

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT



STUDY PROJECT REPORT FOR PROPOSED INSTALLATION OF SEPTULI
MEDICAL AND HAZARDOUS WASTE INCINERATOR AT BISUNU VILLAGE,
ON LR. No. KAKAMEGA/MALAVA/500 KAKAMEGA COUNTY

CLIENT

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CERTIFICATION

This Environmental Impact Assessment Project Report has been prepared by Prof. (Eng). James M. Raude; NEMA registered EIA/EA Lead Expert No. 2277. This project report has been prepared in accordance with the requirements of the Environmental (assessment and Audit) Regulations, 2002, pursuant to The Environmental Management and Coordination Act, (EMCA) 1999.

We, the undersigned, certify that the particulars given in this report are correct to the best of our knowledge.

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EXECUTIVE SUMMARY

Introduction

Eng. Prof. James M. Raude herein referred to as lead expert was approached by Health Advantage Kenya Limited; herein thereafter referred to as the proponent to carry out an Environmental and Social Impact Assessment for Establishment of a Medical and Hazardous Waste Incinerator project at Cheptuli sub-location, Bisunu village, Malava Sub County, Kakamega County [0°31'56.8"N; 34°50'28.5"E; 0.532272; 34.841329]. This is to comply with the Legal requirements stipulated in the Environmental Management and Coordination Act, 1999 and the subsequent Legal supplement of 2019. More so, it is a way of promoting benign environmental management for sustainable development. The Lead Expert is registered by the National Environment Management Authority (NEMA) to carry out Environmental Impact Assessments and audits. The proponent intends to buy, mount, commission and operate a private commercial incinerator, at Bisunu in Kakamega County. The commercial incinerator will have a capacity of 3.0 Tonnes per loading and is design to have one operator, a store, and the incinerator components. The incinerator is designed in such a way that it will be using the liquefied gas as a source of fuel. The use of the gas is to ensure efficiency in burning since the process requires high temperatures that range between 860°C-1200°C and the incinerator is set to achieve these high temperatures in a short time. The Lead Expert is registered by the National Environment Management Authority (NEMA) to carry out Environmental Impact Assessments and audits.

These high temperatures ensure good turbulence and therefore minimizes the production of dioxins and furans (PCDDs and PCDFs respectively) from the combustion of waste. Besides, the use of acidic solution in chamber 3 (see Appendix 1) will ensure that oxidation is maintained. Chamber 1 that is after the burn has water that will ensure quick cooling down of the flue gas in order to prevent *de novo* synthesis of the PCDDs and PCDFs. Chamber 2 has some basic solution that ensure less escape of the acidic gas as effluent to the atmosphere. The chimney height is also well above ground and it has a fan at the bottom that will ensure sufficient dispersion of effluent gas to the atmosphere for natural dilution.

This EIA report seeks an approval from National Environmental Management Authority (NEMA) in accordance to the Environmental Management and Coordination Act (EMCA) 1999.

Building and construction activities are listed in schedule 2 of the Act as projects that will require EIA. The EIA/EA lead expert was assigned by the proponent to conduct an Environmental and Social Impact Assessment for the proposed Development project. Preliminary designs and site plan for proposed project have been completed and they include: a feed gate, ash tray, Air pump, diesel burner, after burner, filter, tanks (chamber 1 – water, chamber 2- basic solution, chamber – 3 acidic solution), valves, inflow and outflow pipes and a chimney with a fan at the bottom. See attached architectural drawings in appendix 4.

The development and installation of this commercial incinerator will be done professionally and with due regard to the right building and installation procedures. The process involves mounting. The

process involves mounting a pre-designed incinerator.



Figure I: Photos of the Public Participation Process



Figure II: Project Location

Photo showing how to enter the exact location -[S 00° 20'23.911", E; 036° 01'13.211"]

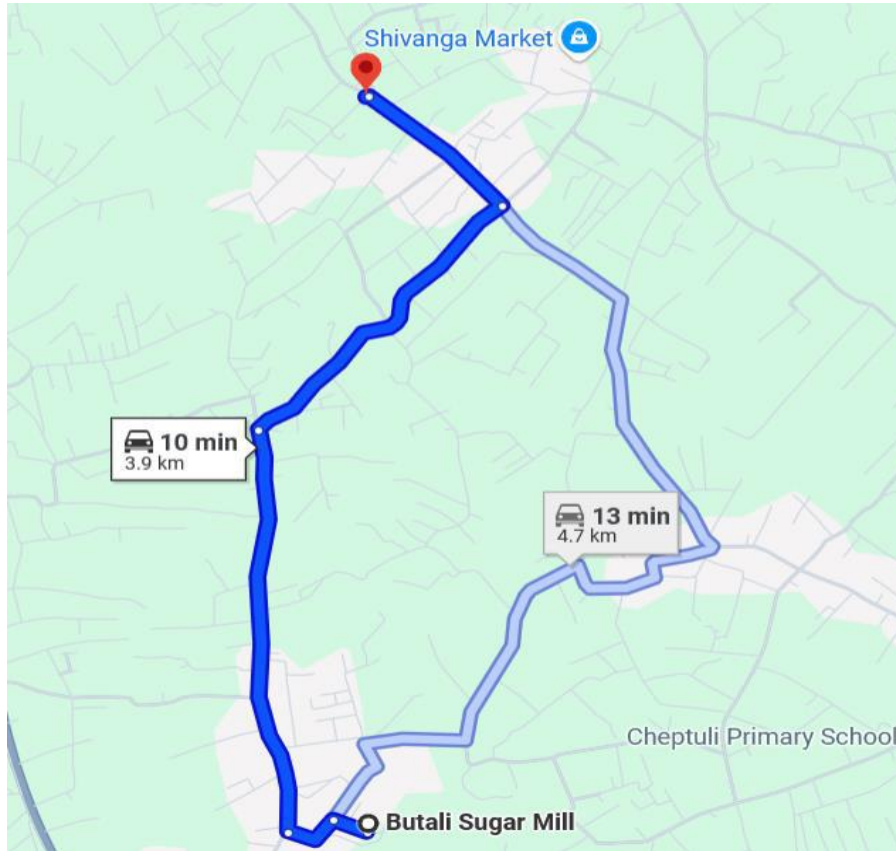


Plate 1: Direction To the Proposed Site



Photos 2: Photos of the Neighbourhood

INTRODUCTION

Health Advantage Kenya Limited intends to establish a medical and hazardous waste management strategy by mounting an incinerator in Kakamega County at Bisunu Village. The incinerator will be mounted at Cheptuli sub-location, Bisunu village, Malava Sub County, Kakamega County. It's at a distance of 37.1km from Kakamega Town along Kakamega-Webuye highway, past Butali Sugar Factory and only 3.9 Kms from Butali Sugar Factory towards Shivanga market. The purpose is to enhance environmentally sound waste management within the area. The proposed development will be situated on LR. No. Kakamega/Malava/500 (see attached deed plan) measuring 2.2 Ha. Health Advantage is a Limited company incorporated in Kenya with its headquarters in Nairobi. The project is proposed to undertake incineration activities.

To implement an integrated approach to medical and hazardous Waste Management Practices in Kakamega County, Health Advantage Kenya Limited prepared detailed Project Report for solid waste management of the Kakamega Municipality and subsequently, identified land at Bisunu for establishing an Incinerator. Waste is classified as municipal waste, agricultural waste or industrial waste. According to its characteristics, waste is further classified as hazardous or non-hazardous waste. A number of industrial wastes is defined as hazardous waste by Basel Convention if they exhibit one or more of the hazardous characteristics to the Convention. The long term goal of the proponent is to implement an Integrated Solid Waste Management system.

An incinerator is a furnace for burning waste. For medical and hazardous waste management, incineration is the second most popular method next to landfill. Management of waste has become an elaborate process in all modern societies as civic authorities struggle to find hygienic ways to help remove wastes from the lanes and community areas and need to come up with ways to control the growing amount of waste that civilized society churns out every day.

Incineration methods comprise combusting of organic substances and wastes which are usually household wastes, medical and hazardous wastes as well. Usually landfill method of accumulating wastes leads to a problem of dealing with high volumes of waste matter.

Incineration method offers a solution of rapidly reducing the voluminous wastes which accumulate. Incineration methods use the combustion process to reduce many organic and even inorganic wastes to ashes. These are then converted to ashes and transferred to landfill areas.

The ash, gases, particulates and heat which are generated in the high heat thermal treatment which wastes are subjected to in incinerators, are then utilized to generate the power to run such incinerators. Thus, incinerators help to conserve energy.

Clinical and hazardous substances are best eliminated with the help of incinerators. The pathogens and harmful toxins in such substances get perished in the high temperature of such devices. As landfill areas are becoming limited, incineration method is one of the useful ways of handling and managing solid wastes.

However, such method is not without side effects. Combustion of wastes can lead to environmental pollution since the gases which are let off are pollutant to the air; again, many by-products of e-waste when combusted lead to toxic substances which need to be removed or else can pollute land and air. The ash, flue gas and other types of emissions are perilous to human life and these if not treated and allowed to escape into the atmosphere, can lead to further pollution of the environment.

To deal with the different types of wastes which are generated by society, today there are

different types of incinerator plants which are designed. These can be of moving grate, rotary kiln, fluidized bed, fixed grate and so forth. The modern incinerators come with scrubbers and cleaning equipments which help to remove harmful emissions and by products such as dioxins and heavy metals which can pollute the environment. Thus, incineration method has its benefits over other forms of waste treatment methods but the emissions and by products need to be treated accordingly to reduce the negative side effects of such a method.

Incineration with energy recovery is one of several waste-to-energy technologies such as gasification, plasma arc gasification, pyrolysis and anaerobic digestion. Incineration may also be implemented without energy and materials recovery.

In several countries, there are still concerns from experts and local communities about the environmental impact of incinerators. In some countries, incinerators built just a few decades ago often did not include a materials separation to remove hazardous, bulky or recyclable materials before combustion. These facilities tended to risk the health of the plant workers and the local environment due to inadequate levels of gas cleaning and combustion process control. Most of these facilities did not generate electricity.

Incinerators reduce the solid mass of the original waste by 80–85% and the volume (already compressed somewhat in garbage trucks) by 95-96%, 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. Garbage trucks often reduce the volume of waste in a built-in compressor before delivery to the incinerator. Alternatively, at landfills, the volume of the uncompressed garbage can be reduced by approximately 70% by using a stationary steel compressor, albeit with a significant energy cost. In many countries, simpler waste compaction is a common practice for compaction at landfills.

Incineration has particularly strong benefits for the treatment of certain waste types in niche areas such as clinical wastes and certain hazardous wastes where pathogens and toxins can be destroyed by high temperatures. Examples include chemical multi-product plants with diverse toxic or very toxic wastewater streams, which cannot be routed to a conventional wastewater treatment plant.

The proposed integrated solid waste management project shall consist of the following components:

1. **Primary collection of Medical and Hazardous Waste (MHW):** Door-to-Door collection of MSW is to be implemented.
2. **Transportation of MSW:** After collection MSW will be transported in the closed/covered vehicles to the processing and disposal site at the proposed site.
3. **Processing and Disposal of MSW:** MSW is to be processed for energy recovery before final disposal into landfill site. Only inert or processing rejects to be land filled which is to be in range of 20-30% of total waste transported to the site. Processing and disposal site is to be developed at Bisunu Village, Cheptuli sub-location, Bisunu village, Malava Sub County, Kakamega County. An EIA study project report has been prepared for this project based the secondary information collected from the published sources, reconnaissance survey, primary socio-economic survey and environmental monitoring of air, noise, soil, ground water and surface water in the study area. The baseline data was generated on meteorology, air quality, noise levels, ground and surface water quality, land environment including soil quality, land use pattern, biological environment and the socio-economic status. The meteorological data for complete year has also been collected to know the prevailing seasonal conditions. Identification & prediction of significant environmental impacts due to the proposed integrated waste processing facility with an Environmental Impact statement

followed by delineation of appropriate impact mitigation measures in an Environmental Management Plan are included in the EIA Report.

Project Description

The proponent aims to mount a Solid Waste incinerator herein referred to as “development of incinerator” on the named parcel of land as detailed below:

Operational activities	Details	Remarks
Total Cost of the project	KES. 12,000,000.00	Total cost of project
Rates	KES. 12,000.00	Annual Leasing cost
Incinerator – Profile		

Legislation, Institutional and Legal Framework

The major laws governing such activities are:

1. Environmental Management and Co-ordination Act (EMCA), 1999
2. Environmental (Impact Assessment and Audit) Regulations, 2003
3. Environmental Management and Co-ordination (Waste Management) Regulations, 2006
4. Environmental Management and Co-ordination (Water Quality) Regulations, 2006
5. Occupational Safety and health Act, 2007 and all its subsidiary legislations
6. The Explosives Act, Cap 115
7. Public Health Act Cap. 242: Part ix (Section 115, Section 116, Section 118); Part xi (Section 129, Section 130; Part xii (Section 136)
8. County Government Act, 2012
9. Local Authority Act (Cap 265); (Section 160; Section 173; Section 170; Section 201, Section 176; Section 174; Section 264)
10. Physical Planning Act (Cap 286); (Section 29; Section 30; Section 36)
11. Land Planning Act (Cap 303) (Section 9)
12. Water Act (Cap 372) Part II (Section 18 and Sub-section 3), Section 73, Section 75, Section 76, Section 77)
13. Occupiers Liability Act, cap 34
14. Work Injury Benefits Act, 2007
15. Climate Change Act, 2016

Environmental Impacts

The EIA considers the potential impacts of the proposed development on a topic by topic basis covering the physical environment; habitats, flora and fauna; impacts on people and communities, and environmental quality (air quality and noise).

Positive Impacts

- Creation of employment opportunities for the local residents during construction phase of the project.
- Provision of market for supply of building materials during the construction phase because the project will require supply of building materials which will be sourced locally.

- Increased business opportunities for small scale traders like food vendors around the construction site. This shall improve the local housing and business developments.
- Contribution towards the national and local revenue earnings.
- Improved Security in the surrounding area

Negative Impacts

A number of adverse impacts have been identified especially during the construction phase. During the operation phase, there will be negative impacts too. These have been assessed as not significant or of low significance. Some of these impacts are temporal e.g. during construction or a direct consequence of the operational activities while others would only arise in the event of an accident. Most of these impacts can be avoided or reduced through risk management and mitigation measures. They include the following:-

- The need for the contractor to ensure participation by women and youth during project construction.
- Increase in traffic on road adjacent to the site during construction, which in turn leads to increased air pollution through CO₂, NO_x vehicle emissions.
- The construction works, delivery of building materials by heavy trucks and the use of machinery/equipment, generators, metal grinders and concrete mixers will contribute high levels of noise and vibration within the construction site and the surrounding area.
- Risks of Accidents and Injuries to workers due to the intensive engineering and construction activities. This will run to the operational phase of the project.
- Increased Energy Consumption that is consumption of fossil fuels (mainly diesel) to run transport vehicles and construction machinery.
- Increased water use since the project activities will require large quantities of water.

Mitigation Measures

- Efficient sourcing and use of raw materials through accurate budgeting and estimation of actual construction requirements.
- Minimization of construction waste by ensuring that the amount of construction materials left on site after construction is kept minimal, use of durable, long- lasting materials that will not need to be replaced as often, Provision of facilities for proper handling and storage of construction materials, purchase of perishable construction materials such as paints incrementally, use of building materials that have minimal packaging and use of construction materials containing recycled content.
- Encourage reuse/recycling of materials where possible in order to reduce solid waste
- Dust emission during construction and operation will be minimized through strict enforcement of onsite speed controls as well as limiting unnecessary traffic.
- Ensuring that construction vehicles preferably deliver materials during off-peak hours when traffic volume is low.
- Adherence to the occupational health and safety rules and regulations stipulated in Occupational Safety and Health Act, 2007
- The proponent shall ensure that water is used efficiently at the site by sensitizing construction

staff to avoid irresponsible water usage

- Ensuring efficient solid waste management
- The proponent will construct a toilet for the construction workers.
- The site will be secured and manned for 24 hours by security guards.

Public Participation and Consultation/Disclosure

The United Nations Conference on Environment and Development (Rio Conference) of 1992 through Local Agenda 21, and the Convention on Access to Information, Public Participation in Decision making and Access to Justice in Environmental Matters (Aarhus Convention) of 1998 recognize the benefits of public participation in environmental decision-making. Unfortunately, public participation has in some instances been viewed as a mere administrative formality. The public was consulted and their views were collected by administering a semi-structured questionnaire and checklist as appropriate (see appendix). Public consultation was carried out in a way designed to capture concerns of the immediate neighbourhood of the project as well as other stakeholders. A questionnaire was administered to a sample of the public comprising adults and the youth. The categories of the participants included landowners, tenants, squatters and special groups.

Conclusion

The proposed incinerator development project is essentially meant to alleviate the appalling poor solid waste management in Kakamega County and beyond. The proposed project will contribute to improved waste management in Kakamega County. The site is quite ideal since the neighborhood is not populated.

All the negative impacts that have been identified as arising from the development of this Solid Waste Management (Incinerator) project can be mitigated with appropriate measures. Mitigation and monitoring activities will require participation by the contractor, proponent, NEMA, County Environment Officers, Kakamega Municipal council; and all administrators of Kakamega County. The methodology is proposed under the Environmental Management Plan (EMP) of this study report. The EMP will also acts as the beginning of a basis for the formulation of Environmental Management System (ISO 14001: 2004) for the development project by the proponent.

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ACRONYMS

$^{\circ}\text{C}$	Degrees Celsius
EIA	Environmental Impact Assessment
EMCA	Environmental Management Coordination Act
EMP	Environmental Management Plan
IEA	Initial Environmental Audit
Km	Kilometers
NEMA	National Environment Management Authority
OHSO	Occupational Health and Safety Office
SWM	Solid Waste Management
KRA	Kenya Revenue Authority
TOR	Terms of Reference (TOR)
PCDDs	Polychlorinated dibenzo-p-dioxins
PCDFs	Polychlorinated dibenzofurans

CHAPTER ONE: INTRODUCTION

1.1 Background Information

Incinerators primarily reduce solid trash by burning the materials. You can also use incinerators for burning off harmful organic pollutants or hospital waste. Incinerator usage presents several advantages, such as destroying combustible toxins and reducing the amount of waste. They also present several disadvantages, including air pollution and potential for hazardous ash output and high operation costs. Although there are approximately seven different types of mainstream incinerators, the most popular incinerators include rotary kiln, fluidized bed and liquid injection. These types of incinerators provide versatility for large- and small-scale needs.

1. Rotary Kiln

Rotary kiln incinerators earn their name by rotating the waste in a cylindrical container. This movement ensures thorough mixing of the waste with air. Rotary kilns operate at temperatures ranging from 1,500 to 3,000 degrees Fahrenheit. The mixing motion allows the kilns to have a greater resistance to high temperatures than other types of incinerators. One can use a rotary kiln for incinerating large quantities of gas, sludge, liquid and solid wastes. Rotary kilns offer a mobility advantage due to their size, and the kiln's shape lets you burn an entire drum of waste at once.

2. Fluidized Bed

Fluidized bed incinerators use an inert granular material for the incineration process. Fluidized bed incinerators operate at temperatures ranging from 1,400 to 1,800 degrees Fahrenheit. One can incinerate solid, gas, sludge or liquid wastes. However, one can't use fluidized bed incinerators for any wastes that melt. The melted materials interfere with the fluidization process.

3. Liquid Injection

Liquid injection incinerators atomize the waste into droplets. This method creates the greatest possible mixing with air. One inserts the liquefied waste through nozzles. The incinerator operates at temperatures ranging from 1,200 to 3,000 degrees Fahrenheit. One can incinerate solids only if they first melt them and pump them into the incinerator as a liquid. Two advantages of using liquid injection incinerators include the ability to burn traditionally noncombustible materials, such as contaminated water, and the equipment's ability to operate in a horizontal or vertical position.

4. Burn Pile

The burn pile, or burn pit is one of the simplest and earliest forms of waste disposal, essentially consisting of a mound of combustible materials piled on bare ground and set on fire. Indiscriminate piles of household waste are strongly discouraged and may be illegal in urban areas, but are permitted in certain rural situations such as clearing forested land for farming, where the stumps are uprooted and burned. Rural burn piles of yard waste are allowed in many rural communities, along with small quantities of domestic or agricultural waste generated on site, though not large quantities asphalt shingles, plastics, or other petroleum products that can produce dense black smoke. Burn piles can and have spread uncontrolled fires, for example if wind blows burning material off the pile into surrounding combustible grasses or onto buildings. As interior structures of the pile are consumed, the pile can shift and collapse, spreading the burn area. Even in a situation of no wind, small lightweight ignited embers can lift off the pile via convection, and waft through the air into

grasses or onto buildings, igniting them.

5. Burn Barrel

The burn barrel is a somewhat more controlled form of private waste incineration, containing the burning material inside a metal barrel, with a metal grating over the exhaust. The barrel prevents the spread of burning material in windy conditions, and as the combustibles are reduced they can only settle down into the barrel. The exhaust grating helps to prevent the spread of burning embers. Over time, the very high heat of incineration causes the metal to oxidize and rust, and eventually the barrel itself is consumed by the heat and must be replaced.

Private burning of dry cellulosic/paper products is generally clean-burning, producing no visible smoke, but plastics in household waste can cause private burning to create a public nuisance, generating acrid odors and fumes that make eyes burn and water. Most urban communities ban burn barrels, and certain rural communities may have prohibitions on open burning, especially those home to many residents not familiar with this common rural practice.

In the United States, private rural incineration of small quantities of household or farm waste is typically permitted so long as it is not a nuisance to others, does not pose a risk of fire such as in dry conditions, and the fire does not produce dense, noxious smoke. However, a handful of states, such as New York, Minnesota, and Wisconsin, have laws or regulations either banning or strictly regulating open burning to concerns about health and nuisance impacts of open burning. People intending to burn waste may be required to contact a state agency in advance to check current fire risk and conditions, and to alert officials of the controlled fire that will occur.

6. Moving Grate

Control room of a typical moving grate incinerator overseeing two boiler lines. The typical incineration plant for municipal solid waste is a moving grate incinerator. The moving grate enables the movement of waste through the combustion chamber to be optimized to allow a more efficient and complete combustion. A single moving grate boiler can handle up to 35 metric tons (39 short tons) of waste per hour, and can operate 8,000 hours per year with only one scheduled stop for inspection and maintenance of about one month's duration. Moving grate incinerators are sometimes referred to as Municipal Solid Waste Incinerators (MSWIs).

The waste is introduced by a waste crane through the "throat" at one end of the grate, from where it moves down over the descending grate to the ash pit in the other end. Here the ash is removed through a water lock.



Figure 1. 1Moving Grate Incinerator in operation

Municipal solid waste in the furnace of a moving grate incinerator capable of handling 15 metric tons

(17 short tons) of waste per hour. The holes in the grate elements supplying the primary combustion air are visible.

Part of the combustion air (primary combustion air) is supplied through the grate from below. This air flow also has the purpose of cooling the grate itself. Cooling is important for the mechanical strength of the grate, and many moving grates are also water-cooled internally. Secondary combustion air is supplied into the boiler at high speed through nozzles over the grate. It facilitates complete combustion of the flue gases by introducing turbulence for better mixing and by ensuring a surplus of oxygen. In multiple/stepped hearth incinerators, the secondary combustion air is introduced in a separate chamber downstream the primary combustion chamber.

7. Fixed Grate

The older and simpler kind of incinerator was a brick-lined cell with a fixed metal grate over a lower ash pit, with one opening in the top or side for loading and another opening in the side for removing incombustible solids called clinkers. Many small incinerators formerly found in apartment houses have now been replaced by waste compactors.

8. Rotary-kiln

The rotary-kiln incinerator is used by municipalities and by large industrial plants. This design of incinerator has 2 chambers: a primary chamber and secondary chamber. The primary chamber in a rotary kiln incinerator consists of an inclined refractory lined cylindrical tube. The inner refractory lining serves as sacrificial layer to protect the kiln structure. This layer needs to be replaced from time to time. Movement of the cylinder on its axis facilitates movement of waste. In the primary chamber, there is conversion of solid fraction to gases, through volatilization, destructive distillation and partial combustion reactions. The secondary chamber is necessary to complete gas phase combustion reactions.

The clinkers spill out at the end of the cylinder. A tall flue-gas stack, fan, or steam jet supplies the needed draft. Ash drops through the grate, but many particles are carried along with the hot gases. The particles and any combustible gases may be combusted in an "afterburner".

9. Fluidized Bed

A strong airflow is forced through a sandbed. The air seeps through the sand until a point is reached where the sand particles separate to let the air through and mixing and churning occurs, thus a fluidized bed is created and fuel and waste can now be introduced. The sand with the pre-treated waste and/or fuel is kept suspended on pumped air currents and takes on a fluid-like character. The bed is thereby violently mixed and agitated keeping small inert particles and air in a fluid-like state. This allows all of the mass of waste, fuel and sand to be fully circulated through the furnace.

10. Municipal Waste Incinerators

Municipal waste incinerators work on the mass burn principle. The waste collected from household is normally stored in large bunkers which provide a buffer on what is usually a tidal flow situation in respect of material reception. Material is usually removed from these bunkers by grab cranes which are used to select and mix it. Operators become very skilled at doing this. After contraries (bulky objects, massive non-combustible materials) have been moved, it is then fed via feed hoppers into the incinerator. These are more usually of the inclined moving grate type where the mass moves down the grate under the effect of gravity and mechanically imported, often reciprocating, motion which is designed to turn the materials over to expose new surface for combustion. They typically operate at 850°C and by the nature of the operation, require well directed over bed

secondary air to ensure efficient combustion of the waste. The exhaust gases often after being put through a boiler to cover energy are usually passed after conditioning with water to an electrostatic precipitator to remove suspended particulates which usually carry absorbed and adsorbed residual organic matter. In some cases, dry lime injection is practiced prior to the electrostatic precipitator to neutralize acid components and sometimes wet gas scrubbing is used after the electrostatic precipitator to reduce acidic or other emissions to lower levels of contaminants. Rotary kilns have and are sometimes used for the incineration of municipal waste but they are much less common than the moving hearth type.

This report presents the assessment criteria, the methodologies for the assessments, the identification of the possible impacts of the project, analyze project alternatives, recommend mitigation measures for all impacts identified as per the Terms of Reference (TOR) of the EIA and to give an outline of a environmental monitoring plan for the development.

1.2 Need for the Project

This project aims at producing lasting impacts on the improvement as far as solid waste management in Kakamega County is concerned. However, a number of technical, financial, institutional, economic, and social factors contribute to the failure to sustain the projects, and they vary from project to project.

As urbanization continues to take place, the management of solid waste is becoming a major public health and environmental concern in urban areas of many countries in Kenya. The concern is serious, particularly in the urban and peri-urban areas. Poor visual appearance of these counties will have negative impacts on official and tourist visits and foreign investment.

Recognizing its importance, many cities in Kenya are in the process of improving solid waste management. Although some projects succeed in providing lasting positive impacts on the management of solid waste most towns are still faced with several problems due to various technical, financial, institutional, economic, and social constraints faced by the counties.

A survey sponsored by the proponent has established that demand exists for such development and that the target clientele would cherish an environment that meets the following criterion:

- A serene environment that is clean and free of solid waste.
- A solid waste handling facility close to good infrastructure
- A well secured solid waste management facility
- Mass skilled and unskilled job opportunities for the neighbouring community
- The need therefore exists for providing such a development to aid in local community economic growth and improve on the environment.

1.3 Scope, Objective and Criteria of the Environmental Impact Assessment (EIA)

1.3.1 Scope of the Report

The EIA exercise has been conducted to evaluate the impacts of the proposed incinerator installation on the environment and proposals have been given on how to eliminate or minimize

any undesirable effects resulting from its implementations (construction, installation and future operations). This report includes an assessment of impacts of the installations and operations on the following:

- Physical environment;
- Flora and fauna;
- Land use;
- Socio-economic aspects;
- Health issues;
- Fire response preparedness;
- Climate change aspects
- Spill/leak containment;

The report has assessed the impacts of the proposed incinerator project on the environment in accordance with the EMCA, 1999 guidelines and EIA/EA regulations. The scope of the EIA study covered:

- A review of the policy, legal and administrative framework
- Description of the proposed project
- Baseline information
- Provisions of the relevant environmental laws
- Assessment of the potential environmental impacts on the project area
- Development of the mitigation measures and future monitoring plans

1.3.2 Project Objectives

The purpose of this EIA is to ensure adequate identification of potentially negative environmental impacts. Secondly to propose workable mitigation measures and thirdly to formulate an environmental management plan (EMP) articulating envisaged impacts. The overall objective of the study on the other hand is to ensure that all environmental concerns are integrated in all the project development processes with an aim of managing hazardous waste without compromising the natural environment and the ecology of the area. Specific objectives include:

- To identify possible environmental impacts, both positive and negative
- To assess the significance of the impacts
- To assess the relative importance of the impacts of relative plan designs, and sites
- To propose preventive mitigation and compensative measures for the significant negative impacts of the project on the environment.
- Generate baseline data for monitoring and evaluating how well the mitigation measures are being implemented during the project cycle.
- To describe the present status of the socio-economic attributes of the project site;
- To assess the hazards associated with the development
- To present information on impact of alternatives
- To present the results of the EIAs that can guide informed decision making and safe

operation of the incineration plant.

- To identify and predict any potential positive, negative, reversible, irreversible short and long term impacts, as well as any cumulative environmental and socio-economic impacts that may arise from the project;
- To facilitate mitigation of possible negative impacts caused by the proposed development;
- To outline a suitable environmental management and monitoring plan for the duration of the project.

1.3.3 Terms of Reference (TOR) for the EIA Process

The TOR for the EIA included but not limited to the following:

- i. The proposed location of the project
- ii. A concise description of the national environmental legislative and regulatory framework, baseline information, and any other relevant information related to the project.
- iii. The objectives of the project.
- iv. The technology, procedures and processes to be used, in the implementation of the project.
- v. The materials to be used in the installation, construction and implementation of the project.
- vi. The products, by-products and waste to be generated by the project.
- vii. A description of the potentially affected environment.
- viii. The environmental effects of the project including the social and cultural effects and the direct, indirect, cumulative, irreversible, short-term and long-term effects anticipated.
- ix. Recommend a specific environmentally sound and affordable waste management system.
- x. Analysis of alternatives including project site, design and technologies.
- xi. An environmental management plan proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment, including the cost, timeframe and responsibility to implement the measures.
- xii. Provide an action plan for the prevention and management of the foreseeable accidents and hazardous activities in the cause of carrying out development activities.
- xiii. Propose measures to prevent health hazards and to ensure security in the working environment for the employees, residents and for the management in case of emergencies.
- xiv. An economic and social analysis of the project.
- xv. Such other matters as the Authority may require.

1.4 Methodology Outline

Environmental Impact Assessment was conducted for the site since the proposed site is located within an area with no rich natural resources whose total effect to the surroundings could not be adverse. It was also noted that the proposed development and use of facility on completion will

greatly promote hazardous waste management which is a big issue of concern not only in Kakamega County but in the Country at large.

The general steps followed during the assessment were as follows:

- I. Environment screening,
- II. Environmental scoping that provided the key environmental issues
- III. Desk Stop studies and interviews
- IV. Physical inspection of the site and surrounding areas
- V. Reporting

Environmental Screening: This step was applied to determine whether an environmental impact assessment was required and what level of assessment was necessary. This was done in reference to requirements of the EMCA, 1999, and specifically the second schedule. Issues considered included the physical location, sensitive issues and nature of anticipated impacts.

Environmental Scoping: The Scoping process helped narrow down onto the most critical issues requiring attention during the assessment. Environmental issues were categorized into physical, natural/ecological and social, economic and cultural aspects. The TOR was then developed and submitted for approval.

Desktop Study: This included documentary review on the nature of the proposed activities, project documents, designs policy and legislative framework as well as the environmental setting of the area among others. It also included discussions with managers and design engineers as well as interviews with neighbors.

Site Assessment: Field visits were meant for physical inspections of the site characteristics and the environmental status of the surrounding areas to determine the anticipated impacts. It also included further interviews with neighbors.

Reporting: In addition to constant briefing of the client, this environmental impact assessment project report was prepared. The contents were presented for submission to NEMA as required by law

CHAPTER TWO: BASELINE CONDITIONS

2.1 Introduction

The scope of environmental impact assessment for the proposed development includes a comprehensive description of the existing environmental and social status around the site and Kakamega Town in general. An evaluation of the proposed site and its immediate surroundings was undertaken with respect to the physical environmental resources, the carrying capacity of the natural environment and existing environmental management infrastructure (drainage and waste handling systems), health and safety, social and economic aspects and ecological aspects among others. The following subsections give a brief description of the environmental setting of the area, part of which will be necessary while designing and implementing the project.

2.2 Project Location/Site

The incinerator will be mounted at Cheptuli sub-location, Bisunu village, Malava Sub County, Kakamega County. It's at a distance of 37.1km from Kakamega Town along Kakamega-Webuye highway, past Butali Sugar Factory and only 3.9 Kms from Butali Sugar Factory towards Shivanga market. The purpose is to enhance environmentally sound waste management within the area. The proposed development will be situated on LR. No. Kakamega/Malava/500 (see attached deed plan) measuring 2.2 Ha.

2.2.1 Sub-County Geographical/Agro-Climatic perspectives.

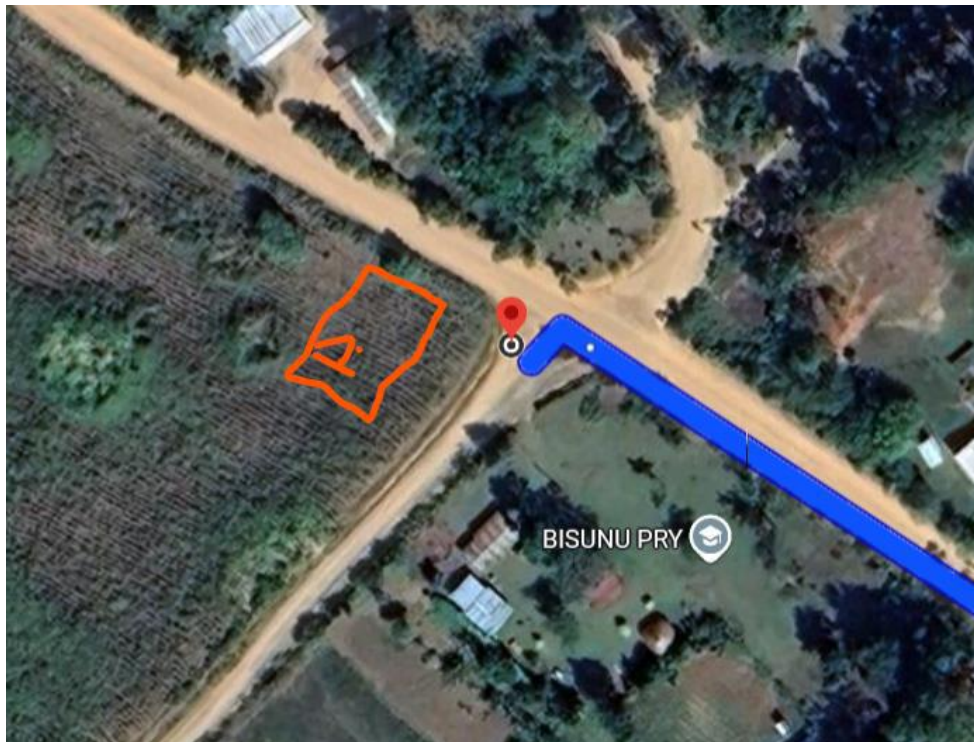


Figure 2. 1: Photo of the Proposed Site

Kakamega county covers an area of 3,051.3 Km². Kakamega County is divided into 12 administrative Sub-Counties with a total of 32 divisions 60 electoral wards and twelve constituencies. The county population projection in 2019 is estimated at 1,867,539, comprising of 987,133 male and 970,406 females with a population density of 515 per square kilometre. With a county population growth rate of 1.2% per annum the population is projected to increase further to 2,138,415 in 2027 assuming constant mortality and fertility rates. The labour force is estimated at 994,955 in 2024. About 62% of the total population is in the rural areas. The rate of unemployment is 24%. (CIDP, 2022).

Kakamega County is located at an altitude of between 1240 meters and 2000 meters above sea level. The county is characterized by a rugged topography that varies from place to place with the Nandi escarpment forming a major feature on the eastern border. Its main escarpment rises from 1700 meters to 2000 meters. On the southern side, there are several hills with a general elevation that rises up to 2000 meters. The county is also comprised of several hills such as Misango, Imanga, Eregi, Butieri, Shikhokhochole, Mawe Tatu, Lirhanda, Kiming'ini hills among others. Some of the main rivers traversing the county include Nzoia, Yala, Lusumu, Isiukhu, Shiastala, Firatsi, Kipkaren and Sivilie. The geology of the county is made of intrusive (mainly granites), Nyanzian volcanic and the Kavirondian sediments. However, the granites cover most parts of the area. Specifically, the sequence of rocks and sediments that characterize Kakamega county are of a geological structure of the Precambrian basement system formed in the Jurassic periods of Mesozoic era from the geological processes. These occurred during the middle and late cretaceous through the early tertiary and Pleistocene periods. The basement system rocks mainly stretch to the east of the Nandi fault and they comprise extrusions of the acid to basic Nyanzian volcanic at high depths including basalts, andesitic tuffs, agglomerates and rhyolites overlain by highly thick series of coarse Kavirondian conglomerates, grits and finely banded mudstones stretching to the central parts. Nyanzian volcanics also present in the area includes granitized gneisses, augengneisses, migmatites and small portions of hornblende. The Nyanzian and Kavirondian sedimen. The County comprises of 12 Sub-counties, 60 wards, 187 Village units and 400 Community Areas. Table 2.1 below shows the administrative units in the county with respect to Divisions Locations, Sub Locations and number of households.

Table 2. 1: Administrative Units and Area of Kakamega County by Sub-Counties
(Adopted from CIDP, 2023)

S/No	Sub County	No. of divisions	No. of locations	No. of sub locations	Area (Km) ²
1.	Likuyani	2	4	13	302
2.	Lugari	2	6	10	265.8
3.	Matete	2	4	8	101.2
4.	Malava	5	16	56	427.2
5.	Navakholo	4	12	24	258
6.	Lurambi	2	5	15	161.7
7.	Ikolomani	2	10	25	142.6
8.	Shinyalu	2	6	23	445.5
9.	Mumias east	2	9	19	149.2
10.	Mumias west	2	6	11	165.3
11.	Matungu	2	9	20	275.8
12.	Butere	3	12	30	210.4
13.	Khwisero	2	7	20	145.6
	Total	32	106	274	3,051.30

Land is the main source of livelihood for many people in Kakamega County. All socio-economic activities depend largely on land. Thus, rights of land ownership and land use are critical in influencing growth in all sectors.

Mean Holding Size Kakamega County has an approximate mean holding size of 1.5 Hectares (Ha) of land on average. The bulk of the land holdings in the county are small-scale and are found mainly in the high potential agricultural areas. The medium and large scale farms account for a small per cent of the holdings, but cover the largest area under farming. On the other hand the mean holding size for land ownership in urban areas is 0.05 ha on average.

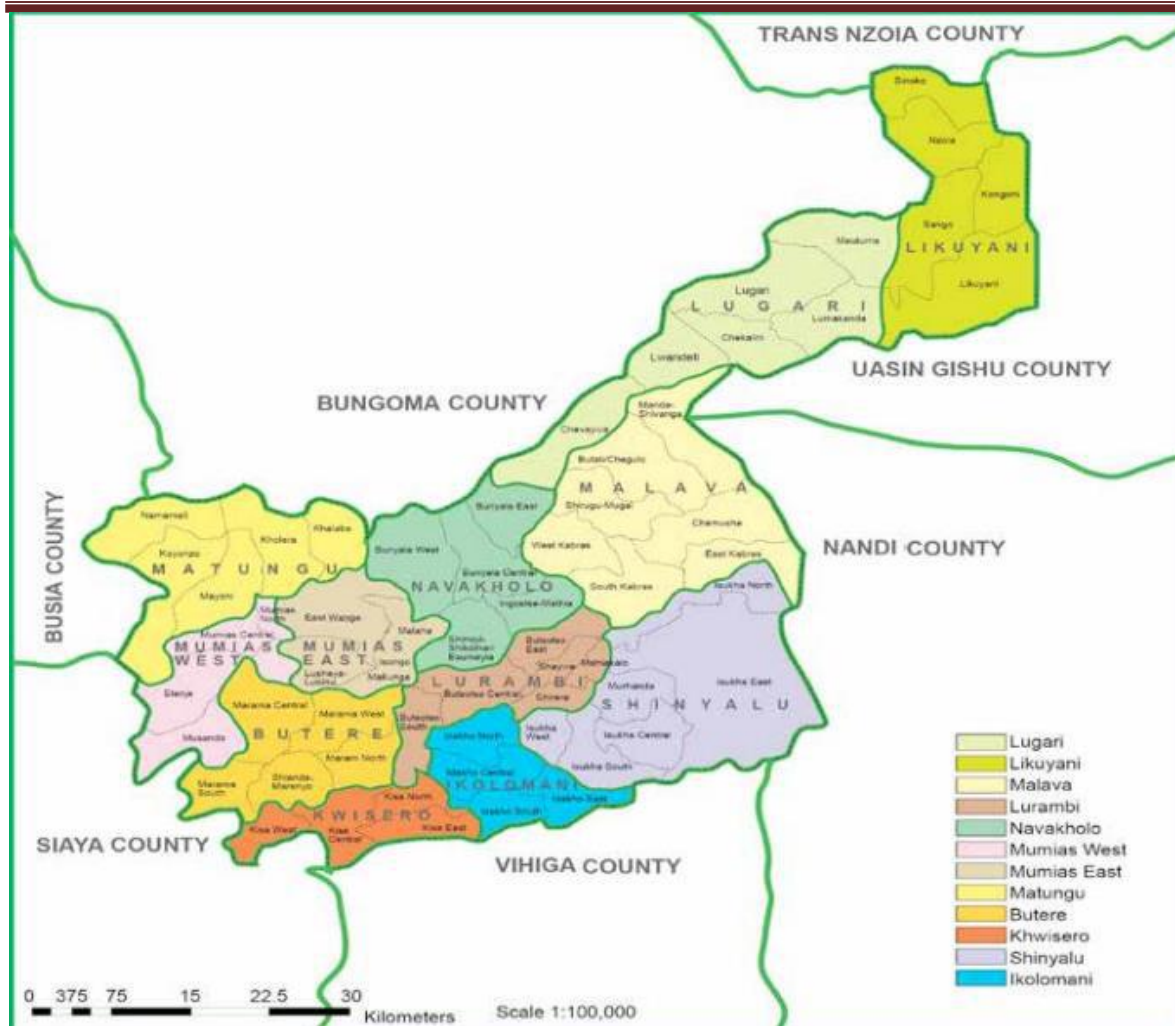


Plate 2. 1: Geographical location of Kakamega – Town sub-county

Table 2. Shows the constituency, size of the county wards and the population size per ward.

Table 2.2: County Electoral Wards by Constituency

County Electoral Wards by Constituency

Table 2. 2: County Electoral Wards by Constituency

S/No.	Constituency	Wards	Number of wards
1	Likuyani	Likuyani	5
		Sango	
		Nzoia	
		Sinoko	
		Kongoni	
2	Lugari	Lumakanda	6
		Mautuma	
		Lugari	
		Chekalini	
		Lwandeti	
		Chevaywa	
3	Malava	Manda-Shivanga	7
		Butali-Chegulo	
		Shirugu-Mugai	
		South Kabras	
		West Kabras	
		Chemuche	
		East Kabras	
4	Navakholo	Bunyala East	5
		Bunyala Central	
		Bunyala West	
		Ingotse/Matiha	
		Eshinoyi/Eshikomari/ Esumeiyia	
5	Lurambi	Butsotso South	6
		Butsotso Central	
		Butsotso East	
		Shieywe	
		Mahiakalo	
		Shirere	
6	Ikolomani	Idakho North	4
		Idakho Central	
		Idakho South	
		Idakho East	
7	Shinyalu	Isukha West	6
		Isukha South	
		Murhanda	
		Isukha Central	
		Isukha North	

		Mumias Central	
		Mumias North	
10	Matungu	Mayoni	5
		Namamali	
		Koyonzo	
		Kholera	
		Khalaba	
11	Butere	Marama West	5
		Marama North	
		Shianda/ Marenyo	
		Marama South	
		Marama Central	
12	Khwisero	Kisa Central	4
		Kisa West	
		Kisa East	
		Kisa North	
	Total		60

2.2.2 Topographic Characteristics

The main topographic features in the Kakamega-county are the Rift Valley floor, Menengai crater with its drainage and relief system. There are various inland lakes on the floor of the Rift Valley that form drainage for nearly all the permanent rivers and streams in the Sub-county. The Mau escarpment with an average altitude of 2500m asl does influence the rainfall patterns in the district due to its forest cover. Most of the rivers originate from the catchment. The topography of the area has greatly influenced economic activities. In parts of the county where volcanic soils are found, crop and dairy farming are common with major crops being wheat, maize, beans, sorghum, finger millet, cassava. While in the drier parts, livestock keeping poultry, sisal farming and other activities linked to tourism are practiced.

Climate

The climatic conditions are strongly influenced by altitude and physical features. The district covers areas with altitudes between 1240m and 2000m asl and receive an average rainfall between 1280.1 and 2214.1mm annually. The rainfall pattern is evenly distributed all year round with March and July receiving heavy rains while December and February receives light rains.

Agro ecological zones

There are 2 Major Agro-Ecological zones upper midland (UM) and lower midland (LM) which supports a wide range of crops. Major food crops in the County include; Maize, beans, sweet-potatoes, bananas, sorghum, Irish potatoes, indigenous vegetables and cassava. Agriculture is the mainstay of Kakamega populace and contributes 65% of total income..

Temperatures

The average temperature was high in the months of February and March at slightly over 20° C while it was lowest during the month of June.

Table 2. 3: Average Monthly Climatic Data (2013 - 2023)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	41.87	58.76	156.65	272.62	247.50	189.69	211.22	239.70	185.83	179.14	123.81	92.20
Average Temp (°C)	18.6	20.0	20.6	19.8	19.0	18.2	17.6	18.0	18.8	18.9	18.6	18.3
Min Temp (°C)	13.1	13.9	14.7	15.2	14.9	14.4	14.0	14.2	14.4	14.2	14.5	13.7
Max Temp (°C)	25.1	27.0	27.5	25.5	23.9	22.7	22.0	22.4	23.4	23.9	23.8	24.1
Evaporation (cm/Month)	75.6	69.4	73.9	73.3	87.1	78.8	75.8	81.5	84.1	86.2	82.1	78.9
Relative Humidity (%)	69.2	65.1	66.6	76.7	81.3	82.1	83.1	81.5	79.0	79.6	81.3	77.3

Types of soils

The distribution of soil types have been influenced by the extensive variation in relief, climate, volcanic activity and underlying rock types. The soils are derived from weathered volcanic and basement rock system. The following are the different types of soils in the sub-county:

- Latosolic: well drained red soils derived from volcanic and basement complex rocks found in areas such as Ngata. The following crops are grown in this area: wheat, maize, sunflower, millet, potato, pigeon peas vegetables, beans, peas, sheep and dairy.
- Planosolic: poorly drained dark brown clay with highly developed textured top soils and have high fertility found in areas such as parts of Ngata, Rongai, Upper parts of Solai. The crops grown in this area are wheat, maize and vegetables.
- Alluvial and Lacustrine deposit: these are shallow soils developed from sediments from volcanic ashes and other sources. They cover the rift valley floor and found in areas between Solai and Menengai crater and the soils in larger parts of Kambi ya Moto division. They have low to moderate fertility. Main economic activities in the areas are livestock, sorghum, sisal and millet.

2.2.3 Land Use Characteristics

The dominant land use cover within the project area is scrublands at 62%, followed by grasslands at 37 %, while tree cover and cropland have the least area at 0.44 and 0.01 % respectively as shown in Error! Reference source not found..4.

Table 2. 4: Land Cover Statistics

Land Cover	Total Area (ha)	% Area
Cropland	4,705	54.65
Trees	2,100	24.39
Shrubland	1,059	12.30
Grassland	668	7.76
Built-up	69	0.80
Barren / sparse vegetation	9	0.10

Error! Reference source not found..4 clearly shows the different land use land cover within the region. The land cover data was derived from the European Space Agency (ESA) with a spatial resolution of 10 m (Zanaga et al., 2021).

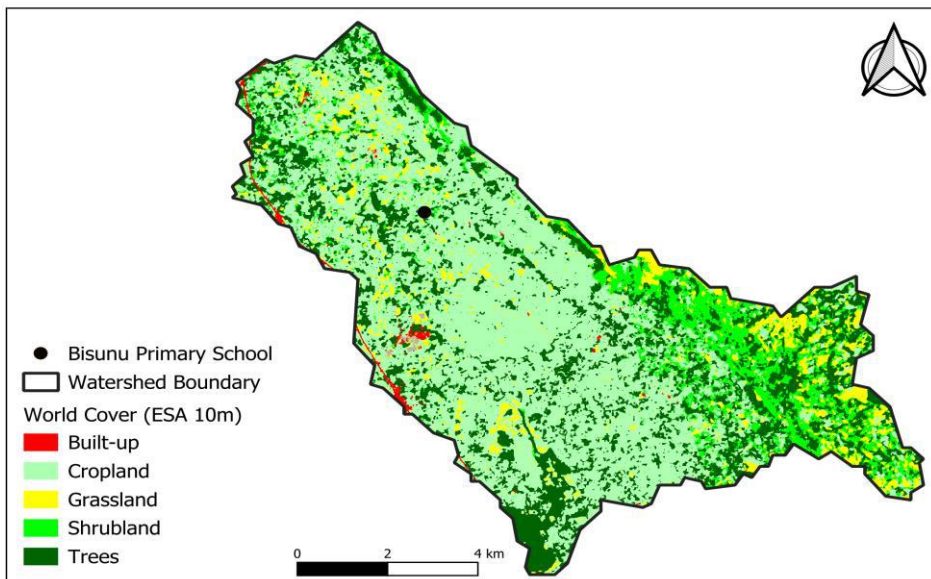


Plate 2. 2: Land Use Land Cover

Kakamega is a major dynamic regional administrative, commercial, educational and industrial centre. The town has a vibrant informal sector that offers employment to many of its residents.

2.2.4 Hydrological Functions

The Upland forest is the main water catchment area; it is rich in forest products, and biodiversity. The catchment has multiple land use types i.e from pastoralism to commercial farms. The changes are associated with increasing human population, which has led to increased pressure on resources. Developments in Kakamega town and other urban centres have affected negatively on the catchment area. These impacts are manifested through erosion, high silt loads, and pollution from industrial and domestic wastes, agro-chemicals, urbanization and degradation, deforestation, encroachment into sensitive habitats. The polluter pays principle should be used to charge all organizations that contribute to environmental pollution. The government has introduced stringent measures on water and waste management targeting polluters in private and public institutions. Management issues that Kakamega municipality is faced with include:

- Solid and liquid waste management
- Industrial Pollution
- Domestic wastes
- Urban farming

The impacts arising from human activities such as waste, agro -chemicals, and industrial waste (chemical, solid waste, municipal and domestic wastes, hazardous and toxic wastes), accumulate in the lake. Environmental issues in this catchment emanate from:

- Land use and land ownership.
- Land settlement
- Livestock and crop farming.
- Forestry.

- Conflicts
- Urban development.
- Water resources
- Communication.

These impacts are a clear reflection of the failure to enforce and adhere to environmental standards as stipulated in various Acts, By-laws and policies.

The informal artisans popularly called '*jua kali*' are among water polluters through discharge of used oil, grease, discarded filters and burning of old rubber tyres whose blockages affect the open drains leading to flooding especially in the slums, flat and swampy areas.

2.2.5 Social Economic Characteristics

The increase in population calls for an accompanying increase in human developmental activities, which form a basis for employment and income creation and by extension the sustainability of human life. In Kakamega, the economy is dogged by a variety of problems leading to the stagnation of its key sectors. In order to revive the economy therefore, the following strategies have been propose:

- Capitalize on the location advantage (with the accompanying characteristics of centrality and connectivity) that Kakamega enjoys to boost its economy by developing, diversifying and improving the quality of its service, manufacturing and administrative functions.
- Initiate planning and management interventions to jump start activities in high potential sectors of the economy such as, tourism, rail transportation etc, which are currently dormant.
- Diversify products in the tourism sector and encourage local tourism. Carry out studies to identify the cause of decline in the industrial sector and propose the most environmentally appropriate and economically viable type of industries for the town.
- Urgently supply all economic sectors with requisite infrastructure and services to enhance growth.
- Planning and management interventions are needed in order to enhance the capacity of the vibrant informal sector by re-organizing activity spaces, providing support infrastructure and services such as sheds, social amenities, credit facilities, among others.
- Decongest the CBD by organizing informal sector activities, and by allowing regulated and planned expansion of commercial functions into the southern residential area, and other strategic areas such as nodes and strips.
- Rationalize the pricing of land and activity spaces in the CBD (especially controlling the charging of goodwill) to promote growth.
- Support urban agriculture activities in the planning area by providing planning and extension services and by putting in place measures to mitigate related environmental consequences.

2.2.6 Communication

Postal & Telecommunication Services

Malava sub-county in Kakamega is connected to the national and international telecommunication and postal network. Consumers in industrial area and CBD are relatively well served. The town has a generally fair distribution of postal services. Private phone lines are mostly inaccessible to the majority of the urban poor due to high connection and usage costs. These are especially inadequate especially in the low-income residential areas. There is also poor maintenance of public call boxes. Fax and Email services are also available in the town. All main telephone service providers have connectivity at the proposed site.

Transportation

Malava, the nearest sub-county headquarters in Kakamega town is well linked to the international, national and regional transportation systems. The Highway linking Kakamega to Kampala and the main Kenya-Uganda Railway passes in Webuye, which is nearby. These provide both freight and passenger services. At the local level, Kakamega town itself has a network of roads laid out in a grid iron pattern providing access to all areas of the town. The sub-urban areas are directly connected to the town center, but lack direct linkage between themselves.

Road Transport

At present, the main problem associated with this transit traffic has been the frequency of accident occurrences. The internal road network (within the town) is in very poor condition but are currently undergoing repairs. There is one major public transport terminus in the CBD, which is used for both through and local traffic. It is shared between large capacity vehicles (buses), and small mini-buses (matatus). This terminus is badly organized and its condition has deteriorated severely. There are several other terminuses along the main streets and within residential areas. These routes are however not conveniently situated and they lack sheltering cover. Although public (matatu) transport is the main mode for motorized transport in Kakamega town, Non-motorized transport (pedestrians and cyclists) is an emerging common mode of movement in the town. The main problem facing non-motorized transport is lack of appropriate support infrastructure such as foot paths and cycle tracks. The proposed site is connected by earth road all the way to the site. There will be no need of creating any access road to the site. Probably some improvement might be necessary only when deemed necessary.

2.2.7 Electricity

The main provider of electric power is the Kenya Power & Lighting Company. The demand for power is growing rapidly and at the moment it exceeds the supply. There are also frequent power interruptions, which have very adverse effects on manufacturing industries and key services like hospitals, telecommunication and water supply. Many industries and key institutions are forced to install standby power generators. The proposed site is less than 600m from the nearest service line.

2.2.8 Solid Waste Management

The management of solid wastes in Kakamega town is primarily the responsibility of the Kakamega Municipal Council. However, in recent years, private sector entrepreneurs have increasingly been involved in refuse collection and disposal. Most of the old town is covered by municipal collection services but the outlying and newly developed areas are not served. These areas rely heavily on individual, private or in house initiatives.

Kakamega town has only one designated dumping site. Here open dumping in an abandoned quarry site is practiced. The majority of waste generators however dump their refuse in undesignated dumping sites where it is either burnt or left unattended.

The main problems confronting solid waste management include, poor organization, low public awareness on environmental health, lack of adequate personnel and appropriate equipment and use of poor waste handling techniques. A few initiatives by NGO's (WWF) and CBO's are however helping to reverse the situation albeit in a small scale.

Solid Waste Management is a major problem world-over and in Kenya offers several challenges from clogged drainage and sewers, waterborne diseases like typhoid, cholera and diarrhoea, increased upper respiratory diseases from open burning of the garbage to malaria. Integrated Solid Waste Management (ISWM) also called sustainable solid waste management is a new concept of dealing with waste which is gaining currency in Kenya. Waste management has been the responsibility of local authorities but the scenario is changing with the realization that local authorities on their own are not capable of managing waste. Like other cities in the world, solid waste management is an expensive venture gobbling up to 30 to 50% of revenues. This is unsustainable and Kenyan cities and towns end up with endless heaps of garbage dotting the landscape.

Municipal solid waste management (MSWM) encompasses the functions of collection, transfer, resource recovery, recycling, and treatment. The primary target of MSWM is to protect the health of the population, promote environmental quality, develop sustainability, and provide support to economic productivity. To meet these goals, sustainable solid waste management systems must be embraced fully by local authorities in collaboration with both the public and private sectors. Although in developing countries the quantity of solid waste generated in urban areas is low compared to industrialized countries, the MSWM still remains inadequate. The ministry of local government is in the process of developing a national solid waste management policy. Many local authorities has followed suit and have localized the best practices in their various by-laws and other policy frameworks.

A number of refuse storage chambers have been constructed at various points within the low- income neighbourhoods. The chambers are large enough to hold one week's garbage. The town has been zoned into three operational zones – the public, private and low-income areas. Community based groups have been empowered to collect garbage in the low-income areas. Proposals by Kakamega Municipality to improve on Solid Waste Management include:

- Launch public education and awareness campaigns on safe waste handling and disposal methods at production points.
- Conduct regular public cleaning campaigns.
- Promote waste minimization techniques such as recycling.
- Adopt proper methods of waste disposal and treatment such as landfill and composting.
- This will include developing and appropriate waste disposal site and instituting effective monitoring and control measures to regulate the discharge of untreated toxic wastes into open dumps.
- Improve Municipal waste collection systems by creating an autonomous waste management department, supplying it with appropriate easy to service equipment and recruiting qualified personnel.
- Privatize some aspects of the solid waste management process such as removal, transfer and

billing.

Effects of Environmental Degradation Cultivation of riparian reserve along major rivers and wetlands has led to siltation which causes reduction in water body mass. Chemicals like washing detergents and agro-chemicals when, Solid waste disposal in the upstream at the Kakamega's dumpsite is a major contributor of environmental pollution and degradation (Kakamega County Integrated Development Plan, 2012-2017), destroy algae and increase water pollution thereby leading to loss of biodiversity. Quarrying activities lead to blockage of water ways, siltation in addition to threatening human safety especially when the quarry sites are left open and without perimeter fence. In addition environmental degradation has resulted in extreme weather conditions as a result of overall climate change. This has a negative effect on small scale farm holders who depends on rain-fed agriculture. A change in climate also reduces the ability of the physical environment to support the flora and fauna. Ultimately, the County economy would be adversely affected hindering the realisation of Kenya Vision 2030 development goals under this sub-sector.

2.2.9 Agricultural Landscape of Kakamega County

Kakamega, Kenya, is a rapidly growing centre with a diverse economic base of agricultural processing, regional services and tourism. Particular environmental concerns are caused by the interrelation between human settlements, Kakamega Forest National Reserve and expansion of the town into geologically fragile areas and rich agricultural land. The proposed site is bear with fairly fertile soils and therefore its agricultural productivity is good.

2.2.10 Climate Risk Assessment

There exists a forest ecosystem that plays a significant role in human existence. This includes; land conservation, securing of water sources, control of climate change, and creation of natural environs essential to natural life. Kakamega Forest Ecosystem comprises Kakamega, Lugari, and Butere/Mumias Forest Zones. The Kakamega zone has Kakamega Forest, the only remaining tropical rainforest, Malava, Kisere, and Bunyala forests. Lugari Forest Zone has Turbo, Lugari, and Nzoia forests. The Butere/Mumias Zone has only one gazetted forest area which is Misango hills. The Forest ecosystem is facing degradation resulting in deforestation which adversely impacts the natural environment through the drying of rivers, siltation of surface water bodies, and decline in land production among other effects.

There are over 60 wetlands in Kakamega County. These wetlands reveal an enormous diversity and support a variety of ecosystem services. Many wetlands are threatened by climate change resulting in loss of biodiversity and disruption in ecosystem benefits to the society.

The project proponent shall act with guidance provided by the Climate Change Act (2016) and the Kakamega County Action Plan to ensure compliance from the construction to decommissioning phases.

CHAPTER THREE: PROJECT DESCRIPTION

3.1. Site location and characteristics

Health Advantage Kenya Limited is desirous to mount an incinerator in Kakamega town to enhance environmentally sound waste management within the proposed area (See Plate 3.1).



Plate 3. 1: Surrounding area around the site



Plate 3. 2: Agricultural Land near the Proposed Site

To the left of the site about 20m is a homestead of the land owner and to the right is a fallow land with some grass and the dominating sparsely spaced trees are acacia. 200m away is a small scale factory and 500m down slope is an agricultural land. Most of the people living in the area practice mixed farming and the major cash crop is wheat. The roads in the area are well developed and therefore, the proposed site is accessible.

The process of incineration provides the advantage of volume reduction as well as the ability to dispose of recognizable waste. On-site incinerators provide a quick and easy way of disposing medical waste. This is the most widely accepted and feasible method of managing highly infectious waste. It is the method approved by the Ministry of Health in Kenya. Health Advantage Kenya Limited engaged a consultant who designed a locally assembled incinerator that is geared towards enhancing sound waste management in Kakamega County. The project is basically aimed at incinerating hazardous waste generated in Kakamega Municipality and its environs that currently is finding its way illegally to the dump site.

3.2 Project design/Nature

The incinerator is designed in such a way that it will be using the liquefied gas as a source of fuel. The use of the gas is to ensure efficiency in burning i.e high temperatures that are required and range between 800⁰c and 1200⁰c. The incinerator will be of the controlled air type, designed for 8-hour-day operations and rated at 75kg per hour.

This design has been executed with due consideration of the existing topography at the proposed project site. In addition, measures have been taken to ensure that the existing land mass, strata and vegetation is least disturbed during development. In general, the design of the project will optimize the use of best available technology to prevent or minimize potentially significant environmental impacts associated with the project development. Also, it will incorporate efficient operational controls together with trained staff, to ensure high level business and environmental performances. Table 3.1 presents a summary of technical specifications which appendix A is a picture of the proposed incinerator.

Table 3. 1: Summary of Technical specifications of incinerator - cyclone separator

INCINERATOR	
Brand Type and Model	“ALFA-THERM” Oil Fired Incinerator Model GWC-75
Auxiliary Fuel	Diesel
Type of Burner Operation	Monoblock fully automatic burners one each for primary and secondary chamber
Burning Capacity	75 kilograms per hour
Temperature	Primary Chamber [800 ⁰ C+50 ⁰ C] Secondary Chamber [1050 ⁰ C+50 ⁰ C] Higher temperature can be attained by adjusting the temperature from the respective controllers.
PRIMARY CHAMBER	
Type	Static Solid Heart
Material of Construction	Mild Steel

Refractory thickness	115mm thick
Material	Refractory bricks confirming to IS-8
Insulation thickness	115mm thick
Materials	Insulation bricks IS-2042
Waste Charging	Manual
Ash Removal	Manual
SECONDARY CHAMBER	
Type	Static Solid Hearth
Material of Construction	Mild Steel
Refractory thickness	115mm thick
Material	Refractory bricks confirming to IS-8
Insulation thickness	115mm thick
Material	Insulation bricks IS-2042
BURNER	
No. of Burners	2 Nos (1 each for primary & secondary chamber)
Type	Monoblock fully automatic oil fired
Fuel	Diesel
Make	“Alfa-Therm”
CHIMNEY	
MOC	Mild Steel
Height of chimney	10 meters from ground surface

As per the 3rd schedule of the Environmental Management and Coordination (Waste Management) Regulations of 2006, the incineration facility will be considered as class 2A – Commercial Industrial Incinerators for disposal of waste that contains hazardous and biomedical waste. The incinerator conforms to the standard of the 3rd schedule;

(a) Basic Design.

The incinerator consist of an automatic feeding system, primary and secondary chambers, scrubber system and a 10 meter high stack/chimney.

(b) Feeding and charging system

As indicated above the incinerator has an automated feeding system. The waste is only introduced into the incinerator after acquiring the necessary temperatures reset with the machine. **(c)**

Primary Chamber

There is a distinct primary chamber. The primary chamber is fitted with a diesel fired burner and the air supply is automatically controlled. A temperature of 850°C will be maintained at the primary chamber.

(d)Secondary Chamber

There is a distinct secondary chamber. The secondary chamber is fitted with a diesel fired burner and the air supply and the residence time of the flue gases is automatically controlled. The temperature inside the chamber is monitored and the temperatures will be maintained at 1100°C.

(e)Particulate removers

The incinerator is fitted with a cyclone separator.

(f) Chimney/stack

The chimney is 10 meter high and as required the other considerations in regard to the roof will be considered during the construction stage. An inductor fan is fitted to ensure the diluting of air inside the chimney and exit velocity of the air meet the required standards.

(g) Location

The building and construction designs will be submitted to the local authorities for approval as required.

(h) Emission Limits

Regular tests shall be carried out by qualified and accredited institution to determine stack and/or ground level concentrations of the gases being emitted from the incinerator.

3.2.1 Project activities

The project is designed to have a shed where the incinerator will be installed. This will therefore mean some civil works involving construction and electrical wiring will be undertaken. The construction activities will involve excavation of the top soils, clearance of some vegetation, fencing etc. The area has no public sewer line hence the residents rely mainly on septic tanks or the pit latrines. Other activities include:

1. A competent architect has made the final design of the project and the constructions will follow details as given by the project consultants.
2. A competent engineer will facilitate the installation and management of the incinerator according to the manufactures specification.
3. The structures will be founded on solid ground using reinforced concrete strips laid on concrete blinding. The laying of the foundation will follow details as given by the structural engineers on site.
4. The solid wastes will be collected by a private companies contracted for their environmentally sound and friendly waste disposal strategy

3.2.2 Construction activities

The following are the activities proposed during construction:

- i. Site preparation (clearance of some vegetation, cutting of existing shrubs, preparation of a site store, fencing to avoid intrusion, building of a toilet).
- ii. Excavation of the site to a level that will create a platform upon which the structure/building will be constructed.
- iii. Disposal of excavated materials/earth moving, filling and foundation laying.
- iv. Sanitation facility including septic system will be constructed for use at the facility.
- v. Building works, trampling and removal of construction wastes
- vi. Procurement of construction materials and delivery of the same to the site
- vii. Storage and utilization of materials
- viii. Civil and electrical works
- ix. Completion of the incinerator shed and waste stores,
- x. Solid waste collection and commissioning of the incinerator

3.2.3 Input Materials

The houses will be constructed using common construction materials by following standard construction procedures that are not expected to compromise the safety of the neighbouring communities as well as the general environment. Among the inputs required for construction are:

- i. Raw construction materials e.g. sand, cement, natural building stone blocks, hard core, gravel.
- ii. Timber (eg. Doors and frames, fixed furniture, etc)
- iii. Glass pane
- iv. Pipes (steel and plastic) for plumbing and waste conduits
- v. Water
- vi. Acidic solutions
- vii. Basic solutions
- viii. Water
- ix. Paints, solvents, white wash etc.
- x. Construction labour force (both skilled and unskilled).

3.3 Proposed Development Components

3.3.1 Waste Reception

Waste will be delivered to the site by road from around Kakamega County and other parts of the country. Delivery by road will be in compliance with regulations. The waste handling/reception will comprise of;

The proponent: will procure a track and obtain waste transportation license from the National Environment Management Authority (NEMA). A container offloading bay will be provided at the site that will also be installed with safety measures and environmental protection provisions. The bay will also receive wastes from delivery trucks.

Waste Sorting: Waste sorting will be done before loading into the trucks. Minor sorting bay will therefore, be provided fitted with appropriate quantification facilities, documentation and holding zones. Necessary safety and environmental protection provisions will be provided.

Waste Storage: The proposed go-down will consist of two main areas, the machine area and the temporary storage area. It is uneconomical to start the incineration process without enough waste, because of the heating process. Therefore the temporary holding area will be enough to hold a days capacity i.e. approximately 600 kilograms.

Incineration facility description: The design, acquisition and final installation has been done and will be in conformity to the Waste Management Regulation, 2006, guidelines, criteria, procedures for installing/operating incinerators. In addition it has been proposed that the proponent regularly subject its operation to air quality measurements to ensure sound environmental management in its operation. The solid waste container shall include a 5m³ solid waste container, attached to a feed conveyor system for loading the materials into the screw hopper. The incineration plant will be fitted with constant air emission monitors that will provide a CEM including a draw sample system that will monitor O₂, CO, HCl, hydrogen fluoride, sulphur dioxide, NO_x, particulate, and HC. This will eventually regulate particulate matter to the atmosphere reducing air pollution. The incinerator will be installed and operated by competent persons at all times to ensure efficiency and

environmental conservation.

3.3.2 Waste Disposal

The process does not use any water and therefore water will only be used for sanitary and washings within the site. Waste water emanating from operation areas will not be allowed into the natural drainage system. Due to the potential residuals of hazardous pollutants, the wastewater will be collected and channeled into a septic system designed for use at the premises. As per the manufacturer's guidelines out of 100 kilograms of waste, 4 kilograms of ash will be generated. The ash is considered clean and will be disposed of at the municipal council's dumping site. The management will seek permission from the council for the disposal.

Water supply: There is no surface water source within the vicinity of the proposed site. This leaves sources options as rain water harvesting and groundwater for a project.

Air Quality Survey: Baseline Atmospheric Environment Monitoring was conducted to characterize the existing environment before implementation (Do Minimum) of the proposed incinerator site. The conclusions below were drawn from the exercise conducted on the 31st January 2025.

Gaseous parameters;

All gaseous parameters (carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone and total volatile organic compounds) were measured and quantified at all survey locations. During the assessment, all measured gaseous parameters complied with the EMC (Air quality) regulations 2014 limits. The ambient air quality data (gaseous) measured around the monitoring locations are considered to be within a typical range of emissions for such neighborhood.

The findings of the gaseous monitoring program indicate that the air quality at the project site is generally good before commissioning of the project. All pollutants measured are at levels that do not pose Environmental, Health, Safety and compliance concern.

The practices in place to control and manage gaseous pollutants should be maintained.

Particulate Matter (PM₁₀ and PM_{2.5})

Particulate parameters concentrations (PM₁₀ and PM_{2.5}) were measured and quantified across the survey locations. During the assessment, all measured particulate parameters complied with the EMC (air quality) regulations 2014 limits.

PM₁₀ and PM_{2.5} concentration levels recorded were within the typical range of emissions for similar neighborhood. The findings of the monitoring program indicate that the particulate matter atmospheric environment is generally good. Particulate pollutants measured are at levels that do not pose Environmental, Health Safety and compliance concern.

Support services: The site will not be complete until support facilities are put into place. These will include;

- i. Offices
- ii. Sanitation facilities (toilets, bathrooms, hydrants, wastewater drains)
- iii. Health and safety provisions (fire extinguishers, hydrants, signage, exits, first Aid points etc)
- iv. Security arrangements

Project Approval: The project will be developed on land owned by the proponent as per the ownership documents supplied. The development plans are yet to be submitted to the County Council of Kakamega for approvals. For full implementation of the project, the following pre-

requisites will be met:

- 1) Approval designs by the County Government of Kakamega
- 2) Appointment of established competent and capable contractors and consultants to undertake the development
- 3) Acquisition of NEMA approval.

After the pre-requisites are met the proponent will then commission the development as is planned.

3.4 Project Activities

3.4.1 Pre-Construction stage

The pre-construction has also involved getting to collaborative agreements with key stakeholders including project manager, architects, quantity surveyors, engineers/contractors (structural, mechanical, electrical), material suppliers, landscapers, and financiers). A programme has been set and an agreement made between the proponent and the project consultants. Further, it involved site identification and entering into a five years lease. Further, it involves seeking pre-requisite licenses like EIA.

3.4.2 Installation and Civil Works Stage

The project will be constructed based on applicable standards of Kenya and any other standards which may be incorporated. The constructions will as well incorporate environmental guidelines, health and safety measures. The project inputs will include the following;

- Construction raw materials will include sand, cement, stones, gravel, ballast, metals, among others. All these will be obtained from licensed dealers and especially those that have complied with the environmental management guidelines and policies.
- Construction machines will include machinery such as trucks, concrete mixers and other relevant construction equipment. These will be used for the transportation of materials, clearing of the vegetation and resulting construction debris. Most of the machinery will use petroleum products to provide energy.
- A construction labor force of both skilled and non-skilled workers will be required.

In addition the proponent has hired qualified and registered consultants. During the construction phase of the project, the project's sign board must be erected to make the public aware of the proposed development and to keep away intruders, which will indicate the following:

- A pictorial impression of the proposed building
- The developer's name and address
- The County authority approval number
- The project architect's details
- The project engineers' details
- The project's quantity surveyors
- NEMA approval number
- The project Environmental Consultants
- Environment Consulting Company

- Other professionals involved in the project.

Construction activities include the following:

- A temporary site office and a sanitation facility for use by the construction workers.
- Procurement of construction material from approved dealers
- Storage of the construction materials.
- Transportation, storage of construction materials and disposal of the resulting construction wastes/debris using light machinery. All debris and excavated materials will be dumped on sites approved by the council engineer.
- All required kinds of works will be done by registered experts such as: - Masonry, concrete work and related activities, - Structural steel works.

The project will commence after the National Environmental Management Authority (NEMA) issues the Environmental Impact Assessment (EIA) license.

3.4.3 Operations

Once the development is completed, the proponent will use the facility to conduct incineration for various clients. Maintenance activities will include facility cleaning, routine checks and other necessary repairs. Workers will be fully employed onsite including the truck drivers who will be transporting the waste for incineration.

Solid waste management: The project proponent will provide facilities for handling solid waste generated within and around the facility. These will include dustbins/skips for temporarily holding waste within the premises before final disposal at the designated dumping site by NEMA approved solid waste handling company.

Effluent and waste water management: The area is not served by sewer system. The proponent hence intends to use septic system for efficient effluent management. Inorganic waste generated from the premise such as oil and fuel should however be treated before release to the system.

Cleaning: The proponent will be responsible for ensuring regular washing and cleaning of the pavement of the entire facility. Cleaning operations will involve the use of substantial amounts of water, disinfectants, detergents e.t.c.

3.5 Decommission phase of the project

The aim is to make the place be occupied by the proposed structures equivalent or better than its original condition in the event of decommissioning of the site. In the unlikely situation that the proponent decides to decommission the project, a decommissioning plan should be put in place. The necessary objectives, activities, actions, mitigation measures and allocation of responsibilities pertaining to prevention, minimization and monitoring of potential impacts associated with decommissioning and closure of the facility as outlined in Table 3.2.

Table 3. 2: Decommissioning Plan

ACTION	Responsible party	Time Frame
Removal of all underground facilities like water pipes, electricity and telephone cables	Proponent / contractor	Once

Landscaping the area	Proponent / contractor	Once
Used oil containers to be incinerated or re-used	Proponent / contractor	Once
Report the intention to decommission the site to Kenya Power in order for them to remove the electricity lines on the sites	Proponent	Once
Report to NEMA on the intension to decommission the incinerator for an appropriate site for disposal of the obsolete incinerator	Proponent	Once
Clear disposal of all waste materials like broken stones from demolished masonry wall, waste metals etc. by an authorized/licensed waste disposal site	Proponent / contractor	Once

3.6 Need for the Development

Waste management has been the responsibility of local authorities but the scenario is changing with the realization that local authorities on their own are not capable of managing waste. Like other cities in the world, solid waste management is an expensive venture gobbling up to 30 to 50% of revenues. This is unsustainable and Kenyan cities and towns end up with endless heaps of garbage dotting the landscape. Thus such developments are guaranteed of attracting the desired clientele. Additionally, the proposed venture will create both direct and indirect stable employment opportunities. Above all, it will provide security to the residents.

3.7 Alternatives to Project

The management of solid waste is an evolving area of with improvements are being sought to reduce the toxicity and risk associated with the handling of these wastes. In this section, alternatives to the proposed project of installing an incinerator are discussed including the “do nothing” alternative.

3.7.1 The “Do Nothing” Alternative

The “do nothing” alternative would mean that the current state of solid waste management would remain the same. This also means that the land on which the proposed project is intended will remain fallow. Therefore, the no project option is the least preferred from the socio-economic and partly environmental perspective due to the following factors;

- There will be no incinerator installation yet there is acute need for such facility within Kakamega County.
- Local skills would remain under utilized
- Discouragement for investors and yet the land will still remain idle.
- No employment opportunities will be created for Kenyans bearing in mind that the proposed project will have employment opportunities both directly or indirectly during construction and operations phases and thus improve lifestyles and livelihoods.
- Vision 2030 will be far from being achieved/ attained bearing in mind that this is one of sector which need infrastructural improvement to gear the nation towards realization of vision

2030.

From these analysis, it becomes apparent that the No Project alternative is no alternative to the local people, and the government of Kenya.

3.7.2 Technological Alternatives

Existing incinerator which are believed to be almost 50 years old do not have emission controls to prevent particulates, PM₁₀, dioxins, furans, hydrochloric acid and other pollutants from being released into the environment. Most of the alternative methods to incineration have one or two disadvantages when compared to incineration. That is:

- They are more expensive
- They require additional mechanical equipment such as shredders to render the waste unrecognizable and reduce volume.
- They have limitations in the type of waste that can be burned e.g. cytotoxic, pathological and chemotherapeutic waste

This option is unacceptable when one considers the costs associated with operating these old and inefficient incinerators and the associated health effects.

3.7.3 Alternatives for the site/relocation

Relocation options means that the proponent will look for a different plots to establish the proposed development. Suitable selection of the site of the plant will have positive effects on energy efficiency thus reducing emissions and impacts on the environment. Important criteria assessed: were topographical criteria; ambient air quality; Soil contamination; Traffic situation; Nature conservation; Landscape conservation; Townscape. All these factors when considered, helped in identify the proposed site because of the many advantages over other potential sites for relocation.

Bearing in mind that the land cannot be used for agriculture since it is bare and not fertile, the owner does not have another use. Assuming the proposed project will be given a positive response by the relevant authorities including NEMA, the proposed site will earn some revenues unlike when idle as is the case now.

3.7.4 Analyses of Alternative Construction Materials and Technology

The proposed project will be constructed using modern, locally and internationally accepted materials to achieve public health safety, security and environmental aesthetic requirements. Equipment's that save energy and water will be given first priority without compromising on cost or availability factors. The proponent should consider installing solar panels so that solar energy is also used as an alternative.

CHAPTER FOUR: POLICY, LEGAL AND LEGISLATIVE FRAMEWORK

4.0 Introduction

There are a number of pertinent laws relating to environmental protection that are applicable to any development and that a developer will need to be aware of when embarking on a particular type of development. There are also several statutory agencies that have powers to control certain types of development that have the potential to affect the environment. These powers of control are typically exercised through a system of permits that include checks and balances on what kind and form of development that is approved. A developer therefore must be prepared to present, explain, and in some cases alter an aspect of a proposal in order to comply with the permitting requirements. This section is therefore intended to act as a guide to the relevant permitting requirements that deal with the environmental impacts of this proposed development and the agencies to which they relate as well as to present other legislation and regulations, which are applicable to the development.

4.1. The Kenyan Laws and Regulations

The Constitution of Kenya under Chapter four - The Bill of Rights, Part II – Rights and Fundamental Freedoms (42) on Environment states that, “Every person has the right to a clean and healthy environment”, which includes the right to:

- a) Have the environment protected for the benefit of present and future generations through legislative and other measures particularly those contemplated in Article 69.

Article 69 (a) of the constitution, by stating ‘*The State shall ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits*, acknowledges the role of the state in ensuring sustainable development as well as the importance of equitably sharing benefits derived from the environment.

- b) Have obligations relating to the environment fulfilled under article 70.”

(http://www.wipo.int/wipolex/en/text.jsp?file_id=207673#LinkTarget_21311)

The right to a clean and healthy environment was previously acknowledged in the Environmental Management and Coordination Act of 1999 (EMCA). However, the elevation of this right to constitutional status has only been achieved in the new constitution.

4.1.1. Environmental Management and Coordination Act No 8 of 1999

Part II of the Environment Management & Coordination Act, 1999 states that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. According to **Section 58** of the Act, Environmental Impact Assessment study needs to be carried out on projects specified in the second schedule of the Act that are likely to have a significant impact on the environment.

The decision by the proponent, to undertake an Environmental Impact Assessment study for the proposed development is in line with this provision. The proposed project falls under category of the projects listed in the second schedule of EMCA 1999.

Part VII, Section 68 of the same Act requires operators of projects or undertakings to carry out environmental audits in order to determine level of conformance with statements made during the EIA. The audit report should be submitted to NEMA.

The developer will have to undertake an environmental audit for the proposed development and prepare a related report for submission to NEMA in the first year of project operation to confirm the efficacy and adequacy of the Environmental Management Plan (EMP) proposed in this EIA study report. This one of the necessary policies and legislation that ensures annual environmental audits (EA) are carried out on every running project, activity or program and a report submitted to National Environmental Management Authority (NEMA) for approval and issuance of relevant certificates.

Part VIII, Section 72 of the Act prohibits discharging or applying poisonous, toxic, noxious or obstructing matter, radioactive or any other pollutants into aquatic environment. **Section 73** requires that operators of project which discharges effluent or other pollutants to submit to NEMA accurate information about the quantity and quality of the effluent. **Section 74** demands that all effluent generated from point sources are discharged only into the existing sewerage system upon issuance of prescribed permit from the local authorities.

Section 87 sub-Section 1 states that no person shall discharge or dispose any wastes, whether generated within or outside Kenya, in such a manner as to cause pollution to the environment or ill health to any person, while **Section 88** provides for acquiring of a license for generation, transporting or operating waste disposal facility. **According to Section 89**, any person who, at the commencement of this Act, owns or operates a waste disposal site or plant or generate hazardous waste shall apply to the NEMA for a license. **Sections 90 through 100** outline more regulations on management of hazardous and toxic substances including oils, chemicals and pesticides. *The proponent shall ensure that environmental protection facilities or measures to prevent pollution and ecological deterioration such as air pollution control equipments, solid waste and effluent management plans, landscaping and aesthetic improvement program are designed, constructed and employed simultaneously with the proposed project.*

This project report has been undertaken in accordance with the Environmental (Impact Assessment and Audit) regulation 2003, which operationalizes the Environment Management and Coordination Act, 1999.

4.1.1.1. Legal Notice No. 121: Section 4-6

Part II of the Environmental Management and Co-ordination (Waste Management) Regulations, 2006 states that:-

- (1) No person shall dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle.
- (2) A waste generator shall collect, segregate and dispose such waste in a manner provided for under these regulations
- (3) A waste generator shall minimize the waste generated by adopting the following cleaner production methods
 - a) Improvement of production process through:
 - i. Conserving raw materials and energy;
 - ii. Eliminating the use of toxic raw materials;
 - and
 - iii. Reducing toxic emissions and wastes
 - b) Monitoring the production cycle from beginning to end by:-
 - i. Identifying and eliminating potential negative impacts of the product;

- ii. Enabling the recovery and re-use of the product where possible;
 - iii. Reclamation and recycling
- c) Incorporating environmental concerns in the design and disposal of a product.

A waste generator shall segregate waste by separating hazardous wastes from non-hazardous waste and shall dispose of such wastes in such facility as shall be provided by the relevant local authority.

The proponent shall comply with the above described regulation throughout the project cycle by adopting green ideas. These shall include the best pollution control equipment, use of renewable energy, 3Rs and incorporation of environmental concerns in overall plant design.

4.1.1.2. Legal Notice No. 120; Part II – Protection of Sources of Water for Domestic Use.

4. (1) every person shall refrain from any act which directly or indirectly causes, or may cause immediate or subsequent water pollution, and it shall be immaterial whether or not the water resource was polluted before the enactment of these Regulations (2) No person shall throw or cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance in or near it, as to cause pollution.

5. All sources of water for domestic uses shall comply with the standards set out in the First Schedule of these Regulations.

4.1.1.3. Legal Notice No. 120; Part III – Water for Industrial Use and Effluent Discharge

10. (1) No person shall use water for trade or industrial undertaking unless such person complies with the standards established by the competent lead agency in regard to that particular activity.

11. No person shall discharge or apply any poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants or permit any person to dump or discharge such matter into the aquatic environment unless such discharge, poison, toxic, noxious or obstructing matter, radioactive waste or pollutant complies with the standards set out in the Third Schedule of these Regulations.

4.1.2. The Water Act, 2002

Part II, section 18, of the Water Act, 2002 provides for national monitoring and information systems on water resources. Following on this, sub-section 3 allows the Water Resources Management Authority to demand from any person or institution, specified information, documents, samples or materials on water resources.

Under these rules, specific records may require to be kept by a facility operator and the information thereof furnished to the authority. Section 73 of the Act allows a person with license (licensee) to supply water to make regulations for purposes of protecting against degradation of water sources. Section 75 and sub-section 1 allows the licensee to construct and maintain drains, sewers and other works for intercepting, treating or disposing of any foul water arising or flowing upon land for preventing pollution of water sources within his/her jurisdiction.

As shown in the engineering design, there exists drainage systems and the proponent proposes to install sufficient waste water management and handling system.

4.1.3. Occupational Safety and Health Act 2007

4.1.3.1. Part II – General Duties of the Occupiers

In Section 6 (1), it is stated that the occupier shall ensure the safety, health and welfare at work of all persons working in his work place.

Without prejudice to the generality of an occupier’s duty under sub-section 1 above, the duties of the occupier includes:-

- The provision and maintenance of plant and systems and procedures of work that are safe and without risk to health;
- Arrangements for ensuring safety and absence of risks to health and connection with the use, handling, storage and transport of articles and substances;
- The provision of such information, instruction, training and supervision as is necessary to ensure the safety and health at work of every person employed;
- The maintenance of any workplace under the occupier’s control, in a condition that is safe and without risks to health and the provision and maintenance of means of access to and egress from it that are safe and without such risks to health;
- The provision and maintenance of a working environment for every person employed that is, safe, without risks to health, and adequate as regards facilities and arrangements for the employees welfare at work;
- Inform all persons employed of:-
- Any risks from new technologies; and Imminent danger; and
- Ensuring that every person employed participates in the application and review of safety and health measures.

Every occupier shall carry appropriate **risk assessments** in relation to the safety and health of persons employed and adopt preventive and protective measures to ensure that under all conditions of their intended use without risk to health and comply with the requirements of safety and health provisions.

The occupier shall send a copy of a report of Risk Assessment carried out under this section to the area occupational safety and health officer and shall take (occupier) immediate steps to stop any operation or activity where there is an imminent and serious danger to safety and health and to evacuate all persons employed as appropriate.

4.1.3.2. Duty to prepare a safety and health policy statement

In Section 7 (1) (a) and (b), it is established that except in such cases that as may be prescribed, it is the duty of every occupier to:-

- Prepare and, as often as may be appropriate, revise a written statement of his general policy with respect to the safety and health at work of his employees and the organization and arrangements for the time being in force for carrying out that policy; and
- To bring the statement and any revision of it to the notice of all of his employees.

4.1.3.3. Safety and Health Committee

Section (9) (1) Illustrates that an occupier shall establish a safety and health committee at the workplace in accordance with the regulations prescribed by the Minister if:-

- i. There are twenty or more persons employed at the workplace; or

- ii. The Director directs the establishment of such a committee at any other workplace.

4.1.3.4. Safety and Health Audits

Section 11 (1) of the Occupational Safety and Health Act 2007 outlines that the occupier of a workplace shall cause a thorough safety and health audit of his workplace to be carried out at least once in every period of twelve months by a safety and health advisor, who shall issue a report of such an audit containing the prescribed particulars to the occupier on payment of a prescribed fee and shall send a copy of the report to the Director. The Audit report referred above shall be preserved and be kept available for inspection by the Occupational Safety and Health Officer.

4.1.3.5. Duties of designers, manufacturers, importers etc with regard to articles and substances for use at work

Section 20 (1) Illustrates that a person who designs, manufactures, imports or supplies any article for use at work shall:-

- i) Ensure that the article is so designed and constructed as to be safe and without risks to health when properly used;
- ii) Carry out, or arrange for the carrying out of such testing and examination as may be necessary to ensure that the article is safe and without risk to health when properly used;
- iii) Take such steps as are necessary to ensure that there is available, in connection with the use of the article at work, adequate information about the use for which it is designed and has been tested, and about any conditions necessary to ensure that, when put to that use, it will be safe and without risks to health.

4.1.3.6. Notice of accidents and dangerous occurrences

Section 21(1) Stipulates that an employer or self-employed person shall notify the area Occupational Safety and Health Officer of any accident, dangerous occurrence, or occupational poisoning which has occurred at the work place.

Where an accident in a workplace, causes the death of a person therein, the employer or self-employed person shall:-

- Inform the area occupational safety and health officer within twenty-four hours of the occurrence of the accident; and
- Send a written notice of the accident in the prescribed form to the area occupational safety and health officer, within seven days of the occurrence of the accident.
- Where an accident in the workplace cause non-fatal injuries to a person therein, the employer shall send to the area occupational safety and health officer, a written notice of the accident in the prescribed form within seven days of the occurrence of the accident; and
- In case of death due to a workplace accident, non-fatal injuries arising from a workplace accident, an occupational disease or a dangerous occurrence at the workplace, involving a self-employed person incapable of submitting notification, such notification shall be

submitted to the area occupational safety and health officer.

4.1.3.7. Health - General Provisions

Under Section 47 (1) It is established that Every workplace shall be kept in a clean state and free from effluvia arising from any drain, sanitary convenience or nuisance, and, without prejudice to the generality of sub section (1):-

- Accumulations of dirt and refuse shall be removed daily by a suitable method from the floors and benches of workrooms, and from a staircases and passages;
- The floor of every workroom shall be cleaned at least once in every week by washing or, if it is effective and suitable, by sweeping or by any other method;
- All inside walls and partitions, and all ceilings or tops of rooms, and all walls, sides and tops of passages and staircase, shall:-
 - i. Where they have a smooth impervious surface, at least once in every period of twelve months, be washed with hot water and soap or cleaned with other suitable method;
 - ii. Where they are kept painted with oil paint or varnished, be repainted or varnished at least once in every period of five years, or such other period as the director may deem necessary, and at least once in every period of twelve months be washed with hot water and soap or cleaned by other suitable method; and In other cases, be kept whitewashed or colour washed and the white washing or colour washing shall be repeated at least once in very period of twelve months.

4.1.4. Work Injuries Benefits Act 2007

4.1.4.1. Obligations of Employers

Section 7 of the Act stipulates that every employer shall obtain and maintain an insurance policy, with an insurer approved by the Minister in respect of any liability that the employer may incur under this Act to any of his employees.

4.1.4.2. Registration of employer

Every employer carrying on business in Kenya shall within the prescribed period and in the prescribed manner register with the Director of Occupational Health and Safety Services and any other information as the Director may require. subsection 4 of section 8 of the Act states that where an employer carries on business in more than one workplace, or carries on more than one class of business, the Director may require the employer to register separately in respect of each place or class of business.

4.1.4.3. Employer to keep record (Section 9)

Section 9 states that an employer shall; keep a register or other record of the earnings and other prescribed particulars of all employees and produce the same on demand by the director for inspection. Such records shall be retained for at least six years after the date of last entry.

4.1.4.4. Right to compensation

An employee who is involved in an accident resulting in the employee's disablement or death is subject to the provisions of this Act, and entitled to the benefits provided for under the Act.

Subsection 3 of section 10 of the Act however states that no employee shall be entitled to compensation if an accident, not resulting in serious disablement or death, is caused by the deliberate and willful misconduct of the employee.

Section 12 of the act stipulates that if an employee is injured in an occupational accident or contracts an occupational disease while the employee, with the consent of the employer is engaged in any organized first aid, ambulance or rescue work, or firefighting or other emergency services, the accident or disease is for the purpose of this Act, deemed to have arisen out of an accident in the course of the employee's employment.

4.1.4.5. Reporting of accidents

A written or verbal notice of any accident shall be given by or on behalf of the employee concerned to the employer and a copy to the Director of occupational health and Safety within twenty-four hours of its occurrence in case of fatal accident.

4.1.4.6. Lapse of right to benefits

A right to benefits in accordance with this Act shall lapse if the accident is not reported to the employer within twelve months after the date of such accident. However, it shall not be bared to compensation if it is proved that the employer had knowledge of the accident from any other source. Section 30 of the Act states that compensation for permanent disablement shall be calculated on the basis of ninety six months earnings subject to the minimum and maximum amounts determined by the minister after consultation with the board. In case of a fatal accident compensation shall be paid to the dependants of the employee in accordance with the set provisions in the third schedule. The employer shall further be liable to pay reasonable expenses for the funeral of the deceased employee subject to the maximum amount determined by the minister, after consultation with the National council for occupational Health and Safety. The First Schedule of the Act gives the minimum degree of Disablement for various body parts while the second Schedule gives a list of work description and the associated occupational disease.

4.1.5. Public Health Act Cap 242

Part IX section 115 of the Act states that no person or institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Section 116 requires that Local Authorities take all lawful necessary and reasonable practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition liable to injuries or dangerous to human health.

4.1.6. Physical planning act, 1999

The said Act section 29 empowers the local Authorities to reserve and maintain all land planned for open spaces, parks, urban forests and green belts. The same section allows for prohibition or control of the use and development of an area. Section 30 state that any person who carries out development without development permission will be required to restore the land to its original condition. It also states that no other licensing authority shall grant license for commercial or industrial use or occupation of any building without a development permission granted by the respective local Authority.

4.1.7. Land planning act cap 303

Section 9 of the subsidiary legislation (the development and use of land Regulations 1961) under which it requires that before the local authority to submit any plans to then minister for approval, steps should be taken as may be necessary to acquire the owners of any land affected by such plans. Particulars of comments and objections made by the landowners should be submitted, which intends to reduce conflict of interest with other socio economic activities.

4.1.8. Building code 2000

A person who erects a building or develops land or changes the use of a building or land, or who owns or occupies a building or land shall comply with the requirements of these by-laws. For the purpose of this by-laws and the following operations shall be deemed to be the erection of a building:-

- a) The alteration or extension of a building.
- b) The changing of the use or uses to which land or building is put.
- c) The formation or lying out of an access to a plot.

Section 194 requires that where sewer exists, the occupants of the nearby premises shall apply to the local authority for permit to connect to the sewer line and all the wastewater must be discharged in to sewers. The code also prohibits construction of structures or building on sewerlines.

4.1.9. The Electricity Power Act, 1997

Section 55 (1) in the execution of works in connection with the construction, modification, maintenance or operation of an electric supply line or apparatus or conductor connected thereto, every licensee shall:-

- a) In no way injure the works, conveniences or property belonging to any such other such authority, company or person, nor obstruct or interfere with public traffic, except with the previous consent of the board.
- b) Take adequate precautions to protect from danger any person engaged upon such works by the provision and maintenance in safe and efficient conditions of the necessary safety appliances for the use of such persons and by ensuring their proper use, or by other means approved by the board.

4.2 Policies

4.2.1 National Population Policy for Sustainable Development (NPPSD)

The National Population Policy for Sustainable Development (NPPSD) was officially adopted by Parliament in May 2000. The policy supersedes the 1984 Sessional Paper No. 4 on population policy guidelines. The policy, apart from building on the achievements of the Population Policy Guidelines also addresses new and emerging issues like HIV/AIDS, gender, the youth, the elderly, persons with disabilities and the environment. The NPPSD outlines a wide range of strategies and actions that need to be undertaken to meet the set goals, objectives and targets through a multi sectoral and multi-dimensional integrated approach involving all stakeholders in the population and health sector (ncapd-ke.org/images).

4.3. International Agreements and Conventions Relevant to EIA

Table 4. 1: Summary of Relevant International Conventions

AGREEMENT/CONVENTION	DESCRIPTION
CLIMATE CHANGE/AIR QUALITY	
Vienna Convention for the Protection of the Ozone Layer, 1985	Protection of the ozone layer, came into force in 1988,
Montreal Protocol on Substances that Deplete the Ozone Layer, 1989	Protection of the ozone layer.
United Nations Framework Convention on Climate Change (UNFCCC), 1994	Control of greenhouse gas emissions.
Kyoto Protocol, 1997	Greenhouse gas emissions targets.
CHEMICAL USE/POLLUTION/WASTE	
The Geneva Convention, 1979	Establishes protocols for emissions of sulphur dioxide, nitrogen oxides, volatile organic hydrocarbons, ammonia, persistent organic pollutants, and heavy metals
Rotterdam Convention, 1998	Sets procedure for import and export of certain hazardous chemicals and pesticides,
The Stockholm Convention, 2001	Prohibits the use, production, import or export of twelve hazardous substances including PCB, DDT and dioxin.
BIODIVERSITY/PROTECTED AREAS	
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), 1971	The conservation and sustainable utilization of wetlands, i.e. to stem progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.
Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES), 1973	To ensure that international trade in specimens of wild animals and plants does not threaten their survival. Accords varying degrees of protection to more than 33,000 species of animals and plants.
United Nations Convention on Biological Diversity, 1992	Promotes development of national strategies for the conservation and sustainable use of biological diversity. Often seen as the key document regarding sustainable development.
United Nations Convention to Combat Desertification, 1994	To combat desertification and mitigate the effects of drought through national action programs that incorporate long term strategies supported by international cooperation and partnership arrangements.
CULTURAL HERITAGE	
UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972 (World Heritage Convention)	Promotes cooperation among nations to protect heritage from around the world that is of such outstanding universal value that its conservation is important for current and future generations.

LABOUR/HEALTH/ SAFETY

Constitution of the International Labor Organization	Promotes opportunities for women and men to obtain decent and productive work, in conditions of freedom, equity, security and human dignity
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So far in Kenya, primary environmental legislation includes EMCA and EIAAR. Subsidiary legislation has been enacted to support EMCA, and it includes the following:

- Environmental Management and Coordination (Noise and Excessive Vibration Pollution) Control Regulations of 2009;
- Environmental Management and Coordination (Wetlands, Riverbanks, Lake Shores, and Sea Shore Management) Regulations of 2009;
- Environmental Management and Coordination (Air Quality Standards) Regulations of 2007;
- Environmental Management and Coordination (Controlled Substances) Regulations of 2007;
- Environmental Management and Coordination (Waste Management) Regulations of 2006;
- Environmental Management and Coordination (Water Quality) Regulations of 2006;
- Environmental Management and Coordination, Conservation of Biological Diversity (BD) Regulations of 2006; and
- Environmental Management and Coordination (Fossil Fuel Emission Control) Regulations of 2006.

4.4 The Environment Management and Coordination Legal Notice No. 121 on (Waste Management)

Provides for the responsibility of waste generation, cleaner production methods, segregation of waste by generator, waste transportation license responsibility of waste transporter, transportation of waste by licensed transporters, license for disposal facility, waste treatment by operators of disposal sites, requirement of environmental audit and reuse and recycling plant. The legal notice provides mitigation measures to industrial waste and their treatment. The hazardous and toxic wastes have been specified by the legal notice that also provides for various requirements of EIA. Details on how toxic and hazardous waste should be handled, stored, treated, transported and even provision of permits. This has to apply to pesticides and toxic substances, biomedical waste, and radioactive waste whereby collection, transportation, storage, treatment and disposal of them have been specified. The legal notice further specifies offence, penalties and operation of regulation that have to be followed when dealing with any type of waste. The proponent will have to adhere to legal notice No 121 in its project cycle that is from construction, operational and decommissioning of the incinerator.

The proponent will fully adhere to the legal notice No. 121 in its project cycle that is from construction, operational and decommissioning of the incinerator. The proponent is also intends to apply for waste transportation license from the Authority.

CHAPTER FIVE: POTENTIAL ENVIRONMENTAL IMPACTS

5.1. Introduction

This chapter outlines the potential negative and positive impacts that will be associated with the proposed development (project). The impacts will be related to activities to be carried out during construction, operational and closure and decommissioning phase of the project.

5.2. Negative Environmental Impacts of Construction Activities

5.2.1. Extraction and Use of Building Materials

Building materials such as hard core, ballast, cement, rough stone and sand required for construction of the housing project will be obtained from quarries, hardware shops and sand harvesters who extract such materials from natural resource banks such as rivers and land. Since substantial quantities of these materials will be required for construction of the buildings, the availability and sustainability of such resources at the extraction sites will be negatively affected, as they are not renewable in the short term. In addition, the sites from which the materials will be extracted may be significantly affected in several ways including landscape changes, displacement of animals and vegetation, poor visual quality and opening of depressions on the surface leading to several human and animal health impacts.

5.2.2. Dust Emissions

During construction, the project will generate substantial quantities of dust at the construction site and its surrounding. The sources of dust emissions will include site preparation and leveling works, and to a small extent, transport vehicles delivering building materials. Emission of large quantities of dust may lead to significant impacts on construction workers and the local residents, which will be accentuated during dry weather conditions.

5.2.3. Traffic flow during construction

There is a likelihood of increase in traffic on road adjacent to the site during construction. The trucks used to transport various building materials from their sources to the project site will contribute to increases in emissions of dust, CO₂, NO_x and fine particulate along the way as a result of diesel combustion. Such emissions can lead to several environmental impacts including global warming and health impacts. Because large quantities of building materials are required, some of which will be sourced outside the project area. Such emissions can be enormous and may affect a wider geographical area. The impacts of such emissions can be greater in areas where the materials are sourced and at the construction site as a result of frequent running of vehicle engines, frequent vehicle turning and slow vehicle movement in the loading and offloading areas may slow down traffic flow.

5.2.4. Noise and Vibration

The construction works, delivery of building materials by heavy trucks and the use of machinery/equipment including bulldozers, generators, metal grinders and concrete mixers will contribute high levels of noise and vibration within the construction site and the surrounding

area. Elevated noise levels within the site can affect project workers and the residents, passers-by and other persons in within the vicinity of the project site.

5.2.5. Risks of Accidents and Injuries to Workers

Because of the intensive engineering and construction activities including erection and fastening of roofing materials, metal grinding and cutting, concrete work, steel erection and welding among others, construction workers will be exposed to risks of accidents and injuries. Such injuries can result from accidental falls from high elevations, injuries from hand tools and construction equipment cuts from sharp edges of metal sheets and collapse of building sections among others.

5.2.6. Solid Waste Generation

Large quantities of solid waste (soil) will be generated as a result of excavation of the site. In addition, additional solid waste will be generated at the site during construction of the building and related infrastructure. Such waste will consist of metal cuttings, rejected materials, surplus materials, surplus oil, excavated materials, paper bags, empty cartons, empty paint and solvent containers, broken glass among others. Such solid waste materials can be injurious to the environment through blockage of drainage systems, choking of water bodies and negative impacts on human and animal health. This may be accentuated by the fact that some of the waste materials contain hazardous substances such as paints, cement, adhesives and cleaning solvents, while some of the waste materials including metal cuttings and plastic containers are not biodegradable and can have long-term and cumulative effects on the environment.

5.2.7. Energy Consumption

The project will consume fossil fuels (mainly diesel) to run transport vehicles and construction machinery. Fossil energy is non-renewable and its excessive use may have serious environmental implications on its availability, price and sustainability. The project will also use electricity supplied by Kenya Power. Electricity in Kenya is generated mainly through natural resources, namely, water and geothermal resources. In this regard, there will be need to use electricity sparingly since high consumption of electricity negatively impacts on these natural resources and their sustainability.

5.2.8. Water Use

The construction activities will require large quantities of water that will be sourced mainly from existent borehole. The water will mainly be used for concrete mixing, curing, sanitary and washing purposes. Excessive water use may negatively impact on the water source and its sustainability.

5.3. Positive Environmental Impacts of Construction Activities

5.3.1. Creation of Employment Opportunities

Several employment opportunities will be created for construction workers during the construction phase of the project and more job opportunities will be created during operational phase of the proposed project. This will be a significant impact since unemployment is currently quite high in Kakamega County.

5.3.2. Provision of Market for Supply of Building Materials

The project will require supply of large quantities of building materials most, of which will be sourced locally. This provides ready market for building material suppliers such as quarrying companies, hardware shops and individuals with such materials.

5.3.3. Increased Business Opportunities

The large number of project staff required will provide ready market for various goods and services, leading to several business opportunities for small-scale traders such as food vendors

5.4 Negative Environmental Impacts of Operational Activities

5.4.1. Environmental pollution

Major pollutants in the gaseous emissions include particulates, nitrogen oxides from cutting scarfing and pickling operations and acid fumes.

5.4.2 Energy Consumption

During operation, the workplace will use a lot of energy mainly for running of the incinerator in place and lighting of the premises. Since electricity generation involves utilization of natural resources, excessive electrical or diesel consumption will strain the resources and negatively impact on their sustainability.

5.5 Positive Environmental Impacts of Operational Activities

5.5.1. Provision of job opportunities and Business Facilities

With increase in human population in any region, small scale business opportunities also crop up aiming for the human population satisfaction. This impact will be significant in increasing the economic power of the local residents.

5.5.2. Employment Opportunities

Some people will be employed by the project as managers, casual workers, cleaners, security personnel, technicians among others.

5.5.3. Revenue to National and Local Governments

Through payment of relevant taxes, rates and fees to the government and the local authority, the industrial project will contribute towards the national and local revenue earnings.

5.5.4. Improved Security

Security will be ensured around the workplace through distribution of suitable security lights and presence of 24-hour security guards. This will lead to improvement in the general security in the surrounding area.

5.5.5. Land rehabilitation

The land on the other hand has been laying fallow over a long period of time. In addition to having a greater economic value of the land, the runoff will be mitigated and all water harvested or directed to a drainage channel as outlined in the design.

5.6. Negative Environmental Impacts of Decommissioning Activities

5.6.1. Solid Waste

Demolition of the project buildings and related infrastructure will result in large quantities of solid waste. The waste will be containing the materials used in construction including concrete, metal, drywall, wood, glass, paints, adhesives, sealants and fasteners. Although demolition waste is generally considered as less harmful to the environment since they are composed of inert materials, there is growing evidence that large quantities of such waste may lead to release of certain hazardous chemicals into the environment. In addition, even the generally non-toxic chemicals such as chloride, sodium, sulphate and ammonia, which may be released as a result of leaching of demolition waste, are known to lead to degradation of groundwater quality.

5.6.2. Noise and Vibration

The demolition works will lead to significant deterioration of the acoustic environment within the project site and the surrounding areas.

5.7. Positive Environmental Impacts of Decommissioning Activities

5.7.1. Rehabilitation

Upon decommissioning the project, rehabilitation of the project site will be carried out to restore the site to acceptable status. This will include replacement of topsoil and re-vegetation that will lead to improved visual quality of the area.

5.7.2. Employment Opportunities

Several employment opportunities will be created during demolition.

CHAPTER SIX: ANALYSIS OF PROJECT ALTERNATIVES

This section analyses the project alternatives in terms of site, technology scale and waste management options.

6.1. No Project Alternative

The No Project option in respect to the proposed development implies that the status quo is maintained. This option is the most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions. This option will however, involve several losses both to the landowner and the community as a whole. The landowner continues to pay rent on the plot while the property remains idle. The “No Project Option” is the least preferred from the socio-economic and partly environmental perspective due to the following factors:

- The economic status of the Kenyans and the local people would remain unchanged.
- The local skills would remain underutilized and for those requiring upgrading, it will not be possible.
- Reduced interaction both at local, national and international levels.
- No employment opportunities will be created for deserving Kenyans who would have worked with the new development.
- Increased urban poverty and crime in Kenya.

From the outlined factors, it becomes apparent that the “No Project” alternative cannot be considered as an alternative by the local community, Kenyans, and the government of Kenya as a whole.

6.2. Analysis of Alternative Construction Materials and Technology

The buildings will be constructed using modern, locally and internationally accepted materials to achieve public health, safety, security and environmental aesthetic requirements. Equipment that saves energy and water will be given first priority without compromising on factors such as cost or availability. The concrete pillars and walls will be made using locally sourced stones, cement, sand (washed and clean), metal bars and fittings that meet the Kenya Bureau of Standards (KEBs) or any other statutory requirements. Heavy use of timber during construction is discouraged because of the negative impacts it has on our forests. The exotic species would be preferred to indigenous species in the construction where need arises.

6.3. Solid Waste Management Alternatives

A lot of solid wastes will be generated from the proposed development. An integrated solid waste management system is recommendable. First, the proponent will give priority to reduction at source of the materials. This option will demand a solid waste management awareness program to the management and the residents. Secondly, recycling, reuse and composting of the waste will be the second alternative in priority (3Rs). This calls for a source separation program to be put in place. The waste will be sold to waste buyers within the area or be collected by a NEMA licensed private waste management company. The third priority in the hierarchy of options is combustion of the waste that is not recyclable in a purpose built incinerator. Finally, sanitary land filling will be the last option for the proponent due to limitations of space.

CHAPTER SEVEN: IMPACTS MITIGATION AND MONITORING

7.1. Introduction

This chapter highlights the necessary mitigation measures that will be adopted to prevent or minimize significant negative environmental, health and safety impacts associated with the activities of the project during its construction, operation and decommissioning phases. Allocation of responsibilities, time frame and estimated costs for implementation of these measures are presented in the environmental management plan (EMP) in CHAPTER EIGHT.

7.2. Mitigation of Construction Phase Impacts

7.2.1. Efficient sourcing and use of Raw Materials

The proponent will source building materials such as sand, ballast and hard core from registered quarry and sand mining firms, whose projects have undergone satisfactory environmental impact assessment/audit and received NEMA approval. Since such firms are expected to apply acceptable environmental performance standards, the negative impacts of their activities at the extraction sites are considerably well mitigated.

To reduce the negative impacts on availability and sustainability of the materials, the proponent will only order for what will be required through accurate budgeting and estimation of a ctual construction requirements. This will ensure that materials are not extracted or purchased in excessive quantities. Moreover, the proponent will ensure that wastage, damage or loss (through run-off, wind, etc) of materials at the construction site is kept minimal, as these would lead to additional demand for and extraction or purchase materials. In addition to the above measures, the proponent shall consider reuse of building materials and use of recycled building materials. This will lead to reduction in the amount of raw materials extracted from natural resources as well as reducing impacts at the extraction sites.

7.2.2. Minimization of Run-off

The proponent will put in place measures aimed at minimizing soil erosion and associated sediment release from the project site. These measures will include terracing and leveling the project site to reduce run-off velocity and increase infiltration of rainwater into the soil. In addition, construction vehicles will be restricted to designated areas to avoid soil compaction within the project site, while any compacted areas will be ripped to reduce run-off.

7.2.3. Minimization of Construction Waste

It is recommended that demolition and construction waste be recycled or reused to ensure that materials that would otherwise be disposed of as waste are diverted for productive uses. In this regard, the proponent is committed to ensuring that construction materials left over at the end of construction will be used in other projects rather than being disposed of. In addition, damaged or wasted construction materials including cabinets, doors, plumbing and lighting fixtures, marbles and glass will be recovered for refurbishing and use in other projects. Such measures will involve the sale or donation of such recyclable/reusable materials to construction companies, local community groups, institutions and individual residents or homeowners. The proponent shall put in place measures to

ensure that construction materials requirements are carefully budgeted and to ensure that the amount of construction materials left on site after construction is kept minimal. It is further recommended that the proponent should consider the use of recycled or refurbished construction materials. Purchasing and using once-used or recovered construction materials will lead to financial savings and reduction of the amount of construction debris disposed of as waste. Additional recommendations for minimization of solid waste during construction of the project include:-

- Use of durable, long- lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time.
- Provision of facilities for proper handling and storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements.
- Purchase of perishable construction materials such as paints incrementally to ensure reduced spoilage of unused materials.
- Use of building materials that have minimal packaging to avoid the generation of excessive packaging waste.
- Use of construction materials containing recycled content when possible and in accordance with accepted standards.

7.2.4. Reduction of Dust Generation and Emission

Dust emission during construction will be minimized through strict enforcement of onsite speed controls as well as limiting unnecessary traffic within the project site. In addition, it is recommended that excavation works be carried out in wet weather; and traffic routes on site be sprinkled with water regularly to reduce amount of dust generated by the construction trucks.

7.2.5. Minimization of impacts on traffic flow

The proponent will put in place measures to address such concerns by ensuring that construction vehicles preferably deliver materials during off-peak hours when traffic volume is low. There will also be provision for caution signs on the access road to alert users on construction activities in progress in order to prevent occurrence of accidents. This will be achieved through proper planning of transportation of materials to ensure that vehicle fills are increased in order to reduce the number of trips done or the number of vehicles on the road. In addition truck drivers will be sensitized to avoid unnecessary racing of vehicle engines at loading/offloading areas, and to switch off or keep vehicle engines at these points.

7.2.6. Minimization of Noise and Vibration

Noise and vibration will be minimized in the project site and surrounding areas through sensitization of construction truck drivers to switch off vehicle engines while offloading materials. In addition, they will be instructed to avoid gunning of vehicle engines or hooting especially when passing through sensitive areas such as churches, schools and hospitals. In addition, construction machinery shall be kept in good condition to reduce noise generation. It is recommended that all generators and heavy-duty equipment be insulated or placed in enclosures to minimize ambient noise levels.

7.2.7. Health and safety of Workers on site

The proponent is committed to adherence to the occupational health and safety rules and regulations

stipulated in Occupational Safety and Health Act, 2007. In this regard, the proponent is committed to provision of appropriate personal protective equipment such as gloves; helmets, overall as well as ensuring a safe and healthy environment for construction workers by providing sanitary facilities (toilets) and portable water while food will be bought by workers from the nearby hotels and individuals.

7.2.8. Reduction of Energy Consumption

The proponent shall ensure responsible electricity use at the construction sit through sensitization of staff to conserve electricity by switching off electrical equipment or appliances when they are not being used.

In addition, proper planning of transportation of materials will ensure that fossil fuels (diesel, petrol) are not consumed in excessive amounts. Complementary to these measures, the proponent shall monitor energy use during construction and set targets for reduction of energy use.

7.2.9. Minimization of Water Use

The proponent shall ensure that water is used efficiently at the site by sensitizing construction staff to avoid irresponsible water usage.

7.3. Mitigation of Operation Phase Impacts

7.3.1. Ensuring Efficient Solid Waste Management

The proponent will be responsible for efficient management of solid waste generated by the project during its operation. In this regard, the proponent will provide waste handling facilities such as waste bins and skips for temporarily holding domestic waste generated at the site. In addition, the proponent will ensure that such disposed of regularly and appropriately. It is recommended that the proponent put in place measures to ensure that recycling and reuse measures are put in place to handle production wastes.

7.3.2. Minimization of Sewage Release

The proponent will ensure that there are adequate means for handling the large quantities of sewage generated by the proposed development.

7.3.3. Environmental protection

To prevent dust emissions, the use of bottom dry dust tapping methods should be used. All waste water should be passed through a three pit oil-water interceptor tank before release into the environment or reuse of the same.

7.3.4. Ensure Efficient Energy Consumption

The proponent plans to install an energy-efficient lighting system for the project. This will contribute immensely to energy saving during the operational phase of the project. In addition, all involved workers will be sensitized to ensure energy efficiency in all operations. To complement these measures, it will be important to monitor energy use during operations and set targets for efficient energy use.

7.3.5. Ensure Efficient Water Use

The proponent will install water-conserving taps and toilets. Moreover, any water leaks through damaged pipes and faulty taps will be fixed promptly by qualified staff. In addition, workers in the proposed industry will be sensitized to use water efficiently.

7.4. Mitigation of Decommissioning Phase Impacts

7.4.1. Efficient Solid Waste Management

Solid waste resulting from demolition or dismantling works will be managed as described in Section 7.2.3.

7.4.2. Reduction of Dust Concentration

High levels of dust concentration resulting from demolition or dismantling works will be minimized as described in Section 6.2.4.

7.4.3. Minimization of Noise and Vibration

Significant impacts on the acoustic environment will be mitigated as described in Section 7.2.6.

Table 7. 1: Impacts and Mitigation Measures during Construction Phase

Potential Impact 1	Removal of vegetation, loss of habitat
Project Activities	Site preparation and clearance
Environmental Receptor	Land, flora, fauna, endemic species
Duration	Immediate/long term
Magnitude	Medium (negative)
Mitigation Measures	Beautification plan during development and construction phase
Significance	Direct/medium negative/reversible impact
Potential Impact 2	Noise, Fugitive dust, Air pollution
Project Activities	Excavation, dropping of construction materials
Environmental Receptor	Humans, flora and fauna
Magnitude	Medium
Mitigation Measures	-Occupational health and safety guidelines -Appropriate scheduling of activities & Construction monitoring -Proper servicing of machines and equipment to reduce exhaust fumes Provision of noise and dust protective gear
Significance	Medium /negative/direct/avoidable impact
Potential Impact 3	Waste Oils and Spills
Project Activities	Refilling of machines and servicing
Environmental Receptor	Land, water, soils, flora, fauna
Duration	long term
Magnitude	Medium
Mitigation Measures	-Ensure proper disposal of oils during servicing -Proper handling and storage of oil products
Significance	Medium, negative, direct, avoidable impact
Potential Impact 4	Sewage/ Human Waste Pollution

Project Activities	Disposal of faeces/ waste during construction
Environmental Receptor	Human, surface water, ground water
Duration	Short-term
Magnitude	Medium
Mitigation Measures	- construction of Pit latrine within the site -Build construction workers capacity on sanitation and hygiene practices
Significance	-Minor, negative, avoidable impact
Potential Impact 5	Disposal of waste materials/ soil heaps
Project Activities	Entire construction
Environmental Receptor	Soils, natural landscape
Duration	Long-term
Magnitude	Medium
Mitigation Measures	-Waste materials and soil heaps should be disposed well
Significance	Minor, negative, direct, avoidable impact
Potential Impact 6	Surface water pollution
Project Activities	Construction works
Environmental Receptor	Human, flora and fauna
Duration	Construction period
Magnitude	Minimum (mainly silt)
Mitigation Measures	-Ensure use of non-poisonous materials in construction -Dispose waste away from natural drainage channels
Significance	Direct, negative, avoidable impacts
Potential Impact 7	Idlers and curious onlookers
Project Activities	Implementation activities
Environmental Receptor	Community members, livestock
Duration	Whole implementation period
Magnitude	Minor
Mitigation Measures	-Seal/fence off the project area/compound -Community awareness campaigns on construction risks
Significance	Minor, negative, direct, avoidable impact.

Table 7. 2: Impacts and Mitigation Measures During Operation Phase

Potential Impact 1	Disease outbreak
Project Activities	Throughout implementation
Environmental Receptor	Land, air, soils, human beings
Duration	Immediate, continuous and periodical
Magnitude	High (negative)
Mitigation Measures	-Ensure establishment of proper waste disposal mechanism -Maintain proper hygienic conditions
Significance	Direct/medium negative/reversible impact
Potential Impact 2	Conflicts due to Noise
Project Activities	Throughout the operation time
Environmental Receptor	Neighbors and people likely to be affected
Duration	long term

Magnitude	Medium
Mitigation Measures	-Develop and enforce by-laws that govern proper management of such a project; activities include noise control measures
Significance	Medium negative/direct/avoidable impact
Potential Impact 3	Water Borne and Water-related Diseases
Project Activities	Wastewater disposal activities
Environmental Receptor	Human
Duration	Continuous/ long term
Magnitude	High
Mitigation Measures	-Capacity building of workers /management committee on causes and prevention of the diseases -Develop and enforce environmental management practices that minimize spread of diseases in the area -Concentrate all the wastewater for proper disposal
Significance	Minor negative/ avoidable impact

Table 7. 3: Social Impacts and Mitigation Measures

Potential Impact 1	Conflict between Management and Residents
Project Activities	Running the Incinerator
Environmental Receptor	Community members /local /residents
Duration	Occasional
Magnitude	minor
Mitigation Measures	-Community capacity building on importance of coexistence -Setting of by- laws to govern punishment of offenders
Significance	Minor, negative, direct, avoidable impact.
Potential Impact 2	Water Use Conflicts
Project Activities	Increased number of users thus creating more demand
Environmental Receptor	Surface water source
Duration	Continuous/ long term
Magnitude	Major
Mitigation Measures	-Develop own water source for use in the premise - Share own developed water source and adhere to a water application schedule
Significance	Direct negative, avoidable impacts
Potential Impact 3	Pressure on Social Facilities
Project Activities	Human living close to the new development
Environmental Receptor	Residents
Duration	Continuous
Magnitude	Medium
Mitigation Measures	-Addition and improvement of existing social facilities

Significance	Direct negative, avoidable impacts
Potential Impact 4	HIV and AIDS Prevalence
Project Activities	Change of lifestyles, population rise
Environmental Receptor	Residents and workers
Duration	Long term
Magnitude	Medium
Mitigation Measures	Conduct awareness campaigns in collaboration with local health personnel on causes and prevention of the spread of the disease
Significance	Minor negative, direct, avoidable impact.
Potential Impact 5	Change of Physical Environment
Project Activities	Land clearing and excavation works
Environmental Receptor	Community
Duration	Implementation period
Magnitude	low, negative (project is basically a renovation with extensions)
Mitigation Measures	-Landscaping -Plant trees a long access roads in the compound -Proper disposal of soil heaps from the excavation works
Significance	Low negative, unavoidable impacts
Potential Impact 6	Project Unacceptability/Negative Social Interaction/Culture
Project Activities	Entire Development
Environmental Receptor	Community members
Duration	Long term
Magnitude	low
Mitigation Measures	-Capacity building of the community on the importance of the project -Support community initiatives
Significance	Low negative, unavoidable impacts

CHAPTER EIGHT: ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

8.1 Sinificance of an EMP

The environmental management plan is a logical framework which guides the proponent of a project in mitigating the negative impacts that may arise as a result of undertaking or implementing a project. It outlines the potential negative impacts, the mitigation measures to address the impacts, those that are responsible for undertaking the measures, the monitorable indicators of mitigation measure and where possible the added costs of undertaking such measures.

The EMP is a crucial tool as it gives the bench marks for the compliance of a project with the set environmental standards as spelled out by EMCA. It is also the most important part of the EIA as it guides the National Environmental Management Authority (NEMA) in decision -making as to whether a project should be permitted to proceed with or without additional modification, or if it should not be permitted at all. Future environmental audits will strife to determine whether the proponent implemented the EMP or not. The proponent should therefore consult and involve professional and technical experts during the construction and operational phase of the project.

It should be noted that this is a well formulated EMP that will in the long run strengthen the project implementation as it will reduce conflict and avoid crisis. It also enhances community ownership of the project as it takes into account their views ensuring its sustainability.

8.2. Environmental Monitoring and Audit

Environmental monitoring during the operation of the project is essential to its sustainability. The proponent should take the leading role during the construction phase of the project. The project has complied with environmental management standards for Kenya as set out by EMCA (1999) and the Environmental impact assessment/audit regulation of 2003, environmental audits should be conducted every second year. This will ensure that the identified potential negative impacts are mitigated during the project cycle. The audit will also help in document failure of action on the recommended mitigations and guide in decision making and the corrective measure to be taken.

Consequently, an environmental management/monitoring plan has been developed to assist the proponent in mitigating and managing environmental impacts associated with life cycle of the project. The proponent maps out a framework that the organization can follow to set up an effective environmental management system.

8.3 Construction and Operational Phase EMP

The necessary objectives, activities, mitigation measures, and allocation of costs and responsibilities pertaining to prevention, minimization and monitoring of significant negative impacts and maximization of positive impacts associated with the construction and operational phases of the industrial project are outlined in Table 8.1.

Table 8.1 A: ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Issues of concern	Mitigation Measures	Responsibility	Frequency of monitoring	Estimated Cost (KES)
Ground and Surface Water pollution	<ul style="list-style-type: none"> -Proper storage, handling and disposal of new and used oil wastes. -Segregate wastewaters containing lubricating oils from other wastewater streams and remove oil. -Separate laboratory wastewater stream from others. -Sampling for quality analysis 	Proponent and Contractor	Continuous monitoring and evaluation	100,000
Generation of solid waste	<ul style="list-style-type: none"> -Provision of waste collection bins at the project site. -Re-use of soil, construction debris and other waste where applicable. -Proper containment and disposal of solid waste. -Contracting a licensed waste collection and disposal company. -Creation of awareness on proper solid waste management. 	Contractor (Construction phase) Proponent (operational phase)	Continuous	100,000

<p>Air pollution through dust and gaseous emissions</p>	<ul style="list-style-type: none"> ▪ Continuously Monitor stack air ▪ emissions for PM, using an opacity meter (for an opacity level of less than 10%) or a dust detector. ▪ Control speed and operation of construction vehicles <ul style="list-style-type: none"> ▪ Regular maintenance of both construction and operational plant and equipment ▪ Prohibit idling of vehicles ▪ Water should be sprayed during the construction activities ▪ Use of low-sulphur diesel for diesel operated machinery. <ul style="list-style-type: none"> ▪ Covering loose materials such as soil piles at the site to prevent dust pollution and spreading by wind. ▪ Vehicles transporting such materials should also be covered. ▪ Use of dust masks by construction workers and staff 	<p>Proponent and contractor Monitoring: inspections, air measurements</p>	<p>Continuous</p>	
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<p>Noise and vibration at construction site</p>	<ul style="list-style-type: none"> ▪ Construction and production activities to be restricted to day time and noise levels contained to acceptable limits ▪ Use of ear protection aids by construction workers. ▪ Sensitize drivers of construction machinery to turn off engine whenever possible. ▪ Inform residents of anticipated extraordinary noise levels 	<p>Proponent and Contractor Monitoring: inspections, noise surveys</p>	<p>Continuous</p>	<p>100,000</p>
<p>Soil erosion and runoff control</p>	<ul style="list-style-type: none"> ▪ Control activities especially during rainy conditions ▪ Control earthworks & compact loose soils ▪ Ensure proper management of excavation activities ▪ Properly construct systems in consultation with relevant agencies and as per the designs 	<p>Proponent Monitoring: Inspections and routine maintenance</p>	<p>Quarterly</p>	<p>150,000</p>
<p>Clearing of vegetation and trees</p>	<ul style="list-style-type: none"> ▪ Minimal clearance of trees and vegetation ▪ Planting trees and grass to cover open/bare grounds. ▪ Maintain vegetation and trees in areas not affected 	<p>Annually</p>	<p>Proponent</p>	<p>200,000</p>
<p>Destruction of Habitats</p>	<ul style="list-style-type: none"> ▪ No off-road driving ▪ Control of earth works ▪ Minimum clearance of vegetation 	<p>Proponent</p>	<p>Continuous</p>	<p>150,000</p>
<p>Record Keeping</p>	<ul style="list-style-type: none"> ▪ Collection and analysis of relevant environmental, health and safety data at the site 	<p>Proponent</p>	<p>continuous</p>	<p>No cost implications</p>

<p>Public health and occupational safety</p>	<ul style="list-style-type: none"> ▪ Provide full protective gear & workmen's compensation cover in addition to the right tools and operational instructions & manuals ▪ Ensure effective wastewater management 	<p>Proponent Monitoring: Observation</p>	<p>Continuous</p>	<p>100,000</p>
	<ul style="list-style-type: none"> ▪ Sensitize workers on environmental management ▪ Ensure wholesome water is available for drinking ▪ Make health and safety awareness a priority. ▪ Use of stable ladders and other climbing/support structures. ▪ Provide fully equipped First Aid kits ▪ & train staff on its use ▪ Ensure public community awareness on proposed project from conception, planning to operational phases. 			
<p>Internal Audits</p>	<ul style="list-style-type: none"> ▪ Monitoring will involve measurements, observations, evaluations assessment of changes in waste management, noise levels, workers safety. 	<p>Proponent</p>	<p>Quarterly</p>	<p>Self</p>
<p>Fire Safety and preparedness</p>	<ul style="list-style-type: none"> ▪ Sensitize the workers on fire risks i.e. ▪ conduct regular fire drills ▪ Provide emergency numbers at strategic points 	<p>Proponent Monitoring: inspections</p>	<p>Continuous</p>	<p>10,000</p>

Contractors lay down area	<ul style="list-style-type: none"> ▪ Special attention should be paid to the ▪ sanitary facilities on site. ▪ Garbage should be disposed off periodically and at approved dumpsites by a licensed contractor 	Proponent Monitoring: inspections	Weekly	100,000
Security	<ul style="list-style-type: none"> ▪ Collaboration with existing security machinery in the area. ▪ Guarding of site by reputable security firm. ▪ Partnering with neighbours and police in community policing. 	Proponent	Continuous	Already in place
Economic and social	<ul style="list-style-type: none"> ▪ Use of local goods and services where possible. ▪ Educate those involved in construction activities on HIV/AIDs and other sexually transmitted diseases. ▪ Contractor and proponent to involve the local youth for unskilled labour. 	Contractor (during construction phase) Proponent (during implementation phase)	Continuous	50,000
Compliance	<ul style="list-style-type: none"> ▪ Apply for all required 	Proponent	Annually	300,000
	<ul style="list-style-type: none"> ▪ licenses and permits before commencement of the proposed project. ▪ Environmental monitoring of the project during construction phase. ▪ Establish a register with clear environmental laws and regulations. ▪ Carryout annual environmental audits during operational phase of the proposed project. 			

8.4 Environmental Management System

For the effective implementation of the EMP, an Environmental Management System (EMS) will be established at the proposed project. The EMS will include the following:

- An Environmental Management cell
- Environmental Monitoring Program

- Personnel Training
- Regular Environmental Audits and Corrective Action
- Documentation – Standard operating procedures Environmental Management Plans and other records.

8.5 Risk Assessment & Disaster Management Plan

For the effective & safe implementation Municipal Waste Processing project, it is important to identify associated safety hazards and carry out a basic risk assessment; an effective risk assessment & disaster management plan has been proposed as part of EIA report. Risk assessment & disaster management plan includes:

- Critical aspects including safety culture, training and awareness, relationships and training of contractor staff and many others.
- Safety measures, possibility of accidents either due to human errors and/ or due to equipment/ system failure.
- Disaster management and response plan to minimize the adverse impacts due to an unfortunate incident and disaster Management aspects.

CHAPTER NINE: CONCLUSIONS AND RECOMMENDATION

9.1 Conclusions

All possible environment aspects have been adequately assessed and necessary control measures have been formulated to meet statutory requirements. Thus implementing the proposed project will not have any appreciable negative impacts. Moreover, the landfill area requirement will reduce significantly as the about 75% to 80% of solid waste will be converted into usable form and only inert (20-25%) would be disposed in a constructed ash pit. This would save upon the future requirements of area for land filling. Generation of green power would be an added advantage where possible.

9.2 Recommendation

The private developer should therefore be licensed to implement this proposed medical and hazardous waste incinerator project subject to adherence to the environmental management plan (EMP) proposed in this report as per the statutory requirements.

CHAPTER TEN: AUXILLIARY INFORMATION

10.1 Public Participation

Issues raised

The stakeholders consulted gave both positive and negative views, as well as suggestions for the proponent to consider during construction/installation and operation phases of the incineration station. Their views are as discussed below:

Positive Issues

The following is a summary of the views of the local community interviewed:

- The project is positive for the improvement of standard of Kakamega area since it will help manage hazardous waste in the area and improvement of industrial development, and should therefore be considered for approval.
- The project will improve businesses in the area and also create job opportunities to the local Youth during construction phase.
- The project is a waste management facility hence will promote environmental conservation.
- The project will be a blue print to other similar projects which may come up in the County.
- The project will encourage other investors to consider investing in the County.

Negative Issues

The public consulted also raised negative issues which they anticipate the project will create hence should be mitigated:

- Air pollution may occur during the operation phase.
- Increased water and electricity demand
- Noise pollution
- Insecurity in the area
- Waste generation by the project.
- Accidents and hazards during excavation, construction and Operation Phase
- Employment issues during the construction.

Suggestions by respondents

- The Proponent should ensure proper environmental management practices are put in place.
- The incinerator installed should be modern to ensure minimal particulate matter is released to the atmosphere.
- The proponent should consider employing casual workers from the local areas during construction and operation phase of the project.
- Noise pollution should be controlled.

10.2 Budget

The total project cost is estimated to be KES. 12,000,000 (Twelve million shillings only)

10.3 Monitoring Guidelines

Continuous observations and assessment is essential such that if unforeseen safety dangers are experienced, alternatives must be sort for. Risk assessment of fire outbreaks, and others should not be

ignored in the construction plan. Waste management in the workplace should be strictly followed. Mitigation measures of storm water management are essential. Safety standards should constantly be maintained, in brief, monitoring guidelines could be based on the following parameters:

- Floral and faunal life including the species of birds in the surrounding.
- Waste management including air pollution control
- Examine the changing land use patterns of the area and ecological and economic purposes.
- Accidents and risk assessment arising from the use of water, roads, electricity and or any other amenity.

10.4 Reporting

Constant reporting by the site contractor to the architect is necessary to ensure the project is executed as per the architectural drawings. The safety officer should always remain on site to report any safety concerns for urgent mitigation. The concerned officer should also at all times enforce safety requirements as per the relevant legislations. The contractor must consult the architect to maintain a clear understanding and interpretation of all the aspects of the project.

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APPENDIX



Plate 1: Example of assembled Incinerator