CONVERTING CITY WASTE INTO COMPOST: PILOT NAIROBI

(LNV-BO-10-006-115)

REPORT

PHASE ONE: INVENTORY AND ASSESSMENT

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PREFACE

In response to the need to improve on waste management in Kenya and East Africa as a whole, the Royal Netherlands Embassy in partnership with Wageningen University – LEI and WASTE NL, contracted ECM Centre to undertake the study "Converting City Waste in Compost".

The team from ECM Centre was able to conduct the study through consultations with officials of the National Environmental Management Authority (NEMA), City Council of Nairobi (CCN) and officials within other public and private institutions, as well as evaluate the non-hazardous waste streams generated between May 2009 and July 2009.

I hope this report will contribute to the promotion of the project as well as add value to the ongoing Integrated Solid Waste Management Plan under the City Council of Nairobi.

I wish to express my sincere appreciation to the partners linked to this project for their close cooperation with our team.

September 2009.

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TABLE OF CONTENTS:

LIST OF FIGURES:.....5
LIST OF TABLES:.....6
ACRONYMS: 6
EXECUTIVE SUMMARY 8

SECTION 1: INTRODUCTION.....19

1.1 STUDY BACKGROUND 19
1.2 OVERALL OBJECTIVE OF THE PROJECT 20
1.3 SPECIFIC OBJECTIVES OF PHASE ONE 21
1.4 STRUCTURE OF THE REPORT.....24
1.5 OVERVIEW OF STUDY AREA.....21
1.5.1 GEOPHYSICAL 21
1.5.2 CLIMATE.....21
1.5.3 ADMINISTRATIVE AREA 22
1.5.4 GOVERNANCE.....22
1.5.5 SOCIO-ECONOMIC SCENARIO.....22
1.5.6 WASTE MANAGEMENT SITUATION 23
1.6 APPROACH AND METHODOLOGY.....25
1.6.1 PHASE ONE: PRE-SURVEY OF EXISTING NON-DOMESTIC WASTE GENERATORS 25
1.6.2 PHASE TWO: PRE-SELECTION OF POTENTIAL GENERATORS AND USERS OF ORGANIC WASTE.....25
1.6.3 PHASE THREE: FIELD ASSESSMENTS OF ORGANIC WASTE ON SITE 26
1.6.4 PHASE FOUR: DESK REVIEWS OF EXISTING LITERATURE.....27
1.6.5 PHASE FIVE: DATA ANALYSIS & COMPUTATION OF RESULTS & REPORTING.....27

SECTION 2: ORGANIC WASTE FLOW FROM NON- DOMESTIC WASTE GENERATORS.....28

2.1 GENERAL 28
2.1.1 DOMESTIC WASTE GENERATORS 28
2.1.2 NON-DOMESTIC WASTE SOURCES 28
2.2 INVENTORY AND ANALYSIS OF NON-DOMESTIC ORGANIC WASTE GENERATORS ...28
2.2.1 OVERVIEW OF NON-DOMESTIC WASTE GENERATORS 28
2.2.2 MAPPING AND CHARACTERISTICS OF NON-DOMESTIC ORGANIC WASTE GENERATORS 29
2.2.3 QUANTIFICATION AND CHARACTERIZATION OF THE NON-DOMESTIC WASTE STREAM 32
2.2.4 ORGANIC WASTE RESOURCE FLOW FROM NON-DOMESTIC SOURCES.....34
2.2.5 VARIATIONS IN WASTE GENERATION RATES.....36
2.2.6 FACTORS INFLUENCING VARIATIONS IN GENERATION RATES AND TRENDS 37
2.2.7 WASTE FRACTIONS BY INSTITUTIONAL CATEGORY 38
2.2.8 COMPOSITION OF NON-DOMESTIC WASTE 58
2.2.9 INSTITUTIONAL WASTE MANAGEMENT PRACTICES.....59
2.2.10 WASTE COLLECTION & DISPOSAL SYSTEMS 59
2.3 DESTINATION OF NON-DOMESTIC ORGANIC WASTE.....62
2.3.1 WASTE MINIMIZATION.....65

2.3.2 SEGREGATION AT SOURCE....65
2.3.3 WASTE RECOVERY....66

SECTION 3: INVENTORY AND ANALYSIS OF USERS....67

3.1 GENERAL....67
3.2 WILLINGNESS TO PAY FACTOR....68
3.2.1 SUPPLY SEGMENT OF COMPOST PRODUCTION IN NAIROBI....68
3.2.2 DEMAND SEGMENT OF COMPOST PRODUCTION IN NAIROBI....68

SECTION 4: SOLID WASTE COMPOSTING, BIOGAS AND TREATMENT PROJECTS IN KENYA....70

4.1 GENERAL....70
4.2 COMPOSTING....70
4.2.1 FEEDSTOCK CHOICES....71
4.2.2 COMPOST MARKETS AND INSTITUTIONAL SUPPORT....71
4.3 BIOGAS GENERATION IN KENYA....74
4.3.1 BIOGAS FROM ORGANIC WASTE....74
4.3.2 INSTITUTIONAL BIOGAS GENERATION....75

SECTION 5: INSTITUTIONAL ENVIRONMENT OF WASTE MANAGEMENT....77

5.1 GENERAL....77
5.2 INSTITUTIONAL-ARRANGEMENTS....78
5.2.1 MINISTRY OF LOCAL GOVERNMENT....78
5.2.2 NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY....79
5.2.3 CITY COUNCIL OF NAIROBI....79
5.2.4 DEPARTMENT OF ENVIRONMENT....80
5.2.5 MINISTRY OF HEALTH....81
5.3 LEGISLATION GOVERNING ORGANIC WASTE RECOVERY....82
5.3.1 THE PUBLIC HEALTH ACT....82
5.3.2 POLICIES, STRATEGIES AND ACHIEVEMENTS OF CCN....83
5.3.3 SOLID WASTE MANAGEMENT BY-LAWS ON COMPOSTING....84
5.4 LINKAGES TO EXISTING PLANS AND PROGRAMMES....85
5.4.1 PROPOSED INTEGRATED SOLID WASTE MANAGEMENT PLAN....85
5.4.2 NAIROBI RIVER BASIN PROGRAMME....86

SECTION 6: CONCLUSIONS AND RECOMMENDATIONS....88

6.1 CONCLUSIONS....88
6.2 RECOMMENDATIONS....90

SECTION 7: BIBLIOGRAPHIES....93

LIST OF ANNEXES

ANNEX A: WASTE COLLECTION & TRANSPORTATION....95
ANNEX B: APPLICATION FORM FOR A LICENCE TO TRANSPORT WASTE....96
ANNEX C: TRACKING DOCUMENT FOR WASTE COLLECTOR....97
ANNEX D: APPLICATION FEES FOR WASTE MANAGEMENT LICENSES....98
ANNEX E: ORGANIZATIONS AUDITED....99
ANNEX F: ENVIRONMENTAL MANAGEMENT PRACTICES IN SELECTED HOTELS....102
ANNEX G: STUDY QUESTIONNAIRES....105

LIST OF FIGURES

FIGURE 1: DISTRIBUTION OF NON-DOMESTIC WASTE GENERATORS IN NAIROBI....31
FIGURE 2: BASELINE PROJECTION OF NAIROBI'S POPULATION AND SOLID WASTE GENERATION RATES (KARANI & MUTUNGA, 2005)....32
FIGURE 3: PROJECTION OF WASTE GENERATION (TONNES PER DAY) FROM SELECTED SECTORS IN NAIROBI CITY....33
FIGURE 4: ORGANIC WASTE RESOURCE FLOW FROM GENERATION TO REUSE/RECYCLING/RECOVERY....36
FIGURE 5: WASTE FRACTIONS GENERATED FROM HOTELS....38
FIGURE 6: WASTE FRACTIONS GENERATED FROM RESTAURANTS....39
FIGURE 7: WASTE FRACTIONS GENERATED FROM SPORTS CLUBS....39
FIGURE 8: WASTE FRACTIONS GENERATED FROM EDUCATION CENTRES....41
FIGURE 9: WASTE FRACTIONS GENERATED FROM HOSPITALS....42
FIGURE 10: WASTE FRACTIONS GENERATED FROM PRISONS....44
FIGURE 11: WASTE FRACTIONS GENERATED FROM FOOD PROCESSING COMPANIES....45
FIGURE 12: WASTE FRACTIONS GENERATED FROM FLOUR/ANIMAL FEED....46
FIGURE 13: WASTE FRACTIONS GENERATED FROM GOLF CLUBS....47
FIGURE 14: WASTE FRACTIONS GENERATED FROM FARMS....48
FIGURE 15: WASTE FRACTIONS GENERATED FROM MARKETS....50
FIGURE 16: WASTE FRACTIONS GENERATED FROM SHOPPING MALLS....52
FIGURE 17: WASTE FRACTIONS GENERATED FROM ARMY BASES....53
FIGURE 18: WASTE FRACTIONS GENERATED FROM SLAUGHTERHOUSES....54
FIGURE 19: WASTE FRACTIONS GENERATED FROM GROCERIES....55
FIGURE 20: WASTE FRACTIONS GENERATED FROM SUPERMARKETS....56
FIGURE 21: WASTE FRACTIONS GENERATED FROM SANITATION FACILITIES....57
FIGURE 22: PERCENTAGE VOLUME OF NON-DOMESTIC WASTE FRACTIONS....58
FIGURE 23: NON-DOMESTIC WASTE COMPOSITION....59
FIGURE 24: INSTITUTIONAL WASTE HANDLING AND TRANSPORTATION....62
FIGURE 25: DESTINATION OF ORGANIC WASTE....64
FIGURE 26: INSTITUTIONAL ACTORS IN WASTE MANAGEMENT....77
FIGURE 27: STRUCTURE AND RESPONSIBILITIES OF THE DEPARTMENT OF ENVIRONMENT....81

FIGURE 28: MAJOR RIVER POLLUTANTS IN NAIROBI 87

LIST OF TABLES

TABLE 1: POTENTIAL NON-DOMESTIC WASTE GENERATORS AND USERS WITHIN NAIROBI 25
TABLE 2: CLUSTERED STUDY SITES WITHIN NAIROBI 26
TABLE 3: INVENTORY OF THE INSTITUTIONAL CATEGORIES ASSESSED IN THE STUDY 30
TABLE 4: BASELINE PROJECTION OF NAIROBI'S POPULATION AND SOLID WASTE GENERATION RATES (KARANI & MUTUNGA, 2005) 32
TABLE 5: BASELINE PROJECTION OF SOLID WASTE GENERATION RATES (TONNES/DAY) FROM SELECTED (KARANI & MUTUNGA, 2005) 33
TABLE 6: TOTAL SOLID WASTE GENERATED FROM NON-DOMESTIC SOURCES 34
TABLE 7: TOTAL ORGANIC WASTE GENERATED FROM NON-DOMESTIC SOURCES 34
TABLE 8: CORRELATION VARIABLES USED TO DETERMINE VARIATIONS OF ORGANIC WASTE GENERATION RATES 37
TABLE 9: DESTINATION OF ORGANIC WASTE BY VOLUME (TONNES PER DAY) 65
TABLE 10: KEY BARRIERS TO INSTITUTIONAL COMPOSTING 67
TABLE 11: INSTITUTIONS/COMMUNITY BASED ORGANIZATIONS INVOLVED IN COMPOSTING 72
TABLE 12: ANALYSIS OF COMPOST SAMPLES TAKEN FROM CPMEG (2008) 73
TABLE 13: OVERVIEW OF THE ACTORS INVOLVED IN INSTITUTIONAL SOLID WASTE MANAGEMENT AND THEIR RESPONSIBILITIES 78

LIST OF PICTURES:

PICTURE 1: SHOWING THE PILE UP OF WASTE IN A PRISON WITHIN NAIROBI 43
PICTURE 2: COMPOST HEAPS IN A GOLF COURSE (R: LEAVES AND GRASS ONLY; L: LEAVES AND TWIGS ONLY) 48
PICTURE 3: OPEN DUMPING AT THE CITY PARK MARKET IN NAIROBI 50
PICTURE 4: OPEN DUMPING IN GIKOMBA MARKET, NAIROBI 51
PICTURE 5: A BIODIGESTER BEING BUILT FOR USE IN AN ECOSAN TOILET IN NAIROBI. 57
PICTURE 6: OPEN DUMPING 61
PICTURE 7: WASTE INCINERATOR 61
PICTURE 8: WASTE SEGREGATION 65
PICTURE 9: MEMBERS OF THE CPMEG GROUP DISPLAYING THEIR COMPOST PRODUCT 73
PICTURE 10: BIOGAS GENERATION FROM WASTEWATER GENERATED FROM A SLAUGHTERHOUSE 75
PICTURE 11: LAGOON 76
PICTURE 12: OPEN DUMPING ALONG THE NAIROBI RIVER 87

ACRONYMS, ABBREVIATIONS AND SYMBOLS

ASK	Agricultural Society of Kenya
CBD	Central Business District
CBOs	Community Based Organizations
CCN	City Council of Nairobi
CPMEG	City Park Market Environmental Group
DAP	Di-ammonium phosphate
DEMA	Dagoretti Environmental Management Association
DOE	Department of Environment
ECM	Environmental Cost Management Centre
E.M.	Effective Microorganism
EMCA	Environmental Management and Coordination Act
GTZ	Deutsche Gesellschaft für Technishe Zusammernarbeit
IETC	Industrial Energy Technology Conference
ITDG	Intermediate Technology Development Group
ISWM	Integrated Solid Waste Management
ISWMP	Integrated Solid Waste Management Plan
JICA	Japan International Cooperation Agency
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KARI	Kenya Agricultural Research Institute
KINAKASHA	Kiserian Nairobi Kikuyu Athi Slaughterhouses Association
KIRDI	Kenya Industrial Research Institute
KIOF	Kenya Institute of Organic Farming
KNBS	Kenya National Bureau of Statistics
KOAN	Kenya Organic Agricultural Network
LA	Local Authority
MEMR	Ministry of Environment and Mineral Resources
MOE	Ministry of Environment
MSEs	Micro-and-Small Enterprises
NAWACOM	Nakuru Waste Collectors and Recyclers Management
NEMA	National Environmental Management Authority
NL	The Netherlands
NRBP	Nairobi River basin Programme
PPM	Parts Per Million
SEP	Special Energy Programme
SWM	Solid Waste Management
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
UPA	Urban and Peri-Urban Agriculture
WMR	Waste Management Regulations

EXECUTIVE SUMMARY

INTRODUCTION

The 'Converting City Waste in Compost Project' is being implemented in an effort to explore options for the development of a viable system of collecting, processing, distribution and marketing of valorized organic city waste material, for application in urban and peri-urban agriculture within East Africa and Nairobi in particular. This is a project of the City Council of Nairobi (NCC) and the United Nations Environment Project (UNEP), with funding from the Ministry of Agriculture, Nature and Food Quality.

The first phase of the project involves an inventory and analysis of organic waste sources, coupled with the quantification and characterization of non-domestic organic waste streams in Nairobi City. This study represents the findings of phase one and forms a basis for evaluating the potential for diversion of organic waste from Nairobi to compost production and biogas generation. The diversion of organic waste for compost and biogas production provides a means of closing the nutrient loop, a concept that involves moving away from a linear process of resource extraction, manufacture, consumption and disposal, towards a cyclical system where resources remain in use almost indefinitely.

Problem Statement

Waste management is a persistent problem in Kenya's urban areas. Rapid population increase and urbanization has not been accompanied by an equivalent increase in the capacity of urban authorities to efficiently manage the waste generated. Waste recovery is mainly carried out for inorganic waste, resulting in the accumulation of organic waste at the Dandora dumpsite among other [undesignated] dumpsites. A comprehensive system for segregation of waste at source for recycling purposes is generally lacking. Practices including indiscriminate dumping and open burning, typify the general solid waste management situation at the institutional level. The result of this has been the degradation of essential natural resources (such as the Nairobi, Mathare and Ngong rivers) through disposal of raw untreated sewage, increased generation of methane and other greenhouse gases at various dumps, and pollution of [ground and surface] water and soil. Despite there being elements of functioning nutrient cycles for non-domestic waste streams within institutions, many gaps still exist. The study identifies the gaps required to close the nutrient loop; this will not only help to reduce the huge volumes of organic waste going into dumpsites but will also reduce the amounts of methane and leachate generated there that have adverse impacts to the environment, safety and health of the local residents.

Interventions in Solid Waste Management

In a comprehensive baseline survey conducted by JICA in 1999, recommendations were made to improve solid waste management in Nairobi. The key recommendations included inter alia: developing of priority projects to oversee institutional restructuring and financial reforms; promotion of private sector involvement; construction of the final disposal site; and improvement of the collection and transportation system. The City Council of Nairobi (NCC) has since taken steps to increase technical capacity through the formation of the Department of Environment (DoE), as well as outsourcing waste collection services to external contractors. In 2006/2007 the National Environmental Management Authority (NEMA) introduced a licensing process for vehicles and enterprises that transport solid waste (solid waste is however defined in broad terms and does not explicitly distinguish between recyclable or compostable materials). Despite these interventions, waste minimization at source as well resource recovery concepts continue to be lacking at both the domestic and non-domestic levels.

NCC in partnership with UNEP, Industrial Energy Technology Conference (IETC) and the Ministry of Environment and Mineral Resources (MEMR), is currently developing a new Integrated Solid Waste Management Plan (ISWM) for Nairobi, with the aim of reducing waste streams by at least 50% through recycling. The unusable residual waste will then be shipped to a new sanitary landfill to be developed in Ruai (in the South East of Nairobi).

Goal and Objectives
The goal of the Project is to connect generators of relatively pure organic waste streams with agricultural and horticultural users in the urban and peri-urban areas of Nairobi. In so doing, the project aims to close the nutrient cycles through compost production and biogas generation from the compost.

Implementation of the project is organized into three (3) phases:
i. Phase One: Inventory and Assessment;
ii. Phase Two: Preparation and Implementation of Pilot Projects; and
iii. Phase Three: Analysis and Information Sharing Phase.

Specific Objectives of Phase One: Inventory and Assessment
- To generate an inventory and analysis of organic waste sources,
- To generate an inventory and analysis of users, producers and markets for compost and bio-energy,
- To generate an inventory and analysis of solid waste- and agriculture-based composting, biogas, and treatment projects in Kenya,
- To analyse the institutional environment of waste management and (peri-) urban agricultural domain,
- To quantify and characterize non-domestic organic waste streams (sources, quantified flows and destinations, including mapping) as input to UNEP/NCC project,
- To formulate concept sourcing strategies for UNEP/NCC project.

Approach and Methodology (Phase One)
The inventory and assessment of organic waste from non-domestic sources within Nairobi was undertaken in five (5) broad stages:
i. Pre-survey of existing non-domestic waste generators,
ii. Pre-selection of generators and users of organic waste,
iii. Field assessments of organic waste on site: amount and type of organic waste generated; extent to which they are already being used; Current economic returns from sale of organic by-products; willingness to release materials for alternative reprocessing.
iv. Desk reviews of existing literature,
v. Data analysis & computation of Results.

The study covered institutions in both the private and public sector; though only 50 sites out of more than 3,000 institutions and commercial establishments were sampled, the study targeted the largest with respect to size. Data from these categories is therefore fairly representative. Data collection included the use of structured questionnaires, checklists, sampling techniques, maps, photography, literature review, and consultations.

Of the organic waste generators assessed 30% fell within Nairobi's Central Division, whereas 90% of the industries were within Embakasi Division which comprises mainly of manufacturing industries. The study focused on restaurants, hotels, markets, secondary and tertiary educational institutions and hospitals formed key. These institutions are expected to increase exponentially over the next 5 years, either in number or in capacity (KNBS, 2009).

Only physical characteristics of the waste were studied. The methodology used to analyze the quantities and characteristics of the waste were:

- Surveys at the Point of Generation
- Quantification of Waste by examination of records at the Point of Generation
- Sorting and weighing of Samples
- Visual observation of Samples

A review of literature on previous waste management studies for Nairobi was undertaken, as well as the current legal framework and regulations in place, which govern the waste management sector. An analysis of both quantitative and qualitative data generated from the study was undertaken and a report detailing the findings of Phase one of the project was compiled.

Overview of the Study Area

Nairobi City, the capital of Kenya lies in the highlands of the southern part of Kenya at about 1660 m above sea level, located at 1°17′S 36°49′E and occupies 684Km^2 (square kilometers) of the 6966.1Km^2 covered by the entire Nairobi province. The most prominent geographical feature of the Nairobi area includes the Ngong Hills and the Nairobi, Mathare and Ngong rivers.

Nairobi's population is estimated at 2,750,561 with an annual growth rate of 4 to 5% (KNBS, 2008). Other estimates put it at over 3million, especially due to the day population which comes for work and business, and departs in the evening to the surrounding districts. The current spatial dimensions of Nairobi are (i) the central business district, (ii) low income residential areas and informal settlements, (iii) permanent residential (iv) commercial and (v) peri-urban & agricultural areas. Though, Nairobi is deemed to harbor the most sophisticated middle class in eastern Africa, the gap between the rich and the poor continues to increase.

The informal housing settlements of Nairobi are home to over half of the city's population. The density of informal settlement is reflected in the amount of land they occupy: one third of Nairobi's population lives on an estimated five percent of the city's land (personal communication, KNBS). The illegal status and inaccessibility of these settlements make local authorities reluctant to provide them with services.

Organic waste forms the largest portion of the total waste streams finding their way into Nairobi's official dumpsite in Dandora and other undesignated sites such as those in Kayole and the Mathare North quarry. Dandora dumpsite continues to present the greatest challenge due to its putrid nature, foul odour, leachate production, and emission of methane - with the attendant risk of global warming. In a 2006 study commissioned by UNEP, Dandora dumpsite was found to be responsible for severe public health and environmental impacts.

ORGANIC WASTE FLOW FROM NON- DOMESTIC WASTE GENERATORS

The primary organic waste generators fall into two broad categories: domestic generator (sources at the household level which account for close to than 80% of the total organic waste generated within the city) and non-domestic generators (emanating from industries, commercial enterprises, as well as organizations and institutions).

Inventory and Analysis of Non-Domestic Organic Waste Generators

Public and private institutions including restaurants, universities, colleges, schools, groceries, farms, dispensaries, food processing companies, and flour/animal Feed mills, comprise the largest share of organic waste generators in the non-domestic sector. The study sites comprised 77.2% privately owned institutions, companies and commercial establishments, with the remaining 22.8% being public institutions - mainly government, such as prisons, army bases, municipal operated facilities, and publicly held companies. The

study found that whereas the public institutions still relied on NCC to collect, transport and dispose their waste, private institutions rely on private waste contractors to do the same.

Community based organizations and recycling groups have benefited greatly from the private institutions which are diverting their waste into uses such as composting for organic waste, and recycling for glass, paper and plastic waste. This has established an avenue for job creation at the micro-enterprise level, as well as reducing the amounts of waste going into the final disposal site - albeit, by very small quantities.

Municipal waste generation from domestic sources account for 83.67%, while commercial institutions and markets accounted for 10.67% of the total waste stream generated within Nairobi province (Karani & Mutunga, 2005). The study showed that, hotels and restaurants form the largest share of organic waste generators by volume of waste. A few private institutions have waste segregation activities taking place as well as efforts to divert different waste components into either re-use or recycling. Community based organizations and recycling groups have benefited greatly from the private institutions which are diverting their waste into uses such as composting for organic waste, and recycling for glass, paper and plastic waste. The study showed that close to 60% of the organic waste generated from the sampled institutions comprised mainly of raw vegetable and fruit waste. The remaining 40% comprised of cooked/leftover food, spent production waste, bones, and plant matter.

Although, the study concentrated mainly on solid organic waste from food stuffs, there were 3 industries, mainly the Ecosan toilets, which had bio-solid waste as a result of treating their waste water from their production lines. The other 47 institutions were found to discharge their waste water directly into the City Council's sewer line and thus, they did not retain any bio-solid wastes.

Market waste comprised of approximately 95% organic waste by volume and weight which makes it the largest generator of organic waste. Slaughterhouses on the other hand were found to be the second largest generators of organic waste.

The organic waste from the segregated waste ends up as animal feed in chicken, cattle, and pig farms, while some of it ends up in composting and biogas. In other institutions, waste is taken to a disposal area where waste scavengers separate the wastes, into inorganic and organic, carrying away the recyclables.

Waste Fractions

Hotels: 10 hotels from all five classes were sampled in the study, which is about 14% of the total number in Nairobi. On average Hotels generate 890 kg of waste per day, with 5 star hotels generating about 2,000kg per day, while the ones in the 1 star bracket generate 200kg per day.

Restaurants: Five (5) out of about 984 restaurants in Nairobi were assessed individually, and another fifty (50) which share a common waste collection area were studied as a cluster. They generate a total of 2.1 tonnes/day of solid waste with 81% of this total being organic waste. More than 50% of the restaurants that were audited were found not to segregate their wastes at source. Organic waste is either sold to pig farmers or used for composting.

Sports Clubs: There are about 30 sports clubs in Nairobi (KNBS, 2008) two of which were audited in the study. Estimated amount of solid waste generated is 0.08tonnes/day which is 83% organic comprising mainly of raw food waste, left over foods, ash, bones and yard waste.

Education Centres: At these institutions the key waste fraction was paper, at 50% by volume of the total waste composition.

Hospitals: Two hospitals out of 54 health centres in Nairobi were audited in the study. Within hospitals, the segregation of wastes was into either hazardous or non-hazardous streams. The collection, transportation and disposal patterns for hazardous and non-hazardous waste streams vary significantly. Within the private hospitals it was noted that there was separation at source of different waste fractions: organic waste, PET bottles, paper and plastics.

Prisons: There are 4 prisons in Nairobi which were all included in the study. due to these institutions being public, they tend to confer the onus of waste management to the city council of Nairobi and the burning of inorganic waste was prevalent. Improved waste management within the prisons would have to also focus on domestic waste generated from the wardens' houses, impress upon residents to separate their wastes and use bag for the containment of waste.

Food Processing Industries: There are about 152 food processing companies in Nairobi (KNBS, 2009). About 80% of the waste generated from these facilities is spent production waste. Packaging waste forms a significant portion of the waste fraction generated within these institutions. This is mainly in the form of plastics either the HDPE (High-density polyethylene) or the LDPE (Low Density Polyethylene). Due to the value of these materials in the recyclables market, at between Ksh.6 - 13 per Kg, the demand for these items is very high.

Flour/Animal Feed Mills: In Nairobi, there are close to 164 flour and animal feed companies, including small posho mills in the residential areas (KNBS, 2008); these generate about 90% waste in the form of spent production waste such as bran, pollard, fingerlings, sweepings and some sandy soil. This category embodies the best example of industrial ecology system approach where waste can be used as a raw material to generate a new product, significantly reducing waste quantities.

Golf Clubs: There are 15 golf clubs in Nairobi; these generate about 1.5 tons/day of yard waste per day on average and about 13 – 25 tons/month of compost, however, none of them use the organic waste from the club house kitchens when generating the compost for landscaping of the courses and for maintenance of the fairways.

Farms: Once outlawed by policy makers, it is now estimated that there are about 363 farms in and around Nairobi province (KNBS, 2008). Urban agriculture generates huge amounts of waste, 60-70 percent of which is organic (Runkua et al, 2009). Waste generated comprises mainly of manure, crop residues, yard waste, and packaging materials. Despite compost heaps being a common feature in these farms, biogas production was not.

Markets: Solid waste generated from markets was the highest compared to the other non-domestic waste generators. An analysis of four markets showed that each market generates at least 19 tonnes per day, comprising about 95% organic waste (raw fruits and vegetables, meat, saw dust, left over cooked foods), with theremaning 5% being packaging materials (papers and synthetics). Market waste, though largely uncontaminted, is often not scavenged but is sometimes collected for either pig feed or for composting.

Shopping Malls: There are a total of 17 shopping malls in Nairobi. The influx of people into these shopping malls allows them to be point sources of waste. It was estimated that 60% of the waste generated from shopping malls is organic (mainly food waste) with an average

generation rate of 1.1 tonne per day. This organic waste is fairly contaminated due to the lack of segregation practices at source.

Army Bases: On average army bases generate about 2 tons per day of solid waste; the organic waste fraction is estimated at about 1.2 tons per day which is about 60% of the waste generated, comprising mostly of raw food wastes from the staff kitchens, and the residences in the bases.

Slaughterhouses: Nairobi is served by ten (10) slaughterhouses. The proprietors of the abattoirs at Dagoretti have come together to establish lagoons where effluent from their premises can be contained, treated, and then disposed of appropriately by approved companies. The potential for the generation of biogas using animal manure and slurry from the slaughterhouses is apparent, with a generation rate of about 16 tonnes per day of animal manure.

Grocery Stores: It is estimated that there are about 207 green groceries in Nairobi; the study found that about 85% of the waste generated is purely organic, comprising mostly of raw fruits and vegetable waste. From an overview of the Micro and Small-scale Enterprise (MSE) green groceries, within the residential areas, it was found that, there is very little waste generated, less than 20kg per day, as the size of the operations is small compared to those of the larger groceries.

Supermarkets: In, 2008, the Kenya National Bureau of Statistics, (KNBS) estimated that there were 69 supermarkets in Nairobi. An over view of the four sampled supermarkets, revealed that, the daily generation rate of solid waste from these stores is about 2.5 tonnes and 73% of this waste, is organic.

Composition of Non-Domestic Waste

Most institutions assessed in the study generate non-hazardous waste, with the exception of hospitals, dispensaries, clinics located within the educational institutions and prisons. Generally, organic waste forms a significant amount of the total waste generated, accounting for a total of 74% by volume and weight, of the total waste generated from the non-domestic sources, with inorganic waste accounting for 26%.

INSTITUTIONAL WASTE MANAGEMENT PRACTICES

It was found that with respect to institutional waste management practices, there are some distinctions between the private and public sector. These distinctions are: (i) financial capacity to adequately manage waste collection and disposal; and (ii) technical capacity with respect to source segregation, composting and biogas generation. Most private institutions have taken it upon themselves to manage their own waste collection, transportation, processing, recycling or disposal, and monitoring of waste materials. 94% of the institutions assessed in the study, do not rely on the City Council for waste collection services, rather they use private contractors. Public institutions on the other hand prefer to use the City Council to collect and dispose off their wastes.

Waste Collection & Disposal Systems

Generally waste is collected from various collection points within the institution/ establishment, and put into a collection area awaiting final collection by the waste contractor for final disposal. It was also found that there are no existing transfer stations set up in or within areas for the separation of wastes before final collection and disposal to the dumpsites. 4% of the institutions that were audited were found to be dumping their waste in the open, mainly to avoid the cost of disposal which would be incurred if a waste contractor was to be hired. Incinerators are commonly used hospitals for hazardous wastes and are either found within the hospital or in a licensed site. The costs incurred for waste collection

services vary from one institution to the other mainly due to the choice of waste contractor, volume of waste collected, and frequency of waste collection. All licensed waste collectors, are currently permitted to dispose of solid, non-hazardous wastes at the Dandora dumpsite. However, there are some private waste contractors who dispose off their wastes in other undesignated dumpsites.

Destination of Non-Domestic Organic Waste

The approved designated waste disposal facilities in Nairobi are: (i) Dandora Dumpsite (ii) approved incineration sites; and (iii) approved farms for the disposal of animal manure. The study revealed that about 77.2 tonnes of both organic and inorganic waste per day goes into the Dandora dumpsite. Composting, though only practiced in 6 of the 50 institutions sampled, was able to account for the diversion of about 14.4 tonnes of organic waste per day. The destination of organic waste by volume (tonnes per day) is presented below:

	Dandora Dumpsite	Burning	Composting	Biogas	Animal Feed	Bone Meal	Open Dumping
Total Quantities of Organic Waste	77.2	4.4	14.4	10	11.7	4.6	12.9
No. of Institutions	33	5	6	1	3	4	5

INVENTORY AND ANALYSIS OF USERS OF ORGANIC WASTE

An overview of the findings indicates that there is interest in compost and biogas generation within the city by some institutions. All the re-users/recyclers of organic waste interviewed were found to use fractions of organic waste to generate compost. The generation of biogas was limited to the use of manure, waste water or slurry as the feedstock.

Supply Segment for Compost Production in Nairobi

The analysis showed that indeed there are significant quantities of fairly uncontaminated organic waste that is going into Dandora dumpsite/Open Dumps/being burnt. The study confirms that the availability of organic waste is not the limiting factor for compost production in Nairobi, rather the operational framework which brings together all pertinent stakeholders is lacking.

Demand Segment for Compost Production in Nairobi

The key factors to be considered in composts production with respect to the demand segment were: access to adequate volumes of fairly uncontaminated waste; availability of adequate space to generate and store the compost; and increased demand for compost. There is indeed a significant demand for well for fortified compost; the quality of compost referred to here is based on the available nutrients in the compost. The inconsistency in the quality of compost was noted to be the greatest concern among the users because each user has a different uses for the compost. Moreover, this was the key determining factor with respect to willingness to pay. Of the 10 companies and individuals who were interviewed, more than 50% stated that they are willing to pay Kshs. 500-1000 per 50 kilogram bag of compost, if it was fortified to suit their needs. However, all the users stated that they were not willing to pay for unfortified compost.

SOLID WASTE COMPOSTING AND BIOGAS PROJECTS IN KENYA

The valorization of organic waste offers a means to closing the nutrient cycle and reducing the emission of methane and other toxins from dumpsites. Research by the City Park Market Environmental Group (CPMEG) reveals that market waste is able to yield compost with varying amounts of nitrogen, carbon, potassium and phosphorous. Heavy metals are a common problem with recycled materials but the main sources (used batteries, plastics,

metals, other inorganic materials) are removed before composting and so present no problems in the finished product.

Compost Markets and Institutional Support
The lack of marketing is a major constraint facing existing. Poor marketing research, weak advertising and poor public access to the composting sites negatively affect compost marketing. Nevertheless, unfortified compost was found to sell for as much as Kshs. 20 per kilogram.

This study audited 6 composting units in the peri-urban areas of Nairobi; CPMEG based within city park market was the only group audited which was selling the compost they generate. This group has been composting for the last 10 years, with initial funding coming from the Chandaria foundation. CPMEG employs two full-time workers as well as other casual labourers. One other successful group involved in composting is the Nakuru Waste Collectors and Recyclers Management, or NAWACOM established in 2006. They produce a standardized, packaged organic fertilizer product for sale at about Kshs. 30 per kg. Their product is approved by the Kenya Bureau of standards and is currently in high demand within Nakuru's peri-urban farms.

Bahri, 2005, approximated that there are about 10-15 Community Based Organizations (CBOs) in the composting business in Kenya, estimated to recover about 5% organic waste and involving about 10,300 people. The groups are agents of organizational and institutional development within the low-income urban communities. They represent a significant step in terms of social organization and environmental awareness.

Biogas Generation in Kenya
It is estimated that there are more than 300 existing plants throughout the country since the inception 25 years ago of the Special Energy Programme (SEP) under the Ministry of Energy. The generation of biogas from organic waste has been limited to the use of waste water, animal manure or human excreta as the feedstock, excluding the use of food wastes. Of the fifty establishments audited in the study, only 2% are generating biogas for use within their institution – these include slaughterhouses which are using waste water and/or slurry as feedstock. Another 6% of the institutions audited had actual plans to set up biogas generation plants. Lack of technical capacity for the generation of biogas using kitchen wastes as the feedstock is a hindrance. This gap in knowledge and technology was found to be present in all the institutions which were audited, including those which were found to be generating biogas from animal manure. The Kenya Power and Lighting Company Ltd (KPLC) is in the process of completing 11 biogas engine stations, which in 2008,were estimated to cost Sh886 million and expected to connect 10,000 people by lighting their homes and institutions as well as powering small scale enterprises.

INSTITUTIONAL ARRANGEMENTS IN WASTE MANAGEMENT
The actors Involved in institutional Solid Waste Management and their Responsibilities is shown below:

Primary Parties Involved	Responsibilities
1. Central Government {Ministry of Local Authorities}	- Formulate a national policy with respect to waste reduction, recycling and solid waste management (SWM). - Enact a national SWM law. - Set technical standards. - Research on SWM. - Ensure that laws and regulations are applied. - Provide guidance to local governments.

Primary Parties Involved	Responsibilities
2. Nairobi City Council	- Formulate a local policy and prepare local strategies and plans (short and long term). - Finance SWM. - Levy waste tax. - Formulate regulations (Solid Waste Management By-Laws, 2007). - To formulate guidelines with respect to: - Methods of discharging waste (types of containers to be used); - The waste reporting requirements of business waste generators; and - Recycling (types of waste to be recycled).
3. NEMA	- Formulate regulations (Waste Management Regulations, 2006) - To license waste collectors - To license all recycling, composting and incineration activities.
3. Contractors	- To provide waste collection, haulage and street sweeping services under contractual arrangements.
4. Business (industrial and Commercial) Waste Generators	- To manage (collection, treatment and disposal) their waste except those accepted by the local government as municipal waste. - To submit reports on their waste (types, quantity, pre-treatment and other information) as required by the municipal regulations.

Linkages to Existing Plans and Programmes

- Integrated Sustainable Waste Management (ISWM): addresses the management of the solid waste stream as a set of resources rather than waste; it considers the waste stream not as a homogeneous mass but as a set of individual materials that can be handled in different and appropriate ways to maximize recovery and minimize disposal (Dulac, 2001). The potential for conversion of organic waste into a resource, through composting, biogas generation, and energy production through the gasification or pyrolysis of these wastes is immense. In addition; this recovery would yield both economic and socioeconomic benefits.
- Nairobi River Basin Rehabilitation Programme: this is a project of NEMA in partnership with UNEP. It seeks to rehabilitate the Nairobi River, and enhancing the ecological integrity and socio-economic value of the river basin. The Programme interventions focus on: environmental education, awareness creation, and public communication; conservation of the riparian reserve; integrated waste management; and the restoration of Nairobi Dam of abattoirs and their wastes.

LEGISLATION GOVERNING ORGANIC WASTE RECOVERY

Kenyan legislation is not supportive of composting activities in urban areas. Neither subsidies nor financial and technical assistance are forthcoming from local government. Although the central government recognizes the environmental benefits derived from composting domestic wastes, few real policy incentives are being extended to these groups to facilitate their operations. The Council has not integrated composting activities within its solid waste management system - the by-laws do not have specific clauses on composting. Legislation touching on waste recovery issues in Kenya includes the following, among others:

- The City Council's Bylaws on solid waste management (the bylaws do not contain policy guidelines on recovery of waste through either recycling or reuse).
- Environmental Management and Coordination (Waste Management) Regulations, 2006 Part II (6) mention a broad policy of segregation of waste, which states that a waste generator should segregate waste by separating hazardous waste from non hazardous waste.
- The Public Health Act (Republic of Kenya, 1972)

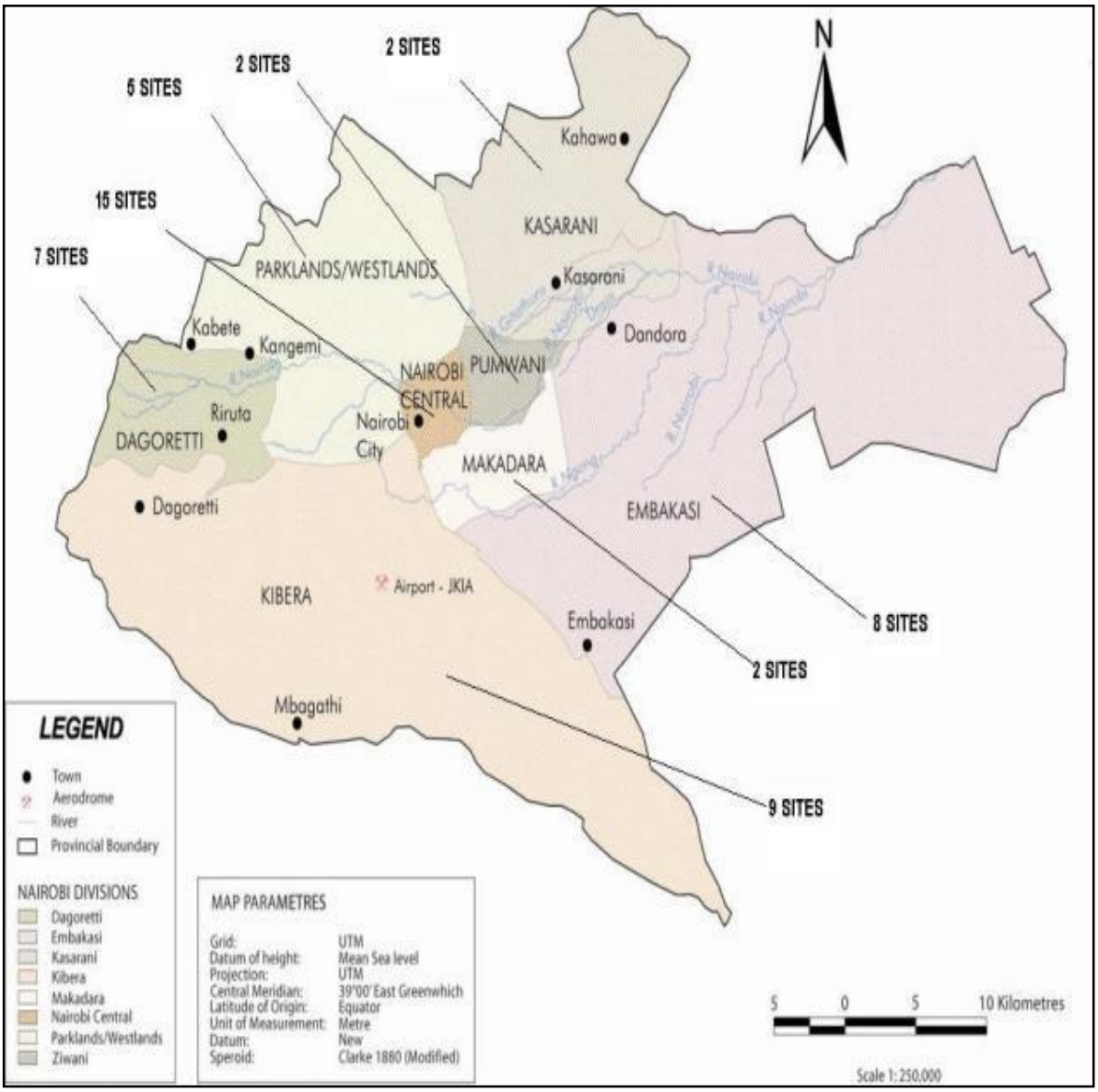
- The Solid waste management bylaws (2007)

CONCLUSIONS AND RECOMMENDATIONS

The study showed that though there are efforts on the ground to try and incorporate sound waste management practices into their operations, there are still some poor waste management practices taking place, such as burning, open dumping within institutional compounds. Waste recovery within institutions, is currently limited to the inorganics with little recovery taking place for the organic waste flow. Further, the fragmented legal and institutional framework that governs waste management fail to effectively address organic waste recovery and has led to accumulated volumes of organic waste at the main Dandora dumpsite, as well as the burning and open dumping of theses wastes in unapproved sites. Evaluation of the willingness to pay factors in potential markets for compost indicates that there is a need to have structured operations for compost production which emulate a business model - incorporating quality control, innovation, and developing a market oriented product which is competitive.

The project should develop a strategy that incorporates the involvement of all the key players including: non-domestic waste generators (institutions and commercial establishments); waste collectors (private waste companies as well as the cleansing section within the Department of Environment of NCC), waste management regulators (NEMA, NCC, Ministry of Public Health), and financial institutions (for provision of Financial and technical support is urgently required in form of loans, especially at the micro-finance level). Bearing this in mind, a small-scale pilot project should be implemented to test the potential for recovery of organic waste for commercial gain, through biogas generation and/or compost production.

Map 1: Institutional Study Site Locations within Nairobi



Adapted from UNEP Nairobi City Profile, 2007

SECTION 1: INTRODUCTION

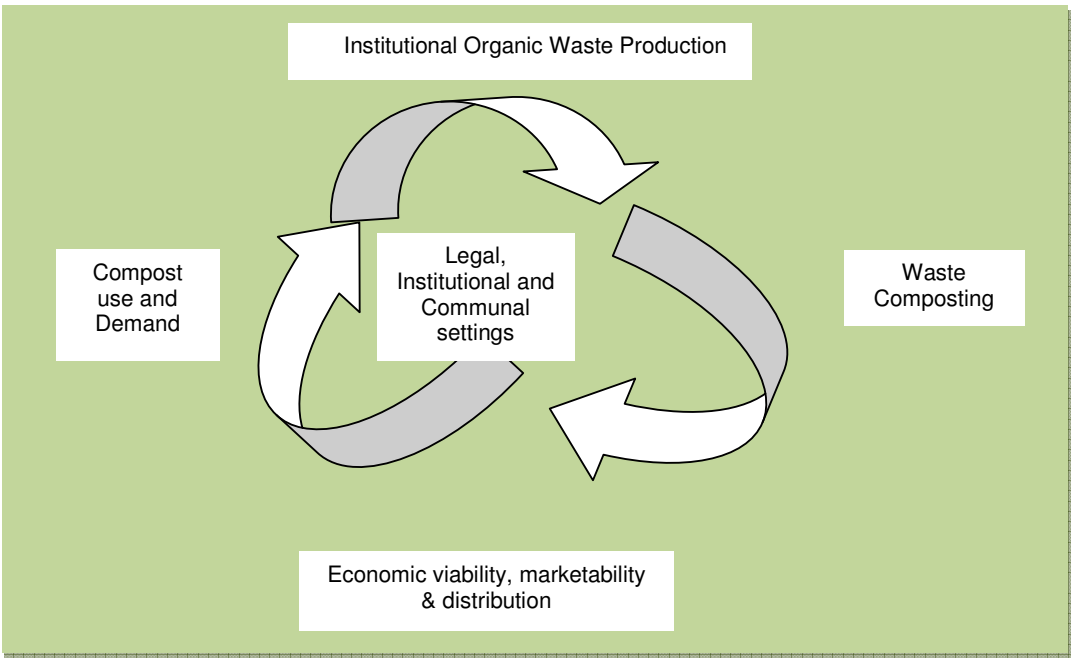
1.1 STUDY BACKGROUND

The "Converting City Waste into Compost" project funded by the Ministry of Agriculture, Nature and Food Quality is being implemented in an effort to explore options for the development of a viable system of collecting, processing, distribution and marketing of valorized organic city waste material, for application in urban and peri-urban agriculture within East Africa and Nairobi in particular.

This report presents the study findings of phase one of the project - an inventory and analysis of organic waste sources, quantification and characterization of "non-domestic organic waste streams" in Nairobi City (quantified flows[1] and destinations, including mapping). It is a major input to the "Converting City Waste into Compost project of the City council of Nairobi (CCN) and the United Nations Environment Project (UNEP). The study forms a basis upon which the potential for diversion of organic waste into compost production and biogas generation in Nairobi can be evaluated.

The diversion of organic waste for compost and biogas production provides a means of closing the nutrient loop, a concept that involves moving away from a linear process of resource extraction, manufacture, consumption and disposal, towards a cyclical system where resources remain in use almost indefinitely. (See Figure 1 below)

Figure 1: The Nutrient Recycling Loop



An overview of waste management within institutions showed that despite there being elements of functioning nutrient cycles, many gaps still exist. The study sought to identify these gaps required to close the nutrient loop. This will not only help to reduce the huge

1 The quantified flows in the report are more indicative than representative, due to the methodology used to quantify the wastes.

volumes of organic waste going into Dandora dumpsite, but will also reduce the amounts of methane and leachate generated there that have adverse impacts to the environment, safety and health of the local residents.

1.1.1 Interventions in Solid Waste Management

In a comprehensive baseline survey conducted by JICA in 1999, recommendations were made to improve solid waste management in Nairobi. The key recommendations included inter alia: developing of priority projects to oversee institutional restructuring and financial reforms; promotion of private sector involvement; construction of the final disposal site; and improvement of the collection and transportation system. The City Council of Nairobi (CCN) has made positive steps towards implementing the strategy by increasing technical capacity within the formation of the Department of Environment (DoE), as well as scaling up efforts to collect garbage by outsourcing the service to external contractors. In addition, a major development in the solid waste management system occurred between 2006-2007 through the National Environmental Management Authority (NEMA) and the CCN. NEMA has introduced a licensing process for vehicles and enterprises that transport solid waste; "solid waste" is however defined in broad terms and does not explicitly distinguish between recyclable or compostable materials. The CCN, though it has insufficient waste collection vehicles, has greatly increased the regularity and professionalism of its own collection operations and the city is considerably cleaner.

Despite these interventions, more remains to be done. Waste minimization at source as well resource recovery concepts continue to be lacking at both the domestic and non-domestic levels. Consequently, CCN in partnership with United Nations Environmental Programme (UNEP) – Industrial Energy Technology Conference (IETC) and Kenya's Ministry of Environment and Mineral Resources (MEMR), is currently developing a new Integrated Solid Waste Management (ISWM) Plan for Nairobi[2]. The plan aims to reduce waste streams by at least 50% through recycling as well as evaluate the potential for establishing waste transfer stations where waste will be separated and recycled. The unusable residual waste will then be shipped to a new sanitary landfill to be developed in Ruai (in the South East of Nairobi). The ISWM strategy also foresees the development of public-private partnerships for all elements of waste collection, separation, recycling and disposal.

The Project provides organic waste data, from the municipal, commercial, institutional waste streams with respect to:

- sources
- waste handling & disposal practices
- quantification and characterization of the waste
- mapping of organic waste flows – sources to destination.

However, on a much broader scale, it identifies the potential for diversion of organic waste from these sources, as well as identifying existing nutrient cycles that appertain to organic waste recovery for either energy generation or compost production. The project provides a linkage to the ongoing ISWM project through the diversion of organic waste from non-domestic sources.

1.2 GOAL AND OBJECTIVES OF THE PROJECT

The aim of the Project is to connect generators of relatively pure organic waste streams with agricultural and horticultural users in the urban and peri-urban areas of Nairobi. **(**Domestic

2 The ISWM project plan was launched at UNEP headquarters, Gigiri, Nairobi in March, 2009

organic waste was excluded due to the generally poor waste management & disposal practices).

The project explores ways to close the nutrient cycles in urban and peri-urban Kenya through compost production and biogas generation. The project is scheduled to be implemented in three (3) phases:

- Phase One: inventory and assessment;
- Phase Two: preparation and implementation of pilot projects; and
- Phase Three: analysis and information sharing phase.

1.2.1 SPECIFIC OBJECTIVES OF PHASE ONE

Phase One of the Project, forms the inventory and assessment phase. The specific objectives for this phase are:

- To generate an inventory and analysis of organic waste sources,
- To generate an inventory and analysis of users, producers and markets for compost and bio-energy,
- To generate an inventory and analysis of solid waste- and agriculture-based composting, biogas, and treatment projects in Kenya,
- To analyse the institutional environment of waste management and (peri-) urban agricultural domain,
- To quantify and characterize non-domestic organic waste streams (sources, quantified flows and destinations, including mapping) as input to UNEP/CCN project,
- To formulate concept sourcing strategies for UNEP/CCN project.

1.3 OVERVIEW OF STUDY AREA

1.3.1 Geophysical

Nairobi is the capital and largest city of Kenya; it is the principal economic, administrative, and cultural center of the country. It is also one of the largest and fastest growing cities in Africa. The city and its surrounding area form the Nairobi Province, one of the eight (8) provinces in Kenya. It lies at an elevation of about 1660 m (about 5450 ft) in the highlands of the southern part of the country (Source)

The city is located at 1°17′S 36°49′E and occupies 684Km^2 (square kilometers) of the 6966.1Km^2 covered by the entire province. As Nairobi borders the Rift Valley to the west, minor earthquakes and tremors occasionally occur. The Ngong Hills, located to the west of the city, are the most prominent geographical feature of the Nairobi area, coupled by the presence of three rivers - Nairobi, Mathare and Ngong rivers.

1.3.2 Climate

Nairobi enjoys a fairly moderate climate; the altitude makes for some chilly evenings, especially in the June/July season when the temperature can drop to 10 °C (50 °F). The sunniest part of the year is from December to March, when temperatures when temperatures average the mid-twenties during the day. The mean maximum temperature for this period is 24 °C (75 °F). There are two rainy seasons but rainfall is only moderate. The cloudiest part of the year is just after the first rainy season, when, until September, conditions are usually overcast with drizzle (CCN, 2009).

There are two rainy seasons; however the rainfall experienced can be moderate. The cloudiest part of the year is just after the first rainy season, when, until September,

conditions are usually overcast with drizzle. As Nairobi is situated close to the equator, the differences between the seasons are minimal and are differentiated as 'wet' and 'dry'. The timing of sunrise and sunset also varies little throughout the year.

1.3.3 Administrative Area

The main administrative divisions of Nairobi are Central, Dagoretti, Embakasi, Kasarani, Kibera, Makadara, Pumwani and Westlands. Nairobi has a number of constituencies, namely: Makadara, Kamukunji, Starehe, Langata, Dagoretti, Westlands, Kasarani and Embakasi. Most of the institutions in Nairobi are found within the Central Division, with most industries found within the industrial area located in Embakasi Division.

1.3.4 Governance

The City Council of Nairobi has legal mandate from the Local Government Act (Cap 265) of the Laws of Kenya, to provide and manage basic social and physical infrastructure services to the residents of Nairobi. These services include basic education, housing, health, water and sewerage, refuse and garbage collection, planning and development control, urban public transport and fire services among others. Highly centralized decision-making at national and local levels affects its capacity to respond to local development needs. Consequently, since the 1999 JICA survey on waste management in Nairobi, little has been achieved in improving the situation.

1.3.5 Socio-economic Scenario

Nairobi's population is estimated to be 2,750,561 with an annual growth rate of 4 to 5% (KNBS, 2008). Other estimates put it at over 3million, especially due to the large day population which comes in the morning for work and business, but departs in the evening to the surrounding districts. The province is experiencing rapid population growth, largely due to rural-urban migration and a natural rate of increase. The current spatial dimensions of Nairobi are (i) the central business district, (ii) low income residential areas and informal settlements, (iii) permanent residential (iv) commercial and (v) peri-urban & agricultural areas. These areas are zoned out by the City Council of Nairobi to control development within Nairobi.

As the centre of economic activities, Nairobi's demand for goods and services continues to rise. Food production for Nairobi is largely supported by the districts adjacent to Nairobi, such as Kiambu, Limuru, etc.

The increase in urban poverty in Nairobi, largely due to rising unemployment, continues to impede social development and contributes to the proliferation of slums such as Mathare, Kibera, Korogocho, Mukuru etc. This has impacted negatively on the environment through degradation and pollution of natural resources. The degradation of resources such as Nairobi River, Mathare River and Ngong River is responsible for a number of diseases including increased incidences of malaria, typhoid and cholera.

Though, Nairobi is deemed to harbour the most sophisticated middle class in eastern Africa, the gap between the rich and the poor continues to increase. This is evident in the provision of services by CCN which include *inter alia* access to good healthcare, sanitation facilities, safe drinking water, waste management, etc.

The informal housing settlements of Nairobi are home to over half of the city's population. The density of informal settlement is reflected in the amount of land they occupy: one third of Nairobi's population lives on an estimated five percent of the city's land (personal communication, KNBS). The most common housing situation for residents of informal settlements is renting, not ownership. Illegal landlords (who may or may not live in the slums

themselves) collect rent from tenants. Land allocation decisions are made through local chiefs and village elders, rather than through recognized municipal authorities. The land on which informal settlements are constructed is hazardous because of steep slopes, flooding, or proximity to industry. The illegal status and inaccessibility of these settlements make local authorities reluctant to provide them with services. However, the completion of Phase 1 of the Kibera Slum Upgrading project will see some of the slum dwellers move into newly constructed high-rise flats in the area.

Some of Nairobi's poor engage in waste scavenging as a means of income generation. The degree of scavenging is quite intensive at the Dandora waste disposal site as evidenced by the vast numbers of people working there. Scavenging is done mainly for plastics, scrap metals, paper, etc. There is significantly less scavenging for organic waste materials due to its poor re-sale value.

Urban agriculture exists throughout the city on both private and public land. Though the legal status of urban agriculture still remains unclear in Nairobi, it is an important survival strategy for the urban poor (especially for those without rural land holdings) as it reduces the amount of income expended on food (Kettel et al., 1995). Freeman (1991) estimated that one-third of urban households in Nairobi grew food crops. A study on urban agriculture by the Mazingira Institute (1987) estimated that three quarters of urban farmers consumed all that they produced. These figures have more than doubled over the recent years.

1.3.6 Waste Management Situation

Uncollected solid waste is one of Nairobi's most visible environmental problems. Municipal services in garbage collection and disposal would appear to be unsuccessful as evidenced by littering and untidiness which has an immediate adverse environmental impact.

Organic waste forms the largest portion of the total waste streams finding their way into Nairobi's official dumpsite in Dandora and other undesignated sites such as those in Kayole[3] and the Mathare North quarry. Dandora dumpsite continues to present the greatest burden due to its putrid nature, emission of methane with the attendant risk of global warming, foul odour, and leachate production. Further, it offers a breeding ground for pests and insects. In a 2006 study commissioned by UNEP, Dandora dumpsite was found to be responsible for severe public health and environmental impacts. The dumpsite is a serious threat to people living in the nearby area with 328 children and youth aged between 2-18 years having been examined, had concentrations of lead in their blood exceeding internationally accepted levels. 42 percent of soil samples taken recorded lead levels almost 10 times higher than the acceptable levels - over 400 parts per million (ppm) as compared to 50 ppm. (UNEP, 2006[4]).

Organic waste is not usually scavenged, but is useful to different groups of people: street children sometimes use it for their meals; some of the larger restaurants and hotels sell their food scraps to farmers to be used as pig feed; organic waste is also important to the urban agriculture sector; in some cases livestock, including goats, cattle, and chicken feed on waste heaps.

Responsibility for the provision of most urban services is allocated to the local government authority, through the CCN. The services provided by CCN include: primary education, health services, road construction and maintenance, water supply, sewerage, housing, solid waste management, drainage, markets, and social services.

[3] Dandora is the only approved dumpsite in Nairobi, however, the Ministry of Environment has allowed for waste collectors to dump wastes collected within Nairobi in the proposed Kayole dumpsite, despite NEMA {the licensing authority for waste collectors} not approving this move.

[4] Opening Remarks by Peter Aquah, Deputy Director of the United Nations Regional Office for Africa at the start of the ISWM plan consultative meetings of stakeholders.

However, over the last 10 years it has become apparent that there is need for a more integrated waste management system which will encompass the involvement of all stakeholders at all levels of the waste supply chain (personal communication, CCN). The Integrated Solid Waste Management Plan initiative follows the failure by CCN to fully implement the recommendations of JICA's comprehensive waste survey of Nairobi in 1998. Efforts were made in line with JICA's recommendations such as the decentralization of waste collection activities, which has seen the involvement of private waste collectors. In addition, the amendment of solid waste by-laws in 2007 was effected as a result.

The problems plaguing the management of Nairobi's urban services can be traced to both the local and central levels of government. The personnel at both levels suffer from a lack of adequate mandate. Moreover, with respect to waste management, there is a lack of coordination of activities between CCN and NEMA. These problems are exacerbated by political difficulties at the city level; interference by the elected councilors into the operations of the city council continues to impede progress.

The organizational, fiscal and political problems faced by central and local government in Kenya have resulted in an inability to cope with the staggering rates of population growth and rural-urban migration. There is excessive strain on existing facilities and under-investment in new ones.

Since the decentralization of waste collection activities was undertaken, several private companies are now providing waste collection services. However, only upper-income residents and businesses are able to afford the monthly fees charged. Rarely do these companies venture into the informal settlements due to the difficulties faced in collecting fees from residents.
The CCN lacks a policy on the involvement of community groups in waste management (though it does participate in several notable efforts[5]). The department of environment[6] within the CCN recognizes the need to reduce waste at source, conduct mass media campaigns, and develop clear and enforceable policies and by-laws promoting waste reduction, recycling, and community participation. There is, however, lack of political will to do so (Personal communication, CCN Cleansing Section).

1.4 STRUCTURE OF THE REPORT

The report is structured as follows:

- ***Section One:*** provides a background to the study and the study area, objectives, approach and methodology of the study;
- ***Section Two***: provides an overview of the non-domestic waste generators, mapping and characteristics of these waste sources, analysis of the quantities and fractions of waste generated from non-domestic waste generators;
- ***Section Three***: provides an overview of the users of organic waste, as well as the willingness to pay by these users;
- ***Section Four:*** provides a brief overview of biogas and composting in Kenya, as well as in the institutional arrangements;
- ***Section Five:*** discusses the existing institutional and legal framework for solid waste management in Nairobi, and how it interplays into organic waste recovery;
- ***Section Six***; provides the conclusions and recommendations of the report.

[5] One such effort is with the City Park Market Environmental Group, ensuring, that the group is able to carry out composting activities within the market, without paying any rates to the City Council of Nairobi.
[6] The City Council of Nairobi's department of environment comprises of three sections - cleansing, environmental planning and management and the parks section.

1.5 PROJECT APPROACH AND METHODOLOGY

This section presents the methodology used to conduct the assessment of organic waste from non-domestic sources within Nairobi; it was undertaken in five (5) broad phases:

- Phase One - Pre-survey of existing non-domestic waste generators,
- Phase Two - Pre-selection of potential generators and users of organic waste,
- Phase Three - Field assessments of organic waste on site ,
- Phase Four - Desk reviews of existing literature,
- Phase Five - Data analysis & computation of Results.

1.5.1 Phase One: Pre-survey of existing non-domestic waste generators

At the inception phase of the project, key potential sources of non-domestic organic waste were identified. These sources were then contacted via email, letters or telephone to request permission to undertake an assessment of the waste generated.

The study was able to identify organic waste generators based on the following criteria:

- Institutions which handle (non-hazardous) organic materials e.g. raw and/or cooked vegetables,
- Institutions which process (non-hazardous) organic materials,
- Institutions which grow/cultivate organic materials.

1.5.2 Phase Two: Pre-Selection of potential generators and users of organic waste

The first step for data collection was to clearly set the boundaries in terms of geographical location, administrative coverage, and different sectors of waste generators, with respect to non-domestic organic waste and potential organic waste users as shown in **Table 1**.

Using purposeful sampling, fifty (50) generators of non-domestic waste were pre-selected based on the positive feedback from the institutions/establishments, allowing for ECM Centre to undertake assessments of their waste.

Table 1: Potential Non-Domestic Waste Generators and Users within Nairobi

Public or Parastatal Sources	Public or Private combined sources and users	Private or NGO sources
Markets, Fish Markets	Slaughterhouses	Canneries
Army bases	Dairy Businesses	Animal Feed Mills
Universities	Mushroom Producers	Private Stables
Boarding Schools	Hotels	Supermarkets
Police Stables	Country Clubs	Green Groceries
Prisons	Golf Courses	Hospitals
Hospitals	Sports Stadiums	Ecosan[7] Public Toilets
	Private homes on large parcels of land	
	Breweries	
	Fruit/Food Processors	

The data collected on the organic waste stream generated from municipal, commercial, healthcare and industrial generators, covered 50 institutions from the eight administrative areas within Nairobi, with Central Nairobi carrying the most number of sites, as shown in

7 Ecosan Toilets in Kenya, were introduced in Kenya in 2006, by ECOTACT under the name "IKO Toilets", as part of a social enterprise model focusing on ecological sanitation,

Table 2. The study collected data from 57 sites in total due the fact that some of the establishments sampled, operated on more than one area, such as the universities, restaurant chains, supermarket chains, etc.

Table 2: Clustered study sites within Nairobi

Administrative Divisions	Number of Institutions /Establishments Studied	Number of Sites Assessed
Kibera	9	9
Nairobi Central	15	18
Embakasi	8	8
Pumwani	2	2
Dagoretti	7	7
Parklands	5	7
Kasarani	2	2
Makadara	2	4
TOTAL	50	57

1.5.3 Phase Three: Field assessments of organic waste on site

The key primary data collection for Phase One of the project was focused on generating an inventory of organic waste generators, quantification and characterization of the organic waste. The main questions the study was concerned with included:

- The amount and type of organic waste generated;
- The extent to which they are already being used;
- Current economic returns from the sale of organic by-products;
- Willingness to release materials for alternative reprocessing.

The study covered institutions in both the private and public sector (**see Annex 1**). 30% of the organic waste generators assessed, were within the Nairobi Central area, which is the hub of commercial activities in Nairobi province. Whereas, 90% of the industries in Nairobi are within the Embakasi area, these mainly comprise of manufacturing industries. Moving toward the periphery of Nairobi province, the economic activities are mainly small-scale farming, with interspersions of a few industries as well as recreational facilities such as golf courses, sports clubs etc.

Based on time series data of waste generation rates for Nairobi by JICA (1998) and Karani & Mutunga (2005), as well data on the industrial sector from the Kenya National Bureau of Statistics (2008 & 2009), the study was able to identify the key areas where the study should focus. Restaurants, hotels, markets, secondary and tertiary educational institutions and hospitals formed key point sources for the study. These institutions are expected to increase exponentially over the next 5 years, either in number or in capacity(KNBS,2009) and are sources of potentially pure organic waste due to the existing waste management practices such as segregation on site, and the lack of contamination of the organic waste due to the lack of other waste streams e.g. within markets.

Though the study was only able to sample 50 sites, which may not be representative of the more than 3,000 institutions and commercial establishments in Nairobi, the study targeted the largest with respect to size, in both categories; data from these categories is therefore fairly representative.

The data collection tools employed in the study were the use of guided questionnaires (incorporating both open and semi-structured questions), checklists, observation, and geo-referencing[8]. The differentiation of organic waste was achieved by using a guided questionnaire which offered detailed sub-categorizations of the organic waste. (**See Annex 5)**

Only physical characteristics of the waste were studied. The methodology used to analyze the quantities and characteristics of the waste were:

- Surveys at the Point of Generation: This involved on-site assessments of the waste generated by institutions & commercial establishments. It was done through measurement or observation of the waste disposed during a given time period. Since waste generation is highly variable from place to place, or from one time to another, the assessments were conducted 24 hours prior to disposal, in order to capture fairly representative data on daily waste generation rates. The surveys undertaken yielded qualitative and quantitative data on the existing waste streams. However, because the study did not incorporate the direct analysis methodology, the quantitative data generated is more indicative than representative.
- Quantification of Waste by examination of records at the Point of Generation: Some institutions maintain records that reflect the amount of waste disposed over time. This information often can be found in invoices from the waste hauler or from the log sheet. Typically, the amount of waste is expressed in terms of volume rather than weight, so a volume-to-weight conversion factor may be necessary in order to quantify the weight of waste.
- Sorting and weighing of Samples
- Visual observation of Samples

1.5.4 Phase Four: Desk Reviews of Existing Literature

A review of literature on previous waste management studies for Nairobi was undertaken, as well as the current legal framework and regulations in place that govern the waste management sector.

1.5.5 Phase Five: Data Analysis & Computation of Results & Reporting

An analysis of both quantitative and qualitative data generated from the study was undertaken and a report detailing the findings of Phase one of the project was compiled.

[8] Using a GPS Garmin Unit

SECTION 2: ORGANIC WASTE FLOW FROM NON- DOMESTIC WASTE GENERATORS

2.1 GENERAL

The Waste Regulations of Kenya, 2006, define a waste generator as any person whose activities or activities under his or her direction produces waste, or if that person is not known, the person who is in possession or control of that waste. The primary organic waste generators can be classified into two broad categories:

- Domestic Generators
- Non-Domestic Generators

2.1.1 Domestic Waste Generators

These include sources at the household level, which account for close to than 80% of the total organic waste generated within the city (Bahri, 2005). Despite some composting activities taking place at the household level, the organic waste stream from most houses in Nairobi is still considered to be fairly impure due to the lack of "in-house" waste segregation.

2.1.2 Non-Domestic Waste Sources

Non-domestic streams are those emanating from industries, commercial enterprises, as well as organizations and institutions.

2.2 Inventory and Analysis of Non-Domestic Organic Waste Generators

2.2.1 Overview of Non-domestic Waste Generators

Public and private institutions, commercial establishments, enterprises, industries and farms form the cluster of non-domestic waste generators. There are close to 3000 registered and operational entities in this category (KNBS, 2008[9]).Restaurants, Universities & Colleges, Secondary Schools, Groceries, Farms, Dispensaries, Food Processing Companies and Flour/Animal Feed Industries, comprise the largest share, with respect to number, in the non-domestic sector. Due to rapid urbanization, increased population growth, as well as an increase in the demand for goods and services, it is expected that the number of entities in the non-domestic sector, such as industries, schools, groceries, restaurants etc, will increase exponentially over the next 5 years, if the status quo is maintained. (KNBS, 2008)

In the past, CCN was responsible for the collection, transportation and disposal of waste generated from the non-domestic sector. However, due to lack of consistency in service delivery, the services of private contractors have been sought. Public institutions continue to rely on CCN for waste collection, transportation and disposal. Irrespective of which entity collects the waste, more than 80% of the waste collected is disposed off at the approved Dandora dumpsite as well as other illegal sites such as the K-Quarry and Mathare North sites (personal communication, CCN).

[9] KNBS – Kenya National Bureau of Statistics – http//:www.cbs.go.ke

Since the enactment of the Environmental Management and Coordination Act[10] (EMCA) 1999, industries, institutions as well as other commercial establishments, have had to comply with set guidelines on waste management. The Act gives provisions for setting standards, licensing of waste disposal sites and control of hazardous waste. However, lack of enforcement mechanisms to entrench these regulations is a challenge. Nonetheless, some institutions and commercial establishments are undertaking environmental audits of their operations in order to manage their waste better. Some institutions are incorporating environmental management systems, as well as other management tools such as kaizen in their operations, to improve the efficiency of their supply chains.

Despite the intervention of the Waste Management Regulations, 2006, waste generators continue to be actors in the upstream, with have little participation in the downstream activities of the waste generated from their institutions. As a result, most non-domestic waste generators continue to disregard practices such as waste minimization and segregation at source, recycling and re-use of waste. Moreover, there are no economic instruments in place to encourage reuse or recycling of waste. Consequently, waste minimization and material recovery concepts are not seen as crucial or necessary, and instead they are perceived to potentially increase operational costs.

2.2.2 Mapping and Characteristics of Non-Domestic Organic Waste Generators

Organic waste generators in the non-domestic sector are primarily institutions, commercial establishments or institutions, which handle food, farm produce or animals as shown in **Table 2**. Of the fifty institutions sampled, 41% are in the services sector, which account for more than 50% of the organic waste generated from non-domestic sources.

The distribution of institutions, commercial establishments is governed by CCN zoning controls as stipulated in the “Guide of Nairobi City development Ordinances and Zones”, 2007[11]. The distribution is such that most commercial establishments are within the Nairobi central area, whereas most agricultural activities are in the peri-urban areas such as Dagoretti and Kasarani, with industries - heavy and light, being clustered in the Industrial area within Embakasi, see Figure 2**.**

Hotels and Restaurants form the largest share of organic waste generators by volume of waste. They are mainly found within the Nairobi Central area or within institutions such as office complexes, or residential areas. Due to the nature of business of these types of establishments, it was found that, there is relatively low waste segregation at source taking place. Waste segregation is mainly undertaken to reduce losses during the preparation of food in the kitchens. Despite the rationale for the segregation at source practice within these establishments, it still serves to yield a fairly pure waste stream, which would be ideal for composting. Within the five star hotels, it was found that there are already initiatives in diverting organic waste into either pig or cattle feeding, a practice that has been going on for more than seven years in each of the sampled establishments.

10 EMCA (1999) - provides for the establishment of an appropriate legal and institutional framework for the management of the environment and related matters. It is a framework environmental legislation that establishes appropriate legal and institutional mechanisms for the management of the environment. It provides for improved legal and administrative coordination of the diverse sectoral initiatives in order to improve the national capacity for the management of the environment - http://www.nema.go.ke/index2.php?option=com_content&do_pdf=1&id=44

11 Guide of Nairobi City Development Ordinances and Zones, City Planning Department, City Council of Nairobi 2007

Table 3: Inventory of the Institutional Categories assessed in the study

ID.	Institutional Categories	Sector[12]	Number Sampled	As a % of the total	Type
1	Hotels	Services	11	19.3	Private Companies
2	Restaurants	Services	5	8.8	Private Companies
3	Sports Clubs	Services	2	3.5	Private Companies
4	Education Centres	Services	3	5.3	Government Institutions
5	Hospitals	Services	2	3.5	Government & Private Institutions
6	Prisons	Services	4	7.0	Government Institutions
7	Food Processing Companies	Consumer/Non-Cyclical	2	3.5	Private Companies
8	Flour/Animal Feed Mills	Consumer/Non-Cyclical	3	5.3	Private Companies
9	Golf Clubs	Recreation	3	5.3	Private Establishments
10	Farms	Agricultural	2	3.5	Privately Owned
11	Markets	Retail(Department & Discount)	4	7.0	Municipal
12	Shopping Malls	Retail(Department & Discount	2	3.5	Private Establishments
13	Army Bases	Security	2	3.5	Government Institutions
14	Slaughterhouses	Consumer/Non-Cyclical	2	3.5	Private Companies
15	Groceries	Retail(Department & Discount)	2	3.5	Private Companies
16	Supermarkets	Retail(Department & Discount)	4	7.0	Public Companies
17	Sanitation Facilities	Services	4	7.0	Private Companies
T	Total Sampled		57	100.0	

*Government – Owned/Ran by government departments;
**Municipal – Ran by the City Council of Nairobi;
***Private Companies/Institutions – Owned by Individuals/Groups which are not affiliated with the government;
****Public Companies/Institutions – Owned by the public through shareholders investments

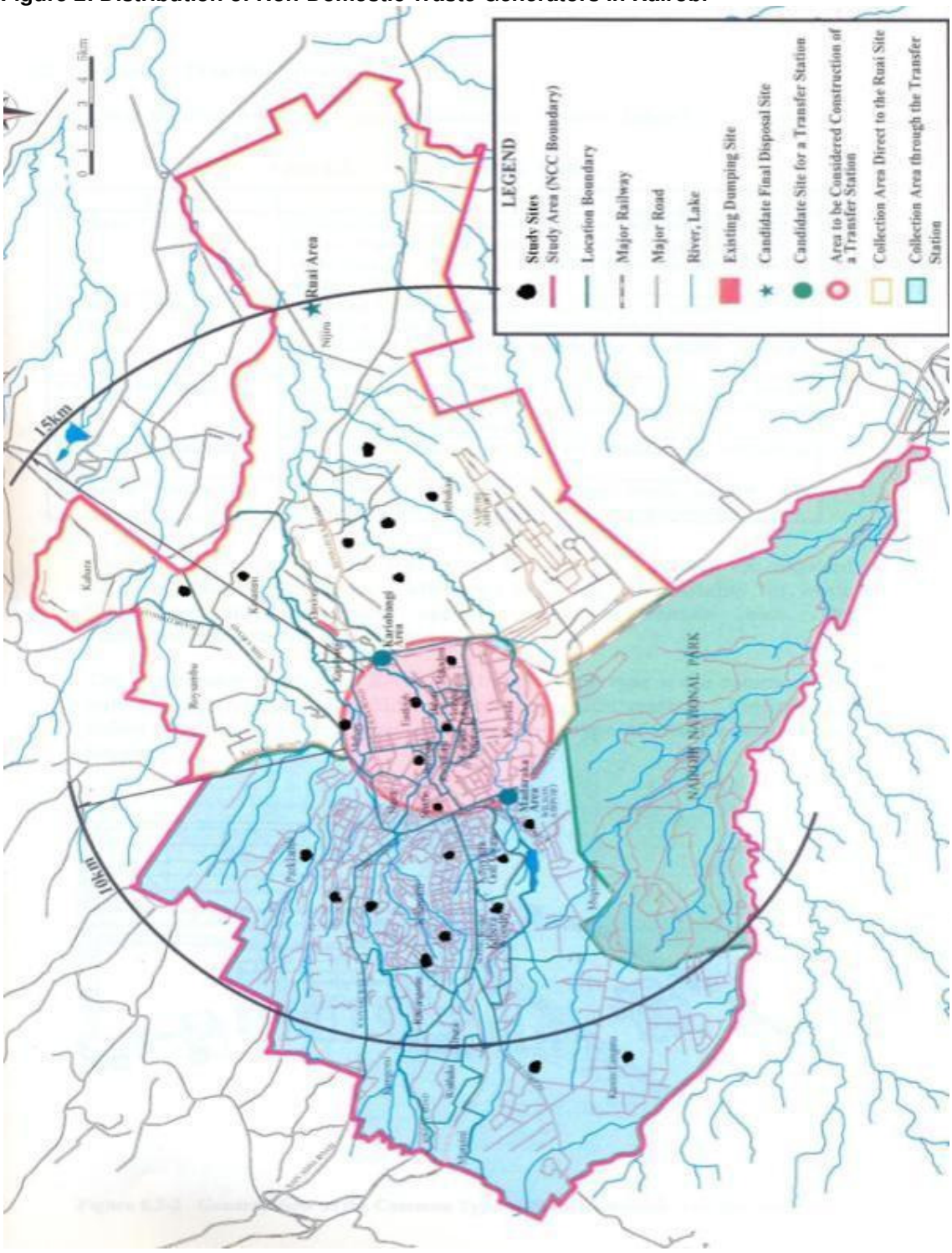
The study sites comprised 77.2% privately owned institutions, companies and commercial establishments, with the remaining 22.8% being public institutions - mainly government, such as prisons, army bases, municipal operated facilities, and publicly held companies. The study found that whereas the public institutions still relied on CCN to collect, transport and dispose their waste, private institutions rely on private waste contractors to do the same.

Private entities have institutionalized various waste management practices within their establishments resulting in improved waste management. However, waste reduction, minimization and separation at source still appear to be lacking in both public and private sectors. In a few private institutions there are some waste segregation activities taking place, as well as efforts to divert different waste components into either re-use or recycling. Community based organizations and recycling groups have benefited greatly from the private institutions which are diverting their waste into uses such as composting for organic waste, and recycling for glass, paper and plastic waste. This has established an avenue for

12 Sectoral classification based on the Kenya National Bureau of Statistics & Kenya Association of Manufacturers

job creation at the micro-enterprise level, as well as reducing the amounts of waste going into the final disposal site - albeit, by very small quantities. These kinds of partnerships are highly significant at the macro and micro levels of waste management.

Figure 2: Distribution of Non-Domestic Waste Generators in Nairobi



Adapted & Modified from JICA, 1998: Study on Solid Waste Management in Nairobi City, Republic of Kenya

2.2.3 Quantification and Characterization of the Non-Domestic Waste Stream

Karani & Mutunga[13] (2005), projected that waste generation rates within Nairobi would increase by 16% between 2005 and 2008. Solid waste generation in 2008 was estimated, based on this population projection, to be at about 2,730 tonnes per day. In subsequent studies conducted by other institutions, current waste generation rates are estimated at about 2,400 tonnes per day (ITDG, 2004).

Figure 3: Baseline Projection of Nairobi's population and Solid Waste Generation rates (Karani & Mutunga, 2005)

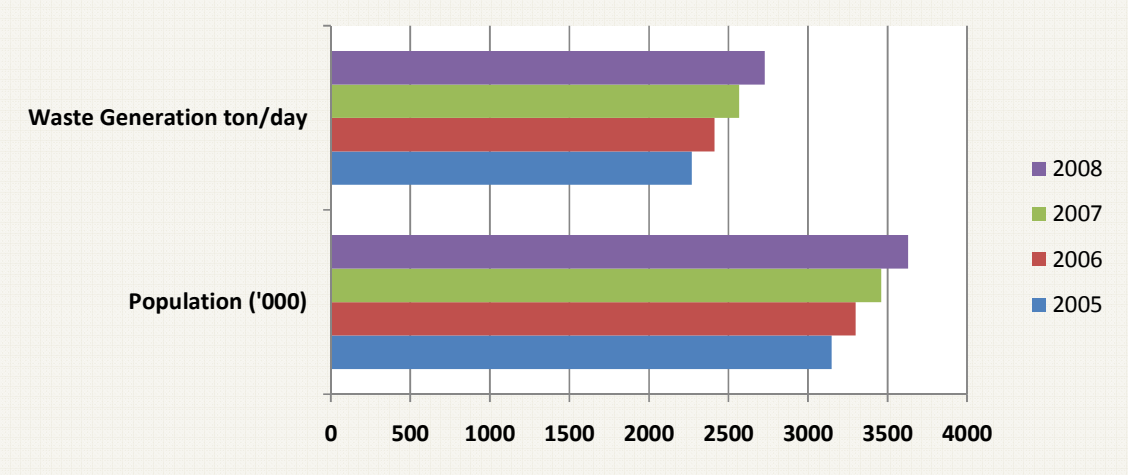


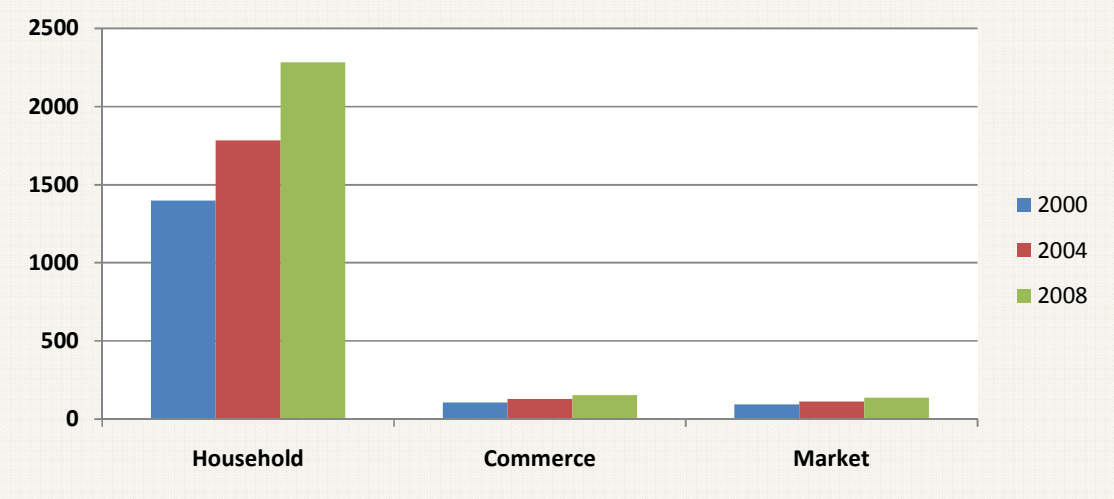
Table 4: Baseline projection of Nairobi's population and Solid Waste Generation Rates (Karani & Mutunga, 2005)

Year	2004	2005	2006	2007	2008
Nairobi population (`000)	3,012	3,148	3,300	3,461	3,630
Waste generation- tons/day	2,141	2,269	2,413	2,566	2,730

Despite, domestic sources, accounting for 83.67%, and consequently being the largest generators of municipal waste, commercial institutions and markets accounted for a significant 10.67% of the total waste stream generated within the province. Nonetheless, it is likely that the given projections by Karani & Mutunga may have more than doubled in 2008, due to the increase in the number and size of institutions, production capacities in industries, improved technology, increased urban farming etc, between 2005 and 2009.

[13] Baseline Projection of Population and Solid Waste Generation In Nairobi, Karani & Mutunga, 2005

Figure 4: Projection of Waste Generation (tonnes per day) from selected sectors in Nairobi City



Source: JICA (1998), Karani & Mutunga (2005)

Table 5: Baseline projection of Solid Waste Generation rates (tonnes/day) from selected (Karani & Mutunga, 2005)

Baseline Projection of Solid Waste Generation Rates for Selected Sectors			
Sector	2000	2004	2008
Commerce	106.7	128.5	154.9
Market	94.1	113.4	136.6
Total	200.8	241.9	291.5

From the data in **Table 5**, institutions and commercial establishments are generating up to 168 tons/day of solid waste**.** Projections by Karani & Mutunga (2005) in **Figure 4**, is that non-domestic waste would reach 291.5 tons/day in 2008. The data in the survey shows that despite the small sample size, it is possible that daily waste generation is beyond 291.5 tons which was predicted by Karani et al.

Markets, Hotels, and Education Centers were found to be the largest generators of solid waste. This was attributed to the amount of materials – organic and inorganic, that are used to cater for the high numbers of people serviced. Slaughterhouses and Ecosan toilets generate significant volumes of solid waste as well; however, due to waste fractions being limited to only manure, human excreta, bones, skins and hides, it was felt that these categories of waste generators were less representative of the non-domestic solid waste, as compared to the rest.

Sports clubs, flour mills, animal feed mills, and food processing companies generated the least amounts of solid waste, mainly due to the production methods which try to minimize waste either by waste recycling or by purchasing pre-processed raw materials. The sports clubs tend to have limited numbers of people - generally about 20-40 people will be at these clubs during the week under normal circumstances.

Table 6: Total Solid Waste Generated from non-domestic sources

Category	Total Number Sampled	Total Solid Waste Quantity[14] per day (tonnes/day)	Total Solid Waste quantity per year (tonnes)
Hotels	11	14.0	5124
Restaurants	5	2.1	769
Sports Clubs	2	0.2	73
Education Centres	3	10.4	3806
Hospitals	2	2.0	732
Prisons	4	1.9	717.4
Food Processing	2	1.7	620.5
Flour/Animal Feed Mills	3	1.0	366
Golf Clubs	3	2.2	805.2
Farms	2	5	3660
Markets	4	76	27740
Shopping Malls	2	3.5	732
Army Bases	2	4.0	1464
Slaughterhouses	2	32	11680
Groceries	2	2.0	732
Supermarkets	4^	2.5	915
Sanitation Facilities[+]	4	7.5	2745
TOTAL	57	168	62681.1

[+] This figure is for the human excreta that is collected, and not disposed off into the sewer line

^ Four (4) supermarkets were sampled, however, they all belong to one chain of supermarkets

2.2.4 Organic Waste Resource Flow from Non-Domestic Sources

This analysis aims to quantify the flow of organic waste resource in terms of mass[15], from the sampled non-domestic waste generators. Organic waste accounts for more than 80% of the total waste volume and weight generated by the institutions studied. Most of it is however disposed off together with other types of waste such as plastics and paper.

The service sector yielded more than 50% of the organic waste data on non-domestic waste generators. This is attributed to the fact that there is a higher demand and consumption of organic materials due to the nature of operations within these institutions/establishments. For example, within hotels, restaurants, education centres, hospitals and prisons, organic materials (manly food stuff) form a key component within the supply chain.

Market waste is comprised of an estimated 95% organic waste, by volume and weight[16], which is fairly uncontaminated unlike organic waste from most other institutions or from households; its potential for diversion into composting is therefore very high. Markets were found to be the largest generators of organic waste, from all the categories of institutions sampled.

Table 7: Total Organic Waste generated from Non-Domestic Sources

[14] These are estimated quantities, which do not take into account dry weight

[15] The quantification of waste by mass is based on an analysis of the estimates derived from the institutional representatives and not the actual measurements.

[16] Based on observations as well as data from the City Council of Nairobi.

Category	Total Number Sampled	Total Organic Waste generation rate[17] (tonnes/day)	Average total Organic Waste generation rate (tonnes/day)	Total Organic Waste generation rate (tonnes/year)	Average total organic waste generation rate (tonnes/year)
Hotels	11	11	1.0	4015.0	365.0
Restaurants	5	1.7	0.3	630.3	126.1
Sports Clubs	2	0.2	0.1	47.6	23.8
Education Centres	3	4.2	1.4	1522.6	507.5
Hospitals	2	1.2	0.6	439.2	219.6
Prisons	4	1.4	0.4	502.2	125.6
Food Processing	2	1.4	0.7	497.8	248.9
Flour/Animal Feed Mills	3	0.9	0.3	329.4	109.8
Golf Clubs	3	1.5	0.5	563.6	187.9
Farms	2	5	2.5	3660	1830
Markets	4	72.2	18.1	27740	6935
Shopping Malls	2	2.1	1.1	768.6	384.3
Army Bases	2	2.4	1.2	878.4	439.2
Slaughterhouses	2	28.8	14.4	10540.8	5270.4
Groceries	2	1.7	0.9	622.2	311.1
Supermarkets	4^	1.8	0.5	640.5	160.2
Sanitation Facilities[+]	4	7.5	1.9	2745	686.3
TOTAL	57	145	45	56143.2	17930.7

** Figures have been rounded off to the nearest one decimal place.

[+] This figure represents human excreta that is collected, and not disposed off into the CCN sewer line.

^ Four (4) supermarkets were sampled; however, they all belong to one chain of supermarkets.

The study showed that close to 60% of the organic waste generated from the sampled institutions comprised of mainly raw vegetable and fruit waste. The remaining 40% comprised of cooked/leftover food, spent production waste, bones, and plant matter. Although, the study concentrated mainly on solid organic waste from food stuffs, there were 3 industries, mainly the Ecosan toilets, which had bio-solid waste as a result of treating their waste water from their production lines. The other 47 institutions were found to discharge their waste water directly into the City Council's sewer line and thus, they did not retain any bio-solid wastes.

Slaughterhouses were found to be the second largest generators of organic waste[18]; however, this organic waste is in the form of manure. With an estimated cumulative[19] generation rate of 28.8 tonnes per day of organic waste, about 30-40% of it is currently going into disposal sites that are licensed by NEMA for this type of waste.

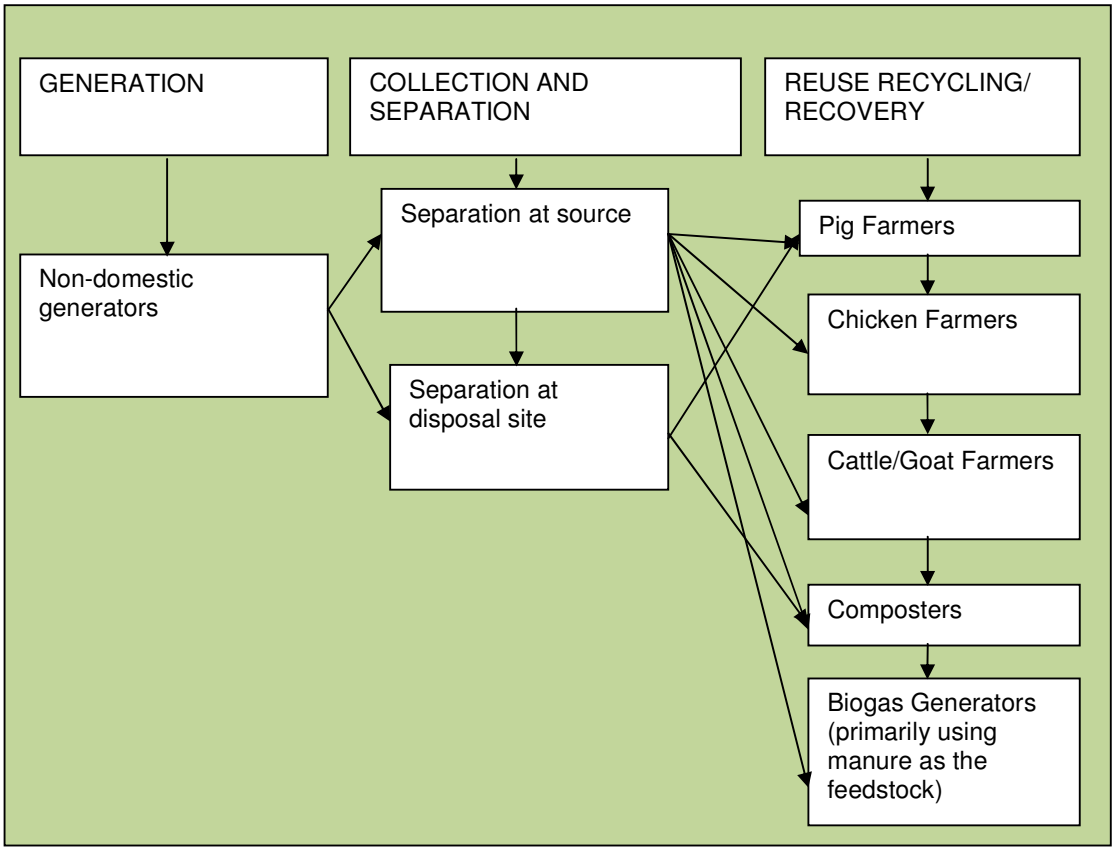
Markets and education centers generate significant quantities of solid organic waste, in the form of raw vegetables/fruits and left over foods. These institutions were found to dispose their wastes into Dandora dumpsite, with little to no reuse, recycling or recovery taking place at source or at the collection & transportation levels of their waste management chain.

[17] These are estimated quantities, which do not take into account dry weight

[18] Organic waste from slaughterhouses also includes the dissolved organic wastes in the slurry emanating from these facilities, however, the study only focused on the solid waste.

[19] Total of all the sampled slaughterhouses

Figure 5: Organic Waste Resource flow from Generation to Reuse/Recycling/Recovery



From an analysis of the flow of organic waste from source to the final destination within the commercial & industrial sector, it was found that the 3R approach (reduce, reuse and recycle) is being incorporated in some institutions, farms and commercial establishments.

Segregation at source, though not a common practice, is taking place within some hotels, hospitals, restaurants and slaughterhouses. The organic waste from the segregated waste ends up as animal feed in chicken, cattle, and pig farms, while some of it ends up in composting and biogas units as shown in **Figure 5** above.

In other institutions, waste is taken to a disposal area where waste scavengers separate the wastes, into inorganic and organic, carrying away the recyclables. The organic waste from this separation was found to either go into pig farms as swine feed or composting unit. Cattle and chicken farms did not take up organic waste from the disposal sites as they felt it was contaminated and hence unfit for use as feed.

2.2.5 Variations in waste Generation Rates

The estimates of organic waste generation were correlated with the following factors depending on which category the institution assessed, fell into:

Table 8: Correlation Variables used to determine variations of organic waste generation rates

CATEGORY	CORRELATION VARIABLE USED
Hotel	Bed Occupancy/Conferencing Facilities/Banqueting Facilities
Restaurants	Sitting Area/Tonnage of Raw Foods procured
Sports Clubs	Club Membership//Tonnage of Raw Foods procured
Education Centers	Student and Teachers Membership
Hospitals	Bed Occupancy
Prisons	Prison capacity/Prison Personnel
Food Processing	Tonnage Capacity
Flour/Animal Feed Mills	Tonnage Capacity
Golf Clubs	Acreage
Farms	Acreage
Markets	Vendors /Tonnage of Raw Foods procured
Shopping Malls	Stalls/Tonnage of Raw Foods procured
Army Bases	Army Personnel
Slaughterhouses	Slaughtering Capacity / Tonnage Capacity
Groceries	Tonnage of Raw Foods procured / Customer Capacity
Supermarkets/Retail Stores	Tonnage of Raw Foods procured / Customer Capacity
Sanitation Facilities	Tank Capacity / Customer Capacity

This correlation permits estimates of waste quantities to be “scaled up” to a level larger than the individual generator – e.g. to the countywide or statewide level (UNEP/IETC, 2006). This is possible primarily due to the fact that the amount of waste generated is more often directly influenced by the correlation variable. Thus, it would be easier to compare institutions within the same category, by comparing the correlation variable and as such extrapolate their projected waste quantities.

2.2.6 Factors Influencing Variations in Generation Rates and Trends

Though, there exists only limited data on the institutional waste generation rates in Nairobi, the study was able to capture other factors, though untested, which affected the amounts of waste generated within institutions, these are:

2.2.6.1 Seasonal Variations

Seasonal variation is a component of a time series which is defined as the repetitive and predictable movement around the trend line in one year or less. With respect to waste generation, it is detected by measuring the quantity of waste over small time intervals, such as days, weeks, months or quarters. These seasonal variations are with respect to:

- Weather Changes
- High and Low Season in the tourism sector

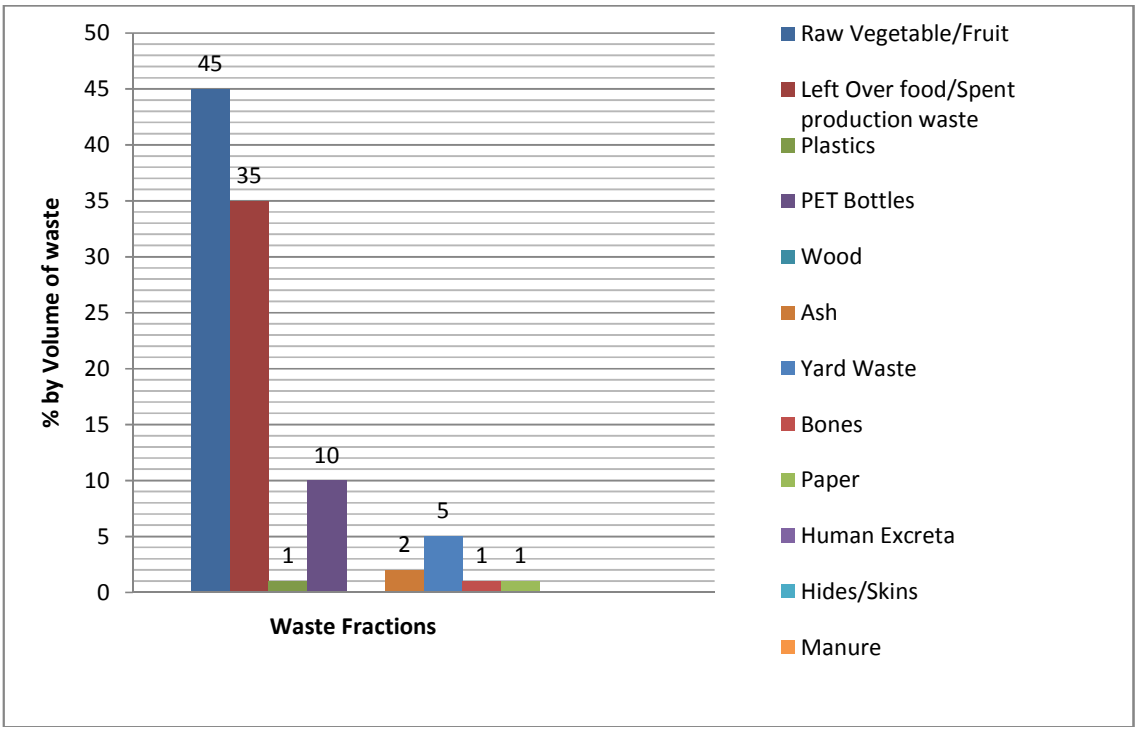
Respondents interviewed in the study, stated that, seasonal variations play a key role in the amount of wastes generated from the commercial sector. This was especially reported in the markets, golf courses as well as learning institutions. Though, this parameter was not physically measured, data generated from the questionnaire survey suggest, that there is a variation in waste quantities; during the rainy season market waste increases by about 10-20% whereas in the dry season, the waste decreases by about the same quantities. However, with the current increase in greenhouses for food production, there is a slight increase in the consistency of certain products into the markets (ASK, 2009).

2.2.7 Waste Fractions by Institutional Category

2.2.7.1 Hotels - Large & Small

Hotels in Kenya are between the one star to five star classes. There are 22 hotels in Nairobi between the three to five star classes, with 49 between one to two star classes (KNBS, 2009). 10 hotels from all five classes were sampled in the study, which is about 14% of the total number in Nairobi. However, all classes of hotels were sampled in the study.

Figure 6: Waste Fractions generated from Hotels

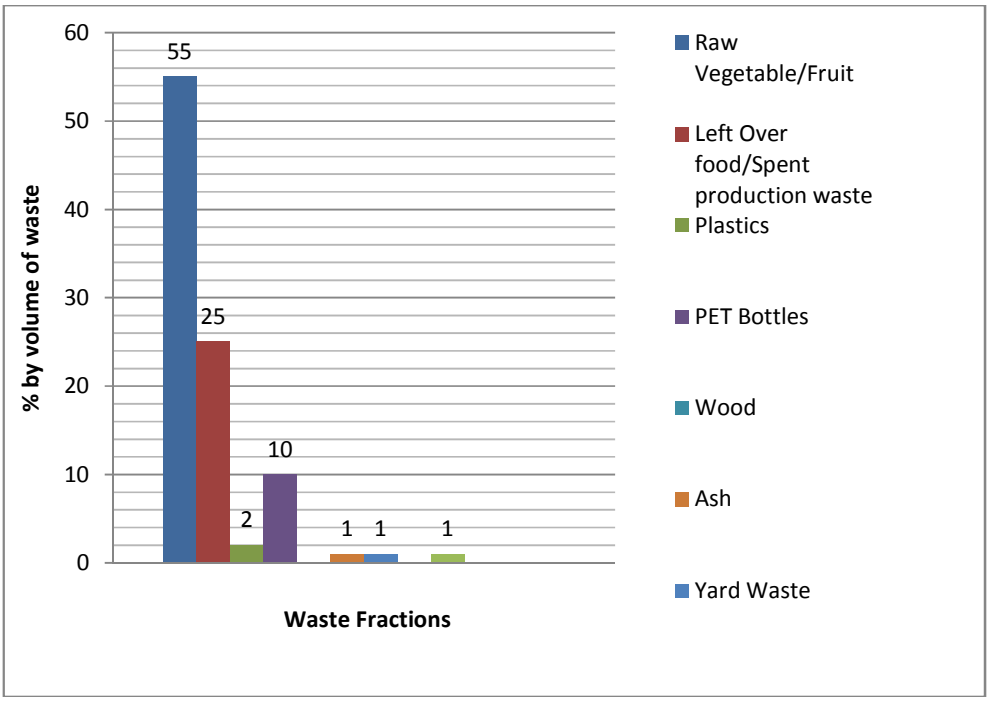


On average Hotels generate 890 kg of waste per day, with 5 star hotels generating about 2,000kg per day, while the ones in the 1 star bracket generate 200kg per day. Raw fruit/vegetable waste comprises 45% of the waste fraction generated from Hotels. This is mainly because more than 95% of the hotels are purchasing whole fruits and vegetables, which are then processed within the hotel, as opposed to the 10%, which purchase processed vegetables, thus greatly minimizing their waste. Despite waste volumes being proportionately linked to the size of the hotel with respect to the occupancy at any given time, it is prudent to note that the larger hotels in the 5 star bracket appear to have institutionalized better waste management practices as opposed to the smaller ones. For instance, most 5 star hotels have cold storage rooms where they store organic waste before disposal. This allows the waste to be “fresh’ for use as animal feed. This has been a key reason as to why most animal farmers prefer the organic waste from such institutions.

2.2.7.2 Restaurants

There are about 984 restaurants in Nairobi (KNBS, 2009). Out of these, five (5) were assessed individually, and another fifty (50) which share a common waste collection area were studied as a cluster.

Figure 7: Waste Fractions generated from Restaurants



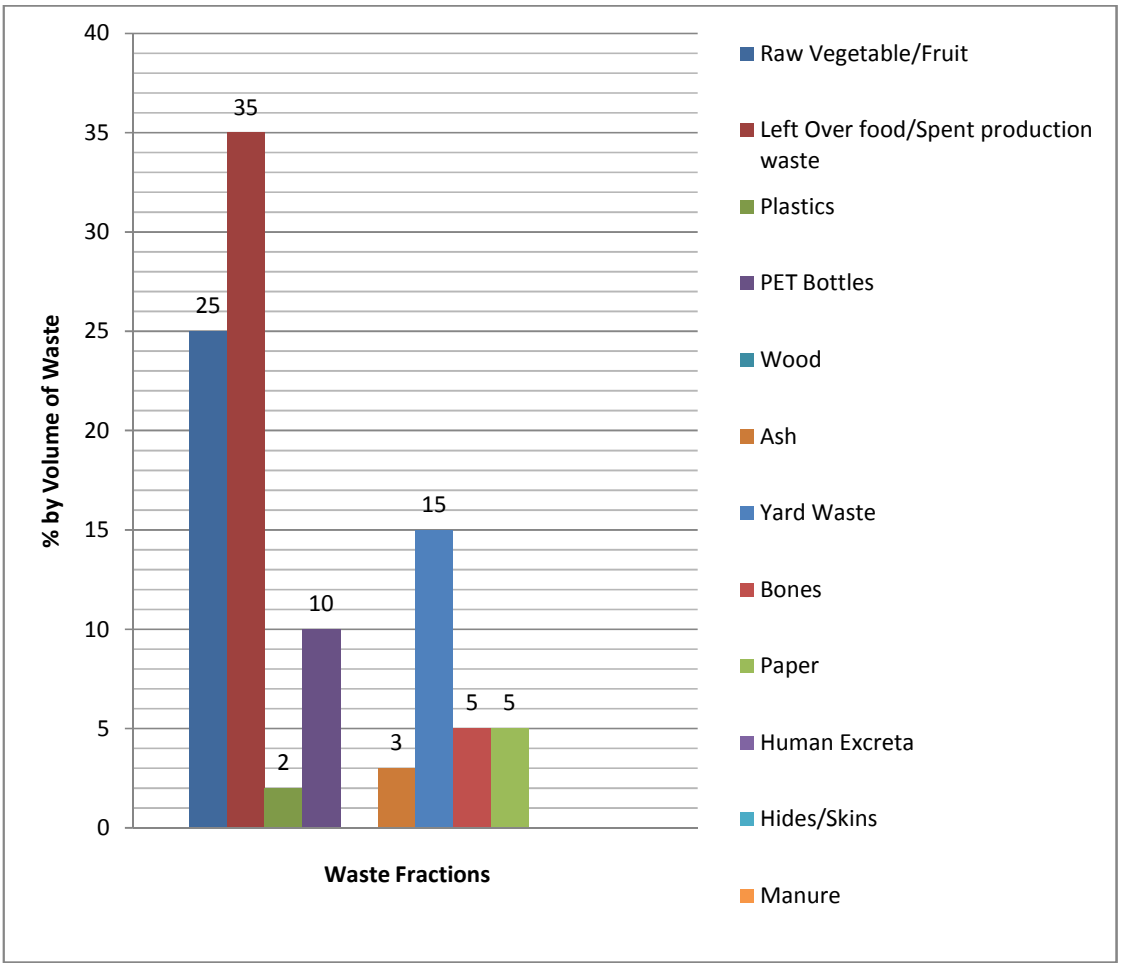
An analysis of the sampled institutions showed that they generate a total of 2.1 tonnes/day of solid waste with 81% of this total being organic waste. Organic waste from processing of raw fruits and vegetables and from left over foods accounts for 80% of the organic waste. More than 50% of the restaurants that were audited were found not to segregate their wastes at source. Organic waste is either sold to pig farmers or used for composting.

PET bottles form about 10% by mass of the total waste generated from restaurants; as the value of PET bottles in the recycling sector is very low, demand for the product is also very low. Though this is expected to change in the short-term, it has led to an accumulation of this product in recyclers' warehouses and stores, awaiting a price increase.

2.2.7.3 Sports Clubs

Sports clubs provide recreation for the upper middle class and the social elite in Kenya. There are about 30 sports clubs in Nairobi (KNBS, 2008) two of which were audited in the study.

Figure 8: Waste Fractions generated from Sports clubs



An overview of the clubs that were audited showed that the total estimated amount of solid waste generated by a sports club is 0.08tonnes/day. These facilities were found to be least generators of waste. The waste generated is 83% organic comprising mainly of raw food waste, left over foods, ash, bones and yard waste. Leftover food waste forms the largest component of the total organic waste fraction. Ash generated from these facilities comes from burning of charcoal used for barbeques. The yard waste is also significant because of grounds maintenance activities at such facilities which yield about 8kg-15kg of yard waste per week. However it was found that this waste fraction is readily assimilated back into the flower beds as mulch. Bones, leftover foods and raw food waste are often carried away, without any charges, by some club members as pet food or pig feed. As a result of this demand, there is segregation of the wastes in the kitchen.

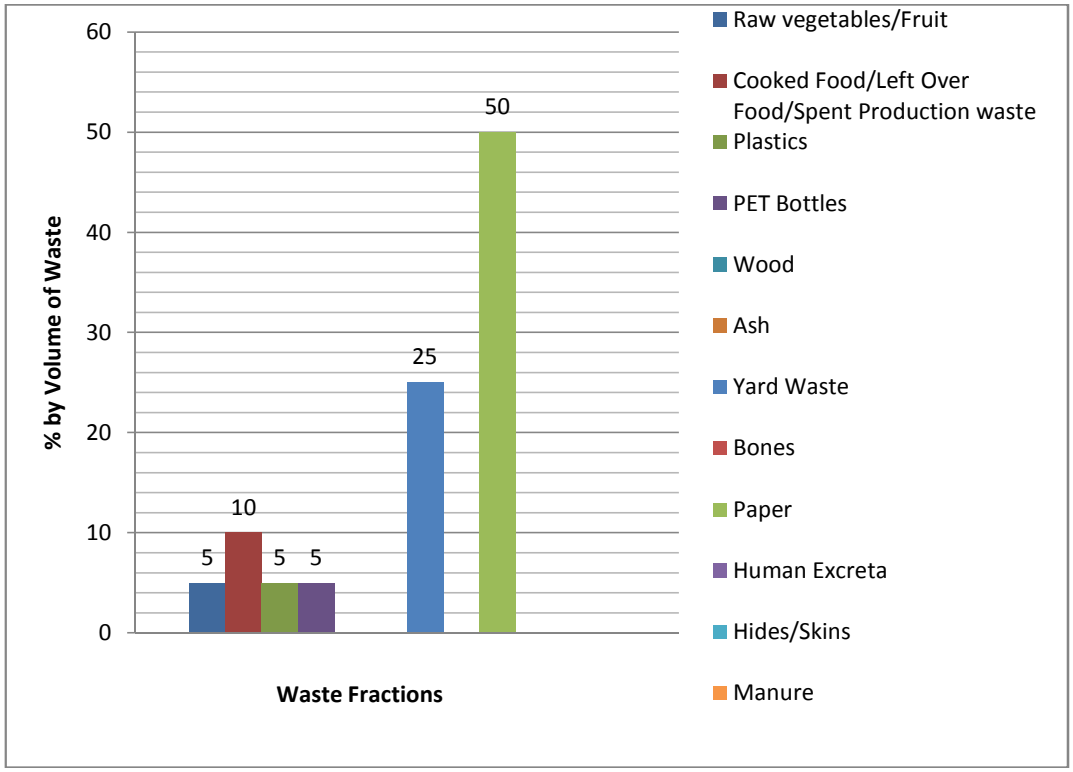
2.2.7.4 Education Centers

There are more than 2000 education centres in Nairobi. These include both private and public primary schools, secondary and tertiary level institutions. These institutions have continued to increase since the inception of free primary school education in 2003 and are projected to increase even further.

It was noted that within these institutions, the key waste fraction was paper, at 50% by volume of the total waste composition. Boarding facilities tend to generate more organic waste as compared to the day facilities, however they have adopted organic waste recovery concepts such as composting, swine feed, and biogas generation. These concepts are

supported by the fact that there are some farming activities taking place within these institutions through either crop or/and animal husbandry.

Figure 9: Waste Fractions generated from Education Centres



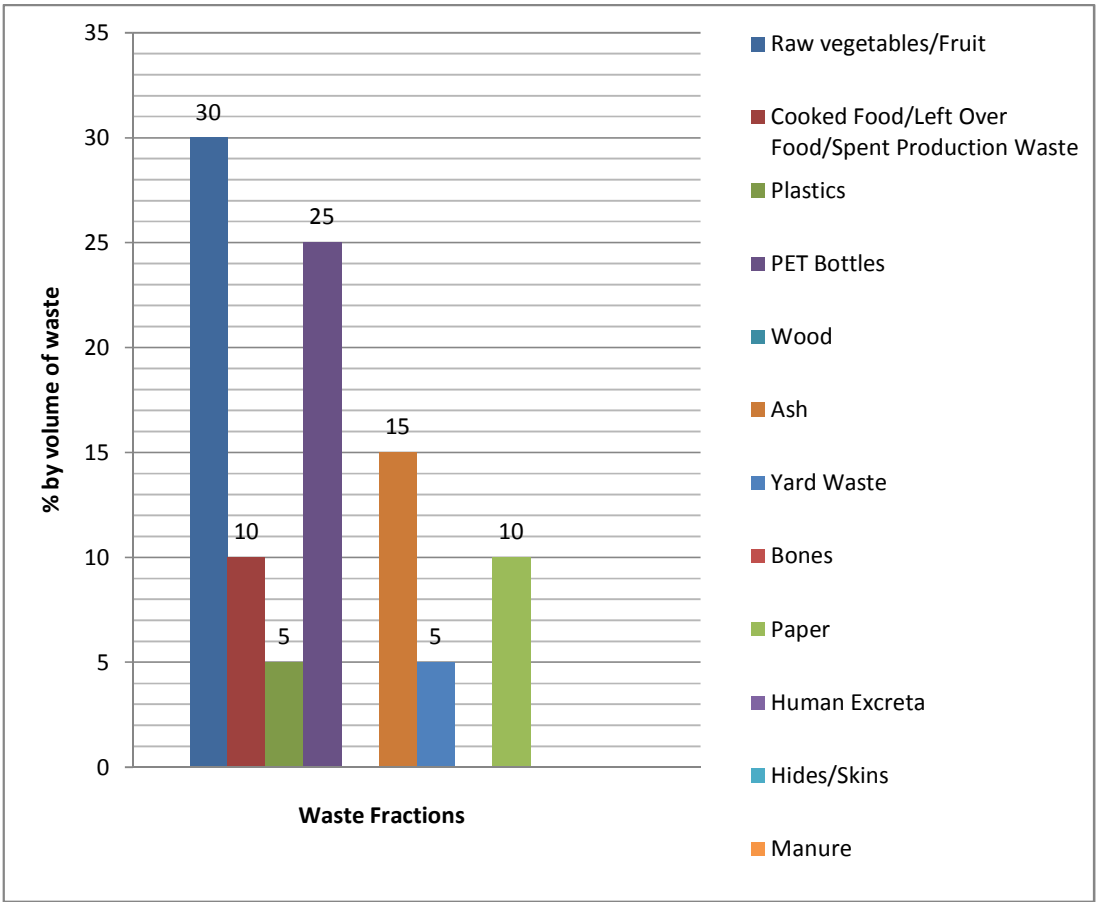
It was also noted that universities and colleges which offered boarding facilities tended to use external waste contractors to collect, transport and dispose off their wastes. However, boarding schools at the secondary school level tended to manage their wastes in-house through burning or composting, with few institutions having private waste contractors. The cost of disposal would be about Kshs. 20,000 – 40,000 per month, for an unspecified amount[20] of waste.

2.2.7.5 Hospitals

Hospitals generate both hazardous and non-hazardous waste. Two hospitals out of 54 health centres in Nairobi were audited in the study.

[20] Most waste collection companies in Nairobi do not charge per kilo/tonne of waste removed from the source, instead they attach a value, based on other parameters, for the cost for removal.

Figure 10: Waste Fractions generated from Hospitals



The collection, transportation and disposal patterns for hazardous and non-hazardous waste streams vary significantly. Private waste contractors are required to have permits, an approved incineration site/incinerator for the burning or destruction of hazardous waste from hospitals. Within the private hospitals it was noted that there was separation at source of different waste fractions: organic waste, PET bottles, paper and plastics. Within hospitals, the segregation of wastes was into either hazardous or non-hazardous streams. In addition waste within the public hospital readily accumulates for at least two weeks, every two months or so, without being collected, as opposed to the private hospital which had its waste collected on a daily basis. It was also noted that within the public hospital, there was some scavenging of the waste by street urchins as well as some community based recycling groups at the skip in the collection area.

2.2.7.6 Prisons

All prisons in Kenya are under the Ministry of Home Affairs. There are 4 prisons in Nairobi (KNBS, 2008). The study was able to audit the waste generated within all four institutions. The largest prison is the Kamiti Maximum and Medium Security prison, as it has the highest capacity with about 2,300 inmates. However due to these institutions being public, they tend to confer the onus of waste management to the city council of Nairobi and the burning of inorganic waste was prevalent. In one institution, it was found that due to unpaid dues, the waste had accumulated to nearly unmanageable quantities as shown in Picture 1**.**

In all prisons in Nairobi there are facilities for prison wardens to reside with their families. This is in fact the largest source of the organic waste generated with respect to food waste, in these institutions. The main waste fraction generated from the prison holding areas are plastics form packaging materials for bread, milk sachets etc.

In one prison (Nairobi West Prison), a pilot project had been initiated in 2006, in conjunction with UNEP and E.M Technologies to generate compost manure from water hyacinth harvested from Nairobi dam. Though the project is still underway, they are able to generate about 2 tonnes of compost per month. (Personal Communication, Nairobi West Prison, 2009)

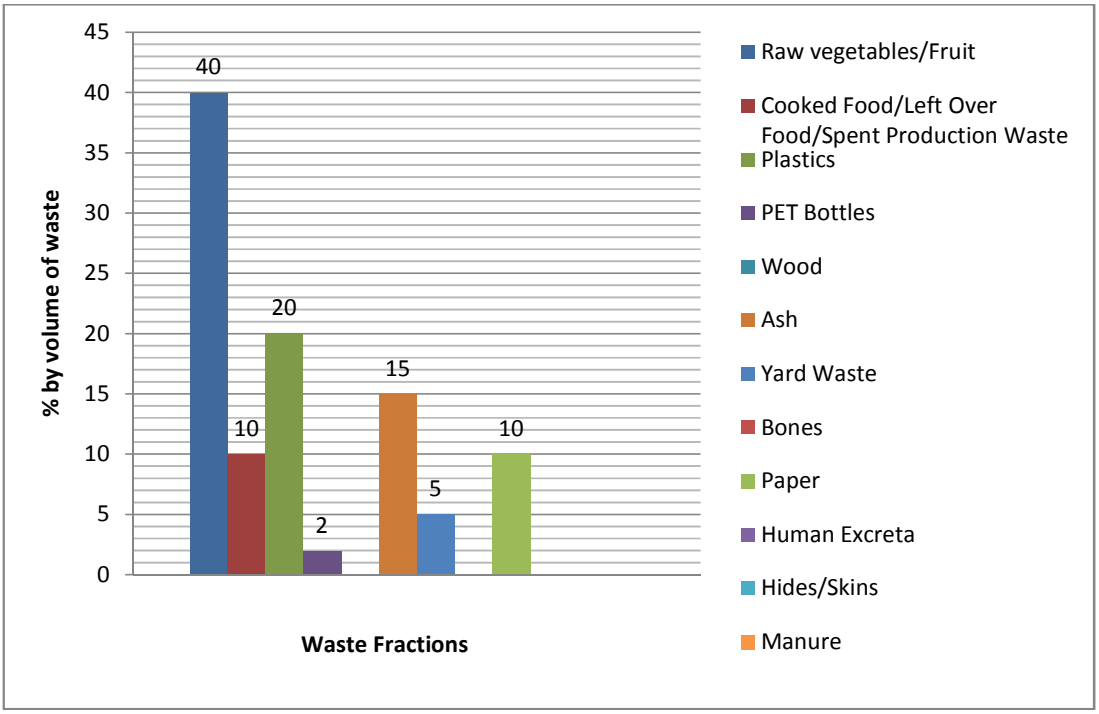
Picture 1: Showing the pile up of waste in a prison within Nairobi

On the whole, the prisons in Nairobi have almost negligible collection coverage[21], due to their inability to regularly pay for the collection of waste, and the inability of CCN to collect wastes frequently due to the breakdown of the vehicles and excavators[22]. Improved waste management within the prisons would have to focus on the domestic waste generated from

21 The percentage of the total (household and commercial) waste generating points that have regular waste collection or removal.
22 These are used for removing the accumulated wastes or for leveling the wastes in the disposal areas.

the wardens' houses, impress upon the residents the need to separate their wastes, as well as improve on the use of plastic bags/liner bags for the containment of waste.

Figure 11: Waste Fractions generated from Prisons

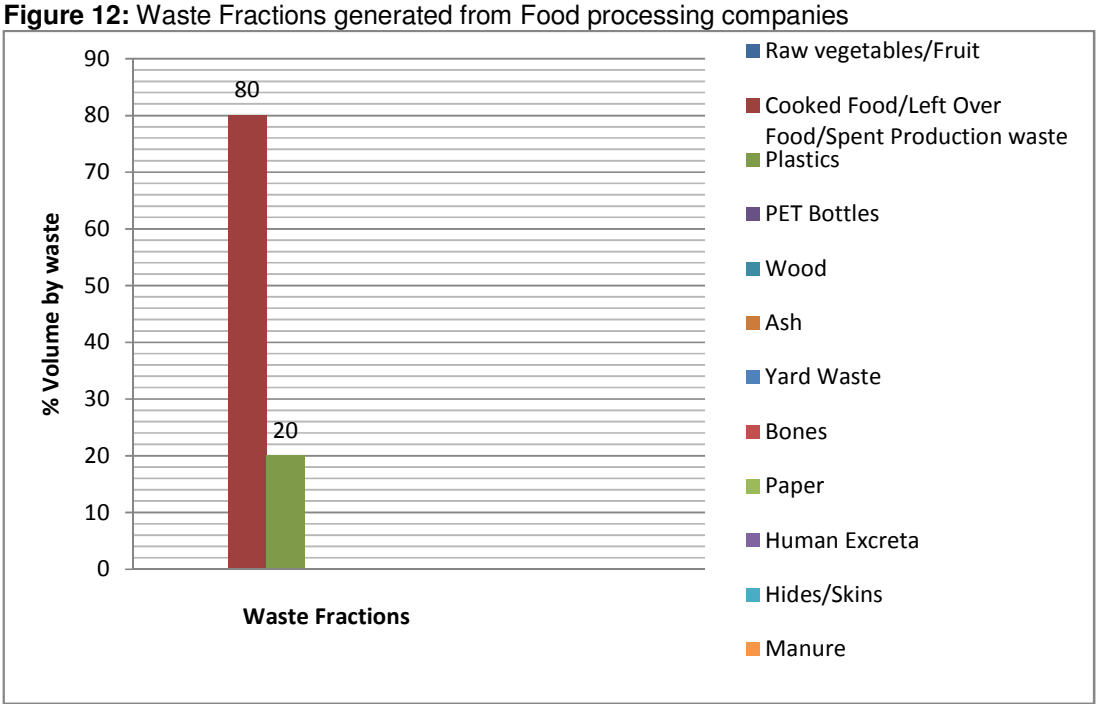


2.2.7.7 Food Processing Industries

There are about 152 food processing companies in Nairobi (KNBS, 2009). These companies' process and/or package fruits, fruit juices, pickled foods, milk, bread, jams, yoghurt etc. These products are processed and/or packaged for consumption by the local market as well as for export. Whereas these light industries are mainly situated within Nairobi's industrial area, there are a few which in the peri-urban areas of Nairobi. Due to the nature of these industries, the owners are extremely sensitive to visits from outsiders, thus, we were only able to capture data from two (2) companies.

Most of the fruits and pickled food stuffs are often preserved in a sulphite based preservative, hence rotting/spoilage is greatly minimized for up to 1 year. However, for the manufacture of peanut butter, milk based products, there is considerable waste generated from the facilities. Hence, about 80% of the waste generated from these facilities is spent production waste, such as the skins of the peanuts, sweepings from the production process, as well as waste water which contains dissolved organic matter such as milk.

Figure 12: Waste Fractions generated from Food processing companies



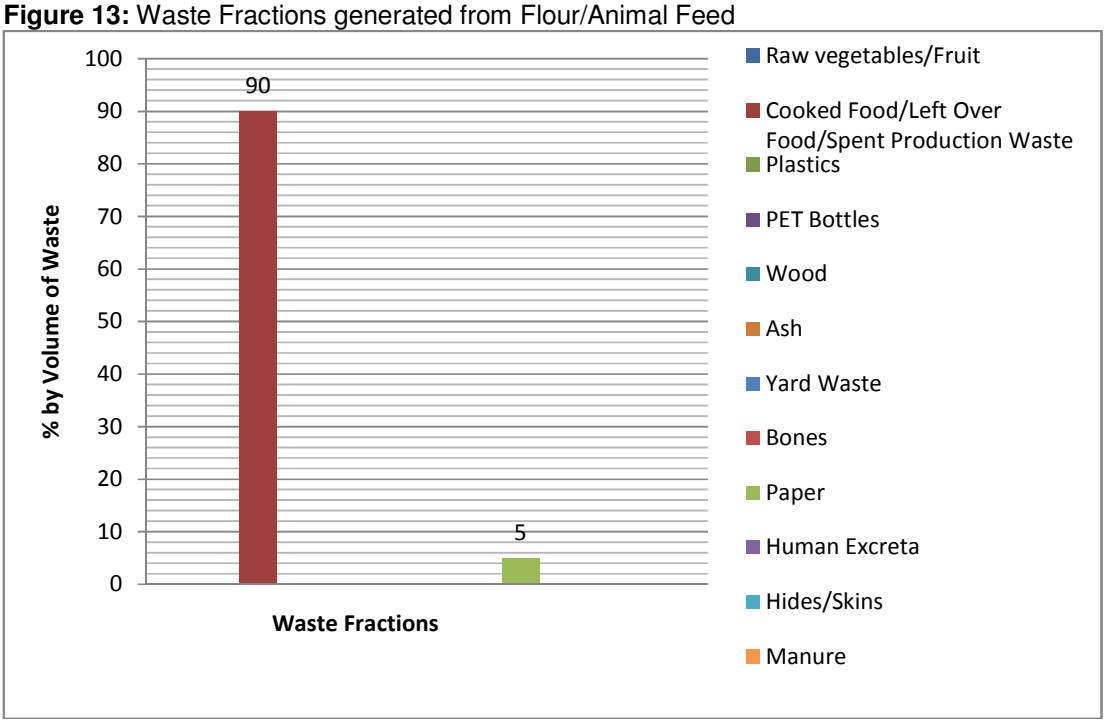
Packaging waste forms a significant portion of the waste fraction generated within these institutions. This is mainly in the form of plastics either the HDPE (High-density polyethylene) or the LDPE (Low Density Polyethylene). Due to the value of these materials in the recyclables market, at between Ksh.6 - 13 per Kg, the demand for these items is very high.

Most food processing companies will readily give away their plastics to a recycler on condition that they collect the wastes often and carry away all the plastics, whether damaged or not. In the long term, the relationship between these companies and the recyclers is mutually beneficial in that, the recyclers get the a regular supply of plastics for free and thus are able to make a good margin after reselling, while the companies get the waste removed from their sites avoiding costs of disposal.

2.2.7.8 Flour/Animal Feed

The processing of wheat and maize to produce flour and animal feed, generates about 90% waste in the form of spent production waste such as bran, pollard, fingerlings, sweepings and some sandy soil. In Nairobi, there are close to 164 flour and animal feed companies, this number includes the small posho mills in the residential areas (KNBS, 2008).

Figure 13: Waste Fractions generated from Flour/Animal Feed



On average the capacity of these companies is between 150 - 180 tons per day, if their production lines run for 24 hours per day. However, most operations are between 8-10 hours due to the shortage of maize and wheat supplies, which limits production. Of all the waste categories, it was found that this category embodied the best example of industrial ecology system approach, where waste can be used as a raw material to generate a new product. That is, the waste generated from the flour mills – bran and/or maize germ, can be re-used to produce animal feed. Some companies have both a flour mill and animal mill, whereas others do not. Thus, those that only have animal fed mills purchase bran and/or pollard from the flour mills. This has helped reduce the amounts of waste generated from these companies significantly between 500-900[23] tonnes a day.

There is no separation of wastes at source in this category; the waste is disposed in such a way that wastes from the production lines do not mix up with waste from the offices or staff kitchens.

2.2.7.9 Golf Clubs

Considered a preserve of the elite, golf clubs in Kenya continue to increase in number as well as size. There are 15 golf clubs in Nairobi, which extend to the bordering towns such as Kiambu, in Central province. These areas occupy between 60 – 250 acres of land, covered by 90% grass and trees and 5% water in ponds.

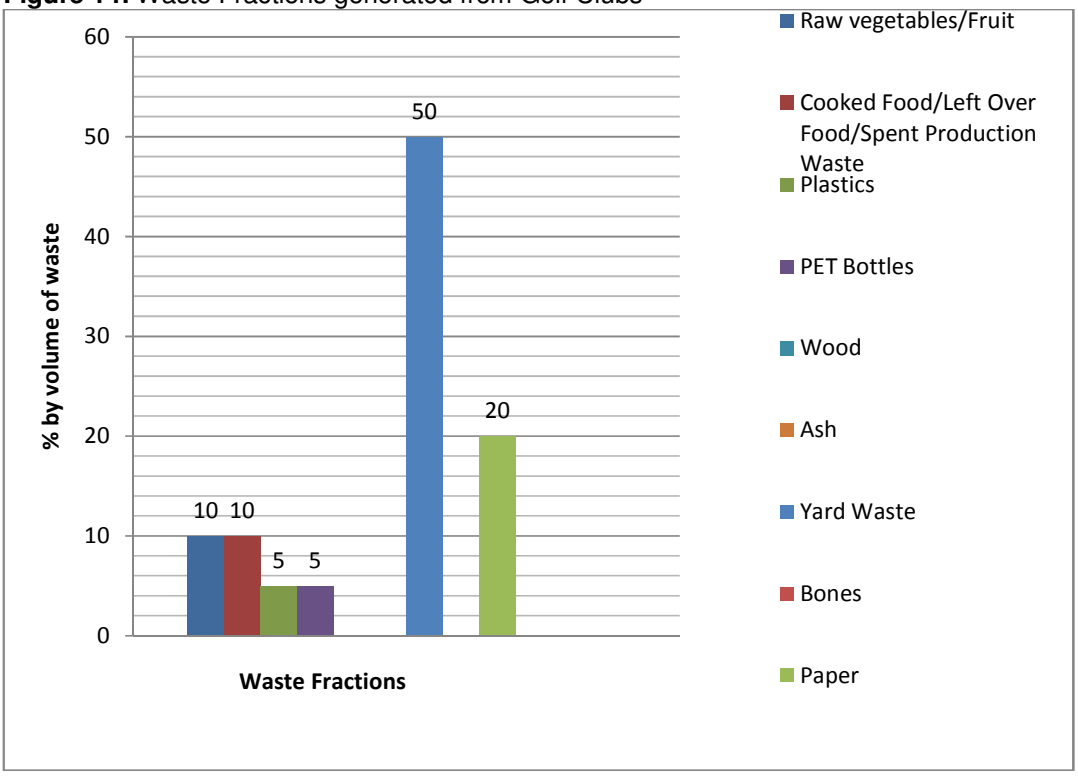
Golf clubs generate about 1.5 tons/day of yard waste per day on average. The large, 18-hole courses generate about 4 tons/day of yard waste, which comprises 90% grass. Within all the golf courses which were audited, there is reuse of the yard waste to generate compost. On average, they generate about 13 – 25 tons/month of compost, however, none of them use the organic waste from the club house kitchens when generating the compost. Due to the high costs of fertilizers, with some golf courses spending about Kshs. 500,000 per year on them, the use of compost manure greatly subsidizes these costs. All the golf courses use the

[23] 900 tonnes are for the mills that have flour mills, while 500 tonnes is from the animal mills, or where there both animal and flour mills at the same site.

compost heaps to generate compost, with the exception of one; there was no clearly defined methodology for mixing the components of the compost heap. The clearly defined methodology, which was noted, was the separation of the yard wastes, such that grass was separated from the twigs, the rational being that the decomposition time for the two components was significantly different and as such, there was a need to have two separate heaps for each as shown in Picture 2 and Figure 14.

The compost generated within these golf courses, is used in the landscaping of the courses, and for maintenance of the fairways. In one of the golf courses, it was found that, there was no use of fertilizers at all, and the Estate & Golf supervisor believes that there was absolutely no need to use them. Nonetheless, the use of effective microorganisms (E.M) was observed in two of the golf courses, as an additive to the compost heaps, to speed up the decomposition process. Aside, from this, there was no addition of nutrients, neither testing of the final compost to measure the levels of nitrogen, potassium or phosphorus, C: N ratios, and/or heavy metal contents.

Figure 14: Waste Fractions generated from Golf Clubs



Waste from the club houses comprises mainly the kitchen waste – raw fruits/vegetables and left over foods. However, none of the golf courses whose waste was audited, allowed their members to carry away the waste, thus, the waste collectors carried all the waste for final disposal at Dandora dumpsite. Due to the numerous tournaments, about 5 per month, as well as the dining of the members at the club, there is a lot of paper waste from the hand towels used in the cloakrooms and the dining rooms.

During the rainy season, the amount of yard waste generated is double that which is yielded during the normal season. This is attributed to the fact that in the rainy season, the grass grows faster, and the maintenance activities for the greens and fairways are done every fortnight, as compared to every three weeks in the normal season. More than 80% of the

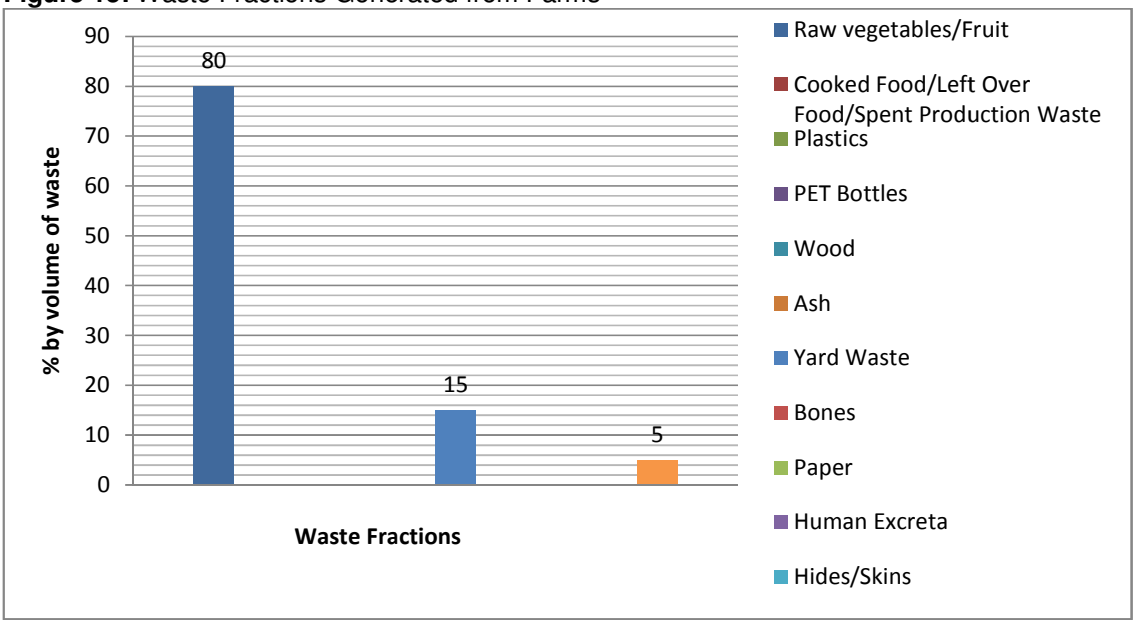
waste generated from the golf course comes from the fairways, which require regular maintenance as opposed to the greens.

Picture 2: Compost heaps in a golf course (R: leaves and grass only; L: leaves and twigs only)

2.2.7.10 Farms

In Nairobi, farming is done along roadsides, along and between railway lines, in parks, along rivers, in and within the city, as well as in the outskirts such as Dagoretti, Karen, Ruai etc. Once outlawed by policy makers, urban farming has taken Nairobi by storm. The practice is spreading to small backyards in residential estates. It is estimated that there are about 363 farms in and around Nairobi province (KNBS, 2008).These farms extend toward Kiambu, Thika, Mavoko, Kajiado etc. A study conducted on the impact of urban and peri urban horticulture in Nairobi found that urban agriculture generates huge amounts of waste, 60-70 percent of which is organic. These can be recycled and composted for reuse in urban farms. (Runkua et al, 2009).

Figure 15: Waste Fractions Generated from Farms



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The waste audit, conducted in farms that practiced both animal and crop husbandry in the Dagoretti-Karen area, found that all the waste generated is organic, comprising mainly of manure from the animal fecal wastes, crop residues and yard waste. This would vary of course, in flower farms, which would have paper waste from the packaging materials; however, the variation is not expected to be more than 20% from one farm to another.

In all the audited farms, composting was part of the farm operations, to act as a supplement for the inorganic fertilizers. However, in one farm affiliated to the Kalimoni Organic Green Grocery, compost manure was the only soil additive used, mainly because it is a certified organic farm, thus the use of synthetic fertilizers is prohibited. According to the Kenya Organics Agricultural Network (KOAN) and Kenya Institute of Organic Farming (KIOF) this is a growing trend, and it is expected to increase the demand for improved qualities of compost, to support the growth of different crop varieties.

Despite compost heaps being a common feature in these farms, biogas production was not. This was attributed to the fact that there were no households on the farms to consume the biogas.

2.2.7.11 Markets

As the key trading points for raw food stuff, these centres are controlled by the municipal councils in Kenya. In Nairobi there are about 19 markets, each providing an area for the trade of goods – raw fruits and vegetables, meat, clothing, and in some the sale of electronic goods. The largest vegetable market in East Africa is the Wakulima Market, which covers 5 acres of land area within the Central Business District (CBD). This market hosts an estimated 4,000 traders, 98% of whom, trade in fruits and vegetables. The other markets in Nairobi include: City Market, The Asian Foundation Market, Burma Market, Kangemi Market, Kenyatta Market, Gikomba Market and Retail Market. These markets are situated in the CBD, as well as near residential areas.

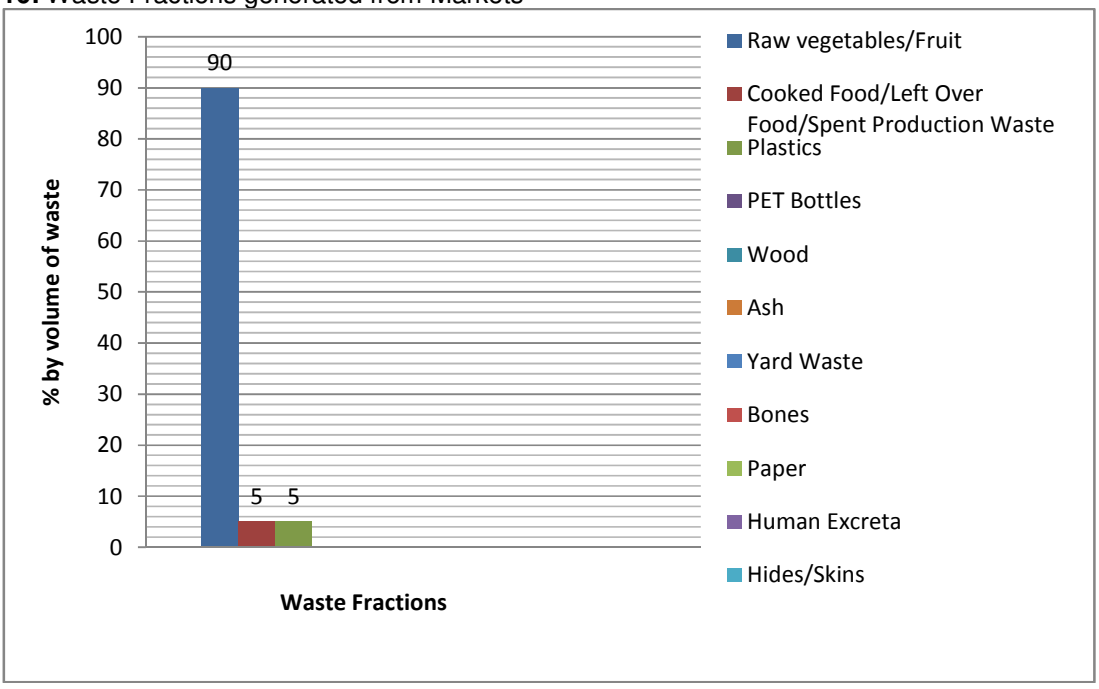
The solid waste generated from markets was the highest compared to the other non-domestic waste generators. An analysis of four markets showed that each market, on average, generates at least 19 tonnes per day, comparative to the 15.1 tonnes per day[24] that had been projected for the year 2008, by Karani & Mutunga (2005). Market waste comprises about 95% organic waste, with theremaning 5% comprising mainly plastics which are use for packaging within the market.The organic waste fraction is composed of mainly raw fruits and vegetables, meat wastes, fish entrails, with some saw dust in some markets, as well as left over foods from the small restaurants in the market vicinity.The waste is often dumped in one collection area, by each trader, after which, it is collected for final disposal at the Dandora dumpsite by the City Council of Nairobi.

[24] The 15.1 tonnes per day was for all 19 markets, however, 19 tonnes per day is for the 4 markets only.

Picture 3: Open Dumping at the City Park Market in Nairobi

Market waste, though largely uncontaminted, is often not scavenged by waste pickers at the market premises, except for the Asian Market, where, the organic waste is collected for either pig feed or for composting.Nonetheless, the quantities of organic waste which are carried away by the waste pickers are often insignificant compared to the amount of waste that ends up being carried away for final disposal.

Figure 16: Waste Fractions generated from Markets



The City Council of Nairobi, though trying to regularly collect and transport wastes from the markets, has in some instances, due to the breakdown of vehicles or delays in waste collection, allowed for the accumulation of huges volumes of wate within the markets.Gikomba Market, was one market found to have accumulated vast amounts of organic waste, in an open dump within the market. The dumpsite, is now overflowing with organic waste, which is getting into the Nairobi River as Shown in **Picture 4**.

Within the Asian Market, there are some composting activities taking place.This is undertaken by a small womens group, who have been composting organic waste from the market since the inception of the market in 1997.The group does not pay any charges to use the composting site within the market and the City Council employees within the market readily support their effort by not imposing any charges.The largest constraint for this group has been the marketing of their compost, consequently, they have accumulted more than 800 kilograms of compost in their store over a period of 12 months. Aside from this, the lack of improved technology, has prevented them from yielding a competitive form of compost, which is pelletized, instead, they produce the powder form, whose market demand is low.

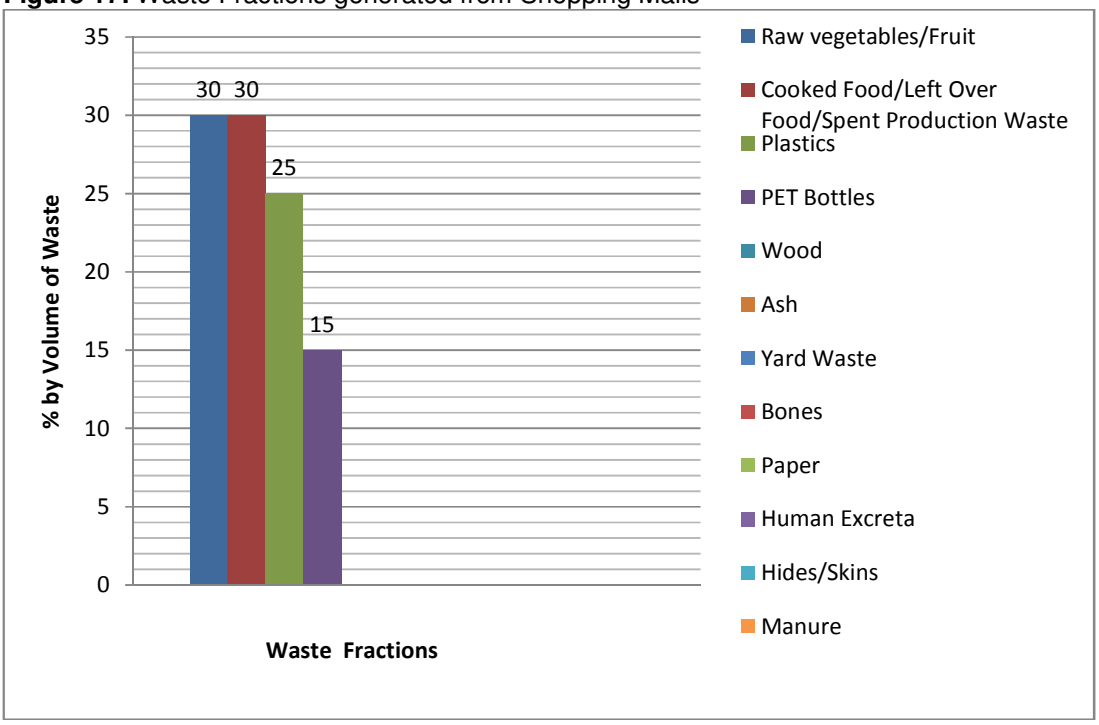
In City Market, some of the flower traders give away their wastes to the flower farmers.Though, not all the flower wastes are carried away by these farmers, they take away at least 40-50% of the flower waste for use in their flower farms.However, the diversionof organic wastes to other uses in most of the markets is limited, and as such, more than 80% of the generated wastes is currently, either deocomposing in dumpsites inthe market, or carried away for disposal at Dandora. Currently, each trader in the market pays at least 50Kshs. per day for waste collection, to the City Council of Nairobi, however, the traders are not satisfied with the delivery of this service. In City Market, each trader is responsible for the disposal of the waste generated from their stall into the waste collection trucks. This practice, has seen the market, become cleaner, as there is no accumulation of wastes in the market any more.Though, this concept, cannot be easily adopted in Wakulima market due to the large number of traders (4,000), compared to the 250 traders in City Market, it has yielded positive results in improving waste management.

Picture 4: Open Dumping in Gikomba Market, Nairobi

2.2.7.12 Shopping Malls

Nairobi being the hub of commercial activities is home to the largest shopping malls in Kenya and East Africa. These malls house department stores such as Nakumatt Supermarkets, Uchumi Supermarkets as well as other clothing retail stores, food courts among other stores. There are a total of 17 shopping malls in Nairobi, most of which are situated in residential areas such as Westlands, Kilimani, Ngong Road, Eastleigh, South B, Karen, Muthaiga, Gigiri etc. The study was able to audit the waste from 2 of the largest malls in the city, which serve the upper middle class of Nairobi.

Figure 17: Waste Fractions generated from Shopping Malls



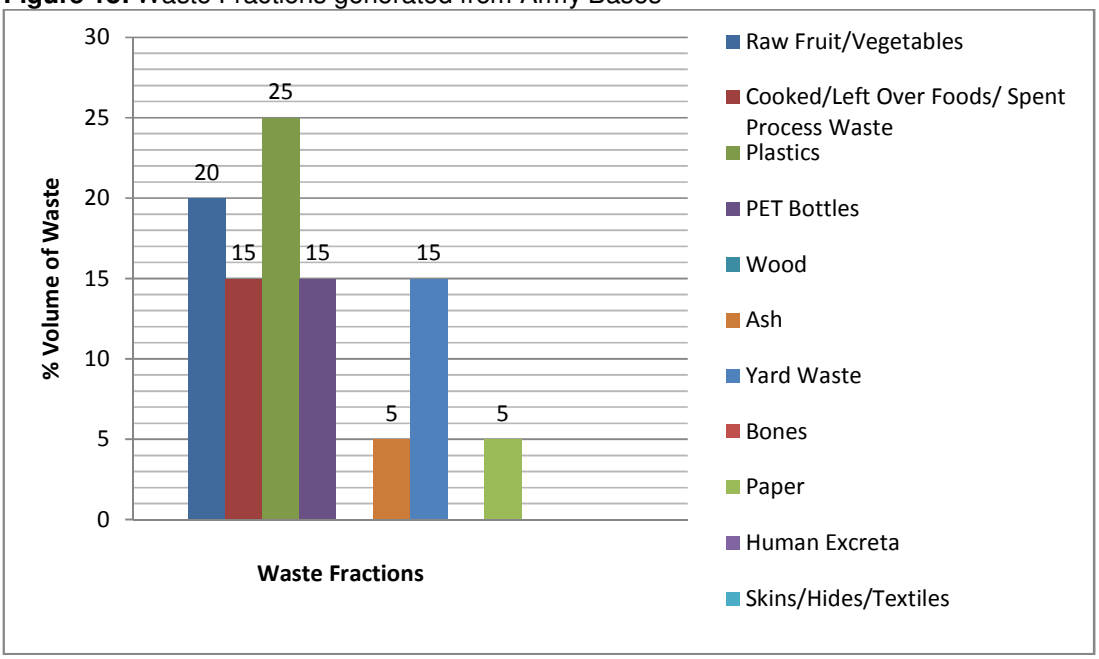
The influx of people into these shopping malls, allows for these establishments to be point sources of waste. It was estimated that 60% of the waste generated from shopping malls is organic; mainly food waste from the food courts, and the supermarkets. The organic wastes unlike in other institutions or establishments, which were audited, are not recycled, reused or scavenged by waste pickers. All the organic waste generated is disposed off, by private waste contractors to Dandora dumpsite. Plastic waste generated from these establishments, is often carried away by some of the employees, who resell them.

The organic waste from shopping malls was found to be fairly contaminated, due to the lack of segregation practices from the various sources such as restaurants. Leftover food wastes are readily mixed with the raw food wastes. However, with an average generation rate of 1.1 tonne per day of organic waste, these establishments could be good point sources of divertible organic waste, from Dandora to composting, if proper waste management practices were inculcated by the various traders.

2.2.7.13 Army Bases

Army bases are a blend of both domestic and non-domestic waste sources. The domestic waste within institutions emanates from the staff residences located within the bases/camps, whereas the no-domestic waste is from the offices, staff canteens, kitchens, yards etc.

Figure 18: Waste Fractions generated from Army Bases



Army bases were the only public institutions found to keep records of their waste quantity estimates this was attributed to the fact that they have a private waste contractor, whose payment terms are based on the tonnage collected per month. On average it was found that, army bases generate about 2 tons per day of solid waste, with the organic waste fraction estimated at about 1.2 tons per day. The waste generated from all the army bases, is disposed off at Dandora dumpsite, however, there is some open burning of papers, yard wastes that is taking place within these institutions. In the air base, waste is burned to avoid the hovering of birds such as the Marabou Stocks, around the waste disposal areas, which pose flying hazard. The incinerators which are onsite within the air base for the burning of wastes, are not operational anymore, hence the use of open burning. However, there are some sheds which have been erected at different points of the air base, to mitigate against the hovering birds on the open dumps, but, they are not sufficient to cater for all the waste generated in the base. About 60% of the waste generated within the army bases is organic, comprising mostly of raw food wastes from the staff kitchens, and the residences in the bases. However, plastics constitute the largest inorganic waste fraction within these institutions. They emanate mainly from the residences within the institutions, as well as from the packaging materials from the staff canteens, which cater also cater to outsiders who would like to purchase tax free goods.

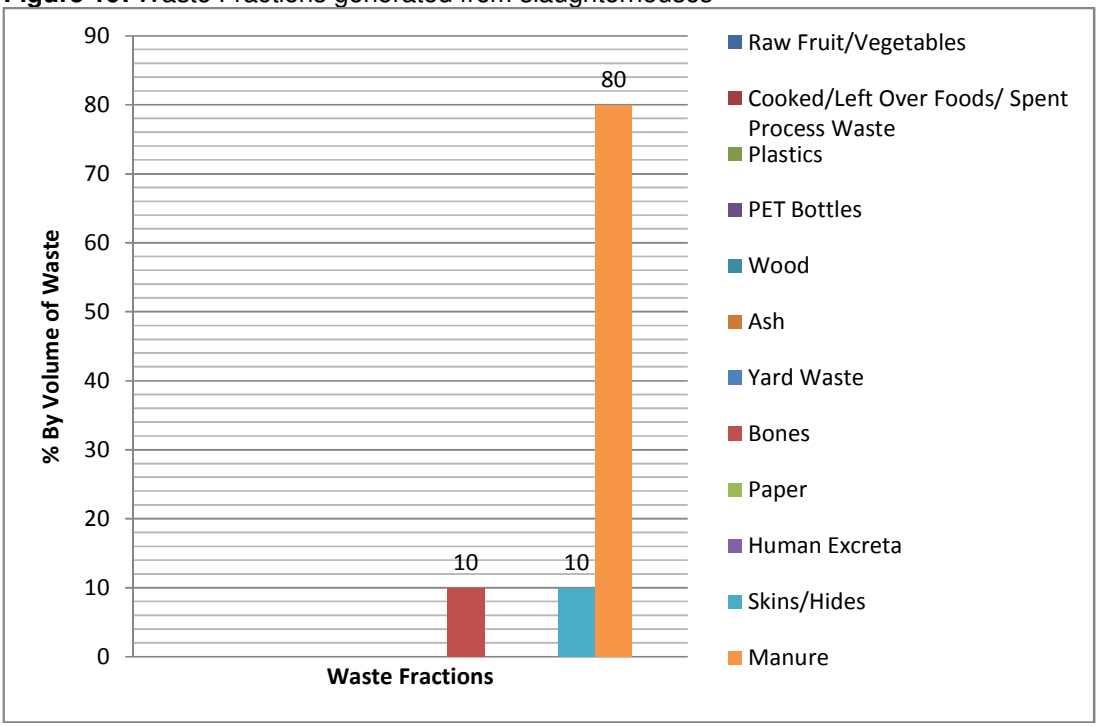
2.2.7.14 Slaughterhouses

Nairobi is served by ten (10) slaughterhouses, however, three (3) of the city's major abattoirs are situated in Dagoretti area. Prior to NEMA's intervention in August 2008, the dagoretti slaughterhouses were for a long time discharging their wastes into River Kabuthi without treating the water. It is estimated that they would discharge 40,000 litres of effluent in a month and all these used to be discharged into the river. The abattoirs were all closed down and forced to comply with NEMA rules on waste disposal and environment protection. The abattoirs have now tried to comply with NEMA by having their solid waste disposed off by approved persons, in approved disposal sites[25]. The proprietors of the abattoirs at Dagoretti have come together to establish an environmental management association - DEMA

[25] We were unable to identify the criteria for approved sites from the managers at the abattoirs.

(Dagoretti Environmental Management Association). Further, they have sunk lagoons where the liquid wastes can be contained treated then disposed off appropriately by approved companies. Despite the new costs in maintenance of the environment, the managers remained enthusiastic at the fact that they have made a turn around and that the community around also appreciate this.

Figure 19: Waste Fractions generated from slaughterhouses



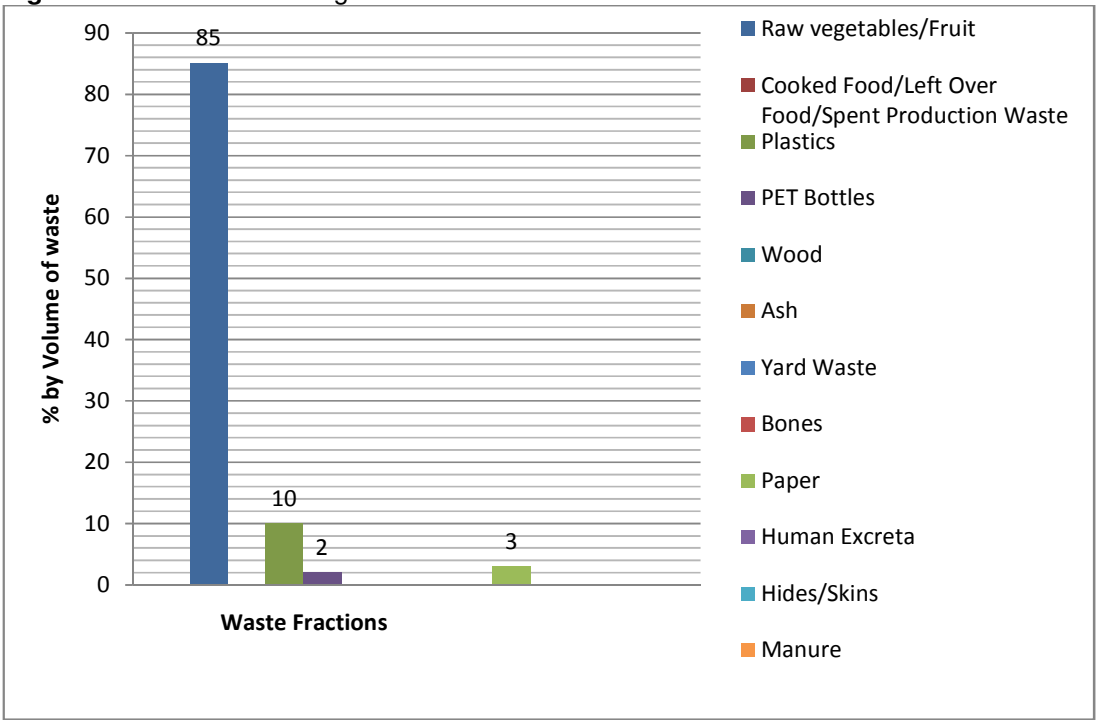
The potential for the generation of biogas using animal manure and slurry from the slaughterhouses is apparent, with a generation rate of about 16 tonnes per day of animal manure. Currently, KIRDI is partnering with one of the largest abattoirs in Dagoretti to set up a biogas unit, which is hypothesized to allow for the distribution of biogas to nearby shops. However, it was found that one of the two slaughterhouses, whose waste was audited, are already generating biogas, from the waste generated from the production line, which is rich in dissolved organic matter, this facility is currently using the biogas in the staff kitchen, with plans to increase the biogas capacity in order to use it in the production lines.

2.2.7.15 Grocery Stores

It is estimated that there are about 207 green groceries in Nairobi; these include the MSEs as well as the large established ones, situated in shopping malls. One key chain of green groceries in Nairobi is ***Zucchini*** green groceries, located within two of Nairobi's largest shopping malls, handling more than 2 tonnes of produce per day, in each location. Other groceries such as those within supermarkets also handle significant quantities of produce; however, due to the variations in waste fractions, the two types of establishments were categorized differently. The study was able to audit waste generated from the Zucchini green groceries, and found that about 2 tonnes of waste are generated per day from these stores.85% of this waste is purely organic, comprising mostly of raw fruits and vegetable waste. This organic waste is usually the left-overs of the fruit and/or vegetable juices, or rotting fruits and vegetables.

Zucchini green groceries, currently, give away all their wastes, to a pig farmer in Kabete. Thus, none of their wastes are disposed off at Dandora dumpsite, and this has been going on for more than 10 years. The pig farmer takes away both the organic and inorganic wastes, daily.

Figure 20: Waste Fractions generated from Groceries



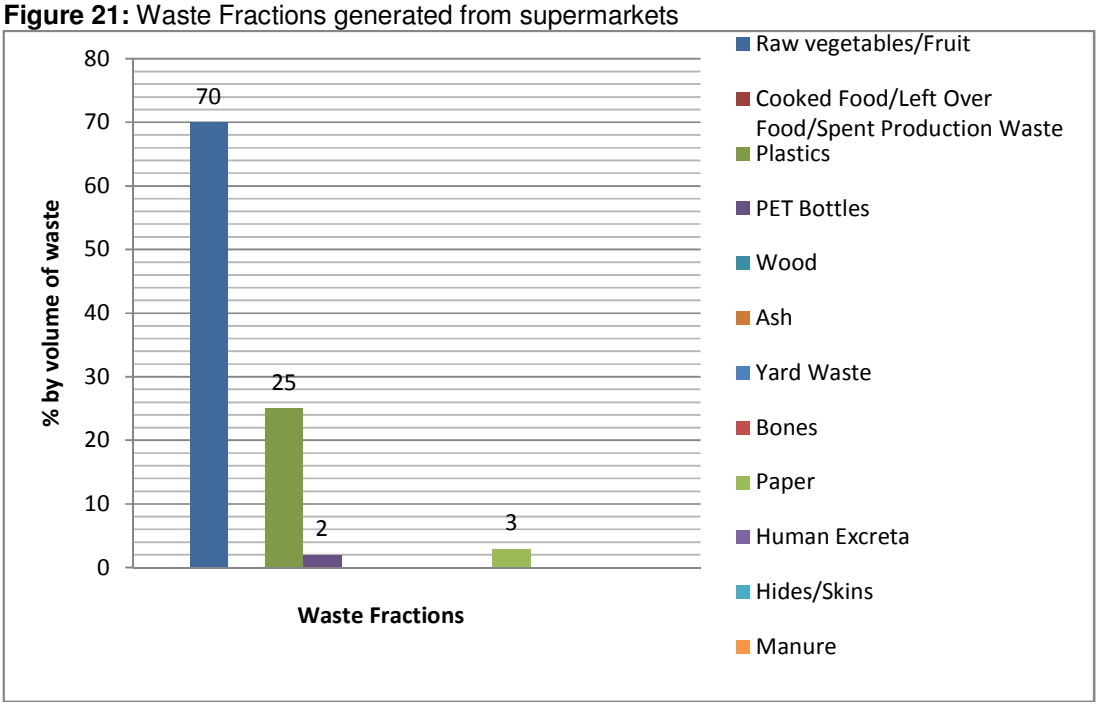
The plastics generated within these establishments are from the packaging materials. From an overview of the Micro and Small-scale Enterprise (MSE) green groceries, within the residential areas, it was found that, there is very little waste generated, less than 20kg per day, as the size of the operations is small compared o those of the larger groceries.

2.2.7.16 Supermarkets

Nakumatt Holdings, Uchumi Limited and Tuskys Supermarkets are currently, the largest retail stores in Nairobi. Situated in the central business district, as well as along major highways, they serve more than 500-1000 people per day. These stores provide household goods – foodstuff, textiles, electronics etc. Aside from these large stores, there are other medium to small sized supermarkets, in Nairobi. In, 2008, the Kenya National Bureau of Statistics, (KNBS) estimated that there were 69 supermarkets in Nairobi. An over view of the four sampled supermarkets, revealed that, the daily generation rate of solid waste from these stores is about 2.5 tonnes.73% of this waste, is organic.

Most of the plastic wastes are the 30 micron, non-perforated bags, which are used to pack goods for customers. Supermarkets, also generate significant volumes of cardboard box waste, however, these wastes, are reused to store goods in the warehouses of these supermarkets, or sold to recyclers and other users.

Figure 21: Waste Fractions generated from supermarkets



2.2.7.17 Sanitation Facilities

The concept behind ecological sanitation (Ecosan) is that sanitation problems could be solved more sustainably and efficiently if the resources contained in human excreta and wastewater were recovered and used rather than discharged into the water bodies and the surrounding environment.

The end-of-pipe sanitary systems that are used today in Kenya are based on the modern misconception that human excreta are simply wastes with no useful purpose and must be disposed of. In addition, the study was able to get an overview of the current wastewater disposal system in Nairobi, which offers numerous opportunities for the recovery of energy. Ecotact[26] is the pioneer of the Ecosan toilets in Nairobi for public use. This company, through a contractual agreement with the City Council of Nairobi, has set up 50 Ecosan toilets in Kenya, 10 of which are in Nairobi. These toilets, are designed such that they operate using a dry system, whereby, the flush toilet is not used. The liquid waste; urine, is harvested in about four 200 litre tanks, whereas the solid waste is collected separately.

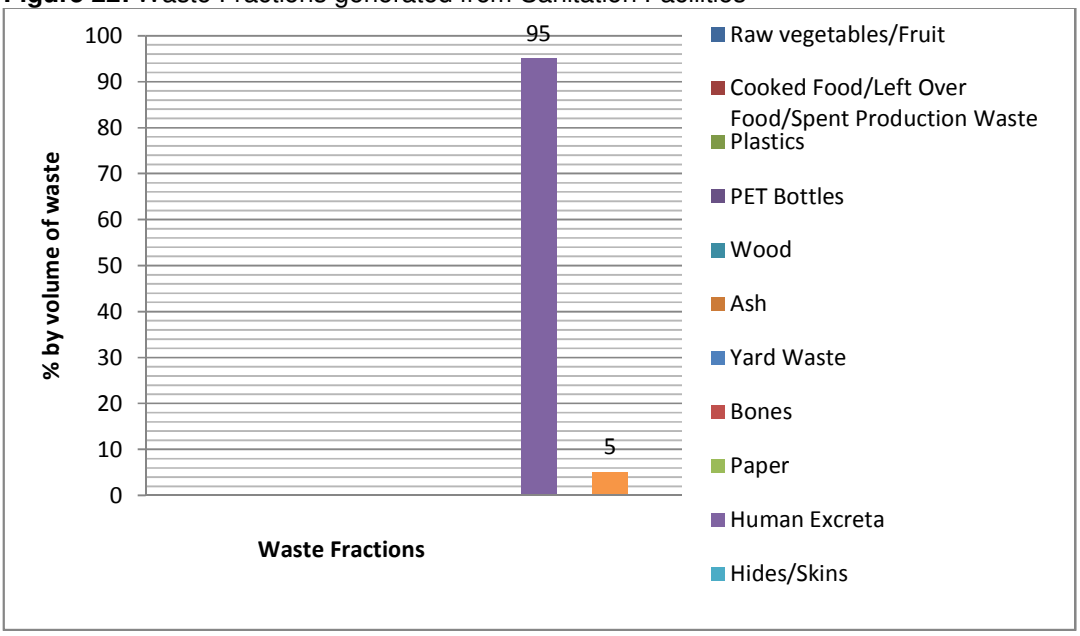
Currently, the toilets are harvesting the solid waste in biodigesters; however, this is only taking place in one of the 50 toilets, due to the limitation of access to space in an area with adequate sunlight. The basic principle of Ecosan is to close the loop between sanitation and agriculture without compromising the health of a human being. Human excreta contains almost all nutrients[27] that are needed for growing of crops, however, it is highly pathogenic. Ecotact in partnership with JKUAT (Jomo Kenyatta University of Agriculture and Technology) and KARI (Kenya Agricultural Research Institute) are testing the levels of pathogens as well as the applicability of the manure yielded from the decomposition of the human excreta.

[26] A social enterprise incorporated in Kenya in 2006, with the sole objective of developing innovative social investments in environmental sanitation and management in Africa and beyond.

[27] Urine (very few pathogens): 88% of the nitrogen, 67% of the phosphorus and 71% of the potassium carried in domestic wastewater faeces contain 12% of the nitrogen, 33% of the phosphorus, 29% of the potassium and also 46% of the organic carbon.

Picture 5: A Biodigester being built for use in an Ecosan toilet in Nairobi.
The Biodigester will then be used to collect fecal matter from the toilet, which can then be used to (i) generate biogas for use in the small kiosks, located near the toilet (ii) generate compost for use in farms. These biodigesters are in place in two (2) of the 50 toilets. However, there are plans to increase the number.

Figure 22: Waste Fractions generated from Sanitation Facilities



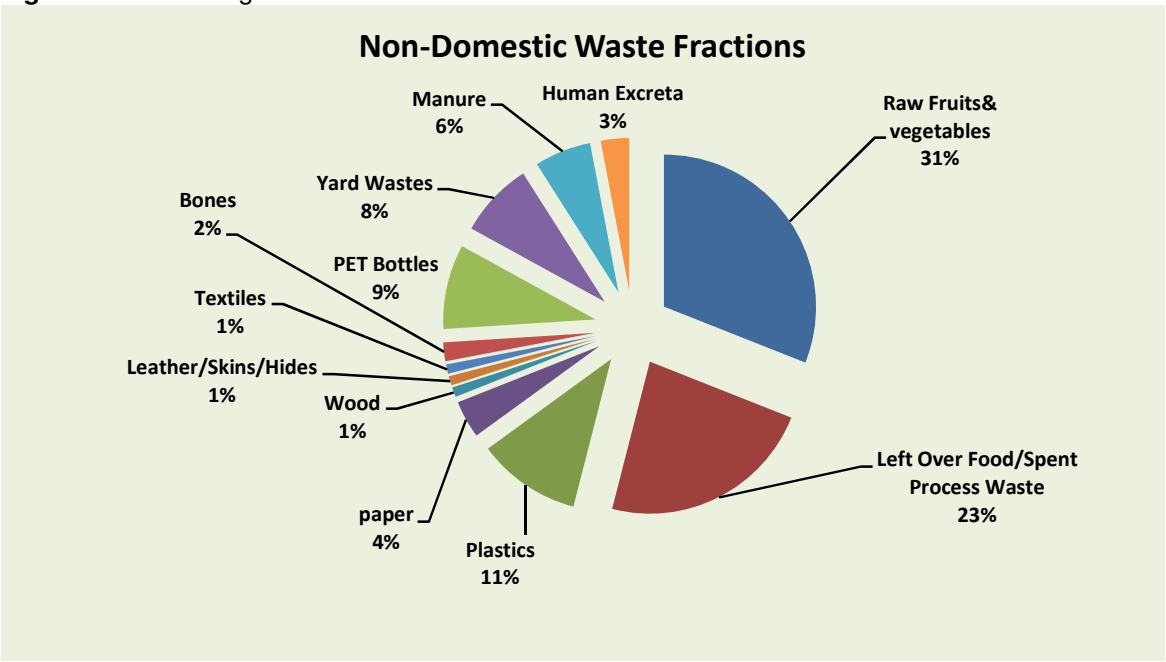
Currently, cement companies; have expressed interest in utilizing the harvested urine from the Ecosan toilets to enrich their cement. Based on an overall view of material flows, it was observed that 95 % of the waste generated from these Ecosan units is human excreta, with only about 5% being manure from the decomposition of fecal waste.

2.2.8 Composition of Non-Domestic Waste

Most institutions assessed in the study generate non-hazardous waste, with the exception of hospitals, dispensaries, clinics located within the educational institutions and prisons. The constituent fractions of waste which were assessed were similar across the board, from one institution/establishment to the next. There were slight variations, however, as in the case of the slaughterhouses, which do no handle raw food/fruits, but instead live animals. The composition of waste within these facilities, as well as in the Ecosan toilets, varied significantly from the rest of the institutions/establishments.

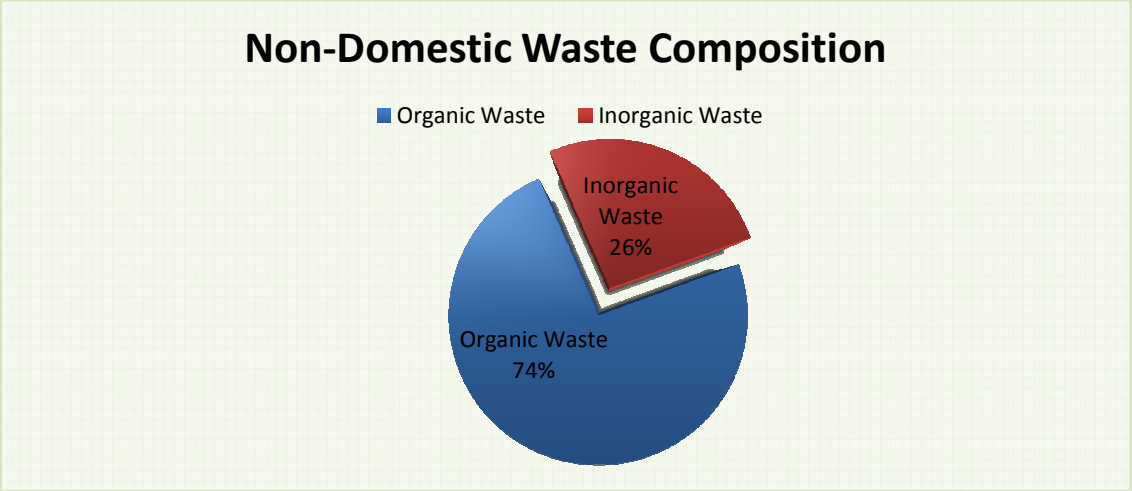
Generally, however, the waste was either organic or inorganic, and was categorized as shown in **Figure 23**. Institutional waste, from the categories which were audited, consists of mostly raw fruit and vegetable waste, with textiles, wood shavings/wood and skins/hides constituting the least. Though, organic waste forms a significant amount of the total waste generated from these institutions, it was found that plastics, PET bottles found to account for at least 20% of the institutional waste. This has increased over the years, and is expected to increase in the coming years, due to plastics being the preferred packaging material for many goods. Moreover, the increased consumer demand for drinking water and soft drinks in PET bottles is another underlying factor for the increase.

Figure 23: Percentage Volume of Non-domestic waste Fractions



On the whole, organic waste was found to account for a total of 74% by volume and weight, of the total waste generated from the non-domestic sources, with inorganic waste accounting for 26%, shown in **Figure 24.** In most of the government institutions, it was found that the organic waste was greatly generated from the residences in the vicinity of the institutions. These residences house the staff and their families. This was visible in the public hospital, army bases and prisons. Unlike in private institutions, the organic waste was contributed mostly by the production processes.

Figure 24: Non-Domestic Waste Composition



The waste composition represented here, excludes (i) all non-hazardous wastes, and (ii) non-domestic sources which do not yield any organic wastes

While **Figure 24** is only representative of institutions which handle organic material as part of their production line inputs, it shows that the commercial sector is indeed generating significant organic waste which in more than 50% of the institutions, is finding its way to the Dandora dumpsite.

2.2.9 Institutional Waste Management Practices

The collection, transportation, processing, recycling or disposal, and monitoring of waste materials within institutions has mainly been a preserve of the generator. While previously, the local authorities (LAs) used to be responsible for this, today, institutions have taken it upon themselves to manage their own waste. 94% of the institutions assessed in the study, do not rely on the City Council of Nairobi to handle and transport their waste. Instead, they prefer to use private waste collectors, who they feel are more reliable in delivering of waste collection services.

Waste handling in institutions involves the collection and/or transportation of wastes from the institutions disposal containers to the final disposal site such as Dandora, or in other instances, the waste is burnt within the institution. Whereas private institutions have a preference for private waste collectors, public institutions appear to use the City Council of Nairobi to collect and dispose off their wastes.

It was found that with respect to institutional waste management practices, there are some distinctions between the private and public sector. These distinctions are as follows:

- **Financial capacity** - to adequately manage waste collection, treat and dispose of their waste - the private institutions have allocated more finances to this than the public sector
- **Technical Capacity** - with respect to source segregation, composting and biogas generation, it has been observed that the private institutions are more aware of the benefits and procedural application of best practices in waste management

2.2.10 Waste Collection & Disposal Systems

All institutions assessed in the study possess some sort of system for waste collection. Generally, it follows that the waste is collected from various, bins, or collection points within

the institution/commercial establishment, put into a skip (provided by the private waste collection companies[28] in 90% of the institutions), or an collection area within the institution, in plastic liner bags, awaiting final collection by the waste contractor, for final disposal. Skip volumes within the institutions/commercial establishments range from 100 - 500kg.However, 86% of the institutions/establishments, whose waste was audited, use the plastic liner bags instead of skips. It was also found that there are no existing transfer stations set up in or within areas for the separation of wastes before final collection and disposal to the dumpsites. Hence, for the institutions where the waste was being separated at source, this was done either in the kitchens/production areas or at the waste collection areas, prior to collection by the waste contractors.

The costs incurred for waste collection vary from one institution to the other. This is mainly due to:

- The waste contractor,
- Volume of waste collected,
- Frequency of waste collection.

Dumping at Dandora dumpsite, is seen as the cheaper, less demanding option by institutions and commercial establishments. Not only, do they get rid of their wastes quickly, but, they also do not need to worry about what happens to the waste once disposed. While the reuse and recycling of institutional organic waste may appear to have the highest economical benefits especially through labour-absorption and reduction in production costs, most institutions continue to opt for the dumping or burning of organic wastes. The activities at source prior to final disposal of waste include inter alia: sorting, separation and treatment of any waste water to acceptable BOD levels.

2.2.10.1 Open Dumping

4% of the institutions that were audited were found to be dumping there wastes. This was especially a common practice in most public institutions which used this disposal method to avoid the cost of disposal, which would be incurred if a waste contractor was to be hired.

[28] BINS Limited, Zoa Taka Ltd, were found to provide companies with a skip, however, other private collectors provided only plastic liner bags.

Picture 6: Open Dumping

2.2.10.2 Incineration

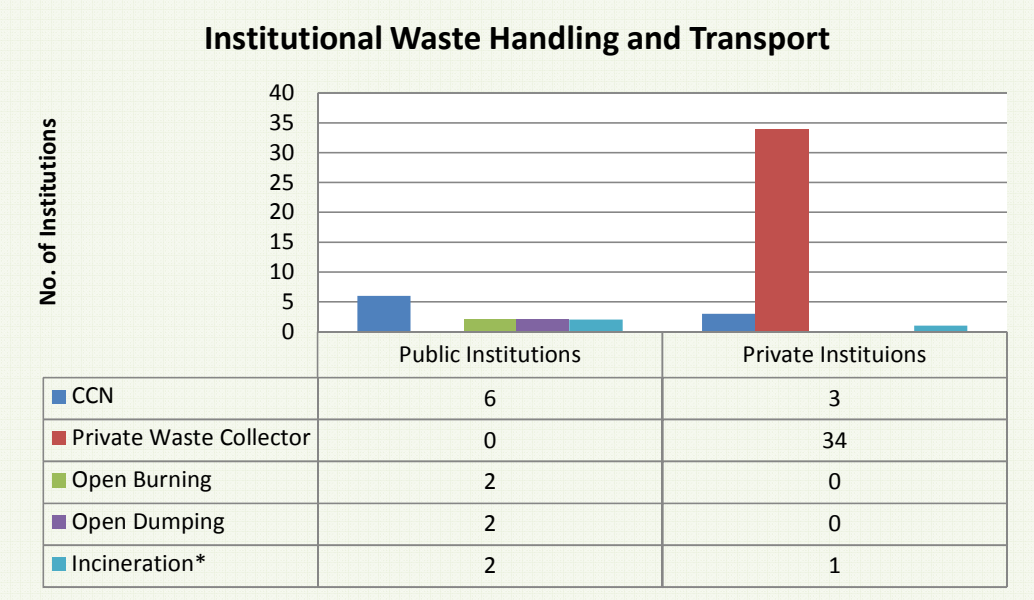
Incinerators are commonly used hospitals for the destruction of hazardous wastes. They are either found within the hospital or in a licensed site, where a private waste contractor is permitted to incinerate wastes, before final disposal of the ash. However, it was also found that some institutions, such as the air base, have existing but non-operational incinerators.

Picture 7: Waste Incinerator

2.2.10.3 Disposal at Dumpsites

All licensed waste collectors, are currently permitted to dispose off solid, non-hazardous wastes at the Dandora dumpsite. However, there are some private waste contractors who are thought to dispose off their wastes in other dumpsites, due to the difficulties faced by truck drivers when tipping wastes at the Dandora dumpsite. These difficulties include; the demand for bribes by some outlawed groups which operate within the dumpsite, incidences of violence and destruction of trucks upon refusal to part with bribes.

Figure 25: Institutional waste handling and transportation



	Public Institutions	Private Instituions
CCN	6	3
Private Waste Collector	0	34
Open Burning	2	0
Open Dumping	2	0
Incineration*	2	1

*Incineration in this context is not for medical waste only, but also for other solid, non-hazardous wastes

More than 50% of the private institutions, commercial establishments and organizations prefer to use private waste collection companies, as opposed to the city council's services. The reasons for this are that they are deemed to be more reliable with respect to service delivery. It was found that in two (2) publicly owned institutions, waste collection had been halted by the City Council of Nairobi, due to unpaid waste collection bills as well as the breakdown of equipment that was required to remove the huge volumes of accumulated wastes. The provision of waste collection and transportation services for Nairobi was decentralized in 2007, following the implementation of the waste management regulations by NEMA, as well as the solid Waste by-laws by the City Council of Nairobi. The decentralization of these services has allowed other players such as the private waste collection companies and recyclers to gain legitimacy in their operations, by being able to acquire licenses for their operations see **Annex 1, 2, & 3**.

2.3 DESTINATION OF NON-DOMESTIC ORGANIC WASTE

In the general provisions provided under the Waste Management Regulations, 2006, NEMA, it states that:
No person shall dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle" Further, it also states *"Any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed off such waste in the manner provided for under these Regulations. Without prejudice to the foregoing, any person whose activities generates waste has an obligation to ensure that such waste is transferred to a person who is licensed to transport and dispose off such waste in a designated waste disposal facility"*[29].

In keeping with this, institutions are therefore mandated to separate their wastes into either hazardous or non-hazardous waste and ensure that the disposal of these wastes is undertaken by a licensed contractor. In addition, the approved designated waste disposal facilities in Nairobi are:

[29] "Disposal site" means any area of land on which waste disposal facilities are physically located or final discharge point without the intention of retrieval but does not mean a re-use or re-cycling plant or site.

- Dandora Dumpsite,
- Approved Incineration sites, and;
- Approved Farms for the disposal of animal manure

However, the regulations also allow for the diversion (source reduction[30], reuse and recycling of wastes). In addition the Solid Waste Management By-Laws, 2007, CCN, provide for the small scale resource recovery activities to be undertaken by organized groups at designated sites before disposal of wastes.

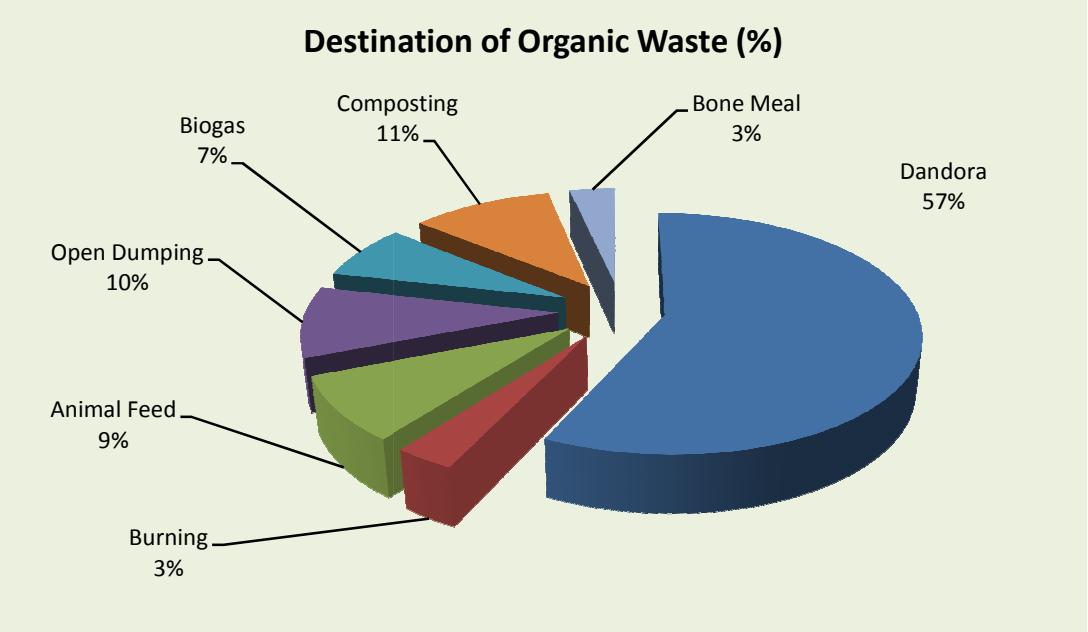
The study revealed that about 77.2 tonnes per day are going into the Dandora dumpsite. This was the situation in 33 of the sampled institutions/commercial establishments. Though, prohibited by the City Council of Nairobi, burning of waste is still taking place in institutions. It was estimated that about 4.4 tonnes of organic waste are being burnt per day, within the institutions in the sample frame. The reasons for this are that, these institutions are not able to pay for waste collection services and thus the waste collection contracts have been terminated. In some institutions, we found that they burnt some waste fractions such as the plastics, yard waste and allowed for the decomposition of the organic waste. However, in others, all the waste was burnt.

Composting, though only practiced in 6 of the 50 institutions sampled – mainly the secondary level education centres, some prisons, golf courses, hotels and farms, was able to account for the diversion of about 14.4 tonnes per day. Though, the main component of these compost heaps is yard waste and with only one using the kitchen waste, composting has shown to divert at least 11% of the organic waste generated from the sampled institutions. Golf courses were found to compost the largest amounts of organic waste, with all the institutions readily using up the compost generated within their own operations.

[30] Source Reduction is advocated for through the Cleaner Production Principles (WMR, 2006), which aim to conserve raw materials and energy by:

- eliminating the use of toxic raw materials within such time as may be prescribed by the Authority
- reducing toxic emissions and wastes
- Identifying and eliminating potential negative impacts of the product.
- enabling the recovery and re-use of the product where possible.
- reclamation and recycling.
- incorporating environmental concerns in the design, process and disposal of a product.

Figure 26: Destination of Organic Waste



The diversion of organic wastes into agricultural activities such as animal feed, composting for use on farms, account for about 20%, of the destination of organic wastes. It was noted, however, that the waste that is diverted for these application, is often separated at the source, with little or no contamination. This segregation is purposefully, as per request from the waste collectors, who in some instances will provide the plastic bags for the material they need.

The potential for diversion of institutional organic wastes, is obvious, based on this study, which showed, that 33 of the 50 institutions sampled, disposed off their organic wastes at Dandora dumpsite, in addition, practices such as the burning of organic wastes such as grass clippings, twigs etc, as well as the open dumping of wastes within institutional compounds undertaken by a cumulative 10 out of institutions, underscore this conclusion.
Current, waste recovery efforts through the methanogenic fermentation of wastes, gasification through pyrolysis or composting are not sufficient, at the institutional level. Despite, the need to subsidize the costs of energy and or fertilizer as is the case in golf courses, the valorization of organic waste is still very limited. With an estimated diversion of about 24.4 tonnes per day of organic waste, 10 of which are purely animal manure, shows, that most institutions, in both the private and public sector, have not adequately ventured into the exploitation of the benefits of organic wastes.

Table 9: Destination of Organic Waste by volume (tonnes per day)

	Dandora Dumpsite	Burning[31]	Composting	Biogas	Animal Feed	Bone Meal	Open Dumping
Total Quantities of Organic Waste (tonnes per day)	77.2	4.4	14.4	10	11.7	4.6	12.9
No. of Institutions	33	5	6	1	3	4	5

The peri-urban & urban agricultural domain in Nairobi appears to favour the use of compost in farming. However, as in the case of the farms visited by the team, the source of the organic waste to generate the compost comes from cattle, goats and pig faecal waste, which is generated within the farm and not organic waste generated from kitchens.

2.3.1 Waste Minimization

Institutions in Nairobi, today, continue to contribute to the huge volumes of inorganic waste. These include plastics, paper, glass, metal etc. Whereas, methods for managing inorganic wastes from institutions have been developed, which in most instances involve the recycling of these products, organic waste recovery continues to be a non-issue. However, within institutions such as hotels, restaurants, golf courses, green groceries concepts for the management of organic waste continue to emerge, perhaps due to the huge volumes generated of this waste stream within these institutions.

2.3.2 Segregation at Source

It is essential to save the recyclable waste material from going to the waste processing and disposal sites. Recyclable wastes within institutions have for long, been limited to inorganics such as plastics. However, organic waste offers potential for recovery as well, and thus, segregation at source, for this waste flow, would be very useful. This would save institutions some of the money, they are using on waste disposal.

Picture 8: Waste Segregation

[31] The burning indicated here does not include the incineration of wastes. However, none of the institutions sampled incinerated their organic waste.

2.3.3 Waste Recovery

Recovery can be defined as any waste management operation that diverts a waste material from the waste stream and which results in a certain product with a potential economic or ecological benefit. Recovery mainly refers to the following operations:

- material recovery, i.e. recycling (direct recycling or reuse within industrial plants at the place of generation is excluded)
- energy recovery, i.e. re-use a fuel;
- biological recovery, e.g. composting;
- Re-use.
-

Institutions in Nairobi, are not adequately exploiting the potential of waste recovery. This has contributed to the increased volumes of organic waste being disposed off at Dandora dumpsite.

SECTION 3: INVENTORY AND ANALYSIS OF USERS OF ORGANIC WASTE

3.1 GENERAL

Organic waste recovery appears to be limited within Nairobi, especially for municipal and commercial organic waste to a few institutions such as schools, farms, golf courses, slaughterhouses. The recovery of organic waste in most of these institutions is as a result of (i) the increased demand for fertilizers (ii) the increased demand of energy (iii) the promotion of certified organic farming (iv) the reduction of operational costs. Aside from these institutional users of organic waste, other identified users include: landscaping companies, small scale commercial composters, roadside nurseries.

All the re-users/recyclers of organic waste interviewed were found to use other fractions of waste excluding kitchen waste such as raw fruits, vegetables, left over food, to generate compost. The use of organic waste to generate biogas was limited to the use of manure, waste water or slurry as the feedstock. There was no use of organic waste from raw fruits, vegetables, leftover food as the feedstock for biogas generation.

Institutions are re-using organic waste because:

- It is readily available; from their kitchens, yards etc.
- Recycling it helps to keep the environment clean – some institutions have incorporated an environmental policy into their operations. Thus the production of compost is one way of maintaining a cleaner environment.
- It helps reduce their operational costs – when used to make compost; institutions are able to reduce the use of synthetic fertilizers which are costly. Also, when biogas is used to supplement the energy demand in institutions, it has resulted to savings in the energy costs.
- It is healthier – the certified organic farmers, who were interviewed, stated categorically, that, the use of compost as a soil additive left the soil more compact and healthier.

An overview of the findings indicates that there is interest in compost and biogas generation within the city by some institutions. However, the issues and concerns for most of these interested parties are shown in **Table 10.**

Table 10: Key Barriers to institutional composting

ISSUE/CONCERN	POTENTIAL COMPOSTERS
Financial	Who would bear the costs for buying bins and bags for source segregation? What are the total costs incurred in compost generation[32] weighted against the potential benefits?
Social	Keeping the garbage for longer durations on their sites Awareness raising for source segregation of waste - to yield pure organic waste streams
Technical	Methods for composting Information about segregation of waste (different types of waste)
Environmental	Odour, leakage and attracting birds, animals and flies.

[32] Most institutions stated that they would need a cost benefit analysis before considering such a venture.

3.2 WILLINGNESS TO PAY FACTOR

An analysis of the users of compost revealed that the level and rate at which users (or their proxies) are willing to pay compost generators is based on certain factors. These factors, from our analysis, influence to a great extent, the demand segment of compost production. While the supply segment intrinsically determines the demand segment, the willingness to pay factors discussed here are founded upon the opinions and perceptions of the potential& existing users of compost.

3.2.1 Supply Segment of Compost Production in Nairobi

An analysis of the organic waste supply showed that, indeed there are significant quantities of organic waste, which are going into Dandora dumpsite/Open Dumps/being burnt. A fairly uncontaminated organic waste stream from markets, hotels, farms etc is however, being reused or recycled.

In addition, the study confirms that indeed the availability of organic waste is not the limiting factor for compost production in Nairobi, despite there being existing diversions for the organic waste into either animal feed, bone meal production etc . Instead, the operating framework, which brings together all pertinent stakeholders is lacking. From an overview of the non-domestic waste sector, it appears that indeed, the much needed stimulus to allow for the segregation of wastes at source, recycling, reuse and recovery of wastes from/at the source, is lacking. This stimulus could be either in form of tax rebates for institutions or other economic instruments.

The study found that waste from markets and restaurants, was more accessible for scavenging, compared to more restricted areas, such as army bases, hospitals and large private institutions. This is mainly because the waste collection areas in markets and most restaurants are not secluded from the public eye, as compared to those in the army bases, hospitals and other restricted areas. However, it is agreed that the key factors to be considered in composts production with respect to the demand segment were:

- Access to adequate volumes of fairly uncontaminated waste,
- Availability of adequate space to generate and store the compost,
- Increased demand for compost.

3.2.2 Demand Segment of Compost Production in Nairobi

The increased demand for food in urban areas, has led to the increase of commercial urban farming. However, due to the limited available space in and within Nairobi required to promote the practice, only small sized farms exist in Nairobi. Nonetheless, there is still a significant demand for fertilizers, as well for fortified compost. Most of the users have positive perceptions and are willing to continue using compost; however, there is a need for more reliable qualities of compost. The quality of compost, referred to here is based on the available nutrients in the compost. The inconsistency in the quality of compost was noted to be the greatest concern among the users, because each user has a different need from the compost. Moreover, this was seen as the key determining factor with respect to willingness to pay.

Of the 10 companies and individuals who were interviewed, more than 50% stated that they are willing to pay Kshs. 500-1000 per 50 kilogram bag of compost, if it was fortified. However, all the users stated that they were not willing to pay for unfortified compost. Moreover, the willingness to pay for compost is higher among landscapists, roadside

nurseries, as compared to farmers, who feel that they can generate their own compost, tailored to their specific needs for less that 10kshs. Per kilogram of compost generated.

The key willingness to pay factors for compost production, based on the views of the users are:

- The nutrients that can be derived from the compost,
- The types of organic waste used for composting,
- The supply of adequate and reliable quantities of compost,
- The packaging and branding of compost.

SECTION 4: SOLID WASTE COMPOSTING, BIOGAS AND TREATMENT PROJECTS IN KENYA

4.1 GENERAL

The valorization of organic waste offers potential for numerous opportunities as well as a means to closing the nutrient cycle and reducing the emission of methane and other toxins from dumpsites. In Kenya, community based organizations, individuals and a few institutions are readily recovering organic wastes for either compost or biogas production. Human excreta and slaughterhouse residues are converted in biogas plants into gas and quality manure instead of landing as in the past in refuse heaps or being dumped untreated into nearby waterways.

Analysis of secondary data from compost samples from the city park market environmnetal group (CPMEG), conducted by a private researcher, reveals that market waste is able to yield compost with varying amounts of nitrogen, carbon, potassium and phosphorous**.** Many urban soils are also very low in carbon and recycled organic waste helps to restore carbon to the soil. Heavy metals are a common problem with recycled materials but batteries, the main source are removed before composting together with all plastics, metals and other inorganic materials, and so present no problems in the finished product.

4.2 COMPOSTING

For purposes of this document, composting is defined as a method of waste management, in which organic waste materials decompose in a controlled environment. Composting is a natural micro-biological process where bacteria break down complex organic molecules and release water vapour and carbon dioxide resulting in organic materials and mineral nutrients to be used for improving soils and aiding in the growth of plants.

The outcome of the active biological activity is a material or product called compost. Compost is a safe and/or ready for use on native soils. It smells like earth. It is not a fertilizer, because the level of nutrients it contains is rather low. The high organic content in the municipal waste stream of developing countries is ideal for composting, but there is not enough accurate, unbiased information available to municipalities, who may be familiar with composting in agriculture, but who do not see it as a way to solve their urban waste problems.

Composting in waste management is different from agricultural composting because:

- It involves a greater variety of materials selected among the waste stream.
- It is a controlled process, designed to deliver finished compost in a shorter time;
- The mineral value of the compost is lower, making it a good soil conditioner but not a rich fertilizer[33].
- The rate of action of the micro-organisms is controlled by regular turning or aeration (in some instances, the use of effective micro-organisms, to increase the rate of decomposition has been incorporated.

[33] This is with reference to unfortified compost.

4.2.1 Feedstock Choices

The second basic choice in composting is the choice of materials to compost. This can be a choice of waste streams to be composted, and also of specific waste materials. The choice of the organic materials to be composted was found to be dependent upon the overall goal of composting. Where the goal in waste management, is to reuse and/or recycle organic waste. The largest determinant in achieving this is the availability of materials in the institutional/commercial waste stream, which are not already being captured by other recovery activities. However, when there is a commercial interest in the compost product, this choice will include an assessment of the other available materials, focusing on quality, quantity and accessibility.

4.2.1.1 Domestic, institutional, industrial or commercial materials

There are opportunities to compost waste from commercial activities or industries: aquaculture, agriculture, horticulture, livestock and slaughterhouse, and food processing; forestry and forest products; sugar, wine, brewery and alcohol production; and the oil industry. The list of materials suitable for composting is almost endless because composting is a flexible process. However, observations from the study indicate that composting has not been viewed as a commercial lucrative activity, thus, current composting activities in institutions, farms, have been limited to unfortified compost production.

4.2.1.2 Faecal matter in compost

The use of faecal matter in compost is received with mixed reactions by the various quotas in Nairobi. However, the Ecosan toilets in Nairobi (branded as IKO toilets), see this as viable feedstock for compost production. These toilets harvest both urine and faecal matter for prospective use in composting or biogas production. Nonetheless, the use of faecal matter from sewer lines, latrines and wastewater treatment plant sludges, etc, introduces some complexities into the composting process and raises the requirements for strict control, despite the much higher nutrient value that would be derived from compost produced using it.

4.2.2 Compost Markets and Institutional Support

Availability and access to outlets for the finished product is fundamental in the success of any commercial composting activity. However, lack of market for the compost is a major constraint facing existing composters – especially informal composting groups .Most of the compost lies at the sites for extended periods because the market is irregular and seasonal with moderate sales occurring during the planting season. Poor marketing research, weak advertising and poor public access to the composting sites negatively affect compost marketing. In addition, many gardeners, landscapists are reluctant to use compost made from urban domestic wastes, due to fears of contamination. Nonetheless, unfortified compost was found to sell for as much as Kshs. 20 per kilogram. Opportunity exists to widen the market for these composts by better packaging and promoting a more uniform product to urban hobbyists and the organic farming movement e.g. Kenya Organic Agricultural Network (KOAN).

The study was able to audit 6 composting units in the peri-urban areas of Nairobi. Only one of the six was using market waste as the feedstock, while the others preferred to use yard wastes. However, the CBO based within city park market, is the only group which the team found to be selling the compost they generate. They currently sell a kilo (1kg) of compost for 10Kshs, which is packed in 20Kg sacks. This group, City Park Market Environmental Group (CPMEG), has been composting for the last 10 years, with initial funding coming from the Chandaria foundation. However, they are facing some barriers in trying to expand their business, as well as sustain their operations.

Despite, these constraints, the activities of composting groups have contributed to the generation of employment opportunities for the urban poor. For example, The City Park Market Environmnetal Group (CPMEG) employs two full-time workers as well as other casual labourers. Within these informal composting groups, a majority of the group members join their groups with the aim of earning a living through composting, however, only a small fraction actually depend upon composting as their main occupation. As in the case of CPMEG, the some of women in the group have other casual jobs, which they rely on for a steady income. In most other groups, such as these, members have varying sources of income including employment in the civil service, private sector or are engaged in small-scale business or urban farming. The social role of small-scale community-based composting groups is inherently intangible and complex. Nevertheless, the groups are agents of organizational and institutional development within the low-income urban communities. These composting groups represent a significant step in terms of social organization and environmental awareness (Peters, 1998; IIRR, 1998) and from a developmental perspective, this community mobilization is as important as accompanying local income generation. Kibwage, 2002, found that environmental protection succeeds when people make a living out of it and this is essential in the planning and implementation of community-based composting projects. Estimates of operational costs and revenues from the Nairobi's composting groups indicate that production of 6800 kg of compost requires about Kshs 3320, hence a production cost of about Kshs. 0.5 per kg (Kibwage, 2002). Even at a sales price of Kshs. 10 per kg, substantial profits may be made.

Bahri, 2005, approximated that there are about 10-15 Community Based Organizations (CBOs) in the composting business. This was estimated to recover about 5% organic waste and involving about 10,300 people. Nonetheless, there are other players, such as landscaping companies, hotels, golf courses which are also involved composting.

Table 11: Institutions/Community Based Organizations involved in composting

INSTITUTION/CBO/INDIVIDUAL	LOCATION	SOURCE OF FUNDING	SOURCES OF WASTE	AMOUNT OF COMPOST (tonnes Per month)	COST PER KG.
City Park Environmental Group	City Park Market	Sale of Compost	Market Waste	~0.5	20 Kshs/Kg.
Roses Galore Limited (Landscaping Company)	Muthaiga	Part of the operational costs	Yard Waste	~2	Not for Sale
Railways Golf Course	Off Haile Selassie	Part of the operational costs	Yard Waste	~10	Not for Sale
Karen Country Club	Karen	Part of the operational costs	Yard Waste	~20	Not for Sale
Panafric Hotel	Muthaiga	Part of the operational costs	Yard Waste	~0.5	Not for Sale
Kalimoni Farm	Karen	Part of the operational costs	Animal Manure & Yard Waste	~1	Not for Sale

Table 12: Analysis of compost samples taken from CPMEG (2008)

Site	Base Material	Fortification	Day	% N	% C	C/ N	% P	% K	% Ca	% Mg
Nairobi	City Market Waste	None	0	0.36	57.98	161.06	0.40	1.27	2.03	0.31
Nairobi	City Market Waste	DAP	0	0.65	53.05	81.62	0.40	1.68	1.77	0.37
Nairobi	City Market Waste	None	35	0.93	47.83	51.43	0.43	2.33	5.69	0.65
Nairobi	City Market Waste	DAP	35	1.42	49.16	34.62	0.44	2.86	3.27	0.51
Nairobi	City Market Waste	None	63	2.35	33.00	14.04	0.64	3.70	3.93	0.74
Nairobi	City Market Waste	DAP	63	2.39	36.51	15.28	0.89	3.64	6.35	0.78
Nairobi	City Market Waste	None	84	2.47	28.31	11.46	0.77	4.94	9.47	0.71
Nairobi	City Market Waste	DAP	84	2.56	24.94	9.74	1.03	4.89	9.02	0.88
Nairobi	City Market Waste	None	105	1.74	23.66	13.60	0.99	4.86	9.23	0.97
Nairobi	City Market Waste	DAP	105	2.43	25.13	10.34	0.91	4.95	9.14	0.89
Nairobi	City Market Waste	None	126	2.86	26.06	9.11	1.50	4.83	10.15	0.93
Nairobi	City Market Waste	DAP	126	3.24	20.31	6.27	1.31	5.24	11.50	0.94
Nairobi	City Market Waste	None	147	2.68	23.56	8.79	1.56	4.56	10.08	0.96
Nairobi	City Market Waste	DAP	147	3.49	20.03	5.74	1.85	5.03	11.53	0.92

The CPMEG group, was found to have enriched their compost over a 147-day trial period using DAP, which was found to change the ratios of the carbon, nitrogen, potassium and phosphorus in the compost yielded. The group however, was unable to continue with this enrichment project as they did not have sufficient funds, as well as the lack of transfer of technical capacity to continue with the project. Most of the compost users were found to be enriching their compost using effective microorganisms (E.M.), as well as DAP. However, some of the composters simply used different plants such as the stinging nettle ***Urtica dioica***, to improve the quality of their compost.

Picture 9: Members of the CPMEG Group displaying their compost product

One successful Community Based Organization in Kenya, involved in composting is the Nakuru Waste Collectors and Recyclers Management, or NAWACOM. This local self-help group established in 2006, as a commercial waste recycling operation in Nakuru is composting organic waste from households and farms. The processing unit then turns it into a standardized, packaged organic fertilizer product, for sale at about Kshs. 30 per kg. Their product which is approved by the Kenya Bureau of standards[34], is currently in high demand within Nakuru's peri-urban farms.

4.3 BIOGAS GENERATION IN KENYA

Biogas generation has continued to increase in Kenya, since the mid-fifties, it is estimated that there are more than 300 existing plants throughout the country since the inception of the Special Energy Programme (SEP) under the Ministry of Energy, in Kenya 25 years ago. These plants vary in size, but are primarily either the Indian floating-drum plants and/or Chinese fixed dome plants.

Biogas plants can readily be found in public institutions, like schools and other education centres by private organizations often with foreign sponsors such as GTZ. However, since not only did the technical quality leave much to be desired, but also the social and economic conditions were not taken into consideration during implementation of the plants, the plants themselves soon were no longer filled and/or were out of operation due to technical problems.

4.3.1 Biogas from Organic Waste

The generation of biogas from organic waste has been limited to the use of waste water, animal manure or human excreta as the feedstock, excluding the use of food wastes. In July 2009, the United Nations Industrial Development Organization (UNIDO), along with Homabay Municipal Civic Authorities, set up a biogas plant in the Lake Victoria port town of Kenya. The biogas plant is utilizing organic wastes generated from house to generate power for both lighting and cooking, among other uses. The plant is expected to be producing nine (9) kW, to light about 100 houses and provide cooking gas to 50 houses. The biogas plant is being built to save on wood fuel used in drying fish in the area. Though, the project is not yet operational, it allows for the opportunity for the conceptualization of biogas units which can readily use up the huge volumes of organic wastes going into Dandora dumpsite.

Kenya Power and Lighting Company (KPLC) is in the process of completing 11 biogas engine stations, which in 2008,were estimated to cost Sh886 million, to connect 10,000 people by lighting their homes and institutions as well as powering small scale enterprises. The engines are used to generate onsite power from biogas created from converted animal waste and other agricultural organic materials. Durban Municipality, in South Africa already uses the engines to generate 6MW of electricity from the municipality; waste, a feat that can also be achieved by the Nairobi City Council (General Electric, 2009). In addition to electricity and earnings from the carbon trade, farmers will also benefit from the biogas generation's end-product which is a high-quality organic fertilizer that neutralizes acid levels which have higher pH-value and is nearly odourless.

The project, which is being spearheaded by KPLC, with technical capacity coming from General Electric, will make it easier for the potential beneficiaries to connect to the renewable energy-fed national grid. The renewable energy gains will also extend to medium and large scale manufacturers or individual energy sector investors following the introduction of an engine which processes garbage into biogas. The biogas then powers the engine

[34] The Kenya Bureau of Standards carries out tests on the compost to ensure that it is fit for use in crop planting.

turbines to produce electricity or to generate industrial heat. The engine is set to make it easier for Kenyan manufacturers to control the source of the electricity and also the cost.

An analysis done by the company indicates that 75 % of the cost of setting up the co-generation process[35] is used in setting up the biogas digester and the garbage. The other 25% of the total project will be the cost of the engine. 6-12% of the cost of the whole project can be met by selling carbon credits.

4.3.2 Institutional Biogas Generation

Of the fifty establishments audited in the study, only 2% are generating biogas for use within their institution – these are the slaughterhouses, which are using waste water and/or slurry to generate biogas as shown in the figure below. The biogas is used in the production process, for preparing cooked meat products. However, it was also found that another 6% of the remaining institutions had actual plans and designs to set up biogas generation plants in their institutions. These were mainly slaughterhouses and secondary schools, which would use animal manure, are the feedstock.

Picture 10: Biogas generation from wastewater generated from a slaughterhouse

Lagoons as shown in **Picture 11** below are used to decant waste water generated from within a slaughterhouse in Nairobi. These lagoons produce significant volumes of slurry and sludge, which can still be useful in biogas generation.

[35] The engine can produce electricity which is then sold to the national grid and biogas which can be used for heating, when installed in an industry or household.

Picture 11: Lagoon

Generally, the use of biogas within restaurants and hotels was lacking due to the common misconception that biogas digesters need to setup above ground only and they did not have sufficient space. The lack of technical capacity for the generation of biogas using kitchen wastes as the feedstock is also a hindrance. This gap in knowledge and technology was found to be present in all the institutions which were audited, including those which were found to be generating biogas from animal manure.

SECTION 5: INSTITUTIONAL ENVIRONMENT OF WASTE MANAGEMENT

5.1 GENERAL

Waste emanating from domestic, commercial and industrial sources has reached such great heights that it has become responsible for vast amounts of diseases and health risks, water quality, dirty, and aesthetic repulsive environment. For waste management to change significantly, the behaviour of individuals and groups in society will have to change. The main stakeholders in this process are governments, industry and commerce, individuals and lobby groups.

The current institutional environment of waste management appears to have the following key players:

- Waste Generators
- Service Providers
- Regulators
- Government Departments
- Recycling Sector

Figure 27: Institutional Actors in Waste Management

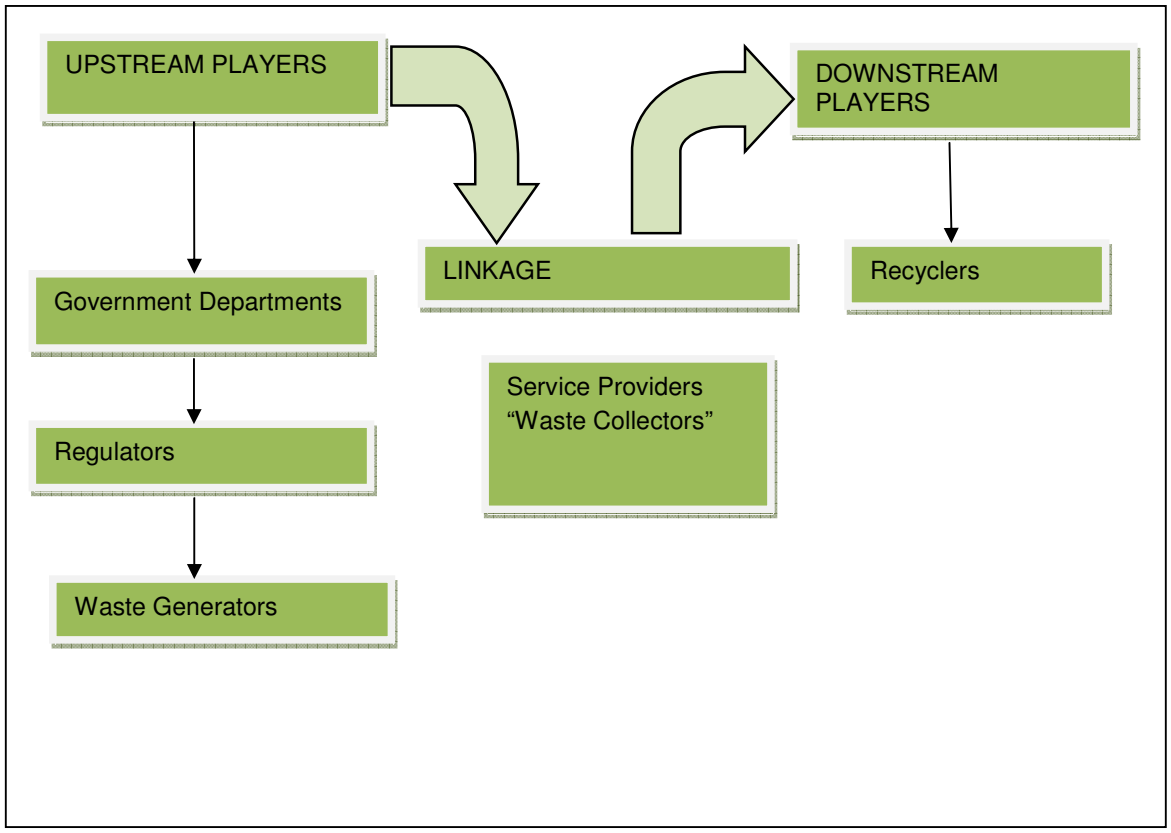


Table 13: Overview of the actors Involved in institutional Solid Waste Management and their Responsibilities

Primary Parties Involved	Responsibilities
1. Central Government {Ministry of Local Authorities}	Formulate a national policy with respect to waste reduction, recycling and solid waste management (SWM). Enact a national SWM law. Set technical standards. Research on SWM. Ensure that laws and regulations are applied. Provide guidance to local governments.
2. Nairobi City Council	Formulate a local policy and prepare local strategies and plans (short and long term). Finance SWM. Levy waste tax. Formulate regulations (Solid Waste Management By-Laws, 2007). To formulate guidelines with respect to: Methods of discharging waste (types of containers to be used); The waste reporting requirements of business waste generators; and Recycling (types of waste to be recycled).
3. NEMA	Formulate regulations (Waste Management Regulations, 2006) To license waste collectors To license all recycling, composting and incineration activities.
3. Contractors	To provide waste collection, haulage and street sweeping services under contractual arrangements.
4. Business (industrial and Commercial) Waste Generators	To manage (collection, treatment and disposal) their waste except those accepted by the local government as municipal waste. To submit reports on their waste (types, quantity, pre-treatment and other information) as required by the municipal regulations.

Source: Adapted & Modified from Karani & Mutunga, 2005

5.2 INSTITUTIONAL-ARRANGEMENTS

The key government institutions, which govern waste management in Nairobi, are:

- The Ministry of Local Government
- National Environmental Management Authority (NEMA)
- The City Council of Nairobi (CCN)
- The Ministry of Health

5.2.1 Ministry of Local Government

The Ministry of Local government which falls under the office of the deputy Prime Minister is tasked with the responsibility of coordinating all local authorities in Kenya. It is empowered by the Local Government Act 1978 (Cap 265 of the Laws of Kenya). In accordance with the Local Government Act, there are 175 councils in Kenya comprised largely of county councils, town councils, municipal councils and city councils - the City Councils of Nairobi, Kisumu and Mombasa.

The main role of local authorities (LAs) is to plan and protect the well-being of its residents through the delivery of services defined in the statute. These roles fall into three broad categories:

- Collection of revenues and the mobilization of resources
- Management and allocation of those resources
- Delivery of services such as waste management and water supply

The Ministry's role is to coordinate and regulate the activities of the City Council of Nairobi as well as other councils in Kenya, to ensure, that these services are delivered to the citizenry. However, the City Council of Nairobi, like other councils, is independent in terms of generating its own revenue and managing its own operations. With respect to waste management therefore, they are the overarching organ of government, charged with responsibility of ensuring that the local authorities have adequate funds, through the Local Authorities Transfer Fund (LATF)[36].

5.2.2 National Environment Management Authority

The National Environmental Management Authority (NEMA) is also key player in the solid waste management scene. Established following the enactment of the Environmental Management and Coordination Act (EMCA) No. 8 of 1999, it is the principal instrument of government in the implementation of all policies relating to the environment.

The Authority became operational on 1st July 2002 following the merger of three government departments, namely: the National Environment Secretariat (NES), the Permanent Presidential Commission on Soil Conservation and Afforestation (PPCSCA), and the Department of Resource Surveys and Remote Sensing (DRSRS). However, following government restructuring in March 2003, DRSRS reverted to its departmental status under the then Ministry of Environment and Natural Resources (MENR).

NEMA is the regulatory agency for waste management in Kenya, through its Waste Management Regulations, 2006.These regulations are meant to streamline the handling, transportation and disposal of various types of waste. The aim of the Waste Management Regulations is to protect human health and the environment. They place emphasis on waste minimization, cleaner production and segregation of waste at source. The regulations have classified various types of waste and recommended appropriate disposal methods for each waste type.

Under the Waste Management Regulations, NEMA licenses transporters, incinerators, landfills, composers, recyclers and transfer stations. Facilities to be licensed include local authorities, transporters and handlers of various types of waste. The licensing employs a risk-based approach by concentrating on facilities considered to pose a high risk to the environment.

5.2.3 City Council of Nairobi

The City Council of Nairobi is responsible for implementing solid waste management policies and regulations in Nairobi. It is charged with the task of providing urban services such as primary education, health services, road construction and maintenance, water supply,

[36] The Local Authority Transfer Fund (LATF) was established in 1999 through the LATF Act No. 8 of 1998, with the objective of improving service delivery, improving financial management, and reducing the outstanding debt of local authorities (LAs). LATF, which comprises 5% of the national income tax collection in any year, currently makes up approximately 24% of local authority revenues. At least 7% of the total fund is shared equally among the country's 175 local authorities; 60% of the fund is disbursed according to the relative population size of the local authorities. The balance is shared out based on the relative urban population densities. LATF monies are combined with local authority revenues to implement local priorities.

sewerage, housing, solid waste management, drainage, markets, and social services. Established through the enactment of the Local Government Act 1978, which provides for the establishment and incorporation of municipal authorities in Kenya, CCN has the legal mandate conferred to it under Section 201 of the Local Government Act to come up with by-laws, as well as enforce and implement deterrent laws and by-laws.

The City Council's mandate in waste management is to implement, and enforce the regulations stipulated in the Solid Waste Management by-laws, amended in 2007. These by-laws are mainly geared toward waste disposal, regulating waste collectors permits and code of conduct, waste collection, fees for waste management, and enforcement. The by-laws do not contain provisions on the prevention of waste. Residents/Institutions are not required to separate waste at source as there are no guidelines on the matter. In addition, the City Council has not formulated an elaborate strategy or launched a sustained campaign to educate the institutions within the city on the importance of proper waste management to protecting the environment, enhancing the cleanliness of the city as well as ensuring the health of the residents themselves.

On the whole, the City Council of Nairobi defines its main responsibilities towards solid waste management as follows:

- to formulate and implement the City Council's solid waste management policies and strategies;
- to provide services for the collection, transportation, treatment and disposal of solid waste;
- to regulate and monitor the activities of all generators of solid waste;
- to regulate and monitor private companies engaged in solid waste activities;
- to formulate and enforce laws, regulations and guidelines relating to solid waste management - a method of discharging waste (types of containers to be used);
- the waste reporting requirements of business waste generators;
- recycling (types of waste to be recycled); and
- to coordinate with other departments of the council, donor agencies, non-governmental organizations and other governmental bodies on solid waste management.

The City Council is the current owner of the Dandora dumpsite. Thus, all tipping fees, accruing from the disposal of waste at the dumpsite are payable to the City Council.

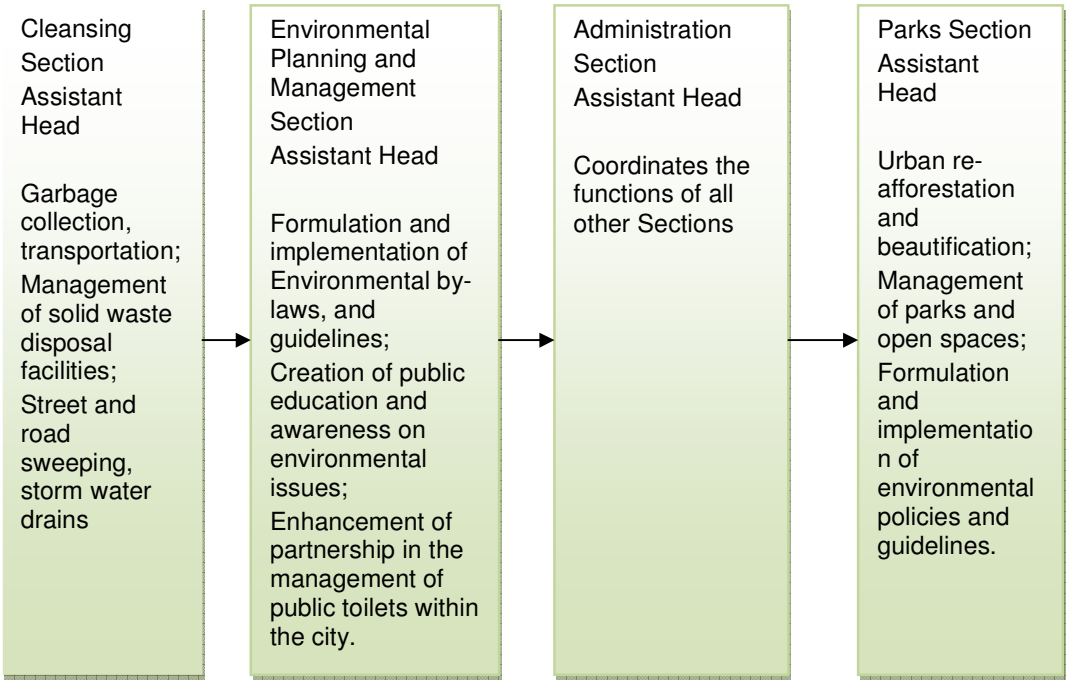
5.2.4 Department of Environment

The Department of Environment is the arm of the City Council, which is charged with the responsibility to primarily plan and manage the environment in Nairobi. Its mandate includes inter alia:

- to implement the CCN`s solid waste management policies formulated by the Council's Environmental Committee;
- to maintain public cleanliness, protect public health and the environment and keep public places aesthetically acceptable by providing services for the collection, transportation, treatment and disposal of solid waste;
- to regulate and monitor the activities of all generators of solid waste; to enforce all laws and regulations relating to solid waste management;
- to co-ordinate with other departments within the Nairobi City Council , donor agencies, Non-Governmental Organizations (NGOs), the private sector and other Governmental entities involved in Solid Waste management;
- to formulate and enforce laws, regulations and guidelines relating to solid waste management;

- to coordinate with other departments within Nairobi city council, donor agencies, non-governmental organizations and other governmental organizations in solid waste management.

Figure 28: Structure and responsibilities of the department of environment



5.2.5 Ministry of Health

The Ministry of Health is also a key actor in waste management in Nairobi. Previously, the Ministry was in charge of waste management and existed in the form of the Cleansing Section within the Public Health Department. However, since this responsibility was transferred to the department of environment, the Ministry of Health plays a more supervisory role, in solid waste management. Under the Public Health Act (1975), part IX, section 115, states that no person/institution shall cause nuisance or liable to be injurious or dangerous to human health. Section 116 requires Local Authorities to take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition capable of being injurious or dangerous to human health.

Such nuisance or conditions are defined under section 118 as waste pipes, sewers, drains or refuse pits in such a state, situated or constructed as in the opinion of the medical officer of health to be offensive or injurious to health. Any noxious matter or waste water flowing or discharged from any premises into a public street or into the gutter or side channel or watercourse, irrigation channel or bed not approved for discharge is also deemed as a nuisance. Other nuisances are accumulation of materials or refuse which in the opinion of the medical officer of health are likely to harbor rats or other vermin.

5.3 LEGISLATION GOVERNING ORGANIC WASTE RECOVERY

The study was able to identify some key weaknesses in the systems and practices of the City Council's Bylaws on solid waste management these include inter alia:

- **Prevention of Waste:** According to the Department of the Environment's "Solid Waste Recycling and Composting Policy with legal Guidelines", waste producers are required to take all practicable measures to prevent at source the production of waste. The City Council's Bylaws on solid waste management do not however prescribe any measures on waste prevention. As a result of the lack of legal provisions to prevent waste, generation of waste is high.

- **Generation of waste (Generating waste):** This was evidenced by heaps of garbage in existence in most low income and slum areas. However, the council does not maintain records for categories of waste generation and collection. It is therefore not possible to confirm the actual quantity of waste generated in the city in the absence of these records.

- **Recycling Re-use and Recovery of Waste:** The City Council's bylaws on waste management do not contain policy guidelines on recovery of waste, through either recycling or reuse. Also the Environmental Management and Coordination (Waste Management) Regulations, 2006 Part II (6) only mention a broad policy of segregation of waste, which states that a waste generator should segregate waste by separating hazardous waste from non hazardous waste. This negates the components into which waste fractions can be divided into, as well as assuming the waste streams that are generated from institutions are only either hazardous or non-hazardous. Lack of regulations on segregation and recovery of waste at source has resulted in unnecessarily large volumes of waste to be transported to the dumpsite only to be transported back to the recycling plants or re-users after recovery. The City Council as well as residents therefore incurs transport expenses which could otherwise be avoided were segregation and recycling to done at source. Further, it is difficult to segregate the waste properly at the dumpsite because of the large quantities and varied nature of the waste dumped at the site.

- **Collection and Transportation:** Section 7 (1) of the Environmental Management and Coordination (Waste Management) Regulations, 2006 states 'that no person shall be granted a license under the Act to transport waste unless such person operates a transportation vehicle approved by the by the National Environmental Management Authority upon the recommendation of the relevant lead agency. Further, Section 8 states that, 'any person granted a license to transport waste shall ensure among other things that the collection and transportation of such waste is conducted in a manner that will not cause scattering of the waste of or flowing out of waste or emission of noxious smells from such waste'. Vehicles to be used in transporting wastes are also required to be labelled as directed by the Authority. In addition, Section 9 of the guidelines states that,' any person licensed to transport waste shall collect waste from the designated areas of operation and shall deliver such waste to the designated disposal site or plant.

5.3.1 The Public Health Act

The main clause that touches on issues of waste in the Public Health Act is: *"It shall be the duty of every local authority to take all lawful, necessary and reasonably practicable measures for maintaining its district at all times in clean and sanitary condition, and for preventing the occurrence therein of, or for remedying or causing to be remedied, any*

nuisance or condition liable to be injurious or dangerous to health, and to take proceedings at law against any person causing or responsible for the continuance of any such nuisance or condition."

The Solid waste management bylaws (2007) do not specify the rights and obligations of the private waste collection companies and their clients, or specifying the standards that must be observed. In general, the private companies are operating in open competition purely on a willing-buyer-willing-seller basis. They simply obtain a business license and start offering Solid Waste collection services, without vetting or regulation. For most of them service commences once a client completes (often name and address only) and signs a form prepared by them, which then becomes the only "contract". The forms specify the monthly charge, the frequency of the collection service, and the storage facilities to be supplied by the company. Because of increasing competition and cases of unsatisfactory service, moreover, some of the firms include (in the form) a promise to refund money for unsatisfactory service. Some of the "contracts", especially those involving small companies, are usually verbal. They are also short term. The "contracts" have no provision for sanctions and there is no legal framework for the companies to deal with payment defaulters or for clients to secure legal redress when service quality is unsatisfactory. The wronged party simply walks out of the relationship. Some of the private companies, however, retaliate for non-payment

5.3.2 Changes in the Nairobi Waste Management System

Reforms on solid waste management carried out by the Council over the last few years have been spontaneous and have not followed any elaborate strategic framework. Although some of the reforms mirror proposals contained in the master plan prepared under the JICA study, we have not seen any evidence confirming that the Central Government or the City Council formally adopted the master plan and agreed to implement it. The reforms are therefore sporadic rather than structured as envisaged in the master plan.

The City Council's overall strategic plan for 2006-2010 does not contain any strategic objective specific to waste management and neither has the function been identified as a key result area to be focused on in the planning period in spite of the city's residents - in a survey carried out by the Council before the formulation of the strategic plan - having noted it to be the operation of the Council with the lowest quality of service delivery. Under these circumstances the vision and goals of the City Council on solid waste management may not be attained.

Although the City Council has developed a detailed policy document on recycling and reuse of waste generated in the city, it has not created formal structures that would facilitate its partnership with the numerous community groups as well as commercial enterprises involved in recycling and re-use of waste. Further, the Council is yet to introduce incentives to encourage reuse or recycling of waste in the city. Garbage that is not waste, estimated by recyclers to be as much as 80% of loads delivered at the dumpsite, is transported at high cost to the dumpsite only to be separated there under difficult circumstances and the recoveries transported back to their place of intended use at unnecessary expense to the residents of the city.

CCN strives to encourage waste reuse, recycling initiatives, income generation technology from waste management, public awareness and education. The garbage collection, transportation and disposal vehicle straight is estimated at 180. With the current capacity of less than 20 vehicles that are always in a dysfunctional state and refuse generation rate of over 1600 tons a day, only 40% of the garbage is collected leaving a 60% collection deficit. The support offered by private refuse collection enterprises has alleviated the problem and is therefore appreciated, Mushrooming of such firms has however created problems of control and haphazard dumping, and due to this development the department formulated and has implemented a policy on private sector involvement in solid waste management.

The City Council is soon implementing zonal contracts in terms of solid waste collection that will be competitive and is believed, will improve on the level of collection thus making the city clean and tidy. The ISWM plan for Nairobi will look into the development of proper waste collection and disposal. In addition, the ISWM aims to reduce waste streams by at least 50% through recycling as well as evaluate the potential for establishing waste transfer stations where waste will be separated and recycled. The unusable waste left over will then be dumped in a new sanitary landfill to be developed in Ruai (in the South East of Nairobi). The ISWM strategy also foresees the development of public private partnerships for all elements (collection, separation, recycling and disposal) of the waste.

Relocation of the solid waste management and disposal facility from Dandora and the closure of the current dumping site are in progress. For many years now, the solid waste generated in Nairobi is transported to and disposed at the Dumping Site located in Dandora, which is about 10 KM east of the city centre. At the site the waste is managed in a crude manner, whereby, after it is off- loaded from the trucks it is pushed into a disused quarry full of storm waster by a bulldozer machine. Some of this waste, however, remains on the land surface, and over the years, it has become an eye-sore and a health hazard to the surrounding community. This has now generated into an environmental concern to the City Council, the Government and other interest groups. There is need, therefore, to close the dumping site and relocate the solid waste disposal operations to a suitable site. The Department of Environment is in process of mobilizing the necessary resources to open up a modern Solid Waste Management facility at Ruai and close down the dumping site at Dandora.

Kenyan legislation is not supportive of composting activities in urban areas. Under the Public Health Act (Republic of Kenya, 1972), a manure heap may be deemed to be a nuisance, in which case the Medical Officer of Health must serve a notice on the person responsible for the nuisance to remove it at the latter's expense. Similarly, composting programmes lack political support from the local and central governments. Apart from the few allocations of small plots to the composting groups, the city council has not integrated composting activities within its solid waste management system. Neither subsidies nor financial and technical assistance are forthcoming from local government. Urban farmers, the largest category of potential customers of this compost, often lack land tenure and may be harassed by authorities. These factors serve to reduce their demand for organic fertilizers which in turn destabilizes the production and marketing of compost (Foeken and Mwangi, 1998; Maxwell and Zziwa, 1992). Although the central government recognizes the environmental benefits derived from composting domestic wastes, few real policy incentives are being extended to these groups to facilitate their operations.

5.3.3 Solid Waste Management by-laws on Composting

The Solid Waste Management by-laws do not have specific clauses on composting; rather there are various clauses that support composting indirectly. Some of these clauses include:

- Occupiers of domestic and trade premises shall separate waste which can be recycled and place it in a different container provided by the council or the waste operator, as the case is, for the purpose." This would be useful in that it would make it much easier to compost since waste is separated. This clause would allow for the segregation of wastes at source, however, it still does not specify the constituent waste fractions, into which segregation should be done.
- The council shall make provisions for small scale resource recovery activities to be undertaken by organized groups at designated sites before disposal of waste. This would be useful in that people interested in collecting organic waste at dumpsites are allowed to.
- A permit holder may do such things as it considers appropriate for the purpose of enabling waste belonging to it to be used again or enabling substances to be reclaimed from such waste and it may use, sell or otherwise dispose of waste belonging to it or anything produced from such waste. This would help in efforts of waste segregation to promote composting by reclaiming organic waste.

According to the Solid Waste Management by-laws, there are a few clauses that directly or indirectly limit the prospects of composting. They include:

- No person shall sort over or disturb anything deposited at a place provided or approved by the council for the deposit of waste or in containers for waste provided by the council or other persons unless he is a person entitled to the custody of the container or is authorized to do so by such a person, or is a person having the function of emptying the container. This limits the access of people interested in composting since they are not allowed to access dumpsites thus cannot collect organic waste for composting.
- It shall be an offence for any person who is not a registered transporter of solid waste or a permit older in the course of any business of his or otherwise with a view to profit to transport any solid waste within the area of jurisdiction of the council unless he belongs to a category of transporters who have been exempted by the council from registration. This limits efforts of composting as transportation of waste from the dumpsite to other places is prohibited if you are not licensed to transport. Licensing is costly thus may reduce efforts of composting.

5.4 LINKAGES TO EXISTING PLANS AND PROGRAMMES

5.4.1 Proposed Integrated Solid Waste Management Plan

Integrated Sustainable Waste Management (ISWM) is the leading concept of the Urban Waste Expertise Programme (UWEP). Integrated Sustainable Waste Management is a concept that has been articulated and refined in the Urban Waste Expertise (UWEP) Programme; it is the result of working more than 15 years on waste issues in Southern countries, and coming to understand that it is not the technical issues, but the other aspects of waste management, which are most likely to influence the success or failure of interventions. ISWM addresses the management of the solid waste stream as a set of resources rather then waste, thus ISWM considers the waste stream not as a homogeneous mass but as a set of individual materials that can be handled in different and appropriate ways to maximize recovery and minimize disposal (Dulac, 2001).

Organic waste reuse has the potential to lead to a massive reduction, of up to about 60% by volume of waste, which is currently going into the Dandora dumpsite. The potential for conversion of organic waste into a resource, through composting, biogas generation, and energy production through the gasification or pyrolysis of these wastes is immense. In addition; this recovery would yield both economic and socioeconomic benefits. The current

food demand in Kenya has more than doubled in the last five years due to increasing populations. However, the reduced productivity of the soils coupled with unreliable rainfall, has created a huge deficit in the food supply. This has greatly affected the urban poor, with estimated projections showing that the city's population is likely to be at about 6 million people by 2025.Consequently, the demand for food is set to increase even further.

5.4.2 Nairobi River Basin Programme

Rivers in Nairobi are an example of how increasingly polluted the city of Nairobi has become due to increased human activities. The different constituent rivers of the Nairobi river basin have experienced heavy pollution from human activities the main pollution being dumping along the river shores. They are polluted with uncollected garbage and human waste from informal settlements; industrial wastes in the form of gaseous emissions, liquid effluents, agro-chemicals, and other wastes especially petro-chemicals and metals from micro-enterprises – the "Jua-kali"; and overflowing sewers. This situation has occasioned the spread of water-borne diseases, loss of livelihoods, loss of biodiversity, reduced availability and reduced potential of the rivers becoming a source of safe usable water, and the insidious effects of toxic substances and heavy metal poisoning which affects human health. (UNEP, 2007).

Even as the amount of garbage dumped in the river increases, the National Environmental Management Authority (NEMA) in partnership with UNEP have come up with the Nairobi River Basin Rehabilitation Programme that seeks to rehabilitate the river into a much better state.

The Programme on the Rehabilitation and Restoration of Nairobi Rivers aims at enhancing the ecological integrity and socio-economic value of the river basin. This will be achieved through multi-faceted efforts involving all stakeholders. To achieve the aforementioned aim, the Programme interventions will focus on four key areas which include: environmental education, awareness creation, and public communication; conservation of the riparian reserve; integrated waste management; and the restoration of Nairobi Dam of abattoirs and their wastes

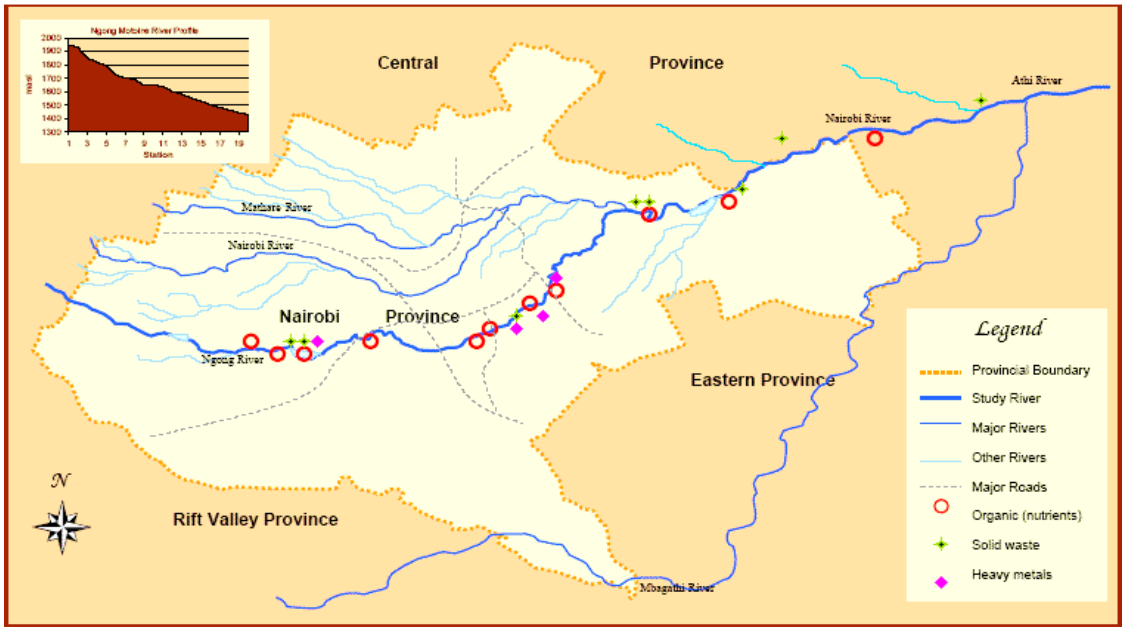
The Nairobi River Basin Initiative has four main objectives, these are:

- To demonstrate how industrial and socio-economic factors contribute to pollution of Nairobi rivers;
- To increase access to information and awareness in order to address the above factors;
- To strengthen capacity development amongst stakeholders to tackle environmental challenges;
- To improve water and environmental quality of the river basin.

Picture 12: Open Dumping along the Nairobi River

Three major causes of degradation of the environment in Nairobi are notably solid, liquid waste and sewage. Over the years, the Nairobi Rivers have come under intensive pressure from various sources of pollution, point and non-point sources. The Nairobi River system has hence acted as a major depository of waste from both domestic and industrial sources. The riparian reserves of the three Nairobi Rivers (Mathare, Ngong and Nairobi) are marked by numerous informal settlements without adequate sewerage and sanitation services. More often than not, the rivers are used for discharging raw sewage. Organic pollutants continue to be the greatest pollutants of the rivers in Nairobi as shown in **Figure 29.**

Figure 29: Major river pollutants in Nairobi



SECTION 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Organic waste forms the largest portion of the total waste streams finding their way into Nairobi's official dumpsite in Dandora and other undesignated sites such as the Kayole[37] and Mathare North quarry. It continues to present the greatest burden within these dumpsites due to its putrescible nature leading to methane formation with the attendant risk of global warming, foul smell, and leachate generation as well as offering a breeding ground for pests and insects.

Phase one of the Project has established, that indeed there is potential for the diversion of organic waste which is currently going into Dandora dumpsite, open dumping within institutional compounds, as well as burning. The municipal markets are the largest sources of fairly uncontaminated organic wastes in Nairobi. They are currently generating about 76-120 tonnes per day of largely organic waste, which is disposed off into Dandora dumpsite. In addition, restaurants, hotels and some industries, which are also good sources of organic wastes, are also doing the same, with a few hotels diverting their organic wastes into either pig or cattle feed.

The study showed that though there are efforts on the ground, by institutions, to try and incorporate sound waste management practices into their operations (See Annex F), there are still some poor waste management practices taking place, such as burning, open dumping within institutional compounds. Private institutions were found to manage their wastes better than public institutions. This variation is observable in the waste collection, transportation and disposal within these institutions. Whereas private institutions use private waste contractors to collect, transport and dispose their wastes, public institutions rely on the City Council of Nairobi. This variation is visible in the accumulation of wastes within the premises of these public institutions, where waste remains uncollected for long periods of time, due to the lack of collection by the City Council of Nairobi. Whereas in the private institutions, waste is collected regularly, albeit, there are periods of accumulation of wastes due to the lack of collection. Nonetheless, this is more apparent within institutions serviced by the City Council of Nairobi.

Waste recovery within institutions, is currently limited to the inorganics, with little recovery taking place for the organic waste flow. The efforts to valorize the organic waste stream are currently restricted to a few institutions, such as golf courses, slaughterhouses, some hotels and green groceries. For most institutions, which are not involved in any form of valorization of organic waste, either through, methanogenic fermentation, gasification, pyrolysis in an effort to recover energy from waste, or through composting, the reasons for not doing so are the costs involved in setting up these recycling units, the environmental and /or public health risks. .

Aside from these financial and technical limitations, within institutions, the City Council of Nairobi has been found to hinder the process of organic waste recovery in Nairobi. The current, slid waste management by-laws, 2007, do not, adequately provide for the recovery of organic waste on site. Instead, it is stipulated, in the by-laws, that small-scale recovery of

[37] Dandora is the only approved dumpsite in Nairobi, however, the Ministry of Environment has allowed for waste collectors to dump wastes collected within Nairobi in the proposed Kayole dumpsite, despite NEMA {the licensing authority for waste collectors} not approving this move.

solid waste is permissible at designated sites prior to waste disposal. This limitation has prevented wide scale exploitation of the economic value, inherent in organic waste, which can be realized through composting, biogas generation and waste to energy recovery at Dandora dumpsite.

In addition, the, there are currently no clauses in the existing legal framework, which solely address the composting business. The existing regulations which influence it either positively or negatively it are fragmented from one government department/institution to another. Consequently, the process has no clearly defined legal structure, to operate under. This has directly affected the legitimacy of the business, which trickles down to the inability of composting businesses – formal and informal, from accessing financing for their operations. Currently, there are no economic incentives such as tax rebates for institutions which are "attempting" to valorize organic wastes, moreover, for companies which have actually, gone ahead to setup a legitimate business generating and selling compost, they still, do not get any reprieve from the government. Thus the taxes imposed on the compost, when packaged and branded, alongside the costs of testing compost samples at laboratories, labour fees etc, consume the minimal profits being realized by commercial composters. Moreover, these additional costs have continued to limit the innovation of compost production, thus hindering the activity from being seen as a sustainable income generating activity.

The City Council of Nairobi is at present developing an Integrated Solid Waste Management (ISWM) plan, which would greatly benefit , from a sourcing strategy to manage the organic waste flow that ends up in Dandora dumpsite as well as other unapproved dumping sites. Today, there is lies an inherent need for municipalities, in and within the region to be able to manage their wastes more efficiently and effectively. As an example the current generation rate of garbage in the city of Nairobi alone is estimated to be 2,400 tons per day (Bahri, 2005) and consists of 60% organic waste, 20% plastic, 12% paper, 8% glass/metal and other. Non-Domestic waste accounts for about 20% of the total waste generated within Nairobi, compared to an estimated 80% from domestic sources. This has been a key reason as to why numerous waste management programmes have neglected waste generated from the non-domestic sources. Yet, with respect to availability of finances, enhanced technical capacities, non-domestic waste generators offer a viable and potentially more sustainable target group through which effective solid waste management practices can be initiated.

To date the City Council of Nairobi, is outsourcing the waste collection, transportation and disposal service to external contractors. This action stems from one of the recommendations made in the Nairobi solid waste management study, by JICA in 1998. Though, this measure has allowed for the collection and disposal of more waste quantities, it has also resulted in the increase of waste collectors, to unmanageable numbers. This has resulted to poor and inefficient monitoring of waste collection activities, by the City Council of Nairobi (personal communication, CCN). In addition, they have an existing public-private partnership whose scope has been limited to advertising, lighting up of the city as well as setting up of waste containers in strategic parts of the city.

Small-scale community composting groups are concentrated in the low-income slum areas where neither the city council nor the private companies appear interested in investing in waste management. The benefits derived from small-scale community-based composting groups in Nairobi range from reducing the amount of solid waste collected for disposal, improving community health and sanitation, restricting environmental pollution, promoting environmental awareness, creating employment and additional income-generating activities and facilitating urban agriculture. The small-scale composting programmes are popular in the management of solid waste because of the financial and moral support from NGOs. However, these models have been largely unsuccessful, due to the inability of these programmes to sustain themselves upon the exiting of the financial support from the NGOs.

6.2 RECOMMENDATIONS

Following the findings of the study, it is recommended that the following measures should be enacted, by various stakeholders in the organic waste supply chain. These actors are the waste generators, waste collectors, and the waste regulators such as government institutions.

Waste Management Regulators – This group incorporates the National Environmental Management Authority (NEMA), The City Council of Nairobi, and The Ministry of Public Health

- The Solid Waste Management bylaws 2007 (CCN) should be revised to include provisions on waste prevention;
- The National Environmental Management Authority (NEMA) should revise the current waste management regulations, to include sections on waste minimization at source, as well prevention. These clauses should be tied to some incentive, preferably financial, such as tax rebates on the successful implementation of waste minimization activities at source.
- The City Council of Nairobi should seek the support of other public sector stakeholders such as members of the provincial administration like Chiefs and District Officers and make use of already existing community initiatives such as Constituency Development Committees and Community Policing programmes to raise public awareness and participation in waste management;
- Through a public-private partnership, initiated by the Ministry of Finance, Ministry of Environment, the City Council of Nairobi and business associations, the 4R concept of waste management – Reduce, Reuse, Recycle, Recover, should be implemented. This should take on a win-win model, for both businesses and the environment, such that, companies which are able to adequately implement and monitor their wastes, ensuring that the 4 R are followed, can realize a tax rebate on the overall operations.
- The City Council of Nairobi, alongside the National Environmental Management Authority (NEMA), should set aside transfer stations, which can be used for the segregation of wastes. Currently there are no facilities for proper segregation activities once the waste is carried away from the institutions for final disposal
- The National Environmental Management Authority (NEMA) should explore the possibility of licensing private organizations to own and manage dumpsites which conform to the requirements of the Solid Waste Management by-laws and the Waste Management Regulations set by the National Environmental Authority.
- The National Environmental Management Authority (NEMA) and the City Council of Nairobi (CCN) should revise their its waste management regulations to include provisions on waste prevention
- The City Council of Nairobi should seek to partner with already existing community initiatives such as Constituency Development Fund Committees and other the Community based programmes in raising public awareness and participation in organic waste recovery through composting and biogas generation, as a strategy for creating employment, especially for the urban poor.
- The Ministry of Finance, alongside the Ministry of Environment and the Ministry of Local Government should develop financial instruments which are aimed at improving waste management at the institutional and/or commercial level.

- The City Council of Nairobi should undertake feasibility studies on the prospects of generating explore the viability of partnering with private firms in energy recovery out of waste through such means as incineration, gasification or fuel generation. These could aim at selling carbon credits, through a cleaner development mechanism project.
- Public education on the advantages of using compost in agriculture and its environmental benefits in both rural and urban areas need to be promoted with the use of video shows, radio, newspapers and magazines, television programmes and public campaigns. This can be spearheaded consultatively between the Ministry of Agriculture, the City Council of Nairobi and the Ministry of Environment
- The current waste management by-laws and regulations need to be revised to incorporate the licensing of informal sector recyclers.
- Composting toilets or other systems that separate human and industrial waste would lower dramatically the cost of treating sewage.
- CCN could therefore, broaden its scope of activities, under the public-private partnership, by adopting a concept that allows for the removal of organic waste from markets by interested and qualified parties.

Waste Generators – This group of stakeholders incorporates the business associations, the institutions and commercial establishments

- Business associations in the private sector such as the Kenya Association of Manufacturers, The Kenya Golf Clubs Association etc should seek consultants to improve the technical capacity of their members in waste management, focusing on the 4Rs concept; reduce, recover, reuse, recycle.
- Public institutions such as prisons need to develop environmental management policies and strategies, which incorporate proper waste management practices. This would be geared toward improving current perceptions[38] on the burden of responsibility of waste generated within these institutions.

Waste Collectors – This group incorporates the private waste companies as well as the cleansing section, within the Department of Environment, within the City Council of Nairobi.

- Create and activate formal structures for its engagement with community groups and other stakeholders in waste management and specifically those who recycle and re-use waste.
- provide incentives to community groups and other organizations involved in recycling and re-use of waste
- Weak criteria for appointing contractors to collect waste allow bidders lacking requisite technical and financial capacity to win tenders. They are however unable to give effective service resulting in inefficient and irregular collection of waste and therefore the growth of large mounds of garbage in many residential areas of the city.

Financial Institutions:

- Financial and technical support is urgent**l**y required in form of loans, especially at the micro-finance level, which can be used to improve the production capacity of the small, as well allowing them to improve the technological

[38] The City Council of Nairobi and licensed waste collectors are deemed to be responsible for the overall waste management of these institutions.

6.2.1 General Recommendations

The Converting City Waste into Compost project should develop a small-scale pilot project, which seeks to test the potential for recovery of organic waste for commercial gain, through biogas generation and/or compost production. This proposed action research project should seek to close up the missing links in the compost production supply chain.

The potential for up scaling of any proposed pilot project within the City is critical, as it will help to focus on legislative issues which are currently hindering the expansion and legitimacy of composting in Nairobi and the greater Kenya area. These issues would be geared toward improving market access of organic waste, creating linkages with the City Council of Nairobi's, improving the testing environment for compost within institutions such as the Kenya Bureau of Standards etc.

SECTION 7: BIBLIOGRAPHIES

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United Nations Environmental Programme (UNEP): Nairobi City Profile 2007

Community-Based Waste Management for Environmental Management and Income Generation in Low-Income Areas: A Case Study of Nairobi, Kenya

The Environmental Protection Act 1990

Environmental Protection (Duty of Care) Regulations 1991

ANNEX A: WASTE COLLECTION & TRANSPORTATION

FIRST SCHEDULE
(To be completed in Triplicate)

FORM I
FORM NEMA/WM/1

APPLICATION/RENEWAL FOR A LICENCE FOR TRANSPORTATION OF WASTE
(Regulation 7)

I hereby apply for a license to transport waste, of which particulars are given below:
Name and address of applicant ……
.....
PIN Number ……..
Registration number and type of vehicles to transport waste ……
…….....
Quantity of waste per vehicle to be transported …….
……
Licensed sites/plant to which waste is to be transported …….
……
Collection schedule ……
……
Any other information ……
……
Attach Recommendation document(s) from the relevant lead agency.
Is Application for: □ Initial license □ Renewal
Previous License Number …….
Date …… …. Signature……
Designation/Title: ……..……..
FOR OFFICIAL USE ONLY
Application received by ……on ……20.....
Fee paid Kshs……. (in words) …….
……

Director General
National Environment Management Authority

ANNEX B: APPLICATION FORM FOR A LICENCE TO TRANSPORT WASTE

FORM II
FORM NEMA/WM/2

LICENCE TO TRANSPORT WASTE
(Regulation 7)
License No TR/HW…….

Name……..
Address …….
……

You are hereby licensed to transport waste to:
……

(Location/district)
from……
(Location/district)

Type and registration number of vehicles licensed ……..
……

This license is valid from ……
20……to……20……..

This license is granted subject to the following conditions:
……
……
……

Date: …… Signature……
. ……

Director General
National Environment Management Authority

ANNEX C: TRACKING DOCUMENT FOR WASTE COLLECTOR

FORM NEMA/WM/3
FORM III
(To be completed in Five Copies)

TRACKING DOCUMENT
(Regulation 8)

A Transporter	Serial No. Registered Name of Transporter……..…… Usual Municipality/District of operation…… License number …… Issuing Authority ……
CONSIGNMENT NOTE FOR THE CARRIAGE AND DISPOSAL OF SOLID WASTE	
B Description of the waste	Area collected..……..…… Type of Waste……..…… Description and physical nature of waste……. Quantity/size of waste ……..… Number of containers……
C Disposer's Certificate	I certify that I have received the waste as described in A and B above. The waste was delivered in vehicle _____ (Registration No.) at _____ (time) on _____ (date) and the carrier gave his/her name as _____ on behalf of _____. The waste shall be disposed off as per disposal license issued by the Authority. Signed: _____ Name:_____ Position: _____ Date: _____ On behalf of: _____

ANNEX D: APPLICATION FEES FOR WASTE MANAGEMENT LICENSES

SECOND SCHEDULE
(Regulations 7, 11, 24, 25, 27)

FEES
1. Application for license/Permit:
For transportation of waste ..... ……KShs.3,000.00
To own/operate a waste processing plant/site KShs.3, 000.00
To own/operate a waste disposal plant/site KShs.3,000.00
To export/transit waste KShs.3,000.00

2. License/Permit
For a license/permit to:
Transport waste KShs.5, 000.00

Own/operate a waste processing plant/site… ……KShs.40, 000.00
Own/operate a waste disposal plant/site……..KShs.75, 000.00
To export/transit waste.....KShs.30, 000.00

ANNEX E: ORGANIZATIONS AUDITED

	Institution/ Organization	Location	Category	Person Contacted	Contacts
1	Department of Defense	Lenana Road	Security- Army	Col. Peter Magut	+254202064290 / 0729 314 162
2	Pembe Mills	Lunga- Lunga Road	Flour/ Animal Feed	Ali Ust. Nassir	+25420 551943
3	Sarova Panafric Hotel	Kenyatta Avenue	Hotel/ Restaurant	Mike Kamau	+254202720822
4	Intercontinental Hotel	Haile Selassie Avenue	Hotel/ Restaurant	Charles Kariuki	+254203200410
5	Gikomba Market	Quarry Road	Market	Oyimba Paul	+254721594208
6	Wakulima Market	Haile Selassie Avenue	Market	Nambegere Mabel	+254722715339
7	Moi Girls Nairobi	Woodley	Education/ High School	Wafubwa Cicilia	+254722655370
8	Ecotact Innovating Solutions	Menelik Road	Sanitation	Kituta Patrick	office@ecotact.org
9	Farmers Choice	Kahawa West	Slaughter House	Mbugua Stanley	+25420811722/020811180-5
10	Hilton Hotel	Mama Ngina Street	Hotel / Restaurant	Gikonyo Peter	+254202790000
11	Sigma Feeds	Bogani Road, Lang'ata	Animal Feed	Shah Kirtesh	+25420891712
12	Rafiki Millers	Off Mombasa Road	Flour/ animal Feed	Priscilla Mendoza	+25420533438
13	Aga Khan University Hospital	Limuru Road	Hospital	Alice Kariuki	+254203662000
14	Lang'ata Womens' Prison	Lang'	Security - Prison	Catherine Mwangi / Mary Nderitu	+254208027125
15	Nairobi West Prison	Langata Road	Security - Prison	Alfred Musila	+254208020174
16	Nairobi Remand and Allocation	Enterprise Road	Security - Prison	Rashid Powon	+254208020163
17	Kamiti Prison	Kahawa West	Security - Prison	Maweu Sam	+254202455100
18	Serena Hotel	Kenyatta Avenue	Hotel / Restaurant	George Njunge	+254202822000
19	Yaya Centre	Ngong Road	Shopping Mall	Ng'ethe Ken	+2542027133360
20	Kenya Comfort Hotel	Milimani Road	Hotel / Restaurant	David Onyango/ Catherine Mwaura	+25420 2727991
21	Moi Air Base	Eastleigh, Huruma	Security- Armed Forces	Col. Thuita	+254206764401

	Institution/ Organization	Location	Category	Person Contacted	Contacts
22	Kalimoni Greens	Karen	Green Grocery	Kanari Lillian	25420 2361188
23	City Park Market	Limuru Road	Market	Omondi Patrick	+254720 11389 omondipatrick@yahoo.com
24	City Market	Koinange Street	Market	Gitari David	+254734075450
25	Lenana School	Ngong Road	Education/ High School	Edward Kinoti	+254722880225/ 02023404/8000766
26	Karen Farm (Kalimoni)	Karen	Farm	Mureithi William	+254726718876
27	Railways Golf Club	Haile Selassie	Golf Club	Johnstone Omondi	+254720926795
28	Uchumi Ltd.	Aga Khan Walk Road	Supermarket/Retail	Francis Kiragu	+254722986940
30	Sarova Stanley	Kimathi Street	Hotel/Restaurant	Josephat Macharia	+254722994385
31	Public Service Club	Mara Road	Club/Restaurant	Anthony Kaka	+254722383397
32	Pumwani Hospital	Eastleigh Road	Hospital	Dr. Charles Wanyonyi	+254722818780 hwwany@yahoo.com
33	Yaya Centre	Argwings Kodhek	Shopping Mall	Ken Ngethe	+254(20) 2713360/1
34	Capital Centre	Mombasa Road	Shopping Mall	Knight Frank	+25420556176
35	TruFoods Limited and Kabazi Canners Limited	Jogoo Road	Food Processing	Mwangi Njiru	+254722386285
36	Nyongara Slaughterhouse	Dagoretti Market	Slaughterhouse	Kennedy Ababu	+254722795902
37	Mumu Slaughterhouse	Dagoretti Market	Slaughterhouse	Evans Kalulu	+254722866590
38	Bio Food Products Ltd.	Enterprise Road	Food Processing	Zoeb Walijee	+254203503595
39	CBD Waste Collection Site	Moi Avenue	Collection Site	Cleansing Section	-
40	Heron Hotel	Milimani Road	Hotel	Mwaniki	+254202720740
41	Jamiat Hotel	Tubman Road	Hotel	Festus Munyithya	+254712058678
42	Grand Holiday Hotel	Tsavo Road	Hotel	Stella	+254202221244
43	Karen Golf Club	Karen	Golf Club	Bernard Ndungu	+254722204431 ndungu@karen.or.ke
44	Muthaiga Golf Club	Kiambu Road	Golf Club	Willis Musumba	+254713101732 muthaigagolf@wananchi.com
45	Ranalo Foods Limited	Kimathi Street	Restaurant	Stella Anne Osewe	+254721323238
46	University of	University Way	Education/Unive	David Mungai	+254714745481

	Institution/ Organization	Location	Category	Person Contacted	Contacts
	Nairobi		rsity		
47	Laico Regency	Loita Street	Hotel	Samuel Matekeya	+254202211199
48	Meridian Court Hotel	Kijabe Street	Hotel	G.V. DeSouza	+254722509826
49	Upper Hill Springs	Mara Road	Restaurant	Simon Kimani	+254721249888
50	New Visa Place	Mara Road	Restaurant	John Kyalo	+2542729458

ANNEX F: ENVIRONMENTAL MANAGEMENT PRACTICES IN SELECTED HOTELS

Hilton Hotel Nairobi

Hotel has an environmental policy/action plan
Recycles Paper, Plastic and Organic waste
A 'no second-day' towel change option given to guests - conserves energy and water use
Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages
Hotel provides fair trade labelled coffee, tea, sugar and flowers
Hotel restaurant provides the option of a vegetarian menu
Provides shuttle busses for meeting participants in place of individual transportation (e.g. cars and taxis)
Initiated an Environmental management and awareness programme called "We CARE". Committed to reducing energy consumption, CO2 Emissions, Waste and water consumption all by 10 - 20%
Hotel is audited yearly as pertains to issues regarding the environment by National Environment and Management Authority (NEMA)

Nairobi Safari Club

Recycles up to 80% of all paper and plastics, 20% of all glass waste and 100% of all organic waste
A 'no second-day' towel change option given to guests - conserves energy and water use
100% of all lighting in rooms and 95% of all lighting in Hotel is reduced energy e.g. efficient lights, use of task lighting, low energy star light bulbs or automatic controls
Water saving devices e.g. automatic shut-off faucets and showers, and low flush toilets installed in all washrooms.
Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages
Hotel provides fair trade labelled coffee, tea, sugar and flowers
Provides shuttle busses for meeting participants in place of individual transportation (e.g. cars and taxis)
Hotel audited in 2006 regarding issues related to the environment by the National Environment and Management Authority (NEMA)

Holiday Inn Nairobi

Recycles plastics and organic waste
A 'no second-day' towel change option given to guests - conserves energy and water use
100% of all lighting in rooms and 95% of all lighting in Hotel is energy efficient
Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages
Hotel restaurant provides the option of a vegetarian menu
Hotel received the Energy management award in 2004 (first place) and 2005 (second place)

Fairmont Hotel Nairobi

Hotel has an environmental policy/action plan
Recycles paper and all organic waste

A 'no second-day' towel change option given to guests - conserves energy and water use

60% of all lighting in rooms and 80% of all lighting in Hotel is reduced energy through automatic controls – photocells and timers

Water saving devices e.g. automatic shut-off faucets and showers, and low flush toilets installed in all washrooms

Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages

Hotel restaurant provides the option of a vegetarian menu

Provides shuttle buses for meeting participants in place of individual transportation (e.g. cars and taxis)

Hotel is committed to a green initiative and is involved in several projects e.g. partner in the Nairobi River Basin project, Standard Charted Marathon and involved in the cleaning of the environment outside of the Hotel

Laico Regency Hotel (formally known as Grand Regency)

A 'no second-day' towel change option given to guests - conserves energy and water use

50% of all lighting in rooms and 40% of all lighting in Hotel is reduced energy e.g. efficient lights, use of task lighting, low energy star light bulbs or automatic controls

Water saving devices e.g. automatic shut-off faucets and showers, and low flush toilets installed in all washrooms

Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages

Hotel provides fair trade labelled coffee, tea, sugar and flowers

Hotel restaurant provides the option of a vegetarian menu

Provides shuttle busses for meeting participants in place of individual transportation (e.g. cars and taxis)

Utalii Hotel Nairobi

Hotel endeavours to reduce paper, plastic, glass and all organic waste

A 'no second-day' towel change option given to guests - conserves energy and water use

Water saving devices e.g. automatic shut-off faucets and showers, and low flush toilets installed in washrooms

Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages

Hotel provides fair trade labelled coffee, tea, sugar and flowers

Hotel restaurant provides the option of a vegetarian menu

Provides shuttle busses for meeting participants in place of individual transportation (e.g. cars and taxis)

Sarova Hotels Nairobi

Recycles up to 90% of all paper, 70% of all plastics, glass and 100% of all organic waste

A 'no second-day' towel change option given to guests - conserves energy and water use

85% of all lighting in rooms and 95% of all lighting in Hotel is reduced energy e.g. efficient lights, use of task lighting, low energy star light bulbs or automatic controls

Water saving devices e.g. automatic shut-off faucets and showers, and low flush toilets installed in all washrooms

Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages

Hotel provides fair trade labelled coffee, tea, sugar and flowers

Hotel restaurant provides the option of a vegetarian menu Provides shuttle busses for meeting participants in place of individual transportation (e.g. cars and taxis) Hotels' environmental action/policy plan under preparation
Inter-continental Hotel Nairobi A 'no second-day' towel change option given to guests - conserves energy and water use 80% of all lighting in rooms and 80% of all lighting in Hotel is reduced energy e.g. efficient lights, use of task lighting, low energy star light bulbs or automatic controls Water saving devices e.g. automatic shut-off faucets and showers, and low flush toilets installed in some washrooms Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages Hotel provides fair trade labelled coffee, tea, sugar and flowers Hotel restaurant provides the option of a vegetarian menu Provides shuttle busses for meeting participants in place of individual transportation (e.g. cars and taxis)
Serena Hotels Nairobi Hotel has an environmental policy/action plan Recycles paper, plastics and glass. Additionally all organic waste is converted to pigswill. The hotel strives to reduce industrial diesel oil fuel consumption by running boilers on lower flames and lagging of all steam lines. 35% of all lighting in rooms and 40% of all lighting in Hotel is reduced energy e.g. efficient lights, use of task lighting, low energy star light bulbs or automatic controls Water saving devices e.g. automatic shut-off faucets and showers, and low flush toilets installed in some washrooms Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages Hotel provides fair trade labelled coffee, tea, sugar and flowers Hotel restaurant provides the option of a vegetarian menu Provides shuttle busses for meeting participants in place of individual transportation (e.g. cars and taxis)
Windsor Golf and Country Club Hotel has an environmental policy/action plan, and is environmentally audited every year Recycles paper, plastics and glass; additionally organic waste is collected for pig feed 30% of all lighting in public areas of the Hotel is reduced energy e.g. energy star bulbs, timer switches and photo-cell outdoor lights Hotel restaurant provides locally-grown organic produce, local food supplies and locally produced beverages e.g. the hotel uses coffee grown on the premises Hotel restaurant provides the option of a vegetarian menu Provides shuttle busses for meeting participants in place of individual transportation (e.g. cars and taxis)

ANNEX G: STUDY QUESTIONNAIRES

a) NON-DOMESTIC WASTE GENERATORS

Date: ___/____/ 2009 Time: _____ Location: _____
Name of Institution: _____
Type of Institution: _____
GPS Coordinates: Way Point: ____ S: _____E:_____
Name of Interviewer(s) _____
Contact Person: _____
Person interviewed: _____Title: _____
Phone: (+254) _____Fax: (+254) _____
Email: _____

1. BACKGROUND INFORMATION:
Approximate size/area of institution
(Size can be measured by area, beds in case of hotel, animals in case horses, people in institutions etc. If in a market, include the sellers.)
Hours of operation?
Days of operation in a year
Days closed in a year

2. WASTE CHARACTERIZATION:
Waste composition (tick all that applies):
Raw veggies & fruits ☐ Cooked/processed food & beverages ☐

Paper ☐ Textiles ☐ Leather/Skins/Hides ☐

Yard waste ☐ Wood ☐ Soil ☐

Cardboard ☐ Meat ☐ Agricultural ☐ other organic _____

Sewage/liquid ☐

Inorganic (plastic, glass, metal, etc) ☐

Do any documentation/records exist on waste generation and collection/disposal? If so can copies be made available?
Is this all the waste? (ask the person in-charge of the dumpsite)
Is this the normal quantity of waste per day? (get a description)
Volume/quantity of the waste generated
(In terms of how many trucks, pick-ups, bins per day, week or month)
What proportion(percentage) of the waste is organic (may need to be defined for some
Sources/origins of the waste (activities, departments etc)
Is there variation in waste composition or quantity:
Describe Variations (composition and quantity
Reasons and periods of variation(time of day, season, and occupancy)
Are there any plans to expand the size/capacity of your institution? When? Describe changes in the

amount and type of waste in the last two years?

3. WASTE MANAGEMENT:

Description of waste management system in the institution

Handling

Collection

Disposal

Any involvement of Nairobi City Council

What are the responsibilities in waste management within the institution (waste collection, disposal, handling etc)

Are there external contractors?(fill in the details on the attached contact sheet)

What are the costs incurred for waste management? How often is waste collected?(periodicity and time)

Who pays for this service? Has this always been the system you have used?

If NO, what other system? Waste destination: How does the waste usually leave the market/institution?

Routes taken

Trucks/Pick-ups/Lorries

Are there waste transfer stations/depots, etc in the neighbourhood? If so where?

Do you separate your wastes?

If yes, how do you separate them?

What happens to the organic waste after separation?

Is waste stream contaminated or mixed with hazardous waste? (Interviewer may need to use best judgement)?

Uses of the organic waste? Is any of the organic waste composted? By who? **(*Fill in the details on the attached contact sheet)***

Claims to the organic waste: (fill in the details on the attached contact sheet)

Payment for the organic waste (if any)

Has the waste management system changed in the last two years***?***

If yes, how so?

4. WASTE MANAGEMENT IMPROVEMENTS:

What improvements could be made to your waste management system?

Ideas on organic waste reduction at source:

Willingness to implement organic waste reduction ideas?

Barriers to implementation (e.g. lack of vehicles, no space available, dirtiness associated with waste, lack of convenience, high staff turnover, lack of time, lack of funds)?

Are you willing to compost own waste?

If yes, would you be willing to have it collected, and under what circumstances (e.g. they don't have to pay for the services, service is regular, compost/organic waste can be sold)? Cost (if any)

ADDITIONAL INFORMATION:

6. Sketch map of the inside and perimeter of the market with location of skips, heaps, and other kinds of waste accumulations (on a sketch pad)

7. Photo-documentation of waste behind or near the stalls, on the ground, in containers, and however it is discharged.

8. Photo-documentation of waste inside, in containers, and however it is discharged

9. Take the measurements of the waste container, sketch the container.

10. Take the measurements of the waste disposal site, sketch the site

WASTE CHARACTERIZATION SHEET:

WASTE TYPE	Sample 1	Sample 2	Sample 3	Average
Raw Vegetable & Fruit Waste				
Paper				
Cooked/processed food & beverage waste				
Leather				
Yard				
Wood (specify if timber, painted wood, demolition waste, etc)				
Soil				
Cardboard				
Meat Waste				
Inorganic				
Agricultural (specify type)				
Other organic (e.g. manure, cooking fats etc)				
Total				

b) ORGANIC WASTE USERS

Date: ___/____/2009 Time: _____ Location: _____
Name of Institution: _____
Type of Institution: _____
GPS Coordinates: Way Point: _____ S: _____E:_____
Name of Interviewer(s) _____
Contact Person: _____
Person interviewed: _____Title: _____
Phone: (+254) _____Fax: (+254) _____
Email: _____

1. BACKGROUND INFORMATION:

Approximate size/area of institution

(Size can be measured by area, beds in case of hotel, animals in case horses, people in institutions etc if in a market, include the sellers)

Hours of operation?

Days of operation in a year

2. COMPOST GENERATION:

Where do you get your compost from

Are there any payments for it?

What costs do you incur when generating your compost?(if they do not buy, or get from another source)

What do you use your compost for?
Do you prefer using compost to ordinary fertilizers? YES ☐ NO ☐
Volume/quantity of the compost generated
(In terms of how many trucks, pick-ups, bins per day, week or month)
Sources/origins of the organic waste
Is the organic waste usually segregated at source?
Do you have a preference for certain types of organic waste, to use in composting?
Which types if any?
Volumes of organic waste to compost?(In terms of how much is required to generate a kilo of compost)

3. COMPOSTING BIOGAS GENERATION PRACTICES
How do you compost your waste
How much compost do you generate per month
What are the costs incurred for compost generation?
Do you sell any of the compost you generate? YES ☐ NO☐
Who are your buyers(enter contact details on contact sheet)
How much do you sell it for
Why do you generate compost? (In terms of , is it a business venture, it's cheaper than using fertilizers)Who pays for this service?
Do you add any value to your compost (any additives)?
Do you generate biogas?
What do you use it for?
What costs do you incur in generating biogas?
Compost destination: How does the compost usually leave the market/institution?
Routes taken
Trucks/Pick-ups/Lorries
Packaging

4. COMPOSTING IMPROVEMENTS:
Why do you think many farmers are not using compost for farming?
What are the main problems you face with regard to generating compost/ biogas?
Willingness to implement organic waste reduction ideas? YES ☐ NO☐
Barriers to implementation (e.g. lack of vehicles, no space available, dirtiness associated with waste, lack of convenience, high staff turnover, lack of time, lack of funds)?