MANAGEMENT OF HUMAN WASTE IN THE INFORMAL SETTLEMENTS OF ELDORET MUNICIPALITY, KENYA: AN ENVIRONMENTAL PLANNING PERSPECTIVE

BY

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DECLARATION

Declaration by the Student

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DEDICATION

First and foremost to my good Lord the Most High and everlasting who made it possible for me to reach this far and who has good plans for me. Secondly to my wife Felecia, son Miki and daughters Michele and Claire, brothers and sisters, Sr. Demtila, and John Eric Oloo whose concern for me I will forever cherish.

ABSTRACT

In Kenya, there is current problem of rural urban migration that put immense pressure on the existing resources in the urban sector. Consequently most urban dwellers live in informal settlements. Heaps of garbage is a common phenomenon in settlements in most Kenyan towns, Eldoret town is not an exception. In most cases, uncollected wastes, which are often mixed with human and animal excreta, are dumped indiscriminately in the streets and drains. Despite the far reaching consequences that arise from poor management of human waste, it is of concern that currently, there are no serious efforts to address the situation. Thus, this study sought to assess the human waste management systems in the informal settlements using Munyaka and Langas in Eldoret Town as a case study. Qualitative research design was used and a total of 384 respondents were selected in two settlements with Munyaka having 127and Langas 257respectively. The households in the informal settlements were sampled using systematic random sampling while handlers of human waste and key informants were sampled using purposive sampling technique. The methods of data collection used included personal interviews, questionnaires, observation, photography and review of related literature. Data was analysed qualitatively and presented using descriptive statistics, frequency distributions and cross tabulations and conclusions drawn from the analysis. The results indicate that majority of the residents in both the settlements lived in rented houses. There was poor excreta disposal in both the settlements areas with over 50% of the respondents not accessible to piped water or experienced irregular water supply which meant that they would find it difficult to use sewer lines as a form of human waste disposal. The study revealed that the main facility used by residents for human waste disposal in the settlements was pit latrines which were poorly constructed not properly maintained and many were constructed near water sources mainly wells and boreholes. Some of the facilities were full and thus discharged their affluent into the environment. The study recommended that with the help of Municipal Council of Eldoret, households in Langas to be encouraged to connect to existing sewer wherever possible. Urine diversion toilets be introduced in the plots bordering farmland in Langas with a view of using urine as fertilizer. Furthermore there is need to exploit the production of biogas. It was also recommended that properly designed and constructed pit latrines, in accordance to health and environmental standards, be used in the informal settlements.

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LIST OF ABBREVIATIONS

BOD	Biological Oxygen Demand
CBO	Community-Based Organization
ECOSAN	Ecological sanitation
EIA	Environmental Impact Assessment
ELDOWAS	Eldoret Water and Sanitation Company
EMC	Eldoret Municipal Council
GOK	Government of Kenya
HW	Human Waste
HWD	Human Waste Disposal
HWM	Human Waste Management
MDG	Millennium Development Goals
NAWASSCO	Nakuru Water and Sewerage Services Company
NEMA	National Environmental Management Authority
NGO	Non Governmental Institutions
UD	Urine Diversion
UDDT	Urine Dyhydrated Diversion Toilets
UN	United Nations
WSP	Water and Sanitation Programme –World Bank Africa Region
WSSC	Water Supply and Sanitation Collaborative Council

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Urbanization is currently a major world issue. The world's urban population currently stands at around 4.5 billion and will almost double to more than 8 billion by 2050 (World Population and Housing Census Programme, 2010). The problem in the urban areas is exacerbated by an increased rural-urban migration by much young population in search of better living conditions (Beall and Fox, 2009; Schilling and Chiang, 2011; Fox, 2012). As a result these areas cannot be adequately planned for leading to proliferation and emergence of informal settlements with very squalid living conditions. One of the emerging and serious threats to the environment in most of the informal settlement is the generation of wastes (Gregory, 2009). Wastes include solid, liquid, gaseous and even radioactive substances and they contain organic, inorganic, soluble and particulate materials and micro-organisms that are diluted, dissolved and/or suspended in water. The materials come from a wide range of sources, including domestic, commercial, institutional, and industrial sources (Alexis, 2010). The waste-water from domestic, commercial, institutional and industrial sources are collectively called sanitary sewage or municipal waste-water.

The African continent is rich in its diversity of forms of informal settlement. Recent demographic studies suggest that an “estimated 72% of the urban population of Africa now lives in slums” (Cohen, 2012), and that two-thirds of all people will live in urban areas within the next 50 years, with 95% of that growth occurring in developing countries (United Nations, 2004). Sub-Saharan Africa (SSA) particularly has the highest percentage of people living in the informal sectors, who experience daily the

realities of vulnerability to a wide range of hazards in the environment including continued proliferation of human wastes, since 69% of the population do not have access to improved sanitation facilities (Hardoy, Mitlan and Satterthwaite, 2011).

Kenya is facing an increasing growth of informal settlements the urban centers. More than 34% of Kenya's total population lives in urban areas and of this, more than 71% is confined in informal settlements (UN-Habitat, 2004). These unprecedented rates of urbanization in Kenya can be linked to massive migratory movements as well as to natural growth, challenging urban planning and thereby causing low quality of housing and the general lack of basic infrastructure especially sanitation, which is a precursor to the proliferation of human wastes (Muriuki, 2009). An aggregation of human settlements, more specifically in the informal sector, has had the potential to produce a large amount of human waste (Cohen, 2006). The situation is not helped by lack of supporting policies for effective urban planning and improvement, yet the way these human wastes are handled, stored, collected and disposed off, can pose risks to the environment and to public health (Alexis, 2010).

Although the problem of human wastes and its subsequent management was more focused in Nairobi, the problem appears to be on the increase in other urban centers in Kenya. Eldoret Municipality, which is currently among the fastest growing urban centres in Kenya, may be currently affected by proliferation of human wastes than other towns such as Kisumu and Nakuru (Nyabeda and Kipkorir, 2010). Moreover, even in the urban and peri-urban areas of Eldoret Municipality, there were higher tendency of many of the local community members to use bush as toilets (Mulwa and Wasanga, 2011). In respect to the problem of human wastes, these areas are

deplorable, lacking the most basic needs and social amenities and face multi-dimensional challenges which require multi-dimensional interventions such as improved sanitation, and human waste management among other intervention (van de Klundert, 2010; Wardhani, 2012).

Human activities create waste, but it is the way the waste is handled, stored, collected and disposed off, which can pose risks to the environment and to public health. In places such as informal settlement where intense human activities are concentrated, appropriate and safe waste management (WM) are of utmost importance to allow healthy living conditions for the population. However, in many parts of the developing world many municipalities are struggling to provide even the most basic services (UNEP, 2002). Typically, in most of these regions, one to two thirds of the solid waste generated is not collected (Winbald and Simpson-Hebert, 2004; Zephora and Kirimi, 2013). As a result, the uncollected waste, which is often also mixed with human and animal excreta, is dumped indiscriminately in the streets and in drains, so contributing to flooding, breeding of insect and rodent vectors and the spread of diseases. According to the World Health Organization, over three million people die throughout the world each year from water borne diseases caused by water sources being contaminated by raw sewage (WHO, 2010). Therefore, to prevent the detrimental effects of the human wastes, they must be properly managed in an environmentally friendly approach.

Human waste management refers to the collection, transportation, processing, and disposal of human wastes (Pellikaan and Robert, 2002). Yet, human waste management is a growing public concern in many urban centres in Kenya including

Nairobi, Mombasa and Eldoret (Zephora and Kirimi, 2013). In many urban areas of the country including in Eldoret Municipality, there is acute lack of data on the status and levels of human waste management (Gesora, 2009; Nyabeda and Kipkorir, 2010). Therefore, the status of waste management in these urban areas remains relatively unknown.

1.2 Statement of the Problem

Developing countries, particularly in Africa, registered increase in population and informal settlements. Kenya registered increased urbanization as was stated in the 2009 Kenya's population and housing census results which reported the urban population as 34.7% of the total population. It is also clear that there is increased urban population in Kenya. Eldoret is the fifth largest urban centre in Kenya and, one that is steadily growing with a current population of about 400,000 persons (KNBS, 2010). The tremendous growth of urban population of Eldoret Municipality has resulted in increased informal settlements, which may exacerbated the problem of human wastes. In Eldoret, the overall wastes including the human wastes generated cannot be totality collected and disposed. According to the recent survey conducted by Open Data (https://opendata.go.ke/Counties/Households-by-main-mode-of-human-waste-disposal/5fav-vwxi), indicated that Uasin Gishu District is one of the counties that suffers higher problems of human wastes proliferation due to lack of proper human waste management equipment such as sewers, septic tanks, cess pools etc. The inappropriate manner that the human waste in Eldoret Municipality is disposed can creates serious environmental problems that affect the health of humans and animals and cause serious economic and other welfare losses. This therefore indicates that human waste management continue to be one of the major challenges in Eldoret

Municipality, with a potential to cause serious environmental degradation and public health concern. Solution to this problem encompass, the need to design better ways of management of human wastes in the town, which can be achieved if up to date information on the state of human waste management in informal settlements of Eldoret Municipality is available. Surprisingly, this kind of information is not known for informal settlements in Eldoret Municipality and thus remains a major hindrance on how to manage the human wastes in the area.

Most towns in Kenya including Eldoret do not collect the totality of wastes generated and of the wastes collected only a fraction receives proper disposal. Waste dumped in the open air which left unattended leads to environmental problems. Moreover a high proportion of the waste collected is disposed in undesignated waste disposal sites including roadsides drains and other public utility areas.

One of the major areas that have been affected by the emergence of informal settlement is keeping pace with development of infrastructure and in particular sanitation. The issue of human waste management is of crucial concern to urban planners and managers and is one of the major challenges in Kenya's urban centres that require attention. Human waste management is a significant component of sustainable environmental management and thus has to be accorded the seriousness it deserves.

Human waste is a severe threat to the public health concerns and general cleanliness. Though, the form of wastes generated in such settlements is predominantly organic and biodegradable, they are becoming a major problem to the overall sustainability of

the ecological balance. The problem that the study addresses itself to is the fact that the discharge of untreated or inadequately treated human wastes from dwelling places, and raw sewage often causes pollution or harmful effects to the environment and human health, including undesirable changes to ecosystems, reduction in the economic value of resources, environmental pollution and human health risks. With the emerging concern on large quantity of human waste being produced both in the form of faeces and urine, the concept of waste management becomes one of the key focus of sustainable development. This fact cannot be overstated when it comes to informal settlements in urban areas in Kenya.

Like most urban centres in Kenya, over 60% of the town population live in informal settlements. In Eldoret, these settlements include: Boma Turkana, Huruma, Kambi Somali, Kamukunji, Kimumu, Langas, Munyaka and Maili Nne. Eldoret Municipality has an area of 147 km^2 with 60% coverage in water supply through a reticulation of 269 km and 38% coverage of sewerage through a sewer network of 269 km. The rest of the areas use numerous dug wells for water supply and other forms of sanitation. Poor human waste management leads to negative economic impact. Health-related costs include costs due to absence from work, costs of medical treatment and even loss of life. In addition, an outbreak of serious diseases like cholera, dysentery, diarrhoea and typhoid among others, could cost millions in lost earnings. Despite these serious consequences that arise from poor management of human waste, it is of concern that currently, there are no serious efforts to address the situation. One of the likely reasons for this inaction is inadequate of information and the proper modus operandi of handling the situation. Therefore, this study sought to assess the human waste management systems in informal settlements of Langas and Munyaka in

Eldoret town. It also sought to determine key challenges and provide viable and sustainable ways of addressing this depressing environmental situation.

1.3 Objectives of the Study

1.3.1 Main Objective

The main objective of the study was to assess the human waste management system in the informal settlements within Eldoret Municipality with a focus on identifying the main challenges therein and recommending practical solutions to the challenges.

1.3.2 Specific Objectives

This study sought to achieve the following specific objectives:

1. To establish the existing state of human waste management in informal settlements in Eldoret Municipality
2. To identify the stakeholders in human waste management in informal settlements in Eldoret Municipality
3. To determine the challenges of the of HWM in informal settlements in Eldoret Municipality
4. To explore workable solutions to the challenges posed by poor HWM given the prevailing conditions

1.4 Research Questions

1. What are the existing facilities and services regarding human waste management in informal settlements in Eldoret Municipality?
2. Who are the stakeholders in human waste management in informal settlements in Eldoret Municipality?

3. What are the challenges of the existing state of human waste management system,
4. What possible solutions can the study offer with regard to the challenges posed by the current state of HWM?

1.5 Justification of the Study

Waste management in general and human waste in particular is inadequate in almost all of Kenyan urban centres. The situation is worse in the informal settlements which house over 60% of the Eldoret town's population. As earlier indicated, according to available literature and records, currently there is no effective mechanism for management of human waste in Eldoret municipality, Ineffective mechanism of human waste management is illustrated by the release of human waste all over in plastic bags or uncovered in open fields or in overflowing toilets which are often poorly designed and constructed near water sources such as wells, hence the need of the study to fill this gap.

The significance of this study is anchored on its discussion of the link between poor human waste management and environmental degradation together with resultant poor health-related impacts and costs. Furthermore, the study sheds light on the need to achieve one of the MDGs which advocates for a clean and healthy environment. It is also anticipated that the study is useful to Local Authorities in their land use planning for the benefit of Eldoret municipality residents, and other local authorities. The study provides strategies to minimize pollution by emphasizing on environmental management and improvement of existing facilities.

1.6 Scope of the Study

This study is limited geographically to Eldoret Municipality, in content to human waste management and by time to six months of study. The content of this study was limited to the human wastes and how to manage the human wastes. This study was limited by time to six months study period.

CHAPTER TWO

LITERATURE REVIEW

2.1 The context and scale of human waste

Human waste is usually referred to as by-products of digestion of faeces and urine. The materials come from a wide range of sources, including domestic, commercial, institutional, and industrial sources (Zhou, 2011). The environmental degradation caused by inappropriate disposal of human waste can be expressed by the contamination of surface and ground water through leachate, air pollution, and littering, which provide an avenue for the spreading of diseases by different vectors like bacteria, viruses, fungus, germs among others (WSSC, 2003). Human waste is a bio-waste and can be a serious health hazard, as it is a good vector for both viral and bacterial diseases. According to the World Health Organization over three million people die throughout the world each year from water borne diseases caused by water sources being contaminated by raw sewage. Nevertheless, the management of human waste is one of the challenges facing any urban area in the world. Human waste is most often transported as sewage in waste water through sewerage systems (Vinneras *et al*., 2003).

Faecal contamination of water sources is highly prevalent worldwide accounting for the majority of unsafe drinking water which is the only water available to 1.1 billion people out of the approximated 7 billion people in the world (WHO, 2000). Marimba (2005) states that faecal contamination of soil or water can be identified by the presence of *E. coli* bacteria. Even in developing countries particularly sub-Saharan Africa, it is common for sewage from sanitary sewers to overflow regularly and pollute water bodies.

Control of diseases related to water and sanitation requires ample quantities of safe water, good hygiene and good sanitary disposal of human waste. A large range of pathogenic organisms of viral, bacterial, parasitic-protozoan and helminths origins may be present in the faeces. Few are excreted with the urine. However, the main risks both with urine and grey water as well as the quantitative occurrence relates to the degree of faecal cross-contamination to these. In many developing countries, excreta-related diseases or carrier ship are common, with correspondingly high concentrations of excreted pathogens (Akinbode, 2002).

Excreta related diseases are still significant causes of mortality and morbidity in many developing countries. The transmission routes of these and the health risk factors involved are important, in order to design and implement or modify excreta use schemes so that the transmission of these diseases are reduced. The pathogens of concern for environmental transmission through faeces mainly cause gastrointestinal symptoms such as diarrhoea, vomiting and stomach cramps. Several may also cause symptoms involving other organs and severe sequels or be an interrelated factor for malnutrition. Major pathogens may be viruses, bacteria, parasitic protozoa, and helminths. The table below summarises the most common organisms in each category and the signs and symptoms or disease associated with them.

Table 2.1: Common organisms in each category and the signs and symptoms or diseases associated with them

Pathogen	Disease (Symptoms)
Bacteria	
Aeromonas spp	Enteritis
Campylobacter jejuni/coli	Campylobacteriosis (diarrhoea, cramping, abdominal pain, fever, nausea;
Escherichia coli (EIEC, EPEC, ETEC,	Enteritis
Plesiomonas shigelloides	Enteritis
Salmonella typhi/paratyphi	Typhoid/paratyphoid fever (headache, fever, malaise, anorexia,
Salmonella spp.	Salmonellosis (diarrhoea, fever, abdominal cramps)
Shigella spp.	Shigellosis (dysentery - bloody diarrhoea, vomiting, cramps, fever;
Vibrio cholera	Cholera (watery diarrhoea, lethal if severe and untreated)
Yersinia spp.	Yersinioses (fever, abdominal pain, diarrhoea, joint pains, rash)
Calicivirus (incl. Noroviruses)	Enteritis
Coxsackievirus	Various: respiratory illness, enteritis, viral meningitis
Echovirus	Aseptic meningitis, encephalitis (often asymptomatic)
Enterovirus types 68-71	Meningitis, encephalitis, paralysis
Hepatitis A	Hepatitis (fever, malaise, anorexia, nausea, abdominal discomfort,
Hepatitis E	Hepatitis
Poliovirus	Poliomyelitis (often asymptomatic, fever, nausea, vomiting, headache,
Rotavirus	Enteritis
Parasitic protozoa	
Cryptosporidium parvum/hominis	Cryptosporidiosis (watery diarrhoea, abdominal cramps and pain)
Cyclospora cayetanensis	(often asymptomatic; diarrhoea; abdominal pain)
Entamoeba histolytica	Amoebiasis (often asymptomatic, dysentery, abdominal discomfort, fever,
Giardia intestinalis	Giardiasis (diarrhoea, abdominal cramps, malaise, weight loss)
Ascaris lumbricoides	Ascariasis (generally no or few symptoms; wheezing; coughing; fever;
Taenia solium/saginata	Taeniasis
Trichuris trichiura	Trichuriasis (unapparent through vague digestive tract distress to
Ancylostomaduodenale (Hookworm)	(Itch; rash; cough; anaemia; protein deficiency)
Schistosomiasis spp	Schistosomiasis, bilharzias

Source: *World Health Organisation (WHO, 2008). URL [Accessed: 12.10.2010].*

More than 120 different types of viruses may be excreted in faeces, including members of the enteroviruses, rotavirus, enteric adenoviruses and human caliciviruses (noroviruses) groups. Hepatitis A is also of major concern and the importance of

Hepatitis E is emerging, when applying wastes to land and is considered a risk for both water- and food- borne outbreaks, especially when the sanitary standard are low (Lucke, 2003). Van de Klundert (2001) says that in developing countries, geohelminth infections are of major concern. Hookworm disease is widespread in most tropics and subtropics areas, and affects nearly one billion people worldwide. *Schistosoma haematobium* are excreted both in faeces and urine while other types of *Schistosoma* are just excreted in faeces. The use of treated excreta should not have an impact but fresh or untreated faecal material, which should not be used, constitute a risk when applied close to fresh water sources where the snail is present.

Pathogens excreted from urine is of limited concern in temperate climates, but any faecal cross-contamination that may occur by misplacement of faeces in the urine-diverting toilet ends up in the urine fraction and is a determinant of possible health risk (Moe and Rheingans, 2006). The main hazard of grey water is, as for urine, due to faecal cross-contamination. Faecal contamination is limited in amounts when one is considering the traditional fractions of grey water, like washing faecally contaminated laundry, childcare and showering (Morgan, 2008). The amount and variability of the pathogens will depend mainly on the infection among the population served and the scale of the sanitation system. Thus, in low income countries, where there is a high prevalence of excreta related diseases, a greater number of pathogens are more likely to be introduced into a sanitation systems, compared to a developed countries where the prevalence of such diseases is generally low.

In most developing countries, perhaps most easily discernible in the poorest countries, unclean water and poor sanitation exposes many to a plethora of diseases that

debilitate them and greatly reduce their productivity (Beall and Fox, 2007). Despite advances in Science, Engineering and Legal Frameworks, the majority of the wastewater from piped sewerage systems in the world is released into the environment without adequate treatment (Bark, Oldenburg and Keipp, 2003). The same is true for most pit latrines and sludge management systems. Only a small percentage of global wastewater is treated using advanced sanitation facilities, mainly in developed countries. Faecal pathogens are transferred to the sewage system through flush toilets or latrines, and these may subsequently contaminate surface waters and groundwater (Jönsson and Vinnerås, 2003). In addition to unclean water, lack of sanitation and poor hygiene are responsible for the transmission of diarrhoea, cholera, typhoid and several parasitic infections (UNICEF, 2005).

Moreover, (WHO, 2000) shows that the incidence of these diseases and others linked to poor hygiene and sanitation e.g. round worm, whip worm, guinea worm, and schistosomiasis is highest among the poor, especially school-aged children. These diseases have a strong negative impact on the health and nutrition of children and their learning capacities, and contribute to significant absences from school (Marimba, 2005). Most significant, however is the persistence and wide distribution of diarrhoeal disease throughout the developing world.

In Sub-Saharan Africa, schistosomiasis kills more than 200,000 people every year (Lucke, 2003). This hurts their prospects for future earnings and makes continuing poverty more likely (Boggs *et al*. 2009). Due to the interconnectedness between water, sanitation, health and poverty, lack of safe water supply and proper sanitation has much wider impacts than on just health alone. Large-scale death and poor health

are not only matters in its own right but also act as a brake on economic development (Veenstra, 2010). The interconnectedness and the impacts that unsafe water and inadequate sanitation have on human health and general well-being makes it absolutely necessary to deal with all these issues or concerns together. Water quality and sanitation are irrevocably intertwined. Poor sanitation leads to water contamination. In many parts of the world, the main source of water contamination is due to human waste (UNICEF, 2005). Thus proper HWM is an important and essential component of healthy living and the enhancement of the environment.

According to the UN-Water Decade programme on Advocacy and Communication two million tonnes of human wastes are disposed into water bodies' everyday with the majority happening in major cities of developing countries. Kazemi and Eek (2008) argue that human waste management has continually been an intractable problem in recent times beyond the capacity of most municipal/state governments. Effective human waste management is critical in ensuring the appropriate and safe disposal of human waste arising from the environment. In Ghana, 70% of the urban population share sanitation facilities with 62% of the sub-Sahara African urban population living in slums (WHO, 2010). The problem of waste management and particularly human waste is worse in slums and squatter settlements. Many cities especially in the developing world, lack adequate and efficient management, sanitary facilities, wastewater treatment and drainage facilities - leading to the pollution of soil, and underground and surface water resources (Jenssen *et al*., 2004). WHO (2000) concludes that within the next 20 years, 60% of the world's population will live in cities with most urban expansion taking place in the developing world particularly in Africa.

Human waste management is an ongoing health and environmental issue that needs constant vigilance and maintenance. Proper management of human waste is unequal on a global scale whereas most people in developing world are faced with poor HWM systems, majority of the people in the developed world have access to proper waste management systems. Melo *et al*. (2005) says that for instance the majority of people in the U.S. do not have to think about their waste. Like garbage that is whisked off the curb each week, their human waste can be washed away with one push of a handle. The waste is managed, monitored and cleaned so that the resulting liquid can be ejected into the river. Further more in those parts of the world human waste is seen as raw materials for use in the production process for instance De Cremer (2007), points out that in Philadelphia, the scum and grease is skimmed off in Phase 1 and sent to a landfill. 70% of its composted bio-solids are used for agriculture, City parks, fields, community gardens and coal mine reclamation. The remaining 30% is sent to a landfill. If properly managed this can also be done in as lawns though on a small scale

As noted by Schönning (2003) urban waste management must be transformed from a disposal-based linear system to a recovery-based closed-loop system that promotes the conservation of water and nutrient resources and contributes to public health as is the case in Latin America. Moreover, it is apparent that both the knowledge and the technology exist, can enable this transformation. There is a gap, however, between the current availability of innovative technology and the promotion/financing of demonstration level projects as well as the development of complementary socioeconomic methodologies to facilitate their implementation.

2.2 Systems of Human waste management

When we consider these systems of human waste management available globally, we can identify three main categories. These are off-site, on site and others. Let us briefly look at each of these systems

2.2.1 Offsite system

In the offsite system, there are basically four main types sewerage systems. These include: conventional sewerage system, simplified sewerage system, condominial sewerage system, and settled sewerage systems (Höglund *et al*., 2002; Melo *et al*., 2005; Corcoran *et al*. 2010), although there are other that are believed to be now obsolete in this category.

The conventional and highly engineered wastewater management technologies and strategies often focus on electro-mechanical solutions that are capital intensive and require ongoing capital investments for effective operation (Melo *et al*., 2005). Many conventional sewage treatment plants are effective, but very expensive and plant usually highly energy intensive, which again adds to cost, and also makes them susceptible to failure (Akinbode, 2002). Conventional sewage systems use a large amount of water; not only for flushing the toilet, but there also has to be a certain minimum water flow to ensure that the gravity operated sewers work.

Concerning the simplified sewerage system, Schall (2011) state that in response to the conventional conservative design criteria and in an attempt to reduce cost, simplified sewerage has been developed. These results in less excavation due to pipes being buried shallower and downstream pipes being shallower (as a result of reduced

gradients) thus reducing pumping costs. The consequence of all these improvements is to reduce the cost passed on to the final user (although comparatively this could still remain high). In some cases high population density, narrow streets, high groundwater and rocky ground can make on-site sanitation problematic, in these cases simplified sewerage may be worth investigating further. Where the place is congested with high plot converge, in some instances the septic tanks without the soakage system or cesspool is connected to a small bore sewer, which is less expensive compared to the conventional sewers.

The condominial approach to sanitation services (which can also be applied to water services) was first developed in Brazil during the 1980s (Melo *et al*., 2005). In this system a service provider will provide a sewerage connection point at the edge of a group of houses. The members of this community are then expected to work together (possibly through CBO structures) to create condominial sewerage that connects to this main sewer. The condominial sewerage generally utilises simplified sewerage design criteria. A number of very successful programmes, such as the Orangi Pilot Project in Pakistan, have used a similar technology (Schönning and Stenstrom, 2011). This is common in low income areas where groups or communities influence local authority to congregate and built a common sewer, which end up at the boundaries.

On the settled sewerage systems, Schuringa (2011) explains that these systems contain an intermediary tank on the house connection sewer. This system allows the solids to settle out from the sewage and make the further transportation simpler. This lack of solids means the sewer does not have to be laid on a constant gradient and can travel up and down reducing the necessity for pumping and keeping sewer depths at a

reasonable depth. The systems were first developed in Australia as a means of conveying overflow from failing septic tanks – a function that can be served in developing cities where septic tank effluent is not safely absorbed into the ground. One of the main reasons why sewerage projects are very expensive compared to water supply project is because of lying pipes deep enough to be able to maintain a self cleansing velocity.

2.2.2 Onsite systems

These are onsite based sanitation facilities which is either built on site or is bought and installed in the ground. They comprises of different compartments which are designed to specifically facilitate anaerobic activities which is the primary treatment. These include several systems such as: septic tanks, biogass plant, and several types of latrines.

Septic tanks contain compartments that may be twin so that they operate in parallel just single as is mostly the case in households. The tanks receive the waste water from either flush or pour-flush toilets. After digestion the wastewater is then subjected to secondary treatment such as sock pit or some trench. This is a relatively safe way of discharging it to the environment and therewith recharging groundwater bodies (Tilley *et al*., 2008). For sceptic tanks to operate efficiently, it requires soakage system such as soak pit. If there is no intention or no need to reuse wastewater, soak pits can offer a cost-efficient opportunity for a partial treatment of storm water, grey water or wastewater effluents from a primary treatment. The wastewater effluent is absorbed by soil particles and moves both horizontally and vertically through the soil pores. Sub-soil layers should therefore be water permeable in order to avoid fast

saturation. High daily volumes of discharged effluents should be avoided (Gilbert *et al*., 2003).

Biogass plant (or "biogas settler") is another form of onsite sewerage system. All the generated wastewater is discharged into an underground fixed-dome biogas plant and the wastewater treated through anaerobic digestion to reduce the organic content (pollution load) (UNEP, 2002). Biogas is produced in the process. The treated effluent from the biogas plant is drained into the existing public sewer line running along the nearby road. Unfortunately, this is not usually guaranteed in informal settlements because of the costs and poor planning.

Latrines are also in the category of onsite sewerage system. In essence there are different types of latrines available based on technology and capital investment (Jackson, 2004). Pit privy is the cheapest type of excreta disposal system known. It is also considered the most common sanitation system in the world. It is based on containment and indefinite storage of human excreta. This requires just a hole to be dug in the ground and excreta deposited in this hole until it is full after which the content is pumped out or filled up by soil to remain underground forever (Scott, Rebecca, 2005). A simple pit latrine is perhaps the simplest and the first step among sanitation solution identified by the UN to meet the criteria of the Millennium Development Goals (JMP, 2004). The simplest form of pit latrine is a hand dug pit that is unlined and covered with a series of wooden logs strapped together allowing the user to defecate into the pit (Figure 2.1). A pit latrine should be properly constructed not only to isolate faeces but also to give comfort by having no smell, giving privacy and pollution.

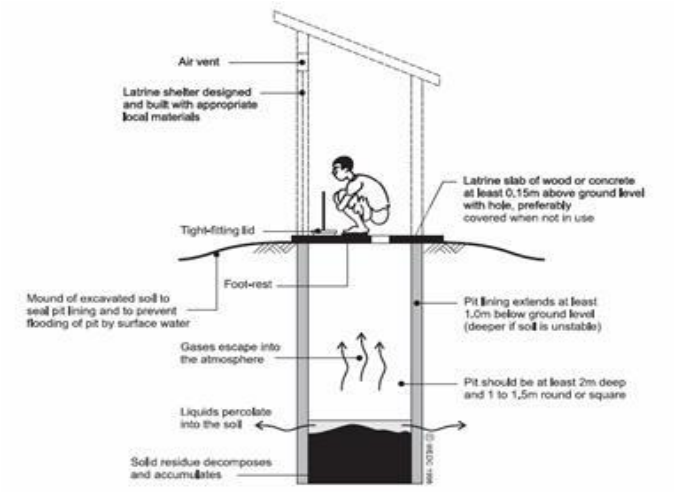

Figure 2.1: Simple pit latrine

(Source: Harvey et al, 2002)

In areas with hard rock near the ground surface or with a high water table, construction of latrines is only possible by raising or extending the pit above ground level (Figure 2.2). In this case the pit should be fully lined with stone, brick, or concrete block masonry, the lining continued up to an appropriate level above the ground. The soil excavated from the latrine pit should be placed in a mound around the pit walls to provide support and to prevent any leakage from the extended latrine floor. When the groundwater is high or the ground is too rocky to excavate by hand there is a case for using a raised pit latrine (other latrine types can also be raised although it is more common for simple pit latrines to be raised).

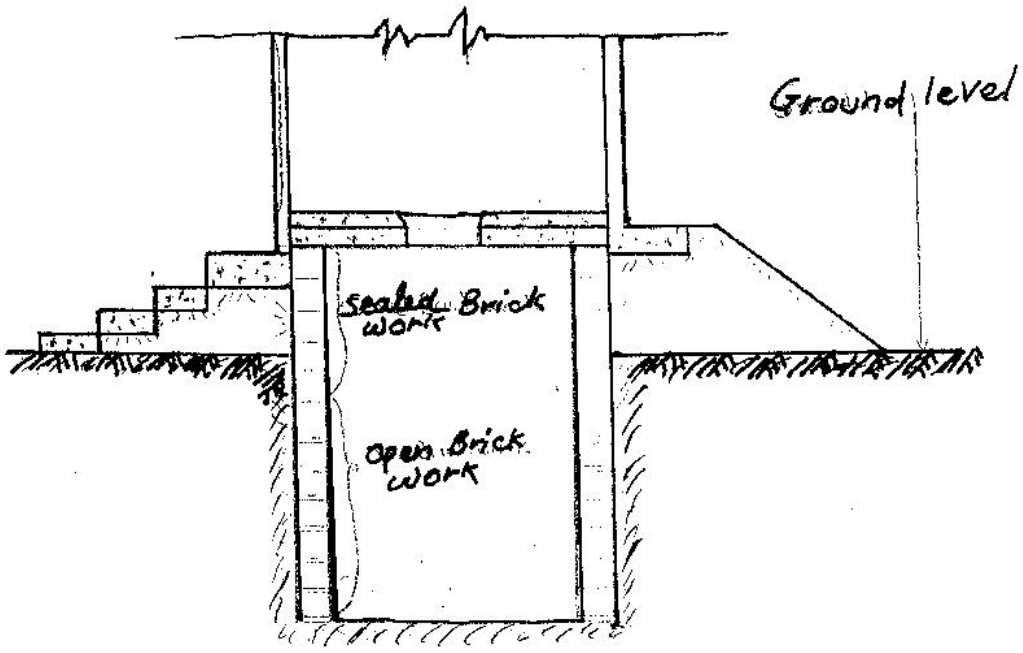

Figure 2.2: Parts of a Raised Pit Latrine

(Source: Sandy Cairncross, Small Scale Sanitation, Ross Institute, Bulletin No. 8) (http://www.gdrc.org/uem/waste/IHWM.pdf. Downloaded on January 12, 2008).

Ventilated Improved Pit (VIP) Latrine

Ventilated Improved Pit (VIP) latrine was developed in Zimbabwe (http://www.ecosanres.org/PDF%20files/ESR%20Publications%202004/ESR1). The main drivers for design were to eliminate two unpleasant aspects of using on-site sanitation systems, flies and smell. Furthermore, the reduction of flies can also reduce the transmission of disease. The technology facilitates the flow of air through the system (Jackson, 2004). One important aspect is that the inside of the toilet should remain dark as means of attracting flies up a vent pipe where they will eventually die and fall back into the latrine. Ventilated Improved Pit (VIP) is a technical modification of simple pit latrines. The difference of VIP from the traditional one is the ventilation arrangement and a concrete slab cover. The pit is ventilated using large diameter pipe extending above the roof of the VIP. When it is ventilated wind passing

over the top of the vent pipe causes a flow of air from the pit through the vent pipe to the atmosphere and a down draught from the superstructure through the squat hole or seat in to the pit. This continuous flow of air removes smells resulting from the decomposing excreta in the pit and vents the gases to the atmosphere at the top of the vent pipe rather than through the superstructure. As a result of the vent technology added VIP improves the disadvantage of the pit latrine by eliminating fly breeding problem, reduction of odor and nuisance problems. There are three common types of VIP latrines: 1. Single pit VIP; 2. Alternating double pit VIP (Permanent VIP); 3. Multiple-pit VIP (Shared)

The construction of a single pit VIP as far as digging is concerned is the same as that of the pit latrine technology. Since the difference is only the vent pipe other dimension and construction techniques could be adopted from the pit latrine mentioned above. However, the important parts for a VIP latrine: vent pipe location and squat hole arrangement need special attention (Smith and John, 2005).

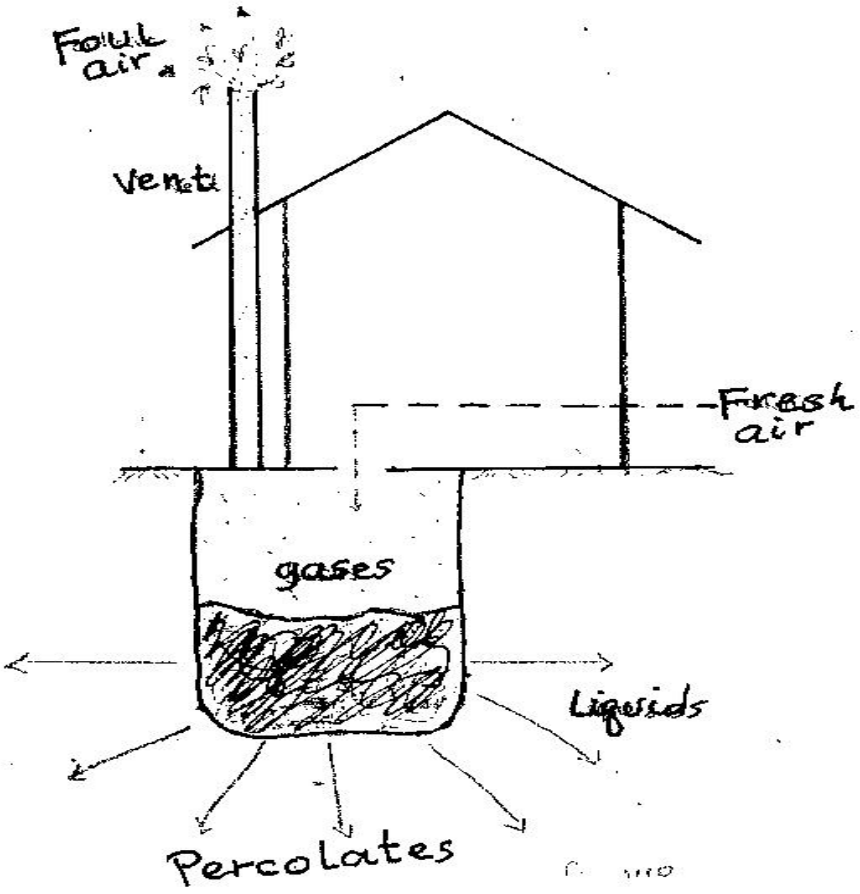

Figure 2.3: Parts of a Single VIP Latrine

(Source: Madleen Wegalin-Schuringen, On-site Sanitation, Building on Local Practice, IRC. 16)

The Alternate or Double VIP; Shayo (2003) explains that the construction of alternate pit sometimes called ‘double vault compost latrine’ or ‘permanent VIP’ is different than the technologies mentioned above. This type is primarily meant to recycle the waste including garbage and other organic waste. The vault has a door arrangement, the size is much smaller than the pits, and it demands water proofing or concrete work. It is a reasonably safe way for an individual to prepare excreta and other waste for use as fertilizer by composting it in such a pit. The method is based on anaerobic decomposition of organic wastes. A pit larger than one cubic meter in size times two is dug in the ground. A superstructure is built for privacy and to protect the user from

adverse weather condition (Figure 2.4). Such alternate use of the pits will make this type of latrine permanent. SEI (2004), further explains that apart from its initial cost, alternate VIPs are useful technologies especially in the crowded urban communities where there is no space to dig pit latrines when ever one is full.

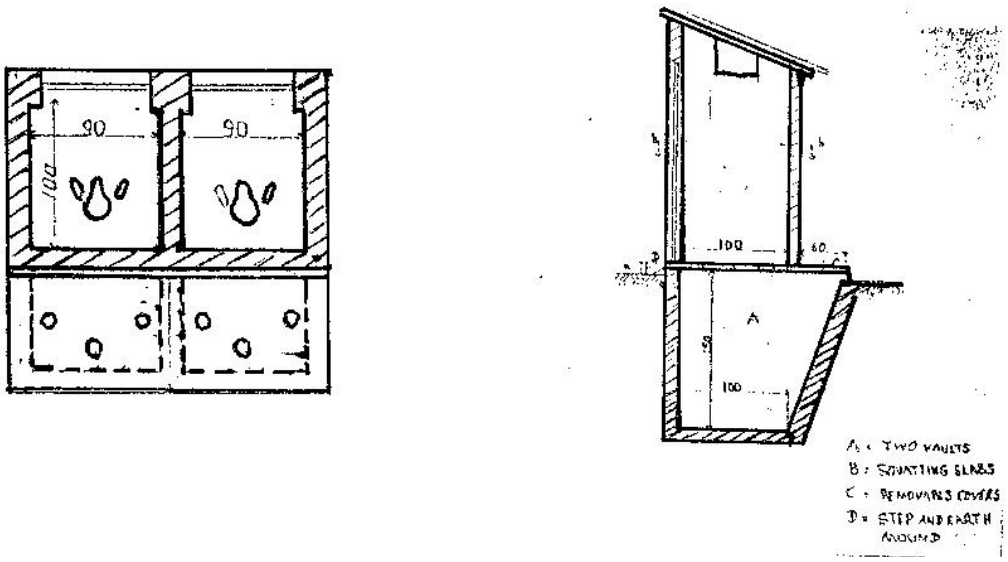

Figure 2.4: Double Vault Latrine Showing Parts of the System
(Source: Uno Winblad and Wen Kilman, Sanitation without water. 1985)

Finally the Multiple-seat VIP is another type of latrine (Figure 2.5). Dranget (1998) points out that multiple pits VIP are exactly the same as that of a single pit VIP latrine but differs in the volume, size and cost. It is intended for a slum area where many people have to share each pit. Although multiple seats VIP functions exactly the same as the single pit VIP; the waste is not recycled. The installation is considered permanent because such technology is very expensive to abandon each time it is full and dig a new one. Rather, availability of a vacuum track in the locality is a necessity to evacuate the pit content whenever necessary. The waste could be used in a composting plant if there is such a recycling and processing program in the locality.

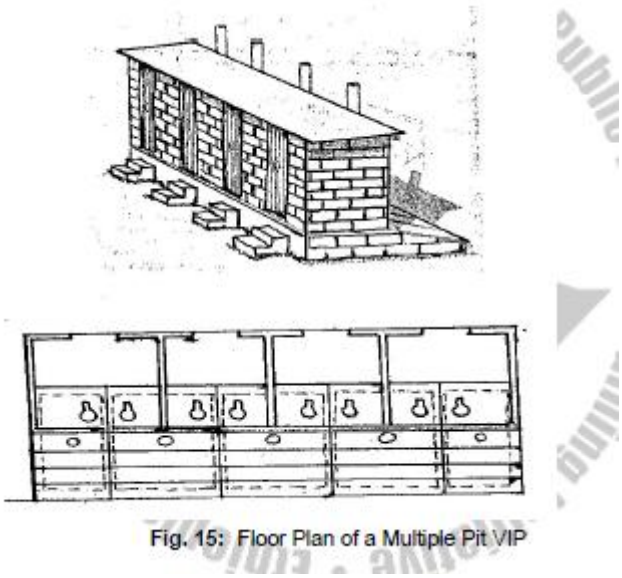

Figure 2.5: Diagram of multiple seat VIP

(Source: Sandy Cairencross, Small Scale Sanitation, Ross Instiotute, Bulletin No. 8. 1988)

2.2.3 Other Systems

A variation of VIP latrine is the Reed Odorless Earth Closet (ROEC). In this system the excreta is deposited into the pit via a chute located at the base of the squat hole or seat (Figure 2.6). The ROEC is fitted with a vent pipe to control odor and insect nuisance.

The advantages of Roec is that it is larger than VIP and hence have longer life, pit can easily be emptied, the pit is displaced and with good care there will not be any smell or other nuisance and the children have no fear of falling into it. While the disadvantage is that the system is such that the chute is easily fouled with excreta, thereby providing a site for flies and odor nuisance.

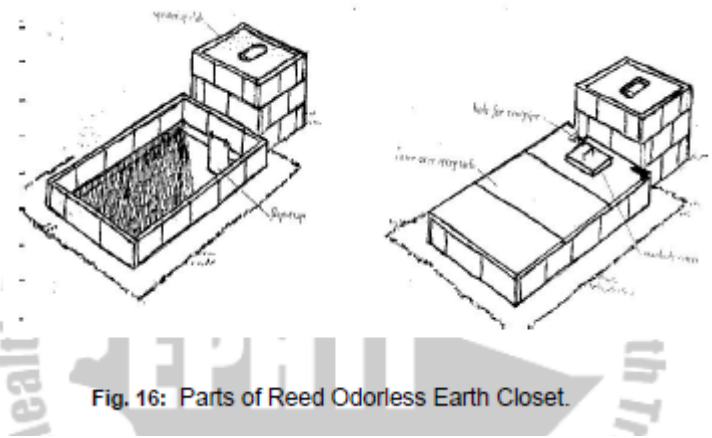

Figure 2.6: Parts of Reed Odorless Earth Closet.

(Source: Uno Winblad, Wen Kilman, Sanitation without Water, 1985)

Aqua privy consists of a tank filled with water into which a chute or drop-pipe carry the urine and feces. Human excreta undergo anaerobic decomposition in both systems; the sludge is also accumulated in the bottom of the tanks. The water will drain off the top and the sludge needs to be emptied on a regular basis. An advantage of the aqua privy is that it reduces odours (De Cremer, 2007).

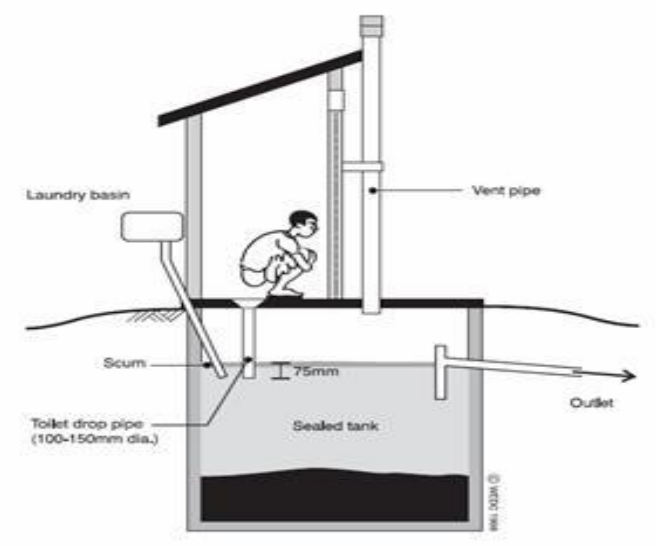

Figure 2.7: An aqua privy

(Source: Harvey et al, 2002)

Brikké (2000), points out that where water is more widely available or traditionally used for anal cleansing a pour flush latrine may be appropriate and can bring a number of further benefits on top of simple or VIP latrines. A water-seal is created by a plastic u-bend which prevents bad odour and flies affecting the user (this system is less susceptible to building errors than the VIP system). The system only requires a few litres of water and so should not put a strain on resources and could be provided by grey water from the kitchen

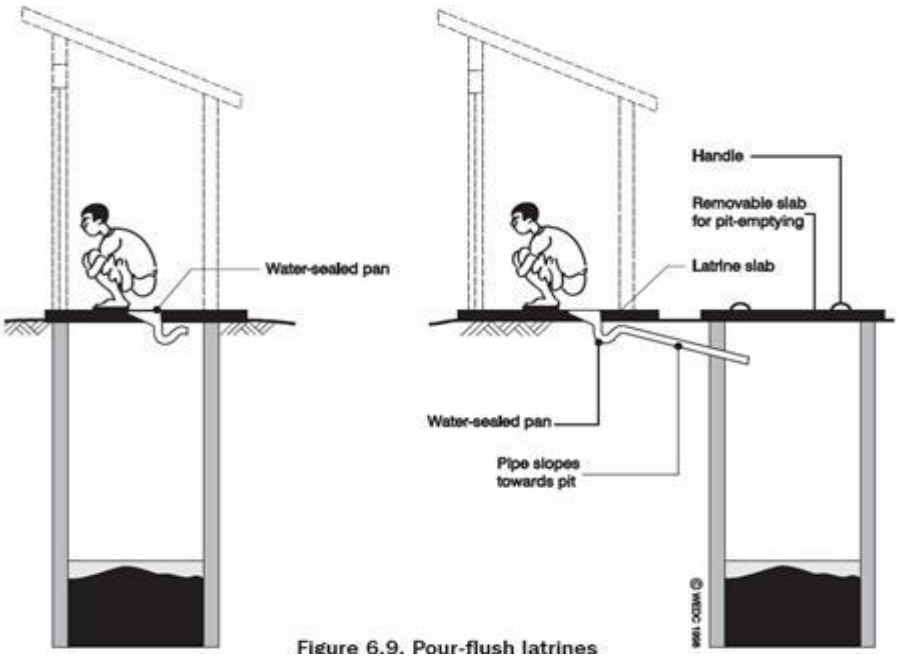

Figure 2.8: A pour-flush latrine set over a pit latrine (left) and discharging to an offset pit (right)

(Source: Harvey et al, 2002)

All flash latrines need to have a water seal to avoid smell and fly breeding. Therefore, pour flash latrines are also called water-seal latrines. This technology is also known as Flush-and Discharge. A person may defecate inside or near the house and pour an amount (usually one litter) of water to flush out the excreta away from the squatting area. This system requires a squatting arrangement, piping to take away the excreta to a sewer or septic tank. This has to accommodate to flush out 400-500 liters of urine

and 50 liters of feces a person generates per year with 15, 000 liters of water. However the water to be used does not need to necessarily be clean water unless the system is connected to the running water. Thus whenever we use the flush-and-discharge process the problem of liquid waste comes into our head. The human feces are a dangerous component in the sewage system. It contaminates not only the harmless urine but also the huge amount of pure water used for flushing the excreta.

Beall and Fox (2007), expressly confirm that in pit systems, which are abundant in many parts of the world, the toilet does form a barrier between human beings and excreta. These are normally basically pits dug underground to various depths but about 1.5m above the ground water table. The pits have different types of super structures on them depending on the availability and ability of those concerned. They are advantageous because they are easy to construct and the cost of construction can be controlled depending on affordability. Normally local material is available for the super structure can be used and the local people can put it up. However in informal settlement where space is limited the pits can easily pollute the water sources depending on their proximity to the water points. When not using Ventilated Improved Latrine odours can be experienced. Pit latrines are mostly designed to retain solids and infiltrate liquids. When liquids infiltrate, nutrients, and worse, pathogens also infiltrate.

These are the most used if there are large settlements, or if the toilets are built too close to water sources, this can lead to a severe pollution of ground and surface waters. This means that if such a system were to be used in crowded informal settlements like Munyaka and Langas, great care and attention needs to be realised

and alignments made to ensure that ground water sources are not contaminated. In this regard this study endeavoured to find out the consequence of badly designed pit latrines in Langas and Munyaka.

2.3 Human waste as a resource

In other parts of the world human waste has been used as a resource and below is some of the example. Burkina Faso has organized groups of young people who collect urine which they use to apply in big fields in Burkina Faso. This is used in planting of onions, maize and others. In Mexico, farmers use urine as fertilisers for planting cabbage and spinach after 2 months treatment with diluted urine. When the two fields are compared one that was fertilized using urine with one without urine fertilizer it was noticed that the one with urine application produces more yield and healthy looking crops.Youth groups also use urine to enrich the compost, which they produce from faeces and organic waste. Costumers are happy to buy the produced out of this compost so that the youth groups can gain an income.

In the city of Oslo (Moe and Rheingans, 2006), observes the grey water from 33 apartments is treated to swimming water quality in the courtyard of the building. The space required for the total system is about 1 m^2/person, and the area is used as a playground. Grey water can be reused after treatment in a bio filter followed by a constructed wetland; the effluent water can often be discharged to local streams, or be used for irrigation, or recharged to the groundwater. The excellent effluent quality also enables upgrading the water for in-house applications with modest use of technology and energy. If reuse is for flushing toilets and car washing it may be possible to use the treated grey water directly. To upgrade to drinking water quality or

for washing, micro filtration, reverse osmosis or carbon filtration may be needed as a single step or in combination along with ultraviolet light or similar disinfection process. Reuse of all grey water makes water savings exceeding 90 percent possible when a water efficient toilet is used. When faeces is treated conventionally, by subjecting to high temperature such as 1000ºC it can be used to make ornaments such as flower vessels or if subjected to 1500ºC with chemical treatments, it can be used to make name cards as widely practiced in Japan. Plant growth of cabbage and spinach after 2 months treatment with diluted urine (upper part of the pictures) compared to water application only (lower part of the pictures).

A grey water tower is a circular bag, which is filled with soil, ash and/or compost mixture and a gravel column at the centre. It is used to treat and reuse grey water - water that has been used for bathing, washing clothes and utensils. Vegetables are planted in holes cut in the sides of the bag and each day the available grey water from a household is poured directly on the gravel column making grow the vegetables (Winbald and Simpson-Hebert, 2004). For the construction of a grey water tower, a circle has to be marked out on the ground with a diameter of around 80 cm. The bottom layer of the tower has to be dug out and the wooden side poles need to be firmly planted into the ground. A shade cloth will be wrapped around the poles and the resulting cylinder will be filled with gravel in the middle and the soil mix all around. The backfill has to be well mixed before applying it. A bucket with its bottom removed can be placed at the bottom in the middle of the tower to increase stability and improve the flow regime. Small stones should be packed in the bucket to increase weight. To prevent fast flow of the water through the bucket and to achieve even

water distribution, small stones (provided they are evenly packed) should be used. Once the bucket is filled up with stones, it is backfilled with the soil mixture.

Then, the bucket can be removed (and reused), leaving the stones in position. The soil should be humid but not too wet, when packing the tower. The soil should be evenly distributed as compacted water will not let water flow through. The procedure of placing the bucket, filling it with stones, backfill it and then remove the bucket has to be repeated for each soil layer until the top layer of the greywater tower of around 1 metre in height (Wardhani, 2008). This could be practiced in the part of Langas settlement which has farm land and space due to the advantage they have is that they require minimal space and investment costs and little labour for maintenance which can be implemented close to the source/household. They contribute to household food security and alleviation of food shortages and poverty, reduction of environmental degradation, eutrophication of water sources and health hazards and reuse of valuable water and nutrient resources and are good for elder people, as they do not need to bend down.

However the disadvantage is the difficulty to estimate the effective need for grey water and not very adapted for large fluctuations. However it would not be appropriate for Munyaka of lack of adequate space in most of the areas. Space for setting up the grey water towers close to the housing is required and unpleasant odours may appear. Urine collection, transport, treatment and reuse is one of the difficult step in resources oriented sanitation systems because the society and the decision makers may not be aware of the advantages. In Arba Minch the transport and collection of urine from UDDTs was first done by car but gradually entrepreneurs

were involved to independently transport by donkey cart without external support. This is a good progress to sustainability of the implemented sanitation systems (Elkington and Shopley, 2009)**.** Youth groups also use urine to enrich the compost, which they produce from faeces and organic waste. Costumers are happy to buy the produced compost so that the youth groups can gain an income.

Elkington and Shopley (2009), points out that when faeces are stored in the absence of moisture (i.e. urine, anal cleansing water and water) and dehydrating agents like ash, lime or sawdust are added after each defecation they dehydrate over time into a crumbly, white-beige, coarse, flaky material or powder. Dehydration means that the moisture naturally present in the faeces evaporates and/or is absorbed by added drying agents. Dried faecal material acts as a good soil conditioner due to its high organic matter content and is a good phosphorus and potassium fertilizer, which also contributes considerable amounts of nitrogen. The advantage is periodical incorporation can improve the structure and water-holding capacity of soil Simple technique for all users, Low cost and low risk of pathogen transmission (when fully dried and properly handled). On the contrary, Supardi and de Kruijff (1987) point out that it is labour intensive and requires that faeces are kept strictly dry. Pathogens may exist in a dormant stage (oocysts) which may become infectious if moisture is added and can therefore only partly replace fertiliser (N, P, K).

2.4 Human waste management practices in Kenyan urban areas

According to Bullard and Glenn (2010) only 32 out of Kenya's 175 local government authorities have a sewerage system. This means that 142 local authorities around the country lack access to any form of sewerage system and are therefore highly exposed

to diseases. They are common features in developing countries and are typically the product of an urgent need for shelter by the urban poor. As such, they are characterized by a dense proliferation of small, makeshift shelters built from diverse materials, degradation of the local ecosystem and have severe social problems. Informal settlements occur when the land administration and planning fails to address the needs of the whole community. These areas are characterized by rapid, unstructured and unplanned development.

On a global scale, informal settlements are a significant problem especially in developing countries housing the world's disadvantaged (Boggs, *et al*., 2009). Informal settlements are a characteristic feature of Kenyan towns. For instance in the conditions in Mukuru in Nairobi are appalling, lacking basic drainage, waste disposal facilities and clean water supply. Worse still, most of the waste generated drains into the Ngong River, which traverses right through the middle of the slum, leaving it almost choked with litter and highly contaminated. Such a large settlement becomes difficult to properly manage. This therefore, raises the need to develop viable solutions before the slums become too large.

The lack of proper sanitation facilities, including toilets, showers, and sewage disposal has been well documented in Nairobi According to a survey by Matrix Development Consultants, ninety four percent of the population in informal settlements does not have access to adequate sanitation. Up to sixty per cent of the population in Kibera and Korogocho must share pit latrines with approximately fifty other people (Matrix Development Consultants, 1993). Even when toilet facilities are available, people complain that they are not conveniently located, that they are

unclean, or that using them at night poses a security risk. Children are especially vulnerable to inadequate toilets because they may lack access to household keys which unlock the community toilets

Mulwa and Wasanga (2011) expressly confirm that one of the preferred modes of disposal is simply to put their human waste in a plastic bag and fling it away. The bags are called “helicopter toilets” or “flyaway toilets.” LVSWSB (2008) documents that the Municipal Council of Kisumu (MCK) is responsible for environmental sanitation services, as well as pit latrine/septic tank drainage. Part of the difficulty in Kisumu is the presence of black cotton soils, which is not conducive to pit latrine construction, as they are loose, and latrines built on them are prone to collapse during the long rains (March-June).

2.5 Stakeholders involvement in human waste management

Numerous stakeholders including the local community members and local leaders in urban communities play different roles in human waste management. Local leaders can be divided into traditional, formal and informal leaders (Smallbone, 2005). Traditional leaders derive their authority from hereditary rights and from their status in the local culture. Formal leaders are appointed by the government or elected as local representatives of the government. Informal leaders are influential members of a community on the basis of their personal status or of their activities in community-based organizations such as political parties, churches, youth and women's organizations, neighbourhood committees, etc. All three types of local leaders may have different roles in human wastes management. Usually formal and informal leaders are more involved in waste management than traditional leaders (Smith and

John, 2005). These roles correspond to different levels of community participation as derived from the water literature and adjusted for human waste management (Fricker, 2001). Community members can participate in waste management by showing proper sanitation behaviour, by contributions in cash, kind or labour, by participation in consultation and by participation in administration and management of human wastes services.

The rationale of effective public participation is clearly based on the fact that everyone generates waste and can be affected directly and indirectly if waste is not well managed (Elkington and Shopley, 2009). In the early 2000s the governments of six EAC countries and Development Partners (European Investment Bank-EIB and the Global Environmental Trust Fund and the World Bank-WB) commenced the preparation and appraisal of a human waste management project (HWM P) to address environmental pollution (Kirimi, 2008). Loans and grants were approved by the Development Partners and the project was implemented over the period 2001-2005.

Involvement in management of waste services includes participation in the management of human wastes services and keeping in contact both with the municipality and the community (Wardhani, 2008). The management committee has the responsibility for the administration of activities, monitoring the work flow, managing manpower and means, and matching the objectives with the means. It has decision-making power and controls the operation of the service. But an NGO or governmental agency starting a human waste management project, may also ask community members to be engaged in the management committee.

A community-based organization may contact the responsible municipal agency to integrate primary and secondary collection. When no service is delivered to the area, or when certain equipment is needed, it can exercise political pressure on the municipality. A community-based organization may design and implement education campaigns, even if it is not directly involved in waste collection or treatment (van de Klundert, 2000). Thus it can support collection services and change the behaviour of households. It may also have a watchdog function, to control that the behaviour of households conforms to the agreed rules and schedules. Traditional leaders are often involved in the mobilization of the community for clean-up campaigns. In a wider level, it is realized that without co-operation with all stakeholders, waste management will not be sustainable in a long run. NGOs worked with communities but after they finish the project, a declining becomes apparent and the communities back to what they were. Seminars and workshops are held without any follow ups to realize/ implement the outcomes (Eek *et al*., 2008). A program to get all of those stakeholders together and find a system that accepted by all and an intensive monitoring and assistances of its implementation is much needed. At the least is to plant the seed of idea that sustainability is a holistic concept that can not be approached without the involvement of all stakeholders. This project is design to provide the above mentioned forum for all stakeholders in waste management to think and work together to decide on what should be done and by whom to achieve a sustainable waste management.

A structural solution also provides fairness for community members, an important factor in cooperation in a social dilemma. Fairness has been an important factor in cooperation (Wardhani, 2008). People use fairness as a norm to bridge their personal need and maintain collective interest. This norm is shared and internalized in

socialization process (Kazemi and Eek, 2008). A collective culture will more likely to share the norm more often than people in individualistic culture.

People's participation has been a dispute in the FGDs and workshops. In one hand, there is information that people are willing to have a waste management program that required them to separate waste while in the other hand there are inputs of the refusal to participate in the program (Koff et al., 2007). There is a type of community that is very enthusiastic in running their waste management program. These communities have some rural community characteristics even though they live in urban area. But there is also different type of community in the urban areas. This difference could be caused by their cultural background or by their urban life style. As has been experience in the monitoring and evaluation in the starter kit provision program done by the team, each community react differently even though they trained in the same training. The sustainable waste management program will only successful of we put into account the social factor in sustainability in its implementation.

The involvement of community in the decision making process is very imperative to the success of sustainable waste management. This procedural fairness plays a very important role to get high cooperation in the program (Hauenstein *et al*., 2011). The maintenance of established infrastructure and services has evolved as a major problem of development projects in the 1980s and 1990s. In the words of a major human wastes expert, Franceys (1999) state that

> In general, self-help efforts have been more successful in producing a specific object, such as a municipality, a latrine system or a human wastes transfer depot, than in maintaining services in a routine way.

A human wastes management system is in fact a continuous maintenance system. To keep the service running, continuous participation of the community receiving the service, is required (van de Klundert and Justine, 2001), for example, to store the garbage in a specific bag or bin, to bring it to an agreed point, to separate it in dry and wet waste etc. This means that community participation is a rather crucial aspect of human wastes management, maybe even more important than in any other urban service. Only recently has the management of human wastes services by communities themselves received attention in some municipalities in Kenya (Kirimi, 2008). This therefore creates a requisite gap in knowledge that must be fulfilled to enhance the involvement of the local people in waste management.

2.6 Challenges in planning of human waste management

The problem of human waste management reflects a dilemma situation due to poor planning (Shinkuma, 2003; Posey, 2005). Poor planning is a situation where a person is faced with a situation whether to choose a personal interest or to act on group interest (Kollock, 1998; de Cremer, 2007). Structural solutions are policies that are created to help individual plan and access to resources and manage the resources. One type of structural solution is to change the payoffs of individual behavior to encourage waste management initiatives (Stangor, 2004). Planning in the field of HWM is the process by which community needs regarding waste management are measured and evaluated, and workable alternatives are developed for presentation to decision-makers. Planning of HWM is both exciting and challenging because most of the technical, environmental, economic, social and political factors and the interrelationships that are involved, are not fully understood (Eik *et al*., 2008). In general terms, the planning process involves the collection, transfer, transport,

processing, disposal, evaluation and presentation of data relevant to issues in the HWM process. Planning is the conscious process for meeting future requirements and objectives with full consideration of any likely contingencies. The plan should guide intended actions specifying the time and priorities for accomplishing these actions.

The planning process is a systematic method of:

1. Recognizing the areas to be changed and improved in the present system.
2. Collecting and analyzing data about the present status.
3. Suggesting actions to overcome/improve the existing situation.
4. Evolving a suitable strategy for implementation with respect to a timeframe.
5. Implementing the proposed plan.
6. Evaluating the actions taken in the light of their success or failure in achieving objectives, and if necessary, modifying the plan to meet changing conditions.

Traditionally in the Kenyan urban centers, waste management was dealt with through Public Health Legislation that as part of a command and control approach (Renkow and Otieno, 2008). In the early 1990s, particularly after the United Nations Conference on Environment and Development held in Rio de Janeiro in January 1992, countries began to formally adopt Environmental Impact Assessment (EIA) policies, undated legislation, strategies and guidelines that required information dissemination and public consultation on projects for which development permits were required (Posey, 2005). Environmentally sound management of waste was highlighted as a major environmental issue in Chapter 21 of Agenda 21 that was adopted at the Rio Conference which re-affirmed the Declaration of the United Nations Conference on Human Environment that was adopted in Stockholm in June 1972. Principle 10 of the Rio Declaration states:

> "Environmental issues are best handled with the participation of all concerned citizens, on a relevant level. On a national basis, each individual should have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities

> in their communities, and the opportunity to participate in decision-making processes. States should facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy should be provided."

This laid the basis for the participatory planning of HWMs, including Kenya. However, public participation in waste management was not well planned or coordinated and at times was in conflict with good environmental management.

After the Rio conference, development agencies and financial institutions, particularly Multilateral Development Banks also sought to address environmental and social risks associated with projects presented to them for financing. They developed and adopted EIA and Social Impact Assessment (SIA) Guidelines within which information dissemination and disclosure policies were enunciated. At the same time, and more so after the United Nations Global Conference for Integrated management of SIDS held in Barbados in 1994, management of wastes was agreed as a major priority area to prevent and reduce pollution in SIDS (Pellikaan and Robert, 2002).

Inadequate human waste services for low-income communities, involves collection and recycling of wastes. The focus of this study is on human waste. Human waste is left out for several reasons, among others because the literature about human waste (often called `sanitation') and community participation is limited. Furthermore, most of this literature is published together with literature on community participation in water supply projects.

2.7 Theoretical Framework

This study focuses on human waste management in the informal settlements of Eldoret town. Settlements represent a relationship between man and the environment in an attempt by the former to provide shelter. Informal settlements with their accompanying challenges such as waste management are a common feature of urban centres in Kenya. These settlements are part and parcel of the urban form of the towns hence a sub-system within the main system, town or municipality. In that case, problems and challenges in these settlements will eventually have ramifications within the whole system. Due to this, the systems view of planning was found to provide an appropriate theoretical framework of the study. From a general perspective, a system is a set of interconnected parts but each part may be seen as a system in itself and the whole system may be regarded as but one part of a larger system. The systems theory first originated in the field of biology in the 1920s out of the need to explain the inter-relatedness of organisms in ecosystems. This theory is based on three fundamental principles. First is that the phenomenon can be viewed as a web of relationships amongst elements or a system. Second, all systems whether electrical, biological, social or spatial have common patterns, behaviours and properties that can be understood and used to develop greater insight into the behaviour for operations of complex phenomena. Lastly, the structure of any system, the many circular inter locking sometimes time-delayed relationships amongst its components is often just as important in determining its behaviour as the individual components themselves.

Recent thinking has tended to the development of the General System Theory to diversified areas, giving rise to the systems view of spatial planning. From this

perspective, the relationship between man and the environment can be identified in system terms. A system view can make us see better the extent of certain problems and provide a frame of reference from which a proper analysis of problems of urban development can be examined. It provides an internally consistent framework for classifying and evaluating a phenomenon or spatial situations. The complexity and inter-relatedness of human and environmental systems make this theory a fitting framework for the study. It essentially shows the main system being and aggregation of the subsystems within the systems. Any disequilibrium in any of the subsystems will in eventually affect the functioning of the whole system. Thus, we can look at Eldoret town as a dynamic system and subsystems in the nature of different land uses such as industrial, commercial, recreational, transport and residential settlements.

2.8 Conceptual Framework

The conceptual framework guiding this study is Sustainable Human Waste Management which is seen as a whole system comprising of sub systems which are made of Stakeholders activities, Wastewater systems elements and related aspects. An illustration of Sustainable Human Waste Management (SWM) is as shown in the diagram below: Similarly SWM takes into accounts other factors such as social – cultural and institutional which all play a role in determining the sustainability of selected choice factors rather than only technological and economic reasons. It recognizes that there is an inter-relation between the aspects, elements and stakeholders.

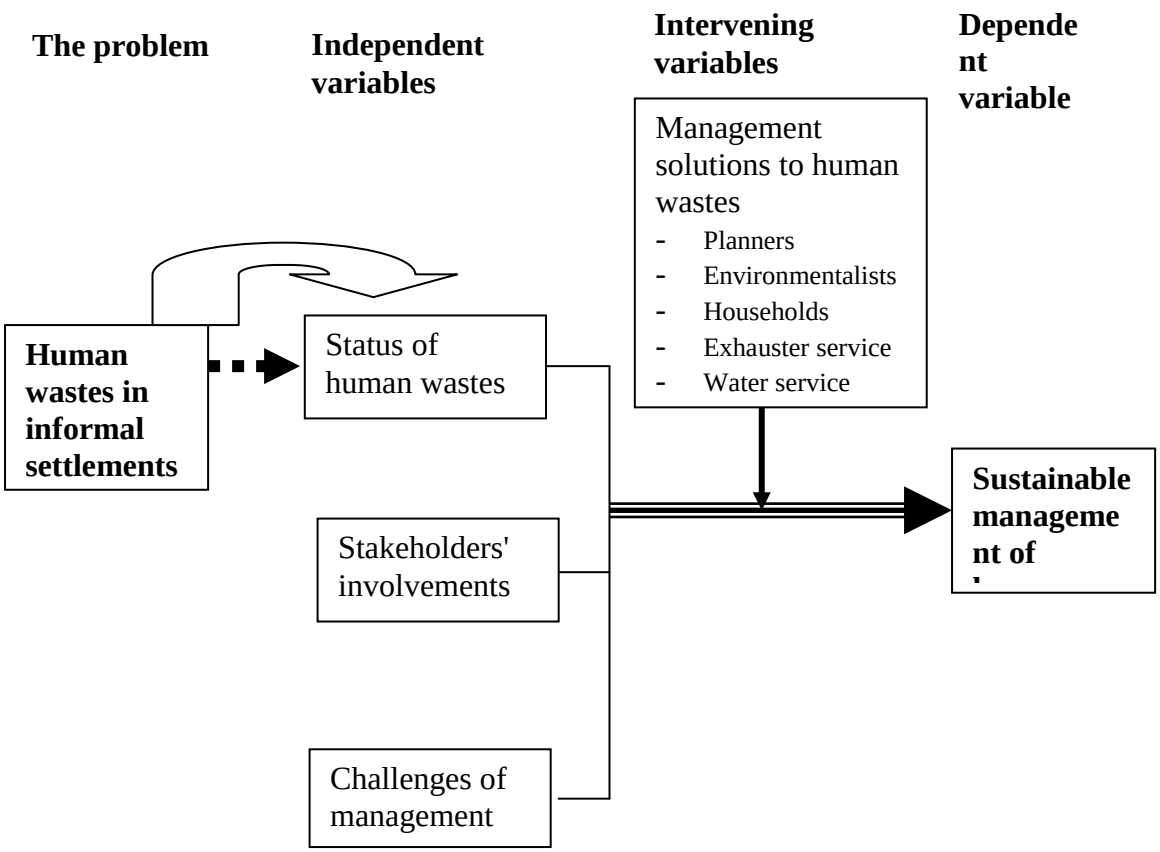

Figure 2.9: Proposed conceptual framework guiding this study

(Source: Author, 2013)

The concept seeks stakeholder participation by including human waste collection, transfer and transportation, treatment and disposal. By so doing there is an interaction with other urban systems and by promoting integrations of different habitat scales. The concept recognises three important dimensions in human waste management and the sustainability aspects. Due to the complexity and interrelatedness of human and environmental systems, this conceptual framework of integrated waste management framework was appropriate in providing the linkages and interdependency between the stakeholders, various activities (elements) and 'points of view' (sustainability aspects). It was also useful in examining the interrelationship between human waste management and environmental degradation together with resultant poor health-

related impacts and costs. This framework has three important dimensions which are the stakeholders, elements and aspects which must all be taken into consideration in the management of human waste. This study uses the method to select the options suitable for Munyaka and Langas. The stakeholders in this study were: planners/environmentalists, NGOs/CBOs, households, exhauster service providers and relevant government officers who interact with each other and share their practices, strategies at each stage in accordance with the Integrated Human Waste Management (IHWM) conceptual framework which guided this study.

2.9 Conclusion

The foregoing literature indicates several observations: Waste management in general and human waste in particular is a global problem. The global picture acknowledges escalating challenges without boundaries; improper management of waste has serious health and environmental impacts and the problem is worse in developing as compared to developed countries. The rural urban migration has created scarcity in the housing sector resulting in about 60% of the population migrates to the cities settling in the informal settlements. These settlements with inadequate infrastructure are ill prepared to provide crucial service such as water and sanitation. In Kenya, the problem is prevalent in our towns especially in informal settlements. Indiscrete disposal of waste including human waste finding its way in our water courses and resulting in water borne deceases and environmental degradation. This situation needs to be dealt with hence the need for such a study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Design

The design chosen in this study was qualitative research design. From the approach, this study was conducted through survey method. Survey design presented focus oriented methodology. Survey design is often used for descriptive purposes (Kothari, 2004).

3.2 Study Area

The study was conducted in Eldoret Town, situated about 320 km north-west of the Kenyan capital, Nairobi. It lies at an altitude of about 1200 m above sea level with approximately latitude 0°31’ North and Longitude 35°16’ East and situated in Eldoret Municipal area which shares 3 districts, namely Eldoret East, Eldoret West and Wareng. It has urban and rural setting with cosmopolitan populace. Due to the affordable cost of housing within the estates at the outskirts of the town, most people have opted to stay outside the town within the estates. This study was conducted in two of the eight informal settlements within Eldoret Municipality, namely Munyaka and Langas estates (Figure 3.1).

There are eight informal settlements in the Municipality namely Maili Nne, Kamukumji, Kambi Somali, Boma Turukana, Munyaka, Langas, Hurruma and Kimumu. Langas was selected to represent the highly populated settlement while Munyaka represented the settlements with smaller population without any conventional sewer and located at the opposite end of town.

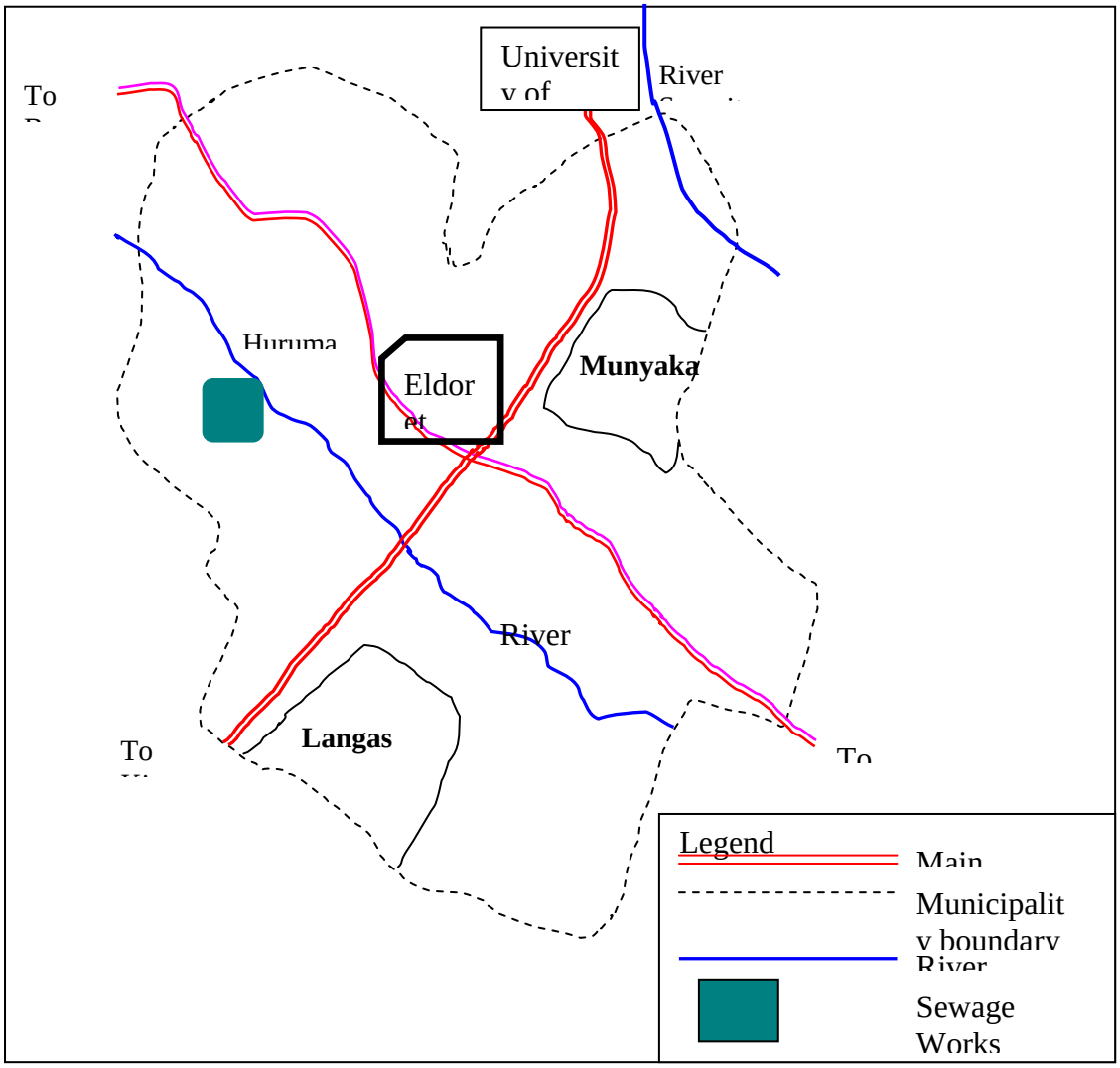

Figure 3.1: Map of Eldoret showing the location of the study areas (Source: EMC)

3.4 Study Population and Sample Size

According to the 2009 census Langas's population was 28,932 while Munyaka's was 5,914. The estimated households of 4,705 and 2,333 for Langas and Munyaka constituted the population for the current study.

The sample size was calculated using the equation adopted from Mugenda and Mugenda (2003). The sample size was calculated using the statistical formula:

$$n = \frac{Z^2 p(1-q)}{d^2}$$

where Z = Score at the respective confidence level

d = Confidence Interval

p = Magnitude of the human waste management

Since, there is no known magnitude of the human waste management in Eldoret Municipality, 50% was assumed to ensure maximum sample size.

At 95 percent confidence level, the sample size (n) would be equivalent to:

$$n = \frac{1.96^2 \times 0.50 * 0.50}{(0.05)^2}$$

$$n = 384.16$$

A total of 12 Key informants from sectors that directly deal with human waste management were also included in the study to supplement and compliment the information gathered from the households. At least one key informant was drawn from private and government institutions involved in sanitation in general and human waste management in Eldoret Municipality. They included Honey sucker/Exhauster operators, private human wastes collectors and government officials in public health, physical planning and environment departments.

3.5 Sampling Frame

To identify the participants in the study, a sampling frame was obtained from the Kenya Demographic Survey based on 2009 population census (KNBS, 2010). This information was provided by the District Statistics Office in the then Uasin Gishu

District. Owing to the heterogeneous composition of the study population and the various categories of participants targeted for the study, a combination of sampling methods was employed to draw the required sample for the study: Systematic random sampling, proportionate sampling and purposive sampling methods were used in the study.

Proportionate sampling method was used to select a representative sample from the two settlements. Sampling was done in proportion to the area, population density and actual number of households in the respective settlements. The actual sample for the Langas and Munyaka was further determined through proportional sampling technique.

Table 3.1: Population and Sample for the current study

Settlement	**Target household**	**Proportion**	**Sample Size**
Langas	4705	4705/7038*384	257
Munyaka	2333	2333/7038*384	127
Total	7038		384

Systematic sampling was used to draw the actual respondents from each settlement involved in the study to meet the proportion of sample allocated to each. The questionnaire was administered to 257 and 127 respondents from the households in Langas and Munyaka respectfully. In both settlements the transect routes were identified and an n^{th} term, 18, was determined and a random household chosen from which every 18^{th} household was picked to participate in the study until the required

sample was attained. This method was chosen because it ensured that each household in the study area stood an equal chance of being chosen for the study.

Purposive sampling was used to select respondents with specialized information from various authorities. It was therefore prudent to sample information purposively from personnel from planning, environment, health, water and sanitation including Exhauster operators. This sampling method was used to select the key informants who had been predetermined to have crucial information and were selected based on that criteria.

3.6 Research tools and instruments of data collection

The variety of data collected required that several instruments be used for purposes of accuracy. In this regard, Kothari (2005) has observed "…researchers want methods that provide high accuracy, general reliability and explanatory power with low cost, rapid speed and a minimum of management demands and administrative conveniences" (p. 18). The study used instruments that were able to raise generalizations that could be explained with high accuracy of interpretation. The researcher used questionnaires, interview schedules, observations and existing information as the main tools for data collection. The selections of these tools were guided by the nature of the data to be collected as well as the objectives of the study and time limits. The research which emphasized a 'bottom-up' approach in which local people are regarded as knowledgeable and able to define solutions according to their priorities.

3.6.1 Questionnaires

Questionnaires were appropriate for this study**.** Questionnaires were used to sample; local community members in the 2 selected informal settlements. The questionnaires were justified on the basis of the fact that they enable the coverage of wide area and extensive contents within a short period of time. The self-administered questionnaires were distributed by the researcher personally to the respondents. This was done with the help of two research assistants in some settlements since distance to some of the settlements may not allow the researcher to visit them.

3.6.2 Interviews

In-depth semi-structured interviews with CBO managers and leaders, representatives of support organisations and government officials were used to derive rich qualitative data. This interviewing approach, unlike questionnaire-based interviewing which tends to be shallow and rigid, probes more deeply and allows for explanations from respondents without necessarily jeopardizing the goal of the research (Scheyvens and Storey, 2003). The interviews were to allow for detailed probing of respondents' views and opinions and facilitate the elaboration of answers when necessary. This was to enable the expansion of the interviews into other areas that originally were not part of the interview schedule, but nonetheless may help towards addressing the aim of the study. The questionnaires were designed to develop a rich understanding of: status of human waste management; stakeholders' involvement and to determine best technologies and practice and to determine the role of local communities in waste management. This method was preferred in this study because it is one through which the researcher has room to probe for clarity of responses. It also gives a chance for self-expression (Kothari, 2005). The household interview schedules sought

information on the background of the respondents, water supply and hygiene, state of human waste disposal facilities and the challenges related to human waste management.

Second, information consisting of in-depth discussions was held with key informants in the study area. This included personnel in the physical planning department, the public health department, the environment department and Honey sucker/Exhauster Operators. They were mainly asked to comment on the study problems and possible solutions given their experience in attempts to address the problem in the area. These sources of information offered complimentary information which was analysed alongside the data obtained from the sample population.

3.6.3 Observations

Observations were focused on the municipality human waste management environment. Most of the observation was done to complement the information provided in the questionnaires. Digital camera was used to complete the information captured through observations. Observation is a qualitative primary research instrument for gathering data in a more natural way that ensures validity and reliability (Rea and Parker, 1997). The direct observation method was specifically used to enable the researcher get a first-hand look at the state of the facilities for human waste disposal in the informal settlements. Attention was given to the state of sanitation infrastructure, and the general environment in which the dwellers of informal settlements find themselves. This method was supplemented by photography. Photographs were taken to depict salient features relevant to human waste management.

3.6.4 Document analysis

The researcher also requested for all the documents that have in the past been used in human waste management, which were synthesized and included in this thesis as supplementary data source. Information on the performance of some of the human waste management strategies were sought including the cost and expenditure to maintaining some of these projects. The documents were sought from the records kept in the office. Substantial secondary data was extracted from various sources. These included published and unpublished documents and research reports on sanitation and waste management in general, and human waste management in particular. Information thus collected provided a good starting point or background information for the detailed household survey.

3.7 Validity and Reliability of the Research Instruments

3.7.1 Validity of the research instrument

Validity of an instrument refers to its ability to obtain data for which it was designed (Mugenda and Mugenda, 2003). To ensure the validity and reliability of our research instruments, several steps were taken. First, the interview schedule was thoroughly discussed between the researcher and his supervisors; secondly, the researcher held training sessions with the research assistants before the commencement of the research. Thirdly, the questionnaire was pre-tested before the actual collection of the data. Pre-testing was done in order to determine the questionnaires' internal consistency and to detect the difficulties that the respondents were likely to face when responding to questions. During the questionnaire pre-testing and training sessions, problems with the questionnaire items were noted and styles of probing and seeking clarifications discussed.

3.7.2 Reliability of the instrument

The reliability is consistency in measurement. To check on reliability of the instrument, the questionnaires were pre-tested through a pilot study to ascertain their effectiveness in soliciting the information intended. Pilot study was carried out in order to determine the questionnaires' internal consistency and to detect any difficulties that the respondents were likely to face when responding to the items. The questionnaires were administered to eight residents drawn from the 2 locations in Wareng District. Split half technique was used to obtain X and Y scores. X distribution took odd positioned items, whereas Y distribution took even positional items. Pearson product moment correlation (r) was used to calculate the reliability coefficient. The coefficient obtained was then converted into an appropriate correlation for the entire test using Spearman and Brown prophecy formula. The reliability coefficient of 0.5 and above was accepted as a good measure of reliability.

3.8 Data Analysis

At the end of data collection, all completed questionnaires were thoroughly examined by the researcher, coded and organized for computer analysis. The data was analysed using Statistical Package for the Social Sciences (SPSS) to generate findings and emerging trends in the data that was collected. Presentation of the findings was made in appropriate and well interpreted diagrams and figures.

3.9 Ethical Considerations

The following ethical considerations were made in the course of the study:

First, a research permit was obtained from the ministry of education which authorised the researcher to undertake this investigation. The relevant authorities, such as the

District Commissioners Office, local government and the Ministry of Environment at the district level, were also made aware of the study. This ensured that the research was conducted in line with the state as well environmental research regulations.

Second, all participants were made to understand the nature and purpose of the study. This enabled them to have informed consent to participate in the study. No respondent was obliged to take part in the study. Likewise, all information obtained from institutional data bases was utilised with the full consent of the owners.

Third, confidentiality of the information gathered at the household level was highly observed to safeguard the respondents from embarrassment and to ensure that their privacy was not interfered with. The identity of the respondents was also withheld to avoid any form of victimisation or personalisation of issues emerging from the study findings.

Fourth, to avoid plagiarism, sources and authors of information adopted in this study were acknowledged appropriately.

CHAPTER FOUR

STUDY FINDINGS

4.1 Socio-demographic characteristics of the respondents

The number of respondents used during the study in Langas and Munyaka was 257 and 127 respectively based on the questionnaire response rates from these two study areas. The overall results showing the demographic data for the respondents in Langas and respondents in Munyaka in the current study are indicated in Table 4.1.

Table 4.1: Socio-demographic characteristics of the respondents

		Langas (n = 257)		Munyaka (n = 127)	
Demographic	Characteristics	Frequency	Percent	Frequency	Percent
Gender	Male	94	36.6	40	31.5
	Female	163	63.4	87	68.5
Age	< 18	33	12.8	6	4.7
	18-35	188	73.2	98	77.8
	36-50	21	8.2	14	11.1
	>50	15	5.8	9	7.1
Marital status	Single	108	42.0	20	15.9
	Married	133	51.8	93	73.2
	Divorced	12	4.7	6	4.8
	Widows	4	1.6	8	6.3
Highest levels of education	None	5	1.9	0	0.0
	Lower primary	23	8.9	1	0.8
	Upper primary	74	28.8	13	10.3
	Completed primary	111	43.2	46	35.7
	Secondary	42	16.3	57	45.2
	College	2	0.8	9	7.1
	University	0	0.0	1	0.8
Occupation	Unemployed	144	56.0	39	30.7
	Farmer	73	28.4	46	36.2
	Salaried employee	16	6.2	16	12.6
	Business	16	6.2	22	17.3
	Banker	8	3.1	4	3.1

Significantly higher number (about two thirds) of males than females (about one thirds) were sampled in Langas and Munyaka. There were no significant gender ratios in Langas (about 1:3; Male: Female) and Munyaka estates (χ^2 = 1.334, df = 1, p = 0.652), indicating that females respondents in Langas and respondents in Munyaka were dominant in both estates. Age distribution indicated that more than two thirds (73%) of the respondents in Langas were aged between 18 to 35 years. Like in the gender distribution, there were no significant age differences of the respondents in Langas and in Munyaka (χ^2 = 2.334, df = 3, p = 0.531). Most of the respondents in Langas and Munyaka were married with the proportion of married being higher in Munyaka (73%) than in Langas (52%). No particular significant differences was diserned between Langas and Munyaka (χ^2 = 0.334, df = 3, p = 0.952). Among the respondents, highest proportion of the respondents in Langas sampled, had managed to complete primary school (43%) followed by those who had just reached upper primary levels of education while 45% had secondary levels of education in Munyaka followed by those who had just completed primary levels of education. Comparatively, there were significant differences in the levels of education was found between Munyaka and Langas estates (χ^2 = 13.119, df = 4, p = 0.0258). Finally most of the respondents in Langas and Munyaka were unemployed followed next by farmers and the least being bankers. There were no significant differences in the occupation of the respondents in Langas and respondents in Munyaka between Munyaka and Langas (χ^2 = 2.104, df = 4, p = 0.5161).

4.2 Current State of Human Waste Management in Informal Settlements in Eldoret Municipality

The study sought to know from the respondents about the availability of water for sanitation services. There is a direct relationship between water availability and human waste management. Furthermore, water, if it is piped, means an extra bill on the household. The primary source of water that the household used is presented in Table 4.2.

Table 4.2: Primary Source of Water for the Household

		Site	
		Langas (n = 257)	Munyaka (n = 127)
Piped water in the house	Frequency	103	81
	Percent	40.1	63.8
Water point/unimproved water source	Frequency	119	31
	Percent	46.4	24.7
Water kiosk	Frequency	30	17
	Percent	11.7	13.6

Majority of the respondents in Munyaka (64%) had piped water compared to the proportion of those with piped water in Langas (40%). However, the proportion of those with water points were found to be higher in Langas than in Munyaka, with each site reporting some low levels of water vending. Water kiosks were low in both study areas. For those who indicated that the water supply was irregular, they were further required to state how many days per week the water was available. Below are the findings:

Table 4.3: No of days per week the water was available in the source

	Site	
	Langas (n =257)	Munyaka (n = 127)
1 day	28.6%	4.8%
2 days	20.8%	14.4%
3 days	19.5%	12.8%
4 days	2.6%	15.2%
Over 5 days	28.6%	52.8%

The statistics in Table 4.3 above reveal that the situation was not very pathetic particularly in Langas, although it could be a cause of alarm. Most of the households, received water for more than five days in a week, 14% received water for only one day in a week, 17% received water for 2 days in a week, and 15% received water for 3 days in a week, while 10% received water for 4 days in a week. As earlier noted, this has a direct impact on the state of sanitation, especially with regard to the facilities of HW disposal.

Coping strategies during times of shortage of water supply are tabulated in Table 4.4.

Table 4.4: Coping strategies during times of shortage of water supply

		Site	
		Langas (n = 257)	Munyaka (n = 127)
Reduce water for domestic uses	Count	33	19
	Percent	12.8	15.0
Stored water	Count	154	91
	Percent	59.9	71.7
Alternative source of water	Count	70	16
	Percent	27.2	12.6

Table 4.4 above shows that most of the respondents, stored water for uses in times of water shortage, 27.2% in Langas and 12.6% in Munyaka used alternative sources of water like boreholes, while 12.8% of respondents in Langas and 15% in Munyaka reduced water for domestic uses. All these strategies have a bearing on the state of hygiene and cleanliness when it comes to facilities of HW disposal.

It was also important to inquire on the amount of water that the household uses daily so that it could be inferred the most appropriate water source and the state of their hygiene in terms of the facilities of HW disposal. Below is how they responded:

Table 4.5: Amount of water used by the household per day

	Langas (n = 257)		Munyaka (n = 127)	
No. of 20 lit. jerry cans per day	Frequency	Percent	Frequency	Percent
1-2	35	13.6	24	18.9
2-3	47	18.3	19	15.0
3-4	30	11.7	23	18.1
4-5	28	10.9	44	34.6
Over 5	93	36.2	13	10.2
Total	233	90.7	123	96.9

Table 4.5 above indicates that 40% of the respondents used over 5, 20-litre jerry cans, which is more than 100 litres, in a day for their domestic uses. This means that majority of the households used a large amount of water on average per day. 15% used 1-2 jerry cans, 20% used 2-3 jerry cans, 13% used 3-4 jerry cans, while 12% used 4-5 jerry cans per day.

Based on the above findings the researcher inquired about the presence of toilet facilities in the households. The results are as shown in Table 4.6.

Table 4.6: Presence and types of facilities for human waste disposal in Langas and Munyaka

			Site	
			Langas (n =	Munyaka (n =
Have human waste disposal facilities	Yes	Frequency	83	38
		Percent	32.3	30.2
	No	Frequency	174	88
		Percent	67.7	69.8
Type of human waste disposal facilities	Pit latrine	Frequency	122	77
		Percent	77.7	61.1
	Raised pit latrine	Frequency	27	51
		Percent	10.5	40.5
	VIP	Frequency	23	16
		Percent	8.9	12.7
	Multiple seat	Frequency	2	5
		Percent	0.8	4.0
	Pour flash	Frequency	19	4
		Percent	7.4	3.2
	Septic tanks	Frequency	44	21
		Percent	17.1	16.7
	Ablution	Frequency	5	3
		Percent	1.9	2.4

There were no significant differences in the proportion of respondents owning human waste disposal facilities in Langas and Munyaka (about 30% in each case). However, significant differences were reported in the types of human waste disposal facilities owned by the local community members (χ^2 = 22.108, df = 5, p = 0.0021) in Langas and Munyaka. Langas, the highest proportion of the local community members owned pit latrines which was however, higher in proportion in Langas than in Munyaka. On the other hand, raised pit latrines were higher in proportion in Munyaka than Langas while pour flash pit latrines were higher among respondents in Langas than Munyaka.

Other waste disposal facilities such as VIP, multiple seats VIP and ablution blocks were owned by less number of people in both sites while close to 16-17% of the respondents owned septic tanks in both sites. Given the kind of settlement where this study was conducted, and the fact that the water source was not reliable, most of the households would be expected to use pit latrines for the purpose of disposing of the HW. Thus 81.8% and 84.8% of the household in Munyaka and Langas respectively use Pit latrines or VIP Latrines .That means that majority of the households use pit latrine; the state and condition of these facilities were in deplorable conditions. 507 (83.7%), used pit latrines/VIP latrine as the facility for HW disposal. A small percentage of 8.9% who are mainly households living in Langas near the sewer line, used pour flush toilets. Nevertheless the conditions of these human waste disposal facilities were found to be very poor in both sites leading to proliferation of human wastes (Figure 4.1).

Figure 4.1: Pictures showing a dilapidated pit-latrines

The pictures in Figure 4.1 above are indicative of the deplorable and vulnerable state in which the facilities for human waste disposal are in the informal settlements of Langas and Munyaka. Only two households that lived in Munyaka used pour flash toilets and used Cesspools to dispose off their human waste as oppose to the case in some part of Langas where there is one trunk sewer line without any connection.

The study also sought to find out the owner of the facility that the household frequently uses. The findings are presented in Table 4.7.

Table 4.7: Ownership of the facility that the household uses for human waste disposal in the study area

		Site	
		Langas (n = 257)	Munyaka (n = 127)
Individual/Privately owned	Count	45	22
	Percent	17.5	17.3
Landlord (shared facility)	Count	183	91
	Percent	72.1	72.0
Public Facility	Count	3	3
	Percent	1.1	2.3

The findings revealed that 72% of the households in both estates use HW disposal facilities that owned by the landlord/lady and therefore shared by other tenants. This has a bearing on the maintenance of the facilities and an explanation of their current state. 17% of the respondents used facilities that were privately owned, that is, it was only the household that used the facility, while only 1% used a public facility. It was in line with this that the study wished to know who was responsible for the maintenance of the hygiene of the facility. Below are the results:

Table 4.8: Maintenance of hygiene of the facilities frequently used

		Site	
		Langas (n =257)	Munyaka (n = 127)
Self	Count	224	115
	Percent	87.0	91.2
EMC	Count	3	12
	Percent	1.3	3.2
Commercial agent	Count	3	0
	Percent	1.1	0.0
Community initiative	Count	26	13
	Percent	10.1	10.2

Majority of the respondents, 87-91%, maintained the hygiene of the facility they used themselves. In the cases where the facility was shared, there was a schedule for each household to clean the facility. 10% indicated that the facility's hygiene was maintained by community initiative, 2.5% indicated that this was done by EMC, while 1.1% in Langas indicated that the facility was maintained by a commercial agent. The hygienic status of the facility is paramount considering the health and environmental implications of the same.

After establishing the facility that was used for human waste disposal, the researcher proceeded to find out the quality of these facilities in terms of privacy, hygiene and convenience in terms of queuing, security and operating time. The key informants were asked to comment on the state of the facilities for human waste disposal and most of them described it as poor, pathetic, deplorable and that sanitation is compromised and poor because of the high population. This was also attributed to the initial lack of planning and lack of a sewer line. The responses from the households

were not much different from those expressed by the key informants. Below is a presentation of how the households evaluated their facilities:

The study investigated the quality of privacy in the facilities that the households used for HWD. These can be attested to by the pictures in Figure 4.2, where it is clear that the privacy of the users of these facilities is compromised.

Figure 4.2: Picture showing the compromised state of privacy in Langas
(Source: Author, 2013)

When the facility of HW disposal has a compromised state of privacy, it also points to other conditions about the same facility. It could be a pointer to negligence, poor construction and further to that, poor hygiene. The research thus went ahead to investigate the state of hygiene in these facilities as discussed in Table 4.9.

Table 4.9: Quality of the facility in terms of hygiene

		Site	
		Langas (n =257)	Munyaka (n = 127)
Clean	Count	76	55
	Percent	29.9	43.2
Fair	Count	90	38
	Percent	35.1	29.6
Dirty	Count	90	35
	Percent	35.1	27.2

Table 4.9 above shows a fair distribution of the responses regarding the hygiene of the facilities for HW disposal. 30% of the households in Langas and 43.2% in Munyaka indicated that the facilities were clean, 35% of respondents in Langas and 30% in Munyaka indicated that they were fairly clean, while 35% of respondents in Langas and 27% of the respondents in Munyaka indicated that the facilities were dirty.

As earlier noted, there is a relation between the privacy and hygiene of the facility for HW disposal. This is evidenced in the cross-tabulation and Chi-square test below:

Table 4.10: Quality of the facility in terms of hygiene

	Quality of the Facility in Terms of Hygiene		
	Clean	Fair	Dirty
Good	222	60	3
Fair	6	123	69
Poor	3	9	111

Of the 123 respondents who lamented about the privacy of the facility for HW disposal as being poor, 111 of them also indicated that the facility was dirty. There is,

therefore, a strong relationship between privacy and hygiene as evidenced in the Chi-square test below:

Where there is no privacy, most of the users will not bother about the facility's hygiene. This can be very detrimental to the overall sanitation, health status and the environment in general. The picture below further shows how the environment has been dilapidated as a result of poor hygienic practices in the informal settlements.

Figure 4.3: Picture showing a heap of 'flying toilets' and unhygienic WD in Langas

(Source: Author, 2013)

Table 4.11: Convenience of the Facility in Terms of Queuing

		Site	
		Langas (n =257)	Munyaka (n = 127)
Satisfied	Count	93	56
	Percent	36.2	44.1
Fair	Count	80	37
	Percent	31.1	29.1
Dissatisfied	Count	84	34
	Percent	32.7	26.8

Queuing can be a very irritating experience when it comes to the use of the facility for human waste disposal. The experience of queuing for biological functions is not usually welcome by many people. In most cases, when such a situation arises, the victims usually go for the next alternative, which may not be environmental and health friendly. Nevertheless, the results above indicate that majority of the respondents, 42.6%, were satisfied with the convenience of queuing, 30.7% indicated that the situation was fair, while a significant number of respondents 26.7% were dissatisfied. This last category (those who were not satisfied) attracted the attention of the researcher. The immediate question is that where do they dispose of their HW when the queue is unbearable? These are a threat to the environment and general sanitation of the settlement, not unless they make use of public facilities. It was thus the contention of this research convenience of the use of the facility for HW disposal was very important and a requirement.

The other convenience that is of great importance when it comes to the use of the facilities for HW disposal is security, especially at during night time. Most households, if not all, mind so much about their security. Given the importance of HW disposal and the centrality of security to the households, it was quintessential that the study investigates the aspect of security when it comes to the facilities that are used for HW disposal. Below are the findings concerning the convenience of the facility in terms of security?

Table 4.12: Response on convenience of facility in terms of security

		Site	
		Langas (n =257)	Munyaka (n = 127)
Satisfied	Count	85	38
	% within Site	33.1	29.9
Fair	Count	90	61
	% within Site	35.0	48.0
Dissatisfied	Count	82	28
	% within Site	31.9	22.0

The results in Table 4.12 above reveal that 33.6% of the respondents in Munyaka was 29.9% in Langas were satisfied with the security of the facility that they use for HW disposal. Up to 35% of the respondents in Munyaka and 48% in Langas were fairly satisfied while 32% in Munyaka and 22% in Langas were dissatisfied with the security of the facilities. In the informal settlements, security is always a thorny issue. It is not surprising that one may not be able to dispose off their HW in the facility provided for, just because of security concerns. As earlier noted, this becomes a potential situation for compromising the environment and sanitation of the area. The picture below suffices to explain this situation:

Figure 4.4: Picture taken in Munyaka of a toilet poorly constructed and a security risk at the same time, especially during the night

(Source: Author, 2013)

The picture in Figure 4.4 above gives a clear threat that is posed by the state of the facilities of HWD in the informal settlements. The compound has no perimeter fence, and further the toilet exposes the users to insecurity while utilizing it.

The convenience of operating time is another important element that is of great importance when it comes to facilities of HW disposal. Some of the facilities can only be used at some time and not other times. One needs to access the facility at all times because HW disposal cannot be scheduled to some particular time. For convenience purposes, the facility has to be accessed at all times. The respondents were required to give the status of convenience of the facility in terms of security, and their responses are as presented in the table below:

Table 4.13: Convenience of the facility in terms of operating time

		Site	
		Langas (n =257)	Munyaka (n = 127)
Satisfied	Count	107	59
	Percent	41.6	46.5
Fair	Count	80	33
	Percent	31.1	26.0
Dissatisfied	Count	70	35
	Percent	27.2	27.6

Table 4.13 above presents the findings on the convenience of the facility of HW disposal in terms of operating time. Majority of the respondents, in Munyaka (41.6%) and Langas (46.5%), were satisfied with convenience of the facility in terms of operating time, 31.1% respondents in Munyaka and 26% in Langas indicated that the situation was fair, while 27.2% of the respondents in Munyaka and 27.6% in Langas were dissatisfied. It was of paramount importance to improve the state of operating time for the facilities.

The foregoing discussion has focused on presenting and interpreting the findings on the state of the facilities for human waste disposal. From the interviews with the households, the picture that comes out is that the state of human waste management was not up to the required standards of sanitation and environmental friendly. The key informants too described the state of the facilities for HW disposal as being in very poor conditions. They indicated that the situation needed to be addressed with urgency, given the looming dangers of people living under such environmental conditions. Such dangers include environmental pollution, health dangers, accidents and aesthetic compromise. This reality is evidenced in the table below which presents

findings on the overall satisfaction of the respondents as pertains the state of HWM in their settlement:

Table 4.14: Overall satisfaction with your present human waste management system

		Site	
		Langas (n =257)	Munyaka (n = 127)
Very satisfied	Count	17	3
	Percent	6.6	2.4
Satisfied	Count	68	55
	Percent	26.3	43.2
Very dissatisfied	Count	37	16
	Percent	14.5	12.8
Dissatisfied	Count	132	50
	Percent	51.3	39.2
Not sure	Count	3	3
	Percent	1.3	2.4

Majority of the respondents, 57.2% (very dissatisfied 13.4% + dissatisfied 43.8%), were not happy with the situation as it is in their settlement. This concurred with what the key informants had alluded to when they described the state as being deplorable, poor and wanting. Only 40.8% of the respondents were satisfied with the current state of the facility for HWM, while 2% were not sure or could not comment on the current state of the facility for HWM. This leaves us with majority of the respondents who were not satisfied with the state of the facilities for HWM where they are living.

The researcher also made an observation that the state of the facilities for HWM was not very conducive. Most of them were in deplorable state as has been demonstrated in the findings and the pictures that were taken from the research areas. These call for

action from all the key players involved in HWM, especially in the informal settlement. This leads the discussion to the next objective of this study, which was to establish the key players in this sector. This is important in knowing who is responsible for what in this area of HWM.

4.3 Main stakeholders in human waste management in informal settlements in Eldoret Municipality

The study investigated the main stakeholders involved HWM in the informal settlements in Eldoret municipality as one of its specific objectives. The research thus begun by inquiring on who was responsible for the cleanliness of the facility for HWM. These results are further separated according to the two areas where the study was conducted. The findings are as presented in the table below:

Table 4.15: Maintenance of the hygiene of the facility

		Site	
		Langas (n =257)	Munyaka (n = 127)
Self	Frequency	223	115
	Percent	86.8	90.5
EMC	Frequency	3	4
	Percent	1.2	3.1
Commercial agent	Frequency	3	0
	Percent	1.2	0
Community initiative	Frequency	28	8
	Percent	10.8	6.3

It can be inferred from the above statistics that one of the main actors involved in human waste management in the informal settlement in Eldoret Municipality, were the users of the facilities for human waste disposal. They were the ones who, in most cases, were concerned with the construction and maintenance of the facilities for HW

disposal. It was them who determine the sanitation and general cleanliness of the facilities. It was the contention of this study that the households that used the facilities of HW disposal were crucial to the overall success of HWM in informal as well formal settlements.

In the informal settlements, most of the people who lived there were tenants, in which 80% of the residents in the settlements under study lived in rented houses. In terms of HWM, this means that they were the primary users, yet they might not have been responsible for the construction and routine maintenance of the facilities for HWM. It was the landlords/ladies who were responsible for providing the facilities and maintaining them. They thus became the second category of the main actors in HWM. From the information gathered from the respondents, it was clear that in these informal settlements the facility for HW disposal that was commonly used was the pit latrine. This facility, for it to be effective and environmental friendly, must be well designed and constructed in accordance to the health and environmental requirements. It has also to be routinely emptied. All these activities have to be accomplished by the owners of the houses that have been rented. This was evident when the households were required to provide information on the cost of construction and emptying the facility that they used. Most of them were not aware of their costs as evidenced in the tables below.

Table 4.16 presents frequencies on how much the household spent in a month for using the facility for HW disposal. Majority of the respondents indicated that there were no charges, that is, monthly payments were not applicable to them. These were those who used pit latrines within the plots that they lived in, so they didn’t pay for

their usage. 39 respondents indicated that they paid Ksh. 450 per month to use the facility. These could be those who used pour flash toilets as their facility for human waste disposal, and therefore had to pay a standard amount monthly to the sewerage company. Only three respondents indicated that he/she paid Ksh. 200 per month to use the facility.

Table 4.16: Cost of emptying the facility for human waste Disposal per Truck

Truck	Langas (n =257)		Munyaka (n = 127)	
Construction cost	Frequency	Percent	Frequency	Percent
5,000-9900	26	32.1	13	27.1
10,00-14999	30	37.0	17	35.4
15000-16999	13	16.0	8	16.7
17,000-19999	9	11.1	7	14.6
20,000 and above	3	3.7	3	6.3
Total	81	100	48	100

The cost of servicing the facility for HW disposal, ranged from Ksh 1000 to 4,500 per truck. The statistics revealed that 426 respondents were not aware of how much it cost to empty the facility per truck. These respondents either had never witnessed the emptying since they came to where they lived, or if they had witnessed were never told or involved in the costing of the exercise. Of those who claimed to be aware of the cost of emptying, the frequencies were as shown in table above. It is worth noting that some of the prices for emptying can cost a fortune to most households and even their landlords/ladies. This could be the reason they were not emptied regularly or not emptied at all. This poses a challenge to the overall exercise of HWM in informal settlements.

It was observed that the households that the facilities had been poorly constructed and hardly maintained thereafter. This was why most of the key informants, especially from the health sector (Public health officials and the in-charge of health centres in these settlements) described the sanitation of the settlements as poor, deplorable and risky to the people's health and environment.

The other main actors in this sector of HWM were the honey suckers. These were private operators who have joined the HWM activities. The study, through the help of National Environmental Management Authority (NEMA), managed to get a list of registered honey suckers operating within Eldoret. There were eight (8) registered honey suckers that the study managed to interview. These were mainly concerned with emptying of facilities for disposal of human waste in individual owned premises and in institutions/organizations.

The honey suckers, from the findings, were private entrepreneurs who saw HWM as a business opportunity and seized it. This was made clear when the honey suckers were asked to state the reason as to why they decided to be involved in HWM. The results were as shown in the table below:

As presented in Table above, all the honey suckers (100%) who responded to the questionnaire indicated that they ventured into HWM sector as a business opportunity. This implies that the main concern of these main actors in the sector of HWM was to do business. It was appreciated that as they did their business, they were playing a crucial role in HWM, but it was also worth noting that not unless they were called on

to be paid for their work, they could not just perform the functions of HWM for other reasons such as environmental, health or otherwise.

They had equipment that they used for emptying the facilities for HW disposal. All the honey suckers that responded to the questionnaire used exhauster vehicles as the main equipment for their operations.

They indicated that they came into this sector after realizing that the EMC was not able to manage HW. In that case, they supplemented what EMC would have provided to the residents of Eldoret. However, it sufficed to note that they worked in conjunction with EMC, ELDOWAS and NEMA in their operations. In the performance of their duties in the HWM sector, they encountered some challenges, the main ones presented in the figure below:

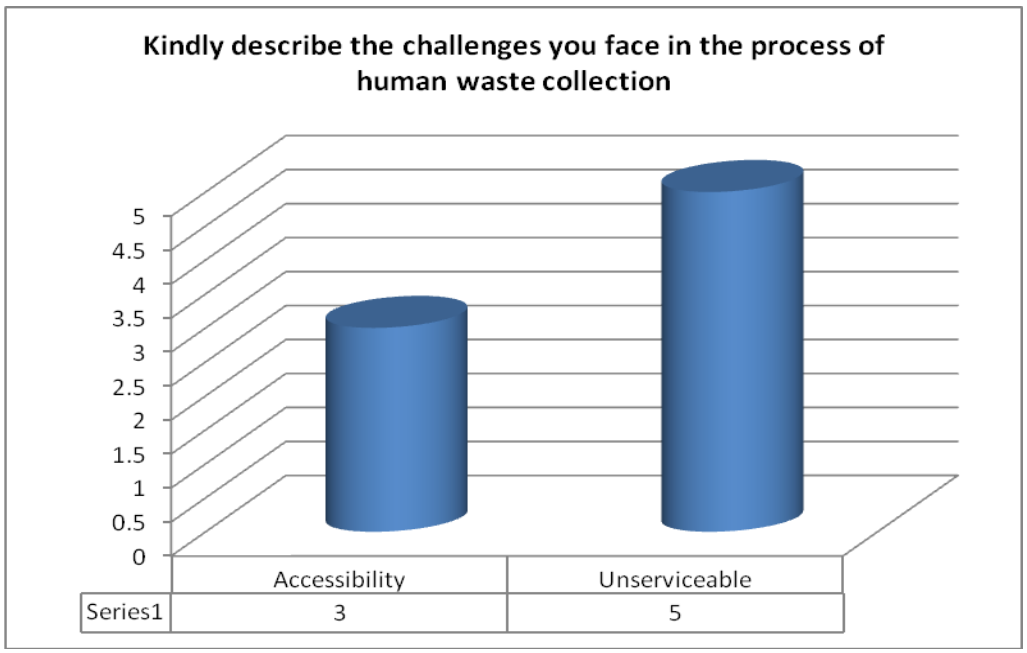

Figure 4.5: Challenges Faced in the Process of Human Waste Collection

Of the 8 honey suckers interviewed, 5 of them pointed out that the main challenge they faced in the course of collecting HW was that the facilities were unserviceable. They indicated that unserviceability of the facilities for HWD arose due to poor usage of the same. Most of the users of these facilities threw insoluble matter in the facilities such as dead animals, plastic materials (papers, diapers, sanitary pads etc), stones and many other non-biodegradable or slow biodegradable matters. The presence of this matter in the facilities for HWD posed the greatest challenge to collection of HW.

The remaining 3 respondents pointed to inaccessibility as the main challenge to the process of HWC. Most of the informal settlements have poor or no planning in as far as infrastructure is concerned. This renders the facilities in such settlement inaccessible by the honey suckers' exhauster vehicles. Other challenges that the honey suckers faced in the execution of their duties included delayed or non payments, negative attitude by the residents/general public and lack of technical skills to maintain their equipment. The honey suckers revealed that some of their clients refused to pay after their facilities had been serviced or paid less than the agreed amounts. Since they sold their services, the lack of payment became a big challenge to their business. They also lamented the negative attitude towards them from among the general public. They informed the researcher that members of the public associated them with officers who worked with the municipal council, who had made sure that the council was not able to undertake waste collection operations, so that they could do business by minting money from the public. The honey suckers were therefore sometimes treated with a lot of disdain. This leads us to consider the next main actor in the HWM sector.

EMC is another main actor in HWM, especially in informal settlements. It plays its role in HWM via three of its departments. The departments that are directly concerned with HWM include the departments of planning, health and environment. The study interviewed the officers in charge of these departments to ascertain their roles in HWM, the challenges that they encountered in executing their mandate and the plans they had for HWM in general. The researcher gained valuable insight into the issues pertaining to HWM within Eldoret municipality from these officers.

The planning department of EMC offered information on what had already been done as far as HWM was concerned and what was yet to be done, especially in the informal settlements. The planning office is in charge of the actual physical planning and approval of structures and infrastructure on behalf of EMC and liaises with other departments that may be related to planning. The officers in the planning office indicated that the state of the facilities of HW disposal was deplorable/pathetic. This, they said were problems of high population density, that was not initially planned for. The high population influx into urban areas, especially in Eldoret, leads to the mushrooming of informal settlements that were not initially planned for by the Local Authority. The emerging situation is that very few can connect to the sewer due to lack of an official sewer line, attitudes, and economic factors among others.

The EMC department has plans and policies for the informal settlements as far as HWM is concerned. For Munyaka, funds from Kenya Informal Settlements Programme, which will also benefit Kamukunji, Langas, and Huruma settlements, have been sourced to help connect to the sewer line. Other efforts being made include ensuring change of attitudes among the public, subsidising disposal costs to encourage

connection to the sewer line, making sewer lines operational and efficient, and to meet a balance with rising costs of rents and provision of appropriate HWM systems. This would be done coupled with educational efforts to sensitize public on the need to embrace new technology and to choose sewers over other means of waste disposal like pit latrines.

The study also identified Eldoret Water and Sewerage Company (ELDOWAS) as a main actor in HWM. They are involved in the provision of services related to water and sewerage. They are therefore responsible for the supply of water, construction and maintenance of sewer lines. For the purposes of this study, officers in charge of planning, construction and maintenance of sewer lines were sought and interviewed to shed more light on the activities of HWM in Eldoret town. The last main actor in HWM that the study identified was NEMA. This is a body that is mandated to manage matters pertaining to the environment. NEMA works in conjunction with other stakeholders in the environment sector to ensure that it is safe, and that all environmental threats are addressed. In line with this study, NEMA is involved in the licensing of honey suckers, watching over HW disposal facilities and activities as well as ensuring that HWM is done in an environmental friendly manner.

4.4 Challenges with regard to human Waste Management

The task of HWM in itself poses a myriad of panning challenges, especially in informal settlements. These problems and challenges are presented in terms of planning for health and environment. The discussion was structured along these aspects that concern HWM.

4.5.1 Health related challenges

There are many challenges that relate to poor planning for health management that may emanate from the human waste disposal.

Figure 4.6: A picture showing open defecation in Langas

(Source: Author, 2013)

Health is a crucial aspect of human and other animals' existence. Good health ensures that all other aspects of human endeavours are not compromised. When health is compromised, it threatens the very existence of the human person and other elements within his/her ecosystem. HWM can pose a great threat to the general health of the environment, especially if HW is not managed properly. It was therefore paramount that this study looks into the problems and challenges that arise in connection to health when dealing with HW.

The key informants were very resourceful with regard to the health problems and challenges that arise during HWM. The most crucial information with regard to health was obtained from those working in the health sector, either under the Ministries of Public Health and that of Medical Services, or with the EMC. The researcher interviewed the medical staffs in charge of the health facilities in both Langas and

Munyaka. In addition, the officers in charge of health matters working for EMC were also interviewed. They gave their views with regard HWM in as far as it affected the health of the communities they work for.

As noted earlier in the discussion under the state of human waste management in informal settlement, it was indicated that the facilities were in a deplorable state. The health workers who were interviewed lamented on the state of HWM in the informal settlements. They indicated that there was poor excreta disposal in the informal settlements. They also indicated that most of the residents in these settlements used pit latrines that were poorly constructed (Figure 4.7) and that they were constructed near water sources, mainly wells and boreholes as shown in the picture below:

In terms of cleanliness, the condition was also wanting. They also observed that some of the facilities of HWD were full and thus discharged their affluent into the environment as shown in the picture below:

Figure 4.7: A picture showing HW being discharged carelessly into the environment

(Source: Author, 2013)

These realities posed a great challenge and problem to health. The researcher was informed that because the pit latrines were constructed near boreholes, and given that the water table was very high and given the topography of the area, leaching was an obvious consequence. It was also noted that most of the pit latrines were shallow and therefore it became easy to release the waste into the environment. That means that water could easily be contaminated and thus prone to be infectious to the users. This fact was further strengthened when the key informants were asked to state the common illnesses that people living in these areas suffered from. Top on the list were typhoid fever (e.g. diarrhoea, cholera), malaria, and respiratory system infections. Most of these diseases were caused by poor management of the human waste

It was noted that the main causes of these diseases were: stagnant water due to poor or no drainage which was breeding ground for mosquitoes, unsafe drinking water as a result of leaching. These factors contribute immensely to the daunting health conditions that prevail in these settlements.

4.4.2 Environmental challenges

The pictures below show the sorry state in which the environment in informal settlement. The settlement is full of different sizes of plots and shapes with developments including Pit Latrines having been put up in public use areas making it difficult to plan and put up proper public water and sanitation facilities. Individual plots have also developed their plots leaving no plan to put up water and sanitation facilities as required by environmental planning and sanitation standards.

Figure 4.8: Poor state of human waste disposal facilities in Langas and Munyaka

(Source: Author, 2013)

This study was done with regard to the effects that human waste has on the environment. There were various challenges that HWM posed in as far as the environment is concerned. This section discusses the various challenges that the current state of HWM in informal settlements poses on the environment.

Challenges related to the environment emerged right from the facilities that were used for HW disposal, to collection and treatment. At the point of disposal, the type and state of the facilities that were used at this point posed a great threat to the environment. From the researcher's first hand observation, most of the facilities (the pit latrines) were poorly constructed (Figure 4.9) and most of them were unhygienic as shown in the picture below:

Figure 4.9: Deplorable state of the environment caused by poor human waste disposal in Langas

(Source: Author, 2013)

These states were not conducive for a healthy environment for human habitation. These sentiments were echoed by health workers from the heath facilities in the areas of study and also by the households, as evidenced in Figure 4.10. The figure shows a fair distribution of the responses regarding the hygiene of the facilities for HW disposal. 231 households claimed that the facilities were clean, 192 respondents indicated that they were fairly clean, while 183 respondents claimed that the facilities were dirty. As earlier noted, there is a relation between the privacy and hygiene of the facility for HW disposal.

It was also noted that the facilities were poorly maintained and some of them were not serviced at all. These resulted in overflow of the HW into the environment. Since the substances released to the environment were not treated and were harmful in that they caused both chemical and air pollution. It was also observed that some of the facilities had pores which were deliberately drilled to release the affluent directly into the

environment. This, the observer noted, was a big environmental challenge. The picture below illustrates this point further:

Figures 4.10: Human waste being released to the environment from toilets in Langas and Munyaka
(Source: Author, 2013)

The households informed the researcher on some of the challenges that they face when it comes servicing of the facility as shown in the bar graph below:

Table 4.17: Challenges faced when servicing the facility

	Site	
	Langas (n =257)	Munyaka (n = 127)
Lack of funds	123	141
Lack of equipment	27	15
Lack of knowledge	6	3
Not applicable	75	216

Majority of the respondents who indicated that they had a challenge when it came to servicing the facility for HWD (264 respondents) said that their main challenge was lack of funds to pay the service providers. This, as earlier discussed, was due to the

economic status of the residents in the informal settlements. Other respondents, 42, indicated that their challenge was that of lack of equipment to service their facility while 9 of the respondents said that their challenge was lack of knowledge to service the facility. The remaining 291 respondents did not respond to this particular question.

A similar scenario was noted when the respondents were asked to indicate the challenge they faced to construct a new facility:

4.4.3 Challenges in constructing the human waste management facility

Table 4.18: Challenges Faced when Constructing the Facility for Human Waste Disposal

	Site	
	Langas (n =257)	Munyaka (n = 127)
Lack of funds	108	84
Lack of equipment	21	6
Lack of knowledge	6	0
Not applicable	96	285

From Table 4.19 above, it is clear that the challenge of lack of funds is still recurrent when it comes to the facilities of HW disposal. This is so because, of the respondents who indicated that there were challenges when it came to the construction of the facility for HW disposal, 192 of them cited lack of funds, 27 cited lack of equipment, while 6 cited lack of knowledge to construct a new facility.

In the face of these challenges, one can validly conclude that since residents lack funds, equipment and knowledge, the facilities are most likely to remain in their deplorable state and thus cause more harm to the environment, in addition to other

aspects that threaten like health and sanitation. Other challenges related to the environment resulted during the collection, transportation and processing of human waste. Some of such challenges are presented in the chart below:

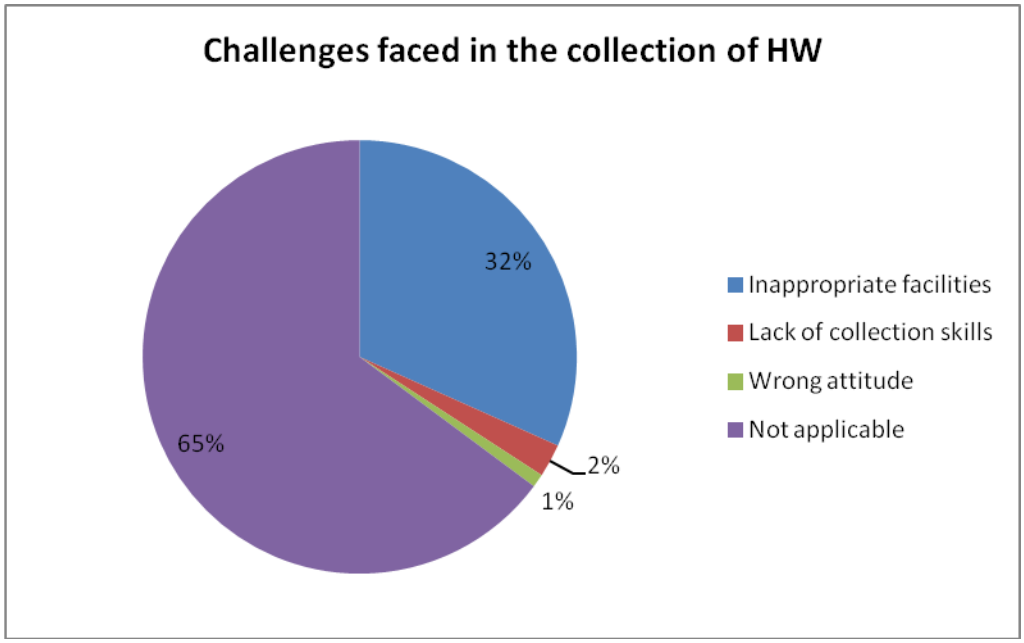

Figure 4.11: Challenges during in the collection of Human Waste

The main challenge that the respondents identified was the use of inappropriate facilities for the collection of HW. 32% of the respondents cited lack of appropriate facilities as a challenge, 2% cited lack of collection skills while 1% cited wrong attitude. The remaining 56% were not aware of the challenges since they might not have participated or witnessed the collection of HW. These challenges of inappropriate facilities, lack of collection skills and wrong attitude were a threat to the environment in that they resulted into environmental unfriendly repercussions such as spillages, odour among others. These are as presented in the graphs below:

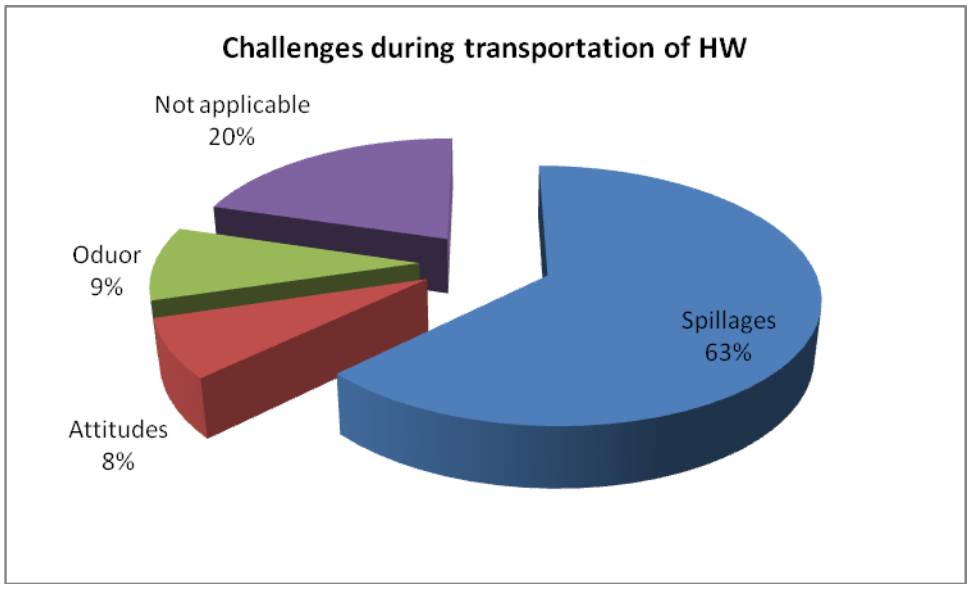

Figure 4.12: Challenges during Transportation of Human Waste

4.4.4 Challenges in transporting the Human Waste

Table 4.19: Challenges during Transportation of Human Waste

	Site	
	Langas (n =257)	Munyaka (n = 127)
Spillages	153	228
Attitudes	18	27
Oduor	27	30
Not applicable	33	90

The challenges posed to the environment during transportation follow up from those experienced during collection. Poor equipment and lack of collection skills which were identified earlier as challenges eventually led to those that were experienced during transportation, such as spillages and odour. 63 % of the respondents indicated that there were spillages of human waste during transportation, which in turn resulted to bad odour, 9%. These two are detrimental to the environment in general and to health and sanitation in particular.

During processing of the HW, similar challenges occur, such as lack of appropriate facilities, 156 respondents, lack of appropriate collection skills, 24 respondents. When there are no appropriate skills and facilities, the effect to the environment during the processing of HW is immense. They thus pose a challenge to the environment.

When it comes to disposal, coupled with the above challenges, the situation becomes worse as far as the environment is concerned. 192 respondents indicated that there was not enough space for the disposal of HW, 45 indicated that there was no designated place, while 24 of them indicated lack of funds as a challenge to human waste disposal. This means that HW may be disposed of to any place designated or not, thus posing an environmental problem.

The above findings were in tandem with those echoed by the key informants from NEMA. They said that up to 2009, the exhausters did not have a definite place to dispose of the HW. But in 2010/2011, NEMA, EMC and ELDOWAS came up with manholes where the exhausters discharged the waste.

NEMA also lamented on the level of pollution in River Sosiani. After carrying out a research on the chemical levels of the river from its source to where it meets Kipkaren River, it was concluded that what was discharged into the river was not well treated. The BOD/COD levels were very high as opposed to the required standards. It was found out that the treatment plate used by EMC was not functioning efficiently, as evidenced at the discharge point of sewage treatment plant and Sosiani River.

The key informants from NEMA thus recommended the strict enforcement of EMCA laws and regulation, especially with regard to waste collection, transportation, processing and treatment. The standards set by EMCA must not be compromised if environmental challenges have to be reasonably reduced or eliminated all together. NEMA also noted that since most people in Eldoret use water from boreholes, it was important that human waste collection, disposal and treatment be done well to avoid illnesses that are related to environmental pollution.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

5.1. 1 The Current State of Human Waste Management in Informal Settlements in Eldoret Municipality

The study sought to know the current state of human waste management in the informal settlements in Eldoret Municipality. There is a direct relationship between water availability and human waste management. Some methods of HWM, like the sewer line, cannot work where there is no reliable source of water. Furthermore, water, if it is piped, means an extra bill on the household. The facilities upon which the residents of the informal settlements of Eldoret relied upon for human waste management included: pit latrines/VIP latrines, to which almost all the residents had access; pour/ flush toilets, with a small user group; a number of the residents also relied on composite latrines; and some relied on septic tanks.

When it came to the ownership of or the responsibility for the facilities used in human waste management, it was found that the majority of said facilities were owned by landlords/ ladies. This implies that these facilities are shared and/or communal and this fact had a bearing on the maintenance, care and cleaning of the facilities. This was achieved: through community initiatives; the EMC and, rarely, by commercial agents. Several residents had private facilities, implying that they did it themselves while only a small number used public facilities, implying that they did not participate in the maintenance, care and/or cleaning of the facilities.

Some of the communal facilities were maintained and cleaned on a rotating, communal schedule to avoid disagreements and the negligence of the facilities. To get the residents' point(s) of view, several issues were examined. The first was privacy, such as no crowds outside, discretion and most of the residents found it to be satisfactory; a few thought it was fair and the minority thought it was poor. Compromised privacy points to other negative factors e.g. negligence, poor construction and poor hygiene among others.

The second factor to be scrutinized was the level of hygiene in these facilities. Most of the residents thought the facilities were clean; a slightly smaller group thought they were fairly clean while the minority thought they were dirty. This implies that the levels of hygiene in the study areas were questionable.

When it came to the convenience of the facilities, i.e. time of operation cueing and use, the majority thought that the operating hours were ok and that queuing wasn't a problem; a few thought that both were fair and a minority felt that it was inconvenient and embarrassing as they had to seek alternative means at times due to queues and locked facilities. This shows that the facilities were, at times, inconvenient to use and/or inaccessible.

Another issue that arose was the security, especially at night. Given the importance of proper human waste management to avoid pollution, environmental contamination and reduce health risks, this was found to be fair by a majority, slightly fair by others and poor by the rest.

5.1.2 Stakeholders involvement in HWM in Informal Settlements in Eldoret Municipality

From the study, it is evident that one of the main actors in HWM are the households. They are the first to generate the waste and the initial users of the facilities for human waste disposal, are the households. The attitudes and perception they have toward of waste collecting and handling as a big bearing on overall success on improvements initiatives. It is they who determine the sanitation and general cleanliness of the facilities. It is the contention of this study that the households that use the facilities of HW disposal are crucial to the overall success of HWM in informal settlements.

The landlords/ladies were found to be responsible for providing the facilities and maintaining them. They thus become the second category of the main actors in HWM. From the information gathered from the respondents, it was clear that, in these informal settlements, the most commonly used facility for HW disposal is the pit latrine. This facility, for it to be effective and environmental friendly, must be well designed and constructed in accordance to health and environmental requirements. It has also to be routinely emptied. All these activities have to be accomplished by the owners of the houses that have been rented. This was evident when the households were required to provide information of the cost of construction and emptying the facility that they used. Most of them were unaware of their costs.

A large number of respondents indicated that there were no charges, that is, monthly payments were not applicable to them. These are those who used pit latrines that are in the plots that they live in, so they don't pay for their usage. Several indicated that they pay a monthly fee for using the facility. These could be those who use pour/flush

toilets as their facility for human waste disposal and therefore they have to pay a standard amount monthly to the sewerage company. The cost of servicing the facility for HW disposal ranges from Kshs. 1,000 to 4,500 per truck. The majority of the respondents were unaware of how much it costs to empty the facility per truck. These respondents either had never witnessed the emptying since they came to where they are staying or, if they had witnessed it, they were never told or involved in the costing of the exercise. A few claimed that they were aware of the cost of emptying. It is worth noting that some of the prices for emptying was considered very high by most households and even their landlords/ladies. These points to the fact that that could be the reason why they were not emptied regularly or not emptied at all. This poses a challenge to the overall exercise of HWM in informal settlements.

The majority of the respondents were not aware of the cost of constructing a new but similar facility. As earlier noted, these could be the tenants who were least bothered with the cost of the facilities that they used since they did not bear the cost directly. However, the cost of constructing a new facility, according to the respondents, ranged from Kshs. 5,000 to 20,000. This is a huge amount for households that live in informal settlements, since they live there because of economic constraints. It remains the onus of the residences owners to build new facilities in case the old ones can no longer be user and environmental friendly. It is in line with this argument that the study further concludes that owners of the premises where people live have a key role to play in HWM.

It was, however, discovered from observation by the researcher and responses from the households that the facilities have been poorly constructed and hardly maintained

thereafter. That is why most of the key informants, especially form the health sector (Public health officials and the in-charge of health centres in these settlements) described the sanitation of the settlements as being poor, deplorable and risky to the people's health and environment.

The other main actors in this sector of HWM were the honey sucker operators. These are private operators who have joined the HWM activities. The study, through the help of the National Environmental Management Authority (NEMA), managed to get a list of registered honey suckers operating within Eldoret. There were eight (8) registered honey suckers that the study managed to interview. These are mainly concerned with emptying of facilities for disposal of human waste in individual owned premises and in institutions/organizations. The honey suckers, from the findings, were private entrepreneurs who saw HWM as a business opportunity and seized it. They have equipment that they use for emptying the facilities for HW disposal. They indicated that they came into this sector after realizing that the EMC was not able to manage HW. In that case, they supplemented what EMC would have provided to the residents of Eldoret. However, it suffices to note that they work in conjunction with EMC, ELDOWAS and NEMA.

EMC is another main actor in HWM, especially in informal settlements. It plays its role in HWM via three of its departments: the departments of planning, health and environment. The study noted that the council through its departments had various roles and functions which promoted good health and environment. It is has the authority and mandate to plan thorough its planning department in liason with the

District Planning office, provision of health services through health department and manage the environment through its environmental department.

The study also identified Eldoret Water and Sewerage Company (ELDOWAS) as a main actor in HWM. They are involved in the provision of services related to water and sewerage. They are responsible for the supply of water, construction and maintenance of sewer lines.

The last main actor in HWM that the study identified was NEMA. This is a body that is mandated to manage matters pertaining to the environment. NEMA works in conjunction with other stakeholders in the environment sector to ensure that it (environment) is safe and that all environmental threats are addressed. In line with this study, NEMA is involved in the licensing of honey suckers, watching over HW disposal facilities and activities as well as ensuring that HWM is done in an environmental friendly manner.

All the main actors play a fundamental role in HWM, especially in the informal sector. However, they encounter some problems and challenges when it comes to the execution of their mandates in HWM.

5.1.3 Challenges regarding planning of human waste management in informal settlements of Eldoret Municipality

Any city or town will be in need of an effective solid waste management system to ensure better human health and safety. The system needs to be safe for workers and safeguard public health by preventing the spread of disease. In addition to these pre-

requisites, an effective solid waste management must be environmentally sustainable and economically feasible. It is quite difficult to minimize the environmental impacts and the cost simultaneously. The balance that needs to be struck is to reduce the overall environmental impacts of waste management as far as possible, within an acceptable level of cost. An economically and environmentally sustainable solid waste management system is effective if it follows an integrated approach, i.e., it deals with all types of waste beginning from its generation to its disposal. The integrated approach must be based on a logical hierarchy of actions. The planning of ISWM is explained below in a Bangalore case study.The task of HWM in itself poses a myriad of problems and challenges especially in informal settlements. These problems and challenges are discussed in terms of health, environment and planning.

Health is a crucial aspect of human and other animals' existence. Good health ensures that all other aspects of human endeavours are not compromised. When health is compromised, it threatens the very existence of the person and other elements within his/her ecosystem. HWM can pose a great threat to the general health of the environment, especially if HW is not managed properly. It therefore became paramount that this study looks into the problems and challenges that arise in connection to health when dealing with HW.

The key informants were very resourceful with regard to the health problems and challenges that arise during HWM. The most crucial information with regard to health was obtained from those working in the health sector either under the ministries of public health and that of medical services or with the EMC. The researcher interviewed the medical staff in charge of the health facilities in both Langas and

Munyaka. In addition, the officers in charge of health matters working for EMC were also interviewed. They gave their views with regard HWM in as far as it affects the health of the communities they work for.

As noted earlier in the discussion under the state of human waste management in informal settlement, it was indicated that the facilities were in a deplorable state. The health workers who were interviewed lamented on the state of HWM in the informal settlements. They indicated that there was poor excreta disposal in the informal settlements. Scattered faeces either rapped in polythene or so or even left in the open are common scenes and so are overflowing toilets in the settlements. They indicated that most of the residents in these settlements used pit latrines that are poorly constructed and that they are constructed near water sources, mainly wells and boreholes. In terms of cleanliness, the condition is also wanting. They also observed that some of the facilities of HWD were full and thus discharged their affluent into the environment.

These realities pose a great challenge and problem to health. The researcher was informed that because the pit latrines are constructed near boreholes, given that the water table is very high particularly in Langas and given the topography of the area, leaching was an obvious consequence of this. It was also noted that most of the pit latrines are shallow and therefore it becomes easy to release the waste into the environment. That means that water is easily contaminated and thus prone to be infectious to the users. This fact was further strengthened by the records at health centres in Langas and Munyaka and when the key informants were asked to state the common illnesses that people living in these areas suffer from. Top on the list were

typhoid fever, gastroenteritis (G.E.) (e.g. diarrhoeal, cholera), malaria, respiratory system infections and HIV/AIDS. Most of these diseases are caused poor management of the environment.

5.2 Conclusions

The facilities relied upon by the residents of the informal settlements of Eldoret for human waste management included: pit latrines/VIP latrines, to which almost all the residents had access; pour/ flush toilets, with a small user group; a number of the residents also relied on composite latrines; and some relied on septic tanks. However, the state of these facilities used in human waste disposal in informal settlements in Eldoret is wanting and not up to the required levels and standard of sanitary expectations. Some of the communal facilities were maintained and cleaned on a rotational communal schedule to avoid disagreements and the negligence of the facilities. Also the level of hygiene in these facilities was poor.

The main actors in HWM are the households through their generation of human waste and the initial users of the facilities for human waste disposal. They also determine the sanitation and general cleanliness of the facilities. The other main actors in this sector of HWM were the honey sucker operators. These are private operators who have joined the HWM activities. There were eight (8) registered honey suckers that the study managed to interview. These are mainly concerned with emptying of facilities for disposal of human waste in individual owned premises and in institutions/organizations. The honey suckers were private entrepreneurs. They supplemented what EMC would have provided to the residents of Eldoret. The Eldoret Water and Sewerage Company (ELDOWAS) were the other main actor in

HWM. They are involved in the provision of services related to water and sewerage. They are responsible for the supply of water, construction and maintenance of sewer lines. The last main actor in HWM that the study identified was NEMA. This is a body that is mandated to manage matters pertaining to the environment. NEMA works in conjunction with other stakeholders in the environment sector to ensure that it (environment) is safe and that all environmental threats are addressed. All the main actors play a fundamental role in HWM, especially in the informal sector.

There were many challenges that relate to poor planning for health management that may emanate from the human waste disposal. These included: poor hygienic standards, poor state of disposal facilities, occurrence of human diseases such as typhoid, malaria, respiratory infections. Challenges related to the environment emerged right from the facilities that were used for HW disposal, to collection and treatment. Also transportation of the human wastes was found to be another major challenge

5.3 Recommendations

1. In an effort to enhance the standards of sanitation in the settlements the EMC should construct Ablution blocks in commercial areas and key locations within the settlements who charge a small fee for their maintenance.
2. Langas has one main sewer line which was constructed along the central road from south west to north east and connecting to the main sewer to the Huruma sewage works. Plots bordering that road can be connected on this 200mm diameter Upvc pipe with a total length of 3475m. Considering the topographical condition, another new main sewer can be located at the north western border of

the area starting in the south western corner of Langas running north following an earth road that divides farm land from the residential area and joining the existing sewer line in the north –western corner of Langas. Munyaka's topography is such that the area slopes gently towards west allowing drainage by gravity towards Eldoret sewage treatment works. There is possibility of constructing a new main sewer following a small valley and connecting system within the settlement areas.

3. The Eldoret Municipal Council should after a survey develop standard VIP Latrine Toilets to be constructed in the settlements. Their implantation should be strictly enforced. Separation of urine and faeces through Urine Diversion Toilets and exploitation of biogas for production
4. Awareness campaign to discourage open defecation and urinating should be mounted.
5. The standards of the facilities used in human waste disposal in informal settlements in Eldoret should be raised and enforced by the EMC, NEMA and ELDOWAS to ensure proper human waste management practices are observed.
6. Some of the more practised activities and facilities that are used, are not environmentally friendly and may cause disease break out, namely the use of pit latrines that are dug next to sources of water e.g. rivers, streams, putting the residents at risk of disease, should be demolished and proper facilities put in place by EMC which is both a planning and enforcement authority s in human waste management.
7. The environment and health departments of Eldoret Municipal Council management should mount sensitization campaigns on proper human waste management practices. This should help remove the negative attitudes and myth that dealing with human waste is a taboo and is left for only those who are

completely unable to success in life This will lead to the better cleaning of the facilities and understanding of the components by the households and residents of these settlements.

8. The major actors involved in human waste management in Eldoret should ensure that there are sufficient, appropriate and secure human waste management facilities in informal residences in Eldoret. This will cause the residents to see their worth and strive to use the appropriate facilities for their needs.

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APPENDICES

Appendix I: Questionnaire for household

Dear Sir/Madam

We kindly request you to assist in filling this questionnaire. We would like to assure you that the information you provide will be treated confidentially and used solely for the purpose of this research.

Thank you in advance.

August, 2011

Questionnaire No: ----------

Part 1: Socio-demographic information

Please indicate your gender: Male [ ] Female [ ]

What is your age: < 18 [ ] 18-35 [ ] 36-50 [ ] >50 [ ]

What is your marital status: Single [ ] Married [ ] Divorced [ ] Widow [ ]

What is you highest level of education: Lower Primary [ ] Upper Primary [ ]
Completed primary [ ] Secondary [ ]
College [ ] University [ ]

What is your occupation: Unemployed [ ] Farmer [ ] Salaried employee [ ]
Business [ ] Banker [ ]

Part 2: Human waste management

	Name of the RA	**ANSWER CATEGORY**
	Date	
A	**DEMOGRAPHIC AND HOUSING INFORMATION**	
1	Name of settlement	1) Munyaka

		2) Langas
2	Occupation of the household head?	1) Self-Employed 2) Employed 3) Casual work 4) Unemployed
3	Where is the work station of the household head?	1) In this Settlement 2) Outside Eldoret 3) Outside this settlement but within Eldoret 4) Not Applicable
4	How long have you lived in this settlement?	1) 1-5 Years 2) 6-10 Years 3) 16-20 Years 4) Over 20Years
5	Who owns the house in which you are living in?	1) Rented 2) Own Occupied
6	If rented, does the owner of the house reside in the neighbourhood?	1) Yes 2) No 3) Not Applicable
B	**WATER SUPPLY SERVICES**	
7	What is your primary water source?	1) Piped Water in the house 2) Water Point /unimproved water source 3) Water Kiosk
8	Is the supply from the source regular?	1) Yes 2) No
9	How many days per week is the water available at the source	1. 1 day 2. 2 days

		3. 3 days 4. 4 days 5. Over 5 days
10	During times of shortage of water supply, how does the household cope?	1) Reduce Water for domestic uses 2) Store Water 3) Alternate source of water
11	How much water do you use in terms of number of 20 litres Jeri cans per day?	1) 1-2 2) 2-3 3) 3-4 4) 4-5 5) Over 5
C	**SANITATION**	
	Human waste	
12	What facility do you use for disposal off human waste?	1) Pit latrine VIP Latrine 2) Composite latrine, 3) Pour Flush toilet 4) Septic Tanks 5) Cesspools 6) Conventional sewers 7) Bucket Latrines 8) Ablution Blocks
13	Who owns the facility that your household frequently uses?	1) Individual /Privately owned 2) Landlord (shared facility) 3) Public Facility
14	If the answer to question 23 is landlord or public utility/toilet, state the number of users per day?	1) 1-5 people 2) 6-10 people 3) 11-15 people

		4) 16-20 people 5) Over 20 people
15	Who maintains the hygiene of the facility you frequently use	1) Self 2) EMC 3) Commercial agent 4) Community initiative
16	How far do you walk from your house to reach the facility?	1) 1-5 metres 2) 6-10 metres 3) 11-15 metres 4) 16-20 metres 5) Over 20 metres 6) Not applicable

Appendix II: Questionnaire for honey sucker operators

Dear Sir/Madam

We kindly request you to assist in filling this questionnaire

We would like to assure you that the information you provide will be treated confidentially and used solely for the purpose of this research.

Thank you in advance.

August, 2011

Questionnaire No: ----------

1	Name of the RA	**ANSWER CATEGORY**
2	For how long have you been in operation?	1) Less than 5yrs 2) 6 – 10 yrs 3) 11- 15 yrs 4) More than 15 yrs
3	What motivated you to enter the business of solid/human waste management?	5. Business opportunity 6. Need for these services 7. Inability by EMC to manage HW.
4	Do you use pit latrine/VIP latrine for disposal of human waste?	Yes No
5	Do you use WC connected to sceptic tank connected to public swage for disposal of human waste?	1) Yes 2) No
6	Kindly describe the challenges you face in the process of human waste collection?	1) Accessibility 2) Unserviceable 3) Lack of payment 4) Non-biodegradable matter
7	What is the mode of payment by the	1) Cash

	residents for your services?	2) Cheque 3) Mobile money transfer
8	Is the solid/human waste you collect sorted?	1) Yes 2) No
9	If Yes, what are the main types of solid/human wastes you collect?	1) Faeces 2) Urine 3) Both
10	What are the challenges you face in sorting out different types of human waste?	1) Accessibility 2) Procedure cumbersome
11	Where do you dispose of the human waste you collect?	1) Open field 2) Sewage Works 3) Refuse Dump Site 4) Manholes
12	What are the challenges you face at the disposal point of human waste?	1) Accessibility 2) Distance
13	Do you encounter problems related to payment for your work?	1) Yes 2) No
14	Do you encounter problems related to accessibility in your work?	3) Yes 4) No
15	Do you encounter challenges in relation to the market in your work?	1) Yes 2) No
16	Do you encounter challenges in relation to competition in your work?	1) Yes 2) No
17	How do you deal with the human waste you collect?	1) Separate 2) Composite
18	What are the challenges you face with	1) Accessibility

	the method of disposal of human waste you use in 17 above?	2) Personnel
19	What are the collection charges	1) Per trips of truck 2) Per volume of truck
20	What are the problems you encounter with your equipment?	3) Lack of spare parts 4) Frequent failures
21	What equipment do you lack?	1) Appropriate Pump 2) Lack of protective gear
22	In general, do you encounter challenges related to accessibility and distance in your operations	1. Yes 2. No
23	In general, do you encounter challenges related to equipment failure and size of tank in your operations?	1) Yes 2) No
24	In general, do you encounter challenges related to competition in your operations?	1) Yes 2) No
25	In general, do you encounter challenges related to payment in your operations?	1) Yes 2) No
26	In general, do you encounter challenges related to attitude in your operations?	1) Yes 2) No

Thank you for your cooperation

Appendix III: interview schedule for key informants– Public health/Environment

Dear Sir/Madam

We kindly request you to assist in filling this interview schedule. As a stakeholder in the water and sanitation sector, your views were highly appreciated. We would like to assure you that the information you provide were treated confidentially and used solely for the purpose of this research.

Thank you in advance.

Interview Schedule No: ----------

1	In your opinion how would you describe the state of sanitation in the informal settlements from a health perspective?	
2	a) From a health point of view please give your comment on the facilities used for HWM in the informal settlements.	
	b) Please give the advantages and disadvantages of the use of each facility above	Advantages:
		Disadvantages:
3	How would you describe the quality of facilities in terms of: a) Cleanliness?	
	b) Proximity to the users?	
	c) Affordability to the user?	
4	In your opinion are the management skills for running the facilities available?	
5	What in your opinion are the main heath challenges of human Waste Management in the settlements?	
6	What are main diseases experienced?	
7	What are the main likely causes?	
8	From a health perspective, state the challenges faced in the informal settlements with respect to:	

	a) Collection of human waste	
	b) Separation of human waste	
	c) Transportation of human waste	
	d) Processing of human waste	
	e) Disposal of human waste	
9	f) Use of human waste	
	a) What plans or policies do you have for improving the settlement's human waste management?	
	b) Who would fund for improvements of human waste management?	
10	What methods do you consider appropriate for the informal settlements with respect to: a) Collection of human waste?	
	b) Separation of human waste?	
	c) Transportation of human waste?	
	d) Processing of human waste?	
	e) Use of human waste?	
11	In your opinion what how efficient is the institutional arrangement for human waste management?	
12	What role does your office play in human waste management?	
13	What public education do you carry out, if any, on human waste management?	
14	What are your projections for human waste output in the next five years?	
15	Do you think you will be able to cope with the human waste situation in the future? If yes, how?	
16	What were the results of a recent study, if any, of the human	

	waste situation in Eldoret?	
17	What is your proposal of the way forward in proper management of human waste in the informal settlement	

August 2011

Appendix IV: interview schedule for key informants – Planning

Dear Sir/Madam

We kindly request you to assist in filling this interview schedule. As a stakeholder in the water and sanitation sector, your views will be highly appreciated. We would like to assure you that the information you provide will be treated confidentially and used solely for the purpose of this research.

Thank you in advance.

Interview Schedule No: ----------

August, 2011

1.	In your opinion how would you describe the state of sanitation in the settlement from an environmental perspective?	
2.	From an environmental point of view, please give your comment on the use of the facilities for HWM in the	
	Please give the advantages and disadvantages of the use of each.	Advantages
		Disadvantages:
3.	How would you describe the quality of the facilities used in the settlement in terms of:	
	b) Cleanliness?	
	c) Proximity to the users?	
	d) Affordability to the user?	
4.	What public education do you carry out on human waste management, especially in the informal settlements?	
5.	What are the main environmental challenges in the settlement?	
6.	What are the main likely causes of these challenges?	
7.	1 What plans or policies do you have for improving human waste management in the settlement?	

	2 Who would fund for improvements of human waste management?	
8.	From an environmental perspective, what are the challenges of human waste management in the informal settlement with	
	b) Separation?	
	c) Transportation?	
	d) Processing?	
	e) Disposal?	
	f) Use?	
9.	What methods do you consider appropriate for the settlement in relation to:	
	b) Separation of human waste?	
	c) Transportation of human waste?	
	d) Processing of human waste?	
	e) Use of human waste?	
	f) Disposal of human waste?	
10.	What do you normally do when the facility needs maintenance and servicing?	

Thank you for your cooperation