COUNTY GOVERNMENT OF BUNGOMA

BUNGOMA MUNICIPALITY INTERGRATED WASTE MANAGEMENT PLAN

2021- 2031
DRAFT PLAN

EXECUTIVE SUMMARY

waste management remains as one of the major development challenges globally, nationally and at the County level. In the year 2010, the new constitution rationalized the portfolio responsibilities and functions of all the county government Departments. Consequently, the County Government of Bungoma formed the Department of Water, Environment and Natural Resources which is responsible for solid waste management in the County. In the year 2019, solid waste management for Bungoma Municipality was delegated to the Bungoma Municipal Board through a municipal charter.

It is indicated that waste management problem is a consequence of multiple factors which include: rapid urbanization; limited human and financial resources; weak organizational structures; ineffective laws on waste management; failure of garbage storage, collection, transportation, recovery and disposal systems; low public awareness; lack of a framework for Public Private Partnerships (PPP) for the sector; and emergence of new streams of waste (e.g. E-waste, End of-Life-Vehicles, sanitary waste) which pose new environmental management challenges. Due to these factors, a large part of the solid wastes in the town remain uncollected. Resultant effects include spread of infectious diseases, blocked sewers, litter in the streets and pollution of River Khalaba and Sio through crude dumping.

The purpose of the Waste Management Plan is to guide Bungoma Municipality on sustainable waste management by ensuring a healthy, safe and secure environment for all. The plan is a deliberate and visionary commitment for the municipal board in the management of wastes. It is proposed that this plan will cover a period of ten (10) years with a review at every three (3) years. With the full implementation of the plan, it is expected that the municipality will have embraced environmentally sound waste management technologies and best practices.

ACKNOLEDGEMENT

The completion of this Integrated Waste Management Plan for Bungoma municipality is a big milestone in the management of wastes. This exercise was possible by putting concerted efforts together. A multidisciplinary team from various Departments were involved in making this process a success. We first recognize the Chairman of Bungoma Municipal Board Arch Douglas Sasita, the chairperson of Environment Committee Hon.Edith Shitandi who initiated the formulation of this plan. Appreciation to the Municipal Manager CPA. Gabriel Kibiriti for coordination and facilitation for completion of this document. Lastly, we appreciate the technical team which was led by Pascal Wakafura – Municipal Public Health Officer who led the team. The other technical team members were: Caleb Kishombe- Municipal Administrative Officer, Andrew Keya – Municipal Physical Planner, Michael Wekesi – Municipal Finance Officer, Susan Misiko – Municipal Accountant and Michael Wafula – Civil Engineer.

. Signed

CPA- Gabriel Kibiriti
Municipal Manager/ Secretary to the Board
Municipal Board of Bungoma

LIST OF ABBREVIATIONS

AMREF: Africa Medical Research Foundation
CBD: Central Business District
CBOs: Community Based Organizations
CECM: County Executive Committee Member
CTS: Central Transfer Station
EAC: East African Community
EALA: East African Legislative Assembly
EACR: East Africa Compliant Recycling
EMCA: Environment Management and Coordination Act
EHS: Environment Health and Safety
EPEA: Environmental Planning, Education and Awareness
ESIA: Environment and Social Impact Assessment
ESMF: Environmental & Social Management Framework
E-Waste: Electronic Waste
GPS: Geographical Positioning System
HCW: Health Care Waste
HP: Horse Power
ICT: Information Communication Technology
IT: Information Technology
ISUD: Integrated Strategic Urban Development
IWM: Integrated Waste Management
ISWM: Integrated Solid Waste Management
KEBS: Kenya Bureau of Standards
NZOWASCO: Nzoia Water and Sewerage Company
MOU: Memorandum of Understanding
MCAs: Members of County Assemblies
MRFs: Material Recovery Facilities
NGOs: Non -Governmental Organizations
PCs: Private Collectors
PPE: Personal Protective Equipment
PPP: Public Private Partnership
RAP: Resettlement Action Plan
SMEs: Small and Medium Enterprises
SW: Solid Waste
SWM: Solid Waste Management
UPVC: UnPlasticized Polyvinyl Chloride
WEC: Ward environment Committees
WEE: Waste Electrical Equipment
WtE: Waste to Energy
WEX: Waste Exchange Platform

Contents

CHAPTER ONE

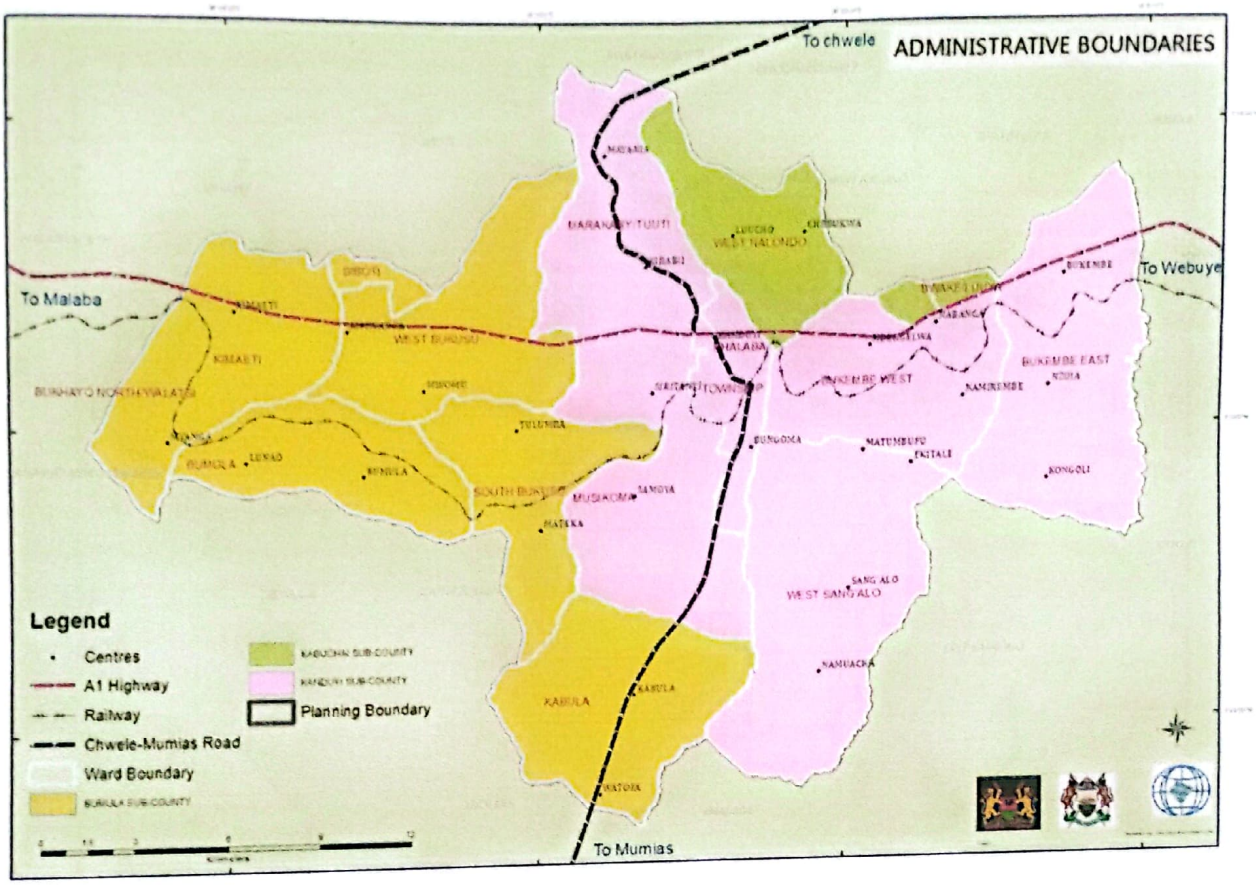
INTRODUCTION

1.1 About Bungoma Municipality

The Municipality is 57.9Km^2 and lies within the Lake Victoria Basin, with coordinates; 000 34'00''N 340 34'00''E /0.56667N 34.566670 E and an altitude range of 4,544ft (1,385m) above sea level. It is fast growing as it serves as the capital of Bungoma County with a population projection of 110,528. The Municipality has about 19,500 households with the average household size estimated at 5 persons per household with women population being slightly higher than those of men according to the 2009 Kenya population and housing census. The township location which is the core urban has the highest population density of about 3,133 persons per square kilometer due to the available business opportunities whereas Musikoma Location having more households practicing agricultural activities has a low density of 863 persons per square kilometer.

Bungoma Municipality is the Headquarters of Bungoma County. The current municipality consists of two locations namely Township and Musikoma. Township location consists of the core urban area whereas Musikoma consists of the rural part of the municipality. The Municipality is also divided into electoral wards of Kanduyi Constituency covering an estimated area of about 57.9 km^2. The wards include; Township, Khalaba and Musikoma. Map 1 shows the Administrative boundaries of Bungoma Municipality. Moreover, there is a proposal to extend municipal boundary as shown in map 2.

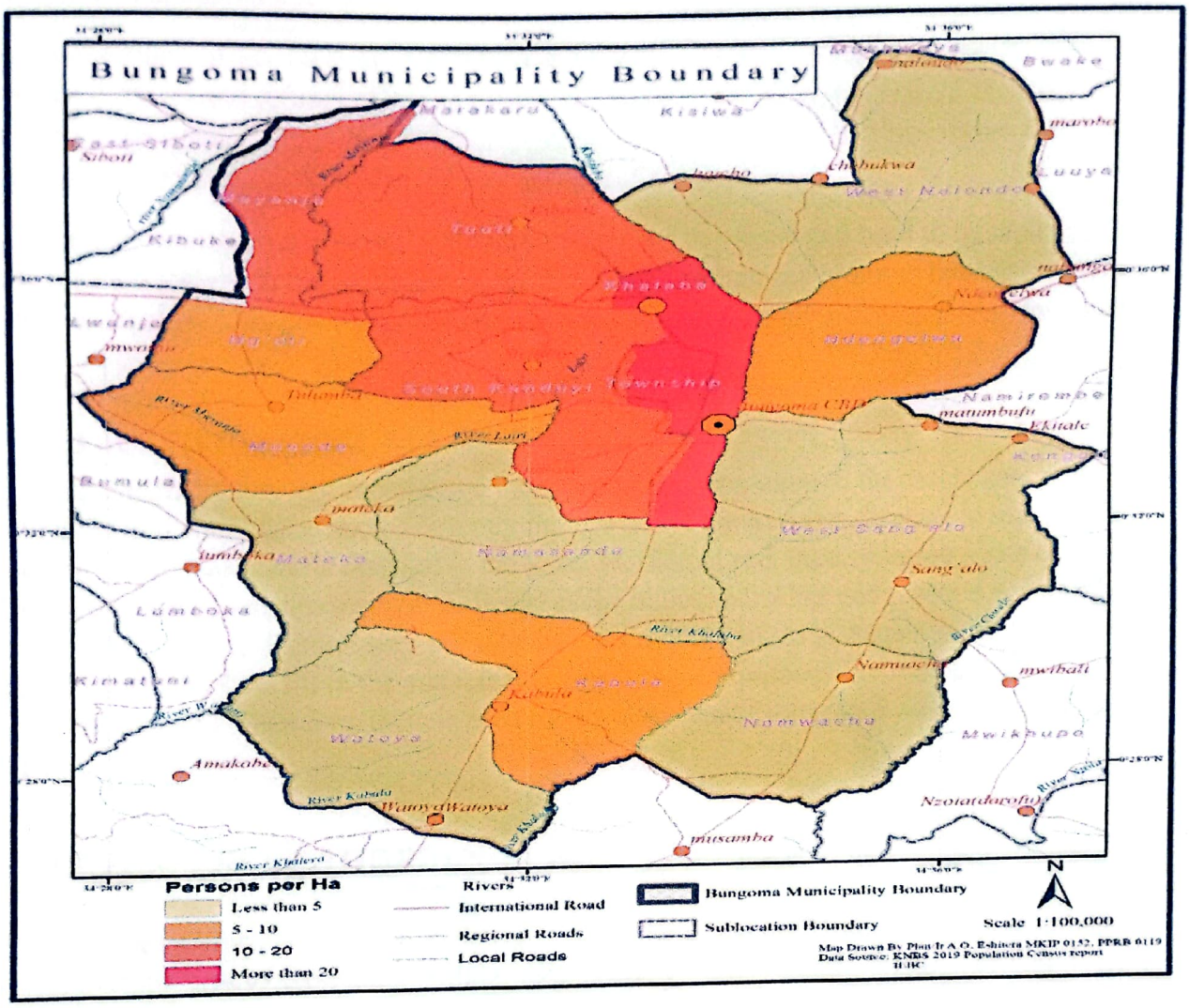
Map 1 The Administrative Boundaries of Bungoma Municipality



All human activities generate waste which requires to be properly managed for the protection of human health and environment while enhancing aesthetics. This scenario is particularly evident in urban settlements which generate large quantities of wastes due to high human population. The impacts of poor waste management within the County's urban settlements are disastrous. As such there is need for proper and efficient waste management.

Kenya Vision 2030 recognizes the need for efficient and sustainable waste management systems to be established as the country develops into a newly industrialized state by 2030. Guided by the Environmental Management and Coordination (Waste Management) regulations of 2006 and other relevant legislative frameworks. This strategy provides for the guiding framework for waste management within Bungoma Municipality. It shall guide the municipality waste management actors by providing effective, efficient and sustainable services while utilizing wastes as an economic resource.

Map 2: Proposed Extended Municipality Boundary



1.2 PROBLEM STATEMENT

Waste generation in Bungoma municipality is mostly from the urban areas which include: Bungoma Central Business District, Mandizini, Muslim, Mjini, Khalaba, Muteremuko and major residential estates like Marell, Sinoko and Kanduyi due to high population density.

Waste disposal is a challenge in the town. Heaps of garbage litter the markets, Bus park and residential areas especially in the Mjini and Mandizini informal settlements.
The town has several garbage collection sites located in Mjini, Mandizini, Kanduyi, Chebukube market and the Bungoma main stage. However, the number of garbage collection sites is low relative to the large population. The collection points are also poorly maintained and waste segregation is non-existent.

Disposal of waste in Bungoma Municipality remains a major challenge as the municipality has not gazetted and designated proper or adequate disposal sites nor established a modern waste

management facility. There exists no sanitary land fill in the municipality which is the minimum environmental standard set for a disposal site.

Bungoma municipality faces an enormous challenge in providing adequate public sanitation, sewage disposal and refuse collection facilities. The main waste water disposal methods include the sewerage system, septic tanks and pit-latrines. A section of the CBD has access to the sewer line which is underutilized due to the low number of connections.

The sewers constructed in early 1960s are in very poor condition and need to be replaced. Very low flow is received at the treatment works due to the low number of sewer connection within the municipality. This flow is further compounded by water supply situation within the town.

1.3 JUSTIFICATION

Bungoma municipality has experienced increased urban population in the recent past resulting into increased waste generation. Currently there is unstructured waste disposal in municipality leading to harvadous waste disposal in the town, inefficient and uncoordinated waste collection. Disposal of waste remains a major challenge as the municipality has not gazetted and designated proper and adequate disposal sites nor established a modern waste management facility. There exists no sanitary land fill in the municipality which is the minimum environmental standard set for a disposal site. Therefore, there is need for development of integrated waste management plan.

1.4 PURPOSE OF THE PLAN ✓

The purpose of Waste Management Plan is to guide the Bungoma Municipality on sustainable waste management by ensuring a healthy, safe and secure environment for all. The Plan is a deliberate and visionary commitment for the municipal board in the management of wastes.
The guiding principles of this Plan are as follows:

- ✓ Sustainability
- ✓ Inclusivity
- ✓ Efficiency
- ✓ Safety

1.5 SCOPE OF THE PLAN ✓

The scope of this plan covers the entire Bungoma municipality of an approximated area of 57.9 km2. The plan entails the following:
1. The management and minimization of waste that will be collected, streamed, diverted, processed or treated and recycled.
2. The management of waste that will be disposed off at a licensed, regulated landfill site inside the Municipality's boundaries or any other waste management site under its direct control.

3. All individuals residing or visiting the Municipality and entities doing business or providing any form of private, public or community service requiring waste management services.
4. All service providers operating in the waste management industry.
5. The management and regulation of all waste that may include liquid or fluid wastes which are generated in the municipality with special provisions for the handling, processing, treatment and disposal of hazardous wastes as well as waste generated by the health services industry.
6. The regulation of waste crossing the Municipality's boundaries to ensure proper management, recycling and control of all types of waste.

1.6 OBJECTIVES ✓

The overall objectives of this plan are:

1. To establish a basis for a plan and regulatory frameworks on integrated waste management.
2. To enhance environmental protection from waste pollution.
3. To establish a sustainable integrated waste management system based on community support and PPP approaches.
4. To raise public awareness on sustainable management of wastes in Bungoma municipality.

1.7 VISION AND MISSION OF THE WASTE MANAGEMENT PLAN IN BUNGOMA MUNICIPALITY.

VISION ✓

A thriving healthy, safe, secure and sustainable waste management system.

MISSION ✓

To create a sustainable, safe and efficient waste management system.

CHAPTER TWO

2.0 CURRENT SITUATION OF WASTE MANAGEMENT IN BUNGOMA MUNICIPALITY

Waste generation in Bungoma municipality is mostly from the CBD, Mandizini, Muslim, mjini, Khalaba, Muteremuko and major residential estates like Marell, sinoko and Kanduyi due to high population density. Some of the wastes from the rural part of the municipality is used as composed manure. The wastes in urban areas is collected every day and disposed at the counties disposal ground.

Solid waste disposal is a challenge in the town. Heaps of garbage litter the markets, bus park, and residential areas, especially in the Mjini and Mandizini informal settlements.

The town has several garbage collection sites located in Mjini, Mandizini, Kanduyi, Chebukube market and the Bungoma main stage. However, the number of garbage collection sites is low relative to the large population. The collection points are also poorly maintained and waste segregation is non-existent. The county's Department of Environment is in charge of solid waste collection and collected waste is transported and dumped at the mwanda dumpsite.

Table 20: Projection of the Total Waste Generation in Bungoma Town

WASTE CHARACTERIZATION	2009 (TONS/DAY)	2015 (TONS/DAY)	2025 (TONS/DAY)
Residential waste	105	127	171
Market waste	26	32	48
Commercial waste	26	32	48
Medical waste	0.28	0.34	0.46
Total	157.28	191.34	267.46

Source: Nile Basin Initiative- Sio-Malaba-Malakisi Watershed Management Study

Approximately 10-20% of the total waste generated is collected. This indicates that the county government does not have sufficient capacity in terms of manpower and facilities to carry out effective solid waste management in the town.

However, the county government has initiated a rapid result initiative integrated solid waste management program to deal with the garbage and litter menace in the town. There are also plans for waste compaction and rehabilitation of the mwanda dumpsite.

Figure 1 Mwanda dumpsite

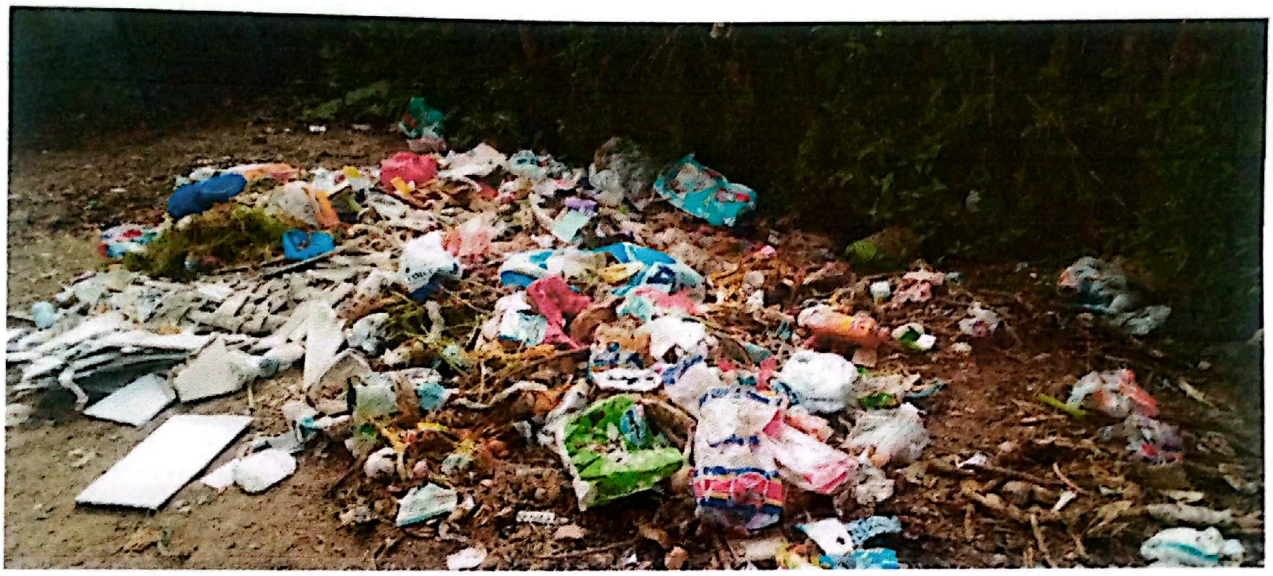
Waste transportation in the municipality is largely basic – open trucks and tractors. The inadequacy in transportation modes has led to littering and open dumping making waste an eyesore particularly plastics in the environment. The municipality also faces the challenge of lack of enough waste collection trucks whereby one truck serves the whole municipality. Frequent breakdown of trucks has led to inconsistency in collection as per schedule leading to accumulation of waste in the designated areas.

Figure 2 Open Collection truck

2.1 WASTE DISPOSAL

Disposal of waste in Bungoma Municipality remains a major challenge as the municipality has not gazetted and designated proper or adequate disposal sites nor established a modern waste management facility. There exists no sanitary land fill in the municipality which is the minimum environmental standard set for a disposal site.

Figure 3 Undesignated waste disposal in Marell Estate



The following is a breakdown of the major categories of solid waste generators: -

1. Retail Agri- markets
2. Hotels and restaurants
3. Wholesale and retail outlets
4. Manufacturing
5. Financial, educational institutions
6. Other offices
7. Construction waste

Waste Streams	
▪ Food, kitchen and garden waste	▪ Scrap metals
▪ Agricultural waste	▪ Construction and demolition debris
▪ Automotive waste (oil, tyres, end of life vehicles (or vehicle parts)	▪ Medical waste
▪ Paper and cardboard	▪ Sewage sludge
▪ E – waste	▪ Batteries, expired chemicals and pharmaceuticals

The most common forms of solid waste generated in the municipality is the organic waste which is mainly generated at household level and agricultural produce/food markets, hotels and restaurants. Inorganic waste such as E-waste, plastics, glass bottles, construction waste and junk are also produced but in low quantities. Public and private health facilities generate biomedical waste.

The waste characteristic is estimated to be as enumerated in the table below:

Table 1: solid waste characterization

Type of waste	Percentage
Organic	51%
Plastics	11%
Paper and paper products	9%
Glass	5%
Metals	2%
Inerts such as sand, rubble, dirt etc.	4%
Others (totally mixed waste at collection)	18%

Source Bungoma Urban Local Development plan

2.2 LIQUID WASTES ✓

Bungoma municipality faces an enormous challenge in providing adequate public sanitation, sewage disposal and refuse collection facilities. The main waste water disposal methods include the sewerage system, septic tanks and pit-latrines. A Section of the CBD is connected to the Sewer Line which is underutilized due to the low number of connections. Outside the CBD a combination of septic tanks and pit latrines are in use.

Sewerage services are provided by NZOWASCO. The Bungoma sewerage system was first constructed in the early 1960s and primarily served the central commercial area. The sewers drain by gravity to newly constructed treatment works, commissioned in 2002 which have a design capacity of 1,350m3/day.

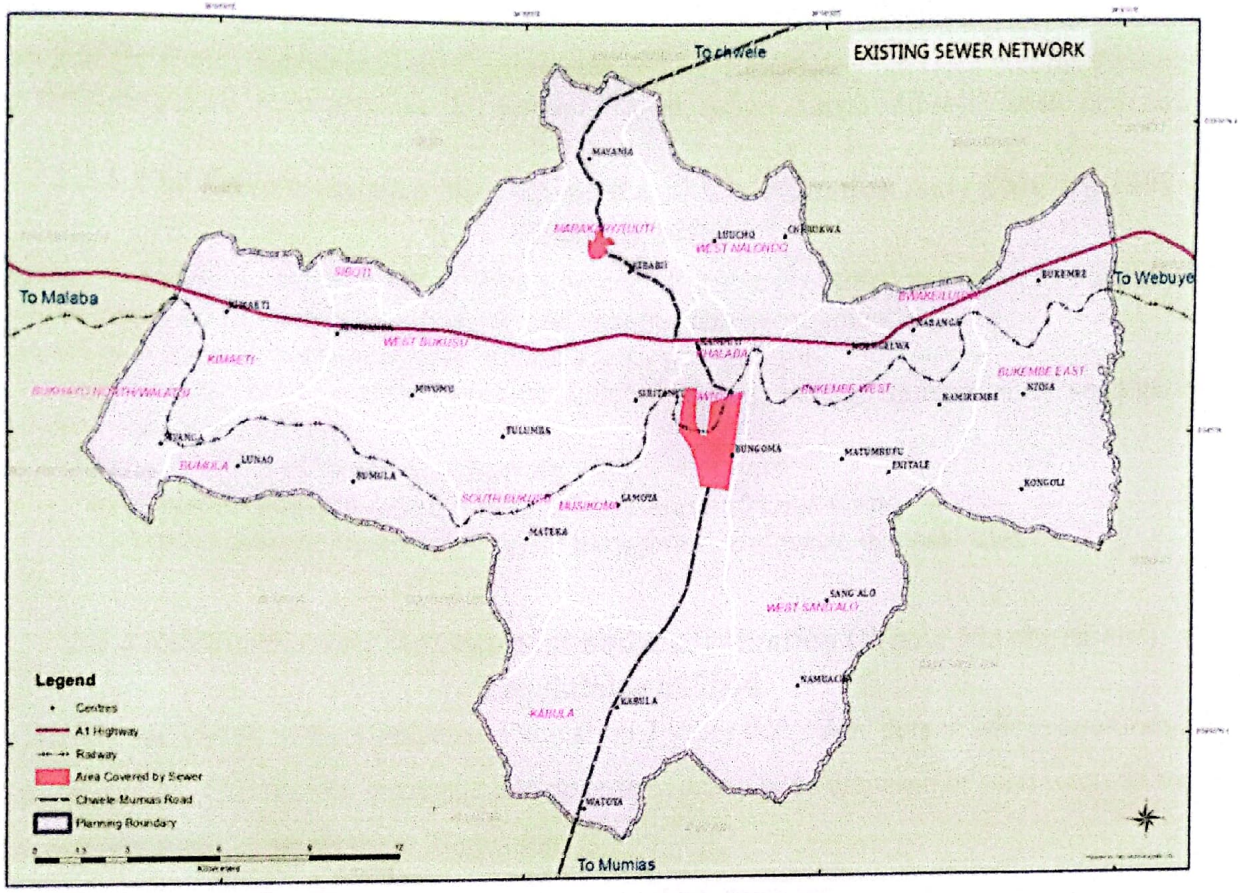
The sewerage network comprises of approximately 11.5 km of UPVC pipes and covers approximately 80% of the central commercial area. Few households are connected to the system due to the topographical conditions. Currently there are 568 sewer connections in the bungoma municipality which is quite low given the growing size of the town.

The sewers constructed in early 1960s are in very poor condition and need to be replaced. However, the sewers constructed in 2002 are in good condition. The Bungoma sewage treatment works is located at the south western edge of the municipality. Commissioned in 2002, the works form a waste stabilization pond system with a design capacity of 1,350 m3/day (dry weather flow). The works consist of an anaerobic pond (5,060m3), primary ponds (2*23,350 m3),

secondary ponds (2*6,750 m3) and maturation ponds (2*6,735 m3). Very low flow is received at the treatment works due to the low number of sewer connection within the municipality. This flow is further compounded by water supply situation within the town.

Figure 4 Sewerage Treatment Works(Lagoons) in Khalaba

Map 3: Existing Sewer Network



2.3 LEGAL FRAMEWORK, POLICIES AND REGULATIONS.

2.3.1 INTRODUCTION

Laws and policies are relevant as they indicate the desired development goals of the formulating institution as well as the means of achieving the goals. Each legislative body provides relevant institutional guidelines that relate to the process of waste management. On the other hand, institutions are agents of policy implementation. An understanding of the relevant policies and institutions helps to ensure proper coordination and implementation of any given plan. Bungoma waste management plan is linked to various laws and policies which include:

2.3.2 Constitution of Kenya 2010

In the Constitution of Kenya 2010 Article 42 on the Environment provides that - —Every person has the right to a clean and healthy environment, which includes the right

(a) to have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69; and

(b) to have obligations relating to the environment fulfilled under Article 70.

Part 2 of the fourth Schedule in the Constitution of Kenya explicitly provides that the County Governments shall be responsible for; refuse removal, refuse dumps and solid waste disposal.

2.3.3 The Environmental Management and Coordination Act (EMCA), 1999 (Revised 2015)

Section 3 of EMCA, stipulates that, "Every person in Kenya is entitled to a clean and healthy environment and has a duty to safeguard and enhance the environment".
The act in Section 9, Section 86 and Section 87also provides for-

a) The standards of waste including such as handling, storage transportation, segregation and destruction of any waste.
b) Prohibition of handling dangerous waste
c) Classification and management of hazardous and toxic waste
d) Transportation, licensing of waste transporters and waste disposal sites

2.3.4 Environmental Management and Coordination (Waste Management) Regulations of 2006

In the Responsibility of the Generator, Regulation 2 states that, "Any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed of such waste in the manner provided for under these Regulations".

Regulation 5 on the Segregation of waste by a generator states that, "(1) Any person whose activities generate waste, shall segregate such waste by separating hazardous waste from nonhazardous waste and shall dispose of such wastes in such facility as is provided for by the relevant Local Authority".

2.3.5 The Occupational Safety and Health Act, 2007

The Occupational Safety and Health Act, 2007 Part IX, Chemical Safety, Section 83 Subsection IV states that at every workplace where chemicals or other toxic substances are manipulated, the employer shall develop a suitable system for the safe collection, recycling and disposal of chemical wastes, obsolete chemicals and empty containers of chemicals to avoid the risks to safety, health of employees and to the environment.

2.3.6 The Public Health Act, 2012

The Public Health Act Revised Edition 2012, Part 126. Rules under Part, The Minister, on the advice of the board, may make rules and may confer powers and impose duties in connation with the carrying out and enforcement thereof on local authorities, magistrates, owners and others as

to—(d) the drainage of land, streets or premises, the disposal of offensive liquids and the removal and disposal of rubbish, refuse, manure and waste matters.

Section 118 - What constitutes nuisance-1. The following shall be deemed to be nuisances liable to be dealt with in the manner provided in this:

Part—(c) any street, road or any part thereof, any stream, pool, ditch, gutter, watercourse, sink, water-tank, cistern, water-closet, earth-closet, privy, urinal, cesspool, soak-away pit, septic tank, cesspit, soil-pipe, waste-pipe, drain, sewer, garbage receptacle, dust-bin, dung pit, refuse-pit, slop-tank, ash-pit or manure heap so foul or in such a state or so situated or constructed as in the opinion of the medical officer of health to be offensive or to be injurious or dangerous to health.
Part (e) states that any noxious matter, or waste water, flowing or discharged from any premises, wherever situated, into any public street, or into the gutter or side channel of any street, or into any or watercourse, irrigation channel or bed thereof not approved for the reception of such discharge constitutes to be a nuisance.
Section 126 - Rules under Part, The Minister, on the advice of the board, may make rules and may confer powers and impose duties in connection with the carrying out and enforcement thereof on local authorities, magistrates, owners and others as to—**part (d)** the drainage of land, streets or premises, the disposal of offensive liquids and the removal and disposal of rubbish, refuse, manure and waste matters.

2.3.7 The County Governments Act, 2012

Section 120, Tariffs and pricing of public services, subsection (3) A tariff policy adopted under subsection (1) shall reflect following guidelines — part (h) promotion of the economic, efficient, effective and sustainable use of resources, the recycling of waste, and other appropriate environmental objectives.

2.3.8 The Environmental (Impact Assessment and Audit) Regulations, 2003

This regulation defines "waste" includes any matter prescribed to waste and any matter whether liquid, solid, gaseous or radioactive, which is discharged, emitted or deposited in the environment in such volume composition or manner likely to cause an alteration of the environment.

Part IV - The Environmental Impact Assessment Study Report, 18. (1) A proponent shall submit to the Authority, an environmental contents of impact assessment study report incorporating but not limited to the environmental following information - (f) the products, byproducts and waste generated project;

Part V - Environmental Audit and Monitoring 36, (2) an environmental audit report compiled under these Regulations shall contain - (b) an indication of the various materials, including non-manufactured materials, the final products, and by products, and waste generated.

2.3.9 THE WATER ACT 2016

AN ACT of parliament to provide for the regulation, management and development of water resources, water and sewerage services, and for other connected purposes.

In the Part II section 10 sub section 2 it outlines national resource water strategy that shall provide governments, plans and programmes for the protection, conservation, control and management of water resources.

2.3.10 URBAN AREAS AND CITIES ACT NO.13 OF 2012

According to this ACT solid waste management is the one of the functions that was delegated to the municipalities. Therefore, municipalities have to come up with policies, plans and programmes for management of solid wastes.

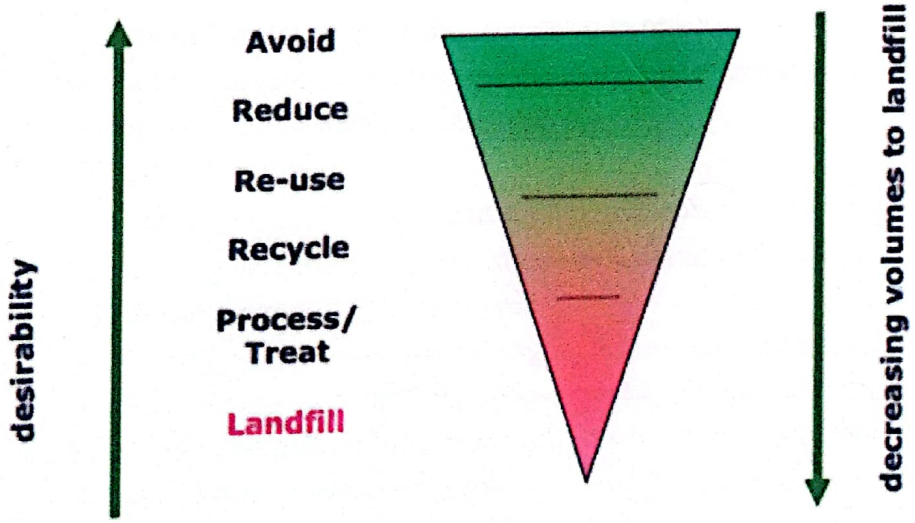
CHAPTER THREE

3.0 STRATEGIC AREAS AND PROPOSED ACTIONS

Based on the baseline surveys; existing literature on the County, community and stakeholder consultations and existing municipal/ county development plans, policies and laws, the IWM plan was done through a rigorous process and Seven (7) prioritized strategic areas were identified. The Seven (7) strategic areas to be implemented in the next 10 years of this strategic plan include: -

1. Waste Reduction at Source
2. Waste Recycling and Composting
3. Incineration and Waste Recovery
4. Planning for a Sustainable Waste Management System
5. Institutional and Organizational Reforms
6. Capacity Building, Environmental Planning, Education and Awareness
7. Management of Hazardous and Special Wastes:(E-Waste, Medical Waste)

Pyramid 1: Waste Management Hierarchy



Details of each of these strategies are outline below:

3.1 WASTE REDUCTION AT SOURCE ✓

Waste reduction at source is the first priority in the ISWM hierarchy. In this plan, source reduction implies reducing the volume of waste at the source/ point of generation by changing the material-generating process. It includes incorporating reduction in the design, manufacture, sale, purchase, and use of products and packaging. Other terms that may be used to mean source reduction, include waste prevention and waste minimization. Source reduction objective is to reduce the amount of materials the municipality will produce and the harmful environmental effects associated with their production and disposal. It includes:

- Reduced material use in product manufacture
- Increased useful life of a product through durability and ease-to-repair
- Material reuse
- Reduced/ more efficient consumer use of materials and increased production efficiency resulting in less production of waste.

Source reduction will offer several opportunities for cost savings for the municipality management which include direct savings on waste collection, transportation and disposal costs.

Specific actions proposed are outlined below:

- ✓ **Waste Reduction Strategies and actions Source reduction legislation:** Source reduction legislation should be reviewed in order to provide guidelines on the following:
  - ♣ County Government/municipality procurement and purchasing requirements
  - ♣ Packaging requirements and guidelines
  - ♣ Labeling guidelines
  - ♣ Business licensing and reporting requirements on waste management
  - ♣ Banning garden and farm waste from disposal in the municipal disposal ground to encourage composting at the source.
  - ♣ Banning specific types of packaging (especially unstandardized plastic bags) for items bought from the supermarkets, shops, kiosks, markets, hardware shops, etc.
- ✓ **Economic incentives:** Introduce both economic incentives and disincentives to encourage source reduction. Proposed possible economic incentives include the following:
  - ♣ Fund research and development of source reduction and education programs in collaboration with public Universities in the region (like Kibabii and masinde muliro University of Science and Technology Universities) by postgraduate students or postdoctoral works. For example, there is need for life cycle analysis of all products in

the market. The results should be formulated into waste management policy briefs for easy utilization by the County Government.

- ♣ Supporting short term waste management and recycling technology training programs at technical colleges targeting youths, disabled and marginalized individuals.
- ♣ Establish waste business centers to act as waste exchange points. Waste exchange is where the waste product of one process becomes the raw material for a second process. This is similar to using pre-consumer recycled material in a product. It represents a way of reducing waste disposal through reuse for that which cannot be eliminated.
- ♣ The County Government /municipality should sponsor programs or create opportunities for volunteer programs such as neighborhood recycling workshops.
- ♣ Developing source reduction measurement standards and improved product designs to ensure value addition to final products.
- ♣ Funding other materials reuse programs and businesses
- ♣ Provide grants and annual prizes to recycling businesses, e.g. for motor vehicles, electronics, scrap metals, etc.
- ♣ Provide prize recognition for businesses that embrace waste reduction at source, especially plastic waste
- ♣ Providing grants, prizes and incentives to schools and other learning institutions who have put in place measures to reduce waste paper generation at source.

✓ **Proposed economic disincentives include the following: -**

- ♣ Creating local taxes/ charges that reflect disposal costs of packaging
- ♣ Increase charges for disposal of product that can be recovered at source and reused
- ♣ Instituting volume-based rates for all waste collection programs. All large waste generators to pay more.

Annual waste audits: Waste audits or assessments are the keys to successful source reduction programs in Bungoma municipality. They will involve assessing the material flow through an institution or businesses and preparing accounting for the amount of materials purchased, used, recycled and disposed off. This should be integrated to the National Environment Management Authority (NEMA) annual Environmental Audit of businesses by making it mandatory for the municipal board Management receiving copies of such audit reports as a feedback mechanism. The municipal Directorate of Environment should develop work sheets and guidelines that will help in guiding waste audits by various institutions and businesses in the municipality.

Selective purchasing: municipal management offices, organizations, institutions, and individuals should be educated and required to preferentially purchase products that are durable, reusable, and repairable; buy in bulk; and avoid purchasing single-use products. It is important for solid waste, environmental, and purchasing officials at all levels of municipal management to work together in planning, implementing, and monitoring source reduction programs. Reduction strategies for local industries: Bungoma municipality has some light industries. These include textile at Wekelekha TTI, bakery

and Buema quarry site. Also present in the main industrial area are large scale factories for maize milling. Other small industries are active in tailoring, making of handicrafts, housing and construction materials.

✓ **Proposed source reduction strategies for local formal and informal industries include the following:**

♣ Designing products and packaging with durability, reuse, and ease of repair in mind.

♣ Initiating "in-house" source reduction programs at company facilities Reduction strategies for offices, institutions and businesses: Proposed source reduction strategies for private and public offices, institutions and organization and local businesses within the municipality include the following:

♣ All businesses, offices and institutions in the town to develop and integrate source reduction internal policies.

♣ Promoting of copy double sided (back-to-back) printing in all offices, cyber cafes, printing and photocopying bureaus.

♣ Use of electronic mail among all staff of institutions/ organizations. Ensure all staff have access to email address.

♣ Install online systems that use bulk Short Message Service (SMS) among staff of the County and other institutions will help local institutions and businesses to increase overall efficiency, reduction of waste paper generation, office space for storage of documents and overall operation costs. The system will further reduce advertising, environmental education/ awareness and billing costs, and also improve on emergency notifications. Bulk messaging will let the County Government /municipality deliver SMS messages on waste management, reduction, recycling, etc. to all residents almost anywhere in the County.

♣ Circulate only one copy of printed material (memos, documents); use routing slips indicating who should read it and who has already seen it.

♣ Establish central physical and on-line document and file storage areas and systems.

♣ Reuse paper that has been printed on only one side for different purposes.

♣ Promote eco- shopping, i.e. the reuse and return of packaging materials

♣ Establish waste exchanges through the proposed waste business centers.

♣ Encourage businesses to sell items in reusable containers.

♣ Shops and supermarkets to provide items in bulk (with discounts) and encourage shoppers to buy in bulk to reduce packaging waste.

♣ Supermarkets and businesses to provide shoppers with incentives to reuse packaging materials like bags, cartons, boxes, etc.

♣ Municipal Environment Directorate to appoint waste reduction programs coordinator.

♣ Promote donation of household items like old clothes, utensils for re-use rather than disposal to dumpsite. This can be done through material exchange/ reuse information programs. Material exchange is where the Municipal managers bring together residents

who would like to discard any unnecessary or unwanted items with residents who are looking for used items in good condition. This could be done monthly or quarterly at municipality-wide level.

Source reduction campaigns:

✓ **Source reduction programs aimed at consumers and residents can achieve significant benefits.** An aggressive source reduction campaign for the residential/consumer sector involves using a variety of approaches in addition to regulatory tools. Decision makers can consider using the following:

♣ Economic incentives such as weight-based garbage fees for all generators, subject to PPP involvement.

♣ Environmental Education programmes in all Schools, Churches, Mosques, and Institutions.

♣ Provision of technical assistance and promotions aimed at increasing participation in source reduction activities like plastic paper bags reduction programs. This should mainly foster reducing the number of plastic bags emerging from major supermarkets (e.g. khetias, Naivas etc.) in the municipality in agreement with the municipal by-laws.

♣ Promotion of backyard composting practices especially in Schools, high income areas, Hotels, Hospitals (kitchen waste only), and other Institutions that produce large amounts of organic waste.

♣ Educate the public on waste reduction legislations and best practices.

♣Reduction of Plastic Waste: Plastic bags have a number of advantages over their substitutes. As a result, they have, through the years, replaced traditional and paper (khaki) bags and secured a firm place in the consumer economy of today including within emerging urban centers and hence the fastest growing component of the waste stream. They have also a number of good environmental qualities. In this regard, some studies have documented reduced generation of solid waste, reduced emissions to water and reduced energy consumption in the production of plastic bags as compared to paper bags. However, an assessment of their environmental impacts cannot be complete without consideration of their total lifecycle repercussions, especially end-of life impacts. It is estimated that over 200,000 plastics bags (2 bags per family) are generated daily (73million/ per year) from Supermarkets and informal Shops in the City. The vast majority destined to end up in the environment, clogging sewers and drains, act as mosquito breeding grounds, blight of landscapes and trees, polluting soil and water, posing a danger to aquatic life and causing death to livestock when inadvertently consumed. Plastic bags take a long time to degrade. Community consultations indicated that flimsy plastic bags are also associated with „flying toilets", another growing concern in slum settlements like mjini, Khalaba and Muteremuko and others. As a result, concern has been expressed from the public at large. According to the banning law published in March 2017, municipal management should work with all major supermarkets and shops

in the municipality and reduce the number of plastic bags used to package items for shoppers.

This is in line with the 3R principle of plastic waste management: re-use, reduce, and recycle. Heavier/ standard bags will also be easier to collect and recycle. This will increase jobs in the recycling (jua kali) sector for municipality residents. The Khetias campaign is geared at imploring shoppers to consider allowing their shopping to be packed in re-usable bags, used cartons and bales instead of plastic or paper bags. In addition, a donation is made by Khetias Holdings to Africa Medical Research Foundation (AMREF) for every purchase of a Khetias re-usable bag. All these are efforts geared at reducing the consumption of plastic bags by 85% in the long run. Khetias management believes that the plastics war can only be won through an aggressive, ambitious, integrated, focused and sustainable approach geared at sensitizing end users and shoppers to adopt a more responsible attitude by refraining from the use of plastic bags and opting to use reusable bags. On the other hand, over the past five years, campaigns to reduce the use of plastic bags in the East African region have been gathering pace. In the year 2017 the East African Legislative Assembly (EALA) passed the Polythene Materials Act, which is supposed to impose levies on producers and consumers of plastic bags. It is estimated that manufacturers of plastic bags in Kenya currently employ thousands of people directly since there are many people engaged in the distribution network, performing different jobs ranging from transportation to sales in the streets near markets. However, the EAC Polythene Materials Control law is yet to be implemented. The some of the above successful initiatives could be replicated by the municipal management to reduce waste generation.

♣ Monitoring and Evaluation of Source Reduction: Monitoring by the municipal Directorate of Environment should be an integral part of source reduction programs. Although standardized methods to measure source reduction have yet to be developed, tracking the costs associated with source reduction and integrating them into the decision-making process is essential to developing accountability. Monitoring will also facilitate evaluation of programs for efficiency and identifying other possible source reduction measures and program revisions. For example, close monitoring programs with major Supermarkets management will provide information on the number of plastic bags that have reduced over time.

3.2 WASTE RECYCLING AND COMPOSTING ✓

Recycling is the process by which materials otherwise destined for disposal are separated at source, collected, processed, and remanufactured or reused. This is increasingly being adopted by urban communities as a method of managing municipal waste and source of income for the urban poor. Whether publicly or privately operated, a well-run recycling program can divert a significant percentage of municipal, institutional and business waste from disposal and can help

to control waste management costs by generating revenue through the sale of re-cyclable materials. Public support for establishing recycling programs continues to increase in Kenyan towns. For the recycling and composting programs to succeed, the municipal management must aim at continually providing consistent stream of high-quality (free of contaminants) recovered waste materials that meet the standards of the market place and limit health risks to workers involved in the sector and therefore consider an upstream sorting of the recyclable waste.

The strategies proposed are categorized into two: **recycling** and **compositing**.

- ✓ **Recycling Strategies**: Establishing an effective recycling program presents major administrative and political challenges to the municipality. For a successful program, strategies proposed and procedures should be continually reviewed and adjusted according to evolving conditions and changing community needs and waste characteristics. The recycling program proposed uses systems approach. Proposed strategies are:
  - ➢ Promote Reducing, Reusing and Recycling of waste (3Rs) approach: It is expected that this will lead to the development of appropriate infrastructure to facilitate waste separation and recovery at source, promotion of incentives as well as formalizing informal waste entrepreneurs in the municipality. To facilitate the waste exchange between industries and to market re-usable materials at the waste Centers, a computer-based Waste Exchange Platform (WEX) should be established. The WEX shall provide a database on the wastes available at the centers (industry waste as well as post-consumer wastes) and operate on current marketing practices. Once the Centers are in operation, individuals as well as businesses and industries can sell re-cyclable/re-usable waste to the Centers. The Centers should initially accept only inorganic re-cyclable that have already been separated at the source from municipal solid waste generated by residential, commercial, institutional or industrial sources. The Directorate of Environment will prepare an investment proposal to secure private sector participation.
  - ➢ Characterization of re-cyclables in terms of volumes and accessibility: Should be undertaken by the municipal Environment Directorate once every year to obtain planning statistics and changing trends in waste characteristics.
  - ➢ Assess and generate sustainable political support: Municipal Environment Directorate should engage community and elected leaders at the Ward and Unit levels to get their support in source separation, willingness to pay for the waste management services, management of community facilities like transfer stations/ skips/ waste collection containers.
  - ➢ Cooperative marketing: Joint/ cooperative marketing of re-cyclable material can enhance marketability by increasing the volume of material available to buyers and consumers. Organize waste materials sellers, pickers and small re-cyclers/ artisans into cooperatives. The purpose of the cooperative movement will be to

help waste sellers, pickers and small scale/ informal re-cyclers in the municipality to make savings and also market their waste materials and re-cycled products at better and negotiated prices. Establishing cooperatives, waste pickers, sellers and re-cyclers can circumvent the middlemen majorly from Nairobi city and increase their profits. The cooperative should also provide welfare services for its members and help to dignify informal waste re-cycling activities. Cooperatives involved should have clear organizational structures and annual plans should be developed by registered members. These cooperative(s) should be benchmarked with successful similar cooperatives in Colombia, Brazil, Argentina, Mexico, Philippines, India and Indonesia where the members of the cooperatives have benefitted from increased incomes and profits. The PPP approach proposed herein shall provide opportunities for cooperatives in the sector to render services for a fee, such as the collection of wastes and / or re-cyclables, street sweeping, composting operations and materials recovery facilities. The incorporation of small-scale waste actors into formal IWM programs and the awarding of contracts to waste management cooperatives can save the municipality money while providing a steady income to waste pickers and small re-cyclers.

- Assessment of markets, market structure and market development strategies for re-cyclables: The above proposed cooperative through the technical support of the municipality Management to undertake annual assessment of markets and market development strategies for re-cyclables. The county government/municipality shall endeavor to secure stable, reliable markets by basing marketing decisions on a clear understanding of the re-cyclables market system and sharing decision making among waste sellers, county government officials, the public and other relevant private sector actors. Assessing markets should involve identifying, profiling, selecting and contracting buyers.
- Appropriate waste management technology for collection and processing: Target to undertake recycling at small and medium scale using appropriate technologies.

✓ **Design of storage containers/ facilities:** A three color (Green, Red and Yellow) waste separation system at the point of generation or source is recommended where it will be possible: Proposed color-coding options for waste segregation/separation in the County of Bungoma

GREEN: Organic / Wet/ bio-degradable and compostable waste (mainly food wastes)

YELLOW: Inorganic Materials/ Dry waste (waste paper, glass, scrap metals, plastics)

RED: Hazardous/ dangerous materials/ Others (Clinical waste generated at the homes, batteries, pampers, expired chemicals and drugs, etc.)

The design, size and type of storage facilities must clearly distinguish the 3 colours and this must be legalized by county laws. Various designs, sizes and types of containers are recommended as outlined elsewhere in this strategy. When small amounts of waste generated a single container with three colours or plastic bags of different colours should be designed and legalized by the county government for households. For institutions, different containers with different colour codes are recommended as the most appropriate facilities. These colour system/codes should be implemented through a municipal-wide campaign and environmental education awareness system, piloting, exhibitions and demonstrations using all forms of media by targeting all city residents, students, etc. Mandatory waste separation at source and recycling regulations with option and flexibility are recommended for this strategy to work in the short and long run. Siting of collection points and options for preparing recyclables for collection. Collection from the communal/ village points is recommended to be contracted locally to a community group of youths or women or a cooperative of waste management actors like waste pickers.
Recommended options for preparing re-cyclables for collection will depend on individual community/ estate needs and circumstances that are appropriate.

The options recommended include the following:

- Source separation using the 3-colour system (Green, Red and Yellow)
- Curbside collection for multiple-family dwellings/ Apartments or gated estates
- House-to-house/ door-to-door collection

  - Start-up plan and commencement of re-cycling programme: The municipal management in partnership with various stakeholders should start with a voluntary or pilot re-cycling program and use information and experience gained from it to plan for a large-scale re-cycling program. The first step will be to select one Unit in High, Medium and Low estates to pilot the waste segregation and re-cycling programs proposed in a period of about 6-12 months. Piloting can also be done in one Unit per Ward depending on availability of funds. Then, the municipal management shall use lessons learned and roll out a mandatory re-cycling program throughout the Municipality.
  - Implement education and publicity program: The whole range of the system proposed should be implemented through a municipal-wide campaign and environmental education awareness system, piloting, exhibitions and demonstrations using all forms of media by targeting all municipal residents and Tertiary Institutions. The proposed section of Environmental Planning, Education and Awareness (EPEA) within the Directorate of municipal Environment should take a leading role in the implementation

of education and publicity program. Program publicity, promotion, and education must be a continuous process.

- Monitoring and Evaluation (M&E): The whole program components shall be continuously monitored and evaluated at the end of every financial year to undertake necessary review and adjustments to achieve success. The municipal Directorate of Environment will design monitoring system using indicators given in this plan. Composting Plans. The compositing programs should target compostable portion of mixed solid waste, including food wastes, waste paper products, and other decomposable organics. Composting organic materials can significantly reduce waste generated and offers economic advantages for the municipality and county government since the costs of other options are high. Composting as part of recycling is the second component in the hierarchy of ISWM at source reduction. When developing and promoting a composting program and when marketing the resulting compost, Bungoma municipal planners and managers should stress that the composting process is an environmentally sound and beneficial means of re-cycling organic materials not a means of waste disposal.

Developing and operating successful composting programs in bungoma municipalities presents several challenges. The challenges that need to be solved during the strategic period include the following:

- Lack of waste separation at source and collection systems
- Developing markets and end users
- Inadequate or non-existing national standards for finished compost
- Lack of knowledge and experienced technical staff on composting
- Potential problems with odours
- Controlling of contaminants from composting sites
- Usually low price of sales for this strategy to succeed the composting procedures recommended at the community/ household level.
- Collection of organic materials from the source and starting by markets where the organic part is high
- Making of compost piles at the household and institutional centers
- Turning, monitoring and screening of final product
- Packaging and marketing of the compost

♣ Utilization of compost in agricultural farms, urban forestry, urban agriculture and landscaping.

- Political support: Get political support for changing the community's waste management approach by the residents, MCAs and other leaders, CBOs, NGOs, etc. Most municipal composting projects whether county or privately operated will require some county governmental political and financial support or approval.
- Composting sites: composting is recommended at the community/ household level (Backyard Composting), institution and hotel backyards in small-scales. All actors must avoid using mixed waste for composting purposes due to contamination. One of the major advantages is the savings in transportation costs for the compost which should be close to the markets and also for the non-compostable and non-re-cyclables wastes. A second advantage is that the difficulty of acquiring a site is significantly reduced. Potential compost uses and marketing: Marketing compost products is crucial to the success of any program. Market outlets to be targeted to expand the market for compost include crop farming applications (urban, peri-urban and rural areas), horticulture, tree nurseries and greenhouses, parks, golf courses, soil remediation, cemeteries, landscaping of the towns/ urban centers, surface quarry reclamation material, roadside landscaping management, forestry applications as a top soil, office parks, new housing estates and playgrounds. All forms of marketing strategies should be used to create market for the compost product.

- ✓ **Environmental education, awareness and capacity building programs:** - Establishing an effective two-way communication process between county government, developers and the public is crucial and public involvement in the must begin during the planning stages. - Concerns voiced by public representatives should be addressed as early in the project's development as possible through video shows in various forums that include churches, schools, radio talks, newspapers and magazines articles/ adverts, T.V. programmes and public gatherings. - Communication with community leaders and neighbors of composting sites should be continuous. - To ensure good relations the public should be informed of the types of materials accepted and prohibited and the collection schedules. A complaint response procedure will also be important to document and respond to complaints promptly. municipal residents active in composting, planners and managers should visit successful compost programs in Kenya and other African countries like South Africa to benchmark and learn appropriate technologies.

  Participation of the County Ministry of Agriculture: County Ministry in charge of Agriculture will be required to take a leading role in market research, developing compost quality standards and running demonstration projects involving of the local farmers and give practical assistance to farmers and other users on the distribution and sale of the compost product. Opportunity exists to enhance synergies between urban and

peri-urban agriculture and other urban sectors through multi-stakeholder consultations on rural and urban agriculture policy, planning and management.

Inventory of materials available for composting: This should be done on a 5-year cycle basis for planning purposes. The planning process should include an accurate assessment of the quantities of materials available for processing and their composition and sources. This will also help in designing waste collection and other disposal programs.

Composting techniques, needs and compatibility: Composting at a household or community-level and other centers (like markets) at a small-medium scale is recommended. Pile, window and in-vessel composting systems are the most recommended in the municipality. A successful composting program will require space, trained manpower, the correct tools, good supply of quality and non-contaminated organic materials, enough water supply and ready market for the compost. Whichever approach is chosen, it should be compatible with existing collection, processing and disposal systems. All composting facilities require some degree of material separation which can take place at the source (as with source-separated programs) or at the processing facility. Labor intensive technologies should be given priority due to availability of cheap labor in the county.

County Government/municipality composting policy: Composting standards and guidelines should be regulated by amending the existing laws. The county government should explore the possibility of setting prices for compost and provide guaranteed supply and flexible price system. The County Government should also facilitate the process by providing permits, zoning variances/ change of user or special land use permits for all composting and re-cycling facilities where need arises.

Budget and financing: The County government to budget for every financial year (with an annual increment as per the inflation rates) to support composting programs at various levels. This can be used in constructing composting facilities at the municipal sanitary landfill and purchase marketing and supply equipment if needed.

- ✓ **Monitoring and Evaluation:** Routine testing and monitoring is an essential part of any composting operation. At a minimum the following should be monitored: compost mass temperatures, oxygen concentrations in the compost mass, moisture content, particle size, maturity of the compost, pH, soluble salts, ammonia, organic and volatile materials content. Overall, municipal management must also monitor the percentage of organic materials being composted, employment opportunities generated, health and safety conditions in composting sites, compost prices and general market conditions. Periodically, evaluation records will help to identify where improvements will be needed and provide information necessary for making the operations more efficient. We assume

that the organic waste is already in a landfill area hence avoiding additional transportation costs. The other assumption is that the organic waste is already sorted out and all hazardous and inorganic materials have been eliminated at the Central Transfer Station (CTS).

The following conditions must be met before a final policy and executive decisions are made:

- Undertake a market feasibility study for organic compost in the county and municipality
- Ensure all organic waste is separated at the source in all the county's urban centers so us to get the required minimum uncontaminated organic waste material
- Ensure that all organic waste is transported to the composting site at no extra cost to the composting plant investor
- Draft county policies and laws that promote organic farming by using organic compost products produced by the county government/municipality. The county government/municipality can also guarantee to purchase a given percentage of compost for farmers and opt to provide an initial short term subsidy to farmers that buy the compost.
- Establish quality control standards and procedures for organic approved by Kenya Bureau of standards

3.3 INCINERATION AND WASTE TO ENERGY RECOVERY

Prioritization of Incineration for the municipal Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials. Incineration and other high-temperature waste treatment systems are described as "thermal treatment". Incineration of waste materials converts the waste into ash, flue gas and heat. In some cases, the heat generated by incineration can be used to generate electric power as will be explained briefly below. Incinerators reduce the solid mass of the original waste by 80–85% and the volume (already compressed somewhat in garbage trucks) by averagely 95% depending on composition and degree of recovery of materials such as metals from the ash for recycling. This means that while incineration does not completely replace landfilling, it significantly reduces the necessary volume for disposal. Furthermore, incineration has particularly strong benefits for the treatment of certain waste types such as clinical wastes and certain hazardous wastes where pathogens and toxins can be destroyed by high temperatures. Incinerators may emit fine particulate, heavy metals, trace dioxin and acid gas, even though these emissions are relatively low from modern incinerators. Other concerns include proper management of residues: toxic fly ash which must be handled in hazardous waste disposal installation as well as incinerator bottom ash which must be reused properly.

One problem associated with incinerating Municipal Solid Waste (MSW) to make electrical energy is the potential for pollutants to enter the atmosphere with the flue gases from the boiler. These pollutants can be acidic and may cause environmental damage by turning rain into acid rain. However, modern industrial technology has solved this problem by the use of lime scrubbers and electro-static precipitators on smokestacks. By- passing the smoke through the basic lime scrubbers, any acids that might be in the smoke are neutralized which prevents the acid from reaching the atmosphere and polluting the environment.

Plant Recovery of energy from waste remaining after organic and re-cyclable solid waste removed is not likely to be cost-effective and could therefore even be counterproductive for the material recovery projects. Moreover, the recent ban of plastic bags has even more reduced its interest and benefits.

3.4 PLANNING FOR A SUSTAINABLE WASTE MANAGEMENT SYSTEM

This strategy focuses on the planning of sustainable storage, collection, transportation and disposal systems. Storage, collection, transport and disposal are the four essential elements of any solid waste management system. Compatibility between each of the three stages of storage, collection and transport is essential to ensure economic operation.

The objective of this strategy is to partly containerize storage, collection and transport system, which does not allow the waste material to come in contact with the ground at any stage of the collection system.

The proposed specific strategies are outlined under the following sub-headings:

Planning for Storage Facilities:

Three Colored Waste Separation System: The municipal management should apply the following criteria to select and purchase storage facilities: Animal proof; insect proof i.e. be protective against breeding of flies/ should have a lid; weather proof/water proof; washable; robust enough to meet the exigencies of normal use; fire proof where it is applicable; cost effective and affordability by municipal residents and must have the three approved colours (Green, Red and Yellow) colours to promote waste separation at source wherever it is possible. It is recommendable that all primary and secondary storage facilities should have excess capacity of 50% to avoid spillage at any point. The design, size and type of storage facilities should clearly distinguish the 3 colours and this must be legalized by county laws. Various designs, sizes and types of containers are recommended as outlined elsewhere in this plan. These colour system should be implemented through a municipal-wide campaign and environmental education awareness system, piloting, exhibitions and demonstrations using all forms of media by targeting all municipal residents and Tertiary institutions etc.

Mandatory waste separation at source and re-cycling regulations with options and flexibility are urgently recommended for this strategy to work in the short and long run. It is also recommended that a 3-coloured waste separation bins are placed at public places and various locations including roadsides, parks, schools, sports venues, leisure and cultural facilities and Government office buildings, as well as public and private housing estates. The municipal board of Bungoma Directorate of Environment shall consider any required adjustments in the number and locations of the bins based on a number of factors, including requests from the public, pedestrian flow and the actual amount of re-cyclables deposited in the bins. The municipal board of Bungoma should encourage and assist property management companies and resident organizations for provision of waste separation facilities on each building floor to facilitate source separation of waste by waste generators as well as broaden the types of re-cyclables collected. The municipal environmental laws should be reviewed to ensure that the responsibility of providing standard storage facilities lies with waste generators including all businesses and shops in commercial areas. Each business must provide facilities in strategic points for its customers. The municipality can only provide storage facilities in public areas not covered by private businesses. Only standard storage containers approved under the municipality laws should be used by waste generators. Temporary and unstandardized containers e.g. oil drums, cartons, boxes, assorted plastic bags and household containers should be prohibited. A variety of facilities may be used for primary storage of solid waste provided they meet the minimum criteria outlined above. Both, (1) primary i.e. individual and (2) secondary or communal storage of facilities are recommended for the municipality. The storage volume/ capacities and type required for solid waste should be a function of the: number of premises/ business size served; rate of waste generation; family size/ household size; frequency of collection; nature e.g. portions of organic/inorganic waste; and abrasiveness of materials e.g. glass, re-cyclable or not. Standardization of primary storage facilities is recommended to maximize labour and transport productivity. Standardization should be a municipal-wide policy. Three types of primary standard containers are recommended: Standardized plastic bags of three colours (Green, Yellow and Red): Plastic bags are suitable in a number of ways – they contain moisture if they have not been torn and they are relatively clean and easy to handle. However, they will require careful organization to distribute by service providers based on experiences from the private sector. The municipality must provide general guidelines to avoid alternative use of the plastics bags and limit susceptibility to tear by scavenging animals. Mass usage will reduce the cost of the bags and distribution. Recovery of the bags is recommended so that they may be recycled into new bags, plastic poles and other products.

Plastic or galvanized -iron bins with lids: These should be promoted in middle and high income estates, hotels, offices, commercial areas/ businesses and institutions. Capacities of 10-100 Kgs/ Litres are recommended. They should be used together with standard plastics bags to promote hygiene standards. Wastes from large containers should be collected from source.

Street Containers: These should be in the municipality, three colours at every point at strategic points for pedestrians to use. Continuous clarity of the 3 colours and display of environmental awareness information is critical for waste separation in the streets. Trainers, environmental inspectors and law enforcers will be required to monitor the usage of these street containers to ensure their effectiveness.

Planning for Solid Waste Collection: The collection system proposed here below should be operated in an integrated way. This means that all of the links in the management chain should be considered when any part of the system is being designed, so that all system components are compatible. Such a way, the county government of Bungoma /municipality should be able to reach a higher collection rate.

Frequency of collection: The frequency of collection is influenced by public expectations, rate of fly breeding and decomposition. An average and general frequency of once per week is recommended as the minimum standard for solid waste in the municipality to reduce the cost. However, in high waste generation spots like markets and busy hotels and other eating places, hospitals, etc., daily collection is recommended to avoid excess accumulation and decomposition.

Time of the day and number of collection days: Collection should be done only during the day (7am-7pm) since the municipality does not experience much traffic jams like large cities such Nairobi and Mombasa. Collection at night may be preferred by collection crews during seasons when daytime temperatures are very high and the sun is very strong. It is recommended that collection vehicles to operate for 6 days of the week (including weekends) but workers should be entitled to off-days and over-time where applicable as per labour and constitutional workers' rights. Workers can work on well-organized shifts like those used in hospitals among medical staff to ensure a continuous public health service to the municipal residents. For industrial, demolition and construction wastes – A big percentage of wastes from industries and construction sites are not biodegradable so they can be collected less frequently than household wastes, either on a regular schedule or at the request of the generator. This also applies to day schools and other institutions without kitchen wastes.

Waste collection points: The point of collection is the location at which the waste passes from the control of the generator to the control of the collection stakeholder. It is the interface between the service recipient and the service provider. Despite the time and effort required, the generator should be responsible for the task of taking the waste to the point of collection and must be willing to do this work. Accessibility should be considered by Ward-Unit leaders when planning these points. Communal points should be prioritized by residents to kerbside systems to reduce house-to-house collection costs.

Stationary waste collection facilities: Recommended secondary/ communal facilities waste collection facilities may be either stationary or portable units. The stationary units should be

designed as covered containers made of heavy duty plastic or steel material with access/ loading facilities and three (3) proportional compartments (Green, Yellow and Red) to promote waste separation at source and prevention of contamination. They should be placed on concrete platforms on communal points selected by Municipal Environmental Officers. Container sizes should range between 0.5-5 tons depending on the waste generation rates at a particular point and area. Stationary facilities are the most recommended for all residential areas in the municipality to enable residents easily drop their wastes for collection.

Collection of municipal waste and recyclables: There are various kinds of vehicles that have been designed to collect different types of waste in separate compartments, but such systems are very expensive and not suited to the economic and social conditions in developing countries. For the bungoma municipality situation, it is better to encourage the informal or private sectors to collect the recyclable fraction directly from the collection points through agreed terms by the municipality.

Street sweeping management: It is recommended that all streets in the Central Business District and major feeder roads should all be mapped and their manual cleaning and landscaping/ beautification be done by the municipality. Streets within residential estates and industrial area should be cleaned during the mandatory monthly clean-ups by adjacent communities as it will be coordinated by the Municipal Environmental Officers. Schools, colleges and other commercial institutions i.e. supermarkets should be integrated into the monthly clean-ups.

Supervision of waste collection: Supervision will be needed for increasing safety and efficiency and for promoting good public relations. There is need of about 3 supervision double cab pick-up vehicles for senior managers and field officers. Supervision will require official documentarian and automation of the transport section by the municipal Directorate of Environment.

Health and safety: Waste collection is a dangerous occupation. There are many kinds of risks of infection and injury. Prevention of illness and injury shall be prioritized because it is not just a humanitarian duty and an employer's responsibility but can also improve morale and motivation, reduce costs and improve service reliability.

Transportation Planning: The following factors should be considered in undertaking waste transport planning process for the municipality:

- Transport distance and road conditions within Bungoma municipality to the disposal grounds
- local availability and sustainability
- cost of vehicles and durability
- vehicle bodies
- waste density

- waste nature and characteristics
- waste generation rates and points
- availability of spare parts and servicing

While standardization of vehicles has been taken into account to aid maintenance system, Bungoma municipality requires more than one kind of vehicle due to its two-stage collection/ transfer proposed system. This is due to the long distance to the proposed disposal ground. Based on the above factors, the following combination of refuse collection vehicles will apply for Bungoma municipality.

I. **Tractors and skip loaders**: Because of the widespread use and relatively low cost of farm tractors in Kenya, the tractor and conventional open trailer is recommended for handling areas with high generation points (hot spots) like markets, institutions, main CBD bus park and commercial points. Tractors have longer economic lives than trucks because of their low engine speeds and simple construction. tractors with gross vehicle weight of 11 tons and body volume (6m3) are the most recommended for the kind of waste densities existing in the municipality. This kind of tractor hydraulic system will be used for both picking up the 4-6 ton containers/ skips and for tipping the wastes without the driver having to leave the tractor seat. To handle the proposed initial 300 skips, the municipality requires 5-7 tractor skip loaders (full sets) to serve the municipality's hot spots effectively.

II. **Preparing the site:** There are many factors that shall be considered when designing and constructing a landfill site, but the primary issues are water pollution and operational efficiency. Polluted water from the waste is prevented from reaching water resources by an impermeable layer which may be a natural clay bed below the site, or an artificial barrier constructed using imported clay, plastic sheeting, bitumen, or soil mixed with bentonite.

A sanitary landfill should have the following design features: Leachate controls Utilities, Gas Controls, Recycling drop-off, Surface water controls, Fencing Access roads, Lighting Special working areas, Wash racks/ sanitary facilities, Special waste handling, Monitoring Wells Structures and Landscaping Operations: Continuous compaction of the wastes in the landfill makes the best use of the void space and promotes decomposition. Compaction and daily covering of the wastes controls smells, insects and rats. A high standard of management is required with strict control of the types of wastes reaching the landfill. Large amounts of daily cover material are required, involving the excavation, transport, spreading of this material and compaction using a landfill compactor.

Gas emissions from the decomposing wastes (mainly methane and carbon dioxide) are collected and can be burnt on-site or sold for electricity generation if they have a commercial value. The existing landfill compactor can be repaired and used for this purpose or a new one purchased.

Preparing cells: Any landfill site should be divided into cells, one main cell being filled before the next is started. Cells on flat land should be formed by excavating them. Excavators, wheeled loaders or tracked loaders are used to excavate or construct cells and stockpile cover soil, but on a smaller site like the one proposed for the municipality they are not needed all the time. The cells of about 1 acre each or slightly less are expected to be 5- 6 meters deep depending on the water levels of the site.

Spreading the waste material: A bulldozer, tracked loader or a landfill compactor will be required. To enable the wastes for easy compaction, they should be placed in layers of less than 50 cm thick.

Compacting and leveling the wastes: The waste is compacted to reduce the amount of space required and to control insects and rodents. This is normally done with a very costly landfill compactor which is specially designed for this purpose, or a bulldozer pulling a sheep foot roller.

Spreading cover material: To prevent litter blowing and to prevent flies and rodents breeding in the wastes. Standard landfilling practice is to cover the compacted wastes every day with a thin layer of soil. This will involve excavating and transporting soil / murram from a nearby source. Wheeled loaders and tipping trucks are used for this purpose. A bulldozer is used for spreading and levelling the cover soil.

Constructing and maintaining site roads and infrastructure: Is an important function to ensure that trucks can travel on the site without difficulties or damage. A grader is useful for this purpose. The site will also need connection to electricity, water and telephone. Sanitary facilities for landfill workers should also be constructed at the site.

After each cell is filled: it is covered with a temporary or final cap, which is usually made to be impermeable by means of clay or a plastic membrane. Topsoil is spread on the final cap and seeded to promote the growth of vegetation which stabilizes the soil.

Stationary equipment: such as a weighbridge, office facilities, pumps, lighting, gas control equipment and wastewater treatment systems are also required and landfill designing engineer should undertake to do that into detail.

Maintenance of the machinery: The maintenance of the machinery to be used on the landfill site is of crucial importance and should be managed according to the principles of planned preventive maintenance

Siting with respect to hydrogeological suitability, grading, compaction in some cases, leachate control, partial gas management, regular (not usually daily) soil cover, access control, basic record-keeping, fencing and controlled waste picking. This may save up to an average of 50% of the operational cost of sanitary landfilling operational expenses. This option should be

considered as an alternative option to save county resources by the landfill planners, engineering designers and ESIA experts without compromising environmental and social impacts to the neighborhood.

Proposed Implementation Approach for a Sanitary / Controlled Landfill:

The municipal management should release an Expression of Interest and Request for Proposal for: "Plan, Design and Built a Landfill, Central Transfer Station, Supply of Equipment and other Support Facilities and Services". It will be prudent to use the design and build approach to save time and resources. The Design and Build Contract is designed for construction projects where the contractor carries out both the design and the construction work under one agreement.

3.5 INSTITUTIONAL, ORGANIZATIONAL, POLICY AND LEGAL REFORMS

There is a need for Institutional re-organization of the municipal Directorate of Environment. This will entail: Establishment of the Ward Environmental officers/community based and Municipal Environmental Officers. The existing sections should be reviewed and upgraded as per the proposed municipal organogram. Staff with technical skills in relevant areas should be recruited to start-of the divisions. The County Executive Committee Member (CECM) for Environmental Management / waste disposal will be in charge of policy and law reforms and resource mobilization for Municipal Directorate of Environment.

The Municipal Manager should be responsible in facilitating the department in terms of human, financial and technical resources. He is also the focal point responsible for the implementation of this Strategy and is expected to exercise overall managerial responsibility for the administration, coordination and implementation of this strategy. This office should be responsible for human resource (HR), revenue collection and approval of all departmental expenditures. Any refuse collection vehicles and relevant staff like drivers and supervisors should be transferred to this Directorate for day-to-day operations.

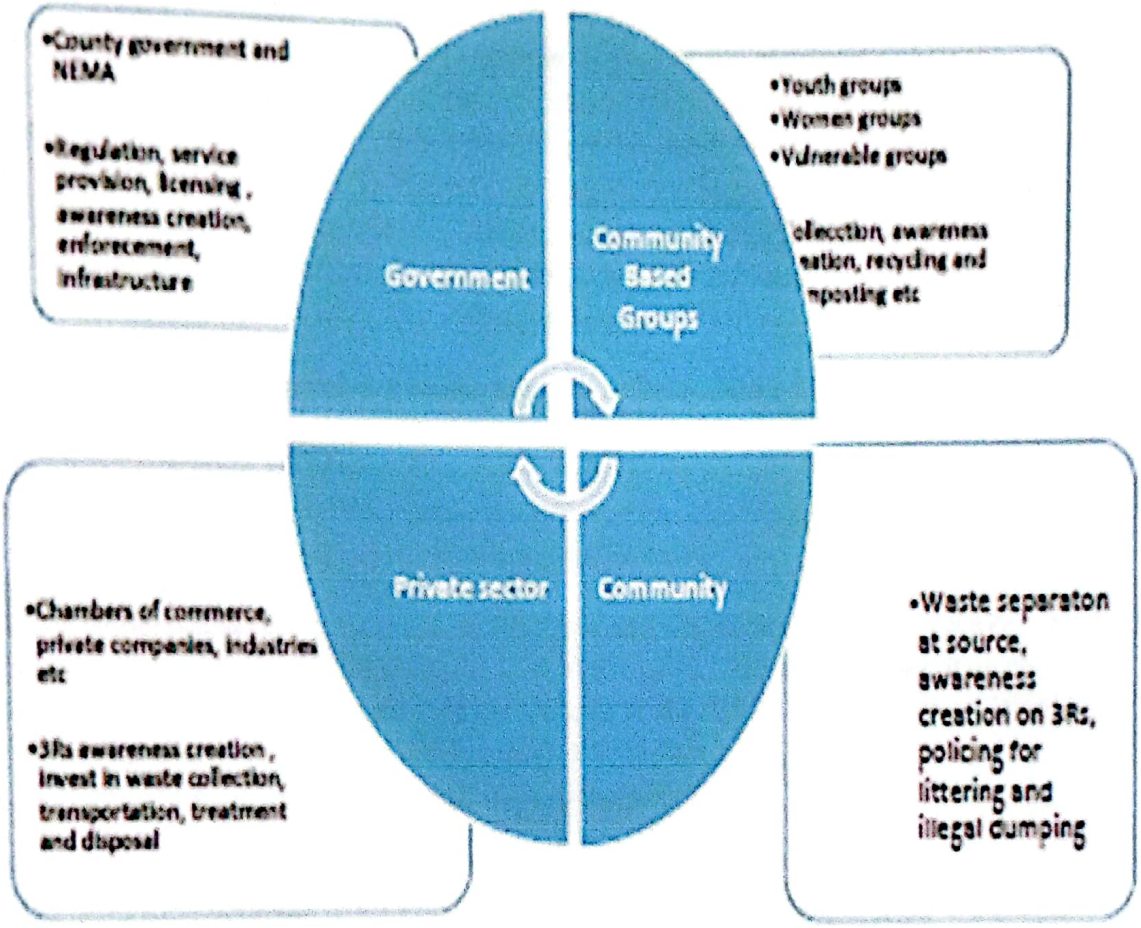
Enforcement and Legal Affairs: To be responsible for the implementation of environmental monitoring, inspection of facilities, enforcement and compliance matters. This section should also handle all environmental cases and prosecution issues.

3.6 CAPACITY BUILDING, ENVIRONMENTAL PLANNING, EDUCATION AND AWARENESS

Capacity Building in IWM Approach to capacity building: Developing integrated solutions for waste management problems in the Municipality requires capacity building, environmental planning, education and awareness. To economically and efficiently operate a waste management programme requires significant cooperation from generators regardless of the strategies chosen- separating re-cyclables from non-re-cyclables, community-based composting

or using colour designed waste storage and collection containers. To maintain long-term programme support, the public needs to know clearly what behaviours are desired from them and why in order to avoid legal and social conflicts. Public education will stimulate interest in how waste management decisions are made. When citizens become interested in their community's waste management programs, they frequently demand to be involved in the decision-making process. This municipal management should support awareness creation and information dissemination campaigns on the provisions of laws, policies and best practices in waste reduction, sorting, re-use and recycling to all stakeholders. There is need for early education through the formal and informal school education system on IWM. To achieve this, the plan implementation should target school going children and other institutions of higher learning and Religious based programmes to implement this plan.

Stakeholders in solid waste management



The key strategies proposed are outlined below:

Capacity building needs: Implementation of this strategy will require broad-based capacity building at the level of county, municipality, ward, private sector and non-governmental organizations. This section excludes capacity development in terms of waste collection equipment which has been outlined elsewhere. The county government of Bungoma should provide capacity development opportunities at all levels through which all stakeholders can

acquire the knowledge and skills necessary for the effective implementation of this strategy. Partnerships should also be established with tertiary institutions or any other professional firms/ institutions in Kenya and internationally to structure appropriate short term courses to meet the local needs in the municipality waste management sector.

Key capacity development needs will include the following strategic areas: the 3 Rs and PPP approaches, waste to energy/ combustion/ incineration technologies, sustainable storage, collection, transportation and disposal systems; policy, institutional and legal reforms and management of special wastes (E-Waste, Hospital, ELVs, hazardous wastes). Capacity building of policy makers in IWM is required at county, ward and ward-unit levels for all residents, technical, administrative and policy stakeholders. Capacity building on IWM and the development of IWM plans using the PPP approach will have great multiplier effects.

Capacity Building through Demonstration Projects on IWM: Demonstration / pilot projects especially through the on-going county government of bungoma and other future WM projects should form the core of IWM activities as these will be instrumental in developing in-depth capacity of local partners on IWM while at the same time leading to designing comprehensive IWM plans for the respective wards within the municipality.

Training of personnel from partner institutions and organizations, policy makers and other stakeholders should also be an integral part of the pilot / demonstrations projects on the IWM and management of specific waste streams in the municipality. County, Ward and Ward-Unit Technical Training of Workers on IWM Training of workers at all levels is an essential part of a successful solid waste collection system.

Training WM manual workers: Manual workers need training in working policies and safe working practices; personal hygiene and basic first aid and customer relations, for example on how to explain to aggrieved citizens on their basic rights.

Training for Waste Collection Drivers: Drivers should participate in the same training courses as manual workers, but they also need additional information including: performing daily vehicle checks and what to do if any deficiencies are detected; driving in ways that do not cause unusual wear and tear; safe reversing procedures; driving on soft ground (if delivering waste to a disposal site); what to do in the event of a breakdown, accident or puncture; use of modern communication equipment and first aid.

Environmental Planning: Waste Inventory and Periodical Assessment Inventory of all waste categories in the municipality and the county in general should be undertaken. This includes source identification, quantification of wastes, including household, commercial, industrial wastes and hazardous wastes (including medical wastes), e-waste, etc. Capacity should be built to enable the County technical staff/municipality to conduct a comprehensive assessment of the extent and effectiveness of the existing waste management practices from collection to final disposal. In addition to the collection and analysis of secondary data, this assessment requires a

series of meetings to be held as well as several interviews to be conducted with different stakeholder groups. The assessment shall analyze the extent and effectiveness of the existing waste management system and the level of compliance with the national and County/ municipality waste management strategies, policies and regulations. It will also identify constraint areas for improvement to meet the desired level of performance.

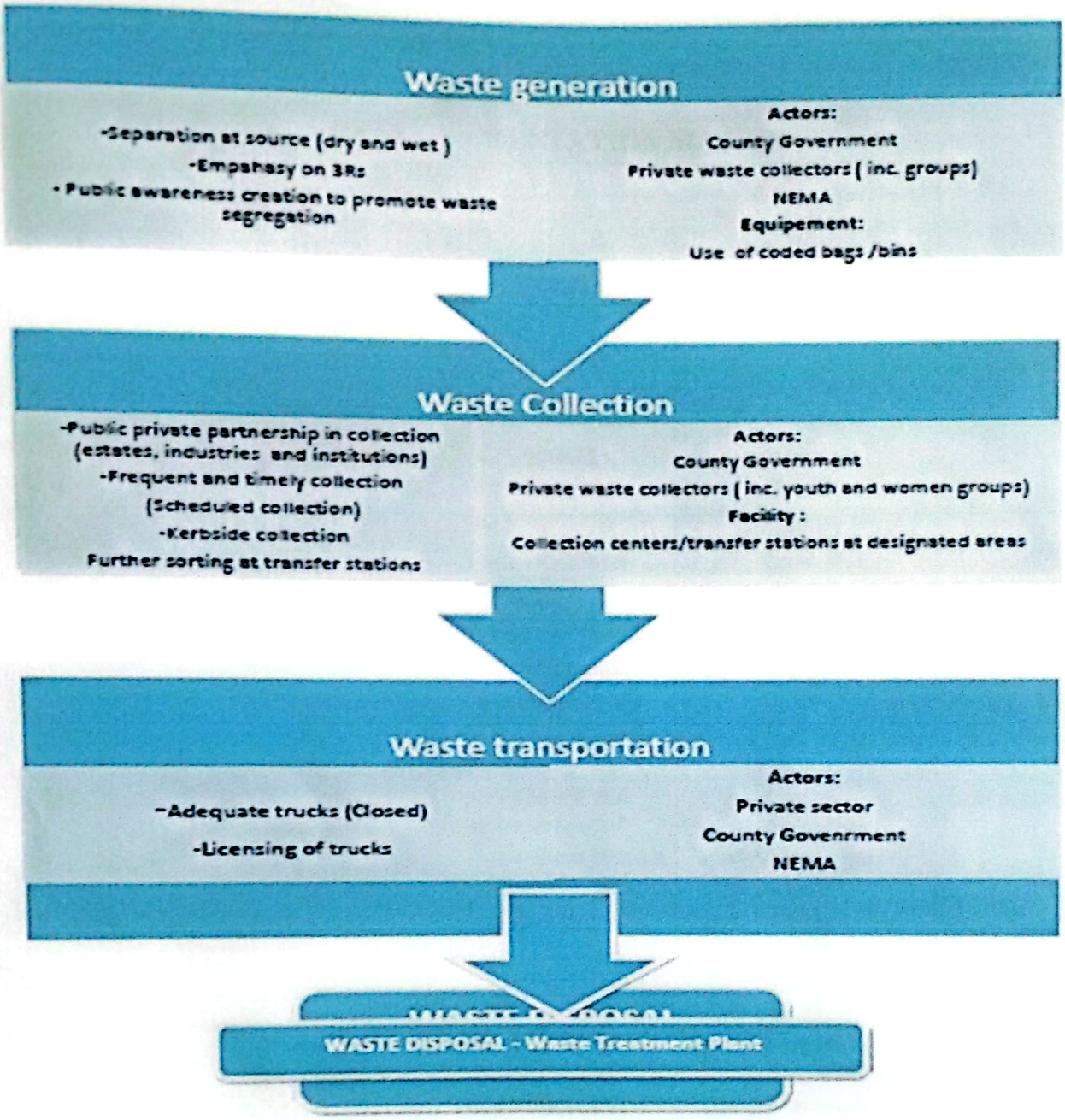
3.7 MANAGEMENT OF HAZARDOUS AND SPECIAL WASTES: E-WASTE, MEDICAL WASTE

The proposed strategy is to separate waste at source using the 3-colour system in order to maximize the collection of hazardous materials with a view to reducing the environmental and health impacts of any unregulated waste. All hazardous wastes should be handled using NEMA national standards, Waste Regulations of 2006 and guidelines during the strategic period. Alkaline batteries can be disposed of as domestic waste, rechargeable batteries and silver oxide batteries can contain heavy metals such as mercury and cadmium which are classified as hazardous substances and may present an environmental threat when disposed of to the landfill. There is no re-cycling or disposal facilities for alkaline, rechargeable and silver oxide batteries, hence they are disposed in landfills as per NEMA guidelines. Lead-acid batteries that have been used are considered a hazardous waste.

Health Care Waste/ Medical Waste Management: Health Care Waste (HCW) is generated in varying quantities at healthcare facilities and because of its pathogenic characteristics, there is need to treat it before disposal. Systems to support the proper segregation of HCW are not always in place in hospital wards and clinics in the municipality. The wastes are disposed through incineration and some find their way to the **Mwanda Dumpsite**. The National Ministry of Health has developed guidelines on the management of health care waste which the County Government must embrace in all its health facilities. Incineration facilities can also be developed through the PPP approach for this category of the sector. Heavy penalties should be considered and enforced for violation of these regulations. e-Waste Recycling due to the many hazardous components and materials used in the manufacture of electronic goods, including mercury, brominated flame retardants and cadmium, e-waste is considered a hazardous waste stream. NEMA has developed e-waste regulations which have taken into consideration extended producer responsibility, recycling, reuse and exportation of the problematic fractions.

The County Government of Bungoma/Municipality should take advantage by adopting the same instead of developing their own regulations. The NEMA e-waste guidelines provide a framework for identification, collection, sorting, recycling and disposing of electrical and electronic waste (e-waste). The guidelines also provide the basis for developing legal instruments to enhance enforcement. The purpose of guidelines is to assist the national and county governments, private sector, learning institutions among others to manage e-waste in a manner that enhances environmental conservation.

Ideal State and Roadmap



CHAPTER FOUR

4.0 IMPLEMENTATION MATRIX

bjective	Strategy	Activities	Actors	Timeline
Formulate ıpropriate gislation and struments	✓ Develop and implement legislation, regulations, policy and guidelines	✓ Legislation and instruments development and harmonization ✓ Ensure implementation of regulations and instruments set	✓ Bungoma municipal Board ✓ County Executive ✓ County Assembly	2 years
	✓ Ensure enforcement of waste management legislation and standards	✓ compliance and enforcement of waste management standards and legislations	✓ County executive ✓ Municipal Board ✓ NEMA ✓ County assembly	Continuous
Capacity ilding	✓ Recruitment of skilled and unskilled personnel	✓ Advertisement of vacancies and appointment of personnel	✓ County Executive ✓ Municipal Board ✓ County public service board	1 year
	✓ Conduct in service training of	✓ Workshop ✓ Short courses	✓ County executive ✓ Municipal	1 year

	personnel on waste management		Board	
	✓ Sensitize the public on integrated waste management	✓ Hold civic education through media and barazas ✓ Publish educational materials ✓ Monthly clean ups and quarterly	✓ County executive ✓ Municipal Board ✓ Community groups ✓ Private companies	✓ Continuous
	✓ Uptake of appropriate technologies	✓ Benchmarking on and best practices of appropriate technologies	✓ County Executive ✓ Municipal Board ✓ NEMA	✓ 1 year
lobilize urces	✓ Lobby for Increased budgetary allocation	✓ Procurement plan preparation	✓ County executive ✓ Municipal Board ✓ County assembly	1 year
	✓ Promote public private partnerships in waste management	✓ Marketing and advertisement ✓ Organizing stakeholders forums	✓ Private companies and corporations ✓ Municipal Board ✓ Community groups	1 year
	✓ Promote and activate waste as a revenue stream	✓ Civic education, campaigns and trainings ✓ Marketing of recycled and reusables	✓ County executive ✓ Municipal Board ✓ Community groups ✓ Private companies	1 year

. Promote and tablish waste egregation, mposting and ecycling stems.	✓ Provision of equipment's and transport system	✓ Procure bins and waste bags labeled according to the type of waste ✓ Plan and organize collection points	✓ County Executive ✓ Municipal Board ✓ NGOs ✓ Private companies	1 year 1 year
	✓ Develop waste segregation and recycling plans	✓ conduct benchmarking for practices on segregation and recycling ✓ conduct training of both staff and other stakeholders ✓ conduct an estate pilot	✓ County executive ✓ Municipal Board ✓ NGOs	3 years
	✓ Develop promotion programs on use of recycled and recovered materials	✓ conduct civic education ✓ publish educational material	✓ County executive ✓ Municipal Board ✓ NGOs	
	✓ Enhance stakeholders collaboration on waste segregation and recycling	✓ campaigns and advertisement ✓ stakeholder workshops		
. planning for a stainable aste anagement stems	✓ Designate, build and operate collection points, transfer stations and disposal sites	✓ Identification of strategic areas ✓ Construction of collection chambers, provision and management of kerbside	✓ County Executive ✓ Municipal board ✓ NEMA	2 years

	✓ Provision of adequate and appropriate waste collection and transportation systems	✓ Buy additional and relevant waste trucks to meet the needs ✓ Maintenance of roads to enable easy access ✓ use of GIS to map and truck waste transportation	✓ County executive ✓ Municipal board	2 years
	✓ Improvement and maintenance of existing facilities and machinery	✓ Upgrade existing waste management facilities ✓ Repair of grounded vehicles and machinery	✓ County executive ✓ Municipal board ✓ NEMA	continuous
Establish environmentally ound frastructure and systems for aste disposal and incineration	✓ Acquiring land for waste management purposes.	✓ Survey and ✓ Acquisition of a suitable land according to set regulations ✓ Acquiring title deeds for the disposal sites	✓ County Executive ✓ Municipal board ✓ NEMA ✓ NLC	3year
	✓ Conduct public participation and sensitization on waste disposal as a land use activity	✓ Call for public participation before acquiring sites ✓ Hold civic education forums ✓ Hold baraza meetings with the communities	✓ County Executive ✓ Municipal Board ✓ NEMA ✓ County Assembly ✓ NLC	1 year
	✓ Conduct environmental ✓ Assessments and audits on the disposal sites	✓ To procure services of a lead expert licensed by NEMA for ✓ a) EIA on proposed disposal site	✓ NEMA, ✓ County Executive ✓ Municipal Board	3 years

		✓ b) Audit on existing sites		
	✓ Establishment of waste treatment and disposal facilities	✓ Develop a sanitary landfill ✓ Put up an incinerator ✓ Set up recycling plant	✓ County executive ✓ Municipal Board ✓ Public private partnerships ✓ Private investors ✓ NEMA	3 years
	✓ Increase security and surveillance in waste disposal sites	✓ Monitoring of activities at sites by enforcement and security officers ✓ Fencing of the existing and proposed sites	✓ County ✓ Executive ✓ -Municipal board ✓ NEMA ✓ Ministry of interior and coordination ✓ County Legal Unit	3years

4.1 FUNDING MECHANISM

The sources of funding for the implementation plan will be from the County Government of Bungoma, Public Private Partnerships, waste generators and the development partners. The funding must be self-sustaining in the long run and strategically integrated in all phases of the waste management system. These phases include initiatives to minimize generation of waste at source, improve collection and transportation systems as well as managing the disposal of waste that cannot be recycled or reused.

4.2 MONITORING AND EVALUATION

Poor waste management has direct and indirect effects to the public health and the environment and therefore monitoring and evaluation is an integral component. The Monitoring and Evaluation system adopted for this Plan will be designed to provide feedback to stakeholders to ensure accountability, transparency, facilitate appropriate decisions on future implementation

and review of the Plan to ensure that the input delivery, work schedules and target outputs are progressing according to the plan.

4.3 CONCLUSION

There is need to introduce service charge to the residents for solid waste collection in order to offer commensurate service provision. It is proposed that a well-designed charging system can have a positive effect in reducing waste generation by producers through offering incentives for those who minimize waste by lowering their chargeable tariff. This initiative requires intensive social marketing and public goodwill. Other premises e.g. supermarkets would be encouraged to buy back valuable used items such as bottles hence enabling greater recovery.

Other than the County annual budgetary allocation, partial funding from various partners can also be explored for the infrastructural components of the Plan. The main aspect in such an arrangement would be the extent to which the County and private sector share the cost.

Nevertheless, the implementation of the waste hierarchy and achievement of the objectives outlined in this Plan is integral to achieving the vision of a zero-waste society, establishing a sustainable future and a better life for all Kenyans.