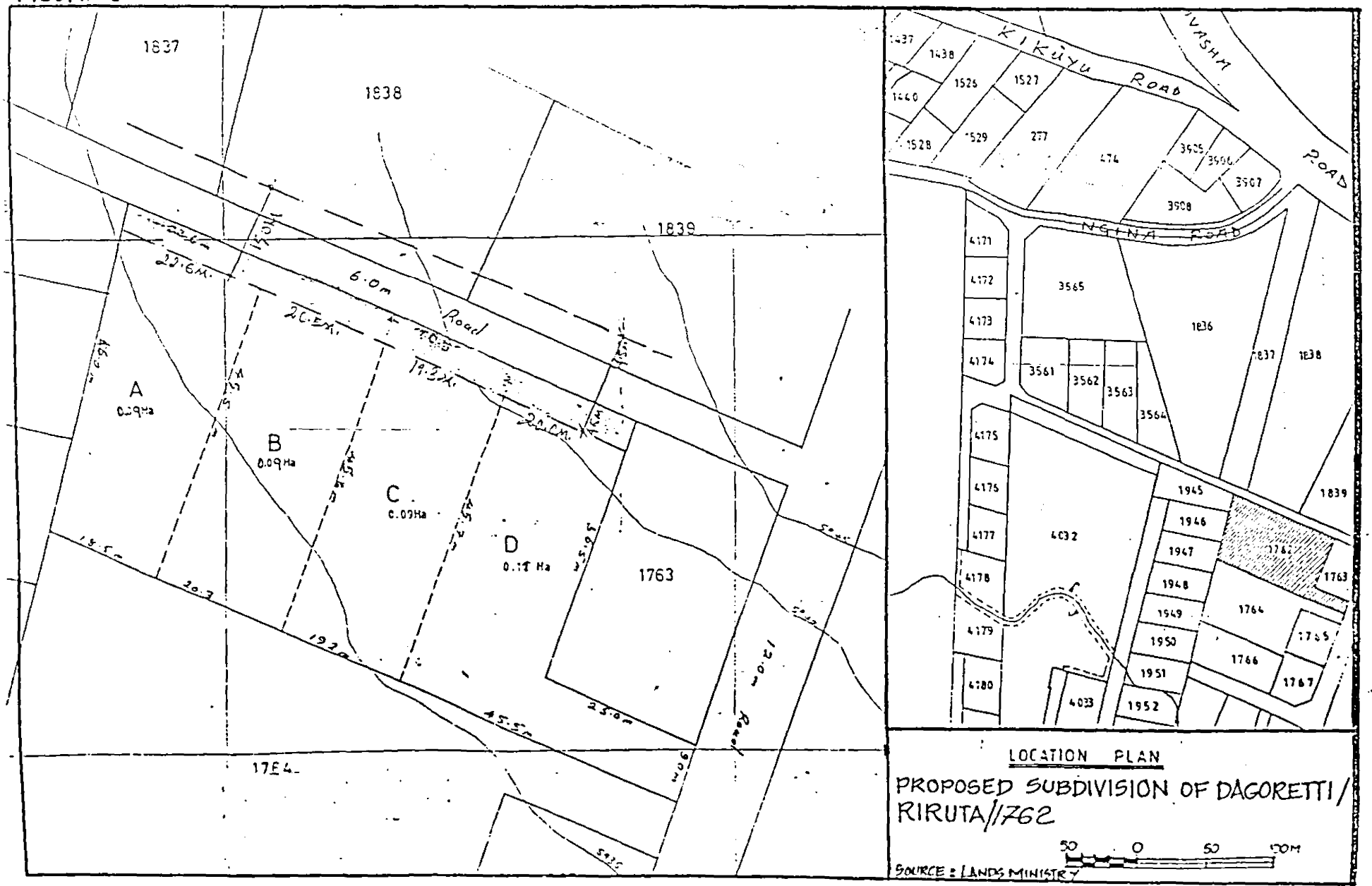
RIRUTA SUBDIVISION OF LAND



Prepared by E.M.K. NGUAH

Source: Adapted from Survey of Kenya

FIGURE 3-5


1837
1838
1839
1763
1764
A
0.09Ha
B
0.09Ha
C
0.09Ha
D
0.11 Ha
6.0m Road
KIKUYU ROAD
NGINA ROAD
IVASHA ROAD
1437
1438
1440
1525
1527
1528
1529
277
474
3905
3906
3907
3908
4171
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3561
3562
3563
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1765
1766
1767
LOCATION PLAN
PROPOSED SUBDIVISION OF DAGORETTI/RIRUTA/1762
50 0 50 100M
SOURCE : LANDS MINISTRY

3.3 Impacts on Water and Sanitation Services

The increase in population in Riruta has exerted pressure on existing water and sanitation services, creating a deficit between demand for water and sanitation services and supply of those services. This has in turn reduced water and sanitation standards in the area because residents have to try and make do with the existing services or supplement them by resorting to other sources such as private service providers, shallow wells and Nairobi River. This has endangered public health and environment quality in the process, because water from these sources is not assured.

3.3.1 Water

Water Demand

Water demand in Riruta is determined by several factors such as population size, occupations, household size and type of connections. These section looks at these factors separately by showing how each affects water demand.

Population Size

According to the 1999 population census Riruta had a population of 65,985 people and a density of 9,035 persons (CBS 1999). The study computed the domestic water demand using this population size.

Table 3-7: Projected Domestic Water Demand-Riruta (litres/day)

Year	1999	2005	2010	2015	2020
Populatio Projections	65,000	85,150	107,250	135,850	170,300
Water Demand	6,093,750	7,982,812	10,054,687	12,735,937	15,965,625

Source: Base Population Figure: GOK (1999)

Projections: Author (2002)

Table 3-7: shows the estimated domestic water demand for Riruta to the year 2020. The researcher assumed that about half of the population has house connections and consumes 150 l/c/d. The rest depend on communal water connections and consume 75l/c/d. The table indicates that domestic water demand will be rising as years go by.

Occupation

Out of the total population of 65,985 people a sample of 90 households was selected, which was stratified into 75 tenants and 15 landlords. A study of these groups of people revealed very interesting characteristics.

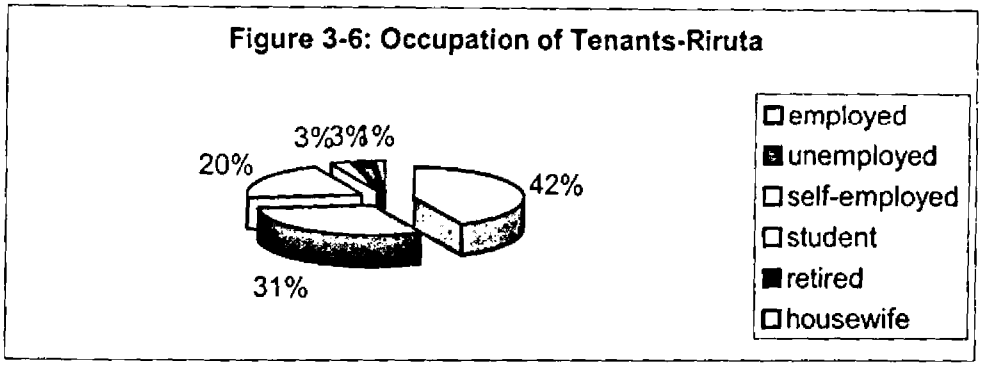
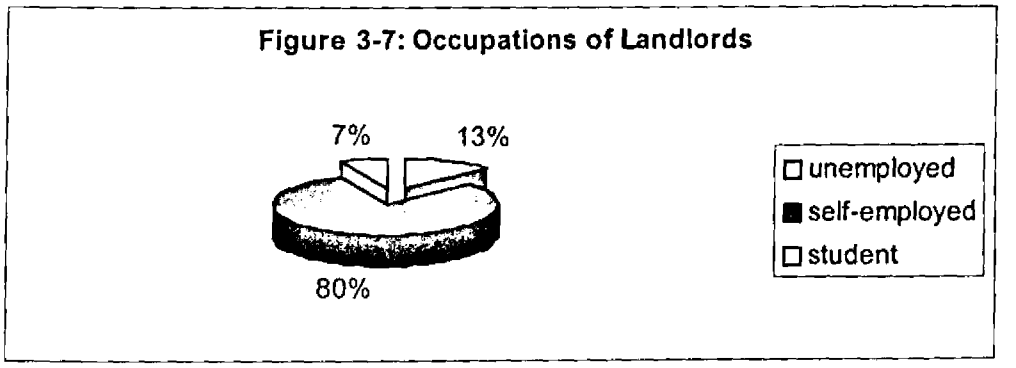


Figure 3-6 shows that about 42% of tenants are employed while 31% are unemployed. This is a very high rate of unemployment and it implies that this proportion will demand less water due to their inability to pay for the same. This means that they would demand more water if all were employed.



Source: Field Study (2002)

Figure 3-7 shows that 80 percent of landlords are self-employed while only 13% were unemployed. This would imply that those who are self-employed demand more than those who are unemployed since they have some level of income.

Table 3-8: Number of households/Plot

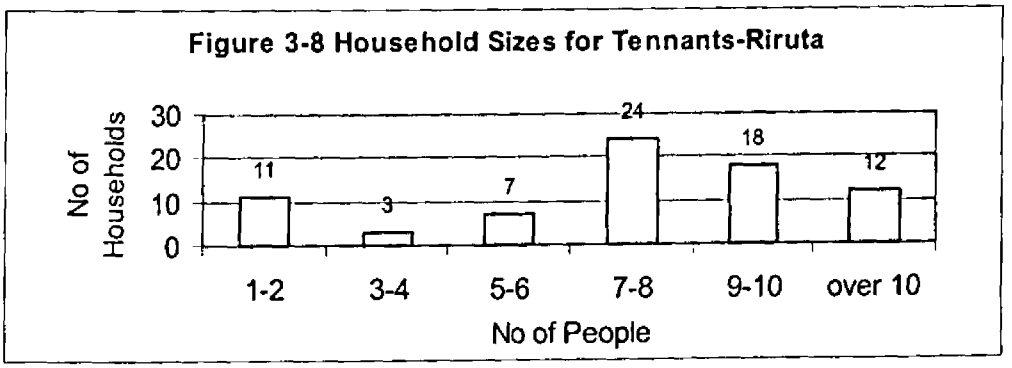
Number of households	Frequency	Percent
6-7	2	13.3
7-8	3	20.0
9-10	2	13.3
over 10	8	53.3
Total	15	100.0

Source: Field Study (2002)

Table 3-8 shows that each of these landlords have erected rental-housing units meaning that even those who are unemployed have some level of income hence some level of purchasing power and therefore demand more water. This implies that their demand for water is high.

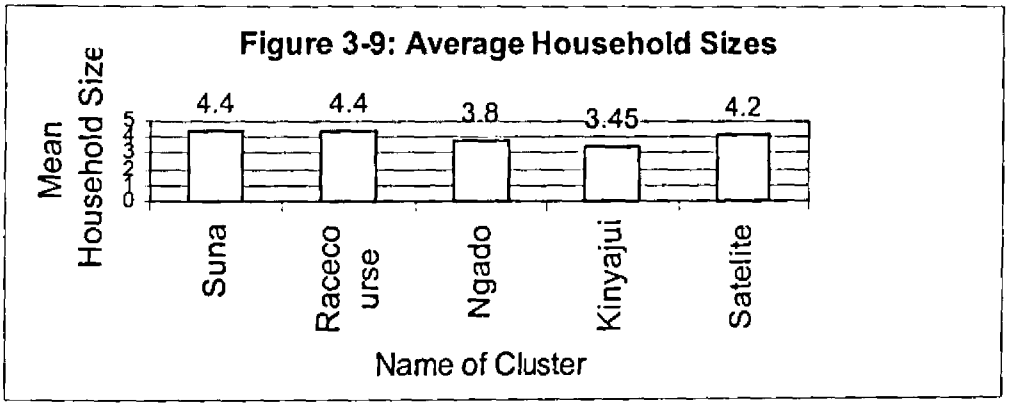
Household Size

Using the water demand table, the water demand for tenants was taken as an average of 75 l of water per capita per day (GOK 1986, GOK-JICA 1999) assuming that all have communal connections. The total household demand is household size multiplied by 75 liters/capita/day.



Source: Field Study (2002)

Figure3-8 shows that out of the 75 tenants interviewed 54 had household sizes of between 7 to over 10 persons. This implies that the demand for water in these large households is more than smaller ones. The average household sizes however differ from cluster to cluster and so does the demand for water.



Source: Field Study (2002)

Figure 3-9 shows the mean household size for all clusters giving an average household size of approximately 4 persons. The water demand per capita is therefore 300l per household per day.

Table 3-9: Household Size for Landlords

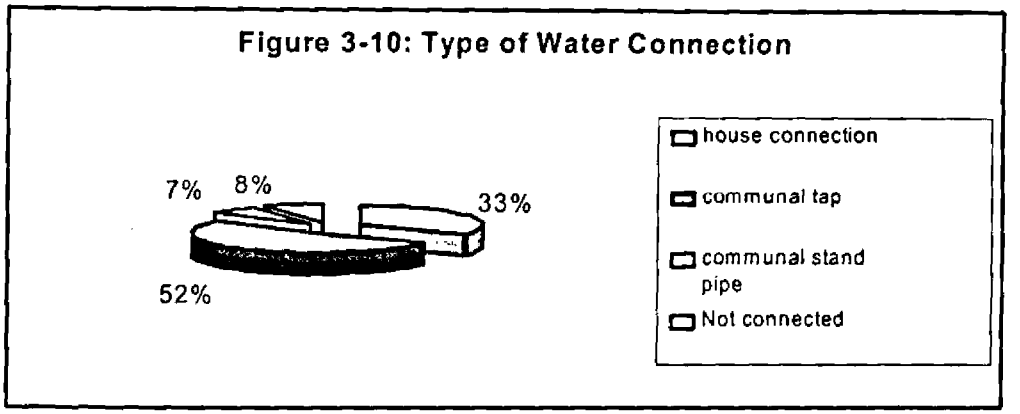
	Household Size						Total
	1-2	3-4	5-6	7-8	9-10	Over 10	
Suna	1		1				2
Raccecourse				1	1		2
Ngando		1		1		2	4
Kinyanjui				2		2	4
Satellite			1	1	1		3
Total	1	1	2	5	2	4	15

Source: Field Study (2002)

Table 3-9 shows that about 70% of landowners had household sizes of between 7 and over 10 persons. This determined their water demand meaning that these households demanded between 1050 and 1500 liters/household/day given a per capita demand of 150 liters/capita/day assuming all have house connections.

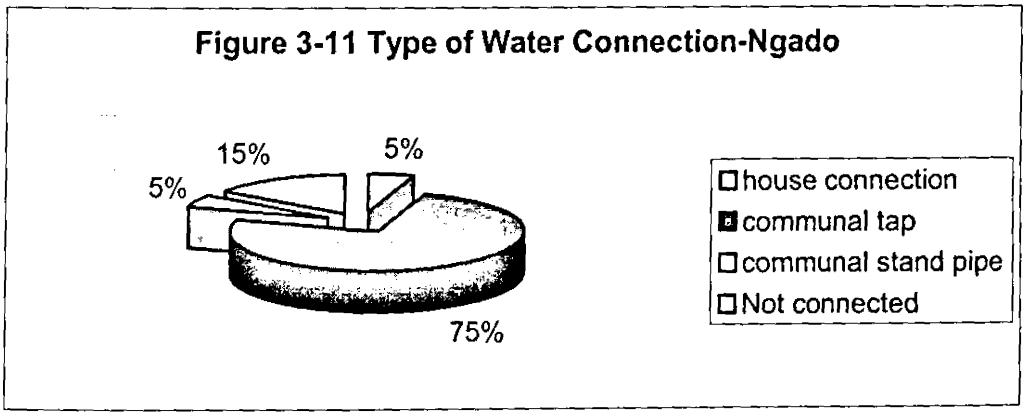
Type of Connection

The type of water connection will also determine the water demand for a household. Those with house connections will demand more water than those without. It also depends on the type of sewage disposal method used so that those with sewerage will demand more water for flashing toilets. The type of water connection will determine access to water in that those not connected will have very little or no access to water.



Source: Field Study (2002)

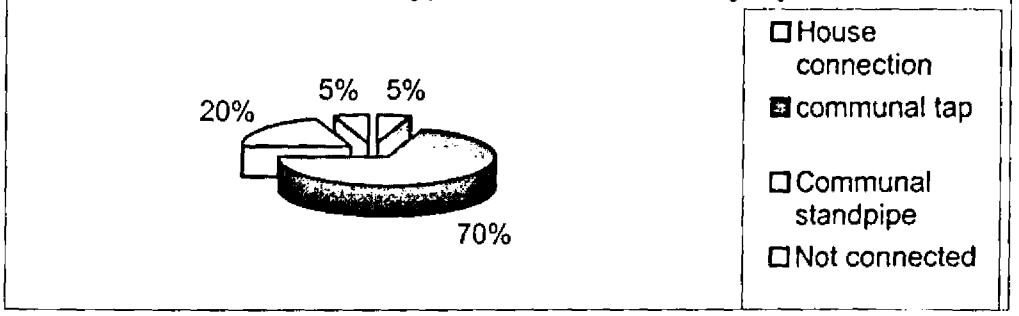
Figure 3-10 indicates that only 8% are not connected out of 75. About 33% had house connections, 52% had communal taps while about 7% had communal standpipes. The total coverage of water connections for tenants in Riruta appears



to be very good. This aggregate however obscures the real picture of water connections. A look at each cluster separately indicates a different story altogether. All tenants in Suna and Racecourse were connected to house connections.

Figure 3-11 shows that about 75% of tenants in Ngando use communal taps while only 5% had house connections. This rate of water connection is poor compared to Suna.

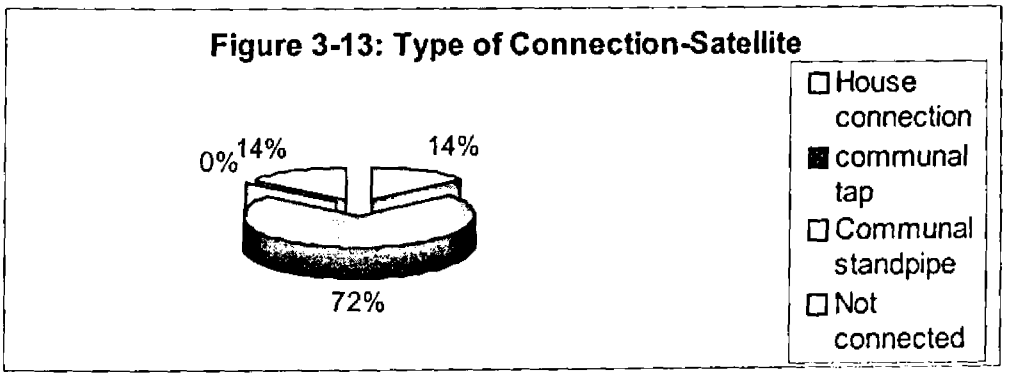
Figure 3-12: Type of Connection-Kinyanjui



Source: Field Study (2002)

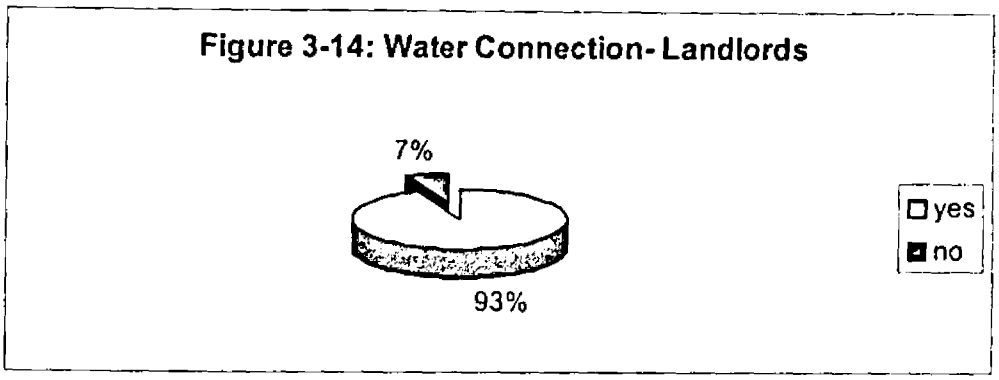
Figure 3-12 shows that 70percent of tenants in Kinyanjui has communal taps implying they demand less water than those with house connections.

Figure 3-13: Type of Connection-Satellite



Source: Field Study (2002)

Figure 3-13 shows the type of water connection for tenants in Satellite. It indicates that about 72 percent had communal taps and only 14 percent had house connections. They will therefore demand less water.

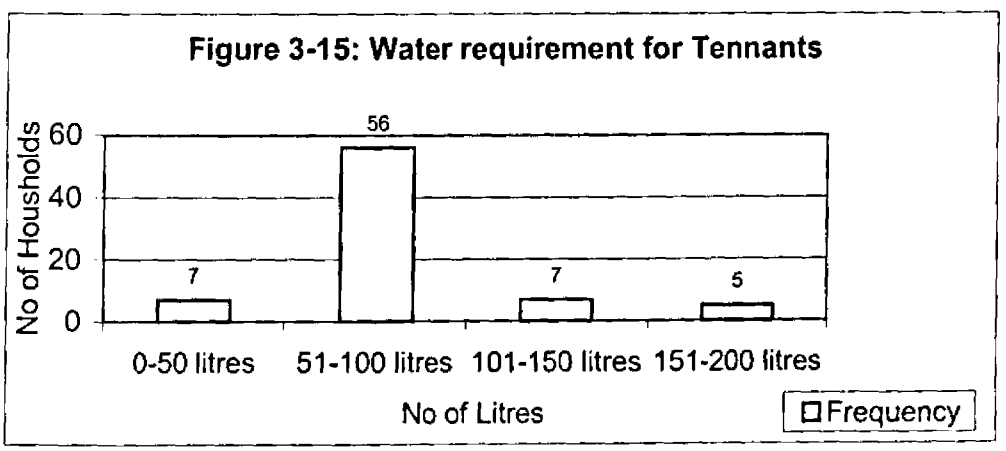


Source: Field Study 92002)

Figure 3-14 shows that except for one case in Ngando, about 93% of the landlords were connected to NCC water supply. The implication therefore is that water demanded will increase from 525–750 liters to between 1050 and 1500 liters granted that any household with house connection requires 150 l/capita/day.

Water Requirement

This should be seen as the actual amount of water received during those days when water is available. This assumption here is that the residents would use more water if it were available on a daily basis.



Source: Field Study (2002)

Figure 3-15 shows that out of 75 tenants interviewed 56 households required 51-100l of water. Only 12 households required more than 100 l of water per day. When compared the water demand for tenants at 300 l /household to the water received of between 51-100l then there is a deficit of approximately between 250 and 200 l/ household.

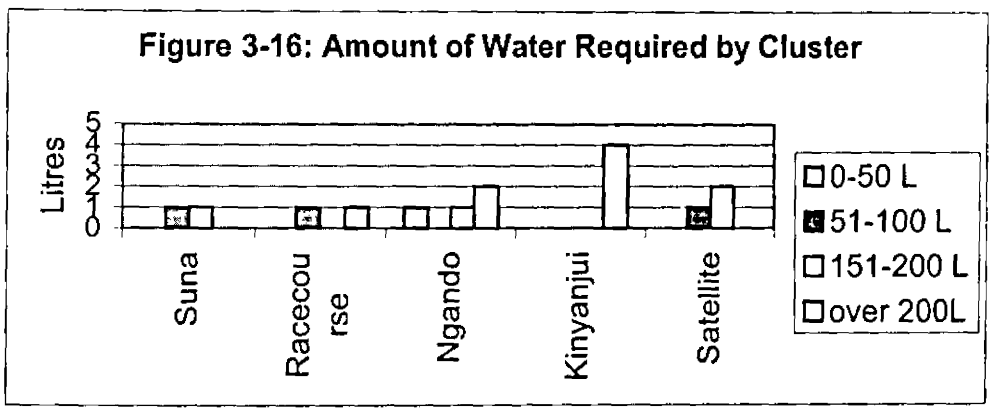


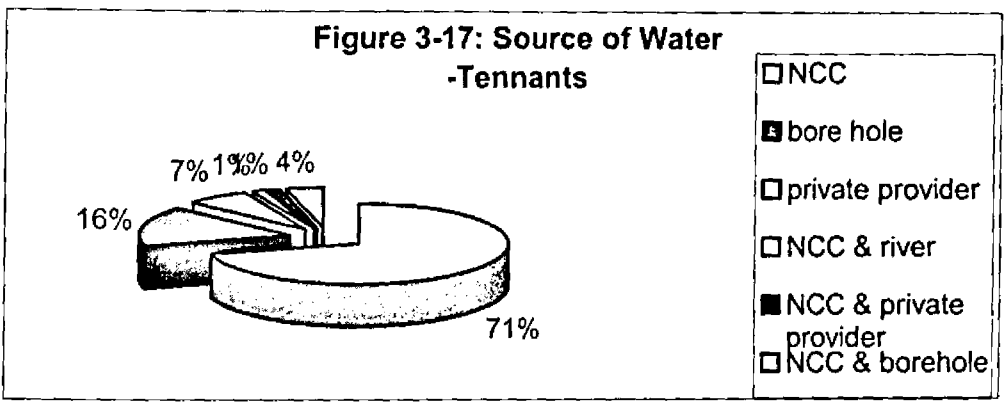
Figure 3-16 shows the amount of water required by cluster. In Kinyanjui all landlords indicated they required over 200L per day. This would appear to be an understatement of demand because given that about 70% of landlords had household sizes of between 7 and over 10 persons then actual demand should have been between 1050 and 1500l/ household/ day. This implies a deficit of between 900 l and 1300 l/household/day.

Water Supply

Water Sources

Reports indicate that 75% of people in urban areas of Kenya are provided with portable water (GOK 1999). The evidence on the ground however indicates that most of the taps are usually dry. In Riruta the level of provision varies between

controlled and uncontrolled areas. Controlled areas of Suna are relatively well provided for as opposed to Ngando. It is therefore important to look at statistics for each of the clusters separately in order to get the real picture.



Source: Field Study (2002)

Figure 3-17 shows that about 71% of tenants source water form the NCC while the rest sourced water from shallow wells, private service providers and Nairobi River. This would appear to mean a very good coverage of portable water provision but it is not good enough given our overall policy goal has been to supply water to every Kenyan by year 2000.

Plate 3-3:The billboard tells it all

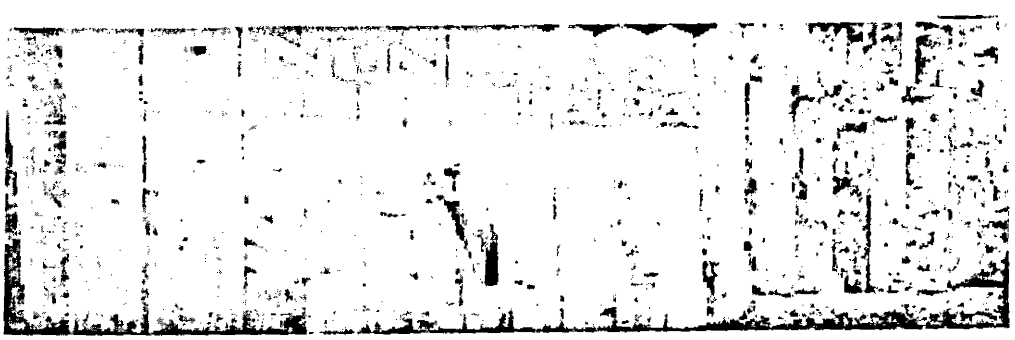


Plate 3-4: Water storage at a water Kiosk

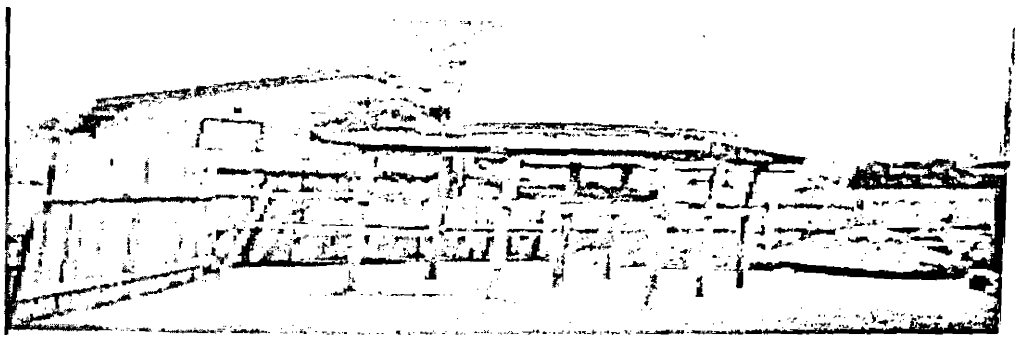
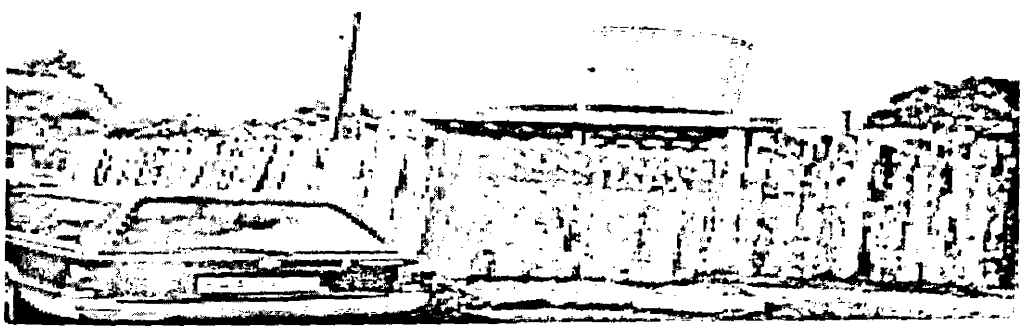
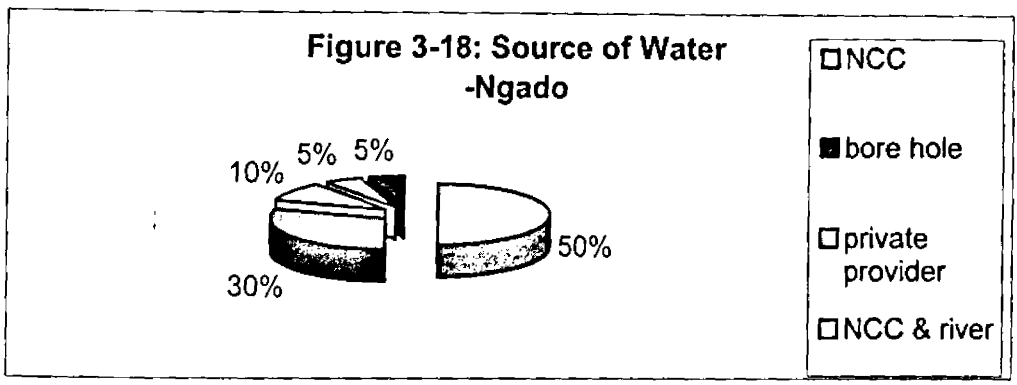


Plate 3-5: Water supply from a water Kiosk



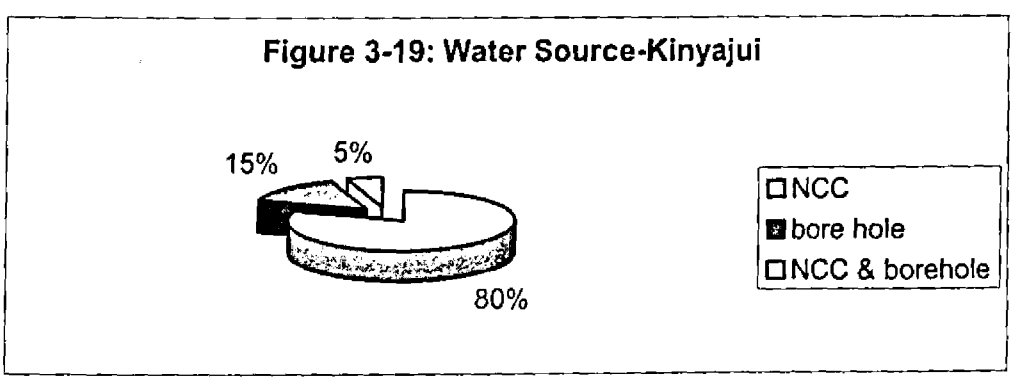
Source: Field Study (2002)

While all tenants of Suna and Racecourse depend on water from NCC tenants in Ngando, Kinyanjui and Satellite depend on a number of sources ranging from shallow wells to river water.



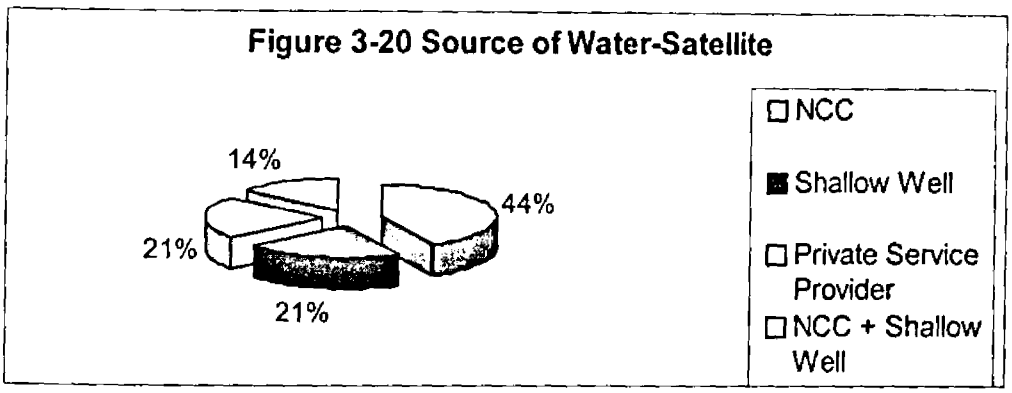
Source: Field Study (2002)

Figure 3-18 shows that about 50% of tenants in Ngando depend on NCC water while 30% depend on shallow wells. Only 5% of them drew water from Nairobi River. The fact that only 50% of tenants received water from NCC when 85% of tenants in the area had water connection implies that 35% do not receive water from NCC despite being connected to NCC water supply.



Source: Field Study (2002)

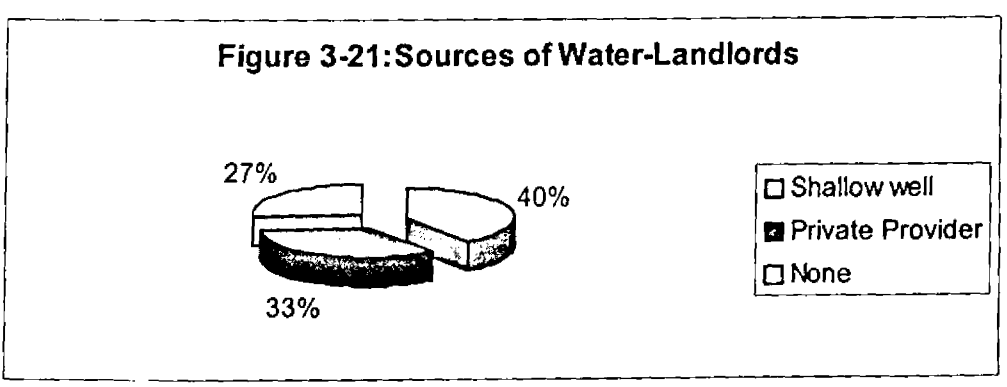
Figure 3-19 shows that in Kinyanjui NCC provide water to 80% of the tenants while about 15% depend on shallow wells. In about 5% of the cases however tenants depend on both NCC and shallow wells.



Source: Field Study (2002)

Figure 3-20 shows that in Satellite only 44 % of tenants depend on water from NCC. About 21% use shallow wells and another 21% use private service providers. This indicates a very high proportion of tenants depending on private service providers for water provision than in other clusters.

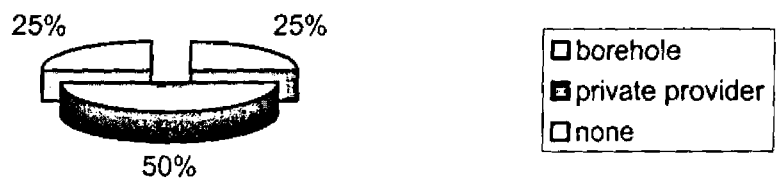
The landlords in Riruta have also improvised by supplementing their water received from NCC with other sources of water such as shallow wells and PSP. All are however connected to NCC water supply.



Source: Field Study (2002)

Figure 3-21 shows that 33% of landlords buy water from private service providers and 40% are using shallow wells. A close look at each cluster separately however reveals that access of water varied between them. In Racecourse they supplement their water requirements by using water from shallow wells.

Figure 3-22: Other Sources of Water-Ngando



Source: Field Study (2002)

Figure 3-22 shows that in Ngando, 50% of landlords used water from private service providers while 25% used shallow wells. This implies that only 25% are using only NCC water supply.

Figure 3-23: Other Sources of Water-Kinyanjui

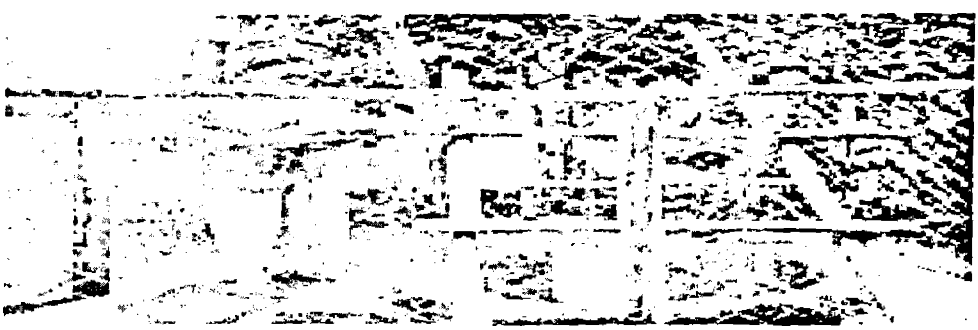
Source: Field Study (2002)

Figure 3-23 indicates that in Kinyanjui despite the fact that all landlords are connected to NCC water 75% supplement their requirements by buying from

private service providers while 25% use shallow wells. The implication here is that despite having NCC water connections the water supply is inadequate hence the need to supplement it with other sources. Note the heavy reliance on PSP in Ngando and Kinyanjui at 50% and 75% respectively.

In Satellite all owners were connected to NCC piped water but about 67% indicated that the water was inadequate and so they supplemented it with shallow wells. This is a very low level of access to NCC water relative to Suna and Racecourse.

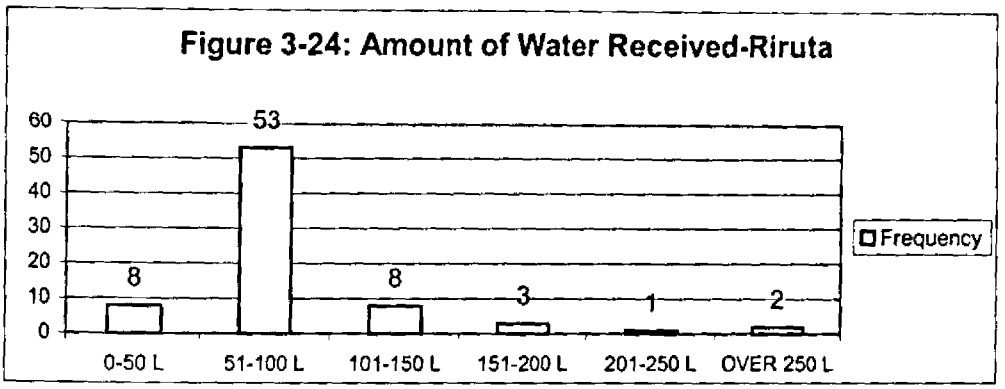
Plate 3-6: Woman Drawing Water from Shallow Well



Note the shallow well is uncovered therefore subject to pollution
Source: Field Study (2002)

Water Received

The deficit in water supply is worsened by the fact that the residents do not receive water on a daily basis. About 55% receive water once weekly, 29% receive twice weekly, and 26% receive water fortnightly or monthly. This implies that residents have to store water in order to ensure supply during the dry days. The process of storage of water involves risk of contamination if it is not handled properly.

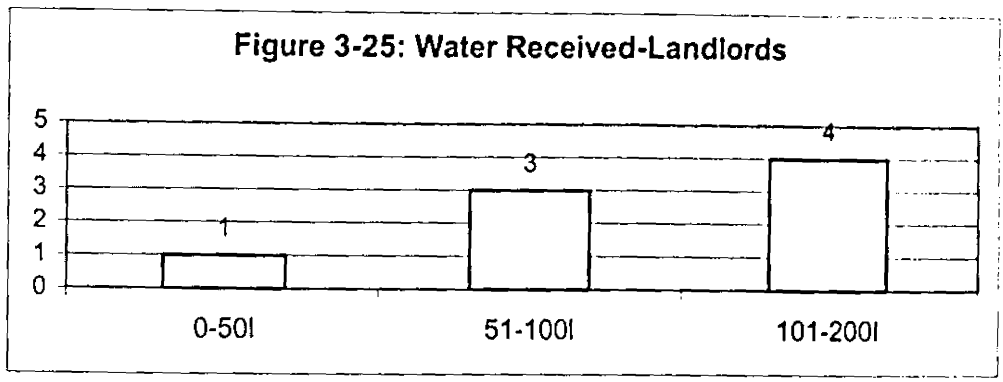


Source: Field Study (2002)

Figure 3-24 indicates that about 70% of the tenants sampled receive between 0-50 and 51-100l while about 11% receive between 101 and 150l. This is very little water considering that most of the households have an average household size of 4 people.

This figure on amounts of water received does not differ much from the figures obtained from amount of water required by tenants. This means that the residents have in away adapted to the water shortage situation in the area and are making do with what is provided.

During water shortages the residents fetch water or buy from PSP. About 12 percent of tenants traveled for distances of between 51-250m to get water. Though the distances are not long, fetching water is an opportunity cost in hours of man-hours, which would have been used in gainful employment.



Source: Field Study (2002)

Figure 3-25 shows the amount of water received by landlords indicating that most received between 101 and 200 l when water is available. This level of water supply is very low when compared to their actual water demand calculated earlier as between 1050 and 1500 l/household per day.

Table 3-10: Water Frequency for Landlords

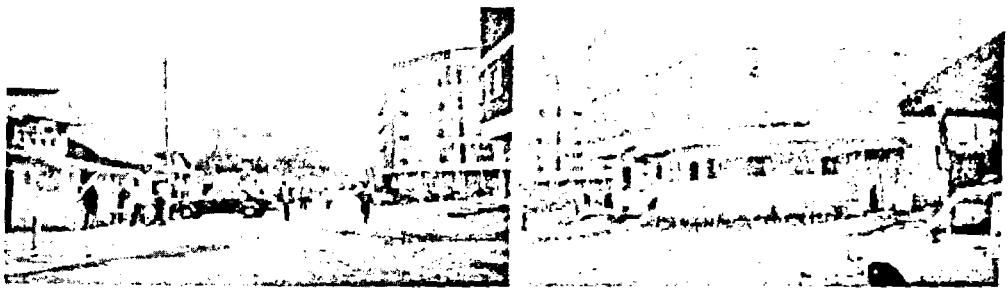
	water frequency				Total
	daily	once weekly	twice weekly	rarely	
Suna		2			2
Racecourse		2			2
Ngando	1	2		1	4
Kinyanjui		4			4
Satellite			3		3
Total	1	10	3	1	15

Source: Field Study (2002)

Table 3-10 shows that about 66% of landlords received water once weekly meaning that the 200l received had to be used in such a way as to last a whole week. Suna, Racecourse, Ngando and Kinyanjui receive water once weekly but in

Satellite the frequency is twice weekly. The level of water supply therefore is not consistent with adequate water supply levels.

Plate 3-7: Dagoretti Corner Shopping Center



Note the height of buildings yet water supply is inadequate
Source: Field Study (2002)

Quality of Water Supplied

Since about 71% of tenants are getting water from NCC, then it is assumed that the water is of assured quality. This is because NCC has an obligation to its residents to treat any water that it supplies. However, 20% are getting water from assorted sources such as shallow wells, PSP and Nairobi Rive, which may not be of assured quality. This is because the PSP are not regulated, about 40% of shallow wells are constructed at close proximity to the pit latrines and Nairobi River is polluted with sewage effluent.

The same case applies for the landlords. About 27% of landlords do not supplement NCC water supply. Their water supply can be assumed to be of good quality since NCC has an obligation under the Public Health Act to treat this water. About 74% however supplement their water requirements with PSP and shallow wells. This water cannot be said to be of assured quality since about 40%

of the pit latrines are built in close proximity to shallow wells and secondly PSP are not regulated and can fetch water from any source.

It is interesting to note that none of the households use rain harvesting for water supply in all the clusters. This is despite the fact that Riruta is the wettest point in Nairobi to the extent that it houses a meteorological station at Dagoretti Corner. Rainwater may not be fit for human consumption given Riruta location in relation to the industrial area of Nairobi but this water can be used for other purposes such as flashing toilets or washing.

Water Recommendations

About 80% of tenants and 53% of landlords recommend that NCC provide them with more water. About 13% of landlords recommend digging of boreholes while 13% recommend overhaul of the water reticulation system.

3.3.2 Sewage Disposal

Demand for Sewage Disposal Services

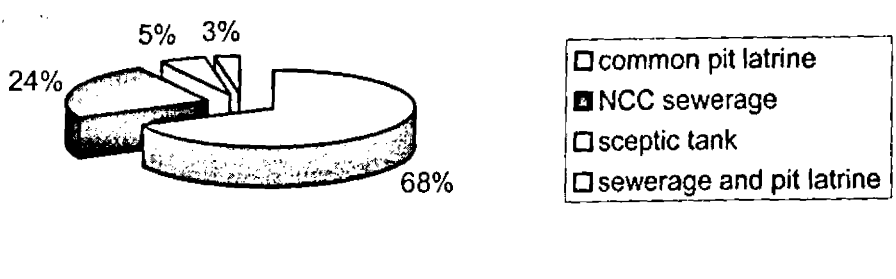
The public Health Act requires that each dwelling should be provided with a pit latrine for sewage disposal. If Riruta has 65000 people and 20,191 households then this population requires 20,191 pit latrines, if no other form of sewage disposal is provided. By year 2000 Riruta will have an estimated 170,300 people. Assuming the average household size of 4 persons will be maintained then there will be 42,575 households. Assuming that the areas cover red by NCC sewer will support a quarter of the households then this implies that 31,931 households will be supported in areas without NCC sewer. This latter population therefore will require about 31,931 pit latrines based on the provisions of the Public Health Act (Cap 342).

Planning standards recommend that for a settlement with a population of 3000 or more having an urban layout, sewerage collection and treatment plant be considered. Where this is not provided septic tanks need to be provided. For areas where the minimum plot size is 0.5 acre then septic tanks are uneconomical because they require drain fields to be provided. For areas with densities of beyond 30 persons per hectare, then conventional sewer is recommended (Ministry Of Lands & Settlement 1992). In Riruta the minimum plot size is below 0.25 acre that is way below the minimum size recommended for trunk sewer. This means that trunk sewer provision is urgent.

Access to Sewage Disposal

Riruta residents rely mainly on pit-latrines for sewage disposal since only Suna, Dagoretti Corner shopping Center; Racecourse and the portion of Riruta in Kawangware shopping center are connected to NCC sewerage system. Only about a ¼ of the population are connected to NCC trunk sewer meaning therefore that 15,143 households were not connected. This people use septic tanks or pit latrines, which are uneconomical and untenable due to risk of pollution of ground water. Moreover the minimum plot size of 0.09 ha is much lower than the minimum below which a sewer must be provided.

Figure 3-26: Type of Sewage Disposal-Tennants

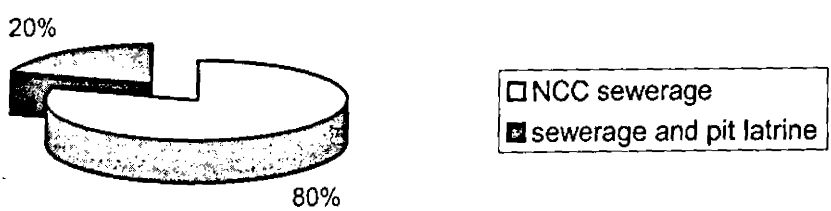


Source: Field Study (2002)

Figure 3-26 shows that about 68% of tenants use common pit latrines, 24% use NCC sewerage system. This implies that common pit latrines are the predominant mode of sewage disposal in the area.

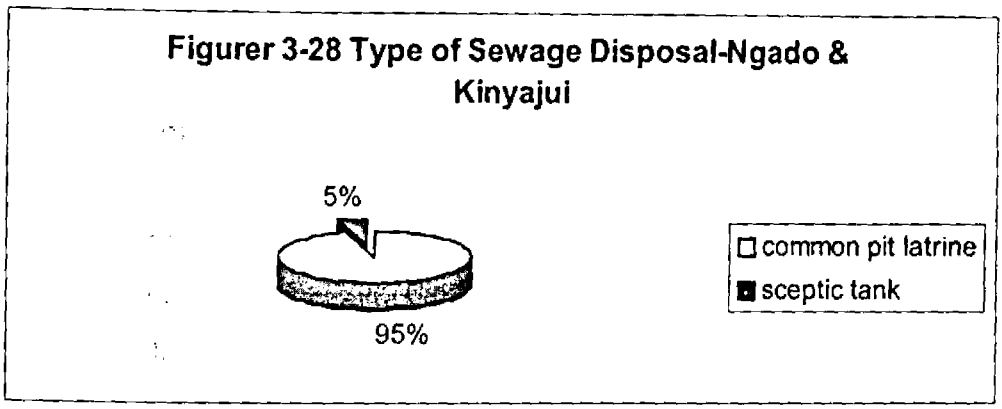
About 20% of tenants claim one toilet is shared between 3 households and about 15 percent claim one toilet is shared between 4 households. This is against the Public Health Act (Cap 242), which provides that each dwelling shall be provided with a latrine. Statistics for the various clusters show that tenants in Suna are connected to NCC sewerage system while other clusters depend on septic tanks and pit latrines.

Figure 3-27: Type of Sewage Disposal-Racecourse



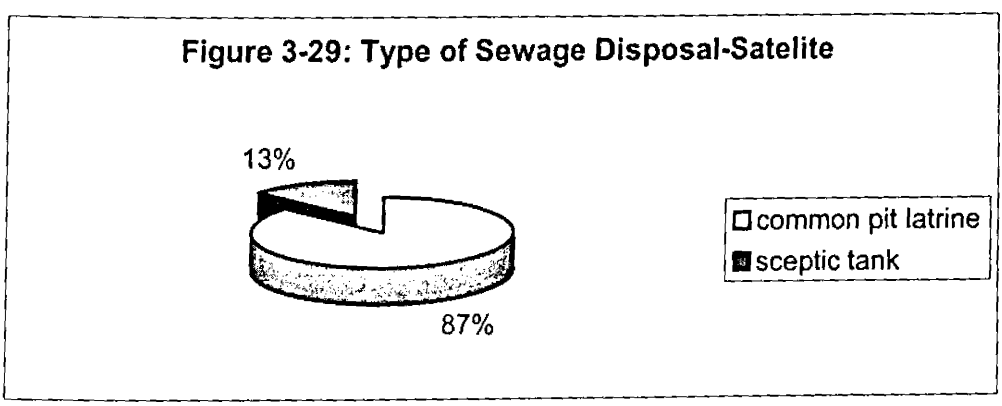
Source: Field Study (2002)

Figure 3-27 shows that in Racecourse 80% are connected but 20% depended on both sewerage and septic tanks. This may be explained by frequent shortages of water hence the need to supplement the water closet (WC) with a septic tank.



Source: Field Study (2002)

Figure 3-28 shows that both Ngando and Kinyanjui are not connected to NCC sewerage system. In both areas 95% of tenants used pit-latrines while the rest relied on septic tanks. This means that the number of pit latrines is very high and portends danger in terms of pollution of ground water sources through sewage infiltration.



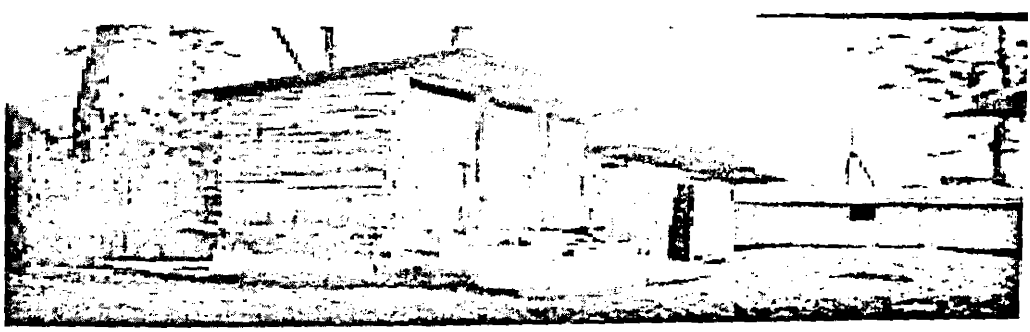
Source: Field Study (2002)

Figure 3-29 shows that in Satellite those tenants using septic tanks were more than in Ngando and Kinyanjui at 13% of the cases. The other 87% relied on pit

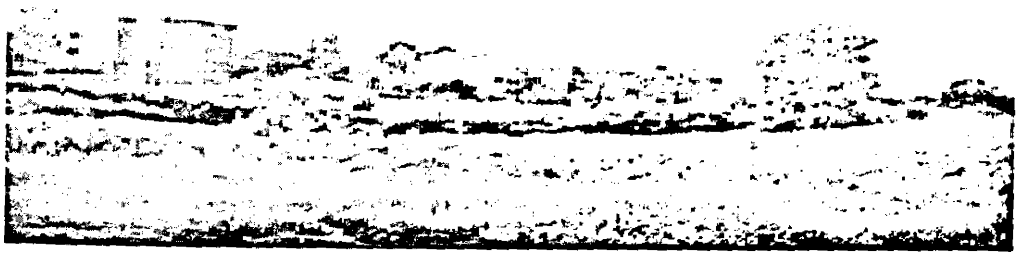
latrines for sewage disposal. This is still a very high number of pit latrines granted that the plot sizes have been declining over time to sizes as small as 0.09Ha.

About 53% of landlords have built more than 10 dwelling units for renting yet only 6.7% have provided more than 5 toilets for their tenants. This implies a problem for tenants during the morning rush hour when about five households have to queue in order to use one toilet. This not only dehumanises them but also results in delays to work.

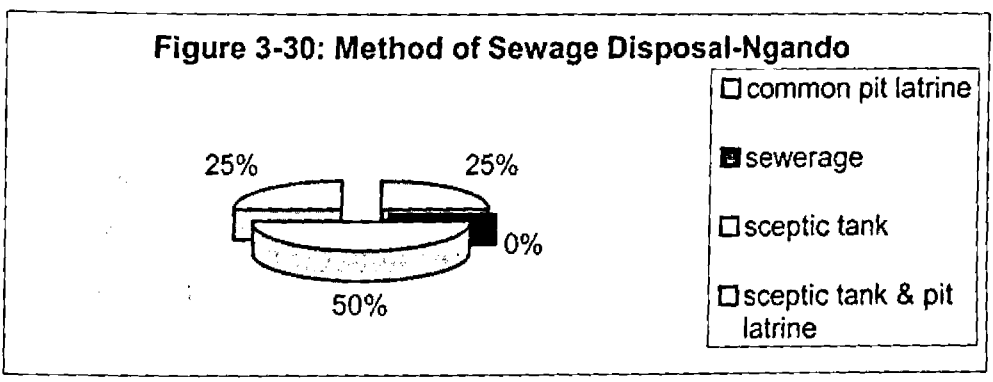
Plates 3-8: Pit Latrines



3-9 High-rise residential buildings in an area with no sewer- Satellite



All landlords in Suna are connected to NCC sewerage system. In Racecourse all landlords use pit latrines for sewage disposal though the area is served to NCC sewerage system.



Source: Field Study (2002)

Figure 3-30 shows that in Ngando 50% of landlords use septic tanks, 25% use pit latrines while 25% use both septic tanks and pit latrines. Ngando is not served by NCC sewerage system yet it is adjacent to areas that have already been connected. In Kinyanjui about 50% of landlords use septic tanks while the rest use both pit latrines. In Satellite all landlords use both septic tanks and pit latrines.

Quality of Sewage Disposal Services

Guided by the profit motif some landlords have only provided makeshift pit latrines, which are unfit and inconvenient for human use. The tenants however seem to have accepted the status quo.

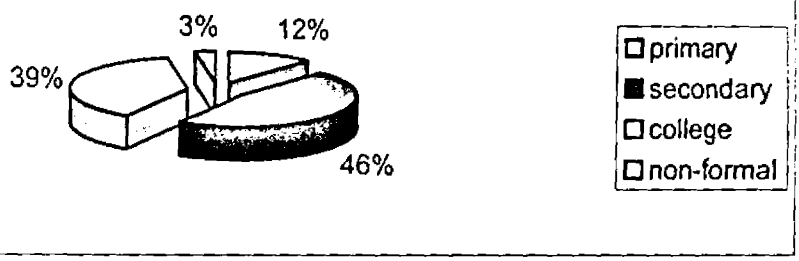
Plate 3-10: Makeshift Pit latrines

Note its proximity to dwelling units

These facilities are conveniently located within the plot about 5 to 10 meters from the housing units. Though about 59% of these facilities are maintained by users, about 30% are not maintained at all. It follows then that 30% of facilities are in very poor hygienic conditions. This is interesting because the sampled tenants were relatively well educated and thus expected to keep the latrines in a hygienic condition.

All landlords however have maintained high standards of sewage disposal hygiene. This is because they have set aside a facility for their exclusive use. The assumption here is that tenants would keep the latrines clean if each dwelling unit was assigned a latrine for its exclusive use.

Figure 3-31: Education Levels for Tenants



Source: Field Study (2002)

Figure 3-31 shows that about 47% of tenants have been to secondary schools, 38 percent to colleges and 12% to primary schools. The unhygienic conditions cannot therefore be attributed to lack of education. They can be attributed to lack of community awareness of the dangers posed by unhygienic pit-latrines or to sheer negligence.

Access to Sewage exhaustion

On overall, the sewage disposal services are very poor. About 61% of the tenants claim the pit-latrines were exhausted after a period of 4 years. About 5% claim their landlords dig alternative pit latrines and abandon the old one, while another 10% claim the landlords drain the sewage into canals and open drains.

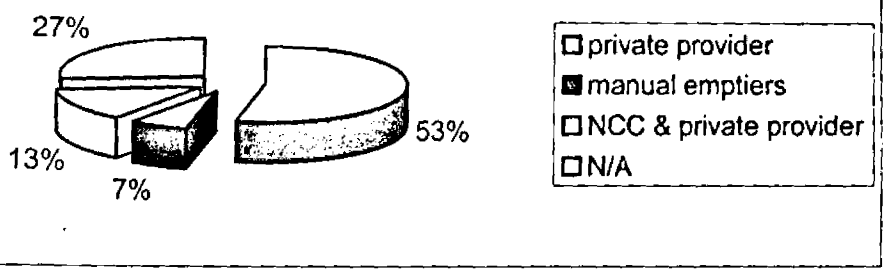
Plate 3-11: Sewage flowing along open storm water drain

Plate 3-12: Man at work amongst his waste

This sewage eventually drains into Nairobi River. Considering that this proportion is only out of 75 tenants the real proportion from the total population of 65,000 is likely to be much higher. This gives an indication of the magnitude of the pollution of Nairobi River.

In Ngando where pit latrine usage was highest due to overcrowding, exhaustion was done between a period of 2 and 4 years. This implies danger in terms of contact between human waste and human beings resulting in high incidence of intestinal worms and skin infections in the area.

Figure 3-32: Sewage exhaustion Provider

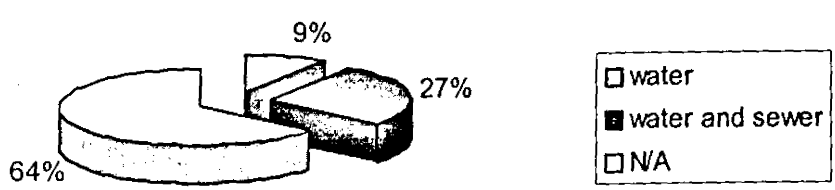


Source: Field Study (2002)

Figure 3-32 shows that NCC provides13% of exhauster services for the tenants while 53 % is provided by PSP and manual emptier account for 7%. It is important to note that the private service providers took the larger share in provision of exhaustion services yet this area is under the jurisdiction of NCC.

For the landlords in both Ngando and Kinyanjui 75% depend wholly on private service providers for sewage exhaustion. Despite the fact that some residents pay for both water and sewer, NCC only provides 13% of sewage exhaustion services.

Figure 3-33: Charges Included In Water Bill



Source: Field Study 2002

Figure 3-33 shows that about 27 % claimed their water bill included charges for both water and sewer. When asked to explain this anomaly one lady claimed that she had forwarded her complaints to NCC who had promised to withdraw the sewer charge.

The foregoing indicates that NCC provides a dismal 13 % of sewage exhaustion services meaning it has outlived its usefulness since PSP have almost taken over. This makes a good case for privatization of exhauster services among other services.

Quality of Sewage Exhaustion Services

Except for Ngando the quality of sewage exhaustion services in other clusters is satisfactory. In Ngando about 25% of exhauster services are provided by manual emptier. This increases the danger of contact with human beings exposing them to sewage related diseases such as skin infections and intestinal worms.

Sewage Recommendations

About 42% of tenants recommend that NCC provide trunk sewer while 11 % recommend repair of blocked sewer. For most of the landlords sewage disposal was not an issue since they had either sewerage or septic tanks.

3.3.3 Solid Waste Disposal

Demand for Solid Waste Services

Solid waste disposal is a major problem in Riruta and a walk along the streets is evidence to this fact. Although the total solid waste generation could not be precisely ascertained, the researcher adopted waste generation rates by a study done by Syagga (1992), which put it at 0.4kg per capita per day. Since Riruta had a population of 65000 people (GOK 1999) then the solid waste generated was

calculated at 26 tons per day. On this basis, the researcher found that if this waste is not collected within seven days then it accumulates to 182 tones. This is a very enormous amount of solid waste and therefore begs for timely and efficient management.

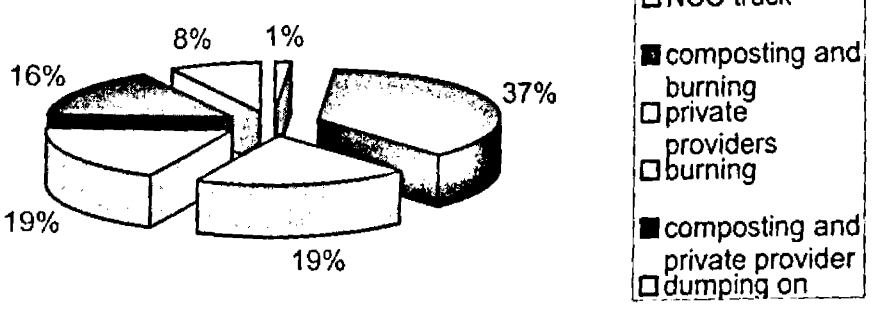
The study concluded that, if NCC is to provide solid waste disposal services, in Riruta then it must provide a minimum of 9 bulk containers of 3 tones capacity. Alternatively this rate of generation implies a demand for dumping sites, which can act as transfer sites where people can dump waste before collection by NCC or other providers of services on a daily basis.

Following the same argument the population of Riruta will be 170,300 people by year 2020. This population will be generating an estimated 18 tons per day and will therefore require 23 bulk containers.

Access to Solid Waste Disposal Services

The situation on the ground indicates that there is little if any solid waste disposal services from NCC, yet the council has an obligation to the residents to provide these services.

Figure 3-34: Methods of Garbage Disposal-Tenants



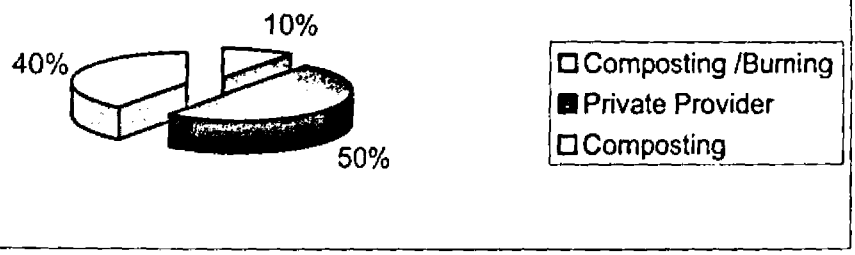
Source: Field Study (2002)

Figure 3-34 shows the Methods of Solid Waste Disposal used by tenants. It indicates that 37% of tenants rely on composting and burning, 16% on Private Service providers while 8 % dumped on the roadside. NCC provided a dismal %. This is rather interesting because Riruta lies within the city boundaries and therefore is under the Jurisdiction of NCC in which case then NCC has an obligation to ensure that the area is clean and sanitary as provided for by section 116 of the Public Health Act.

Plate 3-13: Indiscriminate solid waste disposal

If 37 % of the tenants are using composting, then they must, of necessity, have places to do so. All the tenants sampled indicated that NCC has not provided solid waste disposal sites for solid waste disposal. Declining plot sizes due to increased subdivisions implies that in future composting will not be tenable. For those who cant compost their solid waste they dump on the roadside or along the watercourses blocking drains and polluting the river.

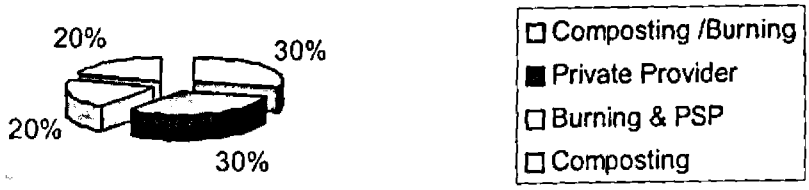
Figure 3-35: Methods of Solid waste Disposal-Suna



Source: Field Study (2002)

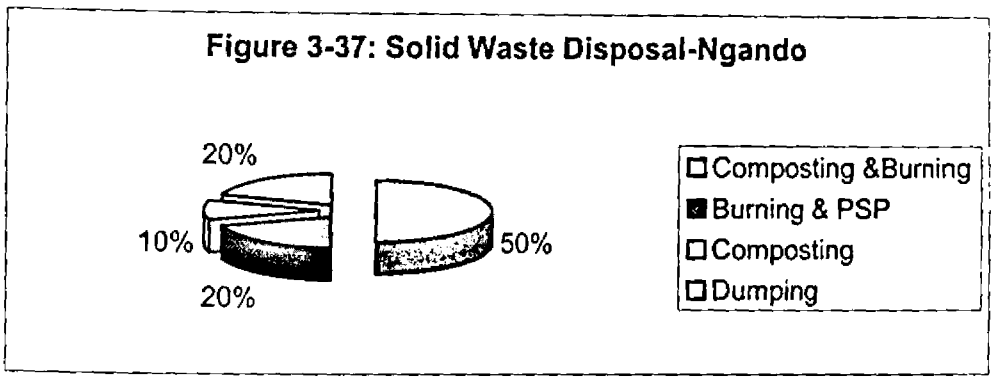
Figure 3-35 shows the methods of solid waste disposal in Suna. It indicates that about 50% of tenants in Suna are using private service providers for waste disposal.

Figure 3-36:Methods Solid Waste Disposal-Racecourse



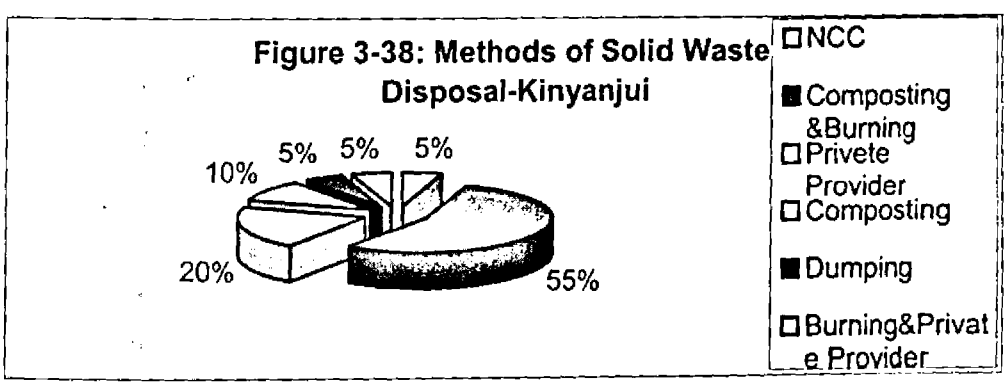
Source: Field Study (2002)

Figure 3-36 shows the methods of solid waste disposal in Racecourse. It indicates that about 30% are using private service providers while another 30 % are using composting and burning.



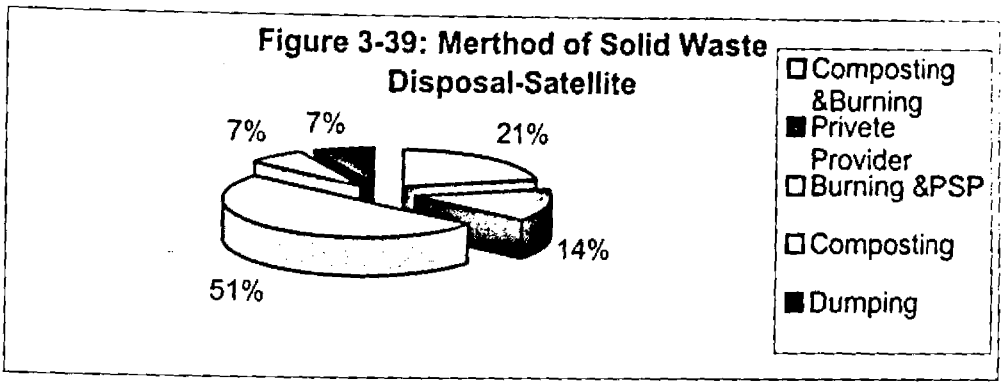
Source: Field Study (2002)

Figure 3-37 shows the methods of solid waste disposal in Ngando. It indicates that about 50% are composting and burning their waste. Only about 20% are using private service providers. Please not that 20% are dumping solid waste on the roadside.



Source: Field Study (2002)

Figure 3-38 shows the methods of solid waste disposal in Kinyanjui. It indicates that about 58 % of tenants are composting their waste while about 21% are using private service providers.



Source: Field Study (2002)

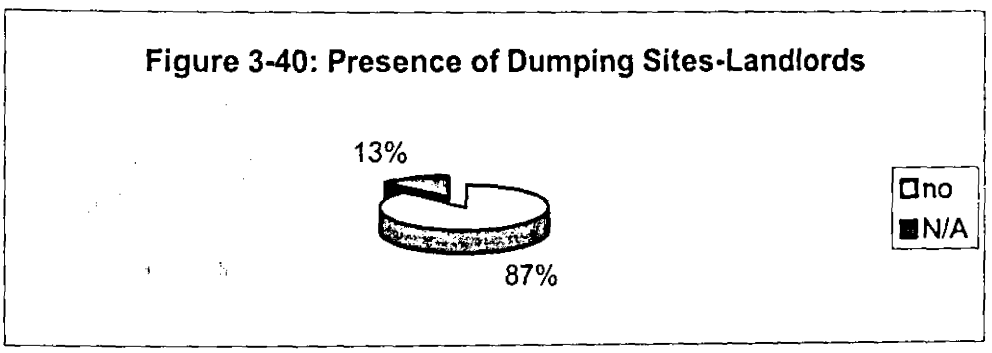
Figure 3-39 shows the methods of solid waste disposal in Satellite. It indicates that about 51% of tenants in Satellite are using both private service providers and burning for solid waste disposal.

The cost of solid waste disposal ranges from Kenya shillings 101 to 250. However, only 35% of tenants used private service providers meaning that most tenants prefer to burn, compost or dump garbage. This may be attributed to lack of adequate finance granted that 31% of the tenants are unemployed. Any proposals for solid waste management therefore need to take cognizance of this fact.

Most landlords have improvised by using other methods of solid waste disposal, rather than waiting for the council to collect it. However, in Satellite they dump indiscriminately on the roadside.

In Suna, about 50%of landlords use private service providers for solid disposal services, while the rest either burn or compost solid waste. In Racecourse 50 % use PSP while the rest burn their garbage. In Ngando 50% used PSP while 25% burn. In Kinyanjui composting and private service providers are used by 75% of landlords This implies high dependence on PSP for solid waste disposal.

It is surprising that in Satellite about 67 % of the landlords dump garbage on the roadside. For this reason therefore 67% of landlords have suffered from respiratory tract infections and in all cases rodents were a big problem.



Source: Field Study (2002)

Figure 3-40 shows that in all the clusters all landlords indicated they had no site for dumping their solid waste.

Plate 3-14: A Waste-collector at Work.

The waste collectors are not regulated so scatter garbage all over the place

Only 19% of tenants reported that members of the community recycled waste. The waste recyclers were mostly waste collectors who sold it elsewhere in Nairobi. This calls for community awareness program to teach people residents

how to recycle waste since much of the wastes consist of domestic waste and papers. This will in turn reduce the tonnage of solid waste to manageable levels.

Quality of Solid Waste Disposal Services

The quality of solid waste disposal services for tenants is poor, in Ngando where 20 percent are dumping solid waste on the roadside. In Suna and Satellite however they have 50 percent are using PSP while in Racecourse 30 percent are using PSP.

The quality of services for landlords in Suna, Racecourse and Kinyanjui is satisfactory. In Satellite however the quality of services are poor since 67 percent of landlords are dumping solid waste. This dumping has serious implications on the health of residents and environment quality.

Plate 3-15: Children at Play in the midst of garbage

Note the children are oblivious of the dangers they are exposing themselves to

Plate 3-16: A Heap of Solid Waste

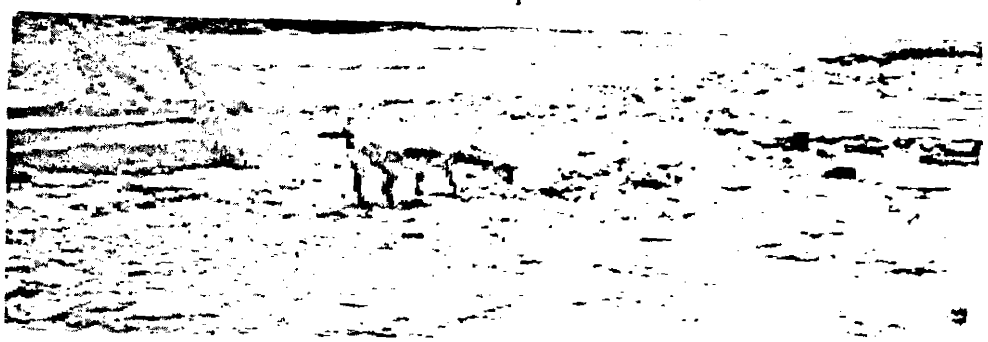


Plate 3-17: Goats partake of solid waste as they scatter it

The goats fattening for man's consumption

Solid Waste Recommendations

The interviewees offered several recommendations that they think would resolve their predicament. About 65% of tenants and 13% recommend provision of solid waste services and dumping sites by NCC.

About 47% of landlords recommend that NCC provide them with solid waste disposal services while about 20% and 13% recommend provision of community education and of dumping sites.

3.3.4 Drainage

About 80% of water consumed ends up as wastewater (Mairura 1988). If all tenants are receiving 100l of water per week on average then all of them are receiving 15l/household/day. Out of this 12l/household/day is disposed as wastewater. Though this amount is negligible, considering the water shortages in the area, clogging of drains by indiscriminate solid waste and raw sewage disposal complicates its disposal.

Plate 3-18: The Drain cum Sewer

Plate 3-19: Clogged Drain

Note the proximity of the housing units to the toilets and the blocked drain

In Riruta, NCC has not provided drainage channels. Whatever drainage channels exist are the natural watercourses, the roads and the drainage channels provided

by each landlord on their respective plot frontages. Each landlord is responsible for construction of water drains on their plot frontage as provided by the Public Health Act. A walk through the streets indicates that even those drains that have been constructed by the landlords are clogged with solid waste, wastewater and raw sewage. This has become a fertile breeding ground for bacteria that pose danger to public health.

3.3.5 Water and Sanitation in Institutions

The education institutions visited indicate they had no problems of water supply and sewage disposal since NCC provides for the same. They however face problems of sewage exhaustion, which are created by residents of adjacent plots. The latter throw flying human waste wrapped in plastics bags and clothing to the school's toilets at night or in the early morning hours. This makes it difficult for NCC exhausters to exhaust the latrines. These institutions visited were Gichagi primary, Dagoretti Corner primary and catholic Nursery. A Summary of the state of affairs at Dagoretti corner primary school below will show the situation.

Dagoretti Corner Primary School.

This school is located near Dagoretti corner shopping center and between Suna and Ngando areas. It has a total of 600 pupils and caters for children who cannot afford formal schools.
The school is connected to NCC water supply. They receive water once weekly and store in a 30,000liter water tank. The school does not therefore experience any water problems. It has 6 pit latrines, which are exhausted once per term by NCC at a fee of Ksh.3000 per toilet.
Some members of the community who don't have toilets throw flying toilets early in the morning making the NCC exhauster unable to scoop the plastics and clothing wrappings. The school therefore hires manual emptier at Ksh.2000 per toilet making sewage exhaustion more expensive.
Although the school burns its solid waste it experiences the problem of rats, which destroy books in the classrooms and in the library.

ource: Field Study (2002)

3.4 Evaluation of Water and Sanitation Services In Controlled Versus Uncontrolled Areas

3.5.1 Water Situation

As regards water connection, Suna and Racecourse score well than other clusters because all tenants have house connections while in Ngando, Kinyanjui and Satellite communal taps are the main mode of connection. All landlords however have house connections.

The frequency of water supply was very poor with 35% receiving water once weekly. Only residents in Satellite received water twice weekly. This poor frequency of water supply from NCC makes the residents supplement their requirements with water from PSP, shallow wells and the Nairobi River.

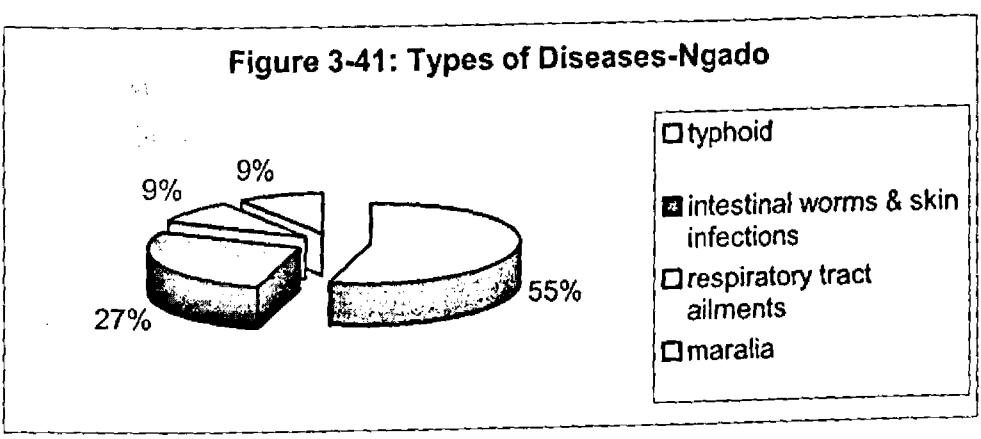
From the findings, Suna and Racecourse seem to have better coverage of NCC water services than Ngando, Kinyanjui and Satellite. However only Ngando seem

to have serious water problems and that's why about 5% of tenants are fetching water from Nairobi River. This shouldn't be misconstrued to mean that other areas of Kinyanjui and Satellite do not have water problems but it means that people in these clusters have improvised by using shallow wells. These wells as we will see later, have their own problems as well and shouldn't therefore be seen as a panacea to the water problems in Riruta.

The poor frequency of water supply and burst water pipes and poor accessibility to NCC water supply is directly related to high incidence of diseases in uncontrolled areas. The health of tenants is secure in Suna than in other clusters. In Racecourse about 10 % of tenants, have suffered from typhoid and 10% respiratory tract infections. Typhoid is related to unsafe drinking water while respiratory tract infections are related more to unhygienic living conditions.

Out of all the clusters, Ngando had the highest incidence of water-related diseases. It recorded about 55% cases of typhoid.

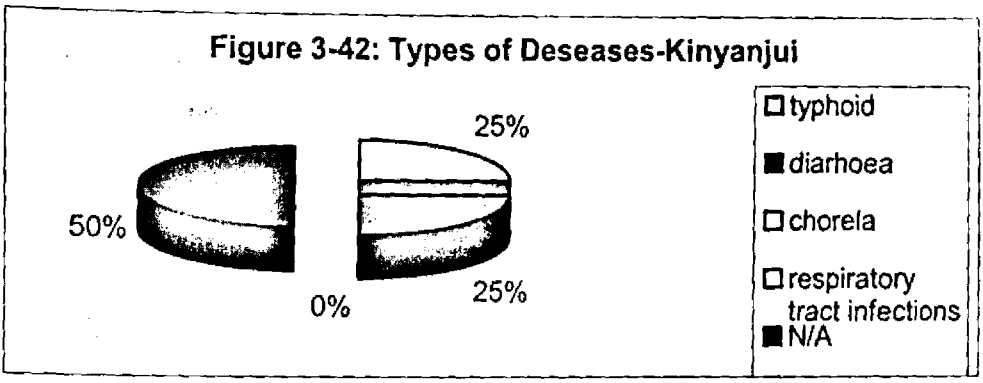
Figure 3-41: Types of Diseases-Ngado



Source: Field Study (2002)

Figure 3-41 shows the level of diseases in Ngando. It indicates that Ngando recorded 55% cases of typhoid. It also had the highest level of unemployment at

50%. The level of unemployment makes the situation even gloomier because residents have to spend the little money available to seek treatment rather than buy foodstuffs. Ngando area is the most crowded of all the clusters.



Source: Field Study (2002)

Figure 3-42 shows the types of diseases in Kinyanjui. It indicates that about 25% of tenants reported have suffered from typhoid while another 25% have suffered from diarrhea. However the level of unemployment in Kinyanjui is lower at 30% compared to Ngando.

There is a very high presence of private service providers in uncontrolled areas in water provision than in Controlled areas. Satellite has recorded 20% cases of typhoid and 7% respiratory tract ailments. The typhoid cases in Satellite can be attributed to the heavy presence of PSP whose water services is not regulated.

We can therefore conclude that, in the controlled areas of Suna, the level of water supply and accessibility to the population is higher compared to the uncontrolled areas of Racecourse, Ngando, Kinyanjui and Satellite. This is directly related to the absence of diseases in Suna while diseases are rampant in the uncontrolled areas of Ngando Kinyanjui, Racecourse and Satellite. The level and accessibility of potable water supply services is therefore directly related to the incidence of

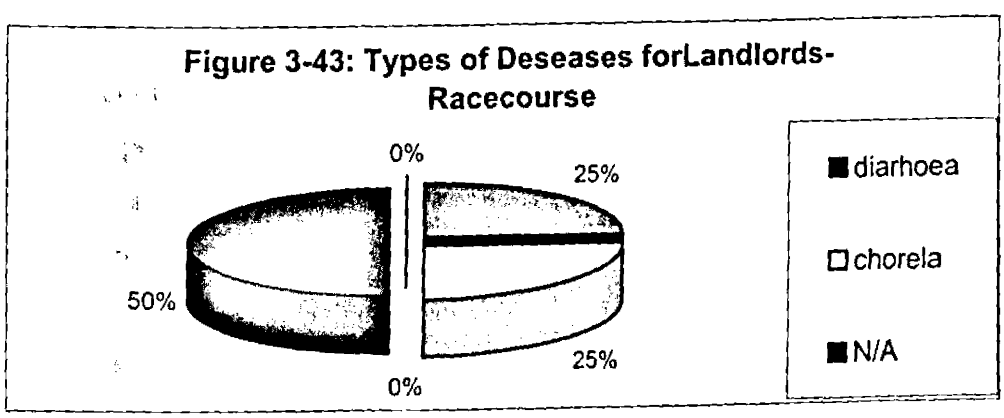
water related diseases so that where the level and accessibility is high then the incidence of disease is lower.

3.5.2 Sewage Disposal Services

All those interviewed in Suna were connected to NCC trunk sewage system and therefore did not have a problem of sewage disposal. However, 80% of them complained of sewer blockage and leakages along Wanyee road causing foul smell and inconvenience to motorists and pedestrians. It follows then that there was no incidence of sewage disposal related diseases in Suna.

In Racecourse, 80% of tenants are connected to NCC trunk sewerage system while 20% use both NCC sewerage and Pit latrines. The coverage of sewage disposal services can be said to be good in Racecourse. Due to this state of affairs then only 10% of those interviewed reported incidence of intestinal worms and skin infections, which are directly, related to poor sewage disposal services in terms of increased risk of exposure of humans to human excreta. The landlords seem to be more affected by water and sanitation diseases in Racecourse.

Figure 3-43: Types of Deseases forLandlords-Racecourse



Source: Field Study (2002)

Figure 3-43 shows the level of disease in Racecourse. It indicates that 25% of landlords have suffered diarrhea and 25% cholera.

In Kinyanjui the sewage exhaustion services are shared between NCC and PSP at about 10% each. Kinyanjui did not report any incidence of sewage related diseases, probably because it had lower population density than Ngando and Satellite.

In satellite the combination of those draining sewage to open drains and those digging other alternative pits is 43.3%. This figure implies high risk of contamination of ground water aquifers and direct pollution of Nairobi River. The level of sewage disposal related diseases are therefore higher in satellite than other uncontrolled areas, accounting for 20% of interviewees. This is due to poor level of sewage disposal services and the presence of 20% pit-latrines being drained to open drains and 20% abandoned pits, raising the incidence of contact with human excreta.

3.5.3 Solid Waste

The level of solid waste disposal services was higher in controlled areas of Suna and very poor in uncontrolled areas of Racecourse, Satellite and Ngando. Despite the fact that residents in Suna have contracted waste disposal services while other have ensured a clean environment by burning their solid waste, the area experiences problems of rodents. This may be explained by the fact that their neighbors in Ngando are not so keen on the condition of the environment and dump solid waste on the roadside. Residents of Suna therefore are experiencing the ripple effect by virtue of being neighbors to Ngando.

3.6 Summary of Issues

1. Legal administrative background of Riruta is such that planning of former farmland was not done in advance of settlements
2. Lack of enforcement of development control regulations has resulted in extensive subdivision of land without provision of attendant infrastructure and emergence of a dichotomy of uncontrolled and controlled settlements
3. Water demand has outstripped water supply despite reasonable levels of water connections from NCC. At an average household size of 4 persons the water demand per day should be 300 l per household per day but the water supply is between 51 and 100 l making a deficit of 150 l per household per day. For landlords, water demand deficit is between 900 and 1300 l per household per day. The water supply comes mainly twice a week meaning the little water supplied has to be stretched to fit one week
4. Residents have adopted coping mechanisms to deal with water deficit by digging shallow wells, buying water from PSP and fetching water from the river. About 40% of tenants use shallow wells, 17%use PSP and 1% use River water
5. Only 25% of tenants are connected to NCC sewerage system. In Ngando and Kinyanjui about 95% are using pit latrines. Therefore, there is presence of too many pit latrines in close proximity to shallow wells, posing danger of water contamination.
6. The sewage disposal services are poor where even those close to trunk sewer are not connected like Ngando. Some even throw flying toilets in school's pit latrines. About 29% of pit latrines for the tenants are in very poor hygienic conditions yet about 97% had at least some primary school education

7. About 10% of tenants and 20% of landlords drain sewage to open drains and to the river while 5% of landlords dig other pits. This pollutes Nairobi River.
8. The study found that demand for solid waste disposal services has far outstripped supply. Solid waste is calculated at 26 tons per day for 65,000 people meaning a minimum of 9 bulk containers of 3-ton capacity should be provided. In Riruta neither bulk containers nor dumping sites have been provided. About 37% of tenants used composting and burning. This will however not be tenable in future due to falling land sizes. About 67% of landlords in Satellite and 8% of all tenants are dumping solid waste on the roadside
9. The residents rely on roads and natural watercourses for drainage. The rest of the drains are constructed by landlords in an ad hoc manner and there is extensive clogging of drainage with solid waste.
10. The pattern of provision of water and sanitation services determines the pattern of incidence of water and sanitation related diseases. High incidence of water and sanitation related diseases in uncontrolled areas as opposed to controlled areas. The highest incidence is in Ngando at 55% cases of typhoid and about 29 cases of intestinal worms and skin infections. In Kinyanjui about 25% of landlords have reported cases of typhoid and 25% respiratory tract ailments. Yet Ngando and Kinyanjui have the highest levels of unemployment at 50% and 30% respectively
11. Pollution of Nairobi River with raw sewage and solid waste is rampant yet about 1 percent of sampled population uses water from this river for domestic purposes.

CHAPTER FOUR
WATER AND SANITATION STANDARDS AND PUBLIC HEALTH, ENVIRONMENT QUALITY STANDARDS

4.0 Introduction

This study has found that the pattern of provision and access to water and sanitation services, highly influences the level of public health and environmental quality. In controlled areas of Suna, where the level of access to water and sanitation services is higher, there was no incidence of water and sanitation related diseases. In uncontrolled areas of Kinyanjui, Ngando, Racecourse and Satellite access to water and sanitation services was poor and therefore the incidence of water and sanitation related diseases was higher.

The study has also observed that the pattern of access to water and sanitation services determines the level of environmental quality. In uncontrolled areas, solid waste and sewage was strewn all over the place clogging drains and resulting in flooding. This formed a good breeding ground for water and sanitation related bacteria and viruses.

This chapter will find out to what extent these findings are supported by literature review and the conceptual framework developed earlier. It will also include hypothesis tests to find out to what extent the findings from the selected sample can be generalized to the entire population.

4.1 Public Health

In the discussion on sources of water, 1 percent of tenants drew water from Nairobi River. According to WHO, total coliforms in drinking water shouldn't

exceed10/100ml, and faucal concentration should be between zero and 100ml. The Nairobi River had coliforms count between 30 and 1800 mg/l even in the watershed areas making it unfit for direct human consumption (UNEP 1999) yet about 5% of tenants in Ngando uses this water for consumption purposes.

About 33% of tenants and 50% of landlords are using water from PSP mainly in Kinyanjui, Satellite and Ngando. Since these private service providers are not regulated they can source water from any source including polluted sources. Their water cannot therefore be said to be of assured quality. This state of affairs explains the prevalence of water related diseases such as typhoid, which scores 20% in the list of diseases attacking the tenants sampled.

About 20% of tenants in Racecourse, 95% in both Ngando and Kinyanjui and 87% in satellite rely on pit latrines for sewage disposal implying very many pit latrines in the uncontrolled areas. At the same time the number of tenants relying on shallow wells is 30% in Ngando, 15% in Kinyanjui and 20% in Satellite. The shallow wells are constructed at close proximity to the pit latrines exposing them to water contamination from seepage of the pit latrines. This posed danger of infiltration of sewage effluent to ground water aquifers and eventually to the shallow wells. This partly explains the high incidence of disease in these areas.

About 68% of tenants rely on pit latrines for sewage disposal and out of these about 11 percent drain the sewage contents from the pit latrines to the open drains. This poses a health hazard to children playing on the streets and adults walking along the streets, since human excreta forms a good medium for transmission of diseases from unhealthy people to healthy ones. This explains why 49% and 9% tenants have experienced intestinal worms and skin infections plus respiratory tract ailments respectively.

The public health Act, prohibits disposal of sewage in a manner likely to endanger to the purity of any water supply or create a nuisance. It also prohibits occupation of domestic or public buildings without proper and sufficient latrine accommodation located conveniently as to be accessible to residents. It provides further that each dwelling house shall be provided with proper and sufficient and separate latrine accommodation and it gives local authorities powers to require the owner of such building to provide the latrine. In Riruta more than four households are sharing one pit latrine therefore flouting the law. In Riruta some residents in Ngando have no pit latrines and depend on pit latrines from neighboring schools.

The proportion of tenants using burning for solid waste disposal is about 56%. That explains why 16 percent of tenant's households suffered from sneezing while 69% experienced bad odors. It also partly explains the presence of 9% of tenants suffering from respiratory tract ailments.

About 8% of tenants dump the solid waste on the roadside and this results in a number of problems namely: insects, rodents and flooding 22%, 13% and 12% respectively. The insects and rodents experienced in almost 75% of households are good vectors for diseases transmission to human beings. The rodents scatter the solid waste into the open drains and these results in flooding when the rains set in.

Owing to poor enforcement of the Public Health Act, landlords rarely clear the drains near their compounds therefore, worsening the problem further. The Act gives powers to local authorities to require owners of building without a drain to make a drain emptying into any sewer belonging to the authority and to maintain it. Stagnant water forms a good breeding ground for mosquitoes and this explains why about 1 percent of tenants have experienced malaria. The Public Health act makes it illegal for anyone to allow presence of water that can allow breeding of

mosquitoes. A profile of diseases that are reported to the health centers in and around Riruta indicates a worrying trend. Diseases such as malaria and typhoid appear to be the order of the day.

Table 4-1: Diseases Reported to Health-Centers (per day)-Riruta

	Typhoid	RTA	Amebiosis	Diarrhea	Malaria	TB
Dagoretti Corner NCC		15	8	10	8	5
Mid-hill Clinic	10		2	4	5	
Riara Health		6		4		6
Orthodox Clinic		5			1	
Al Gadhir Clinic	2	45	18	16	33	20
Total	12	71	28	34	47	31

Source: Field Study (2002)

Table 4-1 shows the number of water and sanitation diseases reported to the health clinics in adjacent to around Riruta per day. It is important to note that these are cares that are reported and that there is likely to be cases that are not reported due tot lack of funds. The figures show that the level of public health in Riruta is very poor.

Plate 4-1: Patients waiting for treatment at Al Gadhir Clinic

The cost of treatment for water and sanitation related diseases is an opportunity cost for residents in terms of money that would have been spent on other needs such as nutritious foods and possibly development projects such as education for their children. Since a sickly population cannot contribute to nation building then the water and sanitation situation is contributing to losses in terms of man-hours lost when people are sick. Urgent attention is therefore required to address the causes of water and sanitation diseases rather than treating the symptoms.

4.2 Environment Quality

The Public Health Act makes it illegal for anyone to construct septic tanks, which have drains, or has any outlet into any sewer. In Riruta this is the practice in uncontrolled areas where 10% of tenants drain their sewage to the open drains. Direct observation shows that about 20% of landlords are draining sewage into open drains. There is therefore widespread accumulation of wastewater and sewage on open. The waste mix creates an eye sore and an environment health hazard. It also forms a good breeding ground for water and excreta pathogens such as poliovirus, salmonella typhi and e-coli (Kilbermatten 1980, Mairura 1988).

The solid waste disposal on open drains and the drainage of pit latrines to the river result in pollution of the Nairobi river waters. According to UNEP, unpolluted water will usually have BOD levels of 2mg/c O_2 or less. For Nairobi river BOD levels are between 40 and 4400 mg/c O_2, indicating pollution of the whole river system including the watershed area. The Western part of the river basin including Dagoretti area, has BOD levels of between 40 and 78.5 mg/c. When we compare these levels with raw sewage, which has BOD of about 600 mg/c O^2, and treated sewage, which has BOD of between 10, and 100mg/cO_2 we find that the river has BOD levels within the range of treated sewage.

Table 4-2: Nairobi River Average Annual BOD5 (1999)

Sampling Point	BOD5 mg/L	Coli
Ondiri Swamp	43	50
Dagoretti Bridge	45.8	80
Naivasha Rd Bridge	50.6	130
J Gichuru Rd	72.5	49
Museum Hill	73	225

Raw Sewage-BOD5 mg/l

Unpolluted Water-BOD5 2mg/l

Drinking Water (WHO)-less than 10 Coliforms per 100ml

Source: UNEP (1999)

Table 4-2 shows the BOD5 and coliform count for Nairobi River by sampling points. It indicates that BOD5 levels are increasing as one moves downstream from 43.5 at Ondiri Swamp to 73 at Museum Hill. It also indicates that coliform count increases as one moves downstream from Ondiri Swamp to Naivasha Rd Bridge but declines at James Gichuru Road and then increases at Museum Hill. Riruta lies between Dagoreti Bridge and Naivasha Road Bridge which recorded

between 45.8 BOD5 mg/l, 80 coliforms /100 liters and 50.6 BOD5 mg/l, 130 coliforms /100 liters

The researcher however thinks that BOD levels in the study area are much more than UNEP would want us to believe. UNEP gives a BOD level of 40 and 78.5 mg/c O_2, but the situation in the study area indicates BOD close or equal to 600mg/c O_2 similar to the BOD levels of raw sewage. The status of pollution of the Nairobi River is not consistent with good environmental quality. To imagine that some 8% of sampled tenants depend on this water for domestic purposes is beyond comprehension.

Plate 4-2: Nairobi River Pollution

Plate 4-3: Pollution of Nairobi River with sewage

4.3 Chi-Square Analysis

Chi-square analysis answers the question whether there exists any relationships between the dependent (X) and the independent (Y) variables under study. The researcher formulated the null hypothesis and the research hypothesis and used chi-square to test the difference between the observed values and the expected values for the data. If the difference is "too big" we reject the null hypothesis Ho and if the difference is too "small" we reject Ha and accept the Ho.

4.3.1 Hypothesis one

Step one:

1. Ho-The sources of water do not reduce the level of public health standards in Riruta
2. Ha-The sources of water reduces the level of public health standards in Riruta

Table 4-3: Source of Water in Relation to Incidence of Disease

	NCC	PSP, Shallow wells, and River	None	Total
Typhoid	10	7	41	58
Intestinal worms & respiratory tract ailments	5	11	16	32
Total	15	18	57	90

Figure 4-3 shows the relationship between sources of water and incidence of water and sanitation related diseases. It indicates that PSP, shallow wells and Nairobi River contribute to the highest incidence of disease at 18 cases.

Step two: Compute the expected values (E)

Where E=r.c/n

r row total

c column total

n sample size

Step three: Compute the chi-square $\chi^2=\sum (O-E)^2 /E = 5.225$

Step Four: Compare computed chi-square with the critical chi-square from the tables at confidence level already determined as 95% in the methodology section. The degrees of freedom have been calculated as (c-1)(r-1)=2.

Critical chi-square at two degrees of freedom=$0.103_{(1,0.05)}$

Therefore, computed chi-square is greater than critical one and it falls in the shaded area at the tail of the distribution. We therefore reject the null hypothesis (Ho) and accept Ha which states that, sources of water reduce the level of public health standards in Riruta.

4.3.2 Hypothesis Two

Following the same process of analysis the second hypothesis is tested as follows:

1. Ho-The methods solid waste disposal do not reduce the level of environment quality standards in Riruta
2. Ha-The methods solid waste disposal reduces the level of environment quality standards of in Riruta

Table 4-4: Methods of Solid Waste Disposal in Relation to Environment Quality

	Composting & burning	PSP	Dumping	Total
Insects& rodents	18	18	5	41
Bad odor, untidiness, flooding	16	8	5	29
None	8	7	5	20
Total	42	33	15	90

Figure 4-4 shows the relationship between the methods of solid waste disposal in Riruta with the standards of environment quality. It indicates that composting and burning contributes to the highest number of problems.

Computedχ^2 =3.4296 is greater than critical χ^2=0.711$_{(4,0.05)}$

We therefore reject the null hypothesis (Ho) and accept Ha which states that, the solid waste disposal methods reduce the standards of environment quality in Riruta.

4.3.3 Implications of Hypothesis Tests

Through the chi-square analysis the researcher has accepted the research hypotheses that, sources of water and methods of solid waste disposal in Riruta reduce the level of public health and environment quality respectively. These findings are consistent with the water and sanitation situation in Riruta and can therefore be generalized for the entire population.

4.4 Summary

1. About 5% of tenants are using Nairobi River water for consumption yet a study by UNEP found that the river has coliform count of between 30 and 1800 mg/l of water even in the watershed areas (UNEP 1999).
2. About 16% of tenants and 33% of landlords source water from private service providers yet PSP are not regulated and therefore can source water from any source including polluted sources. This explains the high levels of typhoid at 20% and 25% of tenants and landlords, respectively
3. About 95% of tenants in Kinyanjui and Ngando and 87% in Satellite rely on pit latrines for sewage disposal yet about 3%, 15% and 20% in Ngando, Kinyanjui and Satellite respectively use water from shallow wells. The latter are constructed in close proximity to the pit latrines exposing them to danger of disease contamination from the pit latrines

4. The public Health Act (cap 242), requires that each dwelling unit should have a separate pit latrine, yet in Riruta more than five dwelling units are sharing one pit latrine
5. About 8% of tenants are dumping solid waste on the roadside resulting in problems of insects, rodents and flooding at about 23 percent, 13 percent and 12%. About 67% of landlords in Satellite are also dumping solid waste. This indiscriminate dumping clogs drains and results in presence of stagnant water forming breeding ground for mosquitoes. This explains the incidence of malaria in about 2% of tenants and 47 cases of malaria reported in health clinics in the area per day
6. About 10% of tenants and 20% of landlords are draining sewage into open drains that is made worse by indiscriminate dumping of solid waste. This waste mix, not only creates an eye sore, but also forms a perfect breeding ground for disease causing pathogens such as poliovirus and salmonella typhi (Kalbermatten 1980, Mairura 1988)
7. In the health clinics, the common water and sanitation related diseases reported are 71 cases of respiratory tract ailments, 47 cases of malaria, 34 cases of diarrhea and 12 cases of typhoid per day among others
8. There is extensive pollution of Nairobi River by solid waste and sewage shown by UNEP at BOD levels of 40 and 4400 mg/c O_2
9. The hypotheses tests indicate that sources of water reduce public health standards and that solid waste disposal methods reduce environment quality standards in Riruta. These results are consistent with the situation of water and sanitation standards in Riruta and can therefore be generalized for the whole of Riruta

CHAPTER FIVE
REORGANIZATION OF RIRUTA AND POLICY RECOMENDATIONS

5.0 Introduction

This study set out to identify the causes of uncontrolled developments and their impacts on water and sanitation services in Riruta and to suggest approaches to sustainable provision of the same in order to make it a satisfactory urban development area.

The data collected by the study was cleaned and descriptive statistics computed such as the mode, frequencies and percentages. The frequency distributions were later represented in form of bar charts and pie charts in order to show trends of distribution much more vividly. The relationships between the variables under study were then tested using the Chi-square analysis at 95% confidence level. The researcher picked the salient points from the observation sheets and transferred them to sketch plans and maps in order to locate the problem areas spatially. Maps, sketches and plates were used to present data such as regional location of Riruta and the magnitude of water and sanitation problems in Riruta.

5.1 Summary of Findings

5.2.1 Causes of Uncontrolled Developments In Riruta

The first objective of the study was to examine the causes of uncontrolled developments in the fringe areas of Riruta. The study has identified several push and pull forces at work in Riruta. The push forces are urbanization, inadequate housing supply in the city center, increasing land values in the city center relative

to Riruta, while the pull forces are the legal administrative background of Riruta, lack of enforcement of development control regulations, extensive subdivision of land and availability of cheap housing.

The study has found that urbanization has resulted in an imbalance of the urban system of population, space and networks. This has been caused by urbanization forces, which have given rise to increased population in Nairobi city center hence a rise in demand for housing and other infrastructure services against a slow growth rate in housing supply. This has resulted in a rise in price of housing pushing middle and low-income earners to the illegal settlements abutting the CBD or to the periphery in areas such as Riruta.

This has consequently resulted in a rise in demand for housing in Riruta, implying increased subdivision of land to even up to 0.09ha, in order to satisfy the growing demand for housing. The lands office has reported receiving at least 10 subdivisions in a month. This scenario has been encouraged by factors such as the legal administrative background of the area and lack of enforcement of development control regulations. The area was formerly under Kiambu county council with basically rural farmlands. After it was annexed to Nairobi, the land remained in the hands of locals who were to surrender original certificates in exchange for new leases from the government. Some heeded the advice but others didn't. Under the circumstances, control on use of land by the lessor (Government) is very limited and owners use it as they please.

Failure to enforce development control has been complicated by the fact that until the enactment of the Physical Planning Act, there has been a sort of a vacuum in development control since the need to control development was fragmented in various government and local authority departments. Responsibility for development control was thus vague and has been responsible for the current

muddle of development scenario we are faced with. The Act has given powers to local authorities to control development in their respective areas of jurisdiction but these powers are inadequate since the local authorities cannot prosecute offenders. The powers to prosecute have been given to the attorney general instead. The act has also failed to recognize other existing acts such as the Registered Land Act (RLA), which gives interest in land to individuals and by so doing these individuals deal with land as indicated in the lease given to them.

Development control is an important facet of development in that it fosters the public interest of safety, health and environmental quality. Absence of the same as in the case of Riruta therefore implies that the public interest is being ignored at the expense of the private interest.

5.2.2 Impacts on Existing Water and Sanitation Services

The second objective of study was to examine the impacts of uncontrolled developments on water and sanitation services in Riruta. The study has found that the 1973 Nairobi Metropolitan Growth Strategy (NMGS) covered Riruta but city fathers have failed to implement the strategies of the plan since the plan was not tied to the financial budget of the city. NCC rationalized the plan instead, by allowing for the investment of modified alternative infrastructure and committed the private sector to provide the same.

In areas where original owners sold land to organized developers such as Suna Developers, the latter have constructed housing estates and provided trunk sewer, water supply system and tarmac roads. Where land was sold to private individuals they have provided either septic tanks or pit latrines for sewage disposal. Driven by the profit motif the private individuals have built many low cost housing units without regard to the building standards. This has given rise to a dichotomy of

two kinds of settlements, well planned/controlled settlements such as Suna and Santak and unplanned/uncontrolled settlements in Ngando, Kinyanjui and Satellite among others.

The pattern of access to water and sanitation services follows the pattern of control of settlements. In the planned settlements all are connected to NCC water supply system, receiving water once weekly. Only two landowners were not connected to NCC sewerage system. About 50% hired the services of private service providers for solid waste disposal while the other half composted or burnt solid waste.

In uncontrolled/unplanned settlements, the level of water and sanitation services varied between them. The water demand per household was 300l but they only received between 50 and 101l, a deficit of 150l per household per day. This water had to be shared to last a whole week. With household sizes of 4 persons, one can begin to understand the magnitude of the problem. In Ngando, Satellite and Kinyanjui therefore, residents supplement their water requirements with shallow wells and private service providers. The problem is however most pronounced in Ngando where 30% use shallow wells and 15% are not connected to NCC water supply.

Only Dagoretti corner, parts of Kawangware and Racecourse are connected to NCC sewerage system. Even at Racecourse 50% of landlords are not connected to NCC sewerage system explained by frequent shortages of water supply. In Kinyanjui and Ngando, 95% of tenants use pit latrines for sewage disposal. This is a very heavy presence of pit latrines and at close proximity to shallow wells. This, compounded by declining plot sizes implies danger of water contamination. About 10% drained sewage to the open drains resulting in pollution of Nairobi

River when it rains. A further 10% have dug alternative pits while abandoning earlier ones.

The demand for solid waste disposal services is higher than supply with Riruta generating an estimated 26 tons of solid waste per day. About 37% of tenants relied on composting and burning for solid waste disposal. The study has found that with declining plot sizes composting and burning will not be tenable in future.

Since NCC has not provided dumping sites 8% of tenants are dumping solid waste on the roadside and along the watercourses. The mixture of solid waste and sewage creates a powerful breeding ground for disease vectors such as salmonella typhi and polio melitus virus making the area inconducive to human settlement.

5.2.3 Water And Sanitation Standards And Public Health, Environment Quality Standards

The third objective of the study was to evaluate the existing water and sanitation standards against the public health standards and the environment quality standards. The study has found that the existing water and sanitation services in Riruta are not consistent with a good public health standards and environment quality standards.

The level of public health follows the pattern of access and quality of water and sanitation standards in Riruta. The level of public health in planned/controlled areas of Suna is higher than in the unplanned/uncontrolled areas of Racecourse, Ngando, Kinyanjui and Satellite. No diseases were reported in Suna while diseases were prevalent in Ngando with 55% interviewees reporting having suffered from typhoid.

The level of environment quality standards is higher in planned/uncontrolled areas where the level of access and quality of water and sanitation services is higher. The standards are lower in unplanned/uncontrolled areas since level of access and quality of water and sanitation services is lower. An interesting scenario is in Racecourse, where environment quality standards are very low despite connection to NCC sewerage and water supply. This is explained by the indiscriminate dumping of solid waste along the access roads and open drains.

The level of pollution along the Nairobi River estimated by UNEP at BOD of between 40 and 78.5mg/c O_2 and coliform count of between 30 and 1800mg/l even in the watershed areas of Dagoretti (UNEP 1999), indicating pollution of the whole river system. The study found that the BOD levels and coliforms count are higher in Riruta due to draining of raw sewage to the open drains and to the river. This spells doom for man who is expected to have a symbiotic relationship with the environment.

5.2.4 Approaches for Sustainable Provision of Water and Sanitation Services

The final objective was to recommend approaches necessary for improvement of water and sanitation services in order to make the area a satisfactory urban development area. The study has found that residents have ideas on what steps need to be taken to alleviate the problems they are facing. Some suggest provision of more water by NCC, provision of NCC sewer and community education on the dangers of indiscriminate dumping of solid waste.

The study has recognized the fact that the solution to the problems of water and sanitation in Riruta lies with the reorganization of the settlement and follow up to ensure development control is maintained. The study further borrows from

success stories in other parts of the world such as the El Meziquital water supply program in Guatemala, Wobulenzi water project in Uganda and water kiosks of Kibera in Kenya among others. The study suggests some of these approaches for improvement of water and sanitation standards in Riruta.

5.2 Recommendations

Based on the study findings, the researcher makes several recommendations to guide the way forward. These recommendations include policy, institutional and legal framework, land use planning of the settlement, formation of water users association, which can join efforts with a strategic partner to promote water access, provision of sewerage system and privatization of solid waste services. The study also recommends further research in areas of water quality management.

5.3.1 Policy, Institutional and Legal Framework

The study has found that the policy, institutional and legal frameworks need to be reviewed to make them more comprehensive and relevant to the current development scenario. This will be in a bid to entrench the right institutions with the right capacities to manage the prevailing urban development challenges.

Institutions

There will be need for institutional reforms to make WSD autonomous before commercializing water, sewage exhaustion and solid waste management services so that WSD can be in a position to perform the new duties efficiently. Privatization of these services will have to take cognizance of the existing CBOs and private service providers, who can form part of the solution to the problems

of water and sanitation in Riruta. This will involve building their capacities through training on issues such as efficient management.

Legal Framework

There is need to review the Physical Planning act so as to recognize other existing acts such as the registered land Act, which gives interest in land to individuals. This will be with a view to harmonizing the Acts in such a way as to repeal the sections of the RLA that are inconsistent with the PPA. If RLA gives interest of land to private individuals then PPA needs to be strengthened to have powers to control development of that land and this should be clear and unambiguous.

There will equally be a need to place planning powers and responsibilities on the community not just by legislation but also by action. This will require building capacity among the community members to regulate and control development on their own.

Policy Framework

There will be need for a clear statement of land use policy that takes account of all the facets of development control. This will be with a view to safeguarding the public interest of health, safety and environment quality. This will guard against the *'laissez faire'* attitude that developers have taken in Riruta and other upcoming fringe areas of Nairobi, such as Embakasi.

5.3.2 Land use Planning–Reorganization of Riruta

Efforts need to be made to ensure that municipal boundaries are not extended arbitrarily without preparation of development plans. This will ensure that users, minimum acceptable land sizes, which form the basis of provision of

infrastructure, are determined. To this extent the study suggests reorganization of Riruta in order to become a sustainable urban development area.

Moreover development control needs to be enforced by using communities in regulation of any development coming up in the area. This stems from the fact that reorganizing the area alone without controlling development in future will be defeatist so long as the forces exerting pressure on Riruta are still in place. Development control will involve strengthening the sections in the Physical Planning Act that require community involvement by recognizing the activities of community Associations such as Karengata. The act could also borrow from Kahawa Sukari Ltd who has managed to control development in Kahawa Sukari Estate in Ruiru (off Thika Road).

However, if communities are not strengthened, by building their capacities to control development, then strengthening the legislation alone will also fail. This will involve enabling the community members to understand the implications and importance of development control in land use.

5.3.3 Provision and efficient management of Water and Sanitation Services

Management of Water

The NCC needs to provide water more frequently. In this regard, NCC can upgrade the pumping system in Gigiri in order to increase its capacity which is currently only managing to pump 60% of daily requirements. Upgrading of internal distribution and reticulation networks will also be necessary in order to ensure that adequate water reaches the individual consumer. The water users can then be asked to upgrade their pipe dimensions in order to hook up to the upgraded water supply system.

To improve water provision and management, a privately owned company can enter into a joint venture with water kiosk owners formed by the landlords to form a commercial entity. The functions of NCC-WSD would be to supply water in bulk. The role of the joint venture would be to:

1. Buy water from NCC in bulk
2. Sell water through improved kiosk and private connections
3. Maintain the distribution network
4. Ensure consumer meters are functional

For this to work however, there will be need for institutional reforms to make WSD autonomous before commercializing water services so that WSD can be in a position to perform the new duties efficiently. Privatization is the sale of government assets to private citizens and opening up state monopolies to competition. It hinges on the neoclassical hypothesis that private ownership and management brings greater efficiency and rapid growth. Privatization broadens the base of ownership by encouraging individuals to feel as though they've a direct stake in the economy.

Another aspect would be involvement of existing PSPs in provision of water by extending them contracts. However these PSPs need to be regulated in order to ensure that they provide water of assured quality.

Meanwhile, there is need for community education on easy ways of treating water from shallow wells or simply boiling it before consumption. The researcher is limited in that she has no capacity to precisely determine the quality of water in the shallow wells and Nairobi River. The standards used are drawn from studies by UNEP on BOD levels and coliforms count of Nairobi River and WHO standards on drinking water. The researcher also used proximity of shallow wells to pit latrines as an indicator of pollution of water. Though the indicators borrowed from UNEP are good in determining water quality in the river, they

cannot be used to establish water quality in the shallow wells unless a study of the shallow wells is done. The issue of proximity to pit latrines is also not conclusive since it's only an assumption, which has not been tested. The researcher therefore recommends a further research on water quality management.

Management of Sewage Disposal

Residents have suggested provision of NCC sewerage services while others have suggested provision of more pit latrines. The option of pit latrines is not tenable because of continuing population growth and the risk of pollution of ground water sources. The presence of trunk sewer in Suna, Racecourse and parts of Kawangware is an opportunity that can be taken to connect the rest of Riruta with trunk sewer.

Since the area is under the jurisdiction of NCC then NCC has an obligation to provide it with the necessary services. The extension of the trunk sewer to cover the rest of Riruta is therefore the responsibility of the council. The council can borrow offshore loans to cover the costs of the same. The landlords can chip in by bearing the costs of individual sewer connections.

The extensive subdivision of land to even up to 0.09 ha calls for connection to trunk sewer according to the planning standards. If trunk sewer is to be provided then NCC must ensure provision of adequate water to make the sewage flow efficiently since provision of trunk sewer without provision of adequate water is self-defeating. This raises the issue of providing a package whole.

There will also be need to promote the links between sanitation and hygiene education. This will control spread of ailments that are due to negligence such as skin infections and intestinal worms. This can be done through community awareness campaigns in the local schools and through the local media.

Management of Solid Waste Disposal

There will be need to privatize solid waste disposal services by taking on board the PSP already present in the area. This will then call for regulation of PSP to ensure that they dump the solid waste in prescribed dumpsites.

There is need to provide dumping sites in each of the clusters in locations that are convenient to the residents. 3-ton large bulk containers can then be placed in each dumping site in which residents can dump to facilitate easy collection by PSP. This will help low income to access the services of PSP by reducing the cost of transport and labor for the PSP and therefore benefit from economies of scale. This is because the PSP will not have to collect solid waste from each of the dwelling units but rather from a common transfer point where neighborhood bins can be placed. The case of Burkina Faso is a good example of this arrangement. Landlords and tenants with high income can also benefit from PSP who collect waste from their compounds if they so wish.

It will be necessary to introduce use of non-motorized transport such as '*Mkokoteni*' to collect solid waste from individual dwelling units in order to reduce transport costs and environmental pollution. By so doing, employment will be created for local residents such as the youth groups and the unemployed.

There will also be need to create awareness among community members to separate organic waste from inorganic waste and use the organic waste to fertilize their flower and kitchen gardens. Moreover community members need to see solid waste as an opportunity to generate incomes through solid waste recycling. To this extent the establishment of small-scale waste recycling enterprises in Riruta will be a step in the right direction.

5.3 Conclusion

The study has been undertaken to answer four questions

1. What are the causes of uncontrolled developments in the fringe areas of Riruta?
2. What are the effects of uncontrolled developments on the water and sanitation services in Riruta?
3. What problems are associated with the existing water and sanitation standards?
4. What approaches are necessary to improve water and sanitation standards in Riruta?

The study has identified two forces of development, namely: the push and the pull factors, which are responsible for uncontrolled developments in Riruta. The push factors are namely urbanization, inadequate housing supply and high land values in the city center relative to Riruta. The pull factors are legal administrative background of Riruta, lack of enforcement of development control resulting in extensive subdivision of land and lastly cheap housing.

Both push and pull factors are resulting in the influx of population in to Riruta creating an imbalance in the urban development system in Riruta. The population is exerting pressure on existing water and sanitation services because provision of these services has not preceded influx of population so the area is not prepared for such influx. The resultant effect has been, very low standards of water and sanitation services in terms of inadequacy and hygiene and these has in turn affected the level of public health and environment quality as provided for in the public health act, the water act, the environment act and international standards from institutions such as WHO and UNEP.

The study has found that we do not have the necessary institutional, policy and legislative frameworks to cope with these changes and the study has therefore

recommended review of existing frameworks to facilitate reorganization of the settlement and to ensure the reorganization works as planned.

The study borrows from success stories in other parts of the world such as water and sanitation program in El Meziquital in Guatemala, solid waste management in Burkina Faso, Wobulenzi water project in Uganda and Kibera water Kiosks in Kenya. To this extent the study has suggested the following:

1. A complete reorganization of Riruta in order to deal with the core of its problems and building capacity of the local community to control development.
2. Provision of huge water tanks in strategic areas of Riruta and formation of water users association to manage the water as a partnership with a strategic private partner
3. Provision of NCC trunk sewerage as a matter of urgency, with landlords paying for individual connection
4. Privatization of solid waste collection services coupled by provision of dumping sites and bulk containers
5. Introduction of carts such as '*Mkokoteni*' for solid waste collection from house to house in a bid to lower the cost of collection
6. Awareness creation on use of organic waste to fertilize flower and kitchen gardens
7. Enforcement of the section of the Public Health Act on provision of drainage by landlords on respective plot frontages and to ensure maintenance of such drains
8. An overall program of community education on dangers of drinking water from shallow wells without boiling it, indiscriminate dumping of solid waste and draining sewage to open drains.. This can be done using local schools and local media.

The combined effect of the above measures will fundamentally change the existing poor environment conditions of Riruta, hence making it a sustainable and satisfactory urban development area.

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APPENDIX

Questionnaires

HOUSEHOLD QUESTIONAIRE FOR TENANTS

DLARATION: Mrs Elizabeth Nguah is undertaking a research on Water and Sanitation services in Dagoretti as part fulfilment for the award of a masters degree in Urban and Regional Planning, Faculty of Architecture, Design and Development, University of Nairobi. Any information given to her is purely for academic purposes and will be treated with utmost confidentiality.

Questionnaire Number:

Please tick any one or more as you think is appropriate

a) Household details

1. Name of respondent.....
2. Sex (1) Male (2) Female
3. Age (1) Below 18 2) 18-25 3) 26-30 4) 31-35 (5) 36-40 (6) 41-45 (7) 46-50 (8) 51-60 (9) Above 60
4. Education level (1) Primary (2) Secondary (3) College (4) Non-formal education
5. Occupation (1) Employed (2) Unemployed (3) Self employed (4) Student

Relationship to head of Household	Age	Sex	Education level	Occupation	Monthly Salary
Spouse					

b) Housing

1. How long have you settled in Dagoretti? (1) 0-1year (2) 2-4 (3) 6-8 (4) Over 8
2. From where did you come from?
3. Why did you migrate? (1) Cheap housing (2) Employment (3) Insecurity (4) Other (specify)
4. How much money do you pay for the house? (1) 1-1000 (2) 1001-2000 (3) 2001-3000 (4) Other (specify)
5. How many numbers of rooms do you have? (1) 1 (2) 2 (3) 3 (4) Other (specify)
6. How many people stay in one room? (1) 1-3 (2) 4-6 (3) 7-9 (4) Over 10

c) Water

1. How much water in jerry cans (20 liter) do you require per day? (1) 1-5 (2) 6-10 (3) 11-15 (4) over 15
2. What are your sources of water? (1) NCC (2) Borehole (3) River (4) Other (specify)
3. If answer to 1 above is NCC how much do you receive? (1) 1-5 (2) 6-10 (3) 11-15 (4) over 15
4. Who provides the water? (1) Landlord (2) Street vendors (3) Private company provider (4) Other (specify)
5. How much do you pay for the water in Ksh a)per Month? b)Per jerry can in Ksh? (1) 0-5 (2) 6-10 (3) 11-15 (4) over 15
6. What kind of supply do you have? (1) House connection (2) Communal tap (3) communal stand pipe (4) other (specify)
7. How often do you receive water? (1) Daily (2) weekly (3) monthly (4) Other (specify)

8. What diseases do you experience? (1) Typhoid (2) Diarrhoea (3) Cholera (4) Intestinal worms (5) Other (specify)
9. How much do you spend on a) Hospital bills per month?
10. What do you think should be done to alleviate the problems? (1) NCC to provide more water (2) Increase more private providers (3) Dig more boreholes (4) Other (specify)
11. If the answer to (2) above is river or borehole how far is it from your house?
12. Who fetches the water? (1) women (2) children (3) Maid (4) Other (specify)
13. What form of transport do you use to transport the water? (1) Manual (2) Mkokoteni (3) Car (4) Other (specify)

d) Sewage Disposàl

1. How do you dispose your sewage? (1) Common Pit Latrine (2) Ventilated Improved Pit Latrine VIP (3) Sewerage (4) Sceptic tank (5) other (specify)
2. If the answer to 1 above is pit latrine, how near is it to your house? (1) 0-20m (2) 21-40 (3) 41-60m (4) over 60m
3. Who cleans and maintains the pit latrines? (1) Landlord (2) Community (3) Hired help by community (4) Other (specify)
4. Is the toilet neglected? (1) Yes (2) No
5. How many people use one latrine? (1) 1-5 (3) 6-10 (4) 11-15 (4) Other (specify)
6. Do you wash your hands after using the latrine? (1) yes (2) No
7. How often is the latrine exhausted/emptied? (1) 1-3 years (2) 4-6 years (3) other (specify

8. Who exhausts it? (1) NCC (2) Private provider (3) Manual emptiers (4) Other (specify)
9. What would you desire to see improved? (1) Provide more pit latrines (2) Exhaust pit latrines on time (3) Provide NCC sewer (4) other (specify)

e) Solid waste

1. How do you dispose this garbage? (1) NCC truck (2) Composting (3) Recycling (4) Private providers (5) Burning (6) Other (specify)
2. If the answer to 1 above is NCC and private providers how much does it cost per month? (1) 0-50 (2) 51-100 (3) 101-150 (4) Over 150
3. Does the landlord provide waste disposal services? (1) Yes (2) No
4. If the NCC truck collects the garbage, how often is this done? (1) weekly (2) Fortnightly (3) monthly (4) Other (specify)
5. Do you receive water bills in time? (1) Yes (2) No
6. What charges does the bill include? (1) Water (2) sewer (3) Garbage (4) other (specify)
7. Do members of your community re-use waste? (1) Yes (2) No
8. What problems are associated with burning of waste? (1) Smells (2) Sneezing (3) Other (specify)
9. What problems do you experience in relation to poor solid waste disposal? (1) rats (2) cockroaches (3) mosquitoes (4) Other (specify)
10. What other problems do you experience concerning waste?
11. What are you doing to resolve these problems? (1) Household clean-ups (2) Community clean-ups (3) NGOs (4) Other (specify)
12. What do you think can be done to solve these problems? (1) NCC to collect garbage on time (2) Provide more garbage dump sites (3) Provide large Bins (4) Recycle waste (5) Other (specify)

THANK YOU FOR YOUR COOPERATION

QUESTIONAIRE FOR PLOT OWNERS

DECLARATION: Mrs Elizabeth Nguah is undertaking a research on Water and Sanitation services in Dagoretti as part fulfilment for the award of a masters degree in Urban and Regional Planning, Faculty of Architecture, Design and Development, University of Nairobi. Any information given to her is purely for academic purposes and will be treated with utmost confidentiality.

Questionaire Number:....

Please tick any one or more as you think is appropriate

a) **Household details**

1. Name of respondent.....
2. Sex (1) Male (2) Female
3. Age (1) Below 18 (2) 18-25 (3) 26-30 (4) 31-35 (5) 36-40 (6) 41-45
   (7) 46-50 (8) 51-60 (9) Above 60
4. Education level (1) Primary (2) Secondary (3) College (4) Non-formal education
5. Occupation (1) Employed (2) Unemployed (3) Self employed (4) Student

Relationship to head of household	Age	Sex	Education level	Occupation	Monthly Salary
Spouse					

b)Water

1. Are you connected to NCC piped water? (1) yes (2) No
2. How much water do you require per day in 20 l jerry cans? (1) 0-10 (2) 11-20 (3) 21-30 (4) other (specify)
3. How frequent do you receive water? (1) daily (2) weekly (3) Monthly (4) Other (specify)
4. Is the water adequate? (1) Yes (2) No
5. What is your other source of water? (1) Borehole (2) Private providers (3) River (4) Other (specify)
6. In what ways do you use this water? (1) Drinking (2) Washing (3) Feeding livestock (4) Other (specify)
7. Do you experience any diseases? (1) Yes (2) No
8. If yes which diseases do you experience? (1) Typhoid (2) Diarrhoea (3) Cholera (4) Intestinal worms (5) Others (specify)
9. How much do you spend on a) hospital bills per month? b) On medicine per month?
10. 10What do you think should be done to alleviate the problems? (1) NCC to provide more water (2) Increase more private providers (3) Dig more boreholes (4) Other (specify)

c) Sewage disposal

1. What sewage disposal facilities do you use? (1) Common pit latrine (2) Ventilated Improved Pit Latrine (VIP) (3) Sewerage (4) Sceptic tank (5) Other (specify)
2. If the answer to 1 above is sceptic tank or pit latrine how do you exhaust it? (1) NCC (2) Private provider (3) Manual Emptiers (4) Other (specify)
3. If the answer is NCC how often do they exhaust it? (1) 1-2 years (2) 3-4 years (3) 5-6 (4) Other (specify)

4. Where are the contents taken? (1) NCC Sewer (2) Draining to the river (3) streets/drains (4) Other (specify)
5. What do you think needs to be improved? (1) Provide more pit latrines (2) Exhaust pit latrines on time (3) Provide NCC sewer (4) Other (specify)

d)Solid Waste

1. What types of garbage do you produce? (1) Food refuse (2) Plastic (3) glass (4) Other (specify)
2. How do you dispose your garbage? 1 NCC truck 2 Composting 3 Recycling 4 Private providers 5 Burning (6) Other (specify)
3. Has NCC provided you with disposal sites? (1) Yes (2) No
4. Where are the sites? (1) 0-50m (2) 51-100m (3) 101-150m (4) Over 200m
5. How often is the garbage collected from the site? (1) Weekly (2) Fortnightly (3) monthly 4 other (specify)
6. What problems do you experience with garbage disposal? (1) Rats (2) Cockroaches (3) mosquitoes (4) flies (5) Other (specify)
7. Are there any efforts to cope with the problem? (1) Yes (2) No
8. What are this efforts? (1) Household clean ups (2) Community clean ups (3) NGOs (4) Other (specify)
9. What do you think needs to be done to solve the problems? 1 NCC to collect garbage on time (2) Provide more garbage dump sites (3) Provide large bins (4) Recycle waste (5) Other (specify)
10. Do you receive water bills on time? (1) Yes (2) No
11. What charges does the bill include? (1) Water (2) Sewer (3) Garbage (3) Other (specify)

THANK YOU FOR YOUR COOPERATION

CHI-SQUARE ANALYSIS

Hypotheses test were carried out using the chi-square (χ^2) method. This was done to answer the question whether there were any relationships between the dependent (X) and independent variables (Y), under study. If there was a relationship, the observed values (O) are not equal to the expected values (E). The chi-square was used to estimate the overall difference between observed values and expected values for the whole of the data. If the difference was too 'big', we reject the Ho and accept Ha. If the difference is too 'small' we fail to reject Ho and reject Ha.

The researcher formulated the following hypotheses:

1. Null hypothesis (H0)
2. Research hypothesis (Ha)

Procedure

Step one: Make a table called a cross-tabulation using the computer or manually to get the observed values and their totals. The column totals should be equal to the row total.

Step two: Compute the expected values. In chi-square analysis O should be equal to E for every cell if Ho is true.

$E=r.c/n$

Where

r	Row total
c	Column total
n	Sample size

Step three: Compute the chi-square

χ^2=sum of $(O-E)^2/E$

Step four: Compare the computed chi-square with the critical chi-square, which the methodology will have determined. The researcher chose 95% confidence level and therefore significance level of 0.05.

Step five: Check chi-square distribution tables by first determining the degree of freedom which is equal to (c-1)(r-1). If the observed value exceeds the critical value we reject Ho and therefore accept the research hypothesis (Ha). Since the confidence level has been chosen at 95% the significance level is 0.05. The latter is the area at the tail of the chi-square distribution.

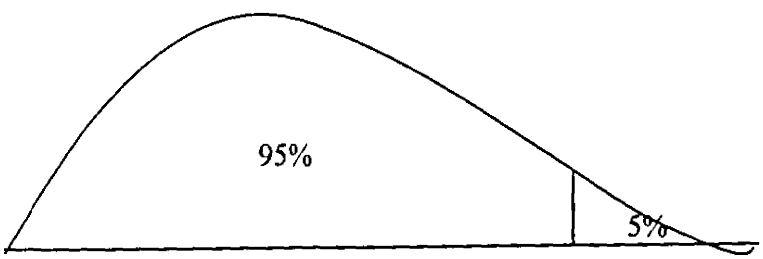

Figure1-1: Chi-square Distribution

Figure 1-1 shows a chi-square distribution. If computed chi-square falls in the shaded area at the tail we reject the null hypothesis and accept the research hypothesis