ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR THE PROPOSED WASTE TYRE PYROLYSIS PLANT IN KWALE/SAMBURU/SOUTH SAMBURU-GORA.

(Latitude -3.793285º and longitude 39.299327º)

(NEMA TOR 574)

PROJECT PROPONENT:

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Document Authentication

This Environment and Social Impact Assessment (ESIA) Study for the above mentioned project have been prepared by Katrina Management Consultants Limited (NEMA Registered and licensed EIA/EA Firm of Experts) in consultation with the Masani Eco Green Ltd (Project Proponent).

This ESIA 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 ESIA Study Report are correct, complete, accurate and righteous to the best of our knowledge and will be sufficient to provide adequate and informative Environmental and Social Impact Assessment on the Masani Eco Green Ltd Development.

PROJECT PROPONENTS

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Signature……Date……

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Abbreviations

Covid-19	Corona Virus Disease
EA	Environmental Audit
EDL	Effluent Discharge License
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
EMP	Environmental Management Plan
EMS	Environmental Management System
ETP	Effluent Treatment Plant
LTP	Leach ate Treatment Plant
Ha	Hectare
KES	Kenya Shillings
KPLC	Kenya Power & Lighting Company Limited
LR No	Land registration number
MDG's	Millennium Development Goals
NEAP	National Environment Action Plan
NEMA	National Environmental Management Authority
OSHA	Occupational Safety and Health Act
pH	Potential of Hydrogen
PPE	Personal Protective Equipment
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization
WRA	Water Resources Authority

Non-Technical Summary

Introduction

Masani Eco Green Ltd proposes to set up a 30-tonne per day pyrolysis plant located along the Nairobi-Mombasa highway within Samburu Kwale County, on Plot Kwale/Samburu/South Samburu-Gora. The proposed project entails the installation of the plant in a shed to be constructed on site. Other support facilities will include; key staff residence, cabro paved surface for storage of waste or scrap tyres, store, office and a workshop. The proponent intends to set up waste to energy plant as a long lasting solution to waste tyre problems.

Pyrolysis is an advanced technique for tyre recycling; it is a thermo-chemical decomposition of organic material at elevated temperatures in the absence of oxygen. Pyrolysis typically occurs under pressure and at operating temperatures about 430 °C. This is latest technology for fuel extraction from rubber/tyre and waste plastics. Pyrolysis plant is renewable energy generation system. Pyrolysis produces gas, oil, carbon black and steel.

To comply with the requirements of the Environmental Management and Co-ordination Act (EMCA) of 2015 and the Environmental Impact Assessment and Audit Regulations 2003, the project owner has commissioned Katrina Management Consultants Limited to prepare an Environmental and Social Impact Assessment (ESIA) Study Report. The environmental study was commissioned in May, 2023. To initiate the public consultation process, Community Public Consultation Meetings were organized by the local leaders including focus group discussion for the Project Affected Persons.

Terms of Reference

The Terms of Reference for this assessment are based on the Environmental Impact Assessment and Audit Regulations dated June 2003. The TOR was submitted to NEMA and issued with a reference number TOR 574 which was reviewed and approved by NEMA on the 18th May 2023, copy of which is attached to this report.

Project location and scope

The proposed Masani Eco Green Ltd development shall be located along the Nairobi-Mombasa highway within Samburu, Kwale County, on Plot Kwale/Samburu/South Samburu-Gora. The proposed site for the Waste Tyre Pyrolysis Plant is currently 8.5 acres but is projected the plant will occupy only 2 acres. The area is served with good road network since it’s adjacent to the Mombasa Nairobi Highway which will ease the access to the facility. The project shall comprise of the following components:

- Boundary Wall and Main Entrance Gate;
- Go-down Shed;
- Administration block;
- Ablution block;
- Access road from the main Road;
- Electricity connection.

Project Cost

The total cost of the proposed project is estimated to cost Thirty Six Million Seven Hundred and One Thousand Six Hundred and Eighty Two Shillings (Ksh. 36,701,682) as per the attached summary of bill of quantities. This amount will be distributed to various project activities that include; procurement of the pyrolysis equipment, builders work, electrical services installations, mechanical service installations, external works, site installations, preliminaries and contingencies. The NEMA fees is payable at 0.1% the project cost with a minimum of 10,000.00 whichever greater. Therefore, the total fee payable to NEMA is Thirty Six Thousand Seven Hundred and One Shillings (Ksh. 36.701).

Legal and regulatory compliance

Masani Eco Green Ltd is committed to comply with all applicable legal provisions and regulations which have been reviewed in the report:

- The Constitution of Kenya (2010)
- Environmental Management & Coordination Act, 1999 (Amended 2015) and Subsidiary Regulations
- Environmental Management and Co-ordination (Waste Management) Regulations 2006
- Environmental (Impact Assessment and Audit) Regulations, 2003
- EMCA (Water Quality) Regulations, 2006
- Environmental Management and Coordination (Air Quality) Regulations, 2014
- Land Act 2012
- The Public Health Act (Cap 242)
- The Occupational Safety and Health Act, 2007
- The Water Act, 2016 and The Water Resources Management Rules, 2007
- The County Governments Act 2012
- Employment Act 2007
- Standards Act Chapter 496
- Draft Waste Tyre Management Regulation, 2013
- Sustainable Development Goals (SDGs)

Public Participation

Legal Notice of 101 of June 2003 requires that all environmental and social assessment process in Kenya to incorporate Public Consultation.

Key stakeholder consultation was undertaken in the project area. The team identified stakeholder who are key to implementation of the proposed project as well as those who rely on such services. The stakeholders included County Government officials, National Government officials, and Non-governmental organization among others.

PCMs – The Consultant in collaboration with the national government led by the ACC Samburu Sub County, the Senior Chief Matopeni carried out public participation on the proposed Masani Eco Green Ltd project. The meetings were held in two venues namely at the proposed Pyrolisis Plant site and at the Chief's Office in Samburu.

In their consultations, the community sensitization meetings targeted in general all community members within the project area.

Project Impacts:

Construction phase

Project impacts and their mitigation measures have been discussed in the report and they include:

- Procurement of construction materials:
- Employment opportunities
- Enhancement of local economy / More cash in circulation
- Occupational health and safety hazards
- Energy utilization:
- Water Utilization
- Waste production:
- Influx of construction workers into the area:
- Construction traffic:

Operation phase

- Pollution – Environmental Degradation
- Electricity consumption – pressure on supply
- Gaseous emissions into the atmosphere
- Reduction in biodiversity in the area due to altered habitats
- Possible changes in soil quality / soil erosion
- Employment opportunities
- Occupational health and safety hazards
- Improvement of infrastructure and social amenities through CSR activities
- Water supply and consumption

Decommissioning phase Impacts

- Solid Waste Generation
- Dust
- Noise and Vibration
- Labour work
- Occupational Health and Safety Hazards

Project Alternatives

Project alternatives discussed in the report include:

- Site alternative
- Alternative Technologies
- Alternative Waste Tyre management
- Alternative Equipment
- "No Project" Alternatives

Impact Matrix

The impact matrix below summarizes the positive and negative impacts by type and mitigation measures.

Environmental Impact	Impact Type								Mitigation	
	Positive		Negative							
	Significant	Not Significant	Significant	Not significant	Short term	Long term	irreversible	Cumulative	No mitigation	Mitigation Required
CONSTRUCTION AND INSTALLATION PHASE IMPACTS										
Employment opportunities	x				x				x	
More Cash in Circulation	x					x			x	
Occupational health and safety hazards			x		x	x				x
Energy utilization	x				x				x	
Water utilization	x			x	x					x
Waste production			x		x					x
Influx of construction workers	x			x	x					x
Increase in social vices e.g. prostitution, STDs, HIV-			x		x					x

Environmental Impact	Impact Type								Mitigation	
	Positive		Negative							
	Significant	Not Significant	Significant	Not significant	Short term	Long term	irreversible	Cumulative	No mitigation	Mitigation Required
AIDS										
Archeological findings				x	x					x
OPERATION PHASE IMPACTS										
Employment opportunities	x					x		x	x	
Increased pressure on infrastructure				x		x		x		x
The Waste Tyre Maintenance	x							x	x	
Land and water pollution – oil spills, effluent discharge			x					x		x
Air pollution / Emissions				x	x				x	
Electricity consumption			x			x				x
Noise and Vibration				x	x				x	
Reduction in biodiversity				x		x		x		x

Environmental Impact	Impact Type								Mitigation	
	Positive		Negative							
	Significant	Not Significant	Significant	Not significant	Short term	Long term	irreversible	Cumulative	No mitigation	Mitigation Required
Limitation of grazing lands			x			x		x		x
Reduction of theft by youth	x					x			x	
Employment opportunities	x					x		x	x	
Improved infrastructure and social amenities through CSR	x					x		x	x	
Provision of alternative fuel i.e. Fuel Oil	x					x			x	
Occupational health and safety hazards	x					x				x
Water supply and consumption			x			x				x
Land-use and landscape changes				x		x		x		x
DECOMISSIONING PHASE IMPACTS										

Environmental Impact	Impact Type								Mitigation	
	Positive		Negative							
	Significant	Not Significant	Significant	Not significant	Short term	Long term	irreversible	Cumulative	No mitigation	Mitigation Required
Solid waste generation				x	x					x
Dust			x		x					x
Noise and vibration			x		x					x
Rehabilitation	x				x				x	
Employment		x			x				x	
Occupational Health and Safety hazards			x		x					x

Conclusion

This ESIA Study Report has been prepared to provide sufficient and relevant information on the proposed project to enable NEMA to establish whether activities of the project are likely to have significant adverse environmental impacts. Mitigation measures have been proposed for identified impacts in this report and an Environmental Management Plan (EMP) for the implementation of the proposed measures has been presented. The EMP presented in this report is a tool to be used by the Project Team during the construction, hand-over and operation periods.

1. INTRODUCTION AND SCOPE OF STUDY

1.1 Introduction

In the modern world energy is used for creating new commodities. By the year 2100, the world population is expected to be in excess of 12 billion and it is estimated that the demand for energy will be increased by five times from what it is now. Also it is estimated that petroleum reserves of the world will be nearly exhausted by (2040). The increasing human population on the earth causes ever-increasing demand of energy. So transformation of energy in to useful and suitable form aims to fulfill and suit the needs and requirement of human being in the best reliable way.

Scrap tyre is an important source of alternative potential energy. The fascination with scrap tyres is due to its easy availability as solid wastes in Kenya as well as all over the world and its favorable pyrolysis characteristics. The number of used tyres is increasing day by day due to the civilization.

A variety of scrap tyres are available in the modern society. They can be classified as rickshaw tyre, motorcycle tyre, truck tyre etc. Disposal of used tyres is of growing interest due to more and more restrictive legislation in developed and western countries. One common way of disposal is land filling. Land filling for disposal of used tyres is connected with some problems: it needs a considerable amount of space because the volume of tyres cannot be compacted. Dumped scrap tyres in massive stockpiles, which provide ideal breeding grounds for disease carrying mosquitoes and other vermin. Also, land filling is a potential danger because of the possibility of accidental fires with high emissions of hazardous gases. However, all of them have significant drawbacks. Therefore, pyrolysis can be considered as viable recycling technology to treat the scrap tyres.

1.2 Background and Rationale of the EIA

To comply with the requirements of the Environmental Management and Co-ordination Act (EMCA) of 2015 and the Environmental Impact Assessment and Audit Regulations 2003, the project proponent has commissioned Katrina Management Consultants Limited to prepare an Environmental and Social Impact Assessment (EIA) Project Report. The environmental study was commissioned in May, 2023. To initiate the public consultation process, Community Public Consultation Meetings were organized by the local leaders including focus group discussion for the Project Affected Persons.

1.3 Scope

As a requirement by the Environmental Management and Coordination (Amendment) Act 2015, of Kenya, a project proponent is required to undertake an Environmental Impact Assessment study before undertaking any project highlighted in Schedule 2 of the Act. This study seeks to fulfill this requirement. This study is necessary at the planning stages of the undertaking to ensure that significant impacts on the environment are taken into consideration during the design, construction, operation, and decommissioning of the facility.

The project scope included literature review; detailed and updated description of the project design and proposed implementation schedule, costs, as well as suitable alternative options; an in-depth analysis of the environmental and social baseline conditions; an outline of policy, legal and institutional framework governing the sector with specific focus on chemical processing; inclusive public participation and meaningful stakeholder engagement; establishment of details of significant environmental and social impacts associated with the construction, operation, decommissioning or after-use plans and post-decommissioning of the project; recommend appropriate mitigation measures for all adverse environmental and social impacts and enhancement of the benefits; and develop an Environmental and Social Management Plan (ESMP) for all the project's phases giving specific actions, responsibilities, cost estimates, timeframes and indicators that can be monitored.

1.4 Terms of Reference

The Terms of Reference for this assessment are based on the Environmental Impact Assessment and Audit Regulations dated June 2003. The TOR was submitted to NEMA and given reference number TOR 574 which was reviewed and approved by NEMA on the 18th May 2023, copy of which is attached to this report.

1.5 Methodology

After preliminary visits to the proposed site, the following were carried out in the preparation of this document:

i) Observations, discussions with stakeholders and lead agencies
ii) Documentary review of the nature of the proposed project;
iii) Policy and legal frameworks, social and environmental setting of the area;
iv) Checklists were prepared to identify possible environmental and human safety issues, photography, etc;
v) Review of the project designs and implementation plans and comprehensive discussions with the project proponent;
vi) Report writing

2. PROJECT DESCRIPTION

2.1 Project Objectives

The objective of the proposed project is to put up a waste tyre pyrolysis plant to extract fuel oil for commercial and industrial uses. This will not only generate revenue to the proponent and Government but also generate environmental benefits by eliminating disposal of waste tyres into land fill and air pollution as a result of burning as well as generate energy and valuable by products (black carbon and steel wire).

2.2 Project Justification

The unique renewable technology has come up with a concept of setting new standard in renewable energy that include using of waste tyres as a raw material and producing green fuel oil, carbon black, steel and gas. With global warming and utilization of rubber, it has now become necessary to recycle the waste and convert it in fuel oil in such a way that it is environment friendly. This is a unique technology that can change energy market scenario in a big way. The fuel oil, steel carbon and gas are commercially valuable materials that can generate additional income the rate of recovery is good and that means million tons of waste can be recycle to million tons of fuel oil, steel and carbon black. Hence today's recycling of scrap tyres not only provides an environment friendly solution to the world for disposal but also generates income and employment highly profitable solution.

2.3 Proposed Project Components

The proposed Masani Eco Green Ltd development shall be located along the Nairobi-Mombasa highway within Samburu Kwale County, on Plot Kwale/Samburu/South Samburu-Gora. The proposed site for the Waste Tyre Pyrolysis Plant is currently 8.5 acres but is projected the plant will occupy only 2 acres. The area is served with good road network since it's adjacent to the Mombasa Nairobi Highway which will ease the access to the facility. The project shall comprise of the following components:

- Boundary wall and main entrance gate;
- Go-down shed;
- Administration block;
- Ablution block;
- Access road from the main road;
- Electricity connection.

2.4 Processing activities

Pyrolysis is an advanced technique for tyre recycling; it is a thermo-chemical decomposition of organic material at elevated temperatures in the absence of oxygen. Pyrolysis typically occurs under pressure and at operating temperatures about 430 °C. This is the latest technology for fuel extraction from rubber/tyres and waste plastics. Pyrolysis plant is renewable energy generation system. Pyrolysis produces gas, oil, carbon black and steel.

2.4.1 Manufacturing Process

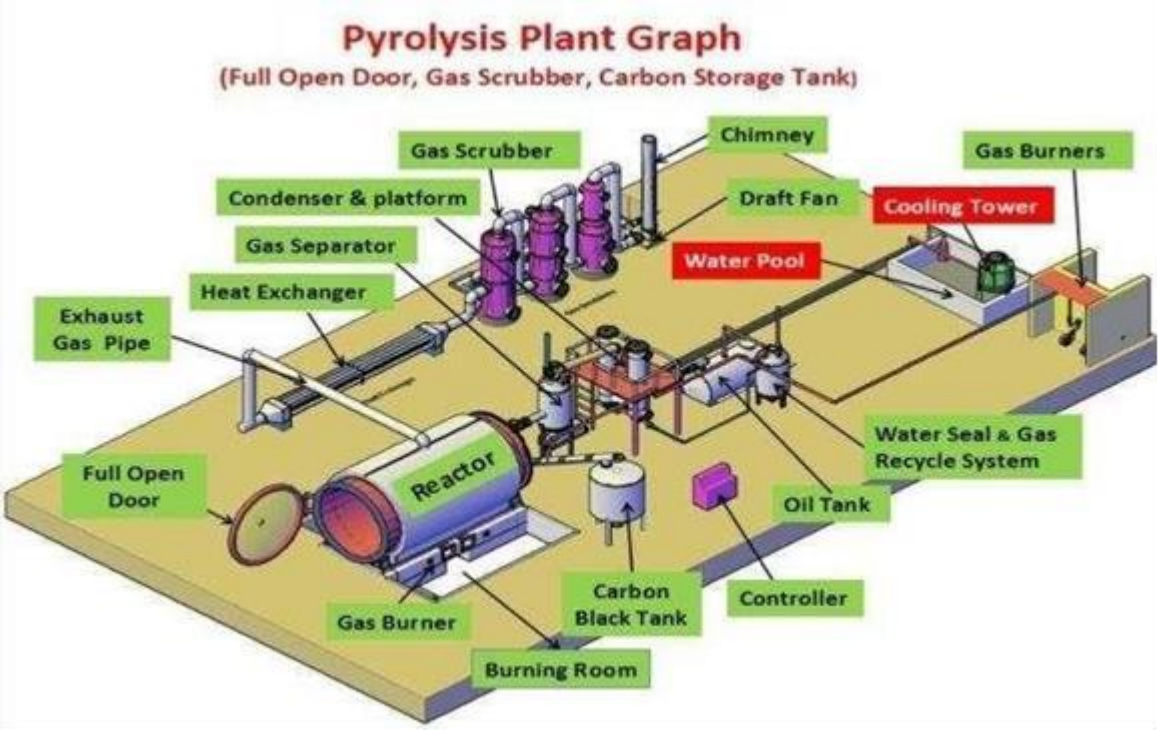


Figure 1: Batch process System

i) The waste tyres are feed in to the reactor vessel and heated under controlled conditions of the temperature and pressure;
ii) The process will bring about molecular restructuring of the rubber under the pyrolysis process as the result; furnace oil in gaseous form is produced along with other gases;
iii) These vaporized gases are passed though heat exchanger, where in the furnace oil is condensed in to liquid form;
iv) The product of pyrolysis in the form of vapor is sent to a water cooled condenser and condensed liquid is collected as a fuel;
v) The non-condensable gases were let out to atmosphere. The TPO collected is crude in nature. For an output of 1 kg of TPO about 2.09 kg of waste tyres feedstock is required. The heat energy required to convert the waste tyres in to products is around 7.08 MJ/kg.
vi) During the process, carbon black and steel are also generated;
vii) The heat exchanger uses coolant water, as a condensing medium and this water is re-circulated through process;
viii) Waste tyres delivered to a site are weighed. Tyres are introduced to system whole or else halved, chopped, or shredded; Magnetic separation is often used to remove ferrous metals from size reduced tyres;
ix) The feedstock is typically dried and preheated, using tyre-derived gas. Oxygen is purged through a combination of the pyrolysis gas preheated and an inert gas system employing nitrogen.

x) Temperature and resistance time in the reactor are two key pyrolysis reactor design criteria. Maintaining a positive pressure in the reactor ensure that leaks do not introduce oxygen from the air.

xi) The liquid stage, Tyre-derived oil, is condensed and cooled. Light and heavy oil fraction may be handled separately. A separator removes any remaining water vapor. The product is filtered.

xii) Solid tyre-derived char is cooled. Typically using a water-cooled stage. The product may be sized and screened to remove the fiber's magnetic separation stage captures magnetic materials remaining in char. washing the char and further size reducing it produces the carbon black product;

xiii) The tyre derived gas maintains operating pressure in the system and provide heat to the system. Vented gases pass through a pollution control train, which may include gas flare;

xiv) Gas can further treated for power generation. It is passed through venture scrubber to remove particulate matter from gas and then it is passes through water cooled condenser which can help us to bring down the temp of Tyre-derived gas and cracking of tar from it. Further it is passed through various filters containing wood waste and saw dust waste to remove % moisture from gas and finally cleaned through fabric filter. Now our gas is ultra clean and can directly feed to gas driven generating set. But for continuous operation of generator we proposed low pressure vessel Waste tyre (Nylon/Radial Tyre) Deliver Pyrolysis Plant Pyrolysis Process for the storage of gas. Through this storage power generation can be done for 24 hours irrespective of gas production rate through pyrolysis of waste tyres.

2.5 Pyrolysis Products

As a result of pyrolysis of waste tyres, following materials are obtained.

2.5.1 Pyrolysis oil

Burning 1 ton of waste produces about 420 liter of pyrolysis oil, 150 kg of steel wire and 270 kg of carbon black. It is a type of Light Fuel Oil or commonly named LFO. Its kinematic viscosity is 2.6 centi-Stokes (CSt) which makes it a non-viscous liquid. The calorific value of the tyre oil is 43.8 MJ or 10,500 kcal per kg which is similar to that of diesel and gasoline. The main oil product produced by this recycling application will be the fuel oil that is widely used for industrial and commercial purposes. The oil has 40 % to 45 % of the amount of recycled scrap Tyre, which can be carried with licensed tanker trucks.

The pyrolysis oil is a quality substitute for petroleum. It is processed by using liquid technology of destructive distillation from biomass from different agricultural sectors in a reactor at temperature of about 500°C with subsequent cooling. Due to their low carbon count, these liquid bio-fuels are a great source of renewable power and heat and acts as a superior quality synthetic fuel. Pyrolysis oil is widely used in industries such as petrochemicals, forestry and other energy-intensive industries. Since it is a kind of tar, which normally contains too high levels of oxygen to be a hydrocarbon, it also helps in conversion of waste into valuable fuel while reducing carbon footprint

2.5.2 Carbon Black Powder

The second product of Waste Tyre Pyrolysis Plant is carbon black. The quantity of carbon black is about 30% to 35% according to Tyre quality. Tyre carbon black has 76% carbon, 10% ash, 3% Sulphur and other metals such as magnesium, copper, iron and zinc. The calorific value of the Tyre carbon black is 26 MJ or 6,200 kcal per kg which makes it good as a solid fuel. It will require further processing from powder into briquette form to make it suitable for combustion. The use of carbon black is as a chemical strengthener in rubber and coloring agent in pigment industries.

2.5.3 Steel Wire Scrape

The third product of Waste Tyre Pyrolysis Plant is steel wire; the quantity of steel wire is about 10% to 15% according to Tyre quality. It's very easy to sell steel wire scrape in local market. The steel wire recovered from the process is usually sold as scrap steel for recycling. For every 1ton of tyres, the fuel needed to complete the conversion of the tyres into oil and carbon black, is about 52 liters of diesel or 2,100 MJ of heat. The heat from the by-products will generate 16,800 MJ from combusting the oil and another 7,000 MJ from combusting the carbon i.e. a total heat content of 23, 800 MJ. There is therefore an 11 times gain in heat by recovering heat energy from waste Tyres which makes it worthwhile.

2.5.4 Pyrolysis Gases

We get pyrolysis gases during process about 10% of waste tyre. The main component of these gases is methane (CH4), so it cannot be condensed and stored. The gases are used to heat the reactor and or for other heating applications.

2.6 Project Implementation

The project will be implemented in the four phases: design and construction, equipment installation, operation and decommissioning.

2.6.1 Design Phase

This phase is the concept of the planned development and the designing of a structure which was envisaged to be functional and to take care of every environmental concern such as liquid and solid wastes and security. This has already been completed.

2.6.2 The Equipment Installation Phase

This phase will be based on the building standards, code and all other relevant regulations applicable in Kenya. All the proposed works will follow standard environmental guidelines, health and safety measures.

a) Equipment installation Activities
i) Construction activities

This will have to be undertaken to provide support and shelter for the additional equipment to be installed. The construction of the building walls, foundation, floor

pavement, and drainage system, among other component of the project will involve minimal masonry works and related activities. General masonry and related activities will include concrete mixing, plastering, slab construction, construction of foundation and curing of fresh concrete surfaces. These activities are known to be labour intensive hence may be supplemented by machinery such as concrete mixers.

ii) Roofing and sheet metal works

Roofing activities will include laying of iron sheets, and structural steel to the roof and fastening the roofing materials to the roof.

iii) Electrical Works

Electrical work during both construction and operation will involve installation of electrical gadgets and appliances including electrical cables, lighting apparatus, sockets etc.

2.6.3 Project's Operational Phase

Completion of construction activities will be followed by operation of the Pyrolysis plant and associated amenities. The activities to be carried out during the operation phase of the proposed project include: Reactor still container, separation system, condensation unit, air compression unit, gear pumping, turbo pumping, oil filtration device, and the control cabinet unit.

2.6.4 Project's Decommissioning Phase

During decommissioning of this Pyrolysis plant project it's advisable to return the excavated land to its original state. Analysis of the soil should be done to check on the salinity levels and the land should be rehabilitated.

2.7 Project Cost

The total cost of the proposed project is estimated to cost Thirty Six Million Seven Hundred and One Thousand Six Hundred and Eighty Two Shillings (Ksh. 36,701,682) as per the attached summary of bill of quantities. This amount will be distributed to various project activities that include; procurement of the pyrolysis equipment, builders work, electrical services installations, mechanical service installations, external works, site installations, preliminaries and contingencies. The NEMA fees is payable at 0.1% the project cost with a minimum of 10,000.00 whichever is greater. Therefore, the total fee payable to NEMA is Thirty Six Thousand Seven Hundred and One Shillings (Ksh. 36.701).

3. BASELINE INFORMATION

3.1 Location

The proposed site is located Masani Eco Green Ltd proposes to set up a 30 tonne per day pyrolysis plant located along the Nairobi-Mombasa highway within Samburu Kwale County, on Plot Kwale/Samburu/South Samburu-Gora.

The site is located on coordinates: **Latitude -3.793285º and longitude 39.299327º.**

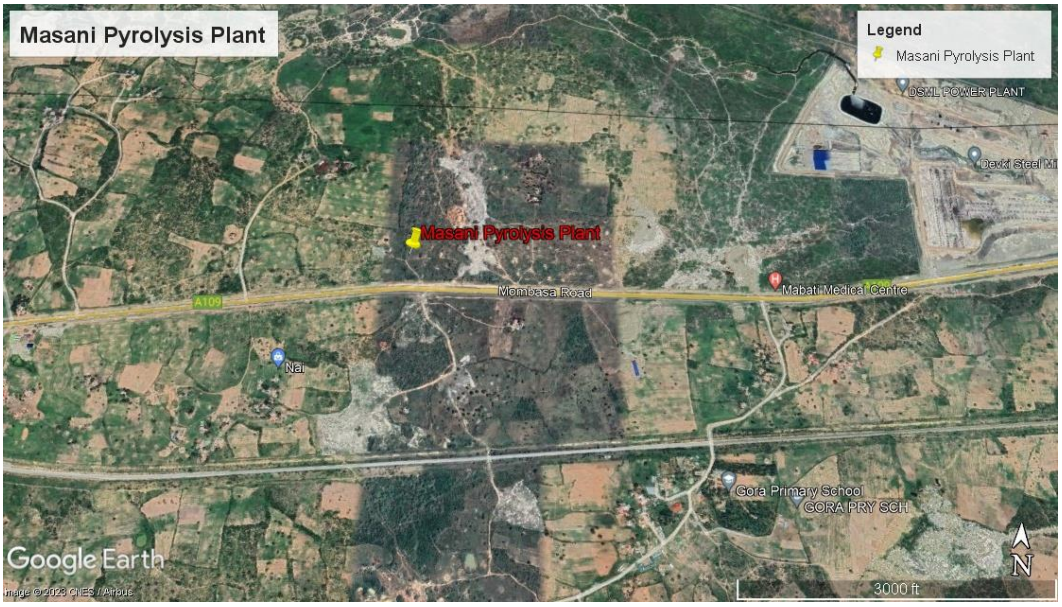


Figure 2: Google map showing location of the facility
(*Source: google earth*)

3.2 Project's surrounding

The site is currently an open parcel of land. The entire land is covered by grass, shrubs and a few mature trees that will be selectively cleared to allow for the construction. The site is near Devki Steel Mill.

Plate 1: Photos showing the proposed project site

3.3 Land Use

Agriculture, mostly of subsistence nature, is the main land use and is mainly owned by absentee landlords leading to the squatter settlement. In the drier areas of the Nyika plateau in Kinango, kasemeni, Samburu and some parts of Lunga Lunga divisions is held under group ranches and land is regarded as communal asset where every member of the community has the right to use it. Development and land use activities have largely been uncontrolled leading to the proliferation of informal settlements.

The proposed project is an industrial project while the land use in the area is a ranch in zoning. This is an activity in character with its surrounding since there is another industry located in the vicinity.

3.4 Climate

Generally, the Kenyan coastal region is characterized with a tropical and monsoon climate. The temperatures are usually high throughout the year. Maximum and minimum temperatures range between 26.5-34^{o}C and 22.5-24.5^{o}C respectively. The region experiences more than 6 hours of sunshine on a daily basis with the period between October and March exceeding 8 hours. Winds follow a typical monsoon pattern; during December to February they blow from the east and east-northeast. By March they start to shift towards the south and by April, the start of the monsoon season, they're predominantly from south-southwest. The predominant wind direction continues to be from the south from May until October with gradual eastwards shift beginning which becomes more pronounced by November and by December the cycle begins again.

The rainfall pattern is bimodal with rainfall averaging between 900-1200mm annually. The long rains come between March and July while the short one is experienced between November and December.

3.5 Topography, Geology and Soils

The project site is characterized by a slightly undulating terrain that slopes towards the Indian Ocean. The land rises gradually from sea level to 900m on the south-western side of the County. It can be divided into six physiographic regions namely:

3.5.1 **The coastal Plain**

This region is generally below 30m in altitude except from Malindi northwards where the land rises to 60m in some places. The coastline consists of beaches, mangrove forests, sand dunes north of the Ramisi River, arid creeks of which the main ones are Msambweni, Chale and Diani beaches. The creeks include marine swamps covered by mangrove forests.

3.5.2 **The Foot Plateau**

The southern extension of the coastal plain lies between 60m and 135m in altitude above sea level. It is characterised by basement rocks that also contain random reddish sand and soil patches.

3.5.3 The Coastal Range

Several sand stone hills mark the coastal range. DakaWacha and Gaabo in the north-western part of the County, Simba (347m), Kiwara (323m) and Jabana in the Kilifi and Mazeras areas and Mangea (705m) west of Watamu. The central part is incised by the Sabaki, Koromi and Goshi Rivers, lowering the altitude to below 150m level.

3.5.4 River Basins and Lowlands

Seven major rivers and numerous minor streams form the county's drainage system. The main rivers are Ramisi, Marere, Pemba, Mkurumunji, Umba, Mwachena and the Mwache River. All these rivers flow into the Indian Ocean The river basin is made up of alluvium and old sediments including sand gravel, silt, clay, and marsh and composed of narrow elongated plateaus and lowlands.

3.5.5 The plateau

At an altitude between 300m and 900m, the plateau is formed of ancient rocks, mainly metamorphic of the basement complex. Flood plains are along the Sabaki River, and in certain areas along the Ndzovuni and Rare (Goshi) rivers. Bottom land (depressions without visible drainage outlets) occurs in the north, drained by the Mukale and Wildeinia Rivers.

The soils were observed to be mainly composed of rock outcrop with patches of brown loamy soil. The soils are poor in fertility except where indigenous vegetation remains and a layer of fertile loam soil has developed. The soils can be grouped into three major units namely coastal plain, coastal uplands and erosional plain. In general terms, the lithology of Kwale County is composed of sedimentary rocks of the Mesozoic and cainozoic eras. The sedimentary rocks consist of a variety of sandstones, siltstones, shales and limestone.

3.6 Baseline Environmental Measurements

3.6.1 Ambient Air Quality

CSI International Limited, a NEMA registered laboratory, carried out the baseline ambient air quality assessment within the project location with strict adherence to the standard protocols. The aim of the exercise was to establish the baseline current air quality for future reference and comparison for the control and mitigation of air pollution at the proposed area. The results of the monitoring process were evaluated against the limits provided in the air quality regulations.

The summary of the results are shown in Table 1 below. With the exception of CO_2, the average levels of pollutants in the area were within permissible limits. However, CO_2 accounts for 0.03% (approximately500 mg/m^3) by volume of the normal dry air, hence the CO_2 levels in the area were within the expected levels. The likely sources of air pollution were the industrial site situated approximately 100m away and the movement of automobiles on the Mombasa – Nairobi Road nearby. There was no activity on going at the area at the time of measurement.

The low concentration of the pollutants indicates no health risk to the staff intended to work in the vicinity and the surrounding residents. The full report is attached in the annexes.

Table 1: Summary of ambient air quality results

	Point A	Point B	Point C	Point D	Average
Carbon Monoxide (CO)	✓	✓	✓	✓	✓
Carbon Dioxide (CO_2)	×	×	×	×	×
Hydrocarbons (C x H y)	○	○	○	○	○
Nitrogen Monoxide (NO)	○	○	○	○	○
Nitrogen Oxides (NO_2)	✓	✓	✓	✓	✓
Nitrogen Oxides (NO_X)	✓	×	×	×	✓
Oxygen (O_2)	○	○	○	○	○
Ozone (O_3)	✓	✓	✓	✓	✓
Particulate Matter (PM_{10})	✓	×	✓	✓	✓
Particulate Matter ($PM_{2.5}$)	✓	✓	✓	✓	✓
Relative humidity (RH)	○	○	○	○	○
Sulphur Dioxide (SO_2)	○	○	○	○	○
Volatile Organic Compound (VOC)	○	○	○	○	○
Key: ✓-within limits, ○ - limits not provided; × - out of limit					

3.6.2 Air Dispersion

The assessment was undertaken to predict and determine whether the pollutants the plant will generate at the time of operation would be of significant effects on local air quality. A detailed air quality assessment including air dispersion modeling was done using AERMOD (8.9.0). The maximum concentrations of the emissions tested were below the ambient tolerance limits stipulated under Air Quality Regulations, 2014 as shown in the table below. The emission source concentration was assumed to be equal to the emission limits. Based on this assumption, it is expected that the contribution of the emissions from the tyre pyrolysis plant would be below the ambient tolerance limits during open operations if the emissions are kept within the source permissible limits. During operation, the contribution of the emissions from the plant is expected to be within the ambient tolerance limit and therefore will comply with the set regulations. Detailed report is attached in the annexes.

Table 2: Summary of air dispersion results

Emission	**Period**	**Comment**
CO (mg/m^3)	1-hour	✓
	8-hour	✓
TSP ($\mu g/m^3$)	24-hour	✓
	Annual	✓
SO2 ($\mu g/m^3$)	24-hour	✓
	Annual	✓
NOX ($\mu g/m^3$)	24-hour	✓
	Annual	✓

Key: ✓ - within limits

3.7 Demographic characteristics

3.7.1 Population

The population of Kwale especially in its urban centers has been on the rise mainly due to rural urban migration, tourism and the influx of foreigners. In the Kenyan Coast as a whole, population distribution in the hinterlands is mainly affected by rainfall distribution, altitude, agro-ecological zones and administrative policy through which a number of settlement schemes have been created. The 2019 population census figures show that the County had 866,820 persons and a density of 104.9 persons per km².

The Coastal population in Kenya is culturally heterogeneous. The largest indigenous ethnic group being the Mijikenda which is comprised of nine sub-tribes namely: Giriama, Digo, Rabai, Duruma, Kauma, Chonyi, Kambe, Ribe, and Jibana. Other indigenous Coastal ethnic groups are: Taita, Pokomo, Bajuni, Orma, Sagala, and Swahili.

3.7.2 Settlement patterns

Settlement patterns in Kwale County are influenced by infrastructure network (roads, water, and electricity) and high agricultural potential zones. High population densities are found in Kinango, Matuga and Samburu Sub Counties along the tarmac road of Mombasa-Nairobi up to Mariakani urban town. These areas are also well supplied with piped water and electricity. High population clusters are also found in Shimba hills area and some parts of Samburu Sub County where there are high potentials for agricultural production. These areas are rangelands and are less productive agriculturally.

3.7.3 Poverty Status

The immediate cause of poverty in the Kwale County has been attributed to landlessness, high and increasing cost of living, inaccessibility to credit facilities, lack of entrepreneurial skills, unemployment, low incomes and HIV/AIDS and discrimination at places of work. In general, poverty has led to over-use and destruction of natural resources where short-term development goals are pursued at the expense of long-term environmental sustainability. Therefore there is need to ensure that environmental concerns are integrated into development planning and that development plans lead to empowerment of local communities to engage in sustainable livelihood activities.

3.8 Environmental quality

3.8.1 Water availability

Kwale County is generally water scarce both in terms of surface and ground water and largely depend on piped water from the Mzima Springs and Baricho Water. The only permanent river is the Ramisi River which feeds the Pambe Water Works and crosses the northern part of Kwale County. The others are temporary due to few catchment areas, sandy soils which have high infiltration rates and high evapo-transpiration rates.

Ground water resources are exploited along the coastline through shallow wells and bore holes but diminish as one move inland. This is because inland boreholes have to be deep and in most cases the water quality is poor; hard, mineralized and saline.

When the study turned to the respondents' sources of drinking water within the project area, the results obtained were as shown in the figure below. Majority of them had access to piped water source (59%), followed by other sources of water through private water vendors at 17%. Drawing directly from the river at 13%, hand dug wells at 9% and borehole water at 2%.

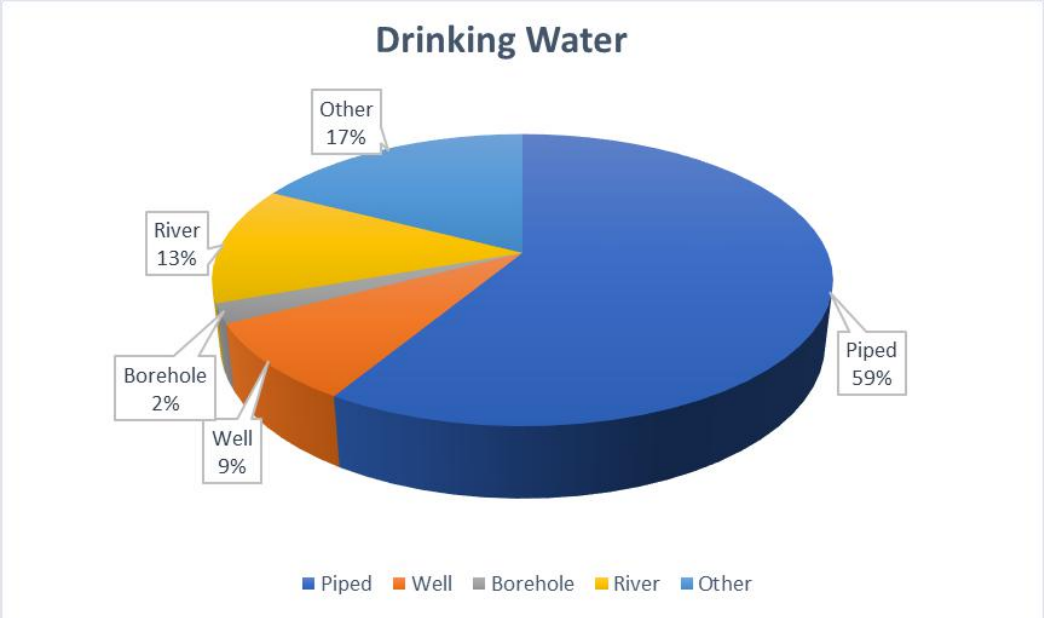


Figure 3: Sources of domestic water in the Project

Source: ESIA Study Socio-economic Survey, 2023

3.8.2 Solid waste and sewerage management issues

The main waste generation sources are domestic, commercial ventures, hotels, markets, industries and institutions including health facilities. The types of waste that are generated can be classified as follows:

- Mixed heavy plastics -Soft drink bottles, detergent bottles, cooking oil/fat bottles, household plastics etc.
- Mixed light plastics - Wrapping films, waste collection bags
- Rubber - Old tires, shoe soles etc
- Mixed paper - Books, office paper, newspapers carton pieces etc
- Metals -Pieces and sheets of aluminum, steel and other metals
- Mixed glass - Coloured and non-coloured, broken or whole glass bottles, panes, household glass items etc
- Organics - Food remnants, wooden debris, yard waste etc
- Biomedical waste- waste from hospitals, dispensaries and medical clinics.

All types of waste are transported to the designated disposal site. These include hazardous types containing pesticides, heavy metals, oils, batteries, acids, domestic and hospital wastes. It is against this background that the private sector has initiated ways to address the problem of waste management through construction of compost pits in areas where collection is limited and providing waste disposal services to complement those provided by the County Government. The project area has no sewerage infrastructure hence the common methods for disposal of human wastes is through pit latrines and septic tank and soak away pit systems. The proposed project will make use of septic tanks and soakage pit for disposal of sewage and waste water.

Respondents on sanitation infrastructure within the area

When the study turned to the respondents' types of sanitation infrastructure being used within the project area, the results obtained were as shown in the figure below. Majority utilises pit latrines at 52% and flush toilets at 7%. Significant population within the area still practice open defecation in bushes and gardens at 39%.

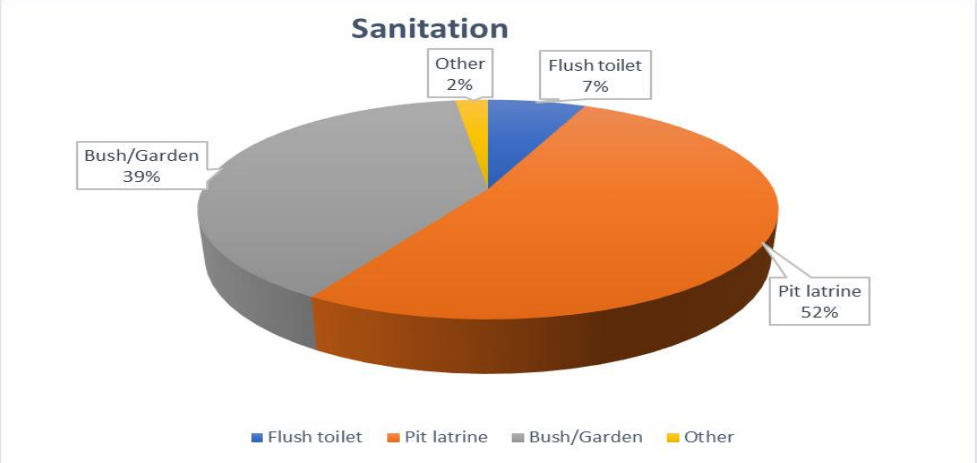


Figure 4: Methods of sanitation in the Project Area

Source: ESIA Study Socio-economic Survey, 2023

3.8.3 Protected areas

Gazetted forests, *kayas* and marine parks constitute the protected areas in Kwale County. The protected areas include Shimba Hills, Mwaluganji Elephant Sanctuary, Kisite-Mpunguti Marine National Park. The *Kayas* (sacred forests) include Chonyi, Kambe, Ribe, Jibana, Kauma and Kayafungo. The marine parks and reserves include, part of the Mombasa marine and National Reserve, Watamu-Malindi Marine National Park and Reserve (coral gardens) and part of the Malindi Marine and National Reserve. The part of Arabuko Sokoke forest which falls in Kilifi County constitutes19,000 Ha out of the 37,000 Ha .The forest is situated between Kilifi creek and The Sabaki River. The forest has a very high biological diversity. It is one of the important sites for bird conservation in Kenya (Kesley and Langton). Six of the bird species listed as rare in the ICBP/IUCN Bird red databook occurs in this forest.

Two of these bird species, the Sokoke Owl (Otus arena) and the clerk's weaver (*Ploceusgolandi*) are found nowhere else in the world except in this forest. In addition to the endemic bird species, Arabuko Sokoke is also home to other terrestrial fauna. For instance it is the only known home for the endangered *Cephalophusadersi*, the frog *Leptopelisflavomacculatus*, and two butterfly species, the *Charaxesprotocles* and the *Charaxeslasti*.

The Marine Parks and Reserves in the coastal zone are made up of several different ecosystems each with a high degree of faunal and floral diversity. The ecosystems include coral reefs, mangroves, tidal and estuarine ecosystems. The coral reef runs parallel to the coast at distances ranging from 500m- 2 km from the shoreline. The coral reefs are one of the examples of biologically productive and taxonomically diverse ecosystems. About 140 species of soft and hard corals have been identified along the Kenyan coast. They are very important in that they form breeding grounds for various marine fauna, they serve as a barrier against the force of the sea and the lagoons they protect provides stable environment for breeding and feeding of marine biota.

3.8.4 Flora and Fauna

Human interference and particularly agriculture have greatly modified the original floral and faunal status of the County. Several vegetation types including coastal dunes, woodlands, bush-lands and savannas are encountered from the shoreline inland. It is likely that prior to the maize and coconut cultivation, Kwale County was covered in bush land. Currently, 30% of the County is covered under maize, coconut trees and citrus plants. The remaining 70% of the site comprises of bush land.

3.9 Infrastructure

3.9.1 Roads

Most rural areas at the coast are served with a dilapidated and narrow road network contrary to most urban centers such as Mombasa, Kilifi and Kwale which are well served by both classified and non-classified roads. The road networks are greatly influenced by existence of important industrial, tourism and commercial centers. Except for the Mombasa-Nairobi highway most of the roads are earth roads. The proposed site has a good road network and adequate transport linkages.

3.9.2 Telecommunications

The county has 14 branches of the public post office available at Kwale, Msambweni, Kinango, Ukunda, Shimba Hills, Lunga-Lunga, Vanga, Kikoneni, Shimoni, Lukore, Diani, Matuga, Mackinnon Road and Samburu.

With emergence of mobile phones and courier services, utilization these modes of communication has since remarkably taken toll leading to neglect of older communication facilities and vandalism of equipment. The three major mobile telephone service providers cover about 75% of the County with major towns such as Kwale, Ukunda/Diani, Msambweni and Kinango well covered. Equally, most of the highway from Likoni to Lunga-Lunga and Mombasa – Nairobi Highway are also well covered.

However, most of the hinterland areas are either completely uncovered or experience difficulty in accessing mobile network. The most affected areas include Kubo Division, Vanga, Samburu, Ndavaya and parts of Lunga-Lunga. Access and uptake of ICT has increased. Courier services are available in Ukunda and Kwale Towns.

Radio, television and the print media are powerful tools for information dissemination, entertainment and education. The county is well covered by the national radio station among other FM stations. Over 75% of households in the region own radios making it the most prevalent medium of communication. Television coverage is mainly concentrated in urban centres. At least five television channels cover the area. The region is supplied by four nationally most popular daily newspaper editions two of which are concentrated mainly in urban centres.

3.9.3 Access to Energy

Lack of access to clean sources of energy is a major impediment to development through health related complications such as increased respiratory infections and air pollution. The type of cooking fuel or lighting fuel used by households is related to the socio-economic status of households. High level energy sources are cleaner but cost more and are used by households with higher levels of income compared with other sources of fuel like firewood which are mainly used by households with a lower socioeconomic profile. 20.1% of residents in Kwale County use electricity as their main source of lighting. A further 17.6% use lanterns, and 41.8% use tin lamps. Electricity use is slightly common in male headed households at 12%as compared with female headed households at 8%. More than half (71.7%) of households rely on firewood for cooking while 12.2% use charcoal, 7.7% use kerosene and 6.6% use liquefied petroleum gas(LPG). The county has potential for solar, wind (Samburu and Kinango) and biogas (along the coastal strip) which has not been exploited.

Respondents on Sources of Energy for Lighting

When the study turned to the respondents' sources of energy for lighting within the project area, the results obtained were as shown in the figure below.

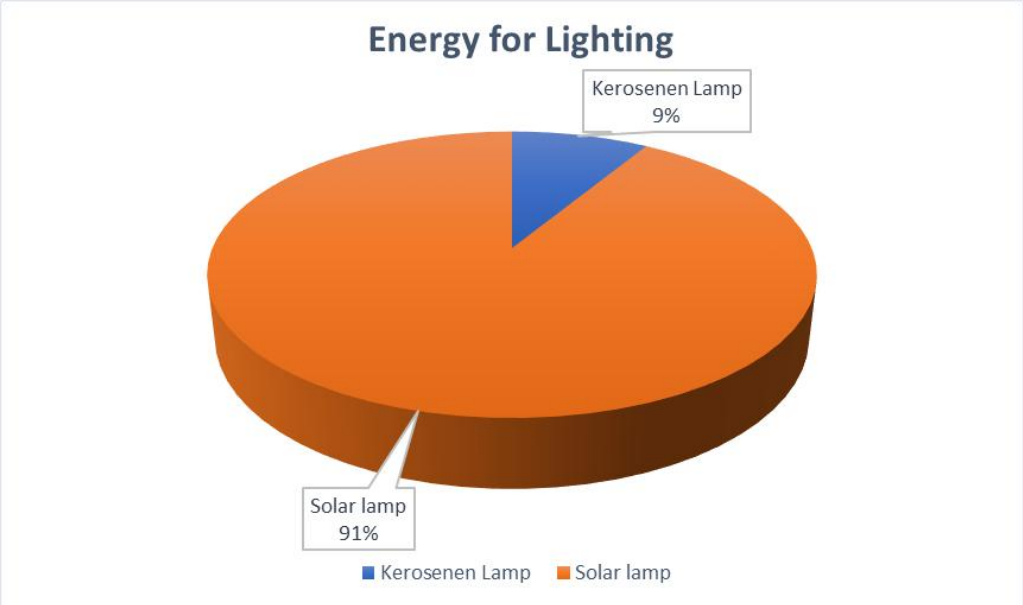


Figure 5: Sources of energy for lighting in the Project Area

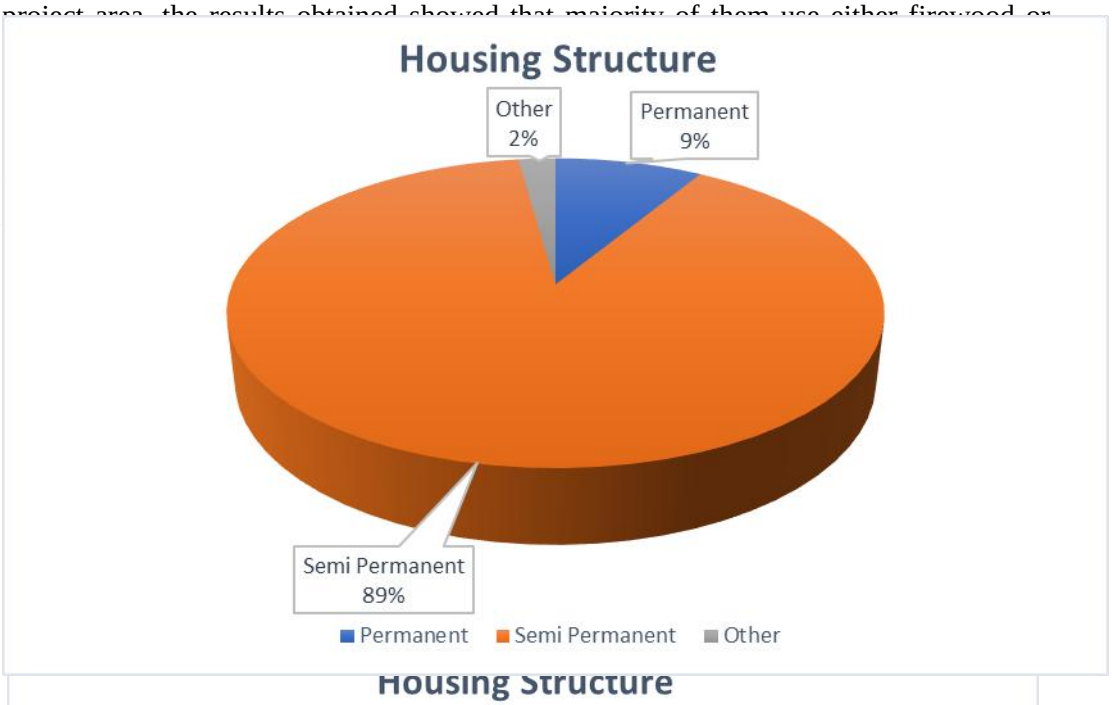
Source: ESIA Study Socio-economic Survey, 2023

It is pleasant to note that a good percentage of the community are now using clean source of energy for lighting - Solar 91%. A small number of the project area respondents use Kerosene lamps (9%). Use of kerosene lamps is unsafe health-wise and may contribute to respiratory and eye related diseases due to smoke emission. None of the respondents is connected to Electricity as a source of lighting.

Respondents on Sources of Energy for Cooking

When the study turned to the respondents' sources of energy for cooking within the project area, the results obtained showed that majority of them use either firewood or

3.9.4



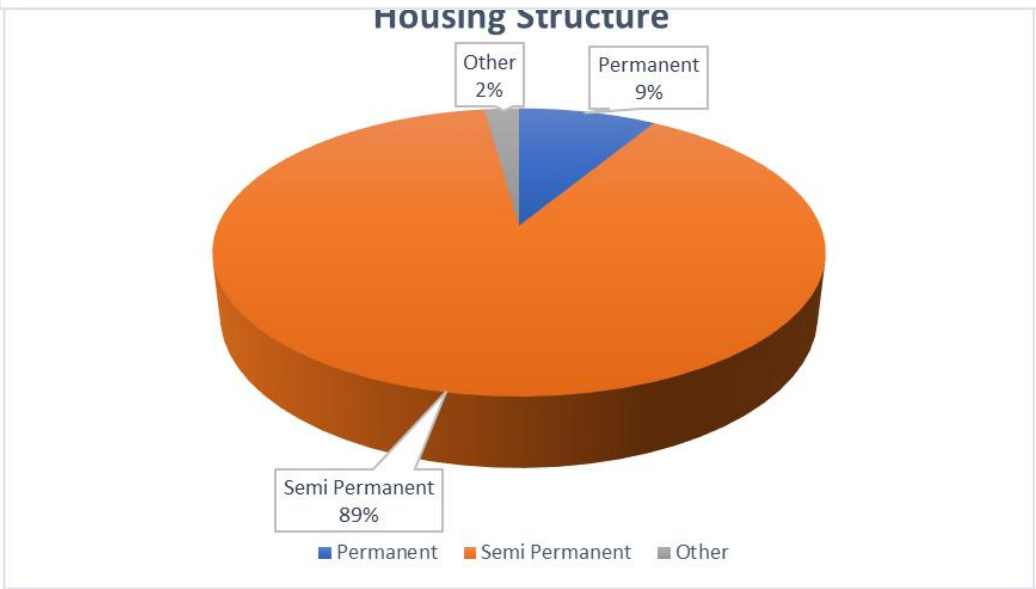


Figure 6: Type of housing in the Project Area

Source: ESIA Study Socio-economic Survey, 2023

3.9.5 Health Profile

Kenya's health system is broadly categorized into four tiers of health care, namely, tier 1 comprising of the community health, tier 2 primary health care and tier 3 are the sub county and County hospitals, and tier 4 are county referral and national referral hospitals.

The County has a total of five (5) government hospitals, ten (10) health centres and ninety (90) dispensaries located in Msambweni, Matuga, Lunga-Lunga and Kinango Sub-Counties. The doctor and nurse population ratio stands at 1:76,741 and 1:3,133 respectively. In addition, the county has a total of thirty six (36) private health facilities and nine (9) health facilities owned by faith based organizations.

The average distance to the nearest health facility within the County is seven (7) kilometres as compared to the required maximum of three (3) kilometres.

The conditions which cause high disease burden in Kwale County are malaria, anaemia, HIV, diarrhoea, respiratory conditions and non-communicable diseases. These conditions highly contribute to the high morbidity and mortality in the county. This calls for tailor – made interventions to address this health challenges in the community.

3.10 Employment

Access to jobs is essential for overcoming inequality and reducing poverty. Therefore, levels and patterns of employment and wages are significant in determining degrees of poverty and inequality. According the 2009 census, Kwale had a labour force of about 352,353 comprising of 165,636 and 186,718 male and female respectively. Wage employment is still very low within the county, contributing just 8.6% of the average household income. Wage labour is mainly concentrated in the hospitality sector, catering to tourist sites such as the natural and marine reserves (Shimba Hills National Reserve and Mwaluganje Sanctuary); historic sites (Shimoni Holes, Diani Mosques); forest, coral and sand beaches (Diani, Tiwi, Gazi, Msambweni) and wildlife habitats (bird and turtle breeding grounds). Other formal wage earners include teachers, public servants, general labourers, and those employed in the production and manufacturing sector (mining, agro industry, distilleries).

Around 30% of the total labour force aged between (15-64 years) is either unemployed or underemployed. This constitutes 105,774 people. The youths are the most adversely affected.

The contribution of self-employment to household income is at 1.9% and 6.2 percent for rural and urban areas respectively. A big number of this group is engaged in the *Jua kali* sector and other Small and Medium Enterprises (SMEs). The agriculture sector, mainly subsistence farming contributes 80.6% to the household income employing about 62,681 people in the County.

When the study turned to the respondents' sources of income within the project area, the results obtained were as shown in the figure below. Subsistence farming contributes 91% to the household income within the project area followed by *Jua kali* sector at 7% and business activities at 2%

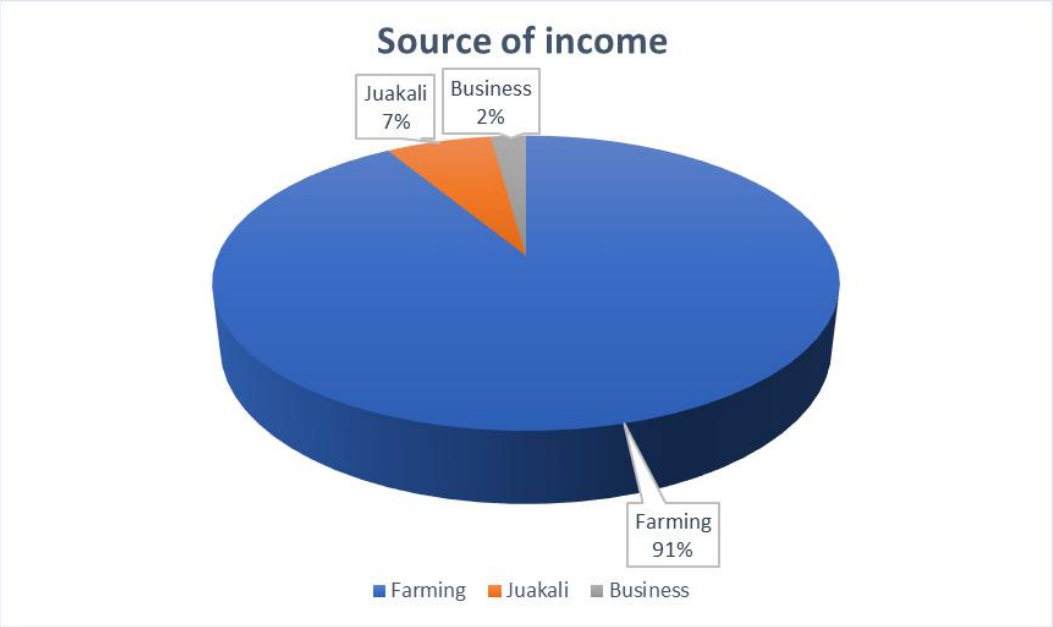


Figure 7: Sources of income in the Project Area

Source: ESIA Study Socio-economic Survey, 2023

3.11 Education, Skills, Literacy and Infrastructure

Literacy is the ability to read for knowledge, write coherently and think critically about the written word. It involves, at all levels, the ability to use and communicate in a diverse range of technologies. Education is very critical for economic development.

The County has a total of 1,072 Early Childhood Development (ECD) centres spread evenly in the county with 820 being public and 252 being private. The County Government has established 238 new ECDE centres.

Kwale County has total of 471 primary schools comprising of 392 and 79 public and private primary schools respectively with a total enrolment of 178,166 pupils which constitute a gross enrolment rate of 107.5 percent and a net enrolment rate of 76.1 percent.

The county has a total of 79 secondary schools with a total enrolment of 25,739 students which constitutes a gross enrolment rate of 35.5 percent and a net enrolment is 25.3 percent. The secondary school teacher population is 1,173 which translate to a teacher student ratio of 1:21 though the teacher distribution is uneven with hinterland schools experiencing high teacher shortage.

The tertiary institutions in the County include a Kenya School of Government (KSG), Kenya Medical Training College and 34 registered public and 4 private vocational training centres. The County has no university but has a satellite campus of Technical University of Mombasa (TUM). With increasing number of students completing high school level, there is a need to have at least one fully fledged university in the County and also improve on the vocational training centres infrastructure and courses.

The County has a total of 150 adult literacy centres with a total enrolment of 7,133 where 4,391 were females and 2,742 were males. With the introduction of the free primary education for all and adult classes in the County, the literacy levels have reached an average of 57 percent.

Majority of the respondents are literate having attended primary school level at 63%, secondary school at 15%. However approximately 22% of the respondents never attended formal education.

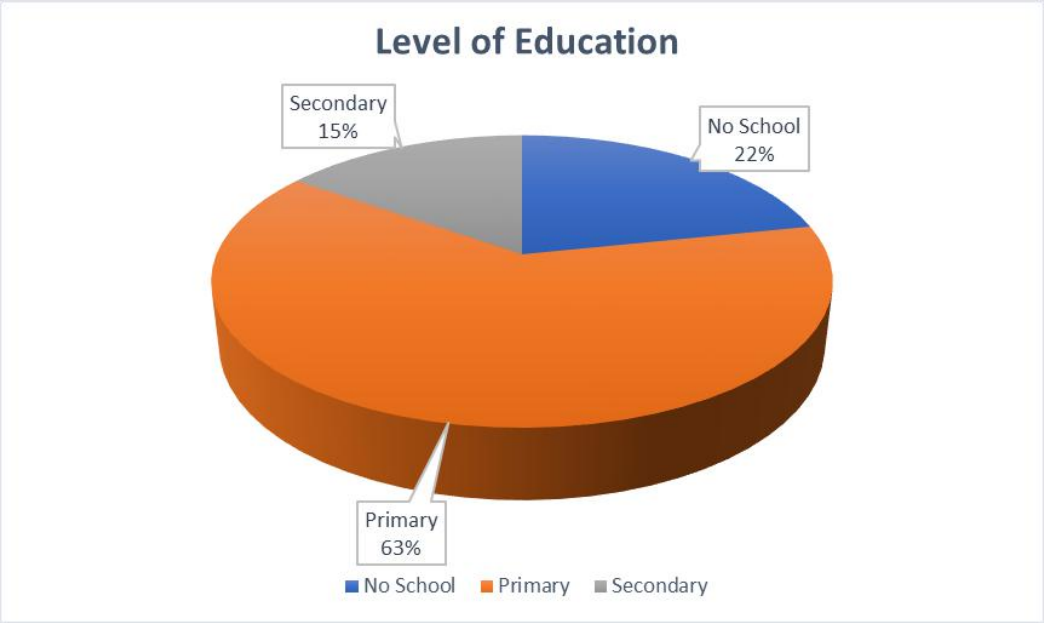


Figure 8: Level of education in the Project Area

Source: ESIA Study Socio-economic Survey, 2023

4. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

Environmental law is principally concerned with ensuring the sustainable utilization of natural resources according to a number of fundamental principles developed over the years. In an ideal setting, the utilization of land and land based resources should adhere to these principles, which are sustainability, intergenerational equity, principle of prevention, the precautionary principle, the polluter pays principle, and public participation.

The EMCA, 1999 was developed based of the principles highlighted in the preceding sections. The basis of the EMCA, 1999 was anchored on the fact that the public should be given effective access to judicial and administrative proceedings and further that it have access to the judicial review of environmental decision making functions effectively.

4.1 Background to environmental management policies and laws

4.1.1 Sustainability

The principle of sustainability requires that natural resources should be utilized in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations. It strives for equity in the allocation of the benefits of development and decries short-term resource exploitation which does not consider the long-term costs of such exploitation.

4.1.2 Principle of intergenerational equity

The principle of sustainability should be examined together with that of intergenerational equity, which focuses on future generations as a rightful beneficiary of environmental protection. Essentially, the principle of intergenerational equity advocates fairness, so that present generations do not leave future generations worse off by the choices they make today regarding development. Its implementation requires the utilization of natural resources in a sustainable manner while avoiding irreversible environmental damage.

4.1.3 Principle of prevention

The principle of prevention states that protection of the environment is best achieved by preventing environmental harm in the first place rather than relying on remedies or compensation for such harm after it has occurred. The reasoning behind this principle is that prevention is less costly than allowing environmental damage to occur and then taking mitigation measures.

4.1.4 Precautionary principle

The precautionary principle recognizes the limitations of science, as it is not always able to accurately predict the likely environmental impacts of resource utilization. It calls for precaution in the making of environmental decisions where there is scientific uncertainty.

Accordingly, it is closely related to the principle of prevention and can be viewed as the application of the principle of prevention where the scientific understanding of a specific environmental threat is not complete. The precautionary principle thus requires that all reasonable measures must be taken to prevent the possible deleterious environmental consequences of development activities. Further, it demands that scientific uncertainty should not be used as a reason for not taking cost-effective measures to prevent environmental harm.

4.1.5 Polluter pays principle

The polluter pays principle requires that polluters of natural resources should bear the full environmental and social costs of their activities. It seeks to internalise environmental externalities by ensuring that the full environmental and social costs of resource utilization are reflected in the ultimate market price for the products of such utilization. Since environmentally harmful products will tend to cost more, this principle promotes efficient and sustainable resource allocation as consumers are likely to prefer to the cheaper less polluting substitutes of such products.

4.1.6 Principle of public participation

The principle of public participation seeks to ensure environmental democracy and requires that the public, especially local communities should participate in the environment and development decisions that affect their lives. It requires that the public should have appropriate access to information concerning the environment that is held by public authorities and should be given an opportunity to participate in decision-making processes.

4.2 Policy framework

4.2.1 Environmental policy

The Kenya Government's environmental policy aims at integrating environmental aspects into national development plans. The broad objectives of the national environmental policy include:

- Optimal use of natural land and water resources in improving the quality of the human environment;
- Sustainable use of natural resources to meet the needs of the present generation while preserving their ability to meet the needs of future generations;
- Integrate environmental conservation and economic activities into the process of sustainable development;

- Meet national goals and international obligations by conserving bio-diversity, arresting desertification, mitigating effects of disasters, protecting the ozone layer and maintaining an ecological balance on earth.

4.2.2 National Environmental Action Plan Framework, 2009-2013

The National Environment Action Plan Framework is the second national environmental policy after the 1994 National Environment Action Plan (NEAP). The development of NEAP is provided for by EMCA, 1999 which requires preparation of Environmental Action Plan at different levels; district, provincial, and national levels. The framework recognizes the intertwined linkages between economic growth and environment in Kenya. It highlights priority themes and activities for the country towards achieving sustainable environment.

The policy framework among others, proposes integration of environmental concerns into regional and local development plans, promotion of appropriate land uses and enforcement of EMCA, 1999 and its subsidiary and other relevant legislations. The policy framework also advocates for efficient water harvesting, storage and usage. On human settlements and infrastructure, this policy framework recognizes the associated environmental issues. These include waste management, sanitation, diseases, land use changes in conservation areas, demand for water, energy, construction materials, pollution, land degradation, biodiversity loss, land and housing tenure, urban planning and design and electronic wastes. In managing operations of the Masani Eco Green Ltd, consideration of the highlighted issues is vital towards contribution to the national sustainable development goals.

4.2.3 The Occupational Safety and Health Policy

This Policy lays emphasis on continual development and implementation of the Occupational Safety and Health systems and programs to reduce incidences of work related accidents and diseases. In addition, it seeks to offer equitable compensation to those who suffer physical injuries and contract occupational diseases. The Policy addresses the current challenges, gaps and future development of safety and health systems and programs in the country. It promotes basic principles of assessing occupational risks or hazards; combating occupational risks or hazards at source; and developing a national preventative safety and health culture that includes information, consultation, research and training. The policy also promotes continuous improvement of occupational safety and health by integrating Kenyan laws and regulations with Regional Protocols, ILO Conventions, ISO standards and the best practices in the world. It sets up mechanisms for resource mobilization for occupational safety and health programs and activities and provides guidance to all stakeholders in the development and implementation of occupational safety and health systems and programs. Masani Eco Green Ltd is committed to put in place occupational safety and health systems and programs to be in tandem with this national policy.

4.2.4 The Kenya Vision 2030, the “Big Four” and the “Bottom Up” Blueprints

The Kenya Vision 2030 is the national long-term development policy that aims to transform Kenya into a newly industrialized, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment.

The Big Four is an economic blueprint that was developed by the government to foster economic development and provide a solution to the various socio-economic problems facing Kenyans. The four items that intended for delivery include Food Security and Nutrition, Universal Health Care, affordable Housing and enhancing the Local Manufacturing industry. Masani Eco Green Ltd will explicitly play a big role in realization of two of the pillars namely food security and local manufacture as soon as it starts its operations in Kwale County

Notwithstanding the job opportunities that will directly emerge from the project development, implementation and decommissioning, there will be opportunities for the supply of materials for construction and raw materials for processing which by all classes of people including those at the bottom of economic pyramid. The earnings from the supply of goods to the project will elevate their status in fulfilment of the *"bottom up"* economic agenda. Masani Eco Green Ltd will play a big role in this regard.

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4.2.5 Sustainable Development Goals (SDGs)

MDGs are eight internationally-agreed goals for socio-economic development that emphasize the following: elimination of extreme poverty and hunger; universal primary education; gender equality; reduction in child mortality; improvement in maternal health; lower HIV/AIDS and major disease incidence; environmental sustainability; and better partnerships with international development partners. The facility has an opportunity to contribute towards local achievement of some of these goals via employment opportunities creation, corporate support to community initiatives and contribution towards achieving environmental sustainability goal.

4.2.6 National Water Policy

The National Policy of Water which was promulgated in April 1999 as Sessional Paper No. 1 of 1999 calls for decentralization of operational activities from the central government to other sectors, including local authorities, the private sector and increased involvement of communities in order to improve efficiency in service delivery. It also tackles issues pertaining to water supply and sanitation facilities development, institutional framework and financing of the sector. According to the policy, in order to enable sustainable water supply and sanitation services, there is need to apply alternative management options that are participatory through enhanced involvement of others in the provision of these services but particularly the private sector.

The overall objective of the National Water Policy is to lay the foundation for the rational and efficient framework for meeting the water needs for national economic development, poverty alleviation, environmental protection and social well-being of the people through sustainable water resource management.

4.3 Legal framework

4.3.1 NEMA

The National Environment Management Authority (NEMA) is the National body charged with coordinating matters of implementation of policy issues relating to the environment. This body was established under the Environmental Management and Coordination (amendment) Act (EMCA), 2015. Other departments that deal with environmental issues in the Sub County include Water Resources Authority (WRA), the Kenya Forestry Service, Kenya Wildlife Services (KWS), National Construction Authority (NCA), County Government of Kwale, among others.

Masani Eco Green Ltd is committed to comply with all applicable legal provisions and regulations which have been reviewed in the table below.

Table 3: Relevant legal and regulatory requirements

Legislation/Regulation/ Standard	Provisions	Compliance/Non-compliance
The Constitution of Kenya (2010)	• Provides for the protection of the right to private property • Provides for the sound conservation and protection of ecologically sensitive areas • Supports the settlement of land disputes through recognized local community initiatives • Gives powers to the state to regulate use of land	• Theproponent will ensure sound protection of the environment and any other ecological sensitive receptor by installing pollution prevention technologies including anti-pollution system to control particulates, Sulphur Dioxide emissions from the processes and deodorization device before the scrubbing system to remove any odor.
Environmental Management & Coordination Act, 1999 (Amended 2015) and Subsidiary Regulations	Ensure environmental protection during project implementation. • Environmental Impact Assessment EIA) • Environmental Audit and Monitoring, Environmental Quality standards and issuance of environmental protection orders • Generation of sector related regulations • Environmental Management and Coordination (Environmental Impact Assessment and Audit) Regulations, 2003 - Waste Management Regulations - 2006 - Water Quality Regulations - 2006 - Wetlands, River Banks, Lake Shores and Sea Shore Management Regulations - 2009 - Air Quality Regulations - 2014	• Masani Eco Green Ltd shall comply with EMCA and subsidiary regulations including best international practices; • The proponent shall have Environmental Policy in place and employ an environmental officer to oversee all environmental matters during construction and operation of the waste tyre pyrolysis plant.
Environmental Management and Co-ordination (Waste Management) Regulations 2006	• Provides for standards for handling, transportation and disposal of various types of wastes including hazardous wastes.	• Carbon black and steel wire waste will be sold to third parties to be used as raw material. • The other wastes will be managed in accordance with Legal Notice No. 121 of 2006. • The proponent shall contract a NEMA registered waste disposal agent to dispose appropriately its solid waste.
Environmental (Impact Assessment and Audit) Regulations, 2003	• No proponent shall implement a project if it is likely to have a negative environmental impact; or for which an environmental impact assessment is required under the Act or these Regulations unless an environmental impact assessment has been concluded and approved in accordance with these regulations.	• The Proponent is carrying out the ESIA for NEMA review and licensing and shall carry successive Environmental Audits at the facility to identify new potential environmental impacts associated with the future operations of the plant.

Legislation/Regulation/ Standard	**Provisions**	**Compliance/Non-compliance**
	• No licensing authority under any law in force in Kenya shall issue a license for any project for which an environmental impact assessment is required under the Act unless the applicant produces to the licensing authority a license of environmental impact assessment issued by the Authority under these Regulations	
EMCA (Water Quality) Regulations, 2006	• Every person shall refrain from any act which directly or indirectly causes, or may cause immediate or subsequent water pollution, • No person shall throw or cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance in or near it, as to cause pollution. • No person shall • (a) Discharge, any effluent from sewage treatment works industry or other point sources without a valid effluent discharge license issued in accordance with the provisions of the Act; • (b) abstract ground water or carry out any activity near any lakes, rivers, streams, springs and wells that is likely to have any adverse impact on the quantity and quality of the water, without an environmental impact assessment license issued in accordance with the provisions of the Act;	• Waste water will be recycled back to the process • The domestic wastewater will be channeled to the septic tank and soak pit on site.
Environmental Management and Coordination (Air Quality) Regulations, 2014	• Provides for ambient air quality tolerance limits. • Prohibits air pollution in a manner that exceeds specified levels. • Provides for installation of air pollution control systems where pollutants emitted exceed specified limits. • Provides for the control of fugitive emissions within property boundary. • Provides for the control of vehicular emissions. • Provides for prevention of dispersion of visible particulate matter or dust from any material being transported.	• The proponent will ensure sound protection of the environment and any other ecological sensitive receptor by installing pollution prevention technologies including anti-pollution system to control particulates, Sulphur Dioxide emissions from the processes and deodorization device before the scrubbing system to remove any odor.

Legislation/Regulation/ Standard	**Provisions**	**Compliance/Non-compliance**
	• Provides for acquisition of an emission license.	
Land Act 2012	Promote Land Conservation including and need to prepare EMP: • Conservation of ecologically sensitive public land • Conservation of land based natural resources • submit an EMP pursuant to existing law on environment	• The proponent is the registered title holder and shall ensure that he complies with the current environmental laws in order to protect the land from any form of pollution.
The Public Health Act (Cap 242)	• No person shall cause a nuisance or shall suffer to exist on any land or premises owned or occupied by him or of which he is in charge any nuisance or other condition liable to be injurious or dangerous to health. • It shall be the duty of every health authority to take all lawful, necessary and reasonably practicable measures for preventing or causing to be prevented or remedied all conditions liable to be injurious or dangerous to health arising from the erection or occupation of unhealthy dwellings or premises	• Housekeeping within the site shall be well maintained in all the operation areas. • Sanitary conveniences shall be provided to the employees during construction and operation of the plant; • The proponent will sensitize the community on the importance of environmental management and carry out HIV/AIDS awareness programs within the community
The Occupational Safety and Health Act2007	• Provides that every occupier shall ensure the safety, health and welfare at work of all persons working in his workplace • Provides that the architectural plans of the plant be approved by the Directorate of Occupational Safety and Health Services before construction activities commence. In approving the plans Directorate of Occupational Safety and Health Services will among other requirements ensure that: - Prescribed dimensions with regards to distance of floor to ceiling of every workroom is upheld - Space defining machine layout for intended use by operators will be within statutory limits - Emergency exits are provided for and are designed to open in accordance to statutory requirements	• The facility has to carry out occupational health and safety audit, fire safety audit, risk assessment and must implement the recommendations. • The proponent shall ensure that firefighting equipment are present and strategically placed within the facility including a standby fire engine; • First Aid kits shall be made available within the workplace and training on first aid done; • Fire assembly points shall be marked where the visitors and employees can gather for briefing in case of a fire; • There shall be provided clear and demarcated emergency exits within the workplace; • Provision of PPEs shall be made mandatory within the workplace. • Application for site registration will be done as soon as construction commences and registration of the factory shall follow when the facility starts

Legislation/Regulation/ Standard	Provisions	Compliance/Non-compliance
	- Sanitary conveniences are provided for with adequacy as to number of intended employees and are designed to have separate approaches - First aid facilities like first aid room(s) are provided for, - There is provision for accommodation for clothes not worn during working hours - There is provision for adequate ventilation - There is provision for storage of fire-fighting water storage tank with a capacity of at least 10,000 litres • Provides that before any person occupies or uses any premises as a workplace, he shall apply for the registration of the premises • Provides that workplace shall be of sufficient size for work to be carried out with ease and shall further have the necessary free space and, having regard to the nature of the work, an adequate amount of air for each employee, the minimum permissible being ten cubic meters per person • Provides that an occupier shall ensure that effective and suitable provision is made for securing and maintaining, by the circulation of fresh air in each workroom, the adequate ventilation of the room • Provides that an occupier shall ensure that effective provision is made for securing and maintaining sufficient and suitable lighting, whether natural or artificial, in every part of his workplace in which persons are working or passing • Provides that sufficient and suitable sanitary conveniences for the persons employed in the workplace shall be provided, maintained and kept clean, and effective provision shall be made for lighting the conveniences; and, where persons of both sexes are or are intended to be employed (except in the case of	operations. • Safety and health committee shall be formed when the factory is operational • Safety signs shall be erected and posted as appropriate when the facility is operational.

Legislation/Regulation/ Standard	Provisions	Compliance/Non-compliance
	workplaces where the only persons employed are members of the same family dwelling there), such conveniences shall afford proper separate accommodation for persons of each sex • Provides that every steam boiler, lifting appliance, air receiver, refrigeration plant, steam receiver and all its fittings shall be thoroughly examined by an approved person, so far as the construction of the plant permits at prescribed intervals. • Provides that where work has to be done inside a confined space in which dangerous fumes are liable to be present, a permit to work has to be issued and the confined space shall be provided with adequate means of egress and ingress. • Provides that in every workplace or workroom, there shall be provided and maintained, and conspicuously displayed and free from any obstruction so as to be readily accessible, suitable means for extinguishing fire. • Provides every workplace there shall be provided and maintained safe plants and systems during its operational phase. • Provides for every workplace there shall be ensured absence/elimination of risks. • Provide for every workplace to ensure provision of information to employees to ensure safety and health. • Provides that every factory stops any hazardous activities and is maintained in a safe and healthy state. • Provides that every workplace carries out workplace risk assessment and send a copy of the risk assessment to the Directorate of Occupational Safety and Health Services (DOSHS). • Provides for preparation of a safety & health policy and submission of a copy to the Directorate of Occupational Safety and Health Services • Provides for prevention of environmental pollution	

Legislation/Regulation/ Standard	Provisions	Compliance/Non-compliance
	• Provides for notification of accident occurrence, cases of occupational diseases and dangerous occurrence to DOSHS • Provides that no employee is discriminated against by virtue of:- - Lodging a complaint about an unsafe condition at the workplace - Being an active member of a health safety committee. • Provides for establishment of a health and safety committee whose composition should be in accordance to the Factories (Health and Safety Committees) Rules L.N. 31of 2004. • Provides for carrying out workplace health and safety as well as fire safety audits on an annual basis.	
Safety & Health Committee Rules, 2004 Legal Notice No. 31	The Legal Notice provides for functions and duties of the health and safety committee, the purpose of meetings and recording minutes, and the roles of the office bearers. It further describes the duties of the occupier and those of the Health and Safety Adviser. Among other items, the rules provide that: • The occupier of every workplace shall establish a health and safety committee; • The committee shall consist of safety representatives from the management and the workers; • The plant occupiers shall appoint a competent person from the management staff to be responsible for safety, health and welfare in the plant or workplace; and the person appointed shall be the secretary to the committee. • Every member of the Health and Safety Committee shall undertake a prescribed basic training course in occupational health and safety within a period of six months from the date of appointment or election, and thereafter further training from time to time; • The occupier of every factory shall cause a health and safety audit of the workplace to be carried out at least once in every	• Safety and health committee shall be formed and trained when the facility is operational

Legislation/Regulation/ Standard	Provisions	Compliance/Non-compliance
	period of twelve months by a registered health and safety adviser.	
Fire Risk Reduction Rules, 2007 Legal Notice No. 59	The Rules provides that an employer/occupier having flammable substances must have fire resistant facility. The occupier to store highly flammable substances in fixed storage tanks, closed vessels, cupboards except for vehicles transporting the same. Flammable materials have to be kept in separate labelled stores. In go-downs, the employer has to maintain a distance of at least 80 cm wall gangway between the walls and stack of goods. Every employer is required to maintain good ventilation to allow exit of flammable fumes, maintain good housekeeping, maintain good electrical fittings, provide and maintain fire exits, form and train fire-fighting teams, conduct fire drills yearly, designate an assembly point, provide and maintain first aid facilities, post fire safety notices, install fire detectors, provide and maintain fire-fighting appliances, conduct an annual fire safety audit and formulate a fire safety policy.	• Fire assembly points shall be marked where the visitors and employees can gather for briefing in case of a fire; • There shall be provided clear and demarcated emergency exits within the factory; • The facility has to carry out fire safety audit, risk assessment and implement the recommendations.
Hazardous Substances Rules, 2007 Legal Notice No. 60	The rules provide that where hazardous substances are handled, washing facilities be provided, protective clothing be kept separate from personal clothing, separate clean and dirty changing rooms be maintained, proper maintenance and testing of engineering controls be done after every 2 years and a report submitted to DOSHS, protection against radioactive, carcinogenic, mutagenic or teratogenic be provided, Material Safety Data Sheets (MSDS) be availed in respect of chemicals handled, correct disposal of hazardous chemical substances be done, containers of hazardous substances be labelled, workers be trained on hazards associated to hazardous substances handled and air monitoring and	• The factory will carry out occupational hygiene measurements and surveys which inform the process of implementing the recommended measures.

Legislation/Regulation/ Standard	Provisions	Compliance/Non-compliance
	measurements be done after every 12 months by an air quality monitor.	
First Aid Rules, 1977 Legal Notice No. 160	These rules provide for first-aid box content with respect to size of a workplace and under whose charge the first-aid box should be placed.	• First Aid kits shall be made available within the facility and training on first aid done.
Eye Protection Rules legal Notice No. 44 of 1978	The rules provide for eye safety in workplaces. Processes where eye protection is required include blasting, cleaning, chipping, metal cutting, arc welding, abrasive wheel use (grinding).	• Provision of PPEs shall be made mandatory within the facility. • Safe procedures and programmes will be provided to the workers
Electric Power(Special) Rules, 1979 Legal Notice No. 340	The rules provide for electrical safety with regards to electrical power installations, use and handling. These rules apply to generation, transformation, conversion, switching, controlling, regulating, distribution and use of electricity.	• Provision of PPEs shall be made mandatory within the facility. • Only qualified personnel will be allowed to handle activities that involve electric power.
Building Operations and Works of Engineering Construction Rules, 1984 Legal Notice No. 40	These rules provide for the safety, health and welfare of workers in construction sites relating to building operations and works of engineering construction undertaken by way of trade or business, or for the purpose of any industrial or commercial undertaking, and any line or siding which is used in connection therewith and for the purposes thereof. The rules apply whether the building operations and works of engineering construction undertaken by or on behalf of the Government or a public body or private developer.	During the construction phase, the contractor will be expected to ensure safety, health and welfare of workers and all persons lawfully present at the construction site.
Medical Examination Rules, 2007 Legal Notice No. 24	The rules apply to workplaces of classified hazards. Every employer has to ensure medical examination of workers in the workplaces of classified hazards.	• During the construction phase there will be noise emission, exposure to dusts and fumes (cement, soil, welding fumes etc) and exposure to

Legislation/Regulation/ Standard	Provisions	Compliance/Non-compliance
		musculoskeletal hazards. • Statutory medical examination will be mandatory on the workers exposed classified hazards during construction and operational phase.
Noise Prevention and Control Rules, 2005. Legal Notice No. 25	The rules provide that 'No worker shall be exposed to noise level excess of the continuous equivalent of 90 dB(A) for more than 8 hours within any 24 hours duration'. They further provide for protection from exposure to high noise levels.	• Provision of PPEs shall be made mandatory within the facility. • Medical examinations and surveillance (audiometry) will be implemented at the facility • Noise measurement and survey will be done at the facility
Work Injury Benefits Act, No. 17 of 2007	This law provides for compensation to employees for work-related injuries and diseases contracted in the course employment and for connected purposes.	• The employer will have an insurance cover for the facility to cater for compensation of injuries sustained by employees while at work
The Energy Act, 2019	• This Act is applicable "to every person or body of persons importing, exporting, generating, transmitting, distributing, supplying or using electrical energy; importing, exporting, transporting, refining, storing and selling petroleum or petroleum products; producing, transporting, distributing and supplying of any other form of energy, and to all works or apparatus for any or all of these purposes."	• The proponent shall obtain the necessary valid licenses to operate the facility that will be handling Pyrolysis Oil
The Petroleum Act	• According to section 13(1) of the Petroleum Act, no person shall store petroleum in bulk without procuring appropriate license from Energy and Petroleum Regulatory Authority. The proprietor has already sought a license to carry out such business from the relevant authorities. Section 19(1) provides that no person shall, in or near any storage shed or installation, do any act, which is likely to cause fire. As part of emergency preparedness for fire incidents, section 20(6) requires an efficient fire service to be provided in every installation and the employees be instructed periodically in the use of various fire appliances.	• The proponent shall ensure adequate measures to ensure the safety of the public and the employees at the site during construction and operation phases. The employees shall also receive fire training periodically.
Weights and Measures Act, Cap 513	• The Act mandates the Weights and Measures Department to annually certify the mechanical pumps and dispensers in order to ensure that they are properly calibrated to dispense the right amounts of the petroleum products. During the certification	• The proponent will seek Weights and Measures Department to annually to certify the weighing machines to calibrate the mas per the required standard. A certificate of verification will be issued.

Legislation/Regulation/ Standard	**Provisions**	**Compliance/Non-compliance**
	exercise, the measuring mechanisms inside the pumps are sealed with a seal-mark of quality assurance. The Weights and Measures Department issues a Certificate of Verification for all the mechanical pumps which is usually valid for 1 year.	The certification and verification will be done annually. The proponent and the management will also ensure that they abide with the requirements of the act.
National Construction Authority Act (NCA) Act No.41of 2011	• It establishes The National Construction Authority which is mandate by the board to oversee the Construction Industry and Coordinate its development.	• The proponent and the contractor will ensure compliance to all the requirements of the Authority before commissioning of the work
Physical and Land Use Planning Act, 2019	• The 2019 Planning Act shall govern matters relating to planning, use, regulation and development of land in Kenya. • It provides for: • The government, at both national and county level, is tasked with the preparation of physical and land use plans. The national, county, inter-county and local plans are required to be integrated, and these plans shall collectively form the basis of how land is to be used in Kenya. • County governments to control development in their respective counties. All applications for development permission shall be made in the relevant county. • Development permission must be sought prior to undertaking any development. A developer who does not obtain such prior permission risks criminal sanctions and demolition of the unapproved works. • Members of the public are given the opportunity to give their views and raise objections to various matters e.g. the suitability of the national and county plans. • The Act lists developments that require development permission. In this regard, developments such as subdivision, amalgamation, change of user, extension of user, extension of lease and approval of building plans require development permission to be issued by the relevant county government. • Processing of easements and way leaves require express development permission, as siting of educational institutions, base transmission stations, petrol stations, eco lodges, campsites, power generation plants and factories. • Development permission in respect of commercial and industrial use is a pre-requisite for other licensing authorities granting a	• The proponent will forward plans to the respective offices for approval to obtained development approvals from the County Department of Physical Planning

Legislation/Regulation/ Standard	**Provisions**	**Compliance/Non-compliance**
	license for a commercial or industrial use, or occupation of land.	
The Water Act, 2016 and The Water Resources Management Rules, 2007	• Protection of surface and groundwater resources; • Protection of water catchments; • Empower Water Resources Authority (WRA) to impose management controls on land use falling under riparian land; • Provides that a permit shall be required for any use of water from a water resource, especially where there is abstraction and use of water with the employment of works.	• Waste water will be recycled back to the process • The domestic wastewater will be channeled to the septic tank and soak pit on site. • Other alternative source of water such as a borehole will have a permit from WRA.
The County Governments Act 2012	• Enforcing protection of trees and other vegetation in urban centers • Approval of development designs before construction can begin • Enforce orderly development in an urban setting	• The waste tyre pyrolysis plant shall work in liaison with the County Government to ensure compliance with land use requirements within the county and obtain the necessary licenses and permits.
Employment Act 2007	• The act stipulates that no person shall use or assist any other person, in using forced labour. • No employer shall discriminate directly or indirectly, against an employee or prospective employee or harass an employee or prospective employee on the following grounds; race, colour, sex, language, religion, political or other opinion, nationality, ethnic or social origin, disability, pregnancy, mental status or HIV status. • An employer shall pay his employees equal remuneration for work of equal value.	• The waste tyre pyrolysis plant shall be a source of employment for many workers of both gender and diverse cultural backgrounds.
Sustainable Development Goals (SDGs)	• Sustainable Development goals which were initiated by world leaders in 2015 as an advancement of the Millennium Development Goals (MDGs) provide concrete, numerical benchmarks for tackling extreme poverty in its many dimensions. The SDGs also provide a framework for the entire international community to work together towards a common end making sure that human development reaches everyone, everywhere. If these goals are achieved, world poverty will reduce by half, tens of millions of lives will be saved, and billions more people will have the opportunity to benefit from the global economy.	• The proposed project will contribute towards alleviating rural poverty by increasing means of livelihood and enhancing food security. The ESIA study will ensure that the proposed project reflects Environmental Sustainability especially during the time of construction and implementation.

Legislation/Regulation/ Standard	**Provisions**	**Compliance/Non-compliance**
	• Goals 6, 7, 13 and 15 of the SDGs revolve around ensuring Environmental Sustainability. The goals highlight on; ✓ Ensuring availability of sustainable management of water and sanitation for all ; ✓ Ensuring a clean and more sustainable supply of water within related watersheds; ✓ Ensuring access to affordable, reliable, sustainable and modern energy for all; ✓ Combating climate change through the reforestation of degraded and degrading landscapes where by reforestation helps in strengthening community resilience to climate change ; ✓ Protecting, restoring and promoting sustainable use of terrestrial ecosystem, sustainably manage forests, and ✓ Combat desertification and halt and reverse land degradation, and halt biodiversity loss.	

4.4 International Conventions and Treaties

A treaty is a binding agreement under International Law concluded by subjects of International Law, namely states and international organizations. Treaties can be called by many names including; International Agreements, Protocols, Covenants, Conventions, Exchanges of Letters, Exchanges of Notes, etc.

Treaties can be loosely compared to contracts; both are means of willing parties assuming obligations among themselves, and a party that fails to live up to their obligations can be held legally liable for that breach. The central principle of treaty law is expressed in the ‘maximpactasuntservanda', translated as "pacts must be respected."

Kenya has ratified the following international conventions.

4.4.1 United Nations Framework Convention on Climate Change

The landmark United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature at the 1992 United Nations Conference on Environment and Development (UNCED) conference in Rio de Janeiro (known by its popular title, the Earth Summit). On June 12th 1992, 154 nations signed the UNFCCC, that upon ratification committed signatories' governments to a voluntary "non-binding aim" to reduce atmospheric concentrations of greenhouse gases with the goal of "preventing dangerous anthropogenic interference with Earth's climate system." These actions were aimed primarily at industrialized countries, with the intention of stabilizing their emissions of greenhouse gases at 1990 levels by the year 2000; and other responsibilities would be incumbent upon all UNFCCC parties. The parties agreed in general that they would recognize "common but differentiated responsibilities," with greater responsibility for reducing greenhouse gas emissions in the near term on the part of developed/industrialized countries, which were listed and identified in Annex I of the UNFCCC and thereafter referred to as "Annex I" countries.

4.4.2 Kyoto Protocol

According to a press release from the United Nations Environment Programme:
"The Kyoto Protocol is an agreement under which industrialized countries will reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990 (but note that, compared to the emissions levels that would be expected by 2010 without the Protocol, this target represents a 29% cut). The goal is to lower overall emissions of six greenhouse gases - carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, HFCs, and PFCs - calculated as an average over the five-year period of 2008-12. National targets range from 8% reductions for the European Union and some others to 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland."

It is an agreement negotiated as an amendment to the UNFCCC, which was adopted at the Earth Summit in Rio de Janeiro in 1992. All parties to the UNFCCC can sign or ratify the Kyoto Protocol, while non-parties to the UNFCCC cannot. The Kyoto Protocol was adopted at the third session of the Conference of Parties (COP) to the UNFCCC in 1997 in Kyoto, Japan.

5. PUBLIC CONSULTATION AND PARTICIPATION

5.1 Overview

The proposed project facilities will mainly serve the public and the local people. Therefore it is imperative that the beneficiaries are involved in the project feasibility, planning, implementation and operation stages. In view of these, the ESIA team adopted a participatory approach during the study noting that stakeholders' participation in Kenya is entrenched in the constitution, several legal instruments and international instruments to where Kenya is a party.

5.2 Legal Requirement for Public Participation

5.2.1 The Constitution of Kenya

Public participation is entrenched in several articles across the Kenya constitution 2010. Article 6 provided for devolution and access to services. Responsibilities in major decision-making process have been bestowed to the public (in the bill of rights, articles 118, 174, 196 and 201). The constitution further in article 21 section 3 requires safeguarding the rights and interests of marginalized groups for equity in public service provision. This can be effectively achieved through active involvement of such groups in decision making process at all levels. Hence need to involve the local people in the project area in studies, design and implementation of the proposed project facilities.

5.2.2 Environmental Management and Coordination Act, 1999

Section 17 of the Environmental (Impact Assessment and Audit) Regulations of 2003 requires that all ESIA studies incorporate consultation with the public during the entire study process. The aim of public consultation in the project were to ensure that all stakeholders' issues and concerns in the proposed facilities are identified and their opinion considered during project planning, design, implementation, operation and decommissioning phase.

5.2.3 County Government Act 2012

Public participation is integral in Kenya's development process as set out in the decentralized system of governance. The county government Act which sets out the service delivery procedure of county governments, has recognized local people involvement in decision making as key to governance. The Act in part VIII stipulates the principles of citizen participation and in part IX it guarantees the citizens‟ right to public communication as well as access to information. To ensure that there is optimal participation, the Act provides for civic education in part X to build the capacity of local people. Therefore meaningful public consultation is significant during planning, implementing and operation of development projects hence the need for such consultations for the proposed development of Masani Eco Green Ltd project in Kwale County.

5.2.4 International Convention (Aarhus Convention 1998)

The Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters entered into force on October 2001. The Convention grants the public rights regarding access to information, public participation and access to justice, in public decision- making processes on matters concerning the local, national and trans-boundary environment. It focuses on interactions between the public and public authorities.

5.3 Objectives of Public Consultations

Public participation is not a one off event but a process throughout the project cycle that requires regular consultations. In regard to the preceding observation, the proposed project involved stakeholders' participation with the following objectives;

- Disseminate and inform the project stakeholders about the proposed project, its key components and activities, location and expected impacts with particular attention to potentially affected persons;
- Create awareness among the public and stakeholders on the need for the ESIA for the proposed project and its due process;
- To obtain information about the needs, concerns, comments, suggestions and priorities of the local people as well as their general reactions to proposed project activities;
- To obtain the cooperation and participation of the key stakeholders, affected persons and local communities in activities that were required to be undertaken for designing, implementing and operating of the proposed project or development of the project facilities;
- Create a sense of ownership, capacity build and ensure transparency in all activities related to the project including but not limited to designing, planning, implementing, environmental management, operation, monitoring and evaluation of the project by all key stakeholders; and
- To establish a clear communication channel, easily accessible and effective grievance procedure between the public, consultant team, the project proponent and the County government of Kwale.

5.4 Stakeholders' Identification/Mapping

The public participation was an inclusive exercise that required proper planning and arrangements.

- The stakeholders are categorised into two groups of primary stakeholders and secondary stakeholders. Primary stakeholders are the beneficiaries of a development intervention or those directly affected (positively or negatively) by it. They included local populations (individuals and community-based organizations) in the project area, in particular, poor and marginalized groups who have traditionally been excluded from participating in development efforts. Secondary stakeholders are those who influence development intervention or are indirectly affected by it. They include the proponent, government and county line ministry and departments, implementing agencies, civil society, NGOs and CBO.

The consultation programme was developed and implemented taking into account the various areas of influence.

- Prior to the public meetings/barazas the site was visited to identify all the stakeholders and appropriate meeting venues. This also presented a platform to consult with the area leaders and the residents hence developing a good rapport. The ESIA team established contacts to enable proper planning and invitation of the public for the consultative meetings. The means of communication used to invite the public was verbal through the area chiefs/village elders and posters. The team in liaison with the Assistant County Commissioner settled on appropriate venues and dates for public meetings. The ESIA team documented minutes and ensured that list of attendance was well documented.

5.5 Consultation Process

Legal Notice of 101 of June 2003 requires that all environmental and social assessment process in Kenya to incorporate Public Consultation. This a requirement informed by awareness that development and implementation of projects can occasion diverse impacts on stakeholders who should consequently be informed appropriately following which they can make informed decision to the proposed development. It is also important to ensure that all stakeholder interests are identified and incorporated in project development, implementation and operation and, against such background, consultation was undertaken far and wide both within the project area and outside with the following objectives; -

i. To disclose the Study to both primary, secondary and other stakeholders;
ii. To obtain the reaction/comments/concerns of all stakeholders so as to understand their perceived view of the proposed project and assess the extent to which their views need to be taken into account. This is important as it helps to ensure that important social issues are not overlooked and there is ownership from the communities in all the project areas;
iii. Improve project design by incorporating their views, thereby, minimize conflicts and delays in implementation;
iv. Increase long term project sustainability and ownership of the project;
v. Identify local leaders with whom further dialogue can be continued in subsequent stages of the project.

5.6 Tools used in stakeholder and public consultations

5.6.1 Reconnaissance Visit

The ESIA study process commenced with a reconnaissance visit to the project area. The consultants alongside the proponent's representatives visited the proposed project site for a reconnaissance survey on 26th to 28th April 2023. The goal of the visit was to familiarize the team with the project site and assess the status of the construction site and the neighbouring facilities. The proponent explained the origin and justification of the project as well as the planning activities that had so far taken place in relation to the proposed project.

The consultant's team also held a meeting with the Area Chief in his office in Samburu Town to inform him about the project and seek his support in mobilizing the public during the public consultation forums. It was agreed that that the consultant and

proponent would present the project proposal before the community leadership before holding public consultations at the proposed site.

5.6.2 Socio-economic Survey

- Socio-economic Survey (Household questionnaires) - This was based on structured questionnaires to gather information on socio economic aspects of the communities in the study area. It was administered through face to face interviews at the household level. The survey was conducted on selected (sampled households). The sampling was confined to communities living around identified project sites and the neighbours that will be affected by the project.

5.6.3 Community Leadership Meeting

Community leadership' meeting. –This meeting was held with the areas village elders together with area chief to inform them about the intention of the proponent to implement the proposed project in the area and in turn elicit discussions and feedback from the meeting. Minutes and attendance registers of this meeting are attached in the annexes of this report.

Plate 2: Meeting with village elders from the community on 13th June 2023

5.6.4 Public Consultation Meeting

PCM – The Consultant in collaboration with the national government led by the Assistant County Commissioner (ACC) Kinango, the Matopeni Location Chief carried out public participation on the proposed Masani Eco Green Ltd project. The meeting was held on 15th June 2023 at the proposed Pyrolysis Plant site. In their consultations, the community sensitization meetings targeted in general all community members within the project area.

During the meeting, Masani Eco Green Ltd representative and the consultants explained the salient features of the project including geographical scope, infrastructure, expected benefits that were cross-checked with the communities and environmental aspects. The community members were given an opportunity to air their views and bring out the issues that were of concern to them. The meetings addressed the following topics: Overview of the project; the waste tyre pyrolysis planting factory, socio-economic aspects including anticipated project benefits; community participation in the project; natural resources including water, land and environmental and social issues including likely negative impacts and the proposed mitigation measures.

Minutes and attendance registers of this meeting are attached in the annexes of this report.

Plate 3: Public Consultation Meeting with the community on 15th June 2023

5.6.5 Focus Group Discussion

The Consultant in collaboration with the Project Proponent carried out a Focus Group Discussions (FGD) with the immediate family members who were the previous owners of the project land to understand the nature of relationship and land tenure of the area. This meeting was held on 16th June 2023 at the proposed Pyrolysis Plant site. A number of issues were discussed including resettlement of the affected families and whether they are satisfied with the compensation made by acquiring the land for the project. Minutes and attendance registers of this meeting are attached in the annexes of this report.

Plate 4: Focus Group Discussions with the Project Affected Persons (PAPs) on 16th June 2023

6. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

This chapter presents an assessment of environmental impacts from the planned project design and activities, and proposes mitigation and management measures to prevent and control these impacts.

The environmental impact assessment and analysis was done using a number of methods and tools. While identifying impacts, a checklist was used. This indicated all possible impacts that would accrue from implementation of this project.

6.1 Legal and regulatory compliance

The national laws and regulations relevant to the development and their relevance to the process project have been discussed.

6.2 Construction and Equipment installation

Key aspects to be considered during construction are:

- Procurement of construction materials;
- Installation of services and interiors of the buildings;
- Use of heavy and light machinery;
- Energy utilisation, major energy consuming activities include:
  - ✓ Lighting;
  - ✓ Excavation;
  - ✓ Transportation;
  - ✓ Hauling and hoisting of materials;
- Mixing raw materials;
- Waste handling trucking and disposal;
- Testing and commissioning of the development.
- Energy sources for these activities include grid electricity and diesel or petrol fuel for machinery/vehicles.
- Water utilisation, including use for the following activities:
  - ✓ Washing of machinery and equipment;
  - ✓ Preparing of mixtures, including water based emulsion paints;
  - ✓ Concrete works, including curing;
  - ✓ General cleaning;
  - ✓ Landscaping;
  - ✓ Controlling dust on site;
  - ✓ Domestic utilisation (sanitary facilities).
- Construction waste will include the following:
  - ✓ Timber from used formwork;
  - ✓ Paints, lubricants and petroleum wastes;
  - ✓ Containers, cement paper bags and other packaging materials;
  - ✓ Metal, glass, plastic containers and other unwanted materials.
- Socio-economic effects;
  - ✓ Labour;
  - ✓ Security;

- ✓ Transport.
- ✓ Archaeological findings and aesthetics.

6.3 Anticipated Positive Project Impacts

6.3.1 Socio-economic impacts

The proposed project is anticipated to generate positive socio-economic impacts. The project will create short term job opportunities (skilled and unskilled labour) during the entire project phases. The proponent will hire at least 15 employees on permanent, contractual and temporary basis during operation phase of the project contract. Other impacts are associated with procurement of materials and revenue from product and by products.

6.3.2 General environmental quality

The proposed project will ensure proper solid waste management within the region and mitigate exposure of the environment and humans to the detrimental effects of solid wastes currently disposed in drainages and open dumpsites/land by recycling synergy of waste tyre into usable fuel; it will offer renewable energy source and limit deforestation; The proposed project will also clear dumping yards and environment of non-bio degradable tyre waste; Subsequently, it will enable the government achieve its commitment to ensuring a clean and healthy environment for its citizenry as entrenched in Article 42 of the Constitution of Kenya.

6.3.3 Revenue to proponent, national and local governments

The county government will earn revenue through payment of relevant fees which will contribute towards the national and local revenue earnings. Improved sanitation in the region will improve the country's economy. The proponent will earn revenue from sell of the product and by products.

6.3.4 Optimal land use

Currently the proposed site bought by the proponent is idle. The installation of the proposed project will ensure optimal land use and benefit the proponent.

Table 4: Summary of impacts and mitigation during construction and installation

Activity	Anticipated Impact	Recommended Mitigation Measures
Procurement of construction materials:	• Natural resource depletion if not rationally done through activities such as quarrying, mining, timber logging.	• The tender documents should specify required standards and certification for procurement of all materials and appliances; • All construction materials should be from approved sources; for example, hardstone for building should be obtained from bona fide commercial quarries; • As far as possible, environmentally friendly and sustainable materials should be used. • Materials not to be used for construction of the buildings include: ✓ High alumina cement; ✓ Wood wool slab in permanent formwork to concrete; ✓ Calcium silicate bricks or tiles; ✓ Asbestos in any form; ✓ Asbestos substitutes or any naturally occurring or man-made mineral fibers; ✓ Lead, lead paint or any other materials containing lead which may be inhaled, ingested or absorbed; Vermiculite, unless it is established as being fiber-free; ✓ Any products containing cadmium that are regarded as being injurious substances; ✓ Any other substances regarded as being deleterious building materials which are not in accordance with statutory requirements or with current accepted good building practice at the time of specification or construction. • The Project Manager should ensure that the Contractors are instructed in the use of all • materials that may have negative environmental (including health) effects; • If any material or substance is used that is at any point in the future deemed to be deleterious to health, then it must be replaced with an acceptable alternative.

Activity	**Anticipated Impact**	**Recommended Mitigation Measures**
Building works:	• Health and safety risk from accidents and incidents; Noise, vibrations and dust.	• Adhere to safety regulations outlined in the County Government Adoptive by-laws, Building Code and the Building Operations and Works of Engineering Construction • The Project Manager should ensure strict safety management through close attention to design, work procedures, materials and equipment; • Schedule noisy construction • Develop a site safety action plan detailing safety equipment to be used, emergency procedures, restrictions on site, frequency and personnel responsible for safety inspections and controls; • All workmen should be provided with personal protective equipment (e.g. dust masks, ear muffs, helmets, overalls, industrial boots, harnesses, etc); • There should be regular site reporting on health, safety and environment (HSE) issues by an appointed HSE representative, daily site inspections should be done to ensure safe work practices are adhered to; • All injuries that occur on site must be reported recorded in the accident registers and corrective actions for their prevention be instigated as appropriate; • Statistical records on accidents and incidents should be collated and analyzed on a monthly basis and forwarded to the Project Manager and / or displayed on the notice boards; • Site personnel should be encouraged to report "near-miss incidents" in order to avoid potential problems and increase safety awareness. • Safety signage should be erected and adhered to at the site
Energy utilization:	• Energy consumption.	• Develop an energy management plan; • Construction machinery and vehicles should be maintained and used in accordance with manufacturer's specifications, to maximize efficiency and lower use of energy, e.g. drivers of construction vehicles should be instructed not to leave them idling for extended periods; • Construction workers should be sensitized on the importance of energy management.
Water Utilization	• Water consumption; Hygiene and sanitation challenges.	• Monitor water consumption and utilization; • Sensitize construction workers on the importance of proper water management; • All wastewater should be drained into approved drainage facilities.

Activity	Anticipated Impact	Recommended Mitigation Measures
Waste production:	• Littering, soil and surface water pollution potential.	• The tender documents should specify the proper disposal of waste during construction and should also ensure that the Contractor leaves the site in a clean and safe condition on completion of the Works; • The Contractor should be required to restore and landscape all areas to the satisfaction of the Project Manager; • All solid waste generated during construction should be collected, stored, and taken away for disposal; • There should be controlled use of raw materials; • Procedures for handling of special wastes, such as waste fuel oil, should be specified; • Comply with guidelines on solid waste disposal and Waste Management Regulations 2006.
Influx of construction workers into the area:	• Proliferation of informal kiosks in the area; • Increase in transport demand.	• Develop a catering program on site for construction staff; • Provide transportation for the workforce to and from the site.
Construction traffic:	• Disruption of local traffic; • Potential for accidents.	• The Contractor should plan itineraries for site traffic.
Archaeological findings:	• Destruction of natural heritage /loss of archaeological findings.	• In the event of an archaeological finding, the Contractor should secure the location 'as is' and immediately call the National Museums of Kenya's Archaeology Section.

6.4 Operation Stage

The key environmental issues during commissioning and operation are as follows:

- Air quality impacts
- Waste generation
- Health and Safety Impacts
- Socio-economic impacts
- Noise pollution impact
- Water supply and consumption;
- Energy consumption and management;

6.4.1 Operational Phase Negative Impacts

1. Air quality impacts

Minimal air pollution is anticipated during operation phase as there will be installed technology to minimize air pollution.

Recommended Mitigation Measures

a. The Proponent will install a complete anti-pollution system to control particulates, Sulphur dioxide emissions from the processes and deodorization device before the scrubbing system to remove any oduor;
b. Vehicles are to be kept in good working order and serviced regularly to minimize emissions;
c. The employees will be provided with overalls and boots, as well as items such as dust masks for those emptying the carbon black;
d. Employees will undergo annual health examinations;
e. The Proponent will ensure employees undergo training;
f. The proponent will carry out stack emission measurements on a quarterly basis to monitor the air quality emitted by the stack in accordance with air quality regulation, 2014;
g. The proponent to carry out ambient air quality testing regularly and compare with the baseline to note any variations and taken corrective action if needed.

2. Waste generation

Several waste streams are similarly anticipated during the operation phase of the Project. The wastes anticipated include general waste, such as office waste, effluent from onsite toilet facilities and the processes and waste associated with plant maintenance. Carbon black and steel wire waste will be sold to third parties to be used as raw material. Waste water will be recycled back to the process. The domestic wastewater will be channeled to the septic tank and soak pit on site. The other wastes will be managed in accordance with Legal Notice No. 121 of 2006. Waste produced during the operation phase of the project will be minimal.

Recommended Mitigation Measures

a. Carbon black and steel wire waste will be used as raw materials in other industries;

b. Process waste water will be recycled back to the process for cooling and wet scrubbing;
c. The domestic wastewater will be channelled to the septic tank and soak pit on site;
d. General waste must be removed from site by licensed waste handlers.

3. Health and Safety Impacts

Potential health and safety impacts during operation phase will be associated with activities such as operating the machines and preventive and corrective maintenance; and handling of raw materials, products and wastes and exposure to extreme thermal conditions.

Operation of machines and preventive and corrective maintenance may results in non-fatal accidents such as minor injuries to hands and in the worst case, fatal accidents through incidences such as explosions, electrocutions or fires.

Similarly machine failure might result in injuries which can also be fatal or non-fatal.

Recommended Mitigation Measures

- Regular maintenance of processing machines and all other infrastructure must be undertaken to ensure optimal functioning and reducing the chance of failure;
- Training of new and old employees on safety and health;
- Appropriate Personal Protection Equipment (PPE) must be worn by all operational personnel;
- Employees will be subjected to the pre and post-employment, periodic and annual medical examination;
- Proper monitoring of the premises and work areas should be effected for maintenance of safety, health and hygiene.

4. Electricity consumption – pressure on supply

The project shall consume large amount of electricity due to activities that will take place once the project is complete. The waste tyre pyrolysis plant will however generate some of its energy needs from the gaseous waste produced for internal use.

Recommended mitigation measures:

- Maximize the contribution of daylight to reduce use of artificial lighting in the buildings;
- Select the most efficient lighting system design and minimum lighting level appropriate for the required application;
- Install energy saving appliances;
- Select the most effective lighting controls for optimal operating efficiency and minimum energy wastage.
- Develop an energy management plan.

6.5 Decommissioning

Decommissioning is the process of shutting down an operational facility in a manner that leaves the area in a safe and stable condition that is consistent with the surrounding physical and social environment. The Contractor will ensure that:

- The process of closure occurs in an orderly, cost effective and timely manner with the allocation of adequate resources;
- The anticipated cost of decommissioning is adequately provided for in the project costs.

The Contractor will be expected to:

- Carry out consultations with stakeholders;
- Develop the action plan for demolition including the assigning of roles for the demolition crew;
- Isolate power at the main switch and remove cables up to that point;
- Dismantle, remove and dispose of construction camp equipment and structures in an appropriate environmentally friendly manner;
- Request utility service providers to disconnect the power, water and telephones as may be appropriate;
- Reinstate the land to its natural condition by filling excavations and planting suitable saplings.

The Contractor must obtain a Certificate of Satisfactory Decommissioning from the relevant Authorities. In the unlikely event that the facilities is closed down decommissioning would comprise the reduction of all buildings and facilities to a safe condition and the restoration of the land to its original condition. The following will be done:

- Notification of intent to all relevant regulatory agencies;
- Liaise with project Consultants including architects, engineers, and environmentalists to ascertain guidelines, anticipated de-commissioning impacts and mitigation measures.

6.5.1 Decommissioning phase Negative Impacts

During the decommissioning phase, another comprehensive ESIA study based on the intended new use of the site will be conducted. Decommissioning may involve one of the following options: facing out operations and evacuating the premise without carrying out any other plans; change of use of the facility; demolition of the property to restore it to the current or better status.

1. Solid Waste Generation

Demolition of the facilities and related infrastructure will result in large quantities of solid waste. The waste will contain the materials used in construction including concrete, metal, drywall, wood, glass, paints, adhesives, sealants and fasteners. Although demolition waste is generally considered as less harmful to the environment since they are composed of inert materials, there is growing evidence that large quantities of such waste may lead to release of certain hazardous chemicals into the environment.

In addition, even the generally non-toxic chemicals such as chloride, sodium, sulphate and ammonia which may be released as a result of leaching of demolition waste, are known to lead to degradation of groundwater quality.

2. Dust

Large quantities of dust will be generated during demolition works. This will affect demolition staff as well as the neighbouring residents.

3. Noise and Vibration

The demolition works will lead to significant deterioration of the acoustic environment within the project site and the surrounding areas. This will be as a result of the noise and vibration that will be experienced as a result of demolishing the proposed project.

7. PROJECT ALTERNATIVES

Several alternative aspects were considered for the proposed project. They included: proposed project technologies, alternative site location and no-go option. Evaluation of the alternatives is governed by a "rule of reason," which requires the evaluation of alternatives "necessary to permit a reasoned choice."

7.1 Alternative technologies

7.1.1 Recycling processes

Pyrolysis

Pyrolysis is a process of converting waste tyres into Pyrolysis oil, Carbon black and hydrocarbon gas and steel wire from tyres. It is the process of molecular breakdown where larger molecules are broken down into smaller molecules. Pyrolysis plant is an industry designed to carry out pyrolysis of waste tyre. In case of tyre pyrolysis, long chain polymer is broken down into smaller chains of Hydrocarbon Gas and Pyrolysis Oil. Heat and catalyst are required for the reaction.

The scrap tires will decompose when it heated up to a 160^0c in the reactor. The decomposed tires transform into oil gas. Waste gas will be processed in the emissions scrubber transmitted by the pipe on the top of the cracking reactor, by the processing of emissions scrubber the harmful gas will changed into clean air then release into the air .When crude oil get through the gas separate the Impurities will be filtrated, so that crude oil can be refined. Crude oil get through the depositing tank to the cooling pool for cooling in it, then transform into liquid. Liquid crude oil will delivered to tanks for store, and the exhaust gas from the crude oil in the tank will transported to exhaust gas recycle system then transported to the bottom of the cracking reactor as fuel to heat up the cracking reactor.

In pyrolysis as a process, the polymer waste is not burned; instead it is broken down into usable finished products like Pyrolysis Oil, Hydrocarbon Gas and Carbon black and steel wire. In case of tyre waste management, pyrolysis is better alternative compared to incineration or dumping. Incineration is burning of waste which leads to loss of valuable energy from polymer waste. Dumping of polymer waste is known to cause land pollution. By pyrolysis of polymer waste, it is possible to recover value from waste in the form of Pyrolysis oil, Hydrocarbon gas and charcoal (Oracle World Wide, 2010).

Finding an efficient way of reusing and recycling used tyres will have a positive impact on the environment, as the recycling of a discarded material will avoid the use of new fossil fuel as coal or petroleum. For example, the oil obtained from pyrolysis can replace diesel fuel. This in turn will mean a reduction in greenhouse gas emissions.

Devulcanisation

It involves breaking the bonds that hold the individual polymer chains together and create a network. There are different methods to breaking the bonds, including using chemicals or microwaves, and biological and ultrasonic methods.

In chemical terms, de-vulcanization means reverting rubber from its thermoset, elastic state back into a plastic, moldable state. This is accomplished by severing the sulfur bonds in the molecular structure. With the proper devulcanization method, a much higher percentage of crumb rubber old tires can be used as compounding.

Traditional devulcanization methods involved exposing cured rubber to elevated temperatures for an extended period of time. However, this "thermal reclaim process" not only severs the sulfur bonds in the polymer matrix, but also breaks the polymer chains, causing a significant decrease in physical properties.

Because of questionable economics and environmental concerns, thermal devulcanization is rarely used today. The current price increase of virtually all types of polymers, including natural rubber, means that for most rubber manufacturers, reprocessing rubber scrap is no longer an interesting alternative, but an economic necessity (Reschner, 2008).

Grinding

Grinding is focused on reducing the size of the waste tyre to a fine, crumb-like substance. These powder-like particles can then be blended and used as filler in plastics. The process also allows for the steel and other fabrics to be separated. These can then be recycled too. The downside to grinding is that the very high temperatures needed lead to the end-product being downgraded. This can be managed if temperatures are controlled. But this can only be done by using large quantities of liquid nitrogen that, in turn, increase the cost of the process.

7.1.2 6.1.2 Land filling

Waste tyres are bulky and difficult to dispose because of their large size and hollow structure. Waste Tyres generally do not decompose as other waste in the landfill. This is due to the process of vulcanization, a method of treating rubber with extreme heat and adding sulfur to make it extremely durable; because of this, other material around the tyre will decompose and cause the tyre to rise to the surface of the landfill subsequently, many landfills around the world stopped accepting waste tyres due to the aforementioned problem of size among others where the land becomes filled quickly.

Shredding of the waste tyres before disposal has been suggested and tried for size reduction before disposal. The high operational costs of this process made it an unattractive option. This situation eventually leads to waste tyres becoming litters in the environment, occupying large size of land. (Tyre recycle line, 2010).

Indiscriminate and illegally discarding of waste tyres in the environment make them reservoir of rain water hence providing breeding space for mosquitoes and other vectors of diseases like malaria, dengue and yellow fever which can pose human health risks. Subsequently indiscriminate disposal of waste tyre finds its way to drainages resulting in frequent flooding experienced.

Deliberate or unintentional fire problems emanating from tyre can be very difficult to extinguish especially when the pile is very huge involving about ten million waste tyres. When piles of tyres ignite, various environmental, health and social problems occur.

Significant pollution such as thick, black, foul smelling smog from the burning rubber is produced. The smog from the burning tyres can cause a number of environmental problems such as:

Air Pollution- Complete combustion of a tyre, will produce carbon dioxide that contribute to greenhouse effects water vapour and inert residues that may contain sulphur dioxide. Incomplete combustion release dioxins and noxious gases. Furthermore, the following substances: volatile organic compounds and hazardous air pollutants such as polynuclear aromatic hydrocarbons (PAHs), dioxins, furans, hydrogen chloride, benzene, polychlorinated biphenyls (PCBs), arsenic, cadmium, nickel, mercury, zinc, chromium and vanadium are released into the atmosphere.

Water Pollution - Tyre combustion causes pyrolysis of the rubber, resulting in oily decomposition waste. The oily discharge can flow into nearby streams, ditches and waterways or can leach into the ground water. In cases where water is used to put out the fire, chemical compounds like aromatic liquids and paraffin may be carried by the water. Then the used water needs to be treated, before it is disposed of, which does not often happen in practice. The situation can pollute nearby streams or may seep into the ground water.

Soil Pollution - Residues that remain on the soil after a fire can have an impact on the environment in two ways: Immediate pollution resulting from decomposing liquid products penetrating the soil. Gradual pollution caused by leaching of ash and unburned residues. Gradual leaching of oily discharge can occur and the toxic residues of the burnt tyre such as zinc salts can cause harm to fauna and flora. It usually takes long time for the contaminated soil to recover unless remediation and or rehabilitation measures are taken. (Tyre recycle line, 2010).

7.2 Alternative site location

The proposed site is adjacent to many quarries and crushers and will be a suitable location for a recycling plant for waste tyre. The land is legally owned and the proponent who has gone into contractual agreement to buy the land to utilize the facility. There are also no significant environmental sensitive features around the site e.g. wetlands, surface water bodies, forest cover or sensitive habitats noted. It is, therefore, likely to have minimal environmental impacts. Relocation option to a different site is an option available for the project implementation. At the moment, there are no alternative sites for the proposed development. The proponent has to look for the land if relocation is proposed. Looking for the alternative land to the project and completing official transaction on it may take a long period. In addition, it is not guarantee that such land would be available and it will be costly for the proponent.

In consideration of the above concerns and assessment of the current proposed site, relocation of the project is not a viable option.

7.3 No go option

The no project alternative option in respect to the proposed project implies that the status quo is maintained; this option is the most suitable alternative from the extreme environmental perspective as it ensures non-interference with the existing conditions.

Under no project alternative, the proponent's proposal would not be approved by NEMA. This option will however, involve several losses both to the land owner and the country at large. The No project option is the least preferred from the socio-economic and partly environmental perspective due to the following factors:

- Urgent need for a sustainable solid waste management in Kenya to ensure a healthy, safe and secure environment for all and to accommodate the ever increasing quantities of waste generated due to increasing population and urbanization;
- Discouragement for investors;
- Land will remain less utilized;
- No employment opportunities will be created;
- Local skills would remain under-utilized.

From the analysis above, it becomes apparent that the No Project Alternative is not the appropriate alternative to the local people, Kenyans, and the government of Kenya. The No Project Scenario is therefore not considered as a viable option.

8. ENVIRONMENTAL MANAGEMENT PLAN

8.1 Introduction

The Environmental Management Plan involves the protection, conservation and sustainable use of the various elements of the environment. The EMP for the proposed project provides all the de tails of its activities, impacts, mitigation measures and expected costs during implementation and decommissioning phases of the project. This project bears the potential of a number of negative impacts on the environment. With proper environmental management procedures in place and adhered to then there should be minimal negative impact of concern emanating from it. Key areas that require mitigation measures include wastewater, solid wastes, maintaining good air quality, safety, and storm water management.

The table below indicates measure for Environmental Management Plan

Table 5: Environmental Management Plan (EMP)

Environmental parameter	Impact	Mitigation measure	Responsible party	Costs (KES)
Construction/equipment installation phase				
Extraction of raw material	▪ Land-use and Landscape change ▪ Poor visual quality	▪ Obtain a change of User (Ranching to industrial) as required. ▪ Source material from supplies that use environmentally friendly processes in their operation. ▪ Ensure accurate budgeting and estimation of actual construction material requirement to ensure that the least amount of material necessary is ordered. ▪ Ensure that damage or loss of material at construction site is kept minimal through proper storage. ▪ Use at least 5%-10% recycled, refurbished, or salvaged materials to reduce the use of raw material and divert material from land fill. ▪ All construction materials should be from approved sources; for example, hard stone for building should be obtained from NEMA licensed sites and bona fide commercial quarries.	▪ Proponent and Contractor	▪ As per BQ and agreement with Contractor
Removal/ clearing of vegetation	▪ Exposing ground to agents of soil erosion ▪ Loss of terrestrial habitat & biodiversity ▪ Permanent loss of vegetation ▪ Habitat fragmentation ▪ Interruption of ecological corridors and migration paths	▪ Proper demarcation and delineation of the project site to be affected by construction work ▪ Designate access route within the site ▪ Design and implement an appropriate landscaping program to help in re- vegetation of part of the project site after construction ▪ Mapping out the conservation zones and ensure Protection of wetlands, rivers, springs and the existing vegetation as much as possible and in line with applicable rules, regulations and standards. ▪ Set a replanting and landscaping programme that focuses on increasing “green area”	▪ Proponent and contractor ▪ KFS	▪ 100,000 for landscaping

Environmental parameter	Impact	Mitigation measure	Responsible party	Costs (KES)
	▪ Erosion and stream sedimentation ▪ Draining of wetlands			
Sewage and effluent	▪ Pollution	▪ Provide adequate sanitary facilities for workers, ▪ Provide solid waste receptacles and storage containers, particularly for the disposal of plastic bags boxes, so as not to block drainage system and to prevent littering of the site.	▪ Proponent and contractor	▪ As per BQ and agreement with Contractor
Movement of vehicles at the site	▪ Compaction of soil ▪ Interference with soil structure leading to low water infiltration	▪ Apply soil erosion control measures such as levelling of the project site to reduce run-off velocity and Increase infiltration of storm water into the soil. ▪ Ensure that construction vehicles are restricted to existing graded roads to avoid soil compaction within the project site, ▪ Ensure that any compacted areas are ripped to reduce run-off. ▪ Storm water drainage lines be well constructed to reduce incidence of pounding and flooding	▪ Proponent and contractor	▪ As per BQ and agreement with Contractor
Utilization of construction materials	Generation of wastes leading to: ▪ Wastage of resources/ materials ▪ Health risk to the worker and environment ▪ Reduced aesthetic value of the site ▪ Blockage of drainage systems	▪ Through accurate estimation of quantities of materials required, order materials in the sizes and quantities they will be needed, rather than cutting them to size, or having large quantities of residual materials. ▪ Ensure that construction materials left over at the end of construction will be used in other projects rather than being disposed off. ▪ Ensure that damaged or waste materials including cabinet, doors, plumbing, and lighting fixtures, marble and glasses will be recovered for refurbishing and use in other projects ▪ Reducing the amount of construction waste generated over time	▪ Contractor and his workers	▪ As per BQ and agreement with Contractor

Environmental parameter	Impact	Mitigation measure	Responsible party	Costs (KES)
		▪ Provide facilities for proper handling and storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements ▪ Purchase of perishable construction materials such as paints should be done incrementally to ensure reduced spoilage of unused materials ▪ Use building materials that have minimal or no packaging to avoid the generation of excessive packaging waste ▪ Maintain a proper waste tracking document ▪ Ensure adequate fire warning, response and management systems are installed. ▪ Hazardous wastes, such as waste oils and grease to be collected in secure storage facilities on-site to prevent accidental release that may result in contaminated run-off and leaching. ▪ Storage areas for hazardous material to be cemented to provide an impervious surface and to prevent uncontrolled discharges to groundwater. ▪ Contract a NEMA licensed waste handler to collect waste oil, waste tyres and general office and domestic wastes. ▪ Practice the 6Rs (Reuse, Recover, Refill, Return, Recycle) of waste Management. ▪ Training of workforce on matters health, safety and environment with regards to waste and its effects.		
Dust emission from movement of transportation vehicles at the site and on the	▪ Air pollution ▪ Causing breathing problems to the workers and the neighbourhood	▪ Sprinkle water on graded access routes each day to reduce dust generation by construction vehicles ▪ Controlling the speed of vehicles on the site ▪ Watering open soil or storage sites ▪ Selecting transportation routes ▪ Provide worker with dust masks	▪ Contractor and his workers	▪ As per BQ and agreement with Contractor

Environmental parameter	Impact	Mitigation measure	Responsible party	Costs (KES)
road		▪ Spiro metric examination on exposed workers at prescribed interval of time		
Utilization of fossil fuel by fuel consuming machineries.	▪ Emission of carbon gas into the atmosphere leading to global warming ▪ Exhaustion of fossil fuel resource ▪ Air pollution ▪ Can Lead to breathing problems	▪ Ensure proper planning of transportation of materials to ensure that vehicle fills are increased in order to reduce the number of trips done per vehicle or the number of vehicles on the road. ▪ Sensitize truck drivers to avoid unnecessary racing of vehicle engines at adding/offloading points and parking areas, and to switch off or keep vehicle engines when not in use ▪ Prompt servicing of vehicles engines ▪ Use of unleaded and low sulphur fuel ▪ Monitor energy use during construction and set target for reduction of energy use.	▪ Contractor and Drivers	▪ As per need
Noise and vibration	▪ Noise generation ▪ Hearing problem	▪ Sensitize construction drivers to avoid gunning of vehicle engines or hooting especially when passing through sensitive areas such as churches, schools, residential areas and hospitals ▪ Sensitize construction vehicle drivers and machinery operators to switch of vehicle or machinery not being used. ▪ Ensure that all heavy duty equipment are insulated or placed in enclosures to minimize ambient noise levels. ▪ Measure to ensure that noise levels does not exceed 75dB(A) ▪ Attenuation of any sound that may affect the inner ear by use of earplugs and earmuffs. ▪ Audio metrical examination of workers at prescribed intervals	▪ Contractor and Workers	▪ 50,000
Water consumption	▪ Excessive use / misuse of water ▪ Generation of excess waste water ▪ Water pollution	▪ Prompt reuse and recycling of water as much as possible where necessary ▪ Install a discharge meter at water outlet to monitor and determine total water usage. ▪ Monitor water consumption and utilization; ▪ Sensitize construction workers on the importance of	▪ Contractor and his workers	▪ 150,000

Environmental parameter	**Impact**	**Mitigation measure**	**Responsible party**	**Costs (KES)**
		proper water management; ▪ All wastewater should be drained into approved drainage facilities.		
Approval of building plan	▪ The development being in alignment with the County Integrated Development Plan (CIDP)	▪ Ensure that the Change of Use is effected and plans are approved by the County Government, Physical Planner and the local Occupational Health and Safety Office	▪ The proponent	▪ Gazetted fee
Incident, accidents, and dangerous occurrences	▪ To enable relevant authorities to monitor incidence occurrences and take necessary measure to minimize them.	▪ Ensure that provisions for reporting incidents, accidents and dangerous occurrences during construction using prescribed forms obtainable from the local Occupational Health and Safety Office (OHSO) are in place.	▪ Contractor and his workers	▪ Gazetted fee
Safety, health and environment (SHE)policy	▪ To give guidelines on how one is to protect himself within a given premises against any incident.	▪ Develop, document and display prominently an appropriate SHE policy for construction works	▪ Contractor	▪ 5,000
Personal protective gears	▪ To protect against any infection or injuries while at work.	▪ Suitable overalls, safety footwear, dust masks, gas masks, respirators, gloves, ear protection equipment etc. should be made available and construction personnel must be trained on their use.	▪ Contractor	▪ 100,000

Environmental parameter	**Impact**	**Mitigation measure**	**Responsible party**	**Costs (KES)**
Supply of clean water	▪ Ensure good health as dirty/untreated water leads to water borne diseases.	▪ Ensure that construction workers are provided with an adequate supply of wholesome drinking water which should be maintained at suitable and accessible points.	▪ Contractor	▪ 100,000
Storage of materials	▪ Can cause accident, material wastage and spoilage, and reduced aesthetic value.	▪ Ensure that materials are stored or stacked in such manner as to ensure their stability and prevent any fall or collapse	▪ Contractor	▪ 5000
First aid	▪ To ensure that when any injury occur it can be taken care of before main treatment at a hospital or a dispensary.	▪ Well stocked first aid box which is easily available and Accessible should be provided within the premises ▪ Provision must be made for persons to be trained in first aid, with a certificate issued by a recognized body.	▪ Contractor	▪ 40,000
Safety and security	▪ Destruction and stealing of materials on site.	▪ Ensure the general safety and security at all times by providing day and night security guards and adequate lighting within and around the construction site. ▪ The Contractor should ensure strict safety management through close attention to design, work procedures, materials and equipment; ▪ Develop a site safety action plan detailing safety equipment to be used, emergency procedures, restrictions on site, frequency and personnel responsible for safety inspections and controls; ▪ All workmen should be provided with personal protective equipment (e.g. nose masks, ear muffs, helmets, overalls, industrial boots, etc.); ▪ There should be regular site reporting on health, safety and	▪ Contractor	▪ 100,000

Environmental parameter	Impact	Mitigation measure	Responsible party	Costs (KES)
		environment (HSE) issues by an appointed HSE representative, daily site inspections should be done to ensure safe work practices are adhered to; ▪ All injuries that occur on site must be recorded in the accident registers and corrective actions for their prevention be instigated as appropriate (Section 62 of the Factories and Other Places of Work Act); ▪ Statistical records on accidents and incidents should be collated and analysed on a monthly basis and forwarded to the contractor and / or displayed on the notice boards; ▪ Site personnel should be encouraged to report "near-miss incidents" in order to avoid potential problems and increase safety awareness.		
Fire Hazards	▪ Destruction of property and lives	▪ Provide adequate number of appropriate fire fighting equipment as well as fire exit options. ▪ Ensure inspection and maintenance of fire equipment ▪ A fire escape route and an emergency assembly point should be clearly indicated ▪ Form and train fire fighting team ▪ Conduct regular fire drills	▪ Contractor and proponent	▪ 200,000
Construction traffic:	▪ Disruption of local traffic; ▪ Potential for accidents.	▪ The Contractor should plan itineraries for site traffic. ▪ Issue notices/advisories of pending traffic inconveniences and solicit tolerance by commuters before the commencement of construction works. ▪ Assign traffic regulators to places during periods of chronic or potential traffic congestions. ▪ Prepare & provide appropriate signage & trained flag persons where the movement of heavy machinery and construction equipment may cross the main roads.	▪ Contractor	▪ 50,000

Environmental parameter	Impact	Mitigation measure	Responsible party	Costs (KES)
Influx of construction workers into the area:	▪ Proliferation of informal kiosks in the area; Increase in transport demand. ▪ Road side vending	▪ Develop a catering program on site for construction staff; ▪ Provide transportation for the workforce to and from the site; ▪ The contractor should identify, demarcate and fence a specific area within which specific number vendors will be allowed to operate. ▪ The vendors should be instructed to maintain the area in a tidy fashion and litter bins should be provided with arrangements in place to have the contents of these emptied on a regular basis and disposed of appropriately.	▪ Contractor	▪ 100,000
Energy utilization	▪ Energy consumption	▪ Develop an energy management plan; ▪ Construction machinery and vehicles should be maintained and used in accordance with manufacturer's specifications, to maximize efficiency and lower use of energy, e.g. drivers of construction vehicles should be instructed not to leave them idling for extended periods; ▪ Construction workers should be sensitized on the importance of energy management.	▪ Contractor	▪ 20,000
Ergonomic	▪ Bad posture may lead to body structural disorder.	▪ Provision for repairing and maintaining of hand tools must be in place ▪ Hand tools must be of appropriate size and shape for easy and safe use ▪ Height of equipment, controls or work surfaces should be positioned to reduce bending posture for standing workers	▪ Contractor	▪ 20,000
Operation phase				
Waste generation	▪ Generation of wastes leading to pollution of the environment	▪ Carbon black and steel wire by products will be sold as raw materials in other industries; ▪ Process water will be recycled back to the process; ▪ The domestic wastewater will be channeled to the septic tank and	▪ Proponent	▪ Wastecollection as per rates

Environmental parameter	Impact	Mitigation measure	Responsible party	Costs (KES)
		soak pit; ▪ General waste must be removed from site by a licensed contractor.		
Occupational health and Safety	▪ Accidents and injuries	▪ Ensure Health and Safety Plan is adhered to by the operation employees and meet Occupational Health and safety Act (OHSA), of 2007, requirements; ▪ Regular maintenance of machines/equipment and tools to ensure failures that can lead potential safety hazards are avoided; ▪ Appropriate personal Protective Equipment (PPE) must be worn by all operation personnel; ▪ Employees will undergo annual health examinations; ▪ The Proponent will ensure employees undergo safety training.	▪ Proponent	▪ 100,000
Air pollution	▪ Unmonitored stack and ambient emissions	▪ The equipment and machines will be installed by professional engineers and will be fitted with a complete antipollution system. This will include a wet scrubber to remove particulates and system sprinkled with calcium hydroxide to remove Sulphur Oxides. The system will be fitted with deodorization machine to extract sulphur hydroxide that cause bad odour; ▪ The gas which cannot be liquefied under normal pressure will go back to combustion system. It can be used as fuel material to heat the reactor; ▪ Undertake daily pH monitoring and quarterly and annual air quality monitoring to ensure efficiency of the wet scrubber; ▪ Obtain Emission license from NEMA; ▪ Vehicles will be kept in good working order and serviced regularly to minimize emissions.	▪ Proponent	▪ 400,000
Accidents and injuries	▪ Machine safety (improper use and maintenance of machines)	▪ All plant, machinery and equipment should only be used for work which they are designed for and be operated by a competent person. ▪ Insist on regular servicing of electrical fittings and appliances by	▪ Proponent	-

Environmental parameter	Impact	Mitigation measure	Responsible party	Costs (KES)
		qualified personnel. ▪ Every machine intended to be driven by mechanical or any other type of power should be provided with safeguards and an efficient starting and stopping appliance, the control of which should be in such a position as to be readily and conveniently operated by the person operating the machine.		
Water Consumption	▪ Overutilization of water	▪ Monitor water consumption ▪ Install internal water meters. ▪ Installing plumbing fittings, appliances and devices to optimize water use efficiency; ▪ Recycling of wastewater to reduce water consumption.	▪ Proponent/ Contractor	▪ As per BQ
Use of energy	▪ Overutilization of hydropower ▪ Overloading hydropower grid	▪ Switch off electrical equipment, appliances and lights when not being used ▪ Install energy saving fluorescent tubes at all lighting points within the facility instead of bulbs which consume higher electric energy ▪ Sensitize occupants of the facility to use energy efficiently ▪ Plant trees within the compound and along the fence.	▪ Proponent	▪ -
Electricity use	▪ Explosions/Fire outbreaks causing injuries and destruction of properties	▪ Regular maintenance of fire extinguishers ▪ Proper electric connections. ▪ Circuit must not be overloaded ▪ Distribution boards switches must be clearly marked to indicate respective circuits ▪ No live exposure connection ▪ Electrical fittings near all potential sources of ignition should be flame proof	▪ Proponent/Contractor	▪ As per BQ and need
Ventilation	▪ Suffocation and lack of clean air may lead to discomfort of the	▪ Enough space must be provided within the premises to allow for adequate natural ventilation through circulation of fresh air	▪ Proponent ▪ Contractor	▪ As per BQ

Environmental parameter	Impact	Mitigation measure	Responsible party	Costs (KES)
	occupants in the facility.			
Lighting	▪ Lack of enough light in the facility may lead to eye straining hence eye problems	▪ There must be adequate provision for artificial and natural lighting in the facility.	▪ Proponent	▪ As per BQ
Decommissioning Phase				
Demolition activity	▪ Lead to accident from falling, and flying objects. ▪ Generation of construction waste ▪ Reduced aesthetic value of that place ▪ Destruction of soil structure ▪ Lead to soil erosion hence water pollution	▪ Develop a decommissioning EIA plan	▪ Proponent and the contractor	▪ Develop BQ and project budget

9. CONCLUSION AND RECOMMENDATIONS

This Study Report has been prepared to provide sufficient and relevant information on the proposed project to enable NEMA to establish whether activities of the project are likely to have significant adverse environmental impacts. Mitigation measures have been proposed for identified impacts in this report and an Environmental Management Plan (EMP) for the implementation of the proposed measures has been presented. The EMP presented in this report is a tool to be used by the Project Team during the construction, hand-over and operation periods.

To ensure implementation, mitigation measures should be reflected in the Conditions of Contract and Bills of Quantities. It is the responsibility of the Proponent to ensure these measures are incorporated into these two documents.

It is recommended that the available waste management systems must be monitored and upgraded (where necessary) to ensure that they adequately handle the anticipated increase in waste and by- products.

In this respect the project CAN PROCEED on condition that the concerns are addressed the proposed mitigation measures are implemented and an EIA license issued with the above conditions taken fully into account amongst any others.

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ANNEXURE

Annex 1:NEMA Approved TOR

Annex2:Registration and PIN

Annex 3:Land ownership documents

Annex 4: Expert practicing licenses

Annex 5 Minutes of public participation

Annex 6: Project Designs

Annex 7:Baseline Measurements Results

Annex 8: Photographic plates