

ENVIROMENTAL IMPACT ASSESSMENT STUDY REPORT

For

THE PROPOSED WASTE PLASTIC AND TYRE PYROLYSIS PLANT IN THIKA

ON PLOT L.R. No. L.R. Thika Municipality Block 29/653



PROPONENT:

JA RECYCLING LTD,
P.O. Box 11324 - 00400,
NAIROBI.
TEL: +254 717178888
Email: jarecyclingltd@gmail.com
rushab@rsl.co.ke

EIA EXPERT

ENVIRON CONSULTING,
P.O. Box 14568 – 00800,
NAIROBI.
Tel: +254 722361330
Email: info@environconsulting.com;
www.environconsulting.com

February, 2017

TABLE OF CONTENTS

1.1	PROJECT OVERVIEW AND JUSTIFICATION.....	8
1.2	OBJECTIVE SCOPE AND CONTENT OF THE EIA PROCESS	9
2.1	NATURE OF THE PROJECT.....	15
2.2	SITE LOCATION.....	15
2.3	SITE CHARACTERISTICS	16
2.4	PROPOSED SITE DEVELOPMENT	16
2.4.1	<i>Waste reception</i>	<i>16</i>
2.4.2	<i>Waste Sorting.....</i>	<i>16</i>
2.4.3	<i>Recycling yard.....</i>	<i>16</i>
2.4.4	<i>Waste disposal.....</i>	<i>16</i>
2.4.5	<i>Water supply.....</i>	<i>16</i>
2.4.6	<i>Support services</i>	<i>17</i>
2.5	SITE AND PROJECT ALTERNATIVES	18
2.5.1	<i>The Proposed Location.....</i>	<i>18</i>
2.5.2	<i>Project Alternatives.....</i>	<i>18</i>
2.5.3	<i>Alternative Schedule.....</i>	<i>19</i>
2.5.4	<i>Alternative Designs.....</i>	<i>19</i>
2.5.5	<i>Alternative Inputs</i>	<i>20</i>
2.5.6	<i>Utilities</i>	<i>20</i>
2.5.7	<i>No Project Option</i>	<i>20</i>
2.5.8	<i>Project Costs and Implementation Schedule</i>	<i>21</i>

4.1	ENVIRONMENTAL SETTING.....	34
4.2	<i>Topography and Drainage</i>	34
4.2.1	<i>Hydrology and Water Resources.....</i>	35
4.2.2	<i>Geology and Soils</i>	35
4.2.3	<i>Biodiversity.....</i>	35
4.2.4	<i>Climatic Conditions</i>	37
4.2.5	<i>Energy Sources</i>	37
4.3	SOCIAL SETTING	37
4.3.1	<i>Population distribution.....</i>	37
4.3.2	<i>Land Use Trends.....</i>	39
4.3.3	<i>Economic Patterns.....</i>	41
4.3.4	<i>Noise Levels</i>	41
4.2.5	<i>Sensitive Areas.....</i>	41
4.4	PUBLIC PARTICIPATION	41
4.4.1	CONSULTATION WITH INTERESTED AND AFFECTED PARTIES.....	41
4.4.2	THE QUESTIONNAIRE	42
4.4.3	ANALYSIS OF THE QUESTIONNAIRE.....	43
5.1	INTRODUCTION	44
5.2	POSITIVE IMPACTS	44
5.2.1	<i>POSSIBLE IMPACTS ON THE ENVIRONMENT.....</i>	45
5.2.2	<i>Brief Description of the Project</i>	45
5.2.3	<i>Operations</i>	48
5.2.4	<i>Decommissioning Phase.....</i>	51

5.3	MITIGATION MEASURES	51
5.3.1	<i>Management Measures</i>	51
5.3.2	<i>Operational Measures</i>	53
5.4	MITIGATION MEASURES	55
6.1	THE EMP GUIDING PRINCIPLES.....	59
6.2	ENVIRONMENT MANAGEMENT POLICY.....	59
6.3	SPECIFIC MANAGEMENT ISSUES	60
6.3.1	<i>Health and Safety</i>	60
6.3.2	<i>Site Operation</i>	60
6.4	MANAGEMENT RESPONSIBILITIES	60
6.5	ENVIRONMENTAL MANAGEMENT PLAN	62
7.1	CONCLUSION.....	69
7.2	RECOMMENDATION	69

DOCUMENT AUTHENTICATION

This project report on Environmental Impacts Assessment has been prepared by Environ Consulting Ltd a NEMA registered and licensed EIA/EA Firm of Experts.

This report has been done with reasonable skills, care and diligence in accordance with the Environmental Management and Coordination Act, 1999 and the Environmental (Impact Assessment and Audit) Regulations 2003.

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

 Sign: Date
Firm of Experts	

PROPONENT

Sign: Date
--------------------	----------------------

EXECUTIVE SUMMARY

Industrialization in Kenya and the implementation of Environmental Management and Coordination (Waste Management) Regulations, 2006, has necessitated the need to develop a hazardous waste treatment plant and more so promoting recycling of waste products in order to cope with the increased waste tyres produced from ever increasing motor vehicle imports in the country. At the same time meet the ever demanding regulatory framework. Ja Recycling Ltd was registered to provide pyrolysis plant on a plot adjacent to Kang'oki dump site in Thika Municipality.

Ja Recycling Ltd is planning to install a plastic and tyre pyrolysis plant in Thika Township – Kiambu County adjacent to the Kang'oki dump site on plot **L.R. No. Thika Municipality Block 29/653**, to convert waste tyre to diesel oil. The process will involve molecular breakdown of larger molecules into smaller molecules in presence of heat and in the absence of oxygen, a process also known as thermal cracking, thermolysis, depolymerization. During the process, object's molecules are subjected to very high temperatures leading to very high molecular vibrations. At these high molecular vibrations, every molecule in the object is stretched and shaken to such an extent that molecules starts breaking down into smaller molecules.

The company plans to rent one of the go-downs and a space within a 0.4199ha plot adjacent to Kang'oki dump site on rental basis. This means that Ja-Recycling will not be conducting any construction activities except to install the proposed plant in an open shade. An Environmental Impact Assessment (EIA) licence for the construction of ware houses has been granted by NEMA and indeed warehouse construction is currently in progress. The purpose of this EIA report to be submitted to the National Environment Management Authority (NEMA) is the proponent to install and operate as highlighted above. The site has good geological structure in a remote location bordering a dump site which is a positive step in waste management process.

The availability of such waste recycling facility is not only a critical environmental issue, but also an essential economic factor for a country that aspires to grow its industrial base. Most international companies expect a hazardous waste management program to be in place that is both economical and meets international standards, especially ISO 14001 considerations. Besides, without the means to such wastes as tyres, it is not possible to enforce the current environmental legislation.

Plastic and tire pyrolysis involves subjecting plastic and tire to high temperature of 400 to 450 degree Celsius, in absence of oxygen. This will ensure that raw materials are broken down into smaller molecules of pyrolysis oil, pyrolysis gas and carbon black. Like plastic and tire, pyrolysis end products are also known as hydrocarbons compounds. The process is great way of recycling waste plastics and tires which are becoming an eye sore in various parts of the country especially towns which has seen a major increate of plastic and tyre waste. The construction of this company will ensure: -

- Recycling of waste plastic and tyre into usable fuel.
- Offers renewable energy source.
- The in product can be used as fuel in existing industrial boilers and furnaces. End products can also be used for generating electricity.
- Eliminates hazard of land pollution by waste plastics and tire.
- Converts waste into energy.
- Clears dumping yards and environment of non bio degradable plastic and tire waste.

In compliance to the Environmental Management and Coordination Act (EMCA), 1999 as well as the related regulations, JA Recycling Ltd has undertaken this ToR as a prelude to the conduction of EIA through a NEMA registered Lead EIA Expert for review and necessary approval purposes.

Our investigation examined the potential impacts of the project on the immediate surrounding with due regard to all the phases from installation through to completing, operation and decommissioning. It encompasses all aspects pertaining to the physical, socio-cultural, health and safety conditions at the site and its environs during and after installation of the project. During the screening exercise, issues identified as those that may be impacted upon by the project activities include: air quality, health and safety, and other environmental hazards and socio-economic welfare of the surrounding communities.

The site

At the time of the assessment, the one acre piece of land had been approved for construction of go-downs for industrial use in readiness of the same and a space has already been identified within the site for the construction of an open shed. The plot is already fenced with a boundary wall to ensure security and restrict movement in and out of the site.

Electricity needs will be met from the KPLC grid whereas having a power generator backup whenever necessary. The main road access to the facility is an all weather road off Thika – Garissa road at Posta area of Makongeni. This road is all weather murrum road serving local residents within the area and more so waste trucks off loading at the dumpsite. The proponent will improve the road to the site to ensure accessibility and safe delivery of raw materials and taking of finished products.

The site is expected to be designed such as to ensure optimal utilization of space, ensure minimal waste movement, easy and safe movement for the forklifts and other machines wherever applicable. At full operations the plant is expected to help recycle a lot of waste from within the country. Wastes will be segregated and contained safely at specific locations around the premises. Spills, emissions and friable materials will be contained in the premises.

CHAPTER ONE:

1. INTRODUCTION

1.1 Project overview and justification

The availability of a commercial hazardous waste management facility is not only a critical environmental issue, but also an essential economic factor for a country that aspires to grow its industrial base. Most international companies expect a hazardous waste management program to be in place that is both economical and meets international standards, especially ISO 14000 considerations. Besides, without the means to treat and dispose hazardous wastes, it is not possible to enforce the current environmental legislation.

Industrialization in Kenya and the implementation of Environmental Management and Coordination (Waste Management) Regulations, 2006, has necessitated the need to develop a waste recycling facility that can cope with the increased demand from industry and more so the increased motor vehicles that ply within the country and at the same time meet the ever demanding regulatory framework. For this reason Ja-Recycling Ltd is a registered company under a single business permit to carry out waste tyre and plastic recycling to diesels that will also add to supply of fuel necessary to power industrial needs within the country.

The project design and technology shown eco-friendly and cost-effective waste pyrolysis plant with the world class design and technology. The waste pyrolysis equipment has been designed to have a lower cost and higher fuel oil output. The waste tyre pyrolysis machine combines continuous and batch type pyrolysis plant. The continuous pyrolysis machine is to feed the raw materials, such as tyre and plastic, on one side and discharge the carbon black continuously from the other side. However, the batch type is to feed the machine with a batch of raw material and take the process and start the next process after cooling down the machine and discharging the carbon black. The proposed plant is based on the green technology (pyrolysis) to achieving the environmentally friendly process, which is the excellent waste tyre management solution for tyre recycling.

The plant process environmentally friendly designed to solve tyre and other environment pollution which are becoming the serious issues in the current industrial dispensation. Due to multiplicity of end products from the process including heat, electricity, steam and so on, the plant will therefore be of benefit to the economy of the country in its operation. Further distillation of the oil by professional pyrolysis oil distillation plant, the end product can be used for vehicle powering.

The main parts of the system includes reactor, transmission device, catalytic chamber, cooling tube, manifold, heavy oil tank, light oil tank, oil condenser, oil-water separator, safety device, vacuum system, dedusting system.

Two main reasons of the great demand of scrap tyre pyrolysis equipment. With the development of social modernization, on the one hand, the rubber industry has been vigorously developing, and the rubber products have been widely used in all works of life, especially in the tyre manufacture; on the other hand, more scrap articles, such as tyres, are generated and accumulated to such huge amount. Because of the erode-resistant characteristic of tyres, the big pollution hazard was posed to the environment and hygiene. This has widely been described as black pollution. The plant was therefore designed to curb and conquer the pollution posed by the aforesaid.

Tyre refining device decomposes waste tyres through high temperature process into kinds of useful resources, such as fuel oil, carbon black, steel wires and fuel gas. Meanwhile, tyre pyrolysis equipment will make renewable resources out of black pollution. During this process, scrap tyres are put into production as raw material, which not only controls environment pollution but also achieves resource regenerating and recycling. What is more, batch tyre pyrolysis plants are suitable for raw materials within 120mm.

The management of hazardous wastes in Kenya is regulated under the Environmental Management and Co-ordination Act (EMCA, 1999), EMCA (Waste Management) Regulations (2006) and other related regulations controlling the all wastes which poses hazardous attributes to the environment and the environmental occupants as a whole. These regulations establish an order of preference for the management of hazardous wastes to be: minimization, recycling, treatment, and land filling. The facility will therefore offer recycling aspect in fulfillment of the regulation's aim.

The installation of the plant will also make the already undesirable land useful from the eyesore of waste in the dumpsite.

1.2 OBJECTIVE SCOPE AND CONTENT OF THE EIA PROCESS

1.2.1 Objectives

The purpose of this EIA is to ensure adequate identification of potentially negative environmental impacts. Secondly to propose workable mitigation measures and thirdly to formulate an environmental management plan (EMP) articulating envisaged impacts.

The overall objective of the study on the other hand is to ensure that all environmental concerns are integrated in all the project development processes with an aim of managing hazardous waste without compromising the natural environment and the ecology of the area.

Specific objectives include:

- i. To identify possible environmental impacts, both positive and negative

- ii. To assess the significance of the impacts
- iii. To assess the relative importance of the impacts of relative plan designs, and sites
- iv. To propose preventive mitigation and compensative measures for the significant negative impacts of the project on the environment.
- v. Generate baseline data for monitoring and evaluating how well the mitigation measures are being implemented during the project cycle.
- vi. To present information on impact of alternatives
- vii. To present the results of the EIA that can guide informed decision making

1.2.2. Scope

The Environmental Impact Assessment was conducted at the site and the surrounding area. The assessment involved the physical examination, interviews with beneficiaries, neighbouring communities, relevant consultants and government agencies.

To generate environmental impacts assessment for submission, it involved a systematic examination of all proposed activities.

The project assessment investigates and analyses the anticipated environmental impacts of the proposed development in line with the Environmental (Impact Assessment and Audit) Regulations of 2003.

Consequently, the report will generate the following:

- Nature of the project and describing the project and associated works together with the requirements
- The location of the project including the physical area that may be affected by the project activities
- The activities that shall be undertaken during the project phases
- The potential environmental impact of the project and mitigation measures to be undertaken during and after the project cycle
- An action plan for prevention and management of possible accidents during the project cycle

- A plan to ensure that the health and safety of the workers and the neighbouring communities
- Identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the project which are necessary to mitigate these environmental impacts and reducing them to acceptable levels.
- Provide information on the consideration of alternatives/ options for site locations and layouts of the project to avoid and minimize potential environmental impacts; to compare environmental pros and cons of each of the options and to provide reasons for selecting the preferred option
- The project budget
- Any other information that the proponent may be requested to provide by NEMA

1.2.3. Criteria

The EIA approach was structured so as to cover the requirements under the EMCA, 1999 as well as the Environmental Management and Coordination (Environmental Impact Assessment and Audit) Regulations, 2003 and amended 2009 regulations. The approach mainly involved an understanding of the project background, technology and processes, implementation plan, operation activities. In addition, baseline information was obtained through detailed physical and biological investigation of the proposed project and its surrounding areas, stakeholder consultations (which included discussions with area residents, private sector, county administration) photography and, continuous discussions with the proponent.

Following the preliminary visit of the proposed site, the following was undertaken

- (i) Screening of the project, a process that identified the project as being among those that requiring EIA under schedule 2 of the EMCA 1999
- (ii) A scoping exercise that identified the key issues to be identified in the study
- ❖ Documentary review on the nature of the proposed activities, policy and legal framework, environmental setting of the area and other available relevant data/information
- ❖ Detailed discussions with the proponent and the consultation with the relevant officials in the regulatory authorities

- ❖ Physical investigation of the site and the surrounding areas using a pre-prepared checklist identifying possible environmental and human safety issues that are likely to be affected
- ❖ Reviewing the proposed project designs and implementation plan/schedules with a view to suggesting suitable alternatives
- ❖ Developing an environmental management plan with responsibilities, schedules, monitorable indicators and time frame among other aspects
- ❖ A comprehensive report including all issues as listed in the Environmental (Impact assessment and audit) Regulations 2003

1.2.4. Terms of Reference (TOR)

The environmental Impact (EIA) report considered the following aspect and other that proved of significance during the study

1. Project developments impacts on the ecology. This in essence covered:
 - The impacts of the development on biodiversity both within and outside the project development site
 - Impacts on habitat quality and issues of habitat disruptions
 - Surface water runoff and containment

2. Social implications of the development within the locality, region and nationally. This included:
 - Economic implications of the development
 - Security, risk and safety
 - Employment
 - Livelihoods
 - Public health implications
 - Demand and development of infrastructures and social amenities

3. Assess the impacts of development on landscape and land use:
 - Determine the impact on change on civic shape, scenery, aesthetic modifications
 - Examine the compatibility and complimentarily of the development of the surrounding land uses

4. Assess the impacts of the development on current demands on water source as well as possible implications on surface and ground water qualities and quantities
5. Develop an environmental management plan (EMP) that would mitigate the possible impacts on the environment

1.2.5. Duties of the proponent

The report emphasizes the duties of the proponent and the contractor/supplier during the project phase. It will be the duty of the proponent to ensure that all legal requirements pertaining to the development are met as specified by the law.

1.2.6. Duties of the contractor/supplier

- Prepare and maintain an approved time and progress chart showing clearly the period allowed for each section of the work
- The contractor/supplier is to comply with all regulations and by-laws of the local authority including serving notices and paying of the fees
- The contractor shall make good at his own expense any damage he may cause to any public and private roads and pavements in the course of carrying out his work
- The contractor/supplier shall be responsible for all the action of the sub-contractor in the first instance
- The contractor or supplier shall take all possible precaution to prevent nuisance, inconvenience or injury to the neighbouring properties and to the public generally, and shall use proper precaution to ensure that safety of willed traffic and pedestrian
- All work which may produce under level of noise, dust vibration or any other discomfort to the workers, and/or guest of the client must be undertaken with care with all necessary precautions taken
- The contractor or supplier shall upon completion of working remove and clear away all plant rubbish and unused materials and shall leave the site in a clean and tidy state to the certification of the site engineer. He shall also remove from the site all rubbish and dirt as it is produced to maintain the tidiness of the premise and its immediate environs

- The standard of workmanship shall not be inferior to the current British codes of practice or the Kenya Bureau of Standards where existing. No materials for use in the permanent incorporation into the works shall be used for any temporary works or purpose other than that for which it is provided. Similarly, no material for temporary support shall be used for permanent incorporation into the works.
- All the materials and workmanship used the execution of the works shall be of the best quality and description. Any material condemned by the site engineer shall immediately be removed from the sit at the contractor/supplier expense

CHAPTER TWO

2. PROJECT DESCRIPTION

2.1 Nature of the project

The proponent (Ja-Recycling) intends to install a plastic and tyre pyrolysis plant in an open shade adjacent to Kang'oki dumpsite in Thika. The project design and technology shown eco-friendly and cost-effective waste pyrolysis plant with the world class design and technology. The waste pyrolysis equipment has been designed to have a lower cost and higher fuel oil output. The waste tyre pyrolysis machine combines continuous and batch type pyrolysis plant. The continuous pyrolysis machine is to feed the raw materials, such as tyre and plastic, on one side and discharge the carbon black continuously from the other side. However, the batch type is to feed the machine with a batch of raw material and take the process and start the next process after cooling down the machine and discharging the carbon black. The proposed plant is based on the green technology (pyrolysis) to achieving the environmentally friendly process, which is the excellent waste tyre management solution for tyre recycling.

The plant process environmentally friendly designed to solve tyre and other environment pollution which are becoming the serious issues in the current industrial dispensation. Due to multiplicity of end products from the process including heat, electricity, steam and so on, the plant will therefore be of benefit to the economy of the country in its operation..

2.2 Site Location

The proposed project is will be located in an open shade whereas, the adjacent go-downs already approved for construction in an acre piece of land on rental basis from the current owner situated parcel - **L.R. No. Thika Municipality Block 29/653**, at Kang'oki dumpsite in Thika – Kiambu County.

At the time of the assessment, the one acre piece of land had been approved for construction of go-downs for industrial use in readiness of the same and a space has already been identified within the site for the construction of an open shed. The plot is already fenced with a boundary wall.

The site is expected to be designed such as to ensure optimal utilization of space, ensure minimal waste movement, easy and safe movement for the forklifts and other machines. At full operations the plant is expected to help recycle a lot of waste from within the country. Wastes will be segregated and contained safely at specific locations around the premises. Spills, emissions and friable materials will be contained in the premises.

2.3 Site Characteristics

The proposed site had been fence off from any interference using a perimeter wall. Adjacent to the site is a dumpsite commonly called “Kang’oki dumpsite”. Electricity needs will be met from the KPLC grid whereas having a power generator backup whenever necessary. The main road access to the facility is an all weather road off Thika – Garissa road at Posta area of Makongeni. This is road is all weather murrum road serving local residents within the area and more so waste trucks off loading at the dumpsite. The proponent will improve the road to the site to ensure accessibility and safe deliver of raw materials and taking of finished products.

Less than two hundred meters of radius are residential apartments to the east of the site.

2.4 Proposed site development

At the site, there will be go-downs and an open shed for the installation of the main plant. A provision of waste sorting yard will be made to allow for manual sorting using human labor and a storage facility for the finished product. One of the go-down will cater for office space for staff within the site.

2.4.1 Waste reception

It is intended that waste will be delivered to the site by trucks from all sourcing points. Delivery will also be by road but in compliance with regulations.

2.4.2 Waste Sorting

Waste tyres of 1.4 meters will be cut starting from the inner ring first.

2.4.3 Recycling yard

All recyclable materials will be moved to a yard for storage depending including wires drawn from the tyres on nature and target re-users. Necessary management provisions will be part of the yard.

2.4.4 Waste disposal

Waste water emanating from operation areas as well as surface run off from the premises will not be allowed into the natural drainage system without passing through screens to remove any waste oil.

2.4.5 Water supply

There is no surface water source within the vicinity of the proposed site. This leaves sources options as rain water harvesting, municipal water and groundwater for a project of the above magnitude. In this case, Municipal water supply will be utilized to cater for water needs in the facility.

2.4.6 Support services

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

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

2.5 SITE AND PROJECT ALTERNATIVES

2.5.1 The Proposed Location

The proposed site is adjacent to a dumpsite and will be a suitable location for a recycling plant for tyres. This means that the proposed site is the only other location found suitable. This conclusion has been arrived at due to the following considered reasons;

- (i) The land is legally owned and the proponent has gone into contractual agreement with the proponent to utilize the facility on tenant basis. This makes the development more feasible to the proponent,
- (ii) Due to the presence of a dumpsite on the east side of the project site can make it possible to present a case of appropriate zoning in future to the Local Government Authorities to ensure minimal social impacts
- (iii) There are no significant environmental sensitive features around the site (no surface water bodies, no forest cover, no wetlands, not sensitive habitats noted, etc.). It is, therefore, likely to have minimal environmental impacts,
- (iv) The proponent is ready to abide by the law for a long term suitability of the site.

2.5.2 Project Alternatives

The consideration of alternatives to a proposal is a requirement of many E.I.A systems. It lies at the heart of the E.I.A process and methodology. During the scoping process, alternatives to a proposal can be generated or refined, either directly or by reference to the key issues identified. A comparison of alternatives will help to determine the best method of achieving project objectives while minimizing environmental impacts or, more creatively, indicate the most environmentally friendly or best practicable environmental option.

From an environmental perspective, not carrying out this development may be the best option. Without the development, the area would remain a relatively undisturbed area providing a habitat for the varied flora and fauna presently observed. This area will continue to be impacted, although minimally, by anthropogenic and natural factors. From a socio-economic perspective the “no action” alternative may not be the best alternative as the numerous benefits to be gained from the development both locally and nationally would not be realized and the resources in the area would continue to be underutilized

In order to enable the proposed project to seek different ways of minimizing its impacts on the environment and at the same time achieve its objectives several alternatives were assessed through its architectural and engineering designs and environmental planning through this EIA. This not only

justifies the course of action (base case) but also enables the risk management to follow a hierarchy of:

1. Avoidance: Temporal and spatial;
2. Elimination and minimization: non-structural ex-ante mitigation
3. Elimination and minimization: structural ex-ante mitigation
4. Elimination and Response: structural ex-post mitigation
5. Elimination, Recovery and Development: non-structural ex-post mitigation

The proceeding subsections review these alternatives in the subjects of: location, time, design, inputs, existence and the base case with mitigation.

2.5.3 Alternative Schedule

This option entails carrying out the proposal at a later time thereby offsetting its impacts to that time. Only benefit is if there be improvements in baseline conditions and technologies that may be involved with the proposal. However these are not guaranteed and it may only lead delays in development, therefore carrying out the proposed project with mitigation would be a preferred option due to this uncertainty. In addition carrying out the proposed project at later time may lead to more operational and logistic costs due to increasing inflation and standards of living.

2.5.4 Alternative Designs

This option curtails undertaking the project but with different infrastructural designs that encompass: buildings, roads, power, water and sewerage. The presented project design was however achieved by considering the options available that would ensure cost-effectiveness and avoid or reduce environmental and social impacts as much as possible.

For the execution of the project and its associated accessories, several options were explored as where they can located and it was preferred to locate the site near the already designated area for waste handling i.e. dumpsite area, to shield the local tenants of the area from pollution. Additionally several of the other proposed designs would result in higher building densities and less internal transport/path optimization. This would mean the project would use more energy and resources as compared to the preferred project option. Additionally the alternative possible designs would also reduce the project's commercial viability as well as its targeted balance with nature that will create

ambience. Furthermore, the design for the plant eliminated use of oxygen that might result into air pollution.

2.5.5 Alternative Inputs

Alternatively the project may use different combinations of inputs such as: transport systems; water; electric and power. This may reduce the project's impacts in several cases but as compared to the project's preferred options for these services they may result in extensive costs and bottlenecks since several of these options/inputs are at a techno-commercial infancy stage and have a varying set of impacts.

2.5.6 Utilities

➤ *Electricity*

The proposed project had various options for its sources of the electricity and these are reviewed in contrast to the preferred option

➤ *Materials*

The project will be installed in an open space and this means that there will be no major construction except of foundation works for raise a platform for machine installation. Alternative for the materials that will be used in the project involve using locally procured materials (base case) with the exception of not using timber and the second option involves primarily importing materials and using timber. The former alternative is preferred option since it will ensure the project contributes to the national economy by creating business opportunities for the suppliers of these materials while conserving the environment by ensuring the most environmentally friendly suppliers are contracted. This option will also not use timber since most of the hardwoods available in Kenya come from the DRC where forestry is largely unregulated while local timber sources are in most cases not sustainable

2.5.7 No Project Option

This alternative means forfeiting the proposed development avoiding all its impact both positive and negative. The only benefit of this option would be negative impacts would be avoided such as losses in flora & faunal habitats, waste generation and pressure on infrastructure. However positive gains from the project on the economy and specifically on waste tyre management would also be lost including employment creation, revenue generation, tourism development, capital injection into the economy and infrastructure developments that may result from the project.

2.5.8 PROJECT COSTS AND IMPLEMENTATION SCHEDULE

The main cost of the proposed project will be in the procurement of the pyrolysis plant and its associated installation works. In addition, there will be other costs incurred during operation stage including: monthly rent, employees' salaries, procuring raw materials for the plant and obtaining operation licences. Procurement and installation of the proposed project is projected to cost **105, 400 USD (one hundred and five, four hundred United States Dollars)**.

The proposed project will involve installation of the plant in already secured place as aforesaid under open shade. The owner of the premise is currently in the process of building go-downs after seeking approvals from relevant authorities.

The project installation is scheduled not to be more than three months from the time approvals are obtained.

CHAPTER THREE

3. POLICY, LEGAL ADMINISTRATIVE FRAMEWORK

3.1 Introduction

The Environmental Impact Assessment is a useful tool for protection of the environment from the negative effects of developmental activities. It is now accepted that development projects must be economically viable, socially acceptable and environmentally sound. It is a condition of the Kenya Government for developers to conduct Environmental Impact Assessment on the development Projects.

Kenya has a policy, legal and administrative framework for environmental management. Under the framework, the National Environment Management Authority (NEMA) is responsible for ensuring that environmental impact assessments (EIAs) are carried out for new projects and environmental audits on existing facilities as per the environmental management and coordination Act 1999.

EIAs are carried out in order to identify potential positive and negative impacts associated with the proposed project with a view to taking advantage of the positive impacts and developing mitigation measures for the negative ones. The guidelines on EIAs are contained in Sections 58 to 67 of the Act.

According to Section 68 of the Environmental Management and Coordination Act (EMCA) 1999, The Authority will be responsible for carrying out environmental audits on all activities that are likely to have a significant effect on the environment.

Environmental auditing (EA) is a tool for environmental conservation and has been identified as a key requirement for existing facilities to ensure sustainable operations with respect to environmental resources and socio-economic activities in the neighbourhood of the facilities.

There is an existing policy, legal and administrative framework regulating the proposed project. The government has established regulation to facilitate the process of EIA study and EA. The regulations are contained in the Kenya Gazette supplement No. 56, legislative No. 31, legal notice No. 101 of 13th June 2003. In addition, the government has a number of National Policies and statutes to enhance environment and sustainable development. Some of the policies and legal provisions are discussed below

In the past, the government has established a number of National policies and legal statutes to enhance environmental conservation and sustainable development. The proponent will need to observe the provisions of the various statutes that are aimed at maintaining a clean, healthy and sustainable environment. Some of the policy and legal provisions are briefly discussed in the following sub-Sections

3.2 Policies

Both the development and environment policies are being formulated by the respective ministries in consultation with relevant stakeholders. Government intentions in reducing air emissions has been on the rise ever since through initiatives of tree planting. This target will be realized through investments by government, private sector, civil society and individuals.

Environmental Impact Assessment (EIA) is a methodology used to identify the actual and probable impacts of the projects and programmes on the environment and to recommend alternatives and mitigating measures. The assessment is required at all stages of project development with a view to ensuring environmentally sustainable development for both existing and proposed public and private sector development ventures. The National EIA regulations were issued in accordance with the provisions of Environmental Management and Co-ordination Act (EMCA) of 1999. The EIA Regulations must be administered, taking into cognizance provisions of EMCA 1999 and other relevant national laws. The intention is to approve and license only those projects that take into consideration all aspects of concern to the public as they impact on health and the quality of the environment.

3.2.1 National Environmental Action Plan (NEAP)

The NEAP for Kenya was prepared in mid 1990s: It was a deliberate policy effort to integrate environmental considerations into the country's economic and social development. The integration process was to be achieved through a multi-sectoral approach to develop a comprehensive framework to ensure that environmental management and the conservation of natural resources are an integral part of societal decision-making

3.2.2 The National Poverty Eradication Plan (NPEP)

The NPEP has the objective of reducing the incidence of poverty in both rural and urban areas; as well as the capabilities of the poor and vulnerable groups to earn income. It also aims to narrow gender and geographical disparities and a healthy, better educated and more productive population. This plan has been prepared in line with the goals and commitments of the World Summit for the Sustainable Development (WSSD) of 1995. The plan focuses on four WSSD themes of the poverty eradication; reduction of unemployment; social integration of the disadvantaged people and the creation of an enabling economic, political, and cultural environment. This plan is to be implemented by the Poverty Eradication Commission (PEC) formed in collaboration with Government Ministries, community based organizations and private sector.

3.2.3 National Policy on Water and Resources Management and Development

While the National Policy on water resource management and development (1999) seeks to enhance systematic development of facilities in all sectors for the promotion of the country's socio-economic progress, it also recognizes the by-product of this process as wastewater. It, therefore, calls development of appropriate sanitation systems to protect people's health and water resource from any source of pollution.

Industrial and business development activities therefore should be accompanied by corresponding waste management systems to handle the waste water and other wastes emanating from such processes. The same project requires that such projects should also undergo comprehensive EIA studies that provide sustainable measures to be taken to ensure environmental resources and people's health in the immediate neighbourhood and further downstream are not impacted by the emissions. As a follow-up to this, EMCA 1999 requires annual environmental audits to be conducted in order to ensure that mitigation measures and other improvements identified during EIA study are implemented.

In addition, the policy provides charging levies on waste on basis of quantity and quality. The "polluter-pays-principle" applies in which case parties contaminating water are required to meet the appropriate cost of remediation. The policy provides for establishment of standards to protect water bodies receiving waste water, a process that culminated in the enactment of the environment Management and Coordination (Waste Management) Regulations 2006.

The key objectives of the policy include:

- To ensure that from the onset, all development policies, programs and projects takes environmental consideration into account.
- To ensure that independent environmental impact assessment (EIA) report prepared for any industrial venture or other development before implementation
- To come up with effluent treatment standards that will conform to acceptable guidelines. This has already been done by NEMA through the Environmental Management and Coordination Waste Management) Regulations 2006, and environmental Management and Coordination (water Quality) Regulations 2006.

3.3 Legal Aspects

The key National laws that govern the management of environmental resources in the country have been briefly discussed in the paragraph below. Note that whenever any of the laws contradict each other, the environmental management and coordination act prevails

3.3.1 The Environmental Management and Coordination Act, 1999

a) Background and administrative Structures

The environment Management and Coordination Act of 1999 received a presidential assent on January 6th, 2000 and was gazetted on January 14th, 2000.

The main objectives of the act are:

- Provide guidelines for the establishment of a legal and institutional framework for the management of environment in Kenya
- Provide a framework of legislation for over 77 statutes in Kenya that contain environmental provisions
- Provide guideline for environmental impact assessment, environmental audit and monitoring, environmental quality standards and environmental protection orders

In 2001, the government established the administrative structure to implement the act. The two main administrative structures are:

i. The National Environmental Council (NEC)

The National Environmental Council (the council) is responsible for policy formulation and directions for the purpose of the Act. The Council also sets national goal and objectives and determines policies and determines policies and priorities for the protection of the environmental.

ii. The National Environment Management Authority (NEMA)

The responsibility of the National Environment Authority, (NEMA) is to exercise general supervision and co-ordination over all matters relating to the environment and to be principle instrument of government in the implementation of policies relating to the environment.

In addition to NEMA, the act provides for the establishment and enforcement of environmental quality standards to be set by the technical committee of NEMA known as the standards and Enforcement review Committee (SERC).

b) EMCA requirements for Environmental Impact Assessment and Audit

The second schedule of the Act lists the projects for which an EIA and/or EA must be carried out. Section 68 of the Act specifies that accurate records should be maintained and annual reports submitted to NEMA, as required.

c) Water Quality and Waste Management Regulations 20006

The regulations were gazetted in September 2006 and come into force in 1st April, 2007. The regulation details the waste management requirements and also requires application of a license to all those premises discharging the waste to the environment.

3.3.2 The Water Act 2002

The purpose of the Water Act is to provide the management, conservation and use and control of water resources and for the acquisition and regulations of use of water, to provide for the regulation and management of water supply and sewerage supply. Except for waters that are wholly situated in a private landowner's domain, the act vests the right over all surface and ground water in the state. This is only subject to the rights which users may acquire under license from time to time.

The overall power for the control for the control of every body of water is exercised by the minister. The minister has the duty to promote the investigation, conservation and proper use of water resources throughout Kenya.

The act provides for a water resource management authority whose functions include, *inter-alia*, developed principles and procedures for allocation for water resources, monitor national water resource management strategy, determine applications for permits for water use, regulate and protect water resources quality from adverse impacts, manage and protect water catchments, e.t.c. In addition, under the water (catchments board) rules promulgated by the minister, the country is divided into six catmint boards, vis-avis Tana Catchments board, Rift Valley Catchment's Board, Athi River Catchment's Board, Ewaso-Nyiro Catchment's Boar, Lake Victoria (North) Catchment's Board and Lake Victoria (South) Catchment's Board. But these boundaries are subject to variation depending on available hydrological information.

Under the act, the minister may declare an area to be a conservation area and direct that special measures be taken for the conservation for the ground water therein. Every person who has been using ground water in an area declared to be a conservation area and who desires to continue with the use must obtain a permit within six months of the order. It's an offence to disobey such an order.

Protection of water supply is clearly a critical issue under the act. Accordingly, whenever the minister is satisfied that special measures are necessary for the protection of a catchment area from

each quarter is obtained; he may declare such an area to be a protected area. By order, the minister may regulate or prohibit the activities within that area which may be contrite to the requisite conservation goals.

An in-depth analysis of the new water Act reveals that the Act has created an integrated water resources management framework in Kenya which is participatory and likely to have a wider acceptance and implementation than the predecessors. Part II, section 18 of the act provides for the National monitoring and information systems on water resources. Following on this, sub-section 3, allows the water resource management authority to demand from any person or institution specified information documents samples or materials on water resources. Under these rules, specified information document, samples or materials on water resources may be kept by a water user and the information thereof furnished by the authority.

Section 73 of the Act allows a person with a license (licensee) to supply water and make regulations for purposes of protecting against degradation of water resources. Section 75 and Sub-section 1 allows the licensee to construct and maintain drains, sewers and other works for intercepting, treating or disposing any foul water arising or flowing upon land for preventing pollution of water sources within his/her jurisdiction.

Section 94 of the Act makes it an offense through or convey or cause or permit to be thrown or conveyed, any rubbish, dirt, refuse, effluent, trade waste or other offensive or unwholesome matter or thing into or near to water resources in such a manner as to cause or be likely to cause pollution of water resource.

Section 23 indicates that the authority shall approve community projects after they are approved by the persons owning or occupying at least two thirds of the particular area concerned in the project and that provision is made by the project for an adequate alternative supply of water when and if the available levels to other users is.

It also prohibits cancellation of a permit of a community project without the consent of the minister.

Section 24 requires all beneficiaries of a community project whose construction is funded in full or in part by the government, if the minister so determines, to pay a rate or charge for that benefit.

3.3.3 The public health Act cap 242

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

Such nuisance or conditions are defined under section 188 wastes, sewers, drains or refuse pits in such estate, situated or constructed as in the opinion of the medical officer of health to be offensive or injurious to human health. Noxious matter or waste flowing or discharged from any projects into a public street or into the gutter or side channel or watercourse, irrigation channel or bed not approved for discharge is also deemed as a nuisance. Other nuisances are accumulation of materials or refuse which in the opinion of medical officer of health is likely to harbor rats or other vermin.

On the responsibility of local authorities, Part XI section 129 of the Act states in part “it shall be the duty of every local authority to take all lawful, necessary and reasonable practicable measures for preventing any pollution dangerous to health of any supply of water which the public within its district has a right to use and does use for drinking or domestic purposes.....”

Part XII section 136 states that all collection water, sewage, rubbish, refuse and other fluids which permits or facilitates the breeding or multiplication of pests shall be deemed nuisance and are liable to be dealt with in the manner provided by this act.

3.3.4 The Physical Planning Act, Cap 286

The local Authorities are empowered under section 29 of the act to serve and maintain all land planned for open spaces, parks, urban forests and green belts, the same section therefore, allows for prohibition or control of the use and development of land and building in the interest of proper and orderly development of an area.

Section 30 states that any person who carries out development without permission will be required to restore the land to its original state. It also states that NO licensing Authority shall grant land license for commercial or industrial use or occupational or any building without development permission granted by the respective local authority.

Finally, section 36 states that if in connection with a development application, local authorities is of the opinion that that the proposed development activity will have injurious impact on the environment, the applicant shall be required to submit together with the application of the environmental impact assessment (EIA) report. EMCA, 1999 echoes the same by requiring that such an EIA is approved by the National Environmental Management Authority (NEMA) and should be followed by annual environmental Audits.

3.3.5 The Energy Act

The Act delegates the Energy Regulatory Commission right to regulate the production, transportation, storage and use of all petroleum products in the country. Section 95 (1) states that: “Petroleum imported or produced locally for use in Kenya, petroleum products, equipment, facilities and installations shall conform to the relevant Kenya Standard: Provided that where no such standard exists, the relevant international standards approved by the Kenya Bureau of Standards shall apply.” In addition, the act provides that: “A person who offers for sale in Kenya or transports or stores petroleum meant for use in Kenya shall ensure that the specifications of such petroleum is in accordance with subsection (1)”

The act ensures that a person who engages in petroleum business shall comply with the relevant Kenya Standard and in the absence of such standard, any other standard approved by the Commission from time to time on environment, health and safety in consultation with the relevant authorities and in conformity with the relevant statutes touching on environment, health and safety standards. In the event of a fire, explosion, oil spill, injury or fatality occurring in the course of operating a petroleum facility or transportation of petroleum, either by accident or through negligence, the operator or person transporting petroleum shall forthwith clean up the polluted or damaged environment, at his own expense, to the satisfaction of the Commission and other relevant authorities. Provided that any person engaged in the transportation of petroleum and petroleum products shall have an oil clean-up plan in compliance with the national oil policy.

It is the duty of The Commission to ensure that, at any given time, the operator of a facility or a transporter to show that he is in compliance with the provisions of this act.

3.3.6 The penal Code Cap 63

Section 193 of the code states that any person or institution that voluntarily corrupts or foils water for public springs or reservoir, rendering it less fit for its ordinary use is equally of an offence.

Section 192 of the same act states that a person who makes or vitiates the same atmosphere in any space to make it noxious of health of a person/institution in dwellings or projects in the neighbourhood or those passing along public way commits an offence

3.3.7 The County Governments Act, 2012

This is an act of parliament that provides for the planning within the county. The act highlights the objectives of the county planning, which in essence provides room for the facilitation of development of a well-balanced system of settlements and ensures productive use of scarce land, water and other resources for economic, social, ecological and other functions across the county. The act also provides for the establishment of the county planning unit which is responsible for the

coordinating of an integrated planning within the county and to interlink county plans and the national planning frameworks while engaging citizens in planning process.

The provided spatial plan addresses the spatial construction or reconstruction within the county and strategic guidance for a land use management systems in the county taking into account any guidelines for a land use management. The act also contains strategic assessment of the environmental impact of the spatial development framework. The spatial plan indicates where public and private land development and infrastructure investment should take place.

The act provides for city and municipal plans which are instruments for development and development controls within a city or municipality. The plans highlight the locations of various types of infrastructure, functions of land use and building plans in addition to development controls. As a result, city or municipal land use and building plans shall be the regulatory instruments for guiding and facilitating development within the city.

3.3.8 The Urban areas and City Act, 2012

The act provides for the basis of the preparation of the environmental management plans for the city. It also has a provision to nurture and promote development of informal commercial activities in an orderly and sustainable manner as much as it provides the basis for development control.

The city development plan shall bind, guide and inform all planning development and decisions and ensure comprehensive inclusion of all functions. A county government shall initiate an urban planning process for every settlement plan in accordance with the Third Schedule in the act. The integrated urban area or city development plan shall reflect an assessment of the existing level of development in the city or urban area, including an identification of communities which do not have access to basic services.

3.3.9 Occupational Safety and Health Act (OSHA) 2007

The Act requires all employers to register their workplaces by making an application to the Director of Occupational Health and Safety Services before they start any operations. The Act also sets minimum standards that are to be maintained in such workplaces to safeguard health, safety and welfare of workers. These are all aimed at elimination of hazardous wastes from workplaces. The act also requires that all workplaces to display the abstract of the act for all workers to read and remind themselves on how to protect themselves from hazard.

The act and its subsidiary legislation makes provision for health, safety and welfare persons employed in factories and other places of work such as in building construction and project operations are defined. The act prohibits emissions of dust, fumes or impurities into the atmosphere without proper treatment to prevent pollution or other ill effects to life and property. These

provisions require that all practical measures be taken to protect all persons employed in a factory from air emission or impurities originating from any process within the factory.

The act also requires that no discharges should be made into the environment from factories and workplaces without proper treatment that requires them harmless to the environment.

The act also has specific measures that need to be taken to protect health, safety and welfare of workers and environmental conservation. The same act also requires all operation that fall under it to apply for registration as such to the Directorate of Occupational Health and Safety Services.

3.3.9.1 Safety and Health Committee Rules of 2004

The rule states that any employer/proponent/occupier who employs more than twenty persons must establish a committee to address health, safety and welfare of workers. The employer must also cause to be carried out a health and safety audit of all its operations in an annual basis by a registered health and safety advisor who should forward such a report to the Directorate of Occupational Health and Safety Services.

3.3.9.2 First Aid Rules

These have details on first aid requirements in terms of facilities and capacity building among residential workers.

3.3.9.3 Hazardous Substances Rules

These regulate the handling, transportation and use of certain listed chemicals which may have negative effects on the body when one is expected. The rules places the duty on all employers to It shall be the duty of every employer to prevent his employees from being exposed to hazardous substance. Where it is not reasonably practical to prevent the exposure, it shall be the duty of every employer to control the exposure of employees from hazardous substances by:

- (a) limiting the amount of hazardous substances used which may contaminate the working environment;
- (b) limiting the number of employees who will be exposed or may be exposed;
- (c) using a substitute for the hazardous substance;
- (d) limiting the period during which an employee will be exposed or may be exposed;

- (e) introducing engineering control measures for the control of exposure, which may include the following:
 - (i) process separation, automation or enclosure;
 - (ii) installation of local extraction ventilation systems to processes, equipment and tools for the control of emission of an air borne hazardous substances;
 - (iii) use of wet methods;
 - (iv) separate workplaces for different processes;
- (f) introducing appropriate work procedures which an employee must follow where materials are used or processes are carried out which could give rise to exposure of an employee and that procedures shall include written instructions to ensure:
 - i) that a hazardous substance is safely handled, used and disposed of;
 - ii) that process machinery, installations, equipment, tools and local extraction and general ventilation systems are safely used and maintained;
 - iii) that machinery and workplaces are kept clean; and
 - iv) that early procedures are in place for corrective action.

3.3.9.4 Noise Prevention and Control Rules of 2005

These rules have set minimum and maximum exposure limits beyond which workers and members of the public should not be exposed to noise without adequate means of protection. The rules also have exposure limits for exposure out of workplaces. The rules have several recommendations on a comprehensive noise control program for workplaces that includes a requirement for medical examination of workers who are exposed to noise. The rules have also set the minimum noise levels that should emanate from a facility to public/neighbouring areas by day or by night.

3.3.9.5 Building Operations and Works of Engineering Rules

The rules guides health and safety matters in all building/construction and civil engineering works

These rules states clearly that it is the duty of the proponent to ensure health, safety and welfare of all workers are and authorized visitors to the site before commencement of operations, the proponent should notify the Director of Occupational Health and Safety Services of the intention so that from then on, the director advises and follows up on the necessary conditions to safeguard the health, safety and welfare of workers on site.

The rules also states that qualified and experienced persons must be appointed to act as safety supervisors by the proponent. These should supervise the enforcement of the standards to achieve the objectives mentioned above.

The rules have specific sections on excavation, transport, demolition, formwork and scaffolds, lifting and lifting equipment and other safety measures.

CHAPTER FOUR

4. BASELINE INFORMATION OF THE STUDY AREA

4.1 Environmental setting

Evaluation of the physical and biological environmental was undertaken through observations around the site, records and available literature. The following sub-sections provide an outline the existing status in this regard.

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.

The upper midland zone lies between 1,300-1,500 metres above sea level and it covers mostly parts of Juja and other constituencies with the exception of Lari. The landscape comprises of volcanic middle level uplands. The lower midland zone partly covers Thika Town (Gatuanyaga), Limuru and Kikuyu constituencies. The area lies between 1,200-1,360 metres above sea level. The soils in the midland zone are dissected and are easily eroded. Other physical features include steep slopes and valleys, which are unsuitable for cultivation. Large parts of Lari, Gatundu north and south sub counties are covered by forests.

The county is covered by three broad categories of soils which are: high level upland soils, plateau soils and volcanic footbridges soils. These soils are of varying fertility levels with soils from high-level uplands, which are from volcanic rocks, being very fertile. Their fertility is conducive for livestock keeping and growth of various cash crops and food crops such as tea, coffee, horticultural products, pyrethrum, vegetables, maize, beans, peas and potatoes. These soils are found in the highlands, mostly in Gatundu South, Gatundu North, Githunguri, Kiambu, Kiambaa, Lari, Kikuyu, Kabete and Limuru Constituencies. Low fertility soils are mainly found in the middle zone and the eastern part of the county which form part of the semi-arid areas. The soils are sandy or clay and can support drought resistant crops such as soya beans and sunflower as well as ranching. These soils are mostly found in parts of Juja, Thika Town, Ruiru, Kabete, Limuru, Gatundu North and Gatundu South Constituencies.

Most parts of the county are covered by soils from volcanic footbridges. These are well drained with moderate fertility. They are red to dark brown friable clays, which are suited for cash crops like coffee, tea and pyrethrum. However, parts of Thika Town, Ruiru, Juja and Lari constituencies are covered by shallow soils, which are poorly drained, and these areas are characterized by low rainfall, which severely limits agricultural development, although they are suitable for ranching and growth of drought resistant crops

4.2.1 Hydrology and Water Resources

As mentioned above, there are limited surface water sources in the area, whereas, the area boasts of two rivers: Chania and Thika Rivers to the far north of the site. Thika town is located on a gentle plain before the ascent into the central highlands. Small valleys are on the western and northern edges following the Chania and Thika Rivers that have waterfalls and meet on the northwestern edge of Thika. Thika Town is also home to Kenya's magical and breathtaking Fourteen Falls which is located 65 kilometres North East of Nairobi off the Thika-Garissa Road. The Fourteen Falls consist of 14 distinct waterfalls on the broad section of the famous Athi River

4.2.2 Geology and Soils

The area is within larger Kiambu County. The study would like to connect the relationship of the geology and what its impact has been on the water quality. Some of the rock chemistry influences the quality and amount of groundwater potential in the area. The local geology lies in the larger Aberdean watershed the catchment area being fed by rivers from the Aberdare ranges. It's characterized by the following rocks: Recent to Quaternary; Alluvium and soils, and tuffs, Tertiary: Likipian Trachytes and Simbara Series Basalts and Kapiti phonolites, the basement system takes the bottomless layers. The short study has shown that the geology of the area has contributed to good quality water mainly because of the basaltic origin that is free from fumaroles and hydrothermal active fluids.

4.2.3 Biodiversity

The site is located within a lowly developed industrial zone and the surroundings are still characterized with natural vegetation comprising of withered grass species (*Themeda thriandra*, *Cynodon dactylon* and *Cenchrus ciliaris*), Shrubs like mainly *Balanities aegyptica* and some poisonous weeds including *Solanum incunum*. However, vegetative cover within the site has had influence from human influence through clearance to pave way for construction activities. The east side of the site is a dumpsite for Thika Municipality that also served Kiambu County.

As a result of human development influence, the area is devoid of wildlife, however, scavenging bird species that feed at the dumpsite could be sported including marabou stalk and domesticated animals as cows and goats.



Typical ground cover in the area



East of the site (Kang'oki dumpsite)



The site perimeter wall

4.2.4 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 34oC in the lower midland zone found partly in Thika Town constituency (Gatwanyaga), 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.

4.2.5 Energy Sources

Energy is the primary source that drives most of the industrial processes and to this regard, machines and lighting. This can be supplied from the national grid or self generators including solar panels and diesel/petrol generators. In addition, it is worth noting that Energy is also a primary driver of environmental change since all fuels are from natural environment and they involve conversions and extraction of resources which in some cases are unsustainable. The main source to the supply will be from KPLC mains and to some extent by internal generators as aforesaid.

4.3 Social setting

4.3.1 Population distribution

The proposed area is experiencing population surge as evidenced from the increasing housing needs being met by construction activities in the area. Specifically to the site location, no data could be obtained to ascertain the current population numbers. However, most of the population in the area

are on rental basis which is bound to change depending with the clientele preference and the employment migrations as seen in other major towns.

The 2009 Population and Housing Census indicate that the county had an urban population of 936,411 in 2009 and in 2012 was projected to be 1,018,773. Urban population is expected to reach 1,108,380 in 2015 and 1,172,453 by the end of 2017. The county urban population distribution per urban centres is as illustrated in table 4 below which shows that Ruiru and Kikuyu towns have the highest number of people living in urban areas, followed by Thika and Karuri towns respectively.

This high population in urban centre can be attributed to the proximity of the county to Nairobi as most of the people work in Nairobi and reside in the county. In addition, industrial development in some districts like Thika West and Ruiru attract more labour force. In these areas, urban planning should be effectively undertaken to avoid strain on the physical amenities from growth of informal settlements. In addition, community policing should be enhanced to reduce insecurity. Also, more infrastructural facilities like transport network, housing, schools and health centres should be built. The population distribution by urban centres is shown below.



Kiambu County

2009 Census			2012 Census		2015 Projections		2017 Projections	
	Population	Density (Km ²)						
Gatundu South	114,180	593	124,223	645	135,149	702	142,962	742
Gatundu North	100,611	352	109,460	383	119,088	417	125,972	441
Juja	118,793	365	140,609	397	140,609	432	148,737	457
Thika Town	165,342	760	179,885	827	195,706	900	207,020	952
Ruiru	201,986	1,003	219,752	1,091	239,080	1,187	252,901	1,256
Githunguri	147,763	852	160,760	927	174,899	1,008	185,010	1,067
Kiambaa	145,053	1,979	157,811	2,153	171,691	2,342	181,617	2,478
Kiambu	108,698	1,026	118,257	1,116	128,660	1,214	136,098	1,285
Kabete	140,427	2,329	152,778	2,534	166,216	2,757	175,825	2,916
Kikuyu	125,402	713	136,432	776	148,432	844	157,012	893
Limuru	131,132	466	142,666	507	155,214	552	164,187	583
Lari	123,895	282	134,792	307	146,648	334	155,125	353
Total	1,623,282		1,766,058		1,921,392		2,032,466	

Population Distribution and Density by Constituency

4.3.2 Land Use Trends

The proposed site is located adjacent to a dumpsite however in the periphery are rental residential units. Major physical land use features are as follows;

North: The northern side of the site is partly a fenced plot with rental residential housing units further two hundred meters or so away.



Adjacent plot to the proposed site

West: the western portion is open field left for the expansion of the dumpsite with rental housing flats at around five hundred meters.

South: the southern section is an open field with residential flats at approximately eight hundred meters.



General Southerly Direction from the site

East: the eastern part of the site is an open dumpsite commonly called Kang’oki dumpsite which serves the wider Kiambu county especially Thika and Ruiru towns.



General easterly direction from the site

4.3.3 Economic Patterns

Covering an area of 2,543.42 square kilometers, it is also considered one of the wealthiest counties in Kenya. It is a leading innovative commercial hub that shares its borders with five other counties; Nakuru and Kajiado to the West, Murang'a and Nyandarua to the North and Nairobi to the South.

Agriculture is the predominant economic activity in the county and contributes 17.4 per cent of the county's population income. It is the leading sub sector in terms of employment, food security, income earnings and overall contribution to the socio-economic well being of the people. Majority of the people in the county depend on the sub sector for their livelihood, with 304,449 directly or indirectly employed in the sector. Coffee and tea are the main cash crops in the county. The main food crops grown in the county are maize, beans, pineapples and irish potatoes. These are mainly grown in small scale in the upper highlands of Limuru, Kikuyu, Gatundu North and South Constituencies.

Lying about 40 kilometers from Nairobi, Thika town is popular for the pineapple plantations and the heavy industrial activity. Several industries including the Broadways Bakery, Bidco Oil Refineries, CMC motor vehicle assembly line and Thika Coffee Mills are based here. The town has witnessed rapid growth due to the explosive real estate boom in the county.

4.3.4 Noise Levels

No notable sources or significant of noise in the area except of passenger vehicles and waste trucks to the dumpsite.

4.2.5 Sensitive Areas

There are no significant sensitive cultural features and/or areas in the vicinity of the site.

4.4 PUBLIC PARTICIPATION

The consultants interviewed some of the immediate neighbours of the proposed project site with a view of seeking their comments on the potential negative environmental impacts of the proposed project to the neighbourhood. This was done by the use of questionnaires (attached), to find out views from the neighbours towards the project. All of the interviewed persons are tenants in the area who migrated due to employment opportunities within Thika town.

4.4.1 Consultation with interested and affected parties

The consultation process included to a large extent public consultation through structured interviews with interested and affected parties. Non-structured interviews were administered to all the Non-interested and affected parties.

4.4.2 The Questionnaire

The respondents filled in the assessment matrix on issues relating to:

- (1) Acceptance of the proposed project by the respondents and
- (2) Whether the proposed project will have negative impacts on the following:
 - ❖ Local residents
 - ❖ Natural ecology of the area
 - ❖ Recreational and leisure facilities
 - ❖ Public health and safety
 - ❖ Water resources and quality
 - ❖ Soils
 - ❖ Road transport

As part of the EIS process for the pyrolysis plant several key stakeholders were engaged to inform both the study and the project. These stakeholders were consulted based on their institutional mandates which govern the project and its activities, and members of the general public who are neighbours to the project. The stakeholders were engaged through Public Participation Questionnaire (appended at the end of this report). The three main purposes of this exercise were to:

- ❖ Informing stakeholders about the project and its likely effects
- ❖ Canvass their inputs, views and concerns, and
- ❖ To enable their views to be taken into account during the decision making.

Thus to achieve these the process was targeted at:

- ❖ Obtaining local and traditional knowledge that may be useful to decision making including any Indigenous Knowledge Systems (IKS);
- ❖ Facilitating consideration of alternatives, mitigation measures and trade-offs (if any);
- ❖ Ensuring that important impacts are not overlooked and benefits are maximized;
- ❖ Reducing chances of conflict through early identification of contentious issues;
- ❖ Providing an opportunity for the public to influence the project design and operational plan in a positive manner;
- ❖ Improving transparency and accountability of decision making, and
- ❖ Increasing public confidence in the ESIA.

The comments stakeholders raised were collated and analyzed to see which issues are of concern and should be addressed through this report. The following subsections list these stakeholders and the comments they raised, whilst referencing to the impact assessment section and the proposed mitigation measures to elaborate how they contributed to the formulation of the EMP of this report.

This was done in respect to the fact that public concern is fundamental to the delineation and management of the project's significant risks.

The results of the questionnaire

	Name	Residential distance from proposed site	Date	Tel. No.	Comments	
					Concerns	Recommendations
1.	Margaret Jodenya	200m	3/4/2017	0717188237	<ul style="list-style-type: none"> • Pollution of the environment (air emissions) 	<ul style="list-style-type: none"> • Control of pollution to the residents
2.	Paul Mwendwa	>300m	3/4/2017	0716568142	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Maintain clean environment
3.	Anthony Mutiso	>300m	3/4/2017	0792260498	<ul style="list-style-type: none"> • Provide employment opportunities for the unemployed 	<ul style="list-style-type: none"> • Avoiding pollution during the project cycle
4.	Vincent Lukaliaingoi	200m	3/4/2017	ID. No. 30097501	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Have the company retain all waste to its premise
5.	Kanini Mutambu	200m	3/4/2017	ID. No. 24451428	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • None
6.	Meshack Mzwo Muli	200m	3/4/2017	0707254505	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Ensure clean environment

4.4.3 ANALYSIS OF THE QUESTIONNAIRE

All the concerns raised by the area residents are already tackled within the report and in the environmental management plan for the proposed project

CHAPTER FIVE

5. ANTICIPATED IMPACTS AND MITIGATION MEASURES

5.1 Introduction

The proposed plant will be handling waste tyres and plastics into diesel oil. It is, therefore expected that there are potential emission of various gases mainly of carbon and hydrogen compounds with carbon black as the main solid waste from the process. The exhaust gases from the pyrolysis reactors are also a cause of concern of potential air quality impacts from the Project. The exhaust gases are mainly hydrocarbons. Harmful substances will be collected by the waste gas cleaning system before emitting out to the atmosphere. This scenario implies potential linkages with the surrounding environment and ecological setting that require to be addressed during the construction and upon commissioning. The following sections outline these linkages as well as proposed corrective measures.

5.2 Positive Impacts

The plant has an overall positive implication to the country, and especially urban, agricultural and industrial sectors. The major threat to the environment and human health today is risks associated with waste management. Not all waste sources of product end users are capable of handling hazardous and toxic materials within the premises without compromising the health of their own workers or the neighboring communities. The result of waste generators disposing wastes without appropriate equipment has been pollution of environmental resources and particularly water sources, air pollution, land contamination and even direct effects to human health. Some of the consumers of tyres have ended up disposing of the waste by open burning which caused pollution to the atmospheric environment. In this regard, therefore, the following are considered main benefits of the proposed plant;

- (i) Mopping up of hazardous and toxic materials from the motor vehicle industry which churns a most of the waste tyres,
- (ii) The plant will open up a chain of employment to suppliers and those who will be employed directly in the plant,
- (iii) The facility will thereby provide an avenue of energy circulation in the environment.

5.2.1 POSSIBLE IMPACTS ON THE ENVIRONMENT

5.2.2 Brief Description of the Project

The proposed pyrolysis plant consists of furnace systems. The main reactor operates at the temperature range of 350°C to 450°C. Waste gases of the main reactor are mainly made up of ($\text{CH}_4 + \text{C}_2\text{H}_4 + \text{C}_2\text{H}_6 + \text{C}_3\text{H}_6 + \text{C}_3\text{H}_8 + \text{C}_4\text{H}_8 + \text{C}_4\text{H}_{10}$), depending on the composition of waste plastics and tyres input fed into the main reactor. After pyrolysis in the main reactor, a catalyst and a second combustion chamber is used to handle and treat the waste gases under designated temperature and pressure. The waste gases are fully burned in the second chamber, whereby the temperature is controlled at 850-1000°C. This is to thermally decompose the potentially aromatic substances as well as odour and gaseous dioxins. The heat generated then re-enters the main reactor, contributing to the heating of the main reactor which is required to maintain designated temperature. This heat reclamation is environmentally beneficial and reduces the cost of fuel used by the system.

The by-products from the system are mainly waste gases and ash. A waste gas cleaning system will be installed for each pyrolysis plant system to reduce the emission of waste gases. This waste gas cleaning system consists of a cyclone, a dosing device for the additive to bind the pollutants, a reactor with a ball rotor to improve the efficiency of the additive, and a bag filter to separate dust from the waste gases. The waste gases are finally exhausted from the 20-metre high chimney installed for each of the pyrolysis furnace system. A Continuous Emission Monitoring System (CEMS) will also be installed to continuously monitor the emission concentrations of waste gases.

Ash generated from the main reactor is mainly dry black carbon charcoal. The ash settles at the bottom of the reactor, where it is discharged out of the reactor via an automated screw pump, and brought to the ash bin. The ash collected in the ash bin will be disposed of every morning.

In terms of the usage of water, a cooling water system will be developed for the pyrolysis plant system. The cooling water for the waste gas-oil separator is a closed circuit system. The cooling water would not contact with the waste gases. Hence, the cooling water will be re-used continuously and only discharged to a sedimentation tank every 3 months.

Each of the pyrolysis furnace system has a temporary storage tank of capacity of 1,000 Litres for storing the useful fuel oil extracted from the pyrolysis process. The useful fuel oil products will be collected at frequent times.

Potential impact	Construction Phase	Operation phase
Air quality (including gaseous, dust and odour emissions)	✓	✓
Noise	X	✓
Water quality	✓	✓
Waste management	✓	✓
Land contamination	✓	X
Ecology	X	X
Landscape and visual	X	X
Hazard to life	✓	✓

✓ - Possible impact

X - Impact not expected

Construction Phase

Air Quality

Dust emission may arise from the construction/installation of the pyrolysis plant. Construction works would include site formation, piling and foundation work, and concreting work. There is no extensive site formation works and the scale of construction site is limited. With the implementation of dust suppression measures stipulated under the Air Pollution Control (Construction Dust) Regulation and adoption of good site practice, no adverse construction dust impact would be expected.

Exhaust emissions may also arise from the operation of diesel-powered construction equipment. However, considering the small scale of the Project and limited area of the construction works, the number of diesel-powered plants would be less. Hence, no adverse air quality impact would be expected from the construction equipment.

Noise

The potential source of noise impact during the construction phase would mainly be the use of powered mechanical equipment (PME) for various construction activities. Considering the small scale of the Project, the number of PME would be limited; also the nearest noise sensitive receivers are the residents more than 200m away from the Project Site. Adverse noise impact during construction phase of the Project would not be expected.

Water Quality

The Project is to be built on a paved ground with adequate drainage connection to the site which is currently in use. With the limited area of excavation works at the Project site, no adverse water quality impact would be expected from the surface run-off. Domestic sewage would be generated

from the workforce during the construction phase of the Project. However, the sewage could be drained to the current sewage drains within the site, no water quality impacts from the construction works of the Project would be expected.

Waste Management

No major earthworks will be required for the Project site, as the site has already been formed at the rented land of the Project Proponent which is currently in use. General refuse, including food waste from the workforce on site and the packaging from the construction materials will be generated. Chemical waste, like the batteries and lubricating oils from the maintenance of construction equipment and installation of the pyrolysis plant system will also be generated. However, the quantities of the general refuse and chemical waste generated would not be significant during the construction phase of the Project and no adverse impact would be expected.

Land Contamination

The Project site surrounding is currently being used as a dumpsite (for example plastic bottles and plastic bags) and other waste is evident in the area. Given the general nature of waste recycling facility, there could be potential land contamination issues within the Project site.

Ecology

The Project site is adjacent to a dumpsite which may not attract other development needs. Therefore, no ecological value is found at the site. Since the proposed plant will be constructed within the built ground, no potential ecological impacts would be expected.

Particulate Matter There will be minimal production of particulate matter during the installation which is mainly installation works for the machinery. This is because; the intended installation will be done in and open shade meaning no construction need for housing of the plant. The construction of the go-downs was commenced after appropriate approvals were obtained from the Kiambu County Council and NEMA from the same county.

The main impacts of the dusty conditions are;

- (i) Aesthetic and visual problems, though there are no notable settlements within the vicinity of the site,
- (ii) Potential risks of health (mainly bronchial infections) though there are no notable inhabitants in the immediate neighbourhood,
- (iii) Deposition of dust on vegetation hampering development of the same,
- (iv) Air pollution aspects including contribution towards climate change.

Land Degradation

No significant impacts in this regard are anticipated.

Health and Safety

The main concern in this regard is the occupational welfare of the construction workers from the effects of dust and emissions from the machineries. There are also potential physical risks from moving machinery, falling from high places especially when installations on heights as chimneys as well as personal injuries from objects around the construction site. Neighbouring residents are not likely to be affected since the proposed site has fenced off to keep off intruders.

Biodiversity

There will be no loss of bio diversity since the installation site has been approved for development and the proponent will be a tenant.

Social Impacts

There are no displacements or direct interference with any social groups within and around the site since no settlements were found at the time of this assessment. Anticipated social impacts would be related to gaseous emissions, generation of dust and noise but there are no inhabitants in the immediate neighbourhood of the site.

5.2.3 OPERATIONS

Air Quality

Potential air quality impacts may arise from the combustion of fuels to supply the required heat energy for main reactors of the pyrolysis furnace system. Major air pollutants emitted from the exhausts of fuel combustion will include nitrogen oxides, sulphur dioxide and particulates.

The exhaust gases from the pyrolysis reactors are also a cause of concern of potential air quality impacts from the Project. The exhaust gases are mainly hydrocarbons. Harmful substances will be collected by the waste gas cleaning system before emitting out to the atmosphere.

Since each pyrolysis furnace system is connected to a storage tank, fugitive emission of volatile organic carbons may arise from the storage tanks, pumps and valves connected to the tanks.

Odour emission is also a potential issue due to the shredding of the waste plastics within the Project site.

Noise

Potential noise sources from the Project include shredding of waste plastics and tyres, valves and pumps of the pyrolysis furnace system. noise impact due to the Project will be insignificant.

Water Quality

Water in the cooling water system of the pyrolysis plant will be reused. Also, the Project site has already will have a septic tank to hold effluent waste, and no adverse water quality impact would be expected during the operation of the Project.

Waste Management

From the process, ash which is mostly dry black carbon charcoal, would be generated during the operation phase of the Project. The ash will be collected from the pyrolysis furnace system daily for potential reuse and recovery. Chemical waste such as the spent lubricating oil, paint and oil filters from equipment maintenance will be properly collected and disposed of in accordance with Waste Disposal. Considering the small quantities of equipment on site, the amount of chemical wastes that would be generated is small.

General refuse is expected to arise from the workforce during the operation of the Project. However, since the Project is not expected to generate a large amount of general refuse and the site has already been in use with proper waste management, adverse impact from general refuse is not expected.

Land Contamination

Land contamination (if any) within the Project site will be identified and possible remediation options will be addressed in the environmental management plan. As any not entirely contaminated soil / groundwater will be properly assessed and remediated, no land contamination issues are expected during the operation of the Project.

Ecology

The project site is located at the existing active dumpsite, No ecological value is found on this land lot and the surrounding area and potential ecological impacts would not be expected from the operation of the Project.

Landscape and Visual

The highest structure for the Project is the chimney for each of the pyrolysis furnace system, which is 20 metres high in the preliminary design. Structure of maximum height of 35 metres will be allowed whenever necessary depending of the prevailing wind streng. Also, with due consideration of the landscape and visual impacts, no adverse landscape and visual impact would be expected from the Project.

Hazard to Life

Potential hazard to life issue may arise from the four temporary fuel oil storage tanks which are used to store the useful fuel oil products for each of the pyrolysis furnace system. However, considering the small storage capacity for each storage tank and the regular collection of the fuel oil products 3 times daily, no adverse hazard to life impact arising from the Project is expected. On the other hand, pyrolysis gas is generated as an intermediate product in the production process. Pyrolysis gas is a flammable substance. Accidental release would lead to fire or explosion hazard. The potential risk to the surrounding population will need to be addressed. Potential cumulative hazard to life issue from the bio-diesel plant as well as escalation impact of the pyrolysis plant would need to be assessed should the operation of the Project site affect those neighbouring plant processing and storage facilities and vice versa.

Health and Safety

The health of the plant workers varies from one section to another as outlined below;

- (i) Health risks are found in the management of the waste holding areas, the transfer routes and preparation procedures. The risks including exposing the workers to a wide open burning of fuel and raw material in case of fire breakout. The neighbourhood could also be affected through wind or surface runoff transferring contaminants and other emissions
- (ii) Combustion areas are the most critical section in respect of health and safety due to amount of heat required in the process.
- (iii) Heat is also a serious impact to the employees operating the plant since they are likely to be open. The general ambient heat around the entire premises is also likely to be relatively high extending the risk to more workers,
- (iv) Personal accidents and risks of getting injured by falling objects to the workers and visitors while moving around the premises cannot be ignored.
- (v) There are risks of fire outbreaks from kilns, oil storage areas posing potential danger to not only the site, but also the neighbouring land users,

5.2.4 DECOMMISSIONING PHASE

The plant is designed for a lifespan of between 50 – 100 years subject to effective maintenance. During this period, it is possible that necessary retrofits will be carried out on the equipment, plant layout could be reviewed and processes could be changed while major structural changes and expansions might be found necessary. At the end of the plant life, a scheduled plant will be necessary to remove the site component, a process referred to as decommissioning.

The following decommissioning actions will be required;

- (i) Removal of any major section of the plant will require a decommissioning process to ensure safe removal, movement, transfer, reuse or disposal. Such actions will be required for furnaces.
- (ii) Any desired expansion of the plant, installation of an major component or notable changes to the plant component will require an environmental impact assessment study carried for review and approval by NEMA,
- (iii) For total removal of the plant, prior notice will be given to NEMA at least one year before,
- (iv) A comprehensive decommissioning audit report of the entire plant will be mandatory at the ultimate removal at the end of the plan life.

5.3 MITIGATION MEASURES

Following are global mitigation measures while specific actions are presented in the matrix under Table 1 below.

5.3.1 MANAGEMENT MEASURES

Corporate Initiatives

While planning the site management, it will be necessary to consider the following basic aspects on environmental conservation;

- (i) The health and safety of the workers, the neighbouring communities and on-site installations should of key importance and necessary mechanisms should be provided at all times during the project cycle,
- (ii) Emissions into the environment have undesirable off-site effects on public health, particularly those in the windward direction. In this regard it will be necessary to plan for a monitoring mechanism and maintenance of records on air quality profiles as part of the corporate capacity building plan,

- (iii) Capacity building in environmental conservation will also be a necessary item in the site management such as to address the entire management structure as well as suppliers of goods and services including waste generators.

Site Operations

Appropriate financial and human resources will require to be provided for continuous improvement of the environmental performance at the premises and the surroundings. In this regard performance evaluations, reviews of management practices and assessment of material consumption and capacity of the workers are among the operational aspects that will require constant attention.

Infrastructural Maintenance

Management of environment at the active site cannot be complete until an effective monitoring and maintenance schedule is established. This includes a continuous performance improvement, integration of environmental issues in hygiene and sanitation, provision of basic “green” facilities (safe in-house movement and performance evaluation from customers) are some of the continuous improvement tools that may be applied. Others important tools include;

- (i) Carrying out regular operation performance appraisals,
- (ii) Follow scheduled maintenance of equipment and facilities,
- (iii) Documentation and record-keeping on resource utilization and conservation,
- (iv) Observing good house-keeping at all times with specific focus on waste management,
- (v) Regular review of site planning,
- (vi) Contractual documents with customers and goods/service suppliers to reflective environmental responsibility,
- (vii) Undertake scheduled monitoring and statutory annual environmental auditing.

Capacity Building

The environmental issues identified in this report require that Environmental and Combustion Consultant Limited establish appropriate technical and physical capacity to ensure sustainability and continuous improvement in environmental management. Capacity is required in;

- (i) Documented guidelines on environmental conservation to enable the firm identify environmental issues and adopt appropriate action plan towards minimizing impacts to the environment, health and safety.

- (ii) The guidelines should be established and formulated into a corporate policy statement, an environmental policy, environmental management programme, environmental management operational manuals, standard operation procedures, standard contractual documents for customers as well as goods and service suppliers and a legal register,
- (iii) Physical infrastructure for environmental management at the site maintained at optimum performance levels. Among the basic structural features are in-house solid waste storage arrangements to prevent residuals reaching the external environments, waste water (leachate and wash water) drains and the related containment reservoirs,
- (iv) Awareness and skills in environmental management for the operators, supervisors, support staff, customers and material suppliers,
- (v) A qualified environmental officer to oversee all matters related to management and conservation aspects who would also take charge of health and safety issues including basic training on specific skills and technical understanding on environmental, health and safety to all workers, a general awareness to the customers, contractors and suppliers.

5.3.2 OPERATIONAL MEASURES

Liquid Wastewater Management

The following are basic aspects for inclusion in the site design and the wastewater handled in accordance with waste regulations Legal Notice No. 120 of September 2006;

- (i) Construct a concrete slab for holding of the scrap metals coming from the tyres.
- (ii) Surface runoff and spills from the plant and any other oil storage areas should be collected and channeled into an oil interception chamber for easy management from environmental contamination.
- (iii) Maintain appropriate records on wastewater quality for compliance evaluation and comparison with the gazetted standards on a continuous basis,
- (iv) Isolate domestic wastewater from process wastewater for containment in septic tanks and regular exhaustion,
- (v) Oil storage areas should be provided with slabs with surrounding bunds to contain any spilt oils. Runoff from the oil storage areas.

Solid Waste Management

Handling of solid wastes at the site will require the following components and handled in compliance with the waste regulations Legal Notice No. 121 of September 2006;

- (i) The waste slab should be provided with compartments for segregation of various categories of waste classified on source and physical nature that should also be handled separately,
- (ii) Provide solid waste holding bins at strategic locations around the premises and install transfer stations and modalities of waste removal to approved dumping grounds.
- (iii) Other solid waste from the facility should be handles as highlighted in the waste management regulation.

Aerial Emissions

Gaseous and particulate matter is perhaps the most critical environmental aspect associated with the proposed operations. The following measures should be considered to reduce the elated impacts;

- (i) The kilns should be designed with provisions of flue gas trapping, smoke interception and stacks fitted with scrubbers (for gases) and filters for particulate matter removal,

Health and Safety

Attention should also be on the health and safety of the workers, visitors, customers and neighbouring community such as to include;

- (i) All moving machine parts and high temperature areas should be fitted with guard rails and restrict access,
- (ii) Provide all employees with personal protective gear and enforce application at all times within the place work,
- (iii) 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,
- (iv) Segregate scrap materials on sources basis and devise safe modes of handling each category especially those that have been removed from the tyres.
- (v) Training and induction of all employees and visitors on site to enhance safety.

5.4 MITIGATION MEASURES

Table 1: Impact – Mitigation Matrix

Development Stage	Environmental Aspects	Anticipated Impacts	Recommendations Mitigation Measures
Construction	Environmental Pollution – Noise and dust generation	<ul style="list-style-type: none"> ▪ Air pollution from - dust, ▪ Emissions from construction equipment and material deliver trucks, ▪ Public nuisance from construction equipment. ▪ Noise from construction activities 	<ul style="list-style-type: none"> ▪ Maintain construction site dump at all times, ▪ Ensure that all civil works are carried out during normal working hours (8:00 am – 5:00 pm) ▪ Construction equipment maintained a good working order at all times, ▪ Fence up the construction site to keep off intruders. ▪ Ensure that all noise is kept to prescribed exposure limits.
	Solid waste generation	<ul style="list-style-type: none"> ▪ Approximately 14kg/day of domestic waste ▪ Around 1,000 kg/day construction waste will be generated 	<ul style="list-style-type: none"> ▪ Construction waste will be used to backfill and to help develop access road to the site ▪ Remaining waste will be sent to landfill ▪ Domestic waste will be segregated for composting
	Drainage	<ul style="list-style-type: none"> ▪ Change in storm water regime around the site, ▪ Soil erosion creating siltation of natural drains during rains, ▪ Discharge of wastewater from the site into dry drainage system with risks of environmental pollution downstream. 	<ul style="list-style-type: none"> ▪ Consider surface contours and channel storm water appropriately, ▪ Link the site drainage with natural drainage pattern in the area.
	Social Issues	<p><u>Noise Levels:</u></p> <ul style="list-style-type: none"> ▪ High noise levels from construction machinery and materials' delivery trucks, <p><u>Health and Safety:</u></p> <ul style="list-style-type: none"> ▪ Bronchial infections from dusts and other emissions, ▪ Water sources contamination, 	<ul style="list-style-type: none"> ▪ Construction to take place only during the day, ▪ Maintain machinery in good working order.
			<ul style="list-style-type: none"> ▪ Keep dry construction materials dump at all times, ▪ Keep emissions from sources the lowest possible limits,

Development Stage	Environmental Aspects	Anticipated Impacts	Recommendations Mitigation Measures
		<ul style="list-style-type: none"> Risks to health and safety of the construction workers, e.g. HIV/AIDS. 	<ul style="list-style-type: none"> Provide personal protective gear to the workers and ensure application at all times, Fence up the construction site to keep off intruders, Install warning signage around the construction site
		<p><u>Cultural Values:</u></p> <ul style="list-style-type: none"> Social interaction of construction workers with local communities, Moral effects (e.g. rise in prostitution, crime, etc.) 	Sensitize workers and local communities on moral values and cultural integration.
Operation	Waste Water Aspects	<ul style="list-style-type: none"> Surface water contamination, Land and soil degradation Pollution from disposal of scrap oil, leachate and wastewater, Pollution from off-site solid waste dumping, 	<ul style="list-style-type: none"> Ensure acceptable solid waste collection systems from sources, storage arrangement and transfer, Develop appropriate documentation and waste manifest for hazardous waste movement, Install oil interceptors and grit traps along all the affected drainage system, Slab the hazardous wastes holding yard and install trapping arrangement for leachate and surface runoff there from.
	Flue gas emission	<ul style="list-style-type: none"> No harmful emissions (dioxins and furans) produced 	<ul style="list-style-type: none"> Emissions will be in accordance with standards, with $<100\mu\text{g}/\text{m}^3$ PM_{10} 90% PM removal with wet scrubber
	Noise Levels	<ul style="list-style-type: none"> Noise generation from factory is expected to be 58 dBA and 45 dBA at a distance of 500m and 100m respectively 	<ul style="list-style-type: none"> Plant will operate 12 hours per day. Noise generated will be with respect to industrial noise exposure limits
	Biological Diversity	<ul style="list-style-type: none"> No signs of significant wild life in the area, Removal of grass cover, arid trees and shrubs, Related microorganisms associated with the scarce vegetation removed. 	<ul style="list-style-type: none"> Ensure solid refuse handlers dispose into approved grounds to avoid biodiversity degradation, Plant trees on the open spaces continuously, Externalize initiative for ecological conservation.

Development Stage	Environmental Aspects	Anticipated Impacts	Recommendations Mitigation Measures
Operations	Social Impacts	<p><u>Income Generating Initiatives:</u></p> <p>No directly negative impact to income generation on the area. Positively affecting the local social and economy</p>	<ul style="list-style-type: none"> ▪ Enhance employment opportunities for the local community, ▪ Provide leadership on opportunity for collaboration with waste recyclers, ▪ Ensure sustainability through cost savings from waste minimization at sources and recycling options, ▪ Expand the scrap metal market and create more opportunities.
		<p><u>Social and Cultural Issues:</u></p> <ul style="list-style-type: none"> ▪ Social nuisance from pollution to physical environment such as land and air by emissions from the site, ▪ Social complaints and concerns on health and safety, ▪ Cultural intrusion from employee intrusion, ▪ Conflict on land use, ▪ Conflicts at off-site solid waste dumping areas, 	<ul style="list-style-type: none"> ▪ Maintain efficiency in the emission reduction point sources and minimize external effects, ▪ Establish a public relation strategy with the neighbourhood for enhanced co-existence, ▪ Undertake statutory annual environmental audit for continuous improvement on social issues. ▪ Enhance monitoring system on social concerns, ▪ Invest in social responsibility initiatives, ▪ Comply with labour laws and related regulations.
		<p><u>Health and safety:</u></p> <ul style="list-style-type: none"> ▪ Risk to workers' health from aerial emissions originating from the site operations, ▪ Risks to life through outbreak of fires, ▪ Health problems from excessive heat, ▪ Risks of fire to the site property and that of the neighbours, ▪ Risks from internal movements of workers and customers, ▪ Slippery surfaces, e.g. store rooms, 	<ul style="list-style-type: none"> ▪ Provide all workers with the necessary personal protective equipment and ensure application at all times, ▪ Enhance good hygiene practices to reduce exposure of the employees and customers to infections, ▪ Provide suitable signage for fire escapes and convenience directions, ▪ Develop a disaster management manual on a wide range of health, safety and security issues, among

			<p>them fire accidents,</p> <ul style="list-style-type: none"> ▪ Undertake scheduled fire safety drills,
Operations	Solid Waste Management	<ul style="list-style-type: none"> ▪ Risks to Health and safety, ▪ Risks to environmental pollution, ▪ Ground water quality degradation at off-site disposal sites, ▪ Aesthetic pollution in the site and neighbourhood (acetylene gas production residuals – calcium oxide slurry), ▪ Public nuisance at off-site disposal sites, ▪ Illegal waste dumping 	<ul style="list-style-type: none"> ▪ Develop a procedure for waste segregation on site, through provision of necessary containers for various waste categories, ▪ Contracts with external waste recyclers and/or handlers should include conditions on waste transfers and verification of final destination, ▪ Characterize all wastes and keep a record of types and quantities. Annual waste audit may be necessary.
	Compliance	<ul style="list-style-type: none"> ▪ Penalties from non-compliance, 	<ul style="list-style-type: none"> ▪ Environmental compliance to be based on the provisions of MCA, 1999 and the Waste Regulations thereof (Legal Notices 120 and 121 of September 2006), ▪ Undertake annual environmental audits as per the law, ▪ Establish environment compliant objectives for the specific operations in liaison of a legal expert,, ▪ Establish a corporate environmental policy, ▪ Establish an environmental management committee with a qualified team leader, ▪ Increase workers awareness on environmental policies and their responsibilities, ▪ Develop a legal register for continuous compliance self evaluation

CHAPTER SIX

6. ENVIRONMENTAL MANAGEMENT PLAN

This environment management plan presents integrated scenarios with the environmental aspects, anticipated impacts during construction and occupation as well as preventive (mitigation) action plans. Other issues covered include the responsibilities, costs implications, timeframes and parameters for monitoring of the trends. The EMP matrix is designed such that it is self-implementing and can be implemented.

6.1 The EMP Guiding Principles

The development and operation of the waste management plant would be expected to observe environmental conservation requirements in accordance to the national regulations. To realize this goal, acceptability and minimal effects to the physical environment as well as the wellbeing of the surrounding communities will require to be integrated in the completion of the project through constant consultations, evaluations and review of the design aspects and modes of operation throughout the project cycle. Among the factors that need to be considered in this project implementation and its post evaluation initiatives will include;

- (i) Preservation of the natural beauty of the immediate surrounding areas,
- (ii) Control of soil erosion and siltation of springs downstream as public sources of water,
- (iii) Enhanced integration of environmental, social and economic functions,
- (iv) Incorporation of safety provisions in the premises including easy accessibility to the road, adequate in-house signage and information systems among others.
- (v) Enhancing the contractor's performance,
- (vi) Realization of cordial relations among various community, economic, social and cultural groups as well as between the local community and the contractor,
- (vii) Enhancing equity and maximizing social and economic benefits for the local community through income generation from employment,

6.2 Environment Management Policy

It is recommended that specific guidelines are developed to allow integration of environmental management considerations in the construction, commissioning as well as the use of public amenities and resources within site area. The guidelines will be a basis for compliance actions, responsible practices for the college residents and appropriate code of conduct for all stakeholders. Among the factors that need to be considered in this guideline will include;

- (i) The contractor and other players in the construction activities be prevailed upon to implement this EMP,

- (ii) The development should appreciate the interests of the neighbouring communities at all stages of the project,
- (iii) Maintenance of the natural beauty of the countryside around the site area such as to include green belts and other beautification initiatives,
- (iv) Enhanced integration of environmental, social and economic functions in the project design and implementation plans including safety provisions,
- (v) A site specific environmental, health and safety plan is established soon after commissioned.

6.3 Specific Management Issues

6.3.1 Health and Safety

Safety Issues

Collaboration with relevant environmental and health related authorities, compliance to OSHA 2007 as well as appropriate experts would be necessary to provide necessary advice in this regard. At the site, appropriate safety measures would be observed, but it will also be necessary to involve the workers and neighboring communities on awareness and sensitization at all times, e.g. provision of personal protection equipments to all workers and non-interference by the neighbourhood.

Health Issues

Ensure that the plant operates efficiently so as to avoid any direct burning of the raw materials which might cause pollution to the environment through complete combustion. Control emissions from the machineries as well as dusty conditions throughout the construction cycle and check operation points upon commissioning. The proponent should also ensure that workers are protected from any other hazard which might pose risk to health. In addition, occupier will ensure that risk assessment is conducted for the plant and remedial action put in place.

6.3.2 Site Operation

It will be necessary to monitor certain social and economic trends associated with the zone operations. Commissioning of the facility, it is anticipated that it will motivate increased traffic flow into the area, reduce vehicular speed at the entrance point and heavy commercial trucks accessing the zone. Road accidents would be expected to rise initially before taking a predictable trend and residents residing in the area will learn to live with the new surroundings. More economic activity opportunities will also appear leading to a larger shopping centers around the free zone area.

6.4 Management Responsibilities

In order to implement the management plan, it is recommended that a position is created for an appropriate expertise to oversee matters of environment and social management as well as enhanced safety and security measures within and around the site. The services of an

environmental expert may be required to co-ordinate and monitor environmental management for the site during construction and post monitoring audits. This would be done under the responsibility of the site contractor during construction.

The responsibility relationship is as follows;

- (i) Ja-Recycling will be responsible for all coordination activities and liaisons, particularly in regard to issues of environment, social and safety issues,
- (ii) The Project Manager is the Contactor's link with the Ja-Recycling on matters of environmental and social nature and is responsible of implementing the environmental management plan established under this report,
- (iii) It would also be recommended that a Safety, Health and Environmental (EHS)/Public Relations Office (PRO) created on the basis of ability to directly interact with the local community for social sustainability. Upon commissioning, the Management should establish a PR office.
- (iv) NEMA shall be responsible of surveillance of environmental and social aspects of the project implementation. It will be expected that their concerns are communicated to the Ja-Recycling.

6.5 ENVIRONMENTAL MANAGEMENT PLAN

Table 2: EMP Matrix

Development stage	Impacts Anticipated	Proposed Actions	Responsibility and Timeframe	Targets and Cost Estimates	Monitorable Indicators
Construction	Environmental Pollution	<ul style="list-style-type: none"> ▪ Ensure contractor undertaking on environmental considerations, ▪ Monitor trends on health and safety of construction workers and neighbourhood, ▪ Contractor to maintain material balance records at all times 	<p>Ja-Recycling and Contractor</p> <p>Continuous throughout construction period</p>	<p>Sustainable construction</p> <p>No direct cost involved</p>	<ul style="list-style-type: none"> ▪ Complaints from neighbourhood, ▪ Concerns from environmental authorities and local Municipal Council.
	Waste Management	<ul style="list-style-type: none"> ▪ Disposal of waste be done in accordance to waste regulations, ▪ Contractor to undertake safe waste disposal, ▪ Verify legality of waste disposal destination 	<p>Ja-Recycling and Contractor</p> <p>Continuous throughout construction period</p>	<p>Safe construction waste management</p>	<p>Compliance with waste management regulations</p>

Development stage	Impacts Anticipated	Proposed Actions	Responsibility and Timeframe	Targets and Cost Estimates	Monitorable Indicators
	Social Aspects	<ul style="list-style-type: none"> ▪ Address concerns of neighbouring land users as per this report, ▪ Integrate public safety in the construction process, ▪ Utilize local labor for construction for enhance social harmony. 	<p>Ja-Recycling and Contractor</p> <p>Initiate action with construction</p>	<p>Social harmony</p> <p>No direct cost involved</p>	<p>Residents complaint</p> <p>Public opinion</p>
Commissioning	–	<ul style="list-style-type: none"> ▪ Construction camp decommissioning on pre-planned schedule, ▪ File a completion report to NEMA for initial inspection 	<p>Ja-Recycling</p> <p>Upon operation commencement</p>	<p>Identifiable baseline status of the plant</p>	<p>Fulfillment of the mitigation measures recommended</p>
Operations	Environmental Pollution	<ul style="list-style-type: none"> ▪ Equipment specifications to conform with environmental standards, ▪ Integrate environmental components in the site design (waste management, emission controls, etc.), ▪ Apply to the extent possible provisions of the waste management regulations, Thika Municipal Council by-laws, Public Health Standards, etc., ▪ Enhance in-house awareness and sensitization on environmental protection initiatives, 	<p>Ja-Recycling</p> <p>Immediately and continuous</p>	<p>Integration of environmental components/ide as in the site operations.</p> <p>Cost shall be established</p>	<ul style="list-style-type: none"> ▪ Discharges into the public drainage system, ▪ Emissions into the air, ▪ Related health effects to the site operators, ▪ Public complaints.

Development stage	Impacts Anticipated	Proposed Actions	Responsibility and Timeframe	Targets and Cost Estimates	Monitorable Indicators
	Waste Management	<ul style="list-style-type: none"> ▪ Maintain Isolation of surface storm water drains from those carrying oil/grease residuals, ▪ Enhance water recycling for conservation purposes (Whenever applicable), ▪ Compliance to waste management regulations (Legal Notice Nos. 120 and 121), ▪ In-house training on waste management options for managers and supervisors, ▪ Provide leadership in waste recycling and re-use. 	<p>Ja Recycling</p> <p>Immediately and continuous</p>	<p>Streamlined waste flow paths.</p> <p>KShs. 500,000 as initial capital</p>	<ul style="list-style-type: none"> ▪ Waste categories and separation, ▪ Mode of transfer ▪ Final destinations.
Operations	Air quality	<ul style="list-style-type: none"> ▪ Dry materials shall be kept dump or covered at all time, ▪ Install gadgets to intercept the particulate matter as well as controlling gaseous emissions. 	<p>Ja-Recycling Management managers</p> <p>Initial installation are design controlled</p>	<p>Reduced concentrations of aerial pollutants</p> <p>To be determined during operation</p>	<p>Visibility of chimney emissions,</p> <p>Public complaint</p> <p>The measured air quality aspects must meet the set standards in the Air Quality Regulation</p>
	Vegetation cover	Introduction of vegetation (trees, shrubs and grass) on open spaces within and around the site. Indigenous species	<p>Ja-Recycling</p> <p>Upon</p>	Greening the compound and	Number of trees planted.

Development stage	Impacts Anticipated	Proposed Actions	Responsibility and Timeframe	Targets and Cost Estimates	Monitorable Indicators
		would be preferred.	commissioning	landscaping KShs500,000 over 5 years	This action will develop a vegetated landscape that will also help in holding the soil intact thus reducing erosion and dust.
	Social Aspects	<ul style="list-style-type: none"> ▪ Draw of-site contracts to enhance socially acceptable procedures, ▪ Involve more independent interested parties (waste collectors) in establishing options for waste recycling, 	Ja-Recycling Upon commissioning then continuous	Social acceptability and co-existence.	Health problems and degradation of environmental resources, The public opinion, Satisfaction to the relevant authority.
	Health and Safety	<ul style="list-style-type: none"> ▪ Constitute health and safety committee, ▪ Maintain safety reticulation (e.g. fire detection and fighting equipment), ▪ Train on HS issues and provide PPEs and enforce applications, ▪ Install all machines and equipment with protective guard rails at the moving parts. 	Ja-Recycling Immediately	Quick and effective response to emergencies. Annual budget of KShs. 250,000	<ul style="list-style-type: none"> ▪ The security and safety of the neighbouring premises, ▪ Safety cases over a period of time, ▪ Response period on safety and medical aspects.
Operation	Noise levels	<ul style="list-style-type: none"> ▪ Initiate a noise mapping programme 	Ja Recycling	Compliance	Occupational levels of 70dBA,

Development stage	Impacts Anticipated	Proposed Actions	Responsibility and Timeframe	Targets and Cost Estimates	Monitorable Indicators
		<p>and keep monitoring,</p> <ul style="list-style-type: none"> ▪ Undertake a annual hearing survey of all the workers, ▪ Train, provide ear muffs/corks and enforce application, 	<p>Supervisors.</p> <p>Upon commissioning and continuous.</p>	<p>KShs. 300,000 for equipment and professional guidance</p>	<p>External receptors as defined under the EMCA regulations on noise and vibrations (2009)</p>
	Compliance Aspects	<ul style="list-style-type: none"> ▪ Develop an environmental policy, ▪ Establish a legal register on critical relevant environmental laws, ▪ Annual environmental audits as required by law, ▪ Develop Standard Operation Procedures focusing on environment, health and safety. 	<p>Ja-Recycling Continuous</p>	<p>An all time compliance</p> <p>About KShs. 200,000 per year</p>	<p>A facility to ensure compliance with laid down guidelines at all times</p>
	Institution Framework	<ul style="list-style-type: none"> ▪ Adapt environmental aspects in administrative framework, ▪ Review the contracting arrangement at all levels of the operations, ▪ Establish a monitoring and reporting protocol on environmental conservation, ▪ Engage a professional to oversee 	<p>Ja-Recycling Continuous</p>	<p>Coordinated environmental management</p> <p>No direct costs anticipated</p>	<p>To ensure that all actions on environment are integrated in the future corporate business plans</p>

Development stage	Impacts Anticipated	Proposed Actions	Responsibility and Timeframe	Targets and Cost Estimates	Monitorable Indicators
		environmental management.			
Corporate Initiatives	Capacity Building (Documentation and human resources capacity)	<ul style="list-style-type: none"> ▪ Establish an information resource point (for reference by the site operators), ▪ Document in-house guidelines and procedures on environmental management, ▪ Develop a training programme for workers on safety, health, and environment, ▪ Engage a qualified staff to oversee environment, health and safety. 	Ja-Recycling Continuous	Sustainability and sharing with others No direct costs involved	To provide necessary knowledge, tools and awareness to all workers for effective human resource capacity development.
	Physical infrastructural capacity	<ul style="list-style-type: none"> ▪ Establish a waste collection, transfer and storage mechanisms, ▪ Characterize and identify all waste streams up to final destinations, ▪ Monitor the carrying capacity of the environmental infrastructure receiving the wastes, ▪ Install monitoring facilities along the waste pathways 			This provide organized system for the workers with respect to environment, health and safety protection
	Collaboration	Collaborate with other players on environmental protection, waste	Ja-Recycling	Sustained capacity	Kenya Institute of Waste Management is recommended

Development stage	Impacts Anticipated	Proposed Actions	Responsibility and Timeframe	Targets and Cost Estimates	Monitorable Indicators
		management programmes.		building	
Decommissioning	Composite impacts	<ul style="list-style-type: none"> ▪ Notify NEMA and other authorities on intension to stop operations at least 1 year in advance, ▪ Carry out a decommissioning audit and submit report to NEMA for review six months in advance, ▪ Close down equipment and participate in the plan for site inspection, ▪ Initiate removal following strictly recommendations of the decommissioning audit report. ▪ Initiate a programme to rehabilitate the site to near its original state, ▪ Monitor the site on related parameters for 1 year. ▪ ALTERNATIVE: Negotiate with a new operator BUT undertake an environmental liability audit. 	<p>Ja-Recycling, NEMA, Kiambu county, ERC and environmental expert.</p> <p>Process to take 2 years on a pre-agreed schedule</p>	<p>Rehabilitated site</p> <p>Costs to be identified through the decommissioning audit report</p>	<p>Air quality and soil status in the area.</p> <p>Social and economic implications in the area</p> <p>Destination of waste material disposal.</p>

CHAPTER SEVEN

7. CONCLUSION AND RECOMMENDATION

7.1 Conclusion

From the foregoing, it is concluded that the proposed pyrolysis plant is in appropriate location in as far as land use and interactions with human social and economic setting is concerned. There are minimal habitations in the neighbourhood, no significant sensitive environmental features are found within the vicinity and the area is not fully zoned for waste handling (damping site) giving an opportunity to isolate the location for this purpose in future. The proposed development has been approved by Kiambu County Council subject to compliance with all regulations while land transfers to the ownership of the proponent have been accomplished. However, there are certain social concerns that touch on general environmental pollution, groundwater contamination, health of the workers, attraction of human settlements in future and soil contamination. For this reason, appropriate preventive measures have been developed in this report. The measures, if integrated in the site design and operations and maintained throughout the site lifespan, will ensure environmental and social sustainability of the factory.

7.2 Recommendation

It is recommended that the plant be licensed to proceed subject to full implementation of the environmental management plan in addition to observing the mitigation measures established for every impact identified. Among the specific recommendations include,

- (i) Ensure waste and wastewater management regulations are complied with through provision of appropriate facilities including wastewater treatment facility, solid waste collection bins and transfer arrangements. Hazardous waste holding units should be isolated from the external environment at all times,
- (ii) Aerial emissions be controlled through appropriate extraction fans in the operation areas into bag houses, electrostatic precipitators and installed scrubbers in the stacks to ensure no hazardous residuals finds their way back in to the natural environment,
- (iii) Safety measures for the workers and the neighbouring community shall be integrated in the entire project cycle,
- (iv) Compliance with the existing laws and regulations shall be upheld at all times,
- (v) The above environmental management plan shall be adopted and applied as the basis for addressing environmental and social aspects throughout the project cycle with necessary amendments as may found appropriate. In this connection, it will be the guiding tool for future audits and monitoring exercises.

REFERENCES

- (1) Kenya gazette supplement Acts 2000, Environmental Management and Coordination Act Number 8 of 1999. *Government printer, Nairobi*
- (2) Kenya gazette supplement Acts *Building Code 2000* by government printer, Nairobi
- (3) Kenya gazette supplement Acts *Land Planning Act (Cap. 303)* government printer, Nairobi
- (4) Kenya gazette supplement Acts *Local Authority Act (Cap. 265)* government printer, Nairobi
- (5) Kenya gazette supplement Acts Penal Code Act (Cap.63) government printer, Nairobi
- (6) Kenya gazette supplement Acts *Physical Planning Act, 1999* government printer, Nairobi
- (7) Kenya gazette supplement Acts *Public Health Act (Cap. 242)* government printer, Nairobi
- (8) Kenya gazette supplement number 56. Environmental Impact Assessment and Audit Regulations 2003. *Government printer, Nairobi*