TRANBIZ ENTERPRISES LTD

P.O BOX 16898-00100
NAIROBI

PROPOSED INCINERATOR ON PLOT NO. JUJA/JUJA EAST BLOCK 1/2748 IN NYACABA, JUJA SUB-COUNTY KIAMBU COUNTY

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY

Lat Long: -1.116760,37.074970
UTM: 285792.228E 9876494.154N 37M
MGRS: 37MBU 85792 76494
Elevation: 1482.38 m asl

Prepared by:
Ecosustainability Hub Consultants Ltd (8785)
P.O BOX 45820
Nairobi

June 2019

This report has been prepared in accordance with the requirements of the Environmental (Impact Assessment and Audit) Regulations, amended in 2019 under the Kenya Gazette Supplement No. 62, Legislative supplement No.16, Legal notice No. 31 of 2019, pursuant to The Environmental Management and Coordination Act, (EMCA) 2015 Amendment Act.

DECLARATION

This Environmental Impact Assessment (EIA) Study Report is submitted to the National Environment Management Authority (NEMA) in conformity with the requirements of the Environmental Management and Coordination Act, Cap 387 and the Environmental (Impact Assessment and Audit) Regulations, 2003 revised 2019.

DETAILS OF THE CONSULTING EIA/EA EXPERTS

ECOSUSTAINABILITY HUB CONSULTANTS LIMITED	NEMA REGISTRATION NO. 8785
P.O Box 45820-00100 **NAIROBI** **NEMA REG. 8785** **Cell: +254738632518** **Email: info@eshubconsult.com**	

Expert Name	Designation	Reg. No.	Signature	Date
Peter Oluoch Ouma	EIA/EA Lead Expert	7872		
Dan Ahenda	EIA/EA Associate Expert	8428		
Philip Nyongesa Wangia	EIA/EA Associate Expert	8921		
Victor Gathogo	Sustainable Waste Management Advisor			
Moses Kololo	Occupational Health and safety Specialist			

For and on behalf of (Proponent):

TRANBIZ ENTERPRISES LIMITED

P. O. BOX 16898-00100

NAIROBI

Name of Representative: ……………………………………………………………………

Signed: ……………………………………………. Date: ……………………………

EXECUTIVE SUMMARY

Introduction

This Report presents the findings of an Environmental and Social Impact Assessment (ESIA) for the proposed **incinerator on plot no. LR No. JUJA/JUJA EAST BLOCK 1/2748 in Nyacaba, Juja Sub-County Kiambu County.** The ESIA Study Report is submitted to the National Environment Management Authority (NEMA) in conformity with the requirements of the Environmental Management and Coordination Act, Cap 387 and the Environmental (Impact Assessment and Audit) Regulations, 2003 as revised in 2009. Installation of the proposed incinerator will contribute to safe and proper treatment of municipal, infectious medical and industrial wastes otherwise referred to as hazardous waste from Kiambu County and the surrounding Counties. Incineration has numerous benefits especially in terms of treatment of hazardous wastes and other life-risking garbage. The objective of the proposed project is:

- To provide a suitable incinerator currently
- To provide safe treatment of hazardous wastes (Municipal, infectious medical wastes and industrial and other general waste deemed high risk)
- To optimize the use of abandoned quarry and maximize benefits from it.

This ESIA is undertaken in accordance with the Environmental Management and Coordination Act (EMCA), Cap 387 and subsidiary legislation under it. It serves several objectives that seeks;

1. To identify and assess all significant impacts of the proposed incineration plant on the biophysical and human environment
2. To draw an environmental management and monitoring plan with suitable mitigation measures;
3. To ensure environmental, health and safety factors are considered in the decision-making process; and
4. To inform the public and seek their views and concerns on the proposed project.
5. To inform basis for decision making by NEMA.

A participatory approach was employed to carry out the ESIA. This involved several desk studies and review of all relevant available documents on the project activities and components. The Experts also reviewed all the available and relevant legal and policy documents, standards and guidelines. A reconnaissance visit was conducted to check the physical set up of the site and to collect views from all stakeholders

Anticipated (potential) positive Impacts

i. Adaptive reuse of abandoned quarry: The locality has several open quarries that are abandoned. The issue is greatly accelerated by the fact that the quarries are abandoned after use and no elaborate rehabilitation plan is available. Active and abandoned mines and quarries have been a source of negative environmental effects which have led to erosion, formation of sinkholes, and contamination of soil, groundwater, and surface water, and also the loss of biodiversity. The proposed incinerator plant is properly suited for the site and will add value in the land. The abandoned quarry that had long outlived their original intentions are will repurposed into an economic activity that can be a model example for other abandoned quarries.

ii. Decreased quantities of waste

The proposed Incinerator will be able to decrease the quantity of waste by 95% and reduce the solid quantity of the original waste by 80-85% depending on the components that will be in solid waste. Hence, even though incinerator do not completely get rid of dumping ground, they definitely decrease the quantity of land needed. For Counties like Kiambu with shortage of land this is noteworthy since landfills take up big amounts of land required for other productive uses.

iii. Reduced Pollution

Research has shown that solid waste incinerators are less likely to pollute the environment than landfills do. One particular study done during a 1994 lawsuit in the US showed that a waste incinerator location was more environment-friendly compared to a landfill. The research discovered that the landfill was releasing higher quantities of greenhouse gases, nitrogen oxides, dioxin, hydrocarbons, and non-methane organic compounds. Landfills also leach poisonous chemicals into the water below thus contaminating underground water systems. The proposed incinerator using proper scrubber technology will reduce air pollution in the atmosphere as well as contribute to Climate change mitigation.

iv. Trapping of pollutants that would have otherwise been released if open burning was adopted

The main problem concerning the incineration of solid waste is the release of hazardous compounds, particularly dioxin. Nonetheless, the proposed up to date incinerator plant will use filters to trap hazardous gases and particulate dioxin. The proposed incineration plant will operate within the required pollution limits recommended by the NEMA and international protocols.

v. Saving on Transportation of Waste within Kiambu and neighbouring Counties.

The proposed Incineration plant will be in reasonable from Nairobi city and other towns such as Juja, Kiambu, Nyeri etc. This is advantageous since it means waste does not have to be driven for long distances for dumping. It significantly reduces the cost of transport; the money can then be spent on the wellbeing of the community and sustaining the growth waste generators. Additionally, it reduces the harmful gases released by vehicles during transportation, thus drastically reducing the overall carbon footprint.

vi. Better control over odor and noise

The proposed Incineration plant will be able to provide less bad smells because waste gets burnt, unlike landfills where waste is allowed to decay thereby emitting unpleasant smells, which cause air pollution. The production of methane in landfills may also lead to explosions that cause noise pollution, which is unheard-of when it comes to the use of incineration plants.

vii. Prevention of the production of methane gas

In landfills, when the waste is decaying methane gas is generated which if not controlled, may explode causing further global warming. Unlike landfills, incineration plants do not produce methane, therefore making them safer.

viii. Elimination of harmful germs and chemicals

The proposed Incineration plant will function at very high temperatures of above 1,250ºC that can destroy germs and chemicals that are harmful. Thus, it is a very effective method when it comes to eliminating clinical waste.

ix. All weather operation

The proposed incinerator can function in any type of weather. For instance, during a rainy season, waste cannot be dumped in a landfill because the rain will possibly wash down poisonous chemicals into the ground and consequently create leachate thus contaminating the underground water as well as the neighboring land. Waste can also not be dumped when it is windy since it will get blown into the surroundings. On the other hand, incinerator will not be limited to weather changes since it will burn waste without leakages. Incineration plant also has the capacity to function 24 hours a day is more efficient in managing waste compared to landfills.

x. Effective for Metal Recycling

When the proposed incinerator will be burning waste, the metals still remain whole because they have a high melting point. After the process of burning waste is done, the workers remove the remaining metal and recycle it. This removes the need for separating out any metal before waste disposal. When garbage is taken to a landfill, it is usually not organized which results in wasting of resources that could have been recycled. Therefore, using an incinerator will makes it easier to remove and reuse metals.

xi. Computerized monitoring system

The proposed incinerator has a provision for a computerized monitoring system device to allow for the troubleshooting of most problems. This will enable operators to discover a problem before it becomes more serious and much more expensive to repair. A computer will also make operators work easily as they will be able to track the operational efficiency of the incinerator plant.

xii. Potential Uses of ash waste

The ash that comes from the combustion of waste can be used in construction, get shipped or even landfilled.

xiii. Job creation to the locals

The proposed incinerator plant will directly or indirectly create jobs for the locals.

Potential negative impacts

i. Degradation of the air quality and the environment

Incinerator produce smoke during the burning process that can pollute the environment is proper filter or scrubber is not installed. The smoke produced includes acid gases, carcinogen dioxin, particulates, heavy metals, and nitrogen oxide. These gases are poisonous to the environment. This is a potential impact that forms the whole basis for this assessment.

ii. The possibility of antidote to recycling

Incineration does not encourage recycling and waste reduction. This is not a calculated strategy for any society. The point of focus should be on reducing waste and recycling most of it. Merely burning most of the waste without recycling some of it will only further environmental damage because it may encourage more waste production.

iii. Ash waste risk

Even though the ash that remains from the process can be comparatively small in quantity, it contains a number of poisons and heavy metals which requires further treatment. If not disposed correctly, it can cause serious harm to the public and the environment. The proponent has proposed measures in place for ash management.

iv. Due to the geography of the abandoned site, surface water from precipitation may gather within the site and interfere with the operation at the sites or even lead to transportation of leachates to unintended environments. This may be made worse during extreme rainfall event. The site must be adapted (climate proofed) against heavy downpour and associated impacts. The proposed measures to control flooding include removal of potential water hazards, Filling the surfaces that might collapse during or after the flooding process, installing water diversion systems at the site, installing, at both the surface and underground, a system to monitor hydrogeological and geotechnical aspects, and make a projection of hydrological and hydrogeochemical development of precipitation.

Environmental and Social Management and Monitoring Plan (ESMMP)

The ESMMP outlined in section eight of this report the identified issues of concern (potential negative impacts) and mitigation measures as well as responsibilities, costs and measurable indicators that can help to determine the effectiveness of actions to maintain and upgrade the quality of environment; as regards the proposed project. This monitoring is done in relation to the baseline environment. Regular monitoring is therefore necessary to monitor the change in parameters. The ESMMP has considered for all phases; installation, operational and decommissioning.

Conclusion

From the assessment, the EIA experts concludes that the proposed incinerator for waste treatment in Nyacaba is appropriate. This conclusion has been made in terms of environmental impact, site selection, public health and public participation. By using a multi-criterion assessment model for economic, social, public health and environmental effects, this study indicates the proposed incineration plant has taken much consideration of the local residents' health and environment. A location analysis is also applied and some influences of waste incineration plant is illustrated. This study further concludes that public participation is a necessary condition for improving the environmental impact assessment and increasing total welfare of different interest groups in Nyacaba. This study finally offers some corresponding recommendations for improving the environmental impact assessment and enhancing the benefits of the proposed waste incineration project.

The ESIA report for the proposed project has revealed that only significant issues is from the perspective of

i. Pollutant emissions, disposal (management) of fly and bottom ash, which causes serious pollution to the environment and is a threat to public interests and public health;
ii. Technology used in the incinerator; the older generations of incinerators are often much more dangerous to public health. More advanced incinerators have flue gas cleaning systems to reduce the air pollution.
iii. Waste incineration deflects attention from more sustainable solutions, such as redesigning products for recyclability or eliminating toxic, hard-to-recycle plastics which is a holistic issue beyond the proponent of this project.

Recommendations

i. The proposed project be supported as the Experts' appraisal of the impacts of the proposed plant from the perspectives of economy, society, public health and environment is largely positive.
ii. In terms of protecting the public health, improving the relevant techniques and standards of the incinerator is a necessity. The proposed incinerator should meet dioxins emission standard as the introduction and development of more eco-friendly waste-incinerating techniques promotes the efficiency of incinerator and plays a vital role in reducing fly ash.
iii. The ESMP should be implemented fully at all stages along the project cycle to maximize related positive environmental, economic, social, and public health influences of the proposed waste incineration plant.
iv. The proponent should explore the opportunities for co-generation. Co-incineration offers new markets for waste-derived fuels using existing infrastructure. It is hard to measure how many facilities are currently using co-incineration in Kenya, since there is no law compelling incinerator operators to report it.
v. The proposed incinerator should have a provision for a computerized monitoring system device to allow for the troubleshooting of most problems related to filter (scrubber system). A computerized monitoring will also make operators work easily as they will be able to track the environmental and operational efficiency of the incinerator plant.
vi. There is controversy over the possible health implications of waste management policies and both policy makers and the public require more information on the likely health impacts (and importantly, the associated nature and extent of the uncertainties).

vii. Nyacaba community engagement: Behavior change and public participation is key to a functional waste system. The proponent should continuously engage the public through the office of the County Commissioner to handle issues as they come by.

viii. Social inclusion: Waste management system relies heavily on informal workers, who collect, sort, and even manage generated waste. The project proponent should address waste picker livelihoods through strategies such as integration into the formal system, as well as the provision of safe working conditions, social safety nets, child labor restrictions, and education.

ix. Climate change and the environment: The project should continuously strive to promote environmentally sound waste disposal. It should support greenhouse gas mitigation through adoption of scrubber technology that capture Greenhouse gases. The value chain should also support resilience by reducing waste disposal in waterways and safeguarding infrastructure against flooding. In this regard, Stack emission assessment should be conducted on quarterly basis.

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SECTION ONE: INTRODUCTION

1.1 Background Information

This Report presents the findings of an Environmental and Social Impact Assessment (ESIA) for the proposed Waste incinerator on plot no. LR No. JUJA/JUJA EAST BLOCK 1/2748 in Nyacaba, Juja Sub-County Kiambu County. Waste incineration is a method of waste disposal whereby high temperatures are used to sufficiently oxidize the combustible components in waste. Compared with landfills and composting, incineration is more effective in dealing with municipal and infectious waste due to a few advantages, such as taking up comparatively small space, decreasing the volume of waste and possible generating electricity (co-generation). Although there are bright prospects regarding the waste incineration industry, some issues, such as improper locations, lack of environmental impact assessments (EIA) and an excessive production of fly ash, have called for proper site evaluation and ESIA process. Hence, it is necessary to ensure the process of waste incineration is harmless to the environment and public health. In this regard, this ESIA is conducted in conformity with the requirements of the Environmental Management and Coordination Act, Cap 387 and the Environmental (Impact Assessment and Audit) Regulations, 2003 as revised in 2009. From the assessment it is envisaged that the Installation of the proposed incinerator will contribute to safe and proper treatment of hazardous waste from Kiambu County and the surrounding Counties. Incineration has numerous benefits especially in terms of treatment of hazardous wastes and other life-risking garbage. This Environmental and Social Impact Assessment (ESIA) is thus submitted the National Environment management Authority (NEMA) for review and decision making purposes by the Authority.

1.2 The project proponent

The project proponent is Tranbiz Enterprises Limited. The proponent has is involved in waste management and offers market based solution for the same in Kenya. **Appendix 2**: the pin and certificate of incorporation of the proponent.

1.3 The state of the proposed site and the neighbourhood

The proposed site is an abandoned quarry. In Nyacaba area where stone mining for construction industry is the main activity, owners leave the quarry pits open and most of the abandoned ones have been filled with a very small layer of stone rubble and dust where no further rehabilitation takes place. The quarry owners report that filling up of the quarries after use is an expensive exercise which would not translate to good profits, as the depth of the quarries is large. The proposed site is an abandoned quarry measuring about 50m in depth and 150m wide.

Plate 1: The proposed site for incineration plant is an abandoned quarry site.

Plate 2: View of the neighbouring site

1.4 Problem statement

Around the world, waste generation rates are rising. In 2016, the worlds' cities generated 2.01 billion tonnes of solid waste, amounting to a footprint of 0.74 kilograms per person per day. With rapid population growth and urbanization, annual waste generation is expected to increase by 70% from 2016 levels to 3.40 billion tonnes in 2050 (World Bank). In Kenya Urban area, the urban poor, are more severely impacted by unsustainably managed waste. In low-income countries, over 90% of waste is often disposed in unregulated dumps or openly burned. These practices create serious health, safety, and environmental consequences. Poorly managed waste serves as a breeding ground for disease vectors, contributes to global climate change through methane generation, and can even promote urban violence. In health sector alone, a number of medical centers in the country lack incinerators thus opting for open dumping or even burying. Medical waste which consist of the sharps (syringes), infectious and highly infectious waste such as placenta and anatomical wastes which must be properly handled. However, this is not safe thus the urgency of having an incinerator.

1.5 Justification of the project

Managing waste properly is essential for building sustainable and livable cities, but it remains a challenge for many developing countries and cities. Effective waste management is expensive, often comprising 20%–50% of municipal budgets. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported.

Health and safety: The proposed incinerator will overall improve public health and livelihoods by reducing open burning, mitigating pest and disease vector spreading, and preventing crime and violence.

In Kenya, management of hazardous wastes is regulated under the Environmental Management and Co-ordination Act- EMCA (Waste Management) Regulations (2006) and other related regulations. These regulations establish an order of preference for the management of hazardous wastes to be: minimization, recycling, treatment, and land filling. A number of waste generation facilities in the country lack proper waste management systems thus opting for open dumping or even burying. However, this is not safe thus the urgency of having quality and functional incinerators. Installation of the proposed incinerator will thus foster proper treatment and final disposal of hazardous waste within Kiambu County and the surrounding Counties.

NB: ***Compared to landfilled, the incineration of waste presents better results on global warming, acidification, nutrient enrichment, and even ecotoxicity in soil.***

1.6 The scope and Objectives of the proposed Project

The proposed project aims to:

- To provide a suitable incinerator currently
- To provide safe treatment of hazardous wastes (Municipal, infectious medical wastes and industrial ad other general waste deemed high risk)
- To optimize the use of abandoned quarry and maximize benefits from it

1.7 Objectives of the ESIA Process

This ESIA is undertaken in accordance with the Environmental Management and Coordination Act (EMCA), Cap 387 and subsidiary legislation under it. It serves several objectives that seeks;

- To identify and assess all significant impacts of the proposed incineration plant on the biophysical and human environment
- To draw an environmental management and monitoring plan with suitable mitigation measures;
- To ensure environmental, health and safety factors are considered in the decision-making process; and
- To inform the public and seek their views and concerns on the proposed project.
- To inform basis for decision making by NEMA.

1.8 The ESIA Methodology

Environmental Impact Assessment (EIA) refers to a critical examination of the effects of a proposed project on the environment before its implementation. Impacts describe any negative and positive environmental influence caused by a project. EIA is applied on the basic principle that the effect of a project on the environment needs to be established before it is implemented. The basic assumption is that if a proper EIA is carried out then, the safety of the environment can be properly managed during the projects implementation, commissioning, operation and decommissioning. A project is defined as a specific set of human activities in a particular location and time frame and intended to achieve an objective(s). The term environment is used in its broadest possible sense to embrace not only physical and biological systems but also socio-economic systems and their inter-relationships. In order to evaluate the proposed waste incineration plant in the environmental impact, this study constructed an analytical framework to explore related environmental, economic, social, and public health influences of the proposed waste incineration plant. It also, based on the framework, created a quantified multi-criterion ESIA model and a location analysis for evaluating the existence of such a plant in Nyacaba. The ESIA process took into account operational, social, cultural, economic, legal, health and safety, climate change and administrative considerations. Specifically, the process include the following:

- Identifying the anticipated Environmental Impacts and the scale of impacts of the proposed incinerator.
- Identifying and analyzing alternative methods or technologies for implementing the proposed incinerator installation project;
- Proposing mitigation measures to be undertaken during and after the implementation of the project;
- Developing an Environmental Social Management and Monitoring Plan (ESMMP) with mechanisms for Monitoring and Evaluating the compliance and environmental performance, cost for mitigation and time frame of implementing the measures

A participatory approach was employed to carry out the ESIA. This involved several desk studies and review of all relevant available documents on the project activities and components. The Experts also reviewed all the available and relevant legal and policy documents, standards and guidelines.

A reconnaissance visit was conducted to check the physical set up of the site and to collect views from the community. Attached at the appendix are samples of questionnaires survey. For the wider reach, it is anticipated that the proposed project will be advertised in two local dailies of wider reach, published in Keya gazette and radio station of wider circulation.

The main output is an ESIA study report comprising of executive summary, assessment methodology, project description, study area, legal and Institutional framework, and anticipated impacts and an Environmental Social, Management and Monitoring Plan (ESMMP).

NB: In this ESIA study, all the aspects illustrated have been considered here (e.g. waste transport, occupational factors, greenhouse gases, risk perception etc.) and were be part of a more complete and exhaustive exercise. However, we aimed to establish a baseline scenario that can be useful in the future for prognostic assessment of emission standards and waste management during facility auditing upon approval and operation as well as in identifying knowledge gaps, and providing a framework for future comparative risk assessment.

1.9 ESIA Experts

NEMA registered EIA/EA Experts undertook the ESIA and prepared this report as provided for in the Environmental (Impact Assessment and Audit) Regulations of June 2003. The Experts were:-

Name of Expert	Position	Task And Assignment	Qualification	General Experience	Relevant Experience
Peter Oluoch Ouma	Team Leader-ESIA Lead Expert	Supervisory and overall Coordination ESIA Standards and Specification, Impact determination analysis, Environment and Social management Plan and sustainability aspect of the project. Proposal and managing of green design for the proposed project. Volatile organic compounds management, Greenhouse house management for Climate Change Mitigation Training of project Tranbiz installation team and staff on incineration requirements	Bsc. (Env. Science), Egerton University Msc. (Climate Change and Adaptation)University of Nairobi	11 Years in Environmental management services	8yrs
Dan Ahenda	Ecologist-EIA Associate Expert	Coordinating of baseline assessment of the project-Air quality	Bsc. Environmental Science Egerton University. Applying the mitigation hierarchy to manage Biodiversity Impacts; Trained in the National Museum of Kenya.	7yrs.	4yrs.
Philip Wangia	Environment and project management EIA Associate Expert	Project Sociologist: Consultative public participation and highlighting of community issues and concerns in Nyacaba. Documentation of concerns of interested and affected parties	Msc. Project Management studies-Kenyatta University Bsc-Environmental Science Egerton University	10yrs	5yrs
Victor Gathogo	Sustainable Waste Management Advisor SEA Expert	Impact determination and advisory on proper scrubber technology for installation in the incinerator and disposal of residual ash	Bsc Environmental Science Egerton University Msc. Energy Studies Kenyatta University SEA trained in Sweden	11yrs.	8yrs.
Moses Kololo	Occupational Health and safety Specialist	Working on the Occupational Health and safety issue related to the project Risk Assessment of the project Determination of baseline radiation level at Nyacaba and sharing of the report with Tranbiz and NEMA	Bsc Environmental Science with IT-Maseno University Nebosh trained on OSHA	8 yrs.	5 yrs.

SECTION TWO: PROJECT DESCRIPTION

2.1 The nature and location of the Project

The proponent (Tranbiz Enterprises Ltd) intends to install a waste handling incineration plant at an abandoned quarry in Nyacaba located in Juja Sub-county of Kiambu County. The proposed incinerator is a Box type furnace (dimensions. 3500 (l) x 2100 (w) x 2400 (h)**.**

The proposed Waste incinerator on plot no. LR No. JUJA/JUJA EAST BLOCK 1/2748 in Nyacaba, Juja Sub-County Kiambu County**.** The proposed site is an abandoned quarry. In Nyacaba area where stone mining for construction industry is the main activity, owners leave the quarry pits open and most of the abandoned ones have been filled with a very small layer of stone rubble and dust where no further rehabilitation takes place. The quarry owners report that filling up of the quarries after use is an expensive exercise which would not translate to good profits, as the depth of the quarries is large. The proposed site measures about 50m in depth and 150m wide.

Figure 1: 3D Satellite view of the location of the proposed site on google map. The surrounding area to the site are either abandoned quarries or active mines.

Lat Long: -1.116760,37.074970

UTM: 285792.228E 9876494.154N 37M

MGRS: 37MBU 85792 76494

Elevation: 1482.38 m asl.

URL: https://www.google.com/maps/place/-1.116760,37.074970

From Juja, the site can be accessed via Weitethie underpass using the service lane just after River Ndarugo bridge.

Figure 2: Satellite vie with locations

Plate 3: View of the proposed incinerator site

2.2 Proposed Product and process description

The proposed incinerator will be a box type furnace (dimensions. 3500 (l) x 2100 (w) x 2400 (h) mm) equipped with:

- A self-balancing door for front-charging, dim. 1000 x 800 mm.
- a clean-out door for the down gas chamber
- a sideway connection for the stack
- 2 main burners with a capacity of 21000 kcal / h each with electronic temperature control from 0 to 1,250ºC.
- The stack – beside the furnace – is made of 5 mm Cor-Ten A steel, in
- standard flanged sections of 3 m., total height 18 m., outside with a diameter of 758 mm., equipped with: A foot plate with anchor bolts and a top ring
- The reaction chamber - integrated in the stack - height 1500 mm., outside diameter of 958 mm., made of 5 mm. Cor-Ten A steel and equipped with: Two air plenums; An afterburner with a capacity of 24000 kcal / h, with electronic temperature control from 0 to 1,250ºC.
- The ventilator for primary and secondary air, capacity 1500 m³ / h; with connections to the furnace and the reaction chamber
- The control panel for adjusting of the plant operation, with: The main switch, On / off buttons for the burners and the ventilator
- Hand adjustable time-clocks for the burners and the ventilator
- Digital displays of the electronic burner temperature controls
- One layer of zinc silicate and a layer of heat resisting paint, colour aluminum will minimize the risk to human health and the environment.

2.2.1 Means of Monitoring temperature in both primary & secondary chambers

The proposed incinerator will have 2 main burners with a capacity of 21000 kcal / h each with electronic temperature control from 0 to 1,250ºC.

2.2.2 Methods of Disposing off the Incineration ash.

At the plant Facility, an ash pit will be constructed where the ash will be placed after incineration. If full, the ash will be collected by the registered Municipal waste collection company bins and taken to Dandora landfill or any other land fill that is NEMA approved.

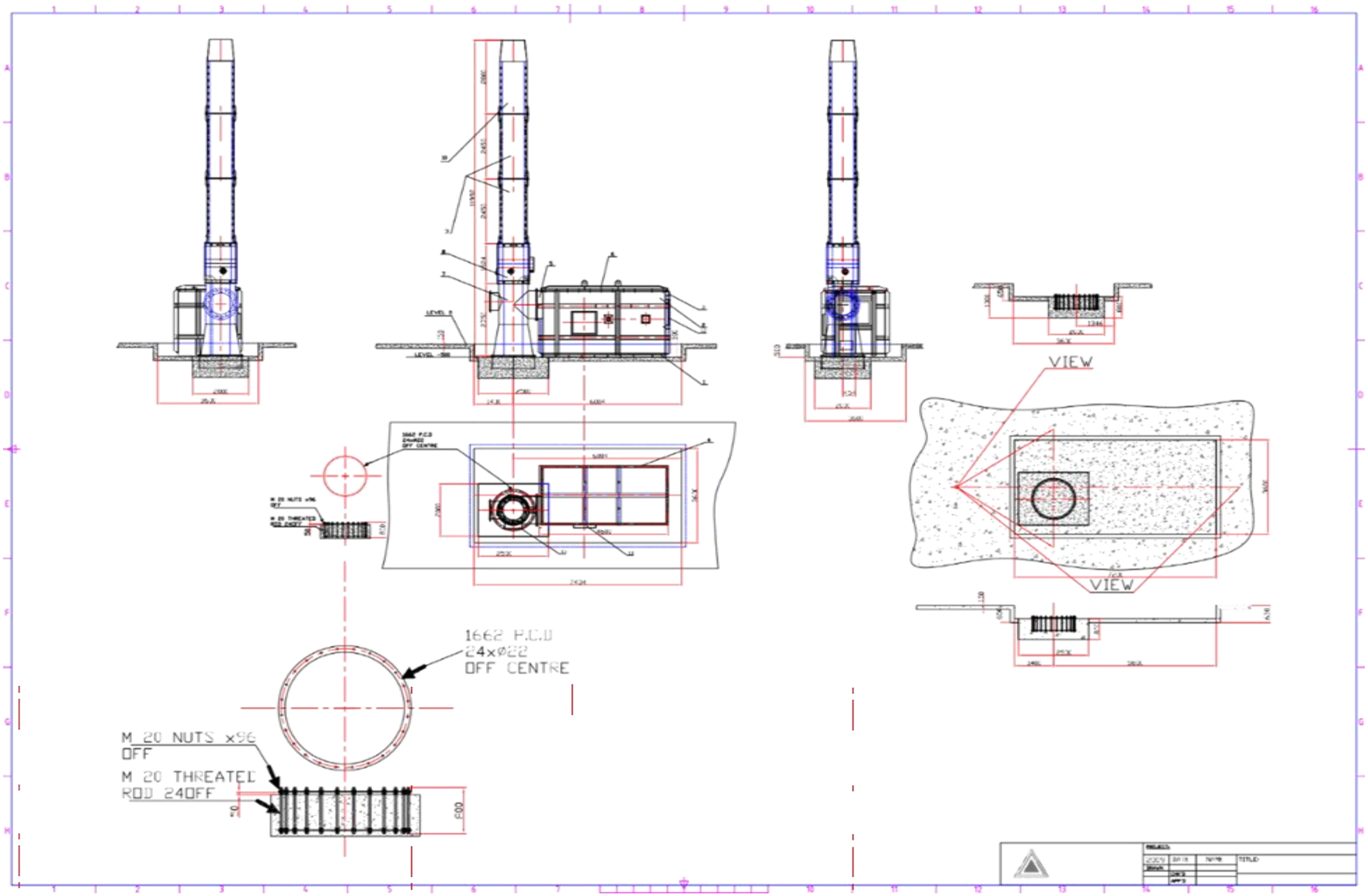

Figure 3: Proposed incinerator design

2.2.3 Proposed operations procedure for the proposed incinerator

- Start, load, and adjust equipment settings as specified by the manufacturer to ensure effective and efficient incineration of materials.
- Adhere to specified secondary burner pre-heat and post-incineration burn-down times.
- Complete all data on the Monthly Incineration Record form as presented in the standard operating procedure Pathological Waste Incinerator-Operating Permit Requirements.
- Monitor automated incinerator operating systems, coordinate a response to system failures, and document corrective actions. Examples include: burners failing to operate at appropriate temperatures or for appropriate time cycles, stack fan failures, continuous afterburner temperature monitoring or recording device failures, etc.
- Perform minor equipment maintenance such as cleaning around burner nozzles, changing paper in the continuous afterburner temperature recorder
- Coordinate, direct, and document the work of journey-level personnel in the repair and maintenance of incinerator components and systems, as needed.
- Clean ash and bone out of the primary burn chamber after completing each daily burn event.
- Periodically clean ash out of the secondary burn chambers. Store ash and bone in metal waste containers labeled "Bottom Ash" with lids kept closed.
- Once ash is cool, transfer to open top metal drum. Make sure lids are closed after adding ash.
- Maintain cleanliness in areas surrounding the incinerator

2.3 Detailed Incineration Processes and Environmental Releases

Waste incineration is one of many societal applications of combustion. As illustrated in Figure 4, the waste-incineration facility includes the following operations:

- Waste storage and feed preparation.
- Combustion in a furnace, producing hot gases and a bottom ash residue for disposal.
- Gas temperature reduction, frequently involving heat recovery via steam generation.
- Treatment of the cooled gas to remove air pollutants, and disposal of residuals from this treatment process.
- Dispersion of the treated gas to the atmosphere through an induced-draft fan and stack.

There are many variations to the incineration process, but these unit operations are common to most facilities. This section of the ESIA study report addresses the combustion and air-pollution control operations that will be used in incinerating municipal solid-waste, hazardous-waste, and medical-waste being the proposed project.

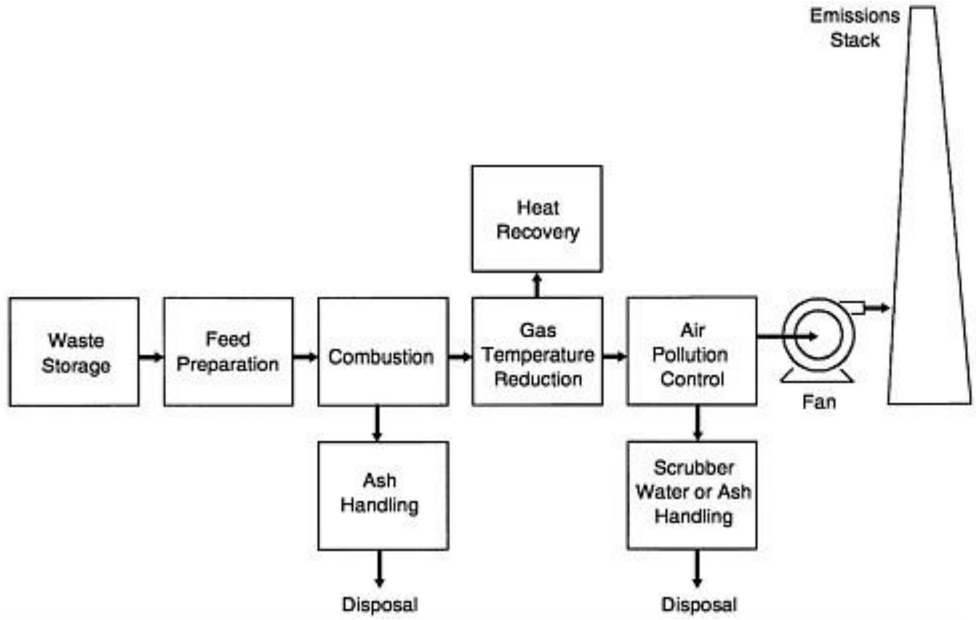

Figure 4: proposed waste-incineration facility schematic

2.3.1 Waste storage, feed preparation, and feeding

There are common waste storage, waste staging, feed preparation and feeding practices for municipal solid-waste, hazardous-waste, and medical-waste incinerators. These practices are highly waste-and facility-specific. Proper design and operation of these "front-end" plant operations have been considered and are important for several reasons:

- While the plant is operating, the potential for worker exposure to hazardous materials is the greatest in this part of the facility. Without appropriate engineered and administrative controls, including personnel protective equipment, operators can be exposed to hazardous dust and vapors.
- This part of the plant is the highest potential source of fugitive dust and vapor emissions to the environment, and the greatest potential fire hazard.
- Without proper waste preparation and feeding, the furnace combustion performance may be impaired.

2.3.2 The combustion processes

2.3.2.1 Proposed considerations

Combustion is a rapid, exothermic reaction between a fuel and oxygen (O_2). In incineration applications, the fuel is predominately waste (although fossil fuels may be co-fired) and the oxygen source is air. Combustion produces many of the same stable end products, whether the material burned is natural gas, coal, wood, gasoline, municipal solid waste, industrial wastes, hazardous waste, or medical waste. The flame zone of a well-designed incinerator is sufficiently hot to break down all organic and many inorganic molecules, allowing reactions between most volatile components of the waste and the oxygen and nitrogen (N_2) in air. The predominant reactions are between carbon (C) and oxygen, producing carbon dioxide (CO_2), and between hydrogen (H) and oxygen, producing water vapor (H_2O). Incomplete combustion of organic compounds in the waste feedstream produces some carbon monoxide (CO) and carbon-containing particles. Hydrogen also reacts with organically-bound chlorine to produce hydrogen chloride (HCl). In addition, many other reactions occur, producing sulfur oxides (SO_x) from sulfur compounds, nitrogen oxides (NO_x) from nitrogen compounds (and, a little, from the nitrogen in the air), metal oxides from compounds of some metals, and metal vapors from compounds of others. The furnace is designed to produce good mixing of the combustion air and the gases and vapors coming from the burning waste. Nevertheless, in parts of the furnace where combustion is not complete (for example, near the walls of the furnace), combustible components of organic compounds are burned off, leaving the incombustible particulate matter known as fly ash entrained in the flue gas. The incombustible portion of the waste (known as bottom ash) is left behind.

The proposed incinerator facility incorporate a number of general methods for ensuring proper combustion and reducing emissions. A steady situation with no major fluctuations in the waste-feed supply rate, combustion-air flows, or other incineration conditions promotes efficient combustion. Inefficient combustion can result in higher levels of products of incomplete combustion. Similarly, the more often the facility is started up and shut down (for maintenance or because of inadequate or varying waste stream volume), the more uneven the combustion and the greater the potential for increased emissions.

Optimal design and operation of a furnace requires attention to incineration temperature, turbulence of the gas mixture being combusted, and gas-residence time at the incineration temperature. To achieve efficient combustion, every part of the gas stream must reach an adequately high temperature for a sufficient period of time, and there must be adequate mixture of fuel and oxygen.

The temperature achieved is the result of heat released by the oxidation process, and has to be maintained high enough to ensure that combustion goes to completion, but not so high as to damage equipment or generate excessive nitrogen oxides. Temperatures will be controlled by limiting the amount of material charged to the furnace to ensure that the heat-release rate is in the desired range, and then tempering the resulting conditions by varying the amount of excess air.

Turbulence will be needed to provide adequate contact between the combustible gases and oxygen across the combustion chamber (macroscale mixing) and at the molecular level (microscale mixing). Proper operation is indicated when there is sufficient oxygen present in the furnace, and the gases are highly mixed. Cool spots can occur next to the furnace's walls; where heat is first extracted from the combustion process. Such cool spots on walls are more substantial in waterwall furnaces than in refractory-lined furnaces.

A number of new design features and operating techniques have been proposed and will be adopted to increase temperature, extend residence time, and increase turbulence in the proposed waste incinerator in order to improve combustion efficiency and provide other benefits like improved ash quality. They include high-efficiency burner systems, waste-pretreatment practices such as shredding and blending, and oxygen enrichment in addition to the features and methods discussed in the subsequent sections. Considerable attention has also been given to measurement and control of key process operating conditions to allow better control of the whole combustion process.

2.3.2.2 Furnace Type

The proposed furnace types will consider municipal solid-waste, industrial/hazardous-waste, and medical-waste incineration. Municipal solid-waste furnace designs have evolved over the years from simple batch-fed, stationary refractory hearth designs to continuous feed, reciprocating (or other moving, air-cooled) grate designs with waterwall furnaces for energy recovery. The newer municipal solid-waste incinerators are waste-to-energy plants that produce steam for electric power generation. In the proposed incinerator, the waste to energy option can may be considered later if an industrial facility is located in the neighbourhood.

The predominant hazardous-waste incinerator designs options are liquid-injection furnaces and rotary kilns. Hazardous wastes are also burned in cement kilns, light-weight aggregate kilns, industrial boilers, halogen-acid recovery furnaces, and sulfuric-acid regeneration furnaces.

Medical wastes are burned in fixed-hearth incinerators, with the primary chamber operated in the starved-air mode (newer “controlled air” designs) or excess air mode. The proposed design incorporate secondary, afterburner chambers.

2.3.2.3 Furnace Design Considerations the proposed waste incinerator

The design of the furnace is critical to optimal combustion. Furnace configurations depend on what they were designed to burn. Older designs, many of which are still used, do not generally permit as efficient combustion as newer designs.

Sizing

Poor combustor design can prevent stable, optimal combustion conditions. Sizing a furnace to match the quantity of waste fed to the incinerator is important with respect to temperature, turbulence, and time. If the heat input from the waste is too low for the furnace size, the temperature in the furnace may drop to such an extent that complete combustion is not achieved, particularly in waterwall furnaces. If the furnace is too small for the quantity of waste fed, the temperature will be high and there may be difficulty in supplying sufficient oxygen for complete combustion, and the quantities of unburnt residues might be increased.

Grates

In older incinerator systems, traveling grates simply transported refuse into the combustion zone. Newer grate systems are designed to agitate the waste in various ways, causing it to be broken into smaller pieces as combustion proceeds. This process permits exposure of a larger surface area of waste to air and high temperatures, assisting complete combustion by preventing unburnt material from simply being transported through on the grate.

Air-Injection Systems

For complete combustion to occur, air must be injected into the furnace in at least two locations: under the grate that carries burning waste (primary or underfire air) and above the grate to mix additional oxygen with the combustion gases (secondary or over-fire air). Additional controls have been provided in the modern proposed solid-waste incinerator to better regulate both the under-fire air at various points on the grate, depending upon burning conditions, and the over-fire air in response to temperature and heat transfer taking place in the furnace. In such advanced systems, primary air is injected into the drying, burning, and burnout zones of the grate, with a separate system for secondary air. Control may be effected by manual or automatic adjustments to dampers. The latter method is preferred, because it allows for automatic control loops with continuous monitoring devices. The temperature and oxygen needs of the furnace can be controlled by adjusting the quantity of primary and secondary air entering the furnace. In plants built before the middle 1980s, particularly those with holes in the furnace walls, the entry of primary and secondary air is not as well controlled, and the excess-air rates required for adequate combustion can be several times the amount that would be required with a more modern design. This can result in larger volumes of flue gas to be treated for contaminant removal, and reduced efficiency of utilization of the exhaust heat.

Arches and bull Noses

To achieve complete combustion, gases produced must remain in the high-temperature zone of the furnace for a minimal residence time, usually 1-2 seconds. Achieving that residence time is usually accomplished by designing the furnace to retard the upward flow of gases, for example, by installing irregularities into the furnace walls. Modern facilities are configured to achieve improved combustion efficiency by using arches and bull noses. Arches, which are structures above the burning and burnout zones, are used to prolong the stay of combustion gases above the grate area. Bull noses are protrusions that are built into the furnace walls, usually near the point of injection of over-fire air, to upset the normal upward flow of the heated gases volatilizing from the burning waste. The induced gas redirection retards the movement of the combustion gases out of the furnace and promotes mixing with air.

Flue-gas Recirculation

Flue-gas recirculation systems are used to recycle into the furnace relatively cool flue gas (extracted after the heat exchangers have reduced its temperature) that contains combustion products and an oxygen concentration lower than air. The process is used to lower nitrogen oxide formation by limiting the flame temperature and by slightly diluting the flame oxygen concentration. Care must be taken to ensure that not too much flue gas is recirculated, lest the combustion process be adversely affected.

Auxiliary Burners

Waste feedstock, particularly municipal solid waste, is heterogeneous, and its components, or even the whole waste stream, may vary in combustibility. That can make it difficult to maintain the minimal temperature necessary throughout a furnace. In modern combustors, maintenance of temperature can be aided by auxiliary burners that are typically set to come on automatically when the furnace temperature falls below a predetermined point; the threshold is usually set between 1,500 and 1,800°F at the location of the auxiliary burner, which is close to the chamber exit. The auxiliary burners are fed fossil fuels and are particularly intended to be used during system startup, shutdown, and upsets.

2.4 Gas-temperature reduction techniques

The most common combustion-gas cooling techniques for incinerators are waste-heat boilers, and direct-contact water-spray quenches. Gas cooling techniques are integral to incineration system design, and can be important with respect to emissions of certain pollutants. As discussed later in the subsection, emissions of mercury and dioxins and furans can be affected by the rate of gas cooling and the air pollution control device (APCD) operating temperature. Dry APCDs, including scrubbers and particulate control devices, achieve the highest degree of reduction of mercury, dioxins and furans, and acid gases when flue-gas temperatures are lowered to about 300°F or less at the APCD inlet. Combustion gases will be quenched by water sprays atomized into the hot gas flow.

2.5 Air-pollution control techniques

Incinerator APCDs were designed to remove two classes of pollutants which are particulate matter and acid gases. More recently, some method for improving the removal of dioxins and/or mercury is considered necessary. In Kenya, NO_x emission limits have been established for incinerators. Increasingly stringent regulations proposes use of more than one particulate-control device or more than one type of scrubber in a given incineration facility, and emissions have typically been reduced more than would be expected with the single device alone. Proposed incinerator is equipped for particulate, acid gas, and as well as dioxin and mercury removal as follows;

i. The incinerator will employ fabric filters. Fabric filters, also known as baghouses, started to replace, or be used in tandem with, ESPs as the preferred design for particulate removal because of their improved capacity for filtering finer particles. Fabric-filter systems (particularly in larger incineration facilities) are preferred because of their superior fine-particle-emission and metal-emission control efficiencies and their ability to produce a dry residue rather than a scrubber wastewater stream.

ii. Spray dryer absorbers (wet scrubber) systems will be used for acid gas HCl and sulfur dioxide (SO_2) removal.

iii. Dry powdered activated carbon injection systems will provide dioxin and furan and mercury removal.

Note: Cement kilns and coal-fired boilers that burn waste as fuel have traditionally used either fabric filters or dry electrostatic precipitators as active control techniques. Passive controls include the neutralization of acid gases by cement materials and the recycling of cement kiln dust back into the process.

Particulate Collectors

Fine-particle control devices fall into three general categories, which are **filtration collectors**, including fabric filters (baghouses); **electrostatic collectors**, including dry and wet electrostatic precipitators (ESPs) and ionizing wet scrubbers; and **wet inertial-impaction collectors**, including venturi scrubbers and advanced designs that use flux-force condensation-enhancement techniques. When properly designed and operated, all of them are capable of effective fine-particle control, but they are not all equally effective.

Fabric filters are used at relatively low flue-gas temperatures (about 280-400°F). Flue gas containing particles passes through suspended filter bags. The particles suspended in the gas streams are collected on the filters and periodically removed and fed to a collection hopper.

Fabric filters are widely used today in municipal solid-waste incineration facilities, cement kilns, and lightweight-aggregate kilns because of their highly efficient collection of fine particles. They are used in a smaller number of hazardous-waste incinerators and medical-waste applications. The performance of fabric filters is relatively insensitive to particle loading, or to the size distribution and physical and chemical characteristics of the particles. They are limited to an operating temperature range between the gas dew point on the lower end and the bag-material thermal-stability limit on the upper end. A typical and practical operating-temperature for this technology in municipal solid-waste applications is about 300°F, but the best environmental performance is achieved at lower temperatures (to minimize dioxin and furan production within the APCD itself).

The primary factors affecting the performance of fabric filters are fabric type and weave, air-to-cloth ratio (gas flow rate to total bag surface area), cleaning method and frequency, bag cake formation and maintenance, and bag integrity with respect to mechanical, thermal, and chemical breakdown. The fabric type must be matched to the temperature range of the application and the chemical composition of the gas for good performance and bag longevity. Maximal air-to-cloth ratio for good performance is also a function of fabric type and weave. The method, intensity, duration, and frequency of the bag-cleaning cycles are important to maintain mechanical integrity of the bags and good cake formation. Good cake formation (as measured by baghouse pressure differential) is required for good performance of woven and felted bags; it is less critical for laminated membrane bags, which can function using surface filtration alone.

In properly designed and operated fabric-filter systems, maintaining bag integrity is the critical determinant of day-to-day performance. Bag integrity can be monitored via pressure drop, visual stack-opacity inspections, continuous online stack-opacity monitors, or other continuous monitoring techniques that use optical sensing or triboelectric sensing.

During shutdowns, bag integrity can be checked by visual examination of the clean-gas plenum for localized dust buildup. More-sensitive techniques involve the use of fluorescent submicrometer powder and black-light examination of the plenum.

Dry ESPs are widely used today in municipal solid-waste incineration facilities and on cement kilns and coal-fired boilers that burn hazardous waste. Wet ESPs are less widely used and are primarily in hazardous-waste incineration applications. Dry ESPs operate above the dewpoint of the gas. Wet ESPs are constructed from materials that resist acid corrosion and operate under saturated-gas conditions.

Dry ESPs are less effective than fabric filters for collection of submicrometer particulate matter (0.1-1.0 μm) but are nevertheless very effective collection devices. Their performance is influenced by a variety of design characteristics and operating conditions, including the number of electric fields used, charged electrode wire (or rod) and grounded collection plate (or cylinder) geometry, specific collection area (ratio of collection surface area to gas flow rate), electrode design, operating voltage and current, spark rate, collector cleaning method (to limit buildup or re-entrainment of dust), fluctuations in gas flow rate and temperature, particulate-loading fluctuations, particle-size distribution, and particle resistivity (less important for wet ESPs). Wet ESPs have superior submicron particle collection capabilities because they do not suffer rapping re-entrainment and dust layer back-corona problems associated with dry ESPs.

In a properly designed unit, the important monitoring and process-control measures are inlet gas temperature (dry ESPs only), gas flow rate, electrical conditions (voltage, current, and spark rate), cleaning intensity and frequency, and hopper-ash level (dry ESPs only).

The proposed incinerator will use wet inertial-impaction scrubbers. Wet inertial-impaction scrubbers primarily venturi scrubbers, have historically been the particulate matter control technology of choice for most hazardous-waste and medical-waste incinerators. They are inherently less efficient for submicrometer particulate matter than fabric filters or ESPs, but nonetheless can meet regulatory requirements in many applications.

The primary performance criterion for most wet inertial-impaction scrubbers is the gas-pressure drop, a measure of the energy applied to atomize scrubbing liquid and create fine droplets for particle impaction. For injector venturi scrubbers, the corresponding criterion is liquid-nozzle pressure drop. Other important design and operating characteristics are the liquid-to-gas ratio, inlet gas temperature (to avoid scrubber-liquid evaporation), solid content of recirculated scrubber liquid, mist eliminator efficiency, materials of construction to avoid corrosion and erosion, particulate loading, and particulate-size distribution. In a properly designed unit, the most-important monitoring and process control measures are pressure drops, liquid and gas flow rates, and liquid blowdown rate (blowdown is used to control solids buildup).

A few designs use steam injection or scrubber-liquid subcooling to enhance flux force and condensation. For those designs, steam-nozzle pressure and scrubber-liquid temperature are additional useful monitoring measures.

2.5 Acid Gas Scrubbers

The proposed method used in APCD for removal of acid gases is a packed-bed absorber. A scrubbing liquid is trickled through a matrix of random or structured packings through which the gas is simultaneously passed, resulting in gas-liquid contact over a relatively large surface area. The scrubbing liquid can be water or an alkaline solution, which reacts with the acid-gas constituents to form neutral salts. The wastewater discharge from the packed-bed absorber is a salt-water brine that must be managed properly. This effluent may contain unreacted acids, trace organics, metals, and other solids removed from the gas stream.

Packed bed absorbers have been used for decades in the United States, primarily in hazardous-waste and medical-waste incineration applications. They have been used in Europe for municipal solid-waste applications. The European installations include duel-stage wet absorbers, in which the first stage is operated with an acidic scrubber liquid and the second stage is operated with an alkaline scrubber liquid. Acid gases, such as HCl, that are highly water soluble are largely collected in the first stage. Acid gases, such as SO_2, that are not very water soluble are effectively collected in the second, alkaline stage.

The important design and operating criteria for wet acid-gas absorbers are gas velocity, liquid-to-gas ratio, packing mass transfer characteristics, pH of the scrubbing liquid, and materials of construction (to prevent corrosion).

Few larger hazardous-waste and medical-waste incineration facilities have used spray-dryer scrubbers for acid-gas control. The spray dryers use slurries of lime, sodium carbonate, or sodium bicarbonate as the alkaline reagent. The water in the atomized slurry droplets evaporates, cooling the gas, and the alkali particles react with the acid-gas constituents to form dry salts. The salts and unreacted alkali must be captured in a downstream fabric filter or electrostatic precipitator. Dry-injection scrubbers, which use an alkaline reagent without water, have also been used in recent years. They are typically not as efficient as spray-dryer absorbers at removing emissions. The important design and operating criteria for spray-dryer absorbers and dry-alkali scrubbers include gas temperature in the reagent contacting zone, reagent-to-acid gas stoichiometry, reagent distribution in the gas, and reagent type.

2.6 NO_xControls

NO_x emissions will be reduced by combustion-furnace designs, combustion-process modifications, or add-on controls. Combustion-furnace designs that reduce thermal NO_x include a variety of grate and furnace designs, bubbling and circulating fluidized-bed boilers, and boiler designs, especially those with automatic controls, that permit flue-gas recirculation. Combustion-process modifications that reduce NO_xformation include controlling the amount of oxygen available during the combustion process, and operating within a specific temperature range. For minimizing NO_x production in the combustion process, it is recommended that there be a lower-oxygen condition just above the grates (or in the primary chamber of a dual-chamber facility) coupled with a higher excess-oxygen condition at the location of overfire air injection (or in the secondary chamber of a dual-chamber facility). Municipal solid-waste incineration facilities tend to create the most NO_x when furnace temperatures are higher than is necessary (higher than 2,000°F) to destroy products of incomplete combustion (PICs). To minimize NO_x formation, and the formation of PICs, the furnace should be operated within fairly narrow ranges of temperature and excess oxygen (9-12%) with turbulent (well-mixed) conditions.

Some NO_x formation is inevitable from nitrogen present in the fuel and from atmospheric nitrogen, and it may be necessary to use flue-gas controls to achieve further reduction of these emissions. Add-on NO_x flue-gas control systems include selective noncatalytic reduction (SNCR), selective catalytic reduction (SCR), and wet flue-gas denitrification.

SNCR reduces NO_x by injecting ammonia or urea into the furnace via jets positioned at the location where temperatures are about 1600-1800°F. In the proper temperature range, the injected ammonia or urea combines with nitrogen oxide to form water vapor and elemental nitrogen.

SCR operates at a lower flue gas temperature than SNCR, and in addition uses a catalyst. Ammonia is injected into the flue gases when they are at about 600°F, and the mixture is passed through a catalyst bed. The catalyst bed may be shaped in a variety of forms (honeycomb plates, parallel ridged plates, rings, tubes, and pellets), while the catalyst can be one of a variety of base metals (such as copper, iron, chromium, nickel, molybdenum, cobalt, or vanadium). Each combination has advantages and disadvantages with respect to catalyst-to-NO_x contact, fouling of the catalyst, and pressure drop through the catalyst. The biggest disadvantage of SCR for incineration applications is that the combustion gas must always be reheated to the required 600°F temperature range after cooling below this level to remove particulate matter. The catalyst beds required for SCR must be installed downstream of highly effective particulate removal devices to avoid fouling.

Wet scrubbers for NO_x removal are comparable to wet acid gas absorbers in configuration. They use strong oxidizers in aqueous solution to convert NO to NO_2 (which is water soluble in caustic solution) or NO_3- (nitrate), which is water-soluble. The exact chemistries of these systems are considered proprietary by the vendors.

2.7 Carbon Adsorption and Other Dioxin and Mercury Removal Techniques

Carbon injection refers to the injection of finely divided activated carbon particles into the flue gas stream ahead of the particulate APCD. The carbon particles adsorb pollutants on their surface, and then the carbon particles are themselves captured in the particulate APCD. Activated carbon has a large surface-area-to-volume ratio, and is extremely effective at adsorbing a wide range of vapor-phase organic-carbon compounds, and also some other vapors (like mercury) that are otherwise hard to control. Maximum effective use of the technique requires optimization of the rate of injection of activated carbon (Brown and Felsvang 1991). Studies in Europe and practical experience in the United States and elsewhere indicate that this technique can substantially reduce emission of dioxins and furans and of mercury. Also, Lerner (1993) reported that cadmium chloride is effectively removed from a flue gas stream by using activated carbon.

Dioxins and furans are removed along with mercury by injection of powdered activated carbon in a number of municipal-waste incinerators and a few hazardous-waste incinerators. Removal efficiency is a complex function of carbon type, dosage, gas temperature, and gas-to-solid contact efficiency. Other add-on control technologies s are adsorption in granular activated carbon or coke beds, catalytic oxidation in SCR units (which are also the most efficient NO_x controls demonstrated commercially), and injection of an inhibitor of dioxin-formation catalyst. For high efficiency mercury removal, Tranbiz enterprises Ltd can adopt a powdered activated-carbon injection upstream of dry particle collection devices, usually fabric filters. As for dioxin removal, the effectiveness of powdered activated-carbon injection is determined by the carbon type, dosage, gas temperature, and gas-contact efficiency. Other processes for mercury removal are granular activated-carbon filtration in fixed-bed reactors, selenium porous-media filter, gold-amalgamation filter beds, sodium sulfide injection, and wet scrubbing with mercury-reactive solutions.

Note: Fixed-bed carbon adsorbers used often produce mercury and dioxin removal efficiencies that are higher than conventional technologies used alone (e.g., scrubber/fabric filter with injection of activated carbon).

2.8 Proposed system operation

Many variables that affect incinerator operation are controlled by operators, so the combustion conditions that control emission rates may be substantially affected by operator decisions. Poor operator control either of the furnace (by permitting temperature or oxygen concentration to decrease) or of the stoking operation can cause reduced combustion efficiency. In the proposed incinerator, mixing and charging of waste into the incinerator, grate speed, over-fire and under-fire air-injection rates, and selection of the temperature setpoint for the auxiliary burner will entirely or partially ne controlled by plant personnel.

In addition, the extent of emission control achieved by post-combustion APCDs depends on how the devices are operated. Suboptimal operation can be caused by poorly trained or inattentive operators, faulty procedures, and equipment failure. Operators must be attentive to the flow rate of waste into the incinerator and furnace operation so as to allow for effective function of APCDs.

There will always be a need for operator to deal with unexpected situations. The incinerator will require calibration and maintenance, as the combustor parts can wear out or malfunction. Examples of what can go wrong include clogged air injection into the incineration chamber, fouled boiler tubes, a hole in the fabric filters, and a clogged scrubber nozzle.

2.8.1 Worker Training

In compliance with OSHA 2007, proponent will be required to undertake worker training in hazardous-material management. Annual refresher courses will also be required, as is supplemental training for supervisory personnel. The training is an important requirements for inspection plans and worker-training plans for the proposed incinerator that manages hazardous waste, including combustion facilities. The inspection plans address facility maintenance, leak inspections, and calibration schedules for monitoring equipment. The training plans are intended to address hazardous-material safety and facility operations.

2.8.2 Monitoring and Data Collection

Environmental regulations particularly EMCA Air Quality Regulation of 2014 as well as Waste Management Regulations of 2006 have led to extensive monitoring of key incineration process conditions, including waste feed rates; feed rates of ash, chlorine, and toxic metals (determined by sampling and analysis of the waste stream); combustion temperatures; gas velocity (or gas residence time); facility-specific air-pollution control-system operating measures; and stack-gas concentrations of O_2, CO, total hydrocarbons, HCl, NO_x, and SO_x, and opacity. **The ESIA experts proposes that Tranbiz Enterprises Ltd adopts a computerized system that collect and record process data, automatically control such process conditions as combustion temperature (by varying fuel feed and air flow rates), and automatically cut off waste feeds if operating conditions stray outside limits set by permits. For example, a low combustion temperature or high stack-gas CO concentration might initiate an automatic waste-feed cutoff.**

The proposed incinerator requires continuous monitoring of important air-pollution control-system operating conditions, including pressure drops across venturi scrubbers, pH of acid-gas absorber scrubbing solutions, voltage or power supplied to electrostatic collectors, and fabric-filter pressure drops or triboelectric[1] sensor readings. Stack-gas monitors are often used to monitor the performance of the air-pollution control system directly for such measures as HCl, SO_2, NO_x, and opacity.

With electronic transmission of such sensor outputs, the performance of the control and monitoring systems could be more-readily displayed and monitored. Reliable continuous emission monitors (CEMs) for dioxins and furans or for metals would be desirable, because automatic devices electronically linked to such devices (for example, to optimize the injection of alkaline and carbon reagents and water in the emissions control devices) could directly control those emissions of greatest potential health consequence. Such arrangements have been in use for continuous automatic control of acid gases for some time. CEMs for mercury have undergone in-use testing in Europe, for example see Felsvang and Helvind (1991).

2.9 Possible process emissions

The principal products of combustion are CO_2, water vapor, and ash, which are respectively oxidation-reaction products of carbon, and hydrogen, and non-combustible materials in the fuel. However, when the combustion reactions do not proceed to their fullest extent, other substances, some of which are potentially harmful, can be produced. The types and concentrations of contaminants in the waste stream (flue gas) flowing from any incineration process depend on the process type, the waste being burned, and combustion conditions. Such

[1] **Triboelectricity refers to an electric charge that is generated by friction**.

pollutants derive from three sources: they or their precursors are present in the waste feed, they are formed in the combustion process because of incomplete oxidation, or they are created by reformation reactions in the gas cooling or APCD.

As discussed in earlier in this subsection section , the products of primary concern, owing to their potential effects on human health and the environment, are compounds that contain sulfur, nitrogen, halogens (such as chlorine), and toxic metals. Specific compounds of concern include CO, NO_x, SO_x, HCl, cadmium, lead, mercury, chromium, arsenic, beryllium, dioxins and furans, PCBs, and polycyclic aromatic hydrocarbons. In addition, the total quantities of particulate matter and acid particles (which may largely be liquids condensed after emission) that escape the APCD are also considered independently. The following discussion focuses on the source and control of the following pollutants: particulate matter, acid gases, mercury (Hg), lead (Pb), and products of incomplete combustion. They are used to represent the pollutants from incineration that are of concern for possible health effects.

2.9.1 Particulate Matter

Particulate matter consists primarily of entrained noncombustible matter in the flue gas, and the products of incomplete combustion that exist in solid or aerosol form. Particle concentrations in the flue gas in the absence of control devices have been found to range from 180 to more than 46,000 mg per dry standard cubic meter (0.08 to more than 20 grains per dry standard cubic foot).

Particulate matter from waste combustors includes inorganic ash present in the waste and carbonaceous soot formed in the combustion process. The inorganic-ash fraction of the particulate matter consists of mineral matter and metallic species. These materials are conserved in the combustion process and leave the combustion chamber as bottom ash or fly ash. Soot is a product of incomplete combustion that consists of unburned carbon in the form of fine particles or as deposits on inorganic particles. High-molecular-weight organic compounds condense on the surface of the particles, particularly on the carbon, downstream of the combustor.

The following four methods are priposed for limiting particulate emissions from waste combustors

- Limiting the ash content of the waste feed via source control or selection.
- Designing and operating the primary combustion chamber to minimize fly-ash carryover.
- Designing and operating the combustion chamber(s) in accordance with good combustion practice to minimize soot formation.
- Using well-designed and well-operated fine-particle APCDs.

Source control of ash-producing waste constituents is an obvious method to reduce particulate emission, but it is impractical for waste combustors. However the incinerator can be able to meet particulate matter emission limits by stringent source selection alone. The first three methods listed above are effective in reducing particle loadings in the combustion gas but are generally not sufficient by themselves to meet current and proposed maximum-available-control-technology (MACT) emission standards for particulate matter. Add-on particulate control is expected to be needed to meet the proposed MACT standards for the incinerator.

Fine-particle control devices are in three general categories: filtration collectors, including primary fabric filters (baghouses); electrostatic collectors, including dry and wet electrostatic precipitators (ESPs) and ionizing wet scrubbers; and wet inertial-impaction collectors, including venturi scrubbers and advanced designs that use flux-force condensation-enhancement techniques.

2.9.2 Acid Gases

Acid gases are flue-gas constituents that form acids when they combine with water vapor, condense, or dissolve in water. Acid gases include NO_x, SO_x, HCl, hydrogen bromide, hydrogen fluoride, and hydrogen iodide. HCl and SO_2 are often present in uncontrolled flue-gas streams in concentrations ranging from several hundred to several thousand parts-per-million-by-volume. The concentrations of NO_x, hydrogen fluoride, and sulfur trioxide are typically below several hundred parts-per-million-by-volume. Free halogens such as chlorine, bromine, and iodine can also be produced at low concentrations from combustion of wastes that contain compounds of those elements. Emissions of SO_2, HCl, and the other halogen acids can only be controlled through the use of add-on APCDs, which have been previously described in this chapter.

There are two sources of NO_x from incineration (and other combustion) processes, commonly referred to as thermal NO_x and fuel NO_x. Thermal NO_x is formed by the reaction of nitrogen and oxygen in the combustion air. Its formation is favored by high temperature (i.e., flame zone temperature), relatively large residence time at this temperature, and higher oxygen concentration. Fuel NO_x is formed by the oxidation of chemically-bound nitrogen in the waste (or fuel). Conversion of bound nitrogen to NO_x is strongly influenced by the localized oxygen concentration; it is less sensitive to temperature than thermal NO_x formation. Fuel NO_x formation can exceed thermal NO_xformation by an order of magnitude in incinerators burning wastes containing bound nitrogen.

Note: NO_x formation can be reduced, to a degree, by furnace design and combustion process changes as described earlier in the chapter. Add-on controls are required for more effective removal.

2.9.3 Mercury

Heavy metals in waste are not destroyed by incineration. Metallic elements with high vapor pressures, or with compounds that have high vapor pressures, can be converted to the vapor phase in the combustion chambers and tend to condense as the flue gas is cooled. They can adsorb onto fine (generally submicrometer) particles. It is likely that mercury remains in the vapor phase in the air-pollution control section of the incineration process, depending on temperature, and the same may be true for some of the more-volatile metal compounds.

Mercury emission from waste combustors is determined largely by the mercury feed rate and by whether mercury-specific APCDs are used. Virtually all mercury species found in wastes are volatile at combustion temperatures, so there is a high degree of partitioning to the gas phase, regardless of the chemical form of mercury or the combustion-system operating conditions. There is evidence that mercury is present primarily as elemental mercury vapor at incinerator combustion temperatures. The rate of cooling in the air pollution system and the

HCl/Cl_2 concentrations in the gas affect the conversion of elemental mercury to water-soluble mercuric chloride (Gaspar et al. 1997; Chambers et al. 1998; Gaspar 1998).

Mercury emission will be limited through operator control of waste feed rates. Conventional APCD such as fabric filters, ESPs, inertial-impaction scrubbers, and other wet scrubbers are at best only partially effective for mercury removal at normal operating temperatures. Traditional wet-scrubber APCDs have provided moderate (20-90%) mercury control efficiencies. The most-modern facilities use powdered activated-carbon injection into the gas stream for mercury removal. The best performances of conventional APCDs are typically those of wet scrubbers operating at saturation temperature or lower. Lower scrubber-water temperatures lead to vapor condensation, and reduced mercury vapor pressure. Soluble forms of mercury, such as $HgCl_2$, are preferentially removed in wet scrubbing systems.

2.9.4 Lead

Lead (Pb) emissions from the proposed waste incinerator will be influenced by the concentration of Pb in the waste feed, the chemical form of Pb, the physical matrix of the waste, the degree of ash carryover from the primary combustion chamber, thermal conditions in the primary and secondary combustion chambers that affect Pb volatilization, and the air-pollution control system efficiency for fine-particle removal from the gas. The method of feeding waste to the combustor chamber (in batches vs. continuous feeding) can have an indirect effect on Pb emissions.

The concentration of Pb in the waste is important because Pb is conserved in the combustion process; all the Pb fed to the combustor exists with the bottom ash, is collected as fly ash, or is emitted as fine particles in the stack gas. The chemical form of Pb, the feed location and physical waste matrix, and local temperature in the combustion system are important because they affect the extent to which Pb is vaporized in the combustion process. Volatile forms of Pb, such as $PbCl_2$, might vaporize completely in the combustion process, whereas nonvolatile species, such as PbO, tend to partition to the bottom ash in the primary combustion chamber. Pb in liquid wastes fed through burners is exposed to flame temperatures and is, thus, more likely to vaporize than Pb in solid wastes. Pb in combustible solid wastes (e.g., paper or plastics) will vaporize to a greater extent than Pb in mostly noncombustible items, such as glass. The combustion-chamber temperature profile also affects the vapor pressure and degree of volatilization of the Pb species.

The extent of Pb vaporization in the combustion process is important because it affects the distribution of Pb among the fly-ash particle-size fractions. Pb that does not vaporize during combustion either partitions to the bottom ash or carries over as fly ash with a particle-size distribution characteristic of the incoming waste material. Pb that does vaporize, however, recondenses in the cooler downstream air-pollution control environment and adsorbs to the finer particles. The finer particles are more difficult to remove from the gas. Thus, Pb-removal efficiency tends to be lower than the overall particle-removal efficiency. The behavior of Pb and other metals in the combustion environment has been extensively studied by EPA and others (Campbell et al. 1985; Barton et al. 1987, 1990, 1996; Fournier et al. 1988; Fournier and Waterland 1989; Carroll et al. 1995).

The design and operation of the primary combustion chamber as they affect ash carryover and the design and operation of the APCD also influence Pb emissions. The principles are the same as those described earlier for particulate-matter emission control. In summary, there are four general methods proposed for limiting Pb emissions from waste combustors:

- Limiting the Pb content of the waste feed via source control.
- Designing and operating the combustion process to minimize Pb vaporization.
- Designing and operating the primary combustion chamber to minimize fly-ash carryover.
- Using well-designed and properly operated APCDs.

From a practical standpoint, the second method is likely to be the most difficult to implement because the objective of the combustion process is to burn all the waste completely.

Note: The most-reliable methods of limiting Pb emissions are source control and good particulate APCD performance.

2.10 Products of Incomplete Combustion

Organic and inorganic substances that are broken down into free-radicals (molecular species possessing an unpaired electron) in the combustion unit sometimes do not combine with oxygen or hydroxyl radicals and instead combine among themselves to form many organic compounds. Most of these compounds can be destroyed in the postflame zone of a well-designed incineration system. Such compounds that are not combusted and released into the exhaust gas are called products of incomplete combustion (PICs). PIC emissions heavily depend on combustion conditions, which, in turn, depend on the design and operation of the combustion device. Depending on the temperature, some of the heavy organic constituents can condense onto fine particles. Examples of PICs are CO and trace organic chemicals. (The latter can also be remnants of the original feed stream.) PICs include simple compounds (e.g., methane, ethane, acetylene, and benzene), dioxins and furans, partially oxidized organic compounds (e.g., acids and aldehydes), and polycyclic aromatic hydrocarbons.

2.10.1 Dioxins and Furans

As discussed in earlier in this section dioxins and furans are the most-hazardous organic PICs that have been found in the flue gas of any combustion device. (“Dioxins and furans” refers collectively to polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs)). For poorly designed and poorly operated incineration facilities, the flue-gas dioxin and furan concentrations can be much higher than those generated by typical combustion devices. The polybrominated analogues have also been found in incineration emissions (see for example, Sovocool et al. 1989).

The proposed incinerator can produce dioxins and furans from three points in the process: stack-gas emissions, bottom ash, and fly ash. Often, bottom ash and fly ash are mixed for waste management purposes, but they may contain different amounts of dioxins and furans. The incineration facilitity is able to achieve zero discharge with respect to aqueous waste, so there are no major contaminated waste water streams.

Three possible sources of dioxin and furan emissions are the following: (1) uncombusted components of the original fuel (dioxins and furans are present in the materials that are thermally treated, and some quantity of this material survives thermal treatment); (2) formation from precursor compounds (dioxins and furans are formed from the thermal breakdown and molecular rearrangement of particular precursor compounds); and (3) de novo synthesis (dioxins and furans are synthesized from a basic chlorine donor, a molecule that takes chlorine to the predioxin molecule, and the formation and chlorination of a precursor) (EPA 1994b).

All types of organic chemicals, including polychlorinated dioxin and furans, can be destroyed under high-temperature oxidizing conditions. Destruction can occur at around 1800°F or higher if oxygen and organic molecules are well mixed as in practical combustion devices. Destruction of polychlorinated dioxins and furans present in the waste feed stream can take place at temperatures as low as 1350°F if oxygen and organic molecules are perfectly mixed (Duvall and Rubey 1977; Dellinger et al. 1984). However, dioxins and furans are also produced within the incineration process from precursors that are not destroyed below 1,800°F. Lahl et al. (1990) suggest that, although dioxins and furans may be present in the incoming mixture, most of the dioxins and furans in the exhaust gases are the products of formation within the incinerator and not persistence of the compounds present in the waste stream.

It is known that the presence of catalytic metals (e.g., copper, nickel, zinc, iron, and aluminum and their salts) and the temperature range of 450-750°F can promote dioxin and furan formation (e.g., Stieglitz and Vogg 1987; Vogg et al. 1992). Other requirements for dioxin and furan formation include prolonged gas-residence time in the stated temperature range, the presence of carbon as gaseous PICs or particles, and the presence of chlorine as HCl, Cl_2, or metal salt. Some types of organic compounds, such as chlorophenols and chlorobenzenes, tend to act as precursors for this type of secondary dioxin and furan formation. There is evidence that sulfur and ammonia can inhibit dioxin and furan formation.

As noted above, three sources have been proposed for the dioxins and furans found in the products of combustion. In addition, a substantial amount of research has been performed on effects of combustion conditions, facility configuration, waste stream composition, and pollution-control equipment. Siebert et al. (1988) investigated various factors associated with the operation of municipal solid-waste combustors and found APCD outlet temperature, presence of acid-gas controls, and the startup year of the facility to be the most-important determinants of dioxin and furan formation. Fangmark et al. (1993) studied the effect of bed temperature, oxygen concentration, variations in HCl and water, and temperature and residence time in the postcombustion zone on dioxin and furan formation and concluded that post-combustion temperature was the most important. A study conducted for the American Society of Mechanical Engineers, ASME (1995), indicated that there was no statistically significant cross-incinerator correlation between chlorine content of the waste stream fed to incinerators, and the dioxin and furan concentration in the emissions of those incinerators. Numerous factors have been associated with dioxin and furan formation, including the presence of particulate carbon, metal catalysis, combustion efficiency, temperature, and presence of precursors. The only consensus at this point seems to be that good combustion efficiencies and low post-combustion temperatures reduce the secondary dioxin formation.

Note: In the proposed incinerator, dioxin and furan emissions can be controlled through good combustion practice and rapid cooling of the combustion gas to air-pollution control system temperatures (generally ranging from 285°F to 300°F). Rapid combustion-gas cooling is inherent in many wet-scrubbing system designs, except for units equipped with waste-heat boilers. Dioxins and furans, as well as mercury, are also removed by injection of powdered activated carbon in a number of municipal-waste incinerators and a few hazardous-waste incinerators.

2.11 Fugitive emissions

The most common fugitive emissions are (from liquid wastes) vapors from tank vents, pump seals, and valves; and (from solid wastes) dust from solid-material handling, together with possible fugitives from particulate APCDs. The magnitude of those emissions and their control mechanisms are similar to those in other process industries that handle hazardous materials and are therefore regulated under RCRA subpart BB. However, the high-temperature seals on rotary-kiln incinerator are a potential source of vapor and dust emissions peculiar to such incineration facilities; these emissions are controlled by maintaining a negative pressure in the kiln.

Fugitive emissions, consisting of vapors or particles from waste tipping, waste feeding, incineration, and ash handling are mitigated by designing buildings to be under negative pressure. Air is drawn from the waste-handling areas into the combustion chamber, where it is mixed with the combustion gases. Potential fugitive emissions collected in this manner and drawn through the combustion chamber and emission-control devices leave the plant with odors virtually destroyed and dust removed by the particle-control devices.

Fugitive dusts can also be created in the bottom-ash pits and the fly-ash hoppers. Enclosed ash-handling areas are part of incinerator designs. In the proposed incinerator system, emissions created in the ash-handling areas (bottom ash and fly ash) will be drawn through the emission control devices so that workers are not unnecessarily exposed to dust from the ash. Such dusts, particularly fly-ash dusts from particulate APCDs, may be enriched in toxic metals and contain condensed organic matter.

2.12 Ash and other residues

Types of Ash and Other Residues

Residues that will be generated by the proposed incinerator include bottom ash, fly ash, scrubber water, and various miscellaneous waste streams. Bottom ash is the remains of the solid waste that is not burned on the grate during the combustion process and consists of unburned organic material (char), large pieces of metal, glass, ceramics, and inorganic fine particles. Bottom ash is collected in a quench pit beneath the burnout section of the grate.

Fly ash is the solid and condensable vapor-phase matter that leaves the furnace chamber suspended in combustion gases and is later collected in APCDs. The APCDs in use capture a high percentage of the contaminants in the flue-gas stream. Fly ash is a mixture of fine particles with volatile metals and metal compounds, organic chemicals, and acids condensed onto particle surfaces. It can also contain residues from reagents, such as lime and activated carbon, themselves with condensed or absorbed contaminants. Fly ash is collected in hoppers beneath the APCDs. Scrubber water is a slurry that results from the operation of wet scrubbers and contains salts, excess caustic or lime, and contaminants (particles and condensed organic vapors) scrubbed from the flue gas.

In addition, there are various other waste streams that may be generated by the incinerator. The initial sorting of municipal-solid waste produces a stream of large items unsuitable for burning (such as whole refrigerators, gas stoves, and auto batteries).

In 1995, the International Ash Working Group reviewed the available scientific data and developed a treatise on municipal solid-waste incinerator-residue characterization, disposal, treatment, and use (IAWG 1995). It found that the different temperature regimes in a municipal solid-waste incineration facility impart different characteristics to the residues collected from the various operational steps in a facility. Its report concluded that the development of management strategies for incinerator residues requires knowledge of the intrinsic properties of the material, including the physical, chemical, and leaching properties.

Cement kilns burning hazardous waste are in a class by themselves. All cement kilns are major sources of particulate emissions and are regulated. Kiln-exhaust gases contain large amounts of entrained particulate matter known as cement-kiln dust, a large fraction of which is collected in APCDs. The kiln dust so collected is generally recycled to the kiln feed.

Ash Handling

Two concerns of on-site ash management at incineration facility are the safety of workers and the possibility that fugitive ash will escape into the environment during handling or removal of the ash for disposal. Both concerns require that the ash be contained at all times both inside and outside the facility, as described above. In the facility, water will be used to quench the ash, simultaneously reducing dust generation and minimizing the possibility of ash-dust inhalation or ingestion by workers. In modern systems, a closed system of conveyors to transport the ash from the furnace to trucks helps to minimize worker exposure. Although some facilities have partially closed ash-removal systems, few have completely enclosed ash-handling systems throughout the plant.

Ash and Scrubber-Waste Disposal

Fly ash from the waste incineration is characteristically more likely than bottom ash to exhibit the toxicity characteristic as defined by the RCRA leaching test as a result of high concentrations of lead or cadmium. It is important for ash to be tested to determine whether it is hazardous. If it is hazardous according, it must be disposed of as hazardous waste.

All residues generated by hazardous-waste incineration, except waste burned for metal recovery, are considered hazardous waste. That stems from the “derived-from” rule, which states that residues generated by the treatment of hazardous waste remain hazardous until delisted. Ash from hazardous-waste combustion must be handled and disposed in a secure hazardous-waste landfill that is designed to ensure that there will be no groundwater pollution.

The proposed management method for ash that will be generated by incineration is landfill disposal, either commingled with municipal solid waste or alone in an ash monofill, although some ash may used in production on construction materials, roadbeds, or experimental reefs upon testing. Dry and spray-dry scrubber waste is incorporated in the fly ash, because the APCD is where the injected material is collected. Wet-scrubber wastewater should be discharged to on-site wastewater-treatment systems.

2.13 Proposed best practices for reducing Incineration emissions for the proposed project

The EIA Experts proposes the proponent;

- Screen incoming wastes at the plant to reduce incineration of wastes (such as batteries) that are noncombustable and are likely to produce pollutants when burned.
- Maintain a continuous, consistent thermal input rate to the incinerator to the extent possible. In municipal solid-waste facilities, optimize mixing of waste in pit or on tipping floor (to homogenize moisture and BTU content).
- Optimize furnace operation, including temperature, oxygen concentration, and carbon monoxide concentration. In municipal solid-waste incinerator, this can be done by optimizing grate speeds; underfire and overfire air-injection rates, locations, and directions; and operating auxiliary burners.
- Survey furnace emission-control devices and related equipment regularly to ensure that they continue to be operative and properly sealed and insulated.
- Select correct type of nitrogen-reducing reagent (either ammonia or urea) and optimize the injection rate and location, if add-on of NOx control is required.
- In dry air pollution control systems, optimize flue-gas temperature in control devices (to minimize dioxin formation and to maximize condensation and capture of pollutants while avoiding gas dewpoint problems.
- Select correct alkaline reagent (e.g., lime slurry, dry lime, Na_2CO_3 or $NaHCO_3$) to maximize absorptive capacity and optimize injection rate and location.
- Optimize type of sorbent (such as carbon) used (to maximize adsorptive capacity) and optimize injection rate and location for removal of mercury and dioxins and furans.
- Optimize voltage and other electric conditions of an ESP (to maximize capture of particles).
- Optimize baghouse pressure drop, bag-break detection, wet-scrubber pressure drop, pH, and liquid-to-gas ratio.
- Maintain a maximum gas flow-rate limit to ensure adequate residence time in the combustion chamber and proper operation of the air pollution control equipment.
- Implement a training and certification program for plant operators.
- Inspect and calibrate continuous emission monitors and other process instrumentation.
- Adequate operator training and certification is needed with monitoring of performance conditions to ensure that emission targets are met.

2.14 Project Location Suitability

Following the current conditions of the site environment illustrated above on the site, the proposed site is the only location found suitable. This conclusion has been arrived at due to the following considered reasons;

- The land is legally owned by the proponent as shown by the land ownership documents. This makes the development more feasible to the proponent,
- There are no significant settlements around the site, and hence it will be possible to present a case of appropriate zoning in future to the Local Government Authorities to ensure minimal social impacts.
- There are no significant delicate ecosystems around the site (no surface water It is, therefore, likely to have minimal environmental impacts,
- The proponent is ready to abide by the law for a long term suitability of the site.

2.15 Project Cost

The proposed project is estimated to cost a total of Ten million Kenya Shillings (KSh.10,000,000).

SECTION THREE: POLICY, LEGAL ADMINISTRATIVE FRAMEWORK

3.1 Introduction

This section explores a general overview of legal and regulation guidelines that are relevant to the proposed incineration plant both at the global and national scale. This has been done to ensure that adequate measures are taken by the proponent to abide by the existing laws, policies and regulations, and international best practices for waste handling. Legislation, laws, policies and regulations specific to environmental management can directly or indirectly affect the development of proposed project. A brief discussion on the various legal frameworks involved for this project is presented in subsequent sections. Tranbiz Enterprises Ltd will strive to ensure that all required environmental procedures described in this section will be complied with, in order to demonstrate their commitment and responsibility to protecting the environment. Environmental regulations and standards in Kenya are determined and enforced through various levels of statutes the majority of which are sector specific. The Environment Management Act - 2015 is the governing law for the Protection and Development of the Environment in the Kenya, and is considered the base for various environmental regulations and guidelines. The following ***International standards*** have also been considered

i. **WHO Policy and Guidelines (www.who.org)** www.searo.who.int/LinkFiles/Publications_and_Documents_prevention_guidelines.pdf (p.70) www.searo.who.int/en/Section23/Section1108/Section1835/Section1864_8658.htm

ii. **ii. International Organization for Standardization (ISO) (www.iso.org)**

iii. **Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal**. Basel Convention Secretariat (www.basel.int). Medical Waste is considered a hazardous waste under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. The Basel Convention imposes use of a prior informed consent procedure for movement of such wastes across international borders. Shipments made without consent are illegal. Parties have to ensure that hazardous waste is disposed of in an environmentally sound manner (ESM. Strong controls have to be applied from the moment of generation, to its storage, transport, treatment, reuse, recycling, recovery and final disposal

iv. **World Bank, Operations Policy** The purpose of World Bank Good Practice Note is to increase the awareness of the health risks related to occupational exposure, provide a list of resources on international good practices available to minimize these risks, and present an overview of some of the available product alternatives on the market.

According to Sections 58 and 138 of the Environmental management and Coordination Act (EMCA) CAP 370 and Section 3 of the Environmental (Impact Assessment and Audit) Regulations 2003 (Legal No. 101), residential developments require an Environmental Impact Assessment project/study report prepared and submitted to the National Environment Management Authority (NEMA) for review and eventual Licensing before the development commences. This was necessary because many forms of developmental activities cause damage to the environment and hence the greatest challenge today is to maintain sustainable development without interfering with the environment. Other supporting legislations are discussed hereunder.

3.2 Kenya's Legislations Relevant to the proposed Project

3.2.1The Constitution of Kenya (CoK) 2010

The Constitution of Kenya 2010 recognizes the environment as part of the country's Heritage; it thus provides for the right to a clean and healthy environment for every citizen. Articles 42 and 69 obligate the state to enact legislations to protect the environment. *The proponent (Tranbiz Enterprises Ltd.) will operate within the confines of the law as far is the proposed project is concerned.*

3.2.2 Environmental Management and Coordination Act 2015

The requirement of an EIA license is prescribed in Section 58 of EMCA. It provides that any person, being a proponent of a project, shall before financing, commencing, proceeding with, carrying out, executing or conducting any undertaking specified in the Second Schedule of the Act, submit a report to the Authority in the prescribed form. Tranbiz Enterprises Ltd is undertaking a comprehensive ESIA study at his own expense as required by EMCA 2015 (Amendment Act) since the proposed structure is an *activity out of character with its surrounding, with a structure of a scale not in keeping with its surrounding. Reference: Section 1 of the Second Schedule sets out projects which require EIA.*

The impact of a proposed incinerator on the environment is critical and the regulatory body charged with approving the environmental aspects of projects and issuing the relevant environmental licenses is the National Environment Management Authority (NEMA). The requirements of EMCA with respect to development projects reflect a worldwide appreciation of the adverse effects of unbridled development that now find a Constitutional anchor in the right to a clean and healthy environment and public participation as well as the obligations of the Courts under Article 70 of the Constitution. These concerns are aptly captured by the phrases sustainable development and the pre-cautionary principle. The relevant matters that Tranbiz Enterprises Ltd has taken into account in screening the project for the necessity of an EIA include but are not limited to:-

i. The characteristics of the intended development;
ii. The location of the intended development and characteristics of potential impact;
iii. The size of the development as well as comparison with other neighboring developments;
iv. The probability of any environmental impact; and
v. The duration and reversibility of such

3.2.3 Environmental (Impact Assessment and Audit) Regulations 2003, amended 2019, Legal notice No. 31 and 32 of 2019.

These Regulations stipulate how an EIA will be undertaken and what the EIA study report should contain. It also provides regulations on Environmental Audits (EA), which the proponent will be required to undertake.

NB: It *is important to note that the proponent will fully comply with section 17 part 1 of EMCA regulation which states that "During the process of conducting an environmental impact assessment study under these Regulations, the proponent shall in consultation with the Authority, seek the views of persons who may be affected by the project"*

3.2.4 The Waste Management Regulations-2006

The EMCA Waste Management Regulations, 2006 is the governing law for waste management in Kenya. This regulation is described in Legal Notice No. 121 of the Kenya Gazette Supplement No. 69 of September 2006. The objective of this Regulation is to protect human health and the environment. The regulations consist of eight parts and classify various types of waste and recommended appropriate disposal methods for each waste type. This also contains requirements for handling, storing, transporting and treatment of all waste categories as provided therein. The regulations also specified a series of responsibilities for the waste generator. As Kenya develop towards achieving Vision 2030 its imperative that all forms of development and waste associated with it is managed in a responsible manner. All Any waste (other than the hazardous waste) at all phases of the project shall be separated at source and disposed off in accordance with this act. Waste production shall be minimized as much as possible.

3.2.5 The Water Quality Regulations -2006

The EMCA Water Quality Regulation – 2006 is concerned with the protection of water quality and applies to drinking water, industrial water, effluent discharge, water used for agricultural, recreational, fisheries, wildlife and other purposes. This Act is divided into 6 Parts as follows:

- Quality standards for sources of domestic water;
- Monitoring for sources of domestic water;
- Standards for effluent discharge into the environment;
- Monitoring guide for discharge into the environment;
- Standards for effluent discharge into public sewers and,
- Monitoring for discharge of treated effluent into the environment.

The proponent shall undertake regular monitoring of Wastewater(if any) from the proposed project and undertake regular recording of water use to help understand the variations that may result from misuse to prompt necessary corrective action.

3.2.6 The Factories and Other Places of Work (Hazardous Substances) Rules, 2007

This Regulation control the export, import, usage, and management of controlled substances (Ozone depleting substances). The EMCA *Controlled Substances Regulation* – 2007 also provides guidelines for packaging, labelling, Storage, distribution, transportation or handling and disposal of these substances. Medical waste has been listed as a hazardous substance and its threshold limit values given, therefore these rules apply to all workplaces where medical waste is present.

3.2.7 The Physical Planning Act – 1999 (Chapter 286) revised 2012

The *Physical Planning Act Chapter 286* is the main Act that governs land planning. The respective County Authority (Kiambu County Government) must approve development and issue a certificate of compliance. Section 29 of this Act gives the powers to County Authorities to reserve and maintain all land planned for open spaces, parks, urban forests and green belts.

3.2.8 The Water Act 2016

The *Water Act, 2016* provides guidelines on use and management of the of the water resources and prohibits the water pollution. As per Part II, section 3 of this act states *"every water resource is hereby vested in the state, subject to any rights of user granted by or under the Act or any other law"*. The act also species that a permit is required from The Water Resource Authority in case of supply to over twenty (20) users.

3.2.9 EMCA (Air Quality) Regulations, 2014

The objective of these Regulations is to provide for prevention, control and abatement of air pollution to ensure clean and healthy ambient air. The overall objective is to protect human health and to allow for safety. The regulations under section 31 require an owner or occupier of a controlled facility shall- (a) inform the workers of the hazards in specific work environments; (b) train the workers on the potential hazards of any hazardous substance to which they are exposed and the safety precautions to be taken to prevent any harm to their health; (e) Take exposure reduction measures recommended under Part IX of the Fifth Schedule of these regulations The regulations prohibit, any person from causing the emission of air pollutants (such as liquid and gaseous substances) and suspended particulate matter listed under Second Schedule (Priority air pollutants) to exceed the ambient air quality levels as stipulated under the Second Schedule (Ambient air quality tolerance limits) and Seventh Schedule (Emission limits for controlled and non-controlled facilities).

3.2.10 The Occupational Safety and Health Act, 2007 (No. 15 of 2007)

The Act applies to all workplaces where any person is at work, whether temporarily or permanently. The objective of this Act is to secure the safety, health and welfare of persons at work; and protect persons other than persons at work against risks to safety and health arising. Under Section 16 of this Act, it is mentioned that *no person shall engage in any improper activity or behavior at the workplace, which might create or constitute a hazard to that person or any other person.* This Act repealed the Factories and Other Places of Work Act and provides general duties of occupiers of work places. The Act provides for safe use of plant, machinery and equipment and states that all plant, machinery and equipment whether fixed or mobile for use either at the workplace or as a workplace, shall only be used for work, which they are designed for and be operated by a competent person.

Though not explicitly provided, the act and the rules made there under have various sections on hazardous materials that apply to medical wastes. The OSHA stipulates that an employer shall not require or permit his employee to engage in the manual handling or transportation of a load which by reason of its nature is likely to cause the employee to suffer bodily injury. It also states that any person supplying, distributing, conveying or holding in chemicals or other toxic substances shall ensure that they are packaged, conveyed, handled and distributed in a safe manner so as not to cause any ill effect to any person or the immediate environment.

3.2.11 Public Health Act Cap 232

The *Public Health Act Cap 232* makes provisions for securing and maintaining health. It consists of directives that affect human health. Under Part IX section 115 of this Act, it is stated that no person or institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Any noxious matter or wastewater flowing or discharged into a watercourse is deemed as a nuisance. The Public Health Act Cap 247, Section 3 gives provisions for use of poisonous substances. It refers to regulations for protection of persons against risk of poisoning, imposing restrictions or conditions on the importation, sale, disposal, storage, transportation or use of poisonous substances. This Act also requires persons concerned with importation, sale, disposal storage, transportation or use of poisonous substances to be registered and licensed and provides measures for detecting and investigating cases in which poisoning has occurred.

3.2.12. The County Government Act 2012

Under this Act, Kiambu County assumes a number of roles in its area of jurisdiction, which includes the Juja area. Devolution to county governments has impacted all kinds of developments in an area. The administrative changes have impacted operational plans and costs.

Section 160 (a) of The County Government Act, Chapter 265 empowers every County Government to establish and maintain sanitary services for the removal and destruction of, or otherwise dealing with, all kinds of refuse and effluent and, where any such service is established, to compel the use of such service by persons to whom the service is available.

Section 201(1) – (4) expands the jurisdiction of local authority to make by-laws in respect of all such matters as are necessary or desirable for the maintenance of the health, safety and well-being of the inhabitants of its area or any part thereof and for the good rule and government of such area or any part thereof and for the prevention and suppression of nuisances. The by-laws so made may control, regulate, prevent, prohibit or compel certain activities to be undertaken and prescribe offences in case of contraventions.

SECTION FOUR: BASELINE INFORMATION OF THE STUDY AREA

4.1The Host Environment

The proposed incinerator is located in Nyacaba on LR. No. JUJA/JUJA EAST BLOCK 1/2748 in Juja Sub-County, Kiambu County **(Latitude: 1° 7'4.98"S- Longitude: 37° 4'31.30"E)** at an elevation of 1102M above the sea level. The proposed landfill is an abandoned quarry.

Appendix 1: *The lease agreement for the project site.*

Plate 4: View of the site which is an abandoned quarry

Administratively, Nyacaba is located in Juja Sub-county of Kiambu County on coordinates Latitude: Kiambu County is located in central Kenya, it borders Murang'a County to the North and North East, Machakos County to the East, Nairobi and Kajiado counties to the South, Nakuru County to the West, and Nyandarua County to the North West. The main economic activity in the county is agriculture- tea, coffee, dairy, poultry and horticulture. Kiambu's major urban centers are Thika, Ruiru, Gatundu, Limuru, Kabete, Githunguri, Kiambaa, Kikuyu, Kiambu, Lari and Karuri. It is a predominantly rural county, but its population is getting rapidly urbanized relative to Nairobi city's growth. The Agikuyu community is the dominant ethnic tribe in the area, but in light of its growing urban migrant population, it is slowly beginning to take the face of a cosmopolitan town. Sub-counties in Kiambu includes; Thika, Ruiru, Juja, Kiambu, Kiambaa, Githunguri, Limuru, Lari, Kikuyu, Kabete, Gatundu South and Gatundu North.

NOTE: *The main economic activity is Nyacaba is quarrying for building in construction industry. This demand for stones in turn supports the fact that there is an enormous reliance on stone aggregates making the quarrying industry a major player in the provision of essential building materials and providing employment opportunities. However, quarries are undeniably of economic significance. However, they are also a source of so many problems, both when still active and after being abandoned. More significantly, they result to the degradation of land, drainage problems and visual intrusion because many are not rehabilitated after use. Ndarugu area is notorious for such quarries that exist in total disregard for people's safety and the environment. For many years, these stone harvesters have led to adverse negative environmental effects either during the mining process* *or long after the mines have been closed. They leave the open pits uncovered after the stones are exhausted, not even protecting them with a barbed wire fence.*

4.2 Topography and Drainage

Kiambu County is divided into four broad topographical zones viz, Upper Highland, Lower Highland, Upper Midland and Lower Midland Zone. The Upper Highland Zone is found in Lari Constituency and it is an extension of the Aberdare ranges that lies at an altitude of 1,800-2,550 metres above sea level. It is dominated by highly dissected ranges and it is very wet, steep and important as a water catchment area. The lower highland zone is mostly found in Limuru and some parts of Gatundu North, Gatundu South, Githunguri and Kabete constituencies. The area is characterized by hills, plateaus, and high-elevation plains. The area lies between 1,500-1,800 metres above sea level and is generally a tea and dairy zone though some activities like maize, horticultural crops and sheep farming are also practiced. There are also large plantations of pineapples owned by Del Monte in parts of Thika Sub County.

4.3 Climatic Conditions

The county experiences bi-modal type of rainfall. The long rains fall between Mid-March to May followed by a cold season usually with drizzles and frost during June to August and the short rains between Mid-October to November. The annual rainfall varies with altitude, with higher areas receiving as high as 2,000 mm and lower areas of Thika Town constituency receiving as low as 600 mm. The average rainfall received by the county is 1,200 mm. The mean temperature in the county is 26o C with temperatures ranging from 7oC in the upper highlands areas of Limuru and some parts of Gatundu North, Gatundu South, Githunguri and Kabete constituencies, to 34^{0}C in the lower midland zone found partly in Thika Town constituency (Gatuanyaga), Kikuyu, Limuru and Kabete constituencies (Ndeiya and Karai). July and August are the months during which the lowest temperatures are experienced, whereas January to March are the hottest months. The county‘s average relative humidity ranges from 54 percent in the dry months and 300 percent in the wet months of March up to August.

4.5 Land Use

The current land use around the proposed site is an idle abandoned quarry site. The project area is under the jurisdiction of Kiambu County Government and the land use classification of Juja in mixed development with both commercial and residential establishments, however, a number of ongoing quarrying sites neighbors the proposed Incinerator site.

4.6 The Fauna and Flora

The site as currently is has no flora or fauna. However, the surrounding has indigenous shrubs like *Lantana drip, Lantana camara, Solanum inca, Sesbania quad, Cordia oval* amongst others, grasses. A number of animals like hyena, leopards, and monkeys are also speculated to be in the area though none was observed during the site visits. Rodents and insects were observed in the area.

SECTION FIVE: PUBLIC CONSULTATION AND PARTICIPATION

5.1. Introduction

Consultative Public participation (CPP) process is a policy requirement by the Government of Kenya and a mandatory procedure as stipulated in EMCA CAP 387 section 58, on Environmental and social Impact Assessment for the purpose of achieving the fundamental principles of sustainable development. CPP basically entails engaging members of the public to express their views about a certain project. Public participation tries to ensure that due consideration will be given to public values, concerns and preferences when decisions are made. If well conducted CPP is beneficial in various ways:

- Obtains local and traditional knowledge that may be useful for decision-making;
- Facilitates consideration of alternatives, mitigation measures and tradeoffs;
- Ensure that important impacts are not overlooked and benefits are maximized;
- Reduce conflict through the early identification of contentious issues;
- Provide opportunity for the public to influence project design in a positive manner;
- improve transparency and accountability of decision-making; and
- Increase public confidence in the EIA process.

This chapter describes the process of public consultation and public participation followed to identify the key issues and impacts of the proposed project. The specific objective of the consultation and public participation were to:

- Inform the stakeholders about the project with Special reference to its key components and location.
- Incorporate the information collected in the ESIA report
- Explain to the neighbors the nature of the proposed project, its objectives and scope;
- Gather comments, suggestions and concerns of the interested and affected parties about the project.
- Give neighbors an opportunity to present their views, concerns and issues regarding the Proposed incinerator Development
- Obtain suggestion from neighbors on possible ways that they fill potential negative impacts can be effectively mitigated.

5.2 Methodology used in Public Consultation

The exercise was conducted by a team of experienced registered environmental experts. Stakeholders' participation forms were distributed to the project neighbors as key stakeholders. Consultation meetings were held in order to gauge the attitudes of the local community towards the proposed incinerator. Two separate consultative meetings were held including a courtesy call to Assistant Chiefs office. Detailed outcomes of each meeting are discussed in the next clauses.

1st stakeholders meeting

This meeting was held on 12th June at the project site. The meeting brought together participants from Nyacaba Village.

5.3 Issues raised

The stakeholders consulted gave both positive and negative views. They also suggested the mitigation measures that the proponent and other relevant authorities could do to address such concerns.

5.3.1 Positive Issues

- The project contribute to improved health and at the same time promote economic growth to the company as well as the county and national governments through revenue and job creation.
- The project is a waste management facility hence will promote environmental conservation.
- The project will spur other similar projects which may come up in the County.
- The project will encourage other investors to consider investing in Kiambu County.

5.3.2 Negative Issues

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

- Air pollution may occur during the operation phase.
- Increased demand for available social amenities and other services
- Noise pollution during installation and operation
- Waste generation by the project.
- Occupation safety and health concerns during operation Phase

5.3.3 Suggestions by respondents

- The Proponent should ensure proper environmental management practices are put in place.
- The incinerator installed should be installed properly to ensure minimal or no particulate matteris released to theatmosphere.
- The proponent should consider employing casual workers from the local areas during construction and operation phase of the project to promote the host community.
- Noise pollution should be controlled during installation and operation phases.

Note: The responses of the key stakeholders interviewed are annexed in Appendix 4

Plates showing experts engagement with the neighbors.

SECTION SIX: ANTICIPATED IMPACTS AND MITIGATION MEASURES

6.1 Introduction

The determination of 'significance' incorporates judgments of the above together with the potential magnitude of the impact. In addition, the frequency of impacts upon the receiving environment is a factor in determining the significance. An impact that is moderate in size but continuous can be more significant than one that is infrequent or rare.

Project impacts can also be considered direct or indirect:

- Direct: Effects directly attributable to the incineration activities or actions; and
- Indirect: Effects not directly attributable to the plant activities or actions.

The determination of significance is therefore dependent upon decisions of the following factors:

ESIA significance factors that will be considered

Significance Factors	**Description**
Extent/Magnitude	Potential impact should be quantified with range limits wherever possible and relevant modeling may be undertaken in order to predict impacts for appropriate factors.
Reversibility	A reversible impact is one in which the condition which the impact effects can be returned to the baseline condition prior to the impact.
Duration	The length of time of an impact may be short, medium or long term. Typically, this is defined as <5 years, 5-15 years and >15 years respectively.
Standards	Complying with the national and international standards, which may exist for a particular impact, also helps define the potential significance of an issue. With regard to the proposed project, this would consist of both Kenyan and international guidelines.
Sensitivity of receptors	In many areas the sensitivity is further defined by consultation and baseline surveys, which help detail the existing environment.

6.2 Anticipated Impacts of the proposed project

The anticipated impacts emanating from a proposed project can either be positive or negative, direct or indirect, immediate or long term. Some impacts can work in synergy to cause a greater impact. Environmental impacts for the project are determined by breaking down the project into its activity components and examining the tasks in each component. Mitigation measure(s) for each identified impact are then prescribed and subsequently, an Environmental Management Plan (EMP) is formulated for the proposed project. The pollutants of concern including dioxins and furans, heavy metals (in particular, cadmium, mercury, and lead), acid gases, and particulate matter, either are formed during waste incineration or are present in the waste stream fed to the incineration facility.

Emissions of dioxins and furans result, in part, by the processes in the combustion chamber that lead to the escape of products of incomplete combustion (PICs) that react in the flue gas to form the dioxins. PICs are formed when combustion reactions are quenched or incompletely mixed. The combustion chamber for incineration must therefore be designed to provide complete mixing of the gases evolved from burning of wastes in the presence of air and to provide adequate residence time of the gases at high temperatures to ensure complete reactions. Bottom of Form The operation of the combustion chamber also affects the emission of pollutants, such as heavy metals, that are present in the waste feed stream. Such compounds are conserved during combustion and are partitioned among the bottom ash, fly ash, and gases in proportions that depend on the compounds' volatility and the combustion conditions. Mercury and its salts, for example, are volatile, so most of the mercury in the waste feed is vaporized in the combustion chamber. In the cases of lead and cadmium, the partitioning between the bottom ash and fly ash will depend on operating conditions. More of the metals appear in the fly ash as the combustion-chamber temperature is increased. In general, there is a need for the combustion conditions to maximize the destruction of PICs and to minimize the vaporization of heavy metals. It is also important to minimize the formation of NO_x (which is favored by high temperatures or the presence of nitrogen-containing fuels).

In addition to the composition of the waste feed stream and the design and operation of the combustion chamber, a major influence on the emissions from waste-incineration facilities is their air-pollution control devices. Particulate matter can be controlled with electrostatic precipitators, fabric filters, or wet inertial scrubbers. Hydrochloric acid (HCl) and sulfur dioxide (SO_2) can be controlled with wet scrubbers, spray dryer absorbers, or (to a lesser extent) dry-sorbent injection and downstream bag filters. NO_x can be controlled, in part, with combustion-process modification and with ammonia or urea injection through selective or nonselective catalytic reduction. Concentrations of dioxins and mercury can be reduced substantially by injecting activated carbon into the flue gas, or by passing the flue gas through a carbon sorbent bed, which adsorbs the trace gaseous constituents and mercury.

The application of improved combustor designs, operating practices, and air-pollution control equipment and changes in waste feed stream composition have resulted in a dramatic decrease in the emissions that used to characterize uncontrolled incineration facilities. Rates of emission of mercury have decreased, at least in part, as a consequence of changes in the waste feed streams resulting from the elimination of mercury in some waste stream components, such as alkaline batteries.

To maximize combustion efficiency, it is necessary to maintain the appropriate temperature, residence time, and turbulence in the incineration process. Optimal combustion conditions in a furnace ideally are maintained in such a manner that the gases rising from the grate mix thoroughly and continuously with injected air; the optimal temperature range is maintained by burning of auxiliary fuel in an auxiliary burner during startup, shutdown, and upsets; and the furnace is designed for adequate turbulence and residence time for the combustion gases at these conditions. The combustion efficiency of an incinerator

Potential Environmental Impacts of this (proposed) project and the mitigation measures of the negative impacts are tabulated below.

CONCERN	POTENTIAL NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
	SITE PREPARATION AND INSTALLATION PHASE	
Dust disturbances	▪ Eye irritation; ▪ Skin irritation; ▪ Impairment of normal sweating of the skin as it blocks pores on the skin; ▪ Chocking of the throat; ▪ Respiratory difficulties; ▪ Difficulty in breathing; ▪ Potential course of chest complication and ailment	▪ Employees involved in the construction work to be provided with dust masks; ▪ Project management and contractor to enforce strict use of personal protective clothing; ▪ Complains of dust related aliments among employees given access to medical attention.
Noise disturbances	▪ Reduced concentration of people ▪ Shouting during conversation among workers on site ▪ Noise induced hearing loss among workers who are continuously exposed to high noise levels ▪ reduction in productivity and efficiency of the workers at the workplace ▪ Stressing the worker and thus reduced concentration.	▪ All construction work to be limited to daytime only; ▪ All employees likely to be exposed to ear noise to be provide with ear protectors; ▪ Contractor to ensure strict enforcement on user of ear protectors; ▪ Where applicable and possible exceptionally noisy machines to be fitted with noise reduction devices; ▪ Any employee who may complain about ear related pain and or complication while at work to access medical attention at the expense of the contractor or project proponent; ▪ Where employees are likely to be exposed to continuous
Solid waste	▪ Cause visual pollution making such areas unsightly. ▪ Poorly managed and disposed cement bagging waste can attract dieses vectors	▪ Construction solid waste to be handled, managed and disposed according to the waste management regulations; ▪ Waste handling bins to be provided for workers onsite, each bin should have a lid which should always be covered;

			▪ Colour code to be used to distinguish waste bins of different waste; ▪ Solid waste to be disposed only at licensed disposal sites; ▪ In a case of cement bagging, they can be stored recycled or put into different usage.
Occupational injuries	▪ complete incapacitation of the affected employee ▪ loss of life ▪ Increase in Costs of litigation and compensation		▪ Appropriate personal protective equipment such as safety belts for workers working at height to be provided. ▪ Proper use of PPE provided. ▪ Appropriate training of workers of ways of working safely. ▪ Appropriate supervision at workplace. ▪ Rest times to be strictly observed to reduce stress. ▪ Noise and dust and other factors can result in reduced concentration to a level of causing and accident to be appropriately mitigated.
OPERATIONAL PHASE			
Local air quality degradation	▪ Air quality health hazards such mainly bronchial infections, skin problems, visibility, etc. for employees and public are likely effects from uncontrolled air pollution. ▪ Concentrations of dioxins in air water and	▪ CO_2, water vapor, and ash, which are respectively oxidation-reaction products of carbon, and hydrogen, and non-combustible materials in the fuel. ▪ Particulate Matter (entrained noncombustible matter in the flue gas, and the products of incomplete combustion existing in solid or aerosol form), inorganic ash present in the waste and carbonaceous soot formed in the combustion process.	▪ Installation of electrostatic precipitators, fabric filters, or wet inertial scrubbers for particulate matter control. ▪ Limiting the ash content of the waste feed via source control or selection. ▪ Optimize voltage and other electric conditions of an ESP (to maximize capture of particles) ▪ Designing and operating the primary combustion chamber to minimize fly-ash carryover. ▪ Choosing advanced combustion designs and emission-control technologies for the pollutant of concern

	soil in the food chain to levels dangerous to human health		▪ Having well-trained and certified employees that ensure that the combustor is operated to maximize combustion efficiency and that the emission control devices are operated to optimize conditions for pollutant capture or neutralization ▪ Installation of well-designed and well-operated fine-particle of Air pollution Control device (APCD) such as filtration collectors, including primary fabric filters (baghouses); electrostatic collectors, including dry and wet electrostatic precipitators (ESPs) and ionizing wet scrubbers; and wet inertial-impaction collectors, including venturi scrubbers and advanced designs that use flux-force condensation-enhancement techniques. ▪ Optimize furnace operation, including temperature, oxygen concentration, and carbon monoxide concentration by optimizing grate speeds; under-fire and over-fire air-injection rates, locations, and directions; and operating auxiliary burners. ▪ Maintain a maximum gas flow-rate limit to ensure adequate residence time in the combustion chamber and proper operation of the air pollution control equipment. ▪ Optimize baghouse pressure drop, bag-break detection, wet-scrubber pressure drop, pH, and liquid-to-gas ratio. ▪ Quarterly stack emission assessment of the incinerator
		▪ Acid Gases (flue-gas constituents that form acids when they combine with water vapor, condense, or dissolve in	▪ Installation acid gas scrubbers such as packed-bed absorber. The scrubbing liquid can be water or an alkaline solution,

		water. Acid gases include NO_x, SO_x, HCl, hydrogen bromide, hydrogen fluoride, and hydrogen iodide. HCl and SO_2 are often present in uncontrolled flue-gas streams in concentrations ranging from several hundred to several thousand parts-per-million-by-volume)	which reacts with the acid-gas constituents to form neutral salts. ▪ Furnace design and combustion process changes ▪ Optimize flue-gas temperature in control devices (to minimize dioxin formation and to maximize condensation and capture of pollutants while avoiding gas dewpoint problems. ▪ Installation of stack-gas monitors
		▪ NOx	▪ Combustion-furnace designs, combustion-process modifications, or add-on controls such as ammonia or urea injection through selective or nonselective catalytic reduction.
		▪ Hydrochloric acid (HCl) and sulfur dioxide (SO_2), hydrogen bromide, hydrogen fluoride, and hydrogen iodide	▪ Installation of wet scrubbers, spray dryer absorbers, or (to a lesser extent) dry-sorbent injection and downstream bag filters.
		▪ Mercury	▪ Injecting activated carbon into the flue gas, or by passing the flue gas through a carbon sorbent bed, which adsorbs the trace gaseous constituents and mercury.
		▪ Lead (Pb) emissions	▪ Limiting the Pb content of the waste feed via source control (**Highly recommended**) ▪ Designing and operating the combustion process to minimize Pb vaporization. ▪ Designing and operating the primary combustion chamber to minimize fly-ash carryover. ▪ Using well-designed and properly operated APCDs

		▪ Products of Incomplete Combustion (PICs); free-radicals (molecular species possessing an unpaired electron) in the combustion unit sometimes do not combine with oxygen or hydroxyl radicals and instead combine among themselves to form many organic compounds (e.g., methane, ethane, acetylene, and benzene), dioxins and furans, partially oxidized organic compounds (e.g., acids and aldehydes), and polycyclic aromatic hydrocarbons.	▪ The combustion chamber for incineration be designed to provide complete mixing of the gases evolved from burning of wastes in the presence of air and to provide adequate residence time of the gases ▪ Carbon removal through of finely divided activated carbon particles into the flue gas stream ahead of the particulate APCD. ▪ Systematic injection of granular or powdered activated carbon upstream in the incinerator to remove dioxins and furans.
Impacts of solid waste including bottom ash, fly ash, scrubber water, and various miscellaneous waste streams and other residues like such as lime and activated carbon, themselves with condensed or absorbed contaminants	▪ Potential impact on public health and safety		▪ Initial sorting of municipal-solid to remove stream of large items unsuitable for burning (such as whole refrigerators, gas stoves, and auto batteries ▪ Knowledge of the intrinsic properties of the material, including the physical, chemical, and leaching properties by the incinerator operator. ▪ Solid waste to be handled managed and disposed according to the Environmental Management and Coordination (Waste Management) Regulations 2006. ▪ Tranbiz Enterprise to contract a NEMA licensed waste collection company to be collecting all solid waste from the apartments; ▪ Solid waste to be collected daily from the apartments for disposal at NEMA licensed disposal sites only.

		▪ Only NEMA licensed vehicles to be used to collect and transport waste from the facility. ▪ Waste handling bins to be provided, each bin should have a lid which should always be covered; ▪ Colour code to be used to distinguish waste bins of different waste; ▪ Waste to be sorted at source; ▪ There should be no scattering of waste during transportation to and from disposal site;
Ash handling at the site	▪ Health risks including exposing the workers to a wide range of chemical poisoning, toxicity or long term health complications ▪ Safety of workers and the general public and the possibility that fugitive ash will escape into the environment during handling or removal of the ash for disposal	▪ The ash be contained at all times both inside and outside the facility. ▪ Use of water to quench the ash, simultaneously reducing dust generation and minimizing the possibility of ash-dust inhalation or ingestion by workers. ▪ Enclosed ash-handling systems throughout the incinerator
Ash disposal	▪ Soil quality degradation that may result from deposition of pollutants from the plant operations or carried to other areas through surface runoff, ▪ Pollution of water sources through direct deposition, surface runoff and/or infiltration into groundwater aquifers ▪ Health risks including exposing the workers to a wide range of chemical poisoning, toxicity or long term health complications ▪ Safety of workers and the general public and the possibility that fugitive ash will escape into the environment during handling or removal of the ash for disposal	▪ Fly ash residues are to be transported and disposed of only after it has been solidified in the incineration plant. ▪ Ash be handled and disposed in a secure hazardous-waste landfill that is designed to ensure that there will be no groundwater pollution. ▪ Regular testing of ash to determine its toxicity

Scrubber waste disposal	▪ Soil quality degradation that may result from deposition of pollutants from the plant operations or carried to other areas through surface runoff, ▪ Pollution of water sources through direct deposition, surface runoff and/or infiltration into groundwater aquifers ▪ Health risks including exposing the workers to a wide range of chemical poisoning, toxicity or long term health complications	▪ Wet-scrubber wastewater be discharged to on-site wastewater-treatment system
Operational inefficiency leading to GHG emissions	▪ Altered natural concentrations of gases leading or contributing to unnatural warming of the earth. ▪ Dilution of Climate change mitigation and adaptation effort	▪ Screening incoming wastes at the plant to reduce incineration of wastes (such as batteries) that are non-combustable and are likely to produce pollutants when burned. ▪ Certification procedure for incinerator control-room operators. ▪ Emissions be reduced by modifying operating characteristics such as furnace temperature, air-injection rate, flue-gas temperature, reagent type, and injection rate, and by selecting optimal combustor designs and emission-control technologies. ▪ Use and continued calibration and maintenance of continuous monitors of emissions and process characteristics provide real-time feedback and facilitate maintenance of optimal operating conditions at all times by incineration operators. ▪ Computerized continuous emission monitors (CEMs) for CO, O2, SOx, NOx, and HCl. ▪ Survey furnace emission-control devices and related equipment regularly to ensure that they continue to be operative and properly sealed and insulated.

		▪ Congregation from the heat exchange system
Occupational hazards or injuries to works, visitors and general public	▪ Complete incapacitation of the affected employee or persons ▪ loss of life ▪ Increase in Costs of litigation and compensation ▪ Disruption of the plant operational activities	▪ Plant operators and worker training in hazardous-material management and annual refresher courses. ▪ All workers should be provided with protective gear. These include working safety boots, overalls, helmets, goggles, earmuffs, respirators/masks and gloves. ▪ A first aid kit should be provided within the site. This should be fully equipped at all times and should be managed by qualified person. ▪ The proponent should have workmen's compensation cover (WIBA). It should comply with workmen's compensation ▪ Adequate sanitary facilities should be provided and standard cleanliness maintained. ▪ Safe operation procedures/ clear instruction provided to the workers and general public to ensure that safety is maintained. ▪ Workers operating within the high temperature zones should not exceed 2hrs continuous presence or/as may be directed by the Occupational Health and Safety Experts. ▪ Mounting of safety signage's within and outside the incinerator plant
Increased demand for water and electricity supply to the site;	✓ Increased demand and intermittent supply	▪ Approximate volumes of water to be required for use at the site be computed in order to put in place mechanisms of reliable supply; ▪ Water saving devices such as push taps to be installed to minimise lose through loose taps;

		▪ Treated waste water to be used in flashing toilets and irrigating of lawns. ▪ Rain water to be harvested from the roofs and stored. ▪ Energy saving bulbs to be used in lighting in all areas within the site and associated facilities. ▪ Solar Security lighting of the site and the surrounding and the lighting to be fitted with photocell sensors to avoid day lighting.
Storm water generation and flooding at the site from precipitation	▪ Possible transportation of bottom ash, fly ash, scrubber water, and various miscellaneous waste streams and other residues like such as lime and activated carbon, themselves with condensed or absorbed contaminants to unintended natural environment. ▪ Disruption of the plant operational activities leading to economic losses	▪ Rainwater from the constructed roofs within the site to be harvested and collected and stored in underground collected tanks for later use ▪ Appropriate site landscaping to be employed ▪ Vegetation cover of all open area to reduce surface run off ▪ Revegetation of all open areas to reduce surface run off
Increased vehicular traffic	▪ Possible traffic congestion of local road especially at Weitethie junction connecting to Nyacaba road. ▪ Possible of occasional experience of delays on the said local road; ▪ Pedestrians and cyclists using local roads will have to exercise more care with increase of vehicular traffic on the said roads; and ▪ There will be an increase of exhaust emission from vehicles delivering the combustible waste which will pollute local atmospheric air.	▪ All users of said roads to always observe traffic rules this will give pedestrians and cyclist their space and safety while using the road; ▪ Speed limits to be strictly observed ▪ Motorist to be sensitised to use unleaded fuel as opposed to leaded fuel
Social impacts	▪ Behavioural change such as alcoholism ▪ Emergence of new cultures ▪ STD and HIV AIDs	▪ Awareness creation on topical issues among residents such as STD and AIDS, drug and substance abuse

	▪ Drug and substance abuse	
Conflict with Nyacaba Community	▪ Stalled operation and losses to the proponent	▪ Continuous public participation and engagement for improving the environmental impact assessment and increasing total welfare of different interest groups in Nyacaba and beyond ▪ Pursuing economic achievements with regard to social, public health and environmental issues that of concern to the locals ▪ Independent Audits and strict supervision by NEMA, County Governments and other stakeholders
DECOMMISSIONING PHASE		
Noise	▪ Reduced concentration of people in the neighbourhood ▪ Shouting during conversation among workers on site ▪ Noise induced hearing loss among workers who are continuously exposed to high noise levels ▪ reduction in productivity and efficiency of the workers at the workplace ▪ stressing the worker and thus reduced concentration	▪ Demolition works and other decommissioning activities to be limited to day time. ▪ Appropriate ear protective devices to be provided to workers working in noisy environment. ▪ Engineering controls on plant and equipment used in decommissioning to reduce noise. ▪ Noise control and hearing conservation programme to be developed. ▪ Audiometric tests to be carried out to workers exposed to noise by designated medical practitioner. ▪ Post notices and signs in noisy areas. ▪ Education and training for workers on importance and proper use of PPE. ▪ Appropriate acoustic barriers around areas generating noise to be provided.

		▪ Noise attenuators such as trees on site to be preserved.
Dust	▪ skin irritation, chocking including coughing	▪ Appropriate personal protective equipment to be provided to all workers. ▪ Appropriate use of PPE provided to be enforced. ▪ The site to be secured with dust screens. ▪ Water sprinkling on dusty grounds to be done.
Occupational injuries	▪ Complete incapacitation of the affected employee ▪ loss of life ▪ Increase in Costs of litigation and compensation	▪ Appropriate personal protective equipments such as safety belts for workers working at height to be provided. ▪ Proper use of PPE provided. ▪ Appropriate training of workers of ways of working safely. ▪ Appropriate supervision at workplace. ▪ Rest times to be strictly observed to reduce stress. ▪ Noise and dust and other factors can result in reduced concentration to a level of causing and accident to be appropriately mitigated.

SECTION SEVEN: PROJECT ALTERNATIVES AND PROPOSED ACTION

7.1 Proposed site

After many considerations of numerous factors, this option was found to be the most suitable for the proposed development, in this particular case, the proponent determined this particular option since it would be the most appropriate for the installation of incinerator to handle hazardous waste from within Kiambu County and nearby Nairobi County so as to have wider service coverage. The option was best as compared to other options like co-location, open dumping or burning. Advantages of this option:

- Minimal disputes: Since the site would be solely operated by the proponent; there would be few or no disputes as in case with other options like co-location.
- The company can have more additional installation on the same site.
- The combustion capacity of the incinerator will be higher than in any other option.

Disadvantages

- Cost and Time frame: The process is slightly longer and costly since there are many phases involved from site acquisition, construction to operations.

7.2 Alternative designs or Technology

The selected design was the most efficient and cost effective. Alternative designs would not be economical and at the same time not fully functional. The selected Incinerator is a P300 TECHNIFAN INCINOVATE MACHINE having 2 main burners with a capacity of 21000 kcal / h each with electronic temperature control from 0 to 1,250ºC with a scrubber to be put up on this site. Advantage: Other design options lack scrubbers and ash pits and therefore would result in to pollution of air and soils.

7.3 Zero option

Under this alternative, there would be no incinerator project to be implemented on this site; this would mean that there would be no positive impacts to be achieved from the project and at the same time, no negative impacts to be noted.

Advantages:

- No possible emission of flu gases, fly ash, bottom ash, PIC etc from the facility.
- There would be no strain on the existing infrastructures and facilities.

Disadvantage:

- Loss of revenue to the proponent: The installation of an incineration plant is an expensive process. Particularly, the costs of constructing the infrastructure to the costs of operating the incineration plant is very high. Besides, an incineration plant requires trained personnel and devoted staff to man its operation. Incinerator plant also need regular maintenance, which adds to the already high costs of operating it.
- The existing poor disposal of hazardous waste will not improve in the area thus more health complications
- The land would remain un-utilized thus no economic value would be achieved.

7.4 Alternative option for hazardous waste Management

Under this alternative, adoption of incinerator was compared to landfill and the following is concluded

- Incinerator will be able to decrease the quantity of waste by 95% and reduce the solid quantity of the original waste by 80-85% depending on the components that were in solid waste. Hence, even though incinerator will not completely get rid of dumping ground, it definitely decrease the quantity of land needed. For Counties that are small in size and with a shortage of land like Kiambu, this is noteworthy since landfills take up big amounts of land required for other productive uses.
- Research has shown that solid waste incinerators are less likely to pollute the environment than landfills do. One particular study done during a 1994 lawsuit in the US showed that a waste incinerator location was more environment-friendly compared to a landfill. The research discovered that the landfill was releasing higher quantities of greenhouse gases, nitrogen oxides, dioxin, hydrocarbons, and non-methane organic compounds. Landfills also leach poisonous chemicals into the water below thus contaminating underground water systems.
- Incineration plant will function at very high temperatures that can destroy germs and chemicals that are harmful. Thus, it is a very effective method when it comes to eliminating clinical waste.
- Incineration plant is able to provide less bad smells because waste gets burnt, unlike landfills where waste is allowed to decay thereby emitting unpleasant smells, which cause air pollution. The production of methane in landfills may also lead to explosions that cause noise pollution, which is unheard-of when it comes to the use of incineration plants.
- In landfills, when the waste is decaying methane gas is generated which if not controlled, may explode causing further global warming. Unlike landfills, incineration plant will not produce methane, therefore making it safer.
- Another advantage of incinerator is it can function in any type of weather. For instance, during a rainy season, waste cannot be dumped in a landfill because the rain will possibly wash down poisonous chemicals into the ground and consequently create leachate thus contaminating the underground water as well as the neighboring land. Waste can also not be dumped when it is windy since it will get blown into the surroundings. On the other hand, the incinerator is not limited to weather changes since they burn waste without leakages. Incineration plant will also function 24 hours a day and are more efficient in managing waste compared to landfills.

SECTION 8: ENVIRONMENTAL AND SOCIAL MANAGEMENT MONITORING PLAN (ESMMP)

8.1 Introduction

An Environmental Management and Monitoring Plan (EMMP) outline is developed to ensure sustainability of the project, during operation through to decommissioning of some aspects. The plan provides a general outlay of the activities, associated impacts, mitigation action plans and appropriate monitoring indicators. Implementation timeframes and responsibilities are also defined. The primary responsibility for the integration of the mitigation measures for the proposed incinerator lies with the project proponent.

8.2 Environmental Inspection and monitoring

Inspections

Inspections typically are conducted to determine whether incinerator operations and related activities are being directed in compliance with applicable regulations, project commitments and specifications, disposal plans and/or permit conditions. For such a high risk project, a formalized environmental inspection program may be mandated by conditions attached to permits or governmental agencies.

Source of inspection requirements

Inspections are conducted to verify that a project is being constructed in compliance with applicable regulatory requirements and contract/subcontract specifications. Sources of environmental inspection requirements include project permits and other regulatory agency approvals, environmental regulations and other project plans.

All sources of environmental compliance requirements must be reviewed to identify inspection requirements that will be included in the EIA license. Examples of project activities that may require inspection include, but are not limited to:

- Transportation, Storage and handling of hazardous/waste
- Stack emissions standards
- Installation and maintenance of flood control structures within site
- Risk mitigation implementation

Documentation and record keeping

Environmental inspections will be documented and records retained in project files. Examples of documentation are telephone conversation logs, written correspondence, inspection logs and inspection reports. The inspector must develop an appropriate field inspection checklists, forms or other documentation. Checklists and forms generally will contain the following:

- Date and time
- Location
- Activity being inspected
- Inspector’s observations and relevant data
- Need, if any, for corrective action
- Name, title and signature of inspector

Monitoring requirements are often identified in project permits or approvals, or as a component of environmental mitigation and resource protection plans that a project is required to prepare and agencies must approve.

Sources of monitoring requirements and parameters

Monitoring requirements are typically specified in environmental analysis documents and project permits and approvals. Agency required resource protection plans or mitigation plans could also be a source of monitoring requirements. Monitoring of resources is often required where specific development plans or resource information was not available during the permitting process, and therefore, impacts to a resource could not be determined. All sources of environmental compliance requirements must be reviewed to identify any monitoring requirements and incorporated into the EIA license. Examples of parameters that will require monitoring activity include, but are not limited to:

- Air quality or air emissions
- Ash handling and disposal
- Biological resources
- Site flooding control structures

Management tools

Data management tools will be developed by Tranbiz enterprises Ltd to address project-specific monitoring and documentation requirements. The project's monitoring requirements, such management tools will include matrices or computerized databases, schedules and maps annotated with monitoring requirements and information.

Matrices and databases – Development of a matrix that identifies all agency-specified monitoring requirements will be helpful in planning, executing, documenting and reporting monitoring activities. Identification of monitoring requirements by resource, the nature of each requirement, special technical expertise required, waste incineration activity, monitoring location, and type of documentation will provide adequate record of compliance and any agency reporting requirements can be incorporated.

Regulatory reporting requirements

Tranbiz enterprises Ltd will undertake routine regulatory reporting to NEMA, Public Health, Kiambu County Government, Juja Community leaders etc. on the progress and monitoring parameters within specified timeframes and so that appropriate documentation and information can be collected to satisfy requirements.

8.3 Significance of an EMMP

EMMP for the proposed incinerator is to provide a logical framework within which identified negative environmental impacts can be mitigated and monitored. In addition, the EMMP assigns responsibilities of actions of various actors and provides a timeframe within which mitigation measures and monitoring can be done. The EMMP is a vital output of an Environmental Impact Assessment as it provides a checklist for project monitoring and evaluation for sound environmental planning at entire life of the project.

There will be a need to entrench within the working operations of the proposed project a sound EMMP that will ensure no significant environmental pollution occurs as a result of the proposed activity. To achieve this, the following will need to be done: -

- Tranbiz enterprises Ltd centre to develop and document Environmental Management Policies that will guide incinerator operation activities. The policies should address environmental conservation measures to be put in place, occupational and safety matters of all users;
- Availing of necessary finance for implementation of EMMP; and
- The Tranbiz enterprises Ltd and its contractors to ensure that they carry out their work within Environmental and Occupational, Health and Safety requirements.

8.4 Monitoring Plans

This EMMP covers the following key management (monitoring) plans which will need to be implemented and are covered in the EMMP.

The Management covers the following component: -

- Air quality management
- Solid Waste Management Plan;
- Risk Management Plan;
- Occupational Hazards Management Plan; which includes radiation levels monitoring
- Site flooding management plan

8.5 EMMP Implementation

This EMMP implementation will be overseen by Tranbiz enterprises Ltd. However other institutions like NEMA, may undertake their own environmental management actions.

8.5.1 NEMA

NEMA is the oversight institution over the environment in Kenya. Its role will be of monitoring compliance to the environmental indicators as identified in this EMMP. The role of NEMA will be:

- Oversight Monitoring As the lead agency responsible for the protection of environment in Kenya; NEMA will play the leading oversight role of monitoring the activities of the project according to the EMCA 2015 and the EIA/EA Regulations.
- Site Inspection visits; NEMA will undertake site visits to inspect and verify for themselves the nature and extent of the impacts and if the mitigation measures proposed in this EMMP are being complied with or vice versa.

8.5.2 Tranbiz enterprises Ltd as a licensed operator

Tranbiz enterprises Ltd will undertake monitoring of the activities to ensure internal compliance is achieved. The inspection and monitoring will be undertaken by the project management team under proponent and will occur during incineration process. The team will endeavour to ensure that all the mitigation measures highlighted in the EMMP are being followed. They will produce an internal compliance inspection report that will be shared with NEMA if required.

Summary of Environmental and Social Management Monitoring Plan.

CONCERN	POTENTIAL NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES	MONITORING ASPECT	RESPONSIBILITY	COST (KSHS)
SITE PREPARATION AND INSTALLATION PHASE					
Dust disturbances	▪ Eye irritation; ▪ Skin irritation; ▪ Impairment of normal sweating of the skin as it blocks pores on the skin; ▪ Chocking of the throat; ▪ Respiratory difficulties; ▪ Difficulty in breathing; ▪ Potential course of chest complication and ailment	▪ Employees involved in the construction work to be provided with dust masks; ▪ Project management and contractor to enforce strict use of personal protective clothing; ▪ Complains of dust related aliments among employees given access to medical attention.	▪ Complete PPE for ▪ Medical examination report ▪ Audiometric tests for noise impacts	▪ Proponent ▪ NEMA Inspectors ▪ DOSH	20,000 for PPE
Noise disturbances	▪ Reduced concentration of people ▪ Shouting during conversation among workers on site ▪ Noise induced hearing loss among workers who are continuously exposed to high noise levels ▪ reduction in productivity and efficiency of the workers at the workplace	▪ All construction work to be limited to daytime only; ▪ All employees likely to be exposed to ear noise to be provide with ear protectors;			20,000 for PPE and Audiometric tests

	▪ Stressing the worker and thus reduced concentration.	▪ Contractor to ensure strict enforcement on user of ear protectors; ▪ Where applicable and possible exceptionally noisy machines to be fitted with noise reduction devices; ▪ Any employee who may complain about ear related pain and or complication while at work to access medical attention at the expense of the contractor or project proponent; ▪ Where employees are likely to be exposed to continuous			
Solid waste	▪ Cause visual pollution making such areas unsightly. ▪ Poorly managed and disposed cement bagging waste can attract dieses vectors	▪ Construction solid waste to be handled, managed and disposed according to the waste management regulations; ▪ Waste handling bins to be provided for workers onsite, each bin should	▪ Records of collection and disposal ▪ Waste collection equipment such as bins	▪ Proponent ▪ NEMA ▪ Employees	▪ 50,000 Monthly for solid waste management

		have a lid which should always be covered; ▪ Colour code to be used to distinguish waste bins of different waste; ▪ Solid waste to be disposed only at licensed disposal sites; ▪ In a case of cement bagging, they can be stored recycled or put into different usage.			
Occupational injuries	▪ Complete incapacitation of the affected employee ▪ Loss of life ▪ Increase in Costs of litigation and compensation	▪ Appropriate personal protective equipment such as safety belts for workers working at height to be provided. ▪ Proper use of PPE provided. ▪ Appropriate training of workers of ways of working safely. ▪ Appropriate supervision at workplace. ▪ Rest times to be strictly observed to reduce stress. ▪ Noise and dust and other factors can result in reduced concentration to a level of causing and accident to be appropriately mitigated.	Safety methods and procedures instituted Incidents report Staff welfare programs like WIBA OSHA Audit reports Safety committee instituted	NEMA inspectors NEMA Inspectors DOSH	100,000 for staff occupation training 100,000 for OSHA Audits

OPERATIONAL PHASE						
Local air quality degradation	▪ Air quality health hazards such mainly bronchial infections, skin problems, visibility, etc. for employees and public are likely effects from uncontrolled air pollution. ▪ Concentrations of dioxins in air water and soil in the food chain to levels dangerous to human health	▪ CO_2, water vapor, and ash, which are respectively oxidation-reaction products of carbon, and hydrogen, and non-combustible materials in the fuel. ▪ Particulate Matter (entrained noncombustible matter in the flue gas, and the products of incomplete combustion existing in solid or aerosol form), inorganic ash present in the	▪ Installation of electrostatic precipitators, fabric filters, or wet inertial scrubbers for particulate matter control. ▪ Limiting the ash content of the waste feed via source control or selection. ▪ Optimize voltage and other electric conditions of an ESP (to maximize capture of particles) ▪ Designing and operating the primary combustion chamber to minimize fly-ash carryover. ▪ Choosing advanced combustion designs and emission-control technologies for the pollutant of concern ▪ Having well-trained and certified employees that ensure that the combustor	▪ Stack emission assessment reports ▪ Nyacaba community feedbacks ▪ Presence of pollution control devices. ▪ Direct observation of particulate matter.	NEMA inspectors NEMA Experts DOSH DOSH advisors Nyacaba Community Combustion Experts	1,000,000 for investment in proper air quality device 50,000 quarterly for stack emission report 250,000 for combustion design experts

		waste and carbonaceous soot formed in the combustion process.	is operated to maximize combustion efficiency and that the emission control devices are operated to optimize conditions for pollutant capture or neutralization ▪ Installation of well-designed and well-operated fine-particle of Air pollution Control device (APCD) such as filtration collectors, including primary fabric filters (baghouses); electrostatic collectors, including dry and wet electrostatic precipitators (ESPs) and ionizing wet scrubbers; and wet inertial-impaction collectors, including venturi scrubbers and advanced designs that use flux-force condensation-enhancement techniques.			

			▪ Optimize furnace operation, including temperature, oxygen concentration, and carbon monoxide concentration by optimizing grate speeds; under-fire and over-fire air-injection rates, locations, and directions; and operating auxiliary burners. ▪ Maintain a maximum gas flow-rate limit to ensure adequate residence time in the combustion chamber and proper operation of the air pollution control equipment. ▪ Optimize baghouse pressure drop, bag-break detection, wet-scrubber pressure drop, pH, and liquid-to-gas ratio.			

			▪ Quarterly stack emission assessment of the incinerator.			
		▪ Acid Gases (flue-gas constituents that form acids when they combine with water vapor, condense, or dissolve in water. Acid gases include NO_x, SO_x, HCl, hydrogen bromide, hydrogen fluoride, and hydrogen iodide. HCl and SO_2 are often present in uncontrolled flue-gas streams in concentrations ranging from	▪ Installation acid gas scrubbers such as packed-bed absorber. The scrubbing liquid can be water or an alkaline solution, which reacts with the acid-gas constituents to form neutral salts. ▪ Furnace design and combustion process changes ▪ Optimize flue-gas temperature in control devices (to minimize dioxin formation and to maximize condensation and capture of pollutants while avoiding gas dewpoint problems. ▪ Installation of stack-gas monitors	▪ Stack emission assessment reports ▪ Nyacaba community feedbacks ▪ Presence of pollution control devices	NEMA inspectors DOSH Nyacaba Community Combustion Experts	1,000,000 for investment in proper air quality device 50,000 quarterly for stack emission report 250,000 for combustion design experts

		several hundred to several thousand parts-per-million-by-volume)				
		▪ NOx	▪ Combustion-furnace designs, combustion-process modifications, or add-on controls such as ammonia or urea injection through selective or nonselective catalytic reduction.			
		▪ Hydrochloric acid (HCl) and sulfur dioxide (SO_2), hydrogen bromide, hydrogen fluoride, and hydrogen iodide	▪ Installation of wet scrubbers, spray dryer absorbers, or (to a lesser extent) dry-sorbent injection and downstream bag filters.			
		▪ Mercury	▪ Injecting activated carbon into the flue gas, or by passing the flue gas through a carbon sorbent bed, which adsorbs the trace gaseous			

			constituents and mercury.			
		▪ Lead (Pb) emissions	▪ Limiting the Pb content of the waste feed via source control (**Highly recommended**) ▪ Designing and operating the combustion process to minimize Pb vaporization. ▪ Designing and operating the primary combustion chamber to minimize fly-ash carryover. ▪ Using well-designed and properly operated APCDs			
		▪ Products of Incomplete Combustion (PICs); free-radicals (molecular species possessing an unpaired electron) in the	▪ The combustion chamber for incineration be designed to provide complete mixing of the gases evolved from burning of wastes in the presence of air and to provide adequate residence time of the gases			

		combustion unit sometimes do not combine with oxygen or hydroxyl radicals and instead combine among themselves to form many organic compounds (e.g., methane, ethane, acetylene, and benzene), dioxins and furans, partially oxidized organic compounds (e.g., acids and aldehydes), and polycyclic aromatic hydrocarbons.	▪ Carbon removal through of finely divided activated carbon particles into the flue gas stream ahead of the particulate APCD. ▪ Systematic injection of granular or powdered activated carbon upstream in the incinerator to remove dioxins and furans.			

Impacts of solid waste including bottom ash, fly ash, scrubber water, and various miscellaneous waste streams and other residues like such as lime and activated carbon, themselves with condensed or absorbed contaminants	▪ Potential impact on public health and safety	▪ Initial sorting of municipal-solid to remove stream of large items unsuitable for burning (such as whole refrigerators, gas stoves, and auto batteries. ▪ Knowledge of the intrinsic properties of the material, including the physical, chemical, and leaching properties by the incinerator operator. ▪ Hazardous Solid waste to be handled managed and disposed according to the Environmental Management and Coordination (Waste Management) Regulations 2006. ▪ Tranbiz Enterprise to contract a NEMA licensed waste collection company to be collecting all solid waste from the apartments;	▪ Solid waste tracking reports ▪ Nyacaba community feedbacks ▪ NEMA registration for waste handlers ▪ Presence of ash handling system	NEMA inspectors County Government of Kiambu Nyacaba Community The proponent	1,000,000 annually for sustainable waste management

		▪ Solid waste to be collected daily from the apartments for disposal at NEMA licensed disposal sites only. ▪ Only NEMA licensed vehicles to be used to collect and transport waste from the facility. ▪ Waste handling bins to be provided, each bin should have a lid which should always be covered; ▪ Colour code to be used to distinguish waste bins of different waste; ▪ Waste to be sorted at source; ▪ There should be no scattering of waste during transportation to and from disposal site;			
Ash handling at the site	▪ Health risks including exposing the workers to a wide range of chemical poisoning, toxicity or long term health complications	▪ The ash be contained at all times both inside and outside the facility. ▪ Use of water to quench the ash, simultaneously	▪ Ash waste tracking reports	NEMA inspectors County Government of Kiambu Nyacaba Community The proponent	1,000,000 annually for sustainable waste management

	▪ Safety of workers and the general public and the possibility that fugitive ash will escape into the environment during handling or removal of the ash for disposal	reducing dust generation and minimizing the possibility of ash-dust inhalation or ingestion by workers. ▪ Enclosed ash-handling systems throughout the incinerator	▪ Nyacaba community feedbacks ▪ NEMA registration for waste handlers ▪ Presence of ash handling system		
Ash disposal	▪ Soil quality degradation that may result from deposition of pollutants from the plant operations or carried to other areas through surface runoff, ▪ Pollution of water sources through direct deposition, surface runoff and/or infiltration into groundwater aquifers ▪ Health risks including exposing the workers to a wide range of chemical poisoning, toxicity or long term health complications ▪ Safety of workers and the general public and the possibility that fugitive ash will escape into the environment during handling or removal of the ash for disposal	▪ Fly ash residues are to be transported and disposed of only after it has been solidified in the incineration plant. ▪ Ash be handled and disposed in a secure hazardous-waste landfill that is designed to ensure that there will be no groundwater pollution. ▪ Regular testing of ash to determine its toxicity	▪ Ash waste tracking reports ▪ Nyacaba community feedbacks ▪ NEMA registration for waste handlers ▪ Presence of ash handling system	NEMA inspectors County Government of Kiambu Nyacaba Community The proponent	1,000,000 annually for sustainable ash
Scrubber waste disposal	▪ Soil quality degradation that may result from deposition of pollutants from the	▪ Wet-scrubber wastewater be discharged to on-site	▪ Scrubber waste tracking reports	NEMA inspectors County Government of Kiambu	2,000,000 annually for onsite waste-treatment system

	plant operations or carried to other areas through surface runoff, ▪ Pollution of water sources through direct deposition, surface runoff and/or infiltration into groundwater aquifers ▪ Health risks including exposing the workers to a wide range of chemical poisoning, toxicity or long term health complications	wastewater-treatment system	▪ Nyacaba community feedbacks ▪ NEMA registration for waste handlers ▪ Presence of an onsite waste water treatment system	Nyacaba Community The proponent	
Operational inefficiency leading to GHG emissions	▪ Altered natural concentrations of gases leading or contributing to unnatural warming of the earth. ▪ Dilution of Climate change mitigation and adaptation effort	▪ Screening incoming wastes at the plant to reduce incineration of wastes (such as batteries) that are non-combustible and are likely to produce pollutants when burned. ▪ Certification procedure for incinerator control-room operators. ▪ Emissions be reduced by modifying operating characteristics such as furnace temperature, air-injection rate, flue-gas temperature, reagent type, and injection rate,	▪ Certification certificates for incinerator operators ▪ Emission assessment reports ▪ Number of refresher courses for plant operators	NEMA inspectors County Government of Kiambu Nyacaba Community The proponent	1,000,000 annually for monitoring, technology upgrade and maintenance

		and by selecting optimal combustor designs and emission-control technologies. ▪ Use and continued calibration and maintenance of continuous monitors of emissions and process characteristics provide real-time feedback and facilitate maintenance of optimal operating conditions at all times by incineration operators. ▪ Computerized continuous emission monitors (CEMs) for CO, O2, SOx, NOx, and HCl. ▪ Survey furnace emission-control devices and related equipment regularly to ensure that they continue to be operative and properly sealed and insulated.			

		▪ Congregation from the heat exchange system			
Occupational hazards or injuries to works, visitors and general public	▪ Complete incapacitation of the affected employee or persons ▪ loss of life ▪ Increase in Costs of litigation and compensation ▪ Disruption of the plant operational activities	▪ Plant operators and worker training in hazardous-material management and annual refresher courses. ▪ All workers should be provided with protective gear. These include working safety boots, overalls, helmets, goggles, earmuffs, respirators/masks and gloves. ▪ A first aid kit should be provided within the site. This should be fully equipped at all times and should be managed by qualified person. ▪ The proponent should have workmen's compensation cover (WIBA). It should comply with workmen's compensation	▪ Complete PPE for ▪ Medical examination report ▪ Audiometric tests for noise impacts ▪ Signage mounted	▪ Proponent ▪ NEMA Inspectors ▪ DOSH	500,000 annually for PPE supply, medical examination for workers as well as signage. 150,000 annually for OSHA audits

		▪ Adequate sanitary facilities should be provided and standard cleanliness maintained. ▪ Safe operation procedures/ clear instruction provided to the workers and general public to ensure that safety is maintained. ▪ Workers operating within the high temperature zones should not exceed 2hrs continuous presence or/as may be directed by the Occupational Health and Safety Experts. ▪ Mounting of safety signage's within and outside the incinerator plant			
Increased demand for water and electricity supply to the site;	✓ Increased demand and intermittent supply	▪ Approximate volumes of water to be required for use at the site be computed in order to put in place mechanisms of reliable supply;	▪ Presence of water conservation infrastructure	NEMA inspectors County Government of Kiambu EPRA The proponent	200,000 annually for water and energy conservation

		▪ Water saving devices such as push taps to be installed to minimise lose through loose taps; ▪ Treated waste water to be used in flashing toilets and irrigating of lawns. ▪ Rain water to be harvested from the roofs and stored. ▪ Energy saving bulbs to be used in lighting in all areas within the site and associated facilities. ▪ Solar Security lighting of the site and the surrounding and the lighting to be fitted with photocell sensors to avoid day lighting.	▪ Number of solar modules installed		
Storm water generation and flooding at the site from precipitation	▪ Possible transportation of bottom ash, fly ash, scrubber water, and various miscellaneous waste streams and other residues like such as lime and activated carbon, themselves with condensed or absorbed contaminants to unintended natural environment.	▪ Rainwater from the constructed roofs within the site to be harvested and collected and stored in underground collected tanks for later use	▪ Number of rainwater harvesting and storm water management infrastructure	▪ Site Civil and landscape Engineers ▪ NEMA ▪ Proponent	▪ 300,000 annually

	▪ Disruption of the plant operational activities leading to economic losses	▪ Appropriate site landscaping to be employed ▪ Vegetation cover of all open area to reduce surface run off ▪ Revegetation of all open areas to reduce surface run off	equipment installed.		
Increased vehicular traffic	▪ Possible traffic congestion of local road especially at Weitethie junction connecting to Nyacaba road. ▪ Possible of occasional experience of delays on the said local road; ▪ Pedestrians and cyclists using local roads will have to exercise more care with increase of vehicular traffic on the said roads; and ▪ There will be an increase of exhaust emission from vehicles delivering the combustible waste which will pollute local atmospheric air.	▪ All users of said roads to always observe traffic rules this will give pedestrians and cyclist their space and safety while using the road; ▪ Speed limits to be strictly observed ▪ Motorist to be sensitised to use unleaded fuel as opposed to leaded fuel	▪ Drivers training report ▪ Records on type of fuel used	▪ NEMA ▪ Proponent	▪ 50,000 annually for drivers training
Social impacts	▪ Behavioural change such as alcoholism ▪ Emergence of new cultures ▪ STD and HIV AIDs ▪ Drug and substance abuse	▪ Awareness creation on topical issues among residents such as STD and AIDS, drug and substance abuse	Number of Sensitization meetings	▪ Proponent ▪ Nyacaba community ▪ Office of the Deputy County	▪ 50,000 for sensitization meetings

				Commissioner Juja	
Conflict with Nyacaba Community	▪ Stalled operation and losses to the proponent	▪ Continuous public participation and engagement for improving the environmental impact assessment and increasing total welfare of different interest groups in Nyacaba and beyond ▪ Pursuing economic achievements with regard to social, public health and environmental issues that of concern to the locals ▪ Independent Audits and strict supervision by NEMA, County Governments and other stakeholders	▪ Number of public participation held with Nyacaba community	▪ Proponent ▪ Nyacaba community ▪ Office of the Deputy County Commissioner Juja	▪ 40,000 per stakeholder meeting and engagement
DECOMMISSIONING PHASE					
Noise	▪ Reduced concentration of people in the neighbourhood	▪ Demolition works and other decommissioning	▪ Complete PPE for	▪ Proponent ▪ NEMA Inspectors	200,000 for PPE supply, medical examination for

	▪ Shouting during conversation among workers on site ▪ Noise induced hearing loss among workers who are continuously exposed to high noise levels ▪ reduction in productivity and efficiency of the workers at the workplace ▪ stressing the worker and thus reduced concentration	activities to be limited to day time. ▪ Appropriate ear protective devices to be provided to workers working in noisy environment. ▪ Engineering controls on plant and equipment used in decommissioning to reduce noise. ▪ Noise control and hearing conservation programme to be developed. ▪ Audiometric tests to be carried out to workers exposed to noise by designated medical practitioner. ▪ Post notices and signs in noisy areas. ▪ Education and training for workers on importance and proper use of PPE.	▪ Medical examination report ▪ Audiometric tests for noise impacts ▪ Signage mounted	▪ DOSH	workers as well as decommissioning report.

		▪ Appropriate acoustic barriers around areas generating noise to be provided. ▪ Noise attenuators such as trees on site to be preserved.			
Dust	▪ skin irritation, chocking including coughing	▪ Appropriate personal protective equipment to be provided to all workers. ▪ Appropriate use of PPE provided to be enforced. ▪ The site to be secured with dust screens. ▪ Water sprinkling on dusty grounds to be done.			
Occupational injuries	▪ Complete incapacitation of the affected employee ▪ loss of life ▪ Increase in Costs of litigation and compensation	▪ Appropriate personal protective equipments such as safety belts for workers working at height to be provided. ▪ Proper use of PPE provided. ▪ Appropriate training of workers of ways of working safely.			

		▪ Appropriate supervision at workplace. ▪ Rest times to be strictly observed to reduce stress. ▪ Noise and dust and other factors can result in reduced concentration to a level of causing and accident to be appropriately mitigated.			

SECTION NINE: CONCLUSION AND RECOMMENDATION

9.1 Conclusion

A participatory approach was employed to carry out the ESIA. This involved several desk studies and review of all relevant available documents on the project activities and components. The Experts also reviewed all the available and relevant legal and policy documents, standards and guidelines. A reconnaissance visit was conducted to check the physical set up of the site and to collect views from all stakeholders

Anticipated (potential) positive Impacts

i. Adaptive reuse of abandoned quarry: The locality has several open quarries that are abandoned. The issue is greatly accelerated by the fact that the quarries are abandoned after use and no elaborate rehabilitation plan is available. Active and abandoned mines and quarries have been a source of negative environmental effects which have led to erosion, formation of sinkholes, and contamination of soil, groundwater, and surface water, and also the loss of biodiversity. The proposed incinerator plant is properly suited for the site and will add value in the land. The abandoned quarry that had long outlived their original intentions are will repurposed into an economic activity that can be a model example for other abandoned quarries. The proposed incinerator is sited in an appropriate location in relation to land use classification and socio-economic setting.

ii. Decreased quantities of waste

The proposed Incinerator will be able to decrease the quantity of waste by 95% and reduce the solid quantity of the original waste by 80-85% depending on the components that will be in solid waste. Hence, even though incinerator do not completely get rid of dumping ground, they definitely decrease the quantity of land needed. For Counties like Kiambu with shortage of land this is noteworthy since landfills take up big amounts of land required for other productive uses.

iii. Reduced Pollution

Research has shown that solid waste incinerators are less likely to pollute the environment than landfills do. One particular study done during a 1994 lawsuit in the US showed that a waste incinerator location was more environment-friendly compared to a landfill. The research discovered that the landfill was releasing higher quantities of greenhouse gases, nitrogen oxides, dioxin, hydrocarbons, and non-methane organic compounds. Landfills also leach poisonous chemicals into the water below thus contaminating underground water systems. The proposed incinerator using proper scrubber technology will reduce air pollution in the atmosphere as well as contribute to Climate change mitigation.

iv. Trapping of pollutants that would have otherwise been released if open burning was adopted

The main problem concerning the incineration of solid waste is the release of hazardous compounds, particularly dioxin. Nonetheless, the proposed up to date incinerator plant will use filters to trap hazardous gases and particulate dioxin. The proposed incineration plant will operate within the required pollution limits recommended by the NEMA and international protocols.

v. Saving on Transportation of Waste within Kiambu and neighbouring Counties.

The proposed Incineration plant will be in reasonable from Nairobi city and other towns such as Juja, Kiambu, Nyeri etc. This is advantageous since it means waste does not have to be driven for long distances for dumping. It significantly reduces the cost of transport; the money can then be spent on the wellbeing of the community and sustaining the growth waste generators. Additionally, it reduces the harmful gases released by vehicles during transportation, thus drastically reducing the overall carbon footprint.

vi. Better control over odor and noise

The proposed Incineration plant will be able to provide less bad smells because waste gets burnt, unlike landfills where waste is allowed to decay thereby emitting unpleasant smells, which cause air pollution. The production of methane in landfills may also lead to explosions that cause noise pollution, which is unheard-of when it comes to the use of incineration plants.

vii. Prevention of the production of methane gas

In landfills, when the waste is decaying methane gas is generated which if not controlled, may explode causing further global warming. Unlike landfills, incineration plants do not produce methane, therefore making them safer.

viii. Elimination of harmful germs and chemicals

The proposed Incineration plant will function at very high temperatures of above 1,250ºC that can destroy germs and chemicals that are harmful. Thus, it is a very effective method when it comes to eliminating clinical waste.

ix. All weather operation

The proposed incinerator can function in any type of weather. For instance, during a rainy season, waste cannot be dumped in a landfill because the rain will possibly wash down poisonous chemicals into the ground and consequently create leachate thus contaminating the underground water as well as the neighboring land. Waste can also not be dumped when it is windy since it will get blown into the surroundings. On the other hand, incinerator will not be limited to weather changes since it will burn waste without leakages. Incineration plant also has the capacity to function 24 hours a day is more efficient in managing waste compared to landfills.

x. Effective for Metal Recycling

When the proposed incinerator will be burning waste, the metals still remain whole because they have a high melting point. After the process of burning waste is done, the workers remove the remaining metal and recycle it. This removes the need for separating out any metal before waste disposal. When garbage is taken to a landfill, it is usually not organized which results in wasting of resources that could have been recycled. Therefore, using an incinerator will makes it easier to remove and reuse metals.

xi. Computerized monitoring system

The proposed incinerator has a provision for a computerized monitoring system device to allow for the troubleshooting of most problems. This will enable operators to discover a problem before it becomes more serious and much more expensive to repair. A computer will also make operators work easily as they will be able to track the operational efficiency of the incinerator plant.

xii. Potential Uses of ash waste

The ash that comes from the combustion of waste can be used in construction, get shipped or even landfilled.

xiii. Job creation to the locals

The proposed incinerator plant will directly or indirectly create jobs for the locals.

Potential negative impacts

i. Degradation of the air quality and the environment

Incinerator produce smoke during the burning process that can pollute the environment is proper filter or scrubber is not installed. The smoke produced includes acid gases, carcinogen dioxin, particulates, heavy metals, and nitrogen oxide. These gases are poisonous to the environment. This is a potential impact that forms the whole basis for this assessment.

ii. The possibility of antidote to recycling

Incineration does not encourage recycling and waste reduction. This is not a calculated strategy for any society. The point of focus should be on reducing waste and recycling most of it. Merely burning most of the waste without recycling some of it will only further environmental damage because it may encourage more waste production.

iii. Ash waste risk

Even though the ash that remains from the process can be comparatively small in quantity, it contains a number of poisons and heavy metals which requires further treatment. If not disposed correctly, it can cause serious harm to the public and the environment. The proponent has proposed measures in place for ash management.

iv. Due to the geography of the abandoned site, surface water from precipitation may gather within the site and interfere with the operation at the sites or even lead to transportation of leachates to unintended environments. This may be made worse during extreme rainfall event. The site must be adapted (climate proofed) against heavy downpour and associated impacts. The proposed measures to control flooding include removal of potential water hazards, Filling the surfaces that might collapse during or after the flooding process, installing water diversion systems at the site, installing, at both the surface and underground, a system to monitor hydrogeological and geotechnical aspects, and make a projection of hydrological and hydrogeochemical development of precipitation.

Environmental and Social Management and Monitoring Plan (ESMMP)

The ESMMP outlined in section eight of this report the identified issues of concern (potential negative impacts) and mitigation measures as well as responsibilities, costs and measurable indicators that can help to determine the effectiveness of actions to maintain and upgrade the quality of environment; as regards the proposed project. This monitoring is done in relation to the baseline environment. Regular monitoring is therefore necessary to monitor the change in parameters. The ESMMP has considered for all phases; installation, operational and decommissioning.

Environmental statement

From the assessment, the EIA experts concludes that the proposed incinerator for waste treatment in Nyacaba is appropriate. This conclusion has been made in terms of environmental impact, site selection, public health and public participation. By using a multi-criterion assessment model for economic, social, public health and environmental effects, this study indicates the proposed incineration plant has taken much consideration of the local residents' health and environment. A location analysis is also applied and some influences of the proposed waste incineration plant are illustrated. This study further concludes that public participation is a necessary condition for improving the environmental impact assessment and increasing total welfare of different interest groups in Nyacaba. This study finally offers some corresponding recommendations for improving the environmental impact assessment and enhancing the benefits of the proposed waste incineration project.

The ESIA report for the proposed project has revealed that only significant issues is from the perspective of

i. Pollutant emissions, disposal (management) of fly and bottom ash, which causes serious pollution to the environment and is a threat to public interests and public health;
ii. Technology used in incinerator; the older generations of incinerators are often much more dangerous to public health. More advanced incinerators have flue gas cleaning systems to reduce the air pollution.
iii. Waste incineration deflects attention from more sustainable solutions, such as redesigning products for recyclability or eliminating toxic, hard-to-recycle plastics which is a holistic issue beyond the proponent of this project.

9.2 Recommendations

i. The proposed project be supported as the Experts' appraisal of the impacts of the proposed plant from the perspectives of economy, society, public health and environment is largely positive.
ii. In terms of protecting the public health, improving the relevant techniques and standards of the incinerator is a necessity. The proposed incinerator should meet dioxins emission standard as the introduction and development of more eco-friendly waste-incinerating techniques promotes the efficiency of incinerator and plays a vital role in reducing fly ash.
iii. The ESMP should be implemented fully at all stages along the project cycle to maximize related positive environmental, economic, social, and public health influences of the proposed waste incineration plant.

iv. The proponent should explore the opportunities for co-generation. Co-incineration offers new markets for waste-derived fuels using existing infrastructure. It is hard to measure how many facilities are currently using co-incineration in Kenya, since there is no law compelling incinerator operators to report it.

v. The proposed incinerator should have a provision for a computerized monitoring system device to allow for the troubleshooting of most problems related to filter (scrubber system). A computerized monitoring will also make operators work easily as they will be able to track the environmental and operational efficiency of the incinerator plant.

vi. There is controversy over the possible health implications of waste management policies and both policy makers and the public require more information on the likely health impacts (and importantly, the associated nature and extent of the uncertainties).

vii. Nyacaba community engagement: Behavior change and public participation is key to a functional waste incinerator system. The proponent should continuously engage the public through the office of the County Commissioner to handle issues as they come by.

viii. Social inclusion: Waste management system relies heavily on informal workers, who collect, sort, and even manage generated waste. The project proponent should address waste picker livelihoods through strategies such as integration into the formal system, as well as the provision of safe working conditions, social safety nets, child labor restrictions, and education.

ix. Climate change and the environment: The project should continuously strive to promote environmentally sound waste disposal. It should support greenhouse gas mitigation through adoption of scrubber technology that capture Greenhouse gases. The value chain should also support resilience by reducing waste disposal in waterways and safeguarding infrastructure against flooding. In this regard, Stack emission assessment should be conducted on quarterly basis.

APPENDICES

Appendix 1: Land documentation

Appendix 2: KRA Pin and Certificate of incorporation for the Proponent

Appendix 3: EIA/EA expert Practicing license for consultants

Appendix 4: Duly filled Public participation forms for Public consultation.

Appendix 5: Incinerator specification.