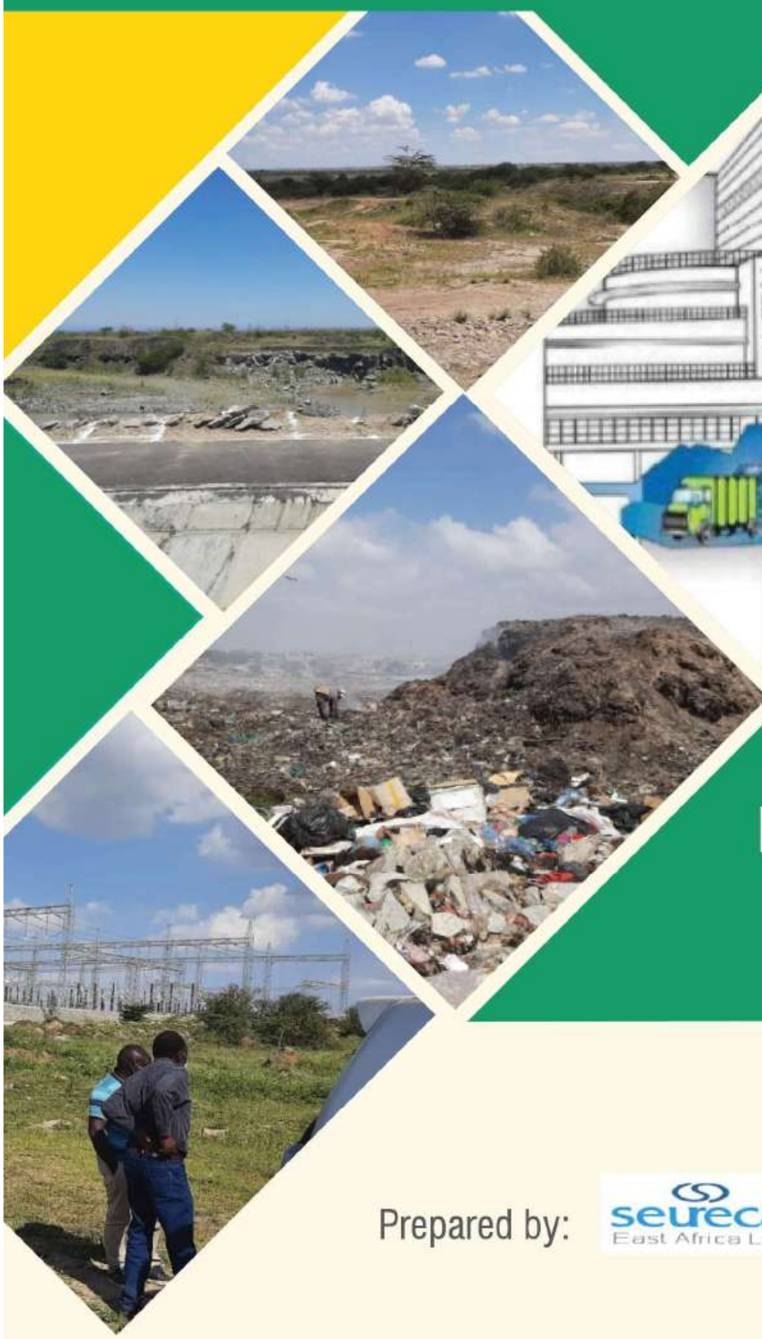
Task 6: Environment & Social Impact Assessment Study

Feasibility Study for Waste to Energy Plant in Nairobi City County

KGN-BDD-07-2020



Task 6
Environment & Social Impact Assessment Study

October 2021

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GENERAL INFORMATION

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V9	19/1/2022	Initial version

CERTIFICATION

A consortium of Seureca East Africa Limited, Development Environergy Services Limited and Seureca Veolia was commissioned by Kenya Electricity Generating Company PLC (KenGen) hereafter referred to as “The Proponent” to undertake Environmental and Social Impact Assessment for the proposed Establishment of Waste to Energy Power Plant at Ruai, Kasarani Subcounty, Nairobi County. This report has been prepared in accordance with the Environmental Management and Coordination Act CAP 387 and the Legal Notice 101 (Regulations for Environmental Assessment and Audit) of June 2003 for submission to the National Environmental Management Authority (NEMA).

We, the undersigned, certify that the particulars in this report meet the ESIA/EA code of conduct as issued by NEMA to the best of our knowledge.

Consultants Representative
P.Eng.Tech. Geoffrey Nagillah Makanga
Designation: Seureca’s Lead Expert Reg. No. 2330
Signed at Nairobi on ………day of December, 2021.

Signature: …………………………………………
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Designation: Seureca’s Lead Sociologist
Signed at Nairobi on ………day of December, 2021.

Signature: ……………………………………………
Mrs. Catherine Nyumoo,
Designation: Enviropro Kenya Ltd Project Manager
Signed at Nairobi on ………day of December, 2021.

Signature: ……………………………………………

Proponent Representative
Eng. Joshua Were
Designation: KenGen’s Environment and Sustainable Development Manager.
Signed at Nairobi on ………day of December, 2021.

Signature…………………………………………Stamp: ....

DISCLAIMER

This ESIA Study is confidential to Kenya Electricity Generating Company PLC (KenGen) hereafter referred to as “The Proponent” and any use of the materials thereof should strictly be in accordance with the agreement between KenGen (the Client) and Seureca Veolia (The Consultants) mentioned herein. It is, however, subject to conditions spelt out in the Environmental (Impact Assessment & Audit) Regulations, 2003, under the Kenya Gazette Supplement No. 56 of 13th June 2003. This study provides information on the proposed project as at the time of the Environmental Social-Impact Assessment(ESIA).

ACKNOWLEDGEMENT

The ESIA Experts are grateful to the project proponents at Kenya Electricity Generating Company PLC (KenGen) and Nairobi Metropolitan Services (NMS) management and its team for commissioning us to conduct this Environmental and Social Impact Assessment Report in respect of the proposed project. We would like to acknowledge with great appreciation all residents among other stakeholders who participated in the public consultation process for their cooperation throughout the exercise.

We further acknowledge the support from the project officers from the various parties who assisted the experts' team either directly or indirectly towards the successful completion of this report.

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Acronyms and Abbreviations

AAR	Annual Average Rainfall
AAQ	Ambient Air Quality
APCr	Air Pollution Control residues
AWWDA	Athi Water Works Development Agency
ACSR	Aluminium Conductor Steel Reinforced
amsl	Above mean sea level
BAT	Best-Available Technologies
B.O.D	Biological Oxygen Demand
B/C	Benefit – Cost ratio
Bgl	Below Ground Level
CEMS	Continuous Emissions Monitoring Systems
CIA	Cumulative Impact Assessment
CIAGs	Cumulative Impact Assessment Guidelines
CIDP	County Integrated Development Plan
COD	Chemical Oxygen Demand
CV	Calorific Value
DFS	Detailed feasibility study
EPC	Engineering Procurement and Construction
EIA	Environmental Impact Assessment
EHS	Environment, Occupational Health and Safety
EMCA	Environment Management & Coordination Act
EMMP	Environmental Management & Mitigation Plan
ERSWEC	Economic Recovery Strategy for Wealth and Employment Creation
ESAP	Environmental and Social Action Plan
ESMS	Environmental and Social Management System
FIRR	Financial Internal Rate of Return
FS	Feasibility Study
GCV	Gross Calorific Value
GHG	Greenhouse gases
GIIP	Good International Industrial Practices
GPS	Geographical Positioning Coordinates

GWh	Gigawatt hours
GWh/y	Gigawatt hours per year
HIA	Health Impact Assessment
HMB	Heat and Mass Balance
HSE	Health, Safety, Environment
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IPP	Independent Power Producer
KCAA	Kenya Civil Aviation Authority
KenGen	Kenya Electricity Generating Company
KNBS	Kenya National Bureau of Statistics
Km	Kilometers
KPLC	Kenya Power
KSh	Kenya Shilling
kV	Kilovolt
KVA	Kilo Volts Amperes
kW	Kilowatt
kWh	Kilowatt-hour
KWS	Kenya Wildlife Services
LCOE	Levelized Cost of Electricity
LFG	Landfill Gas
LILO	Loop In Loop Out
m2	Square metre
MCA	Member of County Assembly
MOU	Memorandum of Understanding
MoE	Ministry of Energy
MRF	Material Recovery Facility
MW	Megawatts
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NaMSIP	Nairobi Metropolitan Services Improvement Project
NEMA	National Environment Management Authority

NGOs	Non-Governmental Organizations
NMS	Nairobi Metropolitan Services
NPEP	National Poverty Eradication Plan
OHS	Occupational Health & Safety
OHTL	Overhead Transmission Lines
OSHA	Occupational Safety & Health Act
O&M	Operation & Management/ Operating & Maintenance Cost
PAPs	Project Affected Persons
PDA	Project Development Agreement
PPA	Power Purchasing Agreement
PPE	Personal Protective Equipment
PPC	Public Participation & Consultation
PPP	Public Private Partnerships
RAP	Resettlement Action Plan
RoE	Return on Equity
SESO	Standard Environmental and Social Obligations
SDGs	Sustainable Development Goals
SHA	Shareholder Agreement
SIA	Social Impact Assessment
SoK	Survey of Kenya
SOP	Standard Operating Procedure
SOP	Social Action Plan
STP	Sewage Treatment Plant
SR	Scoping Report
TCMP	Traffic Control Management Plan
TDS	Total Dissolved Solids
TPD	Tonnes Per Day
ToR	Terms of Reference
TSS	Total Suspended Solids
uPVC	Unplasticized polyvinyl chloride
USD	United States of America Dollar
V	Volts

VAT	Value Added Tax
VOCs	Volatile Organic Compounds
WB Op	World Bank Operational Manual
WFD	Waste Framework Directive
WTEP	Waste-to-Energy Plant
Wp	Watt peak
WRA	Water Resources Management Authority

1 Executive Summary

1.1 Introduction

Nairobi Metropolitan Region is experiencing increased environmental pollution due to current poor municipal solid waste disposal practices from its growing urbanization and population which has seen significant increase in waste generation. This has created severe environmental nuisance and degradation with regards to air pollution, surface and groundwater contamination posing immense threats to the quality of life in the city and its environs. To address this inadequate solid waste management and as part of the national solid waste management strategy 2014 and in accordance with the constitutional guarantee to every citizen on access to a clean and healthy environment, the Government of Kenya, through Kenya Electricity Generating Company PLC (Kengen) initiated the development process of a Waste to Energy (WtE) Power Plant at Ruai ward, Kasarani Sub county, Nairobi County in partnership with the Nairobi Metropolitan Services (NMS).

The plant as proposed will contribute to energy security and diversification and matches the growing demand for energy in a carbon constrained world. The facility will also contribute to the resolution of waste management problems in Nairobi and its environs by reducing the volume of waste, decreasing the need for storage and easing dumpsites management hence mitigate exposures of the environment and humans to the detrimental effects of poorly managed municipal solid waste. This is a step towards taking measures for greenhouse gas (GHG) emissions reductions as a steady global warming measures plan for a low-carbon society in compliance with the Sixth Sustainable Development Goal that emphasizes the provision of safe clean water and a safe environment.

According to the World Bank's Environmental Management guidelines on screening approach and operational procedures mainly Environmental and Social Risks and Impacts (ESS1), a Waste to Energy (WtE) Power Plant facility is classified under Category A project and its construction must be preceded by undertaking of a full Environmental and Social Impact Assessment (ESIA) study as outlined in the Second Schedule II of EMCA 1999, Cap 387 and the Legal Notice 101 (Regulations for Environmental Assessment and Audit) of June 2003 for submission for approval to the National Environmental Management Authority (NEMA). The entire ESIA study process has been designed to:

a) Ensure that potential environmental and social impacts associated with the construction, operation and decommissioning of the proposed Waste to Energy (WtE) Power Plant at Ruai is identified, assessed and if unavoidable they should be minimized, mitigated, and/or offset and an environmental and social management plan developed to aid in managing the potential impacts appropriately in a manner that is socially responsible and reflects sound environmental management practices.
b) Conform to the regulatory framework stipulated by the National Environmental Management Authority (NEMA) - the body that will review this report and make decisions on grant of an environmental license to the development; and
c) Comply with international requirements as a condition of accessing international financing from the World Bank/IFC guidelines.

As per the feasibility study report, the proposed WtE Power Plant shall sit on 27 ha of land owned by Nairobi County under the custody of Athi Water Works Development Agency (AWWDA), Land reference (LR) No. 12979/1. The plant is designed to process and generate electricity from a maximum 3,000 t/d of municipal waste.

1.2 Waste to Energy Plant Technology

The Waste to Energy (WtE) power plant components include: Combustion boiler to produce 415^{0}C steam for the steam turbo generator for power generation technology with a proposed incinerator capacity of: 3*650 t/d and 2*22.5 MW synchronous generators with 10% design margin. The power shall be connected to the grid through a loop in loop out connection to the existing 132 kV Mangu to Juja line which is located next to the waste to energy facility.

Other components of the project include; perimeter fencing, access road, gatehouse, weighbridge, drainage, offices and overall site infrastructure. The plant has a daily water requirement estimate of about 8.5million litres which shall be sourced from Nairobi Sewerage Water Treatment Facilities ponds as the primary source with alternative being a borehole to be drilled as part of the project and abstraction from the adjacent Nairobi River for provision emergency utilization. The plant operations will be a closed system with water re-used as part of the daily process. The facility will obtain appropriate licenses for water abstraction prior to operation commencement.

A 52 tonne/hour mechanical press shall be used for dewatering (leachate) the waste up to 45% (residual moisture) in output quantity. There will be leachate collection drains from the pit and thus leachate present in the garbage will be collected in this collection pit which would be transferred to the leachate treatment plant for treatment. The condensed water from Leachate treatment plant will be recycled for quenching of bottom ash. Surplus treated leachate would be used for the internal purposes of plants like washing, gardening, and for green belt and excess disposed of to the nearby Ngong river within allowable legal guide values.

Other wastes generated from the facility such as bottom ash has been proposed for adoption into road construction while all other residual wastes shall be buried in the Landfill with a protective non-woven geotextile to prevent punctures in the high-density polyethylene (HDPE) sheet.

1.3 Details for Baseline Survey

From the Acoustic description and Measurement of Environmental Noise, as per international standards ISO 1996:1822, the ambient noise levels measured at site were 48.4 dB (A) and 52.6 dB (A) mainly characterized with movement of large herds of livestock, aircrafts passing over, birds chirping, and dogs barking during the nocturnal schedule. These results are within OSHA, 2007 and Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009, 1st Schedule Maximum Permissible Noise levels for commercial sites with limits of 60 dB (A) during the day and 35 dB (A). These levels should be expected during the operational phase of the project with the boundary wall being erected as a noise buffer as well as lining the boundary with tree linings. The nearest residential units are located approximately 700metres away and with the buffers proposed it is not expected that the inhabitants will be adversely affected by noise levels generated from the site.

River, Borehole and Sewerage effluent water quality laboratory analysis as per KEBS (KS 459-1:2007) standards to ascertain the microbiological and physio-chemical water health condition indicate that the water quality at the selected points were not within the recommended national and WHO potable water standards with parameters such as; Phenols, Fluorides, Copper, Zinc, Total Nitrogen and E-coli were above respective stipulated limits with Sewerage effluent water containing higher concentrations levels. All other parameters tested are within the respective EMC limits. The above limits are attributed to the high levels of water pollution in rivers around the Nairobi Metropolis area with Nairobi river adjacent to the site no exception from poor waste disposal into water bodies. In addition, the proposed project site being the lowest point within the Nairobi area receives storm water runoff and wastewater from the larger Metropolis area with significant potential for contamination. The site is therefore prone to contamination as evidenced by the surface and groundwater test results. The project, nonetheless, will ensure that effluent discharge from its operations will meet EMCA,1999, Water Quality Regulations, 2006, Schedule 7 Guideline values for discharge into the Environment.

Air quality survey was undertaken for Particulate Matter (PM_{10}, $PM_{2.5}$), Volatile Organic Compounds (VOCs), Sulphur Oxides (SO_2), Nitrogen Oxides (NO_2) and Carbon Dioxides (CO_2). The results

obtained are well within WHO Air Quality Guidelines-Global Update 2005 and Kenyan Air Quality Regulations, 2014.
The Study also undertook air quality dispersion modelling with the receptor domain adopted for the pollutant's concentration predictions being a 3 x 2-kilometer rectangular extent around the plant. Based on the modelling exercise outcome, areas of significance were observed with potential adverse air quality concentration recorded over the 24 hours average meteorological conditions with maximum incremental ground level concentration of $PM_{2.5}$, PM_{10}, SO_2, NO_2 and carbon monoxide (CO). The location of maximum peak concentration of pollutants was on the immediate South West side of the proposed plant. Therefore, potential air quality impact zone during the project operation phase is within 2km radius in the south westerly direction as the most sensitive impact area. However, the area is noted to be sparsely populated with no residential properties within 2km radius, thereby minimal adverse direct impact foreseen for the immediate community.

This therefore requires project proponents to employ technologies that shall meet stringent international standards such as European Union Directive 2010/75/EC on industrial emissions (integrated pollution prevention and control) to minimize any adverse air quality on the environment.

Soil quality laboratory analysis was carried out according to section 37 of the Soil Protection Act and the adopted Dutch Soil Intervention guidelines to ascertain the chemical soil health condition. Parameters of the collected samples from the selected sites indicated that the soil exhibited strongly alkaline conditions. All the values obtained for soil results were below the Dutch Target Values guidelines of 5000mg/l on groundwater and soil intervention values[1], with emphasis on heavy metals and hydrocarbons contaminants which implies that the soil is good to sustain humans, plant and animal life.

Biological and socio-cultural environmental study of the core area (proposed project site) was carried out during which no rare, sensitive or endangered fauna or flora species were observed onsite. Therefore, there would be no negative impact on the biological and socio-cultural environment from construction and operation activities of the project. They are neither listed on the International Union for Conservation of Nature (IUCN) Red list of threatened species nor on the Kenya Wildlife Services' Priority species list.

1.4 Project Impacts

Several impacts anticipated (positive and negative) throughout the lifecycle associated with the proposed project were identified through field work, desktop analysis and the use of experts' judgment methods as enlisted below: -

1.5 Positive Impacts Anticipated:

- Landscape and visual improvement with enhanced solid waste collection and disposal within the greater Nairobi Metropolis area.
- Effective land use of the project that was largely unutilized open grasslands being elevated to an industrial status zone.
- Facility will reduce overall greenhouse gases emissions from the open dumpsites paving way for Dandora reclamation and restoration.
- Improved energy supply mix with base load diversification for national grid distribution thereby improving energy security for the country.
- Improved youth employment with development of waste transfer stations across Nairobi Metropolis area where unemployed youth would be given priority in employment.

[1]5 (Dutch Intervention Soil and Groundwater values - Table 1 Groundwater target values and soil and groundwater intervention values9)

- Knowledge transfer from the specialized skills during plant's construction and operation and decommissioning.
- Significant improvement in water quality with improved solid waste management thereby reducing ground water pollution and reduction in drainage blockages by poor waste disposal.
- Enhanced local and national economies with improved stable energy supply;
- Improved solid waste management through its utilization as a valuable fuel feedstock for the WtE plant.
- Enhancement of infrastructure within the immediate project area of Ruai ward.
- Matching the growing demand for renewable energy in a carbon constrained world.

1.6 Negative Impacts Anticipated:

- Air Pollution associated with odors and gases mainly from waste transportation;
- Air and dust pollution attributed to plant emissions and odor from waste delivery;
- Enhanced localized air pollution with vehicular emissions from large traffic flow to the plant;
- Noise pollution from large traffic flow to and around the site;
- Aesthetics/ visual intrusion;
- Traffic congestion along the main access route to the site with increased traffic by waste delivery trucks.
- Potential cropping up of unplanned settlements along the access road from those intending to benefit from waste handling;
- Accidental leachate release from the waste reception storage causing surface and groundwater pollution;
- The high influx of casual workers around the greater Ruai area leading to several social structural changes of the immediate community;
- Injury and loss of life from potential accidents from large vehicular traffic delivering materials to the site;
- Habitat loss and degradation from the infrastructural development;
- Health precautions from Covid-19 impacts large population congregations at project sites.

1.7 Public Consultation and Participation

Consultative public participation (CPP) process identified stakeholders from both National and County Government, regional authorities, communities, local leaders and community-based organization (CBO)'s alongside the affected households within a 2km radius of the proposed project site. The stakeholders were engaged either individually or as groups based on the best modality available to brief them and get feedback from them as per the schedule for engagement.

The stakeholders consulted had an overwhelmingly positive review of the project with a minority non-supportive views registered. The majority of about 80% of stakeholders see the project as having a positive contribution to the enhancement of solid waste management, employment to the residents, improved solid waste management, enhanced water quality, increased greener stable electricity supply to the national grid, and enhanced economies with improved business opportunities.

However, the stakeholders raised concerns for consideration and action by the proponent and its contractors during facilities construction, operation and decommissioning phases of the project. These concerns are;

- Covering of waste delivery trucks to minimize foul smell and discharge of waste on public roads within the - county;
- Expansion of the Kangundo Road from Outer Ring Road Junction to dual carriageway to minimize traffic snarl up from the significant traffic experiences due to the prevailing dilapidated conditions of the roads and associated infrastructure;

- Properly designed WtE facilities to ensure its existence does not affect water quality in their shallow water supply wells (leachate contamination and landfill operations), pollution of the surrounding air (foul smell) nor attraction of scavenging birds and humans (illegal open dumping by waste transporters vehicle breakdown) leading to instances of insecurity and illegal settlements around the project site resulting in development of slums;
- Residents were concerned whether the Dandora dumpsite was being relocated to Ruai, and what would happen should the plant break down with potential for of accumulation of raw materials onsite in the open;
- KenGen to ensure that the landfill protects the groundwater from contamination;
- Ensure the flue gas emissions and effluents from the facility are within the required legal guide limits.

1.8 Proposed Mitigation Measures

The pollutants of concern include dioxins and furans, heavy metals (in particular, cadmium, mercury, and lead), acid gases, and particulate matter, either formed during waste incineration or are present in the waste stream fed to the incineration facility. These potential pollutants emissions will be mitigated by the application of improved combustor designs, operating practices, and air-pollution control equipment. Changes in waste feed stream composition have resulted in a dramatic decrease in the emissions that used to characterize uncontrolled incineration facilities. The technical regulations on hazardous waste storage areas will be complied with relating to Regulation 8(1), (2) of Waste Management Regulations on hazardous waste management. Water requirement has been calculated as ~8.5 MLD for WCC and ~2.5 MLD for ACC.

The treated sewage water located about 8km from the site can however be utilized to minimize cost and complexity of the system. The 3,000 m^3/d total effluents generated from the boiler blow down, cooling tower blow down, softener, and Water to Energy~~DM~~ plant would be collected in a neutralizing pit commonly known as N pit; Sanitary wastewater from the project will be treated through a bio-digester before being discharged into the environment or re-used for planting.

Non-hazardous bottom ash waste after pre-treatment shall be disposed of in an inert waste landfill with optional use as foundation material in road construction or in brick making. Hazardous fly ash materials will be landfilled on a stable land that can support the weight of the materials over an extended period, with a preference for low permeability soil which must be fully isolated from natural hydrology. The leachate generated during stabilization and pre-processing processes characterized by high chemical and biological oxygen demand (COD, BOD) shall be subjected to a hybrid process involving both biological and physicochemical methods for leachate treatment with Continuous monitoring of effluent quality to meet the requirements of EMCA,1999, Water Quality Regulations, 2006.

1.9 Environmental Social-Management Plan (ESMP)

The ESMP is the synthesis of all proposed mitigation and monitoring actions, set to a timeline with specific responsibility assigned and follow-up actions defined. The Contractor employed by the proponent during the construction period will be responsible for developing and implementing a site-specific induction for all construction workers. This induction will include all EHS hazards and their control measures. The induction will also include a disaster risk management planning exercise. The Contractor will ensure that all construction workers are trained and competent and hold the appropriate certification for the tasks that they will be undertaking. It will be noted that most of these measures will be part of the project's operational costs. A summary of the ESMP is presented in Table 1 below.

Table 1: Summary of ESMP

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
Emissions During Construction					
• Whilst there are no significant impacts identified associated with the construction phase, potential dust and vehicular emissions generated and escape offsite are the main concerns that need to be addressed. • A dust and vehicular traffic management programme will be implemented that sets out measures for the visual assessment of dust and vehicular emissions, additional mitigation if excessive dust and vehicular emissions are observed and normalized responses for responding to, substantiating and dealing with any dust nuisance complaints.	• Minimization of dust and vehicular emissions and avoidance of a dust nuisance. • Avoidance of health impacts to the workforce and local community.	• No significant ingress of construction dust & vehicular emissions into properties of local communities.	• Monitoring programme will be developed in line with the requirements of the IFC EHS Guidelines for Waste to Energy /Waste Management Facilities, 2007 guidelines. • Grievance mechanism records. • VOCs emissions measurements.	• In advance of and during construction activities.	• Within the general responsibilities of the construction supervisor – no significant material additional costs.
Emissions During Operation					
• The Sulphur content of the flue gas and fly ash will not exceed 2%, as this would lead to increases in SO2 emissions from the plant. • Emissions monitoring for HF, HCL, SO2, NOx, CO and PM10 &2.5.	Emissions are limited to minimize impact on human health.	Emissions within standards set by the Applicable Air Quality Standards and Guidelines.	Emissions monitoring. Details to be agreed with NEMA prior to operation and to be in line with the requirements of the IFC EHS Guidelines for Waste Management facilities.	During operation.	Air quality monitoring costs: • Capital cost NOx/SO2/PM ~ $75,000 including data logger • Capital cost meteorological measurements ~ $30,000 • Installation & setup air quality monitoring equipment ~ $20,000 • Periodic operational costs, air quality and met monitoring (including data validation) ~ US $ 100,000 • Total: ~$225,000 Monitoring of Sulphur & Nitrogen oxides (NOx) content is under the general

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
					responsibilities of the construction supervisor – no material additional costs associated with this activity.
Noise Disturbance during Construction and Decommissioning					
• Although minor construction noise impacts are not high enough to require further mitigation, good site practice will be employed to minimize noise through the following measures: • selection of low noise equipment; • temporary screening of the equipment; • switching equipment off when not in use; and • construction of on-site buildings first to act as noise screens. • Maintenance of construction equipment as per manufacturers guidelines for optimal operation.	• Minimization of noise to avoid exceedance of noise criteria as set out in Chapter 7. • To minimize noise disturbance to local residents and receptors.	OSHA, 2007 and Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009, 1st Schedule Maximum Permissible Noise levels for commercial sites with limits of 60 dB (A) during the day and 35 dB (A).	• Noise monitoring will be required to ensure noise levels are within agreed limits.	• During construction	Capital costs (one-off purchasing noise measurement equipment) ~ $3,200 Monitoring cost (ambient noise prior to construction) ~ $430 ($430 x 1) Monitoring cost (during construction) ~ $4,300 ($430 x 10)) Total: $8,000
Noise Disturbance during Operations					
• The predicted noise levels have identified the need for noise mitigation to limit noise impacts to Minor significance. • The key items that are likely to require mitigation in order to reduce noise levels at the nearest receptor are as follows: radiator fans; engine room; ventilation outlet units; air cooled condenser for DCC; and venting units. • The choice of noise mitigation measures will be developed during further detailed design as well as	Minimize operational noise levels to meet IFC and Kenyan standards.	OSHA, 2007 and Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009, 1st Schedule Maximum Permissible Noise levels for commercial sites with limits of 60 dB (A) during the day and 35 dB (A).	Noise monitoring will be required to ensure noise levels are within agreed limits.	• During operation using 24hrs TWA.	Monitoring cost (ambient noise During commissioning) ~ $860 (1 x daytime and 1 x nighttime @ $430 each) Monitoring cost (during operation) ~ $4,300 (5 x $860) Total: $5,200

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
selection of quieter equipment or provisions of on-site barriers to screen noise from key equipment items. • WTE Plant will establish a contractual design limit to ensure that agreed noise levels are achieved.					
Impacts on Water Resources					
• Appropriate construction methodology will be applied to ensure that groundwater contamination does not occur. Additionally, in order to mitigate potential impacts that could result from poor borehole construction, ministry of water guidelines shall be strictly enforced as detailed in Water Act, 2012. • The potential contamination and/or erosion risks from construction related activities can be mitigated by industry-standard good construction management practices. • WTE Plant, which is examining a collective approach to coordinate surface water management with the neighboring KPLC substation site. During construction it is likely that temporary drainage channels will be created to channel and divert surface water from the WTE Plant site, away from the down slope agricultural plots; a similar approach will be developed to divert and distribute site run-off (particularly storm water run-	Minimize risk to water resources from construction activities	• IFC Environmental, Health and Safety Guidelines for Waste Management facilities. • Reference Document on Best Available Techniques for Large Combustion Plants (BREF Note) produced by the European Commission. • International best practice.	• Water abstraction to be monitored to ensure compliance with WRA permit requirements • The Construction Management Plan will set out requirements for monitoring of construction activities and compliance with legislation/guidance and best practice.	• During construction and operation.	• Development of Construction Management Plan will entail approximately 20man days of WTE Plant staff or others as appropriate. • No material additional costs are anticipated above general budgets for responsibilities of WTE Plant environment manager for the implementation of the plan.

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
off).					
Traffic and Transport Impacts					
• Measures to mitigate the likely significant effects from traffic movements arising during construction, operation and decommissioning have been developed in the form of a Traffic Control Management Plan (TCMP), see Annex B for details. • The management plan will include procedures which will assess the likely number and intensity of vehicular movements and outline methods which will be adopted to minimize the overall footprint and secondary impacts such as dust. • The key issues addressed by the management plan in terms of mitigation measures include: • access to construction areas; • routing of construction traffic; • temporary traffic control and management; • road crossings; • parking facilities; • keeping highways clean of mud and dust; • driver training; • road safety and awareness training for school children; and reducing the probability of traffic accidents. • Regulations regarding the	• Mitigate impacts from increased construction and operational traffic on the following: • Road user delays; • Road user safety; • Highway infrastructure degradation; and • Increased levels of noise, vibration and air pollution.	• IEMA Guidelines for the Environmental Assessment of Road Traffic used to inform Significance criteria which are fully defined in Chapter 7.	The TCMP will set out requirements for monitoring.	• During construction and operation.	• Development of TCMP will entail approximately 20man days of WTE Plant staff or others as appropriate. • Approximately $50,000 over project lifetime to implement the mitigation measures that will be included in the TCMP.

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
transportation of heavy loads limit the cargo weight and size to the maximum amounts allowed for transporting vehicles. The Kenyan Traffic Act (revised 2009), states that all heavy and medium vehicles are also required by law to carry a warning sign at the rear of the vehicle.					
Waste Management					
• All waste related impacts likely to arise during construction, operation and decommissioning can be mitigated very effectively by the implementation of standard best practices in terms of environmental controls and management practices. • Waste streams generated during construction should be managed with due regard to the waste hierarchy. Specifically, the following principles will be adopted, in order of preference: • Waste minimization; • Reuse and recycling; • Waste treatment; and • Disposal. • Good practice also requires that during operation of the Project: • All hazardous materials are stored in clearly labelled containers; • Storage and handling of hazardous materials is in accordance with national and local regulations	• Minimization of waste generated; • Effective treatment and disposal of generated waste, in line with national and international standards.	World Bank/IFC Environmental, Health and Safety Guidelines for Waste Management Plants, and the Reference Document on Best Available Techniques for Large Combustion Plants (BREF Note) produced by the European Commission.	• The Waste Management Plan will set out requirements for monitoring.	During construction and operation.	• Development of Waste Management Plan will entail approximately 20man days of WTE plant staff or others as appropriate. • No material additional costs are anticipated above general budgets for responsibilities of WtE plant environment manager for the implementation of the plan.

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
appropriate to their hazard characteristics; and • Fire prevention systems and secondary containment will be provided for storage facilities, where necessary, to prevent fires or the releases of hazardous materials to the environment.					
Unplanned Events					
• WtE Plant will develop an EMS that will, among other things, seek to prevent and limit environmental accidents and develop contingency procedures in case of such accidents. Given that most unplanned and emergency events have both environmental and health and safety consequences, the EMS, will be developed alongside the Health and Safety Management System. Ideally this will be done within the overall framework of an Integrated Quality, Environmental and Health and Safety Management System. • A Safety Programme will be set up by WtE plant for specific use at the Project site. This will include details on: • Training, instruction and information; • Inspection and testing; • Accident investigation and reporting; • Accident report review and follow up; and Year-end report.	• Prevent and limit Environmental ensure Contingency procedures are in place in case of such accidents.	• World Bank/IFC EHS Guidelines for Waste Management Facilities, 2007 guidelines	• The Unplanned Events and Emergency Response Plan will set out requirements for monitoring.	• During construction and operation	• In addition to development of the EMS development of the following plans and procedures will take around 20 man days of WtE Plant staff or other's time: → Emergency Response Plan → Risk Assessment Procedures → Safety programme setup → Safety programme implementation over project lifetime • Approximately $5,000 to $10,000 for materials to support the safety programme implementation • HAZOP costs to be developed as part of engineering scope of work.

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
• A comprehensive Emergency Response Plan will be developed and implemented • As an integral part of the Safety Programme and the Emergency Response Plan, fire prevention and firefighting capability will be among the top priority requirements of the Project • A Hazard and Operability (HAZOP) study will be conducted on the plant during the design stage. Further assessments will be carried out on major new equipment or subsequent design modifications. • Mitigation measures to prevent contamination of land and water will be developed and implemented. • Risk assessment procedures will be developed and implemented by trained personnel.					
Landscape and Visual Impacts					
• Good practice mitigation measures will be implemented to mitigate construction, operation and demolition impacts. These include: • Machinery and materials will be stored tidily during construction. • Tall machinery including cranes will not be left in place for longer than required. • Temporary roads and works areas will be maintained free of dust;	• Minimization of any impacts of the proposed project upon the Landscape character, view and visual amenity.	• Significance criteria as set out in the Guidelines for Landscape and Visual Impact Assessment produced jointly by the British Landscape Institute and the British Institute of Environmental Management and Assessment (IEMA).	• Monitoring to ensure that visual screening and dust control measures in the Management and Action Plans for the Project are Implemented effectively.	• During construction and operation.	• Costs have been built into capital project costs and operation and maintenance budgets regarding visual design of the plant. • Good practice mitigation will not incur significant additional material costs above general housekeeping best practice. • Development of Conceptual Landscape Plan will cost around $2,500. Further detailed plan and

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
• Outdoor construction lighting shall be unobtrusive and shall not allow light to shine upwards or towards residential areas; • Security and work lighting (both driving construction and operation) shall be shielded and directed downwards. • The following mitigation measures are recommended throughout the operational phase of the proposed power plant to further minimize landscape and visual impacts during operation: • The design, orientation and materials will be appropriately and reasonably developed to match existing site and landscape characteristics; • Appropriate use of non-reflective surfaces and surface color treatment; • An appropriate landscape plan shall be developed and adopted using tree belts and buffer screenings to provide visual relief and shade; • Minimization of external signage clutter and signs which have a silhouette effect on the skyline; • Roads providing access to site facilities and works areas will be landscaped and maintained free of dust where feasible; • Outdoor lighting shall be as unobtrusive as possible and shall be					costs of landscaping will be ascertained depending on the conclusions of the Conceptual • Landscape Plan.

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
shielded and directed downwards to prevent side spill. The use of tall mast lights shall be carefully assessed before use; • Monitoring to ensure that visual screening and dust control measures in the Management and Action Plans for the Project are implemented effectively.					
Social and Socio-Economic Impacts					
• Impacts on local employment and the local economy during construction, operation and decommissioning will be managed through the following: • Development and implementation of a Human Resources Policy; • Provision of on the job training; • Employee contracts shall be mandatory; • Provision of employment certificates to workers on completion of contracts; • Development and implementation of a Local Procurement Policy; • Implementation of a clear Grievance mechanism. • Impacts of a new workforce on community health and wellbeing during construction and operation will be mitigated through the following: • Develop and implement a Health Risk Assessment; • Develop and implement a Workforce	• Maximize impacts on employment and the local economy during construction. • Maximize impacts on employment and the local economy during operation. • Minimize impacts of a new workforce on community health and wellbeing during construction and operation. • Minimize impacts on employment	• Kenyan labor law and the World Bank/IFC Performance Standards	• The Occupational Health and Safety Management Plan, the Worker Management Plan, The Stakeholder Engagement Plan and the Social Investment Strategy will set out relevant monitoring requirements.	• During construction and operation	• Development of the following plans and policies will entail around 20man days of WtE Plant (or other's) time: • Human Resource Policy • Stakeholder Engagement Plan • Local Procurement Policy • Health Risk Assessment • Workforce Management Plan • social investment strategy • Provision of on the job training (costs to be incorporated into Workforce Management Plan as developed).

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
Management Plan; and • Implement a clear Grievance Mechanism • Where possible (as skills permit) WtE PLANT will look to recruit from the local communities surrounding the proposed Project site during construction and operation. • WtE PLANT will develop and implement a social investment strategy that will support social development initiatives in communities neighboring the proposed Project.	legacy issues associated with the change in land use.				

The importance of the proposed project to national development and the local community cannot be overemphasized. The proposed project will help meet surging demand for proper waste treatment within Nairobi Metropolis area, improve water quality, protection and management and reduce waste pollution in the city, extend lifespan of the existing dumpsites, convert waste into electricity, enhance reliable base load energy and recycling. On the basis of the above discussions, it can be concluded that the proposed project is environmentally, legally, socially and culturally acceptable. On that basis, it is recommended that the project be issued with the necessary clearance for the proponent to commence implementation in compliance with the relevant legislation and planning requirements.

2 Introduction

The Kenyan Government envisages an energy sector that is well supplied with adequate and quality energy services. To meet these, very broad energy policy objectives calls have been made for the delivery of cost effective and environmentally sound energy service to all sectors of the economy. In endeavoring to provide clean energy services then, security of supply, affordability and sustainability are considered as pivotal pillars for an energy system development. The Country's Vision 2030 development blue-print for economic growth has set out access to affordable and quality energy as its main cornerstone divesting from expensive thermal plants with a shift to renewable energies.

Nairobi Metropolitan Region is experiencing increased environmental pollution mainly due to inadequate collection and disposal of municipal solid waste. To address this inadequate solid waste management and as part of the national solid waste management strategy 2014, the Government of Kenya, through Kenya Electricity Generating Company PLC (KenGen) initiated the development process of a Waste to Energy (WtE) Power Plant at Ruai, Kasarani Sub county, Nairobi County, in partnership with the Nairobi Metropolitan Services (NMS). The process will involve incineration of solid waste at high temperatures in order to generate electricity from the heat produced.

2.1 Background and Project Rationale

2.1.1 Dandora Dumpsite Closure and Restoration Plan

Dandora dumpsite is Nairobi's principal dumping site established in 1977 sprawling over 28 Hectares and handling all the wastes generated by Nairobi City (receiving over 2200 tonnes of waste on a daily basis). Poor waste management at the dumpsite and around the city has had significant consequences on socio-economic activities of the county.

The dumpsite has become an environmental hazard from the careless dumping of solid wastes ranging from both toxic and non-toxic materials polluting both surface and underground waters from leachate formation that end up into the Nairobi River which is located a few meters from the site. Inhabitants use this water for domestic purposes posing significant health and environmental risks. Shallow aquifers are vulnerable to leachate contamination. Consumption of leachate-polluted water is a known source of gastrointestinal illness, reproductive problems and neurological disorder (WHO report, 2006). As air and water from rain mix with the decomposed waste materials, contaminants from the solid wastes are extracted into the liquid phase to form leachate. Leachates toxicity is determined by the composition of the waste materials, availability of moisture, and the local temperature conditions and it's the main sources of ground and surface water pollution if it is not properly collected and treated and safely disposed of as it may percolate through soil reaching water aquifers. The constantly burning mountainous garbage heap produces acidic fumes of Sulphur, lead and other heavy metals not only causing serious air pollution and acid rain but the noxious fumes also affect the respiratory system of the inhabitants with some experiencing breathing difficulties. Several studies have been commissioned to assess the impact of the dumpsite on the environment showing dangerously high levels of heavy metals in the surrounding environment and in the body of local residents. Lead and cadmium levels were 13,500 ppm and 1,058 ppm respectively, compared to the action levels in the Netherlands of 150 ppm/5ppm for these heavy metals. The Stockholm Convention on hazardous pollution, which Kenya has ratified, requires actions aimed at eliminating these pollutants. The promise to act was agreed by the government, interested stakeholders and the civil society. Many global Non-Government Organizations (NGOs) have called upon Kenyan government representatives and stakeholders to honor the Convention and keep the promise of reduction and elimination of such harmful pollutants. However, indiscriminate dumping at the site goes on due to lack of an alternative site and the dumpsite beneficiaries who are totally against its relocation. Attempts to relocate has been strongly opposed by those benefiting from it as well as opposition by residents in the backyard of proposed sites. By 2011, the dumpsite was deemed full and yet it continues to operate, and the site fully utilized economically by scavengers for daily income through waste materials collection for re-use and recycling even though the site operations pose significant health implications to the residents.

While some critics will defend the habit, it is a disastrous short-term solution to a larger, complex and longer social and economic problem. Public participation will be at the core of the decommissioning of the facility, relocation and setting up of a waste to energy plant in its place. The local communities and various interested and affected stakeholders (IAPs) understand their role as participants in the change process to decommission the dumpsite and set up the WTE plant. The national and county governments in liaison with various IAP's have in the past put forward a number of proposals to solve the problem. This included closing the dumpsite, re-cultivation, relocation of waste management, and proper recycling facilities. Fortunately, the developments of those ideas have been embraced as a presidential legacy flagship project thereby gaining both financial and political goodwill through development of a waste to energy plant and associated infrastructure.

2.1.2 Justification for Municipal Solid Waste to Energy Plant

The Kenyan Government envisages an energy sector that is well supplied by an intermix of energy sources that is adequate, affordable and high quality energy services. To meet these, very broad energy policy objectives calls have been made for the delivery of cost effective and environmentally sound energy service to all sectors of the economy. In endeavoring to provide clean energy services then, security of supply, affordability and sustainability are considered as pivotal pillars for an energy system development. Consequently, a broad energy mix involving both traditional and non-traditional energy sources development have been adopted as the solution including WtE Plants.

Kenya's cheapest source of power is hydropower but it is affected by erratic weather attributed to pronounced climate variability which greatly affects the efficiency and reliability of power generation, cost and electricity supply capacity in Kenya. The government in its efforts to power the country's Vision 2030 development blue-print for economic growth has set strategic diversification of electricity generation source as a key goal to achieve sustainable development. Diversifying Kenya's energy mix is of great importance, as over-reliance on hydropower and fossil fuels leaves the nation vulnerable to drought-induced power outages and increasing energy costs from volatile fuel prices. expected to create an enabling environment for the long term government goals such as the Big Four Agenda by adopting modern energy services which are crucial to human well-being and to a country's economic development- a correct path to achieve the United Nations' sustainable development goal number seven which focuses on the provision of sustainable, affordable, reliable and modern energy for all.

Nairobi like other developing world cities is characterized by rapid population growth, and urbanization. With a population of nearly 5 million people the amount of solid waste generated is ever increasing. The surrounding metropolis towns are fast growing and do not have proper waste management systems. Uncontrolled dumping leads further to serious problems of environment, safety and land availability. Improperly managed waste usually results in downstream costs higher than what it would have cost to manage the waste properly in the first place. Noncompliance with applicable environmental laws and regulations results in penalties, negative reputation and conflicts with stakeholders. Kenya Vision 2030 recognizes the need for establishing efficient and sustainable waste management systems to support the level of industrialization that is envisaged by 2030. Effective waste management has important economic and social impacts in addition to environmental benefits. For this reason, waste management should not be viewed as an economic activity for generating income, but rather a public service requiring financing for cost recovery

Failure to handle waste in an environmental sound manner has the potential of causing pollution to the atmosphere, water and soil. Uncollected and illegally or improperly disposed wastes pose serious risks to public health and the environment. The Waste to Energy (WtE) project for Nairobi and the larger Metropolis is more than just a power production project to compliment other on-going power production plant development, rather, it's also envisaged to tackle the health, sanitation and environmental issues that currently plague the waste and water management system in Nairobi and neighboring counties.

The major Advantages for adopting technologies for recovery of energy from urban wastes are to reduce the quantity of waste and net reduction in environmental pollution, besides generation of substantial quantities of energy. In recent years, technologies have been developed that not only help in generating a substantial quantity of decentralized energy but also in reducing the quantity of waste for its safe disposal. Sustainable energy and waste management therefore should be supported with policies that promote a "circular economy", balancing product life cycles (from production to disposal), and that minimize adverse economic, environmental, and societal impacts.

2.2 Legal requirements

According to the World Bank's screening approach and operational procedures mainly OP4.01, a Waste to Energy Power Plant facility is classified under Category A (High Risk) project and its construction must be preceded by development of a comprehensive Environmental and Social Impact Assessment (ESIA) study as also recommended by section 58 Schedule II of the Environment Management and Co-ordination Act, Cap 387 and the Legal Notice 101 (Regulations for Environmental Assessment and Audit) of June 2003 for submission to the National Environmental Management Authority (NEMA).

This ESIA has therefore been carried out to meet the requirements of IFC PS1 (International Finance Corporation Performance Standards). The remaining IFC PS set out objectives and requirements to avoid and minimize potential environmental and social adverse effects on the environment and to offset/compensate for any residual effects. PS 2 to 8 have therefore been considered as part of the assessment process and discussed where relevant within the topic specific sections. The Environmental, Health and Safety (EHS) Guidelines and NEMA regulations including the waste management, EIA regulations, water, noise and air quality regulations among others are technical reference documents that address IFC's expectation regarding the industrial pollution management performance of projects. This information supports actions aimed at avoiding, minimizing, and controlling EHS impacts during the construction, operation, and decommissioning phase of a project or facility.

2.3 Terms of Reference for the ESIA Process

The following Terms of Reference (ToR) for the proposed Waste to Energy Power project were to guide the ESIA process.

- Identification of both positive and negative impacts and the most appropriate interventions during construction and operation.
- Collection of baseline socio-economic data of the proposed project area and potential impact expected from project construction, implementation and operation from existing secondary data sources.
- Collection and assessment of baseline environmental data
- Analyzing alternatives for the proposed project.
- Development of an environmental and social management and monitoring program (ESMMP) during construction and operation and presentation of plans to minimize, mitigate, or eliminate negative effects and impacts.
- Description of implementation of ESMMP.
- Identification and consultation with key stakeholders and conducting interviews with these stakeholders.
- Collection of secondary data.
- Acquisition of an Environmental and Social Impact Assessment License from NEMA.

2.4 Scope of the ESIA Study

The Kenya Government policy on all proposed facilities, activities and programmes requires that an Environmental Impact Assessment is carried out at the planning stages of any proposed project undertaking that is likely to harm the environment. This is to ensure that significant impacts on the environment and surrounding communities are taken into consideration during the design, construction, and operation and decommissioning of the proposed development. This ESIA study will entail development of a 3000tonne/day WTE plant at Ruai. The development will largely entail construction of the power plant and its associated infrastructure including 42km of transmission line, substations, landfills, wastewater treatment facilities, waste receipts, transfer and feedstock yards and offices with associated amenities

2.5 Objectives of the ESIA

The primary objective of this ESIA is to ensure that potential environmental and social impacts associated with the construction, operation and decommissioning of the proposed Waste to Energy Power Plant at Ruai is identified, assessed and if unavoidable be minimized, mitigated, and/or offset and an environmental and social management plan developed to aid in managing the potential impacts appropriately in a manner that is socially responsible and reflects sound environmental management practices.

2.6 ESIA Approach and Methodology

This ESIA study was undertaken considering the requirements of the EMCA1999, CAP 387, as well as the Environmental Impact Assessment and Audit Regulations, 2003. The goal of this approach was to identify impacts likely to result from the proposed engineered WtE Power Plant on the basis of the baseline conditions established during the fieldwork and information obtained from the documents reviewed. It involved understanding the project background, the preliminary designs and the implementation plan. The approach and methodology applied during the study enabled collection of both primary and secondary data. Qualitative and quantitative methods of data collection were employed. Secondary data was obtained through literature reviews while primary data was obtained through physical observations, field surveys, laboratory analysis, photography, interviews and stakeholders' consultation.

For objective predictions of the impacts, the site area was subjected to an environmental scoping process. This was a process of evaluating the significance of the project impacts and possibilities of handling the same that led to this report. Detailed evaluation of the project area was being undertaken to focus on any significant environmental issues.

The communities living within the proposed project coverage area were interviewed during consultation meetings and participation processes. The tools that were used included questionnaires, site checklists, photography and discussions with stakeholders. Overall, the ESIA study was undertaken through the following stages;

2.6.1 Screening

The initial stage of this assessment was project screening. Screening of the project sought to ascertain whether or not this project falls within a category that requires EIA prior to commencement. Other considerations made during this stage included a preliminary assessment of the environmental sensitivity of the areas at the project site through assessment of project site maps.

Based on the legal framework and literature review including World Bank ESS and EMCA 1999, the proposed project falls under the category of projects to be subjected to ESIA study as provided for by the second schedule of the Environmental Management and Coordination Act of 1999 and Category A under the World Bank Environmental and Social Standards.

2.6.2 Scoping

Project scoping was the next stage which was done to delineate project issues that required detailed analysis. The aim of this stage was to ensure that the ESIA study adequately addresses all the crucial issues of environmental and social concern to the decision-makers. This was done by narrowing down proposed project issues to those requiring detailed analysis. The process involved dialogue with all project stakeholders to ensure that this aim was fulfilled. It also involved collection of primary and secondary data through field visits and literature review respectively.

From evaluation of this data, a rapid assessment of the project site and its surrounding areas was done. The key benefits of scoping include:

- Enables early key stakeholder's identification and engagement.
- Ensures that the assessment focuses on the key likely environmental and social impacts.
- Enables the early identification of existing data and data gaps.
- Inform the public about the proposal.
- Identify the main stakeholders and their concerns and values.
- Define the reasonable and practical alternatives to the proposal.
- Define the boundaries for an EIA in time, space and subject matter.
- Set requirements for the collection of baseline data and other information.
- Establish the Terms of Reference for the study.

2.6.3 Documentary Review

Various relevant documents were reviewed for a clear understanding of the terms of reference, environmental status of the project area, data on demographic trends (for the project area, the beneficiary areas and the adjoining towns and counties), land use practices in the affected areas (either as catchments, irrigation scheme, or the beneficiary areas), development strategies and plans (Local, National and International) as well as the policy, legal and institutional documents.

2.6.4 Site Assessment

A physical inspection of the proposed site and their surrounding environment was conducted. This was done with an aim of establishing the anticipated positive and negative impacts on the biophysical environment (hydrology, climatic patterns, ecology and geology), socioeconomic trends (population trends, settlement trends, economic patterns, cultural setting and linkages, land ownership issues, etc.) and the project affected persons (PAPs) and beneficiaries.

Specific objectives of the field assessment included:

- Obtaining any available information and data on water, land and agriculture from the local public offices.
- Undertaking rigorous consultative public participation with key stakeholders including decision makers and project affected groups including local residents as well as other stakeholders.
- During the scoping phase, public consultations were also organized with the stakeholders. A detailed field study was conducted for the proposed project between 5/Aug/21 to 19/Aug/21 by KenGen and the ESIA team.
- Evaluating the environmental setting around the proposed site - observations were focused on the topography, land tenure, surface and groundwater sources, public amenities, land cover, climate, flora and fauna, soils, etc.
- Evaluate social, economic, physical and cultural settings in the entire project site.

2.6.5 Detailed ESIA Report Activities

This assignment involved a series of activities carried out in liaison with the Proponent, relevant Government departments, local authorities, community groups and other organizations in the area with a view to sharing their experiences and information with respect to environmental resources and social aspects. Effective evaluation of the social baseline status was achieved through interviews (consultative discussions) and physical inspection of the entire project area.

The baseline conditions provided the starting point for the impact's predictions and benchmark for the mitigation measures. Details of the activities are listed under the terms of reference, and the outputs for each activity are outlined in the sub-sections below;

- Review of the proposed project details
- Establishment of the current baseline conditions to provide a documented foundation for the impact predictions and a benchmark for the development of mitigation measures

- Update of the legislative and regulatory requirements as a basis for drawing a compliance monitoring protocol for the construction and commissioning phases.
- Environmental and social impacts assessments for the identification of significant impacts to the environment and the nearby communities. Types and levels of impacts as well as criteria for developing suitable mitigation measures were assessed.
- Environmental and social management plans consisting of mitigation measures, authority responsible for monitoring and evaluating anticipated impacts, timeframes and environmental costs were developed.

2.6.6 Consultation

Interaction with the stakeholders and communities living around the project area was undertaken through scoping and through the field data collection exercise. Findings of the detailed ESIA report will be presented to stakeholders for their feedback before submission to NEMA. Among the forums undertaken were sensitization and feedback sessions involving all levels of stakeholders, and public participation through issuance of questionnaires and transect walks as documented in table 2 below.

Table 2: Summary of Consultations Held during ESIA study

Date	Day	Time	Stakeholder	Venue	Status/remarks
6th August 2021	Friday	11-1200hrs	NMS- Project boundary clarification & stakeholders engagement planning	Virtual	Accomplished
9th August 2021	Monday	930am-11:00am	Ruai Ward Administrator/ Environment Officer	Ward Adminstrator Offices -Ruai	Accomplished
10th August 2021	Tuesday	9:00am-11:00am	DCC Njiru ACC -Ruai	DCC Office - Ruai	Accomplished
		11:30am-12:45pm	Ruai Chief & Assistant chief -Nyabuto	Ruai chiefs office	Accomplished
		2:30pm-3:30pm	NEMA Kasarani incharge - Brief seeking appointment	Nyayo House	Rescheduled
		4:00pm-5:00pm	EPRA Environment Section -Brief to seek appointment	Longonot Towers, Upperhill-	Accomplished - Feedback on email achieved
11th August 2021	Wednesday	10:00am-12:00 noon	Nyumba Kumi leadership & individual household stakeholders	Wings View Hotel	Accomplished
		2:30pm-4pm	Kenya Power	Virtual	Adan/Arthur
12th August 2021	Thursday	10.00am-1200hrs	Kamulu Leadership meeting	Wings View Hotel	Adan/Arthur
		2.30pm-4:15pm	Private Waste Collectors leadership	CBD	Adan/Arthur
13th August 2021	Friday	10:00am-11:30am	Nairobi Water & Sewerage -Environment Office	Virtual	Accomplished
		12:00-12:45pm	KAA Environment Office	KAA Office - JKIA	Accomplished engagement done on email.
		1:30pm-2:00pm	KCAA Environment Office	Aviation House	
		2:00pm-4.00pm	Kenya Airforce Embakasi Garisson Commander	Embakasi	Achieved.
	Monday	9.00am-1000am	Kasarani Subcounty Administrator/	Kasarani	Accomplished

16th August 2021			NEMA Kasarani incharge - Brief seeking appointment		
		10:00am - 1200pm	WRA Environment office	NHIF Building	Physical & virtual meetings held
		2.00pm-4.00pm	Ministry of Energy	Virtual jointly with KP	Adan/Arthur
17th August 2021	Tuesday	10.00am-11.00am	2:30pm-4pm	Virtual	V
		11:30am-12:30am	Athi Water Services Board	Virtual	Adan/Arthur

The aim of carrying out the public consultation was to find out whether the people were familiar with the proposed project activities, impacts and whether they were ready for the project to be undertaken in their area. The feedback received was also to be used in the project design and implementation.

A socio-economic survey was undertaken in all the locations that will be affected/benefit from the project. Semi-structured interviews were done with relevant County Government departments specifically the Lands and physical Planning, Energy, water, Environment, Sub-County Commissioner, Assistant County Commissioner and residential officials (Nyumba Kumi) who own properties near the project site where the proposed project is to be developed to get their views especially now that they are also developing a housing estate at the same site. Focus group discussions with men, women, elderly and the youth from the surrounding community near the proposed project was also undertaken and interviews with the local administration namely MCA, chief and assistant chief, village elder was also organized.

2.7 Presentation of the Report

The process indicated above culminated with the production of this ESIA Study Report designed to ensure that the proposed development project complies with Environmental Management and Coordination Act (EMCA, 1999). The report is organized in 10 chapters as outlined below:

1. Executive summary.
2. Introduction.
3. Project Description.
4. Policy, Legislative and Regulatory considerations.
5. Description of Baseline Environment.
6. Analysis of Alternatives.
7. Consultation and Public Participation.
8. Anticipated Impacts and mitigation measures.
9. Environmental and Social Management Plan.
10. Environmental and Social Monitoring Plan.
11. Grievance Redress Mechanism.
12. Conclusion and recommendations.
13. References.
14. Annexes

3 Project Description

3.1 Name of Project

Establishment of a Waste to Energy (WtE) Power Plant in Nairobi City County.

3.2 Project Proponent

The project proponent is Kenya Electricity Generating Company PLC (KenGen) in Partnership with the Nairobi Metropolitan Services (NMS).

Kenya Electricity Generating Company PLC (KenGen) is the leading electric power generating company in East Africa. Today, KenGen PLC has an installed generation capacity of 1,798MW, of which about 86% is drawn from green sources namely: Hydro (818MW), Geothermal (706 MW), Thermal (253MW), and Wind (26MW). Of the electricity consumed by Kenyans daily, over 70% is generated by KenGen mostly from green sources.

Nairobi Metropolitan Services (NMS) is a creation in the Public Service through a declaration by the President pursuant to the Deed of Transfer of Functions from the Nairobi City County Government to the National Government published vide Gazette Notice No. 1609 of 2020. Various services hitherto offered by the County Government under the transferred function of County Planning and Development Services under the Physical and Land Use Planning Act, 2019; the County Government Act, 2012; the Land Act, 2012; the Urban Areas and Cities Act, 2011; the Rating Act Cap 267; the Valuation for Rating Act Cap. 266, Survey Act Cap. 299 and any other Act of Parliament under which Planning and Development Services function is offered by the Nairobi City County Government has been transferred and will be offered by the Nairobi Metropolitan Services.

3.2.1 Roles of Kenya Electricity Generating Company PLC (KenGen)

The 2No parties to the project have entered into a legally binding arrangement with clearly defined roles for Kengen enlisted as follows;

- Provide the necessary expertise, capacity, buildings and technical assistance to NMS during implementation of the waste to energy power plant
- Jointly undertake and participate in the planning meetings and activities with NMS geared towards implementation of the project;
- Through National Treasury, raise financing for engineering, construction and commissioning of the Waste to Energy Power plant including the related power plant infrastructure - access roads, electricity, water, sewage system and other necessary utilities;
- Identify the possible power plant initial capacity that would be developed;
- Operate and manage the waste to energy power plant upon commissioning of the power plant.

3.2.2 Roles of The Nairobi Metropolitan Services (NMS)

Role of NMS has been defined as follows;

- Provide all the requisite material and data that may be necessary or required to facilitate implementation of the project;
- Jointly undertake and participate in the planning meetings and activities with KenGen geared towards implementation of the project;
- To perform such other functions as may be necessary or identical to the entire successful implementation of the project.
- Construction of a dedicated lane from the Outering Road junction to Ruai shopping center to minimize traffic during and after construction of the WTE facility.
- Provision of piped water to the Ruai Ward residents as part of forestalling potential groundwater contamination in future from plant operation and consequent health implications to the population thereby protecting the community.

- Assurance of adequate and timely delivery of solid waste and other input material to the waste to energy power plant at such terms and conditions as may be agreed.

3.3 Project Objectives

The increasing industrialization, urbanization and changes in the pattern of life, which accompany the process of economic growth, give rise to generation of increasing quantities of wastes leading to increased threats to the environment. In recent years, technologies have been developed that not only help in generating a substantial quantity of decentralized energy but also in reducing the quantity of waste for its safe disposal. Sustainable energy and waste management therefore should be supported with policies that promote a “circular economy”, balancing product life cycles (from production to disposal), and that minimize adverse economic, environmental, and societal impacts.

The proposed project has the overall objective of contributing to increased renewable energy use pledged to stimulate economic growth and accelerate job creation to improve the economic wellbeing of its shareholders’ earnings through reduction of electricity cost by ensuring availability, reliability and efficiency of power supply by utilizing Municipal solid waste (MSW) as a fuel feedstock for power generation.

Failure to handle waste in an environmental sound manner has the potential of causing pollution to the atmosphere, water and soil. Uncollected and illegally or improperly disposed wastes pose serious risks to public health and the environment. The prevalence of parasites, tetanus, malaria, hookworm, cholera and diarrhea is attributed to unsanitary conditions caused by waste being simply strewn around cities, villages and other inhabited areas. Uncontrolled dumping leads further to serious problems of environment, safety and land availability. Improperly managed waste usually results in downstream costs higher than what it would have cost to manage the waste properly in the first place. Noncompliance with applicable environmental laws and regulations results in penalties, negative reputation and conflicts with stakeholders. Kenya Vision 2030 recognizes the need for establishing efficient and sustainable waste management systems to support the level of industrialization that is envisaged by 2030. Effective waste management has important economic and social impacts in addition to environmental benefits. For this reason, waste management should not be viewed as an economic activity for generating income, but rather a public service requiring financing for cost recovery.

In summary, the Municipal waste to energy power plant facility in Ruai of Nairobi City is to mitigate the environmental pollution occurring due to the poor waste disposal while resolving the concern of waste processing by introducing a WTE plant as an effective resolution to the problem that will reduce volume of waste.

3.4 Project Location

The proposed Waste to Energy Power project is aimed at addressing the challenge of inadequate solid waste management faced by Nairobi City County and the Nairobi Metropolitan Services (NMS) area. The proposal seeks to complement other on-going power production plant development while addressing municipal solid waste concerns. The plant as proposed will increase the level of electric power fed into the national grid with a broadened energy mix and in the same breath greatly improves solid waste management within Nairobi Metropolitan Services area to mitigate exposures of the environment and humans to the detrimental effects of solid waste generated daily currently and disposed in Dandora open dumpsite. This is a step towards taking measures for emission reductions as a steady global warming measures plan for a low-carbon society.

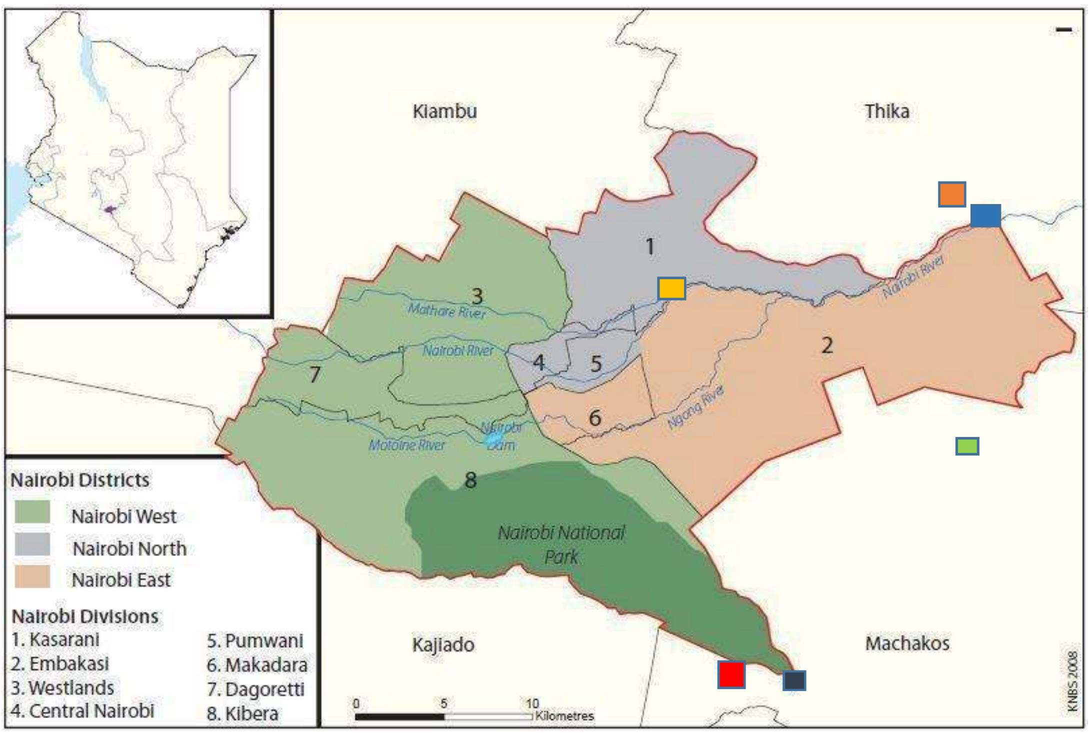
3.4.1 Project Location and Access

The site is 30 km east of Nairobi City Centre off Kangundo road, east of the city along eastern bypass at Ruai in Nairobi East subcounty, Kasarani Constituency (Figure 1) on Latitude 10 12’ 46” S and Longitude 370 03’ 57” E. In line with the stakeholder and public consultation, the WTE Power project has been designed to cover mainly Nairobi City County wastes service area in the initial phase with expansion consideration for major satellite towns and counties of Nairobi Metropolis area.

3.4.2 Project Components

The proposed solid waste management system will consist of a new Waste to Energy power plant (Combustion in boiler for steam generation and steam turbo generator for power generation technology with a proposed incinerator capacity of: 3*650 t/d and 2*22.5 MW synchronous generators with 10% design margin), project perimeter fencing, access road, gatehouse, weighbridge, drainage, offices and overall site infrastructure. There will be leachate collection drains from the pit and thus leachate present in the garbage will be collected in the collection pit. Owing to the criticality of leachate management, drains will be cleaned at regular intervals to avoid choking and putrefaction. Leachate would be transferred to the leachate treatment plant and treated leachate would be disposed of to the nearby river within allowable properties. Landfill - A protective non-woven geotextile to prevent punctures in the high-density polyethylene (HDPE) sheet.

The geographic location of the Project Area is presented in figure 1 below identified as Ruai STP Riverbank while figure 2 show the geographic location of the plant.

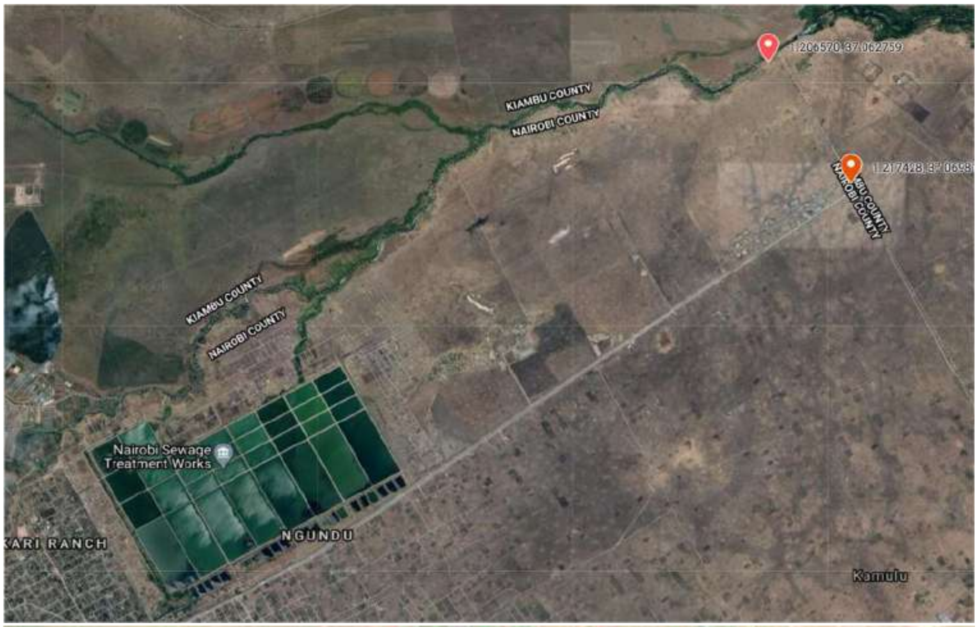


Color Code	Site name	GPS Coordinates
	Dandora Dump Site	-1.243811° N, 36.899602° E.
	Ruai STP End	-1.217428° N, 37.069816° E.
	Ruai STP River Bank	-1.206570° N, 37.062759° E.
	Near Athi river substation (Triumph power)	-1.459027° N, 36.952297° E.
	Athi river Near Gulf power plant	-1.457722° N, 37.002139° E.
	Export Processing Zone- 1 (EPZ-1)	*-1.356614° N, 37.059258° E.*

Figure 1: The geographic location of the Project Area identified as Ruai STP River Bank

Nairobi's three districts and eight divisions

(source: city of Nairobi Environmental Outlook- UNEP/GRID-Sioux falls.



Points	*GPS Coordinates*
P1	*284707.00, 9866166.20*
P2	*284548.78 , 9866436.21*
P3	*284155.55 , 9865843.21*
P4	*283997.39 , 9866113.11*

Figure 2: Geographic Location LR No. 12979/1 of the proposed Waste to Energy Plant
(source: google Maps).

3.5 Feedstock Resources

3.5.1 Legacy Waste Composition

The physical characteristics of the legacy waste indicates the following composition: inert material (soil/sand/earth) 80.1%, stones/bricks, concrete 1.7%, textile 9.9%, Polythene/plastic 6.8%, metals 0.4%, coconut shell/hair 0.3%. The legacy waste can be reclaimed from the site through screening to separate the inert waste and the combustible fraction (approximately 15%) which can be used in the WTE plant. It should be noted however that all of the inert material (approximately 80% of the legacy waste) will not be of use for the WTE plant. This therefore requires a re-assessment of Dandora Dumpsite decommissioning in light of much of the waste onsite not useful as the proposed plants feedstock.

3.5.2 Nairobi Waste

A physical waste characterization was carried out in Nairobi and the surrounding counties to establish the composition of disposed waste. A total of 5 physical waste characterization studies were carried out. The data in the pie chart and tables 3 and 4 below show the information obtained from the Nairobi waste characterization study carried out in Dandora

Average GCV (ARB): 1,778 kcal/kg (7.44 MJ/kg)
Seasonal variation: 23.8%
Minimum GCV (ARB): 1,354 kcal/kg (5.67 MJ/kg)
Moisture content: 64.5%

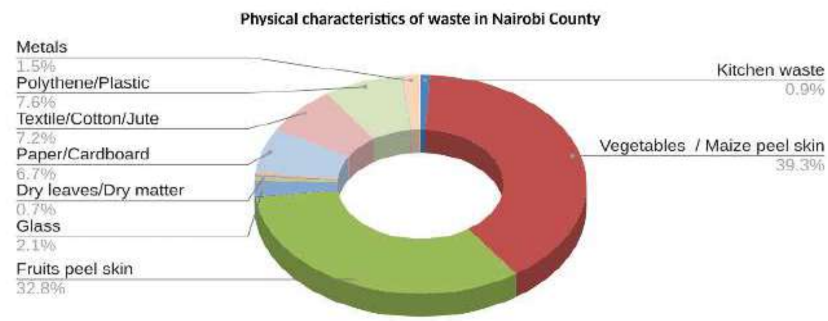


Table 3: Physical characteristics of legacy waste at Dandora dumpsite (Nairobi)

Material	Nairobi
Waste composition	
Organic	72.8%
Combustible	23.2%
Recyclable	3.7%
Inerts	0.30%
Total	**100%**

Table 4: Preparatory Survey for Integrated Solid Waste Management in Nairobi in the Republic of Kenya.

Type of Waste	% Composition By Weight
Food Waste	68.99
Paper	9.43
Plastics	9.42
Rubber & Leather	0.27
Textiles	0.72
Yard Waste	0.70
Lumber & Logs	0.36
Other Organic Waste	1.74
Glass	3.15
Metals	2.28

Dirt, Ash, Stone, Sand	2.51
Unclassified Residual Waste	0.34
Domestic Hazardous Waste	0.09
Batteries – Dry Cells	0.03
Other Domestic Hazardous Waste	0.06
TOTAL	**100**

(Source: Final Report of (October 2010) JICA.)

3.5.3 Waste Handling and Delivery Process to the Plant

Collection Point Operated by Community Based Organizations (CBOs)/NMS

NMS operates many waste collection points jointly with CBOs. The procedure is as follows: the CBOs are encouraged to bring waste using mainly handcarts (mkokoteni) to the collection points where they either segregate the valuable materials or not. Then, the remaining waste is collected and transported by the NMS collectors to the final disposal site. This kind of joint operation is seen mainly in slums and low-income areas. As of December 2020, NMS had registered and licensed 140 CBOs which were carrying out solid waste collection activities. The CBOs pay to NMS a collection and transportation charge that ranges between Ksh 500 and Ksh 5,000 each time the collection is provided. However, it is necessary to develop criteria to charge CBOs according to the amount of waste collected. On the other hand, the already developed CBOs have their own trucks to transport wastes from the collection points to the disposal site.

The proposed WTE Plant development will utilize Dandora Dumpsite’s existing and newly collected Municipal solid waste (MSW) from the wider Nairobi Metropolis transfer stations as a fuel feedstock for power generation through combustion and is expected to generate electricity that will be directly fed into the national power grid. The capacity of the WTEP will be 3000 tonnes/day and will produce up to 44.3 MW of electrical energy that will be fed into the national grid. It is planned that the WtE Project will work 24 hours daily, and 7920 hours annually. The remaining 840 hours per year consists of time required for maintenance and planned/unplanned shutdowns.

Tipping Floor and MSW Storage Pit

NMS will contract the services of waste handlers who are registered with NEMA to handle municipal waste. The waste handlers will be collecting municipal waste from households to the transfer stations where pre-sorting and processing will be done before the materials are transferred to WTE Plant at Ruai for energy generation.

Each truck carrying the municipal solid waste will be visually inspected before it goes to the weighbridge for material offloading. For effectiveness, the drivers of the truck should also be provided with training on the different materials in the MSW and their uses. The weighbridge operator will then instruct the driver to proceed to the tipping floor, where the driver will unload the waste in the designated area only. This tipping floor will be above the ground level and MSW storage pit will be on the ground level for effective unloading of waste. Sufficient quantity of decomposing microbial cultures (inoculums and sanitizer) will be inoculated at this point with a sprayer to reduce odor.

MSW storage pit capacity will be designed for storage of material for approximately two (02) to three (03) days. This pit will be equipped with two (02) grab cranes and grab bucket for MSW mixing, homogenization, and feeding to the hoppers for further segregation/processing. There will be leachate collection drains from the pit and thus leachate present in the garbage will be collected in the collection pit. Owing to the criticality of leachate management, drains will be cleaned at regular intervals to avoid choking and putrefaction. This area will be covered with a roof and adequate transparent sheets will be provided in the roof for sunlight. Systematic turning of the material, which mixes the different components and aerates the mixture, generally accelerates the process of breaking down the organic fraction. Material will be fed into the hopper for further pre-processing. Negative suction will be maintained by providing suction of primary air fan and secondary air fan for controlling the odor.

Magnetic Separator

The waste contains ferromagnetic materials such as iron and steel, which can be easily removed by a magnetic separator. As a general rule, magnetic separation is performed on processed MSW (either after homogenizing or after shredding). The overhead belt type magnetic separator is suspended over a feed conveyor carrying the MSW. The magnet itself is stationary and the rubber belt is set to travel faster than the feed conveyor for effectively removing the magnetic materials from the MSW.

Mechanical Press

Waste will be fed to the mechanical presses from the storage pit through a magnetic separator. The mechanical presses remove water by pressing or squeezing the waste. Water and organics removal take place in the mechanical press. Waste with reduced moisture will be transferred to the next press. After pressing through the press, the compacted MSW will be transferred to the shredder for sizing.

Shredder

Shredding is necessary in order to increase the ratio of surface area to volume of the MSW material. This will ensure that more area is available for combustion air to fuel interaction leading to improved combustion characteristics. The metallic parts have been removed before passing it to the shredders in order to improve the performance of the Shredder and prevent damage to its blades.

Eddy Current Separator

The Metallic-Nonferrous parts from the MSW are removed with Eddy Current Separator. It uses the principle of secondary current generation in the conducting materials. It consists of two (02) drums at the driving end of the conveyors. The inside drum is an electromagnet rotating at higher speeds than the outer drum. The inner drum generates eddy current in the metallic parts of the MSW as it passes on the belt. These secondary currents induce magnetic properties in the conducting materials and thus repel away the metallic objects farther than the non-metallic fraction. The metals and Non-Metals are collected separately in two different containers. Typical diagram of eddy current separator is shown in figure 3 below:

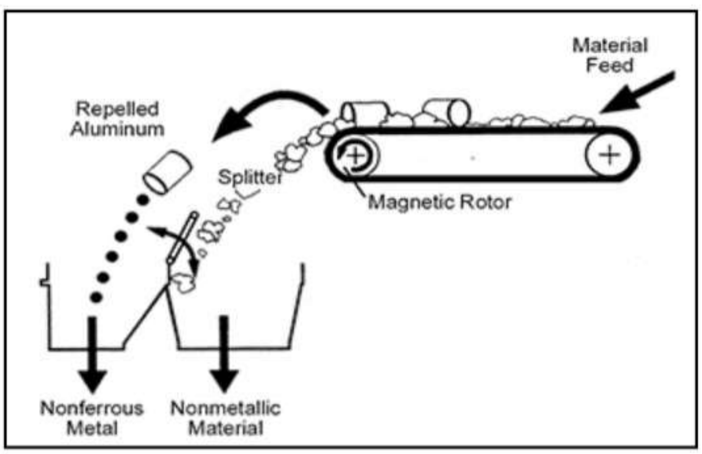


Figure 3: Eddy current separator

Fuel Storage

The material will be transferred through conveyors to fuel storage. Processed waste with reduced moisture, properly sized and better-quality waste will be stored in the MSW pit for eight (08) to ten (10) days. Moisture level will be around 45-50% in the processed waste. Leachate will be formed and separated from the storage yard. Processed waste (better quality) will be fed to the incinerator by a grab bucket. Inoculum dosing will be provided for odor control and negative suction will be maintained by providing suction of primary air fan and secondary air fan for controlling odor and smell.

Disposal of Waste

All ash and hazardous materials are sent to landfill sites through vehicles. The weighbridge operator weighs the tare vehicle as well as loaded vehicle after the unrequired material is loaded. Total landfill area requirement: 7.5 Ha (13% bottom ash to landfill, 100% fly ash and valorization).

3.5.4 Water Requirement and Balance

The source of water will be Ruai Sewage Treatment Plant, located at about 8 km from the site. The treated sewage water will be transported to the site through a pipeline. Current Proposed connection is via a HDPE pipe of - DN 350 estimated to cost about Kshs 19,230 per Meter. Various options for routing the pipeline are being examined with a view to minimizing cost and complexity of the system as shown in Figure 4: below.

Figure 4: Treated sewage effluent water pipeline to the WtE Plant

Wastewater Treatment Plant Effluent

The water system of the project has been considered based upon reuse/recycle of wastewater. The project will be using treated sewage water from Nairobi Water Sewerage and Company Ltd wastewater treatment ponds for conserving natural fresh water. For reducing water requirement, a water-cooled condenser cooling system has been proposed instead of an air-cooled condenser system. Water requirement is envisaged for water cooled condenser (WCC). Water requirement has been calculated ~8.5 MLD for WCC and ~2.5 MLD for ACC. Lesser water requirement has been observed in the case of ACC but huge space will be required and poor specific steam consumption (kg/kWh). Potable water will be provided by the Nairobi Water and sewerage company connection to the site and will be billed monthly.

Other effluents generated from the power plant, boiler blowdown, cooling system blowdown etc. will be brought to a centralized effluent collecting pit. After neutralization, the effluent will be used as service water for floor washing, horticulture, sprinkling on road and other general purposes. The condensed water from Leachate treatment plant will be recycled for quenching of bottom ash. Surplus treated leachate would be disposed to nearby drain within specific parameters.

The effluents generated from the boiler blow down, cooling tower blow down, softener, and DM plant would be collected in a neutralizing pit commonly known as N pit. Total effluent generated from the plant would be 3,000 m^3/d. This effluent collected is to be treated, as it consists of various chemicals. This involves addition of required chemicals basically to improve the pH, as all other properties to meet the desired requirements. This wastewater is then used for the internal purposes of plants like washing, gardening, and for green belt.

Sources of effluent:

- Backwash from side stream filter (SSF), softener, primary sand filter (PSF), activated carbon filter (ACF), ultrafiltration (UF), reverse osmosis (RO) and mixed bed (MB),
- Blowdown from Cooling tower and Boiler.

Water treatment plant would be operated for meeting desired water properties in boiler drum, deaerator, cooling towers and utilities (coolers and heat exchangers). Water treatment plant will consist of a soft water plant (secondary treatment) and a Demineralised (DM) water plant (tertiary treatment) where soft water will be required in the cooling tower and DM water in the Deaerator.

Six (06) cooling tower cells are proposed for cooling load of water-cooled condenser, oil cooler and air coolers etc. Total circulation water requirement is 13,000 m3/h. Capacity of the softener plant will be 300 m^3/h and the capacity of DM plant will be 10 m^3/h with 22 hours' operation. Properties of treated sewage water are considered from Nairobi Water & Sewage Plant, as shown in table 5 below:

Table 5: Inlet water properties

parameters	UoM	Value (inlet water)	Value (soft water)	Sewerage Effluent	water quality standards (max allowable limits)
Hardness	ppm	300	<10		
Total Dissolved Solids	ppm	550	550	890	1200(mg/L)
Biological Oxygen Demand-5days at 20 °C)	ppm	30	30		30 (mg/L)
Chemical Oxygen Demand	ppm	150	150		50(mg/L)
Total Suspended Solids	ppm	140	140	26	30 (mg/L)

Domestic Wastewater

The drainage system is designed as follows in figure 5 below:

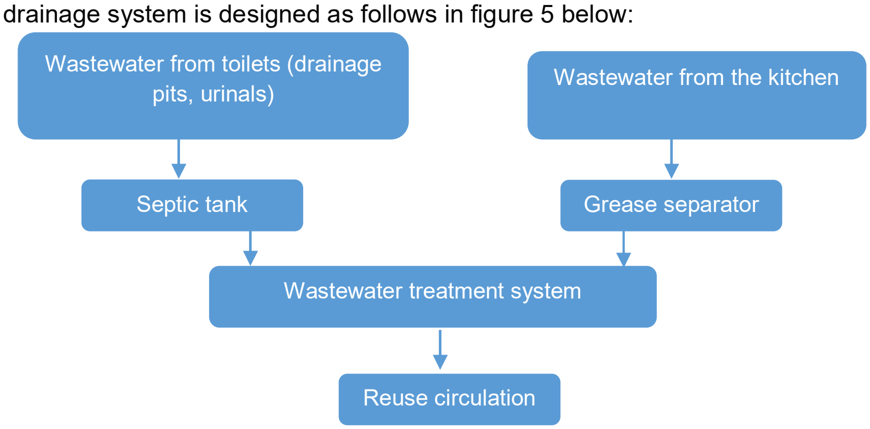


Figure 5: Wastewater Collection Process

Wastewater from the toilet (pit, urinal pit): The wastewater from the latrines used during construction period for the site workforce shall be treated in the three chambers septic tank. Wastewater from employees' kitchens is led through an oil separator for preliminary treatment. After being preliminarily treated, the wastewater treatment system of the project will be treated through a bio digester before being discharged into the environment or re-used for planting.

A septic tank with three chambers as shown in figure 6 below will be installed to ensure high efficiency to handle grey water generated at the facility during operations.

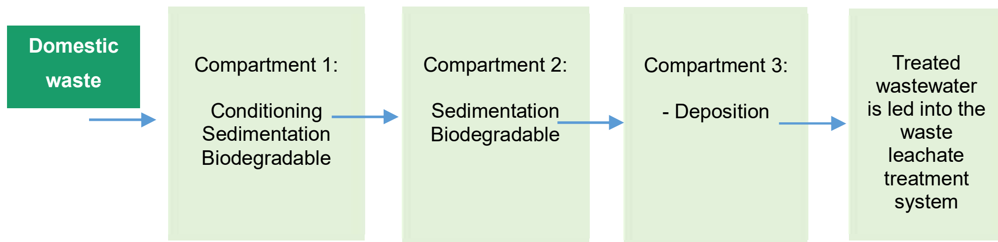


Figure 6: Process of Wastewater Treatment by Septic Tank 3 Compartment

Process of Wastewater Treatment Technology

The process technology for domestic water treatment is illustrated in figure 7 below.

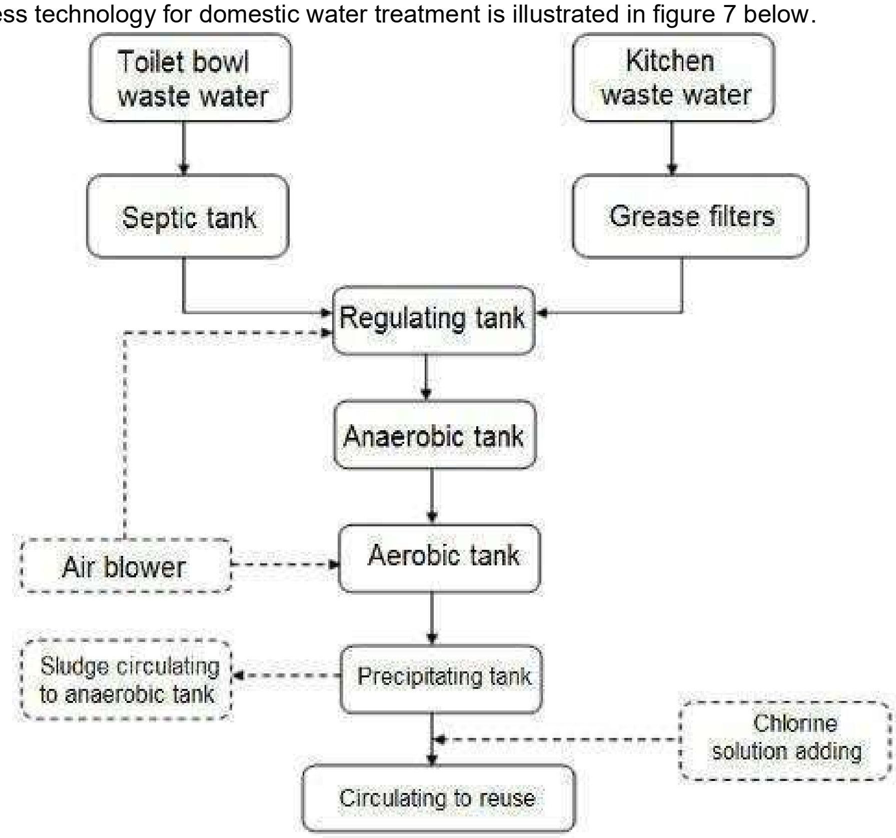


Figure 7: Process Technology for Domestic Wastewater Treatment

The proposed system will have all domestic wastewater collected and concentrated in the conditioning tank with air blower providing air and uniformly mix the air throughout the tank area, preventing sedimentation in the tank producing an unpleasant odor, while also regulating the flow and concentration of input wastewater.

An anaerobic tank, heterotrophic microorganisms operating in the discretionary environment transform to aide in bioremediation in anaerobic tank, the nitrogen components are converted to N2 released into the air.

An aerobic process follows with microorganisms using dissolved oxygen to break down and convert organic matter wastewater into biomass, CO2 and water. Microorganisms are grouped together in the form of activated sludge. Dissolved oxygen is supplied from the air blower through the air distribution system. When the source of dissolved oxygen is ensured, the biological oxidation of pollutants and the nitrification process take place. The resulting water is cleaned and the microbial biomass increases. Through use of a precipitating tank biomass generated will be separated. Wastewater will be distributed to the lamination tube for sludge discharge. The amount of sludge discharged in the reservoir will be collected periodically and the water prior to discharge is sterilized for reuse.

3.6 Project Design and Technology

The plant proposed plant design and technology include;

a) **Proposed Fuel:** Refuse derived fuel prepared from Municipal Solid Waste.

b) **Technology:** Combustion in boiler for steam generation and steam turbo generator for power generation;

- High moisture is not suitable for gasification and pyrolysis
- High inert is permissible in incineration
- Lower heating values is permissible in incineration only
- Preprocessing with least number of equipment will be suitable for incineration.

c) **Processing plant design capacity:**
The proposed plant shall have the following properties;
  - 3,000 t/d as per received MSW ± 20%
  - Cooling tower circulation rate: 13,000 m^3/h
  - Water circulation rate in condenser: 12,000 m^3/h
  - Water circulation rate in utility: 1,000 m^3/h
  - Softener plant capacity: 300 m^3/h
  - DM plant capacity: 10 m^3/h.

3.6.1 Design Capacity of Waste to Electricity Plant

Plant will operate at rated capacity of 3,000 t/d in the 8th year at 74.4% and in the 5th year at 85% collection efficiency. Proposed capacity of incinerator: 3*650 t/d (in terms of processed msw) and turbine: 45 MW (2*22.5 MW synchronous generators with 10% design margin) to capture fuel quality variation. The auxiliary power consumption of WTE plant will be 6.8 MW (i.e. 15% of 45 MW approximately) due to heterogeneous and mixed up nature of fuel and addition of preprocessing plant. Waste-to-Energy is an option for treatment of municipal solid waste (MSW). The proposed plant will utilize incineration technology to process the waste to generate electricity. Waste available for the power plant power generation against its rated capacity of 3,000 t/d in 2023 (1st year) shall be 1,327t/d, the 5th year shall be 2,465t/d and in the 8th year shall be 2,786/d.

The proposed WTE facility will be part of an integrated solid waste management system that is tailored to the specific local conditions with regards to waste composition, collection and recycling, informal sector, environmental challenges, financing, resource prices, and other aspects. The waste to energy process is demonstrated in figure 8 below.

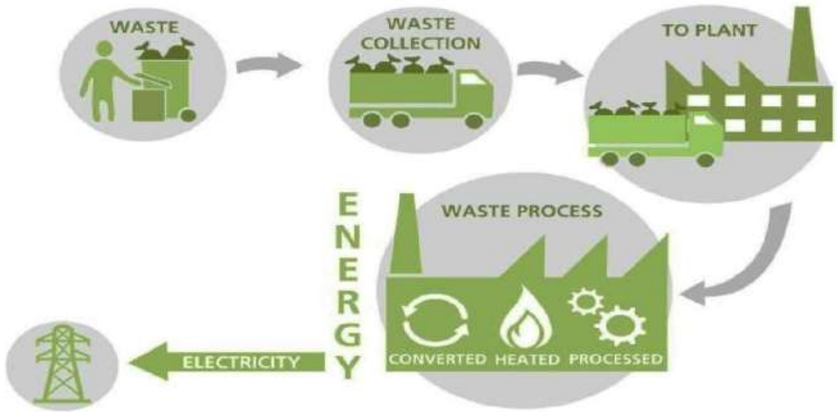


Figure 8: Waste to energy process tree

The Waste to Electricity (WTE) project may compromise two (2) separate facilities. These include a waste pre-treatment facility that will include a transfer station (waste sorting facility) among other waste pre-treatment processes such as mechanical & biological treatment facilities. The second facility will include the actual Waste to Electricity plant complete with anaerobic digesters, methane capture technologies and mass burn technologies.

The waste will be combusted across three process lines using grate combustion. After the combustion process, gases will be directed to the waste heat boiler to produce steam. Steam at 40 bar pressure and 400°C temperature will be sent to the turbine for electricity generation. Air cooled condensers will be used for the cooling of the steam-water mixture that exits the turbines. All electricity produced at the WTE will be exported to the national electricity grid.

A Flue Gas Treatment System will be implemented. Scrubbers will be installed for SO_2 treatment, and for the removal of SO_2 in the flue gas, dry hydrated limestone and carbon will be used. For NOx removal, a Selective Non-Catalytic Reduction (SNCR) system will be used. There is the potential to convert this to a Selective Catalytic Reduction (SCR) system if required. Bag filters will be used to reduce emission of fly ash.

For HCl and HF emissions, acid and alkali scrubbers will be used and Volatile Organic Compounds will be removed from flue gas by activated carbon. Dioxin and furan emissions will be controlled by maintaining the combustion temperature and adding activated carbon in the flue gas treatment system. A Continuous Emission Monitoring system will be installed to monitor all emissions. Compliance reporting from the monitoring will be done on a quarterly basis to oversight authority in NEMA and DOSH as required for ambient air quality.

Odor generation will only occur in the bunker area where the waste is temporarily stored. This odor will be eliminated by maintaining negative pressure by drawing in air for use as a primary air source for the combustion process. The bunker area will be covered.

3.6.2 Pre-processing Section

The mixed collected waste is first pre-treated prior to combustion. Pre-treatment is required mainly to remove the inert, moisture and compostable fraction from mixed waste to make the quality refuse derived fuel for combustion. Waste is tipped off in the MSW storage pit and retention of approximately 8 to 10 days is given for stabilization. During this period, leachate is seeped and collected in the leachate pit which will be treated in the dedicated leachate treatment plant. Simultaneously, the waste is mixed with help of the grab crane to make it more homogenous. After the stabilization, the dumped waste will be subjected to a screening section where unwanted metallic parts and inert shall be removed. Compostable fraction less than 25 mm shall be separated out and will be composted. Being having the high moisture the mixed waste can be further passed through the dewatering screw process where further moisture removal takes place to make the required quality fuel for the combustion. The processed waste fuel is stored in a storage pit and fed to the feed hopper via grab cranes. Odor generation will only occur in the bunker area where the waste is temporarily stored. This odor will be eliminated by maintaining negative pressure by drawing in air for use as a primary air source for the combustion process. The pre-processing section and bunker area will be enclosed as shown in figure 9 below.

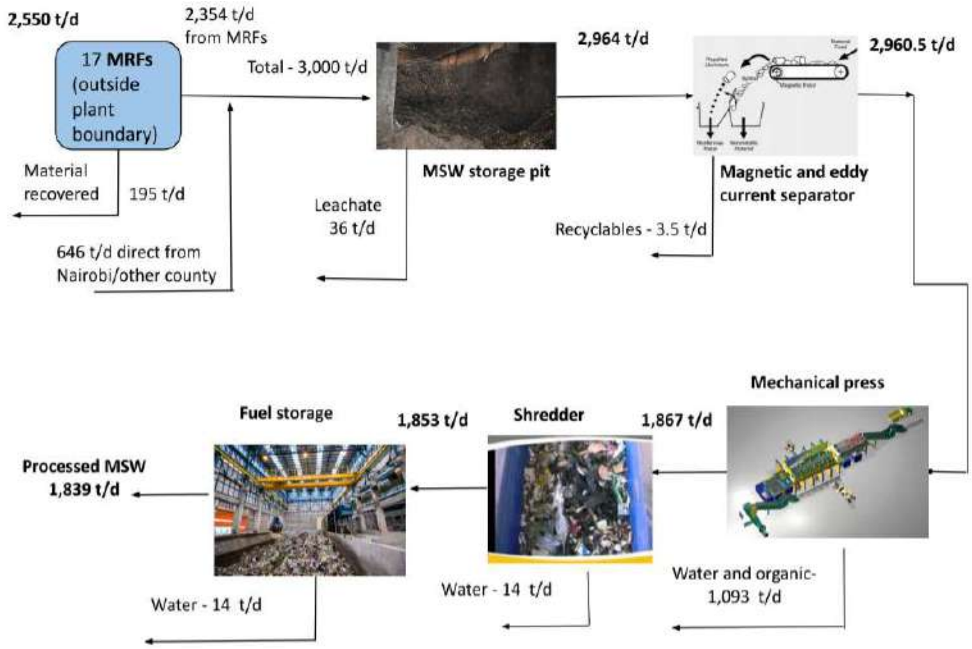


Figure 9: Pre-processing plant schematic diagram.

3.6.3 Incinerator Section

The waste will be combusted by grate systems. Combustion technology with grate systems is a common thermal disposal method for MSW domestic waste. The waste (1,839 t/d with <45% moisture level) is fed to the incinerator feed hopper through grab cranes. The feed hopper will be designed to have a waste column in the waste chute which allows a continuous feed to the grate in the combustion chamber. The operation of a movable grate is through a hydraulic system and speed is controlled/set using automatic combustion control operation. The lower part of the waste column in the feed chute is pushed to the grate by hydraulically operated ram feeders.

After the combustion process on the grate, gases will be directed to the waste heat boiler to produce steam. The furnace of the incinerator consists of water-cooled membrane wall structure that maximizes waste heat recovery. The furnace wall is lined up with highly heat resistant refractory materials. The feed water is evaporated based upon the natural circulation process. The water and steam circuit basically covers three main parts:

- Economizer
- Boiler drum and evaporator
- Super-heater.

The feed water extracts heat from the flue gas in a convective path. Feed water is heated up to 10°C below the boiling point of feed water at required pressure. The economizer is located at the outlet of the furnace and multi pass for maintaining the variation of the flue gas outlet temperature of the boiler margin in the design of economizer (feed-water preheater). The feed water for economizer is diverted to a heat exchanger installed inside the steam boiler drum which leads to heating of the feed water by saturated steam or saturated water of the boiler drum. This results in an increase of the flue gas temperature at the outlet of the boiler.

The feed water is converted to steam (saturated in steam drum) in the evaporator and steam boiler drum. The evaporation takes place on the principle of natural circulation. The saturated steam is separated from the water in the boiler drum, which is located at the top of the waste heat boiler. The water from the boiler drum is sent to different water wall membranes and evaporator via down comers. The superheaters are coil type heat exchangers which are used to convert saturated steam to superheated steam generated in the boiler at pressures of 40 to 45 kg/cm2 (a). The main steam temperature is controlled by spraying the feed water in the attemperator (connecting pipes) which is installed between super heater coils. The purpose of a superheater is to raise the temperature and to cool the super heater coils.

The superheated steam temperature of 415°C is selected to limit the tube metal temperature for minimizing the harmful effect of chlorine in fuel. At the bottom of the grate, combustion air is supplied for drying and combustion purposes. The combustion air system can be divided into two streams, primary air and secondary air.

3.6.4 Primary Air System

Primary combustion air is sucked from the upper part from MSW/refuse pit to minimize the odorous air and supplied to the bottom of the grate via primary air fan maintaining required pressure into the furnace. Primary air is preheated up to required temperature by steam coil air primary pre-heater. The air distribution is split into sections for uniform distribution of combustion air on the grate. The amount of air supplied to each section is adjusted and set individually using automatic combustion control.

3.6.5 Secondary Air System

Secondary air is puffed inside the furnace through the secondary air nozzles mounted on the furnace wall. It also protects the furnace from inside against the abnormal high temperature. Secondary air volume requirement inside the furnace is determined by the oxygen content at the economizer outlet and based on the actual temperature measured at furnace walls. Secondary air is preheated to prevent excessive temperature reduction of the furnace inside and to supply the additional combustion air into the furnace. The process is also controlled in a way that legal requirements say residence time, oxygen content and temperature of the flue gas at minimum 850°C with residence time more than 2 seconds.

3.6.6 Flue Gas Cleaning System

Combustion of these waste fuels results in generation of a mixture of gases termed as flue gas consisting of water vapor, carbon dioxide and excess air which includes acid gases like HCL, HF, HI, SO_2, NO, organic substances, heavy metals and fly ash particles. Dioxins and furans are formed by burning chlorine-based chemical compounds with hydrocarbons. A dedicated flue gas treatment system will be implemented.

Scrubbers will be installed for SO_2 treatment, and for the removal of SO_2 in the flue gas, dry hydrated limestone and carbon will be used. For NOx removal, a selective non-catalytic reduction (SNCR)/ semi dry system will be used to meet the environment compliance requirements. Bag filters will be used to reduce emission of fly ash. For HCl and HF emissions, acid and alkali scrubbers will be used and volatile Organic compounds will be removed from flue gas by activated carbon. Dioxin and furan emissions will be controlled by maintaining the combustion temperature and adding activated carbon in the flue gas treatment system. A continuous emission monitoring system will be installed to monitor all emissions. Compliance reporting from the monitoring will be done on a quarterly basis to oversight authority in NEMA and DOSH as required for ambient air quality. The figure 10 below illustrates a typical incineration line.

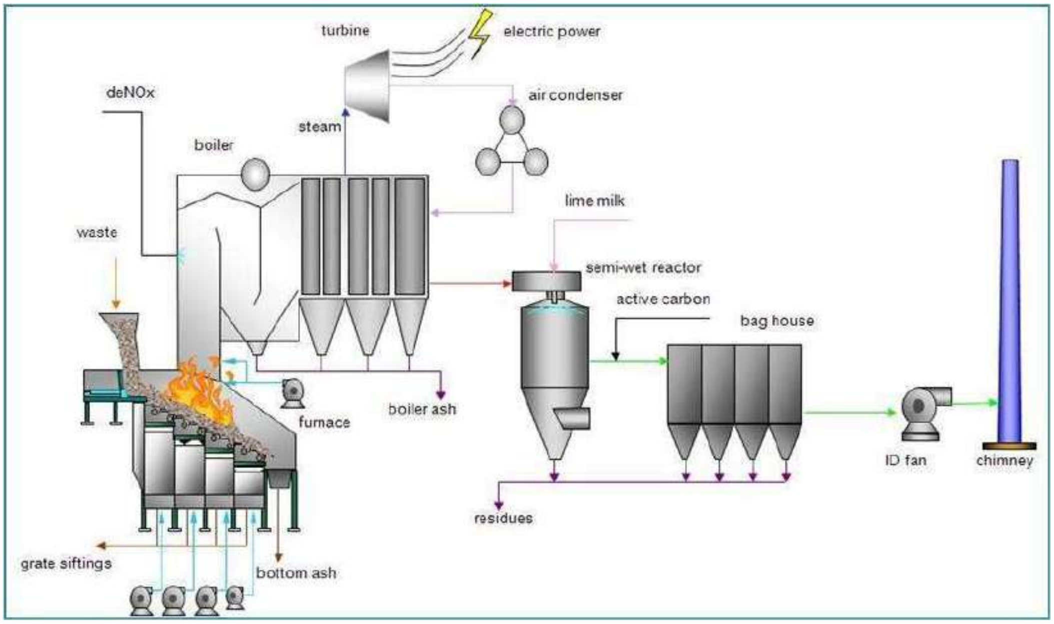


Figure 10: Typical incineration line

Flue gas passed through the bag filter is sent through the stack (chimney) by the induced draft fan and discharged outside the system.

3.6.7 Ash Handling System

After thermal processing, approximately 10-20% (by weight) of the waste remains from municipal solid waste incineration as bottom ash and fly ash as byproducts. Bottom ash is mainly made up of all the unburnt fractions of the waste, which are found at the furnace exit in the form of solid products with a grey appearance. Fly ash includes boiler ash, fly ash from flue gas filtration, calcium or sodium residues from flue gas treatment, filter cakes from flue gas cleaning.

The bottom ash is typically classified as non-hazardous waste, the pre-treatment of this ash follows the steps like screening, metal recovery, maturation and valorization-the process of reusing, recycling or composting waste materials and converting them into more useful products including materials, chemicals, fuels or other sources of energy. After the pre-treatment it can be disposed of in inert waste landfill as well as used in foundation material in road construction or in brick making. Fly ash contained toxic elements. According to Fabricius and al. (2020) and Quina et al. (2008), the main chemical elements in fly ash come from non-recyclable waste incinerators are Pb, S, K, Hg, Zn, Cd, Cr, Ni, Na and Ca. Therefore, fly ashes are usually classified as hazardous waste. The treatment of fly ash follows the following steps such as recovery which includes metal recovery and salt recovery, stabilization through lime and solidification.

Fly ash considered as hazardous waste should be located on stable land that can support the weight of the landfill over an extended period over the lifespan of such a site estimated at between 20-30 years, with a preference for low permeability soil which must be fully isolated from natural hydrology. Figures 11 and 12 below show the general treatment methods for fly ash.

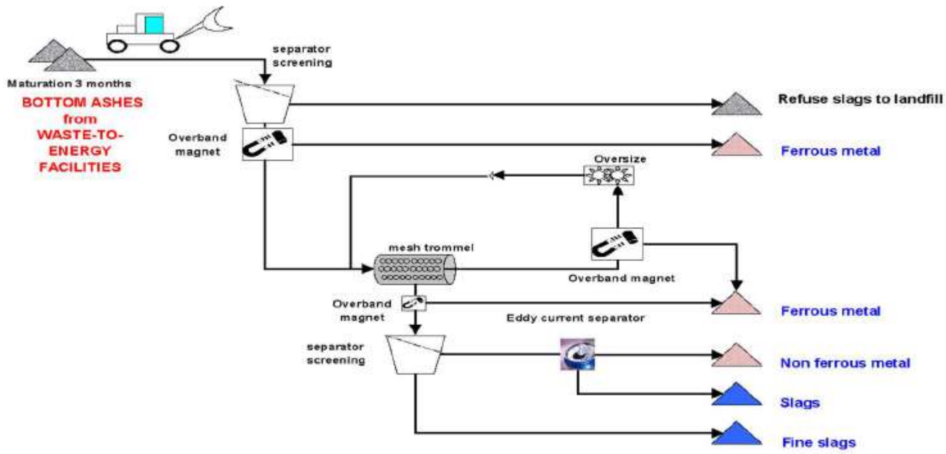


Figure 11: Bottom ash pre-treatment diagram

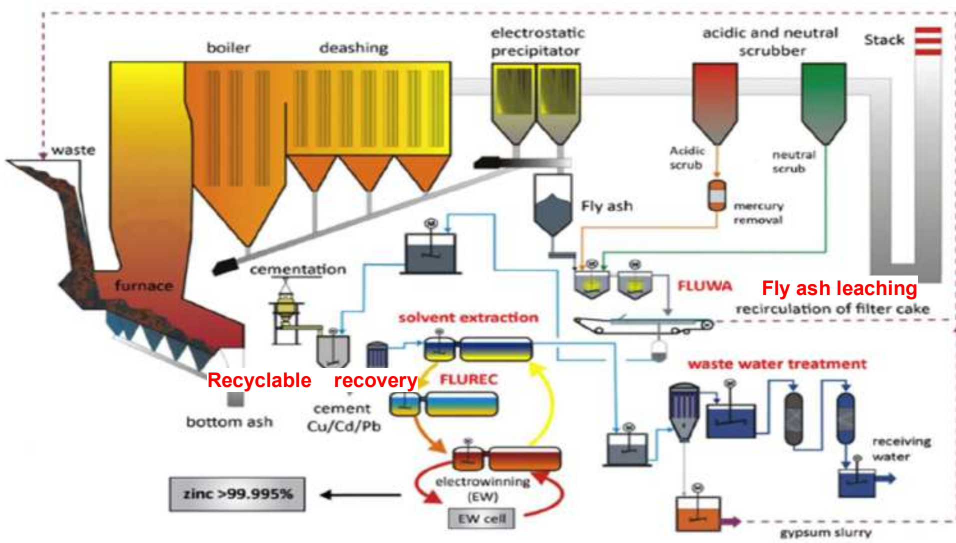


Figure 12: General process of metal separation from fly ash

3.6.8 Fly Ash Management

Fly ash produced by the project includes: Substances produced from the acidic depletion reaction collected from the bottom of the reaction tower and the coarse dust particles in the exhaust fumes, and dust in the smoke are collected from the dust bag filter.

Fly ash under the reaction tower and fly ash from the ash hopper of the dust filter are respectively pumped using gas to transfer silo to the storage dust. Silo contains solid intermediate solid-state design, after the solidified fly ash will be brought out of landfill.

The fly ash of the project is composed of three components: the bottom of the furnace exhaust duct, the ash tower reaction and dust discharging device. The dusty bottom of the conveyor belt was fed to the centrifuge, discharged to the bottom of the furnace, and to the bottom of the slag mixture, which was then discharged into the slurry tank. The fly ash of the semi-dry absorption tower and the dust bag ash filter bag, using the engine system to store the fly ash storage in the plant, then use the air shot pump to put into solidification to carry out solid chemical treatment. In the short term, solid ash handling technology of fly ash is often used to dissolve solid, solid cement technology, chemical stabilization techniques - chemical treatment techniques of wet form and solidification of cement stabilizer.

The technique of stabilizing fly ash, which this project uses is a mixture of chemical chelating - the substance that makes heavy metal ions in the fly ash stay clamped, finally immobilization of solid objects is formed. Stabilized solids that meet the criteria will be brought to landfills as hazardous waste, to be buried. Figure 13 below shows the process for treating fly ash solidification.

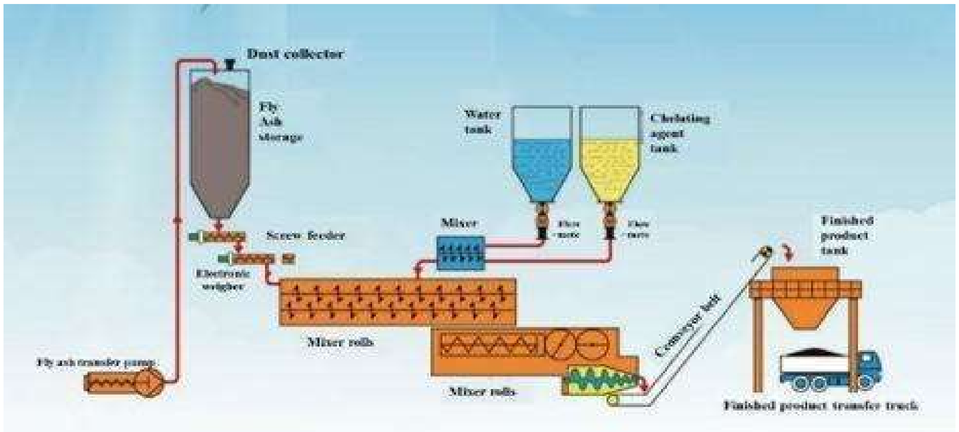


Figure 13: Technology process for treating fly ash solidification

Slag Management

The bottom slag is discharged after being discharged and fed to the cooling gutter, as the conveyor moves to the slag pit and is dredged onto the truck to be discharged outside the plant for processing. Garbage passes through the relatively small burner slot through the belt conveyor to the slag pit. Figure 14 below shows a slag removal equipment.

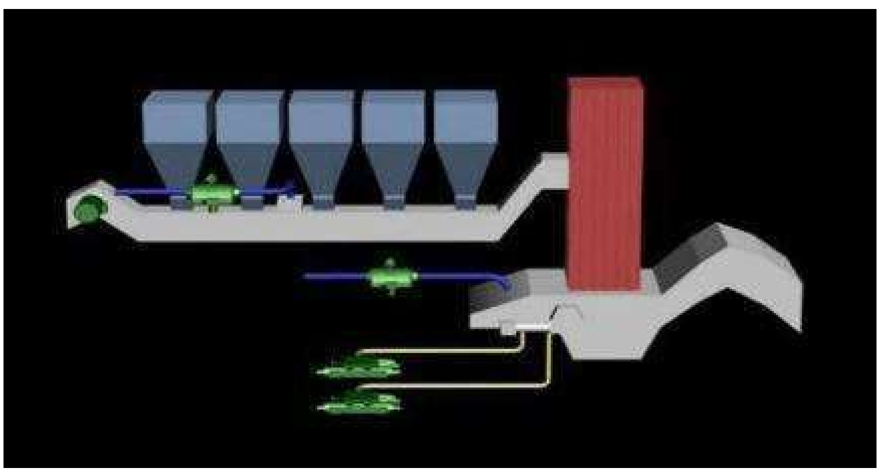


Figure 14: Slag Removal System Equipment

Choice of Slag Removal System Equipment

→ ***Slag Discharge Machine***

The tightness between the slag and the bottom of the furnace is quite a high-performance process. It is beneficial to improve the efficiency of the boiler. There are also advantages such as water savings, reliable operation, maintenance and repair.

→ ***Conveyor taking excess ash***

The conveyor is installed under the boiler grate. Some unburden matter will be moved to the slag pit.

→ ***Slag Pit Management***

On the construction side digging a slag pit, to ensure the storage of the project waste from 3 ~ 5 days. In the slag pit, a lifting crane is installed as shown in figure 15 below for operation purposes.

Figure 15: Slag Pit

3.7 Steam Turbo Generator (STG)

Using Reaction type bleed condensing steam turbine technology, Steam at 40-45 bar pressure and 415°C temperature will be generated and utilized by the turbine for electricity generation varying between 29.7MW to 43.9MW.

The steam is generally extracted from a point where parameters required for the air pre-heater and the deaerator are met, while the leftover steam goes to the exhaust stage where it passes on to the condensing system. The drains at each point are collected in a common header and finally to the vessel depending on the location of the outlet and the pressure at which it is extracted. The steam turbo-generator comprises a steam turbine, gear box, generator, condensing system, lube-oil system, electrical items and its accessories.

3.7.1 Steam Condensate System

Water cooled condensers of 47,000 Mcal/h capacity will be used for the cooling of the steam-water mixture that exits the turbines. Water cooled exchanger is used to cool the steam exhaust of the turbine with treated wastewater from the Ruai STP plant whose Capacity is 150 MLD against the required 8.5 MLD WCC and 2.5 MLD ACC. The basic components are tube bundles served by axial flow fans, fan drives, speed reducers, and an enclosure with supporting structure.

Six (06) cooling tower cells are proposed for cooling load of water-cooled condenser, oil cooler and air coolers etc. Total circulation water requirement is 13,000 m3/h. Capacity of the softener plant will be 300 m3/h and the capacity of DM plant will be 10 m3/h with 22 hours' operation. The circulation rate of the cooling tower has been determined by calculating range and approach. Range is the temperature difference between hot water and cold water across a condenser. Approach is the temperature difference between cold water temperature and wet bulb temperature (WBT) of ambient. Variation of wet bulb temperature across one (01) year is shown in table 6 below:

Table 6: Wet bulb temperature of Nairobi[2]

Day/ Month	Oct-2020	Nov-2020	Dec-2020	Jan-2021	Feb-2021	Mar-2021	Apr-2021	May-2021	Jun-2021	Jul-2021	Aug-2021	Sep-2021	Oct-2021
1	25.5	23.1	25.3	22.0	22.8	24.4	26.4	24.2	22.2	25.3	19.6	21.2	25.5
2	25.5	24.2	24.5	24.2	25.2	24.5	26.9	23.1	22.0	21.5	22.8	20.4	26.9
3	25.3	22.8	23.4	25.3	22.4	24.4	26.1	24.2	25.0	20.4	21.5	20.4	28.2
4	26.1	23.9	24.2	25.3	26.2	23.6	26.4	22.0	22.0	21.5	17.5	20.4	26.9
5	26.1	24.2	24.5	23.7	24.6	24.5	25.0	25.3	21.5	18.2	23.1	21.2	28.0
6	27.2	23.9	24.5	25.5	26.1	23.3	24.2	24.2	22.0	20.4	21.5	22.0	23.6
7	22.9	24.2	26.4	25.5	23.9	24.4	27.2	22.0	23.1	19.6	23.1	22.8	23.6
8	26.1	22.3	24.2	25.5	21.1	23.3	25.3	26.4	21.5	18.2	22.0	24.2	23.1
9	26.1	22.8	24.2	23.3	23.1	25.5	23.1	22.8	19.3	20.0	23.1	21.2	23.1
10	26.1	23.1	24.2	24.8	23.1	26.1	24.2	23.9	22.2	18.2	26.4	21.5	26.4
11	26.1	23.1	24.5	18.2	22.3	26.2	28.0	22.2	22.0	19.3	17.1	18.9	24.2
12	26.4	25.3	25.3	23.4	25.0	25.5	24.2	22.2	18.2	17.8	15.0	22.3	24.5
13	26.9	24.2	25.3	23.4	22.0	25.5	25.3	22.8	22.2	23.1	20.4	24.2	20.7
14	25.5	23.1	23.6	23.1	24.2	26.1	26.4	22.8	23.1	22.0	19.3	24.5	26.4
15	26.4	25.3	25.5	25.3	26.4	26.1	25.3	24.2	24.2	19.3	20.4	24.5	24.6
16	26.4	23.1	23.6	24.5	24.6	24.2	25.3	24.2	21.5	23.1	19.3	25.3	26.9
17	23.4	25.3	22.7	25.5	25.5	24.5	25.5	23.4	21.5	19.3	23.1	27.8	26.9
18	23.1	25.5	23.4	25.5	25.5	24.8	24.2	23.9	21.2	20.7	20.4	27.2	26.4
19	24.2	26.4	23.6	26.1	26.1	25.5	25.0	22.3	22.0	21.2	24.2	24.4	24.5
20	23.1	25.0	25.3	26.9	25.2	25.5	25.3	25.0	20.7	21.2	23.1	24.5	21.5
21	24.2	26.4	24.5	22.4	25.5	24.2	25.3	17.5	20.7	21.5	24.2	23.1	23.1
22	25.3	25.3	26.4	23.9	23.1	24.5	23.9	21.6	21.5	24.2	24.2	24.5	26.4
23	26.9	22.7	25.5	-	22.0	26.4	22.8	24.2	19.3	23.1	26.1	23.1	26.1
24	26.1	26.4	25.5	-	24.2	25.5	25.0	21.5	21.2	21.5	25.3	23.4	25.2
25	23.1	27.8	26.1	-	20.6	25.4	23.9	22.0	19.3	20.4	23.4	22.3	27.2
26	20.0	26.9	25.5	-	24.6	24.4	24.2	21.5	22.0	21.2	23.4	22.5	22.4
27	21.5	25.3	23.6	-	27.2	25.3	25.3	22.0	18.2	20.7	26.4	26.1	24.5
28	24.2	22.8	23.6	-	24.6	25.5	24.2	23.1	22.0	19.3	25.2	26.1	26.4
29	22.2	20.0	24.5	-	-	26.9	25.3	23.1	22.0	16.4	27.3	28.0	23.9
30	20.4	27.2	25.5	-	-	26.1	25.3	20.4	21.2	21.5	25.3	26.1	24.2
31	23.1		25.0	-	-	26.4	-	22.0	-	23.4	23.4	-	26.4

Maximum wet bulb temperature (WBT) has been observed as 28.2 ^{0}C. Therefore, the approach has been designed at 30^{0}C temperature on conservative side. If the wet bulb temperature is lower, the approach would be better.

[2] https://www.wunderground.com/history/monthly/ke/nairobi/HKNW/date/2021-10

3.8 Hazardous Waste

Hazardous waste generated from the plant is very little, and the plant does not have the function of treating hazardous waste. As a result, hazardous waste generated when the project is put into operation will be collected and classified separately; there is a sticker for each kind of waste and stored in a separate warehouse with a roof, a spillway, concrete pavement and the contractor will sign a contract with the collector with the transportation function to transfer and dealt with in accordance with the law.

The technical regulations on hazardous waste storage areas are complied with Regulation 8(1), (2) of Waste Management Regulations on hazardous waste management. The floor area of the hazardous waste storage area shall be tight and shall not penetrate and prevent rainwater from flowing in from outside. Covered with sun and rain cover for the entire hazardous waste retention area, the storage area is designed to restrict the wind directly inside. To apply isolation measures to other types or groups of hazardous waste having the capability to react chemically together. The hazardous waste storage area is guaranteed to be free from overflow of liquids when leakage or spillage occurs.

3.8.1 Hazardous Landfill

The incineration of household waste inevitably produces 2 products: bottom ash and fly ash. It is necessary to provide outlets such as reuse/storage facilities during the design phase of the incinerator.

Bottom ash (BA) is made up of grains which form a heterogeneous mixture of glass, gravel, scrap metal and unburnt elements. It exits the furnace in the form of solid products with a grey appearance. After treatment, bottom ash is considered as a non-hazardous/inert waste. It can be stored in a non-hazardous waste landfill or can be valorized and used as a road construction material.

The fly ashes (FA) are constituted of the boiler ash, the fly ash from the flue gas filtration, the residue and filter cakes from flue gas treatment. It presents significant concentrations in pollutants and chemicals. Fly ash is considered as a hazardous waste and requires further treatments before being buried in a hazardous waste landfill. Samples of bottom and fly ash are displayed in figure 16.

Figure 16: Bottom ash (left) and fly ash (right)

Cell Design of Hazardous Landfill

Cell design of hazardous landfill is shown in below figure 17:

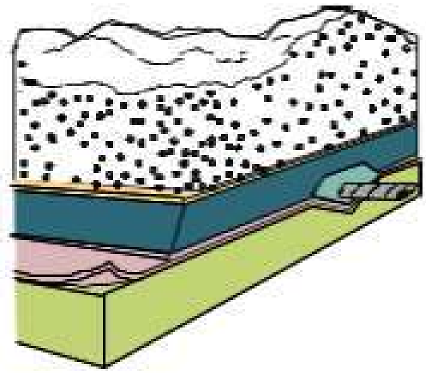


Figure 17: Cell design view of hazardous waste (HW) landfill

The bottom layer of a landfill is always composed of two parts, fulfilling two functions:

Barrier Layer

A Barrier layer made of a composite liner system, which acts as confinement between the waste deposit and the substratum is proposed in place for the facility.
Drainage layer, which allows collecting leachate for further storage and treatment will be part of the barrier layer.

The design proposed for the barrier layer has taken into account the specific unfavorable soil conditions. Indeed, given the low permeability of the site, a low permeability layer needs to be created. The solution of implementing a 5 m clay barrier is a possibility, but as the possibility of excavating is limited in the context of the site, it is proposed to replace part of the clay layer by a Geo-benthic complex layer (GCL).

Therefore, the barrier layer proposed is composed of (from top to bottom):

- A protective non-woven geotextile to prevent punctures in the HDPE sheet;
- A sheet of HDPE with a thickness of 2.5 mm, with properties defined and controlled as mentioned in the GRI standards GM13.
- A Geo-Synthetic Clay Liner (conformed to the European standards EN 13493:2018)
- A layer of minimum 2 meter of compacted clay with a permeability < 10 x 10-10 m/s
- Natural substratum prepared and graded according to the project profile.

The structure of the bottom layer of the landfill cell is as shown in figure 18 below.

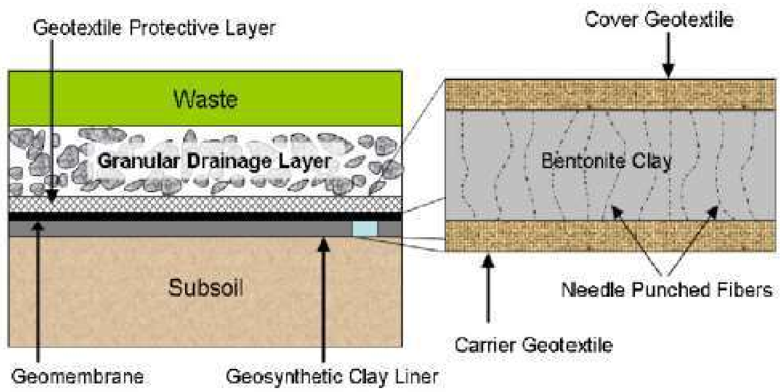


Figure 18: Structure of the bottom layer of the cell

Drainage Layer

The drainage layer is composed of (from top to bottom):

- A geotextile filter to prevent contamination or plugging of the drainage system by solids;
- A layer gravel which collects leachate and allows it to flow through the leachate collection system;
- Perforated pipes specially designed for gravity flow of leachate towards low points for further treatment.

Cell Design of Inert Landfill

Inert landfill sites do not present as many requirements as hazardous and non-hazardous waste landfill sites do.

The bottom layer of the inert landfill will be composed of the natural substratum. Given the low permeability of the natural substratum, it is proposed to have a layer of 0,5m of clay compacted at the bottom to the cell. The layout of the landfill is illustrated below in figure 19.

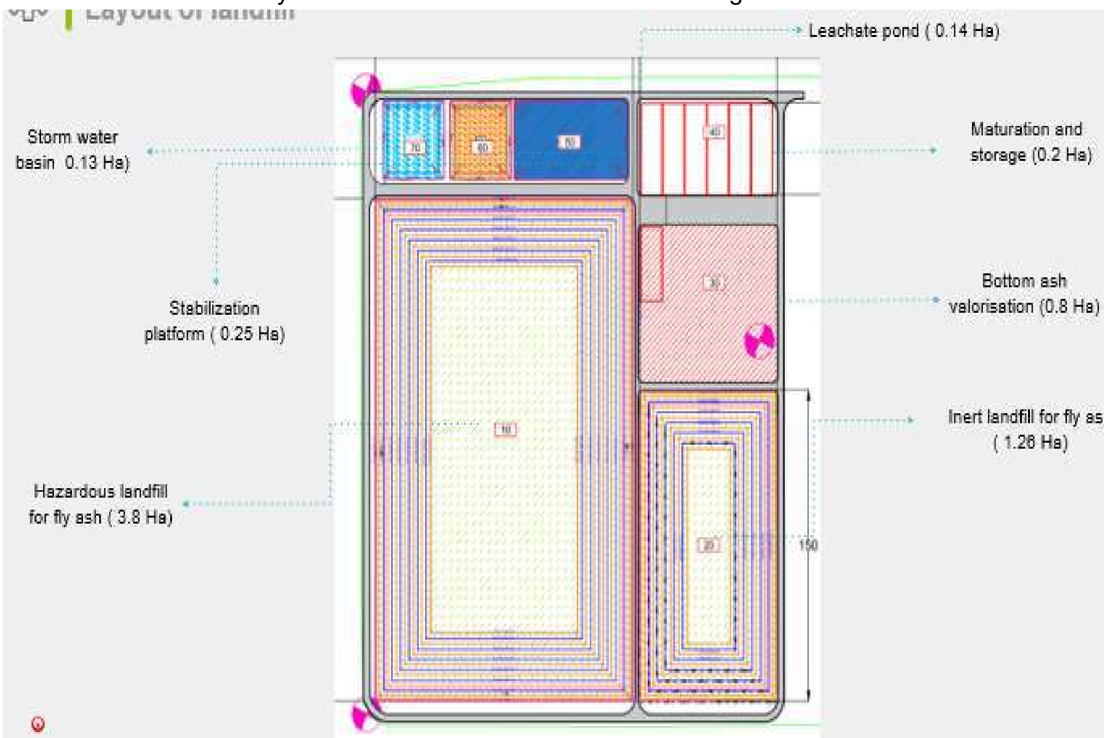


Figure 19: Layout of landfill

Leachate Collection System

Once it has been submitted to the maturation process, bottom ash is considered as an inert waste and does not generate leachate. Therefore, there is no need to implement a leachate collection system for the inert waste landfill.

Final Closing System

A layer of 50cm of soil will be put on the top for rehabilitation. This layer will support the establishment of vegetation. A gentle slope of around 3.8% will be created at the top of the dome, to ensure proper rainwater drainage.

Surface Water Management

Proper surface water management is vital to the operation of a landfill. The purpose of a surface water management system is:

- To control the storm water run-on and run-off and keep them separate from the waste and any contaminated water originating from the waste,
- To minimize environmental impacts to surface water,
- To minimize the site (especially embankment) erosion.

The components of a surface water management system should be designed to accommodate the volume of water associated with Kenya's usual rainfall level. Particular care will be taken to ensure that the storm water drainage system can cope with a particular rainfall event. Wherever possible, rainwater should be drained by gravity to the storm water pond. Figures 20 and 21 show the detailed view of the leachate collection system.

Annexure - 1 Detail view: final closing system hazardous waste landfill

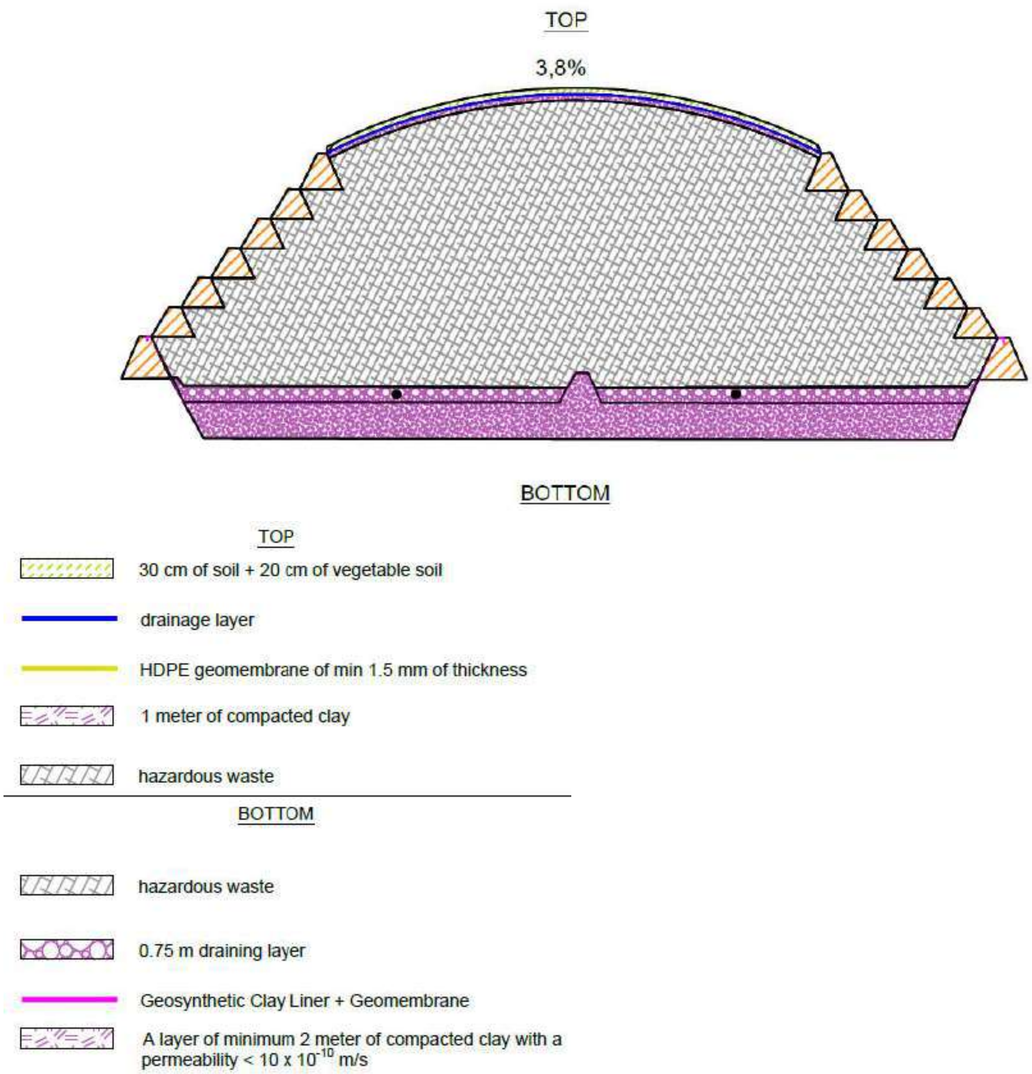


Figure 20: Final closing system of HW landfill

Annexure - 2 Detail view: Leachate collection system

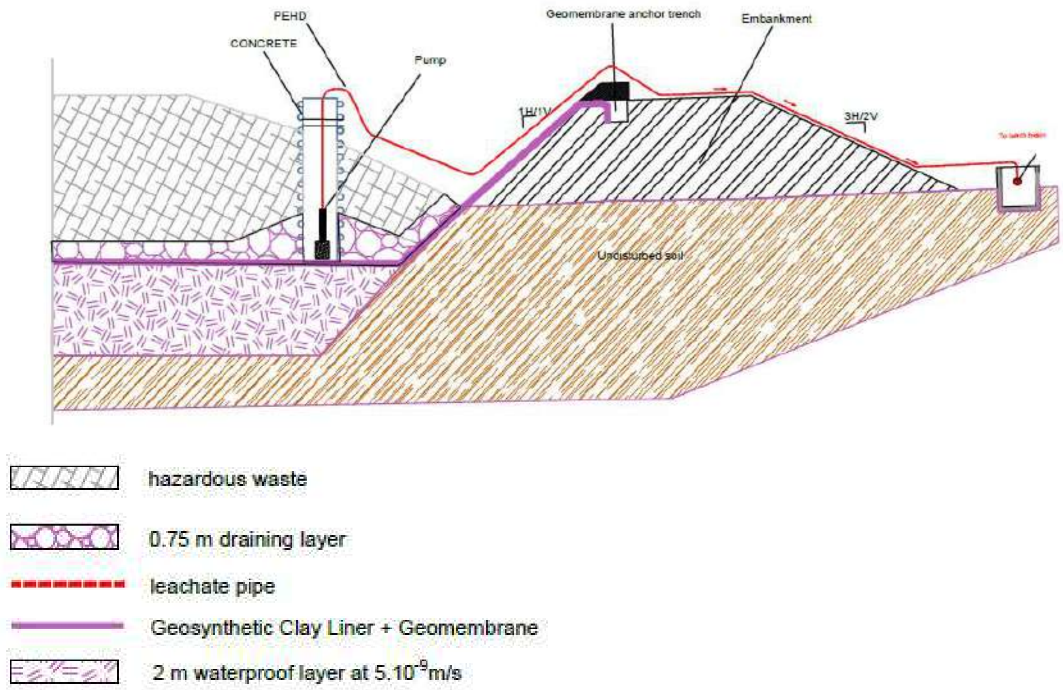


Figure 21: Leachate Collection System

3.8.2 Leachate Treatment Plant

Leachate is the water-based complex liquid, consisting of innumerable organic and inorganic compounds, which percolates through landfills and accumulates at the bottom. The water from interstitial moisture of the decomposing waste and also due to precipitation subsequently moves through the waste deposit collecting the leached chemicals thereby forming leachate. Leachate contains a host of chemicals that may be toxic to both humans and the environment.

The leachate generated during stabilization and pre-processing processes is characterized by high chemical and biological oxygen demand (COD, BOD) and often consists of high concentrations of organic contaminants, heavy metals, toxic materials, ammonia and inorganic materials as well as refractory compounds.

There are many different methods currently being used to treat the leachate. Most of these methods are adapted for wastewater treatment processing and Out of the many methods, some of them have been listed below:

- Biological treatment processes: aerated lagoon, membrane bioreactor, etc.
- Chemical treatment processes: oxidation with ozone, UV, hydrogen peroxide, …
- Physico-chemical treatment processes: coagulation, flocculation, precipitation, activated carbon, etc.
- Membrane treatment processes: reverse osmosis, Nano filtration, etc.

Biological processes methods include the activated sludge process (ASP), sequencing batch reactors (SBR), membrane bioreactors (MBR), aerobic lagoons and constructed wetlands. Some of the techniques used for treatment are recirculation, activated sludge, trickling filters, stabilization ponds and sequencing batch reactors. Physicochemical treatment processes which use some of the techniques which are filtration, activated carbon adsorption, coagulation/flocculation, air stripping. The combination of physical-chemical and biological processes gives the best results in terms of pollutants removal. So it is preferred to implement a hybrid process involving both biological and physicochemical methods for leachate treatment.

On site treatment methods will be employed whereby lagoons with impermeable liners at the bottom will be constructed to encourage a first phase of anaerobic decomposition, followed by aerobic decomposition. Full evaporation in the final storage lagoon is desirable and the discharge of treated effluent is directed to an artificial wetland for further tertiary treatment. If full evaporation is not possible, recirculation of treated effluent back to the landfill is recommended. Continuous monitoring of effluent quality will be done to meet EMCA,1999, Water Quality Regulations 2006. The leachate treatment plant shall be designed to handle leachate concentrations as common from a reactor landfill.

The final location of the PCW will be defined during the design review as the best place to take into account also the vital interest of neighbors. After final treatment in the maturation pond the effluent will meet the requirements of NEMA and can be used for irrigation, evaporation or percolation. There will be an onsite laboratory to periodically take measurements of key environmental parameters to ensure that any discharged effluent is within permissible standards.

The project will take advantage of evaporation of leachate as well as recirculation of effluent through the plant but in the event of wet weather when evaporation is reduced or saturation to stifle recirculation, the effluent will be applied to water the vegetation in the buffer zone or discharge into the river after normal quality tests as required by national and international standards regarding effluent discharge have been conducted. A percolation area is designated just next to the maturation ponds for excess water, which cannot be utilized.

Also, the high Biochemical Oxygen Demand (BOD) of leachate makes its treatment inevitable. Leachate when escaping to a nearby environment poses an enormous threat to the groundwater and surface water contamination hence making the process of Leachate Management exceptionally critical. While the characteristic of leachate depends considerably on the waste deposit, age of the landfill, temperature and moisture content, it is significantly concentrated in terms of toxic chemicals and thus the treatment of leachate becomes crucial in preventing the high-risk contamination. The capacity of the leachate plant would be 1,100 m3/d which will be treated. Electromechanical system which consists of screening, equalization tank, dissolved air floatation (DAF), Low rate digester (LRD), dual media filter, air stripping tower and sludge handling system to meet allowable properties of leachate.
Properties of typical leachate and treated leachate are shown in table 7 and 8 below:

Table 7: Leachate Property of Typical Plant

Parameter	UOM	Values
Chemical Analysis		
pH Value at 25 °C	-	3.5-5
Chloride	mg/L	7,000
Phenols	mg/L	0.8
Arsenic (as As)	mg/L	0.007
Lead (as Pb)	mg/L	0.08
Cadmium (as Cd)	mg/L	0.6
Copper (as Cu)	mg/L	<0.1
Mercury (as Hg)	mg/L	<0.05
Zinc (as Zn)	mg/L	39
Fluoride (as F)	mg/L	42
Ammonia (as NH3)	mg/L	546
Cyanide (as CN)	mg/L	0.05
Oil & Grease	mg/L	227
Solids Dissolved (TDS)	mg/L	50,000-55,000

Parameter	UOM	Values
BOD3 days at 27°C	mg/L	18,000-32,000
CCO (as O2)	mg/L	40,000-65,000
*Cobalt (as Co)	mg/L	<1.0
*Specific gravity	g/cm3	2.16
General Parameters		
Chromium Total (as Cr)	mg/L	0.6
Hexavalent Chromium (as Cr6+)	mg/L	ND (<0.01)
Nickel (as Ni)	mg/L	1.0
Nitrate (as N)	mg/L	95
Total organics compound	mg/L	46,164
Solids Suspended (TSS)	mg/L	2,000
Odour		Objectionable
Total Kjeldahl Nitrogen (as N)	mg/L	2,500-3,000
Ammoniacal Nitrogen (as N)	mg/L	750-1,000

Table 8: Leachate treatment plant design and performance parameter

Parameter	UOM	Max Allowable Limits
1,1,1 - trichloroethane	mg/l	3
1,1,2-trichloethane	mg/l	0.06
1,1 - dichloroethylene		0.2
1,2-dichloroethane		0.04
1,3-dichloropropene	mg/l	0.02
Alkyl mercury compounds		Nd
Ammonia, ammonium compounds, NO3 compounds and NO2 compounds (sum total of ammonia - N time 4 plus nitrate-N and nitrate-N	mg/l	100
Arsenic	mg/l	0.02
Arsenic and its compounds	mg/l	0.1
Benzene	mg/l	0.1
Biochemical oxygen demand (BOD 5 days at 20 degC)	mg/l	30
Boron	mg/l	1
Boron and its compounds - non marine	mg/l	10
Boron and its compounds - marine	mg/l	30
Cadmium	mg/l	0.01
Cadmium and its compounds	mg/l	0.1
Carbon tetrachloride		0.02
Chemical oxygen demand (COD)	mg/l	50
Chromium VI	mg/l	0.05
Chlorides	mg/l	250
Chlorines free residue		0.1
Chromium total		2
cis-1,2-dichloro ethylene		0.4
Copper	mg/l	1
Dichloromethane	mg/l	0.2

Parameter	UOM	Max Allowable Limits
Dissolved iron	mg/l	10
Dissolved manganeses	mg/l	10
E-coli	counts/100 ml	Nill
Fluorides	mg/l	1.5
Fluorides and its compounds	mg/l	8
Lead	mg/l	0.01
Lead and its compounds	mg/l	0.1
n-Hexane extracts (animal and vegetable fats)	mg/l	30
n-Hexane extracts (animal and vegetable fats)	mg/l	5
Oil and grease	mg/l	Nill
Organo - phosphorous compounds (parathion, methyl parathion, methyl demeton and ethyl parantrophenyl, phenylphoshorothoate, EPN only)	mg/l	1
Polychlorinated biphenyls, PCBs	mg/l	0.003
pH (Hydrogen ion activity - marine)		5-9
pH (Hydrogen ion activity - marine)		6.5-8.5
Phenols	mg/l	0.001
Selenium	mg/l	0.01
Selenium and its compounds	mg/l	0.1
Hexavalent chromium VI compounds	mg/l	0.5
Sulphide	mg/l	0.1
Simazine	mg/l	0.03
Total suspended solids (TSS)	mg/l	30
Tetrachloroethylene	mg/l	0.1
Thiobencarb		0.1
Thiram	mg/l	0.06
Total coliforms	mg/l	30
Total cyanogen	mg/l	Nd
Total nickel	mg/l	0.3
Total dissolved solids	mg/l	1200
Colour in Hazen units	HU	15
Detergents	mg/l	Nill
Total mercury	mg/l	0.005
Trichloroethylene	mg/l	0.3
Zinc	mg/l	0.5
Whole effluent toxicity		
Total phosphorus	mg/l	
Total nitrogen	mg/l	

Leachate Treatment Process

Water leaks after filtration into the regulating tank, using the pump in the settling tank where added condensate and condensation aids make the solids and colloids in the rubbish bind together, the leaked water after the condensation will flow into the settling tank longitudinal sedimentation. Leachate water through pre-treatment, into the superheated tank conducting heat-up, then continues into the tank of air to remove most of the organic matter, water after entering the oxygen tank is fed into the O/A system, first into tank A, under anaerobic condition, microorganisms use organic coal in wastewater to convert nitrate to nitrogen gas. Then the wastewater through the stream is pushed into the tank O, under aerobic condition, the remaining organic substance continues to decompose, at the same time microorganisms conduct oxidation of nitrite - ammonia nitrate to nitrate, back to tank A to separate nitrogen. Water from the O/A system continues into the ultrafiltration membrane to eliminate COD, and other suspended substances. The water after the ultrafiltration process into the chemical softening system, the reverse osmosis system, to filter suspended solids, resolved solids, water hardness, color of water, nitrogen, ammonia, ion chlorine and other indicators. Water after treatment complies with the EMCA (Water Quality) Regulations, 2006 on industrial waste and transfer to use for cooling towers; the project does not release waste into the environment.

→ **Chart of Waste Leachate Treatment Process**

Leakage capacity of 200 m^3/day and night. Water after treatment meets EMCA (Water Quality) Regulations, 2006 on industrial wastewater, column B. The waste leachate treatment process is shown in figure 22 below.

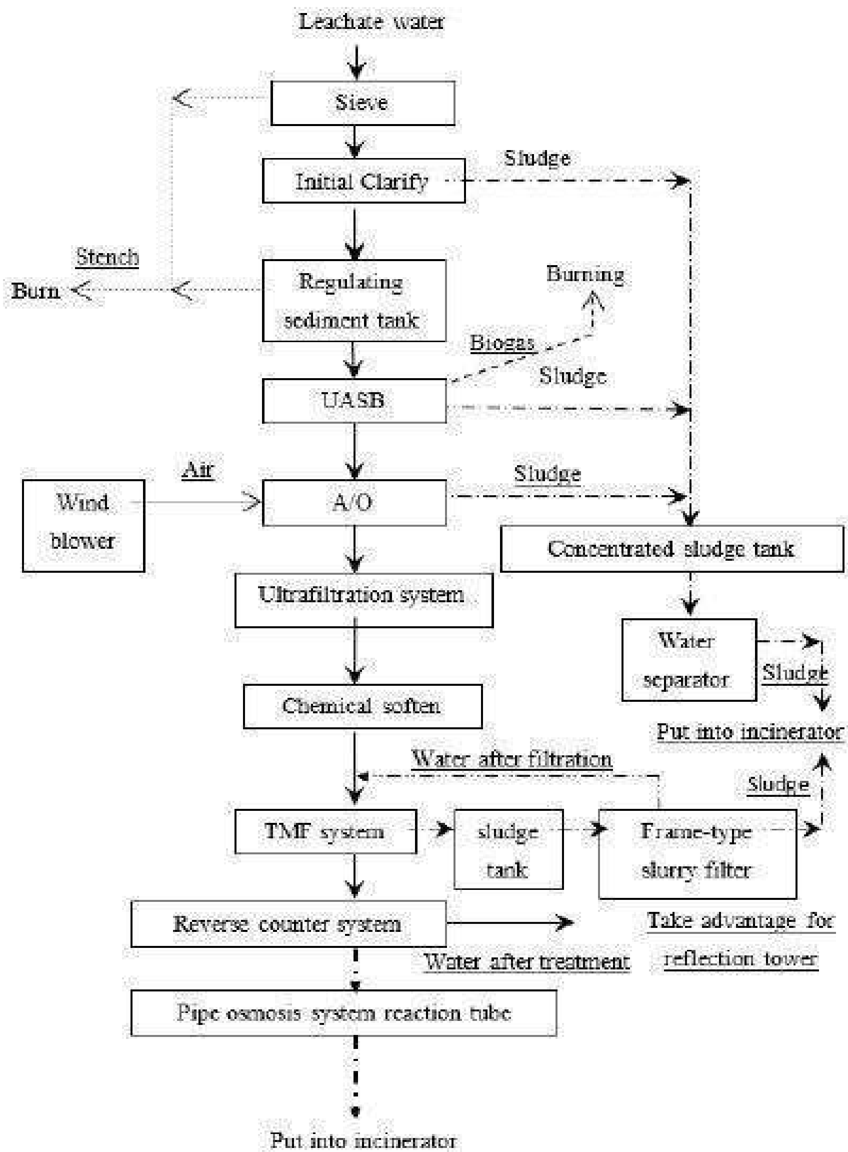


Figure 22: Waste Leachate Treatment Process

3.8.3 Sludge treatment system:

Leachate after settling and condensation, will produce sludge, sludge is pumped to cassava tank treatment, in the process of decomposition in the anaerobic tank and aerobic tank will produce large amount of activated sludge; through the centrifugal pump will go to the muddy condensing pond, the mud after condensed, it will be pumped to the water separator will proceed to separate the water and sludge after the separation of water will be transferred to the incinerator.

Stench Treatment System

This project uses deodorization method is system pretreatment, sludge treatment system uses a closed design, then through the wind turbines collect the odor to the garbage dump; in the next through the wind blower to the treatment furnace.

Utilization of Concentrated Water After Reverse Osmosis (RO)

Concentrated water is used for absorption, recovery, reuse, water addition for slag re-grinders, ash stabilization, preparation of lime milk, reduction of exhaust gas temperature of the reaction tower. Table 9 below shows the waste leachate content before treatment.

Table 9: Waste leachate content before treatment by central water treatment system and treatment efficiency

Items		COD mg/L	BOD_5 mg/L	NH_3-N mg/L	SS mg/L
Pretreatment system	Water in	50000	30000	2000	10000
	Water out	35000	22500	1500	2000
	Reduced efficiency	30%	25%	25%	80%
UASB system	Water in	35000	22500	1500	2000
	Water out	7000	3375	1200	1400
	Reduced efficiency	≥80%	≥85%	20%	30%
A/O system	Water in	7000	3375	1200	1400
	Water out	≤350	168.75	12	28
	Reduced efficiency	≥95%	≥95%	98.9%	98%
Nano filter - NF system	Water in	350	168.75	12	28
	Water out	70	33.7	6	1.4
	Reduced efficiency	80%	80%	50%	95%
Reverse penetration system Ro	Water in	70	33.7	6	1.4
	Water out	21	6.75	0.9	0
	Reduced efficiency	70%	80%	85%	100%
Water out design Requirement for water quality standards	Total volume of water out	≤60	≤10	≤1.0	≤10

3.8.4 NOx Deoxidation System

In order to ensure that the NOx concentration in the smoke reaches 200 mg/Nm^3, the project uses the SNCR system in the furnace.

NOx formation in garbage incinerators is primarily related to NOx in garbage and incineration temperatures. In nitrogen-containing garbage (mainly nitrogen-containing organic compounds) burned to form, Nitrogen in the air under high temperature reacts with oxygen to form NOx. The above complex process mainly involves the amount of oxygen, temperature and Nitrogen content when burned. Figure 23 below show the NOx deoxidization system.

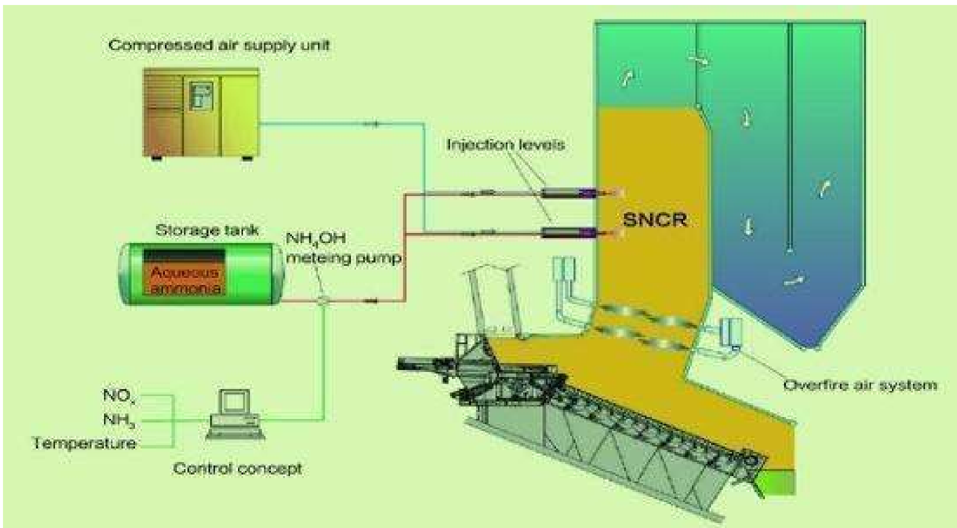


Figure 23: NOx Deoxidization System

The project can use two methods to reduce NOx content:

1. Through optimized combustion and post-combustion technologies to reduce the amount of NOx generated, keeping the combustion temperature between 850 and 1000 ℃, according to current operating experience, can be reduced to below 400mg// Nm^3
2. Install a NOx SNCR deoxidization (non-catalytic descaling) solution, inject urea solution into the first pipe of the boiler to generate the NOx reducing reaction to N_2, which can reduce the NOx content in smoke down to less than 200mg / Nm^3. Depending on the initial NOx concentration, SNCR removal efficiency is 30% to 50%.

The SNCR method is sprayed with ammonia, at high temperatures (900 - 1100℃), through the reaction of ammonia liberated from ammonia and NOx, will be reduced to N_2, H_2O and CO_2 reach NOx degradation Target. The principle of reaction is as follows:

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$

The basic NOx degradation process in the SNCR system is as follows:
1. Receiving and storing the reducing agent;
2. Amount of reducing agent, diluted with water mixture;
3. Spray the reducing agent into the proper position after dilution;
4. The reducing agent is mixed with the waste gas resulting in the reduction of NOx

The SNCR system mainly includes ammonia water storage and reception systems, charging booster systems, injection systems and automatic control systems. Specifically see the figure 24 below:

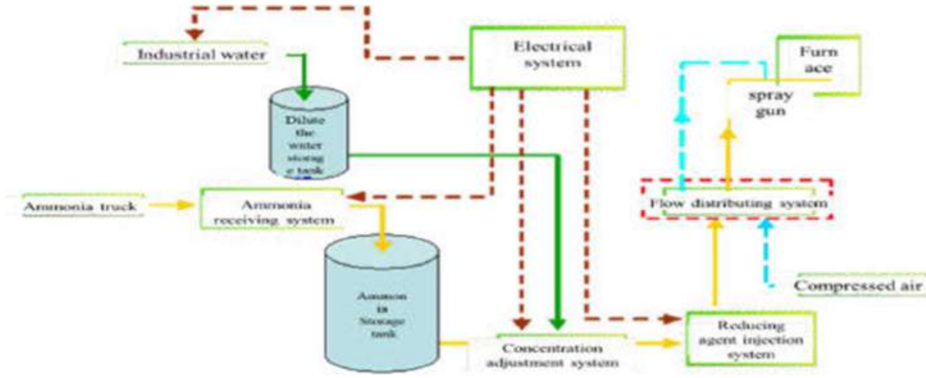


Figure 24: SNCR System

Ammonia water is delivered exclusively into the plant, using a 25% ammonia pump in a tank, an ammonia tank designed to meet the plant's five-day operation. In operation, ammonia water is drawn out by a booster pump, after which the mixture is separated into incinerators, and then sprayed into the furnace by a high-pressure nozzle. There are two booster pumps installed as shown in figure 25 below;

Figure 25: Two Booster Pumps Additionally Installed

Each of the burners has an injection system; each sprayer is made up of spray guns, spray guns made of stainless steel 304, composed by gun body, nozzle, spray nozzle as in figure 26 below.

Figure 26: Spray Gun SNCR

Spray Gun SNCR

Based on the actual needs of the project, the system uses compressed air to create a foggy, air-sprayed gauntlet that uses a certain speed of air to push the liquid out, thereby achieving a frost-producing effect.

The SNCR control system consists of automatic and manual. When operating automatically, can automatically control the level of solution in the bath tank, automatically adjust the pressure of the pump output, automatically control the compressed air pressure, and automatically regulate the volume flow; automatic control of the NOx content in the boiler flue, when the NOx price is higher than the system setting, will automatically start up and so on.

The control system can fully measure, monitor, operate, automatically control, alert, protect, interlock, and record all NOx deactivators, functional control systems can check trends all the time, historical trends and tables.

Deacidification System

Smoke after NOx oxidation will be directed into the reaction tower with shielding plates. The vortex mist sprayer installed at the center of the tower, sprayed with lime milk sprayed in the same direction as the smoke in the neutral reaction tower. In the tower, the rate of reduction is low, the acid in the smoke and alkaline will have a longer exposure time. Because evaporated water will cool the smoke rapidly, reducing it to a reasonable temperature, thereby improving the efficiency of the reaction. At the same time, a heavy reactant and dust particles will rupture from the bottom of the tower.

Pre-cleaning air before entering the filter bag will pass through the pipe into the charcoal granule, in the filter bag, reactor and activated charcoal adsorbed inside the bag, again reacting the acid not fully reacted to absorb Dioxin and heavy metals. The ash from the dust filter reactor and the neutralization reactor enters the silo through the transfer system by means of a gas transfer device or system.

The waste incineration system is usually produced by lime milking systems, semi-dry reaction towers, vortex fogging systems, activated carbon sprays, dust bag filters, and ash transfer systems as in figure 27 below.

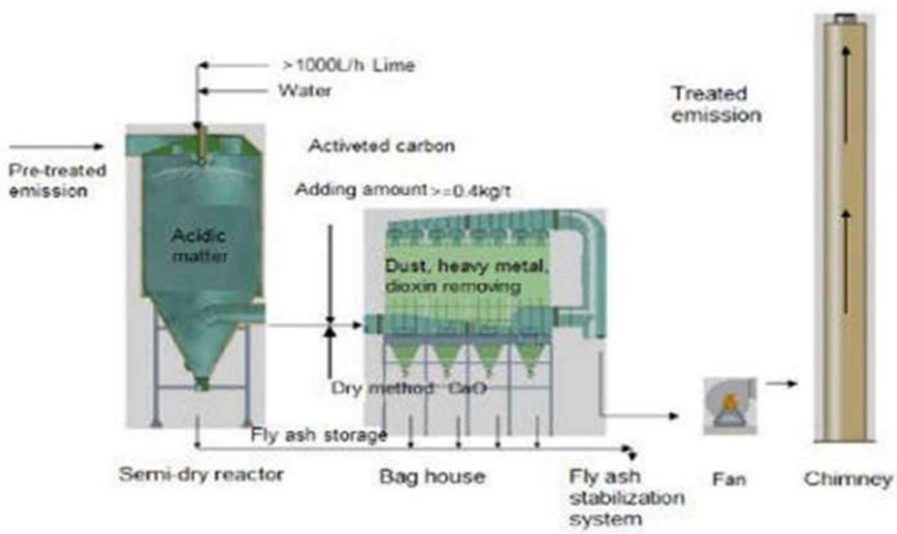


Figure 27: Deacidification System Lime milk production system

The lime-milking system is used to prepare, store and transport lime milk for dry semi-dry smoke systems, combining systems from CaO powder transport systems, lime powder silos, lime powder measure device (measured in small silos or weighing electronic balances), NOx tank, lime milk tank, lime pumps, valves and piping.

Under the control system, the lime from the silo enters the metering device, and passes to the NOx gutter for stirring, opening the solenoid valve between the NOx tank and the lime milk tank. Lime milk will flow into the reservoir for backup.

Lime milk can also be made by people: First, put a certain amount of water into the NOx gutter, start the mixer, then pour the necessary amount of lime into the NOx gutter; after stirring, dump into the lime milk tank for backup.

This stage designs a lime silo, on the top of the silo inserts a set of dust filter bags, when the feeder, the filter bag can be automatically started or started manually. Clean the filter bag with compressed air. Silo with lime level sensor: At high level (H), the sensor will send a warning signal to the driver that the tank is full; Silo bottom vibrator ensures that the lime can be rinsed out; When repairing, close the outlet valve of the tank.

Concentration of lime milk (20%) in the tank is determined by measuring the amount of spiral discharge (controlled inverter) or water intake.

Lime milk will be circulated to the reaction tower, the flow rate of the lime in the circulation pipeline will be carefully studied so as not to settle and to minimize the abrasion of the pipe. The circulation value of the pump is always greater than the amount of lime used, in order to avoid the change in lime milk consumption, which affects the smallest flow rate. In order to stabilize the balanced fuser pressure, use a control valve to control circulating pipeline pressure. Design of a backup pump, pump and main pipe connected by a soft hose.

Reaction Tower

The reactive tower is NOx deoxidization and deacidification in the final smoke of the incinerator, inside the tower, reactor and acid in the smoke reacting to each other. The reaction is mainly:
$SO_2 + Ca(OH)_2 = CaSO_3/CaSO_4 + H_2O$
$CaSO_3 + Ca(OH)_2 = CaSO_4 + 2H_2O$
$2HCl + Ca(OH)_2 = CaCl_2 + 2H_2O$
$2HF + Ca(OH)_2 = CaF2 + 2H_2O$

At the same time, water is sprayed into the neutralization tower to evaporate heat, reduce the smoke temperature, make the reaction more powerful, and improve the efficiency of smoke cleaning. In addition, it is also possible to reduce the smoke temperature into the filter bag and to control it within the allowed range.

In the reaction tower as in figure 28 below, it is also possible to remove some heavy metals such as Hg, Pb and Dioxin PCDDS/PCDDFs.

Figure 28: Acid Separation Reaction Tower

Mist Spraying System

Variable vortex mist spraying system shown in figure 29 below, frequency converter, oil and gas lubricating oil cooler, a set of circulating water systems, a pipeline and collector box, an automatic control unit, rinsing trough, a trolley, a set of tools made up.

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Figure 29: Vortex spray mist, Spray nozzle fog and Vortex spray in operation

Smoke passes through a spiral pipe to the top of the reaction tower, dividing plates to ensure that the rate of smoke is divided equally into the spray. In the front of the spray nozzle, the guide plate causes the gas to produce a vortex. Thus, the four directions of the mist-disk will be the downward direction of the smoke.

Lime milk and industrial water will be injected into the mist sprayer. On the bottom of the nozzle, there is a special splitter which ensures that the splash water is properly split into the spray nozzle. In the mist disk, lime milk will accelerate by centrifugal force, and around the disk will turn into small particles. These tiny particles easily react.

The vortex of smoke is opposite to the direction of the dew, so the two substances are strongly mixed. The smoke from the boiler will be cooled by the water sprayed from the mist spray, and the acid will be neutral in lactic acid. The amount of industrial water depends on the temperature of the smoke, the amount of lime milk that is lime depends on the pH of the smoke.

The height and diameter of the reaction tower ensure sufficient time and space for the chemical reaction between the water vapor and the lime to be complete. A portion of the heavy substance generated in the reaction will settle to the bottom of the tower, where the transfer device will pass to the treatment device, most of the reactants will follow the smoke passing through the filter bag of the system.

Activated Carbon Spraying System

Activated carbon spraying system is the most effective technique for cleaning heavy metals and dioxins in the treatment of exhaust fumes. Activated carbon is injected into the smoke outlet pipe of the acidification tower, through the vent pipe will be mixed with smoke, in the process of smoke blowing down the filter bag, activated carbon will adsorb the needle heavy (like Hg) and dioxins in smoke. The amount of activated carbon that absorbs dirt will be trapped in the filter bag, separated from the smoke, so heavy metals and dioxin can be separated from the smoke, the amount of activated charcoal in the bag contains contaminants will form filter to continue the process of adsorption of heavy metals and dioxins not exhausted, ensuring smoke emission standards.

Activated carbon spraying system includes tank silos, feeders, vent sprayers and compressed air systems. Activated carbon purchased from outside is stored in a silo tank. The storage silo capacity is designed for 5-7 days. At the top of the silo contains a dust bag filter, when the dust filter can be operated automatically, it can also be operated manually. Using compressed air is to clean the dust filter. In the bottom of the tank silo is fitted with activated charcoal flow aid to ensure that the coal can be discharged out, including the flow sheet, the valve and the combined pipe, when opening the valve under the tank to feed, transport system on, otherwise it stops. The top of the tank silo has a pipe connected to the hopper as demonstrated in figure 30 below.

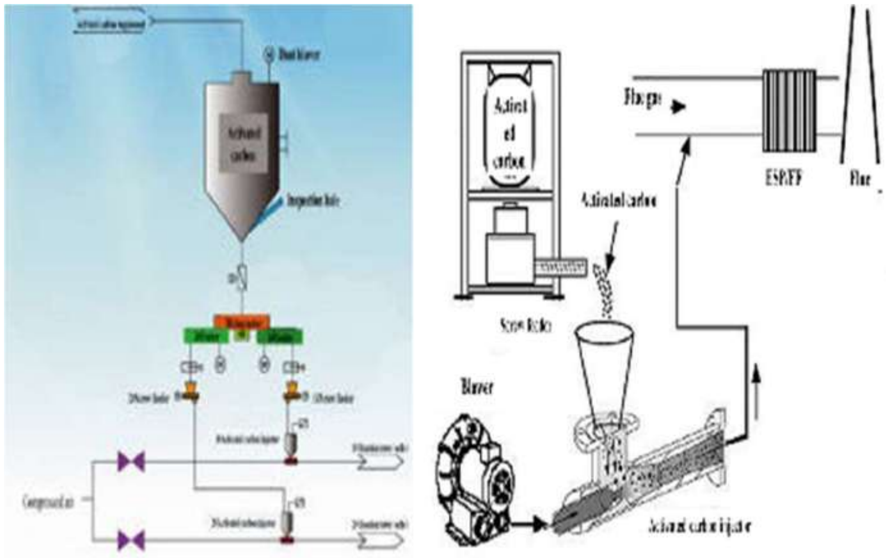

Figure 30: Activated carbon spraying system

Activated carbon from the bottom of the silo tank through the blowing fan forms the gas flow and the venture pipe enters the smokestack. The amount of blowing fan wind must be matched by the activated carbon blown to the middle of the chimney, to ensure a certain rate of blowing, to achieve a uniformly blended effect, and to improve the efficiency of the smoke treatment. In order to accurately control the amount of activated charcoal, the recommendations in the silo are weighed and included with the automatic control system.

High Efficiency Pocket Filter De-acidifier

As required in the "Criteria for controlling the incineration of domestic waste," the dust collector of the incineration plant is required to use a dust bag filter. For the treatment of exhaust fumes of incinerators, in combination with dry semi-dry method, desiccant dehumidification technology, dust filters using the corresponding bag dust filter can improve efficiency and also remove a number of heavy metal components and dioxin. Good filter media and advanced filtration technology are required to add advanced dust filter equipment and high efficiency to maximize the best use of it. Figure 31 below shows a bag – dust removal machine.

Figure 31: Bag-dust Removal Machine

→ **Working Principle and Equipment of Fabric Filter Bags**

Dust bag filters select the type of pulsed filter, remote cleaning, suitable for high temperature; high humidity and corrosive waste discharge; dust removal in exhaust fumes so that exhaust smoke is discharged to meet requirements.

This filter bag comes with round cages, hanging cloth bags, filter dust accumulated outside the fabric bag, fabric bags periodically through the compressed air from the clean side into the bag. The dust is blown out into the dust hopper, through the dusting system. Diagram of hygienic fabric bag as shown in figure 32 below:

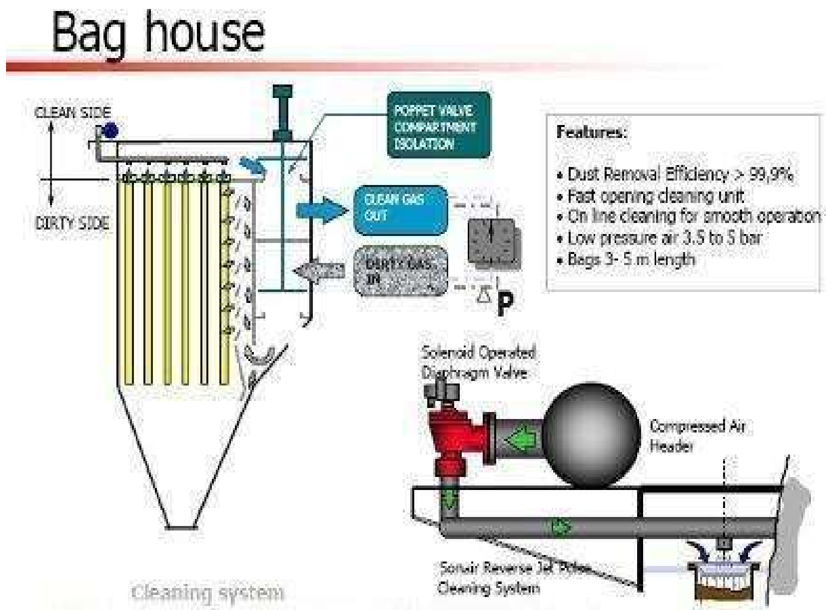

Figure 32: Dust Removal Equipment of Fabric Filter Bags

In maintenance, it is possible to replace the canvas bag, manually isolate the chamber and replace the damaged canvas bag while the other chambers operate normally. The dust hoppers of fabric filter bags come with a heater, ensuring a sure dust release.

Stacked filter dust bag, shutter device and hot air circulation device, through automatic control system for regulating, in startup state and filter protection fault. Important equipment such as pulse valves, PLCs, filter bags, etc. use imported products, ensuring the reliability of the filter bags to operate normally and efficiently.

Because the filter bags use PTFE filter membrane filter bags, the criteria for dust removal efficiency, residual toxicity of pollutant residues, system energy consumption and bag filter's longevity achieved advanced world standards.

The dust bag filter consists of the following equipment: dust hopper, cloth bag, cage rack, maintenance line, air outlet per outlet, chimney outlet, Thermal dust hopper, toilet paper bag control and pulse valve. Each dust bag filter is composed of sealed steel enclosures and chamber compartments; each hygienic chamber compartment can be completely isolated from the smoke. The enclosures and compartments are designed to withstand the pressure difference in the largest furnace. Rack structure uses steel structure as shown in the containing chambers in figure 33 below.

Figure 33: Containing Chamber

Each chamber has an output and input partitions. When a chamber is insulated, it ensures that the dust bag is operating normally. It can also be said that while the filter bag is in operation, it is possible to replace the filter bag in place. For this project there are full doors for inspection and repairing.

The distance between the top of the filter bag and the roof is large enough to handle the replacement of the canvas bag. If necessary, it can be used as a gantry crane for replacement of filter bags. The casing, repair door and electrical fittings on the casing and connection holes ensure the tightness of the filter bag.

In order to achieve a uniform distribution of exhaust emissions, first consider the flow divider in the chimney. To avoid the accumulation of acid or water, the filter bag will be insulated and heated. The thickness of the insulation layer is sufficient to allow the wall temperature to be lower than the dew point. To prevent ash and reaction products in the filter bag, the conveying system and associated equipment are lumps in the storage compartment (hoppers, valves, piping, etc.), the surfaces of which are considered to use the room heat system. Hopper whether the filter bag uses an electric heater.

During calibration, the hopper must always be dried in order to prevent condensation. Because once the condensed liquid is generated, it will affect the dust removal efficiency. Installation of grinding equipment above the dust hopper, which is located outside the dust hopper, is an eternal device. When the dust removal machine is in operation, the device can be operated from the floor below the dust hopper. Below the hopper there is a conveyor and rotary valve. Calculations based on ensuring smoke emissions are evenly distributed on the surface of the filter bag.

Dust bag filters, shown in figure 34 below, include racks and accessories, designed to ensure efficient cleaning of the smoke, and long service life. Sanitary system is a superior design to ensure the high efficiency of the filter, reduce pressure, and increase longevity. Cleaning the filter bag (using a compressed air pulsation system) will use the meter of the compressor. The characteristics of the air compressor meet the internal filtration is not clogged or lumps.

Figure 34: Fabric Bags Filter Fabric bag filter has the following stand out features

3.8.5 Layout Smoke Cleaning System

Smoke removal systems as illustrated in figure 35, are located behind the waste heat recovery boiler, which is the reaction tower, bag dust collector, ventilator and chimney, respectively. Reaction towers, bag dust disposing machines, and air distribution fans are housed inside. Lime storage activated carbon storage is located near the main power plant area.

Figure 35: Smoke Cleaning System

Onsite Smoke Monitoring System

Smoke detectors are controlled by an on-site industrial computer, with spot smoke detectors installed, SO_2, NOx, HCl, HF, CO, NH_3, powder dust and smoke flow meters as well as other monitoring signals are sent to the central control room via sensors, displayed on the computer. Use the device import, each one of the assembly output assemblers in a placeholder, cannot execute the network manager with the protective environment of the guard policy.

At the same time, publicize the results of on-site smoke monitoring and receive public and social monitoring.

Monitoring of this system includes: SO_2, NOx, HCl, HF, CO, CO_2, powder dust, O_2, H_2O, NH_3, smoke flow, smoke temperature and smoke pressure. Figure 35 shows the smoke monitoring system.

Smoke Exhaust Ventilation System

The production line of the project is equipped with a fan, which directs the smoke from the outlet of the bag filter into the environment.

Due to the large amount of fluctuations in the combustion smoke, it is recommended to install an additional speed regulator for the blower to accommodate the load change requirement, an inverter speed regulator should be installed. Smoke after being processed meets the requirements of the wind turbine to exhaust the environment through the chimney 80m of height. The waste incineration plant has a multi-layered chimney, composed of internal steel exhaust pipes and external protective concrete walls, which do not affect smoke emissions so that we only need to stall smoke sampling points at the smoke exits.

The maintenance of the chimney is quite simple and convenient, when conducting inspection and maintenance of a chimney will not affect the operation of the other chimneys as it will have a multi-use chimney.

3.9 Electrical system

The plant electrical system comprises the main generator unit, step up substation for power evacuation and plant auxiliary system. Power would be generated at 11 kV and would be stepped up to 132 kV by power transformers for transmission to the grid. Four step down transformers each of 11/0.420 kV, 2.5

MVA rating and Two step down transformers each of 11/0.725/0.725 kV, 2.5 MVA rating would be installed for supply of power to the plant auxiliary system and equipment.

3.9.1 Power Evacuation

Power evacuation is an important aspect of a power project that allows generated power to be immediately evacuated from the power plant to the grid for distribution or further transmission as shown in figures 36& 37 below. Major and important components of the system are as follows:

- Power transformer
- Circuit breaker (CB)
- Current transformer (CT)
- Potential transformer (PT)
- Lightning arrestor (LA)
- Cables & conductors
- Isolator (Iso)
- Energy meter
- Transmission lines.

The evacuation system for "W t E" plant will be designed as follows:

- Evacuation of power would be carried out through the existing 132 kV transmission line (Mangu-Juja) which is adequate to export maximum of 45 MW power and is approx. 0.860 km distance between proposed Loop In Loop Out (LILO) tower to WTE plant substation.t is most attractive due to less cost, less line losses and has compatible line efficiencies.
- WTE plant power evacuation by Loop In Loop Out (LILO) connection with an existing 132 kV Mangu (Thika) -Juja Line.

The construction of the LILO line will require the following;

- Two (02) dead-end towers
- One (01) angle tower
- One (01) single circuit tension tower
- Three (03) gantries.

The gantries are required to cross the existing 220 kV Kamburu-Dandora transmission line.
The 132 kV substation will comprise the following;

- Two (02) transformer bays. i.e. each of 25/30 MVA, 11/132 kV, ONAN/ONAF, YNd1
- 1 x 132 kV bus coupler bay
- 1 x 132 kV bus potential transformer (PT) bays.
- Two (02) line bays. i.e. one bay for incoming and another bay for outgoing.
- Main and transfer bus bar system.
- 132 kV LILO line connection.

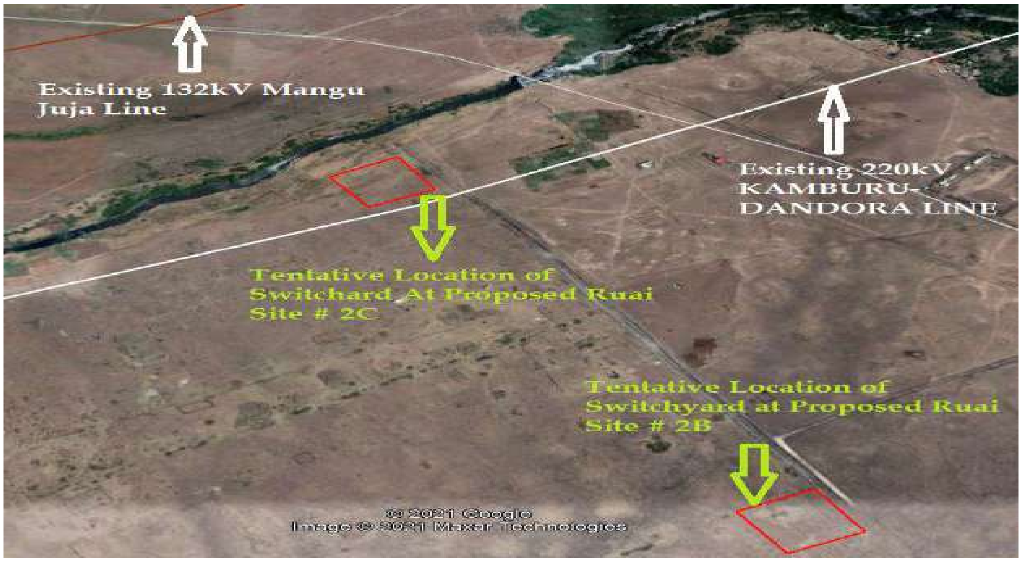

Figure 36: Shows Power evacuation layout and single line diagram;

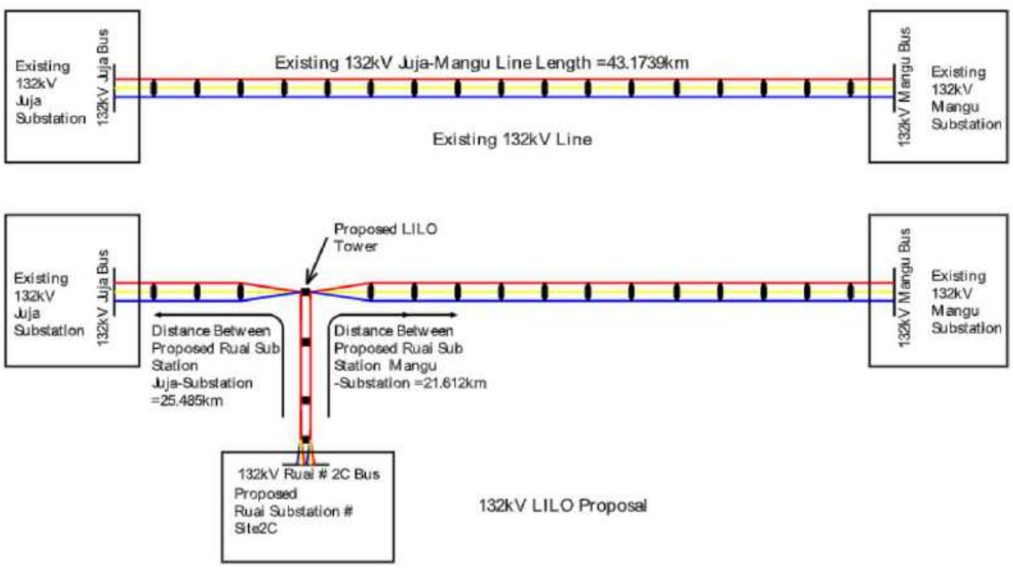

Figure 37: Power evacuation layout and single line diagram

3.10 Land Requirement and Ownership

The proposed project location is within a section (27Ha) of Ruai Sewage Treatment Plant land which occupies approximately 4,000 acres with a buffer zone of 250m all round (as required by World Bank EHS Guidelines). The land is currently owned by the Nairobi County Council with the land reference number LR No. 12979/1. Land is under the custody of Athi Water Works Development Agency (AWWDA). The project proponents KenGen & NMS have entered into an agreement (as attached) under the liaison of the concerned ministry of Energy, Water and Lands and Physical planning for utilization by the project.

Total land required is 27 Ha land requirement (12 Ha for WTE and 15 Ha for landfill without valorization).

3.11 Project Activities

The proposed projects activities include;

- Prior to site preparation, required land shall be delineated and registered under the project company.
- Site Preparation- clearing vegetation for the construction phase and disposal of all waste from the site.
- Construction of civil works and the landfill, installation of machinery and equipment for the power generation plus sourcing of construction materials necessary for the works.
- Site restoration and visual beautification of the project site area, Upon completion of construction.
- Operation and maintenance of the plant and landfill, municipal solid waste material delivery to the plant and incineration waste materials disposal to the landfill and leachate effluent management before disposal.

3.12 Waste Treatment at Site

Proponent will arrange waste treatment works as follows:

- With the maximum number of construction workers on the site, the total volume of domestic wastewater during the construction phase is 60 m3 / day and night. Estimated amount of wastewater generated from mobile toilets is about 40-45 m3 / day and night.
- Thus, with the wastewater generated above, it is expected to install 50 mobile toilets with two chambers to meet the needs of the activities of the staff of the project. Wastes from mobile latrines are expected to be leased to functional units in the area where they are collected and handled periodically.
- Portable toilets: portable toilets made of high-performance composite fiberglass Reinforced Plastic (FRP), which is complete, durable, and easy to install and use:
  - → Size of toilet: 180 x 135 x 260 (cm)
  - → Clean water tank capacity: 800 liters
  - → Waste Tank Capacity: 1,000 liters
  - → Frequency of collection, treatment: 3 days /time.

During construction, portable toilets will be conveniently located with the construction activities of the workers and at the same time away from the surface water in order to limit the impact on the water environment in the event of leakage.

Regular inspection, dredging, no mud, garbage entering the sewage. Temporary domestic wastewater drainage will be included in the drainage / sewerage planning of the area.

3.13 Project Investment Cost Estimates

The estimated construction cost of the project as per the Summarized Bills of Quantities.
Local Currency costs have been estimated based on local costs which will be incurred in Kenya and it includes substation, transmission line, civil and non-EPC costs.

The project with an installed capacity of 45MW, shall be constructed over a period of 3 years at a total cost of $ 198.3 Million USD with 70% of it being debt at an interest rate of 6% with a payback period of 15years as demonstrated in table 10 below.

Table 10: Estimated Project Investment cost

Parameter (All values in Mn US$)	Foreign Exchange	Local currency	Total (in Mn USD)
Inert Landfill & Hazardous Landfill	1.2	4.7	5.9
Equipment cost	119.2	9.11	128.3
Civil Works	8.2	19.2	27.5
Consultancy services (studies, control and auditing)	0	4.3	4.3
Non-Consultancy services	0	19.2	19.2
Total base cost	128.6	56.6	185.2
Contingencies (10%)	12.9	3.3	16.2
Total Project Cost	**141.5**	**59.9**	**201.4**

3.14 Projects Time Frame

The implementation is expected to take about 3 years which shall comprise of:

- Licensing & permitting (Nema license & PPA contract with off-taker)
- Securing term sheets for project financing
- Procurement (EPC tendering & Contracting) for project construction and commissioning.

4 Policy, Legislative and Regulatory Considerations

4.1 Introduction and Objectives

This section will cover the required literature, legislature, studies, reports and governing laws (EMCA, IFC performance standards, IUCN advice notes on environmental assessment in line with the Millennium Development Goals and Vision 2030) that must be adhered to and/or act as a guideline for all activity undertaken relating to this project. The Constitution of Kenya, 2010, Part II (Environment and Natural Resources), & Part (II) "Every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources. The Public Consultation and Participation (PCP) Process is a policy requirement by the Government of Kenya and a mandatory procedure as stipulated by EMCA 1999 section 58, on Environmental Impact Assessment for the purpose of achieving the fundamental principles of sustainable development.

The objective of establishing a regulatory framework is to ensure those implementing the project are well informed, have taken all perspectives into account and ensure all guidelines are observed.

4.2 Social Issues

Apart from the legal provisions in EMCA 1999 on public Participation in development projects where public consultation is mandatory with at least 3No public meetings be done with stakeholders, there is no other legal instrument in the country that addresses social issues in development interventions. However, over the years, the Kenyan government has recognized the importance of entrenching social dimensions of development in its development agenda. Notably, development initiatives are required to deliberately ensure that the marginalized and more vulnerable people in society are actively involved in development processes.

In addition to this, the governments also utilize other more stringent protocols such as those in use by multilateral agencies such as World Bank, EU Reconstruction Bank, IFC on the requirement that a project is screened so as to test its conformity with these institutions safeguard policies. These policies are geared towards mitigating any social and environmental negative impacts that may result from projects. These reports will be discussed more in depth later in this section.

4.3 Environmental Issues

It is the Government's policy that the rights of its citizens to have a clean and healthy environment are met. In return, every person has the responsibility to protect and manage the environment. In this regard, the Government enacted the EMCA (1999) and the Environmental Impact Assessment and Audit Regulations (2003) to provide a framework law for the coordinated management of the environment.

Both the EMCA and the EIA regulations require EIA to be undertaken for certain new enterprises/projects. The umbrella body administering this requirement is NEMA. The Authority has a designated Environmental Committees to oversee the implementation of the EMCA at the Provincial/County and District/Constituency levels.

4.4 The Constitution of Kenya, 2010

Part II (Environment and Natural Resources), (I) the State clearly undertakes to carry out the following:

- Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;
- Work to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya;

- Protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources of the communities;
- Encourage public participation in the management, protection and conservation of the environment;
- Protect genetic resources and biological diversity;
- Establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
- Eliminate processes and activities that are likely to endanger the environment; and
- Utilize the environment and natural resources for the benefit of the people of Kenya.
- Part (II) "Every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources.

<u>Relevance:</u> *The project aims at providing a clean and healthy environment to the people of Kenya through sustainable use of resources, public participation, utilizing the resources to benefit the citizens and application of ESIA to mitigate adverse impacts from the development of the proposed landfill. The project should observe these conditions as far as environmental protection is concerned throughout the project cycle.*

4.5 Policy Framework

4.5.1 Kenya Vision 2030

Kenya Vision 2030 carried forward the achievements of the Economic Recovery Strategy for Wealth Creation and Employment Creation (ERSWEC 2003-2007). ERSWEC provided a 5-year development plan on development and investments in Kenya. The Kenya Vision 2030 aims at transforming Kenya into a globally competitive and prosperous nation offering quality life for all citizens by 2030 in a clean and healthy environment. In Vision 2030, one of the flagship projects is the Solid Waste Management initiative which calls for development of solid waste management systems in five (5) leading municipalities and in the economic zones planned under Vision 2030 The project will offer an opportunity for the local community to empower themselves economically through securing employment and service provision.

<u>Relevance:</u> *To realize sustainable solid waste management strategy, development of proposed waste to energy power plant and later on reclamation and restoration of Dandora dumpsite will be one of the steppingstones needed for realization of the strategy.*

4.5.2 Nairobi Metro, 2030

Nairobi Metro 2030 was developed in the year 2008 to provide a guide for the NMR to play its role in the National growth strategies under the Kenya Vision 2030. It is a transitional document that brings into focus challenges faced under urban growth and development. The document provides a forum to achieve sustained rates of economic growth necessary for successful economic and social development. The Nairobi Metro 2030 provides links with the Central Government through Kenya Vision 2030 and other development plans as well as seeking to strengthen the Local Authorities as part of the devolvement of power and recognizing the need for ensuring efficient and effective management of resources at the grassroots. Nairobi Metro 2030 carries the vision for Nairobi Metropolitan Region to be a World Class African Metropolis supportive to the overall national agenda under the Kenya Vision 2030. The agenda to achieve this vision is the need to enhance mechanisms for economic growth, employment creation, improved lifestyles and improved infrastructure.

<u>Relevance:</u> *Success in regard to this project is expected to show in a number of result areas outlined under the document among them world class infrastructure and utilities. The waste to energy power plant will provide a better sustainable solid waste management approach with improved health, income and overall economic growth*

4.5.3 Least Cost Power Development Plan (2013-2033)

The Least Cost Power Development Plan (2013 – 2033) aims at enhancing national power generation and supply by identifying new least-cost generation and supply sources to meet the energy needs of the nation for sustainable domestic use. The plan recognizes the need to diversify the country's energy sources in order to reduce dependence on unsustainable energy and exposure risk to a single source of energy from climate variability events such as droughts. It also recognizes such initiatives as development, rehabilitation and expansion of generating power plants, expansion and extension of national grid and energy efficiency and conservation. As a waste to Energy power plant connected to the national grid, the proposed project will add 45 MW of sustainable stable base load power generation capacity.

Relevance: *The proposed project offers diversification of energy sources in the country in particular stable baseload within Nairobi Region which is largely reliant on thermal plants.*

4.5.4 National Climate Response Strategy 2010

In response to the challenges posed by climate change, Kenya developed the Climate Change Response Strategy that was launched in 2010. Its purpose is to put in place robust measures to address socio-economic challenges posed by climate change through thorough impact(s) assessment and monitoring. The strategy interventions include all sectors which are vulnerable to climate change including water and irrigation, agriculture, wildlife, rangelands, energy and more broadly, infrastructure. In the energy sector, priority areas include energy efficient innovations and technologies, low-carbon appliances and tools, the development of eco-friendly energy resources such as wind, solar, biogas, and small hydro.

Relevance: *The proposed project is based on providing a sustainable MSW management strategy by deploying a WTE Combustion technology and therefore fits the purpose of the National Climate Response Strategy as minimizes methane which is a greenhouse gas.*

4.5.5 National Climate Change Action Plan 2013 – 2017

The National Climate Change Action Plan 2013 – 2017 was developed to implement the National Climate Change Strategy that was launched in 2010. It advocates low carbon and climate resilient development pathways. It recommends an enabling policy and regulatory framework and details adaptation analysis, priority actions, mitigation options, considerations for technology requirements, national performance and benefit measurement system, recommendation for knowledge management and capacity development. The Action Plan recognizes the promotion and use of alternative energy, such as wind, solar and mini hydro power generation and improved cook stoves, for adaptation and mitigation against the effects of climate change. It both seeks to expand renewable energy generation through centralized and decentralized systems. As such, the proposed Waste to energy project is consistent with the National Climate Change Action Plan.

4.5.6 Sessional Paper No. 10 of 2014 on National Environment Policy

Sessional Paper No. 10 of 2014 on National Environment Policy is a policy document which outlines a broad range of measures and actions responding to key environmental issues and challenges facing the country. It provides a framework for integrated approach to planning and sustainable management of natural resources in Kenya and policy direction on various vulnerable ecosystems in the country. It also considers cross-cutting and emerging issues such as poverty reduction, gender, disability, HIV / AIDS and other diseases in the management of the environment and natural resources. Public participation is a guiding principle of the policy. The Proponent is committed to continuous stakeholder involvement throughout the lifetime of the Project, from development, throughout pre-construction, construction and operations phases, and until decommissioning.

4.5.7 Sessional Paper No. 4 of 2004 on National Energy Policy

Kenya's current energy policy is provided in the 2004 National Energy Policy, Sessional Paper on Energy, known as Sessional Paper no. 4 of 2004. The policy covers the period 2004 – 2023 and strategies for renewable energy are found in paragraphs 6.1 and 6.3 - 6.5, while Chapter 7 includes implementation plans for 2007 – 2012 and 2012 -2024. In January 2011, the preparation of a new and significantly revamped National Energy and Petroleum Policy began. At the time of writing the June 2015 final draft policy was awaiting adoption by the government.

4.5.8 National Energy Policy 2018

National Energy Policy sets out the national policies and strategies for the energy sector that are aligned to the new Constitution and are in tandem with Kenya Vision 2030. The energy sector has been guided by the Sessional Paper No. 4 of 2004 on Energy and governed by several legislations, principally the Energy Act, No. 12 of 2006 and the Geothermal Resources Act No. 12, of 1982. The Feed in Tariff Policy 2008 which was last revised in 2012 has been instrumental in accelerating investment in the renewable energy sub sector. Adoption of the Kenya Vision 2030 and the promulgation of the Constitution, 2010, made it necessary to review both the Policy and the applicable legislation and regulations so as to align them with the Vision and the Constitution.

The overall objective of the energy policy is to ensure affordable, competitive, sustainable and reliable supply of energy to meet national and county development needs at least cost, while protecting and conserving the environment..

4.5.9 KenGen Corporate Environmental Policy Statement

KenGen has a corporate environmental management system (EMS) certified to ISO 14001:2015. All aspects of its operations must conform to the requirements of this EMS. In addition, it is certified to ISO9001:2015 for quality and has an occupational health and safety (OHS) system that is aligned with OHSAS 18001. Labor and worker obligations are set out in its corporate human resources (HR) policy and are aligned as a minimum with requirements of the Ministry of Labor. Together these policies and management systems make up the KenGen environmental and social management system (ESMS). KenGen has three key policies that are relevant to the environmental and social management of this Project, these are further discussed in the ESMP;

- Environmental policy statement
- Occupational safety and health policy statement
- Fire safety and emergency policy statement.

4.5.10 Feed in-Tariffs (FiTs) Policy, 2012

Feed-in-Tariffs (FiTs) Policy of 2008 (revised 2012) is an instrument for promoting investment in electricity generation from renewable energy sources. It allows power producers to sell electricity generated from renewable energy sources to an off-taker at a predetermined tariff for a given period of time. The policy recognizes such renewable energy sources as solar, wind, biomass, biogas and geothermal.

The objective of the policy is to facilitate resource mobilization by providing investment security and market stability for Proponents in electricity generation from renewable energy sources, encourage private Proponents to operate their power plants prudently and efficiently so as to maximize returns and to reduce transaction and administrative costs and delays associated with conventional procurement processes. A Power Purchase Agreement will be negotiated between Kenya Power and the Proponent. This tariff is guaranteed 20 years from the date of the first commissioning of the plant.

4.6 Legislative Frameworks

4.6.1 Energy Act, No. 1 of 2019

The Energy Act No. 1 of 2019 is the consolidated legislative instrument governing the sector with associated subsidiary regulations, including for generation licensing. The Act consolidated the Electric Power Act No. 11 of 1997 and the Petroleum Act Cap. 116. The Act, among others, provides for the establishment, powers and functions of the Energy and Petroleum Regulatory Authority. The Act provides guidance on licensing requirements for generation, importation or exportation, transmission or distribution of electrical energy or supply of electrical energy to consumers. The Act also provides guidance on investment in energy infrastructure and in particular promotion of renewable energy systems, feed-in tariff guidance among other relevant aspects to the proposed plant operations.

Relevance: Application and approval of Expression of Interest to Develop a WTE power project under the Feed in-Tariffs (FiTs) Policy at the specific location. Application and issuance of the Generation license for power generation under the Feed in-Tariffs (FiTs) Policy.

4.6.2 Kenya National Transmission Grid Code, 2016

The 2008 Kenya Electricity Grid Code sets out detailed arrangements for the regulation of the Kenya electricity supply industry. It is the primary technical document of the electricity sector, with provisions covering the generation, transmission, distribution and supply of electrical energy. The Electricity Grid Code has never been officially approved but is commonly used as a guidance document. An exercise to update the Grid Code is currently underway.

4.6.3 Environmental Management and Coordination Act (EMCA,1999, CAP 387)

Environmental Management and Coordination Act 1999: Part 6 of the EMCA, Cap 387, of Kenya provides for environmental social-impact assessment. This is in agreement with Principle 17 of the Rio Declaration which extends the rule of prior assessment of potentially harmful activities to include those activities which have impacts solely within a state: “Environmental Impact Assessment (EIA), as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent National authority.”
The EMCA,1999, (Cap 387) provides, under the Second Schedule, a list of projects that must undergo screening for EIA. The proposed project falls under this schedule and as such requires that an EIA Project Report be undertaken and submitted to NEMA for review. The expert review by NEMA of the project report shall then advise on whether each of the proposed projects requires a full ESIA study or not. Registered experts undertake EIA and their report is submitted to NEMA. Both the project report and the EIA report are open to review by the public and individuals.

The EMCA, 1999, Section 68 and 69 also states that the proponent must submit an Environmental Audit Report one year after commencement of the project, and thereafter undertake Self Audits.

The mandate of NEMA is to “exercise general supervision and coordination over all matters relating to the environment and to be the principal instrument of Government in the implementation of all policies relating to the environment”

4.6.3.1. *Environmental (Impact Assessment and Audit) Regulations, 2003*

These Regulations stipulate how an ESIA will be undertaken and what the ESIA study report should contain. It also provides regulations on Environmental Audits (EA), which the proposed project will be required to undertake. The Regulations are presently under review.

Relevance: *This project falls under the second schedule of the Environment Management and Coordination (Amended) Act, EMCA, Cap 387 and therefore requires an ESIA project report prior to its implementation so that any negative impacts are properly and adequately mitigated in accordance to* *the guidelines provided for in these regulations. The proponent and consultants shall seek the views of the project stakeholders to ensure that their concerns are addressed in this report.*

4.6.3.2. Environmental Management and Coordination (Water Quality) Regulations 2006

The Water Quality Regulations provide for the protection of lakes, rivers, streams, springs, wells, and other water sources. The regulation also stipulates that all projects should refrain from any actions, which may directly or indirectly cause water pollution. All projects are therefore required to refrain from discharging effluent into water bodies and obtain effluent discharge licenses. This regulation gives a minimum distance from a water body for which any development may be undertaken.

Relevance: *During implementation of the project the contractor's activities and during the operational phase, wastewater from the plant will require proper disposal to avoid environmental pollution. In addition, the facility will require an effluent discharge license besides ensuring discharges from the facility will meet legal guide values. Water for construction will be drawn from rivers and treated leachate discharged into a water body.*

4.6.3.3. EMCA (Conservation of Biodiversity, Access to Genetic Resources and Benefit Sharing) Regulations 2006

The Conservation of Biodiversity Act Sections 5-9 provides for the protection of endangered species, creation of an inventory, and monitoring of their status, protection of environmentally significant areas, provision of access permits, material transfer agreements and benefit sharing. These regulations will guide the routing of the transmission line with a view to avoiding areas of environmental significance and protection of endangered species.

Relevance: *The regulation is important with regard to siting of the facility (ies). This will be triggered by excavation works and operation activities.*

4.6.3.4. Environmental Management and Coordination (Wetlands, Riverbanks, Lake Shores and Sea Shore Management) Regulation, 2009

These regulations provide for the protection of all wetlands on both private and public land. The regulations provide for sustainable exploitation of wetlands and are aimed at maintaining both the wetlands and hydrological, ecological, social and economic functions and services.

Relevance: *These regulations are important with regards to site selection of the facility (ies). Treated leachate will be discharged into a water body within the specified effluent standards*

4.6.3.5. Environmental Management and Coordination (Waste Management) Regulations 2006

The Waste Management Regulations sets out standards for handling, transportation and disposal of various types of wastes. The regulations also stipulate the various licenses and fees, which are required for a disposal facility and for transportation of wastes. The regulations further list what are considered hazardous wastes. The regulations also provide standards for setting and operating incinerators.

Relevance: *These regulations are key in the proposed project as they will inform and guide choices of waste segregation, transportation and disposal. Waste will be generated at all stages of the project.*

4.6.3.6. Environmental Management and Coordination (Noise and Excessive Vibrations) Regulations 2009

This regulation define noise as any undesirable sound that is intrinsically objectionable or that may cause adverse effects on human health or the environment. The regulations prohibit any person from making or causing to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment.

Relevance: *The contractor and project proponent will be required to ensure compliance with these regulations in order to promote a healthy and safe working environment throughout the project cycle. This shall include regular inspection and maintenance of equipment and prohibition of unnecessary noise as well as scheduling work at the appropriate times based on the area and conditions. Activities during all phases of the project are likely to generate noise affecting both workers and adjoining settlements.*

4.6.3.7. Environmental Management and Coordination (Air Quality) Regulations, 2014

These regulations provide for the safeguarding of the ambient air quality and give guidelines to prevent and control air pollution. The first and seventh schedules of the regulations provide a list with associated emission limits of prohibited, controlled, and un-controlled air pollutants. The regulations also give ambient air quality tolerance limits. The First Schedule defines ambient air quality tolerance limits; the Second Schedule informs on priority air pollutants. On suspended particulate matter, Section 8 prohibits any person to cause or allow particulate emissions into the atmosphere from any facility listed under the Fourth Schedule in excess of those limits stipulated under the Third Schedule.

Relevance: *The regulations will be particularly relevant to the facility with regard to incineration and release of gases to the atmosphere*. The proposed project will emit noxious gases during all the phases and therefore monitoring will be required at the source and at the boundary fences. Schedule 1 – Ambient Air Quality Tolerance Limits

4.6.3.8. The Environmental Management and Coordination (Controlled Substances) Regulations, 2007; Legal Notice No. 73

The Controlled Substances Regulations defines controlled substances and provides guidance on how to handle them. The regulations stipulate that controlled substances must be clearly labelled with, among other words, —Controlled Substance-Not ozone friendly ‘‘to indicate that the substance or product is harmful to the ozone layer. Advertisement of such substances must carry the words, —Warning: Contains chemical materials or substances that deplete or have the potential to deplete the ozone layer. Persons handling controlled substances are required to apply for a permit from NEMA. Products containing controlled substances include air conditioners, air coolers, refrigerants, portable fire extinguishers, heat pump equipment, dehumidifiers, insulation boards, panels and pipe covers, pre-polymers, etc. The proponent is thus required to comply with these regulations during the project implementation phase.

Relevance: *These regulations are important to the project with regard to air conditioning systems to ensure they are not banned R22 gases rather R410 gases.*

4.6.3.9. Environmental (Impact Assessment and Audit) Regulations 2003 (Legal Notice No. 101)

Regulation 24 – EIA license: - Environmental Impact License shall be issued after the authority approves the study report under regulations 23, and shall be issued in form in the prescribed form. Regulation 28 – false or incorrect information: -Substantial change or modification and when a project poses an environmental threat or revelation that information or data given by the license were false, incorrect or intended to mislead.

Regulation 24 – Annual Environmental Audit: - Annual Initial environmental auditing after presentation of an EIA study report shall be undertaken by the licensee one year after operations to ensure the implementation of environmental management plan is audited on regular basis, an audit report submitted to NEMA annually and ensuring that the criteria to audit is based on environmental management plan developed during the EIA process or after the initial audit.

Regulation 40 - Monitoring changes after project implementation Monitoring by NEMA and Lead Agencies shall be done to establish any possible changes in the environment and their possible impacts, immediate and long-term effects of its operations, identify and determine parameters and measurable indicators and conduct changes that occurred after implementation. The proposed project must have an ESIA license before implementation. The proponent has commissioned this ESIA study since the proposed project is listed in Second Schedule of EMCA, CAP 387.

4.6.3.10. Public Complaints Committee

This is established by section 31 of EMCA, 1999. Its functions are to investigate any allegations or complaints against any person or against the Authority in relation to the condition of the Environment in Kenya. It also investigates any suspected cases of environmental degradation and recommends further action.

Relevance: Relevance: *The* proposed *project proponents and other stakeholders like the public can register or appeal this committee regarding any aspects of the project that violates the law and its licenses.*

4.6.3.11. County Environmental Committees

These are established by the governors as provided in section 29 of Environmental Management and Coordination Amendment Act 2015. The Committee's roles include;

- Development of County Environmental Action Plan;
- Ensuring proper management of the Environment in the County among other functions.

Relevance: *The Act is important with regard to Business license for operations (Trade / Business License) and Development application to be made for any new buildings. Approval of plans for new Structures from the County Government.*

4.6.4 The Water Act 2016:

The Water Act, 2016, provides for the management, development, conservation, use and control of water resources and for the acquisition and regulation of rights to use water, to provide for the regulation and management of water supply and sewerage services. The Act focuses on two key sub-sectors- Water Resources Management (WRM) and Water and Sanitation Services (WSS). The Act establishes relevant authorities and creates catchment management bodies and seven regional service boards. It specifies "public participation", in relation to any application made, or action proposed to be taken. The act further provides for the strategic management of the water resources.

Section 25 deals with permit requirements for use of water from a water resource, while Section 29 details permit application procedure, which shall be subject of public consultation and, where applicable, of an environmental impact assessment.

Section 76 states that no person shall discharge any trade effluent from any trade premises into the sewers of a licensee without the consent of the licensee, which requires an application for consent to be made to the licensee.

Section 94 prohibits any person, without authority under this Act, to willfully obstruct, interfere with, divert or obstruct water from any watercourse, or take actions to cause, or be likely to cause, pollution of the water resource. A person who contravenes these provisions shall be guilty of an offence.

Relevance: *Water is significant to the proposed project. The construction would mean that more water would be needed for various activities. Management of this resource is therefore significant for the success of the project. During operation leachate should be contained and treated to avoid pollution of water resources around. Further, water permits will be needed for water abstraction for plant operation and will be obtained from WRA. The treated sewage water from Nairobi Water and Sewerage Co. Ltd treatment plant will be utilized to minimize cost and complexity of the system.*

4.6.5 Land Act, 2012:

According to Section 128 of the Act, any dispute arising out of any matter under the Act, which involves compulsory acquisition process, should be referred to the Land and Environmental Court for determination. Sections 107-133 of the Land Act specify the procedure to be followed in the process of compulsory land acquisition.

Section 134 of the Act creates a Settlement Fund for land acquisition to provide shelter and livelihoods to people who are involuntarily displaced.

Section 148 gives provisions for compensation for wayleave.
According to Sec 148 (5), If the person entitled to compensation under this section and the body under a duty to pay that compensation are unable to agree on the amount or method of payment of that compensation or if the person entitled to compensation is dissatisfied with the time taken to pay compensation, to make, negotiate or process an offer of compensation, that person may apply to the Court to determine the amount and method of payment of compensation and the Court in making any award may, make any additional costs and inconvenience incurred by the person entitled to compensation.

According to Section 111 of the Act, just compensation shall be paid promptly to all persons whose interests have been affected by the land acquisition.

Relevance: *The project site is a public land under Nairobi City County ownership that the is being acquired mutually between various government departments. Deed of ownership shall be issued to the project proponent prior to project commencement. The transmission lines shall utilize existing Kenya Power & Ketraco infrastructure where mutual agreement shall be signed between the various parties as guided by ministry of Energy, the parent Ministry to all the agencies involved in the project.*

4.6.6 The Registered Land Act, Cap 300, Laws of Kenya:

This provides for the absolute proprietorship over land (exclusive rights). Such land can be acquired by the state under the Land Acquisition Act. This is of particular relevance to any way of leave acquisition. However, its noted that no land acquisition is foreseen in this project with proposed utilization of existing easement lines for power transmission owned by Kenya Power and Kenya Electricity Transmission Co.Ltd.

4.6.7 County Government Act, 2012

The adoption of the new Constitution for the Republic of Kenya in 2010 resulted in a process of power devolution and the creation of 47 counties. The County Governments Act, gazetted in 2012, is the primary law governing the development and operations of counties.

The Act puts a special importance to citizen participation (Part VIII) and access to public information (Part IX). Section (87) (b) specifies the areas for citizen participation which include the approval of development proposals and the granting of permits.

As part of this ESIA, public participation included the organization of consultative meetings as per the provision of this Act on Citizen Participation (Section 87 (b), Part VIII) with different stakeholders related to the Project within Nairobi, Machakos, Kiambu and Kajiado Counties.

4.6.8 The Physical Planning Act (CAP 286)

Section 30 of the Act states that no person shall carry out any development within an area of a local authority without a development permission granted by the local authority under section 33. Section 31 states that any person requiring development permission shall make an application in the form prescribed in the fourth schedule, to the clerk of the local authority responsible for the area in which the land concerned is situated. Section 33 gives the Director of Planning Authority to grant the applicant development permission or decline to grant the applicant such development permission by stating the ground for refusal. Section 36 of the same Act states that the local authority may deem it necessary for a submission of ESIA report together with development application if they feel the project may have some injurious effect on the environment.

The county physical planning department is responsible for regional, local and spatial planning of the county. The department will be responsible for preparing a part development plan of the proposed landfill site and ensure that no encumbrances or encroachment face the project site.

Relevance: *The proposed project should adhere to this Act, although the proposed project location is not subject to any physical development plan. The authorities are basically applying discretionary planning: Relevant planning permits shall be obtained by the facility as part of Licensing requirements for buildings.*

4.6.9 National Construction Authority Regulations, 2014

The NCA published the National Construction Authority Regulations 2014, the Code of Conduct and Ethics for the Construction Industry, and the NCA Strategic Plan (2015-2020) to effectively regulate the construction industry in Kenya. Contractors operating or willing to undertake construction operations in Kenya are required by law to register through the National Construction Authority (NCA), which is constituted under Act No. 41 of 2011 Laws of Kenya. The NCA is mandated to clear builders and contractors as a way of eliminating rogue contractors in Kenya and malpractices in the building and construction industry. The Authority has provided the regulatory framework for registration and renewal of contractors.
It is tasked with the responsibility of inspecting construction and building projects around the country to ensure high quality of work and close projects posing health risks and collapse hazards.

Relevance: *Project proponents must ensure that the construction works are carried out by NCA-registered contractors and supervised by qualified engineers and project expected to obtain a construction permit from the Authority.*

4.6.10 The Occupational Safety and Health Act 2007 (Cap 15)

This legislation is very important in providing a guideline for the project proponent on all issues pertaining to the health & safety rules. The guidelines are meant to provide all governing laws relating to the operations & maintenance of the plant, safety and emergency responses, general workplace provisions for workers, health & safety company policy, housekeeping process, human resources management, workers' rights, establishing of a technical and health & safety team, hazardous materials handling, work permits, registration process for workplaces and penalties.

Relevance: *The Act is relevant in all phases of the project since the project will involve workers at all stages. Various health hazards are likely to emanate from the proposed project's activities such as workplace accidents. Health issues will therefore be integrated into the project to ensure safety of workers in line with OSHA, 2007. The project site will be registered as a Regular workplace and regular monitoring of workplaces the activities will be done to ensure adherence to the Act.*

4.6.11 The public Health Act (Chapter 242 of the Laws of Kenya) (Revised Edition 2012):

The Public Health Act concerns the protection of public health in Kenya and lays down rules relative to, among other things, food hygiene and protection of foodstuffs, the keeping of animals, protection of public water supplies, the prevention and destruction of mosquitos and the abatement of nuisances including nuisances arising from sewerage.

It defines nuisances on land and premises and empowers public health authorities to deal with such conditions. The Act prohibits activities (nuisances) that may be injurious to health.

Part IX, section 115, of the Act states that no person/institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Section 116 requires that local authorities take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction clean and sanitized to prevent occurrence of nuisance or condition liable to be injuries or dangerous to human health, as defined in Section 118.

Relevance: *The Act is applicable in the entire project cycle thus compliance with it will be crucial for the health of neighborhoods and to conserve the environment in the area. The facility shall ensure no open dumping onsite with the facility operating as a closed loop infrastructure. Landfill site will have proper linings to eliminate leachate discharge into the soils and also be properly covered to avoid attracting vermin at the site. The operation phase of the proposed project will require the application of pest control measures to ensure no multiplication of pests hence compliance with this act.*

4.6.12 Public Roads and Roads of Access Act (Cap. 399) Revised Edition 2010 (1972)

Sections 8 and 9 of the Act provides for the dedication, conversion or alignment of public travel lines including construction of access roads adjacent lands from the nearest part of a public road. Section 10 and 11 allows for notices to be served on the adjacent landowners seeking permission to construct the respective roads.

Relevance: *Due to significant traffic expected along Kangundo road delivering materials during construction or feedstock from operations, its critical the main access road to the proposed facility be a dual carriageway with proper public transport terminus for ease of traffic flow.*

4.6.13 Traffic Act Cap 403:

The Traffic Act prohibits air pollution through Section 51 which requires that motor vehicles use proper fuels. The Act requires that every vehicle be so constructed and used as not to emit any smoke, or visible vapor. The amendment further prohibits the use of any stationary internal combustion engine, discharging exhaust gas into the atmosphere without treatment. Legal Notice No. 217 requires all public service and commercial vehicles with tare weight of over 3048 Kg to have a working speed governor installed. The speed governor should be tested and approved by the Bureau of Standard and Chief Mechanical and Transport Engineer as a competent speed limiter.

Some of the relevant provisions by this act to this project include;

- Part II - Registration of Vehicles,
- Part III - Licensing of Vehicles (Motor vehicles and trailers to be licensed)
- Part IV – Driving Licenses (Drivers to be licensed)
- Part V – Driving and other Offences Relating to the Use of Vehicles on Roads (Speed of motor vehicles.)
- Part VI – Regulation of Traffic (68 – Highway Code)
- Part XII – General (105 – Inspection of vehicles)

Relevance: *The vehicles and drivers involved in the proposed project will comply with the provisions of the act, i.e. registration, inspection, licensing, maintain weight limits, and installation of speed governors. It is critical that material ferrying vehicles be road worthy and with a valid waste handling license during plant operation and fully covered to minimize pollution of the environment along the delivery routes.*

4.6.14 The Civil Aviation Act, Cap 394:

This Act mandates the Kenya Civil Aviation Authority (KCAA) to authorize and approve the height of any masts put up to ensure the safety of flying aircraft. This will be of particular relevance to the site selection and height of any chimneys the facilities may have. It is also important in the event the proposed facility attracts large flocks of birds in the area which can impact on the aviation industry.

Section "9.4.4 The appropriate authority shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome unless an appropriate aeronautical study indicates that they are unlikely to create conditions conducive to a bird hazard problem."

Relevance: *The Act is important with regard to the siting of the facility (ies) with regards to the flight path. Bird Hazard Reduction consideration and chimney height considerations have been made with approval having been obtained from KCAA for the proposed facility with conditionalities.*

4.6.15 The Agriculture Act (Chapter 318):

The Agriculture Act is the principal land use statute covering inter alia soil conservation, agricultural land use and conservation issues such as the preservation of soil fertility. The Act prohibits any land use practices that may intensify soil erosion. The Act also provides for protection of watercourses setting aside a riparian zone of a minimum 2m equivalent to the width of river to a maximum of 30m.

Relevance: *The Act is important with regard to the siting of the facility (ies) with respect to the land use and physical planning. The site is within an industrial zone set aside by the National Government in liaison with Nairobi City County for Water Works Development as administered by Athi Water Works Development Agency.*

4.6.16 Way Leaves Act (Cap. 292):

The Act provides for certain undertakings to be constructed e.g. transmission lines, pipelines, canals, pathways etc., though, over or under any lands. This project is under the provision of the Act. Section 3 of the Act states that the Government may carry any works through, over or under any land whatsoever provided it shall not interfere with any existing building or structures of an ongoing activity.

Relevance: *The proposed project shall utilize existing transmission lines easement routes upto Mangu-Juja Substation.*

4.6.17 Employment Act 2007:

This is an Act of parliament that applies to all employees employed by any employer under a contract of service. Employment of children in the following forms is prohibited in the following sections of the Act:

53. (1) notwithstanding any provision of any written law, no person shall employ a child in any activity which constitutes worst form of child labor.
56. (1) No person shall employ a child who has not attained the age of thirteen years whether gainfully or otherwise in any undertaking.

    (2) A child of between thirteen years of age and sixteen years of age may be employed to perform light work which is:

    a) Not likely to be harmful to the child's health or development; and

b) Not such as to prejudice the child's attendance at school, his participation in vocational orientation or training programmes approved by the Minister or his capacity to benefit from the instructions received.

Gender equality considerations need to be made in the employment at site during both construction and operational phase of the facility as per National Gender and Equality Commission Act, 2011.

Relevance: *The proponent in conjunction with the contractor will need to understand and abide by the requirements of the Act ensuring equal opportunities employment for all genders and persons with disabilities.*

4.6.18 HIV/AIDS Prevention and control Act (Act No. 14 of 2006)

Part 11, Section 7 of the Act requires that HIV and AIDs education be carried out at the work- place. The government is expected to ensure the provision of basic information and instruction on HIV and Aids prevention and control to: -

- Employees of all government ministries, departments, Authorities, and other agencies and employees of private and informal sectors.
- The information on HIV/AIDS is expected to be treated with confidentiality at the workplace and positive attitude towards infected employees.

In allocating contractors to the proposed project, the proponent should ensure that the contractor offers such training to the worker as provided by law.

Relevance: *The Act is applicable in the entire project cycle therefore; the proponent and the contractor should adhere with the set regulations and requirements set in the HIV/AIDs Prevention and Control Act in facilitating Occupational health awareness onsite at all times.*

4.6.19 The Sexual Offences Act (No. 3 of 2006)

Relevant Sections in this Act include: -

- 24- Sexual offences relating to position of authority and persons in position of trust.
- 25- Sexual relationship which pre-date position of authority or trust.
- 26- Deliberate transmission of HIV or any other life threatening sexually transmitted disease.

Relevance: *The* proposed *project should adhere to this Act; by ensuring that NO sexual offences are committed, during the project cycle. Sensitization of sexually related diseases will be incorporated in the mitigation measures to minimize such cases occurring in the local community.*

4.6.20 Work Injury and Benefits Act, No. 17 of 2007

The Work Injury and Benefits Act, gazette in 2007, provides for compensation to employees for work related injuries and disease contracted during their employment and for connected purposes. The Act sets employer's obligations and deals with reporting of accidents and medical aid.

The Proponent is committed to implement the Project in accordance with the provisions of this Act. The ESMP laid out in this Report provides measures to assure compliance with the requirements of the Act to make sure employees of the Project are adequately taken care of in case of injury or disease.

Relevance: *The* proposed *project should adhere to this Act with adherence to WIBA requirements during employment ensuring all incidents are registered on the Incident Register and fully investigated and compensated as per the Act.*

4.6.21 The Penal Code (Cap. 63):

Section 191 of the Penal Code states that any person or institution that voluntarily corrupts or foils water for public springs or reservoirs, rendering it less fit for its ordinary use, is guilty of an offence. Section

192 of the same act says a person who makes or violates the atmosphere in any place to make it noxious to the health of persons/institutions in dwellings or business premises in the neighborhood or those passing by, commits an offence punishable by law.

4.6.22 The Environment and Land Court Act, No. 20 of 2011

This is an Act of Parliament to give effect to Article 162(2)(b) of the Constitution; to establish a superior court to hear and determine disputes relating to the environment and the use and occupation of, and title to, land, and to make provision for its jurisdiction functions and powers, and for connected purposes. The principal objective of this Act is to enable the Court to facilitate the just, expeditious, proportionate and accessible resolution of disputes governed by this Act. Section 13 (2) (b) of the Act outlines that in exercise of its jurisdiction under Article 162 (2) (b) of the Constitution, the Court shall have power to hear and determine disputes relating to environment and land, including disputes:

- Relating to environmental planning and protection, trade, climate issues, land use planning, title, tenure, boundaries, rates, rents, valuations, mining, minerals and other natural resources;
- Relating to compulsory acquisition of land;
- Relating to land administration and management;
- Relating to public, private and community land and contracts, chooses in action or other instruments granting any enforceable interests in land; and
- Any other dispute relating to the environment and land.

<u>Relevance:</u> *The* proposed *project where there is any dispute on the proposed infrastructure development site and transmissions lines can seek these courts resolutions where necessary.*

4.6.23 The National Land Commission act, 2012 (No. 5 of 2012) revised Edition 2016 (2015)

The National Land Commission of Kenya is an independent government commission whose establishment was provided for by the Constitution of Kenya to, amongst other duties, manage public land on behalf of the national and county governments, initiate investigations into present or historical land injustices, recommend appropriate redress, monitor and have oversight responsibilities over land use planning throughout the country. It was officially established under The National Land Commission Act, 2012.

The mandate of the National Land Commission is drawn from the National Land Policy of 2009, Constitution of Kenya 2010, National Land Commission Act, 2012, the Land Act 2012 and the Land Registration Act of 2012. Under the National Land Commission Act, the Commission shall among other duties monitor the registration of all rights and interests in land and ensure that public land and land under the management of designated state agencies are sustainably managed for their intended purpose and for future generations. Also, the commission is required to manage and administer all unregistered trust land and unregistered community land on behalf of the county government and develop and encourage alternative dispute resolution mechanisms in land dispute handling and management. The Commission is also required in consultation and cooperation with the national and county governments, to establish county land management boards for the purposes of managing public land. This Act is extremely important since the project area is in default management of the NLC.

<u>Relevance: Relevance</u>: *The* proposed *project proponents under the Ministry of Lands and Energy through NLC shall facilitate issuance of title deed to the project proponent as is ongoing and finalized in time does not delay the project schedule.*

4.6.24 The Standards Act, CAP 496

The Standards Act of 1974 (amended in 2012) provides for the promotion of the standardization of the specification of commodities and codes of practice. It establishes the Kenya Bureau of Standards and defines its functions, management and control. Code of practice is interpreted in the Act as a set of rules relating to the methods to be applied or the procedure to be adopted in connection with the construction, installation, testing, sampling, operation or use of any article, apparatus, instrument, device or process. The act also adheres to international legal standards such as the World bank ESS, the equator principles, JICA policies and IFC performance standards which are further elaborated on in the later parts of this chapter.

The Act contains various specifications touching on electrical products. The Proponent shall ensure that commodities and codes of practice utilized in the Project adhere to the provisions of this Act.
Relevance: *The* proposed *project should ensure all various electrical systems standards are implemented as part of the infrastructural development to safeguard property and lives of citizens who utilizes electricity.*

4.6.25 Legal Licensing Requirements

There is an exhaustive array of legislation in place covering most aspects of installing, commissioning and operating WTE power plant and landfills and retailing energy production as shown in the table 11 below.

Table 11: Compliance Licenses and Permits

Legislation	Requirement (Licenses / Permits)	Regulator
The Land Act, 2012 Valuers' Act, Chapter 532 Way leave Act 292	Land consent for project development Compensation awards at Market value of the property.	Ministry of Lands & Physical Planning
Environmental Management & Coordination Act (EMCA), Cap 387	• Carry out an Environmental Impact Assessment prior to implementation of the project. • The project cycle should follow the recommendations in the EMP of the ESIA report and the conditions as laid out in the NEMA License. • Undertake Initial Environmental Audit a year after facility operation. • Effluent Discharge License	National Environment Management Authority (NEMA)
The Water Act, 2016	• Water discharge license • Abstraction permit for use of borehole/ river water.	Water Resource Authority (WRA)
Energy Act, 2019	• Kenya Electricity Grid Code & Kenya Safety Code • Application of EPRA construction permit before project Implementation Electricity Generating License. • The Renewable Energy Feed-in-Tariff-System (FiT)-PPA Contract.	Energy and Petroleum Regulatory Authority (EPRA) Kenya Power (KPLC)
Petroleum Act, 2019.	• Installation, handling and storage of petroleum products at site/ at the plant for its operations license	
Physical Planning Act (2006) Building Code 1997 Public Health Act,	• Development application to be made for any new buildings. • Approval of plans for new Structures from the County Government • Registration of the workplace with DOSHS	County City Government of Nairobi
Occupational Health and Safety Regulations 2007 (OSHA).	• Display Abstract of Factories and other places of • Work / OSHA. • Hazardous waste handling and management. • Trade / Business License.	Directorate of Occupational safety and Health Services
County Governments Act 2012		County government

4.7 International Treaties, Conventions and Agreements

Kenya has ratified various international conventions on the environment that are applicable to this study. Conventions are agreements that are legally binding on states that have become parties to them. Kenya has the International Convention on Biological Diversity (1992) which promotes the protection of ecosystems and natural habitats, respects the traditional lifestyles of indigenous communities, and promotes the sustainable use of resources.

Kenya is also a signatory to the Basel Convention and Bamako convention, both which govern the control of trans-boundary movements of hazardous wastes and their disposal. This convention was primarily signed to prevent the transfer of hazardous waste from developed countries to less developed countries. In this case this convention directly relates to the project at hand.

The United Nations Framework Convention on Climate Change (UNFCCC or FCCC) is an international environmental treaty produced at the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit. The objective of the treaty is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

The treaty itself sets no mandatory limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms. In that sense, the treaty is considered legally non-binding. Instead, the treaty provides for updates (called "protocols") that would set mandatory emission limits. The principal update is the Kyoto Protocol, which has become much better known than the UNFCCC itself.

The Rio Declaration and Agenda 21 (the Action Plan for the 21st Century) are two non-legally binding instruments also adopted by UNCED. While the Rio Declaration contains general principles and objectives, Agenda 21 contains detailed guidance on their practical implementation. Principle 4 of the Rio Declaration provides that, in order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it. Implementation of the Environmental Management Plan in the report herein is consistent with this principle.

Principle 17 of the Rio declaration provides that environmental impact assessments be undertaken for proposed activities that are likely to have a significant impact on the environment and are subject to a decision by a national authority. The concept of environment impact assessment is also embodied in many other multilateral environmental agreements. Preparation of this ESIA is consistent with this principle, as well as Kenyan legislative requirements EMCA, 1999.

The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to **limit** global warming to, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century.

The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects. Proper waste management reduces the amount of methane released in the atmosphere and thus the relevance to this project.

4.7.1 Equator Principles

The Equator Principles Financial Institutions (EPFIs) adopted the Equator Principles in order to ensure that the Projects they finance and advise on are developed in a manner that is socially responsible and reflects sound environmental management practices. They recognize the importance of climate change, biodiversity, and human rights, and believe negative impacts on project-affected ecosystems, communities, and the climate should be avoided where possible. If these impacts are unavoidable, they should be minimized, mitigated, and/or offset.

The Equator Principles are aimed to ensure that prior to agreeing to provide financing, (a) a project has been subject to an appropriate level of environmental and social assessment in accordance with the requirements of the International Finance Corporation; IFC Performance Standards (2006) and (b) that the project will implement appropriate measures for the management of environmental, social and health issues during construction, operation and decommissioning phases. By adopting the Equator Principles, financial institutions undertake to review carefully proposals for which their customers request project financing. They commit not to provide loans to projects where the borrower will not, or is unable to, comply with the requirements of the IFC Performance Standards. Equator principles are tabulated below.

4.7.2 Equator Principles

Various relevant principles are as enlisted below;

- Principle 1: Categorization of projects.
- Principle 2: The borrower has to conduct an Environmental and Social Impact Assessment (ESIA).
- Principle 3: Applicable Social and Environmental Standards.
- Principle 4: Action Plan and Management System.
- Principle 5: Consultation and Disclosure.
- Principle 6: Grievance Mechanism.
- Principle 7: Independent Review.
- Principle 8: Covenants.
- Principle 9: Independent Monitoring and Reporting.
- Principle 10: Reporting and transparency.

Table 12: Applicability of WB OPs

OP	Title	Triggers	Applicability
4.01	Environmental Assessment	Triggered	This Project falls under category A as per World Bank Operational Policy 4.01, A full environmental impact assessment has been carried out as part of project preparation to ensure the design, construction, operation and decommissioning of the landfill take into account the mitigation measures as it is likely to have significant adverse environmental impacts that can be adequately mitigated.
4.04	Natural Habitats	Triggered	The policy is applicable and the impact is minor in significance due to the presence of eucalyptus trees are and other exotic plants in the proposed site.
4.09	Pest Management	Triggered	The policy is applicable to the project and the impact is Moderate in significance due to the potential multiplication of pests during operation of the landfill.
4.10	Indigenous People	Not Triggered	Not applicable. There are no known indigenous people living on the proposed project site
4.11	Physical Cultural Resources	Not Triggered	Not applicable. Site visits and inventories have not indicated the presence of any cultural (historical, archaeological) sites in the construction area.
4.12	Involuntary Resettlement	Not Triggered	Not applicable. The site will not displace any PAP as the land is unoccupied and belongs to the County Government who is a development partner on the project.
4.36	Forests	Not Triggered	Not applicable. The policy is not applicable to the project- the ecological study indicates absence of forests cover hence this policy

OP	Title	Triggers	Applicability
4.37	Safety of Dams	Not Triggered	Not applicable. The project will not involve construction of dams
7.50	Projects on International Waterways	Not Triggered	Not applicable. The policy is not on any waterway
7.60	Projects on Disputed Areas	Not Triggered	Not applicable. The proposed project site is legally owned by Nairobi County who is a development partner on the project.

The Equator Principles and OP 4.01 set out the process for assessing a project in three key phases: Impacts are assessed on their degree of potential impact and are categorized as either A (High), B (Medium) or C (Low).

- **Category A-** Projects with potential significant adverse social or environmental impacts that are diverse, irreversible or unprecedented;
- **Category B-** Projects with potential limited adverse social and environmental impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and,
- **Category C-** Projects with minimal or no social or environmental impacts.

As earlier mentioned, this proposed project is classified under category A.

The EPs apply to all new project financings with total capital costs of USD10 million or more across all industry sectors globally. The EPs represent a framework for project financing, which is underpinned by the revised IFC Performance Standards (PS).

World Bank's Safeguards & IFC PSs and Environmental Health and Safety Guidelines
The extent to which the EPs apply to a project depends on whether the country in which the project is located is "Designated" or "Non-Designated". Projects within Non-Designated countries such as Kenya are required to follow the standards and guidelines as set out in the IFC PSs and Environmental Health and Safety Guidelines.

The IFC PS are detailed below:

- IFC PS1 – Assessment and Management of Environmental and Social Risks and Impacts.
- IFC PS2 – Labor and working conditions.
- IFC PS3 – Resource Efficiency and Pollution Prevention.
- IFC PS4 – Community Health, Safety, and Security.
- IFC PS5 – Land acquisition and involuntary resettlement.
- IFC PS6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources.
- IFC PS7 – Indigenous peoples.
- IFC PS8 – Cultural heritage.

PS 1 establishes the importance of assessment to identify the environmental and social impacts associated with development, effective community engagement and project information disclosure and consultation with local Project affected communities and environmental and social management measures. This ESIA has therefore been carried out to meet the requirements of IFC PS1.

The remaining IFC PS set out objectives and requirements to avoid and minimize potential environmental and social adverse effects on the environment and to offset/compensate for any residual effects. PS 2 to 8 have therefore been considered as part of the assessment process and discussed where relevant within the topic specific sections in table 13 below.

Table 13: Analysis of IFC performance standards relevant to the project

Performance Standard	Objective	Applicable to the Project
PS 1 - Assessment and Management of Environmental and Social Risks and Impacts	• To promote improved environmental and social performance of clients through the effective use of management systems • To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately • To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.	Yes. ESIA requirements of PS1 have been satisfied and initial ESMP has been prepared. This will be finalized once EPC has been appointed and will be implemented in accordance with Proponent's own ESMS.
PS 2: Labor and Working Conditions	• To promote the fair treatment, non-discrimination, and equal opportunity of workers • To establish, maintain, and improve the worker-management relationship • To promote compliance with national employment and labor laws • To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain • To promote safe and healthy working conditions, and the health of workers • To avoid the use of forced labor	Yes. EPC contractors will be required to fully implement the requirements of PS 2.
PS 3: Resource Efficiency and Pollution Prevention	• To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities. • To promote more sustainable use of resources, including energy and water. • To reduce project related GHG emissions.	Yes. ESMP provides a suite of mitigation measures to ensure compliance with PS3.
PS 4: Community Health. Safety and security	• To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances. • To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities	Yes EPC contractors will be required to fully implement the requirements of PS 3 with oversight from the client's project management team.
PS 5: Land Acquisition and Involuntary Resettlement	• To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs. • To avoid forced eviction. • To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected	Not applicable. Resettlement not required for the site or the transmission line.

Performance Standard	Objective	Applicable to the Project
	• To improve, or restore, the livelihoods and standards of living of displaced persons. • To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites	
PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	• To protect and conserve biodiversity. • To maintain the benefits from ecosystem services • To promote the sustainable management of living natural resources through the • adoption of practices that integrate conservation needs and development priorities	Yes. ESIA has fully assessed the impacts on biodiversity. The main feature on site is the shrub grassland area. A suite of mitigation and enhancement measures has been provided to ensure compliance with PS6.
PS 7: Indigenous Peoples	• To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples. • To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts. • To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner. • To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the indigenous Peoples affected by a project throughout the project's life-cycle. • To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present. • To respect and preserve the culture, knowledge, and practices of Indigenous Peoples	Not applicable as there are no indigenous peoples present within the project area.
PS 8: Cultural Heritage	• To protect cultural heritage from the adverse impacts of project activities and support its preservation. • To promote the equitable sharing of benefits from the use of cultural heritage	Not applicable as there are no sites identified within the site area or along the route of the transmission line there is the potential for buried chance finds. Therefore, a chance find procedure will be developed as part of the ESMP to monitor and record any items that may be discovered during construction.

- **Environmental, Health and Safety (EHS) Guidelines**

This guideline are technical reference documents that address IFC's expectation regarding the industrial pollution management performance of projects. This information supports actions aimed at avoiding, minimizing, and controlling EHS impacts during the construction, operation, and decommissioning phase of a project or facility.

In the context of the proposed project, the most relevant EHS Guidelines to be considered are:

- World Bank Group General EHS Guidelines (2007); and
- World Bank Group EHS Guidelines for Electric Power Transmission and Distribution (2007).

In terms of the IFC Performance Standards, this would be categorized as a Category A or B project, requiring a full ESIA.

Equator Principle 5 (Consultation and Disclosure) requires the Project to undertake a process of consultation with affected communities in a manner that provides them with opportunities to express their views on Project risks, impacts, and mitigation measures, and allows the Sponsor to consider and respond to them. The consultation process should be undertaken in a manner that is inclusive, culturally appropriate, free from intimidation, timely and informed.

Equator Principle 6 (Grievance Mechanism) requires that a grievance mechanism must be developed which allows Project affected parties to raise grievances to either the Sponsor or a third party who will seek to resolve the grievance as appropriate.

IFC Performance Standard 1 (Social and Environmental Assessment and Management Systems) requires community engagement, project information disclosure, consultation and grievance mechanisms to be implemented similar to the requirements of Equator Principle 5.

IFC Performance Standard 2 (Labor and Working Conditions) Objectives are to:

- To promote the fair treatment, non-discrimination, and equal opportunity of workers.
- To establish, maintain, and improve the worker-management relationship.
- To promote compliance with national employment and labor laws.
- To protect workers, including vulnerable categories of workers.
- To promote safe and healthy working conditions, and the health of workers.
- To avoid the use of forced labor.

IFC Performance Standard 4 (Community, Health, Safety and Security):- objectives are to:

- To avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances.
- To ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.

IFC Performance Standard 5 (Land acquisition and InvoluntarySettlement): - objectives are:

- To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.
- To avoid forced eviction.
- To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.
- To improve, or restore, the livelihoods and standards of living of displaced persons.
- To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

4.7.3 Applicable World Bank's Environmental and Social Safeguard Policies

The World Bank's environmental and social standards (ten of them) are a cornerstone of its support to sustainable poverty reduction. The objective of these policies is to prevent and mitigate undue harm to people and the environment in the development process. These policies provide guidelines for the identification, preparation, and implementation of programs and projects. The following standards of the World Bank are relevant for the proposed Waste to Energy power project from an environmental and social viewpoint:

- **ESS1-Assessment and Management of Environmental and Social Risks and Impacts**

ESS 1 is triggered because the activities/interventions proposed under this project may have low impacts on the natural environment and human health. As the project during construction requires minimal clearing up of sites, excavations, which have impacts (though minimal) to physical and biological environment within the project site.

Environmental Assessment is used by the World Bank to identify, avoid, and mitigate the potential negative environmental impacts associated with the Bank's operations early on in the project cycle. The policy states that Environment Assessment (EA) and mitigation plans are required for all projects having significant adverse environmental impacts or involuntary resettlement. Assessment should include analysis of alternative designs and sites, including the "no project option" and require public participation and information disclosure before the Bank approves the project.

In World Bank-funded operations, the purpose of Environmental Assessment is to improve decision making, to ensure that project options under consideration are sound and sustainable, and that potentially affected people have been properly consulted and their concerns addressed. The World Bank's environmental assessment policy and recommended processing is described in ESS 1.

Under ESS 1, the Bank classifies proposed projects in four categories of Environmental Assessment depending on the type, location, sensitivity, scale of the project and the nature and magnitude of its potential environmental and social impacts.

- **Category A:** A proposed project is classified in this category if it is likely to have significant adverse environmental impacts that are sensitive, diverse or unprecedented. Moreover, the EA for this category includes examining the project's potential negative and positive impacts in comparison with those of feasible alternatives and recommends any measures required to prevent, minimize, mitigate or compensate for adverse impacts and improve environmental performance.
- **Category B:** A proposed project is classified in this Category if its potential adverse environmental impacts on human populations or environmentally important areas including wetlands, forests, grasslands, and other natural habitats are less adverse than those of Category A projects. The scope of EA here varies from project to project and it tends to be narrower than that of Category A.
- **Category C:** A proposed project is classified in this Category if it's likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project.
- **Category FI:** A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary in subprojects that may result in adverse environmental impacts.

IFC Guideline Manual (dated December 1998 and updated in 2016) - Procedure for Environmental and Social Review of Projects

Project screening (point 22) – The proposed project is classified as **Category A**, as stated in the IFC Guideline Manual: A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These projects may affect an area broad than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential positive and negative impacts, compares them with those of feasible alternatives (including the "without project" scenario), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and to improve performance. **For a Category A Project**, the project sponsor is mandated to preparing a full report, normally an Environmental Impact Assessment (EIA) and for preparing and updating an Environmental Action Plan (EAP).

- **ESS2 - Labor and Working Conditions**

Recognizes the importance of employment creation and income generation in the pursuit of poverty reduction and inclusive economic growth. The proponent and project can promote sound worker-management relationships and enhance the development benefits of a project by treating workers in the project fairly and provide safe and healthy working conditions.

- **ESS3 - Resource Efficiency and Pollution Prevention and Management**

Recognizes that economic activity and urbanization often generate pollution to air, water, and land, and consume finite resources that may threaten people, ecosystem services and the environment at the local, regional, and global levels. This ESS sets out the requirements to address resource efficiency and pollution prevention and management throughout the project life cycle.

The Waste to Energy Project Triggers this ESS positively in that it provides a vehicle for which waste management and pollution can be managed sustainably and, in the process, provide energy for the nation of Kenya.

- **ESS4: Community Health and Safety**

Addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of developers to avoid or minimize such risks and impacts, with particular attention to people who, because of their particular circumstances, may be vulnerable.

This ESS is triggered by the project and relevant measures have been defined in this study in the ESMP which are meant to provide for the safety of the plant workers and community as a whole

- **ESS5 - Land Acquisition, Restrictions on Land Use and Involuntary Resettlement**

As per World Bank policy, ESS 5 is triggered in case the project results in loss of private properties such as land, houses, structures and commercial places or disruption of formal /informal sources of income and livelihoods happens due to project interventions. The Waste to Energy power plant by virtue of its isolated location, is not likely to involve physical displacement through involuntary land taking as the required land belongs to the NMS. Nevertheless, the Project will be required to comply fully with the mitigation measures to address the adverse social impacts in case the involuntary resettlement issue is triggered as a result of project's interventions.

ESS 5 recognizes that involuntary land-taking resulting in loss of shelter, assets or access and income or sources of income should be addressed in World Bank-financed projects.
Displaced persons should be meaningfully consulted, given opportunities to participate in planning and implementing resettlement programs and assisted in their efforts to improve their livelihoods and standards of living. Absence of legal title to land should not be a bar for compensation, resettlement, and rehabilitation assistance. Vulnerable groups such as IPs, women-headed households, and senior citizens should be entitled to special benefit packages in addition to compensation and resettlement. The standard is applicable whenever there is involuntary land taking resulting in displacement of people and / or loss of livelihood or source of livelihood.

- **ESS6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources**

Recognizes that protecting and conserving biodiversity and sustainably managing living natural resources are fundamental to sustainable development and it recognizes the importance of maintaining core ecological functions of habitats, including forests, and the biodiversity they support. ESS6 also addresses sustainable management of primary production and harvesting of living natural resources, and recognizes the need to consider the livelihood of project-affected parties, including Indigenous Peoples, whose access to, or use of, biodiversity or living natural resources may be affected by a project.

- **ESS7- Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities**

ESS 7 is not triggered because there is no presence of any indigenous community in the project location. This policy states that any development process under World Bank financing should fully respect the dignity, human rights, economies, and cultures of Indigenous Peoples (IPs). The project should engage in a process of free, prior, and informed consultation with IPs that should result in broad community support to the project by the affected Indigenous Peoples. Projects should include measures to avoid potentially adverse effects on the IP's communities or when avoidance is not feasible, minimize, mitigate, or compensate for such effects. They should ensure that the IPs receive social and economic benefits that are culturally appropriate and gender and intergenerational inclusive.

- **ESS8-Cultural Heritage**

The World Bank Policy ESS 8 defines physical cultural resources as movable or immovable objects, sites, structures, groups of structures, natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings, and may be above or below ground, or under water. Their cultural interest may be at the local, provincial or national level, or within the international community.

The Bank assists countries to avoid or mitigate adverse impacts on physical cultural resources from the development projects that it finances. The impacts on physical cultural resources resulting from project activities, including mitigating measures, may not contravene either the borrower's national legislation, or its obligations under relevant international environmental treaties and agreements.

- **ESS9 - Stakeholder Engagement and Information Disclosure**

This ESS encourages Public Disclosure (PD) or Involvement as a means of improving the planning and implementation process of projects. This procedure gives governmental agencies responsibility of monitoring and managing the environmental and social impacts of development projects particularly those impacting on natural resources and local communities. The policy provides information that ensures that effective PD is carried out by project proponents and their representatives. The BP requires that Public Involvement should be integrated with resettlement, compensation and indigenous peoples' studies. Monitoring and grievances address mechanisms should also be incorporated in the project plan. Public involvement is a fundamental principle of the EIA process. Public involvement programmes contribute to EIA studies and to the successful operation and management of the proposed project; this will also promote accountability, transparency and ownership of the project by the relevant stakeholders.

The Public Consultation and Participation (PCP) Process is a policy requirement by the Government of Kenya and a mandatory procedure as stipulated by EMCA 1999 section 58, on Environmental Impact Assessment for the purpose of achieving the fundamental principles of sustainable development.

4.7.4 African Development Bank Environmental Guidelines

The Bank Has Integrated Environmental and Social Impact Assessment Guidelines and Environmental and Social Assessment Procedures (ESAP). The guidelines integrate environmental and social concerns into the life cycle of a project and also stipulate requirements for specific projects. The guidelines aim to identify and then avoid or mitigate potential adverse impacts early on in the project cycle and enhance beneficial impacts at a minimal cost. Overall, the mitigation approach adopted in the guidelines focuses on preventing, minimizing, mitigating or compensating adverse impacts rather than curative interventions that handle adverse outcomes after the emergence of the anticipated problems.

The guidelines also give prioritized Bank crosscutting themes, namely:

- Poverty - so as to ensure that projects assist in reducing poverty;

- Environment - includes the flora, fauna and landscape as well as the natural and cultural heritage and involves considering the human interactions and impacts on the biosphere, both positive and negative;
- Population - demographic trends, migration and resettlement, changes in natural resources and land management and quality of life;
- Health - includes communicable diseases, non-communicable diseases, malnutrition, injuries, psychosocial disorders and wellbeing;
- Gender - includes gender inequalities or differences especially with regard to division of labor (paid and unpaid work), income-generating activities, access to and control over productive factors, and involvement in societal organization; and
- Public Participation - ensures actively involving the project stakeholders, particularly those who stand to gain or to lose from a project.

The ESAP gives the steps to be undertaken when undertaking an ESIA including the generic terms of reference of an ESIA; typical contents of an ESIA and the minimum contents of an Environmental and Social Management Plan (ESMP). It defines ESIA as an Instrument whose purpose is to identify and assess the potential environmental and social impacts of a proposed project, evaluate alternatives, and design appropriate mitigation/enhancement, monitoring, and consultative and institutional strengthening measures. The objective of EASP is to improve decision-making and project results in order to ensure that Bank-financed projects plans and programs are environmentally and socially sustainable as well as in line with Bank's policies and guidelines. The ESAP divides projects into four categories:

- ***Category 1:*** projects are those that are likely to have the most severe environmental and social impacts and require a full ESIA.
- ***Category 2*** projects are likely to have detrimental and site-specific environmental and social impacts that can be minimized by the application of mitigation measures included in an ESMP.
- ***Category 3*** shall not induce any adverse environmental and social impacts and do not need further action.
- ***Category 4*** projects involve investment of Bank's funds through Financial Intermediaries (FIs) in subprojects that may result in adverse environmental or social impacts. Specific requirements for this type of project include an assessment of FI capacities to handle environmental and social considerations.

Under the ESAP, the Borrower is responsible for integrating environmental and social considerations sponsored projects according to the Bank's requirements.

For Category 2 projects such as the proposed project, where there may be small scale resettlement of persons, the Bank requires that the Borrower conducts meaningful consultations with relevant stakeholders, including potential beneficiaries, affected groups, Civil Society Organizations (CSOs) and local authorities, about the project's environmental and social aspects and take their views into account. These consultations shall take place according to the country's legal requirements.

The Borrower shall also give public notification and make the ESIA report available at a public place readily accessible to project stakeholders as soon as the document is ready. NEMA shall undertake this validation exercise for stakeholder's engagement.

4.7.5 Japan International Cooperation Agency (JICA) Environmental Guidelines

JICA Guidelines for Environmental and Social Considerations integrate the Japan Bank for International Cooperation (JBIC) Guidelines for the Confirmation of Environmental and Social Considerations (2002) and the JICA Guidelines for Environmental and Social Considerations (2004).
JICA classifies projects into four categories:

- ***Category A:*** Proposed projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society.
- ***Category B:*** Proposed projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally, they are site- specific, few if any are irreversible, and in most cases, normal mitigation measures can be designed more readily.
- ***Category C:*** Proposed projects are classified as Category C if they are likely to have minimal or little adverse impact on the environment and society.
- ***Category FI:*** Proposed projects are classified as Category FI if JICA's funding of projects is provided to a FI or such an institution substantially undertakes executing agency; the selection and appraisal of the sub- projects.

For JICA, impacts to be assessed include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.

In principle, project proponents should consult with local stakeholders through means that induce broad public participation to a reasonable extent considering the environmental and social factors in a way that is most suitable to local situations, to reach consensus. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently and timely compensated and supported by project proponents.

5 Description of Baseline Environment

5.1 Introduction

This section describes the baseline conditions in the study area and provides summarized information on the physical, biological and socio-economic environment. The purpose of this chapter is to facilitate the evaluation of impacts assessed in the following stage.

For quality control, the study undertook the detailed field assessment and sampling of the following environmental aspects: terrestrial environment; aquatic environment; water quality; soil; air and noise quality. Appropriately samples were then labeled properly, including the sample identification code, date, sampling location, source of sampling and receptor etc. and taken for further analysis as was appropriate.

Labeling: Assured that sample labels were complete and easily identified the sample.
Equipment: The fit for use equipment was employed in the assessment.
Sample Collection: Methods used to collect samples or sampling techniques were standard at every site.

Gathering of baseline data is necessary to meet the following objectives:

- To understand key social, cultural, economic, and political conditions in areas potentially affected by the proposed project;
- To provide data to predict, explain and substantiate possible impacts;
- To understand the expectations and concerns of a range of stakeholders on the proposed development;
- To inform the development of mitigation measures; and
- To benchmark future socio-economic changes/impacts and assess the effectiveness of mitigation measures.

Most importantly, project activities interaction with the baseline conditions is what produces environmental impacts. Environmental data has been collected with reference to proposed project for:

a) Land Environment
b) Soil Environment
c) Water Environment
d) Air Environment
e) Noise Environment
f) Biological Environment
g) Socio-economic Environment.

5.2 Physical Environment

a) A description of the existing soil and geology, landscape, aesthetic values and hydrology. Special emphasis should be placed on storm water run-off, leachate and drainage patterns. Any slope stability issues that could arise should be thoroughly explored.
b) Water quality of the existing river, site ponds, any streams in the vicinity of the development.
c) Terrestrial ecosystem, including but not limited to any wetlands and other ecologically sensitive areas with indication of their function and value in the project area.
d) Noise levels of undeveloped site and the ambient noise in the area of influence
e) Obvious sources of existing pollution and extent of contamination
f) Availability of solid waste management facilities.

5.2.1 Location

The project location is approximately 11km NE of Ruai Town in Nairobi City County, the administrative and commercial capital of the Republic of Kenya and seat of the government.

The city lies on the Nairobi River in the southern part of the country. It is located at latitude -1.206570° N, and longitude 37.062759° E. The city has an elevation of 1660 meters (5,450ft) above sea level.

Nairobi borders Thika and Kiambu to the north, Machakos to the east and Kajiado to the South. It is situated between the cities of Kampala and Mombasa. It is close to the Rift valley. The Ngong hills are towards the west, Mount Kenya is towards the North and Mount Kilimanjaro is towards south-East. Figure 38 below shows the geographic location of the site.

Figure 38: Geographic Location LR No. 12979/1 of the proposed Waste to Energy Plant.
(source: google Maps).

5.2.2 Topography

The plot is located on a gently southern sloping topography into the Nairobi River. Within the fenced compound, the surface gently slopes towards the northwest. The site is characterized by a generally flat and gently sloping to the northwest towards Nairobi River where altitude within the project site is between 1488m and 1484m above sea level to the east and west respectively. Figure 39 below show the gentle slope on which the facility is to be built while figures 40 and 41 below show the mapped layout structure of the site.

Figure 39: Gentle/flat slope of the proposed site location which is an open grassland

.

- **Site Layout**

Detailed site layout of the proposed project is as depicted below;

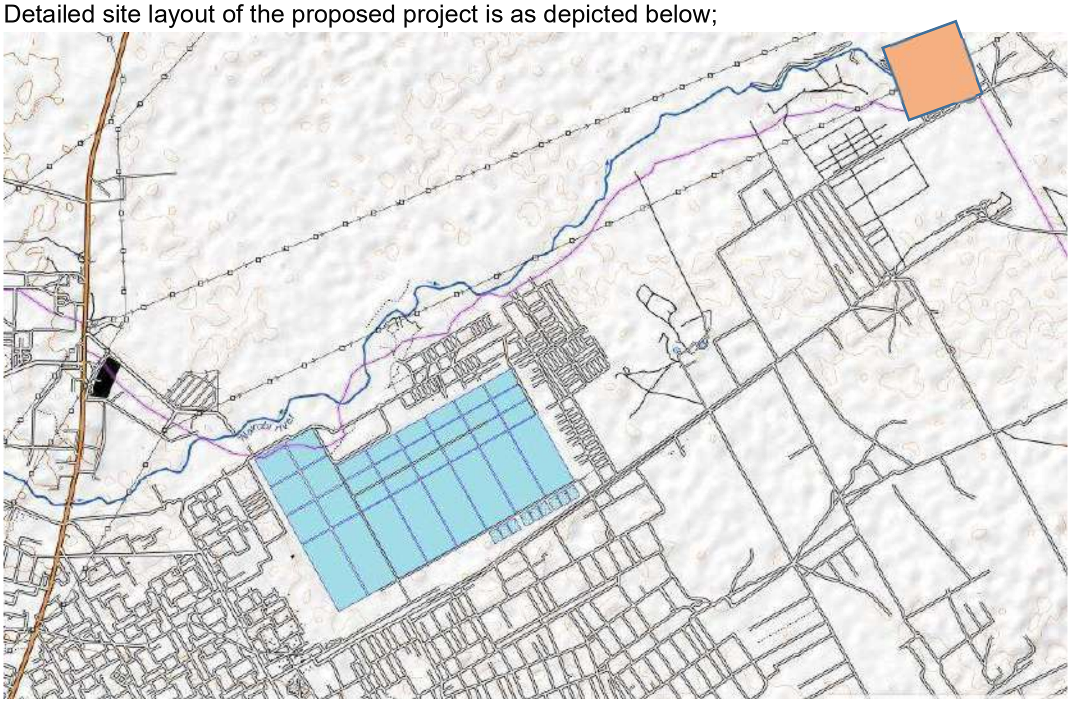

Figure 40: General Infrastructure layout map of the Ruai area showing Wastewater Treatment Ponds and proposed project site to the top right of the map colored orange.

(Source: www.opentopomap.org)

Figure 41: Site layout map of the project showing facility alignment.

(source: WTE feasibility study report for Ruai site).

5.2.3 Access Roads

Most of the access road going to the site has been completed in tarmac covering 10.5km long from Kangundo road junction and an additional 1.5km access road existing shall require upgrading to bituminous status for the power plant operations. Figures 42 and 43 below show the access road to the site.

Figure 42: The tarmacked part of the access road to the site.

Figure 43: The un-tarmacked part of the access road to the site.

The present condition of the driving surface is of murram standard.

5.2.4 Relief and Drainage in the Area

The plot (1484-1489 m amsl) is located on a gently north-western sloping topography into the Nairobi River. Within the fenced compound, the surface gently slopes towards the northwest. North of the site, the valley of the Nairobi River only cuts about 4 m into the relatively soft formations that form the top of the volcanic sequence. The stream is part of the dense, southeasterly oriented drainage system that drains the relatively humid hinterland of Muranga and Kiambu. The area is generally flat with Nairobi River forming the north Eastern boundary of the land. The map below in figure 44 shows the drainage map of Nairobi metropolitan area.

Figure 44: drainage map of Nairobi metropolitan area.

Source: aquadocs.org:-http://hdl.handle.net/1834/7275

5.2.5 Geology

- **Hydrogeology, Soils and Geologic Environment**

The rocks in the Nairobi area mainly comprise a succession of lavas and Pyroclastics of the Cainozoic age and overlying the foundation of folded Precambrian schists and gneisses of the Mozambique belt (Saggerson, 1991). The crystalline rocks are rarely exposed but occasionally fragments are found as agglomerates. The study area is covered by approximately 270 to 300 meters of Tertiary volcanic rocks (tuffs and lavas), which form a thick blanket over massive gneisses of the Precambrian Basement System. Stratigraphically, of the formations underlying the site, the dominant formations are Upper Athi Series (UAS) and associated sediments, and tuff layers (indicative depth: 0 – 50 m bgl), Simbara Series (50 – 130 m bgl), Kapiti Phonolites (130 – 210 m bgl), and basal volcanic sediments underlying the Kapiti (210 - 270? m bgl).

Based on the results of the seismic survey and electrical resistivity imaging which was conducted between 25th and 28th July 2021 at the site, this site can be said to be a three-layered earth model to the maximum depth of about 35m probed.

The first layer is composed of loose top black cotton soils that reach an average depth of 1.0m. This layer shows little variation in depth across the entire site. The eastern part has the deepest loose cover reaching a depth of 1.2m while the central and western sectors have shallow surface cover of 0.5 and 1.0m respectively.

The second layer is the transition layer where the weathered rock and saprolite material is to be expected. This is a thin layer of about 2m. Below this layer forma depth of about 3m is the start of the basal layer that forms the bedrock at this site. The rock is a soft to welded tuff, sometimes changing to trachytic tuff. P-wave velocities suggest that this rock is saturated from a depth of about 10m. Water saturation has the effect on increasing the P Wave velocity within the rock and as such, higher than normal velocities are recorded. Varied weathering grades may manifest in the rock at depth. Great variations in the recorded P-wave velocities are indicative of high frequency changes in the nature of the rock. The rock is however expected to be sound as a mass and able to support light structures. Clay weathering is also to be expected at some zones where chemical activity may lead to formation of whitish clays in fractures and joints within the rock. No cavities were detected at the site from the seismic results displayed in figure 45 below (additional information is contained in the annex 3).

Figure 45: Google earth satellite image showing study site and seismic refraction profiles layout SE azimuth. (source: Ruai site Geophysical survey report).

- **Electrical Resistance Tomography (ERT) Survey**

Results of the ERT survey show that this site depicts a three-layered earth model to a depth of 78m. The first layer is composed of loose top black cotton soils that reach an estimated average depth of 1.0m that is not mapped in the models. The second layer which in the ERT models is modeled as the first layer is composed of the shallowly buried rock. This layer is of marginally weathered rock that is dry. Below this layer from a depth of 15m is the basal layer that forms the bedrock at this site. The rock is a soft to welded tuff, sometimes changing to trachytic tuff. The model indicates that this layer extends to the maximum depth of 78m and is highly water saturated. Varied weathering grades may manifest in the rock at depth. Clay weathering, although minimal, is also to be expected at some zones where chemical activity may lead to formation of whitish clays in fractures and joints within the rock. No cavities were detected at the site from the ERT results as shown in figure 46 below. Figure 47 displays the Geophysical investigation profiles while figure 48 shows Geotechnical investigation test pit positions for the site.

Figure 46: Google earth satellite image showing the location and layout of ERT profiles in red sold lines

(source: Ruai site Geophysical survey report).

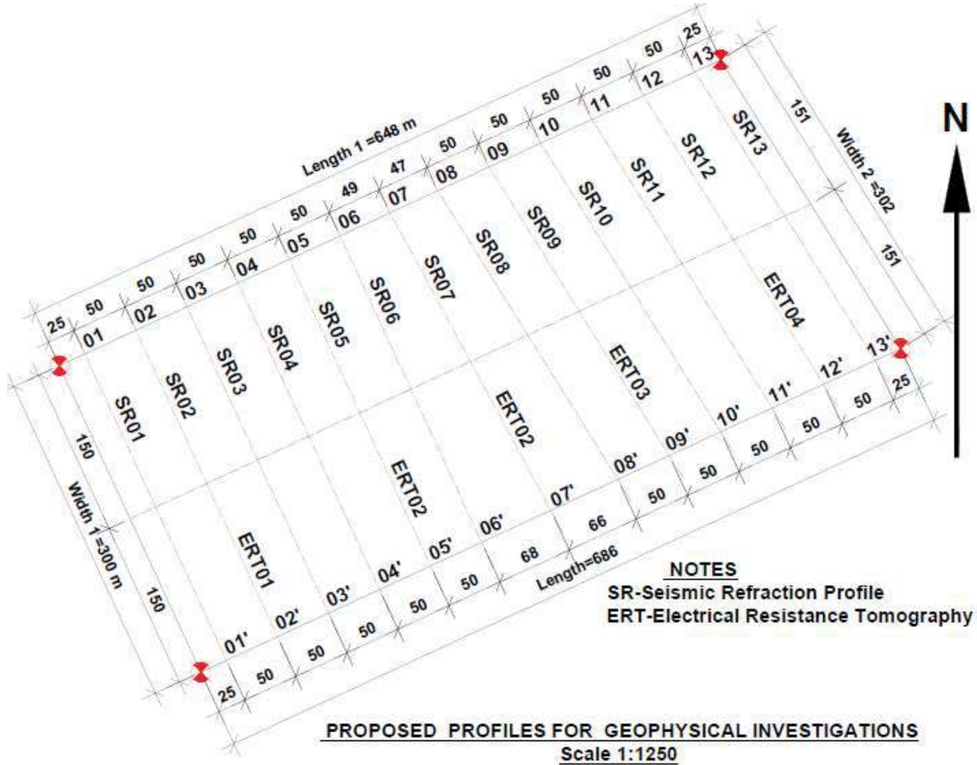

Figure 47: Geophysical investigation profiles for Ruai site

(source: Ruai site Geophysical survey report).

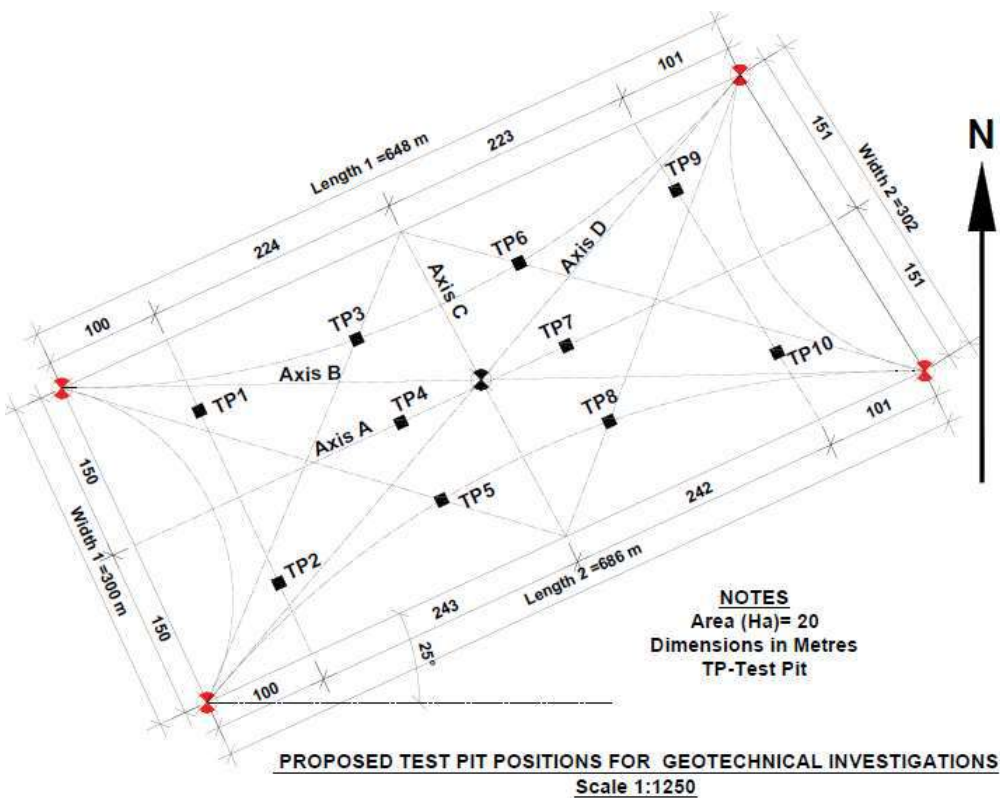

Figure 48: Geotechnical investigation test pit positions for Ruai site

(source: Ruai site Geophysical survey report).

- **Geological Cross-Sections of Study Area**

The geological history of the area can be traced from the Precambrian era (400 - 4,600 million years ago), which is represented by metamorphic rocks of the "Mozambican Basement". Granitoid gneisses and meta-dolerites of the Basement System outcrop about 20 km east of the study site. These (Basement) rocks are, directly, overlain by much younger lava flows and ashes. The period between the Precambrian and Tertiary Periods represents an enormous geological gap, mainly marked by erosion processes. Gradually the surface was lowered, and vast peneplains were formed, with intersecting inselbergs. The different levels of these plains are recognized as remnants of successive cycles of erosion. Figures 49 and 50 below show the local geological map and the regional sub surface geological map respectively.

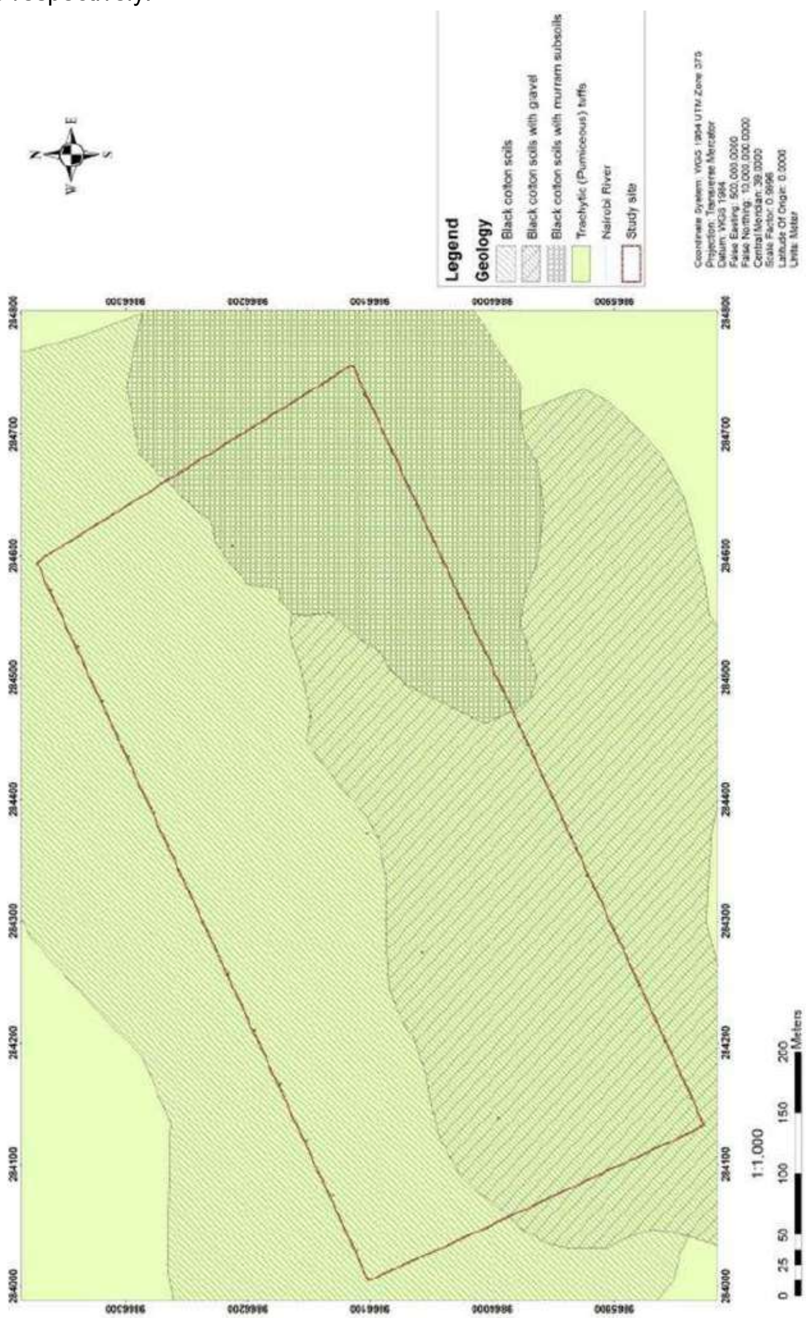

Figure 49: Local Geological map of the study site.

(source: Ruai site Geological survey report).

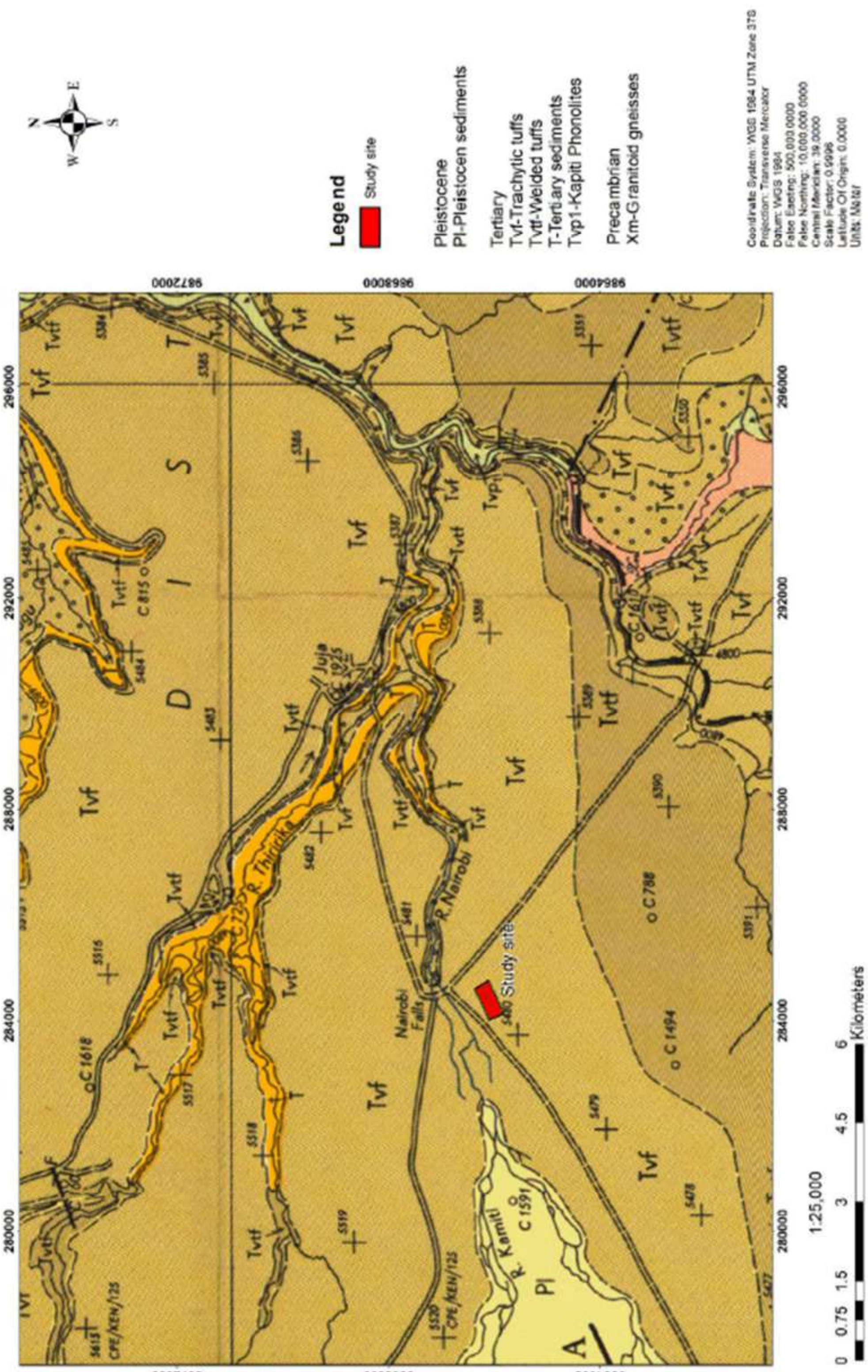

Figure 50: Regional (subsurface) geological map of the study area

(source: Ruai site Geological survey report).

- ***Test Pit at The Proposed Site***

Trial pits excavated within the site to a depth of 1m or to rock, whichever comes first. The average depth of the black cotton soils within the site 0.5m as shown in figures 51 to 53 below.

Figure 51: Photographs taken from trial pits within the site showing black cotton soils cover

(Source: Feasibility study report, (Seureca), September 2021).

- ***Core drilling at the project site***

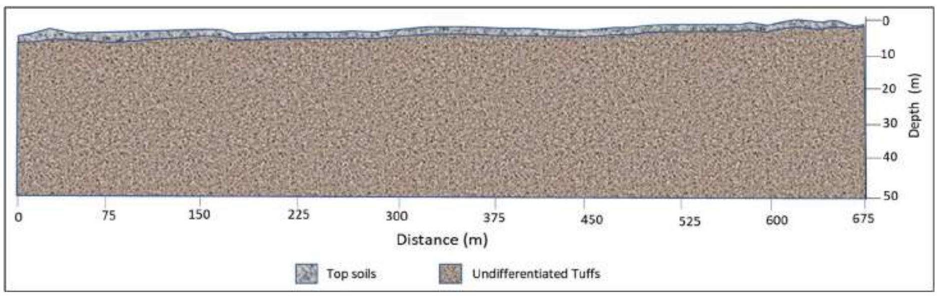

Figure 52: Geological section of the site on the longitudinal axis.

The first layer (overburden) described a loose layer state, reaching to an average depth of 1.0 m across the site. This layer matches closely with the Black Cotton Clay Soils encountered. The stiff layer extends to the limit of investigations at 78.0 m and is highly saturated with water.

Figure 53: A lateritic, granular lay that is a mixture of the black clays reaching a depth of between 0.8 to 1.2m

(Source: Feasibility study report, (Seureca), September, 2021)

- ***Seismic Survey***

The Seismic Survey was conducted to an extent of 35.0 m

The velocity profiles received described a 3-layered earth model comprising:

- A loose overburden extending from the surface to about 1.2 m. This layer showed little variation across the site surveyed
- A transition layer of weathered rock and saprolinic material below the overburden and extending to 3.0 m.

An underlying stiff formation extending from about 3.0 m to 35 m surveyed.

The basal layer is highly varied across the site and depth, from soft to welded to trachytic tuffs. The velocity profiles suggested water saturation from an average depth of 10 m.

No cavities and faults were detected at the site as shown in figure 54 below.

Despite high variation in the basal layer, it is expected to be sound and able to support light-moderately light structures. Figure 53 below shows the seismic model to the maximum depth of about 35m.

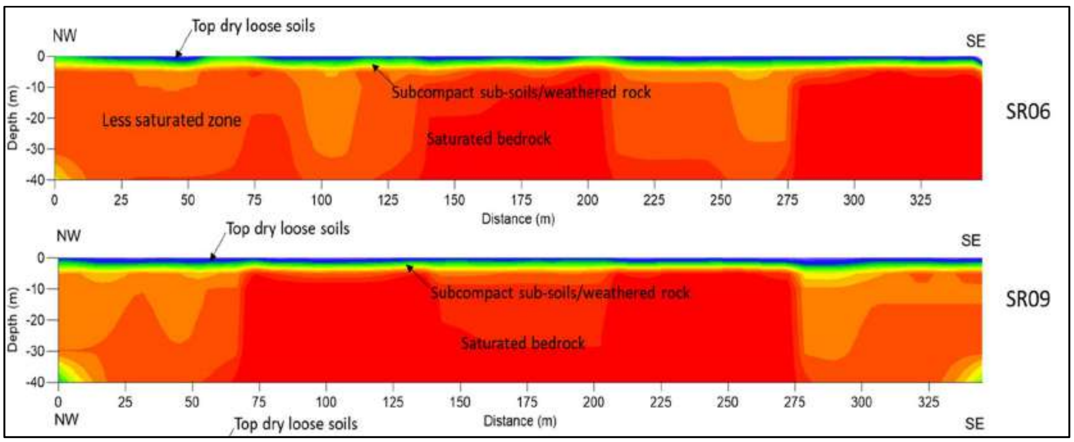

Figure 54: seismic model a three-layered earth model to the maximum depth of about 35m

5.2.6 Climate and Meteorological Conditions

- ***General Conditions***

Under the Koppen Climate Classification, Nairobi has a Subtropical Highland Climate. The rainfall is bimodal with long rains occurring between March and May while the short rains are in August to November. The sunniest and warmest part of the year is from December to March, when temperatures average the mid-twenties during the day. The rainfall ranges between 750mm to 1500 mm, with a mean annual rainfall of 1750mm. The temperature varies from 17^0C to 27^0C. June and July are the months with lowest temperature while the hottest months are January, September with temperatures from 25^0C to 27^0C. Figure 56 below shows the temperature graph for Ruai.

- ***Rainfall***

The rainfall pattern is only moderately favorable, and the volume gradually decreases with the falling elevation from west to east. As in most parts of Central Kenya, the distribution is bimodal, with two distinct dry periods, and two intermittent rainy seasons. The rainy seasons are from March to May, and from October to December. These six months' account for approximately 82% of the annual rainfall. The least amount of rainfall occurs in July. The average in this month is 14 mm | 0.6 inch. Most precipitation falls in November, with an average of 136 mm | 5.4 inch as shown in figure 55 below.

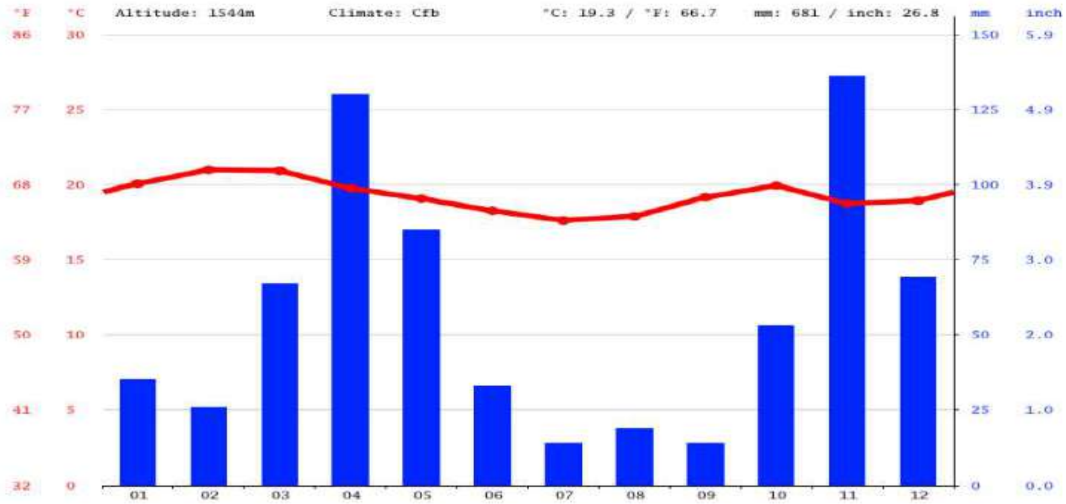

Figure 55: Rainfall Graph for Ruai (source: climate-data.org)

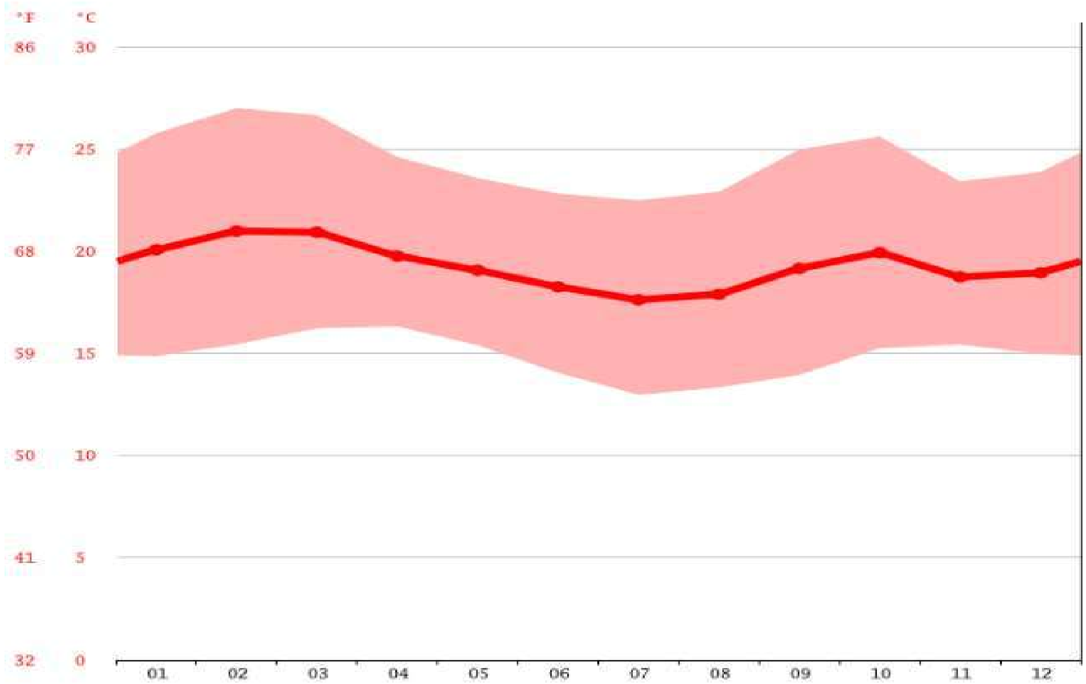

Figure 56: Temperature Graph for Ruai (source: climate-data.org)

- ***Temperature***

The temperatures are highest on average in February, at around 21.0 °C | 69.8 °F. In July, the average temperature is 17.6 °C | 63.7 °F. It is the lowest average temperature of the whole year.

- ***Relative Humidity***

The relative humidity is normally in the range of 55% to 80% of the potential evapo- transpiration within the project area. The lowest temperature occurs in the months of July to August that coincides with the lowest evapo-transpiration amounts. Generally, in the drier months, the evapo-transpiration exceeds rainfall amounts. Maximum wet bulb temperature (WBT) has been observed as 28.2 ^{0}C. Therefore, the approach has been designed at 30^{0}C temperature on conservative side. If the wet bulb temperature is lower, the approach would be better for the effective cooling of the condensate in the cooling tower cells.

5.2.7 Noise Environment

The ambient noise levels of 48.4 dB (A) and 52.6 dB (A) were measured from 6 points at the site from 21st to 27th September 2021 using a Sound Level Meter model Larson Davis LxT Type I integrating sound level meter as guided by the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 and the Factories and other places of work (Noise Prevention and Control) Rules 2005 and in accordance with international noise standards, in particular ISO 1996:1822 - Acoustic Description and Measurement of Environmental Noise. Measurements to quantify noise levels have been undertaken inside and around the project site. The proposed project area is located inside an open field owned by the Ruai Water and Sewerage Company. The tables 14 to 16 below show the noise monitoring locations and sampling results for both day and night while figure 56 show noise level measurement in progress.

- ***Sampling and Analysis***

The site noise sampling was done for the following points as referenced by GPS coordinates in table 14 below and noise measurement equipment used depicted by figure 57 below;

Table 14: Noise monitoring points/locations

Site ID	GPS location
SP1	1°12'39.20"S , 37° 3'55.14"E
SP2	1°12'28.30"S , 37° 3'48.84"E
SP3	1°12'32.45"S , 37° 3'40.96"E
SP4	1°12'39.80"S , 37° 3'31.55"E
SP5	1°12'44.64"S , 37° 3'45.78"E
SP6	1°12'50.44"S , 37° 3'36.87"E

Figure 57: Noise level measurement in progress at SP6.

- ***Result and Discussion***

Table 15: Diurnal noise levels results

Monitoring Point	Monitoring dates	Lmin (dB)	Lmax (dB)	Leq (dB)	EMC limits (dB)
SP1	21- 22September 2021	29.6	60.2	36.6	35
SP2	22- 23 September 2021	25.6	43.0	32.6	35
SP3	23- 24 September 2021	28.3	44.5	31.7	35
SP4	24-25 September 2021	24.1	50.7	33.7	35
SP5	25 -26 September 2021	26.4	60.3	34.2	35
SP6	26 -27 September 2021	27.0	55.6	33.8	35

Table 16: Nocturnal Noise Levels Results

Monitoring Point	Monitoring dates	Lmin (dB)	Lmax (dB)	Leq (dB)	EMC limits (dB)
SP1	21 September 2021	29.3	69.3	43.8	50
SP2	22 September 2021	42.7	43.0	44.3	50
SP3	23 September 2021	31.1	51.4	40.7	50
SP4	24 September 2021	29.9	83.1	49.0	50
SP5	25 September 2021	29.3	79.3	45.3	50
SP6	26 September 2021	29.4	68.7	40.1	50

There are no major activities in the vicinity of the project site and is mainly characterized with movement of large herds of livestock. The nearest residential units are located approximately 700metres away. Assessments were conducted at the project site boundary fence. The project will involve development and operation of waste to energy conversion facilities.

Based on the results presented in the table 15 and 16 above, some of the average noise levels recorded at the proposed project components and selected sites were within permissible limits for residential areas as provided for in the EMC (Noise and Excessive Vibration Pollution Control) Regulations, 2009 which set the maximum limit as 55dB(A) as the occupational exposure level (OEL), during the day and 65 - 85 dB (A) for workshops and plant areas where occasional communication is required. These noise levels were largely influenced by sound from:

i. Herds of Livestock grazing around the area;
ii. Aircraft taking off from the JKIA and passing over the section;
iii. House construction activities including grinding and welding approximately 700 meters away from the site;
iv. Birds chirping, and dogs barking (this was especially during the nocturnal schedule).

The levels are expected to increase during construction and operation phases; however, implementation of the proposed recommended measures will keep the levels within the acceptable limits.

Baseline traffic volumes on the waste disposal routes are yet to be established at present and no traffic count has been completed at this stage. It is therefore recommended that a traffic count be completed along the main proposed route to the site, and in the main areas of residential dwelling likely to be affected by the increase in waste disposal trucks. Table 17 shows the standard permissible noise levels.

Table 17: EMC Maximum Permissible Noise levels- 1st & 2nd Schedules

Zone		*Sound Level Limits dB(A)* (Leq, 14 h)		*Noise Rating Level (NR)* (Leq, 14 h)	
		Day	Night	Day	Night
A.	Silent Zone	40	35	30	25
B	Places of worship	40	35	30	25
C.	Residential : Indoor	45	35	35	25
	Outdoor	50	35	40	25
D.	Mixed residential (with some commercial and places of entertainment)	55	35	50	25
E.	Commercial	60	35	55	25

Time Frame: Day: 6.01 a.m. – 8.00 p.m. (Leq, 14 h) Night: 8.01 p.m. – 6.00 a.m. (Leq, 10 h)

SECOND SCHEDULE

(r. 13(1), 14 (1)(b))

MAXIMUM PERMISSIBLE NOISE LEVELS FOR CONSTRUCTIONS SITES

(Measurement taken within the facility)

Facility		*Maximum Noise Level Permitted (Leq) in dB(A)*	
		Day	Night
(i)	Health facilities, educational institutions, homes for disabled etc.	60	35
(ii)	Residential	60	35
(iii)	Areas other than those prescribed in (i) and (ii)	75	65

Time Frame: Day: 6.01 a.m. – 6.00 p.m. (Leq, 12 h) Night: 6.01 p.m. – 6.00 a.m. (Leq, 12 h)

5.2.8 Water Resources Quality

The City of Nairobi is traversed by three (3) main rivers that compose the Nairobi River Basin, namely; Nairobi River, Ngong River and Mathare River. These rivers join east of Nairobi to discharge finally into the Athi River. The rivers are highly polluted by domestic and industrial wastewaters and solid waste. The Motoine River flows into the Nairobi Dam and leaves as the Ngong River, passing through the Industrial Area where it receives industrial wastewater before its confluence with Nairobi River near the Njiru Shopping Centre. The Motoine River receives agrochemical pollutants from its water head at Dagoretti area and, as it flows eastwards, receives uncollected wastes and untreated sewage from the Kibera slum before entering the Nairobi Dam.

These Regulations (Environmental Management and Coordination, (Water Quality) Regulations 2006) shall apply to drinking water, water used for industrial purposes, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife, and water used for any other purposes. Limits prescribed in the first schedule of the regulations for sources of domestic water have been used for comparison against the obtained river water results as shown in table 18 below.

Table 18: Kenya discharge guidelines for wastewater

Parameter	Discharge in Public Sewers (mg/l)	Discharge into water bodies (mg/l)	Stds for sources of Domestic Water
PH	6.0 – 9.0	6.0 – 9.0	6.5-8.5
BOD_5 (20oC)	500	20	
COD	1000	50	
Suspended Solids	500	30	30
Detergents	30	Nil	
Heavy metals (combined)	1	0.1	
Oils/Grease	50	Nil	
Nitrates (TN)	20	10	
Phosphates (TP)	30	5	
Conductivity	-	1500 uS/cm	
4hr PV Value	No limits	20	
Fecal Coliforms	No limits	1000/100ml for large water bodies, otherwise <10/ml)	Nil/100 ml
Sulphates	-	500	
Dissolved Oxygen	No limits	2	
Phenols	-	2	
Cyanides	-	0.1	
Chlorides	-	1000	
PCB	-	0.003	
Color	No limits	5 Hazen Units	
Odor	No limits	Not objectionable	

(Sources: Department of Water Development)

- ***Sampling and Analysis***

A *Solinst Model 425 Discrete Interval Sampler* (DIS) was used to collect water samples as in table 19.Figure 58 shows the water sampling in progress.

Table 19: Borehole Water Sampling points

Sample ID	Location	GPS	Sampling depth (meters)
Sample A- water sample	Nairobi River water- next to P4 site boundary corner	1°12'31.27"S, 37° 3'31.98"E	-

Sample B – water sample	Borehole water- B/H 01	1°12'42.06"S, 37° 3'36.13"E	23

Date of sampling- 30th September 2021

Figure 58: River water and Borehole water sampling in progress respectively

- ***Result and Discussion***

Surface & underground water sampling was undertaken to ascertain the water health condition based on several parameters. 2No samples each were collected from Nairobi River Water, Nairobi Water Sewerage Treatment Ponds and borehole wells. During the sampling survey, samples were collected for microbiological analysis and physico-chemical analysis as represented in tables 21,22 & 23 below. The results of the water quality laboratory analysis indicate that the water quality parameters of the samples collected at the selected sites were not within the recommended national as represented in tables 20 and WHO potable water standards given Phenols, Fluorides, Copper, Zinc, Total Nitrogen and E-coli were above respective stipulated limits. All other parameters tested are within the respective legal guide values. The pollution is attributed to the low lying area of the site for the ground water besides poor waste handling and disposal in the County in particular poor disposal of waste into water bodies.

Table 20: water sampling results summary for Sewerage Treatment effluent, River Water, Borehole wells and Recommended Standards

Parameter exceeding recommended Max. limits	Sewerage Treatment effluent / Standard (Max Limits) (mg/l)	River Water / Standard (Max Limits) (mg/l)	Borehole wells/ Standard (Max Limits) (mg/l)
Fluorides	3.2/ 1.5	1.6/ 1.5	5.9/ 1.5
Phenols	1.2/ 0.001	0.8/Nil	0.3/Nil
Copper	0.9/ 1.0	0.4/ 0.05	0.26/ 0.05
Zinc	4.56/ 0.5	1.98/1.5	2.34/1.5
Total Nitrogen	6.2	3.96/ 3.0	1.24/ 3.0
E-coli	250/ Nil/100ml	144/ Nil/100ml	100/ Nil/100ml
Total Dissolved Solids (TDS)	890/ 1200	442/ 1200	446/ 1200

Total Suspended Solids (TSS)	26/ 30	0.1/ 30	28/ 30

The baseline data obtained is representative of the soil and water quality at all the measurement locations and can be used to compare subsequent levels when the project is under construction and at its operational phases. The laboratory results report recommended water quality analysis to ensure the water is maintained at the recommended parameters as the WHO standards and KEBS (KS 459-1:2007) standards.

Standard values quoted from environment management & coordination (water quality) regulations 2006, Legal Notice No. 120 1st Schedule for quality standards for sources of domestic water.

Water quality analysis results for the waste water treatment plant's effluent, indicates higher concentration values for the physio-chemical elements tested (more so for Phenols, Zinc, Fluoride, Total Nitrogen & E. coli) compared to the river water into which the waste water treatment plant directly discharges its effluent.

Table 21: Water Quality laboratory test results for the river water

Lab Works East Africa LTD
P.O.Box 6459-00100
Shelter Afrique Centre, 3rd Floor Wing 3A
Upperhill Nairobi Kenya
Phone: +2540202724481 Fax:
technical@labworksea.com

KENAS

Client : Enviropro Kenya Ltd
Address : Kiambu Road 00100, Ruai Sewerage Plant - Waste to energy Project

LABORATORY TEST REPORT

Date Received : 04/10/2021
Date Started : 04/10/2021
Date Completed : 09/10/2021
External Sample ID : Sample A - River Water

Batch No : 21/0187
Sample Ref: LW1234
Sampled By: Client
Report Date: 09/10/2021

PARAMETER	METHOD	RESULTS	Low	Opt	High	Standard (Max Limits)
Chemical Analysis						
pH	ISO 10523	7.370				6.5-8.5
Total Suspended Solutes, TSS, mg/l	APHA 2120 B	0.1				30
Nitrites, mg/l	ISO 6777	0.04				x
Lead as Pb, mg/l	ISO 8288	<0.01				0.05
TDS, mg/l	ASTM D 5907	442				1200
Fluoride, mg/l	ISO 10359	1.6				1.5
Phenols, mg/l	LWTP 023	0.8				Nil
Cadmium, mg/l	ISO 8288	<0.001				0.01
Selenium, mg/l	ISO 8288	<0.001				0.01
Arsenic as As, mg/l	ASTM D2972-15	<0.001				0.01
Copper as Cu, mg/l	ISO 8288	0.40				0.05
Permanganate Value, mg/l	LWTP028	<0.1				1
Alkyl benzyl Sulfonates (Anionic Surfurcatants)	LWTP034	0.90				0.5
Zinc as Zn, mg/l	ISO 8288	1.98				1.5
Total Nitrogen as N, mg/l	LWTP 037	3.96				0.5
Microbial Analysis						
E. coli, cfu/100ml	ISO 9308-1	144				Nil

Table 22: Water Quality laboratory test results for Nairobi Water Sewerage Treatment Ponds

Lab Works
Lab Works East Africa LTD
P.O.Box 6459-00100
Shelter Afrique Centre, 3rd Floor Wing 3A
Upperhill Nairobi Kenya
Phone: +2540202724481 Fax:
technical@labworksea.com

KENAS

Client : Enviropro Kenya Ltd
Address : Kiambu Road 00100, Ruai Sewerage Plant - Waste to energy Project

LABORATORY TEST REPORT

Date Received : 14/12/2021 — **Batch No :** 21/0212
Date Started : 20/12/2021 — **Sample Ref:** LW1356
Date Completed : 20/12/2021 — **Sampled By:** Client
External Sample ID : Sewer Water — **Report Date:** 20/12/2021

PARAMETER	METHOD	RESULTS	Low	Opt	High	Standard (Max Limits)
Chemical Analysis						
pH	ISO 10523	6.890				6.5-8.5
Total Suspended Solutes, TSS, mg/l	APHA 2120 B	26				30
Nitrites, mg/l	ISO 6777	1.2				3
Lead as Pb, mg/l	ISO 8288	<0.01				0.05
TDS, mg/l	ASTM D 5907	890				1200
Fluoride, mg/l	ISO 10359	3.2				1.5
Phenols, mg/l	LWTP 023	1.2				Nil
Cadmium, mg/l	ISO 8288	<0.001				0.01
Selenium, mg/l	ISO 8288	<0.001				0.01
Arsenic as As, mg/l	ASTM D2972-15	<0.001				0.01
Copper as Cu, mg/l	ISO 8288	0.90				0.05
Permanganate Value, mg/l	LWTP028	<0.1				1
Alkyl benzyl Sulfonates (Anionic Surfurcatants)	LWTP034	1.10				0.5
Zinc as Zn, mg/l	ISO 8288	4.56				1.5
Total Nitrogen as N, mg/l	LWTP 037	6.20				0.5
Microbial Analysis						
E. coli, cfu/100ml	ISO 9308-1	250				Nil

Notes

Standard values quoted from environment management & coordination (water quality) regulations 2006, legal Notice No. 120 1ST Schedule for quality standards for sources of domestic water.

< means less than detection limit

Results provided in this test report apply to the sample as received by the laboratory

Measurement uncertainties can only be availed upon request.

ISO - International Organization for Standardization APHA- American Public Health Association

ASTM- American standard test methods

AOAC- Association of Official Analytical Chemists

LWTP and LWTM - Lab Works Procedure adopted from ISO and APHA Methods

1

INTERPRETATION OF ANALYSIS RESULTS
The sample performed as shown above.

Authorized signatory:	Technical signatory:	Technical signatory:
Jacob Kipkoech	Beatrice Wanjiru	David Muiruri

1

Table 23: Water Quality laboratory test results for the Borehole water

Lab Works East Africa LTD
P.O Box 6459-00100
Shelter Afrique Centre, 3rd Floor Wing 3A
Upperhill Nairobi Kenya
Phone: +2540202724481 Fax:
technical@labworksea.com

Client : Enviropro Kenya Ltd
Address : Kiambu Road 00100, Ruai Sewerage Plant - Waste to energy Project

LABORATORY TEST REPORT

Date Received : 04/10/2021
Date Started : 04/10/2021
Date Completed : 09/10/2021
External Sample ID : Sample B - Borehole Water

Batch No : 21/0187
Sample Ref: LW1235
Sampled By: Client
Report Date: 09/10/2021

PARAMETER	METHOD	RESULTS	Low	Opt	High	Standard (Max Limits)
Chemical Analysis						
pH	ISO 10523	7.810				6.5-8.5
Total Suspended Solutes, TSS, mg/l	APHA 2120 B	28				30
Nitrites, mg/l	ISO 6777	0.05				x
Lead as Pb, mg/l	ISO 8288	<0.01				0.05
TDS, mg/l	ASTM D 5907	446				1200
Fluoride, mg/l	ISO 10359	5.9				1.5
Phenols, mg/l	LWTP 023	0.3				Nil
Cadmium, mg/l	ISO 8288	<0.001				0.01
Selenium, mg/l	ISO 8288	<0.001				0.01
Arsenic as As, mg/l	ASTM D2972-15	<0.001				0.01
Copper as Cu, mg/l	ISO 8288	0.26				0.05
Permanganate Value, mg/l	LWTP028	<0.1				1
Alkyl benzyl Sulfonates (Anionic Surfactants)	LWTP034	0.20				0.5
Zinc as Zn, mg/l	ISO 8288	2.34				1.5
Total Nitrogen as N, mg/l	LWTP 037	1.24				0.5
Microbial Analysis						
E. coli, cfu/100ml	ISO 9308-1	100				Nil

Table Result Legend

- ISO - International Organization for Standardization APHA- American Public Health Association
- ASTM- American standard test methods
- AOAC- Association of Official Analytical Chemists
- LWTP and LWTM - Lab Works Procedure adopted from ISO and APHA Methods

5.2.9 Ambient Air Quality

The proposed project site is located within a peri-urban set up and there are few industrial or commercial activities that could cause significant air pollution. The monthly average wind speeds range from 2 m/s to 5 m/s blowing from North West to East direction. Dispersion of atmospheric pollutants is a function of the prevailing wind characteristics at any site.

The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (Cowherd et al, 1998; Cowherd et al, 2010). Wind speed greater than 5.4 m/s leads to erosion of loose dust PM and enhances the degree of dispersion across the landscape. Wind speed at the project area over the monitoring period indicates diurnal mean wind speed ranged from 2 m/s to 6 m/s. Wind speeds were highest in the evening hours and much lower in the night.

Air quality survey was undertaken at 3 points of the project site to determine the baseline air quality as contained in the Environment Management and Coordination Act (EMCA), No. 8 of 1999 using the AQM-09 air quality monitor for Henan Oceanus. The survey analyzed air contaminants of concern; Particulate Matter (PM) with aerodynamic less than 10 micron and 2.5 micron (PM10 and PM2.5), Volatile Organic Compounds (VOCs), Sulphur Dioxide (SO2), and Nitrogen Dioxide (NO2), Carbon Monoxide (CO), Carbon Dioxide (CO2).

The results obtained were well within WHO Air Quality Guidelines-Global Update 2005 and Kenyan standards; Environmental Management and Coordination (Air Quality) Regulations 2014, Third Schedule, Emission Limits for Controlled and Non-Controlled Facilities. The air quality is expected to be impacted by construction, operation and demolition activities; however, implementation of the proposed recommended measures will keep the levels within the acceptable limits. Table 25 & 26 below shows the locations of ambient air monitoring while figure 59 shows the monitoring in progress.

- **Sampling and Analysis**

Table 24: Ambient air monitoring points/ Locations

Site ID	GPS location	Sampling Date
SP1	1°12'31.44"S , 37° 3'51.74"E	24th -25th Sep 2021
SP2	1°12'47.53"S , 37° 3'35.96"E	25th -26th Sep 2021
SP3	1°12'38.64"S , 37° 3'31.89"E	26th -27th Sep 2021

Figure 59: Air Quality Monitoring in progress at SP2

- **Results and Discussion**

The main pollutants of concern often associated with construction and operations encompass PM10 and PM2.5, VOCs, SO2, NO2 and CO2. These pollutants result from a wide range of activities, i.e., excavation, hauling of material, material handling and combustion emissions from diesel engines on site. Progress towards the guideline values should, however, be the ultimate objective of air quality management and health risk reduction in all areas. The results below indicate that the ambient air quality of the sampled locations were within the criteria stipulated in the Kenyan Regulatory Limits – Environmental Management and Coordination (Air Quality) Regulations, 2014 and the WHO/IFC Standards. Table 25 & 26 show particulate matter and gaseous pollutant monitoring results respectively.

Table 25: Particulate Matter (PM) Monitoring results

Monitoring Point	Monitoring dates	PM10 (µg/m3)	PM2.5 (µg/m3)
SP1	24th -25th Sep 2021	11	4
SP2	25th -26th Sep 2021	8	4
SP3	26th -27th Sep 2021	9	5
Regulatory Limits		**100 (EMCA, 1999)**	**25 (WHO guideline)**

Table 26: Gaseous Pollutants Monitoring results

Parameters	Units	SP1	SP2	SP3	Regulatory Limits
Sulphur Dioxide, SO2	ppm	0.001	<0.001	0.001	0.048
Nitrogen Dioxide, NO2	ppm	0.025	0.013	0.020	0.1
Carbon Dioxide, CO2	ppm	142	178	182	n/a
Carbon Monoxide, CO	mg/m3	<0.01	<0.01	<0.01	2
Volatile Organic Compounds, VOCs	ppm	0.11	<0.1	0.1	n/a

In the absence of a local regulatory limit for PM$_{2.5}$, WHO guidelines were used to compare the obtained results in table 26 above. All the monitoring points reported values within the WHO guideline (25 µg/m3).

- **Atmospheric Dispersion Modelling**

The modern air dispersion models differ from the traditional models in several aspects with the most important one being the description of the atmospheric stability as a continuum rather than discrete classes. The atmospheric boundary layer properties are described by two parameters; the boundary layer depth and the Monin-Obukhov length (LMO) that provides a measure of the buoyancy generated by heating of the ground and the mechanical mixing generated by the frictional effect of the earth's surface.

During the day-time, the atmospheric boundary layer is characterized by thermal turbulence due to heating of the earth's surface. Night times are characterized by weak vertical mixing and the predominantly stable layer. The condition is normally associated with low wind speeds and less dilution potential. During windy and cloudy conditions, the atmosphere is normally neutral. For low level releases, the ground level concentrations normally occur during weak wind speeds and stable (nocturnal) atmospheric conditions. The AERMOD dispersion model was used in the estimation of upwind and downwind ground level concentration of the Sulphur Dioxide, Carbon Monoxide, Oxides of Nitrogen (NOx), and Particulate Matter; the main pollutants of concern for industry category (Municipal Waste Incinerators). Dispersion modelling was undertaken to determine the highest hourly, highest daily and the annual average ground level concentrations. The averaging periods were selected to facilitate comparisons of the simulated ground level concentrations to the ambient air quality criteria set out in the Kenyan Environmental Management and Coordination (Air Quality) Regulations, 2014.

The receptor domain adopted for the predictions of pollutant concentrations was a 3 x 2-kilometer rectangular extent around the plant. The receptor domain was segmented into uniform Cartesian grids of 21 meter by 21-meter dimensions to give a square grid network of 493 columns by 288 rows.

The study area domain was segmented into 441 receptor grid points at which the modelled concentration of each pollutant was generated. The network of receptor grid points was used as concentration data points in the software to interpolate a continuous surface and contours of pollutant concentrations across the modelling spatial domain. The frequency of occurrence of each stability class of the project area is indicated in table 27 below. Figure 60 shows the locations of the air quality receptors.

Table 27: Definitions of study area receptor grid Network as used in AERMOD view

Dimension	Interval (Meters)	No. of Rows/Columns	Total Extent (Meters)
Horizontal → East Direction	21	493	9871.40
Vertical → North Direction	21	288	5771.80

Sampling Points/Locations

Figure 60: Location of Air Quality Receptors

Latitude: 01° 12' 31.44"(S)
Longitude: 036° 3' 51.74"(E)

- **Results and Discussion**

Based on the modelling exercise under observed meteorological conditions, 24 hours' average maximum incremental GLC of PM2.5, PM10, SO2 NOx and CO are estimated to be as shown in table 28 below.

Table 28: Maximum Concentration Areas

Pollutant	Averaging Period	Maximum Concentration ($\mu g/m^3$)	Limits ($\mu g/m^3$)	Location	
				X(m)	Y(m)
PM_{10}	1h	1.262	N/A	284580.14	9866460.21
	24hs	0.323	150	284580.14	9866460.21
	Annual	0.104	70	284580.14	9866460.21
$PM_{2.5}$	1h	0.972	N/A	284580.14	9866460.21
	24hs	0.249	75	284580.14	9866460.21
	Annual	0.080	35	284580.14	9866460.21
NO_2	1h	11.65	N/A	284580.14	9866460.21
	24hs	2.980	150	284580.14	9866460.21
	Annual	0.956	80	284580.14	9866460.21
SO_2	1h	3.760	N/A	284580.14	9866460.21
	24hs	0.962	125	284580.14	9866460.21
	Annual	0.309	80	284580.14	9866460.21
CO	1h	12.64	N/A	284580.14	9866460.21
	24hs	3.240	2,000	284580.14	9866460.21
	Annual	1.037	N/A	284580.14	9866460.21

The spatial distribution of ground level incremental concentrations of $PM_{2.5}$, PM_{10}, SO_2, NO_x, and CO on the impact zone area of 3 x 2-kilometer rectangular extent around the plant on modelling grid size of into uniform Cartesian grids of 21 meter by 21-meter dimensions around the proposed site are shown in Figure 61-75 and the same is elaborated in table 28. Modelling result envisages that incremental ground level concentrations of modeled pollutants due to the waste to energy power plant's operations during the assumed aforesaid hours are negligible.

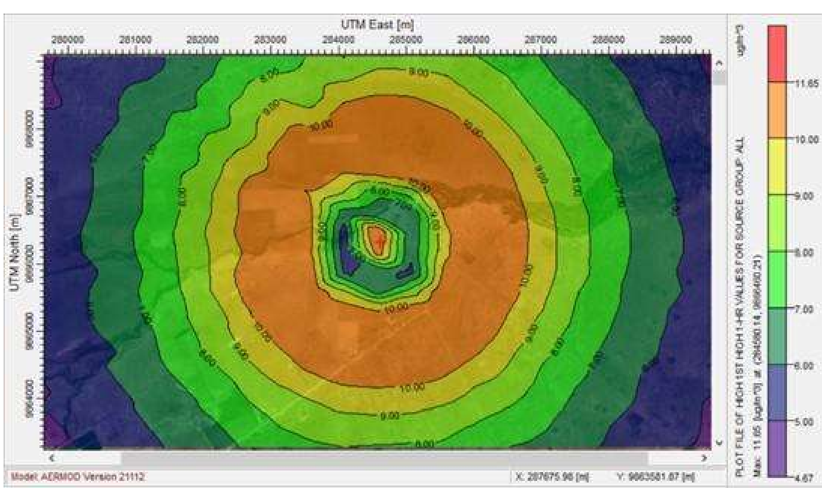

Figure 61: Maximum Ground Level 1 Hour NO2 Concentrations.

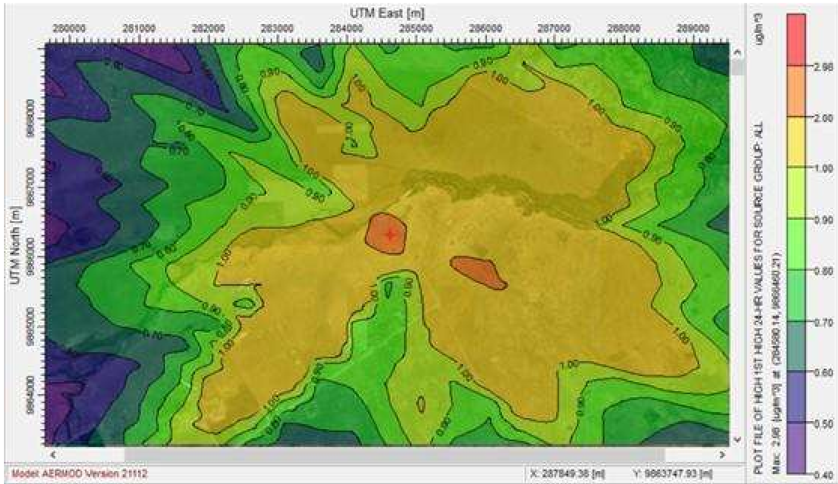

Figure 62: Maximum Ground Level 24-Hour NO2 Concentrations.

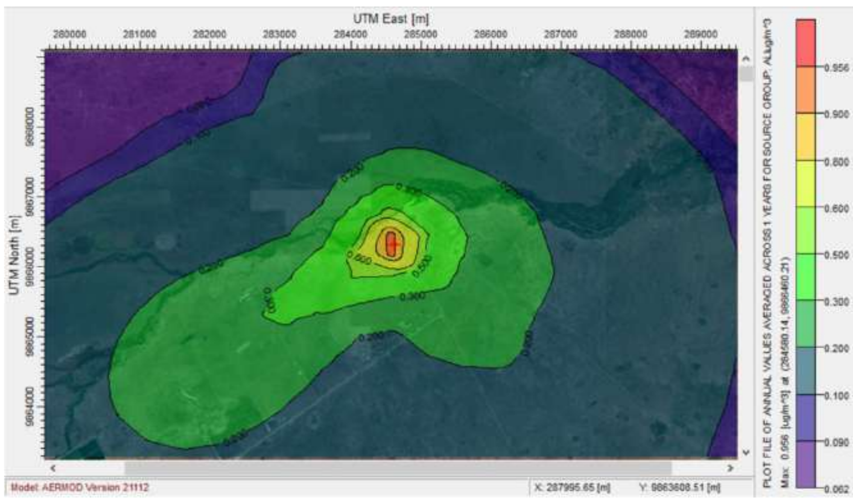

Figure 63: Maximum Ground Level Annual NO2 Concentrations.

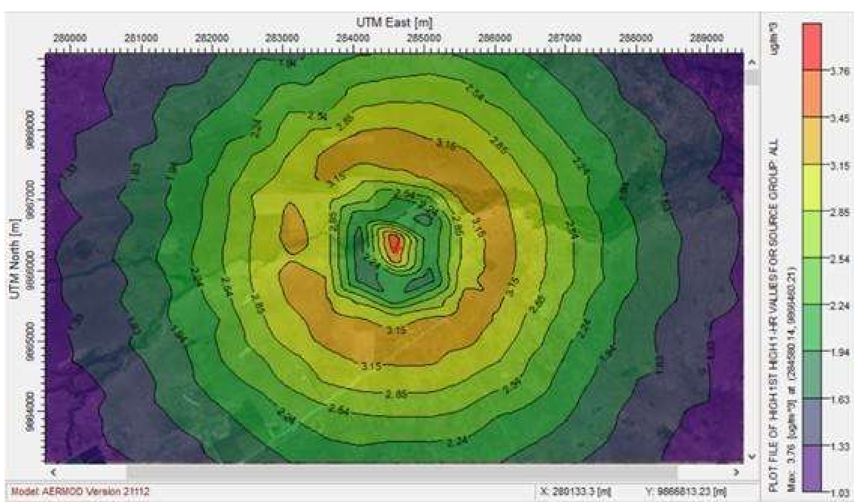

Figure 64: Maximum Ground Level 1 Hour SO2 Concentrations.

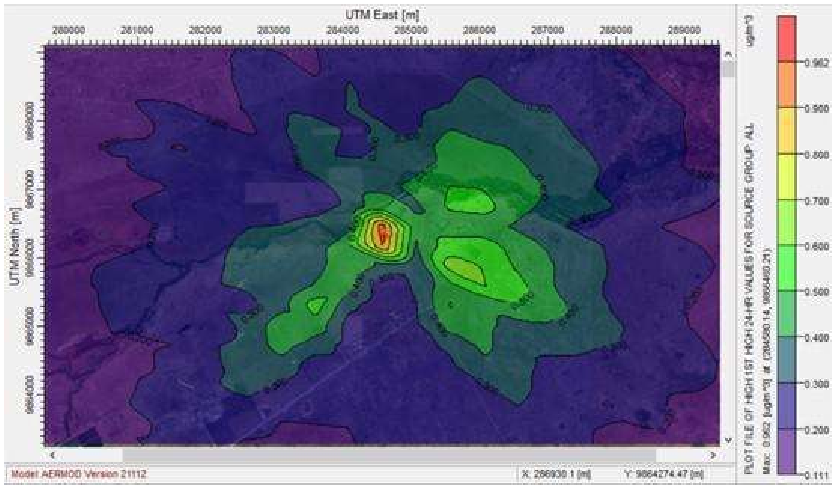

Figure 65: Maximum Ground Level 24-Hour SO2 Concentrations.

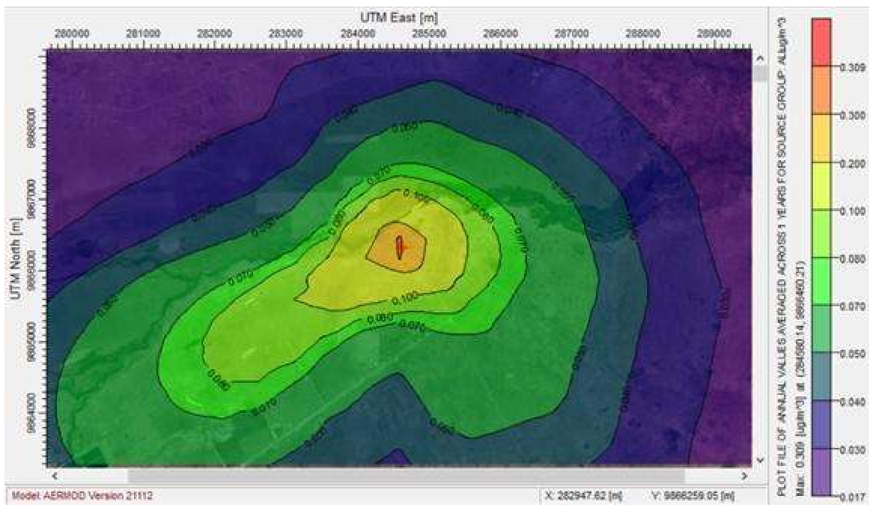

Figure 66: Maximum Ground Level Annual SO2 Concentrations.

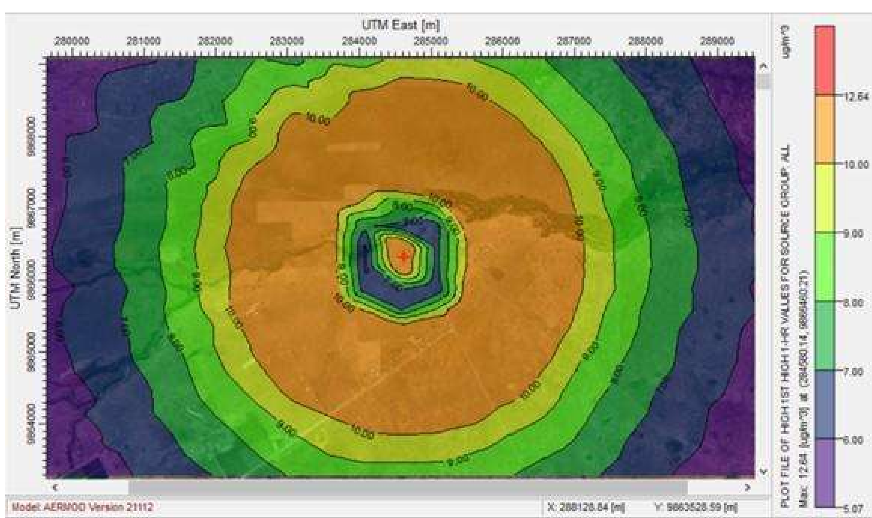

Figure 67: Maximum Ground Level 1hour CO Concentrations.

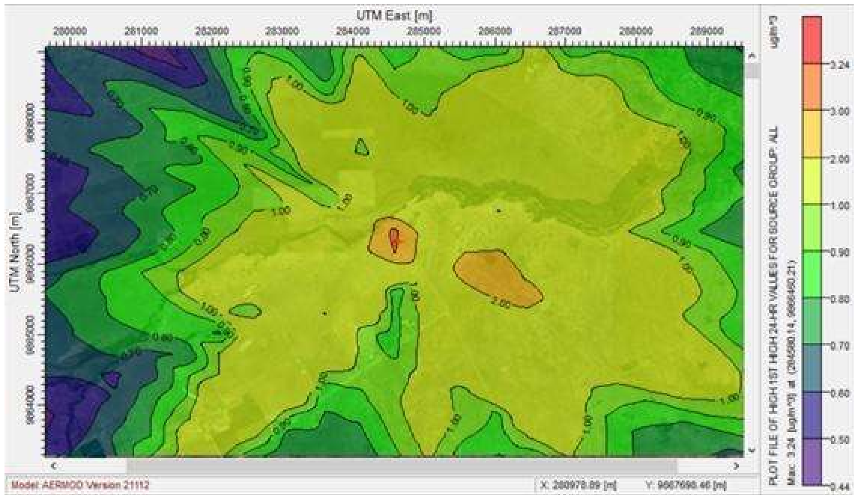

Figure 68: Maximum Ground Level 24-Hour CO Concentrations.

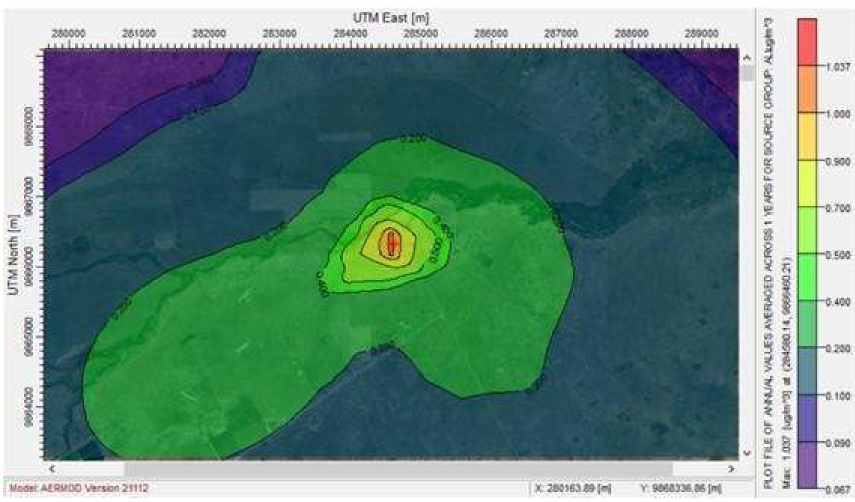

Figure 69: Maximum Ground Level Annual CO Concentrations.

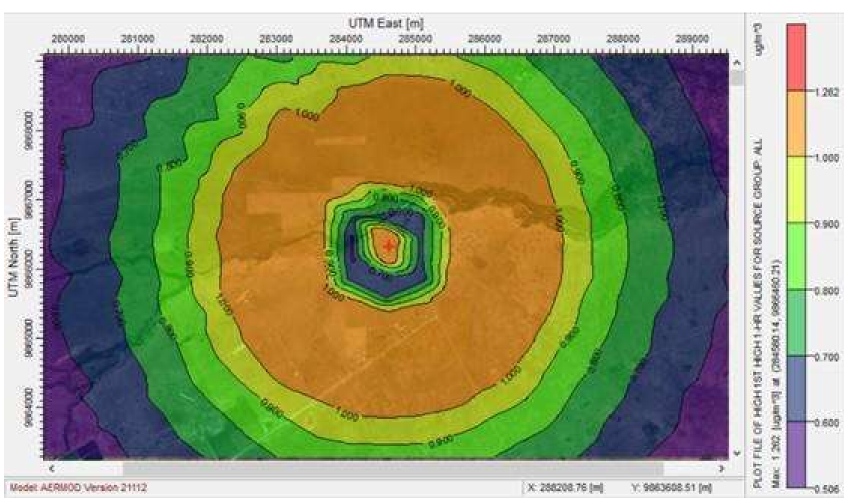

Figure 70: Maximum Ground Level 1 Hour PM10 Concentrations.

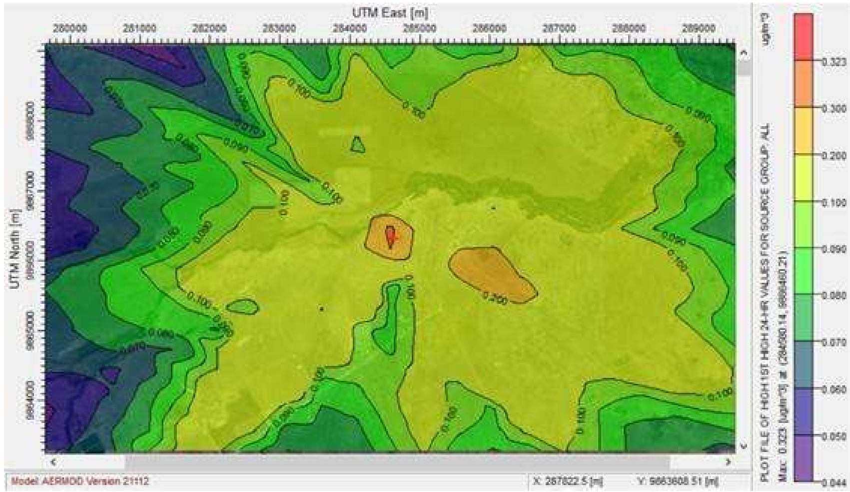

Figure 71: Maximum Ground Level 24-Hour PM10 Concentrations.

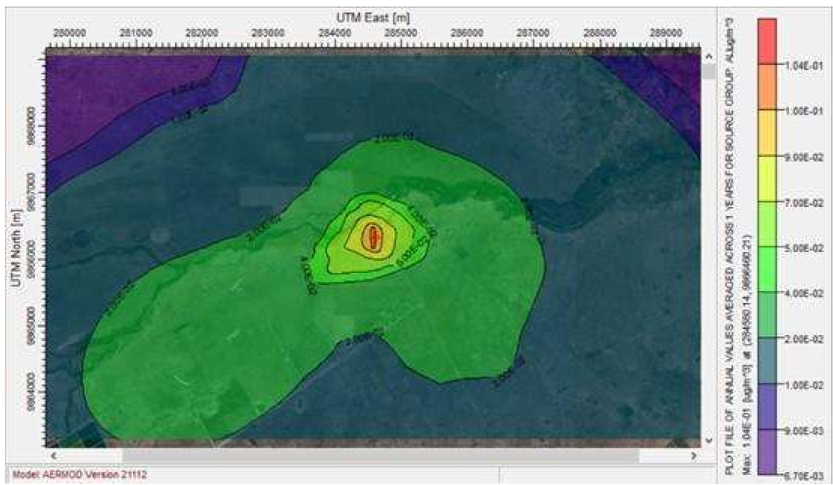

Figure 72: Maximum Ground Level Annual PM10 Concentrations.

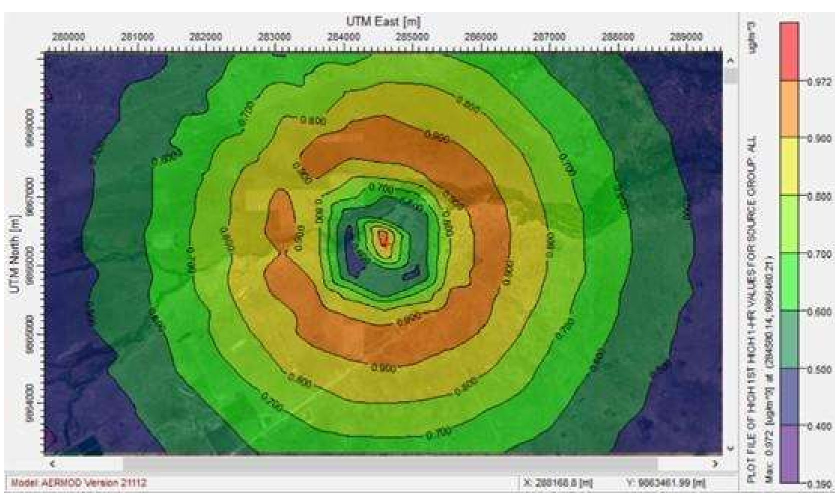

Figure 73: Maximum Ground Level 1 Hour PM2.5 Concentrations.

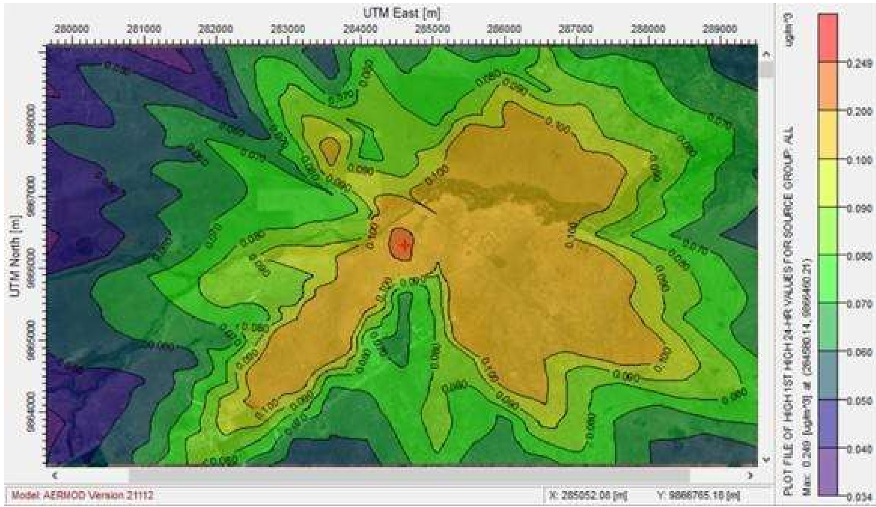

Figure 74: Maximum Ground Level 24 Hour PM2.5 Concentrations.

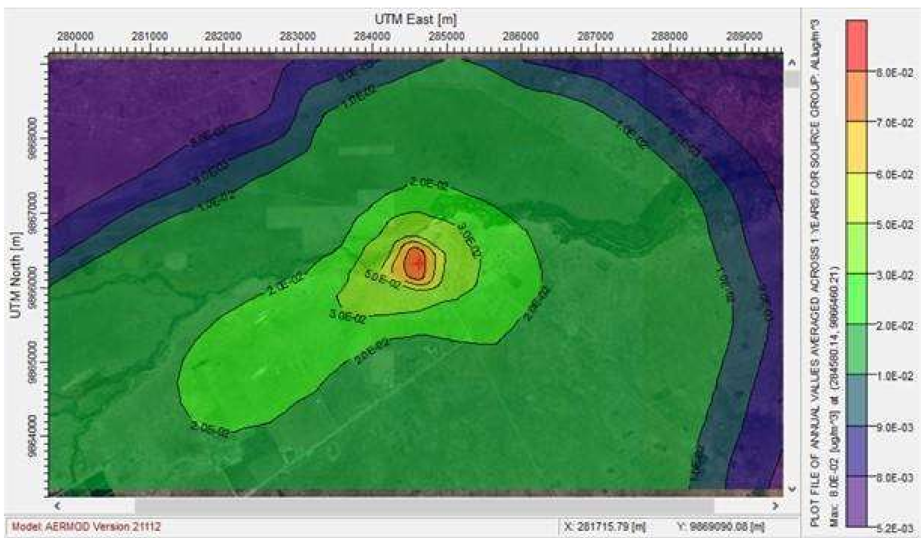

Figure 75: Maximum Ground Level Annual PM2.5 Concentrations.

The isopleths were used selectively to present areas of significance to the assessment criteria. Ground level concentration isopleths depict interpolated values from the concentrations simulated by AERMOD 10.0.1 for each of the receptor grid points specified.

The location of maximum peak concentration of pollutants is on the immediate South West side of the proposed plant therefore it is highly recommended that sensitive receptors such as offices should not be located on the SW side of the plant to avoid atmospheric pollution.

5.2.10 Wind Roses

The model has been prepared with surface data schedules for 3 years (temperature, wind speed, wind direction and cloud cover), considering in this case records from the three years as the most appropriate for modelling of the dispersion of pollutants. Wind roses comprise 36 spokes, which represent the directions from which winds blew during a specific period. Annual wind rose is presented in figure 76 below. The prevailing direction of wind is mainly from NE to SW at a speed of 5.70- 8.80m/s except during July- September when the wind predominantly flows from SE to NW at a speed of 3.60-5.70m/s. The seasonal wind roses are as presented from figure 76 to 85.

Annual Wind roses.

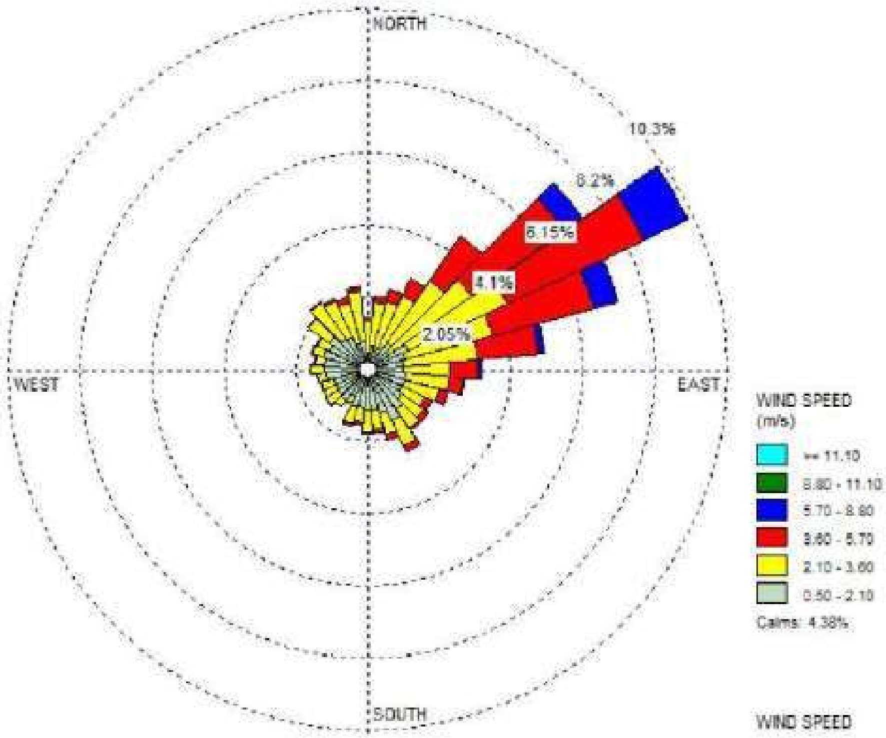

Figure 76: 24hr annual wind rose

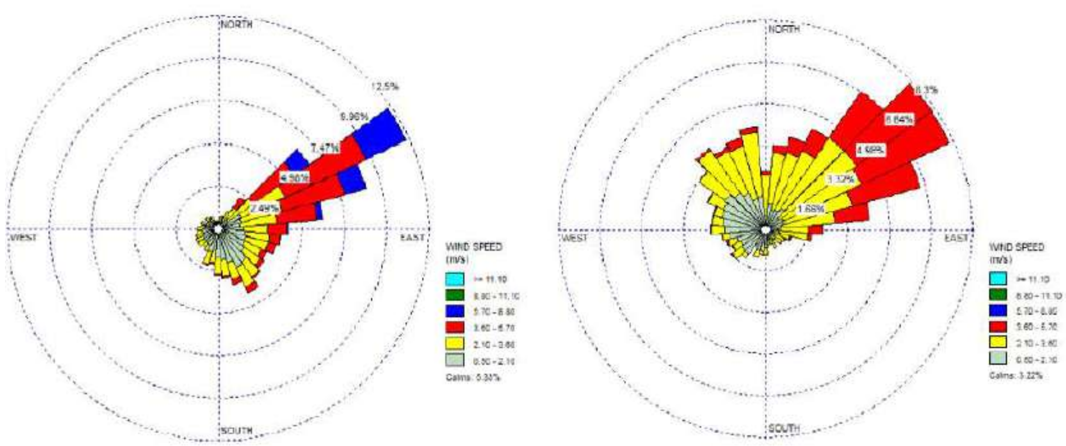

Figure 77: Diurnal and nocturnal wind roses respectively

April – June Wind roses

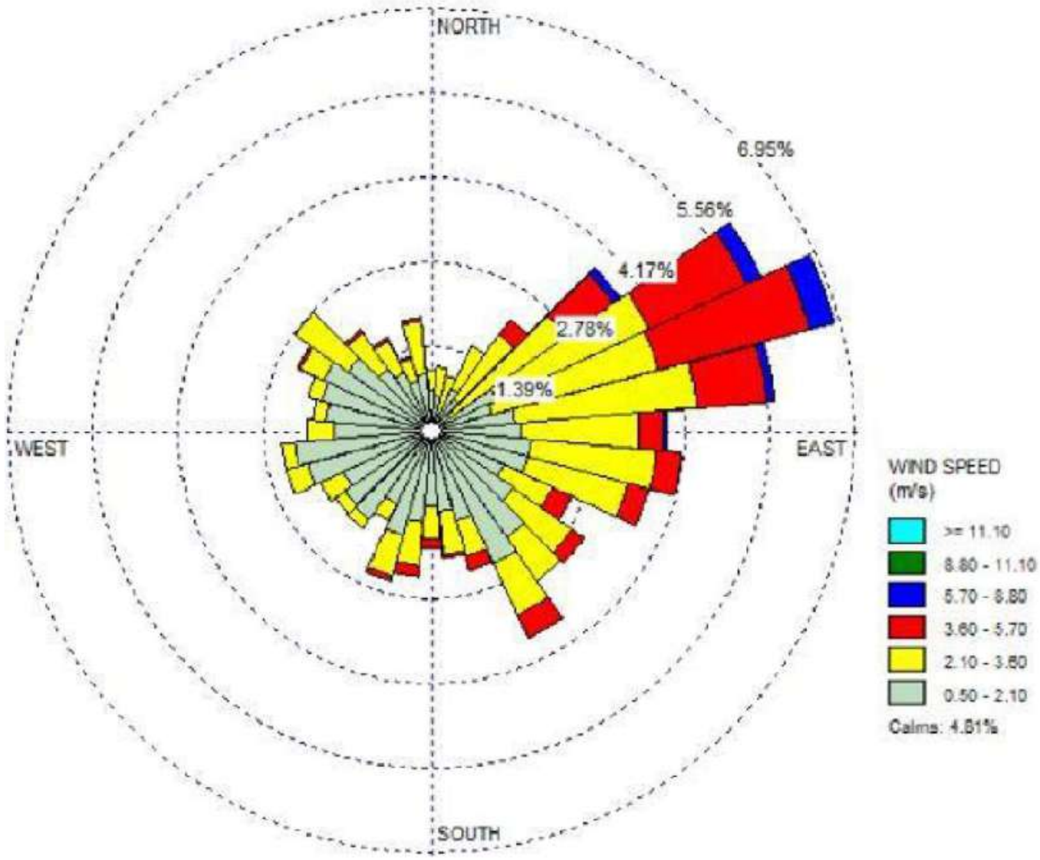

Figure 78: 24 hr. April - June wind rose

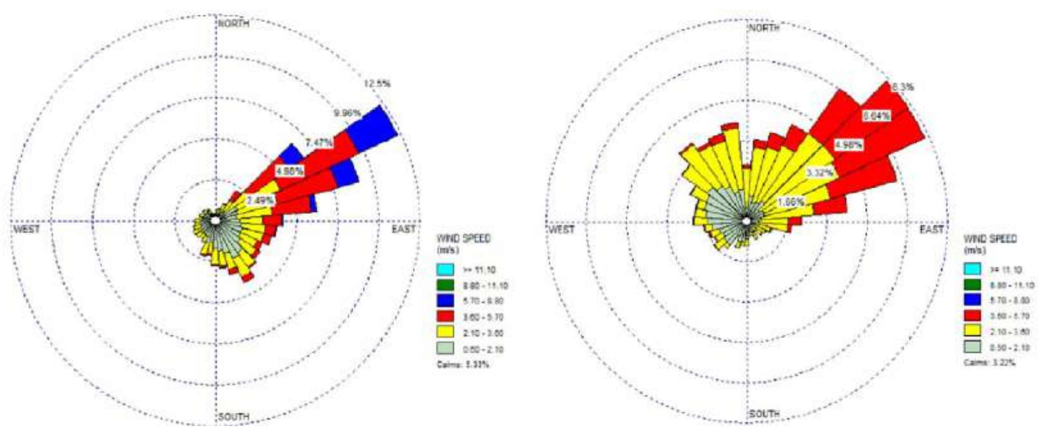

Figure 79: diurnal and nocturnal April - June wind rose

January – March Wind roses

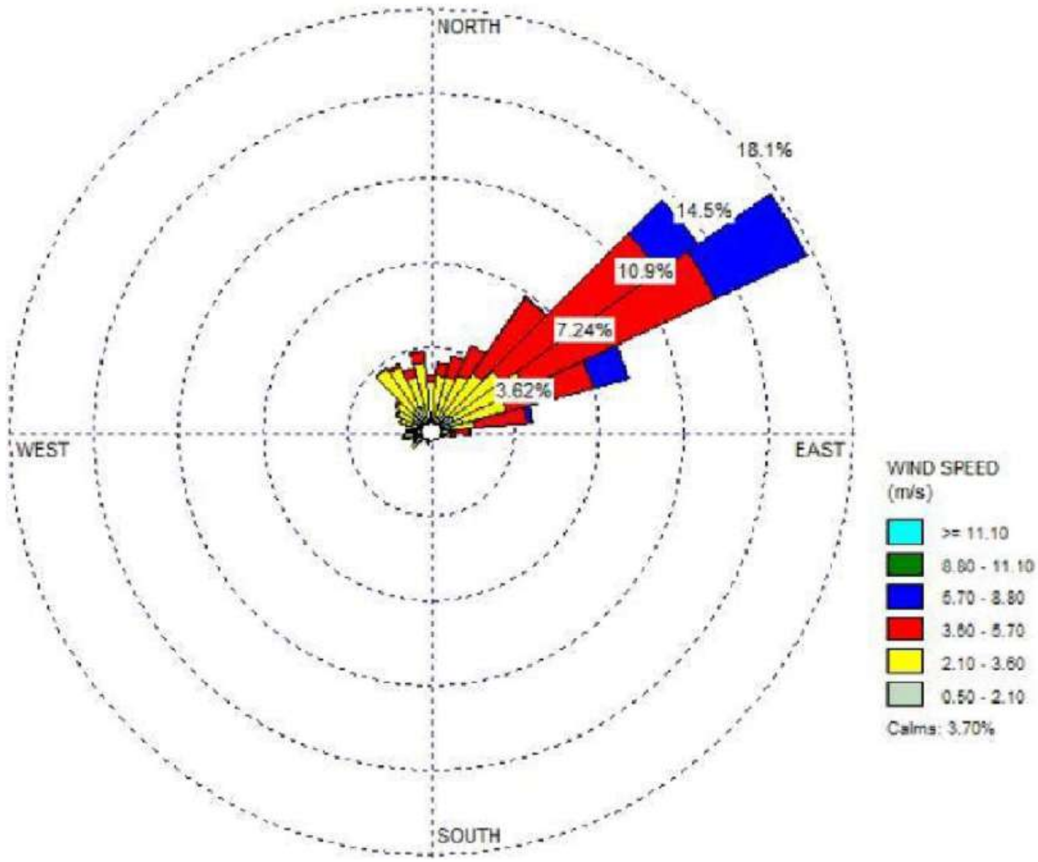

Figure 80: 24 hr. January - March Wind rose

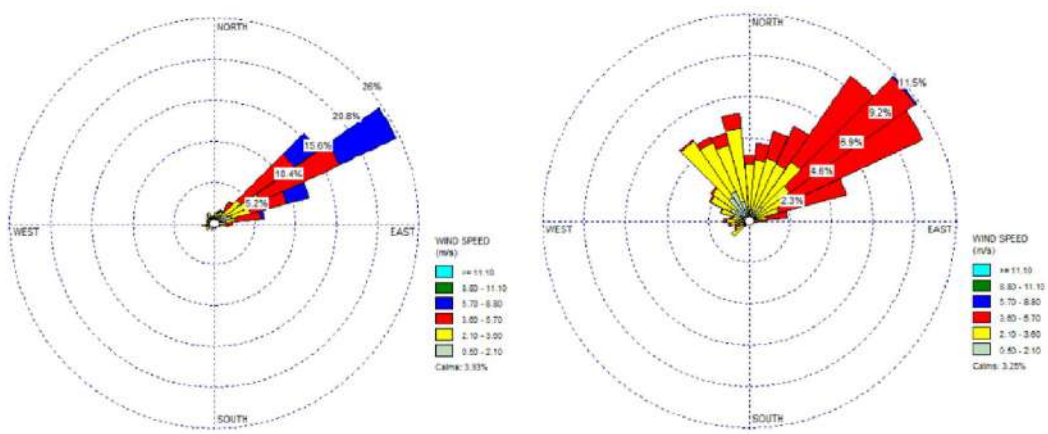

Figure 81: Diurnal and Nocturnal January - March Wind roses

July – September Wind roses

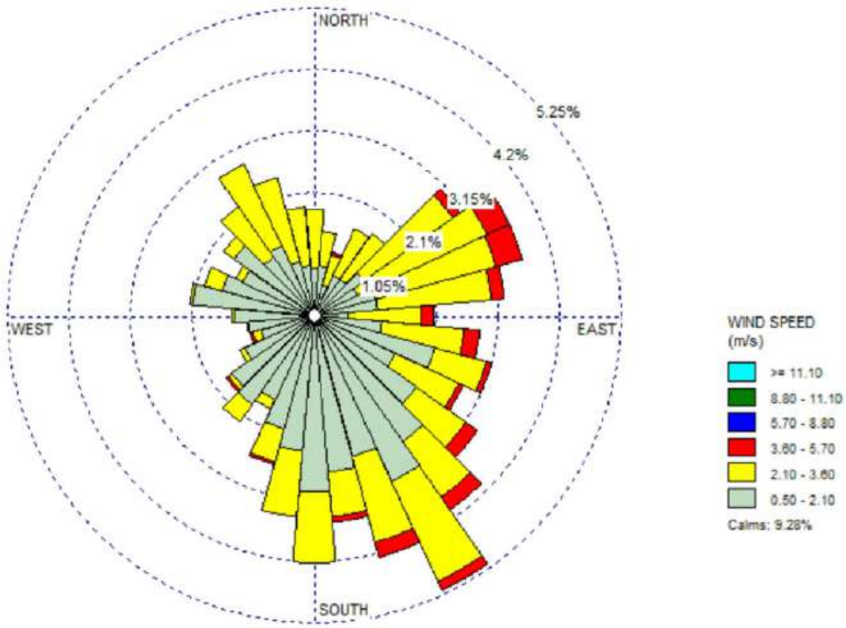

Figure 82: 24 hr. July - September wind rose

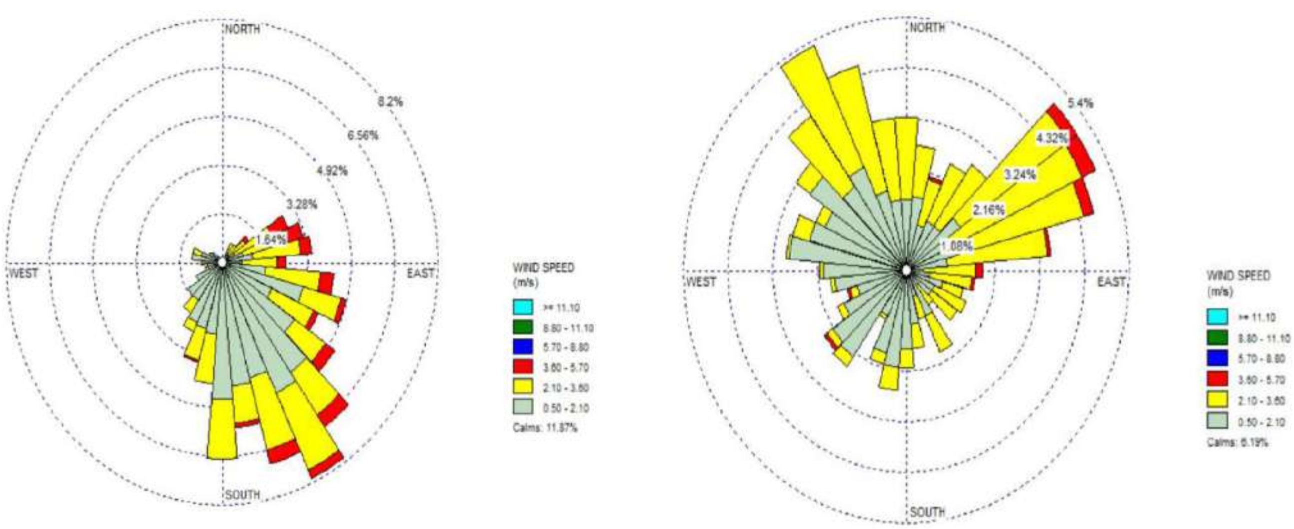

Figure 83: Diurnal and Nocturnal July - September wind roses

October – December Wind roses

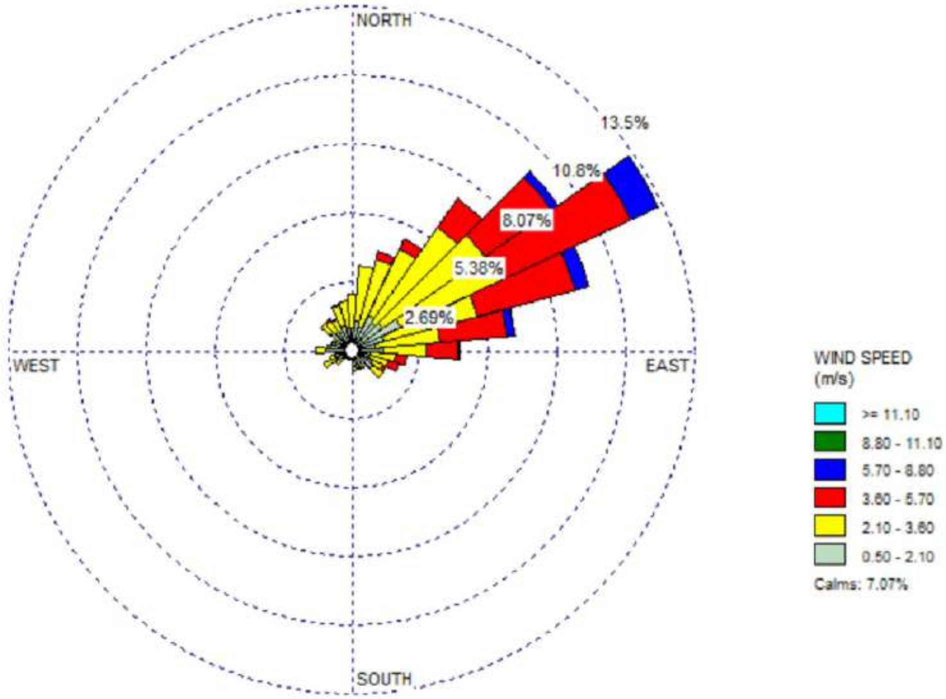

Figure 84: 24 hr. October - December wind rose

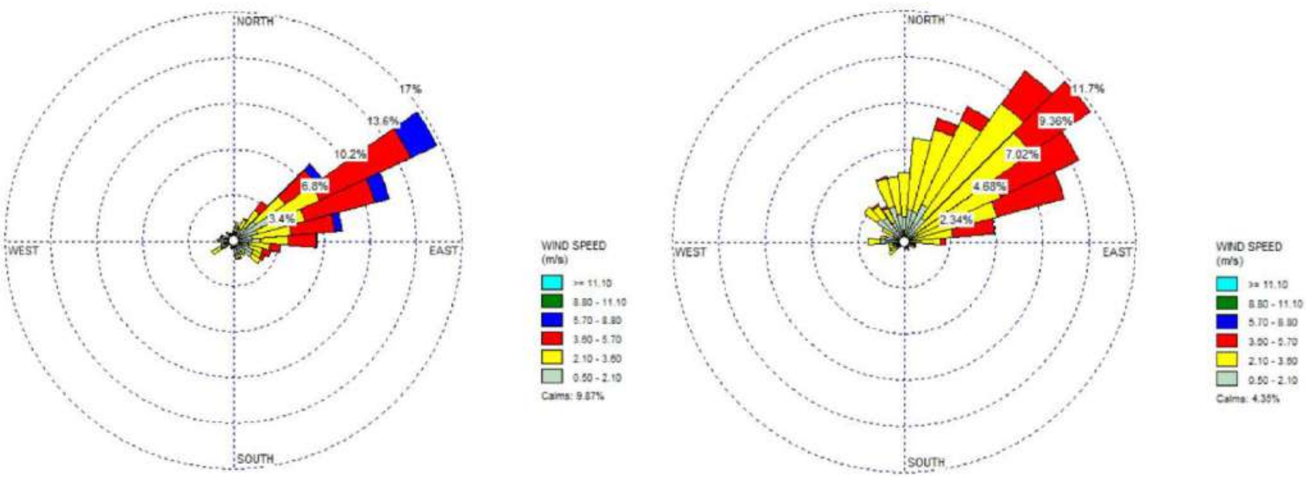

Figure 85: Diurnal and Nocturnal October - December Wind roses

5.2.11 Soil Quality

Soil is an important ecological factor supporting biodiversity on the earth for sustainable development. The productive status of soil needs to be maintained. The characterization of soil quality helps in assessing the health of the soil of the study.

In the absence of a local regulation on soil and groundwater water quality, the Dutch guidelines were adopted. This Circular focuses on the elaboration of the remediation criterion used to determine whether urgent remediation is necessary. The environmental protection remediation criterion (hereinafter referred to as the Remediation Criterion) is included in the amended text of Section 37 of the Soil Protection Act. This Circular also discusses the details of the Remediation Objective, as included in the amended text of Section 38 of the Soil Protection Act. In working out the Remediation Objective, the aim was to achieve harmonization with the Soil Quality Decree. Table 29 below shows the soil sampling locations while figure 86 show soil sampling in progress.

→ ***Sampling Points/Locations***

Table 29: Soil sampling point/ locations

Sample ID	Location	GPS	Sampling depth (meters)
Sample A- soil sample	SP1- Next to P3 site boundary corner	1°12'51.08"S, 37° 3'37.31"E	1.0-1.3
Sample B- Soil sample	SP2- Next to P2 site boundary corner	1°12'27.63"S, 37° 3'47.92"E	1.0-1.3

Date of sampling- 30th September 2021

Figure 86: soil sampling in progress at SP2

- **Results and Discussion**

→ ***Physical Characteristics***

Soils were encountered from the surface extending to about 1.0 m depth and they comprised:
Black Cotton Clay Soils- Characterized by high liquid limit (over 63%) and plasticity values (over 30%). The Soils are expansive and not recommended for any construction purposes (Linear Shrinkage > 3%).

Gravelly Soils mixed with Black Cotton Clay Soils: These soils were encountered as transition layers between the overburden and weathered rock, at a depth of 0.9 m to 1.2 m below the surface. They have low plasticity 10%) and marginal expansively (Linear Shrinkage 3%)

Generally, these soils were of low bearing strength and are classified as SANDY CLAYEY (Elastic) Silts.

Due to the low content gravelly soil and its contamination by the dominant black cotton clay overburden, the available gravel will not be reliable for construction purposes.

→ ***Chemical Characteristics***

Average pH of Soils was 8.9 indicating strongly alkaline conditions
The soils are not likely to be aggressive on Concrete. Sulphate Content was about 0.019% which is very weakly aggressive on Concrete. Chloride Content in Soils is 0.195% which is weakly aggressive against concrete.

Recommendation: cover for reinforcement will be therefore adequate for the foundations

→ ***Rock Characteristics***

Weathered rock from 1.0 m depth transitions to intact rock at a depth of about 1.5 m below the ground level.

A minimum bearing capacity of 450 kN/m^2 is recommended at this stratum. This value increases gradually to a minimum of 600 kN/m^2 at a depth of 5.0 m.

After 10.0m, the rocks are highly saturated and pervious. Any landfill excavated to that depth will require lining and water management measures.

It is recommended that water level monitoring proceeds throughout the design period as groundwater levels change with seasons. (Soil sample laboratory results are in annex 7 of this report).

5.3 Biodiversity Baseline

5.3.1 Ecological Conditions

An ecological survey of the study area was conducted particularly with reference to the listing of species and assessment of the existing baseline ecological flora and fauna (terrestrial and aquatic if applicable) conditions in the study area, with special emphasis on rare, threatened, endemic, protected and endangered species. Migratory species, wild food crop plants and presence of invasive alien species should also be considered.

The study of core area (project site) and buffer area (1.5 km radius) is based upon field survey and information collected from secondary sources.

5.3.2 Flora and Fauna

The site is open grassland with some shrubs especially in the riverine zone. The grassland is used for the pasture of animals like cattle. Livestock was the main animal activity observed. The area proposed for the Waste to Energy Power project is predominated by the desert thorn-shrub grassland and birds with some banana farming activity across the river along its banks away from the proposed site boundary. There are no trees in the site except the riverine vegetation (forests) on the left bank of the Nairobi River.

According to the local people, crocodiles and hippopotamus can be found in the Nairobi River around the wastewater aerobics ponds which are far from the site. With the open grassland with some shrubs, layout of the plant does not involve tree felling and a 10m wide green belt will be developed in the premises.

It should be noted that no rare, sensitive or endangered fauna or flora species were observed during the ecological survey at the proposed site that would be negatively impacted by the construction and operation activities of the Waste to Energy Power project. They are neither listed on the International Union for Conservation of Nature (IUCN) Red list of threatened species nor on the Kenya Wildlife Services' Priority species list either. Table 30 shows the typical surrounding habitat at the site.

Table 30: Typical habitats within and adjacent areas of the proposed site showing grassland and aquatic habitat.

(Source: site visit photos by Geoffrey Makanga)

Major habitat across the landscape of the proposed landfill project area is grassland-bush land. Within the major habitat, microhabitats are distributed within and the surrounding areas of the proposed project site. There is a mixture of bushed grassland and agro-biodiversity consisting of small vegetable farms across the river whose aquatic ecosystem is largely choked by the effects of pollution from different sources including the wastewater treatment plant.

The common indigenous woody plant species is predominated by Acacia hockii, Commiphora, Combretum and Erythrina species. These plants are usually in dry and moist thicket and savanna-type vegetation. None of the plant species are enlisted in the IUCN red list of threatened species. Table 31 and 32 show the flora and fauna present at the site.

Table 31: Selected indigenous plant species within and in adjacent areas

	
Acacia hockii	African senna

	
Prickle pear cactus	Aloe secundiflora
	
Whistling Thorn Acacia/ *Asparagus albus*	
	
Rhamnaceae Black hawthorn	Solanum incanum Sodom-apple

	
Amaranthaceae	Roly-poly
	
Cactaceae/	Mistletoe cactus
	
Crassulaceae	Copper Spoons

Table 32: Birds spotted in the project area

	
Bird: African Bush Pipit Scientific name: Anthus caffer	Superb starling, Lamprotornis superbus

5.4 Socio-Economic Baseline

5.4.1 Population in the Area

Nairobi is the most populous county with a population of 4,397,073. Ruai covering an area of 49.0 sq. kilometers is an administrative unit of Kasarani constituency which covers 152.6 sq. kilometers in area *(County Integrated Development Plan (CIDP) for the period 2018-2022)*. Ruai is connected to the City Centre through Kangundo, Outering and Jogoo roads (Sigoria, 2012. The project site area is moderately populated, and the trends indicate a high population growth rate. The Kasarani constituency has a total population of 780,656 with 381,234 males and 399,385 females. (KNBS, 2019).

5.4.2 Land Use and Land cover

Ruai area is part of the extensive savanna open land, with mainly short grass and scattered drought tolerant trees, due to limited rains. The population of the area has shot up drastically because of the opening of the Eastern by-pass, thereby having residential buildings nearly on all sides of the project area. It is only along the Nairobi River (near the final effluent outlet) and eastern side where individual houses are far from the treatment plant. The land surrounding the treatment plant is heavily under cultivation for food crops. Some of the farmers use the wastewater for irrigation. There are cows, goats and sheep grazed nearby the treatment plant which belongs to the residents and visiting (nomadic) Maasais. The map in figure 87 show the land uses in Nairobi Metropolitan area.

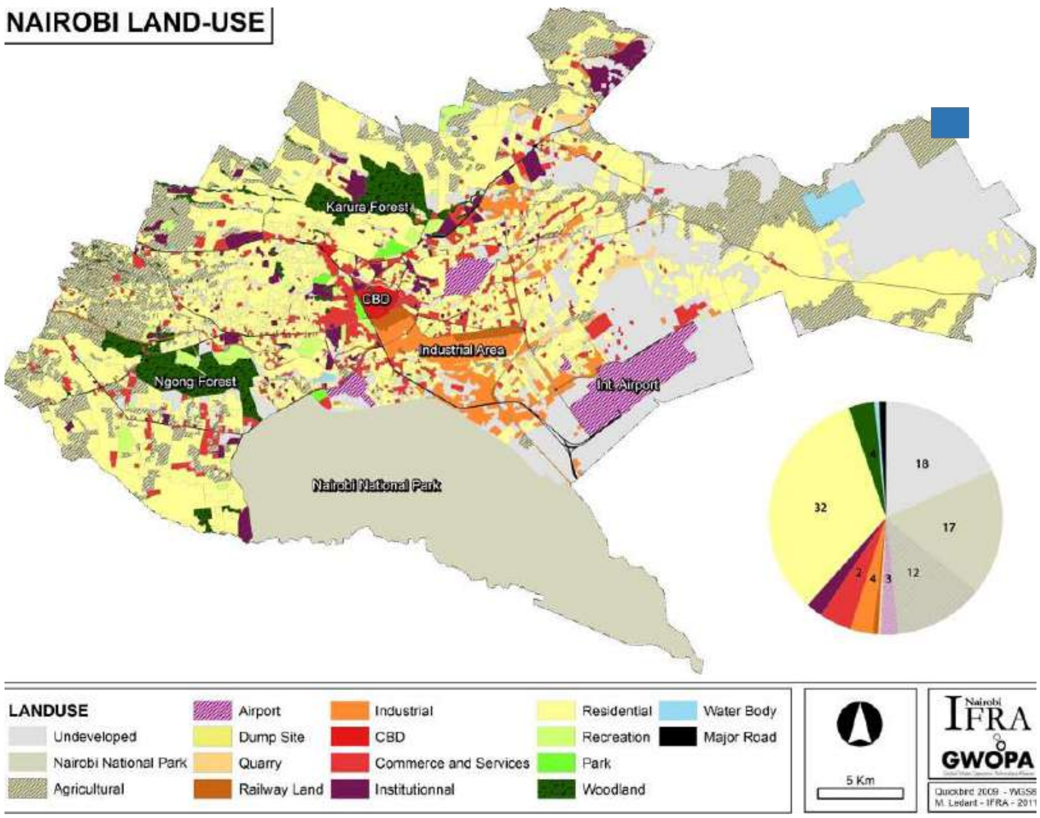

Figure 87: Nairobi Metropolitan area land use map.

Source: African_Urban_Models at geographyforgeographers.com

- **Infrastructure Development**

Nairobi County is one of the 47 counties in the Republic of Kenya. The County has a total area of 696.1 Km2. It has 16 constituencies. Project site is in Kasarani Constituency No. 0280 covering 152.6 Sq. Km in area and which has 5 administrative wards namely: Clay City, Mwiki, Kasarani, Njiru, Ruai.

The current road network in the County is inadequate in terms of coverage to meet current and future demands as envisaged in the Vision 2030. There is heavy congestion on most of the City roads especially during the morning and evening peak hours. The total road network covers 3602 m out of which 1735 Km are tarmac roads while 1867 Km are earth roads. The current poor state of road network is a great impediment to socio-economic growth leading to high production costs and low productivity. Nairobi County hosts 3 airports; Jomo Kenyatta International Airport, Wilson Airport and Eastleigh Airport. Jomo Kenyatta International Airport (JKIA) located 18 kilometers to the East of Nairobi City center, is the biggest Airport in East and Central Africa, and is the focal point for major aviation activity in the region.

The Strategic Plan 2018-2022 aims at implementing strategies that will help Kenya realize the Big Four and the goals set out in the MTP III of Vision 2030. The Big Four is focused on food security, affordable housing, manufacturing and affordable healthcare. Athi Water Works Development Agency (AWWDA) supplies water to 72.1% of the population in Nairobi, Kiambu and Muranga counties and with only 40% accessing sewerage services. Currently, the Agency has a bulk water production capacity of 639,683 m3 /day and a wastewater treatment capacity of 210,500 m3/day

- **Information, Communication Technology**

Posts and telecommunication sub-sector has experienced mixed growth in the recent past. While the County has 38 post office branches; the growth of postal services has rather been declining due to increase in mobile telephony. Mobile telephony has the highest coverage in Nairobi compared to other parts of the country with over 95 per cent of the inhabitants having access to mobile communication.

- **Energy Access**

The main sources of energy in Nairobi County are electricity, solar, LPG, biogas paraffin, charcoal and firewood. 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 used by households is related to the socio-economic status of households/individuals.

High level energy sources are cleaner but cost more and are used by households with higher levels of income compared with simpler sources of fuel, mainly firewood, which are mainly used by households with a lower socio-economic profile.

- **Industry and Trade**

Nairobi County is a major trading center. It provides a conducive environment for doing businesses by both locals and international communities. Majority of Nairobi residents, especially middle earners, get their income from businesses. There are various types of markets namely; open air markets, self-constructed markets, development tenant purchase markets, rental markets, hawker's markets and wholesale markets.

The Gikomba market is Kenya's largest market. It offers affordable secondhand clothing, furniture, accessories, fresh produce and processed materials. Another open-air market is Maasai market situated on Taifa road and it is a place to shop for all sorts of jewelry, fashion, ornaments and paintings. Other markets are Toi markets, city market, Muthurwa market, Githurai market among others. These marketplaces are among major sources of the municipal solid wastes intended for the waste to energy power project.

Nairobi is the home of major industries which accounts for about 80 per cent of the total industries in the country. There are 2061 industries in Nairobi County with 422 being in manufacturing. Most of these industries are located in industrial areas, Kariobangi and Babadogo areas. There are 43 Commercial banks with a network of 364 branches that operate in different parts of the County with the City center having the highest concentration. The huge network of financial institutions coupled with highly skilled personnel makes the County a regional hub in financial services.

- **The Nairobi Metropolitan Region Perspective**

The NMR extends some 32,000 square kilometers that substantially depend on the city for employment and social facilities. This has also been spurred on by the rapid population growth registered in the surrounding areas such as Kiambu, Thika, Muranga, Machakos and Kajiado. It has thus become difficult to separate Nairobi City from this wider metro region.

The Nairobi metropolitan region comprises of fifteen (15) independent local authorities including City Council of Nairobi; Municipal Council of Kiambu, Municipal Council of Limuru, Municipal Council of Machakos, Municipal Council of Mavoko, Municipal Council of Ruiru, Municipal Council of Thika, Town Council of Kajiado, Town Council of Karuri, Town Council of Kikuyu, Town Council of Tala/ Kangundo, County Council of Kiambu, County Council of Masaku, County Council of Olkejuado, County Council of Thika.

Core Nairobi is a national, regional and international strategic centre for education, commerce, transport, regional, cooperation and economic development. It connects together eastern, central and southern African countries. It plays a significant role in the global, regional and local economy. It is a centre of international diplomacy, finance, banking and commerce. The Nairobi metropolitan area is shown in the map on figure 88 below.

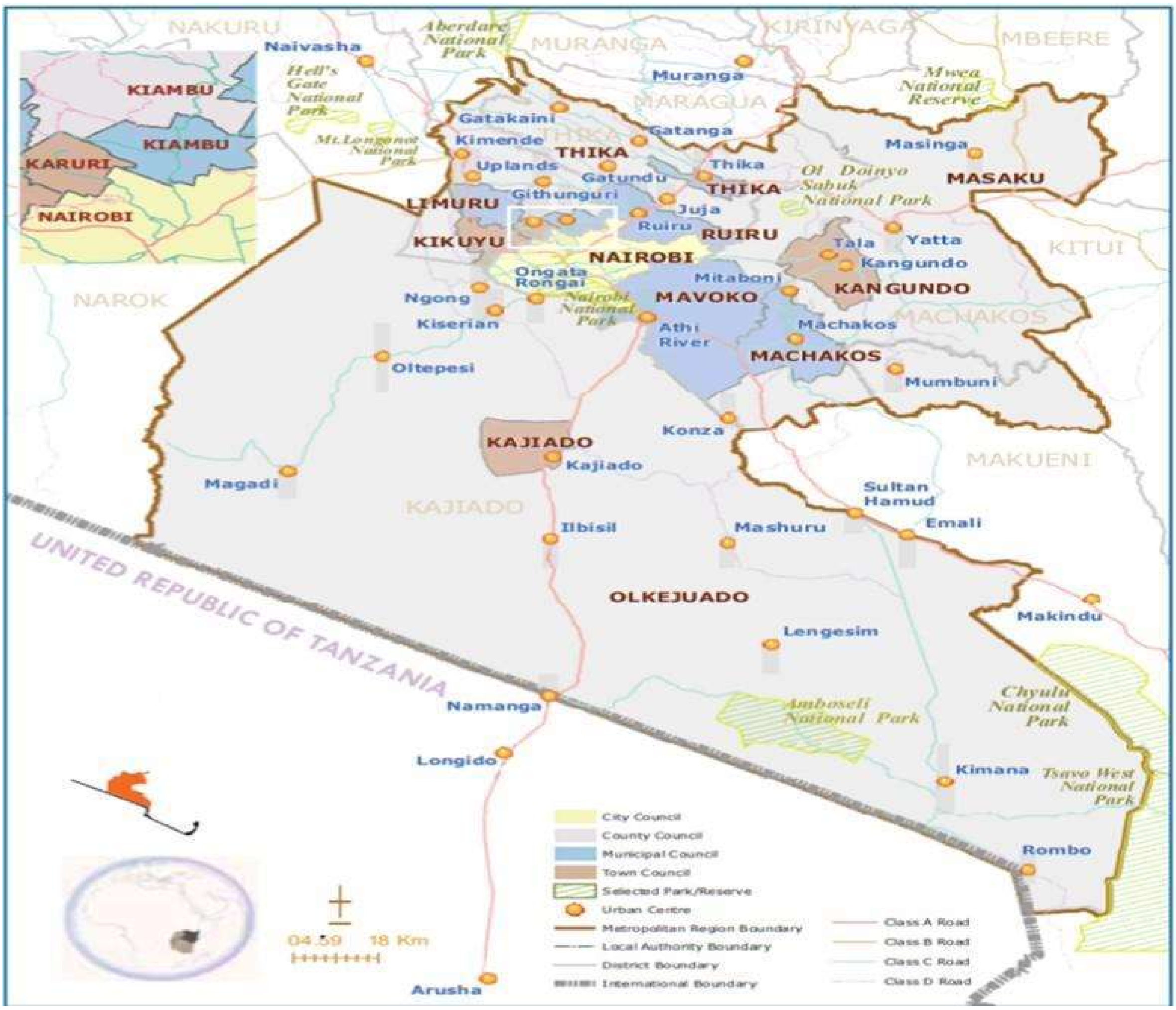

Figure 88: The Nairobi metropolitan region. (source: Nairobi Metro 2030 strategy report).

The tonnage of solid waste generated within Nairobi City County increased to 2.9 million tonnes in 2019 up from 2.7 million tonnes in 2018 with only 55.3 per cent being collected by the county government (KNBS-Economic Survey 2020) as shown in table 33 below.

Table 33: Solid Waste generation and collection, 2015 to 2019

County		2015	2016	2017	2018	2019
Nairobi	Generated	2,353.0	2,477.0	2,601.0	2,725.0	2,977.0
	Collected	772.6	1,260.3	1,259.9	1,233.7	1,646.1

(Source: KNBS-Economic Survey 2020).

Ruai area is part of the extensive savanna land, with mainly short grass and scattered drought tolerant trees, due to limited rains. The population of the area has shot up drastically because of the opening of the Eastern by-pass, thereby having residential buildings nearly on all sides of the project area. It is only along the Nairobi River (near the final effluent outlet) and eastern side where individual houses are far from the treatment plant. The land surrounding the treatment plant is heavily under cultivation for food crops. Some of the farmers use the wastewater for irrigation. There are cows, goats and sheep grazed nearby the treatment plant which belongs to the residents and visiting (nomadic) Maasai.

- **Solid Waste Management**

Major challenges facing Nairobi County with respect to Solid Waste Management include management of waste collection and disposal. Identification and maintenance of final disposal sites will be a critical concern in the immediate term. There is a need for private organizations to take up critical functions like recycling, transportation and Solid Waste Management.

Nairobi County generates over 2400 tons of garbage per day projected to be 3200 tons per day by year 2022. Under the current scenario only about 60% of generated waste ends up in the final disposal dumpsite. Approximately 10% of generated waste is recycled with the rest ending up in rivers and other undesignated places. Electronic and Hazardous waste though not the mandate of the sector has recently found its way to Dandora dumpsite.

6 Analysis of Alternatives

6.1 Introduction

The objective of alternative analysis will be to define the merits and demerits of realistic alternatives, thereby providing decision makers and the public with a clear basis for choosing between options.

An analysis of alternatives of the proposed project was undertaken based on criteria specified in Legal Notice No.101 of 2003: Environmental Impact Assessment and Environmental Audit Regulations. Section 18(1) of the Regulations specifies the basic content of an Environmental Impact Assessment Study Report. Subsection (i) requires an analysis of alternatives including project site, design and technologies and reasons for preferring the proposed site, design and technologies.

We will systematically compare feasible alternatives for the proposed project, technology, design, and operation-including the "without project" situation--in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. Assessment will occur in parallel with development of the designs, to allow maximum exchange between the Environmental expert and the design engineers.

For each of the alternatives, the analysis shall quantify the environmental costs and benefits to the extent possible and attach economic values where feasible. This will include analysis of;

(i) costs and benefits of environmental impacts;
(ii) costs, benefits, and cost-effectiveness of mitigation measures; and
(iii) discussion of impacts that have not been expressed in monetary values, in quantitative terms where possible.

The study will review the various options and alternatives considered to achieve the project's objectives. Each alternative will be analyzed from an environmental, socio-cultural, and economic point of view. Factors to be considered will include:

- Site, Technology and design alternatives: alternative sites, technologies and project designs considered and their cost and environmental implications;
- No project option: provides an analysis of the foregone cost and impacts in the absence of the project.

Under this task, an analysis of alternatives will be carried out in reasonable detail to enable the decision makers to determine the preferred option. Alternatives will be compared in terms of potential environmental impacts, costs, suitability under local conditions, institutional, training and monitoring requirements. When describing the impacts, we will differentiate between irreversible or unavoidable impacts and which can be mitigated. To the extent possible, quantification of the costs and benefits of each alternative will be made, including the estimated costs of any associated mitigating measures.

6.2 Site Selection alternatives

The site selection criteria included the following two criteria, which are a mandatory requirement for all the sites to warrant further consideration:

- In principle, clearance from Kenya Civil Aviation Authority,
- Availability of minimum area of 27ha estimated as the requirement for the WtE plant including inert and hazardous landfill.

The wind rose model in chapter four has been prepared with surface data schedules for 3 years (temperature, wind speed, wind direction and cloud cover), considering in this case records from the three years as the most appropriate for modelling of the dispersion of pollutants. The prevailing direction of wind is mainly from NE to SW at a speed of 5.70- 8.80m/s except during July- September when the wind predominantly flows from SE to NW at a speed of 3.60-5.70m/s. The air dispersion model results therefore informed the layout design of the plant within the site and the surrounding community.

The relative merits and demerits of the site which clear the above mandatory requirements have been evaluated based on the following seven attributes:

- Land availability and land acquisition cost: Sites have been ranked based on the relative cost of acquisition and reclamation costs.
- Proximity to waste generation sources: This attribute has been considered to factor in the transportation cost of municipal solid waste to the candidate site. Sites have been ranked based on their relative proximity to Dandora and Thika dumpsite.
- Potential environmental and social impacts: This attribute considers the proximity of the site to residential, institutional zones and the requirement, if any, of resettling existing occupants/squatters.
- Constraints for site developments: This attribute factors in the constraints arising from presence and requirement to clear legacy waste from the site
- Access to power evacuation facilities: This attribute considers the proximity of the site from a suitable substation/ high voltage transmission line
- Water availability and quality: This attribute ranks the site based on water availability, i.e. perennial river, seasonal and treated wastewater; and water quality, i.e. turbidity and color
- Access to the site: This attribute ranks the site based on the condition of roads in the vicinity.

The attributes for site selection are presented in the tables 34 and 35 below while the selection analysis is on table 36 below.

Table 34: Site Selection Criteria

Sl No	Criteria	Relative Importance	Weightage	Sub-Criteria (Score)
1.	Land acquisition costs	Very High	20%	• Land acquisition cost- (50) • Land reclamation cost (50)
2.	Proximity to waste generation sources	Very High	20%	• Distance from Dandora (90) • Distance from Thika (or other nearby dumpsite in Machakos) (10)
3.	Potential environmental and social impacts	High	16%	• Distance from nearest habitat zone (30) • Distance from nearest school/hospital (30) • Requirement of RAP- (40) - If RAP is not required (30), If RAP is required (10)
4.	Constraints for site developments	High	16%	• No legacy waste (100) • Less legacy waste (80) * • Huge legacy waste (40)**
5.	Access to power evacuation facilities	Moderate	11%	• Distance from nearest compatible substation / transmission line
6.	Water availability	Low	11%	• Source of water (40): Perennial river only - (40); WWTP only (40); Seasonal River only (20) • Quality of water based on turbidity and color (60): Very high turbidity and color (15), High turbidity and color (30), Medium turbidity and color (45); Low turbidity and color (60)

Table 35: Site Ranking Analysis (source: Siting study Report -2021)

Sl No.	Site	Project costs (Mn Ksh)	Project costs (Mn USD)	LCOE (Ksh/kWh)	LCOE (USc/kWh)
1.	Dandora dumpsite	21,554	202.3	19.6	18.43
2.	Ruai STP End	18,927	177.7	17.4	16.30
3.	**Ruai STP RiverBank**	**18,919**	**177.6**	**17.4**	**16.30**
4.	Thika dumpsite	19,351	181.6	17.7	16.64
5.	Near Gulf power plant	19,268	190.9	17.7	16.58

Table 36: Site Criteria Selection Analysis

Criteria	Unit/ Criteria and Weightage	Dandora dumpsite	STP End	STP River Bank	Thika dumpsite	Near Gulf power plant	Remarks
1. Base Data from Survey							
Criteria 1							
Land acquisition cost	Mn Ksh/ Acre	34.20	4.50	4.50	4.50	5.00	
Reclamation cost	Mn Ksh/ Acre	57	1	1	1	1	A nominal value of 1 has been assigned where there is no reclamation cost.
Criteria 2							
Distance from Dandora	km	1	29	29.8	51.2	36.5	A nominal value of 1 has been assigned for Dandora.
Distance from Thika	km	49.1	52.8	53.6	1	77.7	A nominal value of 1 has been assigned for Thika.
Criteria 3							
Distance from nearest residential zone	km	0.1	1.5	1.5	0.5	1.1	
Distance from nearest institutions	km	0.5	1.5	1.5	0.5	1.1	
RAP requirement		Yes	Minor	Minor	Yes	Yes	
RAP requirement	Major resettlement - 0,25 Minor resettlement -0..75	0.25	*0.75*	*0.75*	*0.25*	*0.75*	
Attribute 4							
Height of legacy waste	None -1, Height < 2m - 0,8, Height > 2m - 0,4	0.4	1	1	0.8	1	
Criteria 5							

Criteria	Unit/ Criteria and Weightage	Dandora dumpsite	STP End	STP River Bank	Thika dumpsite	Near Gulf power plant	Remarks
Distance from nearest sub-station/Nearest transmission line	km	7	1	0.5	13	5	
Criteria 6							
		Perennial river	Perennial river	Perennial river	Wastewater	Seasonal River	
Source of water	Perennial river or wastewater plant -1, Seasonal river -0.5	1	*1*	*1*	*1*	*0.5*	
Quality of water		Very high turbidity and color	Medium to low turbidity and color	Medium to low turbidity and color	Medium to low turbidity and color	Medium turbidity and color	
Quality of water	Very high 0.25; High - 0,5; Medium- 0.75, Low -1	0.25	*0.75*	*0.75*	*0.75*	*0.75*	
Criteria 7							
Access to roads		Good	Excellent	Excellent	Compromised	Good	
Access to roads	Excellent-1, Good -0.8, Compromised - 0,6	0.8	*1*	*1*	*0.6*	*0.8*	
2. Raw score							
Criteria 1							
Land cost	50	6.58	50.00	50.00	50.00	45.00	
Reclamation cost	50	0.88	50.00	50.00	50.00	50.00	
Sub-total		7.46	100.00	100.00	100.00	95.00	

Criteria	Unit/ Criteria and Weightage	Dandora dumpsite	STP End	STP River Bank	Thika dumpsite	Near Gulf power plant	Remarks
Criteria 2							
Distance from Dandora	90	90.00	3.10	3.02	1.76	2.47	
Distance from Thika	10	0.20	0.19	0.19	10.00	0.13	
Sub-total		90.20	3.29	3.21	11.76	2.59	
Criteria 3							
Distance from nearest residential zone	30	2.00	30.00	30.00	10.00	22.00	
Distance from nearest institutions	30	10.00	30.00	30.00	10.00	22.00	
RAP requirement	40	10.00	30.00	30.00	10.00	30.00	
Sub-total		22.00	90.00	90.00	30.00	74.00	
Criteria 4							
Presence of legacy waste	100	40.00	100.00	100.00	80.00	100.00	
Criteria 5							
Distance from nearest sub-station/ Tx Line	100	7.14	50.00	100.00	3.85	10.00	
Criteria 6							
Source of water	40	40.00	40.00	40.00	40.00	20.00	
Quality of water	60	15.00	45.00	45.00	45.00	45.00	
Sub-total		55.00	85.00	85.00	85.00	65.00	
Criteria 7							

Criteria	Unit/ Criteria and Weightage	Dandora dumpsite	STP End	STP River Bank	Thika dumpsite	Near Gulf power plant	Remarks
Access to roads	100	80.00	100.00	100.00	60.00	80.00	
3. Weighted scores							
Land availability and acquisition costs	20%	1.49	20.00	20.00	20.00	19.00	
Proximity to waste generation source	20%	18.04	0.66	0.64	2.35	0.52	
Potential environmental and social impacts	16%	3.52	14.40	14.40	4.80	11.84	
Constraints for site developments	16%	6.40	16.00	16.00	12.80	16.00	
Access to power evacuation facilities	11%	0.79	5.50	11.00	0.42	1.10	
Water availability	11%	6.05	9.35	9.35	9.35	7.15	
Access to the site	6%	4.80	6.00	6.00	3.60	4.80	
Total score		**41.09**	**71.91**	**77.39**	**53.32**	**60.41**	
Rank		**V**	**II**	**I**	**IV**	**III**	

Source: *Siting study Report -2021).*

On the basis of the above analysis, Ruai STP Riverbank site is the most suitable site for setting up of the facility with the best weighted score of nearly 80 percent and ranking as the best site with the following key advantages;

- Required 20 ha land for the project is available and it is owned by Nairobi City County - a government agency thus easy acquisition without requiring any resettlement as the site is unoccupied.
- The site is only 21 km from Dandora-400.2 MVA, 220/132kV evacuation substation with existing excellent road networks for easy accessibility.
- The site has been assessed and approved by the Kenya Civil Aviation Authority as being off the flight path, and,
- Proximity to a wastewater treatment plant that could provide affordable water in large quantities for the WTE power plant's operations, and,
- The sparsely populated nature of the sites and its distance away from human settlements which are at least 700metres to the south but atleast 1.5km to the north.

6.3 Waste Processing Technologies Alternatives

6.3.1 Bio-methanation vs Incineration Vs Gasification Vs Pyrolysis

The table 37 and 38 below shows the alternative technologies for waste processing and its ranking.

Table 37: Alternative Technology for Waste Processing

Options	Total score	Ranking
Option 1: Bio-drying with Incineration	68	V
Option-2: Bio-drying with screening and sizing followed by Gasification	69.4	IV
Option 3: Bio-drying, screening, sizing followed up with Incineration	77.6	II
Option 4: Bio-drying, screening, sizing followed up with bio-methanation and gasification	65.6	VI
Option 5: Bio-drying, screening, sizing followed up with bio-methanation and incineration	65.6	VI
Option 6: Stabilization, screening, sizing followed up with incineration	**89.2**	**I**
Option 7: Stabilization, screening, sizing followed up with bio-methanation and incineration	75.6	III

Table 38: Waste Processing Technologies Alternatives Analysis and Ranking

Parameters	Requirement (%)			
	Bio-methanation	Incineration	Gasification	Pyrolysis
Moisture	>50%	<50%	<20%	<10%
Volatile/organic	>40%	>40%	>40%	>40%
Fixed Carbon	<15%	<15%	<15%	<15%
Total inerts	<5%	<30%	<10%	<10%

Parameters	Requirement (%)			
	Bio-methanation	Incineration	Gasification	Pyrolysis
GCV (MJ/kg)	Not Applicable (NA)	>5.4	>8.37	>8.37
C/N Ratio	25-30	Not applicable	Not applicable	Not applicable

Table 38 above outlines Option 6 technology utilizing ***Stabilization, screening, sizing followed up with incineration*** as being ranked best with respect to:

Technology

- Further moisture removal shall be achieved using a dewatering screw press in addition to stabilization, screening and shredding
- It has better combustion efficiency and higher power generation potential.
- From the maturity and investment point of view, this option is one of the most mature technologies being used worldwide.

Power Generation Potential

- Power generation potential has been estimated for the selected option. (stabilization with screening and sizing followed by incineration).
- Power generation considered for minimum calorific value of MSW which was 1,354 in year – 2021.
- Expected range of power generation based on MSW input from Nairobi county: 29.7 MW to 44.3 MW.
- The power generation potential may increase with better quality waste (higher GCV).
- Installed capacity of plant for power generation: 45 MW.
- Two machines of 22.5 MW are considered to achieve better loading in initial years.

6.4 "No Project" Scenario

The no-project scenario will mean the status quo of the area remains and no occurrence of adverse impacts as well as positive impacts posed by the project implementation. Nairobi like other developing world cities is characterized by rapid population growth, and urbanization. With a population of nearly 5 million people, the amount of solid waste generated is ever increasing. The surrounding metropolis towns are fast growing and do not have proper waste management systems. Uncontrolled dumping leads further to serious problems of environment, safety and land availability. Improperly managed waste usually results in downstream costs higher than what it would have cost to manage the waste properly in the first place. Failure to handle waste in an environmental sound manner has the potential of causing pollution to the atmosphere, water and soil. Uncollected and illegally or improperly disposed wastes pose serious risks to public health and the environment. Noncompliance with applicable environmental laws and regulations results in penalties, negative reputation and conflicts with stakeholders. In recent years, technologies have been developed that not only help in generating a substantial quantity of decentralized energy but also in reducing the quantity of waste for its safe disposal. Sustainable energy and waste management therefore should be supported with policies that promote a "circular economy", balancing product life cycles (from production to disposal), and that minimize adverse economic, environmental, and societal impacts.

The Waste to Energy (WtE) project for Nairobi and the larger Metropolis is more than just a power production project to compliment other on-going power production plant development, rather, it's also envisaged to tackle the health, sanitation and environmental issues that currently plague the waste and water management system in Nairobi and neighboring counties. Effective waste management has important economic and social impacts in addition to environmental benefits. For this reason, waste management should not be viewed as an economic activity for generating income, but rather a public service requiring financing for cost recovery

In Nairobi County, Dandora dumpsite, the main landfill site is a sad picture of a multiple tragedy. The City Council of Nairobi decommissioned the dumpsite in 2012, after 8 years of planning. However, conflict between the council and the Kenya Airports Authority over the relocation of the dumpsite to Ruai has brought the process to a grinding halt. The community sees no easy end to this largest and most flagrant violation to human rights and environmental health in the county. The dumpsite exists in contravention of several provisions to the Constitution of Kenya.

In compliance with the provisions of the international best practices, Nairobi City County Government and the Proponent have taken a serious view and considers it imperative to minimize the wastes going to landfill through processing of MSW using appropriate technologies.

If this project is not taken up, then the following benefits associated to it shall be missed;

Environmental benefits

- Waste to Energy plants reduce greenhouse gas emissions by diverting waste from landfills and open burning. The usage of waste for the generation of power will save on fossil fuel and in turn reduce greenhouse gas (GHG) emissions. It is envisaged that implementation of a waste-to-energy plant for Nairobi at the Ruai site will save more than 1.8 million tons of CO2 equivalent GHGs in the 20 years' operation period.
- With finalization of Paris Agreement Rules Book on climate change at COP 26 in Glasgow in December 2021, and Kenya having submitted its Intended Nationally Determined Contributions commitment for the period 2021-2030 with a target of reducing 30 percent of emissions relative to the BAU scenario of 143 million tCO2 eq in line with its sustainable development agenda, this reduction in GHG emissions will greatly boost Kenya's emission reduction targets and be able to be traded as part of its emission offsets under Kyoto Protocol's CDM. Based on the EU-ETS price of a tonne of carbon of 85 Euros as at 10/01/2022, sale of the offset from this facility will be able to generate an estimated KShs 864 million annually.[3]

Under the do-nothing alternative, the realization of the following would be impossible and impractical: solid waste management plan in accordance with the provisions of the constitution of Kenya 2010 for access to a clean and healthy environment to every citizen, which is considered a basic human right. The eighth Sustainable Development Goal emphasizes the provision of safe clean water and a safe environment. Furthermore, Vision 2030 social pillar targets the implementation of an integrated solid waste Management system which this project seeks to achieve.

[3] Live Carbon Prices Today, Carbon Price Charts • Carbon Credits

It will lead to development of unhygienic conditions in the area due to unplanned accumulation of waste and shall become breeding grounds for mosquitoes and other indirect health hazards. With high organic content, the municipal waste is highly putrescible and tends to decompose rapidly and unless carefully controlled, decomposes with the production of unpleasant odor which will lead to pollution and contamination which increases health and environmental risks, negatively impact on the economic development, hence, this alternative is undesirable as there is an 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. The no project option will have the forgone costs and benefits including;

- meet surging demand for proper municipal solid waste treatment and reduce waste pollution in the city to me the eighth Sustainable Development Goal and Vision 2030 social pillar targets,
- extend lifespan of the existing dumpsites and alternatively create an opportunity for their reclamation and restorations,
- convert waste into electricity thus promoting reliable energy by plugging any existing deficiencies.
- Generation of employment opportunities through expansion of business activities.

Thus, from the analysis above, it becomes apparent that the No Project alternative is no alternative to the local people in Dandora, Nairobi City County residents and the Government of Kenya.

6.5 Alternative Power Evacuation System

Unlike the generators in large power stations, which operate in voltage control mode, the generators in small power stations such as this waste to energy project are forced to operate in power factor control mode due to their limited reactive power support. In fixed power factor operation, smaller variations of voltage at the evacuation bus are managed by on load tap changing at the generator transformers. However, during large and frequent variations in voltage, such power plants face difficulty in evacuating the power due to delayed response by the operators and inadequate tap settings of the generator transformers. This project explores the use of static VAR compensators (SVCs) to overcome these practical limitations encountered by small power plants so as to ensure smooth evacuation of every unit of real power generated by such units to the neighboring grid in a grid connected power system scenario.

6.6 Alternative Water Sources

6.6.1 River water

Due to the proximity of the proposed plant to Nairobi river, the river has been considered as an optional source of water to be used in the power plant. This is also due to the availability of the water in all seasons and the apparent perpetuity. Abstraction of river water on the other hand has challenges due to the high-water requirement for the project. A daily requirement of 8.5 million liters of water for the power plant operation has been determined. The primary source of water shall be wastewater treatment facility owned and operated by Nairobi City Water and Sewerage Company Ltd. This source shall be supplemented by a borehole to be drilled as part of the project with the Ngong River passing adjacent facility offering emergency fallback source when the other two sources are not available. The necessary permits should also be obtained before any abstraction of river water is done. However, we note that the exact water requirement for the plant shall be determined during detail design based on the turbine efficiency and reuse facility to be designed among other factors.

6.6.2 Treatment Pond Water

To meet water requirements for the plant, the river water will be supplemented with water from the treatment ponds. This is a very viable alternative as the water will be recycled and put to a more productive use other than lying idle in the treatment ponds. The process of using the water from the ponds will also involve setting up of storage structures which will ensure reuse of already abstracted water within the plant. The treatment pond water is plenty enough to meet the required 8.5 million liters per day as the treatment plant produces up to 160 million liters per day.

6.6.3 Borehole and Municipal Supply

The borehole and municipal water supply alternative are not a viable option as these are sources of water fit for domestic use and human consumption. Therefore, applying these sources of water would be a major waste of good quality water while some parts of Nairobi still incur water rations from the main supply. Also, it is not economically viable to use these sources of water as they require a lot of infrastructural investment.

7 Consultation and Public Participation

7.1 Introduction

Consultative Public participation (CPP) process is a policy requirement by the Government of Kenya and a mandatory procedure as stipulated in EMCA CAP 387 section 58, on Environmental and social Impact Assessment for the purpose of achieving the fundamental principles of sustainable development. CPP entails engaging members of the public who are interested or affected to express their views about a project. According to the International Finance Corporation (1998), Public Consultation is a tool for managing two-way communication between the project sponsor and the general public. Its goal is to improve decision making and build understanding by actively involving individuals, groups and organizations with a stake in the project. This involvement increases a project 's long term viability and enhances its benefits to locally affected people and other stakeholders.

Public disclosure on the other hand is important as it is critical to the effective participation of project affected populations. An informed public is more likely to understand the trade-offs between project benefits and its demerits; be able to contribute meaningfully to project design; and have greater trust in the project proponent. IFC policies on resettlement, land acquisition and compensation provide a framework for public consultation, participation and establishment of a process to redress the grievances of affected people. Consultation with the affected people and with local government officers, civil society and other political representatives of the affected population is essential for gaining a comprehensive understanding of the types and extent of adverse effects.

Public participation ensures that due consideration will be given to public values, concerns and preferences when decisions are made. If well conducted CPP is beneficial in various ways:

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

The specific objective of the consultation and public participation include:

- Inform the stakeholders about the project with Special reference to its key components and location.
- Incorporate the information collected in the ESIA report.
- Explain to the neighbors the nature of the proposed project, its objectives, potential impacts and scope.
- Gather comments, suggestions and concerns of the interested and affected parties about the project.
- Give neighbors an opportunity to present their views, concerns and issues regarding the Proposed Waste to Energy Plant.
- Obtain suggestions from neighbors on possible ways that they feel potential negative impacts can be effectively mitigated.
- To ensure understanding by facilitating an open, culturally appropriate and inclusive approach to engagement that provides timely and accurate information in an accessible and transparent way to all stakeholders, regardless of their status;
- To manage expectations and concerns by providing a mechanism which not only provides stakeholders an opportunity to freely provide comment and feedback but also allows KenGen/NMS to respond to this feedback, thereby addressing concerns

- To manage risks through building sustainable relationships. It is a common trend in most development projects that communities expect more open and transparent dialogue and long-term social commitments from companies. Engagement will allow KenGen/NMS to understand stakeholder interests and issues and work with stakeholders to find mutually acceptable ways to achieve or address these; and
- To create value where engagement allows for partnerships to be developed for the mutual benefit of both KenGen/NMS and the stakeholders. This includes but is not restricted to corporate social investment activities. This relates also to seeking mutual benefit through project design and operations by considering stakeholder's views and benefiting them in all Project activities.

As part of this project stakeholder's identification the following were the key considerations made based on the above objectives;

- identifying the different categories of stakeholders who may be affected by or interested in the Project; and
- identifying specific individuals or organizations within each of these categories taking into account:
  - → the geographical area over which the Project may cause impacts (both positive and negative) over its lifetime, and therefore the localities within which stakeholders could be affected; and
  - → the nature of the impacts that could arise and therefore the types of government bodies, academic and research institutions and other bodies who may have an interest in these issues.

The consultation principles align with the relevant Equator Principles and IFC Performance Standards, with the aim to ensure all reasonable public opinions are adequately considered.

7.2 Methodology used in Public Consultation

A vigorous approach was employed to enhance public participation for this project. A stakeholder analysis was done after a reconnaissance visit by the study team. Key stakeholders were identified based on the criteria indicated below. Subsequent to this, a number of Stakeholders were consulted to inform them about the project and an opportunity was provided to hear their views on potential environmental impact associated with the planned project.

In addition to the above, literature review was done and data collected. A public consultation meeting was held with the immediate neighbors of the project. Suggestions on proposed mitigation measures were examined against the potential or perceived environmental impacts as judged from the project site visits, literature review, and any relevant information on the project as well as past experiences of similar developments.

7.2.1 Tools Used in Data Gathering

The study team utilized various methodologies for data gathering as enlisted below;

Stakeholder Analysis

The consultants in liaison with the project proponents identified all the stakeholders by virtue of their work, locality, interest or roles in the implementation of the project. Through a detailed stakeholder mapping and analysis plan, an agreed list of stakeholders who must be consulted to establish their concerns and input into the project was generated. The identification of stakeholders was based on the following primary questions;

- Which people/groups/institutions would be interested in the proposed Project in Ruai, Kasarani Sub county, Nairobi County?
- What is/would be the role of each stakeholder in the project?
- Who are the potential beneficiaries?
- Who might be adversely impacted? Who has constraints about the initiative?

- Who may impact the initiative? Who has the power to influence?

The criteria as illustrated by the diagrams in figures 89 and 90 below were utilized to develop a stakeholders list for consultation in the project.

Figure 89: Stakeholder Analysis Power/Interest Grid.

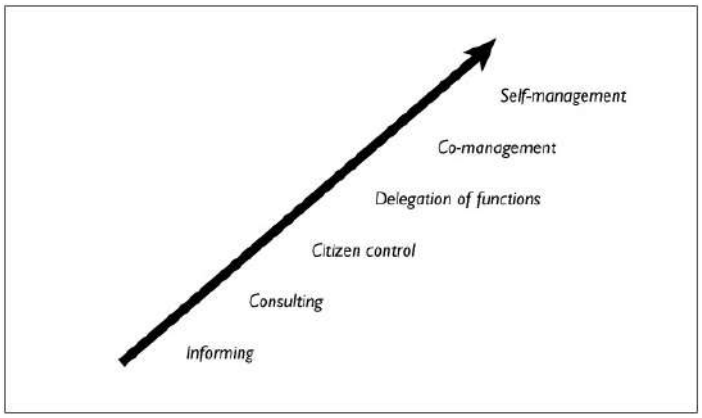

Figure 90: Public Participation Scope of the Project.

On the above guiding questions and criteria, a list of stakeholder's organizations and groups were developed and grouped as; government, civil society, directly affected, interested vulnerable groups and NGOs and private sector operatives. Subsequently, various approaches and methods were identified to engage various stakeholders as detailed in table 39 below.

Table 39: Approaches and Methods for Engaging Stakeholders

Stakeholder/Organization	Approach	Method
Group A (High Influence, High Contribution)	create good working relationships with these stakeholders, to ensure an effective coalition of support through engagement and consultation regularly. Involve in decision-making of strategic priorities, intervention selection, and cost estimate.	Key informant interviews Consensus-building and decision-making forums.
Group B (High Influence, Low Contribution)	These groups may affect the outcomes of the project, but interests are necessarily aligned with the overall goals of the Proposed WTE. Consult on specific areas of expertise/ Contribution through proactive engagement.	Key informant interviews Consensus-building and decision-making forums; One-on-one consultations.

Stakeholder/Organization	Approach	Method
Group C (Low Influence, High Contribution).	create good working relationships with these stakeholders, to ensure an effective coalition of support through engagement and consultation regularly. Involve in decision-making of strategic priorities, intervention selection, and cost estimate. Work with stakeholders to ensure that expressed needs and concerns are directly reflected in the road design.	Key informant interviews Consensus-building and decision-making forums, Solicitation of recommendations for interventions
Group D (Low Influence, Low Contribution).	Keep informed	Solicitation of views

Based on the above criteria, the following stakeholders in table 40 were identified for the project as follows;

Table 40: Identified Stakeholders

Level	Stakeholders Category	Location
National	● NEMA ● Water Resources Authority, ● Kenya Civil Aviation Authority (KCAA) ● Energy and Petroleum Regulatory Authority (EPRA); ● Ministry of Defence- Embakasi Garisson ● Kenya Airports Authority (KAA) ● Kenya Power Ltd ● Ministry of Energy.	Nairobi,
Regional	● Athi Water Water Works Agency; ● Nairobi Water & Sewerage Company; ● Nairobi City County Assembly -Environment Committee ● Nairobi City County Administration -Governor's Office ● Nairobi Metropolitan Services (NMS) -Environment Department.	Nairobi
Local	● The affected parties (15No households within 2km radius of the site) ● Ruai Area County leadership -MCA & Kasarani MP; ● National Govt representatives- DCC -Njiru District; ACC -Ruai; Chief-Ruai & Subchief -Ruai location; Chief-Kamulu & Subchief -Kamulu location ● The general public: communities living in close proximity to proposed facility – Area youth Rep -2No; Area Nyumba Kumi leadership -2No per neighbourhood; Women Rep -Ruai & Kamulu location -2No; PWD rep-2No ● Kasarani Sub-County & Ruai Ward administration teams-Administrator; Ward environment officer & ward public health officer (4No); ● Private waste collector’s association leadership (5No) ● Waste Pickers Association at Dandora dumpsite - Leadership engagements.	Njiru District; Ruai ward; Dandora; Kasarani Sub County

Consequently, the various stakeholders were engaged either individually or as groups based on the best modality available to brief them and get feedback from them as per a work schedule program detailed in table 41 below;

.

Table 41: Schedule for Stakeholders Engagement

Date	Day	Time	Stakeholder	Venue	Facilitator(s)/ Accomplishment
6th August 2021	Friday	11-1200hrs	NMS- Project boundary clarification & stakeholders engagement planning	Virtual	Accomplished
9th August 2021	Monday	930am-11:00am	Ruai Ward Administrator/ Environment Officer	Ward Administrator Offices -Ruai	Physical Meeting
10th August 2021	Tuesday	9:00am-11:00am	DCC Njiru ACC -Ruai	DCC Office - Ruai	Physical meeting
		11:30am-12:45pm	Ruai Chief & Assistant chief -Nyabuto	Ruai Chief's office	Accomplished
		2:30pm-3:30pm	NEMA Kasarani in charge -Brief seeking appointment	Nyayo House	Virtual
		4:00pm-5:00pm	EPRA Environment Section -Brief to seek appointment	Longonot Towers, Upperhill-	Virtual meeting held
11th August 2021	Wednesday	10:00am-12:00 noon	Nyumba Kumi leadership & individual household stakeholders	Wings View Hotel	Accomplished
		2:30pm-4pm	Kenya Power	Virtual	Adan/Arthur
12th August 2021	Thursday	10.00am-1200hrs	Kamulu Leadership meeting	Wings View Hotel	Physical Meeting
		2.30pm-4:15pm	Private Waste Collectors leadership	CBD	Physical Meeting
13th August 2021	Friday	10:00am-11:30am	Nairobi Water & Sewerage - Environment Office	Virtual	Questionnaire filled
		12:00-12:45pm	KAA Environment Office	KAA Office - JKIA	Telephone interview
		1:30pm-2:00pm	KCAA Environment Office	Aviation House	Approval obtained
		2:00 pm-4.00pm	Kenya Airforce Embakasi Garisson Commander	Embakasi	Accomplished
	Monday	9.00am-1000 am	Kasarani Subcounty Administrator/	Kasarani	Accomplished - Virtual meeting

Date	Day	Time	Stakeholder	Venue	Facilitator(s)/ Accomplishment
16th August 2021			NEMA Kasarani in charge -Brief seeking appointment		
		10:00am - 1200pm	WRA Environment office	NHIF Building	Virtual
		2.00pm- 4.00pm	Ministry of Energy	Nyayo House	Virtual
17th August 2021	Tuesday	10.00am- 11.00am	2:30pm-4pm	Kenya Power	Virtual
		11:30am- 12:30am	Athi Water Services Board	Athi Water Offices	Virtual

Simple Stratified Sampling

Immediate stakeholders around the site within a radius of 2km were engaged based on a simple stratified sampling method. As a result, 15No stakeholders within the radius were engaged through use of a structured questionnaire to capture their concerns on the project and perception on the project.

Similarly, sampling was done for water, noise, soil and air quality within the project site based on a simple stratified method for holistic consideration of the area the project might affect.

Focus Group Discussions Forums

Under this methodology, the consultants utilized workshops to interact and get feedback from concerned stakeholders. At the workshops, structured questionnaires and observations were used to guide the public's discussions and get feedback on the project.

Workshops

The consultant held 2No Workshops with about 62No participants at Wings View Hotel in Ruai, Kasarani Subcounty, with various stakeholders drawn from the immediate community. The meetings were held on 11th and 12th August 2021 from 0900hrs to 1300hrs within the Covid-19 safety protocol guidelines that restricted the number of participants to key representatives drawn from the wider community groupings. The community members who participated in the workshops were a representation of the various interest are detailed below:

- Ruai Market Traders Association,
- Ruai Water Residents Users Association (R-WRUA),
- Ruai Churches Association,
- Ruai Muslims Association,
- Ruai Residents Welfare Association,
- Ruai professionals Association
- Kamulu resident's leadership association
- Kamulu Market Association,
- Njiru Sub-County Administration officials including ACC, Chiefs and assistant chiefs for Ruai and Kamulu locations.
- Ruai Ward Administration officials i.e. Ward Administrators.
- Kasarani Sub county administration.
- Project proponents (Kengen) representative –

- Kasarani Member of Parliament Office representative.
- Ruai villages Nyumba Kumi leadership – 17No villages.

The workshop involved consultants in liaison with the proponents briefing the participants explaining the project detailing project design, environmental safeguards in the waste collection, handling and delivery to the proposed Waste to Energy Plant, plant designs, potential impacts, community involvement in the project and mitigation measures to protect against any adverse effects and maximize positive impacts. The consultant detailed the activities in each phase of the project and potential benefits and adverse impacts that the public might face from the project.

The participants were invited to raise queries on any unclear issues regarding biophysical and socio-economic impacts. The concerns were all captured in the meeting minutes where several concerns were raised and addressed by the consultants and project proponents for the public to conceptualize the project design and potential impacts. The meeting minutes were prepared and signed by the consultants and proponent representatives for inclusion in the report. Meeting minutes are appended to the report as Annex 8.

7.3 Stakeholders Data Collection Modalities

Various modalities were used to collect the data from the respondents as follows:

7.3.1 Individual Questionnaires

Client pre-approved structured questionnaires were administered to the individual household respondents around the site. This was done for projects immediate neighbors and institutional stakeholders who were willing to give their opinions on paper. A radius of 2km at the project site was used for administration of questionnaires. This boundary was based on the site reconnaissance outcome where it was established that the area around the project site is sparsely populated with project land and the adjacent lands being mainly government owned as well as private land with minimal human settlement as the land has been reserved for future government infrastructure development. Figures 91 to 93 show various key local stakeholder's engagement during the study.

Figure 91: Sociologist Arthur Odhimabo engaging with Mzee John Kamau, an immediate neighbour to the project site.

Figure 92: Sociologist Ibrahim Adan Meeting with Senior Administrative Officer at Embakasi Garrison Major Amos Saitoti Tuukwo and Proponents representative.

Figure 93: Sociologist Ibrahim Adan meeting with Ruai Ward Administrator Ms. Jane Ndanu to hear her views on the proposed project.

7.3.2 Focused Group Workshops

Focused Group Discussions (FGD) were conducted for key community respondent teams, area leadership, public administrators and major institutional agencies with interest or are affected by the project. Due to the Covid-19 protocol most FGD were done virtually and meeting minutes captured as annexed (Annex 8) in the report. The following groups as per the figures 94-97 below were engaged;

- Project briefs to the leadership at the Nairobi County Assembly Environment Committee.
- Athi Water Works Development Agency (AWWDA).
- Water Resources Authority (WRA).
- Energy and Petroleum Regulatory Authority (EPRA).
- Njiru District Commissioners team.
- Ruai MCA Leadership team.
- Kasarani Sub-County Administration team.

Figure 94: Consultant team with Proponent Representatives and Nairobi County Assembly Clerks during the FGD with Environment Committee through a virtual meeting.

Figure 95: Duncan Saida of Kengen briefing the Ruai Ward Public Members at Wing View Hotel on the proposed Project.

Figure 96: Consultant briefing the community leadership of Kamulu location, Ruai Ward through the proposed project.

Figure 97: Consultant Ibrahim Adan with Duncan Saida of Kengen briefing Njiru County Commissioner and Ruai Assistant County Commissioner.

7.3.3 Photography

The ESIA experts on numerous visits to the proposed project site documented various social aspects through photo documentary of activities on site including meetings held onsite and immediate neighborhood activities and their interactions. Figure 98 and 99 show the local stakeholder meeting at the site and the infrastructure found on the site.

Figure 98: Project Consultants and stakeholders meeting on proposed project site to review suitability.

Figure 99: Complimentary infrastructure in high tension 33KV transmission line on site.

7.4 Stakeholder's meetings feedback

The stakeholders consulted raised both positive and negative views on the project. The project was largely perceived as having a positive impact with an overwhelming majority of around 80 percent seeing its positive contribution to the enhancement of waste and water management. The stakeholders where adverse impacts were noted proposed various mitigation measures to address such concerns as detailed in table 42 below;

Table 42: Stakeholders concerns on project

Stakeholder	Views Registered During Engagements
Ruai Ward Administrator	● Highly supportive of the project as it enhances waste management ● Provision of a matatu terminus to minimize traffic on the road around Ruai market, the key access point to the project site. ● Employ the local youths in waste collection and transportation. ● Ensure waste delivery trucks are covered to minimize foul smell effect to the immediate neighbourhood on Kangundo Road and the larger Ruai area.
Kasarani Subcounty Administrator	● Highly supportive of the project as it enhances waste management within the greater Kasarani Subcounty that includes the Dandora area. ● Expansion of the Kangundo Road to dual carriageway to minimize traffic snarl up on Kangundo road which experiences significant traffic. ● Ensure waste delivery trucks are covered to minimize foul smell and discharge of waste on public roads within the sub county.
Nairobi Water and Sewerage Co.Ltd	● Support the projects fully as it enhances water management in particular it enhances drainage management with improved waste collection reducing waste release into storm drainage infrastructure. ● Ensure air quality emissions from the plant do not affect water quality in the ponds. ● An MOU agreement to be entered for utilization of water from the ponds.
Ruai Water Resource Users Association	● The project may contaminate and pollute groundwater which the Ruai residents rely upon as there is no piped water in the greater area. This has potential to result in significant adverse health complications for the communities. ● The members proposed landfilling sites be properly designed to eliminate potential release of harmful substances into the soil & groundwater. ● Residents proposed a regular monitoring system be installed for ground water testing and results be shared publicly for transparency.
Njiru DCC & Ruai ACC	● The administrators were supportive of the project as it enhances waste management within Nairobi Metropolis. ● Project enhances youth employment with the proposed waste transfer stations. ● Project management to ensure no open dumping to minimize attraction of criminals to the area.
Ruai Nyumba Kumi leaderships	● There should be no open dumping of waste materials at the proposed project site to eliminate attractions of birds and foul smell around the site. ● Air emission from the plant should meet all the regulatory requirements and discharge monitored regularly. ● Air quality monitoring data can be shared with the immediate residents through their nyumba kumi leadership. ● Employment at the project during both construction and operational phases of the project should prioritize the immediate communities.

Stakeholder	Views Registered During Engagements
	● The plant design should eliminate landfilling onsite as the residents rely on groundwater for their water needs. The project site is identified as the lowest point in Nairobi and any groundwater contamination will affect the groundwater for the greater Nairobi and its rivers. ● Residents noted that public infrastructure in Ruai Ward is the least developed and is already under a lot of pressure from the large population in the area. NMS urged to improve the infrastructure in Ruai which is currently already under pressure for smooth operation of the project in particular, Kangundo road dualling and provision of piped water and drainage need to be prioritized. ● Residents urged the proponent and public health officials to undertake a health risk assessment on the waste's treatment and its emissions implications and processes involved in the project.
Kamulu location Residents Nyumba Kumi Leadership	● Residents were concerned with whether the case of Dandora dumpsite would be transferred to Ruai. Members posed what the procedures are in place incase of plant breakdown, does that entail accumulation of raw materials onsite in the open. ● Residents suggested that the fly ash from the plant be used to build roads in Ruai and Kamulu first to minimize landfilling onsite. ● Residents raised health risk mitigation measures the proponents will put in place in case of any health-related incidents in the local community to mitigate any mass outbreak of communicable diseases attributed to the plant? ● Residents proposed a modern health facility be built by project proponents as part of their CSI to mitigate against health risk and improve public health infrastructure in the area. ● Residents urged project proponents to take into consideration the conditions of the roads and associated infrastructure of drainages and water services in Ruai and Kamulu as the plant operations will involve a lot of traffic which is already currently crowded with negligible public amenities. ● The residents strongly voiced their opinion about protection from illegal dumping by waste transporters in the area in the long term where on vehicle breakdown, content is dumped by the roadsides.

7.5 Social Impact Identification

Potential socio-economic impact of the project was handled as part of this project assessment. The potential impact was gleaned through public participation, key informant interviews, focus group discussion via a series of meetings and semi structured questionnaires. Consultations with various stakeholders were made after a stakeholder analysis. The process provided an opportunity for the primary stakeholders to express their concerns and views. During the interview's respondents noted the following concerns:

Highly toxic emissions from plant operations with hazardous metals burned as part of the waste stream;

- Potential groundwater contamination from landfilling exercise onsite.
- Significant traffic congestions envisaged by the community with Kangundo Road already experiencing traffic snarl ups regularly from liquid waste disposal trucks delivering waste to Nairobi Water Sewerage facility.
- Potential for dumping of waste in the open along Kangundo Road from open waste delivery trucks.
- There should be no open dumping of wastes at the plant due to the proximity of the area to the JKIA and Embakasi Military Garisson flight paths. This is part of the conditional approval by KCAA for the project.
- Employment opportunities prioritized for immediate local communities along the ROW.

- Consideration for CSR opportunities for local communities around Ruai i.e. public school's classroom construction, provision of water, assistance for school fees,
- Waste transfer stations are constructed properly to minimize waste discharge percolation into the environment across the project value chain.

The impacts were assessed through public participation, key informant interviews, focus group discussion via 2No community meetings at Ruai Wings View Hotel, and several virtual meetings with various stakeholders, semi structured questionnaires issued to largely public agencies and private businesses within the project area. The perceived potential impact was seen not as an objective fact rather a subjective experience felt differently by different people. Communities' attitudes in relations past KenGen & NMS interactions and behavioral responses were considered important indicators of their likely reaction to the project.

7.6 Perceived Project Benefits

Some of the perceived benefits by stakeholders include enhanced waste management, & water infrastructure improvement, diversification of electricity source and employment of youth within the greater Nairobi area through development of transfer stations and enhanced waste collection and disposal. The perceptions are detailed in figure 100 and table 43 below.

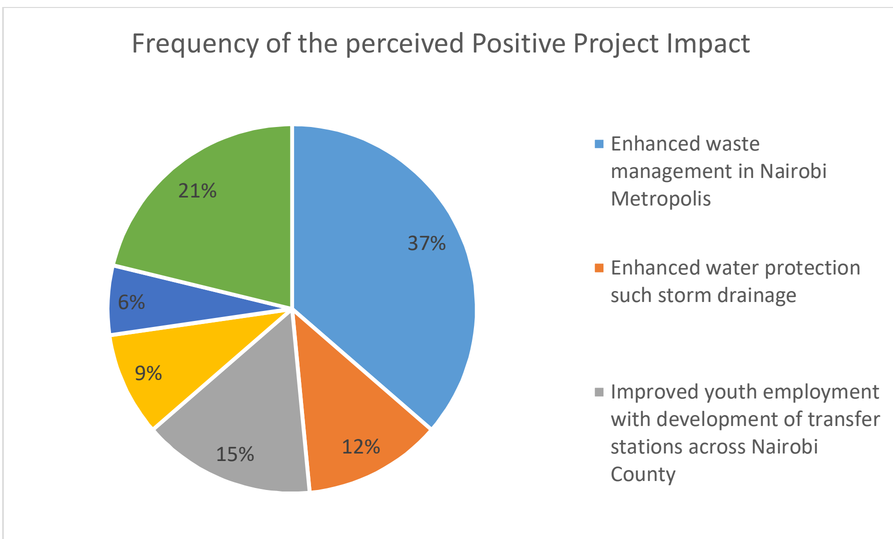

Figure 100: Frequency of the Perceived Project Impact

Table 43: Perceived positive benefits arising from the project

Perceived Positive benefits arising from the project	Frequency	Percent
Enhanced waste management in Nairobi Metropolis	12	36.4
Enhanced water protection such storm drainage	4	12.1
Improved youth employment with development of transfer stations across Nairobi County	5	15.2
Improved electricity base load diversification	3	9.1
Cheaper electricity	2	6.1

Perceived Positive benefits arising from the project	Frequency	Percent
Enhanced local & national economies with improved business communication	7	21.2
Total	**33**	**100**

7.7 Adverse Impacts Associated with the project

During the various community engagement numerous adverse impacts were enumerated by the members of the public at the meetings. This was based on perception of the community in relation to NMS waste management at Dandora dumpsite. The enumerated adverse impacts are presented in figure 101 below;

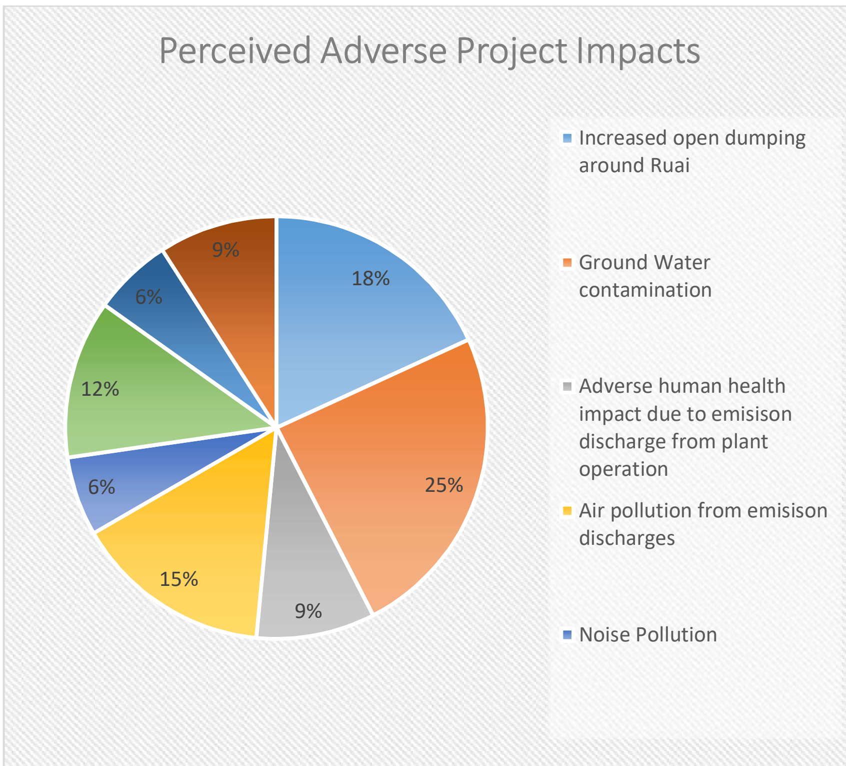

Figure 101: Frequency of the Perceived Negative Project Impact.

Some of the major problems associated with the project as perceived by the stakeholders included groundwater contamination and air pollution from emission discharge of the plant.

Overall, the stakeholders gave the project a positive outlook with a majority at 81% stating that the project has a positive impact as shown in figure 102 below. Thus, the project will have adverse impact on the society but with proper mitigation will enhance waste management within the Nairobi Metropolis area.

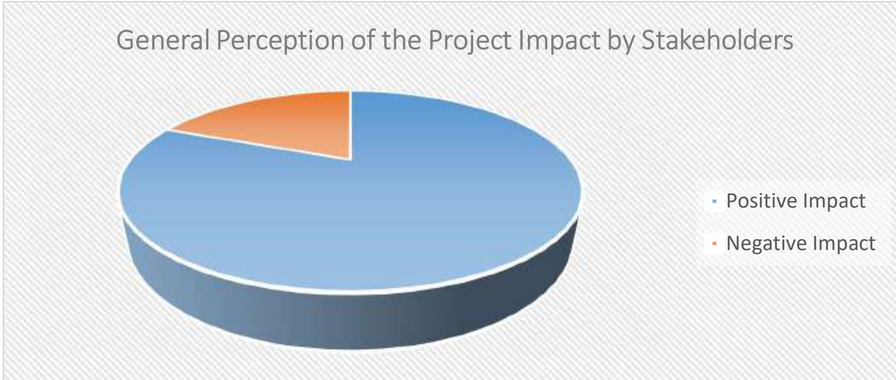

Figure 102: General Public Perception of the Project Impacts.

8 Anticipated Impacts and Mitigation Measures

8.1 Introduction

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

This ESIA uses a systematic, evidence-based approach in order to evaluate and interpret the potential impacts of waste to energy power plant activities on sensitive physical, biological and human receptors. This document has been prepared in accordance with the Legal Notice No. 101 (Environmental Impact Assessment and Environmental Audit) Regulations 2003, which require that a developer to provide a "description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the development."

The methodology used in assessing impacts in this ESIA Report follows EIA principles and also draws upon a number of guidance documents and legislation, including:

- Environmental Impact Assessment and Environmental Audit Regulations, 2003;
- Draft Environmental Impact Assessment Guidelines (NEMA 2012);
- IFC environmental, health and safety guidelines on waste management facilities
- World Bank Operational Policies.

Further details on the legislative context of the assessments undertaken in this ESIA Report are provided in Chapter Three: Policy, legislative and Regulatory Considerations.

8.2 Impact Identification and Assessment

Several environmental impacts (positive and negative) associated with the proposed project were identified through field work, desktop analysis and the use of experts' judgment methods. The following section highlights the impacts anticipated throughout the lifecycle of the proposed project. The impacts identified have been rated using a specific methodology elaborated in this chapter.

8.2.1 Steps of Impact Assessment

The potential impacts of the proposed project were assessed using the following steps:

- Characterization of the baseline conditions or rather the existing conditions before the Project is undertaken and any effects are generated;
- Description of the Project components throughout the Project lifespan (Pre-Production, Operations, and Closure and Post-closure);
- Evaluation of alternatives to the Project to see if impacts can be reduced;
- Identify sources of impacts and the impacts themselves that are generated by any aspect of the Project;
- Rating of impacts before any mitigation (for negative impacts) or enhancement (for positive impacts) is implemented;
- Identification of mitigation and enhancement measures to address the impact; and
- Rating impacts after mitigation to produce a "residual" impact rating 7.5 Impacts Rating Criteria It is important to note that there is no legal definition of significance of impacts and therefore its determination is partially subjective. In this assessment the approach developed by Environment Resource Management (ERM) which is based on the Environmental Health and Safety (EHS) risk rating system has been adopted in rating potential social and environmental impacts of the proposed project. The approach has focused on two elements in rating impacts: (1) the severity and enhancement of the potential impact and (2) the likelihood that the impact will occur.

8.2.2 Severity and enhancement

The severity or enhancement of each potential impact has been rated using the following criteria in the tables 44 to 47 below:

Table 44: Severity Criteria (Negative Environmental Impacts)

Severity	Duration	Description
Low	Short-term (up to one year) Low frequency	Affects environmental conditions, species, and habitats over a short period of time, is localized and reversible.
Medium	Medium-term (one to seven years) Medium or intermittent frequency	Affects environmental conditions, species and habitats in the short to medium term. Ecosystem integrity will not be adversely affected in the long term, but the effect is likely to be significant in the short or medium term to some species or receptors. The area/region may be able to recover through natural regeneration and restoration.
High	Long-term(more than seven years)/ Irreversible Constant frequency	Affects environmental conditions, species and habitats for the long term, may substantially alter the local and regional ecosystem and natural resources, and may affect sustainability. Regeneration to its former state would not occur without intervention. Affects environmental conditions or media over the long term, has local and regional affects or is irreversible

Table 45: Severity criteria (Negative Social or Health Impacts)

Severity	Duration	Extent	Ability to Adapt	Socio-cultural Outcome	Health Outcome
Low	Short-term (up to one year) Low frequency	Individual/ Household	Those affected will be able to adapt to the changes with relative ease, and maintain pre-impact livelihoods, culture, quality of life and health.	Inconvenience but with no consequence on long-term livelihoods, culture, quality of life, resources, infrastructure and services.	Event resulting in annoyance, minor injury or illness that does not require hospitalization
Medium	Medium-term (one to seven years) Medium or intermittent frequency	Small number of households	Those affected will be able to adapt to change, with some difficulty, and maintain pre-impact livelihoods, culture, quality of life and health but only with a degree of support	Primary (direct) and secondary (indirect) impacts on livelihoods, culture, quality of life, resources, infrastructure and services	Event resulting in moderate injuries or illness, which may require hospitalization

Severity	Duration	Extent	Ability to Adapt	Socio-cultural Outcome	Health Outcome
High	Long-term (more than seven years)/ Irreversible Constant frequency	Large part or entirely	Those affected will not be able to adapt to changes and continue to maintain pre-impact livelihood	Widespread and diverse primary and secondary impacts likely to be impossible to reverse or compensate for.	

Table 46: Enhancement Criteria (Positive Environmental Effects)

Severity/ Enhancement	Duration	Extent	Degree of Change	Focus/sensitivity
High level of enhancement	Benefits will be sustained over the long term	Benefits will extend beyond local environment (i.e., linkage of fragmented habitat, e.g., regional corridor)	Direct benefits to species or resources will provide significant opportunities for sustainability.	Benefits will pertain to species, habitats and natural resources that are degraded, or are sensitive, rare, or in need of protection.
Medium level of enhancement	Benefits will be measurable in the short term and possibly longer.	Benefits too many species, habitats and natural resources in the local environment and beyond.	Moderate benefits to species, habitat, and natural resources that may provide some opportunities for sustainability.	Benefits will pertain to species, habitats and natural resources that have some level of degradation, sensitivity, or rarity.
Low level of enhancement	Benefits will be short term.	Benefits to a few species, associated habitat, and resources in the local environment only.	Minor benefits to species, habitat, and natural resources that may provide minor opportunities for sustainability.	Benefits will pertain to species, habitats and natural resources that are not sensitive or rare.

Table 47: Enhancement Criteria (Positive Social and Health Impacts

Severity/ Enhancement	Duration	Extent	Degree of Change	Focus/sensitivity
High level of enhancement	Benefits will be lasting and sustained over the long term i.e.: more than 7 years	Benefits throughout the local community and beyond to Regional/ National level.	Direct benefits to individuals and communities will provide significant opportunities for leveraging secondary benefits and significantly improving livelihoods for themselves and others.	Benefits will pertain to vulnerable groups and those that would otherwise have been 'losers' as a result of the Project.

Severity/ Enhancement	Duration	Extent	Degree of Change	Focus/sensitivity
Medium level of enhancement	Benefits will be felt for a medium period (1 to 7 years) or be intermittent over the longer term	Benefits to many individuals and households in the local community and beyond	Moderate benefits to individuals and communities which will provide some opportunities for furthering themselves and improving livelihoods.	Benefits will possibly pertain to vulnerable groups and those that might have been 'losers' from the Project.
Low level of enhancement	Benefits will be short-term (up to a year)	Benefits to a few individuals and households either in the local area and/or further afield.	Some benefits to individuals and communities, potentially improving opportunities for furthering themselves and improving livelihoods	Benefits will not pertain to vulnerable groups and will only benefit those that would have otherwise benefited from the Project.

Project impacts can also be considered direct or indirect:

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

The determination of significance is therefore dependent upon decisions of the following factors in table 48 below: ESIA significance factors that will be considered.

Table 48: Risk Matrix

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

8.2.3 Anticipated Impacts of the Proposed Project

The anticipated impacts emanating from a proposed project can either be positive or negative, direct or indirect, immediate or long term. Some impacts can work in synergy to cause a greater impact. Environmental impacts for the project are determined by breaking down the project into its activity components and examining the tasks in each component. Mitigation measure(s) for each identified impact are then prescribed and subsequently, an Environmental Management Plan (ESMP) is formulated for the proposed project as shown in tables 49 &50 below.

8.3 Anticipated Positive Impacts

Table 49: Positive Impacts Anticipated from The Project

Aspects	Potential Impact
Landscape and Visual Improvement;	Visual improvement of the environment with the facility development, improved access roads and greenery improvement through planting of trees and grassing of the open spaces after construction works.
Land-Use;	Area is largely open grasslands with shrubs in the immediate vicinity of the waste plant thus project development will give raise to land value elevating it to an industrial status zone.
Climate Change	The facility will reduce overall greenhouse gases in Dandora area as it reduces waste to the dumpsite paving way for Dandora reclamation and restoration, the country and the world as a whole and thus ameliorate climate change impacts.
Energy & Telecommunication	Improved power supply in the area and country Improved green energy production in the country
Improved youth employment with development of transfer stations across Nairobi County	With the construction of the proposed Project, there will be employment opportunities for both professionals and unskilled workers, beneficial both from the economic and social point of view. Economically, it means abundant unskilled labour will be used in production. Socially these people will be engaged in productive employment.
Knowledge transfer	The locals will have an opportunity to learn from some of the specialised skills that are going to be employed in the decommissioning process.
Market for goods	The Project will require materials, some of which will be sourced locally and some internationally. This will provide a ready market for suppliers.
Enhanced local & national economies with improved business communication	The Government will be able to collect revenue from the supply and sale of energy to the public.
Waste as a fuel feedstock	Reduction in illegal dumpsites and clean-up of existing ones because waste will be viewed not just as waste but as a valuable fuel feedstock.
Enhanced waste management in Nairobi Metropolis	The waste to energy plant is expected to consume about 3000 tonnes of solid waste from the metropolitan area daily. Hence there will be a marked improvement in waste management.
Enhanced water protection such storm drainage	The facility is expected to have drainage systems and water infrastructure for storm water collection.
Improved electricity base load diversification	As a result, there will be cheaper electricity.

8.4 Anticipated Negative Impacts

Table 50: Negative impacts anticipated from the project

Impact	Sources of Impacts	Elaboration
Air; Dust Pollution, and Exhaust emissions	Site clearing and excavation activities Truck movements, Heavy equipment and machines	Dust will be emitted during excavation and related earthworks. Air borne particulate matter pollution is likely to occur during clearance, excavation, ripping and shaping. This is likely to affect site workers and nearby facilities and settlements, and in extreme situations leading to respiratory problems.
Air pollution -Odors and gases (mainly from fugitive	-From waste and their decomposition	Odors are likely to emerge from the proposed plant land fill if measures such as covering of the land fill are not taken.
methane and carbon dioxide and non-methane organic compounds) -Suspended particulate matter	-From access road and the WTE project site From delivery trucks	The sources of combustion emissions (e.g., SO2, NOx, CO, and particulates) will be mainly operations of diesel-powered construction equipment: excavator, wheel loader, trucks, motor grader and compactor.
Noise pollution & excessive vibration	Construction and operation of the WTE plant	Construction of the proposed Project will most likely result in noise emissions as a result of the machines that will be used (excavation equipment etc) and construction vehicles delivering materials to site. Heavy equipment will be used for ground ripping and shaping of slopes and floors.
Aesthetics/ visual intrusion	Construction and operation of the WTE plant	Excavations and earth works may interfere with the aesthetic composition of the site from its current natural setting.
Increase traffic on the access road	Waste trucks delivering the solid wastes	Due to increased traffic flow and human activities e.g. creation of secondary businesses along the access road, the number of road accidents may increase significantly. Appropriate speed regulating infrastructure and signage should be factored during the construction and operation phases.
Unplanned settlements	Cropping up of unplanned settlements along the access road	Establishment of the waste to energy plant in the area may lead to demand for menial work at the site which might encourage growth of unplanned settlements.
Surface and Groundwater Pollution;	• Inadequate treatment of leachate at the ponds • Accidental leakages from the waste reception storage at the WTE plant.	Waste to energy plant operation generates leachate which have potential of causing soil, groundwater and surface water contamination. The impact significance is major due to the sensitive resource receptor.
Social Changes	The high influx of casual workers will cause several social changes	The project may cause conflict between groups within the public if proper protocol is not followed when planning interactions between the proponent and the public. Social conflicts due to the labor influx in the area may lead to social vices

Impact	Sources of Impacts	Elaboration
Injury and loss of life	● Installation of machines, and plants ● WTE plant operations ● Dismantling of project installations.	The construction works unavoidably expose workers to occupational health and safety risks. The construction workers are also likely to be exposed to risk of accidents and injuries resulting from accidental falls, injuries from hand tools and construction equipment.
Habitat loss and degradation	The infrastructural development related to the WTE plant including leachate ponds, access roads, administrative units etc.	A detailed ecological survey was undertaken as an integral part of this ESIA. Impacts to the flora and fauna are as a result of loss or damaging of the habitations of the plant and animal species. From the site visits, no resident plants or animal species was listed as an endangered or protected species from IUCN Red List a species.
Soil erosion	Clearing and excavation of the site for the construction of the site office and other structures Storm water.	Project construction involving earthworks and excavation will result in the generation of spoil materials and over burden. This should be utilised on site as much as possible with the excess and undesirable materials carted away and disposed of appropriately.
Construction debris	Demolition works Restoration of the site	This may occur during decommissioning when the site facilities are being taken down or during construction. Necessary safety precaution is advised.
Health Precautions	Covid-19 impacts	Protocols necessary to manage the spread of covid 19 should be put in place both during construction and in the operational stages of the power plant.

8.5 Mitigation Measures for Preventing Negative Impacts of the Project

8.5.1 Preparation Phase

The project preparation stage takes place in a short time. Activities during this period are mainly to get the site ready for construction works and include site clearing, setting up camp, office area and storage facilities for fuel, construction materials, installation of utilities such as water, electricity and service roads. Mitigation measures during this period:

- **For machines** such as heavy construction machines such ground leveling machines i.e. excavators, rollers offloaded and may be assembled and tested before being put into operation. At the same time, its expected during this period little maintenance should be done limiting concerns generation of dust and accumulation of hazardous waste from generation of used oil and greases during vehicle equipment assembly.
- **For soil** during the process of leveling, the aggregate will be covered, and utilized along with the amount of soil excavated during the construction process to backfill sections where this is required. Materials deliver trucks including shall be road worthy and be fully covered to minimize potential discharge of materials and dust onto public roads.
- **For material Storage activities:** Arrange convenient storage and material handling sites considering wind directions, safety and security, away from the campsite of the workers, with the roof to limit the impact of wind and rain among other weather conditions of concern at the construction site. Raw materials storage on site be determined by rate of use avoiding large volumes being stored onsite.

8.5.2 Construction Phase

Time Management

→ ***Appropriate Organization of Construction Solutions***

Based on the ground and construction items in particular daily site management considerations such as solid waste, the contractor will comply with the following:

- Obtain all relevant regulatory requirements,
- Choosing suitable construction time, limiting the construction of works related to digging embankments during rainy and flood season due to safety concerns,
- The contractor in liaison with project consultants manage and organize the construction of the project with the proponent supervision teams with HSE team to offer advisory role for safe works.
- The arrangement of transportation of raw materials and machinery in service of construction shall be carried out during off-peak hours, ensuring road safety and general safety for road users and the general public;
- Provision of appropriate construction safety signages at the construction sites and boundaries of the project area (on the access road to the project area) for warning;
- On the construction site, the construction units shall comply with the regulations on labor hygiene and safety and electric safety;
- The construction units perform shielding against dust and materials falling from heights; environmental hygiene during the process of construction and finishing works.
- When constructing pile foundations for construction works, the construction units shall consider the selection of construction equipment and appropriate construction methods to avoid vibration, smoke, dust, noise and influence on other works.
- The site should be barricaded off with access restriction through use of security systems for safe works and access by only authorized personnel.

Impacts to Air Quality

→ ***Mitigation Measures for Air Pollution***

In this phase, to minimize the negative impacts on the environment, the following measures are applied:

→ ***Dust Minimization Measures***

- Installing a barricade upto 2m height around the site to minimize dust spread to the environment and affect the people around the area.
- Vehicles transporting raw materials must not be overloaded and be fully covered to minimize release of dust into the environment.
- The material in the project area is covered with limited wind to emit dust into the environment.
- Arranging suitable materials delivery hours and access to minimize adverse impact on local traffic during peak hours.
- Spray water onto loose materials to limit dust release into the environment with frequency determined by need assessment.
- Generally, in this area roads have been asphalted and paved, vehicles transporting materials are shielded so the amount of dust generated is limited except in the 1.5km stretch route to the site where speed limits need to be observed.
- All workers to have appropriate personal protective equipment for safe works.
- When constructing high floors, install mesh shields to minimize falling debris and dusts.

→ ***Emission Reduction Measures***

- Requiring that vehicles, machinery and equipment meet the conditions of environmental technical safety, operators must have appropriate driving licenses, training certificates prescribed; implement traffic safety measures when driving vehicles on the road.

- Ensuring adherence to speed limits within the site and along the delivery routes.
- Coordination of trucks and construction machines is rationalized, and at the same time to limit emissions due to large convergence of vehicles or emission activities at the same time. However, the density of construction vehicles depends on the layout of the building.
- Prioritizing the material supply within the neighboring areas to reduce transportation distances and reduce raw material preservation in order to minimize dust and waste generation as well. Reduce the risk of problems.
- Periodical inspection and maintenance of means of transport and construction equipment.
- Using the right fuel for engine design,
- Not exceeding the prescribed tonnage;
- Providing personal safety equipment for workers such as hats, masks, work wear, etc.
- Ensure materials delivery trucks tires are cleared of mud and such.

→ ***Minimize Emissions from Backup Generators:***

- Consider and use low sulfur fuels;
- Periodic maintenance of generators as per manufacturer's guidelines.

→ ***Minimize Bad Stench Arising from Workers' Living Waste:***

- Waste containers be provided on site with tight lids to avoid the odor;
- Regular cleaning and clearing of garbage rooms;
- Contractor to schedule waste disposal regularly to avoid accumulation onsite.
- Propagate to raise awareness of people onsite to ensure enhanced environmental hygiene.

Impacts on Water Resources

→ ***Mitigation measures against impacts on water environment***

Project activities affect the water environment during this period due to the varied construction works involving excavations, material delivery, sanitary wastewater, construction wastewater, solid waste, general construction waste. Various control measures are provided as follows: -

→ ***For Domestic Wastewater***

- Domestic wastewater will be treated centrally before discharging into the environment, ensuring that the content of pollutants in the water after treatment is within the permitted limits.
- Minimize wastewater by promoting the recruitment of local workers to minimize large construction camps requirement and subsequent waste volumes generated.
- Provide an appropriate number of sanitary facilities such as portable toilets depending on the number of workers onsite. The toilets should be conveniently located within the construction sites to minimize long travels around the site exposing workers to hazards and crowding onsite.
- Regular inspection of the work site to avoid accumulation of construction waste, clear drainages of garbage etc.

→ ***For Construction Wastewater***

- Construction ditch system, temporarily settling pit near the construction areas as is necessary.
- Wastewater from the wash area, mixing material is introduced into the temporary collection system, settling through the settling hole to sediment, and then follows the drainage channel of the common drainage system of the area.
- Vehicles operating on site when they are due for maintenance or oil change are taken to professional garages for limited treatment of wastewater on the construction site.
- No oil change or repair at the construction site is allowed to limit the spread of engine oils containing toxic components into the water environment.
- The contractor may utilize the services of NEMA approved waste handlers to dispose of materials.

- Regularly cleaning and clearing the drainage systems, settling holes to ensure drainage during the construction period, once a week.
- No construction during heavy rain, floods for workers and equipment safe.
- Clean up the construction site at the end of the working day.
- In the case of rain, construction machinery on the site is covered.
- The amount of wastewater discharged from the car wash area be collected into the appropriately sized manholes. The effluent may be contaminated with oil, and to be treated onsite before discharge into the environment.

→ ***Storm water Management***

- Overflowing rainwater in the project area in the groove project, preliminarily deposited in the manhole before discharge into the environment (due to rainwater only suspended sediment). The manholes should be appropriately sized.
- Cleaning the construction site at the end of the working day, collecting garbage, not to leak gasoline to minimize the impact of storm water runoff.
- Periodically clear drainage hatches from debris to minimize clogging. Frequency of implementation is monthly and shorter duration during the rainy season. The amount of dredged waste needs to be transported and disposed according to regulations. Figure 103 shows a diagram of drainage and rainwater overflowing during construction

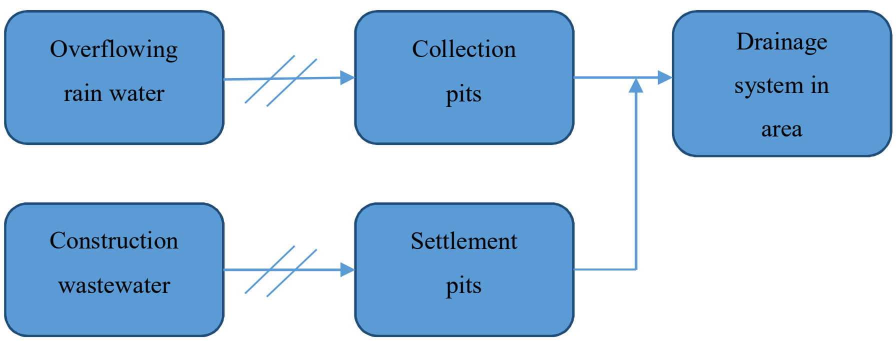

Figure 103: Diagram of Drainage and Rainwater Overflowing During Construction

Feasibility assessment: the proposed measures are appropriate, simple, easy to implement.

Protection of Water Supply and Surface Water, Underground Water

- Proponents will abide by regulations and rules on the protection of water supply, surface water and groundwater.
- The project is committed not to carry out rainwater drainage, construction wastewater, and untreated domestic wastewater into regional water drainage systems. At the same time, the commitment in the process of construction execution does not adversely affect the drainage capacity and drainage system of residential areas in the project area.
- Construction of water supply pipelines for construction and water supply according to each stage of infrastructure, with the installation of pipelines, valves and accessories in strict accordance with the construction regulations and the implementation thereof. Save water used in project activities.
- For mobile toilets, the amount of wastes generated shall be periodically leased to units with related functions to collect and treat them according to regulations.

In addition, the project ensures compliance with the terms and regulations relating to ensuring order, safety and environmental hygiene during the construction process of the works; standards, regulations and technical guidelines for water supply and sewerage systems; Occupational safety and health standards in construction; the regulatory requirements for hygiene and protection of water resources.

Solid Waste Management

→ ***Measures to Minimize the Impact of Solid Waste***

Solid waste and hazardous waste arising during the execution of the project are managed in accordance with the law:

- Manage solid waste in accordance with the Environment Management and Coordination (Waste Management) Regulations, 2006.
- Hazardous waste management in accordance with the Fourth Schedule and regulation 15, 19 (1) & 19 (2) of the Waste Management Regulations, 2006. In the solid waste collection area before being collected by the contracting entity, under appropriate conditions of temperature and humidity, the microbial activity of the microorganisms will produce odors and produce gases causing air pollution. However, garbage generated is collected every day, at the same time, not to focus on for a long time. Garbage collection only affects locally in a short time. In addition, the area of specialized vehicles used to collect garbage is located in the technical area, at the end of the wind direction of the building to avoid odors affecting the air environment in and around the project. At the same time, the project will also arrange a series of green trees that are both quarantined and have a good effect on the environment and limit the spread of smell to the surrounding area.

→ ***Measures to Reduce Domestic Waste***

General waste from construction workers will be collected by temporary 240L garbage cans, with lids and wheels to facilitate transportation. Location of the trash area for the construction area as follows:

- two waste baskets at the location of the camp respectively.
- one basket is located at the location of the mobile toilet installation.

The total number of temporary Containers for the Project is 60. Domestic waste is collected in temporary containers and then transported to the waste collection area.
Collected waste is classified, utilizing recyclable waste:

- For waste is paper, wood can be made into fuel.
- For waste is metal, plastic, cans are collected and sold scrap.
- For other household wastes (non-reusable): the employer leases the unit with the function of collecting, transporting and handling. Frequency of collection: 1 day / time.

The waste collection area is located away from the water source, away from the resting area between the hours and the kitchen, the terrace is poured concrete, covered roof. It is expected that the waste collection area will be located behind the project camp.

Setting up regulations on work order and hygiene, educate workers on sanitation and training workers; implement the rules and regulations of the site; maintain hygiene on site. Figure 104 below shows a sample of waste bins to be used in the plant.

Figure 104: Waste Bins to be provided onsite for collection of small materials waste. The Bins shall be appropriately labelled.

→ ***Measures to Reduce Construction Waste***

The waste generated in the construction process is mainly sludge, broken bricks, cement bags, formworks timber materials, packaging materials, etc.

→ ***Construction Waste Management***

- For excavated soil for construction, the construction unit will utilize part of it to support the construction process and part of the contract with the collecting and transporting unit for processing according to the regulations. The contractor pledges to collect and transport land to ensure environmental protection.
- Scrap materials such as iron, steel, packaging, and cans are collected in a container of 240 liters, placed in the raw material warehouse, to be used for sale to scrap collection facilities.
- Mortar, broken bricks, mortar, screed is used for pouring, building roads in the area.
- Excavated earth and unused waste generated during the construction process are collected at the temporary disposal site located behind the material warehouse and then contracted to the collector with the transport function to the disposal site.

→ ***Hazardous Waste Mitigation Measures***

- Hazardous waste management can be done in accordance with the Fourth Schedule and regulation 15, 19 (1) & 19 (2) of the Waste Management Regulations, 2006.
- Minimize the repair of machinery in the project area.
- The contractor shall provide a container for grease and oil in case of waste oil from damaged machinery and one container of oiled mop. Containers of 60liters of hazardous waste with lid wheeled for convenience of movement and labeled.
- Build temporary storage tanks during the construction period for holding of hazardous waste materials, the location of tanks & such materials warehouses shall be arranged on the flat land, near the construction material gathering area, far from surface water and worker camps.
- Hazardous waste is collected in closed containers and concentrated in temporary storage. When the volume is substantial, the unit will be disposed off appropriately.

Mitigation Measures to Manage Thermal Pollution

- During the process of construction, contractors will build temporary shelters for staff so that workers can rest and shelter from the weather conditions.
- Provide sufficient appropriate protective equipment for staff such safety helmets, protective clothing, masks, gloves depending on the nature of work.
- In addition, the drinking water supply, washing and hand wash for workers will be provided.
- Limiting the concentration of construction vehicles at the same time on the site to minimize potential occupational health concerns during this pandemic period.

Noise Disturbance during Construction and Decommissioning

→ ***Mitigation measures for noise and vibration impacts***

Noise Management

In the construction area of the project, vehicles such as bulldozers, excavators, concrete mixers, etc. will carry out noise pollution assessment. At the same time, after completion of the works, there will be a period of transportation of the machines and equipment to the project site for assembly for the operation phase. Therefore, there is a need to take measures to reduce noise during this period:

- Arrange reasonable working hours, limit the transportation of materials during peak hours, and transport vehicles must not run at over speed, especially when passing through residential areas or at the break-time. In addition, large noise machines will not operate after 10:00pm.
- Regular maintenance of equipment, vehicles, and ensure this equipment, vehicles or machines meet environmental standards requirements such as noise.
- Check the noise level in the construction area to arrange the construction schedule accordingly to be within allowable limits.
- For noise equipment: design to reduce the noise level of the machine when operating; maintain equipment regularly and replace degraded components.
- Limit the simultaneous operation of devices with high noise levels.
- Build appropriate embankments to reduce noise and vibration around the site. This could be in the form of a boundary wall with tree lining.
- Noise protection equipment for workers in high noise areas such as noise-canceling earplugs and noise-canceling earplugs.

Vibration Management

- Anti-vibration at the source: Depending on the specific types of machinery to take remedial measures such as mechanical balancing, the installation of shock absorbers, the use of non-metal materials, replace the principle of gas work compressed by hydraulic, changing working load mode.
- Anti-vibration transmission: Use vibration-reducing vibration (oil damper box, elastic pillow, metal elastic buffer, rubber elastic pillow), use of personal anti-vibration device.

Traffic and Transport Impacts

→ ***Measures to Ensure Traffic Safety***

During the construction phase, the number of vehicles transporting materials for the construction process of the project is relatively large. Therefore, to limit possible impacts such as traffic snarl ups in the area, traffic accidents etc proponent will take the following measures:

- The contractor to raise awareness among its workers & suppliers about the project execution plan and construction schedule for access and delivery of materials to planning purposes for ease of traffic management.
- Arrange staff to signal when there are vehicles entering and leaving the construction area, limiting possible accidents,
- Limit the frequency and density of means of transport during peak hours, at intersections or routes with high traffic density.
- Specify the speed of vehicles in accordance with the site risk assessment guidelines for safe work environment for all stakeholders onsite.
- Provide adequate and appropriate signage within the site to enhance awareness.
- Ensure drivers and equipment operators including cranes have requisite legal authorization as part of their competency affirmation during employment and be regularly verified before entry into the site.
- Ensure all vehicles and equipment onsite roadworthy and regularly serviced.
- Install lights, signage, rails and other controls to operate to guide traffic movement.

Landscape and Visual Impacts

→ ***Mitigation Measures to Protect Ecosystem, Landscape and Environment***

During this period, ecosystem impacts are inevitable. To minimize the impact, the contractor will take the following measures:

- Require construction units to commit to fully and seriously implement measures to collect and treat waste generated by the process of discharging into the environment.
- Strictly implement the regulations set out on the site: discharging & disposing waste, fire and explosion prevention in accordance with regulations.
- Limit the concentration of construction wastes on the construction site to minimize accumulation onsite.
- Arrange reasonable ground plans, ensure the shortest transportation of raw materials and reduce environmental pollution.

Social and Socio-Economic Impacts

→ ***7.5.2.9.1 Management of Pollution Sources During Construction***

- Establishment of project environmental management team: The team shall consist of environmental experts and environmental technicians responsible for monitoring the state of the environment, identifying urgent issues and proposing solutions for concerns such as waste management.
- Management of information on equipment and construction vehicles: management of fuel efficiency. Equipment that does not meet the standards allows for downtime or for maintenance, repair or upgrades.
- Waste management: waste generated during construction be collected and reused where appropriate with authorization from relevant authorities.
- Wastewater management: Wastewater is collected through equipment, systems and pre- treated. Do not discharge untreated wastewater into receiving waters.
- Development of environmental sanitation regulations for construction workers at the construction site; Regulations for waste handling & disposal, organizing suitable camps to facilitate the collection and ensuring proper sanitation and hygiene for workers and around the site.
- Institute measures to clear the site regularly after work completion.
- Ensure site clearance of all constructions remaining onsite as guided by the project engineer.

Mitigation Measures at Material Gathering Yards and Worker Camps

- Raw materials and items such as iron, steel, plastic pipes be located within a designated temporary storage area and properly be sheltered against rain and wind,
- Loose materials such as sand are covered with canvas avoiding the dust spread to the surrounding environment.
- Due to fire risk concerns, it's critical to limit large storage of flammable materials on site during construction. Its essential such sites are secluded, and access restricted with signage and prohibitions for ignition sources.
- Camps, resources, fuel, materials and some equipment during the construction process are collected within the limits of the project, without affecting the surrounding area. This is to ensure the project does not adversely affect pricing of commodities to the disadvantage of other stakeholders.
- Raise the awareness of construction workers in ensuring hygiene and working environment. Workers' waste is collected and disposed off appropriately.

Mitigation Measures for Social Security

The following proposed measures to enhance social security at the site and neighboring communities. Specifically:

- Prioritize the use of local labor. Contractor is urged to give priority to the local neighborhood workers.
- Pay attention to the community's comments on the project implementation plan as well as inform the local authorities and people about the project implementation plan. This can be achieved through posters at the project site and local community leaderships who shall be included as part of the project oversight committees where practicable.
- Establish grievance and complaint handling mechanisms for the project with local community participation.
- Maintain good relationships with local authorities and people in the area to be informed and incorporate conflict resolution issues during project implementation.
- Ensure environmental sanitation in workers' areas (daily garbage collection etc) and timely prevention and testing for the detection of infectious diseases. In particular, during this Covid-19 pandemic, its critical the public health guidelines be adhered to at all times and enforced accordingly by the supervisors.

Measures to Mitigate Impact Construction Impact on water related utilities.

- Organize the construction in accordance with the design and sequence for each item.
- Complete the drainage system of the project prior to returning the site of the temporary drainage system, and at the same time treat the wastewater before discharging into the drainage system temporarily leading to the drainage ditch of the area.
- Avoid construction on rainy day, storms besides ensuring regular cleaning of drainages.

Measures to Mitigate Impacts on Existing Residential Areas

- Arrange reasonable working hours that will Not be a nuisance to the immediate neighbors.
- Limit the delivery of materials during peak hours, and transport vehicles should observe speed limits.
- Maintain equipment and vehicles as per manufacturer's guidelines.
- Increased use of local manpower to reduce construction camps onsite.
- Clear drains, stagnant ponds, kill larva and mosquitoes to prevent disease onsite regularly to minimize potential occupational health concerns.
- The contractor works closely with local authorities to manage security situations.

Labor Safety Measures

Disseminating and strictly obeying regulations on occupational safety requirements for staff, workers and people in the area such as:

- Place signage at appropriate points on the site to guide workers on safety considerations.
- Regular occupational health and safety inspection to forestall incidents.
- Issuances of relevant personal protective equipment to the workers depending on the nature of work.
- Institute a permit to work system for controlled works minimizing unauthorized works.
- Construction execution in the night must be sufficiently lit.
- Toolbox talks are given prior to work commencement to alert workers to dangers onsite.
- All cabling, cranes and scaffolds must be inspected prior to use daily.
- Workers to be reporting near misses and incidents and be fully investigated and closed out.

Measures to Reduce Fire Incident

- Provide fire prevention and response equipment such fire extinguishers, absorbents, sandbags, respirators where necessary as determined by risk assessment and Job Safety Analysis).
- Coordinate response through use of emergency call out directories to access Response and Rescue Department and hospital facilities.

- Regularly undertake fire safety training for construction workers and drills for emergency preparedness.
- Flammable items are placed in secluded open areas with restricted access to minimize potential fire incidents. Safety signage be installed onsite to alert the workers to the dangers onsite.
- Institute smoking policy to guide on the restrictions on such requirements.
- Proponents will develop fire prevention policy and procedures onsite for the safety of all onsite.

Disaster Mitigation Measures

- To arrange appropriate construction plans to limit the construction of works related to excavation and embankment in the rainy season.
- To enhance the updating and monitoring of weather events to organize the construction.
- To limit impacts from natural disasters, construction items need to ensure proper construction techniques and procedures.
- Construction on schedule, not to delay in construction.
- When floods cause flooding in the project area, the contractor will arrange pumps to drain water into nearby drainage ditches to prevent local inundation resulting in damage to the neighboring works and works that have been under construction.
- Regularly propagandize and raise the awareness of workers who abide by internal rules and regulations in the project execution area.

8.5.3 Operation Phase

Emissions to Air During Operation

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

In addition to the composition of the waste feed stream and the design and operation of the combustion chamber, a major influence on the emissions from waste-incineration facilities is their air-pollution control devices. Particulate matter can be controlled with electrostatic precipitators, fabric filters, or wet inertial scrubbers. Hydrochloric acid (HCl) and sulfur dioxide (SO2) can be controlled with wet scrubbers, spray dryer absorbers, or (to a lesser extent) dry-sorbent injection and downstream bag filters. NOx can be controlled, in part, with combustion-process modification and with ammonia or urea injection through selective or nonselective catalytic reduction. Concentrations of dioxins and mercury can be reduced substantially by injecting activated carbon into the flue gas, or by passing the flue gas through a carbon sorbent bed, which adsorbs the trace gaseous constituents and mercury.

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

To maximize combustion efficiency, it is necessary to maintain the appropriate temperature, residence time, and turbulence in the incineration process. Optimal combustion conditions in a furnace ideally are maintained in such a manner that the gases rising from the great mix thoroughly and continuously with injected air; the optimal temperature range is maintained by burning of auxiliary fuel in an auxiliary burner during startup, shutdown, and upsets; and the furnace is designed for adequate turbulence and residence time for the combustion gases at these conditions. The combustion efficiency of an incinerator (emission standard EU 2000/76/EC Directive)

Dust and Emissions from Traffic Activities

When the project comes into operation, the air pollution sources in the project area are dust and noise and from the garbage transportation to the power plant. The mitigation measures will be applied as follows:

Trees and lawns are located in the surrounding area of the project: power plant buildings, offices, car parks and along internal roads to create landscapes and cool space, ensuring the required billion. The green area for the entire project area is expected to account for about 30% of the total area of the project area.

Use of trees with large canopy, large leaves; suitable with the soil conditions in the project is the land with high alum, capable of deodorizing, detoxification. The area of greenery in the project area shall be about 2730m2, the number of trees about 200 trees.

- Regular cleaning of yard, corridor, internal road of the power plant.
- The entire internal route is plastic and concrete to minimize the impact of dust on the air environment. The width of the main road in the area is 7m. The width of the second line is 4m. The width of the transportation line is 16m. The width of the loading and unloading platform is 24m.
- The parking area is arranged appropriately, the parking location of staff working in the power plant and the garbage truck are separately allocated.

For vehicles transporting waste into the power plant:

- Have a reasonable transportation plan. Time to transport waste to the power plant that is off peak and safe for workers from transfer stations to site besides considering traffic congestions.
- Ensure the vehicles are road worthy and fully covered and meeting licensing requirements for waste transportation.
- Use clean fuel, low emission.
- Control the speed and distance between the vehicles in the project area, the maximum speed when entering the power plant area is 10km/h.

Provide installation of ventilation systems of reasonable housing, ensuring open space, minimal response to human activities:

- Make the most of the natural ventilation, reasonable orientation.
- Hygienic areas: use a forced air intake system with a fan.

Emissions from the Operation of the Backup Generator

- Consider using fuels with low sulfur content;
- Periodic maintenance of generators;

- Generators are installed in separate areas, have soundproofing and have exhaust pipes with stack emissions testing done annually.

Waste Incinerator Emissions

To ensure that the gas meets the required standards, this phase of the project uses the combination of "Nitrogen deodorization in the SNCR + deoxidizing acid by semi-dry method + dry lime spraying + activated carbon adsorption + Dust bag filter" to clean the smoke. Smoke after treatment will meet the environmental protection requirements of the project.

Odor Management

The loading and unloading platforms are equipped with washing facilities, washing water and domestic wastewater collected together for biochemical treatment. Water leaks are collected together, and the dust collector is equipped with a flushing device to release toxic gases and odorless gases into the garbage dump. Gas screens are set up at the entrance / exit of the loading and unloading platform to prevent the strange smell coming out of the pit. Gate level of ± 0.00m (± 0.00m layer gate) of the hole in the hopper using a closed gate. When the whole plant stops working, activated carbon adsorption deodorizing equipment is used to remove the effect of strange odor on the surrounding environment. Conveyors of the pre-treatment plant are all closed; at the place where odors are generated, additional suction screens and exhaust fans are installed to absorb odors into the rubbish dump.

In addition, to minimize the odor spreading as the truck transports garbage into the pit, the project owner has a policy of foul odor isolation as follows:

- The garbage truck is a fully enclosed vehicle with an automatic loading and unloading mechanism used to prevent the smell of leaks from the waste trucks and their leaks. After the garbage truck gets into the plant, it will be sprayed and rinsed before moving out of the plant to minimize the odor of the garbage that remains in the vehicle.
- Isolate the production area with housing in the layout of the general power plant area in the local mainstream direction, thus minimizing the effects of bad odor.
- Garbage collector is a closed structure. The smell in the pit is connected through a PVC pipe and using fan blows into the furnace.
- The garbage compartment is regularly irrigated with deodorant.

Smell Gas Treatment System

- The leachate process, the source of the gas produced mainly from wastewater treatment systems and sludge treatment systems. The exhaust gas in the wastewater treatment system is mainly distributed in the waste screen, the regulation tank, the denitrification etc., the air in the sludge treatment system is mainly distributed in the mud tank, the water and mud tank and the place mud pile, transport out to the outside.
- Collected air, exhausted by the exhaust fan through the ventilation duct to the negative pressure zone of the final garbage to the incinerator and combustion treatment. When the overhaul operates, the use of equipment prevents exhaust gas, handles air and escape, and avoids pollution of the gas.
- Feasibility: High, project owners can apply

Measures to Mitigate Water Pollution Environmental Impacts

Water supply and drainage systems are designed to comply with current standards and standards and ensure the requirements of modern infrastructure and quality. When the project comes into operation, the water used is the clean water source of the area.

- Wastewater is treated before being discharged into the general drainage system of the area.
- Sewer and race design flow through all categories of plant.

→ **Leachate Treatment Process**

Water leaks after filtration into the regulating tank, using the pump in the settling tank where added condensate and condensation aids make the solids and colloids in the rubbish bind together, the leaked water after the condensation will flow into the settling tank longitudinal sedimentation.

Leachate water through pre-treatment, into the superheated tank conducting heat-up, then continues into the tank of air to remove most of the organic matter, water after entering the oxygen tank is fed into the O/A system, first into tank A, under anaerobic condition, microorganisms use organic coal in wastewater to convert nitrate to nitrogen gas. Then the wastewater through the stream is pushed into the tank O, under aerobic condition, the remaining organic substance continues to decompose, at the same time microorganisms conduct oxidation of nitrite - ammonia nitrate to nitrate, back to tank A to separate nitrogen. Water from the O/A system continues into the ultrafiltration membrane to eliminate COD, and other suspended substances. The water after the ultrafiltration process into the chemical softening system, the reverse osmosis system, to filter suspended solids, resolved solids, water hardness, color of water, nitrogen, ammonia, ion chlorine and other indicators. Water after treatment complies with the EMCA (Water Quality) Regulations, 2006 on industrial waste and transfer to use for cooling towers; the project does not release waste into the environment.

→ **Sludge Treatment System**

Leachate after settling and condensation, will produce sludge, sludge is pumped to cassava tank treatment, in the process of decomposition in the anaerobic tank and aerobic tank will produce large amount of activated sludge; through the centrifugal pump will go to the muddy condensing pond, the mud after condensed, it will be pumped to the water separator will proceed to separate the water and sludge after the separation of water will be transferred to the incinerator.

→ **Stench Treatment System**

This project uses deodorization method is system pretreatment, sludge treatment system uses a closed design, then through the wind turbines collect the odor to the garbage dump; in the next through the wind blower to the treatment furnace.

→ **Utilization of Concentrated Water After Reverse Osmosis (RO)**

Concentrated water is used for absorption, recovery, reuse, water addition for slag re-grinders, ash stabilization, preparation of lime milk, reduction of exhaust gas temperature of the reaction tower. Table 51 below shows the waste leachate content before treatment.

Table 51: Waste leachate content before treatment by central water treatment system and treatment efficiency

Items		CODcr mg/L	BOD5 mg/L	NH3-N mg/L	SS mg/L
Pretreatment system	Water in	50000	30000	2000	10000
	Water out	35000	22500	1500	2000
	Reduced efficiency	30%	25%	25%	80%
UASB system	Water in	35000	22500	1500	2000
	Water out	7000	3375	1200	1400

Items		CODcr mg/L	BOD5 mg/L	NH3-N mg/L	SS mg/L
	Reduced efficiency	≥80%	≥85%	20%	30%
A/O system	Water in	7000	3375	1200	1400
	Water out	≤350	168.75	12	28
	Reduced efficiency	≥95%	≥95%	98.9%	98%
Nano filter - NF system	Water in	350	168.75	12	28
	Water out	70	33.7	6	1.4
	Reduced efficiency	80%	80%	50%	95%
Reverse penetration system Ro	Water in	70	33.7	6	1.4
	Water out	21	6.75	0.9	0
	Reduced efficiency	70%	80%	85%	100%
Water out design Requirement for water quality standards	**Total volume of water out**	**≤60**	**≤10**	**≤1.0**	**≤10**

→ **Chart of Waste Leachate Treatment Process**

Leakage capacity of 200 m³/day and night. Water after treatment meets EMCA (Water Quality) Regulations, 2006 on industrial wastewater, column B. Figure 105 below shows the Waste Leachate Treatment Process.

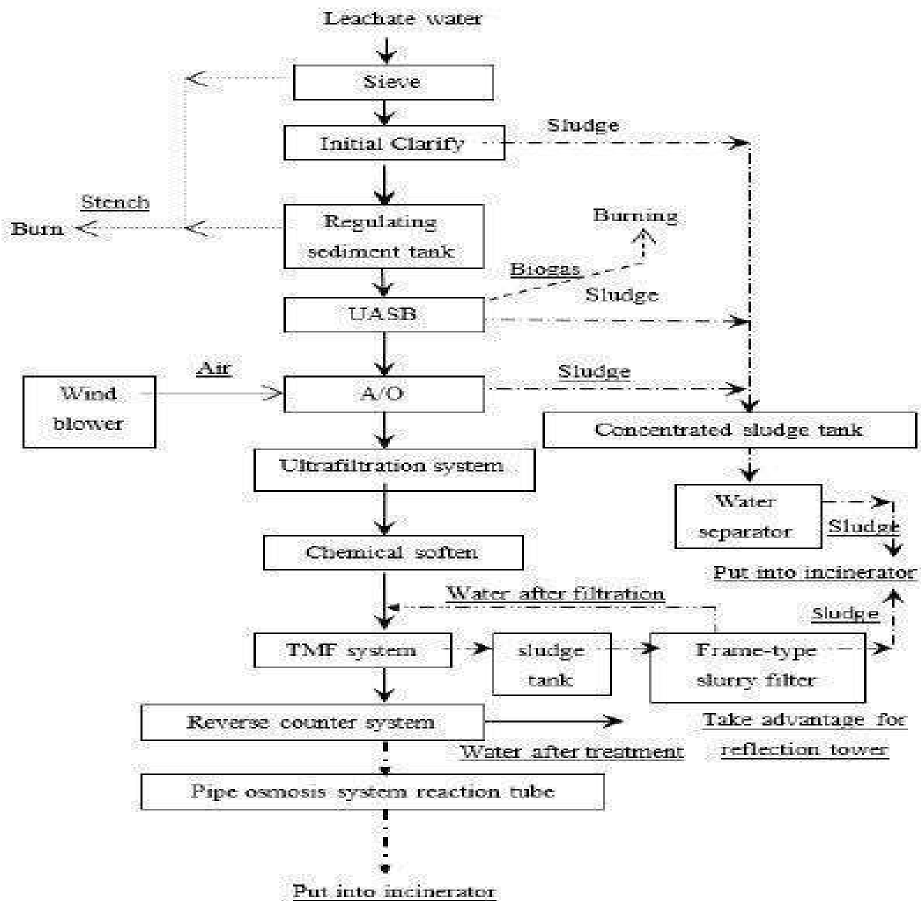

Figure 105: Waste Leachate Treatment Process

→ **Overflow Rainwater**

As the garbage receiving and storage area is located within the main plant site, rainwater overflowing from outside of the plant into the garbage should be prevented.

The rainwater drainage system is designed separately from the wastewater drainage system and is collected by a centrifugal concrete drainage system (D=400-600) along the pavements of the road. Slope direction, slope of the rainwater drainage system is designed according to the traffic system.

The water from the surface of the road is collected through the pit system arranged along the roads with the prescribed distance.

After the rainwater is collected into the main sewer, it is drained out of the power plant, leading to the rainwater drainage system of the planning area and the last receiving point of rainwater.
Feasibility: High efficiency, the contractor can apply.

Measures to Manage and Treat Solid Waste

→ **Fly Ash Management**

Fly ash produced by the project includes: Substances produced from the acidic depletion reaction collected from the bottom of the reaction tower and the coarse dust particles in the exhaust fumes, and dust in the smoke are collected from the dust bag filter.

Fly ash under the reaction tower and fly ash from the ash hopper of the dust filter are respectively pumped using gas to transfer silo to the storage dust. Silo contains solid intermediate solid-state design, after the solidified fly ash will be brought out of landfill.

The fly ash of the project is composed of three components: the bottom of the furnace exhaust duct, the ash tower reaction and dust discharging device. The dusty bottom of the conveyor belt was fed to the centrifuge, discharged to the bottom of the furnace, and to the bottom of the slag mixture, which was then discharged into the slurry tank.

The fly ash of the semi-dry absorption tower and the dust bag ash filter bag, using the engine system to store the fly ash storage in the plant, then use the air shot pump to put into solidification to carry out solid chemical treatment.

In the short term, solid ash handling technology of fly ash is often used to dissolve solid, solid cement technology, chemical stabilization techniques - chemical treatment techniques of wet form and solidification of cement stabilizer.

The technique of stabilizing fly ash, which this project uses is a mixture of chemical chelating - the substance that makes heavy metal ions in the fly ash stay clamped, finally immobilization of solid objects is formed. Stabilized solids that meet the criteria will be brought to landfills as hazardous waste, to be buried. Figure 106 below shows the Technology process for treating fly ash solidification.

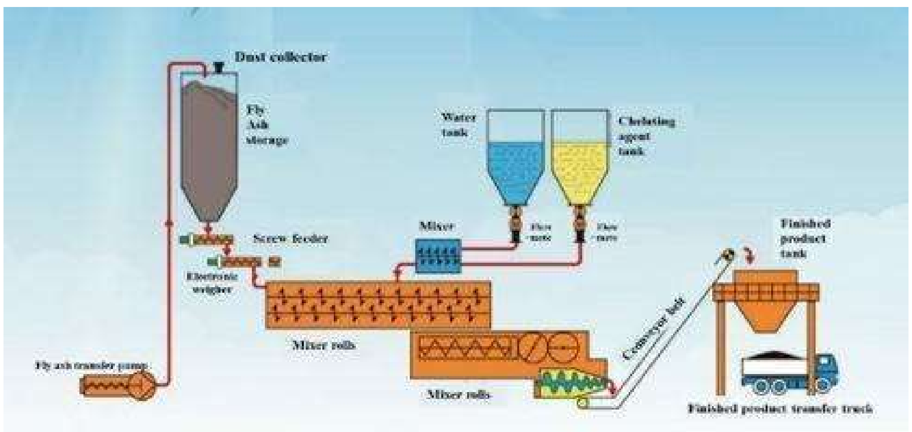

Figure 106: Technology Process for Treating Fly Ash Solidification

Measures to Minimize Noise and Vibration Impacts

The noise source of the project mainly comes from equipment such as steam turbine generators, boiler systems, fans, water pumps, and waste transportation vehicles.

Measures to minimize noise when the project goes into operation:

- Inspection and maintenance of machinery and equipment periodically.
- Set silencers, apply the necessary acoustic absorption materials, use doors and soundproof windows for control rooms and operating rooms, in addition, separate them, handle vibration reduction of background equipment, etc.
- Arrange suitable production to limit resonance noise, limiting noise increase.
- Install noise barriers below each machine to reduce noise and vibration.
- Equipped earplugs for employees working in high noise areas.
- Planting trees in the power plant area to isolate the production area of the power plant with the surrounding areas. Large and high isolation belt.
- For vehicles transporting in and out of the power plant, it must be inspected and maintained periodically and the maximum speed for vehicles entering and leaving the power plant is 10km/h.

- Air-cooled devices are set up outdoors and have high noise levels, so low-noise, low-noise cooling fans are used to reduce the noise intensity. The noise wall is set up on the air-cooling island platform.

Excess Heat Reduction Measures
- Installation of ventilation in the power plant area.
- The roof is used to shield the sun and prevent solar radiation inside the power plant.
- The power plant is built high and has large windows to take advantage of natural ventilation.
- Make sure you plant trees around the power plant.
- Use an air conditioner for the office area.
- Equipped with exhaust fans on the power plant walls to create artificial winds, enhance the exchange of artificial wind, and exchange air inside the power plant and outside.
- Provision of appropriate personal protection equipment for workers.

Unplanned Events

→ **Measures to Manage, Prevent and Control of Incidents During the Operation phase**

→ **Measures to Mitigate Fire and Explosion**

- Must have fire alarm equipment: gas tank, reel hose, faucet, etc. The alarm system should be audible enough to alert all workers onsite.
- When a fire occurs, in each room the sprinkler system will automatically operate, the water will be sprayed into the beam shower beam with great pressure to extinguish the fire. When the water in the fire extinguishing system is extinguished, the water pressure in the water supply pipe is automatically operated by the water pump system to pump the water up to the system.
- These systems and means of fire are regularly inspected and maintained throughout the operation to ensure that the system is always in ready status.
- Arranged appropriate fire brigade network, and fire safety education for employees.
- Fire hydrants are located throughout the building, and are conveniently located in conjunction with fire extinguishers: taps, foams, etc.
- Periodically check the operation status of fire-fighting equipment. Ensure that the equipment is in good working order so that fire and explosion safety response is carried out safely.
- Train workers on effective emergency response regularly.

→ **Measures to Reduce Incidents of Electricity Use**

To ensure safety during the operation of the power system, the power management unit will regularly:
- To check the equipment capacity to suit the load capacity of the source;
- Institute lock out and tag out during maintenance works to reduce potential incidents;
- To develop maintenance procedures and work instructions for safe works;
- Institute permit to work system for controlled, always authorized and safe works onsite.
- Workers handling high tension maintenance works must have appropriate competency, licensing and training.

→ **Measures to Prevent and Mitigate Occupational Accidents**

- Raise awareness through professional training for workers in the operation of machinery and equipment in the power plant.
- Provision of personal protective equipment as and when required.

→ **Measures to Minimize Incidents from the Wastewater Treatment System**

In order to minimize environmental problems for the wastewater treatment system, the following measures will be implemented:

- Employees of the wastewater treatment plant must be trained in the operation and maintenance of the system;
- Strict adherence to the operation and maintenance program established for the wastewater treatment system;
- The program of operation and maintenance of the wastewater treatment plant will be updated every 3 years.
- Carrying out regular monitoring of the flow and quality of wastewater for the wastewater treatment system;
- Regular maintenance of the plant to minimize potential waste discharge into the environment above the guide limits.

→ **Disaster Mitigation Measures**

- Periodically inspect and supervise the drainage system and reinforce the canal banks when there are signs of defects.
- Regularly monitor and update on the current situation of floods, floods in the locality and surrounding areas for protection of the landfill sites and ground water quality.
- Coordinate with specialized agencies in response to flood disasters onsite.
- Regularly undertake ground water and soils quality monitoring through sampling using independent NEMA approved laboratories.

→ **Measures to Reduce the Emergence of Occupational Illnesses**

To ensure the health work in the area of the project is implemented as follows:

- The Project Management Board will coordinate with occupational health experts through hygiene management in the prevention of disease.
- Taking measures to ensure a working environment to limit the emergence of disease.
- With covid-19 pandemic foreseen to be around for the long term its critical to ensure all public health guidelines as issued by the ministry of health are followed.

→ **Measures to Minimize Incidents from Waste Incineration**

In the DCS, it will replace the automatic operation into manual operation, at the same time, increase the corresponding primary wind pressure, increase the combustion, and reduce the load. In the DCS, it will replace the automatic operation into manual operation, remove impurities through the following measures where applicable;

- Adjust the center from the beginning;
- Replacement of damaged shaft or transmission shaft;
- Application of specialized lubricants;
- Replacement hydraulic hose, seat belt, hydraulic cylinder;
- Adjust the output pressure of the hydraulic station;
- To enhance oil purifying.

8.5.4 Decommissioning Phase

→ ***Measures to Minimize Noise and Vibration Impacts***

The noise source of the project mainly comes from equipment such as demolition machinery and solid waste transportation vehicles. Measures to minimize noise during decommissioning are:

- Inspection and maintenance of machinery and equipment periodically.
- Arrange suitable production to limit resonance noise, limiting noise increase.
- Install noise barriers below each machine to reduce noise and vibration.
- Provide appropriate personal protective equipment such as earplugs for employees working in high noise areas.
- For vehicles transporting in and out of the demolition site, there maximum speed should be 10km/h.

- Provide safety signage to alert the workers to the risk of noise and vibrations onsite.

Landscape and Visual Impacts

→ ***Mitigation Measures to Protect Ecosystem, Landscape and Environment***

During this period, ecosystem impacts are inevitable. To minimize the impact, the contractor will take the following measures:

- Require construction units to commit to fully and implement measures to collect and dispose of waste at designated points.
- Strictly implement the regulations set out on the site: solid waste disposal, fire and explosion prevention in accordance with regulations.
- Limit the concentration of excavated materials and construction wastes on the demolition site to avoid the contamination of surface water sources.
- Arrange reasonable ground plans, ensure the shortest transportation of demolition solid waste materials/ landfill materials and reduce environmental pollution.
- Ensure material hauling vehicles are fully covered to minimize discharge of wastes onto the public roads and disposal be to only NEMA licensed & County approved sites.

Impacts to Air Quality

→ ***Mitigation Measures for Air Quality Management***

In this phase, to minimize the negative impacts on the air environment, the following measures are applied:

Dust Minimization Measures

- Installing barricade around the site 2-2.5m high to minimize dust spread to the environment and affect the people around the area.
- Vehicles transporting materials to and from the site must not be overloaded, to prevent shattering of material causing the release of dust into the environment.
- The material in the project area is covered with limited wind to emit dust into the environment.
- Arranging suitable transportation time of materials to and from the site avoid transportation during peak hours inconveniencing the general public in the area.
- Cover all loose materials onsite as well as curbing dusts emissions through use of water sprinkling onsite.
- Access route to the area where the route is not tarmacked, ensure control of speed is limited to avoid dust emissions and potential incidents around the site.
- Provide personal protection equipment for workers onsite.

8.6 Implementation Organization

The proponent is responsible for the implementation of the Law on Environmental Protection and the organization of the environmental section responsible for environmental issues of the project in accordance with the law, as well as control the effective implementation of environmental protection measures during the construction and operation phase of the project.

Measures to strengthen environmental management of the project will be applied as follows:

- The proponent will organize an environmental management unit during the construction phase with a minimum of 2 people, capable of managing the various occupational health, safety and environmental concerns.
- The contractor will plan and implement occupational health, safety and environmental protection action in the Project, in close coordination with oversight agencies such as NEMA, EPRA & DoHSS, in the implementation of environmental protection principles in the proposed area.

Table 52 below presents the function and duty of each unit/institution responsible to carry out the environmental management and monitoring plan.

Table 52: Responsible Units for HSE Management and Monitoring

No	Unit	Roles
1	Contractors	• Coordinate with the proponent and subcontractors, consultants in implementing the mitigation measures proposed in the EIA • Carry out environmental monitoring during the construction process of the project. Report the results of environmental monitoring to the contractor and the environmental authorities.
2	KenGen	• Monitoring and evaluating the implementation of measures to reduce environmental pollution mentioned in the EIA. • Coordinate with specialized agencies in the process of overcoming environmental pollution problems. • Report the results of implementation to NEMA. • Be responsible for the operation of Environmental Protection works.
3	NEMA	• Manage and monitor in compliance with mitigation measures proposed by the EIA report.
4	DoHSS	• Manage and monitor occupational health and safety measures compliance for safe works.

When the project officially comes into operation: The proponent will coordinate with the local authorities in managing and operating the project.

- Power supply system managed by Kenya Power Company.
- The system of water supply, drainage and environmental sanitation works shall be managed by the proponent and the local water supply company.

9 The Environmental & Social Management Plan

9.1 Introduction

The Environmental and Social Management Plan (ESMP) will be the most important output from the ESIA process with a detailed plan and schedule of measures necessary to minimize, mitigate, etc. any potential environmental impacts identified by the EIA (World Bank, 1999). The ESMP is the synthesis of all proposed mitigation and monitoring actions, set to a timeline with specific responsibility assigned and follow-up actions defined. It will address issues related both to the construction and operation phases of the project.

The objectives of the ESMP are:

- To provide evidence of practical and achievable plans for the management of the proposed project.
- To provide the Proponent and the relevant Lead Agencies with a framework to confirm compliance with relevant laws and regulations.
- To provide the community with evidence of the management of the project in an environmentally acceptable manner.

The Environmental and Social Monitoring Plan (ESMP) includes, as appropriate:

- Clearly defined measurable environmental indicators;
- A sampling design (frequency, intensity) sufficient to provide the information necessary to answer questions;
- Analytical system quality assurance and quality controls are effective
- Information for reporting monitoring results in place;
- A clear description of responsibility and designation within the management plan;
- Draw up of a time and task-based implementation schedule, in tabular form.

The ESMP will be divided into two broad components, one dealing with the natural environment and the other with the social environment. We will endeavor to allocate responsibility for undertaking monitoring, as well as the reporting procedure, in the ESMP section of the environmental impact statement.

The Contractor will be responsible for developing and implementing a task specific induction and training for all construction workers. This induction will include all EHS hazards and their control measure.

The induction will also include a disaster risk management planning exercise. The Contractor will ensure that all construction workers are trained and competent and hold the appropriate certification for the tasks that they will be undertaking.

An environmental management and monitoring outline have been developed for the project works. Responsibility for the incorporation of mitigation measures for the proposed project into the project design and BoQs lies with the Proponent, who must ensure specified mitigation measures are implemented and monitored. The estimated costs for the various mitigation measures have been provided where possible but they are largely estimates for guide purposes and may vary during the implementation phase of the project. It will be noted that most of these measures will be part of the project's operational costs. The Environmental socio management and monitoring plan for the various activities are detailed in Tables 53 to 56 below.

9.2 Waste to Energy Power Project's Environmental and Social Management Monitoring Plan (ESMMP)

Table 53: ESMMP for the Construction Phase

Impact	Mitigation Measures	Monitoring Indicator	Responsibility & cost	Monitoring Means	Frequency
Loss of vegetation cover and biodiversity	• Implement proper management measures to prevent damage to biodiversity within the proposed project site with minimal removal vegetation. • Ensure proper demarcation and delineation of the project construction site. • Develop a plan to incorporate the indigenous vegetation onsite as part of construction designs. • Develop an appropriate landscaping plan and use indigenous vegetation for landscaping to preserve floral diversity • Designate access routes and a parking area within the site to reduce vegetation disturbance • Ensure regular inspection of construction works	• Rehabilitation and landscaping plan • Acres of land rehabilitated • Designated parking areas on site • Number of inspection reports	• Contractor Kshs. 2,000,000 one off cost	• Survey Report • Site Inspection Reports	Continuous as part of daily HSE checks
Liquid Wastes	• Develop a wastewater management plan for use at the site in line with wastewater management regulations and water quality regulations • Ensure proper storage of wastewater at the site before disposal to a designated facility by a contracted waste handler registered by NEMA • Prohibit illegal disposal of wastewater into water resources around the project site • Ensure regular inspection of wastewater management practices within the project to check for compliance • Ensure there is proper and adequate sanitation facilities at the site during construction	• Wastewater Management Plan • Quantity of liquid waste generated • Quantity of liquid waste correctly disposed to NEMA Approved disposal sites • Number of Waste storage facilities at the site • Number of Sanitation facilities on site • Number of completed inspection missions	• Contractor • 520,000 Annually for the Analysis of leachate discharge, and groundwater. • Oversight roles - project proponent	• Waste Management Plan and Inventory • Inspection and HSE site reports,	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility & cost	Monitoring Means	Frequency
Change in Air Quality	• Control the speed limit for all motor vehicles coming to or leaving the construction site • Train all workers on the management of air pollution from vehicles and machinery • Prohibit engine idling and over revving of construction vehicles and machinery to minimize emissions. • Sprinkle water at the construction site and on access roads to minimize fugitive dust during dry weather conditions. • Ensure regular inspection and scheduled maintenance for all construction vehicles and machinery. • Provide dust masks at all times when working in dusty conditions. • Continuously monitor dust emission levels at construction site. • Ensure the vehicles transporting loose materials like soil and cement are properly covered.	• HSE incidents numbers of site involving air quality concerns, speeding incidents, • Quantity of dust emitted • Quantity of emissions emitted • Workers trained on air quality management • Number of completed inspection missions	• Contractor •	• Air Quality Monitoring Reports • Vehicle speed limit reports • Inspection • Incidents numbers for overspendings etc	Continuous
Solid Wastes	• Develop and implement a Solid Waste Management Plan before commencement of construction activities in line with the governing regulations • Train workers on proper solid waste management practices • Segregate all solid wastes at source • Re-use, re-cycle or reduce solid waste generation onsite to the extent possible • Dispose all construction wastes that cannot be recycled or reused to a NEMA approved licensed solid waste disposal site within the County using a licensed refuse handler • Provide facilities for proper handling and storage of wastes at designated points • Do not leave wastes on site at the end of the work • Provide adequate number of properly contained litter bins and containers properly marked with type of wastes • Strictly prohibit burning or dumping of any wastes at the site	• Solid Waste Management Plan • Quantity of solid waste generated • Number of solid waste storage facilities on site • Quantity of solid waste correctly disposed to NEMA Approved disposal sites • Number of completed inspection missions	• Contractor •	• Solid Waste Management Plan • Regular inspection • Solid Waste Manifest	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility & cost	Monitoring Means	Frequency
	• Perform regular inspection of solid waste management practices onsite.				
Hazardous Wastes	• Develop and implement Hazardous Waste Manage Plan in line with the governing regulations • Train site workers on proper hazardous waste management • Segregate site wastes by separating hazardous waste from non-hazardous waste • Ensure the hazardous waste collection containers are emptied at appropriate intervals to prevent overflow. • Ensure that hazardous materials are stored in proper areas, where they cannot reach land in case of any spillage. • Incorporate dripping pans at machinery, equipment and area prone to contamination by leakage of hazardous materials such as oil and fuel. • Regular maintenance of all equipment and machines used onsite so as to minimize leakage of hazardous materials. • Containers for storing hazardous waste including used oil should be securely bundled, labelled and disposed in line with the governing regulations. • Undertake regular inspection of hazardous waste management practices onsite. • Strictly prohibit illegal disposal of hazardous wastes onsite. • Store hazardous materials in designated areas secured with a fence.	• Hazardous Waste Management Plan developed and implemented • Number of Trained Workers on Hazardous Waste Management • Amount of Hazardous Waste Segregated • Quantity of accidental hazard spillage • Quantity of hazardous correctly disposed • Number of completed inspection missions	• Contractor	• Inspection Reports • Hazardous Waste Management Plan and Inventory	Continuous
Security concerns	• Develop and implement Site Security Plan • Train workers on the importance of site security • Employ a day and a nighttime security guard for the plant. • Fence the entire plant to restrict entrance to the site • Train the onsite guards to adequately handle trespass incidents.	• Site Security Plan developed and implemented • Number of Security personnel employed • Site Fence	• Contractor • Proponent • Security Personnel	• Inspection • Security reports and intelligence	Construction Phase

Impact	Mitigation Measures	Monitoring Indicator	Responsibility & cost	Monitoring Means	Frequency
	• Inspect the fence around the facility regularly and seal all loopholes • Ensure adequate lighting within and around the plant. • Regularly check and maintain security lights at the site.	• Trained workers on site security • Number of inspection missions			
Noise and Vibration	• Restrict all construction activities to daytime during normal working hours • Conduct construction activities within the maximum permitted noise levels. • Provide prior information to the community of any planned noisy activity that is likely to exceed the permitted noise levels • Strictly ensure the use of protective personal equipment at all times while on site and noise reduction techniques such as silencers and ear mufflers to employees. • Regularly monitor noise levels to comply with permitted maximum levels. • Inspection of activities during decommissioning by carrying out regular Noise level tests. • Emphasize on the use of noise reduction techniques such as silencers and ear mufflers to employees while onsite. • Undertake regular inspection and scheduled maintenance program for all vehicles and machineries on site • Adopt and follow best practicable means to ensure that the quietest available plant and construction techniques are used	• Noise monitoring devices procured and installed on site • Levels of noise and vibration produced at the site • Number of PPE procured and being used by workers • Number of Noise complaints received • Maintenance procedure for vehicles and machinery • Number of inspection missions completed	• Contractor Kshs. 200,000 annually Daily Monitoring by site management	• Noise Monitoring Reports • Inspections	Continuous
Traffic impacts **Congestion and accidents**	Use of traffic signs during operations Use of bumps to slow down traffic Use of flagmen to manage traffic during construction Use of warning signs to warn drivers where appropriate Adhering to specified speed limit (e.g. 10km/hr) within the plant area.	• Community complaints	• Contractor Covered in construction cost	• Observations, • Police reports • Community complaints • Workers observations.	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility & cost	Monitoring Means	Frequency
Visual and Landscape	• Develop and implement a site rehabilitation and landscaping plan to restore the site to a better visual state after construction • Restore natural vegetation through planting of indigenous • Ensure proper storage, regular collection and disposal of waste streams generated. • Carry out the facility inspection work on regular basis • Minimize the use of project construction signage. Necessary signage should be made of non-glare materials and unobtrusive colors. • Remove in a timely manner all the construction machinery, equipment and vehicles that are not in use and keep them in specific locations within the project site. • Ensure proper storage, collection and disposal of waste streams generated. • Undertake regular inspection of site construction activities.	• Site rehabilitation and landscaping plan developed and implemented • Availability of waste management plan developed and implemented • Site inspection missions completed	• Contractor • The cost of rehabilitation is crucial since there will be a lot of work to be done.	• Inspection reports • Waste Management Plan	Continuous
Occupational Health and Safety	• Develop and implement an Occupational Health and Safety Plan for use during construction in line with governing regulations • Train employees on the importance of occupational health and safety requirements and develop work instruction • Provide workers with appropriate personal protective clothing such as helmets, safety boots, gloves, dust masks, ear mufflers and overalls for use during construction • Strictly enforce the use of the Personal Protective Equipment to minimise the accidents during decommissioning • Regular medical checks • Provide fully equipped First Aid Kit and sanitary facilities on site, including water for drinking and bathing, at all times • Provision and placement of appropriate fire extinguishers and training personnel on their use	• Occupational Health and Safety Plan developed and implemented • Number of workers trained on occupational health and safety • PPE procured and being used by the workers • Fire extinguishing facilities on site • First aid kit on site • Signage installed on site • Number of inspection missions completed	• Contractor Covered in construction cost	• Inspection reports • Record of accidents and near misses • Corrective Action Reports	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility & cost	Monitoring Means	Frequency
	● Put clear signage to restricted areas in English and local language ● Prohibit unauthorized persons from entering the site through installation of a perimeter fence. ● Undertake regular inspection to ensure compliance with OSHA, 2007. ● Report all incidents of accidents or near misses and keep proper records of the actions taken. ● Promote HIV/AIDs Awareness.				
Grievances Social Misconception and Conflicts- HIV/Aids	Develop a continuous awareness campaign and training plan for the workers and neighbors (stakeholders) through engagement of the public health officials where necessary. Toolbox talks to alert workers onsite to potential occupational illnesses and HIV/Aids issues.	● Number of complaints logged or absentee workers going to hospital	● Contractor Kshs. 2,000,000 annually	● Awareness training reports,	● Throughout the project life
Population/Demographic movement and employment- Conflict due to competition of employment opportunities with local population and the influx population Security and Crime, Child protection, Gender equity and Sexual harassment	Prioritizes job opportunities for the local community first then compensates the deficit with the influx population. Proper design incorporating lighting to enhance security at the site ● Sensitize the construction workers, locals, and security to be on the lookout on suspicious activities in and around the site ● Liaise with the administration units (County and sub county governments, Police, chiefs, etc.) to provide regular surveillance and patrols to protect workers ● The contractor to have and enforce 'Child Protection Code of Conduct' and Employment Act 2007 ● Ensure no children are employed on site in accordance with national labor laws ● Ensure that any child sexual relations offenses among contractors' workers are promptly reported to the police	● Community leadership involvement in recruitment ● Site employee census establishing immediate local workers.	● Contractor ● Proponent ● No additional cost is anticipated	● Community complaints of unfair recruitment by specific groupings such as gender based, marginalized, vulnerable among others	● Throughout the project life

Impact	Mitigation Measures	Monitoring Indicator	Responsibility & cost	Monitoring Means	Frequency
	• The contractor to have and enforce a Code of Conduct in regard to child protection • Contractor to prepare and enforce a No Sexual Harassment Policy in accordance with national law where applicable • Contractor and implementing agency to prepare and implement a Gender Action plan to include at minimum, in conformance with local laws and customs, equal opportunity employment, gender sensitization • Provision of gender disaggregated bathing, changing, sanitation facilities. • Grievance redress mechanisms including non-retaliation. • The contractor to have and enforce a Code of Conduct in regard to Gender equity and Sexual harassment.				

Table 54: ESMP for the Operation Phase

Impact	Mitigation Measures	Monitoring Indicator	Responsibility	Monitoring Means	Frequency
Liquid wastes	• Develop and implement Liquid Waste Management Plan in line with the governing regulations • Train employees on the importance of proper liquid waste management and water resource management • Reduce, reuse or recycle all liquid waste generated onsite to the extent possible • Dispose all liquid wastes that cannot be recycled or reused to NEMA approved liquid waste disposal facilities a licensed transporter • Prohibit illegal disposal of wastewater into waste resources. • Conduct inspection of wastewater management practices to check for compliance	• Liquid Waste Management Plan Developed and Implemented • Quantity of liquid waste generated • Quantity of liquid waste disposed off to sewer system owners such as municipality through discharge license issued and payment for such discharges. • Number of Waste storage facilities in the plant	• Proponent	• Waste Management Plan and Inventory • Inspection reports • Audit Reports • Laboratory analysis reports, • Effluent discharge license and	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility	Monitoring Means	Frequency
	• Emphasize on proper sanitation during the operation phase of the project.	• Number of Sanitation facilities on at the plant • Laboratory results of wastewater analysis.		their conditions compliance	
Solid Wastes	• Develop and implement Solid Waste Management Plan for the operation phase in line with the governing regulations • Train employees on the importance of proper solid waste management • Reduce, reuse or recycle all solid waste generated to the extent possible • Dispose all solid wastes that cannot be recycled or reused to NEMA approved solid waste disposal sites in the County using a licensed refuse handler • Maintain proper records of solid wastes to know the quantity of wastes generated on site • Provide adequate waste bins and containers at specific places and ensure they are properly marked with type of wastes • Perform regular inspection of waste management practices onsite.	• Solid Waste Management Plan developed and implemented • Quantity of solid waste generated • Number of solid waste storage facilities at the plant • Quantity of solid waste correctly disposed to NEMA Approved disposal sites • Number of completed inspection missions • Annual audits	• Proponent	• Solid waste management Plan and inventory • Inspection Reports • Audit Reports.	Continuous
Visual Impacts	• Develop and implement a site rehabilitation and landscaping plan over the operational phase of the project as is necessary. • Maintain the existing vegetation around the perimeter of the plant to reduce the direct view of the plant. • Restore natural vegetation through planting of indigenous trees. • Ensure proper storage, regular collection and disposal of waste streams generated. • Carry out the facility inspection work on regular basis.	• Site rehabilitation and landscaping plan developed and implemented • Availability of waste management plan developed and implemented • Site inspection missions completed • Annual audits	• Proponent.	• Inspection Reports • Grievance Reports • Audit Reports	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility	Monitoring Means	Frequency
Surface and Groundwater pollution- Leachate generation Impact of leachate on eutrophication and aquatic Eco-toxication in reservoir	Adoption of good operational management plan to minimize leachate generation and the volumes of leachate to be treated, these includes control of surface water run-on, cellular filling and the adoption of intermediate and final cover to minimize leachate generation; ▪ A rigorous program of water quality monitoring should be carried out to ensure that any impacts are identified and immediately addressed. ▪ All water from the waste should be kept in an appropriate leachate pond and treated and quality measured before effluent discharge ▪ Develop an artificial wetland (PCW) for further tertiary treatment of the effluent from the leachate pond. This will provide a long-term solution in the rainy seasons Leachate treatment will be achieved by a combination of aerobic/anaerobic treatment followed by a maturation pond, which is designed as so-called planted constructed wetlands (PCW). There will be an onsite laboratory to periodically take measurements of key environmental parameters to ensure that any discharged effluent is within permissible standards.	• Plant feedstock moisture content reports • Plant efficiency and production analysis considering moisture content. • Volume of leachate waste handled by the plant. • Leachate wastewater quality analysis reports.	• Plant management • Proponent • 520,000 Annually for the Analysis of leachate discharge, and groundwater (4 monitoring wells).	• Leachate plant water quality analysis reports, • Leachate plant maintenance records, • Plant efficiency reports.	Quarterly leachate Discharge analysis Throughout the life of the project
Traffic impacts **Congestion and accidents**	Use of traffic signs during operations Use of bumps to slow down traffic Use of flagmen to manage traffic during construction Use of warning signs to warn drivers where appropriate Adhering to specified speed limit (e.g. 10km/hr) within the project site	• Material delivery trucks incidents, • Waste transportation licenses non-compliance reports by delivery vehicles. • Community complaints involving overspeeding incidents, dusts, disposal	• Plant management • Proponent Covered in operation cost	• Incident investigation reports, • NEMA waste handlers license violations.	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility	Monitoring Means	Frequency
		along the delivery routes by uncovered trucks ● Air quality analysis reports with particulate matter and VOCs limits above guide values.			
Air Pollution **Dust** **Exhaust Emission** **Odor**	During operations, sprinkling water regularly where there is possibility of generation of dust. Vehicles within the project site to be restricted to a speed limit of say 40km/hr No idling of vehicles on site Regular maintenance of heavy equipment used at the site and waste hauling vehicles to ensure their exhaust emissions meet the emissions standards prescribed in EMCA (Air Quality) Regulations, 2014 Daily soil covers compacted wastes to manage odors Odorous sources arising from the project would mainly form the anaerobic leachate treatment pond and the cells (if not covered). The model has used H2S as a surrogate/indicator of odor. The results indicate that the concentration of H2S will be within the regulatory limit of 50 ug/m3 at the boundary fence with the nearest sensitive receptor – Waste with strong odor to be covered immediately they are emptied from delivery vehicles; Control and manage leachate treatment plants to minimize odor. Adhere to air quality regulations with quarterly air quality monitoring. Maintenance of the buffer zone and protective berms.	● Air quality analysis reports with particulate matter and VOCs limits above guide values. ● Incident reports on emission quality concerns. ● Complaints on air emissions ● Annual air quality analysis, ● Staff occupational medical examination results	● Proponent ● Site Management ● Covered in and operation cost	● NEMA/ DoHSS improvement orders, ● Community complaints reports,	Continuous
Hazardous Wastes	● Develop and implement Hazardous Waste Manage Plan in line with the governing regulations ● Train employees on Hazardous waste management	● Hazardous Waste Management Plan developed and implemented	● Proponent	● Inspection Reports	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility	Monitoring Means	Frequency
	• Segregate waste by separating hazardous waste from non-hazardous waste • Containers for storing hazardous waste including used oil should be securely bundled, labelled and disposed in line with the governing regulations • Ensure the hazardous waste collection containers are emptied at appropriate intervals to prevent overflow • Prohibit illegal disposal of hazardous wastes on the plant during maintenance exercise. • Store hazardous materials in designated areas secured with a fence • Undertake regular inspection of hazardous waste management practices onsite.	• Number of Trained Workers on Hazardous Waste Management • Amount of Hazardous Waste Segregated • Quantity of accidental hazard spillage • Quantity of hazardous waste correctly disposed • Number of completed inspection missions • Annual Audits.		• Hazardous Waste Management Plan and Inventory • Audit Reports	
Occupational Health and Safety	• Develop and implement an Occupational Health and Safety Plan • Train employees on the importance of occupational health and safety • Ensure compliance with the governing regulations • Install a fence regularly by netting breakages in order to prevent accidents involving local inhabitants or wildlife • Fence the entire plant to prohibit unauthorized persons from accessing the site • Provide workers with appropriate personal protective clothing such as helmets, safety boots, gloves, dust masks, ear mufflers and overalls. • Strictly enforce the use of the Personal Protective Equipment to minimize the accidents during decommissioning • Regular medical checks • Provide fully equipped First Aid Kit and sanitary facilities on site, including water for drinking and bathing • Put clear signage to restricted areas in Kiswahili, English and local language to reduce risk of accidents	• Occupational Health and Safety Plan developed and implemented • Number of employees trained on occupational health and safety • PPE procured and being used by the employees • Fire extinguishing facilities at the plant • First aid kit on site • Signage installed at the plant • Number of inspection missions completed • Annual Audits	• Proponent	• Inspection reports • Record of accidents and near misses • Corrective Action Reports	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility	Monitoring Means	Frequency
	● Undertake regular inspection of the plant ● Promote HIV/AIDs Awareness				
Grievances Social Misconception and conflicts	Ensure existence of a functional grievance redress committee comprising of representatives from the surrounding community ● Regular documentation and recording of grievances submitted by the community adjacent to the project in the form of a log that ensures timely closure of grievances. (Refer to chapter 10 for the Process of Grievance Redress Mechanisms) ● Creation of awareness on what and how the land fill operates during design, construction and operation phases ● Avail a copy of ESIA report at the landfill offices access to the local community who might have concerns with the operation of the WtE plant. ● Develop and implement a stakeholder engagement plan in the event that the waste catchment area is expanded. -Apply the world bank grievance mechanism in conflict management.	● Number of complaints logged	● Power Plant management and contractor	● Community complaint reports and resolutions. ● Community engagement events to enhance relations.	● Throughout the project life

Table 55: ESMP for the Decommissioning Phase

Impact	Mitigation Measures	Monitoring Indicator	Responsibility	Monitoring Means	Frequency
Solid Wastes	● Develop and implement a Solid Waste Management Plan (SWMP) before decommissioning commencement in line with the governing regulations ● The waste streams generated should be re-used, recycled and reduced to the extent possible	● Solid Waste Management Plan ● Quantity of solid waste generated ● Number of solid waste storage facilities on site	● Contractor ● Proponent	● Solid waste management Plan and inventory ● Inspection Reports	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility	Monitoring Means	Frequency
	• Dispose all demolition waste that cannot be recycled or reused to a licensed waste disposal site using a licensed waste handler • Rehabilitate the site as appropriate using indigenous vegetation species for landscaping to restore biodiversity	• Quantity of solid waste correctly disposed to NEMA Approved disposal sites • Number of completed inspection missions			
Occupational Health and Safety	• Develop and implement an Occupational Health and Safety Plan • Train employees on the importance of occupational health and safety • Provide workers with appropriate personal protective clothing such as helmets, safety boots, gloves, dust masks, ear mufflers and overalls. • Strictly enforce the use of the Personal Protective Equipment to minimize the accidents during decommissioning • Regular medical checks • Provide fully equipped First Aid Kit and sanitary facilities on site, including water for drinking and bathing • Put clear signage to restricted areas in Kiswahili, English and local language • Prohibit unauthorized persons at the site during decommissioning • Promote HIV/AIDs Awareness	• Occupational Health and Safety Plan developed and implemented • Number of workers trained on occupational health and safety • PPE procured and being used by the workers • First aid kit on site • Signage installed on site • Number of inspection missions completed	• Contractor • Proponent	• Inspection reports • Record of accidents and near misses • Corrective Action Reports	Continuous
Change in Ambient Air Quality	• Train all workers on the management of air pollution from vehicles and machinery • Strictly control the speed limit for all motor vehicles during the demolition exercise. • Sprinkle water on dusty places onsite and on dust to reduce fugitive dust emissions • Provide workers with dust masks	• Number of Vehicles on site • Quantity of dust emitted • Quantity of emissions emitted • Workers trained on air quality management • Number of completed inspection missions	• Contractor • Proponent	• Air Quality Monitoring Reports • Inspection reports	Continuous

Impact	Mitigation Measures	Monitoring Indicator	Responsibility	Monitoring Means	Frequency
Noise Impact	• All the decommissioning activities will be done during daytime • The contractor will be kept informed by the community of any noise or vibration complaints. • Conduct demolition activities in line with the maximum permitted noise levels • Inspection of activities during decommissioning by carrying out regular Noise level tests. • Emphasize on the use of noise reduction techniques such as silencers and ear mufflers to employees while onsite. • Develop a regular inspection and scheduled maintenance program for vehicles and machineries in order to abate the noise produced	• Noise monitoring devices procured and installed on site • Levels of noise and vibration produce at the site • Number of PPE procured and being used by workers • Number of Noise complaints received • Maintenance procedure for vehicles and machinery.	• Contractor • Proponent	• Noise Monitoring Reports • Inspections	Continuous

Table 56: Summary of Environmental and Social Management Plan

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
Emissions to Air During Construction					
• Whilst there are no significant impacts identified associated with the construction phase of the proposed development, it is recommended that best practice measures are implemented to minimize the potential for dust to be generated and escape off-site. • In addition, a dust management programme will be implemented that sets out measures for the visual assessment of dust emissions,	• Minimization of dust emissions and avoidance of a dust nuisance. • Avoidance of health impacts to the workforce and local community.	• No significant ingress of construction dust into properties of local communities.	• Monitoring programme will be developed in line with the requirements of the IFC EHS Guidelines for Waste to Energy /Waste	• In advance of and during construction activities.	• Within the general responsibilities of the construction supervisor – no significant material additional costs.

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
additional mitigation if excessive dust emissions are observed and normalized responses for responding to, substantiating and dealing with any dust nuisance complaints.			Management Facilities, 2007 guidelines. • Grievance mechanism records.		
Emissions to Air During Operation					
The Sulphur content of the flue gas and fly ash will not exceed 2%, as this would lead to increases in SO2 emissions from the plant. • Emissions monitoring for HF, HCL, SO2, NOx, CO and PM.	Emissions are limited to minimize impact on human health.	Emissions within standards set by the Applicable Air Quality Standards and Guidelines.	Emissions monitoring. Details to be agreed with NEMA prior to operation and to be in line with the requirements of the IFC EHS Guidelines for Waste Management Facilities, 2007 guidelines.	During operation.	Air quality monitoring costs: • Capital cost NOx/SO2/PM ~ $75,000 including data logger • Capital cost meteorological measurements ~ $30,000 • Installation & setup air quality monitoring equipment ~ $20,000 • Periodic operational costs, air quality and met monitoring (including data validation) ~ US $ 100,000 • Total: ~$225,000 • Monitoring of Sulphur & Nitrogen oxides (NOx) content is

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
					under the general responsibilities of the construction supervisor – no material additional costs associated with this activity.
Noise Disturbance during Construction and Decommissioning					
• Although the Minor construction noise impacts are not high enough to require further mitigation, good site practice will be employed to minimize noise. • Construction noise will be managed through the following measures: • selection of low noise equipment; • temporary screening of the equipment; • • switching equipment off when not in use; and • construction of on-site buildings first to act as noise screens.	• Minimization of noise to avoid exceedance of noise criteria as set out in Chapter 7. • To minimize noise disturbance to local residents and receptors.	• Kenyan regulations relating to noise covered by Section 147 of the Environmental Management and Coordination Act (EMCA), Kenyan Legal Notice No.61 • The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009.	• Noise monitoring will be required to ensure noise levels are within agreed limits.	• During construction	Capital costs (one-off purchasing noise measurement equipment) ~ $3,200 Monitoring cost (ambient noise prior to construction) ~ $430 ($430 x 1) Monitoring cost (during construction) ~ $4,300 ($430 x 10)) Total: $8,000
Noise Disturbance during Operations					
• The predicted noise levels have identified the need for noise mitigation to meet IFC standards and to limit noise impacts to Minor significance.	• Minimize operational noise levels to meet IFC and Kenyan standards.	• Permissible noise levels as set out in the Kenyan Regulations relating to noise i.e. Section 147 of the Environmental Management and Coordination	• Noise monitoring will be required to ensure noise levels are within agreed limits.	• During operation • At what frequency	Monitoring cost (ambient noise During commissioning) ~ $860 (1 x daytime and 1 x

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
• The key items that are likely to require mitigation in order to reduce noise levels at the nearest receptor are as follows: • radiator fans; • engine room; • ventilation outlet units; • air cooled condenser for DCC; and • venting units. • The choice of noise mitigation measures will be developed during further detailed design. However, several well- established mitigation measures will be available such as selection of quieter equipment or provisions of on-site barriers to screen noise from key equipment items. • WtE Plant will establish a contractual design limit to ensure that agreed noise levels are achieved.		Act (EMCA), Kenyan Legal Notice No.61 • The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009. • These are 55 dB during the day, and 35 dB during the night for residential receptors, and 40 dB during the day and 35 dB at night for neighborhood residences. • • In line with IFC guidance i.e. if changes in background noise as a result of noise from the plant are no greater than 3 dB(A) then noise impacts are not significant even if they are above the Kenyan standards or IFC standards. • For a change in overall noise of 3 dB(A) the plant noise must be limited to the same level as the background noise. • For Ruai, plant noise levels will meet the IFC guidelines or be no higher than the baselines levels stated. • Refer to Chapter 7 for details of significance criteria.			night time @ $430 each) Monitoring cost (during operation) ~ $4,300 (5 x $860) Total: $5,200

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
Impacts on Water Resources					
• Appropriate construction methodology will be applied to ensure that groundwater mixing does not occur. Additionally, in order to mitigate potential impacts that could result from poor borehole construction, international best practice borehole construction methodologies will be applied • The potential contamination and/or erosion risks from construction related activities can be mitigated by industry-standard good construction management practices. • WtE Plant, which is examining a collective approach to coordinate surface water management with the neighboring KPLC substation site. During construction it is likely that temporary drainage channels will be created to channel and divert surface water from the WTE Plant site, away from the down slope agricultural plots; a similar approach will be developed to divert and distribute site run-off (particularly storm water run-off).	• Minimize risk to water resources from construction activities	• IFC Environmental, Health and Safety Guidelines for Waste to Energy/Waste Management Facilities, 2007 guidelines. • Reference Document on Best Available Techniques for Large Combustion Plants (BREF Note) produced by the European Commission. • International best practice.	• Water abstraction to be monitored to ensure compliance with WRA permit requirements • In addition, the Construction Management Plan will set out requirements for monitoring of construction activities and compliance with legislation/guidance and best practice.	• During construction and operation.	• Development of Construction Management Plan will entail approximately 20-man days of WtE Plant staff or others as appropriate. • No material additional costs are anticipated above general budgets for responsibilities of WtE Plant environment manager for the implementation of the plan.
Traffic and Transport Impacts					
• Measures to mitigate the likely significant effects from traffic movements arising during construction, operation and decommissioning have been developed in the form of a Traffic Control Management Plan (TCMP), see Annex B for details.	• Mitigate impacts from increased construction and operational traffic on the following: • Road user delays;	• IEMA Guidelines for the Environmental Assessment of Road Traffic used to inform Significance criteria which are • fully defined in Chapter 7.	• The TCMP will set out requirements for monitoring.	• During construction and operation.	• Development of TCMP will entail approximately 20 man days of WTE Plant staff or others as appropriate.

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
• The management plan will include procedures which will assess the likely number and intensity of vehicular movements and outline methods which will be adopted to minimize the overall footprint and secondary impacts such as dust. • The key issues addressed by the management plan in terms of mitigation measures include: • access to construction areas; • routing of construction traffic; • temporary traffic control and management; • road crossings; • parking facilities; • keeping highways clean of mud and dust; • driver training; • road safety and awareness training for school children; and reducing the probability of traffic accidents. • Regulations regarding the transportation of heavy loads limit the cargo weight and size to the maximum amounts allowed for transporting vehicles. The Kenyan Traffic Act (revised 2009), states that all heavy and medium vehicles are also required by law to carry a warning sign at the rear of the vehicle.	• Road user safety; • Highway infrastructure degradation; and • Increased levels of noise, vibration and air pollution.				• Approximately $50,000 over project lifetime to implement the mitigation measures that will be included in the TCMP.
Waste Management					
• All of the waste related impacts likely to arise during construction, operation and decommissioning can be mitigated very	• Minimization of waste generated;	• IFC Environmental, Health and Safety Guidelines for Waste Management Facilities, 2007	• The Waste Management Plan will set out	• During construction and operation.	• Development of Waste Management Plan will entail

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
effectively by the implementation of standard best practices in terms of environmental controls and management practices. • Waste streams generated during construction should be managed with due regard to the waste hierarchy. Specifically, the following principles should be adopted, in order of preference: • Waste minimization; • Reuse and recycling; • Waste treatment; and • Disposal. • Good practice also requires that during operation of the Project: • all hazardous materials are stored in clearly labelled containers; • storage and handling of hazardous materials is in accordance with national and local regulations appropriate to their hazard characteristics; and • fire prevention systems and secondary containment will be provided for storage facilities, where necessary, to prevent fires or the releases of hazardous materials to the environment.	• Effective treatment and disposal of generated waste, in line with national and international standards.	guidelines, and the Reference Document on Best Available Techniques for Large Combustion Plants (BREF Note) produced by the European Commission.	requirements for monitoring.		approximately 20 man days of WtE plant staff or others as appropriate. • No material additional costs are anticipated above general budgets for responsibilities of WtE plant environment manager for the implementation of the plan.
Unplanned Events					
• WtE Plant will develop an EMS that will, among other things, seek to prevent and limit environmental accidents and develop contingency procedures in case of such	• Prevent and limit Environmental ensure Contingency procedures are in	• IFC EHS Guidelines for Waste Management Facilities, 2007 guidelines	• The Unplanned Events and Emergency Response Plan	• During construction and operation	In addition to development of the EMS development of the following

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
accidents. Given that most unplanned and emergency events have both environmental and health and safety consequences, the EMS, will be developed alongside the Health and Safety Management • System. Ideally this will be done within the overall framework of an Integrated Quality, Environmental and Health and Safety Management System. • A Safety Programme will be set up by WtE plant for specific use at the Project site. This will include details on: • Training, instruction and information; • Inspection and testing; • Accident investigation and reporting; • Accident report review and follow up; and • Year-end report. • A comprehensive Emergency Response Plan will be developed and implemented • •As an integral part of the Safety Programme and the Emergency Response Plan, fire prevention and firefighting capability will be among the top priority requirements of the Project • A Hazard and Operability (HAZOP) study will be conducted on the plant during the design stage. Further assessments will be carried out on major new equipment or subsequent design modifications.	place in case of such accidents.		will set out requirements for monitoring.		plans and procedures will take around 20 man days of WtE Plant staff or other's time:, • Emergency Response Plan • Risk Assessment Procedures • Safety programme setup • Safety programme implementation over project lifetime • Approximately $5,000 to $10,000 for materials to support the safety programme implementation • HAZOP costs to be developed as part of engineering scope of work.

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
• Mitigation measures to prevent contamination of land and water will be developed and implemented. • Risk assessment procedures will be developed and implemented by trained personnel.					
Landscape and Visual Impacts					
• Good practice mitigation measures will be implemented to mitigate construction, operation and demolition impacts. These include: • machinery and materials will be stored tidily during construction. • Tall machinery including cranes will not be left in place for longer than required • temporary roads and works areas will be maintained free of dust; • outdoor construction lighting shall be unobtrusive and shall not allow light to shine upwards or towards residential areas; • security and work lighting (both driving construction and operation) shall be shielded and directed downwards • The following mitigation measures are recommended throughout the operational phase of the proposed power plant to further minimize landscape and visual impacts during operation: • the design, orientation and materials will be appropriately and reasonably developed to	• Minimization of any impacts of the proposed project upon the Landscape character, view and visual amenity.	• Significance criteria as set out in the Guidelines for Landscape and Visual Impact Assessment produced jointly by the British Landscape Institute and the British Institute of Environmental Management and Assessment (IEMA).	• Monitoring to ensure that visual screening and dust control measures in the Management and Action Plans for the Project are Implemented effectively.	• During construction and operation.	• Costs have been built into capital project costs and operation and maintenance budgets regarding visual design of the plant. • Good practice mitigation will not incur significant additional material costs above general housekeeping best practice. • Development of Conceptual • The Landscape Plan will cost around $2,500. Further detailed plan and costs of landscaping will be ascertained

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
match existing site and landscape characteristics; • appropriate use of non-reflective surfaces and surface color treatment; • an appropriate landscape plan shall be developed and adopted using tree belts and buffer screenings to provide visual relief and shade; • minimization of external signage clutter and signs which have a silhouette effect on the skyline; • roads providing access to site facilities and works areas will be landscaped and maintained free of dust where feasible; • outdoor lighting shall be as unobtrusive as possible and shall be shielded and directed downwards to prevent side spill. The use of tall mast lights shall be carefully assessed before use; • monitoring to ensure that visual screening and dust control measures in the Management and Action Plans for the Project are implemented effectively.					depending on the conclusions of the Conceptual • Landscape Plan.
Social and Socio-Economic Impacts					
• Impacts on local employment and the local economy during construction, operation and decommissioning will be managed through the following: • Development and implementation of a Human Resources Policy;	• Maximize impacts on employment and the local economy during construction. • Maximize impacts on employment and	• Kenyan labor law and the IFC Performance Standards	• The Occupational Health and Safety Management Plan, the Worker Management Plan, The	• During construction and operation	Development of the following plans and policies will entail around 20 man days of WtE PLANT (or other's) time:

REF Mitigation/ Enhancement Measures	Desired Outcomes	Performance Indicators or Acceptance Criteria	Monitoring	Timing of Mitigation/ Enhancement Measures	Cost / resources
• Provision of on the job training; • Employee contracts shall be mandatory; • Provision of employment certificates to workers on completion of contracts; • Development and implementation of a Local Procurement Policy; • Implementation of a clear Grievance mechanism. • Impacts of a new workforce on community health and wellbeing during construction and operation will be mitigated through the following: • Develop and implement a Health Risk Assessment; • Develop and implement a Workforce Management Plan; and • Implement a clear Grievance Mechanism • Where possible (as skills permit) WTE PLANT will look to recruit from the local communities surrounding the proposed Project site during construction and operation. • WTE PLANT will develop and implement a social investment strategy that will support social development initiatives in communities neighboring the proposed Project.	the local economy during operation. • Minimize impacts of a new workforce on community health and wellbeing during construction and operation. • Minimize impacts on employment legacy issues associated with the change in land use.		Stakeholder Engagement Plan and the Social Investment Strategy will set out relevant monitoring requirements.		• Human Resource Policy • Stakeholder Engagement Plan • Local Procurement Policy • Health Risk Assessment • Workforce Management Plan • social investment strategy • Provision of on the job training (costs to be incorporated into Workforce Management Plan as developed)

The Waste to Energy Power Plant Safeguards team will be visiting the project regularly to ensure compliance to safeguards requirements. Contractor will prepare a CESMP based on the design for approval by the Client and the financiers where applicable before the start of construction works. This will include ESHS documents and Code of Conduct. The Contractor has the key responsibilities regarding compliance to the above ESMP, C-ESMP, ESHS and the Code of Conduct but it is critical for the proponent to ensure adequate monitoring and evaluation for the Contractor for no non-conformances. The contractor will present an Environmental and Social Management Plan and Code of Conduct that will need to be approved and complied with during project execution. At the same time, the Waste to Energy Power Plant Safeguards team will closely monitor to ensure that the above ESMMP is complied with during the project's implementation phase.

9.3 Environmental and Social Management Plan Review

The Proponent will need to review the ESMMP half yearly basis to demonstrate that the sufficiency of the operational, design and monitoring systems for the development stage of the site has been addressed. The review process should be established to ensure continual improvement in the management and operation of the Waste to Energy Power Plant site. The Proponent should also conduct a self-assessment Audit to assess the implementation of the ESMP.

9.4 Emergency Response Plan

Emergency response plan aims to develop a good action plan to protect employees, visitors, contractors and anyone else in the affected area and mitigate the results and effects of any emergencies. Therefore, its critical that a response plan be developed relevant to both construction and operational phases based on facilities identified hazards and risks.

9.4.1 Risk Assessment and Prediction:

Emergency response plan should consider the following situations in their planning for effective response

- An emergency situation that could cause risks on human safety or lead to mass scale disorder;
- An emergency situation that could cause risks to human health, potential fixed assets loss;
- An emergency situation that could cause minor injuries, occupational disease, potential movable property loss.

9.4.2 Emergency Preparation:

Emergency Response Action Team

Emergency response action team is normally established by the project management unit. The team is mainly responsible for preparing emergency response measures and safety guides, disseminating information about the emergency, recording and reporting damage. The team shall also coordinate and respond to emergencies.

9.5 Training

All staff members are required to attend emergency training so that they can gain knowledge for effective response to various situations such as personnel injuries i.e. Cardio-pulmonary resuscitation (CPR), use first-aid kit, masks and fire extinguisher, and implement self-rescue measures during different emergency scenarios.

9.6 Emergency Response Equipment

Emergency equipment needs to be prepared and provided at designated locations to the knowledge of all parties. First-aid kits, masks, fire extinguishers, window breakers, ropes, flashlights, backup lights, exit signs are all important tools during emergency scenarios.

Emergency broadcast system to notify all affected persons and disseminate emergency information is also very important for managing occupational and community health and safety.
All emergency equipment should be properly maintained and tested periodically and ensured to be always available.

9.6.1 Emergency Response Actions

In *consideration* of different emergency scenarios, following measures will be implemented as needed.

9.6.2 Emergency Management

Incident Investigation

Incidents can provide valuable information about facility hazards and the steps needed to prevent and manage them. The emergency action team manage the emergency in accordance with the incident investigation procedures:

- commence the incident investigation to ascertain the contributing factors of an incident and damage/costs incurred;
- prepare an incident investigation report;
- address the report findings and recommendations; and
- disseminate the investigation results to the relevant parties.

9.7 Audit

Audits on emergency response plans should be conducted at least once every three years. The project manager will develop audit protocols which include: (i) review of applicable emergency protective measures; (ii) assessment of risks with regard to the protective measures and reporting of findings; (iii) identification of the appropriate responses for each finding; and (iv) documentation of the actions taken to correct any deficiencies.

Updates on facility policy and emergency plan will be conducted in accordance with the audit findings, if needed. The project manager will reassess relative risks and make proper adjustments for protective measures and policy.

10 The Environmental and Social Monitoring Plan

10.1 Environment Monitoring Programme

Environmental and social monitoring evaluation is essential in the successful running of any project. They are conducted to establish that the project implementation has complied with the set environmental management standards as articulated in the Environmental Management and Coordination Act (EMCA) No. 8 of 2015, and its attendant environmental (Impact assessment and Audit) regulations, 2003. Monitoring should focus on the most significant impacts identified in the ESIA. The main aim of ESIA monitoring is to provide the information required to ensure that project implementation has the least possible negative environmental impacts on the people and environment. Various types of monitoring activity are currently in practice. During the ESIA study baseline Monitoring on basic environmental parameters in the PAI was conducted. Subsequent monitoring would help assess the changes in those parameters over time against the baseline. Other main types of environmental monitoring that will be conducted are briefly described below:

10.2 Compliance Monitoring

This is a monitoring and evaluation conducted to establish that the proposed project has complied with environmental management standards as articulated in the Environmental Management and Coordination Act (EMCA) No. 8 of 2015. It also establishes that the proponent is compliant with the Environmental and Social Management Plan as well as action plans proposed. The purpose of compliance monitoring is to ensure that quality or quantity of an environmental component is not altered by human activity beyond a specified standard of regulation level.

10.3 Effects Monitoring

This is a monitoring study carried out to monitor the effects of the impacts of the project for purposes of re-planning the mitigation measures. After the mitigation measures are implemented, effects monitoring or evaluation can determine if the mitigation measures have achieved their expected results. Below is a monitoring and evaluation plan for the proposed waste to energy power Project. It is therefore recommended that the ministry ensures annual EA is carried out.

The environmental monitoring will begin simultaneously with the commencement of construction and will continue throughout the project operation phase as indicated in the table 57 to 61 below.

Responsibility for environmental supervision during the construction phase of the project belongs to the contractor and is supervised by the Project Management team on the proponent's team.

10.3.1 Environment Monitoring During Construction Phase

Air Monitoring

Table 57: Air Monitoring During Construction Phase

1	Location	about 500m to the North of the project at the project center about 500m to the South of the project
2	Quantity	3 locations
3	Monitoring indicators	Temperature, humidity CO, SO2, NO2, total dust, noise, vibration.
4	Reporting Frequency	3 months
5	Comparative standard	- EMCA Specifications for ambient air quality. - EMCA Specifications on noise - World Bank General EHS Guidelines

Water Monitoring

Table 58: Water Monitoring During Construction Phase

1	Location	NT: Camp for workers
2	Quantity	one location
3	Monitoring indicator	TSS, COD, BOD5, Sulfur, Total N, Total Phosphorus (P), Coliform
4	Reporting Frequency	Once per 3 months
5	Comparative standard	EMCA regulation on domestic wastewater EMCA regulation on wastewater of solid waste burial sites.

Solid Waste and Hazardous Waste Monitoring

Solid waste is monitored daily, temporarily stored at worker camps, and contracted with local companies to collect and process them daily.
Hazardous waste is monitored daily in the temporary storage area of hazardous waste, monitoring the collection and storage process in storage while waiting for the functional unit to transport and treat.
Monitoring frequency: 6 months.

Monitoring of the Subsidence and Fire Incident

Strict supervision of the construction process because the possibility of subsidence occurs high especially in the rainy season. Supervision in construction areas using welding machines, spark cutters, petrol vapors as they may lead to fire and explosion during construction.

Frequency of implementation: continuous daily in the process of construction of the project.

Monitoring Expenses

Table 59: Monitoring cost estimates during construction phase

No	Indicators	Amount	Unit Price (Kshs)	Total Amount (Kshs)
1. Air environment (3 locations, 8 indicators)				
1	Temperature	3	500	1500
2	Humid	3	10000	30000
3	Noise	3	8000	24000
4	Vibration	3	15000	15000
5	Total dust (PM10 & PM2.5)	3	4500	13500
6	CO/CO2	3	5000	15000
7	NO2	3	5500	16500
8	SO2	3	5500	16500
Total				***162,000***
2. Water environment (1 location, 7 indicators)				
1	TSS	1	1100	1100
2	COD	1	1250	1250

No	Indicators	Amount	Unit Price (Kshs)	Total Amount (Kshs)
3	BOD5	1	1250	1250
4	Sulfur	1	1400	1400
5	Total N	1	2400	2400
6	Total phosphorus (calculated by P)	1	1500	3000
7	Coliform	1	1200	1200
	Total			***11,600***
Total estimated expense (1 batch)				**173,600**
Other monitoring expense (monitoring of hazardous waste, subsidence, labor safety)				**1,000,000**
TOTAL EXPENSES OF SUPERVISION IN THE CONSTRUCTION PHASE				**1,173,600**

10.3.2 Environment Monitoring During Operation Phase

Water Monitoring

Table 60: Water monitoring during operation phase

1	Location	Behind the leachate treatment system Behind the wastewater treatment system
2	Quantity	2 locations
3	Monitoring indicator	pH, NH_4^+, NO_3^-, BOD5, TSS, animal and vegetable grease, total surfactant, PO_4^{3-}, Coliform, total dissolved solids, sulfur
4	Frequency	3 months/time
5	Comparative standard	• EMCA regulation on industrial wastewater • EMCA regulation on domestic wastewater, column A and EMCA regulation on surface water.

Emissions Monitoring

Table 61: Emission monitoring plan during operation phase

Location	**Chimney**
Quantity	3 locations
Monitoring parameters	24-hr flue gas monitoring: CO, SO_2, NO_x, HCl, dust, HF, CO, NH_3
	Monitoring by qualified third party (Quarterly): HCl, CO, NO_x, SO_2, dust, heavy metal, dioxin
Applicable standards	- NEMA Regulations - EU Directive 2010/75/EU; - EMCA regulation on solid waste incinerator, - World Bank General EHS Guidelines

In addition, there is installation of sensors that automatically monitor the emission parameters of pollutants such as CO, SO2, NOx, HCl, dust. Continuous online control of environmental data strictly controls the waste management, and public disclosure to the website of the Department of Natural Resources and Environment and related websites.

10.4 Other Monitoring

10.4.1 Monitoring water supply and drainage system

Checking for flooding in the residential infrastructure system; drainage capacity and quality of drainage systems; operation, management, technical operation. Checking the quality of the water supply system. Recording and checking related information feedback from the resident.

Frequency of inspection: every 6 months for the first year and once a year for the following years.

10.4.2 Monitoring fly ash and slag during operation period

During the operation period, the slag will be monitored by sampling methods to detect water content, hazardous materials content every day. Qualified slag will be bagged and delivered for further treatment.

During the operation period, the fly ash will be sampled to detect its water content, hazardous materials content, and heavy metal content every day. Qualified fly ash delivered to the fly ash disposal area within the solid waste treatment area.

10.4.3 Monitoring the subsidence of the construction

Periodically monitor the subsidence of the works to take measures to overcome, reinforce the works when the incident occurred.

Frequency of implementation: 6 months/time

10.4.4 Monitoring fire and explosion

Regular fire and explosion monitoring at the plant site because of the possibility of short- circuit leading to fire.

10.4.5 9.4.5 Monitoring the environmental sanitation conditions

Monitoring the collection and transportation of hazardous waste, solid waste, and environmental sanitation in the public sector.

Periodical inspection of fire prevention and fighting means.

Daily general waste is monitored daily at the solid waste repository, monitoring collection, transportation and handling.

Hazardous waste shall be monitored daily in the hazardous waste repository area, supervise the collection process, store at the warehouse in the process of waiting for functional units to transport and process.

Frequency of monitoring: daily.
Expenses of the other monitoring are estimated at per batch Kshs. 48,000 as show in table 62 below.

Table 62: Monitoring cost estimates during operation phase

No	Indicator	Amount	Unit price (Kshs)	Total amount (Kshs)
	1. Water environment *(2 locations, 11 indicators)*			
1	pH	2	710	1420
2	BOD5	2	1250	2500
3	TSS	2	1100	2200
4	Sulfur	2	1400	2800
5	$NH4^{+}$	2	1400	2800
6	$NO3^{-}$	2	1000	2000
7	$PO4^{3-}$	2	1500	3000
8	Total dissolved solids	2	1000	2000
9	Animals and plants oil and grease	2	1300	2600
10	Coliform	2	1200	2400
11	Total surfactant	2	2500	5000
			Total	**28,720**
	2. Other monitoring (Lead, Zinc, Cadmium, selenium, Permanganate Value & Fluoride			12,600
	TOTAL MONITORING EXPENSES IN OPERATION PHASE (1 batch) exclusive of taxes & fieldwork			41,320

10.5 Mitigation measures implementation

Table 63: Responsible Unit for Implementation of Mitigation Measures

No.	Period	Implementation time	Implementation Unit	Supervision Duty
1	Construction Period	During the entire construction period	Construction contractor	The EHS management committee
2	Operation Period	During the time the property goes into operation	EHS Management Department	Plant Management Unit

The mitigation measures mentioned above in Chapter 8 will be implemented by the construction contractor during the construction stage under the supervision of the EHS management committee, and EHS management department during the operation stage under the supervision of the Plant Management Unit accordingly.

10.6 Performance Indicators

These mitigation measures are implemented to minimize the potential negative impacts associated with the project. A set of standards is used as target indicators to evaluate the performance of mitigation measures. During the construction period, standards of World Bank General EHS Guideline Section 2.0 are used to examine the noise impact.

VOCs such as NO_2, SO_2, CO, and dust will be monitored for ambient air quality monitoring. TSS, COD, BOD_5, Sulfur, Total N, Total Phosphorus (P), Coliform will be monitored to evaluate water quality. During operation period, WHO Air Quality Guidelines-Global Update 2005 and Environmental Management and Coordination (Air Quality) Regulations 2014, Third Schedule, Emission Limits for Controlled and Non-Controlled Facilities are used to examine the level of CO, SO_2, NOx, HCl, dust, Dioxin in emission monitoring, and Hg, Cd, Pb, pH, $NH4^{+}$, NO3, BOD_5, TSS, animal and vegetable grease, total surfactant, $PO4^{3-}$, Coliform, total dissolved solids, sulfur in water monitoring. The table 64 below shows the proposed EMMP.

Table 64: Proposed Project's EMMP

Aspect Issue	Monitoring Activity	Monitoring Parameters	Phase	Monitoring Duration/ Frequency	Responsible Party	Cost Estimate (KSH)
Air Quality	Visual assessment of dust: routine and, if necessary, in response to a complaint.	Monitoring of PM10 & $PM_{2.5}$. Dust fallout monitoring will need to be undertaken at nearby residential areas and villages.	Construction	Daily during period of dust generating activities and when complaint is received	Contractor	No additional cost is associated with visual assessment
	Direct measurement using meters; Sampling and analysis of air samples.	Wind direction and speed (m/s) Air temperature (ºC) Air humidity (%) Precipitation (mm/min); Mercaptans (μgC2H5SH/m³).	Operation	Twice in a year (during dry and rainy seasons)	WtE Power plant management	250,000
	Flow rate to be measured using flow meters; Sampling and analysis of air samples	Amount and quality of landfill gas (laboratory analysis of: Methane (CH4), Carbon dioxide (CO2), Nitrogen (N2) and Oxygen (O2).	Operation	Not less than twice a year	WtE Power plant management	500,000
	Odor assessment	Concentration and substance of Odor emitting from the weekly storage point (waste reception point)	Operation	Since the odor is not quantifiable, there is no prescribed frequency of monitoring. Generally, the odor should be monitored daily or as-and-when necessary, as long as it is not having a major impact on the surrounding area.	Proponent	Included in operation cost
Water Resource	Sampling and analysis of quality of water	River water The following parameters are to be monitored:	Operation	Quarterly	Proponent, WRA, County Environmental Officer	400,000

Aspect Issue	Monitoring Activity	Monitoring Parameters	Phase	Monitoring Duration/ Frequency	Responsible Party	Cost Estimate (KSH)
		pH, temperature, electrical conductivity, Ammonia (as N), Total oxidized Nitrogen (as N), Total organic carbon, Metals (calcium, magnesium, sodium, potassium, iron, manganese, cadmium, chromium (total), copper, nickel, lead, zinc, arsenic, boron and mercury), Total alkalinity (as $CaCO_3$), Sulphate, Chloride, Molybdate Reactive Phosphorus, Cyanide (Total), Fluoride, Trace organic substances (pesticides and solvents), Faecal & Total Coliforms				
	Monitoring groundwater levels	Groundwater	Operation	Quarterly	WtE Power plant management	600,000
	Monitoring precipitation	Precipitation/rainfall	Operation phase	Daily	WtE Power plant management	50,000
Noise Quality	Monitor noise levels during construction	Noise and vibration Levels	Construction	At the start of each new construction activity	Contractor Proponent	100,000

Aspect Issue	Monitoring Activity	Monitoring Parameters	Phase	Monitoring Duration/ Frequency	Responsible Party	Cost Estimate (KSH)
	Monitor noise levels during operation phase	Noise and vibration levels	Operation phase	Once in a year	Proponent	80,000
Waste (solid and liquid)	Visual inspection, disposal records	Waste generation and management	Construction phase	Regularly during construction, as appropriate. Amount and disposal records internal reports will be made daily and monthly	Contractor	Included in the cost of construction
	Sampling and analysis	Amount and quality of Leachate	Operation phase	For measuring the parameters that are easy to be measured automatically - once a day For measuring the parameters which are necessary for daily operation control due to keep the efficiency of water treatment facility and fluctuate in a wide range: Once a week - once a month For measuring the parameters which are not directly needed for operation management of water treatment facility, but fluctuate in a wide range: Once a month For measuring the parameters which are hardly fluctuate: Once a year	WtE Power plant management	included in operation costs
	Sampling and analysis	Amount and quality of effluent discharged	Operation phase	the frequency should correspond to the frequency of the leachate monitoring activities	WtE Power plant management	included in operation costs
Hazardous wastes	Tacking of wastes	Type of wastes	Operation	Upon of every receipt of wastes at landfill Sites by delivery trucks	WtE Power plant management	included in operation costs

Aspect Issue	Monitoring Activity	Monitoring Parameters	Phase	Monitoring Duration/ Frequency	Responsible Party	Cost Estimate (KSH)
Flora and Fauna	Ecological assessment for nearby river.	Macrophytes, algae, fish, protected species)	Operation phases	Quarterly	WtE Power plant management	400,000
Environmental Inspections/ Auditing	Inspection of equipment and processes	Integrity of equipment and adherence to procedures	Construction/operation phases	As part of regular, monthly inspections.	WtE Power plant management and Proponent	Included in construction And operation costs.
Grievances Mechanism	Monitor issues raised through the Grievance Mechanism	Workers and Staff welfare and working conditions	Construction and operation phases	Continuously through construction and operation phases of the project	Contractor and Proponent	Included inconstruction and operation costs.
Population/ Demographic movement and employment	Conflict Complains	Number of locals employed versus others from elsewhere Complains from the local	Project cycle	Continuous	WtE Power plant management and contractor	No additional cost
Public and workers health and safety	Health and Safety Risks	Number of occupational health and safety	Throughout the project cycle	Continuous	WtE Power plant management Contractor	No additional cost
	HIV/Aids	New infections Social survey on social behavior that might led to new infection	Throughout the project cycle	Continuous/regular	WtE Power plant management Contractor	100,000 per annum
Security and Crime, Child protection, Gender equity and Sexual harassment.	Insecurity Child labor Workplace harassment.	Complaint registered Police occurrence book entry register reports from the project site.	Throughout the project cycle.	Continuous.	WtE Power plant management, security agency in the project site, Project WTE Power plant management, County government	No additional cost

Total Cost estimates of Environmental & Social Monitoring Plan is estimated at KShs. 2,480,000

11 Grievance Redress Mechanism

11.6 Overview

Grievances are any complaints or suggestions about the way a project is being implemented. They may take the form of specific complaints for damages/injury, concerns about routine project activities, or perceived incidents or impacts. Identifying and responding to grievances supports the development of positive relationships between projects and the communities, and other stakeholders, they may affect. Grievance mechanisms therefore provide a formal and ongoing avenue for stakeholders to engage with the company, whilst the monitoring of grievances provides signals of any escalating conflicts or disputes.

11.7 Best Practice Principles

The IFC standards and the Equator Principles outline that grievance mechanisms should receive and facilitate resolution of the affected communities' concerns and grievances. The IFC states the concerns should be addressed promptly using an understandable and transparent process that is culturally appropriate and readily acceptable to all segments of affected communities, at no cost and without retribution. Mechanisms should be appropriate to the scale of impacts and risks presented by a project and are beneficial for both the company and stakeholders.

11.8 Grievance Mechanism Development

The management of grievances is therefore a vital component of stakeholder management and an important aspect of risk management for a project.

Grievances can be an indication of growing stakeholder concerns (real and perceived) and can escalate if not identified and resolved. A Grievance Mechanism specific to the Project has been developed with WTE Plant and is described in the following sections.

11.8.1 Objectives of the Grievance Mechanism

The primary objectives of WTE Plant 's approach to grievance management are to:

- Build and maintain trust with community stakeholders;
- Prevent the adverse consequences of failure to adequately address grievances; and
- Identify and manage stakeholder concerns and thus to support effective risk management.

An effective grievance management process should include the components described in Table 65.

Table 65: Key components of effective grievance mechanism

Component	Description
Simple Process	It should be convenient to submit complaints. There should be several, appropriate channels through which community stakeholders can submit complaints free of charge (e.g. no travel costs, free phone number) as well as the informal identification of complaints (e.g. when the WTE Plant employees (or subcontractors) are approached at meetings with the community). The grievance management process should be communicated and disclosed so that community stakeholders are aware of the avenues available to them to submit complaints
Simple Internal Procedure	A simple and consistent procedure is required to record grievances, identify those responsible for addressing them and ensure that they are resolved. The procedure must maintain the confidentiality of the complainant and ensure fairness (fair to the stakeholder, fair to WTE Plant, and consistent). Transparency in how the

Component	Description
	grievance management process works; and involvement of stakeholders in developing resolutions, can help. Responses should seek to address all issues in a grievance and be clearly justified.
Staff Arrangements	Roles and responsibilities in the grievance management process need to be defined and agreed. For example, a WtE Plant Grievance Officer (GO) will be assigned and responsible for the coordination of the grievance management process, from receiving a complaint to reporting back the response. Once received, complaints should be directed to an appropriate staff member/department for investigation and resolution, to ensure an effective response. Even where a formal system has been established, staff not associated with the grievance management process will receive complaints. Systems for managing and forwarding these should be established and all staff trained on how to respond to stakeholders and to feed into the grievance management process.
Training	The launch or modification of the grievance management process should include internal induction and/or training for operational staff and a Community Liaison Officer(s). Training should outline key components, commitments and lines of communication in the process, and roles and responsibilities.
A Set Timeframe	The grievance process should set a timeframe within which complainants can expect: a) acknowledgement of receipt of grievance; and b) response and/or resolution of grievance. The timeframe should be feasible, whilst respecting community stakeholders' need for a swift response and resolution. Where complaints are urgent, tighter timeframes may need to be considered.
Sign–Off	Actions planned to resolve grievances considered to be of significant concern by the Grievance Officer should be signed-off by a member of the senior management, suitably qualified to assess the effectiveness of the response. This will help to ensure standards are met and that there is accountability in the grievance management process.
System of Response	A clear system of response is required to identify who should respond to the complainant and how.
Monitoring Effectiveness	Mechanisms should be set in place for monitoring the effectiveness with which complaints are being recorded and resolved. Reporting locally on the volume and nature of complaints received, and on key performance indicators helps to maintain transparency and trust.

11.8.2 The Process

This process is summarized in Figure 107, with the key steps as follows:

1. **Identification of grievance** through personal communication with WtE Plant, phone, letter, during meeting, other (1). If the grievance is logged on a Grievance Form in Swahili, a witness will be present as the grievance is also translated into English for the database. The witness and Complainant will both sign the Grievance Form after they have confirmed the accuracy of the grievance.

2. **Grievance is recorded in the 'Grievance Log'** (written and electronic) which will be held at WTE Plant's office. The significance of the grievance will be assessed using the criteria outlined in Below.

   Significance Criteria
   Level 1 Complaint: A complaint that is isolated or 'one-off' (within a given reporting period - 1 years) and essentially local in nature.

   Note: Some one-off complaints may be significant enough to be assessed as a Level 3 complaint e.g. when a national or international law is broken (see Level 3).

   Level 2 Complaint: A complaint which is widespread and repeated (e.g. dust from construction vehicles).

   Level 3 Complaint: A one-off complaint, or one which is widespread and/or repeated that, in addition, has resulted in a serious breach of WTE Plant policies or law and/or has led to negative national/international media attention, or is judged to have the potential to generate negative comment from the media or other key stakeholders (eg non-payment of compensation).

3. **Grievance is acknowledged** through a personal meeting, phone call, or letter as appropriate, with a target of 10 working days after submission (maximum time a complainant should wait for a response is 1 month). If the grievance is not well understood or if additional information is required, clarification should be sought from the complainant during this step.
4. **The Grievance Manager (GM) is notified of Level 1, 2 or 3 grievances and the Project Manager/Director is notified of all Level 3 grievances**. The senior management will, as appropriate, support the GM in deciding who should deal with the grievance, and determine whether additional support into the response is necessary.
5. **The GO delegates the grievance** via e-mail to relevant department(s)/ personnel to ensure an effective response is developed e.g. HR, Community Liaison Officer; Contractors etc.
6. **A response is developed** by the delegated team and GO, with input from senior management and others, as necessary.
7. **The response is signed-off** by the senior manager for level 3 grievances, the GO for Level 2 and Level 1 grievances. The sign-off may be a signature on the grievance log or an email which indicates agreement, which should be filed by the GO and referred to in the grievance log.
8. **Communication of the response** should be carefully coordinated. The GO ensures that an approach to communicating the response is agreed and implemented.
9. **Record the response of the complainant** to help assess whether the grievance is closed or whether further action is needed. The GO should use appropriate communication channels, most likely telephone or face to face meeting, to confirm whether the complainant has understood and is satisfied with the response. The complainant's response should be recorded in the grievance log.
10. **Close the grievance** with sign-off from the GO. The GO assesses whether a grievance can be closed or whether further attention is required. If further attention is required, the GO should return to Step 2 to re-assess the grievance. Once the GO has assessed whether the grievance can be closed, he/she will sign off or seek agreement from MD for level 3 grievances, to approve closure of the grievance. The agreement may be a signature on the grievance log or an equivalent e-mail, which should be filed by the GO and referred to in the grievance log.

Note: This process has been designed to be effective through construction and operation, thus:

- The term MD ("Managing Director") is used to designate the person ultimately responsible (as will most likely be the case during operation). During construction, this senior management function is likely to be served by the Project Director and/or Project Manager).
- At least for the initial stages of Project implementation, through a significant portion of construction, the Grievance Officer and Community Liaison Officer functions are filled by the same person. Figure 108 show the grievance management process.

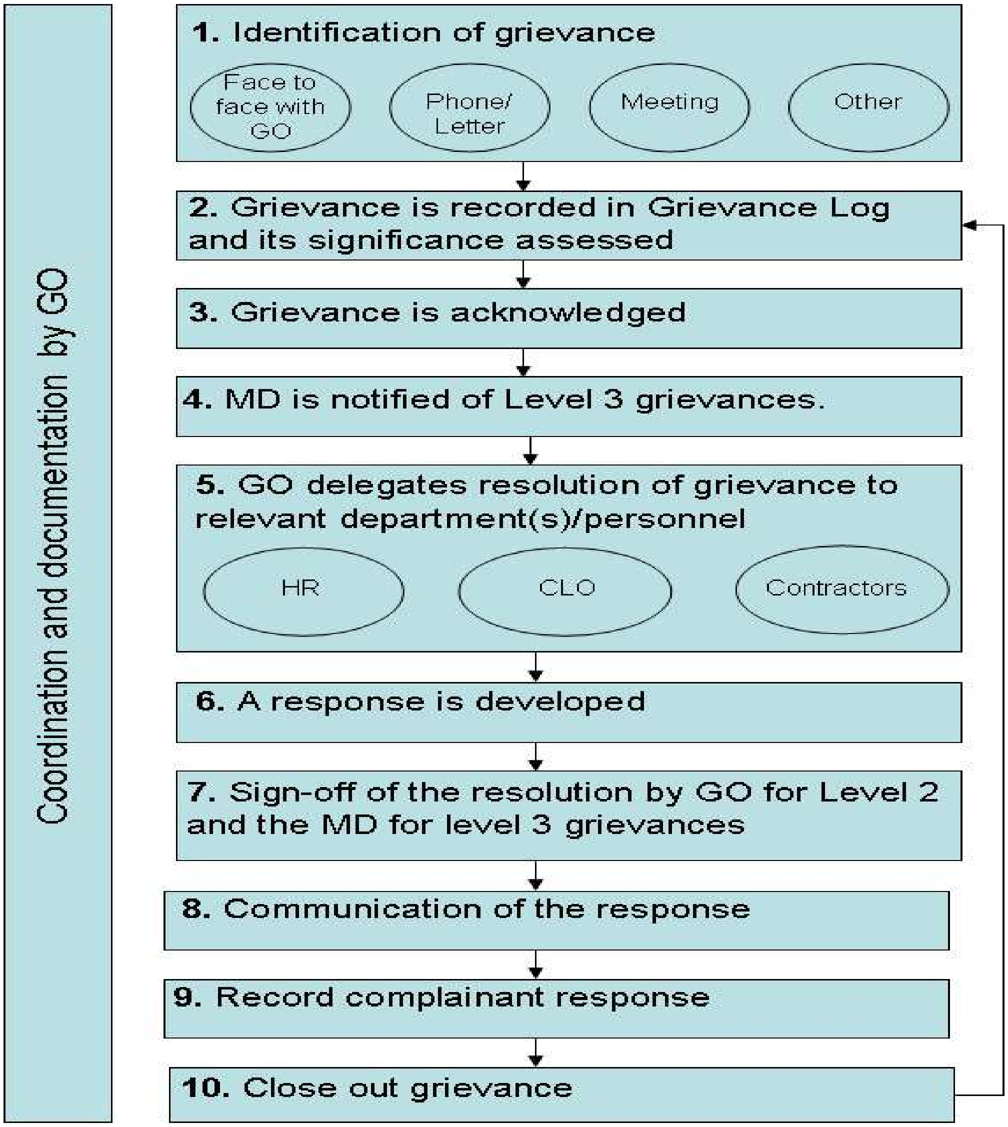

Figure 107: Grievance Management Process

11.8.3 Monitoring of the Grievance Process

Quarterly Reports

Quarterly reports will be compiled by WTE PLANT 's Grievance Officer (GO). These reports will summarize all monitoring for the period, including trend analysis, interpretation of results, recommendations on remedial measures and relevant figures and graphs.

A tracking system will be implemented to identify:

- Non-conformities;
- Areas for improvement;
- Remedial actions; and
- A programme and associated responsibilities for remedial actions.

Annual Reports

The quarterly reports will be combined into an annual report which will include a trend analysis, identification of problem areas, recommendations and all historical results.

12 Conclusion and Recommendations

12.1 Conclusion

Several conclusions can be drawn from findings of this ESIA which mainly touch on the potential significant positive impacts of implementation of the proposed project. The project will minimize exposure of the environment and humans to the detrimental effects of poor solid wastes practices such open dumpsites by containing and isolating these wastes. On the other hand, the implementation of the proposed project will generate potential negative impacts. These impacts manifest at different stages of the proposed project on the environment in its totality. The impacts have been identified and observed to be moderate in significance. The potential significant negative impacts on the biophysical environment include air and water pollution and noise. For these, appropriate mitigation measures have been identified and can be greatly minimized in the sanitary landfill design phase and through good operational practice and all of the impacts identified can be reduced to acceptable levels as proposed in the Environmental and Social Management Plan.

On the basis of the above discussions, it can be concluded that the proposed project is environmentally, legally, socially and culturally acceptable. The potential significant environmental impacts can be adequately mitigated by the proposed measures. It is the responsibility of the proponent and other stakeholders to see to it that the measures are implemented. This way, the environmental threats will be downscaled to acceptable levels. On that basis, it is recommended that the project be issued with the necessary clearance for the proponent to commence implementation.

The importance of the proposed project to national development and the local community cannot be overemphasized. The proposed project will help meet surging demand for proper waste treatment and reduce waste pollution in the city, extend lifespan of the existing dumpsites, convert waste into electricity, promote reliable energy and recycling.

In addition to following the laid down guidelines, project design has also factored in state of art technology in line with sound environmental management practices on leachate treatment and air emissions. Having considered the information collected, collated and analyzed during the study, it is the Experts' considered opinion that:

- Every Kenyan is entitled to a clean and healthy environment as stipulated in Article 42 of Kenya Constitution 2010, the eighth Sustainable Development Goal and the Vision 2030 social pillar targets the implementation of an integrated solid waste Management system and therefore, the project is vital for the improvement of the health and sanitary conditions in Nairobi County and the Nairobi Metropolitan Region.
- The project should be allowed to commence, and activities be managed within the provided ESMMP.
- The proposed ESMMP is adequate to mitigate the potential negative environmental impacts.
- The positive environmental impacts far outweigh the negative ones; the latter can be contained by the proposed ESMMP.
- The proposed project will not compromise the well-being of the neighboring community, ecology or any other conditions if all the proposed mitigation measures are implemented.
- The proposed project is a viable venture that should be given due support.

12.2 Recommendations

- The proposed project to be implemented in compliance with the relevant legislation and planning requirements;
- Public consultation, awareness and environmental campaigns should be maintained on continuous basis throughout the life of the project;

- Efficient and proactive management of the grievance redress system to be established during construction and operational phases of the project;
- The WTE power plant management in partnership with relevant stakeholders should develop elaborate plans and policies for management of wastes not accepted at the dumpsite as guided by the applicable County and National legislations.
- Standard operational procedures and controls of the WTE power plant be strictly adhered to;
- All the proposed mitigation measures should be implemented to ensure sustainability of the project throughout its lifecycle as well as the environmental sustainability of the project area;
- Designs and construction of leachate collection and treatment facilities should be implemented appropriately;
- Possible employment opportunities and other benefits should target local communities including vulnerable groups;
- An elaborate and effective management structure is in place to ensure sustainable management of the WTE power plant;
- Water quality monitoring program shall be scheduled for periodic tests as stipulated in the ESMP;
- Air and noise quality monitoring program shall be scheduled for periodic tests as stipulated in the ESMP;
- The project has attracted high level of community support with terms and conditions on sound management of the WTE power plant;
- NEMA to consider, approve and grant an Environment and Social Impact Assessment License to the proponent based on the ESMMP;
- The proponent to conduct annual Environmental Audits and submit to NEMA.

13 References

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- The World Bank Operations Manual: Operational Policies (OP)/Bank Procedure (BP) 4.01: Environmental Assessment.

14 Annexes

14.1 Annex 1: Government Approval and support Letters

14.2 Annex 2 : Proposed Project Area Layouts

14.3 Annex 3: Geological Survey Report

14.4 Annex 4: Feasibility Design Study

14.5 Annex 5: Land Acquisition Documents

14.6 Annex 6: Laboratory Noise Level Analysis

14.7 Annex 7: Laboratory Soil & Water Quality Analysis

14.8 Annex 8: Laboratory Ambient Air Quality Analysis

14.9 Annex 9: Air Dispersion Modelling

14.10 Annex 10: Field Questionnaires

14.11 Annex 11: Public Participation Invitation Letter

14.12 Annex 12: Public Participation Meeting Minutes

14.13 Annex 13: List of participants

14.14 Annex 14: Consultants Practicing License

14.15 Annex 15: ESIA Terms of Reference

Annex 1

Government Approvals _ support letters

No. 20/55

CERTIFIED TRUE COPY
OF THE ORIGINAL

R. MIANO (MRS)
COMPANY SECRETARY

Kenya Electricity Generating Co. Lt
P. O. Box 47936 - 00100
NAIROBI

Certificate of Incorporation

I Hereby Certify, that THE KENYA POWER COMPANY LIMITED is this day Incorporated under the Companies Ordinance (Chapter 288) and that the Company is LIMITED.

GIVEN under my hand at Nairobi this First day of February One Thousand Nine Hundred and Fifty four.

SEAL.

Companies Registry.

Colony and Protectorate of Kenya.

E. M. LAWTON,

Registrar of Companies.

S353

Kenya Electricity Generating Co. Ltd.
P. O. Box 47936 - 00100
NAIROBI

No. C. 20/55

CERTIFIED TRUE COPY
OF THE ORIGINAL

R. MIANO (MRS)
COMPANY SECRETARY

CERTIFICATE OF CHANGE OF NAME

I hereby Certify, that—

THE KENYA POWER COMPANY LIMITED................................

having, with the sanction of a **Special Resolution** of the said Company, and with the approval of the REGISTRAR OF COMPANIES, changed its name, is now called KENYA ELECTRICITY GENERATING COMPANY LIMITED..

and I have entered such new name on the Register accordingly.

Given under my hand at Nairobi this NINETEENTH day of JANUARY One Thousand Nine Hundred and NINETY EIGHT

Registrar of Companies

GPK 1378—5m—9/76—(F9)

KENYA REVENUE AUTHORITY

www.kra.go.ke

PIN Certificate

For General Tax Questions
Contact KRA Call Centre
Tel: +254 (020) 4999 999
Cell: +254(0711)099 999
Email: callcentre@kra.go.ke

Certificate Date : 24/11/2020

Personal Identification Number

P000591581V

This is to certify that taxpayer shown herein has been registered with Kenya Revenue Authority

Taxpayer Information

Taxpayer Name	KENYA ELECTRICITY GENERATING COMPANY PLC
Email Address	TAX@KENGEN.CO.KE

Registered Address

L.R. Number :	**Building :** STIMA PLAZA
Street/Road : PARKLANDS	**City/Town :** NAIROBI
County : Nairobi	**District :** Nairobi East District
Tax Area : Nairobi East	**Station :** LTO
P. O. Box : 47936	**Postal Code :** 00100

Tax Obligation(s) Registration Details

Sr. No.	Tax Obligation(s)	Effective From Date	Effective Till Date	Status
1	Income Tax - Company	08/01/1993	N.A.	Active
2	Income Tax - PAYE	01/01/1995	N.A.	Active
3	Value Added Tax (VAT)	11/12/1997	N.A.	Active

The above PIN must appear on all your tax invoices and correspondences with Kenya Revenue Authority. Your accounting end month is June unless a change has been approved by the Commissioner-Domestic Taxes Department. The status of Tax Obligation(s) with 'Dormant' status will automatically change to 'Active' on date mentioned in "Effective Till Date" or any transaction done during the period. This certificate shall remain in force till further updated.

REPUBLIC OF KENYA
MINISTRY OF ENERGY

Telegrams: "MINPOWER, Nairobi
Telephone: Nairobi 3310112
e-mail: psenergy@energy.go.ke
Fax: 2240910 or 2228314
When replying please quote

OFFICE OF THE
PRINCIPAL SECRETARY
P. O. Box 30582
NAIROBI

Date: 12th August, 2020

Ref. No. ME/CONF/2/5/1

Mrs. Rebecca Miano, MBS
Managing Director
KenGen
Stima Plaza 'B', Parklands
NAIROBI

Dear Rebecca,

RE: ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY

Reference is made to the attached copy of letter ref: OP/CAB. 1/64A dated 12th August, 2020 addressed to me by Dr. Joseph Kinyua, Head of the Public Service on the above captioned subject.

Take note of the contents therein and arrange to commence all necessary processes and approvals for the implementation of the Waste to Energy Power Plant, taking cognizance of paragraphs 4, 5 and 6 noting the need to fastrack the processes towards meeting the targeted period of 12 months to commissioning the power plant.

Expedite and revert.

Yours Sincerely

Dr. Eng. Joseph K. Njoroge, **CBS**
PRINCIPAL SECRETARY

Copy to:

Hon. Charles Keter, EGH
Cabinet Secretary
Ministry of Energy
Nyayo House
NAIROBI

Dr. Joseph Kinyua, EGH
Head of the Public Service
Executive Office of the President
Harambee House
NAIROBI

Dr. Julius Muia, CBS
Principal Secretary
The National Treasury
Treasury Building
NAIROBI

EXECUTIVE OFFICE OF THE PRESIDENT
HEAD OF THE PUBLIC SERVICE

Telegraphic Address
Telephone: +254-20-2227436
When replying please quote **OP/CAB.1/64A**

Ref. No..
and date

MINISTRY OF ENERGY
RECEIVED
12 AUG 2020
PRINCIPAL SECRETARY

STATE HOUSE
P.O. Box 40530-00100
12th August, 2020 Nairobi, Kenya
................................., 20...........

Dr. (Eng.) Joseph K. Njoroge, CBS
Principal Secretary
Ministry of Energy
Nyayo House
NAIROBI.

Dear Dr. Njoroge,

RE: ESTABLISHMENT OF A WASTE TO ENERGY PLANT IN NAIROBI CITY COUNTY

1. As you are aware, the National Government and the Nairobi City County Government signed a Deed of Transfer of Functions Agreement, transferring to the National Government four (4) functions, which include **solid waste management.**

2. Pursuant to the Deed, the National Government established the **Nairobi Metropolitan Services** (NMS) to implement the transferred functions. Therefore, solid waste management is now under the management of the NMS.

3. Over the years, the Nairobi City County has faced challenges in its quest for better Solid Waste Management. Seeking to address these and other related challenges, some years back, the Nairobi City County Government conducted a feasibility study for a Nairobi Urban Waste to Energy Plant with a view to establishing a waste to energy plant. On its part, in 2012 the National Government, through the state owned Kenya Electricity Generating Company PLC (**KenGen),** had also conducted a feasibility study for a **Nairobi Urban Waste to Energy Plant.**

4. In furtherance of this agenda and considering that **KenGen** has the requisite capacity in the energy sector having undertaken electricity generation through the development, management, and operation of power plants, the Government has directed KenGen and NMS to establish a framework for the installation and running of a waste to energy plant. It is envisaged that this partnership will promote, enhance and enable cooperation and partnership between two parties on the Design, Installation, Commissioning, Financing, Operation and Management of a waste to energy power plant project at Dandora Dumpsite in Nairobi County.

5. The purpose of this letter, therefore, is to request your Ministry to immediately take the necessary steps towards the development of Waste to Energy Power Plant at Dandora. These steps include getting the requisite approvals, and liaising with the National Treasury to raise financing for; **(i)** the engineering, construction and commissioning of the Waste to Energy Power Plant project; and **(ii)** for supporting infrastructure such as access roads, electricity, water, sewerage system and any other necessary utilities. On its part, NMS will avail land within or around the Dandora Dumpsite land, and the solid waste at such terms and conditions as may be agreed.

6. It is the wish of the Government to have this plant ready and operational within the shortest possible time period. In this regard, your Ministry should establish a working framework with NMS, with specific time bound deliverables so as to ensure the plant is installed and commissioned **within** a period of **12 months.**

Yours Sincerely

JOSEPH K. KINYUA, EGH
<u>HEAD OF THE PUBLIC SERVICE</u>

Copy to: **Hon. Charles Keter, EGH**
Cabinet Secretary
Ministry of Energy
NAIROBI.

Hon. (Amb) Ukur Yatani, EGH
Cabinet Secretary
The National Treasury & Planning
NAIROBI.

Maj. Gen Mohammed Abdalla Badi, EBS, SS, NDC (k)
Director General
Nairobi Metropolitan Services
NAIROBI.

Dr. Julius Muia, CBS
Principal Secretary/Treasury
The National Treasury & Planning
NAIROBI.

KENYA CIVIL AVIATION AUTHORITY

efficiently managing air safety

Kenya Electricity Generating Co. PLC
RECEIVED
13 APR 2021
MANAGING DIRECTOR

KCAA/OPS/2406/2 VOL. 7 (106)

8 April 2021

Rebecca Miano (MRS), MBS
Managing Director & CEO
Kenya Electricity Generating Company PLC
P.O. BOX 47936-00100
NAIROBI

Dear MD,

HEIGHT APPROVAL OF POTENTIAL SITES FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY

Your application letter Ref: CP&PPP/WTE/JN/fm/03/21 dated 19 March 2021 for approval of heights of potential sites for waste to energy power plant refers.

Kenya Civil Aviation Authority has analyzed the proposed sites for the construction of aerial masts in order to ensure safety of aircraft operations within the Kenyan Airspace.

Height approval is hereby granted for **SIX (6)** proposed potential sites as tabulated below:

NO.	SITE NAME	COORDINATES IN WGS-84	REQUESTED HEIGHT (M)	APPROVED HEIGHT (M)	REMARKS
1	Athi River Sub Station	1° 27' 32.50"S 36° 57' 8.27"E	80	80	Nil
2.	EPZ -1	1° 21' 23.81"S 37° 3' 33.33"E	80	80	Nil
3.	Gulf Power-Athi River	1° 27' 52.26"S 37° 0' 35.13"E	80	80	Nil
4.	Ruai STP End	1° 13' 2.74"S 37° 4' 11.34"E	80	80	Nil
5.	Ruai STP mid	1° 14' 14.03"S 37° 2' 31.68"E	80	80	Nil
6.	Thika Dumpsite	1° 4' 45.29"S 37° 6' 50.89"E	80	80	Nil

Please note that the following conditions shall apply: -

1. The chimney shall be marked red/orange with alternating white colour bands that should be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension. The top and the bottom bands shall be of red/ orange colour.

Aviation House, JKIA
P.O. Box 30163-00100 GPO Nairobi
Tel: +254 020 6827470 - 5, +254 734 000 491/492, +254 728 606 586/70, +254 709 725 000
Fax: +254 020 6827 808, 6822 300
Website: www.kcaa.or.ke
Email: info@kcaa.or.ke

2. For Chimneys above 45m, the obstruction light shall be affixed at 45m mark and another at the highest point or where not practicable, the top lights be placed sufficiently below the top so as to minimize contamination by smoke.
3. The light to be used shall be red of medium intensity.
4. The waste processing and power generation plants will be fully covered and follow zero liquid discharge to prevent bird attraction.
5. Sorting of waste shall not be conducted on site unless within an enclosed structure to prevent bird attractants
6. The height of the power plant chimney shall not be increased without prior approval from the Director General of Kenya civil Aviation Authority.

This approval does not override any other Government requirements.

Yours SINCERELY,

Capt. Gilbert M. Kibe
DIRECTOR GENERAL

MANAGING DIRECTOR'S OFFICE

KenGen

Kenya Electricity
Generating Company PLC

Our Ref: CP&PPP/WTE/JN/fm/03/21

Date: 19th March, 2021

Capt. Gilbert Macharia Kibe
The Director General
Kenya Civil Aviation Authority
P.O. Box 30163 – 00100 GPO
NAIROBI.

Dear Capt. Kibe,

RE: FEASIBILITY STUDY FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY – REQUEST FOR HEIGHT APPROVAL OF POTENTIAL SITES

KenGen and the Nairobi Metropolitan Services (NMS) were mandated by the Government of Kenya (GoK), vide a letter dated 12th August 2020 Reference No. OP/CAB.1/64A from the Head of Public Service to establish a framework for the installation and running of a Waste to Energy Power Plant at Dandora Dumpsite in Nairobi City County, and acquire the necessary approvals and financing for the Project.

In order to implement this GoK directive, KenGen hired a Consultant, **SEURECA East Africa Ltd- Kenya, Development Environergy Services Ltd (DESL)-India and SEURECA Consulting Engineers-France** on 23rd February 2021 to carry out a Feasibility Study within six months (by 31st August 2021) and confirm the viability of the project and also identify the most suitable site for it. The Consultant has assessed several sites and clearance from Kenya Civil Aviation Authority is required before further investigations like Geotechnical investigations and Environmental and Social Impacts Assessments are carried out on the most suitable site for the Waste to Energy Power Plant.

The **descriptions and locations of the potential sites** (including their co-ordinates) are attached herewith.

KenGen hereby requests KCAA to consider and grant approval for height chimney of 60 – 80 meters for the selected potential sites.

Yours Sincerely

REBECCA MIANO (MRS), MBS
MANAGING DIRECTOR & CEO

Encl. Document with selected potential sites.

Candidate sites for proposed waste-to-energy plant for Nairobi City

KenGen is conducting a feasibility study for the establishment of a waste to energy power plant for Nairobi city. The following candidate sites have been identified for the waste to energy plant and the inert landfill.

Sl. No.	Name of site	County/Sub-County	Coordinates
1	Ruai STP mid	Nairobi/Kasarani	Longitude : 37.069816 Latitude : -1.217428
2	Gulf power-Athi River	Machakos/Mavoko	Longitude : 37.009759 Latitude : -1.4645184
3	EPZ 1	Machakos/Mavoko	Longitude : 37.059257 Latitude : -1.356613
4	Athi river substation	Machakos/Mavoko	Longitude : 36.952297 Latitude : -1.459027
5	Ruai STP End	Nairobi/Kasaran	Longitude : 37.042133 Latitude : -1.237231
6	Thika Dumpsite	Kiambu/Thika	Longitude : 37.114135 Latitude : -1.079248
7	Dandora	Nairobi/ Embakasi North	Longitude : 36.8996021 Latitude : -1.2438109

During preliminary on-site assessments regarding their suitability from the perspective of clearance from aviation authority, concerns were flagged with regard to the sites at Sl No 4 to 7.

In order to help with the assessment, a brief technical description of the proposed waste-to energy plant is as follows:

Waste to energy (WtE)process involves conversion of treated municipal solid waste (MSW) into energy by using well proven technologies like waste treatment, incineration and flue gas cleaning system (Bag filter, ESP, Wet/dry/semi dry scrubber and activated carbon filter). Waste-to energy plants are required to meet emission standards according to international norms (Euro norms and others). In addition, both the waste processing and power generation plants will be fully covered and will follow zero liquid discharge.

WtE is proposed as the waste disposal option for Nairobi city in view of its advantages such as 80% reduction by mass , 90% reduction by volume, and requirement of ten times lesser land area as compared to sanitary landfill.

WtE will include a robust treatment scheme (pre processing) of incoming waste before burning. This area will be covered with roof and adequate transparent sheets will be provided in the roof for sunlight. The pre-processing section will comprise a grab crane and grab bucket for mixing and homogenization of the waste. It will have a pit which can hold 7-10 days of waste required for the power plant. Facilities such as leachate treatment will be incorporated into the design of the plant.

The power plant section of the WtE plant will include an incinerator , turbo generator, flue gas cleaning system and chimney Products coming out from the preprocessing area would be fed into the incinerator. MSW will be incinerated at temperatures above 1000°C for complete combustion. There are two types of technology available : Moving grate and circulating fluidised bed combustion (CFBC). Both technologies are well proven and developed and used worldwide today.

Post combustion, flue gas passes through the flue gas cleaning system (FGCS) for the removal of following pollutants from flue gas:

- NOx removal - Selective Non-Catalytic Reduction (SNCR) and Selective Catalytic Reduction (SCR) technology will be deployed for NOx removal
- Gaseous contaminants - Dry, wet, semi dry and combination of dry and wet system will be used for removal of gaseous contaminants
- Toxic substances such as dioxin and mercury - Activated carbon filter technology will be used
- Particle removal - Cyclone separator, venturi scrubber, bag filter and ESP

The ash generated in the incinerator would be in two forms-bed **ash and fly ash.** Bed ash can be used for road construction and filling of low lying areas. There will be a dedicated scientific landfill for disposal of inert and fly ash where no organic fraction will be sent. A few sites in the above mentioned has adequate area required for both WtE and this inert landfill, based on a 25-year operating period.

Chimney height for the proposed plant power will be approximately 60-80 m. The flue gas is expected to be clear as it exits the chimneys.

KCAA

KENYA CIVIL AVIATION AUTHORITY

efficiently managing air safety

KCAA/OPS/2406/2 Vol. 7 (103)

7 April 2021

The Principal Secretary
Ministry of State for Defence
P.O Box 40668-00100
NAIROBI

Dear Sir,

KENGEN PLC WASTE TO ENERGY POTENTIAL SITE AT DANDORA DUMPSITE.

Kenya Civil Aviation Authority has received an application from Kenya Electricity Generation Company Limited PLC for approval of heights for construction of a waste to energy power plant with chimneys in areas that lie within your airspace. The contact person is **Eng. Flora Kamanja** of P. O. Box 47936-00100 Nairobi and telephone number **0722618285**.

The proposed locations of the site is as tabulated below.

No	Site Name	WGS-84 Coordinates	Height Requested (m)
1.	**Dandora**	**1°14'53.51"S 36°53'58.57"E**	**80**

The purpose of this letter is to kindly request for your comments on the listed site before we issue any approval.

Yours faithfully,

Teresa Njoki
For: DIRECTOR GENERAL

Cc **Managing Director**
KenGen PLC
P. O. Box 47936-00100
NAIROBI

KCAA KENYA CIVIL AVIATION AUTHORITY

efficiently managing air safety

KCAA/OPS/2406/2 VOL. 8 (7)

25 June 2021

06 JUL 2021

KENYA ELECTRICITY GENERATING CO. LTD. RECEIVED 07 JUL 2021 BUSINESS DEVELOPMENT DIRECTOR

Rebecca Miano (Mrs), MBS
Managing Director & CEO
Kenya Electricity Generating Co. Ltd
P.O. BOX 47936-00100
NAIROBI

Dear MD,

RE: HEIGHT APPROVAL FOR THE PROPOSED DEVELOPMENT OF A CHIMNEY AT THE DANDORA SITE.

Your application for approval of development on the above site refers.

Kenya Civil Aviation Authority has analyzed the proposed site for the construction of the structure in order to ensure safety of aircraft operations within the Kenyan Airspace.

A survey of the site was further conducted by a joint team of inspectors from the Ministry of Defence, Kenya Civil Aviation Authority and Nairobi Metropolitan Services.

Height approval is hereby **NOT** granted following the Ministry of Defense recommendation as indicated below:

SITE NAME	COORDINATES IN WGS-84	REQUESTED HEIGHT (M)	APPROVED HEIGHT (M)	REMARKS
DANDORA	1°14'37.72"S 36°53'58.57"E	80	0	The site falls directly within the flight path & the waste incinerator is an incompatible land use

This approval overrides any other communication that may have been conveyed by the Authority.

Yours Sincerely,

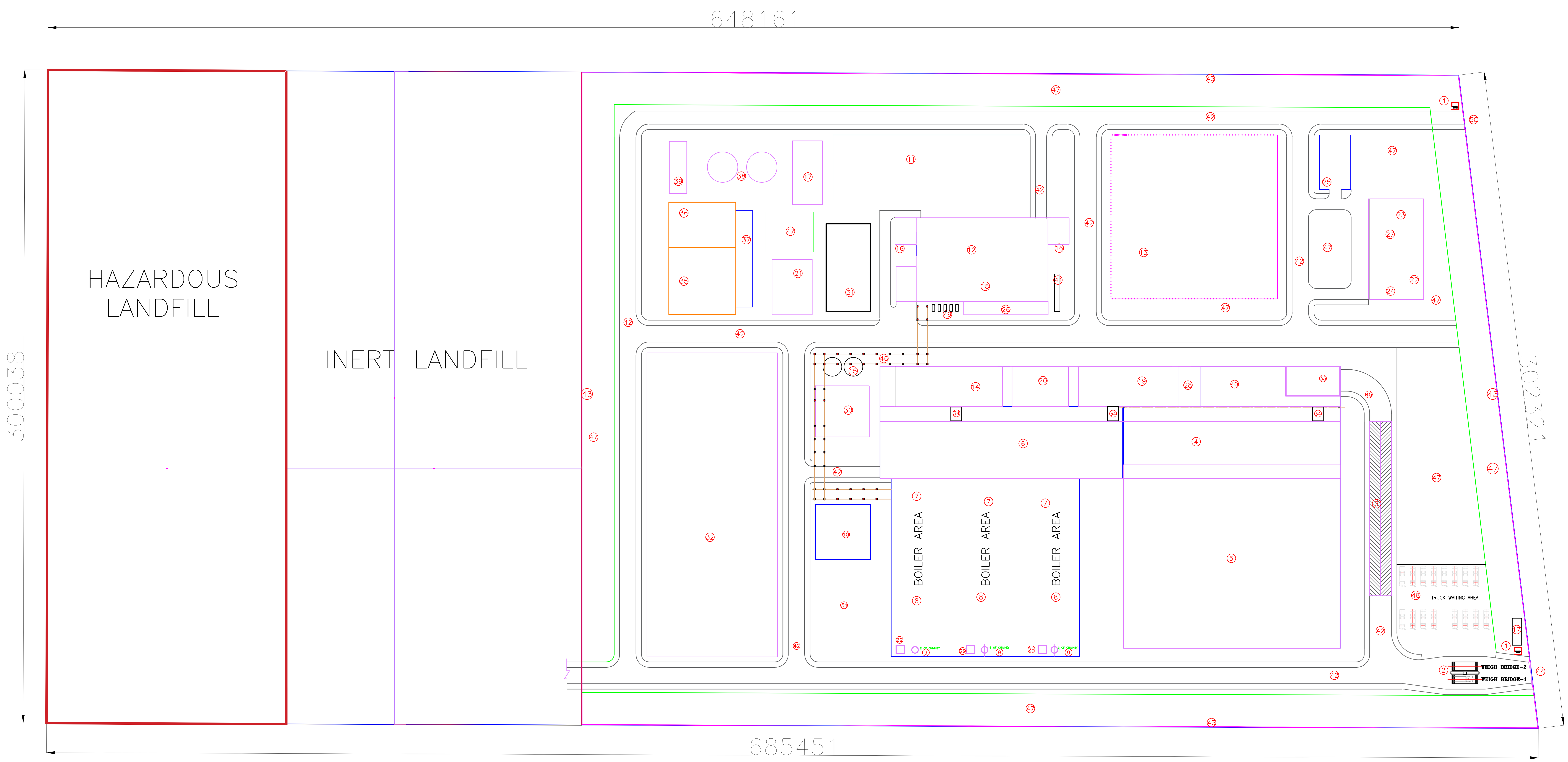
Capt. Gilbert M. Kibe
DIRECTOR GENERAL

Aviation House, JKIA
P.O. Box 30163-00100 GPO Nairobi
Tel: +254 020 6827470 - 5, +254 734 000 491/492, +254 728 606 586/70, +254 709 725 000
Fax: +254 020 6827 808, 6822 300

Website: www.kcaa.or.ke
Email: info@kcaa.or.ke

Annex 2

Proposed Project Area Layouts



1	GUARD HOUSE
2	WEIGHBRIDGE WITH OPERATOR ROOM
3	RAMP
4	MSW WASTE PIT
5	PRE-PROCESSING BUILDING
6	PROCESSED FUEL PIT
7	BOILER AREA
8	FGCS
9	STACK
10	BOTTOM ASH SYSTEM
11	WCC
12	TURBINE BUILDING
13	SWITCHYARD
14	RO PLANT
15	DM WATER TANK
16	GENERATOR TRANSFORMER
17	DRIVER REST ROOM AND WASH ROOM
18	DEAERATOR (2Nos.TG ROOF)
19	WORKSHOP
20	CHEMICAL STORAGE
21	AIR COMPRESSOR HOUSE
22	LAB (IN ADMIN BUILDING)
23	CANTEEN
24	FITNESS CENTER
25	CAR PARK AREA
26	AUX. TRANSFORMER
27	ADMINISTRATION OFFICE BUILDING
28	WORKER TOILET
29	CEMS ROOM
30	LDO STORAGE TANK
31	NEUTRALIZATION PIT
32	LEACHATE TREATMENT PLANT
33	LEACHATE COLLECTION PIT
34	LEACHATE COLLECTION SUMP
35	CLEAR WATER TANK
36	FIRE WATER TANK
37	PUMP HOUSE
38	SOFT WATER TANK
39	SOFTENER PLANT
40	WASTE WATER TREATMENT PLANT
41	DG SET
42	ROADS
43	BOUNDARY WALL
44	MATERIAL GATE ENTRY
45	BRIDGE BETWEEN TIPPING BAY AND RAMP
46	PIPE RACK
47	GREEN AREA
48	TRUCK PARKING
49	BOILER FEED FUMP
50	MAIN ENTRY
51	FLY ASH SILO

FOR BUDGETARY PURPOSE ONLY

Annex 3

Geological Survey Report

CONSULTING SERVICES FOR THE ESTABLISHMENT OF WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY

GEOTECHNICAL INVESTIGATIONS

GEOLOGICAL REPORT

CLIENT	KenGen
CONSULTING ENGINEER	SEURECA VEOLIA
SUBCONTRACTOR	NICI Universal Enterprises

REF: NICI-GR/023/2021-003

SEPTEMBER 2021

EXECUTIVE SUMMARY

The present report describes the results of a field geological mapping at the proposed Ruai STP river bank site for proposed waste-to-energy (WtE) plant by the Nairobi Metropolitan Services (NMS) and Kenya Electricity Generating Company (KENGEN).

The project area is located approximately 11km NE of Ruai town. The study area is generally flat and gently sloping to the northwest towards Nairobi River where altitude within the project site is between 1488m and 1484m above sea level to the east and west respectively.

The surface of the site is composed of loose loamy clay black cotton soils which is underlain by another layer of stiff clays and murram to a depth of about 1.5m.

The study area is covered by approximately 270 to 300 meters of Tertiary volcanic rocks (tuffs and lavas), which form a thick blanket over massive gneisses of the Precambrian Basement System. Stratigraphically, of the formations underlying the site, the dominant formations are Upper Athi Series (UAS) and associated sediments, and tuff layers (indicative depth: 0 – 50 m bgl), Simbara Series (50 – 130 m bgl), Kapiti Phonolites (130 – 210 m bgl), and basal volcanic sediments underlying the Kapiti (210 - 270? m bgl).

Table of Contents

LIST OF FIGURES

LIST OF TABLES

1 CHAPTER ONE: INTRODUCTION

In June 2021, the Geo-consultant was commissioned by NICI universal to carry out a geological mapping exercise of the proposed site for waste-to-energy conversion plant in Ruai, Nairobi, Kenya. The site is referenced as the Ruai STP River Bank site.
This report describes the field methodology and descriptions of the findings for the study, which was principally aimed at establishing the surface geology cover of the proposed site.

1.1 Site Location

The project area is located approximately 11km to the NE of Ruai town as shown in figure 1.1. Approximate coordinates of the site are 37M UTM 284347mE; 9866087mN (WGS 84).

Figure 1.1: General location of the site

1.1 Physiography

1.1.1 Regional physiography

On a regional scale, the study area is situated towards the eastern boundary of an extensive volcanic sheet, which stretches from the eastern shoulder of the Rift Valley to the Muranga-Thika-Athi River area. The volcanic cover comprises several distinct lava flows and eruptive phases. Each unit forms a characteristic small scarp at its eastern extent, as progressively older layers become exposed. Most of the formations gently dip from west to east, according to their flow direction.

The elevated hinterland of the volcanic region is drained and eroded by a series of easterly-flowing rivers, which have developed gorge-like valleys with numerous waterfalls, cascades and rapids.

Further east of the study area, much older "Basement System" rocks emerge from underneath the volcanics, and start dominating the terrain over a several hundred-kilometer-wide zone towards the Kenyan Coast. The Basement landscape is characterized by massive rock outcrops and extensive erosion plains.

1.1.2 Local Physiography

The plot (1484-1489 m amsl) is located on a gently north-western sloping topography into the Nairobi River. Within the fenced compound, the surface gently slopes towards the northwest.

North of the site, the valley of the Nairobi River only cuts about 4 m into the relatively soft formations that form the top of the volcanic sequence. The stream is part of the dense, southeasterly oriented drainage system that drains the relatively humid hinterland of Muranga and Kiambu.

Further towards the West, the landforms change to a hillier country, with steep valleys separating the northwest-southeast trending volcanic ridges. East of Thika, the landscape is dominated by the underlying rocks of the Basement System. The isolated hills ("inselbergs") and ridges are surrounded by piedmont plains and vast erosional bevels. About 20km NE of the investigated site, the massive Ol Doinyo Sabuk (a.k.a.

Kilimambogo) forms the highest hill of the area. This isolated, triangular rock mass reaches an elevation of almost 2000 m amsl, and rises over 600 m above the surrounding plain.
On the volcanic plateau, the original vegetation of dry woodland and bush (commonly interrupted by poorly drained swampy grounds) has largely given way to intensive, agricultural use. Sisal used to be the most abundant crop, but most of it was removed during the 1980's, following a slump in raw prices on the world market. Nowadays, vast unutilized land is being converted to residential and industrial use. At this specific site, waste water management by the Nairobi water and sewerage company is the main form of land use.

1.2 Climate

The study area is marked by a fairly warm, semi-humid to semi-arid climate (Zone IV-3 in: Sombroek et al, 1982). The mean annual temperature is approximately 20^{o}C, while the average maximum and minimum are 24 - 26^{o}C and 12.5 - 14.5^{o}C, respectively.
The rainfall pattern is only moderately favorable, and the volume gradually decreases with the falling elevation from west to east. As in most parts of Central Kenya, the distribution is bimodal, with two distinct dry periods, and two intermittent rainy seasons. The rainy seasons are from March to May, and from October to December. These six months account for approximately 82% of the annual rainfall.
While the rainfall pattern immediately South of this area is comparable to that at larger Nairobi-Thika area, the volume is expected to be approximately 5 to 10% lower. The average at Ndarugu Farm (rain gauge 91.37.026), is 790 mm. The annual potential evaporation is expected to approach 1,880 mm, and the rainfall/evaporation ratio (Rf/Eo) is thus about 50%.

2 STUDY METHODOLOGY

The site investigations were carried out according to a multi-step approach:

a) A desk study phase: Review of existing data, topographical maps, existing studies and borehole site investigations in the area, geological reports and maps, borehole records, etc.
b) Geological fieldwork: Inspection of geological, geomorphological and structural characteristics of the investigated area by foot traverses, verification of existing

data and findings, combined with borehole logs and trial pitting due to lack of rock outcrop at the site.

c) Compilation and evaluation of the gathered data and information to produce a geological map.
d) Reporting.

The Consultant's team, comprising a Geologist and a field assistant, carried out the fieldwork between 25th to 28th July 2021.

3 GEOLOGY

The geology of the area has been described in Report No. 59 of the Geological Survey of Kenya: “Geology of the North Machakos – Thika Area” (Fairburn, 1963). This report gives an adequate overview of the formations encountered in the surroundings of the study site. Further geological information is found in Gevaerts’ “Hydrogeology of the Nairobi Area” (1970).

The geological succession of this region can be broadly divided into:

a) Recent deposits (not common)
b) Tertiary volcanics
c) Precambrian Basement rocks

Each main unit consists of numerous separate formations. In Figure 2.1, the geology of the study area is shown, while the most relevant formations and their presumed equivalents between Thika and Nairobi are shown in Table 2.1. The geological history and the relevant rock types are briefly discussed in the following Sections.

Table 3-1 Tertiary and Pleistocene Rocks between Nairobi and Nyeri (After: Fairburn, 1963). Abbreviations refer to codes used in Geological Map (see Fig. 2.1)

	Nairobi Area	**Thika Area**
Pleistocene	Limuru Quartz Trachyte	Pleistocene sediments (Pl)
Tertiary	Kerichwa Valley Tuff and Nairobi Claystone Nairobi Trachyte Nairobi Phonolite Athi Tuffs and Lake Beds Tertiary Sediments Kapiti Phonolite	Trachytic tuffs with thin basalts (Tvf) Welded tuffs (Tvtf) Athi Tuffs and Lake Beds (Tvf) Tertiary Sediments (T) Simbara Series (Tvb1) Kapiti Phonolite (Tvp1)
Precambrian	Basement System	Basement System (*X*)

3.1.1 Geological History of the Study Area

The geological history of the area can be followed from the Precambrian era (400 - 4,600 million years ago), that is represented by metamorphic rocks of the "Mozambican Basement". Granitoid gneisses and meta-dolerites of the Basement System outcrop about 20 km east of the study site. These (Basement) rocks are, directly, overlain by much younger lava flows and ashes. The period between the Precambrian and Tertiary Periods represents an enormous geological gap, mainly marked by erosion processes. Gradually the surface was lowered, and vast peneplains were formed, with intersecting inselbergs. The different levels of these plains are recognised as remnants of successive cycles of erosion.

Precambrian

During Precambrian times, vast successions of sediments accumulated in a geosynclinal structure covering most of the present eastern Africa. Towards the end of the era, a period of regional folding and metamorphism occurred. This large-scale tectonic activity subjected the original sedimentary rocks to high temperatures and pressures, causing (partial) melting and subsequent re-crystallization and growth of new minerals. Depending on the parent material and the prevailing pressures and temperatures, various types of gneisses and schists were formed.

The metamorphosed rocks were intensely folded, tilted, and dissected by intrusive granitic dykes and domes. An example of the latter is the huge, isolated rock mass of Ol Donyo Sabuk, which is a meta-dolerite intrusive into the surrounding gneisses. In addition, granitization processes resulted in the formation of granulites and migmatites.

3.1.2 **Tertiary**

The Precambrian era was followed by a period of more than 300 million years during which the surface was lowered by erosional processes. Successive stages of uplift and erosion lasted until the Early Tertiary, and gradually removed the upper layers of the Basement, and other younger layers which might have covered them. The resulting erosion surface is known as the Sub-Miocene or Early Tertiary peneplain, and forms the base of the Tertiary and Quaternary volcanic sequence. Remnants of it are found throughout Central Africa.

In subsequent Miocene, Pliocene and Pleistocene times (66 to 2 million years ago), a great series of lava flows flooded out from the edge of the Rift Valley. The volcanic sheets, comprising plateau basalts, trachytes and phonolites, generally become thinner towards the east (i.e. with increasing distance from the Rift).

The main volcanic activity occurred during the Miocene, when most of the Nairobi Volcanics were erupted. The first massive lava flow is known as the “Kapiti Phonolites” (Tvp1). This formation forms a blanket on the old Basement rocks, and buries hills, plains and valleys in the ancient topography. The first phonolite sheet covers a vast area, which reaches its eastern margin at the base of the Ithanga and Kakuzi Hills. From here, the phonolites continue as a narrow flow for almost 300 km further south-eastwards, forming the geologically unique Yatta Plateau.

After the Kapitian lava flow, the Simbara Series (ascribed by Gevaerts to the Middle Athi Series) were extruded. It is likely that this period was also marked by cyclic climatic changes, which accelerated erosion. This led to the deposition of lacustrine and fluviatile deposits within the mainly basaltic lava flows.

The extent of the Simbara basalts and agglomerates is much smaller than the Upper Athi Series, which followed. This deposit is found throughout the Thika area west of Ol Doinyo Sabuk. It comprises tuffs (i.e. hardened volcanic ash) and lakebeds, deposited during a moist, erosive cycle. While the formation is encountered near-surface at Thika, it commonly occurs at depths of 150 to 250 m bgl below Nairobi.

Between the valleys of the Thiririkwa and Nairobi Rivers, a thin layer of Tertiary Sediments covers the Athi Tuffs. These were deposited in the so-called Juja-Lake, and they mainly consist of soft clays and sandstones.

Towards the south, the Athi Tuffs and Lake beds were covered by a thick series of lava flows during the Mid-Tertiary period. The most important formations of this age are the Nairobi Phonolites and Nairobi Trachytes, which may reach a combined thickness of 170 m. These flows, however, have no equivalent in the Thika area (see Table 2a).

Another prolonged period of erosion followed, during which the Simbaran Series receded westwards. Renewed volcanic activity deposited the Welded Tuffs and Trachytic Tuffs. The latter form a thin blanket throughout the Thika area, and filled depressions in the pre-existing topography. They can probably be correlated with the Kerichwa Valley Tuffs of Nairobi.

3.1.3 **Quaternary**

In the Thika area the primary geological activity during this period was erosion. This resulted in steep intersection of the soft volcanic plateau, the formation of soils, laterites and localized sedimentation along the drainage channels.

3.2 **Lithological Units of the Study Area**

The geology at the study site consists of volcanic formations, underlain at depth by metamorphic Basement rocks. The geological units are briefly discussed below (oldest and deepest rocks first). Figures 3.4 and 3.5 are the local and regional geological maps of the study site respectively.

- **Basement System Rocks**

The term “Basement System” refers to ancient rocks formed during Precambrian times. They are part of the “Mozambique Belt”, which essentially is the foundation of the African continent. Basement rocks underlying the volcanic sheet of the study area are probably similar to those exposed further eastwards. They comprise metamorphic rocks of sedimentary origin, and intrusive bodies of basic igneous rocks. East of the study area, the most common Basement rocks are:

- Biotite Gneisses (e.g. Kakuzi Hills)
- Granitoid Gneisses (exposed at Kongoni Hill, Matuu Hill, and Komarock; probably underlying the volcanic sheet around Thika Town)
- Pelitic Schists and Gneisses
- Hornblende-biotite Gneisses
- Meta-dolerites (Ol Doinyo Sabuk)

Tertiary Volcanics

- **Kapiti Phonolites (KP)**

The oldest volcanic formation in the region, and directly overlies the Sub-Miocene Basement topography. The phonolite is a hard, black, fine-grained rock, with conspicuous nepheline phenocrysts, and long slender inlets of feldspar. The formation consists of several lava flows, separated by strata that area usually clayey (Gevaerts, 1970), although occasionally sandy layers may be encountered.

On the isolated Yatta Plateau the Kapiti Phonolite is as much as 150 m thick. Along the eastern margin of the continuous sheet, and within the present study area, this should be considerably less (about 80 metres). However, its thickness is known to be highly variable. Borehole evidence shows that under the plains around the Nairobi-Thika area the formation is sometimes absent or reaches up to > 100 m. This is caused by the irregular topography of the old Basement surface over which the lava flowed.

- **Upper Athi Series (UAS): Tuffs and Lake Beds**

Unlike the thick Athi Series of the Nairobi area (Southwest) (up to 200 m), the formation is rather thin and insignificant around Thika. Nevertheless, it is widespread, and occurs almost everywhere west of Ol Doinyo Sabuk.

In the valley slopes of the rivers in the area and further east, Athi Series material has been exposed along the scarp. The lowest level in the Athi Series consists of the Lower Thika Building Stone. This massively bedded fine-grained layer of tuffs and claystones is pale bluish in colour and resembles a sedimentary deposit (Mudstones or fine-grained limestones). It is only about 10 m thick, and has been mined along the main river courses.

In the area under investigation, the lowest pyroclastic horizon directly overlies the Lower Thika Building stone. The pale, coarse agglomerate is about 15 m thick. The soft rock is unbedded and consists mainly of coarse pumice and glass in a finer groundmass. Obsidian and lava fragments are rare.

- **Tertiary Sediments**

The thickness of the sediments exposed in the Komo River valley to the NE is about 10 metres. The Lakebeds mainly consist of coarse feldspathic grits with small fragments of obsidian. The layer wedges out towards the North and is not encountered in the valleys and boreholes within /around the study site.

- **Welded Tuffs and Upper Trachytic Tuffs with (local) Olivne Basalts**

A thin layer of welded tuff covers the UAS south of Thika River. Its thickness in the vicinity of the site does not exceed 5 metres. At some locations around the area, this rock forms a blanket over the soft rock for machine cutting. It is being exploited for ballast and hand cut dimension stone.

The youngest pyroclastic bed in the region is a grey pumiceous tuff mapped as trachytic tuff. It forms the surface of the plains around Thika over an area of 650 km^2, but similar to the lower pyroclastic layer, it does not reach a great thickness in the region. The pumiceous tuff does not appear south of Nairobi River. Near the study site, it is encountered directly below the black cotton soil cover.

- **Quaternary Deposits**

Quaternary Deposits including soils, alluvium and colluvium are not very significant in the investigated area. Soils near the study site reflect both geology and drainage. Two or three principal soil types were identified on and around the Farm:

- **Black Cotton Soils**

Black cotton soils occur in areas of poor drainage (generally in valleys and swampy patches),

and their evolution is more linked to seasonal waterlogging than to geology. They occur within the river valleys, but also on top of the flat plateaus, where drainage is juvenile. These are the main surface cover within this site as can be seen in photos in figure 2.2 of the trial pits excavated within the site to a depth of 1m or to rock, whichever comes first. The average depth of the black cotton soils within the site 0.5m.

- **Lateritic and Variable Red Loamy Soils**

The lateritic soils occur as discontinuous patches within the generally red, loamy soil of the slopes and higher part of the volcanic ridge. These soils generally form on semi-plain lands, where drainage is better than the bottomlands, and cover clayey weathered tuffs.

Figure 3.1Photographs taken from trial pits within the site showing black cotton soils cover

A lateritic, granular lay that is a mixture of the black clays was also observed to form the NE sector as can be seen in TPs 9 and 10 (Figure 2.3). This layer of granular lateritic soils is deeper than the black cotton soils, reaching a depth of between 0.8 to 1.2m.

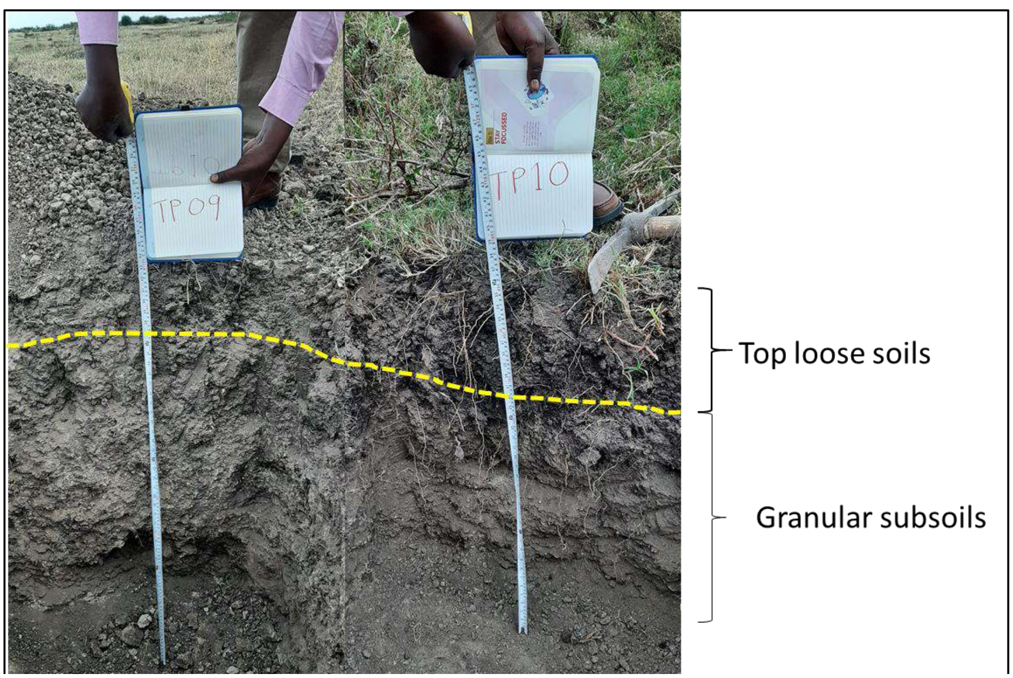


Figure 3.2 Photos of drill cores from the site. The depth to solid rock across the site is an average of 1.0m

Figure 3.3 Photographs of granular lateritic soils inside trial pits within the study site

Geological section of the site on the long axis

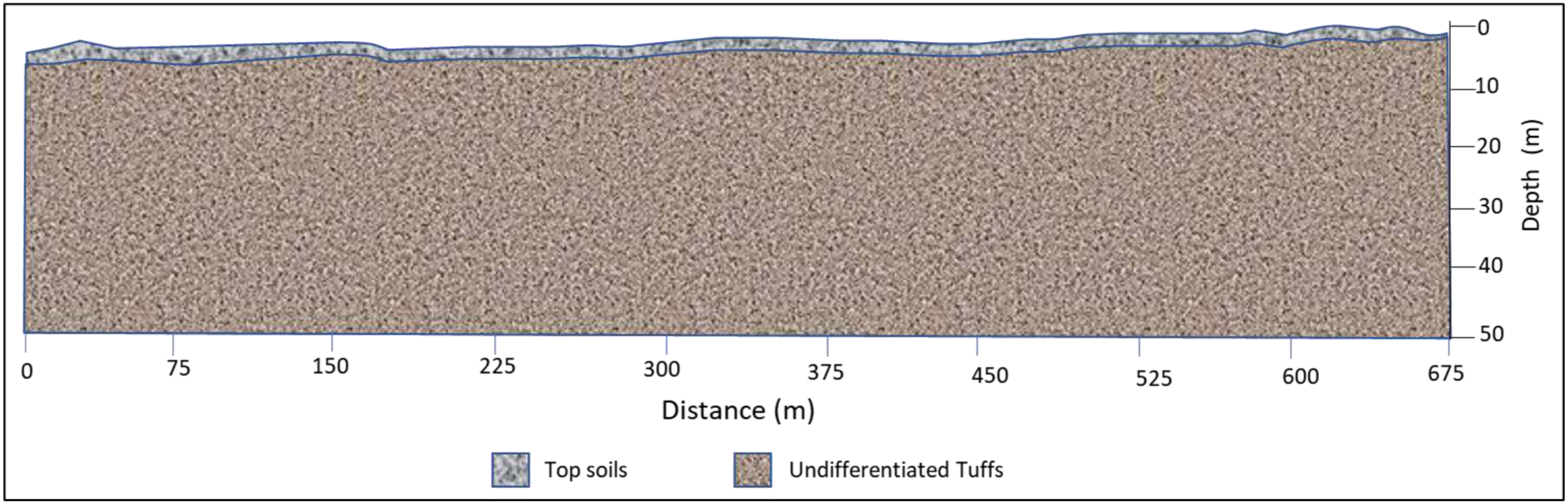


Figure 3.4 Geological section for the site along the long axis

Figure 3.5 Local Geological map of the study site

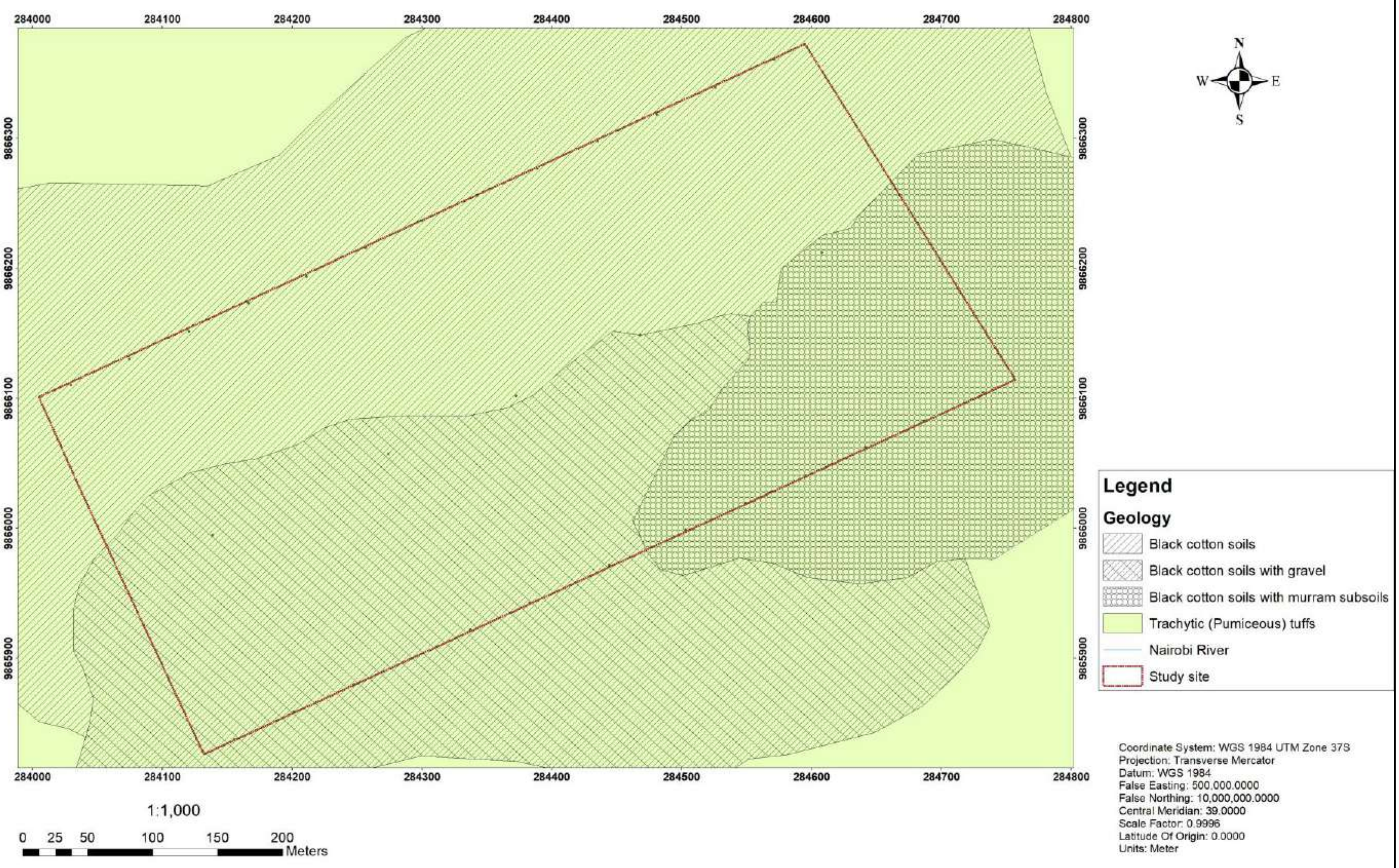
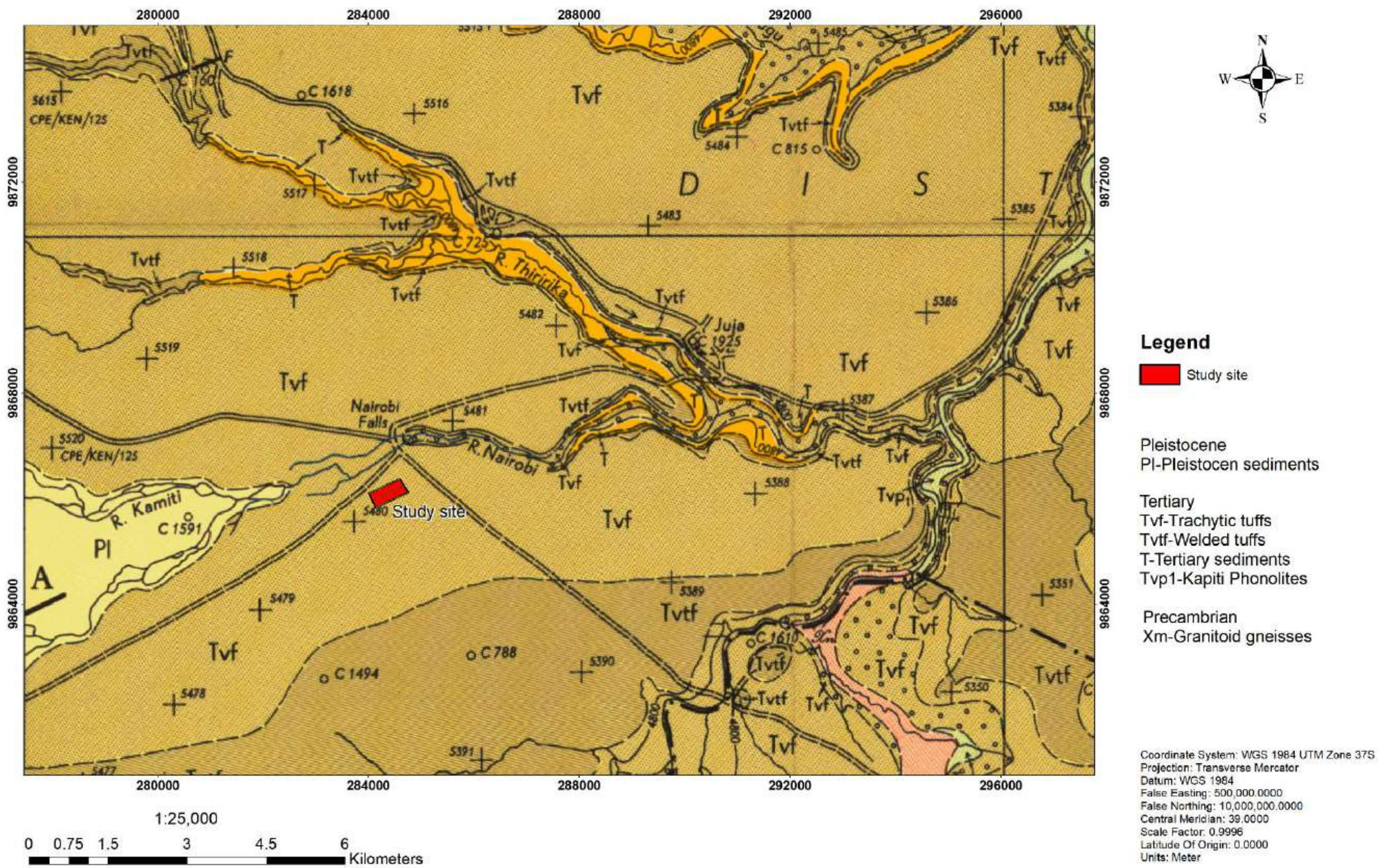


Figure 3.6 Regional (subsurface) geological map of the study area



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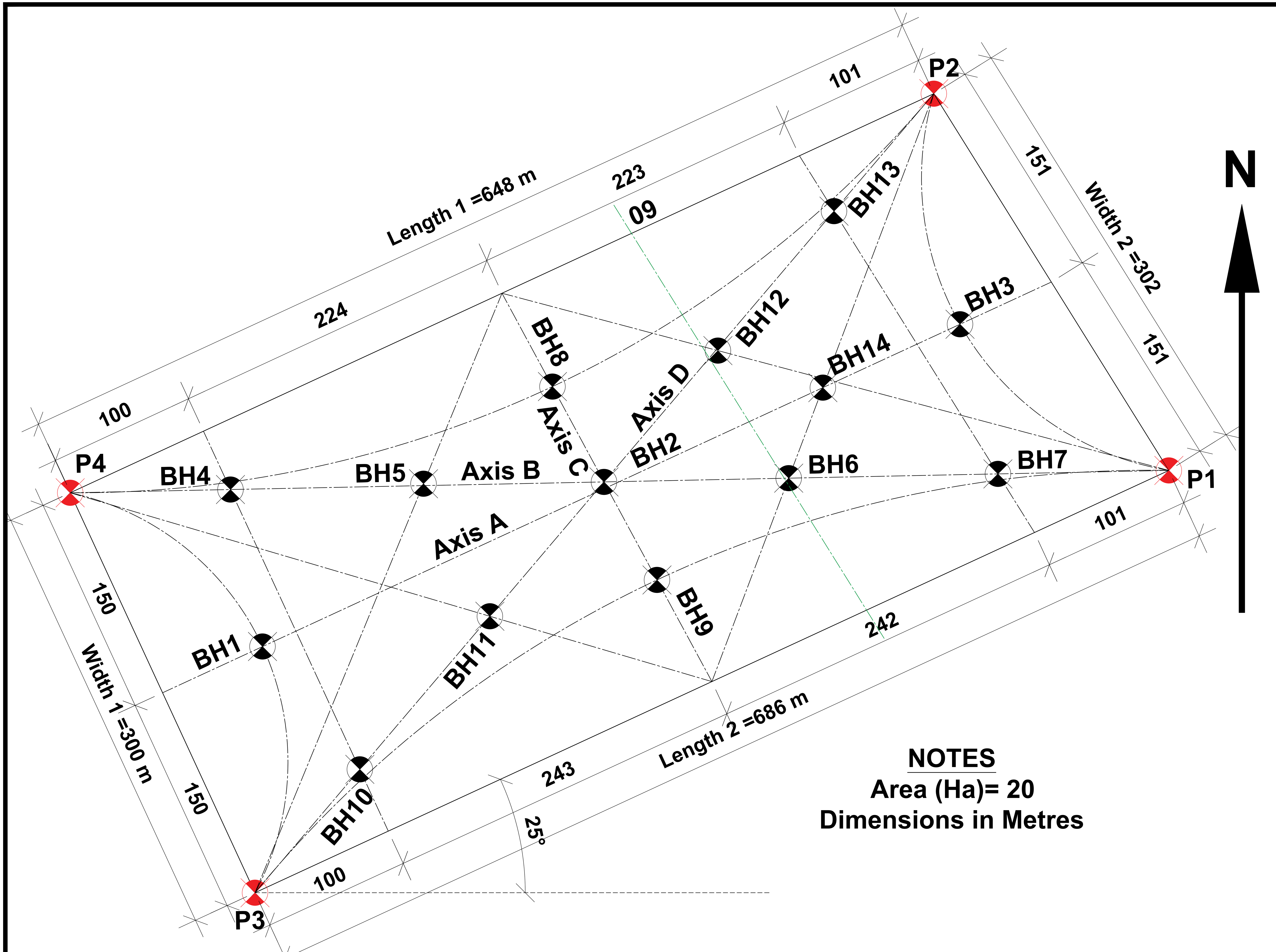


NOTES

Area (Ha)= 20

Dimensions in Metres

PROPOSED BOREHOLE POSITIONS FOR GEOTECHNICAL INVESTIGATIONS

Scale 1:1250

GEOTECHNICAL NOTES

1. All dimensions are in metres, unless otherwise stated.
2. This drawing can be scaled ,and or figured dimensions be used.
3. This drawing must be read in conjunction with relevant Engineering drawings.
4. Each Borehole must be as specified in Diameter, Depth and Position unless otherwise instructed by the Engineer/Expert
5. All investigations and Tests to be in accordance with Standard methodology issued

REV	REVISIONS		SIGN	DATE	APPROVED
I.3		BY			
		CHECKED			
I.2		BY			
		CHECKED			
I.1		BY			
		CHECKED			
I.0		BY	M.K.N	15.07.2021	
		CHECKED			

Client:

KenGen

Consulting Engineers:

SEURECA VEOLIA

SEURECA CONSULTING ENGINEERS
30 RUE MADELEINE VIONNET -93300
AUBERVILLIERS - FRANCE
TEL: +331 85 57 70 00
FAX: +331 45 72 92 93
E-MAIL: contact@seureca.com

Sub-Contractor:

NICI Universal Enterprises Company Limited;
P.O. Box 85868 00200, Nairobi KE

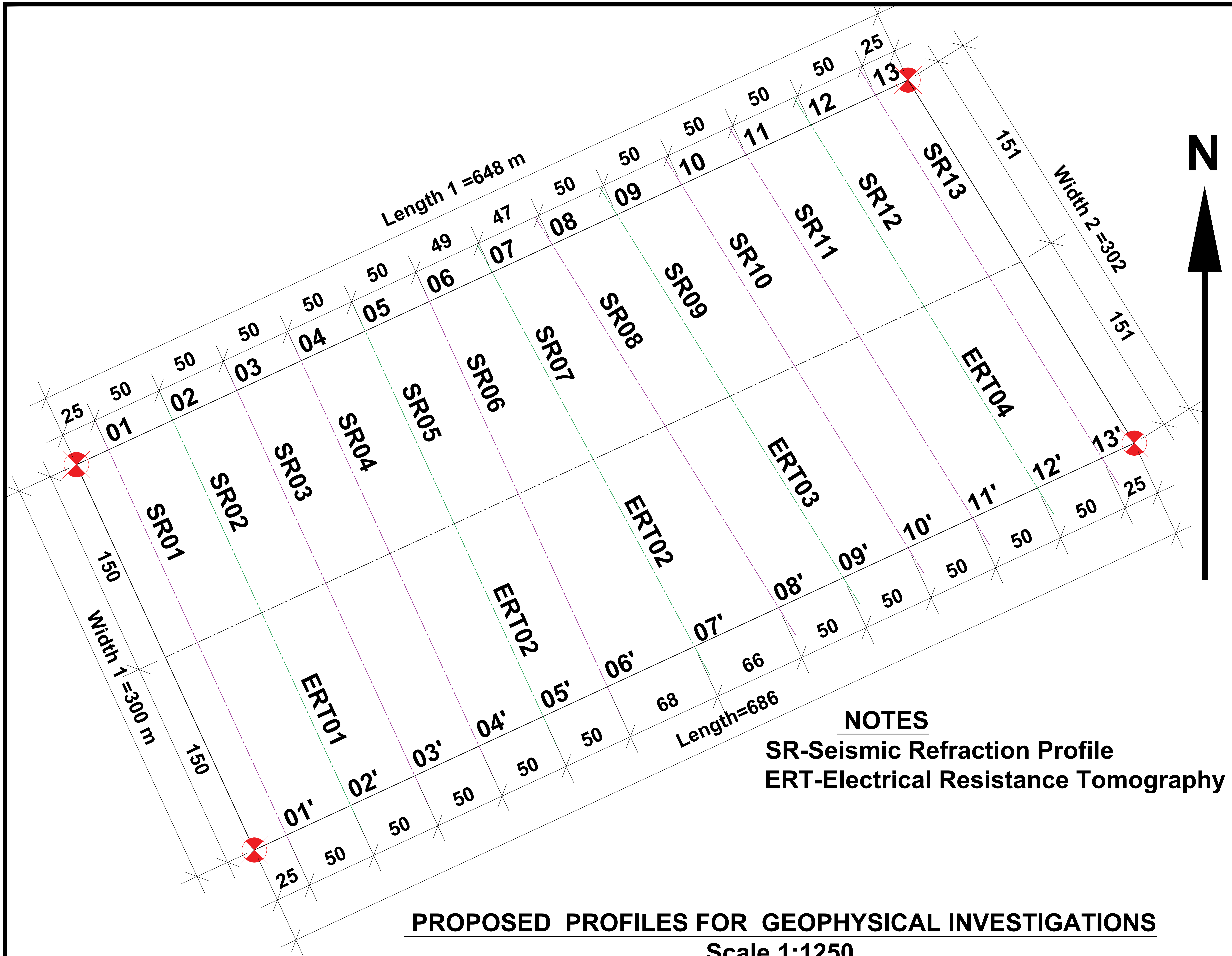
Project:

CONSULTING SERVICES FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY PROJECT

Drawing Title:

GEOTECHNICAL INVESTIGATIONS:
BOREHOLE POSITIONS

Expert:	M.K.N	Drawn by:	M.K.N
Checked by:	NICI	Approved by:	
Scale:	AS SHOWN	Date:	July 2021
Job No.	CEG/NICI/001	ACAD File:	SC-FS-001
P0 STATUS	DRG No. Ceg/NICI-001		R0 REV



NOTES

SR-Seismic Refraction Profile

ERT-Electrical Resistance Tomography

PROPOSED PROFILES FOR GEOPHYSICAL INVESTIGATIONS

Scale 1:1250

GEOTECHNICAL NOTES

1. All dimensions are in metres, unless otherwise stated.
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REV	REVISIONS		SIGN	DATE	APPROVED
I.3		BY			
		CHECKED			
I.2		BY			
		CHECKED			
I.1		BY			
		CHECKED			
I.0		BY	M.K.N	15.07.2021	
		CHECKED			

Client:

KenGen

Consulting Engineers:

SEURECA VEOLIA

SEURECA CONSULTING ENGINEERS
30 RUE MADELEINE VIONNET - 93300
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TEL: +331 85 57 70 00
FAX: +331 45 72 92 93
E-MAIL: contact@seureca.com

Sub-Contractor:

NICI Universal Enterprises Company Limited;
P.O. Box 85868 00200, Nairobi KE

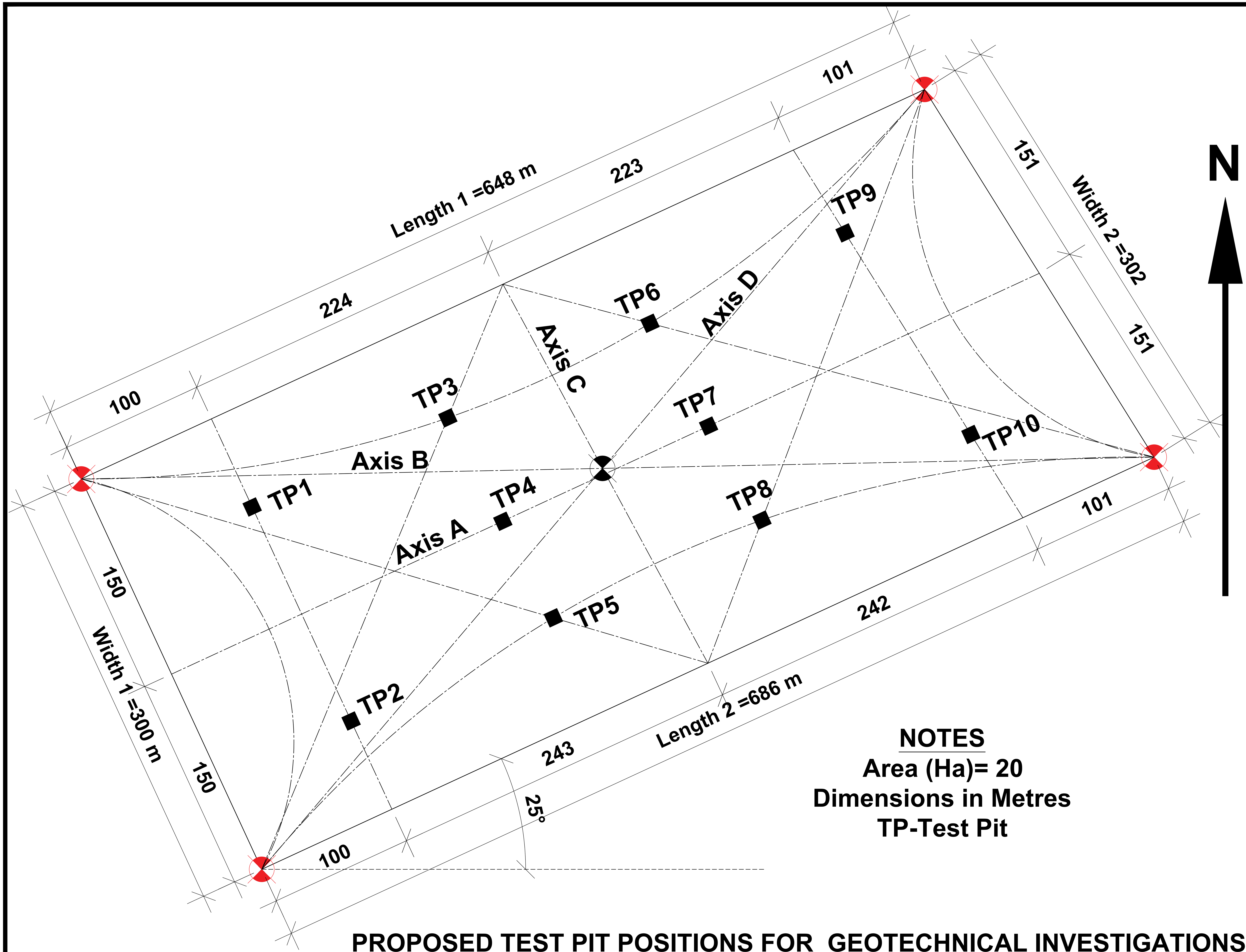
Project:

CONSULTING SERVICES FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY PROJECT

Drawing Title:

GEOTECHNICAL INVESTIGATIONS:
GEOPHYSICAL POSITIONS

Expert:	M.K.N	Drawn by:	M.K.N
Checked by:	NICI	Approved by:	
Scale:	AS SHOWN	Date:	July 2021
Job No.	CEG/NICI/001	ACAD File:	SC-FS-002
P0 STATUS	DRG No. Ceg/NICI-002		R0 REV



NOTES

Area (Ha)= 20
Dimensions in Metres
TP-Test Pit

PROPOSED TEST PIT POSITIONS FOR GEOTECHNICAL INVESTIGATIONS

Scale 1:1250

GEOTECHNICAL NOTES

1. All dimensions are in metres, unless otherwise stated.
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REV	REVISIONS		SIGN	DATE	APPROVED
I.3		BY			
		CHECKED			
I.2		BY			
		CHECKED			
I.1		BY			
		CHECKED			
I.0		BY	M.K.N	15.07.2021	
		CHECKED			

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Sub-Contractor:

NICI Universal Enterprises Company Limited;
P.O. Box 85868 00200, Nairobi KE

Project:

CONSULTING SERVICES FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY PROJECT

Drawing Title:

GEOTECHNICAL INVESTIGATIONS:
TEST PIT POSITIONS

Expert:	M.K.N	Drawn by:	M.K.N
Checked by:	NICI	Approved by:	
Scale:	AS SHOWN	Date:	July 2021
Job No.	CEG/NICI/001	ACAD File:	SC-FS-003
P0 STATUS	DRG No. Ceg/NICI-003		R0 REV

SCHEDULE OF BOREHOLES (14 No., 500 m)

BH No.	Depth (m)	Easting(m)	Northing (m)
BH01	50	284137.621	9865995.271
BH02	50	284370.263	9866107.448
BH03	50	284612.686	9866214.805
BH04	20	284115.609	9866101.952
BH05	20	284247.360	9866106.201
BH06	50	284495.893	9866110.007
BH07	20	284638.506	9866112.911
BH08	50	284335.164	9866172.375
BH09	50	284406.343	9866040.709
BH10	20	284203.814	9865912.033
BH11	20	284292.562	9866015.971
BH12	50	284446.521	9866197.211
BH13	20	284526.886	9866291.809
BH14	30	284519.301	9866171.651

SCHEDULE OF GEOPHYSICAL TESTS

Position	Easting(m)	Northing (m)	Position	Easting(m)	Northing (m)
01	284029.467	9866110.534	01'	284155.314	9865838.205
02	284074.509	9866131.509	02'	284200.702	9865859.180
03	284120.243	9866152.483	03'	284246.090	9865880.154
04	284165.631	9866173.457	04'	284291.478	9865901.129
05	284211.019	9866194.432	05'	284336.866	9865922.103
06	284256.407	9866215.406	06'	284382.254	9865943.073
07	284300.948	9866235.667	07'	284443.831	9865971.559
08	284343.248	9865333.433	08'	284503.301	9865999.015
09	284388.993	9866276.676	09'	284549.045	9866020.154
10	284434.738	9866297.815	10'	284594.790	9866041.294
11	284480.482	9866318.954	11'	284640.534	9866062.433
12	284526.227	9866340.093	12'	284686.212	9866083.541
13	284571.972	9866361.232	13'	284732.024	9866104.711

SCHEDULE OF TEST PITS (10 No.)

BH No.	Easting(m)	Northing (m)
TP01	284125.960	9866080.505
TP02	284194.948	9865931.218
TP03	284262.395	9866142.691
TP04	284300.741	9866070.526
BH05	284335.992	9866003.202
TP06	284403.336	9866208.685
TP07	284444.654	9866136.072
TP08	284481.453	9866071.372
TP09	284539.416	9866271.726
TP10	284627.155	9866131.103

LAND CORNER COORDINATES

BH No.	Easting(m)	Northing (m)
P1	284754.896	9866115.281
P2	284594.844	9866371.802
P3	284132.620	9865827.718
P4	284006.773	9866100.047

GEOTECHNICAL NOTES

1. All dimensions are in metres, unless otherwise stated.
2. This drawing can be scaled ,and or figured dimensions be used.
3. This drawing must be read in conjunction with relevant Engineering drawings.
4. Each Borehole must be as specified in Diameter, Depth and Position unless otherwise instructed by the Engineer/Expert
5. All investigations and Tests to be in accordance with Standard methodology issued

REV	REVISIONS		SIGN	DATE	APPROVED
I.3		BY			
		CHECKED			
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		CHECKED			
I.1		BY			
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CONSULTING SERVICES FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY PROJECT

Drawing Title:

GEOTECHNICAL INVESTIGATIONS:
GEOTECHNICAL POSITIONS

Expert: M.K.N	Drawn by: M.K.N
Checked by: NICI	Approved by:
Scale: AS SHOWN	Date: July 2021
Job No. CEG/NICI/001	ACAD File: SC-FS-004
P0 STATUS	DRG No. Ceg/NICI-004 — R0 REV

CONSULTING SERVICES FOR THE ESTABLISHMENT OF WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY

GEOTECHNICAL INVESTIGATIONS

GEOPHYSICAL REPORT

CLIENT	KenGen
CONSULTING ENGINEER	SEURECA VEOLIA
SUBCONTRACTOR	NICI Universal Enterprises

REF: NICI-GR/023/2021-002

SEPTEMBER 2021

EXECUTIVE SUMMARY

The present report describes the results of a field geophysical survey involving Electrical Resistivity Tomography and Seismic refraction at the proposed Ruai STP River Bank site for the waste-to-energy (WtE) plant proposed by Nairobi Metropolitan Services (NMS) in partnership with Kenya Electricity Generating Company PLC (KenGen) to establish a waste-to-energy (WtE) plant to manage the municipal solid waste (MSW) generated in Nairobi and adjoining counties in the Nairobi Metropolitan Region (NMR).

The project area is located approximately 11km NE of Ruai Town. The study area is generally flat and gently sloping to the northwest towards Nairobi River where altitude within the project site is between 1488m and 1484m above sea level to the east and west respectively.

The surface of the site is composed of loose loamy clay black cotton soils which is underlain by another layer of still clays and murram to a depth of about 1.5m.

The study area is covered by approximately 270 to 300 meters of Tertiary volcanic rocks (tuffs and lavas), which form a thick blanket over massive gneisses of the Precambrian Basement System. Stratigraphically, of the formations underlying the site, the dominant formations are Upper Athi Series (UAS) and associated sediments, and tuff layers (indicative depth: 0 – 50 m bgl), Simbara Series (50 – 130 m bgl), Kapiti Phonolites (130 – 210 m bgl), and basal volcanic sediments underlying the Kapiti (210 - 270? m bgl).

Five ERT profiles measuring 400m each and in a NW-SE azimuth were executed at the site. Thirteen seismic profiles each measuring 345m were also done in the same azimuth.

The seismic and ERT models from the survey indicate that the site has a three-layered earth model. The first layer that extends to a depth of about 1.5m is made up of loose top soils. These are black cotton soils with a cracked surface cover across the entire site. The second layer is of dry marginally weathered tuff. This layer extends to a depth of 10-15m. A very thin layer rests on this layer composed of saprolitic material and stiff clay. Below this layer is the basal layer that forms the bedrock at this site. High levels of water saturation were interpreted from the ERT models depicted by low resistivity values (<100 ohm-m) and increased P-wave velocities from the seismic refraction models. This layer is observed to persist to the maximum depth probed by the ERT of 75m.

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CHAPTER ONE

1 INTRODUCTION

In July 2021, the Geo-consultants was commissioned by NICI universal to carry out a geophysical survey involving Electrical resistivity Tomography and Seismic refraction at the proposed Ruai STP River Bank site for the waste-to-energy plant proposed by Nairobi Metropolitan Services (NMS) in partnership with Kenya Electricity Generating Company PLC (KenGen) to establish a waste-to-energy (WtE) plant to manage the municipal solid waste (MSW) generated in Nairobi and adjoining counties in the Nairobi Metropolitan Region (NMR). .

This report describes the field methodology and descriptions of the findings for the study, which was principally aimed at establishing the nature of the sub-surface geology at the proposed site.

1.1 Site Location

The project area is located approximately 11km to the NE of Ruai town as shown in figure 1.1. Approximate coordinates of the site are 37M UTM 284347mE; 9866087mN (WGS 84).

Figure 1.1 Google earth satellite image showing the location of the study site

1.1 Physiography

1.1.1 Regional physiography

At a regional scale, the study area is situated towards the eastern boundary of an extensive volcanic sheet, which stretches from the eastern shoulder of the Rift Valley to the Muranga-Thika-Athi River area. The volcanic cover comprises several distinct lava flows and eruptive phases. Each unit forms a characteristic small scarp at its eastern extent, as progressively older layers become exposed. Most of the formations gently dip from west to east, according to their flow direction.

The elevated hinterland of the volcanic region is drained and eroded by a series of easterly-flowing rivers, which have developed gorge-like valleys with numerous waterfalls, cascades and rapids.

Further east of the study area, much older “Basement System” rocks emerge from underneath the volcanics, and start dominating the terrain over a several hundred km wide zone towards the Kenyan Coast. The Basement landscape is characterized by massive rock outcrops and extensive erosion plains.

1.1.2 Local Physiography

The plot (1484-1489 m amsl) is located on a gently southern sloping topography into the Nairobi River. Within the fenced compound, the surface gently slopes towards the northwest.

North of the site, the valley of the Nairobi River only cuts about 4 m into the relatively soft formations that form the top of the volcanic sequence. The stream is part of the dense, southeasterly oriented drainage system that drains the relatively humid hinterland of Muranga and Kiambu.

Further towards the West, the landforms change to a hillier country, with steep valleys separating the northwest-southeast trending volcanic ridges. East of Thika, the landscape is dominated by the underlying rocks of the Basement System. The isolated hills (“inselbergs”) and ridges are surrounded by piedmont plains and vast erosional bevels. About 20 km NE of the investigated site, the massive Ol Doinyo Sabuk (a.k.a. Kilimambogo) forms the highest hill of the area. This isolated, triangular rock mass reaches an elevation of almost 2000 m amsl, and rises over 600 m above the surrounding plain.

On the volcanic plateau, the original vegetation of dry woodland and bush (commonly interrupted by poorly drained swampy grounds) has largely given way to intensive, agricultural use. Sisal used to be the most abundant crop, but most of it was removed during the 1980’s, following a slump in raw prices on the world market. Nowadays, vast unutilized land is being converted to residential and industrial use. At this specific site, waste water management by the Nairobi water and sewerage company is the main form of land use.

1.2 Climate

The study area is marked by a fairly warm, semi-humid to semi-arid climate (Zone IV-3 in: Sombroek et al, 1982). The mean annual temperature is approximately 20°C, while the average maximum and minimum are 24 - 26°C and 12.5 - 14.5°C, respectively.

The rainfall pattern is only moderately favorable, and the volume gradually decreases with the falling elevation from west to east. As in most parts of Central Kenya, the distribution is bimodal, with two distinct dry periods, and two intermittent rainy seasons. The rainy seasons are from March to May, and from October to December. These six months account for approximately 82% of the annual rainfall.

While the rainfall pattern immediately South of this area is comparable to that at larger Nairobi-Thika area, the volume is expected to be approximately 5 to 10% lower. The average at Ndarugu Farm (rain gauge 91.37.026), is 790 mm. The annual potential evaporation is expected to approach 1,880 mm, and the rainfall/evaporation ratio (Rf/Eo) is thus about 50%.

1.3 Purpose and Scope of Survey

The purpose of this Geophysical investigation was to conduct a seismic refraction and Electrical resistivity tomography survey of the proposed site at predetermined traverse lines (see figure 1.2) to determine the nature of underlying strata at the site as part of the geotechnical investigations.

The scope of this investigation included:

- Mobilization to the site
- Conducting seismic refraction (SR) and ERT survey traverses which comprised of thirteen (13) SR and Five (5) ERT profiles at the proposed locations.
- Demobilization from the site and analyzing the seismic and ERT data, and;
- Preparing a report indicating the results of the Geophysical investigations

Figure 1.2 Geophysical survey design

CHAPTER TWO

2 FIELD PROCEDURES AND FIELD WORK

2.1 Outline of Field Survey Activity

The geophysical survey was conducted between 25th and 28th July 2021.

2.2 Seismic refraction method

2.2.1 Basic principles of the seismic refraction method

The seismic refraction method uses the seismic wave to determine the thickness and extent of different lithologies where the formations are arranged so that the density increases with each successively lower layer. Seismic surveys are based on the velocity distribution of artificially generated seismic waves in the ground. Seismic waves can be produced by hammering a metal plate, by dropping a heavy ball, or by using explosives. Energy from these sources is transmitted through the ground by elastic waves.

Three types of waves can be created: Compressional (P) waves, Shear (S) wave and Surface waves. The arrival of the seismic wave is detected by geophones (seismometers) placed firmly in the ground. Compressional waves are the first to arrive at the geophones, and therefore are the most useful.

In general, the higher the density and elasticity of the rock unit, the faster the P wave will be transmitted. The velocity is much less and the energy is dissipated more quickly if the material is unconsolidated or poorly consolidated. Three paths are taken by a compressional wave in the ground: direct (surface), refracted and reflected (Figure 2.1).

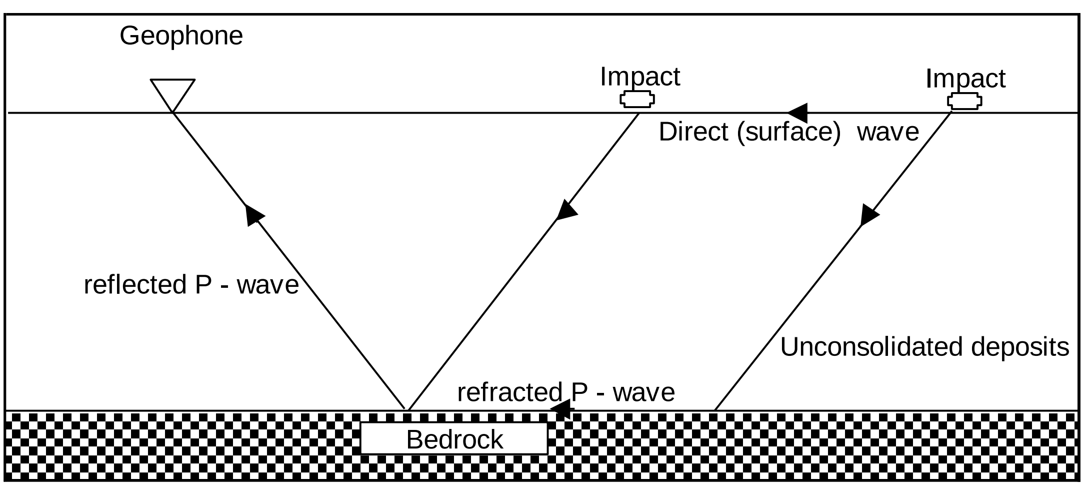


Figure 2.1 A twin layered setting showing three types of P-wave.

The exact arrival time of the seismic wave will depend on which path it takes and density of the material. A single seismic impulse can be recorded as three separate arrivals at the geophone. In practice, however, only the first arrival can be readily recognized. At the geophone - seismic source spacing that is used in refraction surveys, direct waves usually arrive at the geophone after refracted and reflected waves because surface materials are normally less dense than deeper materials.

During a refraction survey, the investigator measures the time the seismic wave takes to reach one or more geophones placed at known distances from the seismic source. By plotting the distance-time relationship, the depth of several geologic units can be estimated at a particular site as long as each successively lower unit has a higher seismic velocity. The elapsed time and the distance travelled also provide information on the type of geologic material. Table 2.1 lists the seismic velocities in different common materials.

Each geologic formation has a characteristic seismic velocity that affects arrival time. In the field, local seismic velocities can be estimated by measuring the travel time to and from a particular formation whose depth is already known from a drilling log.

In the seismic reflection method, the seismic wave is produced by hammer blow or other seismic source. The wave reflects off the bedrock and returns directly to the geophone, where elapsed time is recorded. In order to maximize reliability of the reflected wave energy, hammer stations are usually not more than 9.1 metres from the geophone. The most difficult problem with reflection method is that the reflected wave is not the first to appear on the seismic record. Only signal enhancement enables separation of the primary reflected wave. In practice, the operator strikes a hammer plate one or more times at 5 to 10 sites. Seismic signals are automatically, summed up by the seismograph which cancels out other extraneous impulses which ordinarily obscure the primary reflected wave, leaving the reflected wave.

Table 2-1 Seismic velocities of different geologic formations (after Todd 1980)

Material	P-wave (m/s)	S-wave (m/s)
Ice	3400 - 3800	1700 - 1900
Oil	1200 - 1250	N/A
Vegetal Soil	300 - 700	100 - 300
Dry Sands	400 - 1200	100 - 500
Wet Sands	1500 - 2000	400 - 600
Saturated Shales and Clays	1100 - 2500	200 - 800
Porous and Saturated Sandstones	2000 - 3500	800 - 1800
Marls	2000 - 3000	750 - 1500
Chalk	2300 - 2600	1100 - 1300
Coal	2200 - 2700	1000 - 1400
Salt	4500 - 5500	2500 - 3100
Anhydrites	4000 - 5500	2200 - 3100
Limestones	3500 - 6000	2000 - 3300
Dolomites	3500 - 6500	1900 - 3600
Granite	4500 - 6000	2500 - 3300
Basalt	5000 - 6000	2800 - 2400
Gneiss	4400 - 5200	2700 - 3200

2.2.2 Seismic rays obey Snell's Law

According to snell's Law the angle of incidence equals the angle of reflection, and the angle of transmission is related to the angle of incidence through the velocity ratio Eq 1. This is very similar to optics.

$$\frac{\sin i}{\alpha_1} = \frac{\sin e_1}{\alpha_2} = \frac{\sin e_2}{\alpha_3} \quad \text{......Eq. 1}$$

The angle of incidence equals the angle of reflection, and the angle of transmission is related to the angle of incidence through the velocity ratio. But a conversion from P to S or vice versa can also occur. Still, the angles are determined by the velocity ratios.

$$\frac{\text{Sin } i}{\alpha_1} = \frac{\text{Sin } e_1}{\alpha_2} = \frac{\text{Sin } e_2}{\alpha_3} = \frac{\text{Sin } f_i}{\beta_1} = \frac{\text{Sin } f_2}{\beta_2} = P \qquad \text{Eq. 2}$$

Where *P* is the ray parameter and is constant along each ray.

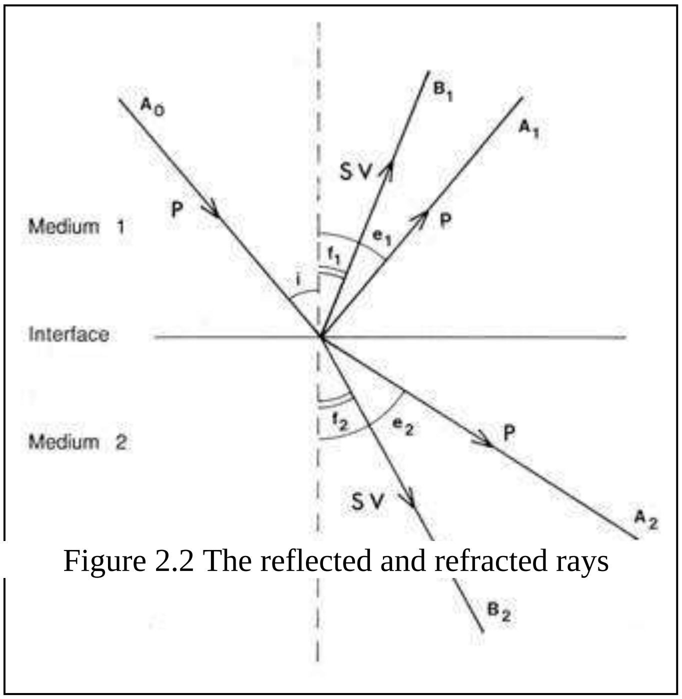


Figure 2.2 The reflected and refracted rays

2.2.3 Critical Incidence

The critically refracted energy travels along the velocity interface at α_2 continually refracting energy back into the upper medium at an angle i_C.

Where $\alpha_2 > \alpha_1$', $e_2 = 90^\circ$

$$\frac{\text{Sin} i}{\alpha_1} = \frac{\text{Sin } e_2}{\alpha_2} \qquad \text{Eq.3}$$

The i_p increases until $e_2 = 90^\circ$

Where $e_2 = 90^{\circ}$ $i = i_C$ the critical angle

$$\text{Sin } i_C = \frac{\alpha_1}{\alpha_2}$$

2.2.4 Head wave or refracted wave

The head wave occurs due to a low to high velocity interface. The energy travels along the boundary at the higher velocity. The energy is continually refracted back into the upper medium at an angle i_C provides constraints on the boundary depth.

2.2.5 Two layered earth model

Energy from the source can reach the receiver via several paths:

1. **Direct wave** i.e. energy traveling through the top layer, traveltime where

$t = x/\alpha_1$

A straight line passing through the origin

Head wave or refracted wave

The energy refracting across the interface, travelling along the underside and then back up to the surface, travel time:

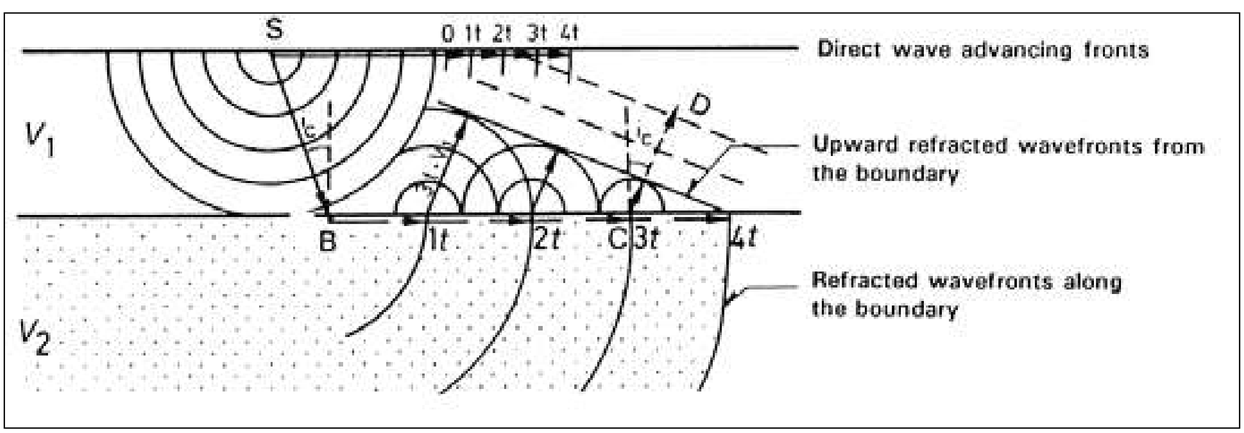


Figure 2.3 Schematic illustration showing the ray paths of incident wave (SB) striking the boundary at critical angle (ic), and the refracted wave (BC) travelling along the boundary with velocity V2 (>V1). The latter is refracted back to the first medium (V1) at t the same angle (i_c) and emerges with a ray path such as CD. Advancement of the wavefronts is shown from the instant (t = 0) when the incident ray strikes the boundary at B (Modified from Klitten, 1987).

$$t = \frac{SA}{\alpha_1} + \frac{AB}{\alpha_1} + \frac{BR}{\alpha_1}$$

with some algebra

$$t = \frac{2Z_1}{\alpha_1} \sqrt{1 - \frac{\alpha_1}{\alpha_1}} + \frac{x}{\alpha_1}$$ i.e., the equation of straight line.

t = a + bx

Where the slope of the line is $1/\alpha_2$ and the intercept is $\frac{2Z_1}{\alpha_1} \sqrt{1 - \frac{\alpha_1}{\alpha_1}} + \frac{x}{\alpha_1}$

2.2.6 **Determining model parameters**

1) The model parameters for a two layered earth model are determined as follows:

- α_1 is determined from the slope of the direct arrival (straight line passing through the origin).

- α_2 determined from the slope of the head wave (straight line first arrival beyond xcross)
- Layer thickness z1 determined from the intercept of the head wave (already knowing α1 and α2)

2) The model parameters for multi-layered models

For multiple layered models we can apply the same process to determine layer thickness and velocity sequentially from the top layer to the bottom.

Head wave from base of layer 2:

$$t = \frac{2Z_1}{\alpha_1} \sqrt{1 - \frac{\alpha_1}{\alpha_2}} + \frac{x}{\alpha_2}$$

Head wave from base of layer 3:

$$t = \frac{2Z_1}{\alpha_1} \sqrt{1 - \frac{\alpha_1}{\alpha_3}} + \frac{x}{\alpha_2} \qquad \sqrt{1 - \frac{\alpha_1}{\alpha_3}} + \frac{x}{\alpha_3}$$

Head wave from base of layer m:

$$t = \sum \frac{2Z}{\alpha} \left[\sqrt{1 - \frac{\alpha}{\alpha m}} \right] + \frac{x}{\alpha_2}$$

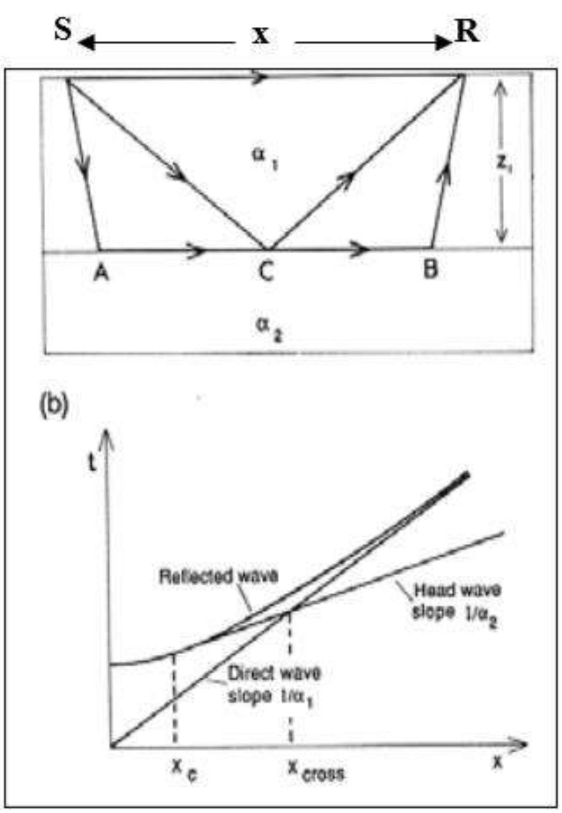


Figure 2.4 Direct wave passing through the origin

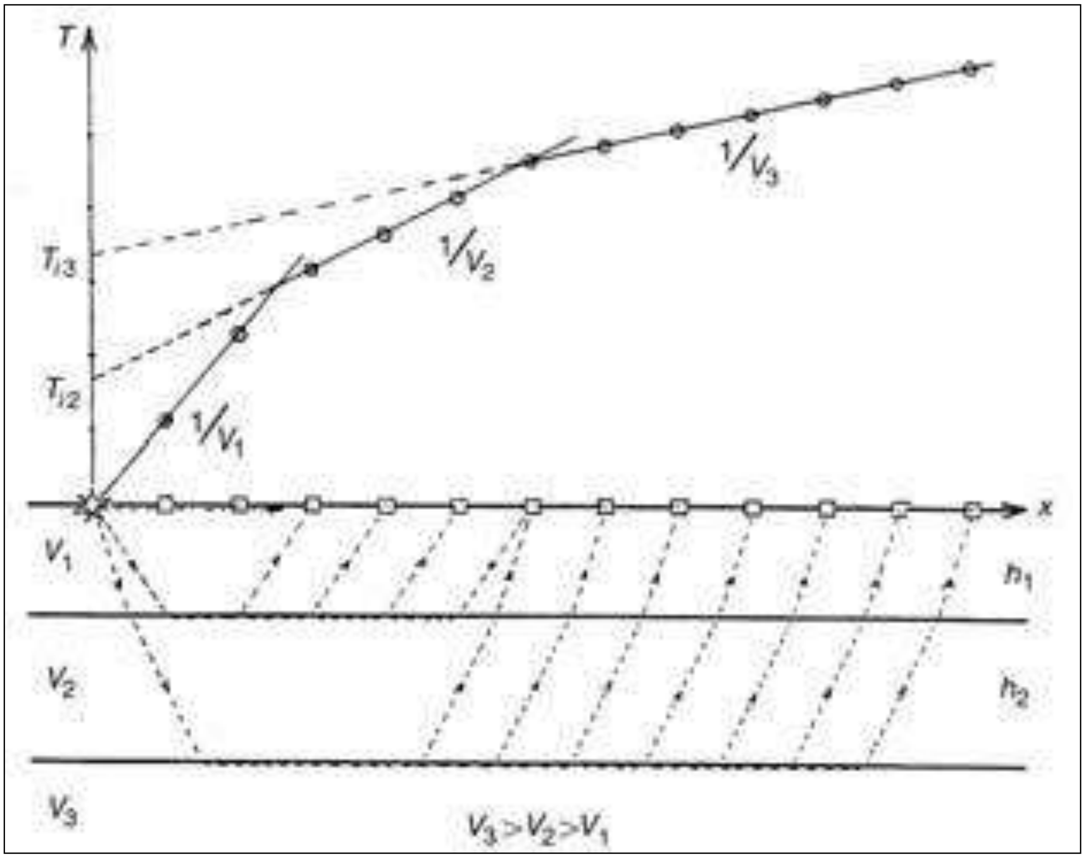


Figure 2.5 The refracted wave showing a three-layer velocity model

2.3 Recording parameters

During the data acquisition the following parameters were preset.

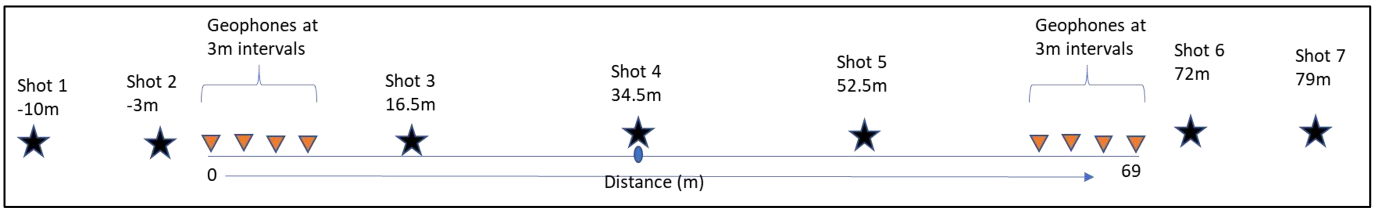
- Sampling Time: 0.125ms (over-sampling is fine)
- Record length: 2080 ms (should be long enough to capture distant arrivals)
- Stacking: was done using 5 shots from a sledge hammer for all the survey work
- Geophone spacing: 3 meters
- Number of shots: Seven shots for each spread at -10m negative off shot, -3m negative end shot, 16.5m quarter shot, 34.5m mid shot, 52.5m 3 quarter shot, 72m positive end shot and 79m positive off shot
- Acquisition filters: acquisition filters are NOT recommended because effect is irreversible and should be carefully applied to filter signal you are certain you will never want such as 50 Hz power line noise
- Display: area variable (more convenient to analyze in the field)
- Channel selection: 24 acquisition channels option was selected since seismic data were acquired using 24 geophones. The distance covered in one array is thus 69m. 5 spreads were used to cover the distance of 345m for each profile.

- Preamp gains: 10000 to 15000 (helped in regulating the sensitivity range of the geophones and to adjust them to the intensity of the signal they were (geophones) cable of detecting at their distance from the energy source).
- Recording format: SEG-2

2.4 Resistivity Tomography Method

2.4.1 Basic Principles of the Resistivity Method

Figure 2.6 Seismic profile acquisition layout



The resistance R of a certain material is directly proportional to its length L and cross-sectional area A, expressed as:

$R = \rho * L/A$ (Ω) (1),

Where ρ is known as the specific resistivity; characteristic of the material and independent of its shape or size With Ohm's Law:

$R = \delta V/I$ (Ω) (2),

Where δV is the potential difference across the resistor and I is the electric current through the resistor, the specific resistivity may be determined by:

$\rho = (A/L) * (\delta V/I)$ (Ω m) (3)

The electrical properties of rocks in the upper part of the earth's crust are determined by the lithology, porosity, and the degree of pore space saturation and the salinity of the pore water. These factors all contribute to the resistivity of a material (the reciprocal to electrical conductivity).

The resistivity of earth materials can be studied by measuring the electrical potential distribution produced at the earth's surface by an electric current that is passed through the earth. Vertical electrical soundings are point measurements that provide information on the vertical resistivity layering at a certain location. Resistivity profiles, on the other hand, are carried out to obtain information on lateral changes in apparent resistivity along a cross section.

2.4.2 Geo-electrical Layer Response

Saturated and/or weathered rocks have lower resistivities than unsaturated (dry) and/or fresh rocks. The higher the porosity of the saturated rock, the lower its resistivity; and the higher the salinity of the saturating fluids the lower the resistivity. In the presence of clays and conductive minerals the resistivity of the rock is also reduced. The relation between the formation resistivity (ρ) and the salinity is given by the “Formation Factor” (F):

$\rho = F \times \rho_w = F \times 10{,}000 / EC$ (µS/cm), where: ρw = resistivity of water. The formation factor varies between 1 (for sandy clays) and 7 (for coarse sands). If a certain aquifer is considered with an average formation factor of 3, then an EC of 300µS/cm will give a formation resistivity of 100 Ω m. The same material, when containing water with an EC of 1,500 µS/cm, will have a resistivity of only 20 Ω m. Brackish water is marked by an EC of 2,000 to 15,000 µS/cm, which is equivalent to a ρ_w of 5 to 0.67.

Deposits containing brackish water will therefore in most cases adopt a formation resistivity of less than 10 Ω m. clayey formations with fresh water will respond similarly (equivalence). Dry and compact rocks are marked by relatively high resistivities, with a common range of 60 to 500 Ohm m. Weathered and water-bearing sandstones and sands are less resistive, with a typical range of 8 to 40 Ohm m, depending on the portion of clays and the water content. The resistivity of impermeable clay layers (alluvial or produced by limestone weathering) usually varies between 2- and 10-Ohm m, while similar figures are recorded for aquifers with brackish to saline water.

The greatest difficulty in sedimentary rocks is formed by:

a) The similar geophysical properties of layers with contrasting hydrogeological characteristics,

b) The large vertical and lateral layer variations, and

c) The modest thickness of the potential aquifer layers.

The resistivity contrasts are less pronounced than for instance in Basement formations. The latter, when fresh, are usually marked by resistivities between 2,500- and 10,000-Ohm m, which make them easy to distinguish from the more conductive weathered zone.

2.4.3 Two-dimensional electrical imaging surveys

A two-dimensional imaging survey is an improvement of the resistivity sounding method that does not take into account horizontal changes in the subsurface resistivity. A more accurate model of the subsurface is a two-dimensional (2-D) model where the resistivity changes in the vertical direction, as well as in the horizontal direction along the survey line. At the present time, 2-D surveys are the most practical economic compromise between obtaining very accurate results and keeping the survey costs down.

2.4.4 Field survey method - instrumentation and measurement procedure

The 2-D electrical imaging/tomography surveys are usually carried out using a large number of electrodes, connected to a multi-core cable. A laptop microcomputer together with an electronic switching unit is used to automatically select the relevant four electrodes for each measurement. Figure 2.7 shows the typical setup for a 2-D survey with a number of electrodes along a straight line attached to a multi-core cable. Normally, a constant spacing between adjacent electrodes is used. The multi-core cable is attached to an electronic switching unit which is connected to a laptop computer. The sequence of measurements to take, the type of array to use and other survey parameters (such the current to use) is normally entered into a text file which can be read by a computer program in a laptop computer. Different resistivity meters use different formats for the control file. After reading the control file, the computer program then automatically selects the appropriate electrodes for each measurement.

In a typical survey, most of the fieldwork is in laying out the cable and electrodes. After that, the measurements are taken automatically and stored in the computer. Most of the survey time is spent waiting for the resistivity meter to complete the sets of measurements. To obtain a good 2-D picture of the subsurface, the coverage of the measurements must be 2-D as well. As an example, Figure 3.2 shows a possible sequence of measurements for the Wenner electrode array for a system with 20 electrodes. In this example, the spacing between adjacent electrodes is “a”. The first step is to make all the possible measurements with the Wenner array with electrode spacing of “1a”. For the first measurement, electrodes number 1, 2, 3 and 4 are used. Notice that electrode 1 is used as the first current electrode C1, electrode 2 as the first potential electrode P1, electrode 3 as the second potential electrode P2 and electrode 4 as the second current electrode C2. For the second measurement, electrodes number 2, 3, 4 and 5 are used for C1, P1, P2 and C2 respectively. This is repeated down the line of electrodes until electrodes 17, 18, 19 and 20 are used for the last measurement with “1a” spacing. For a system with 20 electrodes, note that there are 17 (20 - 3) possible measurements with “1a” spacing for the Wenner array.

After completing the sequence of measurements with “1a” spacing, the next sequence of measurements with “2a” electrode spacing is made. First electrodes 1, 3, 5 and 7 are used for the first measurement. The electrodes are chosen so that the spacing between adjacent electrodes is “2a”. For the second measurement, electrodes 2, 4, 6 and 8 are used. This process is repeated down the line until electrodes 14, 16, 18 and 20 are used for the last measurement with spacing “2a”. For a system with 20 electrodes, note that there are 14 (20 - 2x3) possible measurements with “2a” spacing.

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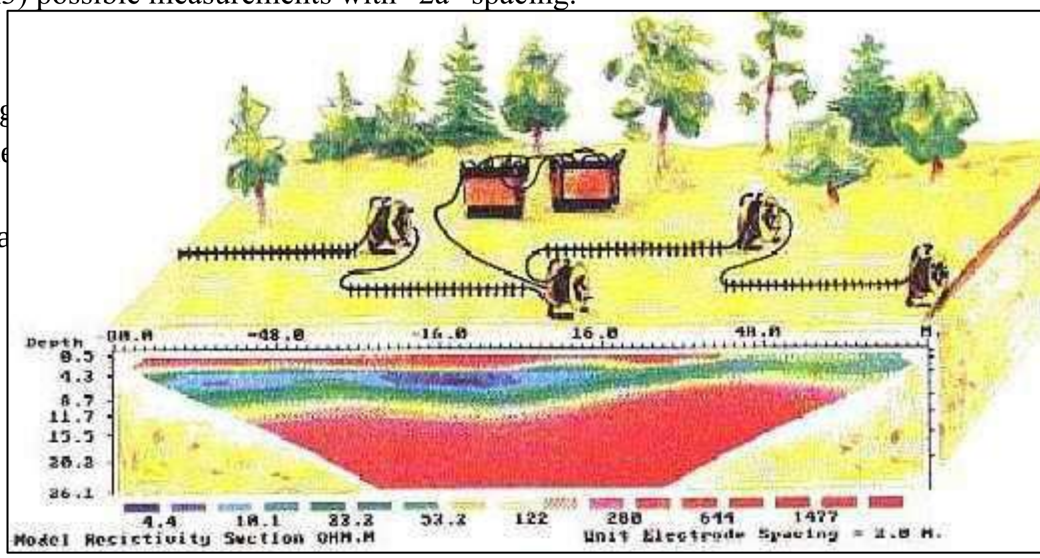


Figure 2.7 General field-setup and the resulting image processed by 2D inversion

Note that as the electrode spacing increases, the number of measurements decreases. The number of measurements that can be obtained for each electrode spacing for a given number of electrodes along the survey line depends on the type of array used. The Wenner array gives the smallest number of possible measurements compared to the other common arrays that are used in 2-D surveys.

One technique used to extend horizontally the area covered by the survey, particularly for

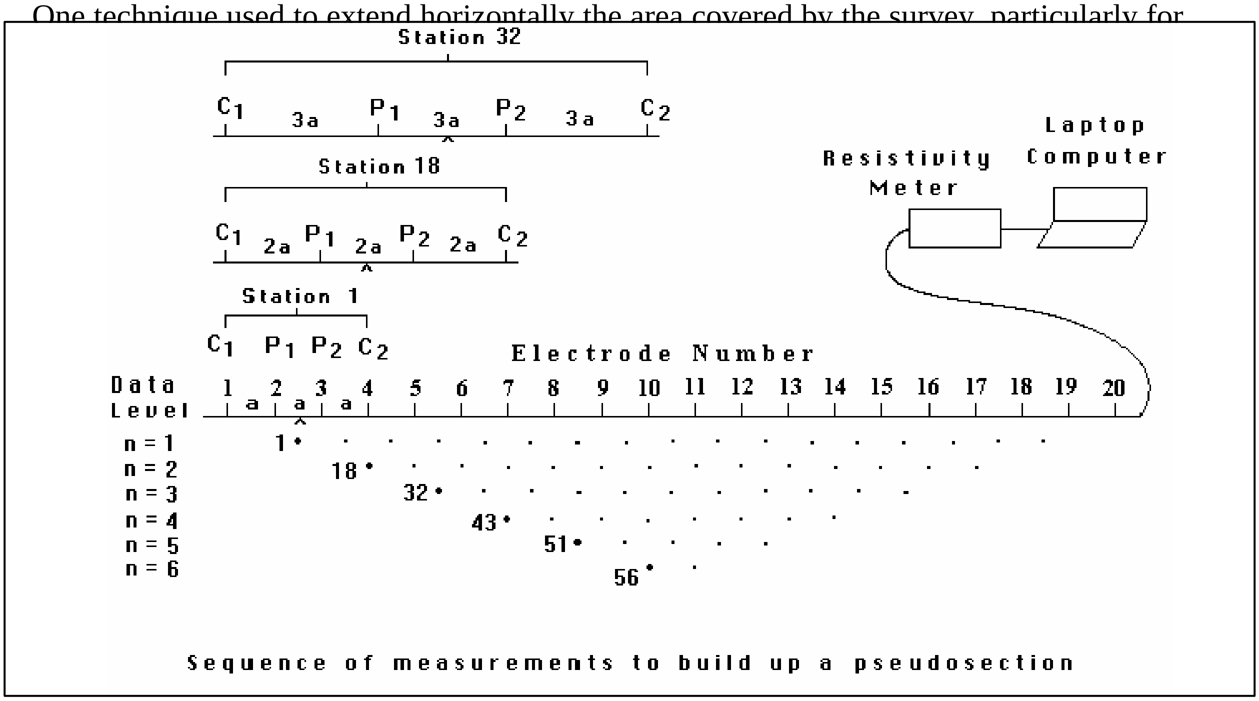
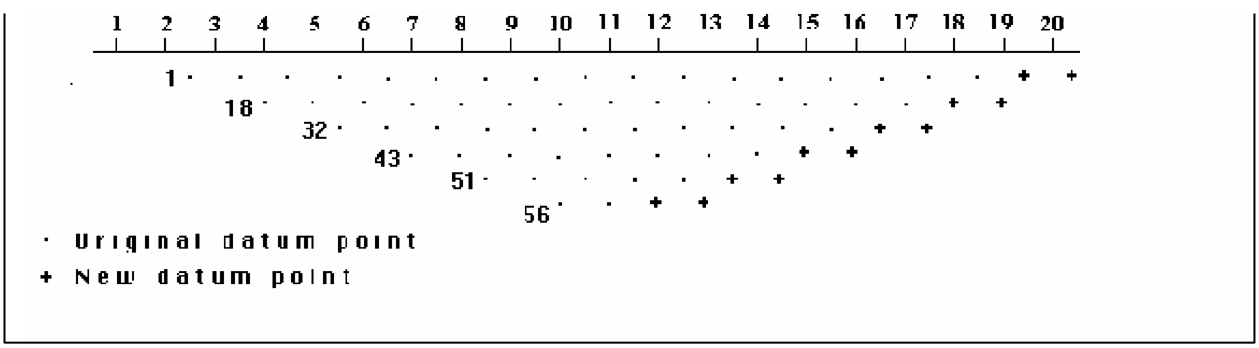


Figure 2.8 The arrangement of the electrodes for 2-D electrical survey



2.4.5 Pseudo section data plotting method

Figure 2.9 The use of the roll-along method to extend the area covered by a survey

To plot the data from a 2-D imaging survey, the pseudosection contouring method is normally used. In this case, the horizontal location of the point is placed at the mid-point of the set of electrodes used to make that measurement. The vertical location of the plotting point is placed at a distance which is proportional to the separation between the electrodes.

Another method is to place the vertical position of the plotting point at the median depth of investigation (Edwards 1977), or pseudo depth, of the electrode array used. This pseudo-depth value is based on the sensitivity values or Frechet derivative for a homogeneous half space.

The pseudo-section plot obtained by contouring the apparent resistivity values is a convenient means to display the data. The pseudo-section gives a very approximate picture of the true subsurface resistivity distribution. However, the pseudo-section gives a distorted picture of the subsurface because the shape of the contours depend on the type of array used as well as the true subsurface resistivity. The pseudosection is useful as a means to present the measured apparent resistivity values in a pictorial form, and as an initial guide for further quantitative interpretation. One common mistake made is to try to use the pseudo-section as a final picture of the true subsurface resistivity because different arrays used to map the same region can give rise to very different contour shapes in the pseudo-section plot. One useful practical application of the pseudo-section plot is for picking out bad apparent resistivity measurements. Such bad measurements usually stand out as points with unusually high or low values.

2.4.6 **Computer interpretation**

After the field survey, the resistance measurements are reduced to apparent resistivity values. Practically all commercial multi-electrode systems come with the computer software to carry out this conversion. In this section, steps involved in converting the apparent resistivity values into a resistivity model section are presented that can be used for geological interpretation.

2.4.7 **Data input and format**

To interpret the data from a 2-D imaging survey, a 2-D model for the subsurface, which consists of a large number of rectangular blocks is usually used. A computer program is then used to determine the resistivity of the blocks so that the calculated apparent resistivity values agree with the measured values from the field survey. The computer program RES2DINV.EXE will automatically subdivide the subsurface into a number of blocks, and it then uses a least-squares inversion scheme to determine the appropriate resistivity value for each block. The location of the electrodes and apparent resistivity values must be entered into a text file which can be read by the RES2DINV program. The program manual gives a detailed description of the data format used.

Table 2-2 Geophysical Units and Common Resistivity Ranges

GEOPHYSICAL UNIT	**RESISTIVITY RANGE (Ohm.m)**
Sandy topsoil of the "high lands", generally iron-stained.	100 - 2,000
Topsoil of clayey sands and silts (black cotton type) *When hard and cracked:*	20 – 100 *100 – 1,500*
Heavy clays (alluvial or intensive clay-producing weathering)	2 – 10
Sandy clays to clayey sands ("loam")	10 - 40
Clayey saprolite, dry	10 - 100
Clayey saprolite, moist	2 - 20
Coarse saprolite or saprock, dry	100 – 800
Coarse saprolite or saprock, water bearing	50 – 150
Saturated zone with saline water	2 - 10
Fresh Basement rocks, compact and dry	2,500 – 10,000

CHAPTER THREE

3 SEISMIC REFRACTION SURVEY RESULTS AND DISCUSSION

3.1 Introduction

The seismic survey was acquired along 13 (thirteen) profiles at each of the pre-determined locations as shown in Figure 3.1. Each of the profiles measures 345m, running in the NW-

Figure 3.1 Google earth image showing the study site and seismic refraction profiles layout

SE azimuth.

3.2 Interpretation and discussion of the seismic models

The interpretation of the seismic models has been divided into three categories based on the observed homogeneity across each model. In this regard;

1. **Category one** is comprised of the fairly homogeneous models that do not exhibit very large variations of the recorded P-wave velocities across the

entire length of the profile. This category has SR 01, SR05, SR07, SR08, SR10

2. **Category two** consists of profile in which considerable variations in recorded P-wave velocities. This may be termed as moderately inhomogeneous. SR 02, SR 03 and SR 04 fall into this category.
3. **Category three** consists of the highly inhomogeneous models where the seismic velocities vary greatly from point to point across the entire profile. In this category is SR 06, SR 09, SR 11, SR 12 and SR 13.

3.2.1 Interpretation and discussion of category one seismic models

The seismic models in this category depict a three-layered model with P-wave velocities ranging from 400m/s to >3000m/s. The lowest velocities recorded represent the top loose soils that reach a maximum depth of about 1.2m. This is the velocity range between 400-1000m/s and represented in the model by the purple-blue colours. It is deepest to the NW part and shallowest from about the distance of 200m towards the SE.

The second layer records velocities between 1000m/s to 2000m/s. This is interpreted to comprise the weathered rock and compact saprolitic material from a depth of 1.2m to about 5m at the deepest point but it is shallower for most of the profile length. This layer is shown by the greenish-yellow colours. The thickness is slightly variable across the profile as is the surficial layer. This is in transition to the fresh rock that forms the basal layer.

The basal layer starts at a depth of 2.5-5m recording velocities from 2000m/s to >3000m/s. These values are typical of soft rock such as tuffs and sandstones at varying levels of water saturation. At the current site, it has been established from electrical resistivity tomography results (subsequent chapter) that these high velocities are as a result of water saturation within the rock mass. This layer is represented by the orange-reddish colours in the model that can be observed to dominated the entire probed depth of ~30m. The little variations that are observed in the coloration are caused by changes in velocities as a result of the varying saturation levels. Less saturated zones being in the light orange colours indicating slower velocities while the most saturated zones are in deep orange-reddish colours indicative of higher velocities. These are interpreted to be zones where the permeability and porosity of the rock mass is reduced.Such zones can be seen in SR01 and SR 08 at 75-130m and from 300m to the end. In profile SR10, this zone can be observed at 175-210m. Figure 3.2 is a collated image of the five profiles under category one.

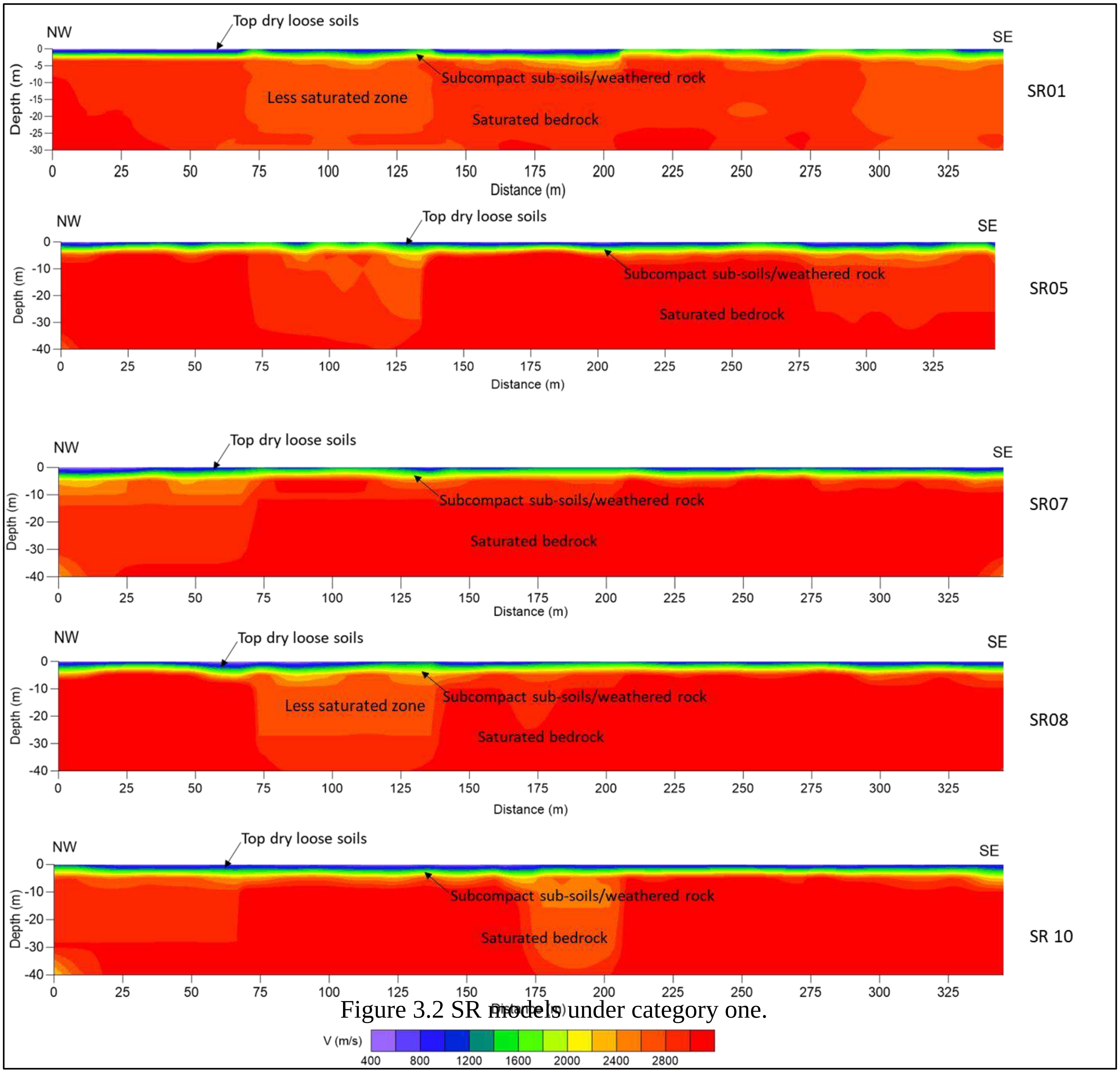


Figure 3.2 SR models under category one.

3.2.2 Interpretation and discussion of category two seismic models

Three seismic models have been categorized under category two; SR-02, SR-03 and SR-04 (Figure 3.3). These depict moderate variations in the velocities recorded. The dominant velocity range is the intermediate to high velocities (2500-3000 m/s). The general nature is a three-layered model similar to the category one nonetheless. The top loose soils recording the lowest velocities (<1000m/s) span the entire length of the profiles with only the thickness variations. The second layer (1200-2000m/s) is rather variable in thickness in the three models. In SR 02, this layer transits to a slightly higher velocity zone. This layer is not uniform in thickness and is seen for example reaching a depth of 30m between the distance of 130-210m in SR 02 where it is more pronounced in yellow-orangish color. The light orange colors as seen in the other profiles as well represents slightly higher velocities than these that is a transition to the fresh bedrock. This is all a manifestation of the variation in the saturation levels within the rock mass rather than the mechanical strength of the rock which is expected to be rather uniform at this site. It is however also anticipated that the increased water content induces weathering to clayish material in different parts if the rock mass but this is not expected to be too extensive. Fractured or highly jointed zones are expected to be more affected in this regard. Such zones of weathering will record lower velocities and are therefore to be distinguished from low velocity zones caused by drier rock conditions.

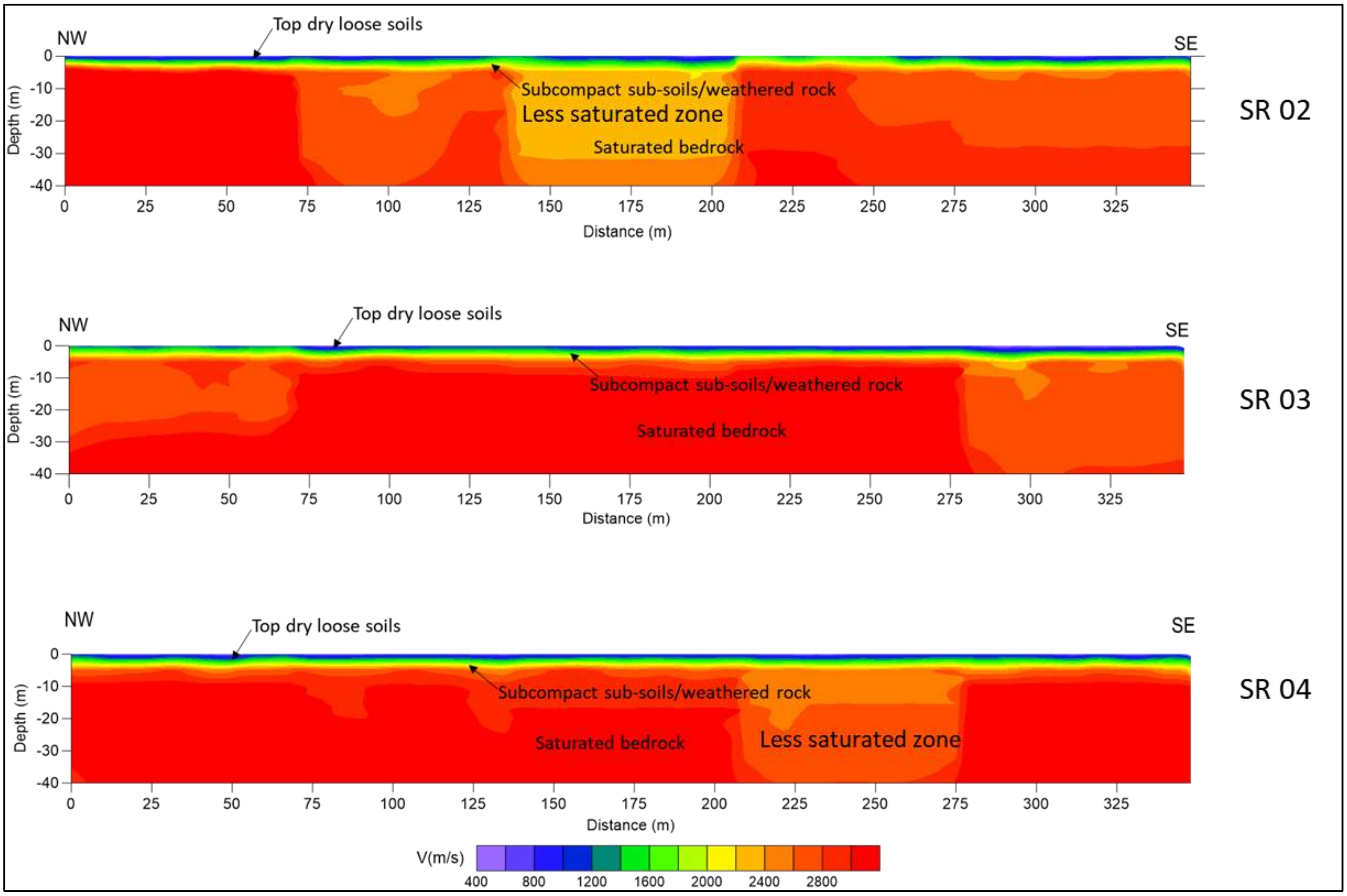


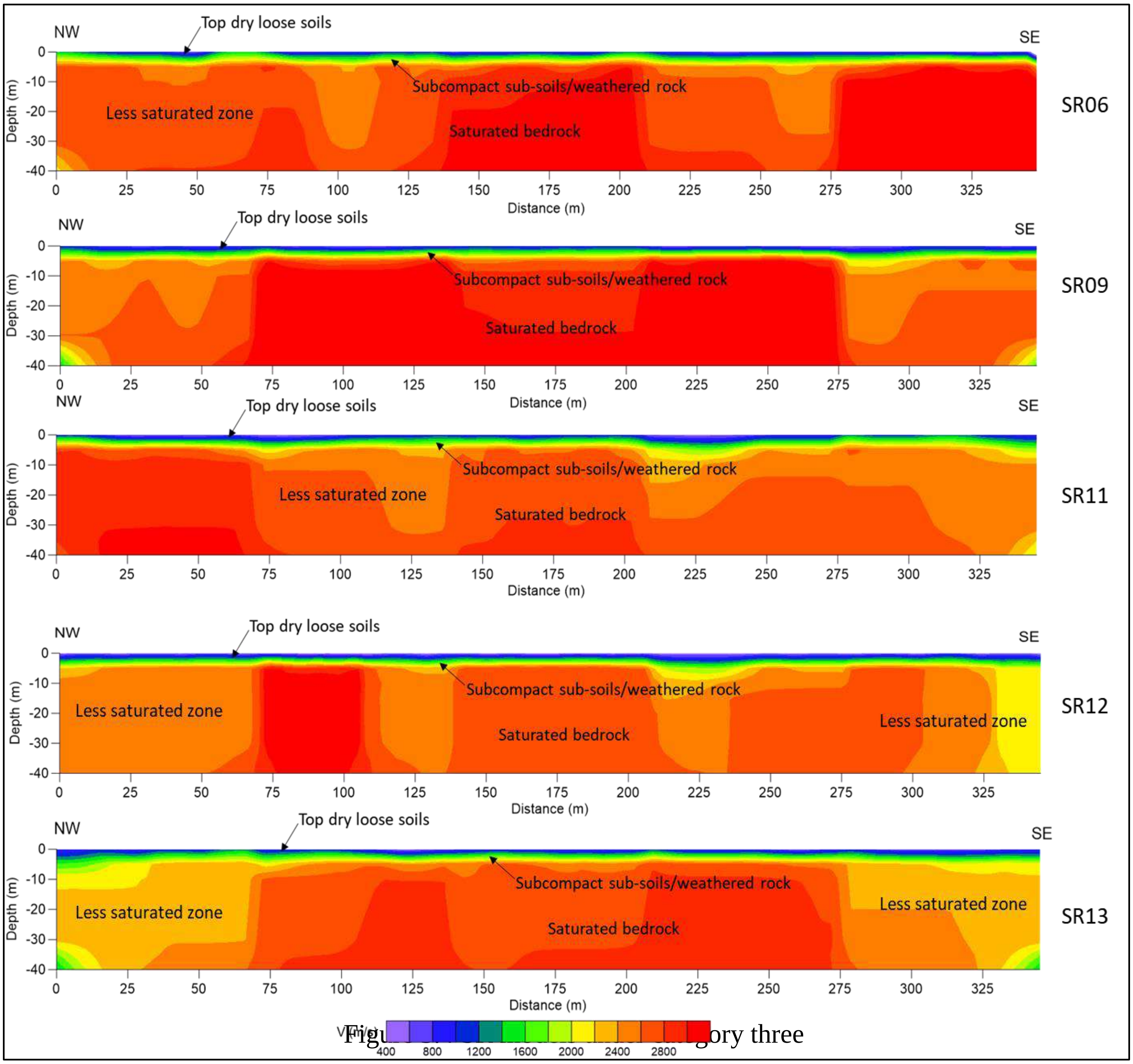
Figure 3.3 SR models under category two

3.2.3 Interpretation and discussion of category three seismic models

Category three seismic models have been selected to represent those models that show great variations in the P-wave velocities recorded. These include SR-06, SR-09, SR-11, SR-12 and SR-13 as in figure 3.4. These models show a great dominance of the intermediate velocities as compared to the models in category one and two.

A common feature in these models is a low velocity zone at the bottom towards the ends. This is interpreted to be caused by the weathering of the basal rock in these zones to produce clays. Large variations that result in lower velocity zones extend to deeper levels than in the other two categories dominate this category. This is again interpreted to represent the typical velocities (2000-2500m/s) of the dry soft rock that has been observed in drill cores to form the subsurface geology of this site. Some high velocity zones in deep orange-reddish colors (>2500m/s) occur intermittently across the profiles. These may represent highly saturated zones or less porous rock mass. Internal rock fabric within the pyroclastic tuffs may also result in such models where the rock transcends from soft rock tuff to trachytic and/or welded tuff that may be expected to record slightly higher velocities.

SR-12 and SR-13 show the most variable nature. Low velocity zones at both ends of the profiles manifest in both profiles. These zones extend to depths up to 30m thereby lowering the mechanical strength of the bed rock.



Figu[illegible]ory three

3.3 Summary and evaluation of the seismic results

Based on the results of the seismic survey, this site has can be said to be a three-layered earth model to the maximum depth of about 35m probed.

The first layer is composed of loose top black cotton soils that reach an average depth of 1.0m. This layer shows little variation in depth across the entire site. The eastern part has the deepest loose cover reaching a depth of 1.2m while the central and western sectors have shallow surficial cover of 0.5 and 1.0m respectively.

The second layer is transition layer where the weathered rock and saprolitic material is to be expected. This is a thin layer of about 2m. Below this layer forma depth of about 3m is the start of the basal layer that forms the bedrock at this site. The rock is a soft to welded tuff, sometimes changing to trachytic tuff. P-wave velocities suggest that this rock is saturated from a depth of about 10m. Water saturation has the effect on increasing the P-wave velocity within the rock and as such, higher than normal velocities are recorded. Varied weathering grades may manifest in the rock at depth. This is particularly observed in the NE end where SR10-SR13 are located. Great variations in the recorded P-wave velocities are indicative of high frequency changes in the nature of the rock. The rock is however expected to be sound as a mass and able to support light structures. Clay weathering is also to be expected at some zones where chemical activity may lead to formation of whitish clays in fractures and joints within the rock. No cavities were detected at the site from the seismic results.

CHAPTER FOUR

4 ELECTRICAL RESISTIVITY TOMOGRAPHY RESULTS AND DISCUSSION

4.1 Introduction

The electrical resistivity imaging was conducted between 25th and 27th July 2021 at the site. Table 4.1 below summarizes the field set up employed to acquire field data and the lengths of the survey lines. The location and layout of the measurements is shown in Fig. 4.1.

Table 4-1 Summary of Geo-electrical Imaging Field Activity Profiles

Resistivity line	Electrode spacing	Length (m)	Direction
ERT 01	10	400	NW-SE
ERT 02	10	400	NW-SE
ERT 03	10	400	NW-SE
ERT 04	10	400	NW-SE
ERT 05	10	400	NW-SE
Total		**2000**	

Figure 4.1 Google earth satellite image showing the location and layout of ERT profiles in red sold lines

4.2 Interpretation and discussion of ERT models

All the five ERT profiles run from the NW to the SE end of the site covering a distance of 400m (figure 4.1).

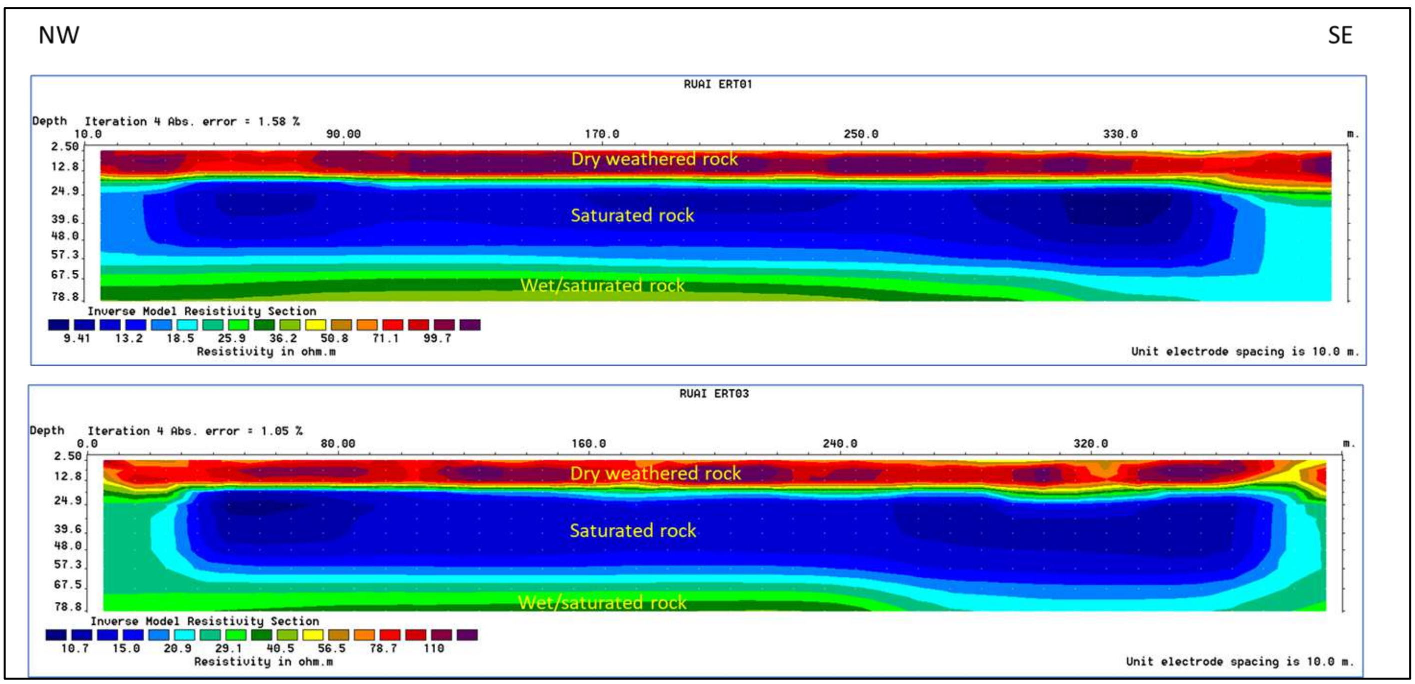
The interpreted geo-electric models show a rather uniform earth model of a layered subsurface where two distinct layers can be identified. The models can be grouped in to two on the basis of the recorded range of resistivities;

4.2.1 Group one

This group consists of the profiles with low resistivity range of less than 150Ωm. This includes ERT 01 and ERT 03 (figure 4.2) which can be seen to depict highly identical models. The lowest recorded resistivity is 9.4 Ωm for ERT 01 and 10 Ωm for ERT 03. This means that clay content is minimal in both profiles.

The layered model has a top high resistivity layer recording values from 50-100 Ωm which is represented by the hot colors. This represents the top dry rock that is marginally weathered with minimal variations across the profile from end to end. More fresh and drier conditions manifest in the deep red-purplish colors. This layer reaches a depth of 10-15m. Below this layer is low resistivity layer that makes up most of the profile. This layer records values between 10-40 Ωm typical of saturated or aquiferous material represented in the models by cool colors (blue to light green). This layer starts from a depth of 10-15m to more than 60m. This is interpreted to be the first major aquifer in this area.

At a depth of 70m, the saturation levels are seen to decline indicated by the increasing resistivity values recorded. This is interpreted to be the lower level of this aquiferous zone. Water content in the rocks is still expected to be significantly higher in this zone too but it is expected that forms the transition to a lower confining stratum that is less permeable, probably the phonolite flow.



4.2.2 **Group two**

ERT 02, 04 and ERT 05 fall into group two of the resistivity models that record higher resistivity values. The highest recorded values are in ERT 02 at over 5000 Ωm. This is interpreted as an erroneous reading since it is not plotted in the model either (figure 4.3). The values recorded by ERT04 and ERT05 of 700 Ωm are much more likely in the materials at this site, albeit at depth. This values even though indicated in the color scale are not plotted in the models.

The models nevertheless follow the layering model as in ERT01 and ERT03. There is a top layer of high resistivities in the range of 60-120 Ωm. This represents the top dry rock that reaches a depth of 15m.

The basal rock that extends to the maximum probed depth of 75m is highly saturated with water. Core samples observed from the site show evidence of this where large pores in the rock and joints have been washed by water. Minimal clay weathering on fractures is expected.

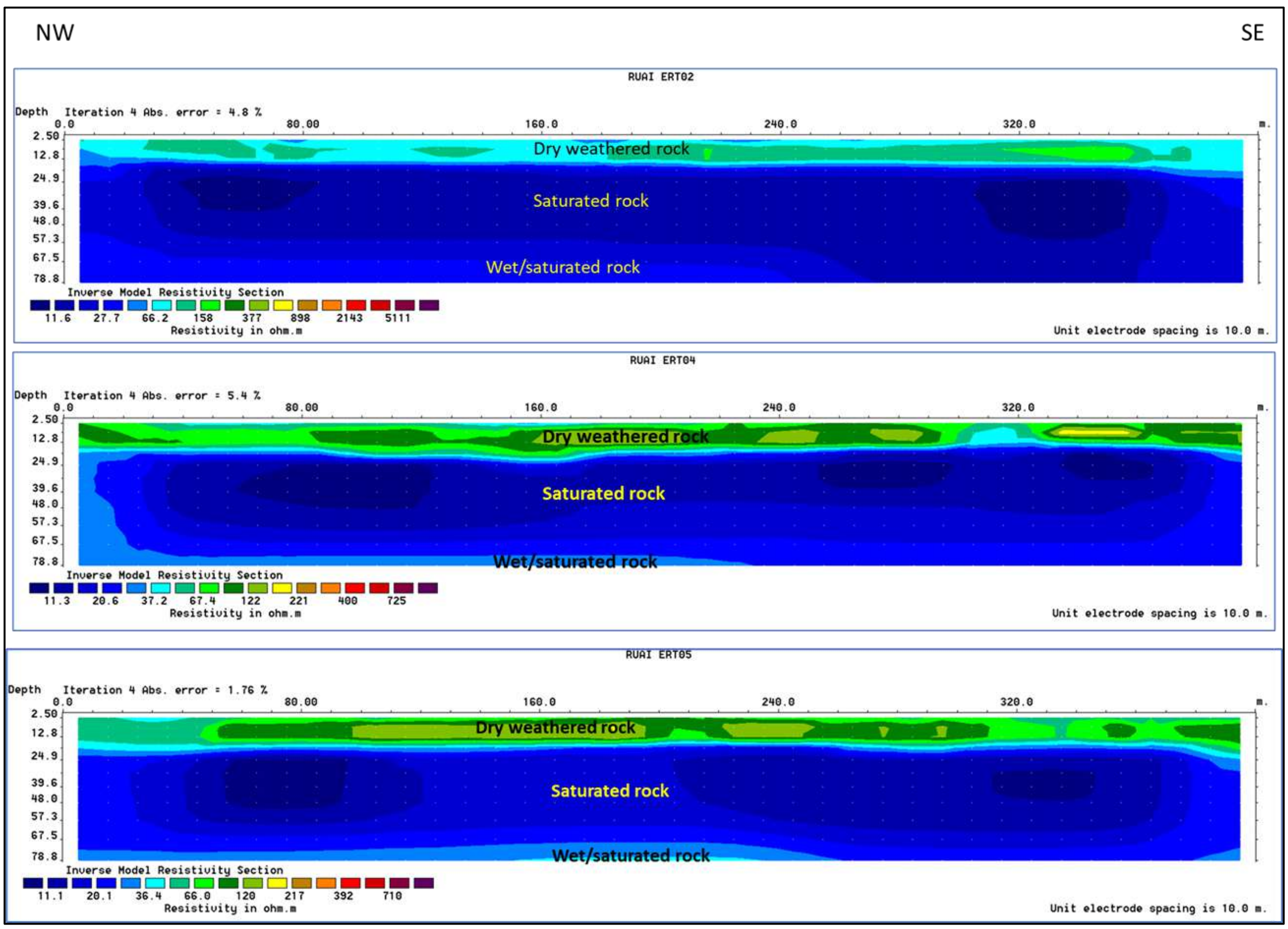


Figure 4.3 Group 1 models of ERT02, ERT04 and ERT05

4.3 Summary and evaluation of the ERT results

Results of the ERT survey show that this site depicts a three-layered earth model to a depth of 78m.

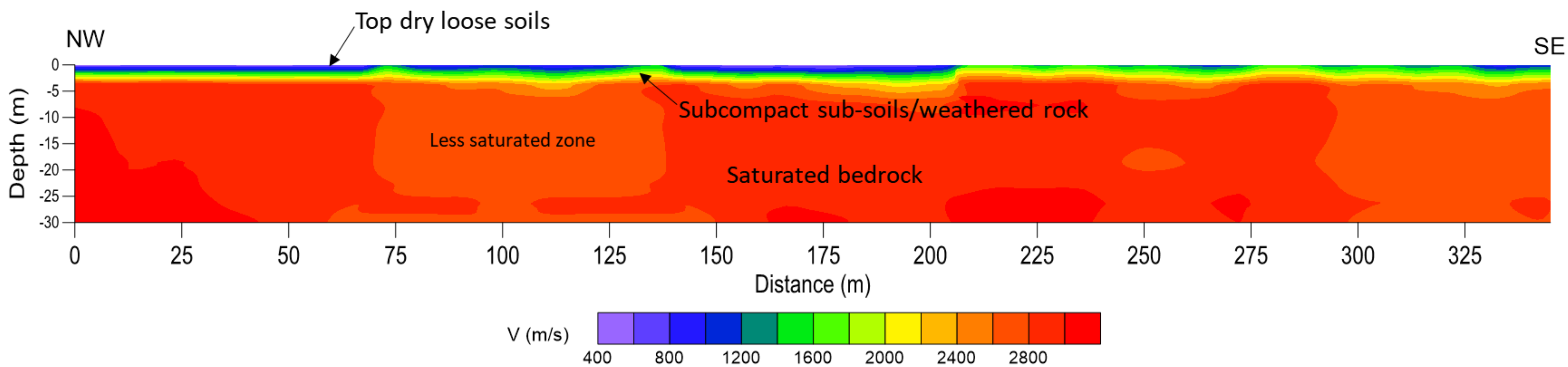
The first layer is composed of loose top black cotton soils that reach an estimated average depth of 1.0m that is not mapped in the models.

The second layer which in the ERT models is modeled as the first layer is composed of the shallowly buried rock. This layer is of marginally weathered rock that is dry. Below this layer from a depth of 15m is the basal layer that forms the bedrock at this site. The rock is a soft to welded tuff, sometimes changing to trachytic tuff. The model indicates that this layer extends to the maximum depth of 78m and is highly water saturated. Varied weathering grades may manifest in the rock at depth. Clay weathering although minimal is also to be expected at some zones where chemical activity may lead to formation of whitish clays in fractures and joints within the rock. No cavities were detected at the site from the ERT results.

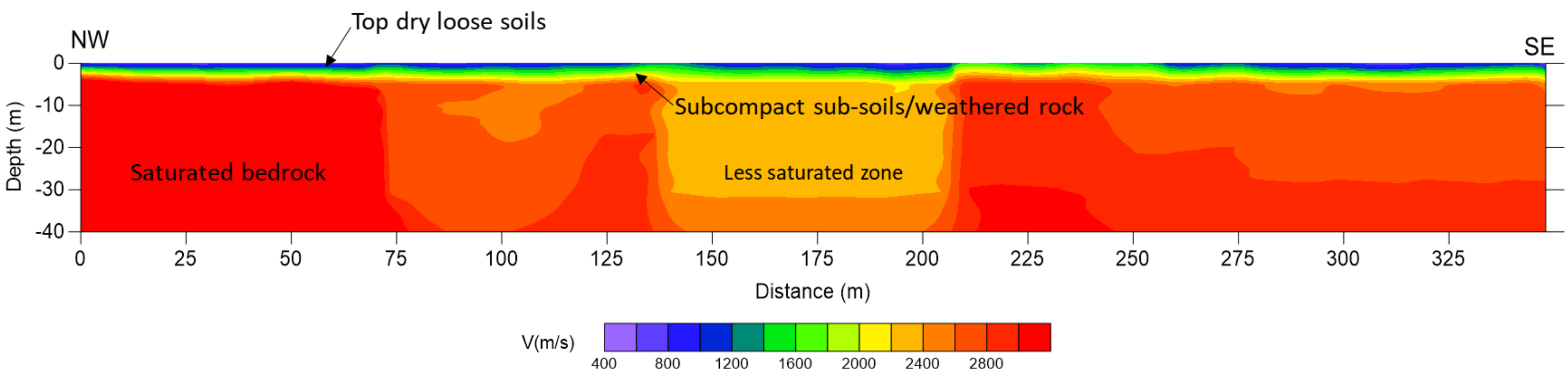
5 CORRELATION BETWEEN THE SEISMIC AND ERT MODELS

There is good correlation between the seismic and ert models. Both depict a three-layered earth model. The high p-wave velocities recorded in the seismic models from a depth of 10-15m can be verified by the high-water saturation levels mapped by the ERT models for this horizon. The uniformity of the models in both geophysical methods is also indicative of the complimentary nature of these two methods. No significant discrepancies can be inferred as far as congruence is concerned between both results.

SR01


Top dry loose soils
NW
SE
0
-5
-10
-15
-20
-25
-30
Depth (m)
Subcompact sub-soils/weathered rock
Less saturated zone
Saturated bedrock
0
25
50
75
100
125
150
175
200
225
250
275
300
325
Distance (m)
V (m/s)
400
800
1200
1600
2000
2400
2800

SR02


Top dry loose soils
NW
SE
Subcompact sub-soils/weathered rock
Saturated bedrock
Less saturated zone
Depth (m)
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-10
-20
-30
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25
50
75
100
125
150
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300
325
Distance (m)
V(m/s)
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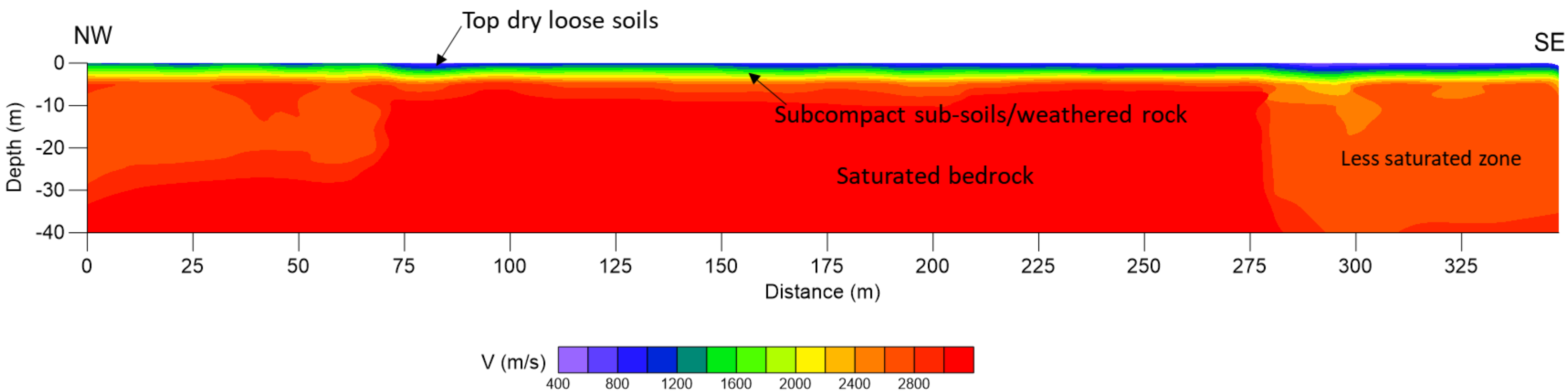
800
1200
1600
2000
2400
2800

SR03


NW
SE
Top dry loose soils
Subcompact sub-soils/weathered rock
Saturated bedrock
Less saturated zone
Depth (m)
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-10
-20
-30
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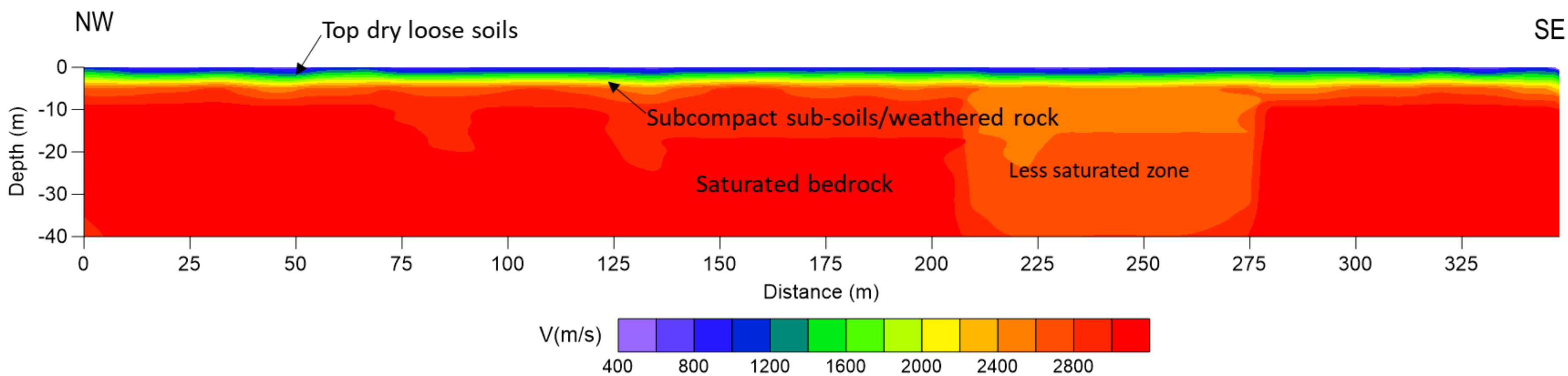
0
25
50
75
100
125
150
175
200
225
250
275
300
325
Distance (m)
V (m/s)
400
800
1200
1600
2000
2400
2800

SR04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SE
Top dry loose soils
Subcompact sub-soils/weathered rock
Saturated bedrock
Less saturated zone
Depth (m)
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-20
-30
-40
0
25
50
75
100
125
150
175
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275
300
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Distance (m)
V(m/s)
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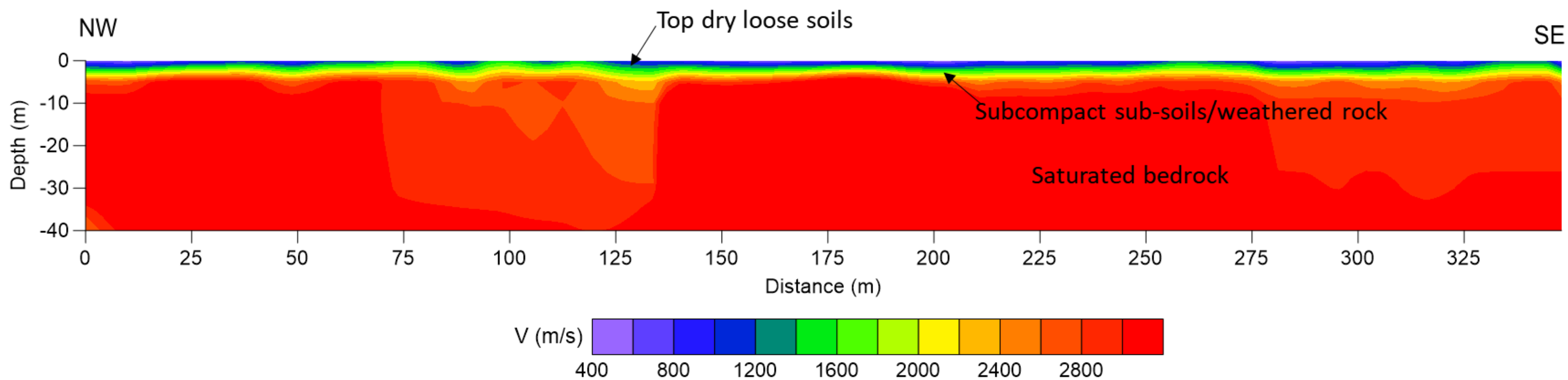
2000
2400
2800

SR05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Subcompact sub-soils/weathered rock
Saturated bedrock
Depth (m)
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75
100
125
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Distance (m)
V (m/s)
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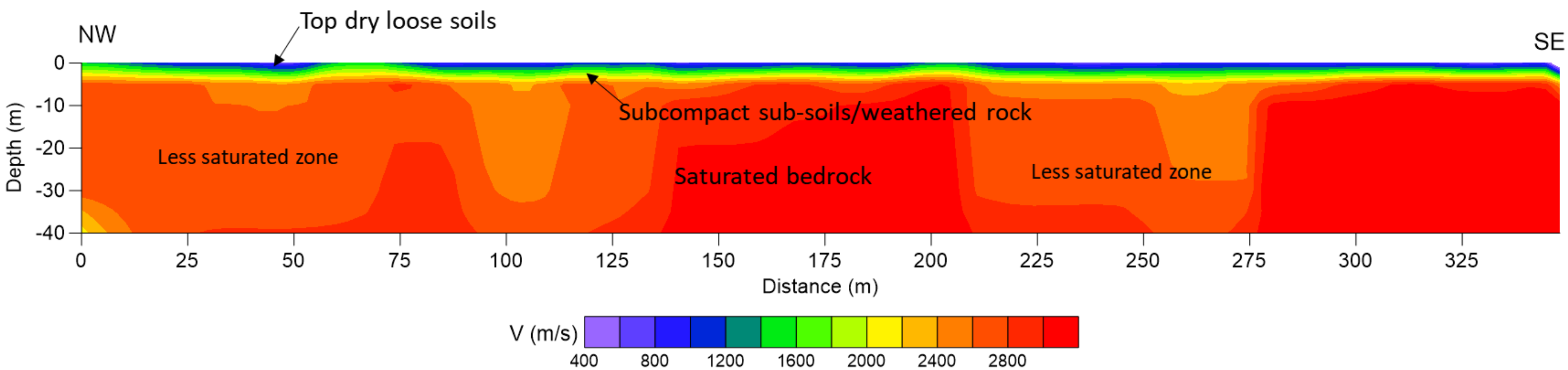
SR06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Subcompact sub-soils/weathered rock
Less saturated zone
Saturated bedrock
Less saturated zone
Depth (m)
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25
50
75
100
125
150
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300
325
Distance (m)
V (m/s)
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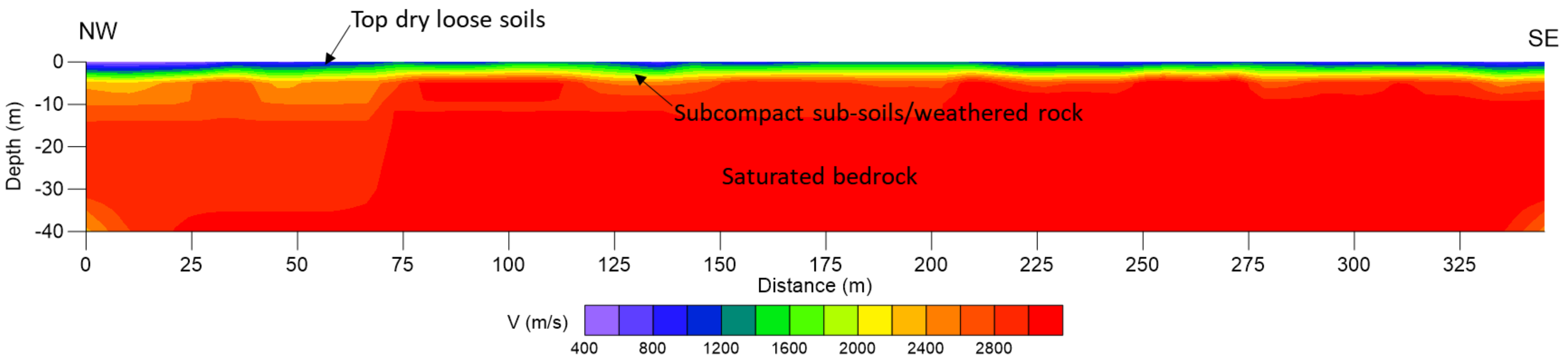
2400
2800

SR07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SE
Subcompact sub-soils/weathered rock
Saturated bedrock
Depth (m)
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-20
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-40
0
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50
75
100
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200
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300
325
Distance (m)
V (m/s)
400
800
1200
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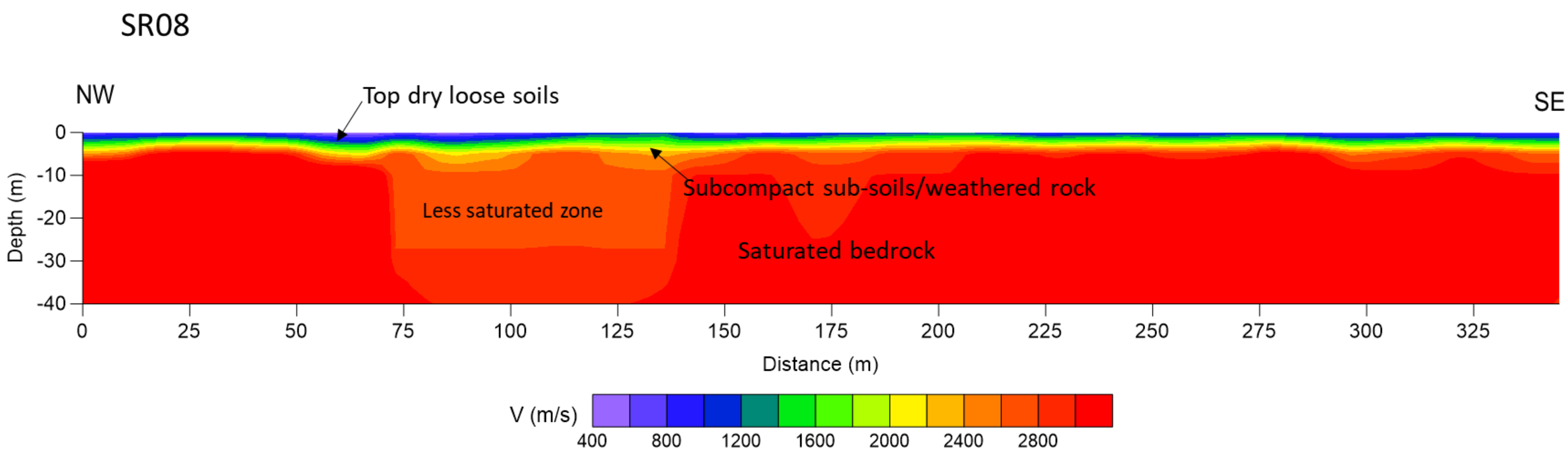
2000
2400
2800


SR08
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SE
Top dry loose soils
Subcompact sub-soils/weathered rock
Less saturated zone
Saturated bedrock
Depth (m)
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25
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100
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1200
1600
2000
2400
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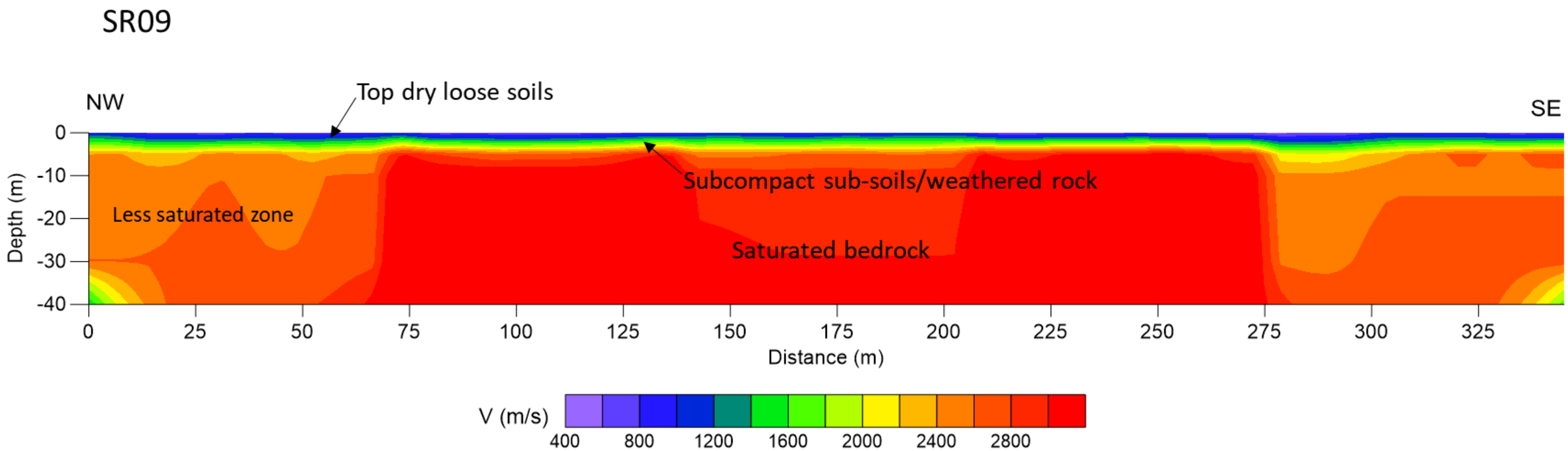
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Subcompact sub-soils/weathered rock
Less saturated zone
Saturated bedrock
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-40
0
25
50
75
100
125
150
175
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275
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325
Distance (m)
V (m/s)
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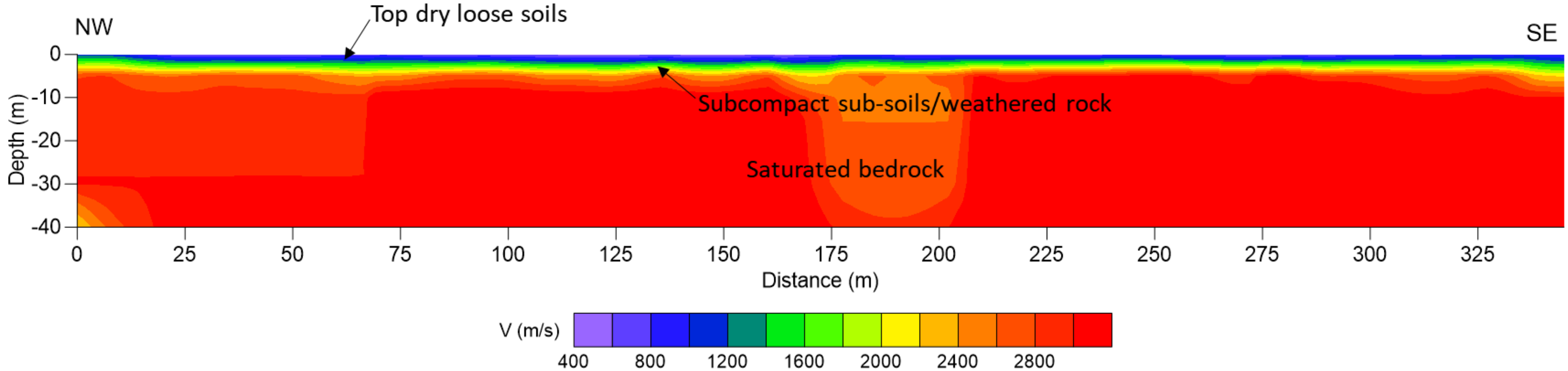
1200
1600
2000
2400
2800

SR10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SE
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Subcompact sub-soils/weathered rock
Saturated bedrock
Depth (m)
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-30
-40
0
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75
100
125
150
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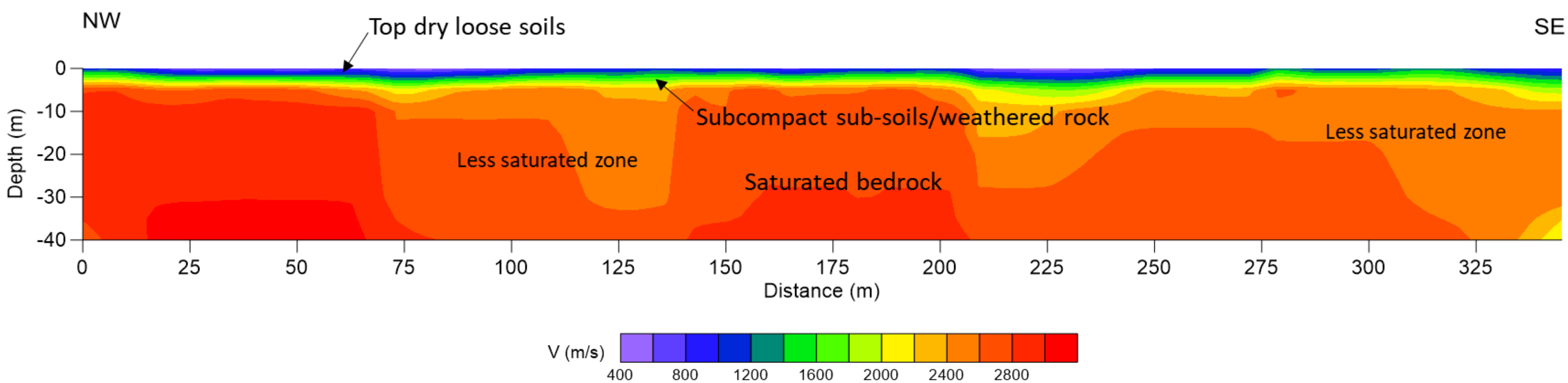
1600
2000
2400
2800

SR11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SE
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Subcompact sub-soils/weathered rock
Less saturated zone
Saturated bedrock
Less saturated zone
Depth (m)
0
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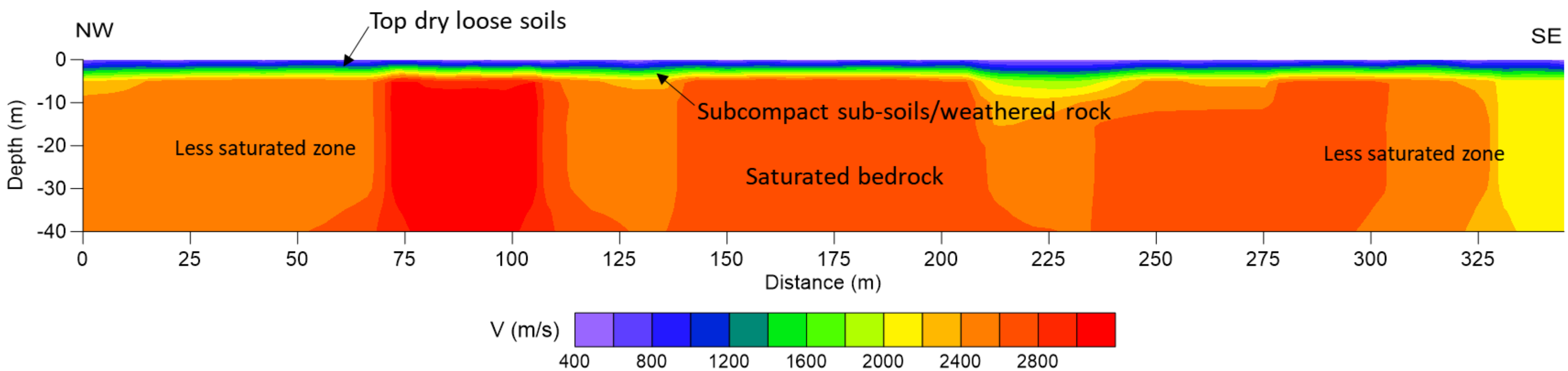
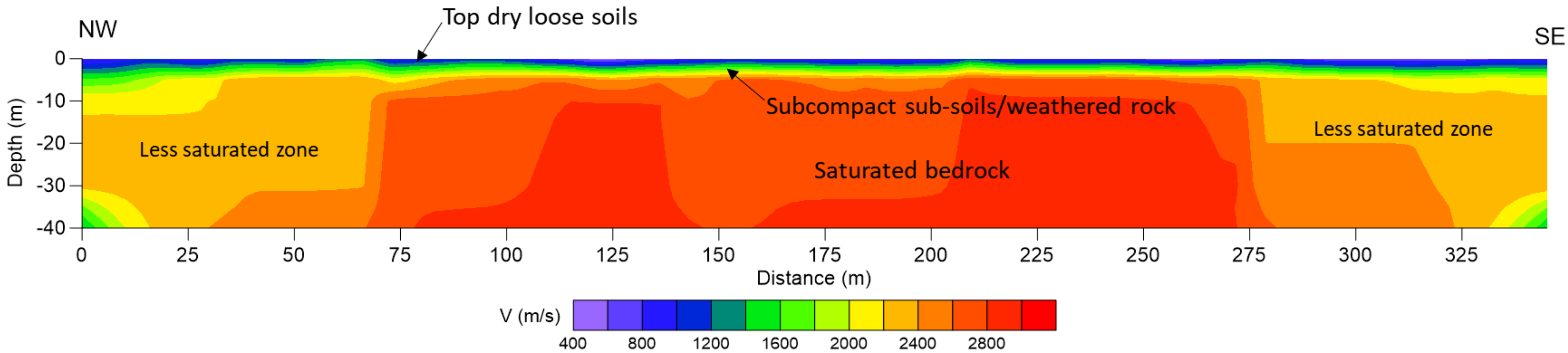
-20
-30
-40
0
25
50
75
100
125
150
175
200
225
250
275
300
325
Distance (m)
V (m/s)
400
800
1200
1600
2000
2400
2800

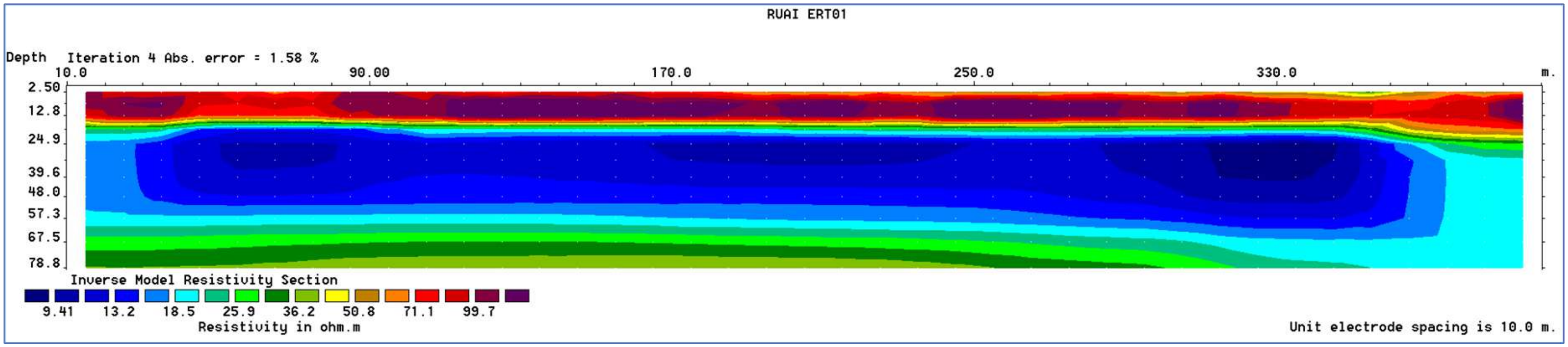
SR12


NW
SE
Top dry loose soils
Subcompact sub-soils/weathered rock
Less saturated zone
Saturated bedrock
Less saturated zone
Depth (m)
0
-10
-20
-30
-40
0
25
50
75
100
125
150
175
200
225
250
275
300
325
Distance (m)
V (m/s)
400
800
1200
1600
2000
2400
2800

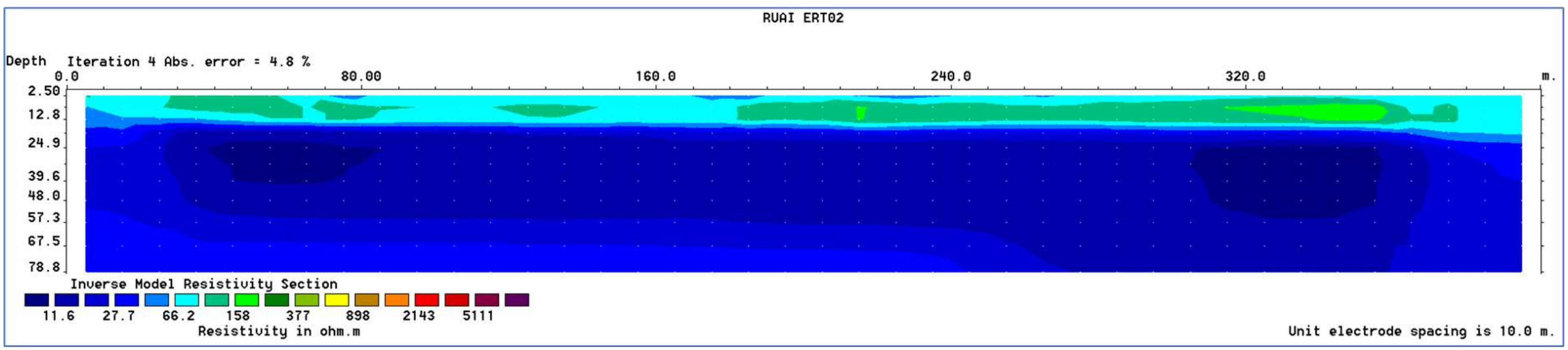
SR13

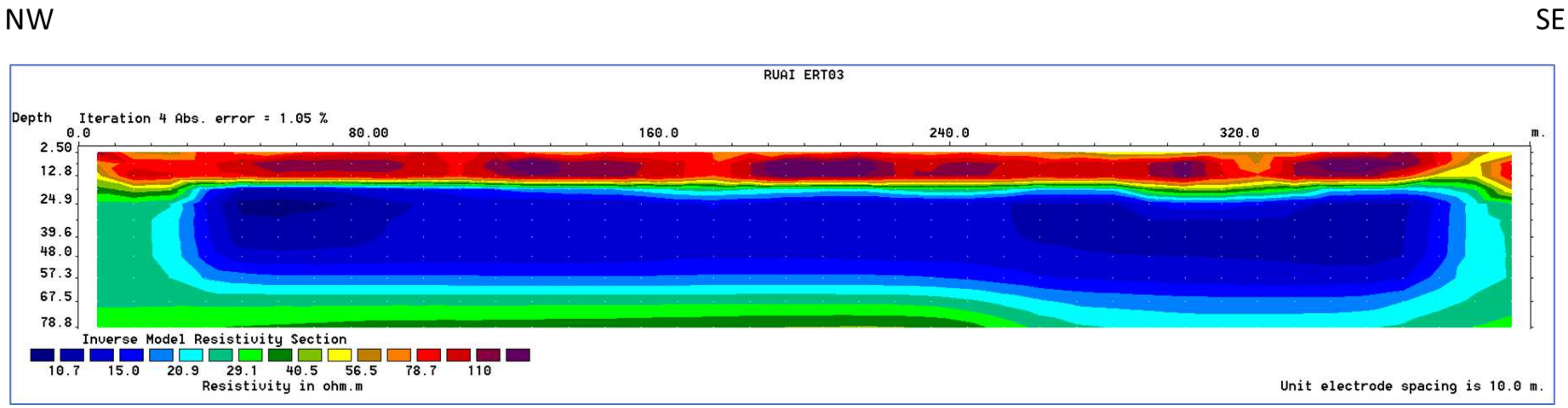

Top dry loose soils
NW
SE
0
-10
-20
-30
-40
Depth (m)
Subcompact sub-soils/weathered rock
Less saturated zone
Less saturated zone
Saturated bedrock
0
25
50
75
100
125
150
175
200
225
250
275
300
325
Distance (m)
V (m/s)
400
800
1200
1600
2000
2400
2800

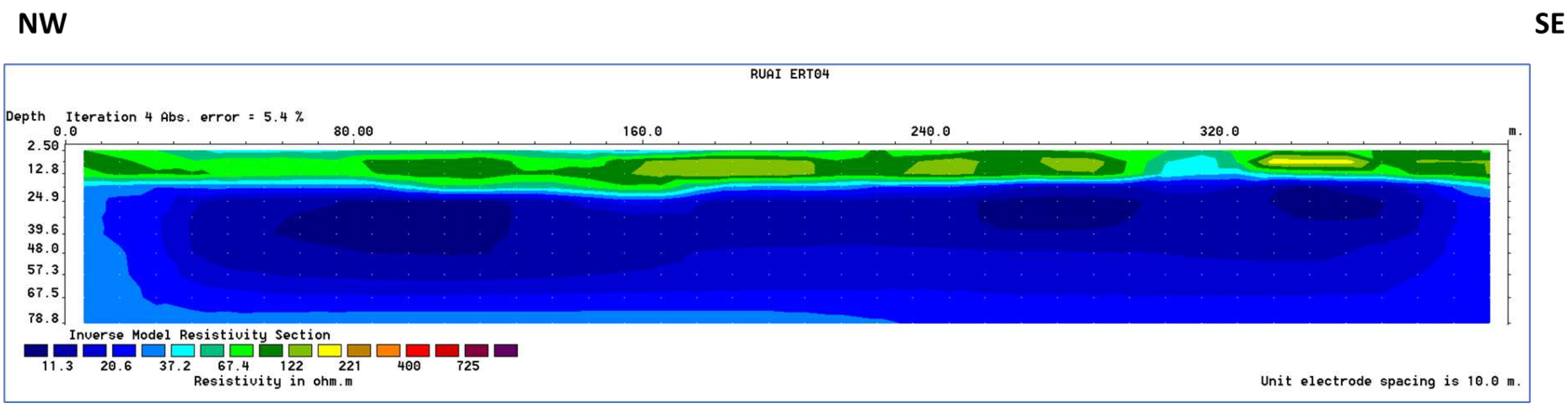
NW SE

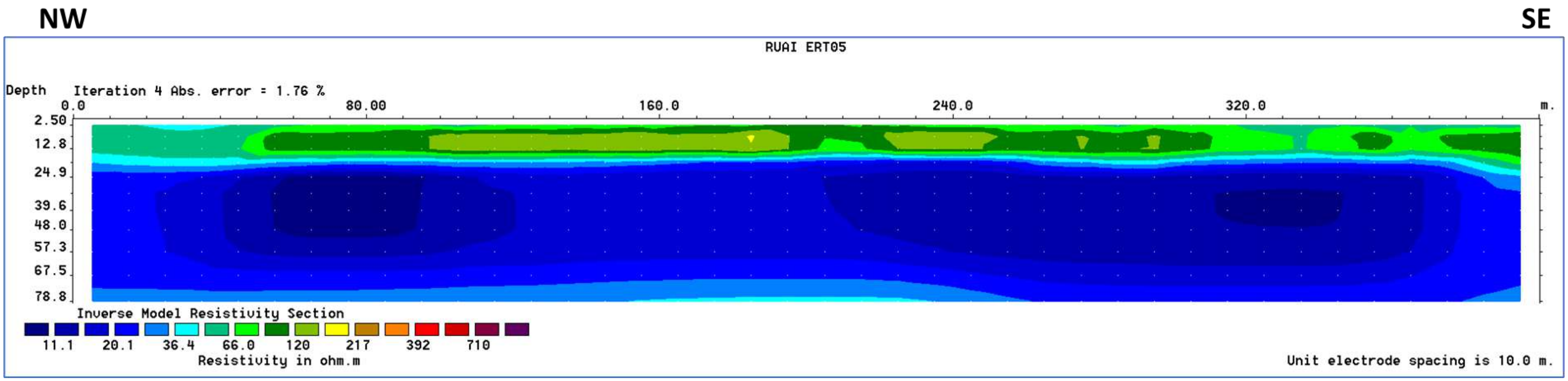

RUAI ERT01
Depth Iteration 4 Abs. error = 1.58 %
10.0 90.00 170.0 250.0 330.0 m.
2.50
12.8
24.9
39.6
48.0
57.3
67.5
78.8
Inverse Model Resistivity Section
9.41 13.2 18.5 25.9 36.2 50.8 71.1 99.7
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.

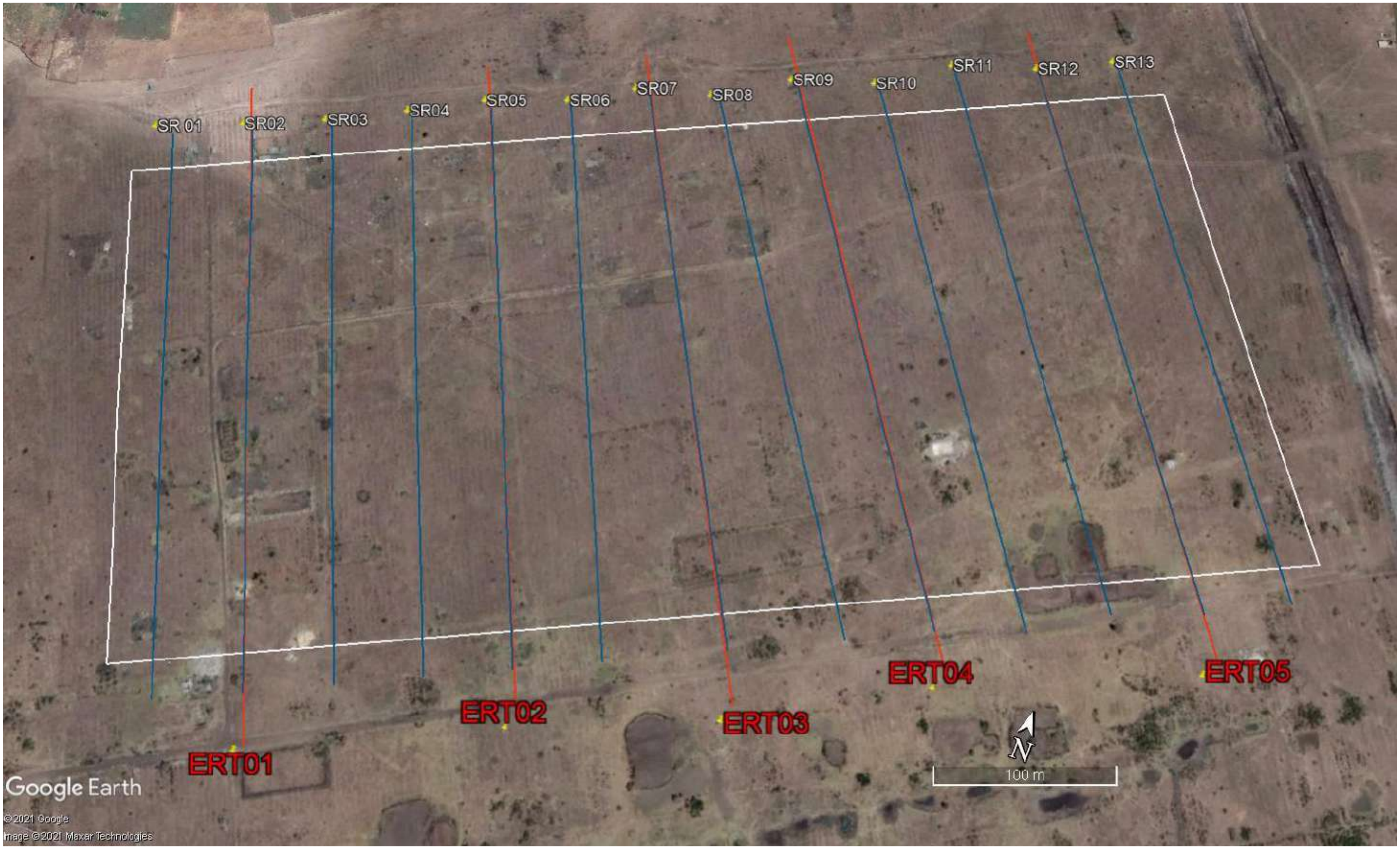
NW SE


RUAI ERT02
Depth Iteration 4 Abs. error = 4.8 %
0.0 80.00 160.0 240.0 320.0 m.
2.50
12.8
24.9
39.6
48.0
57.3
67.5
78.8
Inverse Model Resistivity Section
11.6 27.7 66.2 158 377 898 2143 5111
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.


NW
SE
RUAI ERT03
Depth
Iteration 4 Abs. error = 1.05 %
0.0
80.00
160.0
240.0
320.0
m.
2.50
12.8
24.9
39.6
48.0
57.3
67.5
78.8
Inverse Model Resistivity Section
10.7
15.0
20.9
29.1
40.5
56.5
78.7
110
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.


NW
SE
RUAI ERT04
Depth
Iteration 4 Abs. error = 5.4 %
0.0
80.00
160.0
240.0
320.0
m.
2.50
12.8
24.9
39.6
48.0
57.3
67.5
78.8
Inverse Model Resistivity Section
11.3
20.6
37.2
67.4
122
221
400
725
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.


NW
SE
RUAI ERT05
Depth
Iteration 4 Abs. error = 1.76 %
0.0
80.00
160.0
240.0
320.0
m.
2.50
12.8
24.9
39.6
48.0
57.3
67.5
78.8
Inverse Model Resistivity Section
11.1
20.1
36.4
66.0
120
217
392
710
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.


SR 01
SR02
SR03
SR04
SR05
SR06
SR07
SR08
SR09
SR10
SR11
SR12
SR13
ERT01
ERT02
ERT03
ERT04
ERT05
N
100 m
Google Earth
©2021 Google
Image ©2021 Maxar Technologies

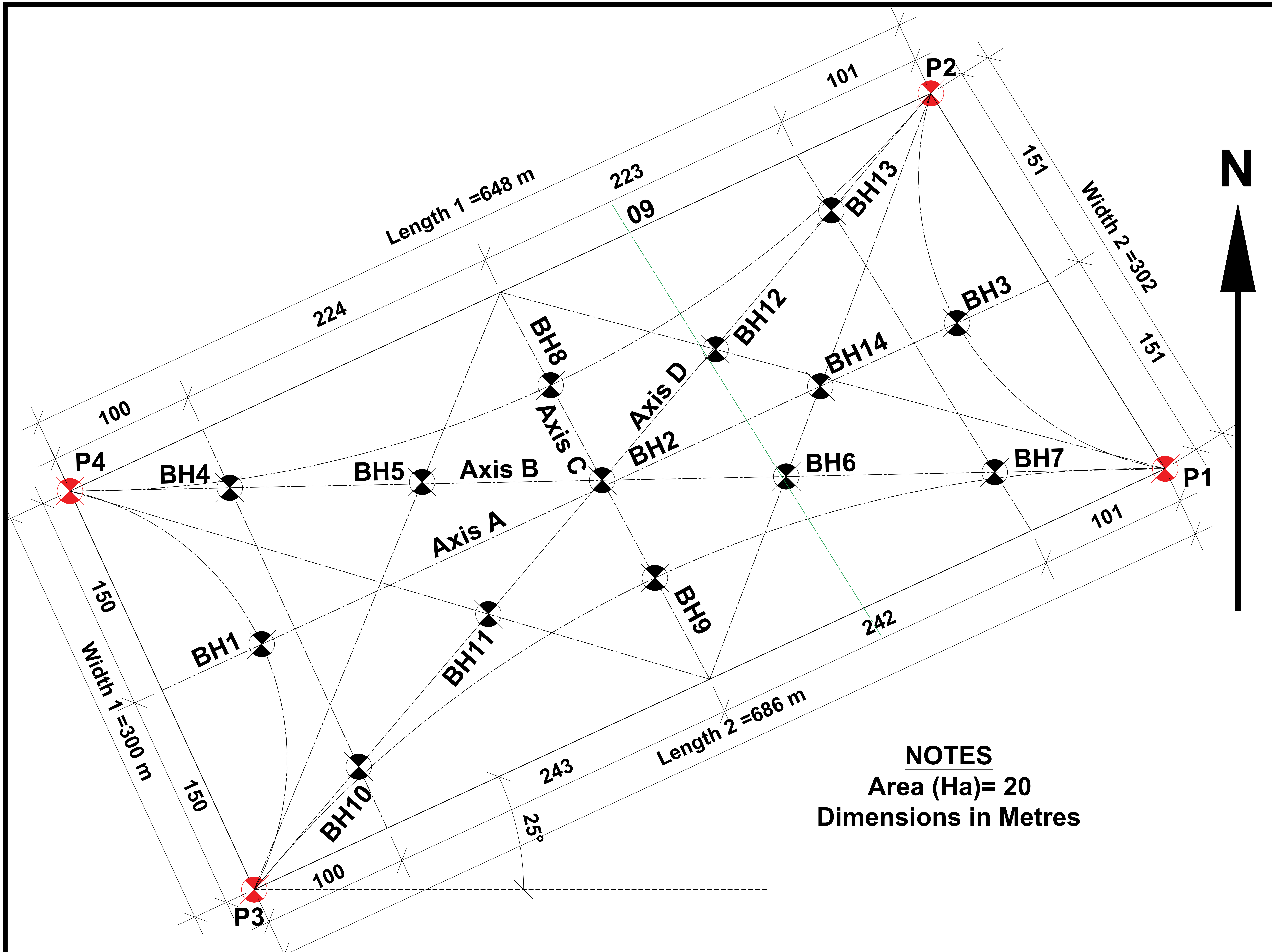
ERT PROFILE START, CENTER AND END COORDINATES (UTM 37S WGS 84)		
X	Y	LABEL
284052.4	9866178	1A
284135.1	9866001	1B
284222.7	9865814	1C
284188.2	9866242	2A
284270.9	9866065	2B
284358.6	9865878	2C
284278.8	9866284	3A
284371.2	9866110	3B
284467.8	9865926	3C
284359.2	9866328	4A
284462.3	9866160	4B
284572.6	9865984	4C
284501.3	9866384	5A
284599.6	9866226	5B
284714.6	9866041	5C

SEISMIC REFRACTION PROFILE COORDINATES (UTM 37S WGS 84)			
X	Y	WPT	
284019.3	9866132	1	SR01
284047.7	9866071	2	
284077.3	9866007	3	
284105.9	9865945	4	
284135.7	9865881	5	
284164.6	9865819	6	
284064.6	9866153	7	SR02
284093.7	9866091	8	
284122.7	9866028	9	
284151.7	9865965	10	
284180.8	9865903	11	
284210	9865840	12	
284110	9866174	13	SR03
284139	9866112	14	

284168.1	9866049	15	
284197.1	9865986	16	
284226.1	9865924	17	
284255.3	9865861	18	
284155.3	9866195	19	SR04
284184.4	9866133	20	
284213.4	9866070	21	
284242.5	9866007	22	
284271.5	9865945	23	
284300.7	9865882	24	
284200.7	9866216	25	SR05
284229.7	9866154	26	
284258.8	9866091	27	
284287.8	9866029	28	
284316.9	9865966	29	
284346	9865903	30	
284246	9866237	31	SR06
284275.1	9866175	32	
284304.1	9866112	33	
284333.2	9866050	34	
284362.2	9865987	35	
284391.4	9865924	36	
284291.4	9866258	37	SR07
284324	9866198	38	
284356.6	9866137	39	
284389.2	9866076	40	
284421.8	9866015	41	
284454.8	9865954	42	
284330.4	9866276	43	SR08
284367	9866217	44	
284403.6	9866159	45	
284440.2	9866100	46	
284476.8	9866042	47	
284514.5	9865982	48	
284375.9	9866298	49	SR09
284412.5	9866239	50	
284449.1	9866181	51	
284485.7	9866122	52	
284522.3	9866064	53	
284560	9866004	54	
284424.7	9866315	55	SR10
284461.3	9866256	56	

284497.9	9866198	57	
284534.5	9866139	58	
284571.1	9866081	59	
284608.8	9866020	60	
284466.5	9866341	61	SR11
284503.1	9866283	62	
284539.7	9866224	63	
284576.3	9866166	64	
284612.9	9866107	65	
284650.6	9866047	66	
284515.9	9866359	67	SR12
284552.5	9866301	68	
284589.1	9866242	69	
284625.7	9866184	70	
284662.3	9866125	71	
284700	9866065	72	
284560.8	9866382	73	SR13
284597.4	9866323	74	
284634	9866265	75	
284670.6	9866206	76	
284707.2	9866148	77	
284744.9	9866088	78	

Some site photos



NOTES
Area (Ha)= 20
Dimensions in Metres

PROPOSED BOREHOLE POSITIONS FOR GEOTECHNICAL INVESTIGATIONS
Scale 1:1250

GEOTECHNICAL NOTES

1. All dimensions are in metres, unless otherwise stated.
2. This drawing can be scaled ,and or figured dimensions be used.
3. This drawing must be read in conjunction with relevant Engineering drawings.
4. Each Borehole must be as specified in Diameter, Depth and Position unless otherwise instructed by the Engineer/Expert
5. All investigations and Tests to be in accordance with Standard methodology issued

REV	REVISIONS		SIGN	DATE	APPROVED
I.3		BY			
		CHECKED			
I.2		BY			
		CHECKED			
I.1		BY			
		CHECKED			
I.0		BY	M.K.N	15.07.2021	
		CHECKED			

Client:

KenGen

Consulting Engineers:

SEURECA VEOLIA

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TEL: +331 85 57 70 00
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E-MAIL: contact@seureca.com

Sub-Contractor:

NICI Universal Enterprises Company Limited;
P.O. Box 85868 00200, Nairobi KE

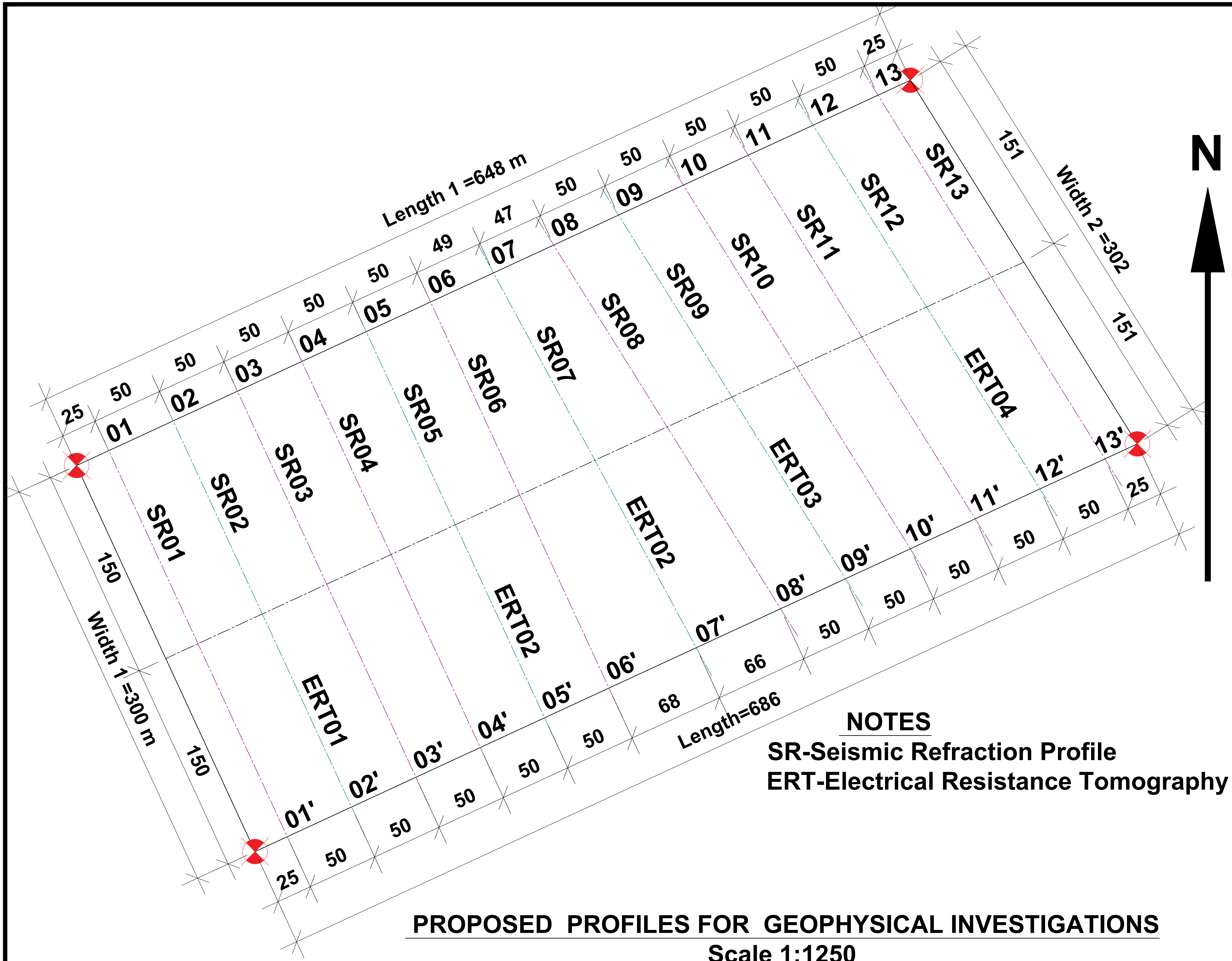
Project:

CONSULTING SERVICES FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY PROJECT

Drawing Title:

GEOTECHNICAL INVESTIGATIONS:
BOREHOLE POSITIONS

Expert:	M.K.N	Drawn by:	M.K.N
Checked by:	NICI	Approved by:	
Scale:	AS SHOWN	Date:	July 2021
Job No.	CEG/NICI/001	ACAD File:	SC-FS-001
P0 STATUS	DRG No. Ceg/NICI-001		R0 REV



NOTES

SR-Seismic Refraction Profile

ERT-Electrical Resistance Tomography

PROPOSED PROFILES FOR GEOPHYSICAL INVESTIGATIONS

Scale 1:1250

GEOTECHNICAL NOTES

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		CHECKED			
I.2		BY			
		CHECKED			
I.1		BY			
		CHECKED			
I.0		BY	M.K.N	15.07.2021	
		CHECKED			

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Sub-Contractor:

NICI Universal Enterprises Company Limited;
P.O. Box 85868 00200, Nairobi KE

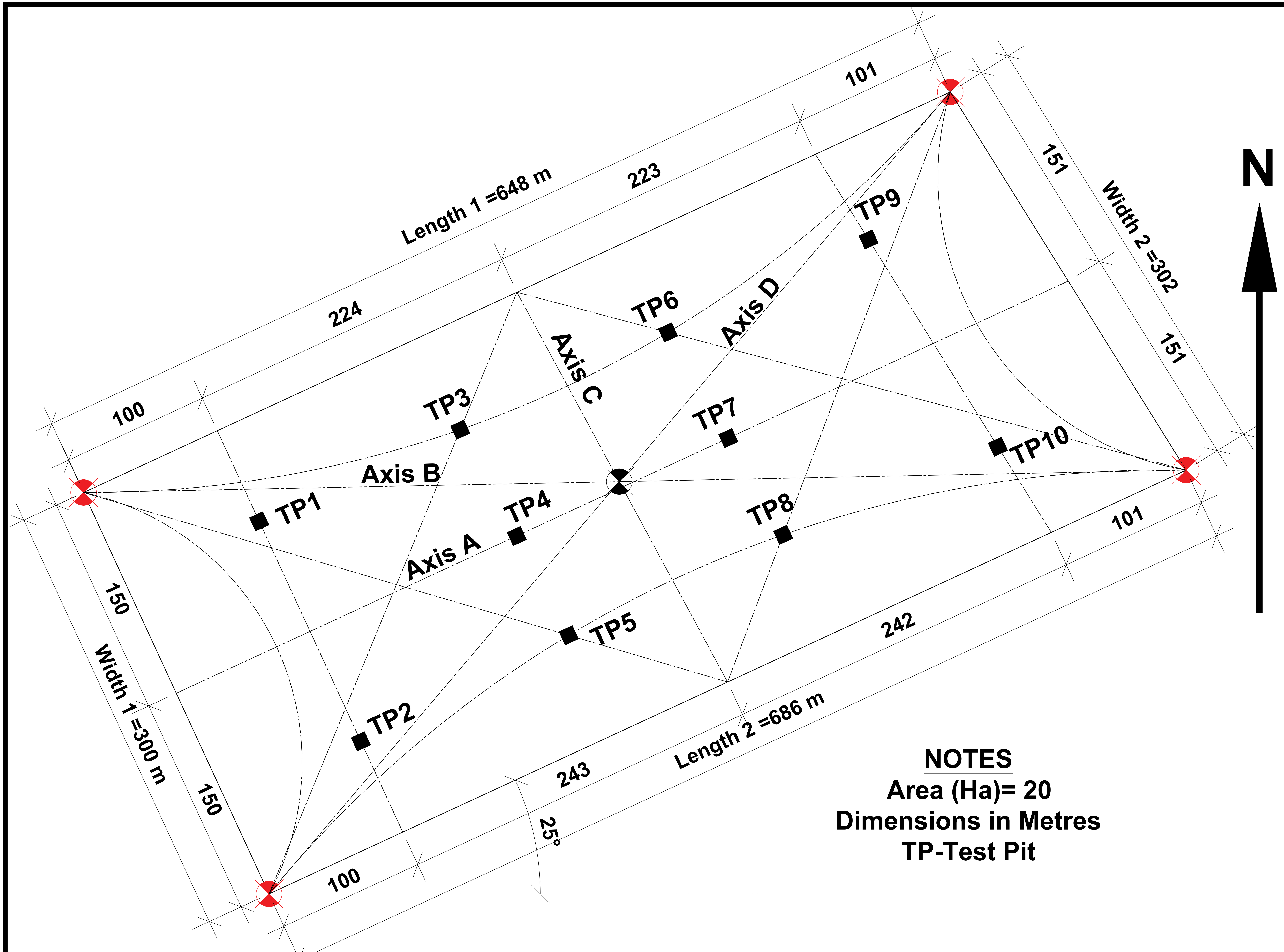
Project:

CONSULTING SERVICES FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY PROJECT

Drawing Title:

GEOTECHNICAL INVESTIGATIONS:
GEOPHYSICAL POSITIONS

Expert: M.K.N		Drawn by: M.K.N	
Checked by: NICI		Approved by:	
Scale: AS SHOWN		Date: July 2021	
Job No. CEG/NICI/001		ACAD File: SC-FS-002	
P0 STATUS	DRG No. Ceg/NICI-002		R0 REV



NOTES

Area (Ha)= 20
Dimensions in Metres
TP-Test Pit

PROPOSED TEST PIT POSITIONS FOR GEOTECHNICAL INVESTIGATIONS

Scale 1:1250

GEOTECHNICAL NOTES

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		CHECKED			
I.2		BY			
		CHECKED			
I.1		BY			
		CHECKED			
I.0		BY	M.K.N	15.07.2021	
		CHECKED			

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Sub-Contractor:

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P.O. Box 85868 00200, Nairobi KE

Project:

CONSULTING SERVICES FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY PROJECT

Drawing Title:

GEOTECHNICAL INVESTIGATIONS:
TEST PIT POSITIONS

Expert: M.K.N		Drawn by: M.K.N	
Checked by: NICI		Approved by:	
Scale: AS SHOWN		Date: July 2021	
Job No.	CEG/NICI/001	ACAD File: SC-FS-003	
P0 STATUS	DRG No. Ceg/NICI-003		R0 REV

SCHEDULE OF BOREHOLES (14 No., 500 m)			
BH No.	Depth (m)	Easting(m)	Northing (m)
BH01	50	284137.621	9865995.271
BH02	50	284370.263	9866107.448
BH03	50	284612.686	9866214.805
BH04	20	284115.609	9866101.952
BH05	20	284247.360	9866106.201
BH06	50	284495.893	9866110.007
BH07	20	284638.506	9866112.911
BH08	50	284335.164	9866172.375
BH09	50	284406.343	9866040.709
BH10	20	284203.814	9865912.033
BH11	20	284292.562	9866015.971
BH12	50	284446.521	9866197.211
BH13	20	284526.886	9866291.809
BH14	30	284519.301	9866171.651

SCHEDULE OF GEOPHYSICAL TESTS					
Position	Easting(m)	Northing (m)	Position	Easting(m)	Northing (m)
01	284029.467	9866110.534	01'	284155.314	9865838.205
02	284074.509	9866131.509	02'	284200.702	9865859.180
03	284120.243	9866152.483	03'	284246.090	9865880.154
04	284165.631	9866173.457	04'	284291.478	9865901.129
05	284211.019	9866194.432	05'	284336.866	9865922.103
06	284256.407	9866215.406	06'	284382.254	9865943.073
07	284300.948	9866235.667	07'	284443.831	9865971.559
08	284343.248	9865333.433	08'	284503.301	9865999.015
09	284388.993	9866276.676	09'	284549.045	9866020.154
10	284434.738	9866297.815	10'	284594.790	9866041.294
11	284480.482	9866318.954	11'	284640.534	9866062.433
12	284526.227	9866340.093	12'	284686.212	9866083.541
13	284571.972	9866361.232	13'	284732.024	9866104.711

SCHEDULE OF TEST PITS (10 No.)		
BH No.	Easting(m)	Northing (m)
TP01	284125.960	9866080.505
TP02	284194.948	9865931.218
TP03	284262.395	9866142.691
TP04	284300.741	9866070.526
BH05	284335.992	9866003.202
TP06	284403.336	9866208.685
TP07	284444.654	9866136.072
TP08	284481.453	9866071.372
TP09	284539.416	9866271.726
TP10	284627.155	9866131.103

LAND CORNER COORDINATES		
BH No.	Easting(m)	Northing (m)
P1	284754.896	9866115.281
P2	284594.844	9866371.802
P3	284132.620	9865827.718
P4	284006.773	9866100.047

GEOTECHNICAL NOTES

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		CHECKED			
L2		BY			
		CHECKED			
L1		BY			
		CHECKED			
L0		BY	M.K.N	15.07.2021	
		CHECKED			

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CONSULTING SERVICES FOR ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT IN NAIROBI CITY COUNTY PROJECT

Drawing Title:

GEOTECHNICAL INVESTIGATIONS:
GEOTECHNICAL POSITIONS

Expert:	M.K.N	Drawn by:	M.K.N
Checked by:	NICI	Approved by:	
Scale:	AS SHOWN	Date:	July 2021
Job No.	CEG/NICI/001	ACAD File:	SC-FS-004
P0 STATUS	DRG No. Ceg/NICI-004		R0 REV

Annex 4

Feasibility Design Study

Annex 5

Land Acquisition Documents

Technical Note

The objective of this technical note is to provide information on the location of the selected site and the general boundary configuration of the Waste to Energy facility.

a) Site selection

An assessment of the candidate sites was presented in the Siting study report submitted on 7th May 2021 with the most preferred site for the establishment WtE plant being Ruai STP riverbank. Based on discussions held among the Key Stakeholders on the submitted report an approval to commence site investigations was issued via mail dated Monday 21st June 2021.While waiting for the written approval to access the recommended site the Consultant has proceeded to earmark the boundaries of the facility to facilitate the commencement of detailed site investigations as per the Terms of Reference for the project.

b) Site Location

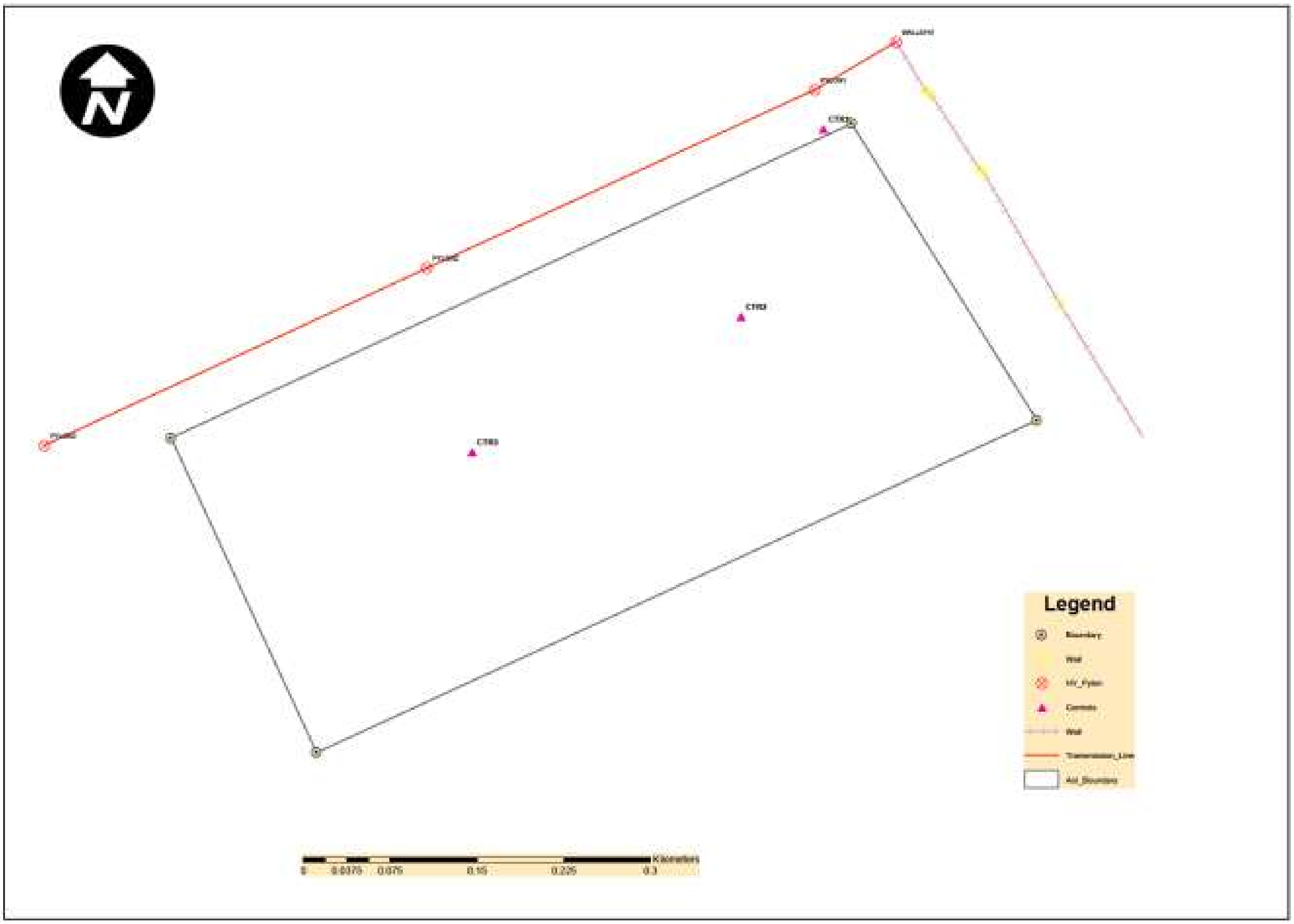
Ruai STP riverbank is located within the Ruai Sewage treatment plant approximately 40km from the Nairobi Central business District. The land is currently owned by the Nairobi County Council with the land reference number **LR No. 12979/1**. The map below shows the general location of the site

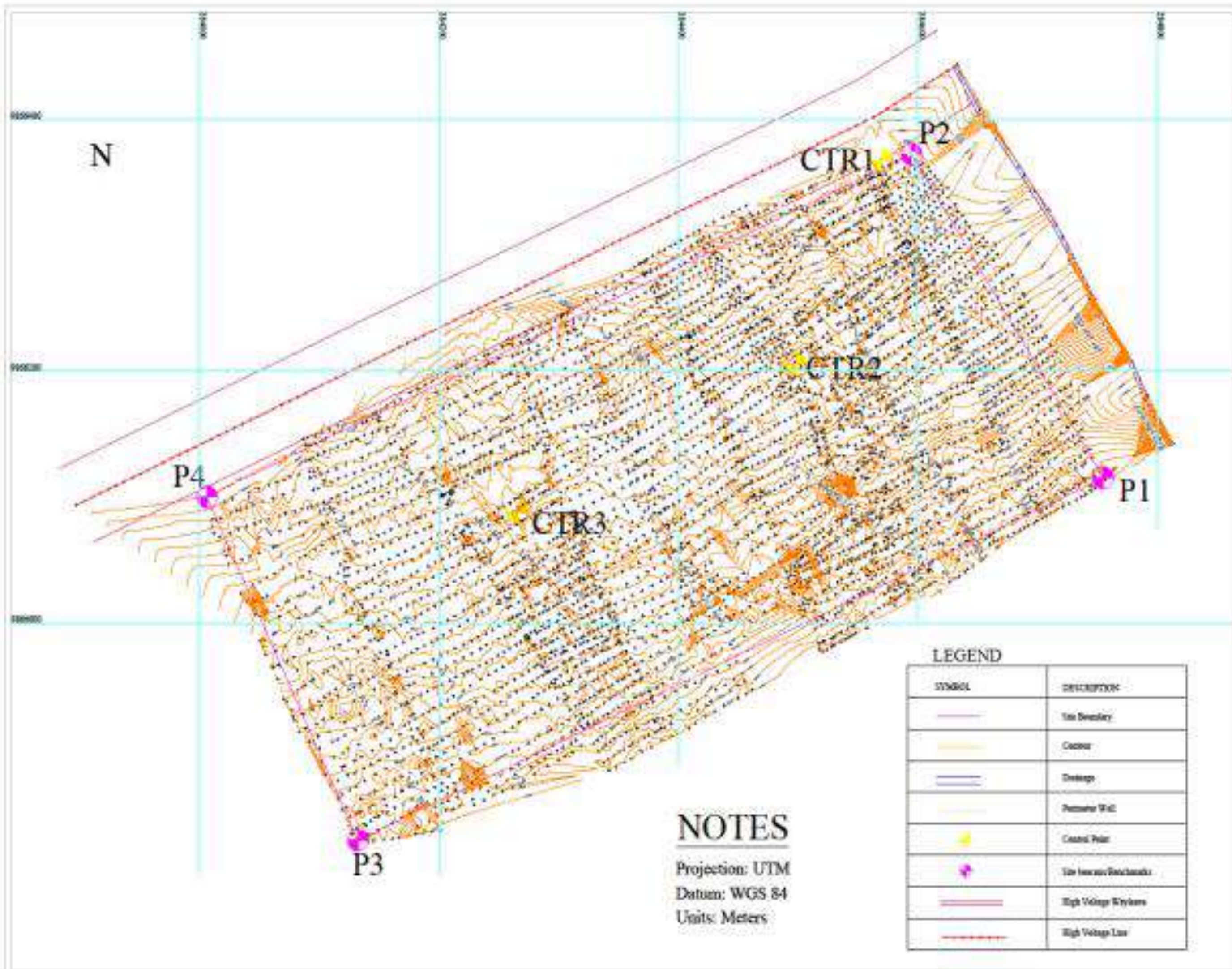
c) Land Requirement

The minimal land requirement for the WtE plant is 20Ha comprising of both the plant and associated landfills. The general plant boundary configuration has been selected based on:

- Overall land requirement for the plant
- Possibility of future expansion of STP ponds by Athi Water Works Development Agency
- Consideration of riparian land requirement (Distance from the river)

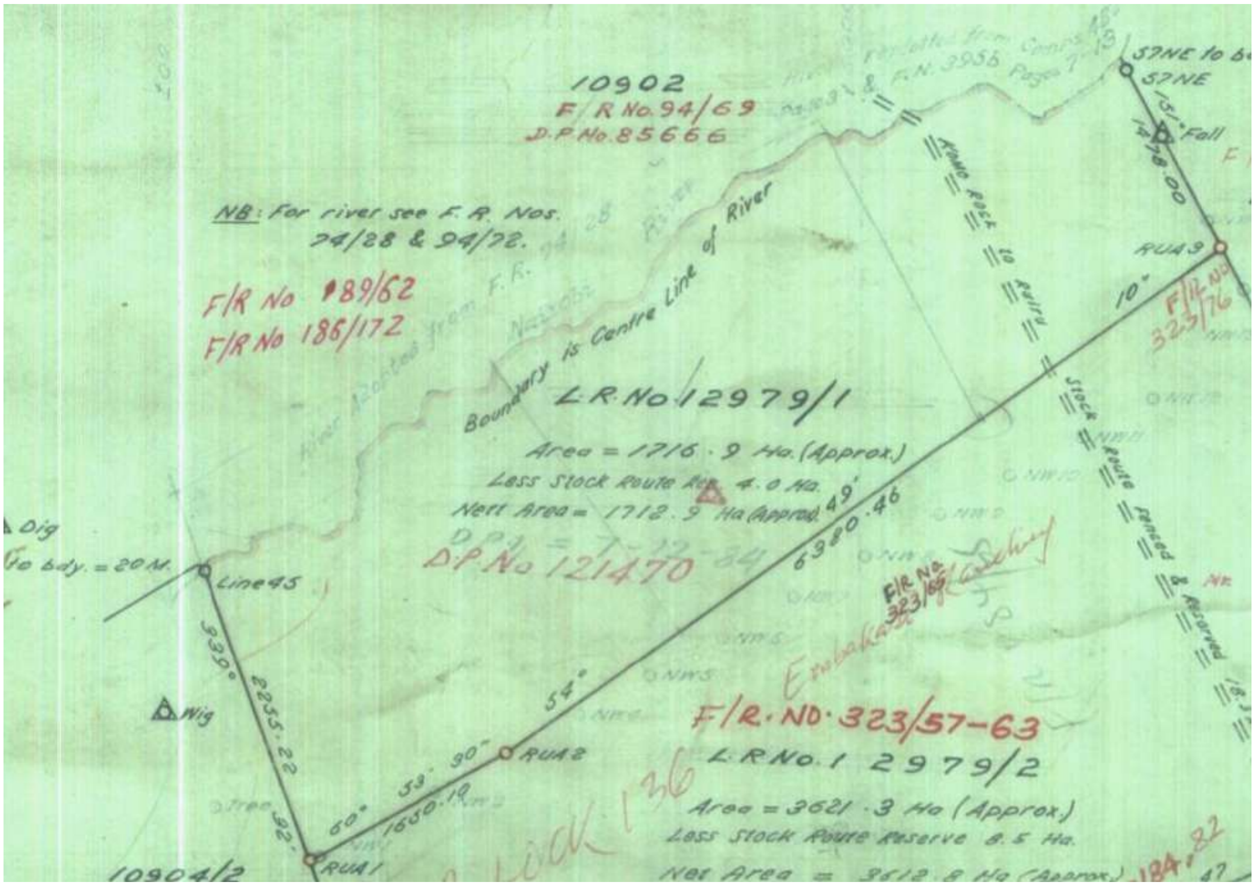
The outline of the boundaries of the facility is presented in the Map below with the proposed dimensions of the area requirement of the Waste to Energy facility.





The coordinates of the points indicated on the map are listed in the table below

No.	Northing	Easting	Elevation
P1	9866115.24	284754.86	1478.918
P2	9866371.77	284594.89	1476.005
P3	9865827.71	284132.63	1478.320
P4	9866099.94	284006.48	1476.203



Registry Index Map of the Proposed WtE site at Ruai

The following activities are currently being carried out within the parcel of land with reference **LR No. 12979/1**

- Topographic survey
- Geotechnical Study
- Environmental and Social Impact Assessment Study

d) Extract from the Siting Study Report

1) General Site Data

The table below highlights general data on the recommended site

Parameter	Ruai STP River Bank
County	Nairobi
Coordinates	Latitude: 37.062759, Longitude: -1.208027
Land availability	20 ha is available Land is under the custody of Athi Water Works Development Agency (AWWDA) Estimated cost of land is 4.50 million Ksh/acre No legacy waste on site
Proximity to waste generation source	29.8 km from Dandora dumpsite 53.6 km from Thika dumpsite
Environmental and social issues	Distance from nearest habitat zone (km) - 1.5 km Distance from nearest school/hospital (km) - 1.5 km No resettlement requirements were identified during initial field visits
Constraints for site development	No legacy waste
Access to power evacuation	Dandora-400.2 MVA, 220/132kV at a distance of 23 km. Transmission lines along the
Water availability	Nairobi river (Perennial River) and Treated sewage water from the Ruai WWTP. The water quality of water from both the river and treatment plant have a moderate to low turbidity and color level
Road network	Excellent road networks

I) Proximity of the waste generation sources

The site is located approximately 29 km from the Dandora dumpsite and 40 km from Nairobi city centre.

II) Potential environmental and social impacts

The nearest habitat is Ruai settlement, which is at a distance of about 1.5 km from the site. The nearest school or hospital is also around 1.5 km from the site. Ruai STP River Bank is located far west from the Nairobi city centre a considerable distance from any school, hospital, forests, cultural sites and other habitat zones. The site is free of any noxious/ pungent fumes or any waste deposits. RAP may not be required for development of the WtE plant at this site.

III) Constraints for site development

Ruai STP River Bank is a wetland area and to overcome the risk of floods, construction of dykes across the river bank will be beneficial.

IV) Access to power evacuation facilities

High voltage transmission line exists in the vicinity at a distance of 200 m from the Ruai STP River Bank site that is across the River-132kV Kindaruma Mang'u -Juja Road Line and on the site is 220kV Kamburu Dandora Line.

On the other hand, dandora substation is 220/132kV, 400.2 MVA, and is located approximately 21 km and 23 km from the site #2 and site#3 respectively. The substation will be compatible with the WtE plant.

V) Water availability

The site is located approximately 100n meters from the Nairobi River (Perennial River) which would provide water supply to the WtE facility. In addition, the site is located within the Ruai WWTP facility which could serve as an additional source of water. Both the WWTP and the Nairobi River were observed to have moderate to low turbidity and colour.

VI) Access to the site

The site has access to excellent road networks and Kangundo road is the nearest highway at a distance of 11 km from the site. The exterior of the WWTP boundaries are connected via public roadways. In between the WWTP ponds, narrow paths are present which are used for internal movements. However, a small road construction (50-100m in length) may be required to improve the access to the sites.

4437

REPUBLIC OF KENYA

MEMORANDUM OF UNDERSTANDING

Between

Nairobi Metropolitan Services

and

Kenya Electricity Generating Company PLC

on

Cooperation in Waste to Energy Power Plant

THIS MEMORANDUM OF UNDERSTANDING (hereinafter referred to as "**MOU**") is made this ..27th..day of .....April......2021

between

the **Nairobi Metropolitan Services,** a public entity established on 18 March 2020 pursuant to Executive Order No. 1 of 2020, as the Institutional Framework to perform transferred functions on behalf of the National Government of P. O. Box 49130 -00100 Nairobi, Kenya (hereinafter referred to as **"NMS"** which expression will where the context so admits include its successors and assignees) on the one part, and

the **Kenya Electricity Generating Company PLC,** a Public Company incorporated under the Company's Act of P. O. Box 47936- 00100 Nairobi, Kenya (hereinafter referred to as "**KenGen**" which expression will where the context so admits include its successors and assignees) on the other part.

(hereinafter referred to jointly as "Parties" and singularly as a "Party")

WHEREAS pursuant to Article 187 of the Constitution, on 25 February 2020 the Nairobi City County Government and the National Government signed a Deed of Transfer of Functions Agreement which was published vide Gazette Notice No. 1609, transferring four (4) functions, which include solid waste management under the County Health Services, to the National Government;

WHEREAS pursuant to the said Deed of Transfer of Functions, on 18 March 2020, the Nairobi Metropolitan Services was established as the Institutional Framework to perform the transferred functions on behalf of the National Government;

WHEREAS KenGen is a power generating company that seeks to deliver affordable clean energy while expanding energy sources;

COGNISANT of the challenges that Nairobi City County has faced in its quest for better Solid Waste Management and the current calorific measurements of the waste generated within the city;

COGNISANT of the technological advances in solid waste management through Waste-to-Energy Projects;

RECOGNIZING that the Nairobi City County Government had initiated a Waste to Energy Programme that did not attain full completion;

RECOGNIZING that **KenGen** has the technical capacity, experience and competency in the energy sector having undertaken electricity generation through the development, management, and operation of power plants; and

RECOGNIZING that Nairobi City County Government has conducted a feasibility study for a Nairobi Urban Waste to Energy Plant and **KenGen** had in 2012 conducted a feasibility study for a Nairobi Urban Waste to Energy Plant.

NOW IT IS HEREBY AGREED AS FOLLOWS: -

ARTICLE 1 – OBJECTIVE

1.1 The objective of this MOU is to establish a framework that will promote, enhance and enable cooperation and partnership between NMS and **KenGen** on the Design, Installation, Commissioning, Financing, Operation and Management of a waste to energy power plant project at Dandora Dumpsite or any other appropriate site in Nairobi County.

1.2 The Parties will make every effort to ensure the achievement of the objectives of this MOU within the stated timelines through collaboration, cooperation and mutual respect.

ARTICLE 2 - INTERPRETATION & GENERAL GOVERNING PROVISIONS

2.1 All matters in this MOU will be interpreted by the general governing provisions as contained herein.

2.2 Where necessary, the parties will facilitate the necessary policy shifts and reviews to provide an enabling environment for the achievement of the objectives of this MOU.

ARTICLE 3 - SCOPE

3.1 This MOU will cover the roles and responsibilities of the parties towards attainment of the overall objective of this MOU.

3.2 The Parties will, by agreement in writing, mutually agree on the benefits that will accrue to each of them out of this arrangement including setting out the terms and conditions under which income and/or any surplus derived from the operations of the Power Plant will be shared and/or accrue to them.

ARTICLE 4 - ROLES AND RESPONSIBILITIES OF THE PARTIES

4.1 Roles and responsibilities of the NMS

a) Avail land within or around the Dandora Dumpsite or any other appropriate site within Nairobi County on such lease terms as shall be agreed by both parties, for use in the Waste to Energy Power Plant project.

b) Ensure adequate and timely delivery of solid waste and other input material to the Waste to Energy Power Plant at such terms and conditions as may be agreed.

c) Provide all requisite materials and data that may be necessary or required to facilitate implementation of the project.

d) Jointly undertake and participate in the planning meetings and activities with KenGen geared towards implementation of the objectives.

e) To perform such other functions as may be necessary or incidental to ensure successful implementation of the project.

4.2 Roles and responsibilities of the KENGEN

a) Provide the necessary expertise, capacity building and technical assistance to NMS during the implementation of the Waste to Energy Power Plant Project.

b) Identify the possible power plant initial capacity that would be developed.

c) Through the National Treasury, raise financing for the engineering, construction, and commissioning of the Waste to Energy Power Plant including the related power plant infrastructure - access roads, electricity, water, sewerage system and any other necessary utilities.

d) Jointly undertake and participate in the planning meeting and activities with NMS geared towards implementation of the objectives.

e) Build, own, operate and manage the Waste to Energy Power Plant upon commissioning for such a duration and upon such terms that will be agreed upon before commencement of the Waste to Energy Power Plant Project. For avoidance of doubt, parties hereby agree that the ownership referred to in this clause strictly refers to the Waste to Energy Power Plant and not the land.

f) Perform such other functions as may be necessary or incidental to ensure successful implementation of the project.

ARTICLE 5 - FUNDING AND RESOURCES

5.1 KenGen will fund the entire Waste to Energy Power Plant project including the update of the feasibility study, the related power plant infrastructure - the access roads, electricity, water sewerage system and any other necessary utilities.

5.2 Both parties will engage the electricity off-taker and/or the regulator for an appropriate Power Purchase Agreement (PPA) that is necessary to ensure financial closure of the project.

5.3 The final tariff will reflect all the project development costs, investment return expectations and any government subsidies that may be necessary for project viability. The gate fee/tipping fee will be determined and embedded in the tariff.

5.4 KenGen will be responsible for the preparatory costs of identifying through procurement, the contractor responsible for the engineering, construction and commissioning of the Waste to Energy Plant and other related costs prior to commencement of construction of the Waste to Energy Power Plant project.

5.5 Except as herein provided, each party will be responsible for costs related to performance of their obligations.

ARTICLE 6 - IMPLEMENTATION OF THE MOU

6.1 The parties will undertake periodic joint meetings and other engagements to review and discuss ways and means of implementing the Waste to Energy Power Plant project.

6.2 The parties will adhere to the internationally accepted principles and values consistent with the applicable domestic laws.

6.3 The Parties may establish a Joint Implementation Committee (hereinafter referred to as JIC) to promote, coordinate and facilitate the implementation of this MOU.

6.4 The Parties will mutually frame Terms of Reference (ToR) and the modus operandi (mode of operation) of the JIC. The JIC may meet as often as it is necessary to implement the objectives of this MOU.

6.5 The parties may enter into any other agreements, instruments or arrangements including service level agreements, Operation and Maintenance agreements, off-take agreements, or any other undertakings as may be required to facilitate successful implementation and operationalization of the project.

6.6 The Joint Implementation Committee will provide progress reports to the Parties on the status of the implementation of this MOU, at the frequency defined in the JIC ToR.

ARTICLE 7 -CONFIDENTIALITY

7.1. During the execution of this MOU, the Parties will regularly exchange information, which could be considered confidential or proprietary information. At the time of furnishing information, the Parties hereby agree that unless the contrary is expressly stated, by label, stamp, or other written communication, any and all such information will be deemed to be confidential.

7.2. Confidential Information will be treated as hereunder. The receiving party agrees:

(i) Not to use, disclose or otherwise deal with that information in a manner that is likely to cause prejudice or injury to the other party or in breach of the procedure provided for hereunder.

(ii) to restrict the use of such information to matters relating to the receiving party's performance of this MOU, and

(iii) to restrict access to such information to employees of the receiving party and its agents whose access is necessary in the implementation of this MOU.

7.3 Confidential information will not be reproduced without the disclosing party's prior written consent, and all copies of written information will be returned to the disclosing party upon request except as the parties may otherwise agree.

7.4 Each Party will only disclose confidential or proprietary information which it owns or otherwise has the right to disclose. To the extent that either Party cannot procure the right to obtain and/or disclose the relevant and necessary information from any third parties necessary for the other Party to perform its obligations hereunder, the then said other Party shall be excused from performing those obligations. Subject to the preceding, the disclosing party makes no representations or warranties, express or implied, as to the quality, accuracy or completeness of the confidential information disclosed hereunder.

ARTICLE 8 COMMUNICATION

Any communication and notices under this MOU will be effective as of the date of receipt and will be deemed to have been sufficiently given if sent by personnel delivery, registered mail, postage prepaid, or e-mail and must be directed to the Head Offices of the Parties as follows;

The Director General
Nairobi Metropolitan Services
Kenyatta International Convention Centre, 23rd Floor
P.O Box 49130 -00100
Nairobi

Managing Director/ Chief Executive Officer
KenGen Pension Plaza II
Kolobot Road, Parklands
P. O. Box 47936, 00100,
Nairobi

ARTICLE 9 - LEGAL STATUS OF MOU

This MOU merely constitutes a statement of the mutual intentions of the parties with respect to its contents and does not constitute any legal obligation binding on either side.

ARTICLE 10 - DISPUTE RESOLUTION

10.1 In the event of a dispute, controversy or claim arising out of or relating to this MoU, or the breach, termination or invalidity thereof ("dispute"), the parties will endeavour in good faith to mutually and amicably resolve any dispute that might arise.

10.2 Any dispute that is not settled within thirty (30) days from the date either Party has notified the other Party of the nature of the dispute and of the measures that should be taken to rectify it will be resolved through executive consultation between the executive management of the parties or their duly authorized representatives.

10.3 Each party will give full and sympathetic consideration to any proposal advanced by the other to settle amicably any matter for which no provision has been made or any controversy as to the interpretation or application of this MOU.

ARTICLE 11 – ENTRY INTO FORCE, AMENDMENT AND TERMINATION

11.1 This MoU will enter into force upon signing by the parties and will remain valid for such time as may be agreed upon by parties and as will be provided for in ensuing agreements pertinent to this MOU.

11.2 Each Party may suggest amendments or modifications to this MOU. In such a case, consultation will be initiated, in order to agree upon the suggested amendments or modifications. All amendments or modifications will be in writing and signed by the duly authorized representatives of each Party. The amendments or modifications agreed upon will form a part of the MOU.

11.3 This MOU may be terminated at any time during the validity period by either Party giving three (3) months' notice in writing of its intention to do so.

12. ASSIGNMENT

Neither Party will be entitled to assign or transfer to a third party all or part of the rights or obligations under the present MOU, without the prior written consent of the other party.

13. SEVERABILITY

The invalidity in whole or in part of any provision of this MOU will not void or affect the validity of any other provision of this MOU. The Parties hereto agree to substitute any provision of this MOU, which is or has become invalid by such a provision which is consistent with the original intent of the Parties.

14. PARTICIPATION IN SIMILAR ACTIVITIES

This MOU will, in no way, restrict the parties from participating in similar activities with other institutions.

IN WITNESS whereof this MOU has been signed by or on behalf of each Party by its duly authorized representative the day and year first above written.

For and on behalf of: Kenya Electricity Generating Company PLC	**For and on behalf of:** Nairobi Metropolitan Services
Managing Director/&CEO	Director General
	EXECUTIVE OFFICE OF THE PRESIDENT P.O. BOX 62345-00200 NAIROBI DIRECTOR GENERAL NAIROBI METROPOLITAN SERVICES
Date: 27/4/2021	Date: 27/4/2021

WITNESSED BY:	**WITNESSED BY:**
The Principal Secretary Ministry of Energy	Deputy Director General
Date: 27/4/2021	**Date:** 27/4/2021

26 MAR 2021

Ag CS / LAD
J2: BDD for action
29/3
c.c
Ag CPM
29/03

REPUBLIC OF KENYA

OFFICE OF THE ATTORNEY-GENERAL
&
DEPARTMENT OF JUSTICE

Our Ref: AG/CONF/21/74/21/ VOL 1 20th March 2021
Your Ref: ME/CONF/2/5/1

KENYA ELECTRICITY GENERATING ... MANAGING ... 29 MAR 2021 CAPITAL PLANNING & RPP RECEIVED

Dr. Eng. Joseph K. Njoroge, CBS
Principal Secretary
Ministry of Energy
Nyayo House
NAIROBI

RE: REQUEST FOR CONCURENCE TO EXECUTE THE PROPOSED MEMORANDUM OF UNDERSTANDING BETWEEN KENGEN PLC AND NAIROBI METROPOLITAN SERVICES FOR THE WASTE TO ENERGY POWER PLANT PROJECT AT DANDORA DUMPSITE

We refer to your letter dated 1st March 2021 forwarding an amended Memorandum of Understanding (MOU) between the Kenya Electricity Generating Company Plc (KenGen) and the Nairobi Metropolitan Services (NMS) on the above subject matter, for our review prior to execution.

Having reviewed the MoU, we note that our previous comments have been incorporated and/or addressed.

We note that the objective of the MoU is to establish a framework that will promote, enhance and enable cooperation and partnership between the parties on the Design, Installation, Commissioning, Financing, Operation and Management of a Waste to Energy Power Plant Project at Dandora dumpsite or any other appropriate site in Nairobi County.

The parties may proceed and execute the MoU on the understanding that:

a) This MoU is not a method of procurement and therefore the identification and engagement of an entity to provide goods, works and/or services must be done in full compliance with Article 227 of the Constitution and in accordance with the Public Procurement and Asset Disposal Act, 2015 and its regulations.

b) The NMS must ensure that the land is available and free from encumbrances.

c) The Parties ensure that adequate budgetary provision has been made to cater for costs and expenses that may be incurred under the MoU.

Kindly note to provide us with a signed copy of the MoU for our information and records.

KENNEDY OGETO CBS
SOLICITOR GENERAL

Copy to: Hon. P. Kihara Kariuki, EGH
ATTORNEY GENERAL

Hon. Charles Keter, EGH
Cabinet Secretary
Ministry of Energy
Nyayo House
NAIROBI

Major General Mohammed A. Badi, EBS, SS, ndc (k)
Director General
Nairobi Metropolitan Services
KICC
NAIROBI

Mrs. Rebecca Miano, MBS
Managing director
Kenya Electricity Generating Company Plc
Stima Plaza B, Parklands
NAIROBI

BDD

KENYA ELECTRICITY GENERATING CO. LTD
RECEIVED
12 JUL 2021
BUSINESS DEVELOPMENT DIRECTOR

12 JUL 2021

ATHI WATER WORKS

Athi Water Works Development Agency
Athi Water Plaza, Muthaiga North Road, Off Kiambu Road
P. O Box 45283 - 00100 Nairobi
Tel: (+254) 20 - 2724292/3, Mobile : (+254) 715 - 638272
E-mail: info@awwda.go.ke
www.awwda.go.ke

14/07/21

When replying please quote: AWSB/TECH/2/3/VOL II (18) pnk

8th July, 2021

Mrs Rebecca Miano, MBS
The Managing Director & CEO,
Kenya Electricity Generating Company PLC,
KenGen Pension Plaza,
P.O Box 47936-00100,
NAIROBI.

Dear, CEO

RE: COMMENCEMENT OF DETAILED SITE INVESTIGATION AT RUAI SEWER SITE FOR WASTE TO ENERGY PROJECT

Reference is made to your letter ref: CPPP/WtE/12/22/JN/fk dated 28th June 2021 on the above subject matter in which KenGen has engaged consultancy services of Seureca to undertake feasibility study on an urban Waste to Energy (WTE) facility in Nairobi County, and of which Ruai Water Treatment plant has been identified as the most suitable site for the development of the waste to energy facility.

Athi Water Works Development Agency (AWWDA), is pleased that following the initial presentation to Nairobi Metropolitan Services and the Ministry of Energy and KenGen approval to proceed with the detailed site investigation at Ruai Plant has been given.

AWWDA will coordinate to ensure the consultant is able to undertake detailed site investigation for the preparation of the feasibility Study. The contact person for this activity is Patricia Kiarie of telephone 0741403616 and email pkiarie@awwda.go.ke.

Yours

ENG. MICHAEL M. THUITA
CHIEF EXECUTIVE OFFICER

MANAGING DIRECTOR'S OFFICE

KenGen
Kenya Electricity
Generating Company PLC

Our Ref: CPPP/WtE/12/22/JN/fk

Date: 28th June, 2021

Eng. Michael Thuita
The Chief Executive Officer,
Athi Water Works Development Agency,
Athi Water Plaza, Muthaiga North Road,
Off Kiambu Road,
P.O. BOX 45283-00100,
NAIROBI

Dear Eng. Thuita,

RE: COMMENCEMENT OF DETAILED SITE INVESTIGATIONS AT RUAI SEWER SITE FOR WASTE TO ENERGY PROJECT

KenGen has engaged consultancy services of Seureca to undertake a feasibility study on an urban Waste to Energy (WTE) facility in Nairobi County. The task commenced in March 2021 and is expected to be completed before the end of this year.

Part of the scope of the study involved carrying out a site selection by identifying potential sites and ranking them. Based on the study conducted, a site at Ruai Water treatment plant facility was identified as the most suitable site for the development of the waste to Energy facility. The estimated size of land required for waste to energy facility is 20 Hectares.

The Siting study report has been presented to the Nairobi Metropolitan Services and the Ministry of Energy and KenGen has thus been given an approval to proceed with a detailed site investigation study at Ruai site.

The Consultant plans to carry out site investigations that will aid in the preparation of the final feasibility study report. The detailed site investigations will include topographical Survey, geotechnical Study and Environmental and Social Impact Assessment. These activities are planned to commence from June 2021 to December 2021.

This letter serves as a notification of the commencement of the site activities and request you for any assistance that the consultant may require during the course of the study.

Yours Sincerely

REBECCA MIANO (MRS), MBS
MANAGING DIRECTOR & CEO

Kenya Electricity Generating Co. PLC
RECEIVED
10 AUG 2021
MANAGING DIRECTOR

REPUBLIC OF KENYA
EXECUTIVE OFFICE OF THE PRESIDENT
NAIROBI METROPOLITAN SERVICES

Telegraphic Address
Telephone +3313002/4
When replying please quote

Kenyatta International Convention Centre
P. O. Box 49130-00100
NAIROBI

Ref: EOP/NMS/CPD/6/VOL I **9th August, 2021**

Dr. Nicholas Muraguri, CBS
Principal Secretary
Ministry of Lands & Physical Planning
P O BOX 30450-00100
NAIROBI

Dear Dr Muraguri,

ESTABLISHMENT OF WASTE TO ENERGY PLANT FOR NAIROBI CITY COUNTY

It has been confirmed to Nairobi Metropolitan Services by ministry of Energy that KenGen has completed the feasibility studies for waste to Energy Plant in Nairobi City County, and that all the necessary clearances obtained from stakeholders.

Among all the sites under consideration, Ruia Sewer Plant River Bank was picked as most suitable, location. The National Government reclaimed the land and fenced it off.

This is to request you to issue the title deed as the waste to Energy Power Plant will require it. Nairobi Metropolitan Services has already given its concurrence to the ministry of Energy to go ahead and implement this vital (Presidential Directive) Project on the site.

Yours Sincerely,

KANGETHE THUKU, EBS
DEPUTY DIRECTOR GENERAL

Lt. Gen. Mohammed Abdalla Badi, CBS, SS,ndc (K)
Director General
Nairobi Metropolitan Services
NAIROBI

Hon. Farida Karoney
Cabinet secretary
Ministry of Lands & Physical Planning
P O Box 30119- 00100
NAIROBI

Hon. Charles Keter, EGS
Cabinet secretary
Ministry of Energy
P O Box 30582
NAIROBI

Eng. (Dr.) Joseph K Njoroge, CBS
Principal secretary
Ministry of Energy
P O Box 30582
NAIROBI

Mr. Joseph W. Irungu, CBS
Principal Secretary,
Ministry of Water & Sanitation and Irrigation
NAIROBI

Mrs Rebecca Miano, MBS
Managing Director & CEO
Kenya Electricity Generation Company PLC
NAIROBI

The Director
Directorate to Environment, Water & Sanitation
Nairobi Metropolitan Services
NAIROBI

The Director
Directorate of Lands, Housing, Urban Renewal and Development
Nairobi Metropolitan Services
NAIROBI

Annex 6

Laboratory Noise Level Analysis

Baseline Noise Survey Report

Waste to Energy Project- Ruai Sewerage Plant

ENVIROPRO KENYA LIMITED

Prepared For:

KenGen
Energy for the nation.

Report Details

This document has been prepared by EnviroPro Kenya Limited

Prepared for:

Report Type:	**Baseline Noise Survey**
Project Name:	**Waste to Energy Project- Ruai Sewerage Plant**
Project Code:	

Name	Responsibility	Signature	Date
C Oduor	Report Compiler		October 2021
	Report Editor		October 2021
	Report Review		October 2021
T Omenda	Project Manager		October 2021

This report is provided solely for the purposes set out in it and may not, in whole or in part, be used for any other purpose without EnviroPro Kenya Limited prior written consent.

Executive Summary

EnviroPro Kenya Limited was commissioned by KenGen to conduct a survey to quantify the existing background noise levels in the area around the proposed development of Waste to Energy project (hereafter referred to as *the project*) located at the Ruai Sewerage Plant.

Measurements to quantify noise levels have been undertaken inside and around the project site. The proposed project area is located inside an open field owned by the Ruai Water and Sewerage Company. There are no major activities in the vicinity of the project site and is mainly characterized with movement of large herds of livestock. The nearest residential units are located approximately 700 m away. Assessments were conducted at the project site boundary fence. The project will involve development and operation of waste to energy conversion facilities.

Findings:

Measurements to quantify noise levels were undertaken within the project area in both the diurnal and nocturnal schedules. The major sources of noise at the project area as observed over the monitoring period include:

i. Livestock herding;
ii. Aircraft taking off from the JKIA and passing over the section;
iii. House construction activities including grinding and welding approximately 200 meters away from the site;
iv. Birds chirping, and dogs barking (this was especially during the nocturnal schedule).

The obtained noise levels were compared against the EMC maximum permissible limits for construction sites. Noise levels obtained during the nocturnal schedule are all within the respective regulatory limit except for SP1. Dogs barking, birds chirping and house construction related activities near the point all contributed to the reported noise levels. Children playing and other domestic activities were also noted to contribute to the reported levels. Noise levels obtained during the diurnal schedule are all within the respective EMC regulatory limit. It is confirmed that background levels are sometimes higher than regulatory limits. With the knowledge of the aforementioned, it further stresses the need for adequate mitigation measures to be factored into its day-to-day operation of the Project development, to avoid exacerbating ambient noise levels.

The baseline data obtained is representative of the noise levels at all the measurement locations and can be used to compare subsequent levels when the project is under

construction and operational phases of the project.

Summary of the obtained results are presented in the Tables 0-1 and 0-2.

Table 0-1: Nocturnal noise levels- Results

Sampling location	**Date of measurement**	**Lmin**	**Lmax**	**Leq**	**EMC limits**
SP1	21st to 22nd September 2021	29.6	60.2	**36.6**	35
SP2	22nd to 23rd September 2021	25.6	43.0	**32.6**	35
SP3	23rd to 24th September 2021	28.3	44.5	**31.7**	35
SP4	24th to 25th September 2021	24.1	50.7	**33.7**	35
SP5	25th to 26th September 2021	26.4	60.3	**34.2**	35
SP6	26th to 27th September 2021	27.0	55.6	**33.8**	35

Table 0-2: Diurnal noise levels- Results

Sampling location	**Date of measurement**	**Lmin**	**Lmax**	**Leq**	**EMC limits**
SP1	21st September 2021	29.3	69.3	**43.8**	50
SP2	22nd September 2021	42.7	43.0	**44.3**	50
SP3	23rd September 2021	31.1	51.4	**40.7**	50
SP4	24th September 2021	29.9	83.1	**49.0**	50
SP5	25th September 2021	29.3	79.3	**45.3**	50
SP6	26th September 2021	29.4	68.7	**40.1**	50

Contents

List of Abbreviations

EHS	Environmental Health and Safety
ESIA	Environmental and Social Impact Assessment
EMCA	Environment Management and Coordination Act
NEMA	National Environment Management Authority
GIIP	Good International Industry Practice
ToR	Terms of Reference
dB	Decibels

1 Introduction

1.1 Background

The noise measurement will form part of a range of specialist studies undertaken for the proposed Waste to Energy project (the Project). The Government of Kenya intends to improve environmental sustainability by improving municipal solid waste (MSW) management and promoting renewable energy in Kenya. In order to manage Nairobi's waste as well as to overcome the hazards at the Dandora dumpsite, Nairobi Metropolitan Services (NMS) is partnering with Kenya Electricity Generating Company PLC (KenGen) to establish a waste-to-energy (WtE) plant within Nairobi Metropolitan Area. An ESIA study is ongoing and the scope includes assessment of baseline ambient air quality levels.

This noise level study was conducted in accordance with Kenyan legislation, as contained in the Environment Management and Coordination Act (EMCA), No. 8 of 1999. The study also took cognisance of the EHS guidelines as prescribed by the International Finance Corporation (IFC).

The Project will affect existing noise levels in the project area; therefore, a baseline noise study was undertaken to define the existing acoustic environment in the Project area prior to development.

The preliminary baseline noise study outlined in this report focuses on the collection of representative data at two monitoring sites located inside and around the Project area. Surveys to collect representative acoustic baseline data at the monitoring locations within the project area were conducted from 21st to 27th September 2021. Data collected throughout the program included sound levels, temperature, wind direction and speed, relative humidity, location, and monitoring site photographs. The surveys were then reviewed along with other available data to establish baseline noise conditions at noise sensitive receptors subsequently identified for the environmental impact assessment.

1.2 Site Description

Measurements to quantify noise levels have been undertaken inside and around the project site. The proposed project area is located inside an open field owned by the Ruai Water and Sewerage Company. There are no major activities in the vicinity of the project site and is mainly characterized with movement of large herds of livestock. The nearest residential units are located approximately 700 m away. Assessments were conducted at the project site boundary fence. The project will involve development and operation of a waste to energy conversion facility. The major sources of noise at the project area as observed over the monitoring period include:

v. Large herds of livestock;
vi. Aircraft taking off from the JKIA and passing over the section;
vii. House construction activities like grinding and welding approximately 200m away from the site;
viii. Dogs barking- This is especially during the nocturnal schedule.

.

1.3 Legislative Guidance

The guidance laid out in ISO 1996-1:2016 - defines the basic quantities to be used for the description of noise in community environments and describes basic assessment procedures. It also specifies methods to assess environmental noise and gives guidance on predicting the potential annoyance response of a community to long-term exposure from various types of environmental noises.

The obtained levels were reported against the limits provided in the EMCA- Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009. The applied limits are outlined in section 3 of this report.

2 Methodology

2.1 Environmental Conditions at the Time of Measurement

The general guidelines require that a baseline noise study be conducted under weather conditions acceptable for noise measurement. Requirements include wind speeds of less than 15 km/h and no precipitation. Temperatures must be within manufacturer's tolerances for instrument operation. Weather data collected included hourly wind speed and direction, temperature, precipitation, and relative humidity.

For this noise study, representative weather conditions were observed by the field crew. The average weather conditions at the time of measurement are summarised in section 4.1 of this report.

2.2 Approach and measurement methodology

The baseline noise measurement methods used were consistent with the requirement of the ISO 1996 protocol Parts 1, 2, 3 standards, entailing the following:

- Inspection of the monitoring locations and the implicated activities
- Compiling photographic reports of the monitoring locations and surroundings.
- Calibration of the sound level meter before and after each measurement.
- At all positions the meter was mounted on a tripod approximately 1.5m above ground level.
- Noise levels expressed in decibels, A-weighted sound pressure level dB (A).

Measurements were conducted for 24 hours at two locations as follow:

- Diurnal schedule -14 hours and
- Nocturnal schedule- 10 hours.

Surveys of this type and duration provide information on daily variability in noise levels, as well as provide an expected typical or average daily condition.

A model Larson Davis LxT Type I integrating sound level meter was used to collect the measurements and sound recordings at each site. The meter logs noise levels and records audible sound over a set monitoring period selected by the user. The effective measurement range of the instrument is 20-140 dBA to ±1 dBA accuracy. The logging rate was set for 30 seconds over the monitoring period.

The annual calibration certificates for the meters used are provided in Appendix 7.2, which also shows the serial numbers of all the equipment used. Microphones were placed 1.2 - 1.5m above the ground, and at least 1.5m from any reflective surface. Note that the A-weighted frequency network and Fast (F) time weighting was used for all measurements.

Data parameters logged every half a minute for each survey period included the following:

- integrated average equivalent noise level (Leq) in dBA;
- maximum noise level (Lmax) in dBA;
- minimum noise level (Lmin) in dBA; and
- 1/3 octave band values in dB.

A glossary of acoustics terminology is provided in Appendix 7.3

A Calibrator was used for calibrating the meters before and after each monitoring period. The calibrator has an estimated uncertainty for sound pressure level of ±0.12 dB at a 99% confidence level. Calibration was performed before and after each 3-hour monitoring period to ensure the noise meter variance was within 0.5 dB.

Data were downloaded to a computer for analysis with the Larson Davis *SLM software program*. The data were Quality Assurance/Quality Control (QA/QC) reviewed to identify sources of noise and filter out invalid data, such as noise from technician activities. Daily and nightly values were calculated as per EMC guidelines; daytime was defined as 6:00 AM to 8:00 PM and night-time as 8:00 PM to 6:00 AM. Field crew recorded precipitation, cloud cover, wind direction, and observed audible noise sources. Weather conditions were also documented and are discussed in section 4.1.

2.3 Instrumentations

The following instruments were used during the measurement:

- Larson Davis Type 1
- Tripod Stand.
- GPS
- Camera
- Acoustic Calibrator
- Open Field Microphone
- Calibration certificates for the acoustic instruments are included in appendix 1 of this report.

3 Applicable Regulatory Limits

3.1 EMCA Regulations

The Environmental Management and Coordination Act (EMCA), 1999, is the framework law on environmental management and conservation. EMCA establishes among others the following institutions; National Environment Management Authority, Public Complaints Committee, National Environment Tribunal, National Environment Action Plan Committees, and County Environment Committees. The National Environment Management Authority (NEMA) was established as the principal instrument of government charged with the implementation of all policies relating to the environment, and to exercise general supervision and coordination over all matters relating to the environment. In consultation with the lead agencies, NEMA is empowered to develop regulations, prescribe measures and standards and, issue guidelines for the management and conservation of natural resources and the environment. The Act provides for environmental protection through;

- Environmental impact assessment;
- Environmental audit and monitoring;
- Environmental restoration orders, conservation orders, and easements.

The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 was used to report the obtained results. The limits for various zones are presented in Table 3-1. These regulations prescribe measures against noise and vibration from specified sources and define permissible noise levels for various activities including mining and construction. The regulation requires a license to be obtained from the National Environmental Management Authority (NEMA) for noise producing activities and provide for noise and excessive vibration mapping by designated mapping bodies. The Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations, 2009 sets out maximum permissible noise levels in the Second Schedule of the Regulation for various zones. Part IV of the Regulations states that where a sound source emits noises which fail to comply with the provisions of the Regulation, such a person shall apply for a license to NEMA.

***Table 3-1**: EMC Maximum Permissible Noise levels- 1st & 2nd Schedules*

MAXIMUM PERMISSIBLE NOISE LEVELS

Zone		*Sound Level Limits dB(A)* (Leq,14 h)		*Noise Rating Level (NR)* (Leq,14 h)	
		Day	Night	Day	Night
A.	Silent Zone	40	35	30	25
B	Places of worship	40	35	30	25
C.	Residential : Indoor	45	35	35	25
	Outdoor	50	35	40	25
D.	Mixed residential (with some commercial and places of entertainment)	55	35	50	25
E.	Commercial	60	35	55	25

Time Frame

Day: 6.01 a.m. – 8.00 p.m. (Leq, 14 h)
Night: 8.01 p.m. – 6.00 a.m. (Leq, 10h)

SECOND SCHEDULE

(r. 13(1), 14 (1)(b))

MAXIMUM PERMISSIBLE NOISE LEVELS FOR CONSTRUCTIONS SITES
(Measurement taken within the facility)

Facility		*Maximum Noise Level Permitted (Leq) in dB(A)*	
		Day	Night
(i)	Health facilities, educational institutions, homes for disabled etc.	60	35
(ii)	Residential	60	35
(iii)	Areas other than those prescribed in (i) and (ii)	75	65

Time Frame: Day: 6.01 a.m. – 6.00 p.m. (Leq, 14 h) Night: 6.01 p.m. – 6.00 a.m. (Leq, 14 h)

Limits under residential areas have been used in this report.

4 Baseline Noise survey Results

4.1 Project Area

The predominant activity in the ESIA Study is livestock herding. Assessments were conducted inside the project site at six points.
In addition to herding, aircrafts taking off from JKIA, security dogs barking at night and birds chirping were also observed to predominantly contribute to the reported noise levels.

Another source of noise, though not dominant is the construction activities observed at the time of monitoring around 200 m from the project site.

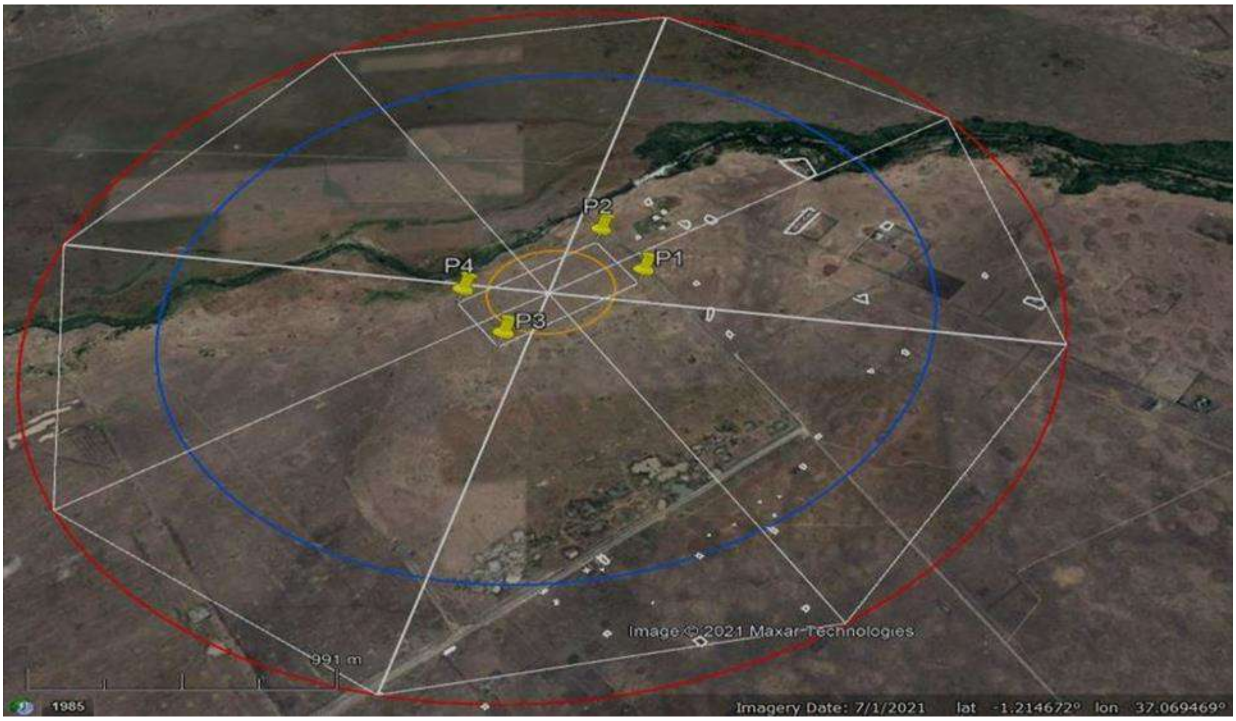


Figure 4-1: project area

The project site showing the measurement locations is presented in section 4.3.

4.2 Meteorology

Ruai's climate is classified as warm and temperate. There is significant rainfall throughout the year in Ruai. Even the driest month still has a lot of rainfall. This climate is considered to be Cfb according to the Köppen-Geiger climate classification. The temperature here averages 19.3 °C | 66.7 °F. In a year, the rainfall is 681 mm | 26.8 inches. The monthly average wind speeds range from 2 m/s to 5 m/s blowing from North West to East direction. Onsite meteorological data for the same period was analysed and used in combination with the modelled data to understand background meteorology.

Dispersion of atmospheric pollutants is a function of the prevailing wind characteristics at any site. The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (Cowherd et al, 1998; Cowherd et al, 2010).

The amount of PM generated by wind is highly dependent upon the wind speed. Below the wind speed threshold for a specific particle type, no particulate matter is liberated, while above the threshold, particulate matter liberation tends to increase with wind speed. The amount of particulate matter generated by wind is dependent also on the surface properties, for example, whether the material is crusted, the fraction of erodible particles, and the particle size distribution (Fryrear et al., 1991).

4.2.1 Wind direction

The dominant winds at the project site over the sampling period was from the North West to direction towards the East.

4.2.2 Wind Speed

One of the factors that favor the suspension dispersal of pollutants in the atmosphere is the intensity of the wind speed regime. Wind speed greater than 5.4 m/s leads to erosion of loose dust PM and enhances the degree of dispersion across the landscape. Wind speed at the project area over the monitoring period indicate diurnal mean wind speed ranged from 2 m/s to 6 m/s. Wind speeds were highest in the evening hours and much lower in the night.

4.2.3 Temperature

The daily maximum and average temperatures for the month of September near the project area were also recorded. The maximum temperatures exceeded 28°C with average daily temperature in the range of 20- 25 ^{0}C.

4.2.4 Precipitation

Short rains were recorded on the last day of monitoring (27th September around 15:00) and averaged 0.5 mm. There was no rainfall reported on all the other days of monitoring.

4.2.5 Relative Humidity

The daily averages for RH over the project area was reported. Daily averages ranged from 55% to 80% throughout the monitoring period.

4.3 Baseline Noise Levels

The Project area is located inside an open field with no major activities except for livestock herding. Figure 4-1 shows the project area. The monitoring sites were marked SP1 to SP6. A brief description of the monitoring locations is provided in Table 4-2.

4.2.1 Description of the assessment points

The areas monitored are all within the vicinity the project site. The six monitoring points are described in Table 4-1.

Table 4-1: Measurement points

Site ID	GPS location	Description
SP1	1°12'39.20"S 37° 3'55.14"E	At the site boundary corner, noise levels mainly affected herding and construction activities of a residential house nearby.
SP2	1°12'28.30"S 37° 3'48.84"E	At the site boundary corner, noise levels mainly affected herding, dogs barking and construction activities of a residential house nearby.
SP3	1°12'32.45"S 37° 3'40.96"E	At the site boundary fence line, noise levels mainly affected herding and birds chirping
SP4	1°12'39.80"S 37° 3'31.55"E	At the site boundary corner, noise levels mainly affected herding and birds chirping
SP5	1°12'44.64"S 37° 3'45.78"E	At the site boundary fence line, noise levels mainly affected herding and birds chirping

SP6	1°12'50.44"S 37° 3'36.87"E	At the site boundary corner, noise levels mainly affected herding and birds chirping

Note: aircrafts flying over the site is a source of noise common in all the monitoring points.

The monitoring locations are further presented in Figure 4-2

Figure 4-2: monitoring points

4.2.2 Measurement Results

The obtained data for each measurement location compared against the respective EMC set maximum limits are summarised in Table 4-2 and 4-3.

Table *4-2*: Measurement Results- Nocturnal schedule

Sampling location	**Date of measurement**	**Lmin**	**Lmax**	**Leq**	**EMC limits**
SP1	21st to 22nd September 2021	29.6	60.2	**36.6**	35
SP2	22nd to 23rd September 2021	25.6	43.0	**32.6**	35
SP3	23rd to 24th September 2021	28.3	44.5	**31.7**	35
SP4	24th to 25th September 2021	24.1	50.7	**33.7**	35
SP5	25th to 26th September 2021	26.4	60.3	**34.2**	35
SP6	26th to 27th September 2021	27.0	55.6	**33.8**	35

Table *4-3*: Measurement Results- Diurnal schedule

Sampling location	**Date of measurement**	**Lmin**	**Lmax**	**Leq**	**EMC limits**
SP1	21st September 2021	29.3	69.3	**43.8**	50
SP2	22nd September 2021	42.7	43.0	**44.3**	50
SP3	23rd September 2021	31.1	51.4	**40.7**	50
SP4	24th September 2021	29.9	83.1	**49.0**	50
SP5	25th September 2021	29.3	79.3	**45.3**	50
SP6	26th September 2021	29.4	68.7	**40.1**	50

5 Potential Impacts

5.1 Construction Phase

The construction phase will comprise excavations and development of the project and associated Infrastructure. In order to determine the significance of the potential for impacts it was imperative to conduct background assessment of noise levels in the proposed Project area, and findings have been discussed in this report. Noise levels reported will serve as reference for future assessment when appraising impacts. It is expected that the construction activities will significantly impact on the exiting noise levels.

5.2 Operational Phase

During the operational phase, noise levels will most likely be skew towards noise generated from production operations. The potential impacts anticipated during this phase will be assessed at a later stage.

6 Conclusion

Measurements to quantify noise levels were undertaken within the project area in both the diurnal and nocturnal schedules. The major sources of noise at the project area as observed over the monitoring period include:

i. Livestock herding;

ii. Aircraft taking off from the JKIA and passing over the section;

iii. House construction activities including grinding and welding approximately 200 meters away from the site;

iv. Birds chirping, and dogs barking (this was especially during the nocturnal schedule)

The obtained noise levels were compared against the EMC maximum permissible limits for construction sites. Noise levels obtained during the nocturnal schedule are all within the respective regulatory limit except for SP1. Dogs barking, birds chirping and house construction related activities near the point all contributed to the reported noise levels. Children playing and other domestic activities were also noted to contribute to the reported levels. Noise levels obtained during the diurnal schedule are all within the respective EMC regulatory limit. It is confirmed that background levels are sometimes higher than regulatory limits. With the knowledge of the aforementioned, it further stresses the need for adequate mitigation measures to be factored into its day-to-day operation of the Project development, to avoid exacerbating ambient noise levels.

The baseline data obtained is representative of the noise levels at all the measurement locations and can be used to compare subsequent levels when the project is under construction and operational phases of the project.

7 Appendices

7.1 Photographic Report

Description: noise level measurement in progress at SP6

Description: Diurnal noise level Measurement in progress at SP4

Description: main activity at the project site

Description: noise monitoring in progress at SP3

Description: noise level monitoring at SP2

Description: ongoing house construction around the project site

Description: noise level monitoring at SP1

7.2 Calibration certificate

Calibration Certificate

Certificate Number 2021001264

Customer:

EMC Consultants
Shelter Afrique Center
Longonot Road, Upper Hill
3rd Floor Wing 3A
Nairobi, , Kenya

Model Number	LxT SE	***Procedure Number***	D0001.8384
Serial Number	0004897	***Technician***	Ron Harris
Test Results	**Pass**	***Calibration Date***	2 Feb 2021
Initial Condition	Inoperable	***Calibration Due***	
		Temperature	23.72 °C ± 0.25 °C
Description	Sound Expert LxT Class 1 Sound Level Meter Firmware Revision: 2.404	***Humidity***	52 %RH ± 2.0 %RH
		Static Pressure	86.06 kPa ± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 μPa.***

Larson Davis PRMLxT1L. S/N 042684
PCB 377B02. S/N 168608
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2017.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

This report may not be reproduced, except in full, unless permission for the publication of an approved abstract is obtained in writing from the organization issuing this report.

Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert Lxt, I770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

LARSON DAVIS - A PCB PIEZOTRONICS DIV.
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ilac-MRA ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

2021-5-17T10:06:56 **Page 1 of 3** D0001.8406 Rev E

Certificate Number 2021001264

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to 1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

No Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 available.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3 cover only a limited subset of the specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis CAL291 Residual Intensity Calibrator	2020-09-18	2021-09-18	001250
Hart Scientific 2626-S Humidity/Temperature Sensor	2020-05-12	2021-05-12	006943
Larson Davis CAL200 Acoustic Calibrator	2020-07-21	2021-07-21	007027
Larson Davis Model 831	2020-03-02	2021-03-02	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2020-03-05	2021-03-05	007185
SRS DS360 Ultra Low Distortion Generator	2020-04-14	2021-04-14	007635
Larson Davis 1/2" Preamplifier for Model 831 Type 1	2020-10-06	2021-10-06	PCB0004783

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.00	113.80	114.20	0.14	Pass

As Received Level: 114.05
Adjusted Level: 114.00

-- End of measurement results--

Loaded Circuit Sensitivity

Measurement	Test Result [dB re 1 V / Pa]	Lower Limit [dB re 1 V / Pa]	Upper Limit [dB re 1 V / Pa]	Expanded Uncertainty [dB]	Result
1000 Hz	-27.73	-29.61	-26.24	0.14	Pass

-- End of measurement results--

Certificate Number 2021001264

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.23	-0.20	-1.20	0.80	0.23	Pass
1000	0.21	0.00	-0.70	0.70	0.23	Pass
8000	-2.05	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted	40.32

-- End of measurement results--

-- End of Report--

Signatory: Ron Harris

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7.3 Noise Terminology

Since the concepts and theories used in the assessment of outdoor acoustics are not intuitive, the following description of key concepts and definitions used in this evaluation are provided to guide the reader. The following lists some of the key terminology that is used in the noise assessment:

- "Sound" or "sound emissions" refer to the acoustic energy generated by natural or man-made sources.
- "Noise" or "noise levels" refer to the levels that can be heard or measured at a receptor.
- A noise "receptor" is a location where measurements or predictions of noise levels are made.
- The "volume" of a sound or noise is expressed on a logarithmic scale, in units called decibels (dB). Since the scale is logarithmic, a sound or noise that is twice as loud as another will only be 3 dB higher. A sound or noise with double the number of decibels is much more than twice as loud.
- Sound emissions and noise levels also have a "frequency." The human ear does not respond to all frequencies in the same way. Mid-range frequencies are most readily detected by the human ear, while low and high frequencies are harder to hear. Environmental noise levels are usually presented as dBA, which incorporates the frequency response of the human ear.
- While low frequency noise may not be "heard," it can often be felt. A "C-weighted" decibel (or dBC) is a frequency-weighting in which the low frequencies are included more than with A-weighting, making this unit useful in determining potential for low frequency noise impacts.
- Low frequency noise (LFN) is the portion of sound below a defined spectrum band. As per Energy Resources Conservation Board (ERCB) Directive 038 (AEUB 2007), LFN is defined as either a clear tone presents below a frequency of 250 Hz or where the overall dBC minus dBA value exceeds 20 dB.
- Outdoor or environmental noise levels are typically not steady or continuous. To account for the time-varying nature of environmental noise, levels are usually expressed as energy equivalent sound levels, or Leq. The Leq is defined as the continuous sound level that has the same acoustic energy as the varying sound for a given time period. This is expressed as a logarithmic average of the measured or predicted noise levels over a given period of time. For constant sources of noise, the sound level and Leq are the same. The noise levels discussed in the assessment represent equivalent sound levels (Leq).
- "Sound power level" or Lw is the level of sound power, expressed in decibels (dB)

relative to a stated reference value of 1 x 10-12 Watt (dB re 10-12 Watts).

- "Sound pressure level" or Lp is the difference between the instantaneous pressure at a fixed point in a sound field, and the pressure at the same point with the sound absent. It is quantified by the following equation:

$$Lp = 10 \log 10(prms/pref)2$$

Where prms is the root mean square sound pressure and pref is the reference root mean square sound pressure of 20x10-6 Pascal.

8 References

i. ISO 1996-1:2016

ii. EMCA (Noise and excessive vibrations) (control) Regulations, 2009

Annex 7

Laboratory Soil _ Water Quality Analysis

SOIL & WATER TESTING REPORT

Ruai Sewerage Plant- Waste to Energy Project

Subsurface Soil & Water Sampling and Analyses – Prepared for KENGEN

KenGen
Energy for the nation.

September 2021

REPORT DETAILS

REPORT TITLE	**SOIL and WATER TESTING REPORT**
REPORT REFERENCE NUMBER	
SAMPLING DATE	**30th September 2021**
PURPOSE OF ASSESSMENT	**Baseline studies**
OPERATING CONDITIONS	**No Operations**
CLIENT	**ENVIROPRO KENYA LIMITED**
CONTACT PERSON	**Mr. Geoffrey Nagillah**
PREPARED BY	**Chrisphine Oduor**
STATUS	**Draft Report**

TABLE OF CONTENTS

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1. INTRODUCTION

1.1 Background Information

EnvriPro Kenya Limited was commissioned to undertake soil and water sampling and analysis at a site in Ruai Sewerage Plant for the proposed Waste to Energy project, in Nairobi County. The Government of Kenya intends to improve environmental sustainability by improving municipal solid waste (MSW) management and promoting renewable energy in Kenya. In order to manage Nairobi's waste as well as to overcome the hazards at the Dandora dumpsite, Nairobi Metropolitan Services (NMS) is partnering with Kenya Electricity Generating Company PLC (KenGen) to establish a waste-to-energy (WtE) plant within Nairobi Metropolitan Area. The testing exercise is part of an ongoing ESIA studies for the site. The site is an open field which borders the Nairobi to the East and with several geotechnical boreholes within.

EnviroPro Kenya Limited is approved by the National Environmental Management Authority (NEMA) for Environmental Assessments, and analysis of the soil and water samples was undertaken by Labworks East Africa Limited Laboratories which are approved by NEMA and are also ISO 17025 accredited.

This report details the sampling and testing methodologies applied and presents the results of sampling performed during the month of September 2021.

1.1 Scope of work

The ToR as agreed with Kengen entailed the following:

- Collect and analyze two subsurface soil samples;
- Collect and analyze one river water sample and one borehole water sample;
- Present the findings in a comprehensive sampling and analyses report.

2. REGULATIONS AND GUIDELINES

2.1 Environmental Management and Coordination, (Water Quality) Regulations 2006

These Regulations shall apply to drinking water, water used for industrial purposes, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife, and water used for any other purposes. Limits prescribed in the first schedule of the regulations for sources of domestic water have been used for comparison against the obtained river water results as presented in Table 1

Table 1: Standards for sources of Domestic Water

FIRST SCHEDULE

QUALITY STANDARDS FOR SOURCES OF DOMESTIC WATER

Parameter	**Guide Value (max allowable)**
pH	6.5 – 8.5
Suspended solids	30 (mg/L)
Nitrate-NO_3	10 (mg/L)
Ammonia –NH_3	0.5 (mg/L)
Nitrite –NO_2	3 (mg/L)
Total Dissolved Solids	1200 (mg/L)
Scientific name *(E.coli)*	Nil/100 ml
Fluoride	1.5 (mg/L)
Phenols	Nil (mg/L)
Arsenic	0.01 (mg/L)
Cadmium	0.01 (mg/L)
Lead	0.05 (mg/L)
Selenium	0.01 (mg/L)
Copper	0.05 (mg/L)
Zinc	1.5 (mg/L)
Alkyl benzyl sulphonates	0.5 (mg/L)
Permanganate value (PV)	1.0 (mg/L)

Nil means less than limit of detection using prescribed sampling and analytical methods and equipment as determined by the Authority.

And any other parameters as may be prescribed by the Authority from time to time

2.2 The Dutch Soil Remediation Circular 2013

In the absence of a local regulation on soil and groundwater water quality, the Dutch guidelines were adopted. This Circular focuses on the elaboration of the remediation criterion used to determine whether urgent remediation is necessary. The environmental protection remediation criterion (hereinafter referred to as the Remediation Criterion) is included in the amended text of Section 37 of the Soil Protection Act. This Circular also discusses the details of the Remediation Objective, as included in the amended text of Section 38 of the Soil Protection Act. In working out the Remediation Objective, the aim was to achieve harmonisation with the Soil Quality Decree. Table 2 present the Duct guideline target and intervention values for groundwater and soil quality.

Table 2: Soil remediation circular 2013

Soil Remediation Circular 2013

Table 1: Groundwater Target Values and soil and groundwater Intervention Values[l]

Concentrations in soil are shown for standard soil (10% organic matter and 25% lutite)

Substance	Target Value	National Background Concentration	Target Value	Intervention Values	
	Groundwater[G]	Groundwater (BC)	Groundwater[G] (incl. BC)	Soil	Groundwater
	Shallow	Deep	Deep		
	(< 10 m below ground level)	(> 10 m below ground level)	(> 10 m below ground level)		
	(µg/l)	(µg/l)	(µg/l)	(mg/kg DM)	(µg/l)
1. Metals					
Antimony	-	0.09	0.15	22	20
Arsenic	10	7	7.2	76	60
Barium	50	200	200	-[H]	625
Cadmium	0.4	0.06	0.06	13	6
Chromium	1	2.4	2.5	-	30
Chromium III	-	-	-	180	-
Chromium VI	-	-	-	78	-
Cobalt	20	0.6	0.7	190	100
Copper	15	1.3	1.3	190	75
Mercury	0.05	-	0.01	-	0.3
Mercury (inorganic)	-	-	-	36	-
Mercury (organic)	-	-	-	4	-
Lead	15	1.6	1.7	530	75
Molybdenum	5	0.7	3.6	190	300
Nickel	15	2.1	2.1	100	75
Zinc	65	24	24	720	800

Substance	Target Value	Intervention Values	
	Groundwater[G]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
2. Other inorganic substances			
Chloride (mg Cl/l)	100 mg/l	-	-
Cyanide (free)	5	20	1,500
Cyanide (complex)	10	50	1,500
Thiocyanate	-	20	1,500
3. Aromatic compounds			
Benzene	0.2	1.1	30
Ethylbenzene	4	110	150
Toluene	7	32	1,000
Xylenes (aggr.)[A]	0.2	17	70
Styrene (vinylbenzene)	6	86	300
Phenol	0.2	14	2,000
Cresols (aggr.)[A]	0.2	13	200

Substance	Target Value	Intervention Values	
	Groundwater[G]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
4. Polycyclic Aromatic Hydrocarbons (PAHs)[E]			
Naphthalene	0.01	-	70
Phenanthrene	0.003*	-	5
Anthracene	0.0007*	-	5
Fluoranthene	0.003	-	1
Chrysene	0.003*	-	0.2
Benzo(a)anthracene	0.0001*	-	0.5
Benzo(a)pyrene	0.0005*	-	0.05
Benzo(k)fluoranthene	0.0004*	-	0.05
Indeno(1,2,3cd)pyrene	0.0004*	-	0.05
Benzo(ghi)perylene	0.0003	-	0.05
PAHs (total) (aggr. 10)[A]	-	40	-
5. Chlorinated hydrocarbons			
a. (Volatile) hydrocarbons			
Monochloroethene (vinylchloride)[B]	0.01	0.1	5
Dichloromethane	0.01	3.9	1,000
1,1-dichloroethane	7	15	900
1,2-dichloroethane	7	6.4	400
1,1-dichloroethene[B]	0.01	0.3	10
1,2-dichloroethene (aggr.)[A]	0.01	1	20
Dichloropropanes (aggr.)[A]	0.8	2	80
Trichloromethane (chloroform)	6	5.6	400
1,1,1-trichloroethane	0.01	15	300
1,1,2-trichloroethane	0.01	10	130
Trichloroethene (Tri)	24	2.5	500
Tetrachloromethane (Tetra)	0.01	0.7	10
Tetrachloroethene (Per)	0.01	8.8	40

Substance	Target Value	Intervention Values	
	Groundwater[G]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
b. Chlorobenzenes[E]			
Monochlorobenzene	7	15	180
Dichlorobenzenes (aggr.)[A]	3	19	50
Trichlorobenzenes (aggr.)[A]	0.01	11	10
Tetrachlorobenzenes (aggr.)[A]	0.01	2.2	2.5
Pentachlorobenzenes	0.003	6.7	1
Hexachlorobenzene	0.00009*	2.0	0.5
c. Chlorophenols[E]			
Monochlorophenols (aggr.)[A]	0.3	5.4	100
Dichlorophenols (aggr.)[A]	0.2	22	30
Trichlorophenols (aggr.)[A]	0.03*	22	10
Tetrachlorophenols (aggr.)[A]	0.01*	21	10
Pentachlorophenol	0.04*	12	3
d. Polychlorobiphenyls (PCBs)			
PCBs (aggr. 7)[A]	0.01*	1	0.01

3. METHODOLOGY

3.1 Sampling Plan and Sampling Locations

Three samples were collected as described in Table 1 below:

Table 3: Sampling location description

Sample ID	**Location**	**GPS**	**Sampling depth (meters)**
Sample A- soil sample	SP1- Next to P3 site boundary corner	1°12'51.08"S 37° 3'37.31"E	1.0-1.3
Sample B- Soil sample	SP2- Next to P2 site boundary corner	1°12'27.63"S 37° 3'47.92"E	1.0-1.3
Sample A- water sample	Nairobi River water- next to P4 site boundary corner	1°12'31.27"S 37° 3'31.98"E	-
Sample B – water sample	Borehole water- B/H 01	1°12'42.06"S 37° 3'36.13"E	23
Date of sampling- 30th September 2021			

The sampling points are further presented in Figure 1 overleaf.

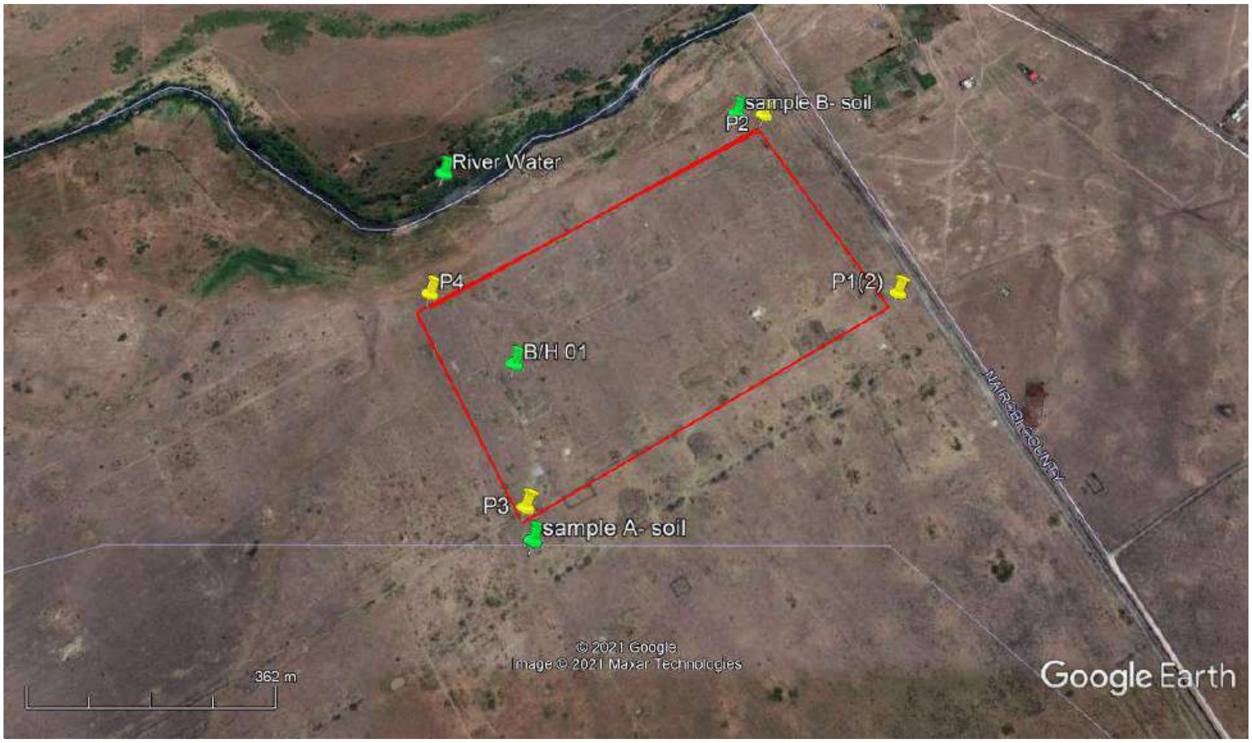

Figure 1: Sampling locations

3.2 Sampling Methodology

3.2.1 Soil sampling

Discrete soil samples were collected using a manual hand auger**.** This system uses an auger, a series of extension rods, a "T" handle, and a thin-wall tube sampler. The auger bores a hole to a desired sampling depth and then is withdrawn.

After reaching the desired depth, the auger was slowly and carefully removed from the boring. Samples were then immediately and directly collected into air tight glass containers. Samples were immediately sealed tightly, labelled accordingly and kept in cold boxes at temperatures below 4^0C. The samples were then submitted to laboratory for analysis. A Chain of Custody form was duly completed for all the samples.

All the sampling equipment were decontaminated accordingly after very sampling and all the holes backfilled to retain the original status of the sampling location.

soil sampling in progress at SP2

Soil sampling in progress at SP1

3.2.2 Water sampling

A *Solinst Model 425 Discrete Interval Sampler* (DIS) was used to collect borehole water sample. The DIS is a “no purge” instrument, designed to obtain representative groundwater samples from a specific sampling zone without the need for purging. It is a stainless-steel sampler pressure activated using a hand pump. The sampler is also equipped with water depth measuring device that has an alarm activated whenever it senses the water level. Water levels at the time of sampling was at 23 meters. Samples were immediately sealed tightly, labelled accordingly and kept in cold boxes at temperatures below 4^0C. The samples were then submitted to laboratory for analysis

Grab water samples from the river were collected using a scoop tied onto a pole while standing on a rock at the edge of the river. The scooped was cleaned according and de ionised prior to sample collection. Samples were immediately sealed tightly, labelled accordingly and kept in cold boxes at temperatures below 4^0C. The samples were then submitted to laboratory for analysis. A Chain of Custody form was duly completed for all the samples.

Temperature, pH and TDS were all measured and recorded onsite.

River water sampling – testing parameters onsite

River water sampling in progress


Borehole water sampling in progress

3.3 Analysis Methodologies and Limits of Detection

Laboratory analysis for all the collected samples was performed by the Labworks East Africa Limited laboratories in Nairobi. This is a NEMA and SANAS accredited, and ISO 17025 certified laboratory. The laboratory was responsible for the preparation of all sampling materials. The samples were analyzed for a variety of parameters as presented in the laboratory analytical reports together with the applicable methodologies.

4. RESULTS

The soil and water analyses results are presented in Tables 2 to 7 below:

Table 4: River Water Results

Lab Works East Africa LTD
P.O.Box 6459-00100
Shelter Afrique Centre, 3rd Floor Wing 3A
Upperhill Nairobi Kenya
Phone: +2540202724481 Fax:
technical@labworksea.com

Client : Enviropro Kenya Ltd
Address : Kiambu Road 00100, Ruai Sewerage Plant - Waste to energy Project

LABORATORY TEST REPORT

Date Received : 04/10/2021
Date Started : 04/10/2021
Date Completed : 09/10/2021
External Sample ID : Sample A - River Water

Batch No : 21/0187
Sample Ref: LW1234
Sampled By: Client
Report Date: 09/10/2021

PARAMETER	METHOD	RESULTS	Low	Opt	High	Standard (Max Limits)
Chemical Analysis						
pH	ISO 10523	7.370				6.5-8.5
Total Suspended Solutes, TSS, mg/l	APHA 2120 B	0.1				30
Nitrites, mg/l	ISO 6777	0.04				x
Lead as Pb, mg/l	ISO 8288	<0.01				0.05
TDS, mg/l	ASTM D 5907	442				1200
Fluoride, mg/l	ISO 10359	1.6				1.5
Phenols, mg/l	LWTP 023	0.8				Nil
Cadmium, mg/l	ISO 8288	<0.001				0.01
Selenium, mg/l	ISO 8288	<0.001				0.01
Arsenic as As, mg/l	ASTM D2972-15	<0.001				0.01
Copper as Cu, mg/l	ISO 8288	0.40				0.05
Permanganate Value, mg/l	LWTP028	<0.1				1
Alkyl benzyl Sulfonates (Anionic Surfurcatants)	LWTP034	0.90				0.5
Zinc as Zn, mg/l	ISO 8288	1.98				1.5
Total Nitrogen as N, mg/l	LWTP 037	3.96				0.5
Microbial Analysis						
E. coli, cfu/100ml	ISO 9308-1	144				Nil

Table 5: Borehole Water Analysis Results

Lab Works East Africa LTD
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technical@labworksea.com

Client : Enviropro Kenya Ltd
Address : Kiambu Road 00100, Ruai Sewerage Plant - Waste to energy Project

LABORATORY TEST REPORT

Date Received : 04/10/2021
Date Started : 04/10/2021
Date Completed : 09/10/2021
External Sample ID : Sample B - Borehole Water

Batch No : 21/0187
Sample Ref: LW1235
Sampled By: Client
Report Date: 09/10/2021

PARAMETER	METHOD	RESULTS	Low	Opt	High	Standard (Max Limits)
Chemical Analysis						
pH	ISO 10523	7.810				6.5-8.5
Total Suspended Solutes, TSS, mg/1	APHA 2120 B	28				30
Nitrites, mg/1	ISO 6777	0.05				x
Lead as Pb, mg/1	ISO 8288	<0.01				0.05
TDS, mg/1	ASTM D 5907	446				1200
Fluoride, mg/1	ISO 10359	5.9				1.5
Phenols, mg/1	LWTP 023	0.3				Nil
Cadmium, mg/1	ISO 8288	<0.001				0.01
Selenium, mg/1	ISO 8288	<0.001				0.01
Arsenic as As, mg/1	ASTM D2972-15	<0.001				0.01
Copper as Cu, mg/1	ISO 8288	0.26				0.05
Permanganate Value, mg/1	LWTP028	<0.1				1
Alkyl benzyl Sulfonates (Anionic Surfurcatants)	LWTP034	0.20				0.5
Zinc as Zn, mg/1	ISO 8288	2.34				1.5
Total Nitrogen as N, mg/1	LWTP 037	1.24				0.5
Microbial Analysis						
E. coli, cfu/100ml	ISO 9308-1	100				Nil

Table 6: Soil Analysis Results- SP2

Lab Works East Africa LTD
P.O.Box 6459-00100
Shelter Afrique Centre, 3rd Floor Wing 3A
Upperhill Nairobi Kenya
Phone: +2540202724481 Fax:
technical@labworksea.com

Client : Enviropro Kenya Ltd
Address : Kiambu Road 00100, Ruai Sewerage Plant - Waste to energy Project

LABORATORY TEST REPORT

Date Received : 04/10/2021 **Batch No** : 21/0187
Date Started : 04/10/2021 **Sample Ref:** LW1237
Date Completed : 09/10/2021 **Sampled By:** Client
External Sample ID : Sample B (Soil) - SP2 **Report Date:** 09/10/2021

Chemical Analysis

PARAMETER	METHOD	RESULTS	Low	Opt	High	Standard (Max Limits)
Antimony, mg/kg	ISO 10523	7.80				22
Barium, mg/kg	ISO 8288	0.1				_H
Total Chromium, mg/kg	ISO 15192	27				x
Lead as Pb, mg/kg	ISO 8288	7.23				530
Cobalt, mg/kg	ISO 8288	<0.01				190
Phalates (Sum), mg/kg	LWTP 046	1.1				x
Pyridine, mg/kg	GCMS01	0.5				11
Cadmium, mg/kg	ISO 8288	15.00				13
Selenium, mg/kg	ISO 8288	<0.01				x
Arsenic as As, mg/kg	ISO 8288	<0.01				76
Copper as Cu, mg/kg	ISO 8288	7.90				190
Mineral Oil as Oil & grease	LWTP029	1.80				5000
Alkyl benzyl Sulfonates (Anionic Surfurcatants), mg/kg	LWTP038	0.20				x
Zinc as Zn, mg/kg	ISO 8288	8.01				720
Cresol, mg/kg	LWTP 034	1.90				13
Tetrahydrofuran, mg/kg	GCMS01	<0.01				7
Cyclohexanone, mg/kg	GCMS01	3				150

Table 7: Soil Analysis Results- SP2 Hydrocarbons

Lab Works
Lab Works East Africa LTD
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Phone: +2540202724481 Fax:
david@labworksea.com

KENAS

Client : Enviropro Kenya Ltd
P.O BOX: Kiambu Road 00100,
Ruai Sewerage Plant - Waste to energy Project
Country : Kenya

LABORATORY TEST REPORT

Date Received : 04/10/2021
Date Started : 04/10/2021
Date Completed : 09/10/2021
External Sample ID : Soil Sample B - SP2

Batch No : 21/0187
Sample Ref: LW1237
Sampled By: Client

PARAMETER	METHOD	RESULTS (in ppm)
	TPH	
TPH	GCMS002	0.13
BTEX	**INTERVENTION VALUES IN BRACKETS**	
Benzene	GCMS003	<0.01 **(1.1)**
Toluene	GCMS003	<0.01 **(32)**
Ethylene	GCMS003	<0.01 **(110)**
Xylene	GCMS003	<0.01 **(17)**
	Heavy PAHS	
Fluoranthene (Fla)	GCMS002	<0.01
Pyrene (Pyr)	GCMS002	<0.01
Benz(a)anthracene (BaA)	GCMS002	<0.01
Chrysene (Chr)	GCMS002	<0.01
Benzo(k)fluoranthene (BkF)	GCMS002	<0.01
Benzo(b)fluoranthene (BbF)	GCMS002	<0.01
Perylene (Per)	GCMS002	<0.01
Benzo(g,h,i)perylene (BghiP)	GCMS002	<0.01
Dibenz(a,h)anthracene(DahA)	GCMS002	<0.01
Indeno(1,2,3-cd)pyrene(IcdP)	GCMS002	<0.01
TOTAL PAHS	GCMS002	0.02

	TOTAL PAHS	
Naphthalene (Nap)	GCMS002	<0.01
2-methyl Naphthalene(mNap)	GCMS002	<0.01
Acenaphthylene (Acy)	GCMS002	<0.01
Acenaphthene (Ace)	GCMS002	<0.01
Fluorene (Flu)	GCMS002	<0.01
Phenanthrene (Phe)	GCMS002	<0.01
Anthracene (Ant)	GCMS002	<0.01
Fluoranthene (Fla)	GCMS002	<0.01
Pyrene (Pyr)	GCMS002	<0.01
Benz(a)anthracene (BaA)	GCMS002	<0.01
Chrysene (Chr)	GCMS002	<0.01
Benzo(k)fluoranthene (BkF)	GCMS002	<0.01
Benzo(b)fluoranthene (BbF)	GCMS002	<0.01
Perylene (Per)	GCMS002	<0.01
Benzo(g,h,i)perylene (BghiP)	GCMS002	<0.01
Dibenz(a,h)anthracene(DahA)	GCMS002	<0.01
Indeno(1,2,3-cd)pyrene(IcdP)	GCMS002	<0.01
Total PAH		0.09
TOTAL PAHS INTERVENTION VALUE		**40**

<0.01 means the results of the sample lower than the detection of 0.01

Table 8: Soil Analysis Results- SP1

Lab Works East Africa LTD
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technical@labworksea.com

Client : Enviropro Kenya Ltd
Address : Kiambu Road 00100, Ruai Sewerage Plant - Waste to energy Project

LABORATORY TEST REPORT

Date Received : 04/10/2021 **Batch No** : 21/0187
Date Started : 04/10/2021 **Sample Ref:** LW1236
Date Completed : 09/10/2021 **Sampled By:** Client
External Sample ID : Sample A (Soil) - SP1 **Report Date:** 09/10/2021

Chemical Analysis

PARAMETER	METHOD	RESULTS	Low	Opt	High	Standard (Max Limits)
Antimony, mg/kg	ISO 10523	7.370				22
Barium, mg/kg	ISO 8288	0.1				_H
Total Chromium, mg/kg	ISO 15192	24				x
Lead as Pb, mg/kg	ISO 8288	6.300				530
Cobalt, mg/kg	ISO 8288	<0.01				190
Phalates (Sum), mg/kg	LWTP 046	1.3				x
Pyridine, mg/kg	GCMS01	0.8				11
Cadmium, mg/kg	ISO 8288	6.60				13
Selenium, mg/kg	ISO 8288	<0.01				x
Arsenic as As, mg/kg	ISO 8288	<0.01				76
Copper as Cu, mg/kg	ISO 8288	6.40				190
Mineral Oil as Oil & grease	LWTP029	1.20				5000
Alkyl benzyl Sulfonates (Anionic Surfurcatants), mg/kg	LWTP038	0.90				x
Zinc as Zn, mg/kg	ISO 8288	12.00				720
Cresol, mg/kg	LWTP 034	3.96				13
Tetrahydrofuran, mg/kg	GCMS01	<0.01				7
Cyclohexanone, mg/kg	GCMS01	5				150

Table 9: Soil Analysis Results- SP1 Hydrocarbons

Lab Works
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KENAS

Client : Enviropro Kenya Ltd
P.O BOX: Kiambu Road 00100,
Ruai Sewerage Plant - Waste to energy Project
Country : Kenya

LABORATORY TEST REPORT

Date Received : 04/10/2021
Date Started : 04/10/2021
Date Completed : 09/10/2021
External Sample ID : Soil Sample A - SP1

Batch No : 21/0187
Sample Ref: LW1236
Sampled By: Client

PARAMETER	METHOD	RESULTS (in ppm)
	TPH	
TPH	GCMS002	0.12
BTEX	**INTERVENTION VALUES IN BRACKETS**	
Benzene	GCMS003	<0.01 **(1.1)**
Toluene	GCMS003	<0.01 **(32)**
Ethylene	GCMS003	<0.01 **(110)**
Xylene	GCMS003	<0.01 **(17)**
	Heavy PAHS	
Fluoranthene (Fla)	GCMS002	<0.01
Pyrene (Pyr)	GCMS002	<0.01
Benz(a)anthracene (BaA)	GCMS002	<0.01
Chrysene (Chr)	GCMS002	<0.01
Benzo(k)fluoranthene (BkF)	GCMS002	<0.01
Benzo(b)fluoranthene (BbF)	GCMS002	<0.01
Perylene (Per)	GCMS002	<0.01
Benzo(g,h,i)perylene (BghiP)	GCMS002	<0.01
Dibenz(a,h)anthracene(DahA)	GCMS002	<0.01
Indeno(1,2,3-cd)pyrene(IcdP)	GCMS002	<0.01
TOTAL PAHS	GCMS002	0.02
	TOTAL PAHS	
Naphthalene (Nap)	GCMS002	<0.01
2-methyl Naphthalene(mNap)	GCMS002	<0.01
Acenaphthylene (Acy)	GCMS002	<0.01
Acenaphthene (Ace)	GCMS002	<0.01
Fluorene (Flu)	GCMS002	<0.01
Phenanthrene (Phe)	GCMS002	<0.01
Anthracene (Ant)	GCMS002	<0.01
Fluoranthene (Fla)	GCMS002	<0.01
Pyrene (Pyr)	GCMS002	<0.01
Benz(a)anthracene (BaA)	GCMS002	<0.01
Chrysene (Chr)	GCMS002	<0.01
Benzo(k)fluoranthene (BkF)	GCMS002	<0.01
Benzo(b)fluoranthene (BbF)	GCMS002	<0.01
Perylene (Per)	GCMS002	<0.01
Benzo(g,h,i)perylene (BghiP)	GCMS002	<0.01
Dibenz(a,h)anthracene(DahA)	GCMS002	<0.01
Indeno(1,2,3-cd)pyrene(IcdP)	GCMS002	<0.01
Total PAH		0.08
TOTAL PAHS INTERVENTION VALUE		**40**

<0.01 means the results of the sample lower than the detection of 0.01

5. DISCUSSIONS & CONCLUSIONS

All the values obtained for soil are all below the Dutch Target Values. The target values indicate the level at which there is a sustainable soil and water quality. In terms of curative policy this means that the target values indicate the level that has to be achieved to fully recover the functional properties of the soil for humans and plant and animal life. Besides this the target values give an indication of the benchmark for environmental quality in the long term on the assumption of negligible risks to the ecosystem.

Borehole and river water results were compared against the EMC (water quality) Regulations, 2006 values for sources of domestic water. Phenols, Fluorides, Copper, Zinc, Total Nitrogen and E-coli were above respective stipulated limits. All other parameters tested are within the respective EMC limits.

It is confirmed that background levels are sometimes higher than regulatory limits. With the knowledge of the aforementioned, it further stresses the need for adequate mitigation measures to be factored into its day-to-day operation of the Project development, to avoid exacerbating soil and water quality levels.

The baseline data obtained is representative of the soil and water quality at all the measurement locations and can be used to compare subsequent levels when the project is under construction and at its operational phases.

Annex 8

Laboratory Ambient Air Quality Analysis

KenGen
Energy for the nation.

Waste to Energy Project
Ruai Sewerage Plant

Air Quality Baseline Assessment

Prepared by:

Enviropro Kenya Limited

September 2021

Report Details

This document has been prepared by Enviropro Kenya Limited

Report Type:	**Air Quality Baseline Assessment**
Project Name:	**Waste to Energy Project- Ruai Sewerage Plant**
Monitoring Dates	**24th to 27th September 2021**
Project Code:	

Name	Responsibility	Signature	Date
C Oduor	Report Compiler		October 2021
	Report Editor		October 2021
	Report Review		October 2021
G Nagillah	Project Manager		October 2021

Executive Summary

Air Quality Baseline study was conducted by EnviroPro Kenya Limited on behalf of Kenya Electricity Generating Company PLC (KenGen), which will form part of a range of specialist studies undertaken for the Waste to Energy Project- Ruai Sewerage Plant (hereinafter referred to as *the Project*). This study was conducted in accordance with Kenyan legislation, as contained in the Environment Management and Coordination Act (EMCA), No. 8 of 1999. The study also took cognisance of the EHS guidelines as prescribed by the International Finance Corporation (IFC).

To begin understanding the specific air quality characteristics of the Project area, a two-phased research approach was adopted. Phase I of the study consisted of a field data collection exercise to establish existing levels of criteria pollutants, such as Particulate Matter (PM) with aerodynamic less than 10 micron and 2.5 micron (PM_{10} and $PM_{2.5}$), Volatile Organic Compounds (VOCs), Sulphur Dioxide (SO_2), and Nitrogen Dioxide (NO_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2) at selected locations in the vicinity of the Project area to understand the background air quality scenario. Results from the aforementioned formed the basis of this report. Monitoring was undertaken from the 24th to 27th September 2021 at 3 points with the project's site boundary fence.

Phase II of the study will assess the potential implications of the proposed Project activities and infrastructure on the surrounding air quality. The latter will be conducted during the environmental and social impact assessment (ESIA) phase, hence will not be discussed further in this baseline report.

i. Findings

The monitoring average results are summarised in Tables 0-1 and 0-2:

Table 0-1: PM Monitoring Results

Monitoring Point	Monitoring dates	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
SP1	*24th -25th Sep 2021*	11	4
SP2	*25th -26th Sep 2021*	8	4
SP3	*26th -27th Sep 2021*	9	5
Regulatory Limits		*100*	*25*

Table 0-2: Gaseous Pollutants Monitoring Results

Parameters	Units	SP1 *24th -25th Sep 2021*	SP2 *25th -26th Sep 2021*	SP3 *26th -27th Sep 2021*	*Regulatory Limits*
Sulphur Dioxide, SO_2	ppm	0.001	<0.001	0.001	*0.048*
Nitrogen Dioxide, NO_2	ppm	0.025	0.013	0.020	*0.1*
Carbon Dioxide, CO_2	ppm	142	178	182	*n/a*
Carbon Monoxide, CO	mg/m^3	<0.01	<0.01	<0.01	*2*
Volatile Organic Compounds, VOCs	ppm	0.11	<0.1	0.1	*n/a*

The baseline meteorology showed that the dominant winds blow from the Northwest to the East. Wind speed intensity averaged 2- 6 m/s with rainfall experienced on the third day of monitoring.

The ambient concentrations for all the pollutants assessed (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO_2, CO and VOCs) are within the EMC Regulatory limits for Rural, Residential, and Other Areas. The values will serve as baseline to which future measurements can be compared with to assess impacts and compliance.

There were no major activities observed within the vicinity of the project area that would significantly impact on the air quality of the area. The values reported could potentially be attributed, but not limited, to the following:

- Movement of large herds of livestock on loose surfaces mainly contributed to the dust levels reported;
- Quarry related operations and movement of trucks on loose paths contributed to CO_2, NO_2 and dust levels reported. The quarries are located about 700 m to 2500 m away from the project site;
- House construction activities like welding and grinding ongoing at the time of monitoring. This is located approximately 450 m away;
- Ruai Sewerage Plant with its related waste treatment activities. The treatment plant is located approximately 4.5 km away from the project site.

In the absence of a local regulatory limit for $PM_{2.5}$, WHO guidelines were used to compare the obtained results. All the monitoring points reported values within the WHO guideline (25 $\mu g/m^3$).

Additionally, there is no local regulatory limit provided for Total VOCs and CO2 in the EMC air quality regulation under Rural, Residential and Other Areas category.

Although the activities taking place on each sampling day at every sampling point cannot be verified, it is strongly believed that the items discussed above are the main sources of the reported pollutants levels.

The main outcome of this study is that a comprehensive understanding of the background air quality now exists. Background concentrations of various pollutants measure will serve as "reference" to which future measurement can be compared.

Contents

List of Abbreviations

AQBA	Air Quality Baseline Assessment
ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethyl-benzene and xylene
EHS	Environmental Health and Safety
ESIA	Environmental and Social Impact Assessment
EMCA	Environment Management and Coordination Act
EP	Equator Principles
GIIP	Good International Industry Practice
IFC	International Finance Corporation
IRIS	Integrated Risk Information System
NO_2	Nitrogen Dioxide
CO_2	Carbon Dioxide
CO	Carbon Monoxide
VOCs	Volatile Organic Compounds
PM	Particulate Matter
SOx	Sulfur Oxides
NOx	Oxides of Nitrogen
ToR	Terms of Reference
USEPA	United States Environmental Protection Agency

1 Introduction

EnviroPro Kenya Limited is conducting an ESIA commissioned by KenGen for the proposed Waste to Energy (WtE) project in Ruai Sewerage Plant (hereinafter referred to as *the project*). This report presents findings of an Air Quality Baseline Assessment (AQBA) study, which will form part of a range of specialist studies undertaken for the Project. This study was conducted in accordance with Kenyan legislation, as contained in the Environment Management and Coordination Act (EMCA), No. 8 of 1999. The study which was conducted on the 24th to 27th September 2021, also took cognizance of the EHS guidelines as prescribed by the International Finance Corporation (IFC).

1.1 Project Description

The Government of Kenya intends to improve environmental sustainability by improving municipal solid waste (MSW) management and promoting renewable energy in Kenya. In order to manage Nairobi's waste as well as to overcome the hazards at the Dandora dumpsite, Nairobi Metropolitan Services (NMS) is partnering with Kenya Electricity Generating Company PLC (KenGen) to establish a waste-to-energy (WtE) plant within Nairobi Metropolitan Area. An ESIA study is ongoing and the scope includes assessment of baseline ambient air quality levels.

1.2 Terms of Reference

As part of the Terms of Reference (ToR) EnviroPro undertook an AQBA of the project area in compliance with the Kenyan EMCA, which defines the precepts of the EIA (Guidelines for EIA, 2002). The scope of work outlined below was informed by the aforementioned:

- Review of the legal context as it relates to air pollutants;
- Evaluation of site meteorology
- Monitoring of background air quality:
    i. Particulate Matter (PM) - PM with aerodynamic diameter less than 10 micron (PM_{10}) and 2.5 micron ($PM_{2.5}$);
    ii. Gases - VOCs, Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_2), carbon Dioxide (CO_2), and Carbon Monoxide (CO).

1.3 Aims and Objectives

The overall aim of this AQBA study is to establish the background air quality scenario at the proposed project site and surrounding receptors. To achieve the aforementioned, the various tasks highlighted in Section 1.2 above were conducted.

1.4 Assumptions and Limitations

Assumptions and limitations associated with this study are listed below:

- Cases Rainfall over part of the monitoring period could have had an effect on the reported results especially that for dust, and;
- The daily data for PM_{10}, $PM_{2.5}$, CO_2, CO, SO_2, TVOCs and NO_2 data collected by the aforementioned is considered sufficient to understand background conditions.

2 Legal Context

2.1 Legislative and Environmental Policy Framework

2.1.1 Applicable Standards

The Environmental Management and Coordination Act (EMCA), 1999, is the framework law on environmental management and conservation. EMCA establishes among others the following institutions; National Environment Management Authority, Public Complaints Committee, National Environment Tribunal, National Environment Action Plan Committees, and County Environment Committees. The National Environment Management Authority (NEMA) was established as the principal instrument of government charged with the implementation of all policies relating to the environment, and to exercise general supervision and coordination over all matters relating to the environment. In consultation with the lead agencies, NEMA is empowered to develop regulations, prescribe measures and standards and, issue guidelines for the management and conservation of natural resources and the environment. The Act provides for environmental protection through;

- Environmental impact assessment;
- Environmental audit and monitoring;
- Environmental restoration orders, conservation orders, and easements.

EMC (Air Quality) Regulations, 2014 under the Act was utilized assessing background levels of pollutants measured in the Project area where applicable (see Table 2-1). In the absence of EMC standards, the following relevant standard was applied:

- $PM_{2.5}$ Daily (WHO guidelines, see 2-2);

***Table 2-1**: EMC Ambient Air Quality Tolerance limits*

FIRST SCHEDULE
AMBIENT AIR QUALITY TOLERANCE LIMITS

Table 1: Ambient Air Quality Tolerance Limits

	Pollutant	Time weighted Average			
			Industrial area	Residential, Rural & Other area	Controlled areas***
1.	Sulphur oxides (SO_X);	Annual Average*	80 $\mu g/m^3$	60 $\mu g/m^3$	15 $\mu g/m^3$
		24 hours**	125 $\mu g/m^3$	80 $\mu g/m^3$	30 $\mu g/m^3$
		Annual Average		0.019 ppm/50$\mu g/m^3$	
		Month Average			
		24 Hours		0.048ppm /125$\mu g/m^3$	
		One Hour			
		Instant Peak		500 $\mu g/m^3$	
		Instant Peak (10 min)		0.191 ppm	
2.	Oxides of Nitrogen (NO_X);	Annual Average*	80 $\mu g/m^3$	60 $\mu g/m^3$	15 $\mu g/m^3$
		24 hours**	150 $\mu g/m^3$	80 $\mu g/m^3$	30 $\mu g/m^3$
		8 hours			
		Annual Average		0.2 ppm	
		Month Average		0.3 ppm	
		24 Hours		0.4 ppm	
		One Hour		0.8 ppm	
		Instant Peak		1.4 ppm	
3.	Nitrogen Dioxide	Annual Average	150 $\mu g/m^3$	0.05 ppm	
		Month Average		0.08 ppm	
		24 Hours	100 $\mu g/m^3$	0.1 ppm	
		One Hour		0.2 ppm	
		Instant Peak		0.5 ppm	
4.	Suspended Particulate	Annual Average*	360 $\mu g/m^3$	140 $\mu g/m^3$	70 $\mu g/m^3$

	Pollutant	Time weighted Average			
	matter (SPM)				
		24 hours**	500 µg/m³	200 µg/m³	100 µg/m³
			Industrial area	**Residential, Rural & Other area**	**Controlled areas*** **
		mg/Kg			
		Annual Average****		100 µg/m³	
		24 hours***		180 µg/m³	
5.	Respirable Particulate Matter (<10µm) (RPM)	Annual Average*	70 µg/m³	50 µg/m³	50 µg/m³
		24 hours**	150 µg/Nm³	100 µg/Nm³	75 µg/Nm³
6.	$PM_{2.5}$	Annual Average	35 µg/m³		
		24 hours	75 µg/m³		
7.	Lead (Pb)	Annual Average*	1.0 µg/Nm³	0.75 µg/Nm³	0.50 µg/m³
		24 hours**	1.5 µg/m³	1.00 µg/m³	0.75 µg/m³
		Month Average		2.5	
8.	Carbon monoxide (CO)/ carbon dioxide (CO_2)	8 hours**	5.0 mg/m³	2.0 mg/m³	1.0 mg/m³
		1 hour	10.0 mg/m³	4.0 mg/m³	2.0 mg/m³
		mg/Kg			
		24 hours**			
9.	Hydrogen Sulphide	24 hours**	150µg/m³		
10.	Non-methane hydrocarbons				
		instant Peak	700ppb		
11.	Total VOC	24 hours**	600 µg/m³		
12.	Ozone	1-Hour	200 µg/m³	0.12 ppm	
		8 hour (instant Peak)	120 µg/m³	1.25 ppm	

Table 2-2: WHO Ambient air quality guideline limits ($PM_{2.5}$)

	Averaging period	**Guideline value in (µg/m^3)**
$PM_{2.5}$	1 year	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)
	24 hours	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
	▪ World Health Organization (WHO). Air Quality Guidelines Global Update, 2005. PM 24-hour value is the 99th percentile. ▪ Interim targets are provided in recognition of the need for a staged approach to achieving the recommended guidelines.	

3 Health and Environmental Implications of Pollutants monitored

The main pollutants of concern often associated with such construction and operations encompass PM_{10} and $PM_{2.5}$, VOCs, SO_2, NO_2 and CO_2. These pollutants result from a wide range of activities, i.e., excavation, hauling of material, material handling and combustion emissions from diesel engines on site.

3.1 Particulate Matter

In terms of health effects, PM size is relevant in terms of health because it determines where in the respiratory system a given particle is deposited (WHO, 2000). Fine particles are thought to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Manahan, 1991). Larger particles are deposited into the extra-thoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000).

Numerous epidemiological studies conducted in Europe and in other parts of the world have shown adverse health effects of exposure to PM_{10} and $PM_{2.5}$ at concentrations that are currently observed in Europe and the rest of the world. WHO estimated that approximately 700 annual deaths from acute respiratory infections in children aged 0–4 years could be attributed to PM_{10} exposure in the European Region in the late 1990s alone. Population health effects of exposure to PM in adults are dominated by mortality associated with long- time exposure to fine PM ($PM_{2.5}$). Short-term and long-term health effects associated with exposure to particulate matter are presented in Table 4-1

3.1.1 Short-Term Exposure

Recent studies suggest that short-term exposure to PM is associated with health effects, even at low concentrations of exposure. Various studies undertaken during the 1980s and early 1990s have looked at the relationship between daily fluctuations in PM and mortality at low levels of exposure. Pope *et al* (1992) studied daily mortality in relation to PM_{10} concentrations in Utah Valley during the period 1985 - 1989. A maximum daily average concentration of 365 $\mu g/m^3$ was recorded with effects on mortality observed at concentrations of < 100 $\mu g/m^3$. The increase in total daily mortality was 13% per 100 $\mu g/m^3$ increase in the 24-hour average. Studies by Schwartz (1993) in Birmingham recorded daily concentrations of 163 $\mu g/m^3$ and noted that an increase in daily mortality was experienced with an increase in PM_{10} concentrations. Relative risks for chronic lung disease and cardiovascular deaths were higher than deaths from other causes.

Morbidity effects associated with short-term exposure to fine PM include increases in lower respiratory symptoms, medication use and small reductions in lung function. Pope and Dockery (1992) studied panels of children in Utah Valley in winter during the period 1990 – 1991 and observed daily PM_{10} concentrations range of between 7 – 251 µg/m^3. Peak expiratory flow was decreased and respiratory symptoms increased when PM_{10} concentrations increased. Pope and Kanner (1993) utilized lung function data obtained from smokers with mild to moderate chronic obstructive pulmonary disease in Salt Lake City. The estimated effect was a 2% decline in Forced Expiratory Volume over one second for each 100 µg/m^3 increase in the daily PM_{10} average.

3.1.2 Long-Term Exposure

Long-term exposure to low concentrations (~10 µg/m^3) of PM is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000; 2002).

Studies have indicated an association between lung function and chronic respiratory disease and airborne PM. Older studies by Chestnut *et al* (1991) found that Forced Vital Capacity (FVC)[1] decreases with increasing annual average particulate levels with an apparent threshold at 60 µg/m^3. Using chronic respiratory disease data, Schwartz (1993) determined that the risk of chronic bronchitis increased with increasing particulate concentrations, with no apparent threshold.

Few studies have been undertaken documenting the morbidity effects of long-term exposure to PM (Table 4-1). Recently, the Harvard Six Cities Study showed increased respiratory illness rates among children exposed to increasing PM, sulphate and hydrogen ion concentrations in ambient environment (Francine *et al*., 2006). Relative risk estimates suggest an 11% increase in cough and bronchitis rates for each 10 µg/m^3 increase in annual average particulate concentrations.

***Table 3-1**: Short-term and long-term health effects associated with exposure to PM*

Pollutant	Short-term exposure	Long-term exposure
Particulate matter	▪ Lung inflammatory reactions ▪ Respiratory symptoms ▪ Adverse effects on the cardiovascular system ▪ Increase in medication usage ▪ Increase in hospital admissions ▪ Increase in mortality	▪ Increase in lower respiratory symptoms ▪ Reduction in lung function in children ▪ Increase in chronic obstructive pulmonary disease ▪ Reduction in lung function in adults ▪ Reduction in life expectancy ▪ Reduction in lung function development

(Source: WHO, 2004)

FVC, is defined as the amount of air that can be forcibly exhaled from the lungs after taking the deepest breath possible

3.2 Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOCs) are part of the large hydrocarbon family, a vast array of aliphatic, aromatic hydrocarbons, their halogenated derivatives, alcohols, ketones and aldehydes. VOCs have a property of conversion into vapor or gas without any chemical change. They are highly reactive hydrocarbons and participate in atmospheric photochemical reactions. Some of them have negligible photochemical activity; however, they play an important role as heat trapping gases in atmosphere. Many VOCs are of natural origin while many owe their existence to anthropogenic activities. Natural sources of VOCs include forests, termites, oceans, wetlands, Tundras and volcanoes. Estimated global emission rate of biogenic VOCs is 1150 Tg yr-1 (Guenther et. al., 1995). The anthropogenic sources of VOCs consist of vehicular emissions, petroleum products, chemicals, manufacturing industries, painting operations, varnishes, coating operations, consumer products, petroleum handling, auto refinishing, cold clean degreasing, printing inks, dry-cleaning etc. In presence of oxides of nitrogen and sunlight, VOCs form ozone and other products. Oxidation of VOCs by reaction with hydroxyl radicals is the main removal process. The oxidation of complex organic molecules leads to the fragmentation, production of a range of reactive free radicals and more stable smaller molecules such as aldehydes. VOCs are cause of concern firstly due to its role in formation of ground level ozone and smog and secondly due to some of them being carcinogenic, mutagenic and teratogenic in nature. Adverse effects of ozone on human health, crop viability and yields are well documented. Wide range of VOCs, imply wide range of reaction rates, which means large range of transport distances. Many VOCs have low reactivity and thus long atmospheric life times and can be classified as Persistent Organic Pollutants (POPs). Some VOCs are Hazardous Air Pollutants (HAPs) by virtue of their toxicity.

International concerns regarding VOCs arise due to their ability of long-range transport, distribution and accumulation in various components of environment, their toxic nature and significant contribution from natural sources. Ambient air monitoring of VOC is aimed to control or avoid adverse impacts on humans and ecology. This should also result in knowledge of types and category of VOCs in terms of photochemical ozone creating potential of VOCs, concentrations of VOC species, their dispersion routes and fate in the environment. secondary origin in ambient air has immense importance as they have direct as well as indirect effects on climate change, ecology and human health.

Vehicular traffic and emission from fossil fuels consumption (wood, coal and petroleum products) results in the release of BTEX with more than 90% estimated to come from anthropogenic sources (gasoline vapors, vehicle exhaust, and chemical production) ((Agency for Toxic Substances and Disease Registry (ATSDR), 2000; ATSDR, 2007a; ATSDR, 2007b; ATSDR, 2010; Commission for European Communities (CEC, 1998).

Evidence from studies in humans suggests that BTEX exposure above regulatory limits can have reproductive, developmental, respiratory and immune effects. Specific effects include sperm abnormalities, reduced fetal growth, low birth weight, cardiovascular disease and respiratory dysfunction. Some effects are seen from exposure to the BTEX chemicals individually, and others were seen from exposure to the combination (www.tedx.org). In addition to the aforementioned health effects, short- and long-term effects of high levels of exposure are summarized in Table 3-2

Table 3-2: *Short- and Long-Term Health Effects of Exposure to VOCs*

Short term (Acute) to high levels of VOCs	**Long term (Chronic) to high levels of VOCs**
▪ Eye, nose and throat irritation	▪ Increased risk of:
▪ Headaches	▪ Cancer
▪ Nausea / Vomiting	▪ Liver damage
▪ Dizziness	▪ Kidney damage
▪ Worsening of asthma symptoms	▪ Central Nervous System damage
▪ Skin and sensory irritation	
▪ Loss of coordination	

3.3 Sulphur Dioxide (SO_2)

SO_2 forms part of the entire group of sulfur oxides (SO_x) and constitutes the component of greatest concern. Emissions that lead to high concentrations of SO_2 generally also lead to the formation of other SO_x. In the context of this project, the main source of SO_2 emissions is the use of heavy equipment burning fuel containing sulfur.

SO_2 can react with other compounds in the atmosphere to form small particles. These particles contribute to PM pollution in the atmosphere. At high concentrations, gaseous SO_2 can harm trees and plants by damaging foliage and decreasing growth. SO_2 and other sulfur oxides can contribute to acid rain which can harm sensitive ecosystems.

SO_2 can have adverse effects on public health and the environment (Alberta Health & Wellness, 2006). Short-term exposures to SO_2 can affect the human respiratory system, making breathing difficult. Children, the elderly, and those who suffer from asthma are particularly sensitive to effects of SO_2.

3.4 Nitrogen Dioxide (NO_2)

Some nitrogen dioxide is formed naturally in the atmosphere by lightning, while some is produced by plants, soil and water. However, only about 1% of the total amount of NO_2 found in air is formed this way. Nitrogen Dioxide (NO_2) is one of a group of highly reactive gases known as oxides of nitrogen or nitrogen oxides (NOx). Other nitrogen oxides include nitrous acid and nitric acid. NO_2 is used as the indicator for the larger group of nitrogen oxides. NO_2 primarily gets in the air from the burning of fuel. NO_2 forms from emissions from cars, trucks and buses, power plants, and off-road equipment.

In terms of this Project, NO_2 will be generated mainly from the vehicular emissions and combustion sources.

NO_2 and other NOx interact with water, oxygen and other chemicals in the atmosphere to form acid rain. Acid rain harms sensitive ecosystems such as lakes and forests. The nitrate particles that result from NOx make the air hazy and difficult to see though. This affects the many national parks that we visit for the view.

Exposure to elevated levels of NO_2 presents the possibility of respiratory problems. This pollutant inflames the lining of the lungs, reducing immunity to lung infections

– exacerbating the occurrence of wheezing, coughing, colds, flu and bronchitis (Kraft et al., 2005).

Increased levels of nitrogen dioxide can have significant impacts on people with asthma because it can cause more frequent and more intense asthma attacks. Children with asthma and older people with heart disease are most at risk.

3.5 Carbon dioxide (CO_2)

Carbon dioxide (CO_2) is the primary greenhouse gas emitted through human activities. Carbon dioxide is naturally present in the atmosphere as part of the Earth's carbon cycle (the natural circulation of carbon among the atmosphere, oceans, soil, plants, and animals). Human activities are altering the carbon cycle–both by adding more CO_2 to the atmosphere, and by influencing the ability of natural sinks, like forests and soils, to remove and store CO_2 from the atmosphere. While CO_2 emissions come from a variety of natural sources, human-related emissions are responsible for the increase that has occurred in the atmosphere since the industrial revolution. The main human activity that emits CO_2 is the combustion of fossil fuels (coal, natural gas, and oil) for energy and transportation, although certain industrial processes and land-use changes also emit CO_2.

Health effect of CO2 include:

Inhalation: Low concentrations are not harmful. Higher concentrations can affect respiratory function and cause excitation followed by depression of the central nervous system. A high concentration can displace oxygen in the air. If less oxygen is available to breathe, symptoms such as rapid breathing, rapid heart rate, clumsiness, emotional upsets and fatigue can result. As less oxygen becomes available, nausea and vomiting, collapse, convulsions, coma and death can occur. Symptoms occur more quickly with physical effort. Lack of oxygen can cause permanent damage to organs including the brain and heart.

Skin Contact: Not irritating. Direct contact with the liquefied gas can chill or freeze the skin (frostbite). Symptoms of mild frostbite include numbness, prickling and itching. Symptoms of more severe frostbite include a burning sensation and stiffness. The skin may become waxy white or yellow. Blistering, tissue death and infection may develop in severe cases.

Eye Contact: May cause mild irritation. Direct contact with the liquefied gas can freeze the eye. Permanent eye damage or blindness can result.

Ingestion: Not a relevant route of exposure (gas).

Effects of Long-Term (Chronic) Exposure: Not harmful.

Carcinogenicity: Not known to cause cancer.

4 Air Quality Monitoring Methodology

Measurement of the air quality parameters were achieved using the *AQM-09* air quality monitor for Henan Oceanus. The AQM-09 Air Quality Monitoring Station can measure outdoor air pollutants in real-time, measuring data quickly and accurately. It can be customized for different applications demands, the measurement parameters can be chosen from the following: the gas type Ozone(O_3), Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2), Carbon Monoxide (CO), Particulate matter $PM_{2.5}$ and PM_{10}, and Meteorological parameters (including of Temperature, Humidity, Wind speed, Wind direction, Barometric pressure).

The monitor was set up in an obstruction free area and operated to log in data every 5 minutes for the parameters tested. Monitoring period of 24 hours was set up for each monitoring point.

The AQM-09

5 Baseline Environment

5.1 Project Area

The predominant land use in the ESIA Study Area is livestock herding. Assessments were conducted around the property's boundary fence. Ruai Sewerage Plant is also in the vicinity of the project area which also borders Nairobi River to the East. There are also quarries with constant movement of commercial trucks on loose surface paths approximately 2- 3 kms away from the project area. These are the main predominant activities around the project area that have implications on air quality.

According to the USEPA (2016), sensitive receptors encompass but are not limited to "*hospitals, schools, day-care facilities, elderly housing and convalescent facilities. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants"*. In addition to the aforementioned, the definition covers human settlements where involuntary exposures are likely to occur. There were no major receptors around the project area at the time of assessment.

The monitoring points are further presented in Table 5-1 and Figure 5-1 with the project's land boundary shown in Figure 5-2.

Table 5-1: Monitoring Locations

Location ID	Description	Site category	GPS Location
SP1	Next to P1 boundary corner. Mainly affected by movement of large herds of livestock on loose surfaces, quarry related activities and house construction activities	Residential, Rural and Other areas	1°12'31.44"S 37° 3'51.74"E
SP2	Next to P3 boundary corner. Mainly affected by movement of large herds of livestock on loose surfaces and quarry related activities	Residential, Rural and Other areas	1°12'47.53"S 37° 3'35.96"E
SP3	Next to P3 boundary corner. Mainly affected by movement of large herds of livestock on loose surfaces and quarry related activities	Residential, Rural and Other areas	1°12'38.64"S 37° 3'31.89"E

Figure 5-1: Monitoring points

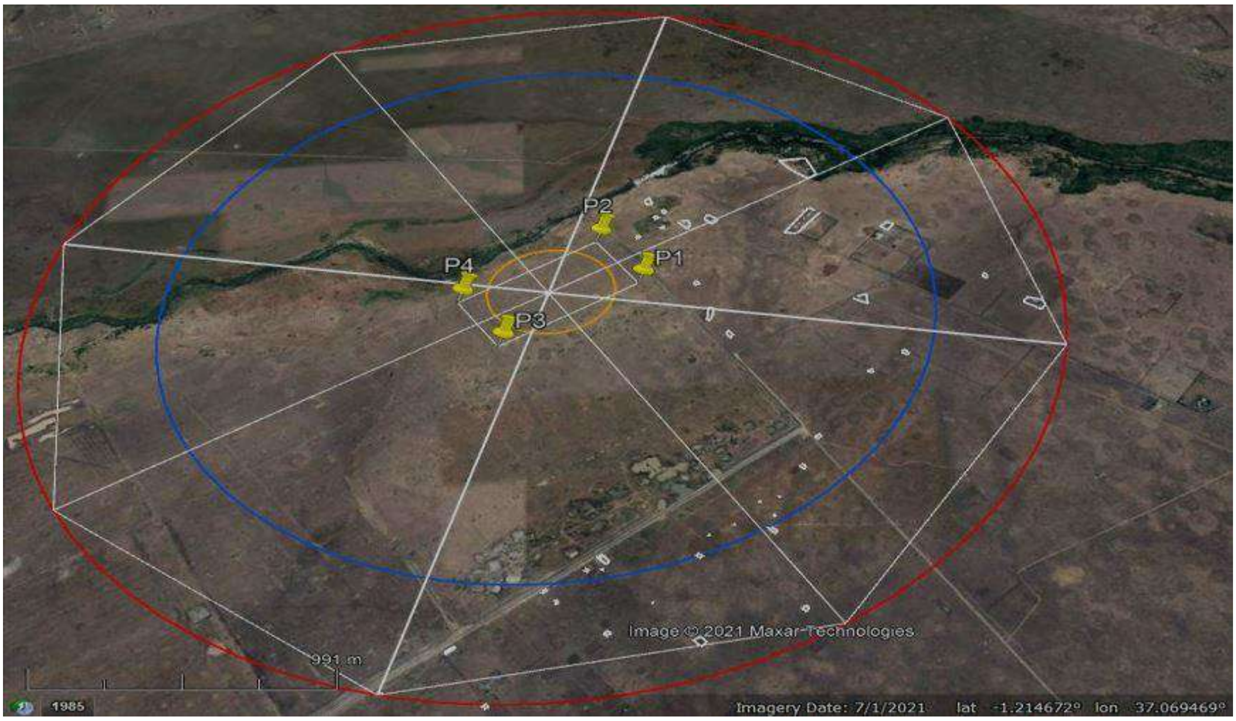

Figure 5-2: Project area

5.2 Meteorology

Ruai's climate is classified as warm and temperate. There is significant rainfall throughout the year in Ruai. Even the driest month still has a lot of rainfall. This climate is considered to be Cfb according to the Köppen-Geiger climate classification. The temperature here averages 19.3 °C | 66.7 °F. In a year, the rainfall is 681 mm | 26.8 inches. The monthly average wind speeds range from 2 m/s to 5 m/s blowing from North West to East direction. Onsite meteorological data for the same period was analysed and used in combination with the modelled data to understand background meteorology.

Dispersion of atmospheric pollutants is a function of the prevailing wind characteristics at any site. The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (Cowherd et al, 1998; Cowherd et al, 2010).

The amount of PM generated by wind is highly dependent upon the wind speed. Below the wind speed threshold for a specific particle type, no particulate matter is liberated, while above the threshold, particulate matter liberation tends to increase with wind speed. The amount of particulate matter generated by wind is dependent also on the surface properties, for example, whether the material is crusted, the fraction of erodible particles, and the particle size distribution (Fryrear et al., 1991).

5.2.1 Wind direction

The dominant winds at the project site over the sampling period was from the North West to direction towards the East.

5.2.2 Wind Speed

One of the factors that favor the suspension dispersal of pollutants in the atmosphere is the intensity of the wind speed regime. Wind speed greater than 5.4 m/s leads to erosion of loose dust PM and enhances the degree of dispersion across the landscape. Wind speed at the project area over the monitoring period indicate diurnal mean wind speed ranged from 2 m/s to 6 m/s. Wind speeds were highest in the evening hours and much lower in the night.

5.2.3 Temperature

The daily maximum and average temperatures for the month of September near the project area were also recorded. The maximum temperatures exceeded 28°C with average daily temperature in the range of 20- 25 ^{0}C.

5.2.4 Precipitation

Short rains were recorded on the third day of monitoring (27th September around 15:00) and averaged 0.5 mm. There was no rainfall reported on all the other days of monitoring.

5.2.5 Relative Humidity

The daily averages for RH over the project area was reported. Daily averages ranged from 55% to 80% throughout the monitoring period.

5.3 Existing Air Quality Scenario

The project area is located inside an open field owned by the Ruai Water and Sewerage Company, in Nairobi County. The area is mainly characterized by livestock herding and quarry related activities. These were noted to have potential impacts on the surrounding air quality. The ambient levels of pollutants such as VOCs, PM_{10} and $PM_{2.5}$, NO_2, CO, CO_2 and SO_2 were assessed along the Project site and at surrounding receptors. The concentrations measured in this baseline data collection survey are discussed in detail below.

The monitoring points are labeled SP1, SP2 and SP3. A brief description of the monitoring locations is provided in Table 5-1.

5.3.1 Description of the assessment points

The areas monitored are all within the boundary fence of the project area. The points are described in Table 5-1

Table 5-2: Monitoring points

Location ID	Description	Site category	Parameters monitored
SP1	Next to P1 boundary corner. Mainly affected by movement of large herds of livestock on loose surfaces, quarry related activities and house construction activities	Residential, Rural and Other areas	PM, SO_2, NO_2, CO_2, CO, VOCs
SP2	Next to P3 boundary corner. Mainly affected by movement of large herds of livestock on loose surfaces and quarry related activities	Residential, Rural and Other areas	PM, SO_2, NO_2, CO_2, CO, VOCs
SP3	Next to P3 boundary corner. Mainly affected by movement of large herds of livestock on loose surfaces and quarry related activities	Residential, Rural and Other areas	PM, SO_2, NO_2, CO_2, CO, VOCs

5.3.2 Particulate Matter- Monitoring Results

Table 5-3: PM Monitoring Results

Monitoring Point	Monitoring dates	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
SP1	*24th -25th Sep 2021*	11	4
SP2	*25th -26th Sep 2021*	8	4
SP3	*26th -27th Sep 2021*	9	5
Regulatory Limits		*100*	*25*

The PM concentrations measured in the ESIA Study Area for the month of September 2021 are presented in Table 5-2.

PM_{10} levels are all within the EMC regulatory limit of 100 µg/m^3. The average concentrations were reported in the range of 9 µg/m^3 to 11 µg/m^3.

In the absence of a local regulatory limit for $PM_{2.5}$, WHO guidelines were used to compare the obtained results. All the measurement points reported values are within the WHO guideline (25 µg/m^3). Average concentrations of 4 µg/m^3 to 5 µg/m^3 were obtained.

Main source of the reported levels is the movement of large herds of livestock on loose surfaces within the project site.

Monitoring trends are presented in the following figures.

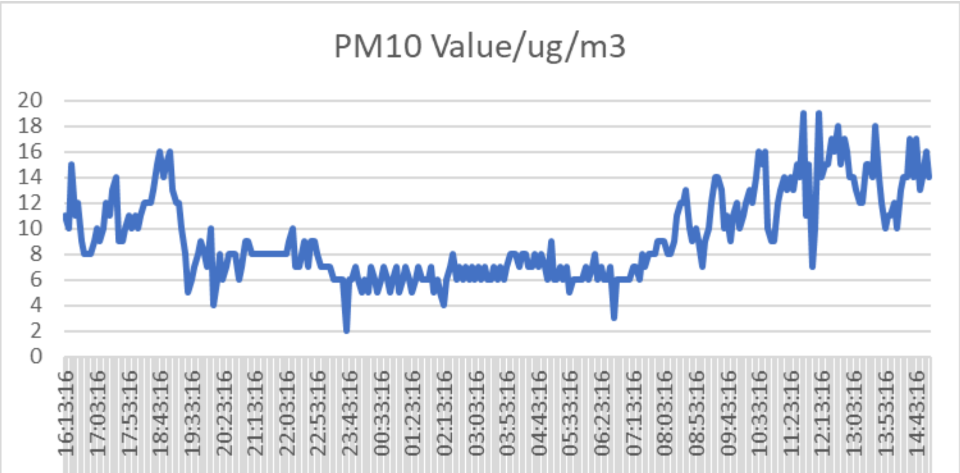

Figure 5-3: PM10 monitoring trend at SP3

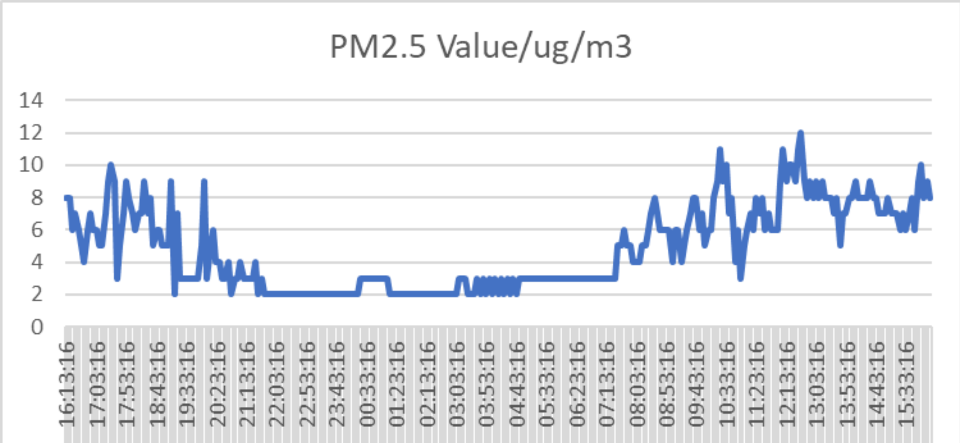

Figure 5-4: PM2.5 monitoring trend at SP3

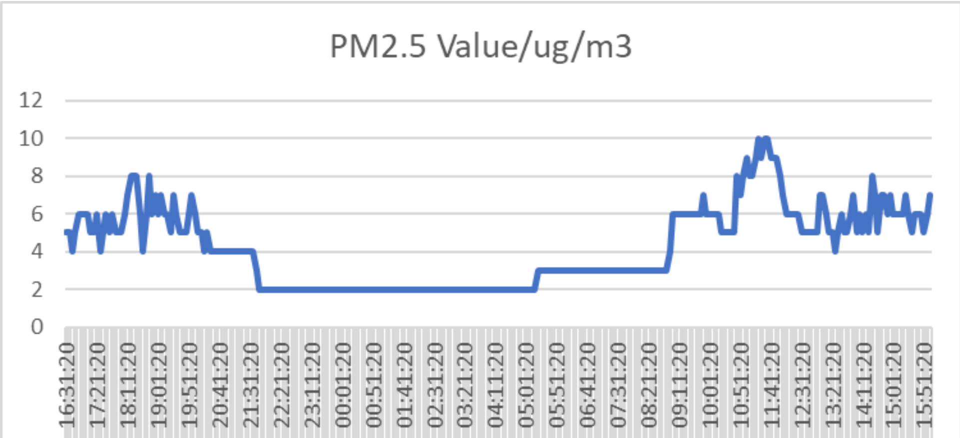

Figure 5-5: PM2.5 monitoring trend at SP2

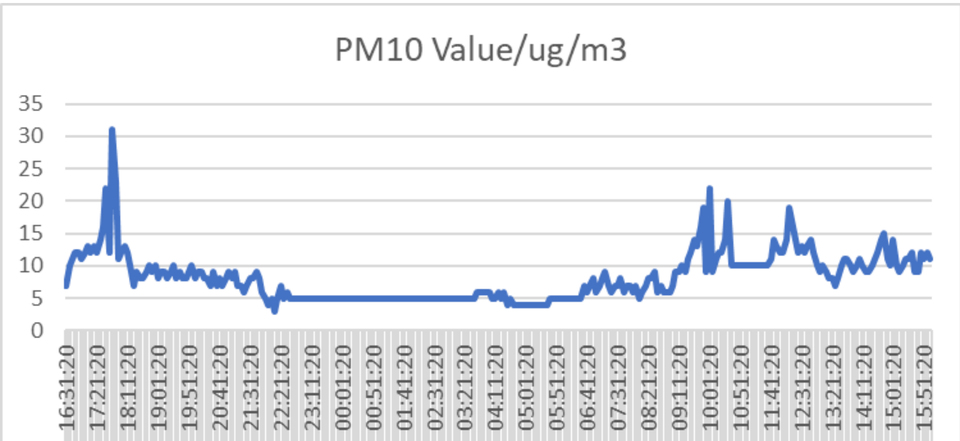

Figure 5-6: PM10 monitoring trend at SP2

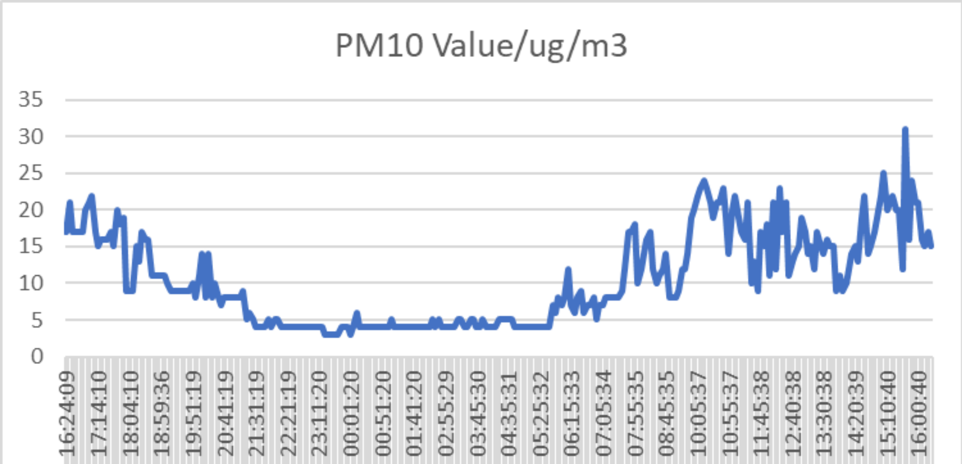

Figure 5-7: PM10 monitoring trend at SP1

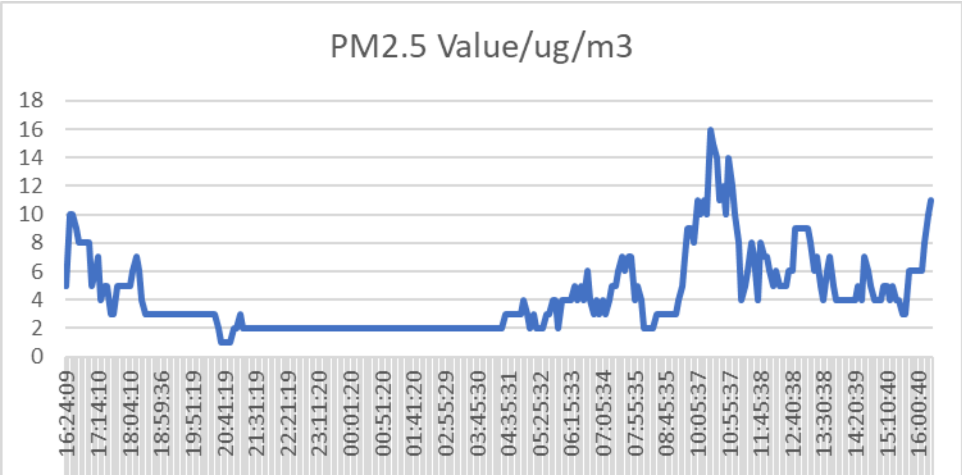

Figure 5-8: PM2.5 monitoring trend at SP1

5.3.3 Gaseous Pollutants (VOCs, NO_2, SO_2, CO_2, CO)- Monitoring Results

The gaseous pollutant monitoring results are presented in Table 5-3.

Table 5-4: Gaseous Pollutants Results

Parameters	Units	SP1 *24th -25th Sep 2021*	SP2 *25th -26th Sep 2021*	SP3 *26th -27th Sep 2021*	*Regulatory Limits*
Sulphur Dioxide, SO_2	ppm	0.001	<0.001	0.001	*0.048*
Nitrogen Dioxide, NO_2	ppm	0.025	0.013	0.020	*0.1*
Carbon Dioxide, CO_2	ppm	142	178	182	*n/a*
Carbon Monoxide, CO	mg/m^3	<0.01	<0.01	<0.01	*2*
Volatile Organic Compounds, VOCs	ppm	0.11	<0.1	0.1	*n/a*

The ambient concentrations measured are all below the EMC regulatory limits for Rural, Residential, and Other Areas, as presented in Table 5-3. The values will serve as baseline to which future measurements can be compared with to assess impacts and compliance.

Although the activities taking place on each sampling day at every sampling point cannot be verified, it is strongly believed that the main sources of the pollutant levels reported are the quarry related operations and house construction activities in the vicinity of the project area.

Monitoring trend for selected pollutants are presented in the following figures:

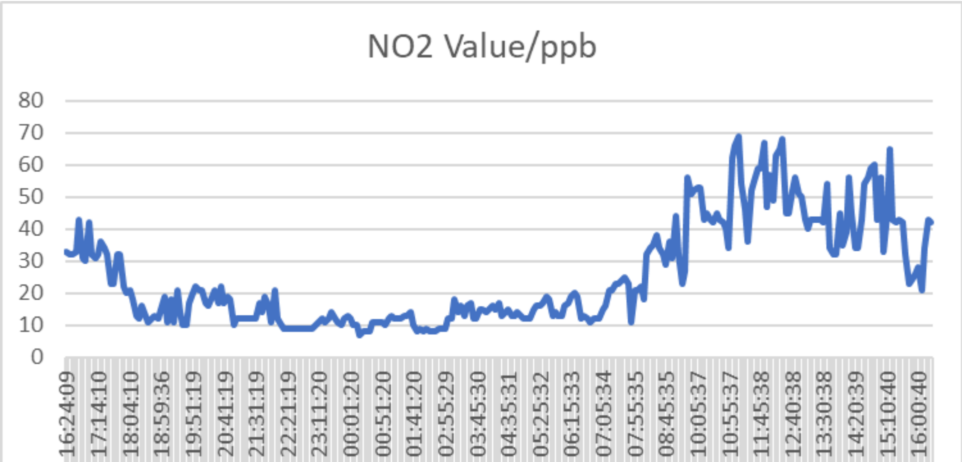

Figure 5-9:NO2 monitoring trend at SP1

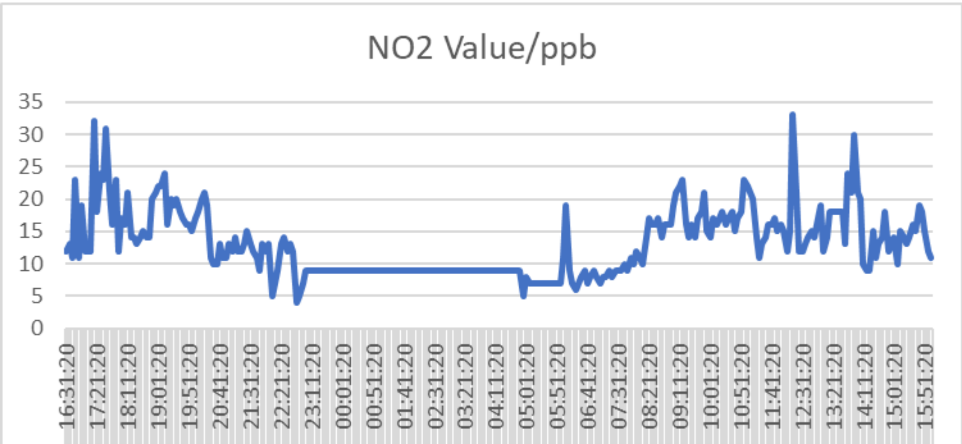

Figure 5-10:NO2 monitoring trend at SP2

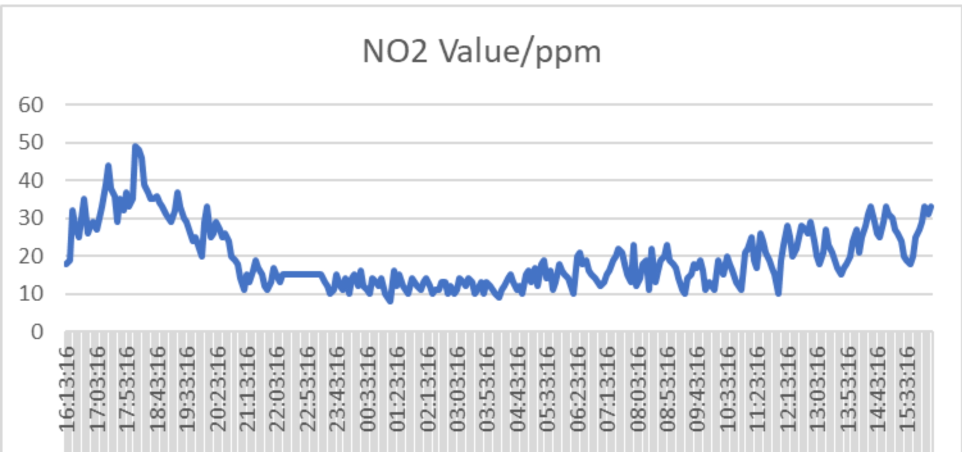

Figure 5-11:NO2 monitoring trend at SP3

6 Potential Impacts

6.1 Construction Phase

The construction phase will comprise excavations and development of the project and associated Infrastructure. In order to determine the significance of the potential for impacts it was imperative to conduct background assessment of air quality in the proposed Project area, and findings have been discussed in this report. Pollutants likely to be emitted during this phase, both PM and gases will serve as reference for future assessment when appraising impacts. It is left to be seen if emissions released during this phase will exacerbate background levels of the pollutants measured.

6.2 Operational Phase

During the operational phase, emissions will most likely be skew towards emissions generated from waste to energy production and its related activities.

The potential impacts anticipated during this phase will be assessed at a later stage.

7 Conclusion

The baseline meteorology showed that the dominant winds blow from the Northwest to the East. Wind speed intensity averaged 2- 6 m/s with rainfall experienced on the third day of monitoring.

The ambient concentrations for all the pollutants assessed (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO_2, CO and VOCs) are within the EMC Regulatory limits for Rural, Residential, and Other Areas. The values will serve as baseline to which future measurements can be compared with to assess impacts and compliance.

There were no major activities observed within the vicinity of the project area that would significantly impact on the air quality of the area. The values reported could potentially be attributed, but not limited, to the following:

- Movement of large herds of livestock on loose surfaces mainly contributed to the dust levels reported;
- Quarry related operations and movement of trucks on loose paths contributed to CO_2, NO_2 and dust levels reported. The quarries are located about 700 m to 2500 m away from the project site;
- House construction activities like welding and grinding ongoing at the time of monitoring. This is located approximately 450 m away;
- Ruai Sewerage Plant with its related waste treatment activities. The treatment plant is located approximately 4.5 km away from the project site.

In the absence of a local regulatory limit for $PM_{2.5}$, WHO guidelines were used to compare the obtained results. All the monitoring points reported values within the WHO guideline (25 µg/m^3).

Additionally, there is no local regulatory limit provided for Total VOCs and CO2 in the EMC air quality regulation under Rural, Residential and Other Areas category.

Although the activities taking place on each sampling day at every sampling point cannot be verified, it is strongly believed that the items discussed above are the main sources of the reported pollutants levels.

The main outcome of this study is that a comprehensive understanding of the background air quality now exists. Background concentrations of various pollutants measure will serve as “reference” to which future measurement can be compared.

8 Appendices

8.1 Photographic Report

Description: Monitoring in progress at SP3

Description: Monitoring in progress at SP2

Description: Monitoring in progress at SP1

Description: a section of the project site surrounding area

Description: movement of herds of livestock a major source of dust within the project area

8.2 Calibration certificate

Calibrate report

Product	Air Quality Monitor System	Model	AQM-09
Quantity	1pcs	Cali date	June ,25, 2021
Product No.	OC20210624615600		
Appearance	☑Clean ☑Non corrosive ☑No damage		
Gas type	H2S: ppm SO₂:ppb NO₂:ppb O3:ppb TVOC:ppm PM2.5:ug/m³ PM10:ug/m³ TSP:ug/m³ Temperature and humidity: ℃/%RH		
Accuracy	±3%F.S		
resolution	0.1ppm 1ppb 1ug/m³		
Response time	≤30S		
Survey range	H2S:0-100ppm NO₂:0-2000ppb SO₂:0-2000ppb O3:0-2000ppb TVOC:0-50ppm PM2.5:0-1000ug/m³ PM10:0-1000ug/m³ TSP:0-1000ug/m³ Temperature: -10-50℃ Humidity:0%-100%RH		
Signal output mode	4G LTE		
Power supply voltage	AC 240V/50Hz		
Power dissipation	≤30W		
Working temperature and humidity range	-20℃-50℃ / 0%RH-100%RH		
Testing condition indoor	Temperature: 25℃ Humidity: 60%RH		
Calibration gas	NO₂ SO₂ O3 TVOC H2S		
Cali gas test	1.H2S: Cali gas concentration: 100 ppm Inspect concentration: 98.2 ppm 2.NO₂: Cali gas concentration: 1000 ppb Inspect concentration: 997 ppb 3.SO₂: Cali gas concentration: 1000 ppb Inspect concentration: 998 ppb 4.O3: Cali gas concentration: 1000 ppb Inspect concentration: 996 ppb 5.TVOC: Cali gas concentration: 50 ppm Inspect concentration: 49.3 ppm 6.PM2.5:Measured value: 42 ug/m³ PM10:Measured value: 47 ug/m³ TSP:Measured value: 52 ug/m³ 7.Temperature: Measured value: 25.4℃ Humidity:Measured value: 51 %RH		
Test result	Qualified		
Remark			

Check: Approval: Tester: QC PASS

Company: Henan Oceanus Import & Export Co., Ltd.

Date: June,25, 2021

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Annex 9

Air Dispersion Modelling

Waste to Energy Project

ATMOSPHERIC DISPERSION MODELLING REPORT

Prepared for:

KenGen
Energy for the nation.

Nairobi, Kenya

Prepared by: Philip ABUOR

October 2021

Date: 28-October-21

Revision	Revision Date	Details	Authorized	
			Name/Position	Signature
00	28th October, 2021	Air Dispersion Modelling Report	Philip Abuor	

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CHAPTER ONE

1.1 INTRODUCTION

EnviroPro Kenya Limited is conducting an ESIA commissioned by KenGen for the proposed Waste to Energy (WtE) project in Ruai Sewerage Plant (hereinafter referred to as *the project*). This report presents findings of an Air Dispersion Modelling for the project area, which will form part of a range of specialist studies undertaken for the Project. This study was conducted in accordance with Kenyan legislation, as contained in the Environment Management and Coordination Act (EMCA), No. 8 of 1999.

The Government of Kenya intends to improve environmental sustainability by improving municipal solid waste (MSW) management and promoting renewable energy in Kenya. In order to manage Nairobi's waste as well as to overcome the hazards at the Dandora dumpsite, Nairobi Metropolitan Services (NMS) is partnering with Kenya Electricity Generating Company PLC (KenGen) to establish a waste-to-energy (WtE) plant within Nairobi Metropolitan Area. An ESIA study is ongoing and the scope includes assessment of baseline ambient air quality levels and air dispersion modelling.

Table 1: *Project Location Summary*

Property Description:	Waste to Energy project
Approximate Coordinates from the point source	Latitude: 01° 12' 31.44"(S) Longitude: 036° 3' 51.74"(E)

1.2 SCOPE OF WORK

Use a mathematical air quality dispersion model to estimate the impact on the ambient concentrations of specific pollutants, including Particulate Matter ($PM_{2.5}$ and PM_{10}), Sulphur Dioxide (SO_2), Carbon Monoxide (CO) and Oxides of Nitrogen (NOx), emitted from the proposed point sources.

The link between the emissions from the stacks and the resulting contributions to ground level concentrations were determined, calculating hour-by-hour concentration distributions to the nearby area over an entire year, showing the results from the spatial distribution of the contribution to pollutant concentration under the form of a map with isopleths. The atmospheric impact assessment of the results was calculated and compared against Kenya Environmental Management and Coordination (Air Quality Regulations), 2014 referring to threshold exposure levels of the population.

1.3 RECEPTOR DOMAIN DESCRIPTION

The receptor domain adopted for the predictions of pollutant concentrations was a 3 x 2-kilometer rectangular extent around the plant. The receptor domain was segmented into uniform Cartesian grids of 21 meter by 21-meter dimensions to give a square grid network of 493 columns by 288 rows.

The study area domain was segmented into 441 receptor grid points at which the modelled concentration of each pollutant was generated. The network of receptor grid points was used as concentration data points in the software to interpolate a continuous surface and contours of pollutant concentrations across the modelling spatial domain.

Table 2: *Definition of Study Area Receptor Grid Network as used in AERMOD View.*

Dimension	Interval (Meters)	No. of Rows/Columns	Total Extent (Meters)
Horizontal → East Direction	21	493	9871.40
Vertical → North Direction	21	288	5771.80

1.4 AIR QUALITY RECEPTORS

A set of five specific receptors were one identified out of which all can be classified as sensitive. The sensitive receptors are indicated in Figure 1 below.

Figure 1: *Location of Air Quality Receptors*

CHAPTER TWO

2.1 METHODOLOGY

The AERMOD dispersion model was used in the estimation of upwind and downwind ground level concentration of the Sulphur Dioxide, Carbon Monoxide, Oxides of Nitrogen (NOx), and Particulate Matter; the main pollutants of concern for industry category (Municipal Waste Incinerators).

Dispersion modelling was undertaken to determine the highest hourly, highest daily and the annual average ground level concentrations. The averaging periods were selected to facilitate comparisons of the simulated ground level concentrations to the ambient air quality criteria set out in the Kenyan Environmental Management and Coordination (Air Quality) Regulations, 2014.

2.1.1 Source Input Parameters

A number of conservative assumptions were made during the assessment of the potential impact on air quality of the stacks' emissions. These were as follows:

- The plant will be operating at maximum capacity and maximum emission rates;
- The plant will be operating 24hr a day, 7 days a week (i.e., 8,760 hours per year).

The source input parameters were provided by the proponent and are as indicated in tables 3-7 below:

1 – Incinerator _Stack1

2 – Incinerator _Stack2

3 – Incinerator _Stack3

Table 3: *Emission Input Parameters Sulphur Dioxide (SO_2)*

Source	T(°C)	Exit Flow Rate (dsm^3/hr)	Exit Velocity (m/s)	Emission Rate (g/s)	Stack Diameter (m)	Release Height (m)
1.	120	15000	50.0	0.625	1.0	80.0
2.	120	15000	50.0	0.625	1.0	80.0
3.	120	15000	50.0	0.625	1.0	80.0

Table 4: Emission Input Parameters Oxides of Nitrogen (NO_2)

Source	T(°C)	Exit Flow Rate (dsm^3/hr)	Exit Velocity (m/s)	Emission Rate (g/s)	Stack Diameter (m)	Release Height (m)
1.	120	15000	50.0	1.92	1.0	80.0
2.	120	15000	50.0	1.92	1.0	80.0
3.	120	15000	50.0	1.92	1.0	80.0

Table 5: Emission Input Parameters for PM_{10}

Source	T(°C)	Exit Flow Rate (dsm^3/hr)	Exit Velocity (m/s)	Emission Rate (g/s)	Stack Diameter (m)	Release Height (m)
1.	120	15000	50.0	0.208	1.0	80.0
2.	120	15000	50.0	0.208	1.0	80.0
3.	120	15000	50.0	0.208	1.0	80.0

Table 6: Emission Input Parameters for $PM_{2.5}$

Source	T(°C)	Exit Flow Rate (dsm^3/hr)	Exit Velocity (m/s)	Emission Rate (g/s)	Stack Diameter (m)	Release Height (m)
1.	120	15000	50.0	0.16016	1.0	80.0
2.	120	15000	50.0	0.16016	1.0	80.0
3.	120	15000	50.0	0.16016	1.0	80.0

Table 7: Emission Input Parameters for CO

Source	T(°C)	Exit Flow Rate (dsm^3/hr)	Exit Velocity (m/s)	Emission Rate (g/s)	Stack Diameter (m)	Release Height (m)
1.	120	15000	50.0	2.083	1.0	80.0
2.	120	15000	50.0	2.083	1.0	80.0
3.	120	15000	50.0	2.083	1.0	80.0

CHAPTER THREE

3.1 AMBIENT AIR DATA

Table 2: ***PM Monitoring Results***

Monitoring Point	Monitoring dates	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
SP1	*24th -25th Sep 2021*	11	4
SP2	*25th -26th Sep 2021*	8	4
SP3	*26th -27th Sep 2021*	9	5
Regulatory Limits		*100*	*25*

Table 3: ***Gaseous Pollutants Monitoring Results***

Parameters	Units	SP1 *24th -25th Sep 2021*	SP2 *25th -26th Sep 2021*	SP3 *26th -27th Sep 2021*	*Regulatory Limits*
Sulphur Dioxide, SO_2	ppm	0.001	<0.001	0.001	*0.048*
Nitrogen Dioxide, NO_2	ppm	0.025	0.013	0.020	*0.1*
Carbon Dioxide, CO_2	ppm	142	178	182	*n/a*
Carbon Monoxide, CO	mg/m^3	<0.01	<0.01	<0.01	*2*
Volatile Organic Compounds, VOCs	ppm	0.11	<0.1	0.1	*n/a*

3.2 MODELING RESULTS

The modelled results are provided in tabular form as discrete values simulated at the boundaries' locations. The isopleths were used selectively to present areas of significance to the assessment criteria. Ground level concentration isopleths depict interpolated values from the concentrations simulated by AERMOD 10.0.1 for each of the receptor grid points specified.

Table 4: Maximum Concentration Areas

Pollutant	Averaging Period	Maximum Concentration (µg/m³)	Limits (µg/m³)	Location	
				X(m)	Y(m)
PM_{10}	1h	1.262	N/A	284580.14	9866460.21
	24hs	0.323	150	284580.14	9866460.21
	Annual	0.104	70	284580.14	9866460.21
$PM_{2.5}$	1h	0.972	N/A	284580.14	9866460.21
	24hs	0.249	75	284580.14	9866460.21
	Annual	0.080	35	284580.14	9866460.21
NO_2	1h	11.65	N/A	284580.14	9866460.21
	24hs	2.980	150	284580.14	9866460.21
	Annual	0.956	80	284580.14	9866460.21
SO_2	1h	3.760	N/A	284580.14	9866460.21
	24hs	0.962	125	284580.14	9866460.21
	Annual	0.309	80	284580.14	9866460.21
CO	1h	12.64	N/A	284580.14	9866460.21
	24hs	3.240	2,000	284580.14	9866460.21
	Annual	1.037	N/A	284580.14	9866460.21

The location of maximum peak concentration of pollutants is on the immediate South West side of the proposed plant.

Values in brackets are predicted model results, whilst the second value is the cumulative value (ambient air quality + model results). The facility is obligated to monitor ambient air quality at the property boundary fence, under the Kenyan Air Quality Regulations, 2014.

Table 5: Concentration of Pollutant in the Receptors under Study

	NO_2 (µg/m³)			CO (µg/m³)			SO_2 (µg/m³)			PM_{10} (µg/m³)			$PM_{2.5}$ (µg/m³)		
	1 hour	**24 hours**	**Annual**	**1 hour**	**24 hours**	**Annual**	**1 hour**	**24 hours**	**Annual**	**1 hour**	**24 hours**	**Annual**	**1 hour**	**24 hours**	**Annual**
Ambient Air Quality Standards (µg/m³)	**411**	**150**	**80**	**N/A**	**2,000**	**N/A**	**N/A**	**125**	**80**	**N/A**	**150**	**70**	**N/A**	**75**	**35**
Mwalimu Farm Ruiru	(7.00) No data	(1.00) No data	(0.10) No data	(7.00) No data	(1.0) No data	(0.1) No data	(1.94) No data	(0.30) No data	(0.040) No data	(0.80) No data	(0.10) No data	(0.01) No data	(0.6) No data	(0.09) No data	(0.010) No data
Proposed Close Knit	(6.00) No data	(1.00) No data	(0.10) No data	(6.00) No data	(1.0) No data	(0.1) No data	(1.63) No data	(0.20) No data	(0.030) No data	(0.70) No data	(0.10) No data	(0.01) No data	(0.6) No data	(0.08) No data	(0.010) No data
Pcea Siloam Church	(8.00) No data	(1.00) No data	(0.10) No data	(9.00) No data	(0.90) No data	(0.1) No data	(2.24) No data	(0.20) No data	(0.030) No data	(0.90) No data	(0.10) No data	(0.01) No data	(0.7) No data	(0.08) No data	(0.009) No data
To The West of The Plant	(6.00) No data	(0.60) No data	(0.10) No data	(7.00) No data	(0.70) No data	(0.1) No data	(1.33) No data	(0.11) No data	(0.030) No data	(0.70) No data	(0.07) No data	(0.01) No data	(0.5) No data	(0.05) No data	(0.009) No data
To The South of The Plant	(9.0) No data	(0.90) No data	(0.20) No data	(10.0) No data	(1.0) No data	(0.1) No data	(2.24) No data	(0.20) No data	(0.040) No data	(1.00) No data	(0.10) No data	(0.01) No data	(0.7) No data	(0.07) No data	(0.010) No data

APPENDIX I: ISOPLETHS

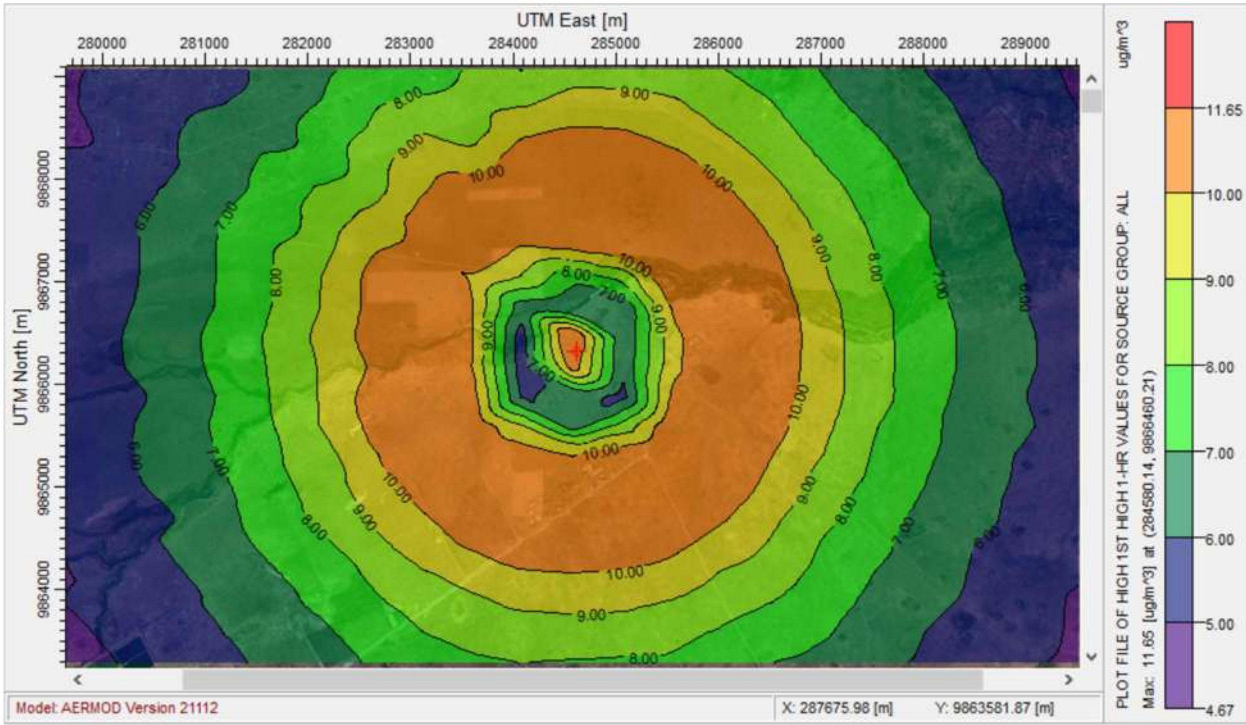

Figure 2: *Maximum Ground Level 1 Hour NO_2 Concentrations.*

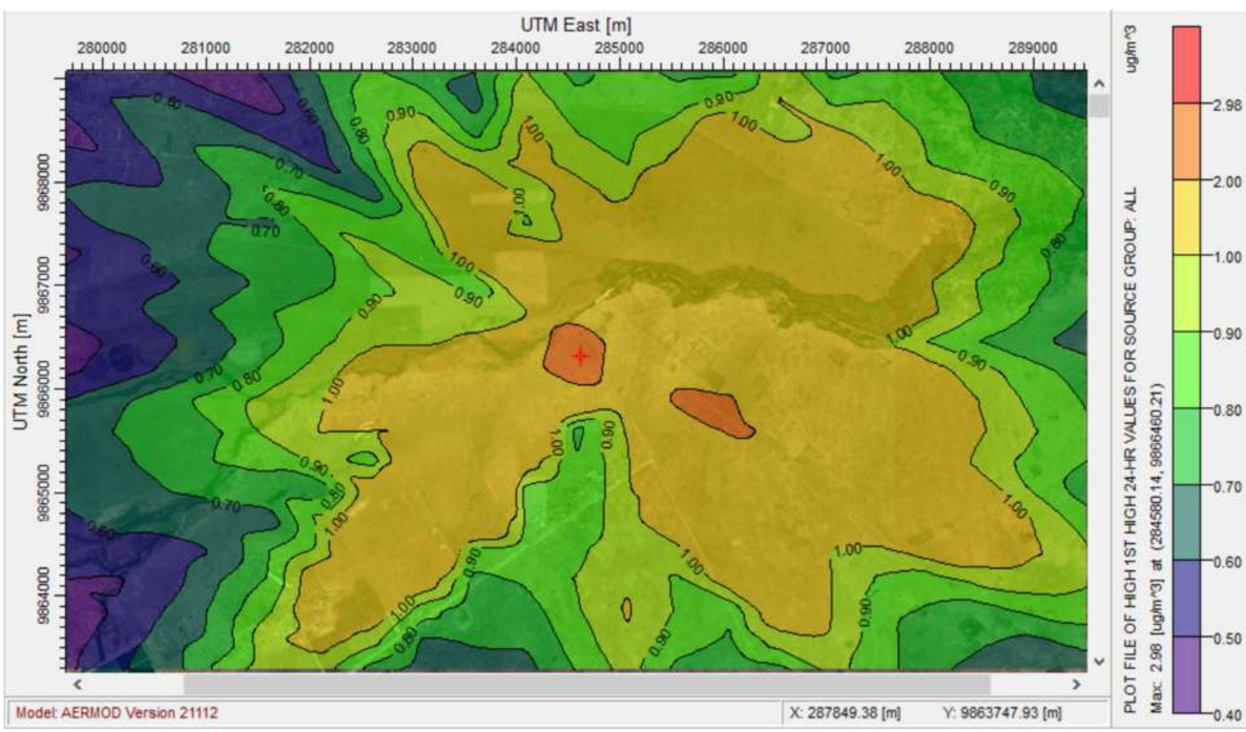

Figure 3: *Maximum Ground Level 24-Hour NO_2 Concentrations.*

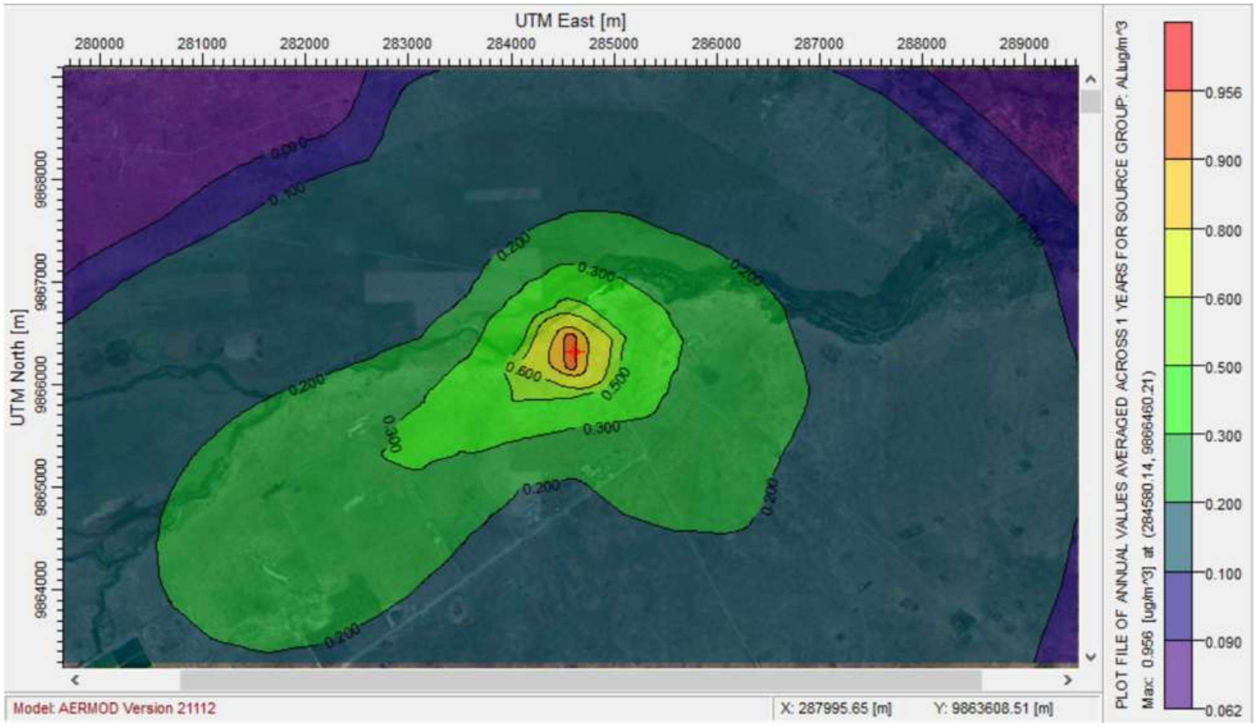

Figure 4: *Maximum Ground Level Annual NO_2 Concentrations.*

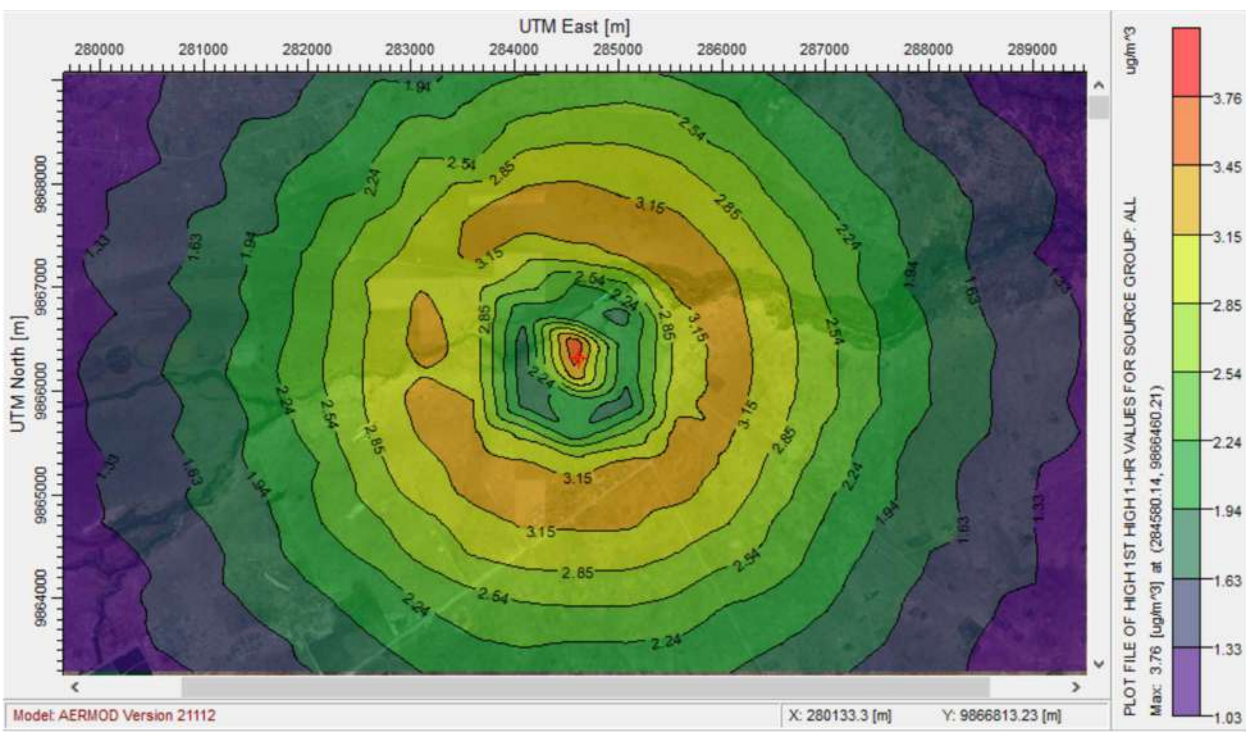

Figure 5: *Maximum Ground Level 1 Hour SO_2 Concentrations.*

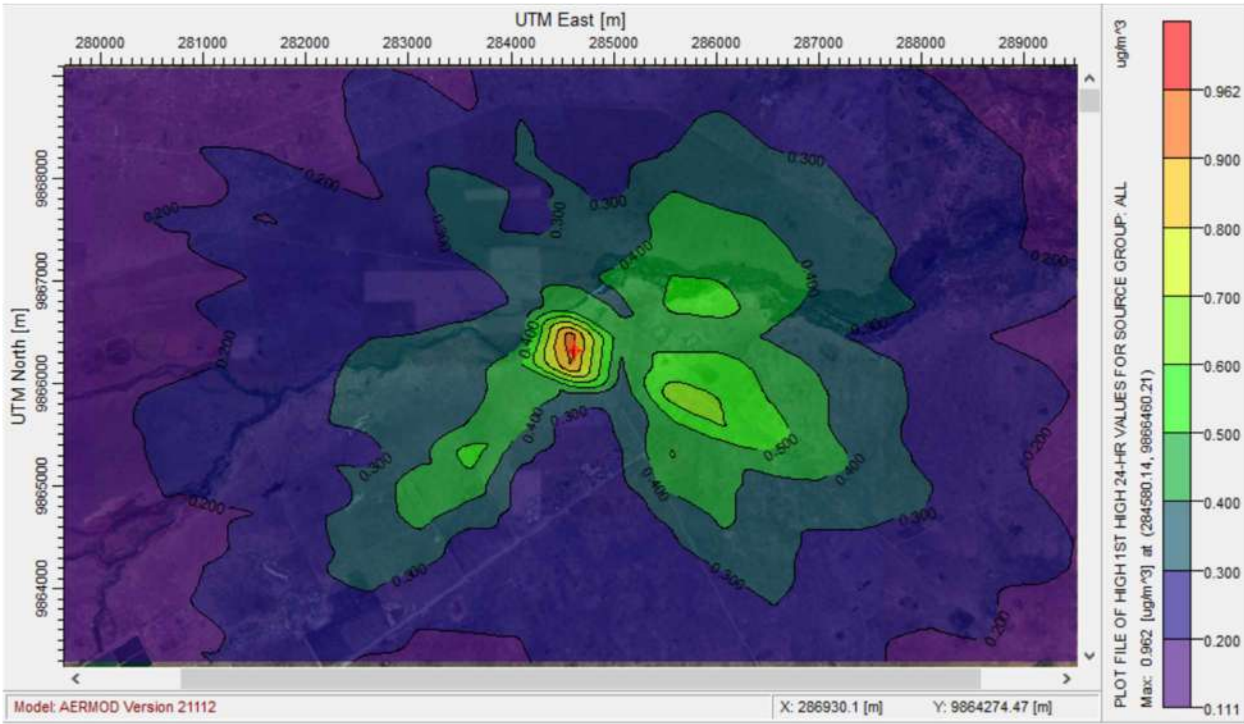

Figure 6: *Maximum Ground Level 24-Hour SO_2 Concentrations.*

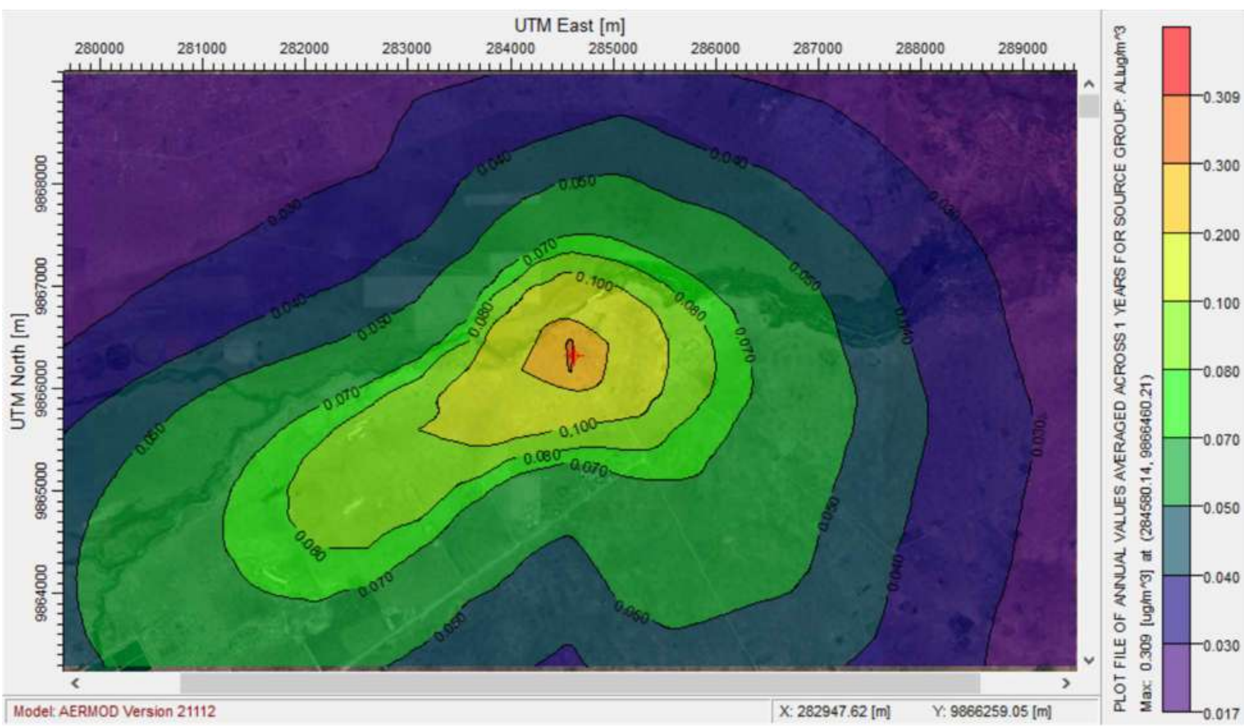

Figure 7: *Maximum Ground Level Annual SO_2 Concentrations.*

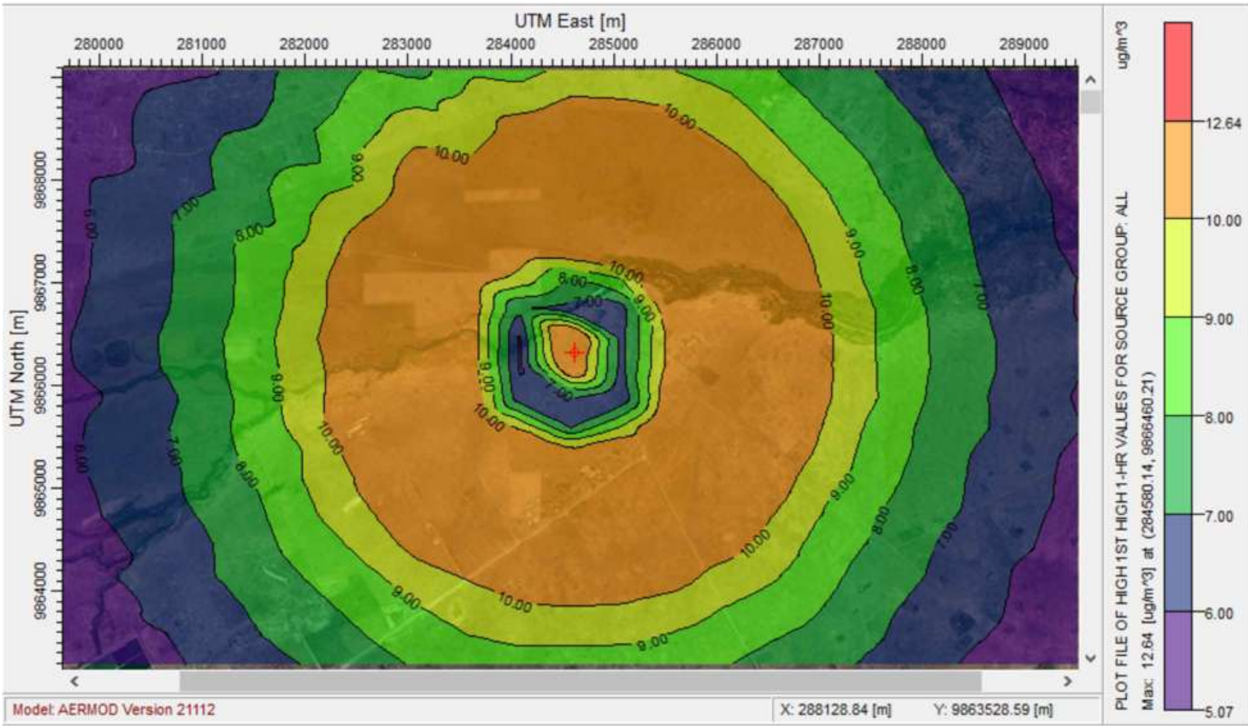

Figure 8: *Maximum Ground Level 1 hour CO Concentrations.*

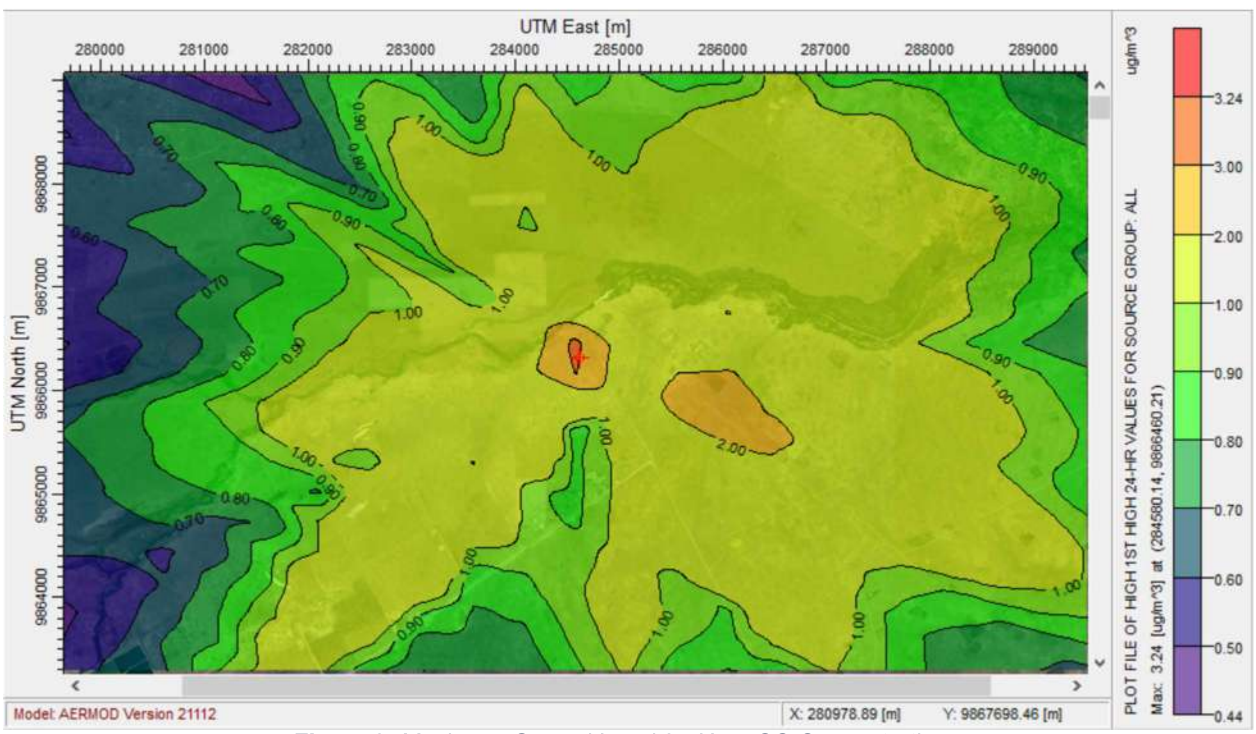

Figure 9: *Maximum Ground Level 24-Hour CO Concentrations.*

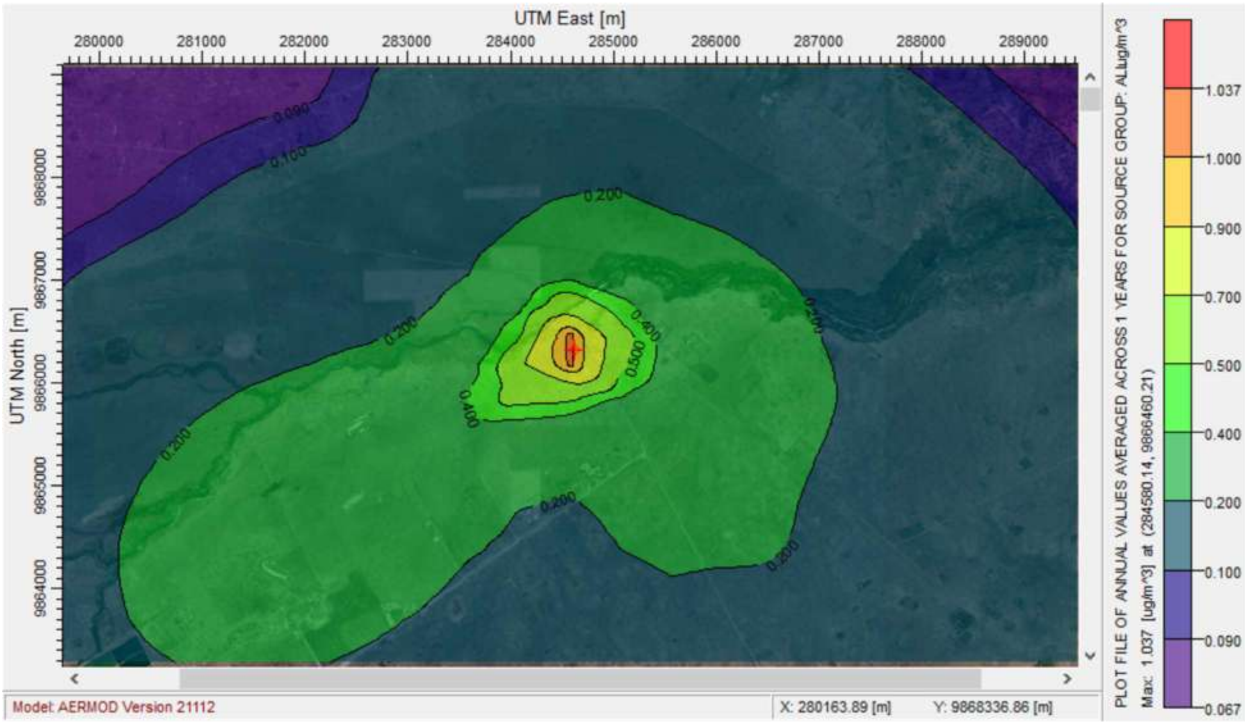

Figure 10: *Maximum Ground Level Annual CO Concentrations.*

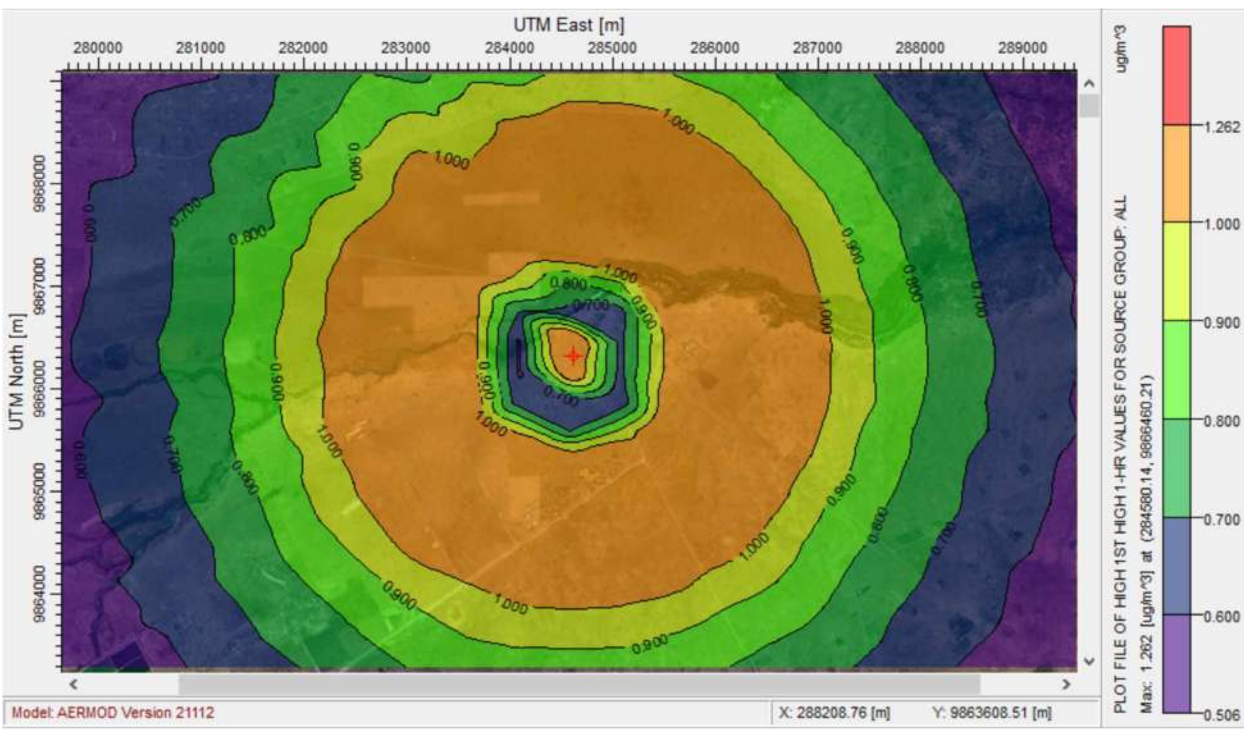

Figure 11: *Maximum Ground Level 1 Hour PM_{10} Concentrations.*

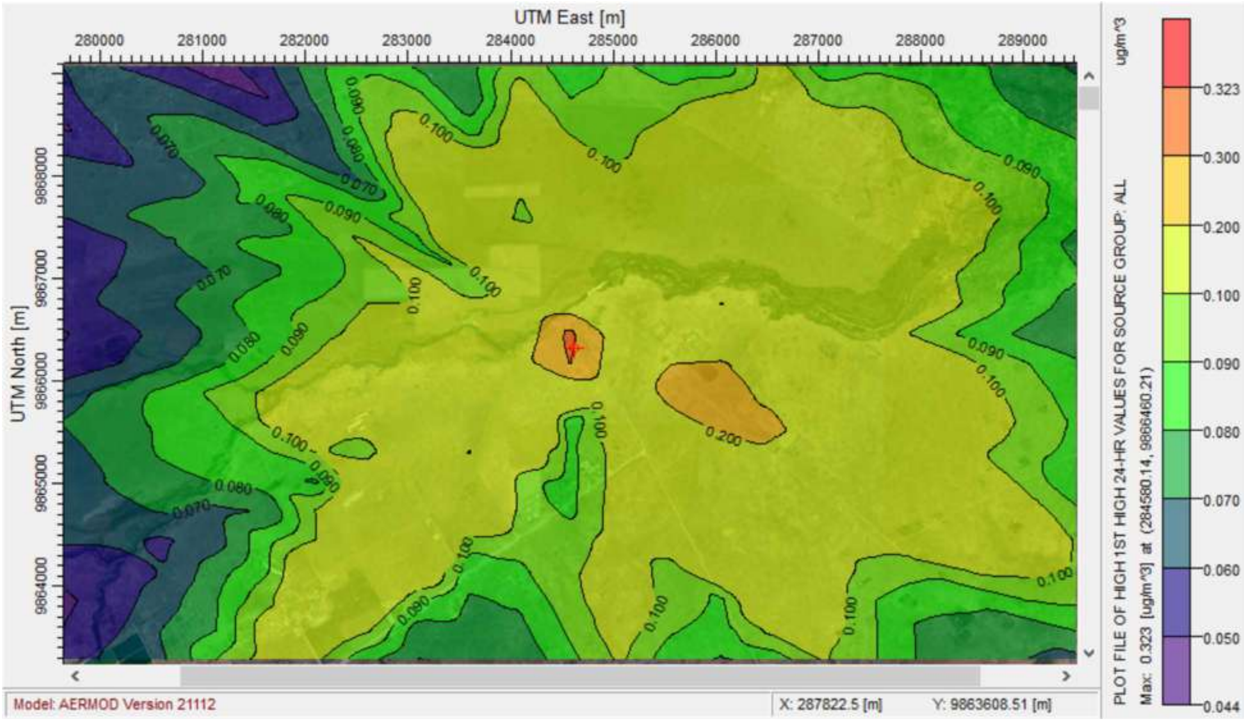

__Figure 12:__ Maximum Ground Level 24-Hour PM_{10} Concentrations.

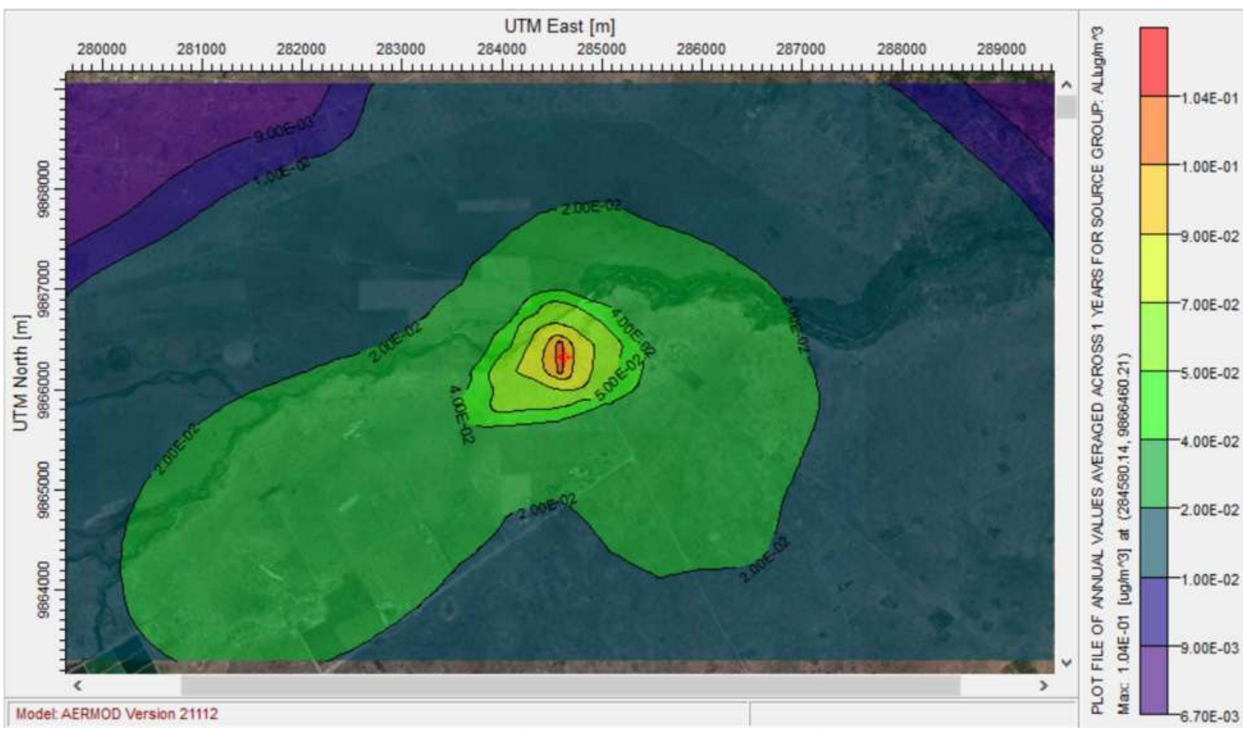

__Figure 13:__ Maximum Ground Level Annual PM_{10} Concentrations.

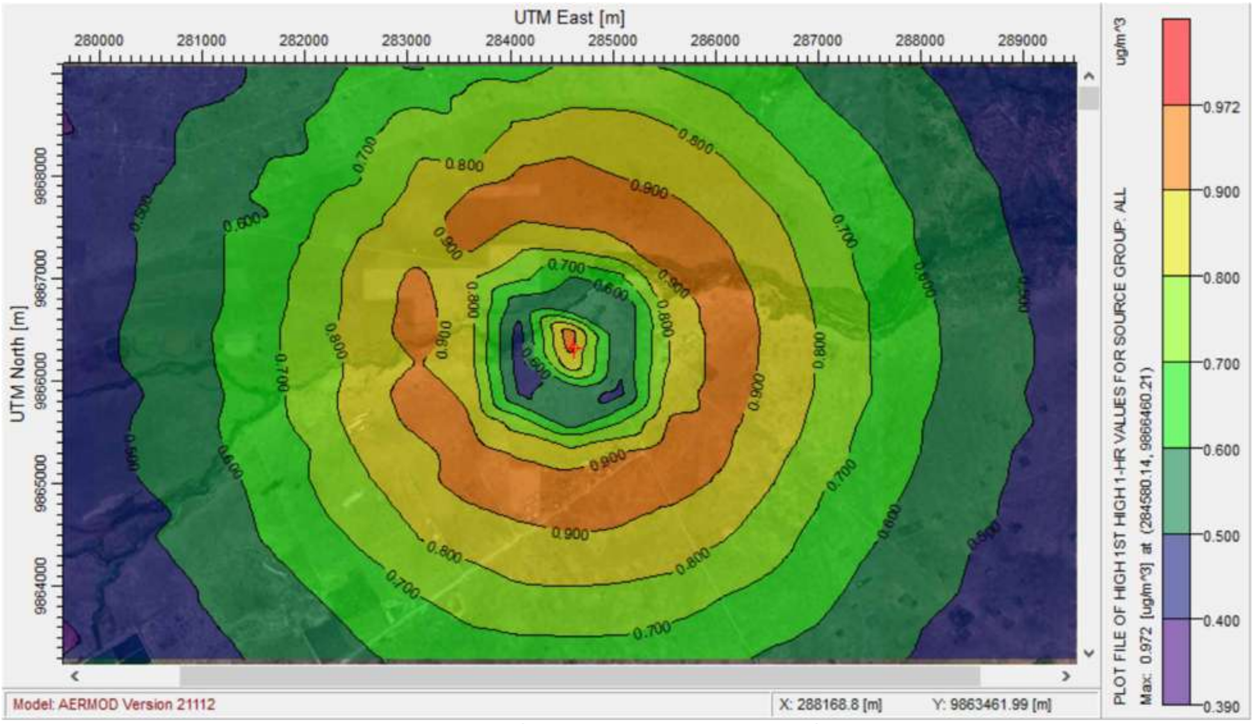

Figure 14: *Maximum Ground Level 1 Hour $PM_{2.5}$ Concentrations.*

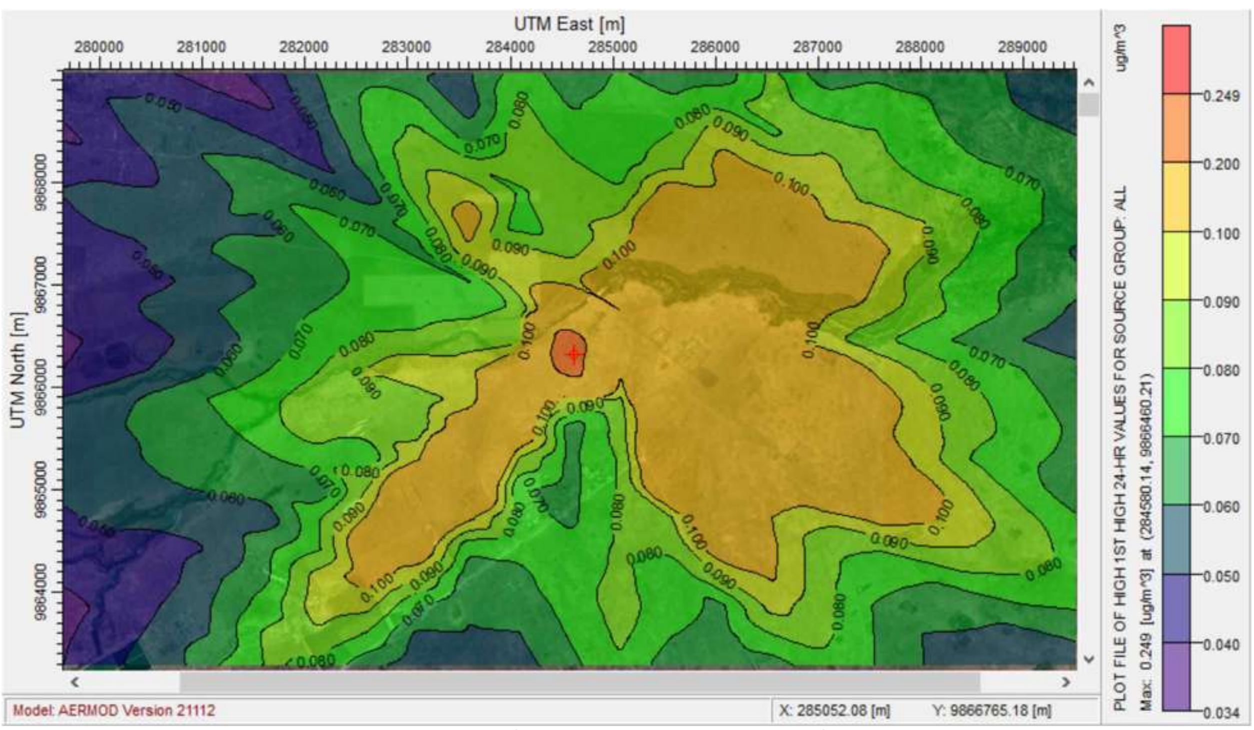

Figure 15: *Maximum Ground Level 24 Hour $PM_{2.5}$ Concentrations.*

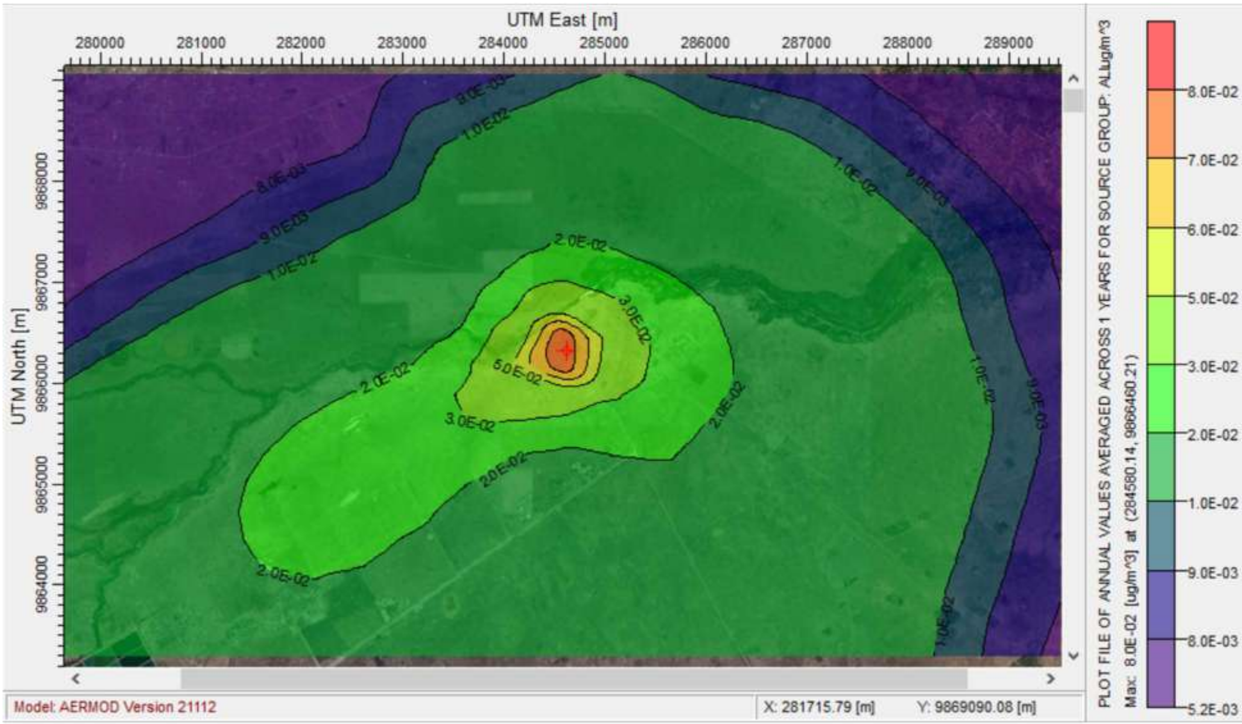

Figure 16: *Maximum Ground Level Annual $PM_{2.5}$ Concentrations.*

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3 **EPA (1992).** *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised,* EPA-454/R-92-019, US-Environmental Protection Agency, Research Triangle Park, North Carolina, 2711

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18 National Environment Management Authority, Reconnaissance Survey of Compliance Levels with Environmental Regulations in Kisumu Municipality (A Case Study of the EIA/EA Regulations 2003, WATER Quality and Waste Management Regulations 2006), May 2010.

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KENGEN LIMITED

WIND DATA

Prepared for:

KenGen Limited
Nairobi, Kenya

Prepared by: Philip ABUOR

OCTOBER 2021

QA/QC & FIRM INFORMATION

Date: 31-October-21

Revision	Revision Date	Details	Authorized	
			Name/Position	Signature
00	31st October, 2021	Wind data Modelling Report	Philip Abuor	

METEOROLOGY

Wind Roses

The model has been prepared with surface data schedules for 3 years (temperature, wind speed, wind direction and cloud cover), considering in this case records from the three years as the most appropriate for modelling of the dispersion of pollutants. Wind roses comprise 36 spokes, which represent the directions from which winds blew during a specific period. Annual wind rose is presented in Figure 3 below. The prevailing direction of wind is mainly from NE to SW at a speed of 5.70- 8.80m/s except during July- September when the wind predominantly flows from SE to NW at a speed of 3.60-5.70m/s. The seasonal wind roses are as presented in figures 6 to 15.

Annual Wind Roses

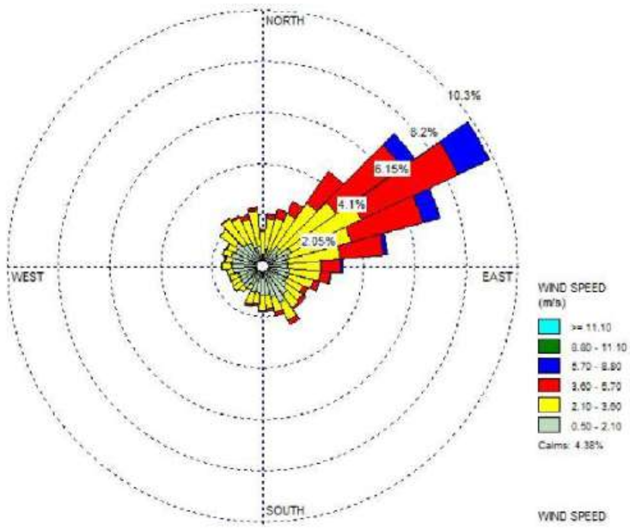


Figure 1: *24-hour Annual Wind Rose.*

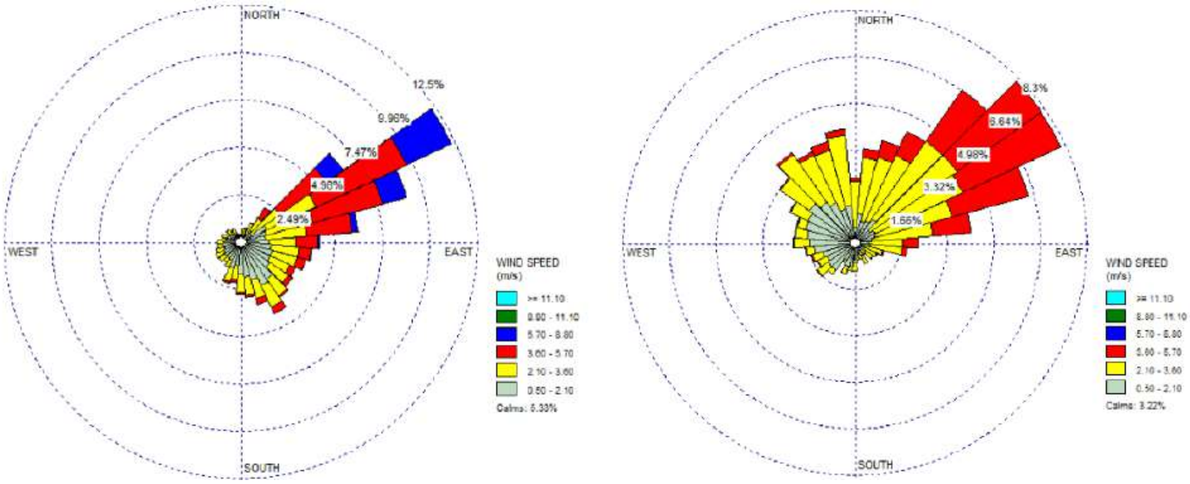


Figure 2: *Diurnal and Nocturnal Annual Wind Roses Respectively.*

April – June Wind Roses

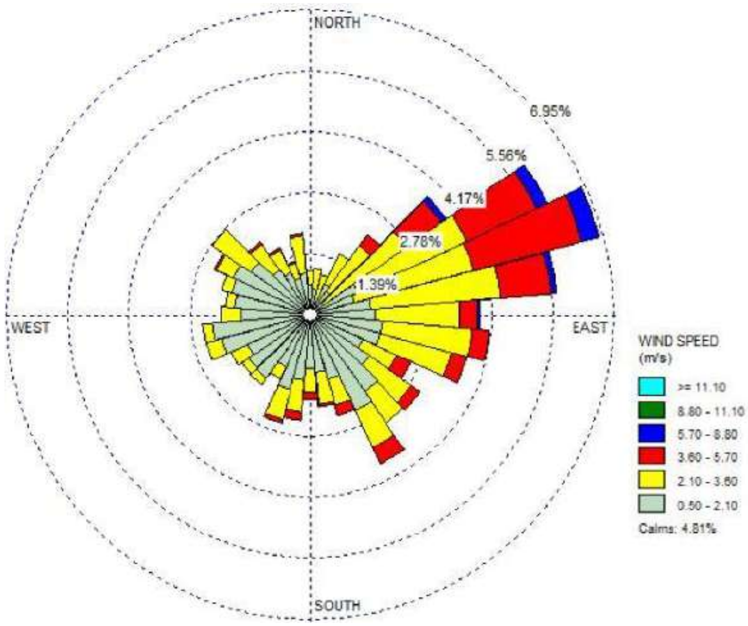


Figure 3: *24-hour April – June Wind Rose*

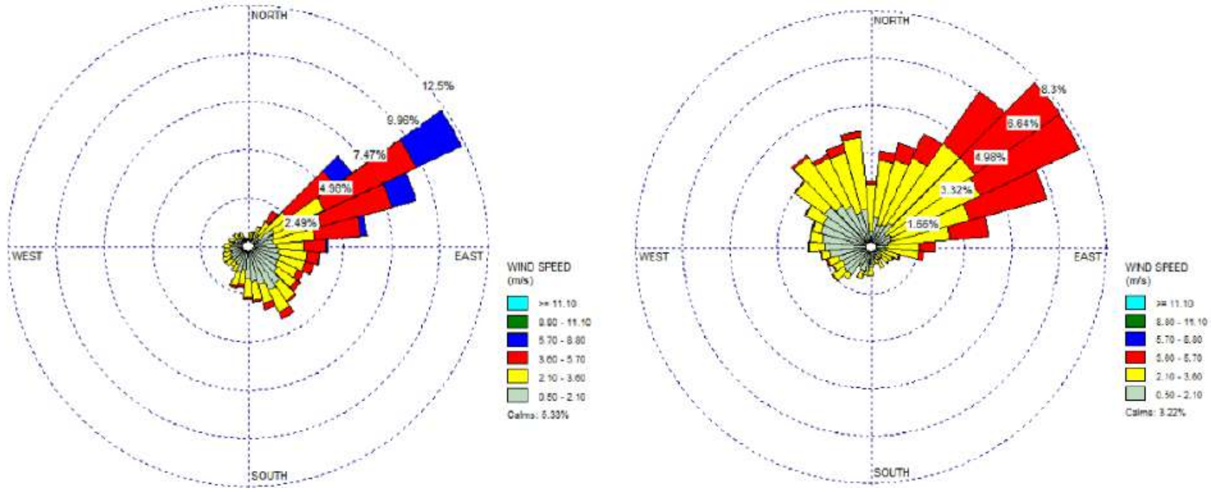


Figure 4: *Diurnal and Nocturnal April – June Wind Rose*

January – March Wind Roses

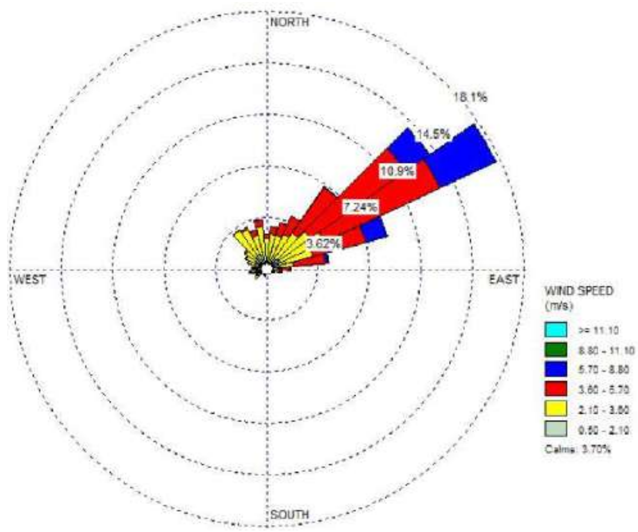


Figure 5: *24-hour January – March Wind Rose*

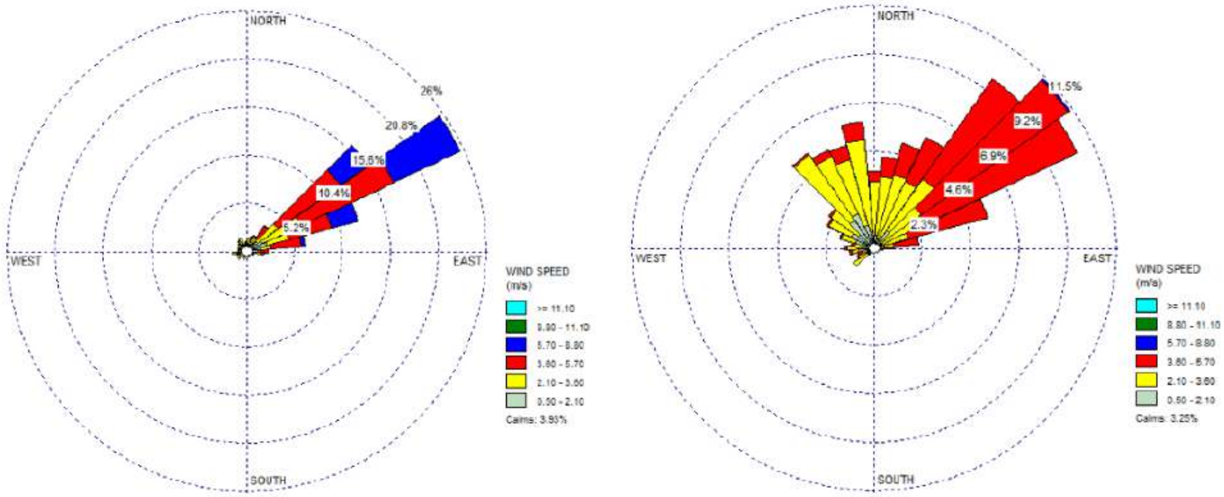


Figure 6: *Diurnal and Nocturnal January – March Wind Rose*

July – September Wind Roses

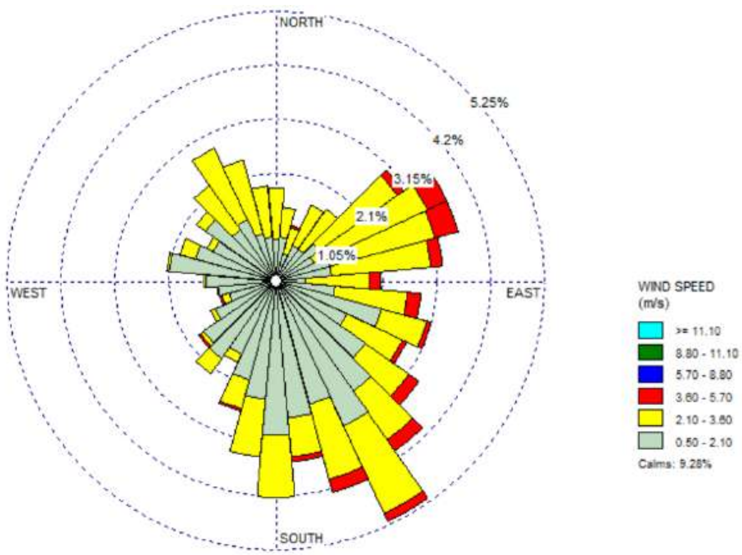


Figure7: *24-hour July – September Wind Rose*

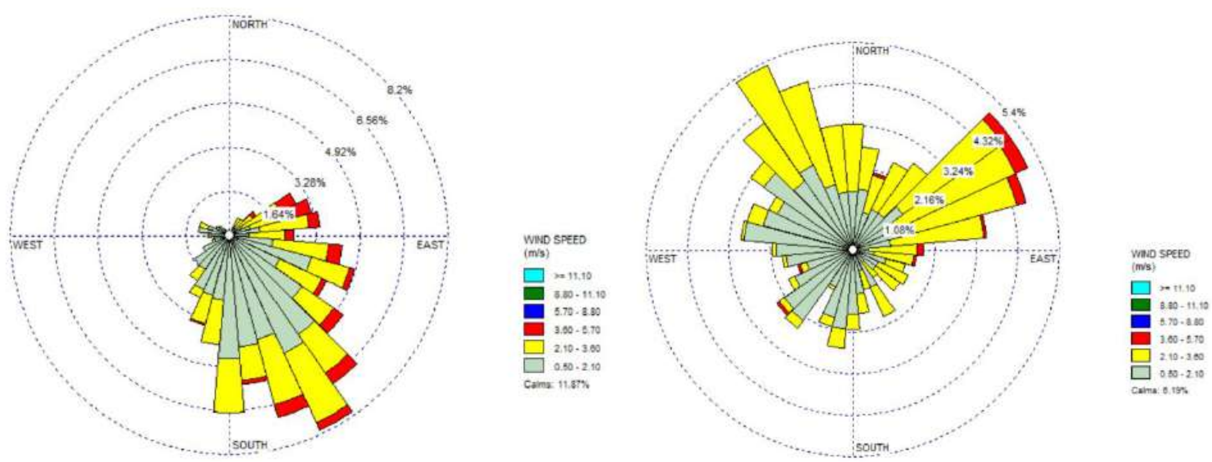


Figure 8*: Diurnal and Nocturnal July – September Wind Rose*

October – December Wind Roses

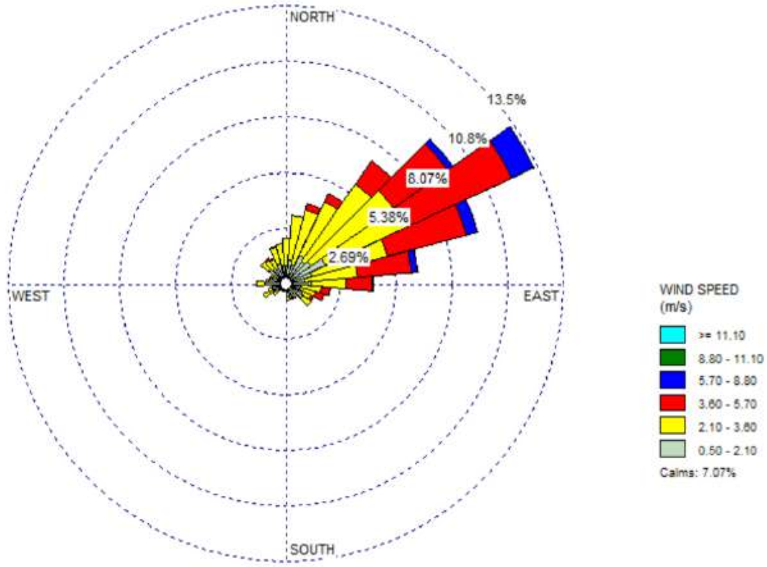


Figure 9: *24-hour October – December Wind Rose*

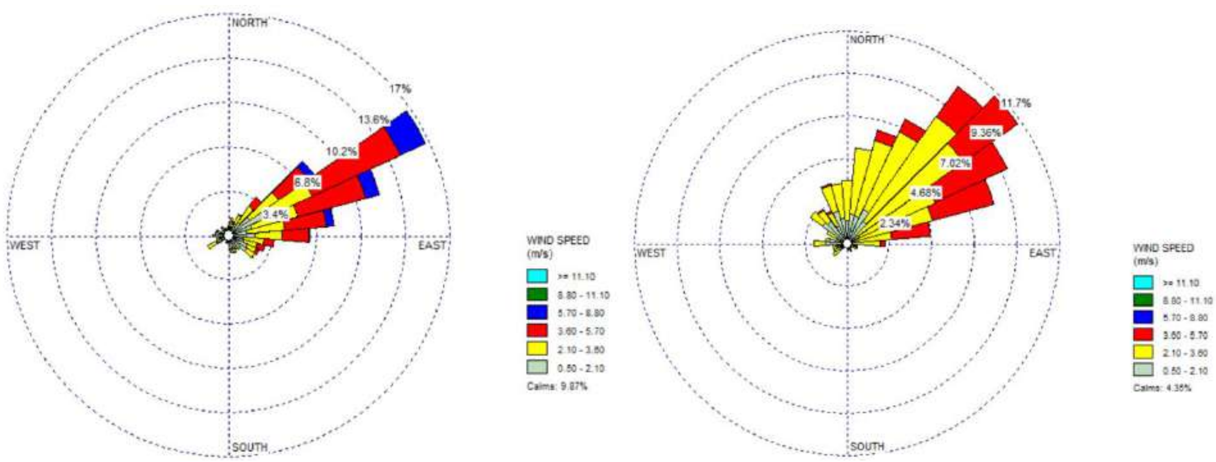


Figure 10*: Diurnal and Nocturnal October – December Wind Rose*

Annex 10

Field Questionnaires

2. **Environmental Concerns**

a) Do you think the proposed project will have any effect on the environment? If yes, explain how and (List any positive & negative)

(Clean Environment)
① Eradication of ~~haphaz~~ Solid waste disposal everywher
② Job creation to Youths.
③ Pollution of Air & other Environmental hazards.

b) **Health and Safety Concerns**

i. Do you think the proposed project poses health safety hazards and risks to you or to the public within the neighbourhood? If yes, explain how and propose how they can be mitigated.

Yes.
The proposed Plant may emit ~~[illegible]~~ Poisonous gases harmful to humans.

3. **Socio-Economic Concerns**

(a) Does the project generate any socio- economic benefits or concerns to you? (Yes) (No)
If yes, kindly explain & propose how they be mitigated.

Engaging the CBO's In the area will eradiate some Insecurity happenings since the Youths will be busy.

4. **General Concerns**

a) What other issues of concern or consideration do you have with regard to the project? Propose specific mitigation measures

① Ensure proper transportation of the solid wastes without dropping on the roads.
② Proper lighting around the area to mitigate insecurity issues.

b) General comments on enhancing environment as well as health and safety during implementation of the project

Invest heavily on public participation for the Community to embrace the Idea and own up the project. proper mechanisms to be put in place to mitigate any hazardous effects.

Signature of the Interviewee: [signature]

Date of Interview: 11/08/2021

Name of interviewer: Arthur Ouma

PUBLIC CONSULTATION AND PARTICIPATION FORM

ENVIRONMENTAL SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED ESTABLISHMENT OF WASTE TO ENERGY POWER PLANT AT RUAI, KASARANI SUBCOUNTY, NAIROBI, KENYA.

Nairobi Metropolitan Services (NMS) in partnership with KenGen have commissioned M/s SEAL-DESL-SEURECA to carry out Environmental Impact Assessment for the proposed Establishment of Waste to Energy Power Plant at Ruai, Kasarani Subcounty, in Nairobi County, Kenya. The project aims to mitigate environmental pollution due to the poor solid waste disposal within Nairobi Metropolis area while resolving the problem of waste processing by introducing a Waste to Energy (WtE) plant to generate electricity. The plant will utilize 3000tonnes of municipal solid waste collected daily generating 45MW of electricity.

According to Environmental Impact Assessment is a statutory requirement under the EMCA, 1999 and Legal Notice No. 101; The Environmental (Impact Assessment and Audit) Regulations of 2003, Public participation and consultation is a key input in this process. Consultations are to be held with the members of the immediate community; and interested/affected parties, in order to obtain their views regarding the project.

Kindly participate by filling in the questionnaire and contribute in the enhancement and sustainability of the proposed project. Your views shall constitute a valuable input in the preparation of the ESIA Report.

Personal Details	~~Jane Ndanu~~
Name	Jane Ndanu
National ID No.	12624674
Occupation	Administrator
organization	Nairobi city County
Contact Address/Email	Kyarunguyane@gmail.com
Cell Phone No.	0721716407
How long have you worked/lived in this area?	3 Years

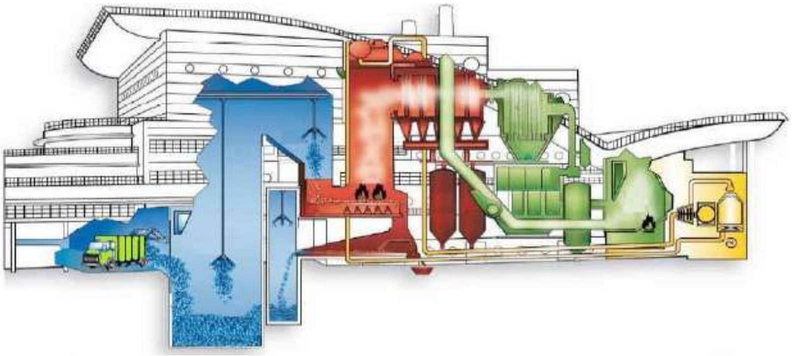
1. **Have you heard of the proposed Establishment of Waste to Energy Power Plant by Kengen using Municipal Solid waste from all over Nairobi Metropolis area to be set up at Ruai Waste Treatment facility in the Kasarani subcounty within Nairobi County?**

Yes	No
✓	

Annex 11

Public Participation Invitation Letter

Kenya Electricity Generating Company PLC



PROJECT CONCEPT FLYER FOR PRESENTATION AT THE STAKEHOLDERS ENGAGEMENT AT WINGS VIEW HOTEL, RUAI, KASARANI SUBCOUNTY, NAIROBI COUNTY

Project Name: ESTABLISHMENT OF A WASTE TO ENERGY POWER PLANT AT RUAI, KASARANI SUBCOUNTY NAIROBI, KENYA

Report prepared and submitted by:

E n E International Consult
We are part of the solution

ON BEHALF OF:

SEURECA VEOLIA

August 2021

1. Introduction

Kenya Electricity Generating Company PLC (KenGen) in Partnership with the Nairobi Metropolitan Services (NMS) proposes to establish a 45MW waste to energy power plant at Ruai. The project is located within Athi Water Works Development Agency (AWWDA) lands that also houses Nairobi wastewater treatment plant within Ruai Ward, Kasarani Subcounty, Nairobi County. The plant will generate electricity and/or heat from about 3,000 tonnes of municipal solid waste collected daily. The plant capacity will be about 1,000,000 tonnes/year.

The project aims to utilize municipal waste to generate power for feeding in to national grid thereby mitigating solid waste management concerns within Nairobi Metropolis area while resolving the problem of waste processing by introducing a Waste to Energy (WtE) plant to generate electricity.

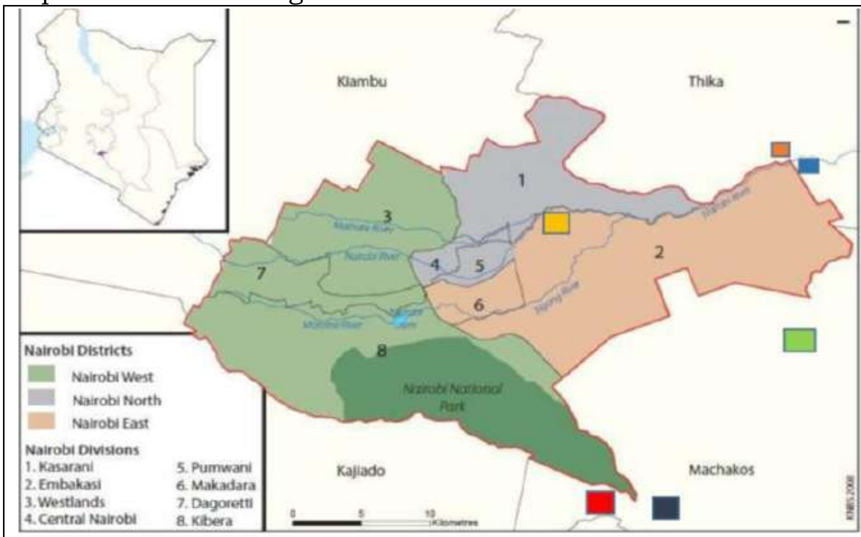
2. Site Selection

The Site for the establishment of the Waste to Energy plant was arrived at after a thorough assessment of six potential candidate sites. Kengen carried out a site selection study in which the following considerations were made:

- Clearance from KCAA
- Land requirement
- Land availability and land acquisition cost
- Proximity to waste generation sources
- Potential environmental and social impacts
- Constraints for site developments.

An assessment of the candidate sites was presented in the Siting study report with the most preferred site for the establishment of the WtE plant being Ruai STP riverbank. This was followed by Consultative meetings among key stakeholders.

The Map below shows the general location of the six assessed candidate sites



Colour Code	Site name	GPS Coordinates
	Dandora Dump Site	-1.243811° N. 36.899602° E.
	Ruai STP End	-1.217428° N. 37.069816° E.
	Ruai STP River Bank	-1.206570° N. 37.062759° E.
	Near Athi river substation (Triumph power)	-1.459027° N. 36.952297° E.
	Athi river Near Gulf power plant	-1.457722° N. 37.002139° E.
	Export Processing Zone- 1 (EPZ-1)	-1.356614° N. 37.059258° E.

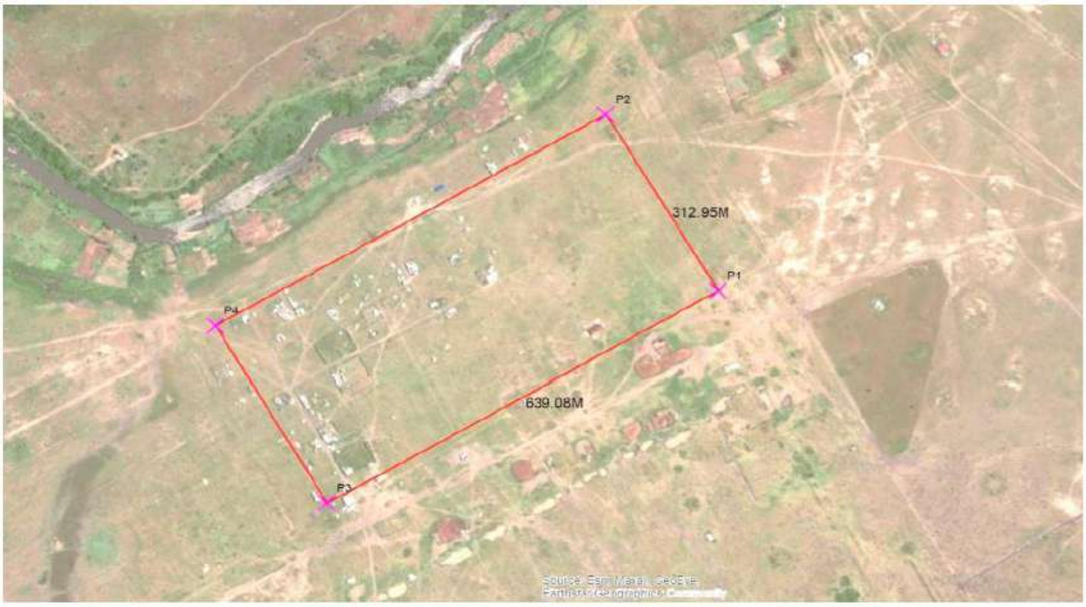
Figure 1: Site Selection maps

2.1 Site Location

Ruai STP riverbank is located within the Ruai Sewage treatment plant approximately 40km from the Nairobi Central business District. The land is currently owned by the Nairobi County Council with the land reference number LR No. 12979/1. The map below shows the general location of the site.

The project is not relocating Dandora dumpsite to Ruai. Rather, the facility is a proper waste to energy power plant where there will no waste storage onsite but direct processing after a temporary pre-treatment.

Figure 2: Proposed project Site Location



No.	Northing	Easting	Elevation
P1	9866115.24	284754.86	1478.918
P2	9866371.77	284594.89	1476.005
P3	9865827.71	284132.63	1478.320
P4	9866099.94	284006.48	1476.203

Figure 3: Boundary Coordinates of the WtE facility.

3. Project Design & Scope

The project will utilize waste collected by NMS within the Nairobi Metropolis area. The feedstock will be collected from households by both private waste handlers and Nairobi City County Environment department and transported to the facility. The plant is designed for the 3,000 t/d capacity. The plant can be run at full capacity from the first day of operation if 3,000 tons of waste is available. This can be achieved through the collection of waste from nearby counties. The materials will be first pre-processed by stabilization followed by screening and shredding. This pre-processing section will produce good quality fuel for incineration. The plant is based on well proven combustion technology.

The WtE plant will operate 24 hours daily, and 7,920 hours annually. The remaining 840 hours per year consists of time required for maintenance and planned/unplanned shutdowns.

3.1 Scope

The project scope includes;

- Construction of the power plant, including site establishment, earthworks, on-site and off-site haul roads
- Construction of associated facilities such as receipt, storage, combustion; boilers, flue gas treatment, residue handling and energy recovery,
- Establishment of waste collection, separation and handling transfer stations within the greater metropolis of Nairobi consisting of 3No counties of Kajiado, Machakos and Kiambu.
- Transportation of residues to landfill.
- LILO connection to 132kV existing Overhead Transmission Line for electricity evacuation (OHTL).

4. Operation Process

- NMS will collect the waste and transfer it to the Ruai Waste to Energy project site.
- Waste will be fed into the pre-processing section where moisture, organics, inert and recyclables will be removed and better-quality processed waste will be stored
- Processed waste will be fed to incinerator for combustion
- After the combustion process, gases will be directed to the waste heat boiler to produce steam.
- Post combustion flue gas shall be treated in flue gas cleaning system for controlling pollutants like SOx, NOx, dioxin furans, Particulates, heavy metals and other pollutants.
- Steam at 40bar pressure and 400°C temperature will be sent to the turbine for electricity generation.
- Electricity produced at Ruai waste to energy plant will be exported to the national electricity grid via the existing 132kV transmission line Kindaruma to Mangu to Juja by LILO connection.

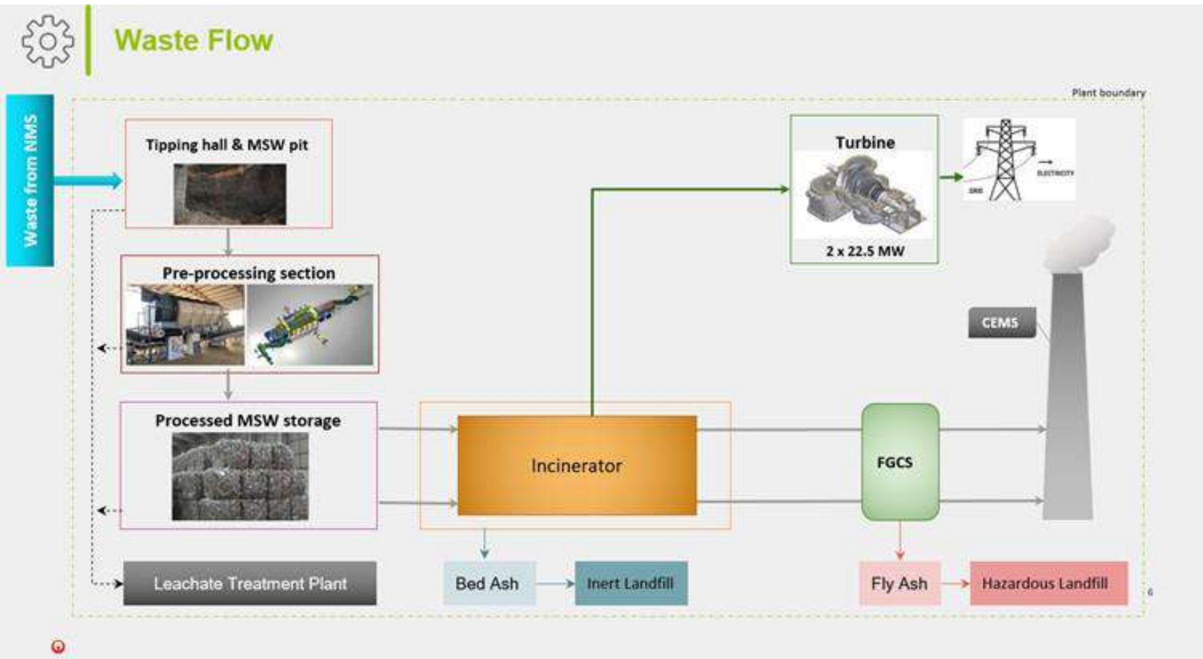


Figure 4: Process Flow Diagram

5. Project Technology

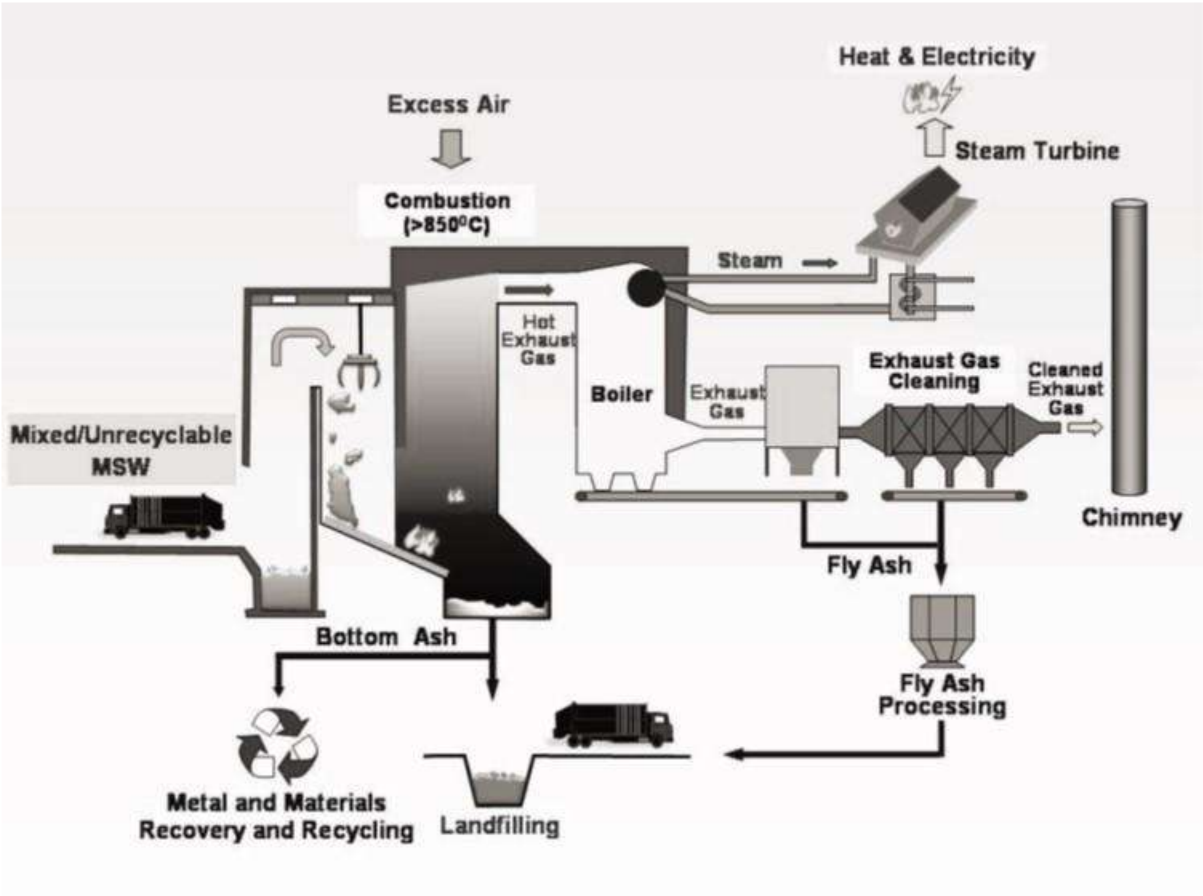
- Waste is combusted after pre-treatment in the pre-processing section
- Flue gas to be kept at a temperature of >= 850°C for more than two (02) seconds in the furnace to ensure dioxin are completely decomposed. This will ensure conformance with the European Union directive 2008.
- The grate system selected suitably for handling such kind of fuel with maximum reliability and sustainability.
- Ram fuel feeders will be used.
- As per the international guidelines, SPM, NOx, Sox, vaporized heavy metals (including lead and mercury) and dioxins and furans have to be removed by injecting the ammonia/urea and lime with activated carbon followed by an efficient bag filter for removing the SPM.

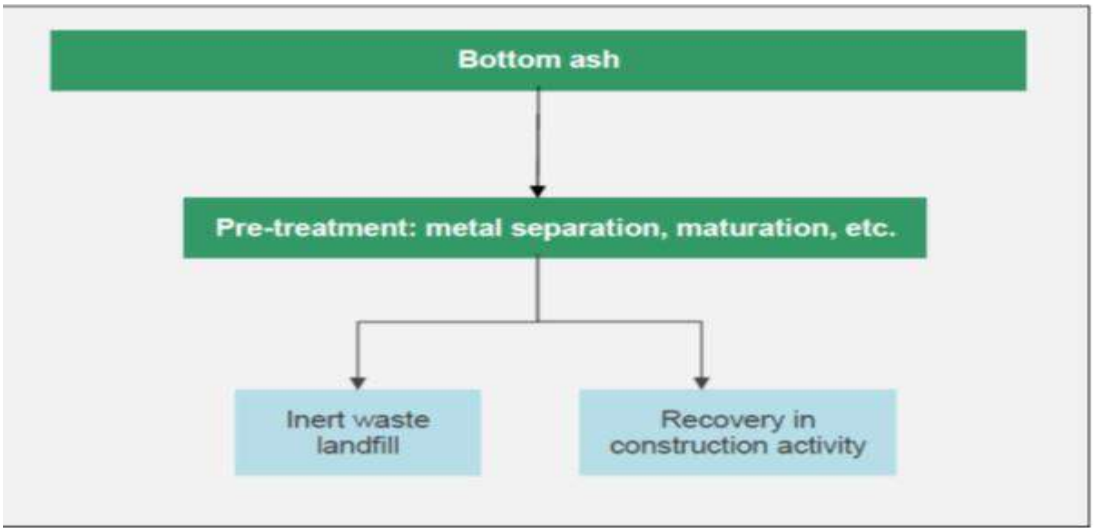
6. Flue Gas Management

A Flue Gas Treatment System will be implemented for the project. This will involve installation of;

- Scrubbers for SO2 treatment,
- For the removal of SO_2 in the flue gas using dry hydrated limestone and carbon will be used.
- NOx removal, a Selective Non-Catalytic Reduction (SNCR) system will be used. There is the potential to convert this to a Selective Catalytic Reduction (SCR) system if required.
- Bag filters to reduce emission of fly ash.
- For HCl and HF emissions, acid and alkali scrubbers will be used
- Volatile Organic Compounds will be removed from flue gas by activated carbon.

- Dioxin and furan emissions will be controlled by maintaining the combustion temperature and adding activated carbon in the flue gas treatment system.
- A Continuous Emission Monitoring system will be installed to monitor all emissions.
- Compliance reporting from the monitoring will done on quarterly basis to oversight authority in NEMA and DOSH as required for ambient air quality.





- Pre-treatment

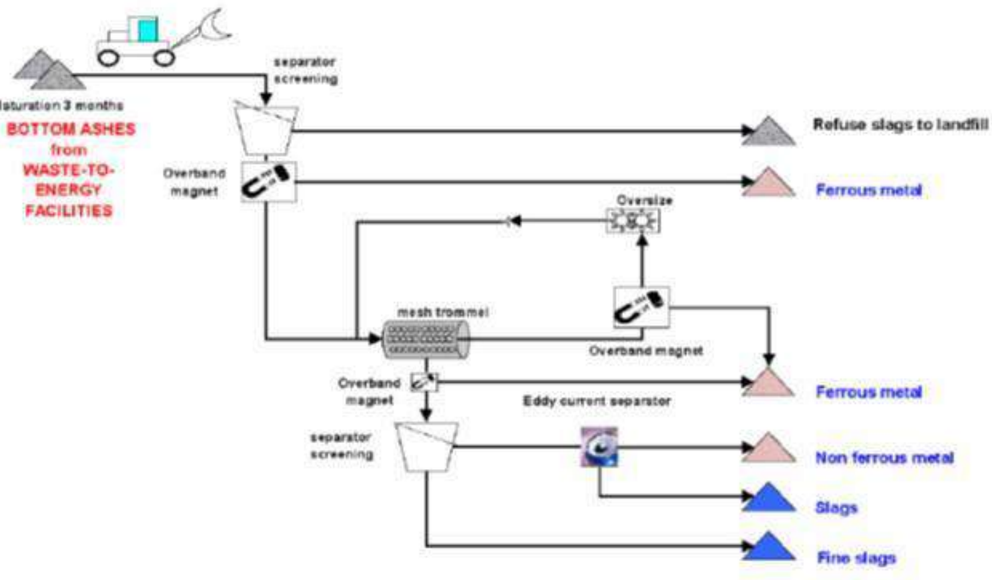
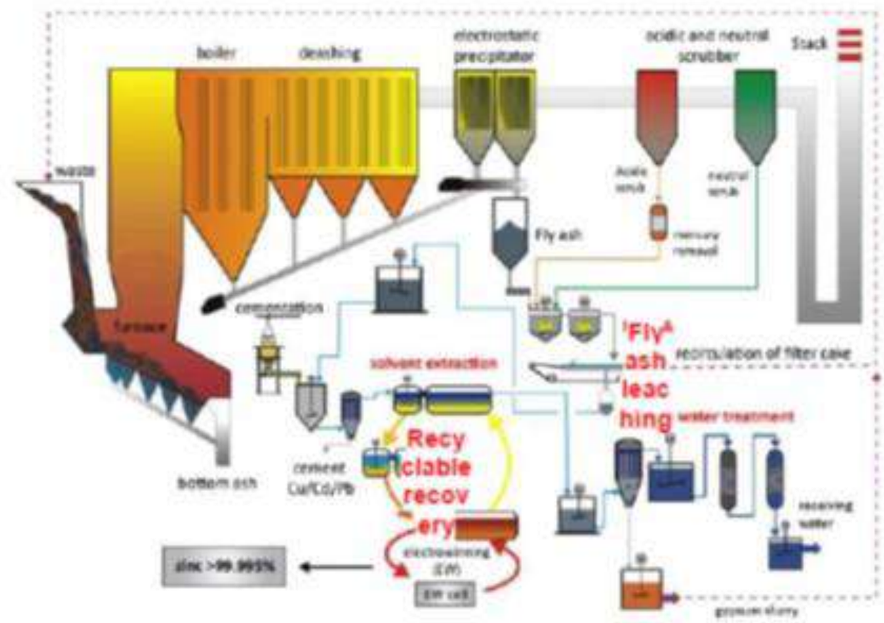


Figure 24: Bottom ash pre-treatment diagram



22 JUL 2021
PRINCIPAL SECRETARY

REPUBLIC OF KENYA
EXECUTIVE OFFICE OF THE PRESIDENT
NAIROBI METROPOLITAN SERVICES

URGENT

Telegraphic Address
Telephone +3313002/4
When replying please quote

Kenyatta International Convention Centre
P. O. Box 49130-00100
NAIROBI

Ref: EOP/NMS/20/06

21st July 2021

Dr. Eng. Joseph Njoroge, MBS
Principal Secretary,
State Department of **Energy**
NAIROBI

Dear Dr. Njoroge,

INVITATION TO PARTICIPATE IN A MEETING ON THE ESTABLISHEMENT OF A WASTE TO ENERGY POWER PLANT IN RUAI

The Nairobi Metropolitan Services (NMS) in conjunction with Kenya Electricity Generating Company (KENGEN) and the Ministry of Energy is in the process of establishing a waste to energy power plant in Ruai, Nairobi.

The plant is part of the wider strategies that the government is implementing to manage solid waste in Nairobi. NMS has organized as site visit to the proposed site in Ruai on Friday 23rd July 2021 and has invited stakeholders to consider the possible effects of the said plant on air operations.

The purpose of this letter is to invite you to join the team for the site visit.

There will be a briefing at 9.00 a.m. in the NMS boardroom on 24th Floor, the same day before proceeding to the site at Ruai.

Yours Sincerely,

KANGETHE THUKU, EBS
DEPUTY DIRECTOR GENERAL

Copy to. Director General

SEURECA VEOLIA

Date:27th August 2021

Ref: **ESIA/8/21**

Chief Executive Officer
Athi Water Works Development Agency (AWWDA),
Athi Water Plaza,
Muthaiga North Road Off Kiambu Road,
Nairobi,
P.O Box 45283-00100
Nairobi.

Dear Sir,

Ref: PROPOSED WASTE TO ENERGY PLANT -RUAI -ENVIRONMENTAL IMPACT ASSESSMENT (EIA) – STAKEHOLDERS CONSULTATION

We, M/s Seureca-Veolia, are a consultancy firm commissioned by Kenya Electricity Generating Company PLC (Kengen) & Nairobi Metropolitan Services (NMS), the project proponents to undertake Environmental Socio-Economic Impact Assessment of a proposed waste to energy power plant in Ruai, Kasarani Subcounty, Nairobi County.

The proposed plant is 45MW capacity using 2No. steam turbines utilizing 10,000m^3/daily sourced partly from the Nairobi City County wastewater treatment facility at Ruai, and abstraction from Nairobi River adjacent the plant. The project proposed site is owned by Athi Water Works Development Agency.

The EIA works entails field data collection including sampling for soil, biota, water, socio-economic data around the site and stakeholder's engagement.

We are therefore seeking your views regarding the project relating to water use from the effluent treatment plant and land ownership arrangements.

Attached herewith is a project information flyer and a questionnaire to register your views about the project.

Most Sincerely,

seureca
30 rue Madeleine Vionnet - 93300 Aubervilliers - France
Corporate Off. 21 rue de la Boetie-75008 Paris - France
Off: +33 1 8557 7030
Fax: +33 1 4572 9293

Christophe LACARIN
Area Manager
SEURECA Consulting Engineers
P.O.BOX 20913-00202
Plums Lane Off Ojijo Road
Nairobi, Kenya

THE PRINCIPAL SECRETARY
MINISTRY OF DEFENCE
ULINZI HOUSE
PO BOX 40668 - 00100
NAIROBI, KENYA

17th August 2021

Our ref: *MoD_92_dm_KESP00531_Stakeholder Consultation Meeting*

Reference: ***Feasibility Study for Waste to Energy Plant in Nairobi City County***

Contract N°KGN-BDD-07-2020

Subject: Environmental Impact Assessment – Stakeholders Consultation Meeting

Dear ....,

We, M/s Seureca-Veolia were commissioned by Kenya Electricity Generating Company PLC (KenGen) the project proponent, to undertake Environmental Socio-Economic Impact Assessment (ESIA) of a proposed waste to energy facility in Ruai, Kasarani Subcounty, Nairobi County. The proposed site for the facility is within the Ruai waste water treatment plant owned by Nairobi City Council and under the custody of Athi Water Works Development Agency with Land Reference number LR No. 12979/1. The table below shows the coordinates of the selected site.

No.	Northing	Easting	Elevation
P1	9866115.24	284754.86	1478.918
P2	9866371.77	284594.89	1476.005
P3	9865827.71	284132.63	1478.320
P4	9866099.94	284006.48	1476.203

The proposed project scope includes; carrying out a feasibility study for the development of a waste to energy power plant and associated infrastructure for receipt, storage, combustion, flue gas treatment, leachate treatment, residue handling and energy recovery. The proposed design incorporates the use of an 80-metre-high chimney.

The ESIA scope of work entails field data collection including sampling for soil, biodata, water, socio-economic data around the site and stakeholder's engagement. As part of a key stakeholder identified in this project who could be affected in terms of flight path concerns due to the height of the chimney, we would like to invite your views on the proposed waste to energy plant.

SEURECA VEOLIA

A project information flyer and introduction letter from KenGen for your information is herein attached.

We therefore, seek your views regarding the project through a questionnaire provided herewith.

We remain,

seureca
30 rue Madeleine Vionnet - 93300
Aubervilliers - France
Corporate Off: 21 rue de la Boetie-75008
Paris - France
Off: +33 1 8557 7000
Fax: +33 1 4572 9293

Yours faithfully,

Christophe LACARIN
Area Manager
SEURECA Consulting Engineers
P.O.BOX 20913-00202
Plums Lane Off Ojijo Road
Nairobi, Kenya

SEURECA VEOLIA

EnE International Consult
We are part of the solution

Emmastraat 210-411 7513 BH, Enschede,
The Netherlands;
1st Floor Lunga Lunga Business Centre,
Lunga Lunga Road,
P.O. Box 71987-00622, Nairobi-Kenya.
Phone: +254 723 66 55 99
E-mail: Ibrahim@eneinternationalconsult.com
Web:www.eneinternationalconsult.com

Date: 16th August 2021

Ref: **EnE/ESIA/16/21**

The Clerk,
Nairobi City County Assembly
P.O. Box: 45844 - 00100
NAIROBI.

Dear Sir,

Ref: PROPOSED WASTE TO ENERGY PLANT -RUAI -ENVIRONMENTAL IMPACT ASSESSMENT – STAKEHOLDERS CONSULTATION MEETING

We, M/s Energy and Environmental International are a local consultancy firm partnering with M/s Seureca-Veolia who were commissioned by Kenya Electricity Generating Company PLC (Kengen) and Nairobi Metropolitan Services (NMS), the project proponents, to undertake Environmental Socio-Economic Impact Assessment of a proposed waste to energy power plant in Ruai, Kasarani Subcounty, Nairobi County.

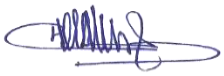
The works entails field data collection including sampling for soil, biota, water, socio-economic data around the site and stakeholder's engagement. As part of the key stakeholders identified for this project as an oversight authority of Nairobi City County government and NMS, we would like to hear your views on the proposed waste to energy plant.

We therefore, seek an appointment with the County Assembly's Environment Committee through your office to get their views regarding the project relating to structure of the project with Kengen, benefit sharing, land ownership at Ruai site, Ruai residents plea for services and infrastructure to support the project, establishment of transfer stations in subcounties and management of Dandora site in the long term.

Attached herewith is a project information flyer and introduction letter from Kengen for your information.

We await your kind consideration for a date and venue we can meet the Environment committee membership.

Most Sincerely,



Ibrahim Adan: (Name and Title of Signatory)
Managing Partner
Energy and Environmental International: (Name of firm)
PO Box 71987-00610: (Address)
Nairobi, Kenya.

SEURECA VEOLIA

Date:27th August 2021

Ref: **ESIA/8/21**

Mr. Mohamed Moulid Shurie, HSC
Chief Executive Officer
Water Resource Authority
NHIF Building, 9th floor, Wing B
Off Mombasa Road,
P.O.BOX 45250-00100,
Nairobi.

Dear Sir,

Ref: PROPOSED WASTE TO ENERGY PLANT -RUAI -ENVIRONMENTAL IMPACT ASSESSMENT – STAKEHOLDERS CONSULTATION MEETING

We, M/s Seureca-Veolia, a consultancy firm commissioned by Kenya Electricity Generating Company PLC (Kengen) & Nairobi Metropolitan Services (NMS), the project proponents to undertake Environmental Socio-Economic Impact Assessment of a proposed waste to energy power plant in Ruai, Kasarani Subcounty, Nairobi County.

The proposed plant is 45MW capacity using 2No. steam turbines utilizing 10,000m3/daily sourced partly from the Nairobi City County wastewater treatment facility at Ruai, and abstraction from Nairobi River adjacent the plant. The water discharged will be treated and released into the environment as per Water Act, 2012 & EMCA Water Quality Regulations, 2006.

The EIA works entails field data collection including sampling for soil, biota, water, socio-economic data around the site and stakeholder's engagement.

We are therefore seeking your views regarding the project relating to water abstraction licensing requirements and quality guidelines for industrial use.

Attached herewith is a project information flyer and a questionnaire to register your views about the project.

Most Sincerely,

seureca
30 rue Madeleine Vionnet - 93300 Aubervilliers - France
Corporate Off. 21 rue de la Boétie-75008 Paris - France
Off: +33 1 8557 7000
Fax: +33 1 4572 9293

Christophe LACARIN
Area Manager
SEURECA Consulting Engineers
P.O.BOX 20913-00202
Plums Lane Off Ojijo Road
Nairobi, Kenya

Annex 12

Public Participation Meeting Minutes

FEASIBILITY STUDY FOR WASTE-TO-ENERGY PLANT IN NAIROBI CITY

Contract No: KGN-BDD-07-2020

MINUTES FOR STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION ON 12TH AUGUST 2021 AT WINGS VIEW HOTEL, RUAI , KASARANI SUB COUNTY.

NAIROBI, KENYA

KAMULU COMMUNITY MEETING.

TIME: 9:30 a.m.

ATTENDANCE

No.	Name	Organization
1	Ibrahim Adan	Seureca- **Moderator**
2	Dancun Saida	Kengen
3	Arthur Ouma	Seureca
4	Mr. Kirugo	Chief - Kamulu
5	Community Stakeholders	As per attendance list.

AGENDA:

The Agenda was proposed and adopted as follows:

1. Introduction and Opening Remarks
2. Consultant's presentation on ESIA specifically on project brief, importance of stakeholder engagement and public participation.
3. Discussion on the Consultant's presentation.

ITEM No.	MINUTES	ACTION
Min. 1.0	**Introduction and Opening remarks**	
	Ibrahim Adan, the moderator, welcomed the participants to the meeting and invited a participant to volunteer and open the meeting with a prayer. This was then followed by a round of introductions of the members present stating their names and institution/village they represent. The members of public present from the round of introduction was noted to be a mix of representatives of 11 villages within Kamulu location, Ward administrations including area chief, assistant chief, County Ward leadership and Kamulu market membership leadership, Businessmen, matatu Sacco leadership, business leaders - traders, religious leadership, youth, women and persons with disabilities among others. The meeting was sufficiently socially distanced, and participants urged to mask up and sanitize within the guidelines of Covid-19 protocols.	Info

	Project brief by Kengen Kengen confirmed that the waste to energy project was a combined initiative with Nairobi Metropolitan Services (NMS). He emphasized the importance of stakeholder engagement and public participation on projects of such magnitude and encouraged free participation in the proceedings of the meeting by the stakeholders.	
Min. 2.0	**Presentation on the process, technology, waste flow of project and need for public participation.**	
	• Mr. Ibrahim gave a detailed overview of the project highlighting the project description, location, technology employed, the process, expected by products and the final output. A power point presentation was used in sharing the project information. • He explained that the public participation and stakeholder engagement process are necessary for the success of any project not only as a requirement for legal requirement and project financing but also as a form of community ownership of the project.	Info
Min. 3.0	**Question and Answer and Deliberations.**	
3.1	Mr. S. K. Nderitu was concerned with whether the case of Dandora dumpsite would be transferred to Ruai. He asked what the procedure was incase of plant breakdown especially due to accumulation of raw materials onsite. He suggested that the fly ash be used to build roads in Ruai and Kamulu first to minimize landfilling onsite. ➢ **Ans.** - The site in Ruai is purely energy generating and any waste brought there forth will be for immediate use in the generation process and no waste shall be stored at the site besides a strategic reserve that will be onsite. In addition, No fresh waste will be dumped onsite in the open. Further, the site operations procedure have will mandatory maintenance hours annually for repair and maintenance of the plant to ensure efficiency of the plant. ➢ The concern on road construction will be raised with NMS leadership and emphasized as critical in the operation of the power plant and should be prioritized with the relevant road construction agencies.	
3.2	Mr. Weston Njiru asked what the disadvantages of the project were and what mitigation measures had been suggested for them. He also suggested the need for and MoU between the locals and the proponents. ➢ **Ans** – The potential for environmental pollution by the project is there and mitigation measures necessary have been put in place in built in the project design. Further, environmental monitoring will be done on real time basis and reporting done quarterly to NEMA based on the baseline information gathered in the pre-implementation stages of the project. ➢ The MoU issue would be highlighted in our report for the relevant authorities' consideration, but it should be up to the locals to raise the issue in further discussions too.	
3.3	Pst. Jack Mutiso asked of the health risk measures the proponents will put in place in case of any health-related incidents in the local community and also what CSR benefits would be accrued from the project. ➢ **Ans** – On CSR, the locals know their needs better and thus can prioritize and communicate them to the proponents within the project implementation committee that will have local community representation. ➢ The project is expected to have a stakeholder consultation committee where all community grievances would be addressed.	

3.4	Chief Maina of Kamulu commented that the project should take into consideration the conditions of the roads and associated infrastructure of drainages and water services in Ruai and Kamulu as the plant operations will involve a lot of traffic which is already currently crowded with negligible public amenities. ➢ **Ans** – The concern on road construction will be raised with NMS leadership and emphasized as critical in the operation of the power plant and should be prioritized with the relevant road construction agencies. ➢ However, Kengen as plant operator needs to undertake a traffic assessment and develop a schedule of when material deliveries are done with consideration for off peak hours to minimize traffic congestion on the roads. This should be done in liaison with NMS & Project contractor take care of both during construction and operation.	
3.5	Mr. Raphael Waweru Who represented people with disabilities raised concerns over environmental pollutants that may emerge from the plant operations and that may cause genetic mutations which result in birth of children with disabilities. He also suggested that the proponents move from Corporate Social Responsibility to Corporate Social Investment in order to make a bigger impact in the community. ➢ **Ans** – We do not envisage what is happening at Dandora dumpsite in this project. There will be no open dumping or landfilling to attract vectors and rodents. It will be a fully covered facility and if any communicable disease emerges it will be monitored and immediate action be taken in liaison with public health officials. ➢ In addition, the plants emissions and discharges are monitored continuously with performance measuring instruments installed onsite for real time data generation. ➢ Social investments are part of every project but are done through community prioritization. Ruai community should through project implementation committee whose membership include immediate neighbors should register their request and prioritize the service needed most for project proponent to consider for support.	
3.5	Rev. Makori praised the project as timely but was concerned with the infrastructure condition in the area especially roads. ➢ **Ans** - The plan on roads expansion concern by the member of public will be registered with the relevant authorities for expansion of Kangundo road into a dual carriage.	
3.6	Mr. Kibe asked what the timeline for the project was and also what the agreement between the proponents and the locals regarding employment would be. ➢ **Ans** - The project has national leadership blessing both at County and National government, thus, with all the licensing approvals met, it is expected to be commissioned in early 2022. ➢ On employment, the proponent has a CSR policy through the stakeholder consultation committee to source a percentage of unskilled labour locally and prioritize skilled labour for the locals.	
3.6	Mr. Francis Thangwa enquired whether immediate neighbours on the site had been consulted and if there existed public utilities at the site. He also asked whether there can be an MoU between the proponents and the local communities and was uncertain on what would happen in case of changes in political leadership. ➢ **Ans** – Neighbours within a 2 km radius of the site have been consulted as the area around the project is sparsely populated. We know the land owners around the site and have ensured that no public utilities are affected. ➢ The Issue of the MoU is best addressed through the stakeholder consultation committee that will be largely composed of local representation. However, the project concerns will be adequately addressed through existing mechanisms as enshrined in the constitution and EMCA, 1999 regulations.	

3.7	Mr. Boniface Gacheru asked what could be done to reduce traffic jam from by pass to Kamulu and how would the waste be collected from houses. ➢ **Ans –** Waste is collected through private collectors or NMS fleets who take it to transfer stations located in the respective sub counties for sorting. The sorted waste is then packed, compacted and transported to the plant on scheduled times are planned and approved by the plant operator Kengen in liaison with NMS. Materials delivery during offpeak hours is envisaged to minimize traffic inconvenience to the general public. ➢ The issue of road infrastructure will be raised to the relevant authorities.	
3.8	Pst. Mutiso asked whether the community will be protected from illegal dumping. Also, he inquired if despite implementation challenges, the project would go on given community goodwill. ➢ **Ans** - We are not replicating what happens in Dandora in Ruai. Illegal waste dumping is an administrative issue that the community through partnership with NMS & area administration can stamp out through reporting and monitoring. ➢ This project could be what Ruai needs to be at spur with development in the area. ➢ We shall voice the community concerns and pleas to the proponents and the political leadership in Ruai and Nairobi City County.	
3.9	**Kengen Comments** Kengen exemplified their procedure on project implementation with regard to stakeholder engagement through the SCC and pointed out that the project being of clean energy, the carbon credits accrued from it thereof will be used to improve the infrastructural condition of the community. He confirmed that the SCC discusses the CSR and hence can recommend for the drafting of the MoU suggested.	
Min. 4.0	**Discussion Points**	
	The stakeholders welcomed the project but emphasized the need for more discussions among themselves and promised to notify the proponents on the deliberations in particular on having an MOU to cater to potential adverse impacts on the community and compensations and such.	Info
Min. 6.0	**AOB**	
	With no further points to discuss, the meeting ended at 1300 hrs	

KenGen

SEURECA VEOLIA

Consultant

Name …Ibrahim Adan……………………………………………………………………

Designation……Sociologist ………………………………………………………………

Signature

Date: 13th August 2021

Employer

Name……Duncan Saida……………………

Designation…Enviromment Officer……

Signature …DnSaida.……………………………

Date……16.8.2021……………………………………

KenGen SEURECA VEOLIA

PUBLIC CONSULTATION AND PARTICIPATION FORM

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED ESTABLISHMENT OF WASTE TO ENERGY POWER PLANT AT RUAI, KASARANI SUBCOUNTY, NAIROBI, KENYA.

Nairobi Metropolitan Services (NMS) in partnership with KenGen have commissioned M/s SEAL-DESL-SEURECA to carry out Environmental Impact Assessment for the proposed Establishment of Waste to Energy Power Plant at Ruai, Kasarani Subcounty, in Nairobi County, Kenya. The project aims to mitigate environmental pollution due to the poor solid waste disposal within Nairobi Metropolis area while resolving the problem of waste processing by introducing a Waste to Energy (WtE) plant to generate electricity. The plant will utilize 3000tonnes of municipal solid waste collected daily generating 45MW of electricity.

PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator: Ibrahim Adan Venue: Kings view hotel – Kamulu meetings.

Date: 12/8/2021. Time: 9:30 am

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
23	JOSEPH MUIRU	13653512	0721-723811	OOP	ASST/CHIEF	
24	Eunice Wangai	3435596	0722734068	Kamuku Kumi Nyumba	Elder Nyumba Kumi	
25	DAVID KAMAU	21394568	0721684061	Anjuadu	Elder.	
26	Francis Thenguri	2008906	0755855169	Elder	Numba Kumi	
27	Duncan Saida	8742257	0722476994	Ex. Office	E.O.	
28	Ibrahim Adan	22621122	0723665599	Semeca	Consultant	

KenGen SEURECA VEOLIA

PUBLIC CONSULTATION AND PARTICIPATION FORM

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED ESTABLISHMENT OF WASTE TO ENERGY POWER PLANT AT RUAI, KASARANI SUBCOUNTY, NAIROBI, KENYA.

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator: Ibrahim Adan Venue: Wingsview hotel – Kamulu meeting

Date: 12/8/2021. Time: 9:30 am

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
12	DOUGLAS G. KIBE	10974844 ~~10978444~~	0720221010	Elder Kamulu	Elder	
13	JAMES K NJOROGE	3509640	0721290751	Elder Kamulu	Elder	
14	D. M. KURUGO	12499145	0722902963	GOP	Snr CHIEF	
15	Ann Munene	10864674	0723746645	Elder Kamulu	village Elder	
16	REBECCA MAINA	13531807	0727605184	elder Kamulu	Village Elder	
17	Arthur Ouma	27505278	0728343270	Sweresa/EGG	Asst Sociologist	
18	SIMON K. NDERITU	5961450	0722380655	ELDER KAMULU		
19	MARTHA KIAIRIMU	27997972	0720927810	ELDER KAMULU	LEADER	
20	LEVENENI MAKORI	8646261	0727-248214	Stage 26 Kamulu	LEADER	
21	Alfred Momanyi	10693068	0724520771	Elder Makongo	Elder	
22	George Kioni	0488100	0722459590	Elder Athi	CHAIRMAN	

KenGen

SEURECA VEOLIA

PUBLIC CONSULTATION AND PARTICIPATION FORM

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED ESTABLISHMENT OF WASTE TO ENERGY POWER PLANT AT RUAI, KASARANI SUBCOUNTY, NAIROBI, KENYA.

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator: Ibrahim Adan Venue: Wings View hotel – Kamulu meeting

Date: 12/08/2021 Time: 9:30

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
1	ISAAC M. NDERITU	12947040	0722346587	Kamulu MARKET TRADERS C.B.O.	CHAIRMAN	
2	CEPHA NJUGUNA	3585959	0722879347	KAMULU LEADERS	ELDER	
3	SAMUEL ORANGI	1069765	0705262136	Kamulu	Riverside Chair	
4	Raphael Wawere	0876128	0722239542	Chairman Kamulu-Ruai PWDs	Chair	
5	BONIFACE GATHERU	11075804	0720749792	Mangoongo Kamulu	locution	
6	WESTON NJIRU	1079722	0722978101	KAMULU Dev-Chair	Chairman	
7.	JACK MUTISO	7808822	0722273534	Kamulu - RUAI	Cluster chair	
8	RUTH NDWIGA	3736360	0722364561	Kamulu village elder	Kamulu	
9	MARY M WAMBUGU	8649367	0717421674	KAMULU Chair Ngunda maendeleo	chair	
10	Elijah Wanyego	7229230	0722597501	Kamulu Spiritual Community	chairlady	
11	JAMES WAWERU K	5514117	0722815900	KAMULU	ELDER	

FEASIBILITY STUDY FOR WASTE-TO-ENERGY PLANT IN NAIROBI CITY

Contract No: KGN-BDD-07-2020

MINUTES FOR STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION ON 11TH AUGUST 2021 AT WINGS VIEW HOTEL, RUAI, KASARANI SUB COUNTY.

NAIROBI, KENYA

RUAI COMMUNITY MEETING.

TIME: 9:30 a.m.

ATTENDANCE

No.	Name	Organization
1	Ibrahim Adan	Seureca- **Moderator**
2	Dancun Saida	KenGen
3	Arthur Ouma	Seureca
4	Nyabuto Omache	Chief - Ruai
5	Dominic Mutie	ACC Ruai
6	Community Stakeholders	As per attendance list.

AGENDA:

The Agenda was proposed and adopted as follows:

1. Introduction and Opening Remarks
2. Consultant's presentation on ESIA specifically on project brief, importance of stakeholder engagement and public participation.
3. Discussion on the Consultant's presentation.

ITEM No.	MINUTES	ACTION
Min. 1.0	**Introduction and Opening remarks**	
	Ibrahim Adan, the moderator, welcomed the participants to the meeting and invited a participant to volunteer and open the meeting with a prayer. This was then followed by a round of introductions of the members present stating their names and institution/village they represent. The members of public present from the round of introduction was noted to be a mix of representatives of 17 villages within Ruai central location, Ward administrations including area chief, assistant chief, County Ward leadership and Ruai Water Users Association leadership, Businessmen, matatu Sacco leadership, business leaders -Ruai market & traders, religious leadership, youth, women and persons with disabilities among others. The meeting was sufficiently socially distanced, and participants urged to mask up and sanitize within the guidelines of Covid-19 protocols. **Project brief by Kengen** Kengen through representation by Mr. Duncan Saida confirmed that the waste to energy project was a joint initiative with Nairobi Metropolitan Services (NMS). The representative	Info

	urged the participants to feel free in raising any issues with regard to the project and assured that their views will be taken into consideration to define the project design and the conditions for its implementation.	
Min. 2.0	**Presentation on the project details, location process, technology, waste flow of project, benefits and adverse impacts and need for public participation.**	
	• The moderator gave a detailed briefing giving introduction about the project, the project details highlighting the main aims of the project, explained the project specifics on raw materials, technology, process, by products and the final output including both benefits and demerits expected and mitigation measures thereof. • He explained that the public participation and stakeholder engagement process as necessary for the success of any project not only as a requirement for financing but also as a form of community ownership of the project and also a legal requirement.	Info
Min. 3.0	**Question and Answer and Deliberations.**	
3.1	A question and answer session ensued after the presentation by the members of public present and Kengen representative and the moderator responded to their questions are detailed below; Mr. Macharia asked where the fly ash landfill is to be sited and whether the gas emission from the plant would affect the quality of rainwater in a harmful way? ➢ **Ans –** The plant technology and efficiency ensure that the by products from the plant are environmentally friendly and whatever is generated in terms of fly ash will be prioritized for road construction through the relevant agencies. In addition, the buried materials landfill will be a proper landfill base and side concreting for ground water and soils protection.	
3.2	Mrs. Purity of WRA was concern whether the landfilling of fly ash would be hazardous materials that would contaminate ground water given that the area has a high-water table. ➢ **Ans –** The moderator confirmed that the landfill will have a bottom impermeable layer to protect the ground water. Also, geotechnical studies undertaken for the site have considered the water table in the area. Regular maintenance and monitoring of ground water and soils for contamination will also help in protection of the water and soils.	
3.3	Mr, Ngare felt that the 312m by 639m plot of land would not be sufficient for both the plant and landfill given future projections. ➢ **Ans –** The technology to be employed will be of high efficiency for incineration and there are 700 hours assigned on plant maintenance annually to ensure that land filled by products are in frequent re-use. Also, all by products are to be treated and tested before release to the environment. In addition, the general land within the project site will be properly considered for land filling and plant operations.	
3.4	Dr. Omsati a resident academician, who was represented by the chief raised concerns on whether the area had been assessed for aviation risks from birds, air pollution from foul smell and traffic congestions and impact from vehicles from delivering the materials. He asked how street children who hung on garbage trucks and bad odour would be handled. He suggested use of closed trucks to avoid spillage of garbage during transportation. ➢ **Ans** The project will not have any open dumping onsite and the receipt and preprocessing areas will be a fully enclosed facility. Furthermore, Kengen in partnership with NMS shall ensure vehicles delivering materials adhere to a set standards and be inspected regularly as part of materials delivery to manage the concerns of materials discharge along the roads and illegal dumping within the area. Therefore, concerns of birds at the site will not be an issue. Foul smell from	

	the plant will be minimal as there are no materials that will be stored in the open on site besides that which is received within the pre-processing site and used within a week and processed accordingly. ➢ Trucks ferrying materials will adhere to set protocol between Kengen & NMS to ensure no unwanted persons will be onsite and be accompanying the vehicles to the site.	
3.5	Mr. John Muna was concerned with an increase in traffic jam due to the project and inquired whether there is a procedure for the waste trucks operations. ➢ **Ans –** Waste will be sorted in transfer stations before transportation to the plant. The waste will be immediately processed for incineration on reaching the plant. No waste will be stored onsite with minimal land filling and therefore no odour is to be expected. ➢ NEMA only registers inspected vehicles for waste handling. The vehicles are licensed annually to ensure they meet the required standards. Every vehicle will have waste tracking forms to document the waste source, composition and weight. The trucks will be operating on a traffic management schedule set up by the proponent. ➢ The waste is collected from transfer stations where it is not expected that street children will accompany the vehicles to the power plant. ➢ KCAA reviewed the flight paths in Nairobi for both Commercial and military operations and gave approvals for the site as off the flight path but with certain conditions. ➢ The plant operators with liaison with NMS will decide operationally on the material delivery hours to minimize the traffic impact with an agreed time routine.	
3.6	Mr. Macharia further noted that the plan for the project can be so elaborate but the problem in Kenya comes in implementation. ➢ **Ans –** KenGen's reputation in Kenya stands for itself given the various projects they have executed both locally and regionally and hence can ensure operational capacity and efficiency. In addition, most of Kengen's project have been implemented in parternship with international financiers who are particular on community concerns during implementation and undertake environmental performance audits.	
3.7	Mr. Zakayo asked who the managers of the transfer stations are and whether they dry the waste even on rainy days. ➢ **Ans** - The NMS shall handle the sorting process in transfer stations in enclosed spaces with conveyor belts and compaction machines. These are conditions and set up will be replicated in all the sub-counties. ➢ There is a leachet treatment facility and fly ash treatment included in the project design. Monitoring will be done on real time basis and quarterly reporting of the findings submitted to oversight authorities like NEMA &WRA.	
3.8	Mr. Karisa, the Administration police present asked of the security mechanism put in place for the project. ➢ **Ans** - The site will be secured by Kengen as per the protocols observed in their various operations in the country. The site access during construction and operation will be controlled access to ensure no illegal access.	
3.9	Mr. Stephen Kiriko Of the Eastern Bypass sacco asked of the authorities considered in the approval of the project. He also questioned if there are plans in the project to protect the ozone layer and whether the composition of the fly ash in terms of impact on water affecting paramters such as COD and BOD are known. Finally he enquired whether there are other case studies based on the project design that could inform its operation.	

	- **Ans** – The ESIA process involve stakeholders both at National and local levels. NEMA involves other lead agencies on ESIA approvals including KCAA, WRA, EPRA & relevant line ministries/department among others based on the scope of the project and jurisdiction. Therefore, approval process of an ESIA is broad-based. - The impacts of emission on ozone layer have been considered and the harmful gasses will be removed through filters in the 80m chimney. In any case such a project will minimize the methane gas and SO2, NO2 and other VOCS will be minimized which are generated in open land filling. There will also be a real time air monitoring device on top of the chimney. - There has be a team from NMS and Kengen leadership who in the past have visited similar projects to review case studies of similar facilities in Ethiopia and Egypt.	
3.10	Mrs. Charity asked who will employ workers for the project and would the locals be considered and what is the process in place for fair consideration of the locals? - **Ans –** NMS will employ workers at the transfer station and waste transportation levels while Kengen will employ at plant construction and operation levels. Kengen has a project implementation committee that will have representation from the immediate communities and therefore its important the persons representing the community is a person who has the residents interest at heart and be fair in giving every village a chance both during construction and operation.	
3.11	Mr Kanyi noted that NMS would have to improve the infrastructure in Ruai which is currently already under rpressure for smooth operation of the project. - **Ans** - The moderator said that he had an appointment with The NCC leadership both at NMS, County Assembly and Governor's office and that their concerns will be relayed to them for actions. In addition, Kengen has a social responsibility budget where they prioritize community requests such as this for consideration and implementation.	
3.12	Mr. Mohammed enquired whether there would be any training offered since some of the youth in the area are unskilled. - **Ans** - Both levels of skilled and unskilled workers will be employed and basic training conferred where appropriate.	
3.13	Mr. Maina Kariuki raised several concerns such as whether the waste could be used for manure instead of use in the project. He was of the view that Ruai community should have an MoU with Kengen and NMS regarding the project and asked whether there would be a complaints committee for incidents that might arise during project construction and operation. - **Ans** - Waste decomposition for manure in large volumes is not as feasible as operation in a waste to energy plant. Therefore, for the larger waste management in Nairobi metropolis area the Waste to Energy plant would be more economically feasible. - Kengen has an operational oversight through community project implementation committee. This committee will handle community complaints to the satisfaction of the public. An MoU on project impact might not be necessary as they are mechanisms within laws of the Kenya to address any significant adverse impact.	
3.14	Mr. Kiriko further asserted that a health risk assessment should be carried out on the wastes and processes involved in the project. - **Ans –** The moderator emphasized that the proposed plant is solely dedicated to municipal waste thus excluding industrial, medical and E-wastes. He also pointed out that the existing sewer treatment facility is an entirely separate project.	

3.15	**Kengen Comments** Kengen affirmed that the stakeholder concerns had been noted and will form basis of other deliberations regarding the project management and all the concerns will be considered in project design and implementation. He pointed out that on project operations, Kengen always involves the local community by forming the Stakeholder Consultation Committee (SCC). The SCC would handle all communal grievances and it composition is made of largely local representation. Through the SCC, 100% of unskilled workers are sourced locally and skilled work is prioritized for the community. Kengen also noted that the project is largely clean energy and thus qualifying for carbon credits which will be invested in the local community as part of CSR for Kengen.	
Min. 4.0	**Discussion Points**	
	The stakeholders welcomed the project but emphasized the need for an MoU between the community and the proponents sighting insecurities that the site might turn into a fully-fledged landfill.	Info
Min. 6.0	**AOB**	
	The stakeholders called for major improvements on social infrastructure in Ruai area especially for the road network, water and sewer system. They proposed a dual carriage for Kangundo road and the connection of the three metropolitan counties of Nairobi, Machakos and Kiambu Through a common road as it would facilitate easy operation of the project. With no further points to discuss, the meeting ended at 1300 hrs	
	Consultant Name ...Ibrahim Adan......... Designation......Sociologist .... Signature Date: 12th August 2021 **Employer** Name....Duncan Saida.... Designation...Environment Officer... Signature ...Saida.... Date...16th August, 2021....	

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
1	John wachra	10324873	0722302959	Rual wrua	Chair	
2	Isaack Somo	2347838	0723562550	Energy & Environment	Enviroment	
3	Benson. Karioki	24102387	0727437830	Administration Police Service	CIP	
4.	JULIUS NJUGUNA	0086750	0722917414	ELDER	Chair	
	REV ALLAN NGIRIA	10160763	0720804561	REV	Church	
6	JOHN. W. MUNA	1194466	0726269291	10 HOUSES ~~ELDER~~	ELDER	
7	Julius Gikonyo	1801784	0720702702	Estan bypass travellers EB	DIRECTOR	
8	Moses Maina	23858220	0723025478	Youth LEADER	CHAIR	
9.	BENSON MUGO	1122248	0721785665	ELDER-SEWARAGE DIV. Chair Committee	CHAIR	
10.	Gichina Kanyi	0836165	0722634446	ELDER TOUTHORI RUCHIRI	MEMBER	
11	FRANCIS WACHIRA	33779925	0722418662	RUAI	NYUMBA KUMI	

KenGen

SEURECA VEOLIA

PUBLIC CONSULTATION AND PARTICIPATION FORM

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED ESTABLISHMENT OF WASTE TO ENERGY POWER PLANT AT RUAI, KASARANI SUBCOUNTY, NAIROBI, KENYA.

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator: Ibrahim Adan Venue: Wings view hotel - Ruai meeting

Date: 11/Aug/2021 Time: 9:30 am

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
01	Charity mwathathi	27476764	0728079663	Nyumba kumi	P.W.D LEADER	
02	Rosemary Ndegwa	7571513	0724593527	Nyumba Kumi	Leader	
03	John M KARIUKI	1084006	mahakariuki05@gmail.com. 0724968268	ELDERS	LENDER	
4.	MOHAMED KHALFAN	1309760	0722873315	Nyumba Chaina.	Chairma	
5	PURITY MARETE	22067436	0720242432	RUAI WRUA	leader	
6	WILSON Z AKAYO	1616139.	0713744023	RUAI MARKET	CHAIR	
7	NYABUTO OMACHE	16008493	0724594782	INTERIOR	SNR CHIEF	
8	ANDARSON CHERUIYOT	9233231	0722313854	NSAO	A CHIEF	
9	RICHARD A. NGARE	6105709	0723889456	NYUMBA KUMI ELDER	VICE CHAIRMAN	
10	DANIEL MACHARIA NJUGUNA HSC	4678290	0722602617	CPF	CHAIRMAN	
11	DOMINIC MUTIE	21557841	0720290170	Interior ACC Ruai	ACC	

KenGen SEURECA VEOLIA

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator IBRAHIM ADAN **Venue** WINGS VIEW HOTEL - RUAI meeting

Date 11/AUG/2021 **Time:** 9:30 am

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
1	OMWENGA CHWEYA	33288310	0790217638	Youth leader	Leadership	
2	STEPHEN M KIRIKO	0714508	0721985589	Eastern bypass sacco	CHAIRMAN	
3	S.P.K MUNGAI	137257	0722803899 0722803899	KIANGAZI	Elder	
4	PASTOR MARY MUTHONI MURIITHI	1686287	0713606224 0723251576	Parent's Pof. PCGiG church	PASTOR	
5	Duncan Landa	8974257	0722476992	KenGen	P. Off	
6	Arthur Ouma	27505278	0728343270	Seneca/E&E	Asst. socialogist	
7	Ibrahim Adan	22621122	0723665591	Seneca/Enf	Consultant	

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator: Ibrahim Adan Venue: Wings View hotel – Ruai. meeting

Date: 11/Aug/2021 Time: 9:30 am

Annex 13

List of participants

KenGen

SEURECA VEOLIA

PUBLIC CONSULTATION AND PARTICIPATION FORM

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator: Ibrahim Adan Venue: Wingsview hotel – Kamulu meeting

Date: 12/8/2021. Time: 9:30 am

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
12	DOUGLAS G. KIBE	10974844 ~~10978444~~	0720221010	Elder Kamulu	Elder	
13	JAMES K NJOROGE	3509640	0721290751	Elder Kamulu	Elder	
14	D. M. KURUGO	12499145	0722902963	GOP	Snr CHIEF	
15	Ann Munene	10864674	0723746645	Elder Kamulu	village Elder	
16	REBECCA MAINA	13531807	0727605184	elder Kamulu	Village Elder	
17	Arthur Ouma	27505278	0728343270	Swerea/EGG	Asst Sociologist	
18	SIMON K. NDERITU	5961450	0722380655	ELDER KAMULU		
19	MARTHA KAIRIMU	27997972	0720927810	ELDER KAMULU	LEADER	
20	LEVENEN MAKORI	8646261	0727-248214	Stage 26 Kamulu	LEADER	
21	Alfred Momanyi	10693068	0724520771	Elder Makongo	Elder	
22	George Rioni	0488100	0722459590	Elder ATHI	CHAIRMAN	

KenGen

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator: Ibrahim Adan Venue: Kings view hotel – Kamulu meetings.

Date: 12/8/2021. Time: 9:30 am

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
23	JOSEPH MUIRU	13653512	0721-723811	OOP	ASST/CHIEF	
24	Eunice Wangai	3435596	0722734068	Kamuku Kumi Nyumba	Elder Nyumba Kumi	
25	DAVID KAMAU	21394568	0721684061	Anjuadu	Elder	
26	Francis Thenguta	2008906	0755855189	Elder	Nyumba Kumi	
27	Duncan Saito	8974257	0722476994	G. K.	E.O.	
28	Ibrahim Adan	22621122	0723665599	Seureca	Consultant	

KenGen

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator Ibrahim Adan **Venue** Wings View hotel – Kamula meeting

Date 12/08/2021 **Time:** 9:30

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
1	ISAAC M. NDERITU	12947040	0722346587	KAMUKU MARKET TRADERS CBO.	CHAIRMAN	[signature]
2	CEPHA NJUGUNA	3585959	0722879347	KAMUKU LEADERS	ELDER	[signature]
3	SAMUEL ORANGI	1069765	0705262136	Kamuku	Riverside Chair	[signature]
4.	Raphael Wawero	0876128	0722239542	Chairman Kamuku-Ruai P...	Chair	[signature]
5	BONIFACE GATHERU	11075804	0720749792	Mangoongo Kamuku	locum	[signature]
6	WESTON NJIRU	10797212	0722978101	KAMUKU Dev-Chair	Chairman	[signature]
7.	JACK MUTISO	7808822	0722273534	Kamuku - Ruai	Cluster chair	[signature]
8	RUTH NDWIGA	3736360	0722364561	Kamuku village ~~elder~~	Kamuku	Ndwiga
9	MARY M WAMBUGU	8649367	0717421674	KAMUKU Chair maendeleo ya wanawake	chair	[signature]
10	Elijah wanyego	7229230	0722597501	Kamuku Spiritual Community	chairlady	Wanyego
11	JAMES WAWERU K	5514117	0722815900	KAMUKU	ELDER	[signature]

KenGen SEURECA VEOLIA

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator IBRAHIM ADAN Venue WINGS VIEW HOTEL - RUAI meeting

Date 11/AUG/2021 Time: 9:30 am

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
01	Charity mwathathi	27476764	0728079663	Nyumba kumi	P.W.D LEADER	[signature]
02	Rosemary Ndegwa	7571513	0724593527	Nyumba Kumi	Leader	[signature]
03	JOHN M KARIUKI	1084006	mathakariuki05@gmail.com 0724968268	ELDERS	LEADER	[signature]
4.	MOHAMED KHALFAN	1309760	0722873315	Nyumba. Chairma.	Chairma	[signature]
5	PURITY MARETE	22067436	0720242432	RUAI WRUA	leader	[signature]
6	WILSON ZAKAYO	1616139.	0713744023	RUAI MARKET	CHAIR	[signature]
7	NYABUTO OMACHE	16008483	0724594782	INTERIOR	SNR CHIEF	[signature]
8	ANDARSON CHERUIYOT	9233231	0722313854	NGAO	A CHIEF	[signature]
9	RICHARD A. NGARE	6105709	0723889456	NYUMBA KUMI ELDER	VICE CHAIRMAN	[signature]
10	DANIEL MACHARIA NJUGUNA HSC	4678290	0722602617	CPF	CHAIRMAN	[signature]
11	DOMINIC MUTIE	21557841	0720290170	Interior ACC Ruai	ACC	[signature]

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator: Ibrahim Adan Venue: Wings View hotel – Ruai. meeting

Date: 11/Aug/2021 Time: 9:30 am

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
1	OMWENGA CHWEYA	33288310	0790217638	Youth leader	Leadership	YS
2	STEPHEN M KIRIKO	071458	0721985589	Eastern bypass sacco	CHAIR man	[illegible]
3	S.P.K Mungai	137257 0722803899	0722803899	Kiangazi	Elder	[illegible]
4	PASTOR MARY MUTHONI MURIITHI	1686287	0713606224 0723251576	Parent's Prof. PCGiG church	Pastor	[illegible]
5.	Duncan Larido	8974257	0722476992	KenGen	Ex. Off	Larido
6	Arthur Ouma	27505278	0728343270	Seneca/E&E	Asst. socialogist	[illegible]
7.	Ibrahim Adan	22621122	0723665591	Seneca/EnE	Consultant	[illegible]

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator: Ibrahim Adan Venue: Wings view hotel – Ruai meeting

Date: 11/Aug/2021 Time: 9:30 am

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
1	John wachra	10324873	0722302959 wachrajohn339	Ruai wrya	Chair	[signature]
2	Isaack Somo	23478385	0723562550	Energy & Environment	Environmentalist	[signature]
3	Benson. Karuga	24102387	0727437830	Administration Police Service	CIP	[signature]
4.	JULIUS NJUGUNA	0086750	0722917414	ELDER	chair	[signature]
	REV ALLAN NGIRIA	10160763	0720804561	REV	Church	[signature]
6	JOHN. W. MUNA	1194466.	0726269291	10 HOUSES ~~ELDER~~	ELDER	[signature]
7	Julius Gikonyo	1801784	0720702702	Eastern bypass travellers EBT	DIRECTOR	[signature]
8	MOSES MAINA	23858220	0723028476	Youth LEADER	CHAIR	[signature]
9.	BENSON MUGO	1122248	0721785665	ELDER-SEWARAGE DIV. Chair COMMITTEE	CHAIR	[signature]
10.	GICHINA KANYI	6836165	0722634446	ELDER TOTUTHORI RUCHIRI	MEMBER	[signature]
11	FRANCIS WACHIRA	3377925	0722419662	RUAI	Nyumba Kumi	[signature]

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PUBLIC CONSULTATION ATTENDANCE REGISTER

Moderator Ibrahim Adan **Venue** DCC office Ruai

Date 5/Aug/2021 **Time:** 10:00

NO	NAME	I.D No.	Mobile No/Email Address	Organization	Designation	Signature
1	James Chacha	11393486	0723955457	Interior	DCC	
2.	Duncan Saida	8974257	0722247699	Ken Gen	FO	
3	Domunic Mutie	21557841	0720290170	Interior	ACC	
4.	Ibrahim Adan	22621122	0723665599	Senreca EnE	Sociologist	
5	Arthur Ouma	27505278	0724343270	Senreca/EnE	Asst Socialogist	
6	NYABUTO OMACHE	16008443	0724594782	INTERIOR SNR CHIEF	SNR CHIEF	

Annex 14

Consultants Practicing License

FORM 7 (r.15(2))

nema

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY(NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

ENVIRONMENTAL IMPACT ASSESSMENT/AUDIT (EIA/EA) PRACTICING LICENSE

License No : NEMA/EIA/ERPL/13757

Application Reference No: NEMA/EIA/EL/18715

Waste to Energy power plant ESIA report. for 25/10/2021

M/S **Geoffrey Nagillah Makanga**
(individual or firm) of address

P.O. Box 14255-20100, Nakuru

is licensed to practice in the

capacity of a (Lead Expert/Associate Expert/Firm of Experts) **Lead Expert**
registration number **2330**

in accordance with the provision of the Environmental Management and Coordination Act Cap 387.

Issued Date: **1/20/2021**

Expiry Date: **12/31/2021**

Signature.....

(Seal)
Director General
The National Environment Management Authority

P.T.O.

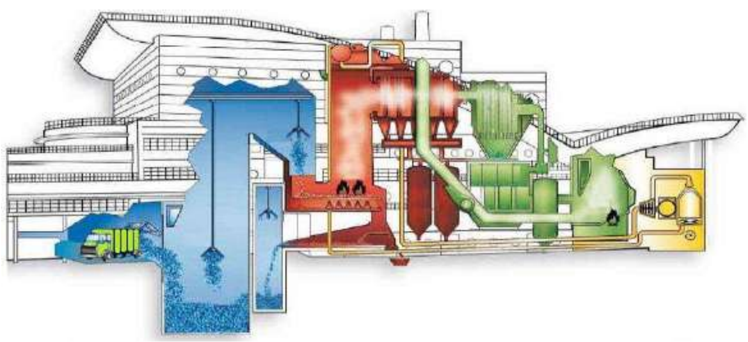
ISO 9001: 2008 Certified

Annex 15

ESIA Terms of Reference

Kenya Electricity Generating
Company PLC

TERMS OF REFERENCE (TOR) FOR THE ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR THE PROPOSED ESTABLISHMENT OF WASTE TO ENERGY POWER PLANT AT NAIROBI, KENYA.



Report Prepared for:

KENYA ELECTRICITY GENERATING COMPANY
KenGen Pension Plaza 2, Kolobot Road, Parklands
PO. Box 47936-00100 NAIROBI
TEL: +254 20 3666000

Report prepared and submitted by:

Geoffrey Nagillah Makanga, NEMA REG. NO. 2330
&
Ibrahim Adan, NEMA REG. NO. 1608.

JULY, 2021

DOCUMENT AUTHENTIFICATION

This Terms of Reference report has been commissioned by Kenya Electricity Generating Company (KENGEN) hereafter referred to as "The Proponent" for the proposed Waste to Energy Power Plant establishment in Ruai, Nairobi County prepared by M/s Seureca's team of consultants in accordance with the Environmental Management and Coordination Act (EMCA) CAP 387 Kenya's supreme environmental law and the National Constitution. Section 58 of EMCA requires that all development project proposed in Kenya is subjected to environmental assessment conducted in line with the Second Schedule (of EMCA, 1999) and the Legal Notice 101 (Regulations for Environmental Assessment and Audit) of June 2003 for submission to the National Environmental Management Authority (NEMA).

We the undersigned, certify that the particulars in this report meet the ESIA/EA code of conduct as issued by NEMA to the best of our knowledge.

P.Eng.Tech. Geoffrey Nagillah Makanga

Designation: Seureca's Lead Expert Reg. No. 2330.

Signed at Nairobi on ....day of July, 2021.

Signature: ....

Table of Contents

List of Figures.

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GLOSSARY OF TERMS

Assets: Comprises land, structures or crops/trees, unless otherwise defined.

Community Sensitization Meeting (equivalent to Local Stakeholder): Meeting convened to inform the community regarding a proposed project.

Compensation: Payment in-kind and/or cash for an asset to be acquired or affected by project at replacement cost, without taking into account depreciation.

Entitlement: Range of measures comprising cash compensation, income rehabilitation assistance, transfer assistance, income substitution and relocation which are owing to business restoration and/or PAPs, depending on the type, degree and nature of their losses, to restore their social and economic base.

Host Community: Community/land area where people, physically displaced by a Project, will be resettled.

Household: Family or collection of people, which function as a single economic unit. Income Restoration: Measures required ensuring that PAPs have the resources to at-least restore, if not improve, their livelihoods.

Indigenous Peoples: People indigenous to an area and include ethnic minorities as defined by World Bank Operational Policy on Indigenous Peoples (OP 4.10).

Key Stakeholders: Those inhabitants of an area affected by a project who have the most to lose and the most to gain from the completion of the project, and whose concerns must be addressed in an environmental assessment.

PAP Consultation Meeting: Meeting with the Project Affected Persons (PAPs) to disclose to them project impacts and proposed restoration measures.

Project Affected Person: Any person who, on account of the execution of the Project, or any of its components or sub-projects would regardless of land type have their: right, title or interest in any house, titled/trust land (including residential, agricultural and grazing land) or any other fixed or movable asset acquired or possessed, in full or in art, permanently or temporarily; business, occupation, work, place of residence or habitat adversely affected; or Standard of living adversely affected.

Proponent: The agency proposing and has responsibility for implementation of a Project. Public Consultation Meeting (PCM): Meeting convened to gain public input prior to consideration of land use application for a proposed project. The forum is used to inform the public about the product and discuss the potential positive and negative impacts and proposed mitigation measures.

Rehabilitation: An enhanced period of maintenance intended to restore a project to its original condition. Structural defects are repaired without major changes to alignment and width standards as would be implemented in a reconstruction.

Relocation: Physical moving of PAPs from their pre-project place or residence, place for work or business premises, to an area within the same land that is not affected by the project.

Resettlement: The settlement of people in a different place.

Resettlement Action Plan: Time-bound action plan, with budget, setting out resettlement strategy, objectives, eligibility criteria, entitlements, actions, responsibilities, monitoring and evaluation. The type of RAP can be categorized by the magnitude of the resettlement required.

Socio-Economic Survey: Census of potential PAPs which is prepared through a detailed enumeration survey based on actual data collected.

Stakeholder Meeting: Meeting with Key Stakeholders to inform them about the project and seek guidance/consensus about the project activities

Wayleave: A Right of Way (RoW) over the land of another. This RoW is for carrying sewer, drain, power line or pipeline into, though, over or under any lands but in so doing may interfere with the existing buildings.

Nomenclature and Acronyms

APCr	Air Pollution Control residues
AWWDA	Athi Water Works Development Agency
ACSR	Aluminium Conductor Steel Reinforced
amsl	Above mean sea level
BAT	Best-Available Technologies
B.O.D	Biochemical Oxygen Demand
B/C	Benefit – Cost ratio
Bgl	Below Ground Level
CEMS	Continuous Emissions Monitoring Systems
CIA	Cumulative Impact Assessment
CIAGs	Cumulative Impact Assessment Guidelines
CIDP	County Integrated Development Plan
COD	Chemical Oxygen Demand
CV	Calorific Value
DFS	Detailed feasibility study
EPC	Engineering Procurement and Construction
EIA	Environmental Impact Assessment
EHS	Environment, Occupational Health and Safety
EMCA	Environment Management & Coordination Act
EMMP	Environmental Management & Mitigation Plan
ERSWEC	Economic Recovery Strategy for Wealth and Employment Creation
ESAP	Environmental and Social Action Plan
ESMS	Environmental and Social Management System
FIRR	Financial Internal Rate of Return
FS	Feasibility Study
GCV	Gross Calorific Value
GHG	Greenhouse gases
GIIP	Good International Industrial Practices
GPS	Geographical Positioning Coordinates
GWh	Gigawatt hours
GWh/y	Gigawatt hours per year
HIA	Health Impact Assessment
HMB	Heat and Mass Balance
HSE	Health, Safety, Environment
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IPP	Independent Power Producer
KCAA	Kenya Civil Aviation Authority

KenGen	Kenya Electricity Generating Company
KNBS	Kenya National Bureau of Statistics
Km	Kilometers
KPLC	Kenya Power
KSh	Kenya Shilling
kV	Kilovolt
KVA	Kilo Volts Amperes
kW	Kilowatt
kWh	Kilowatt-hour
KWS	Kenya Wildlife Services
LCOE	Levelised Cost of Electricity
LFG	Landfill Gas
m2	Square metre
MCA	Member of County Assembly
MOU	Memorandum of Understanding
MoE	Ministry of Energy
MRF	Material Recovery Facility
MW	Megawatts
MSW	Municipal Solid Waste
NaMSIP	Nairobi Metropolitan Services Improvement Project
NEMA	National Environment Management Authority
NGOs	Non-Governmental Organizations
NMS	Nairobi Metropolitan Services
NPEP	National Poverty Eradication Plan
OHS	Occupational Health & Safety
OHTL	Overhead Transmission Lines
OSHA	Occupational Safety & Health Act
O&M	Operation & Management/ Operating & Maintenance Cost
PAPs	Project Affected Persons
PDA	Project Development Agreement
PPA	Power Purchasing Agreement
PPE	Personal Protective Equipment
PPC	Public Participation & Consultation
PPP	Public Private Partnerships
RAP	Resettlement Action Plan
RoE	Return on Equity
SESO	Standard Environmental and Social Obligations
SDGs	Sustainable Development Goals
SHA	Shareholder Agreement

SIA	Social Impact Assessment
SoK	Survey of Kenya
SOP	Social Action Plan
STP	Sewage Treatment Plant
SR	Scoping Report
ToR	Terms of Reference
TSS	Total Suspended Solids
uPVC	Unplasticized polyvinyl chloride
USD	United States of America Dollar
V	Volts
VAT	Value Added Tax
VOCs	Volatile Organic Compounds
WB Op	World Bank Operational Manual
WFD	Waste Framework Directive
WtEP	Waste-to-Energy Plant
Wp	Watt peak
WRMA	Water Resources Management Authority

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Seureca East Africa Limited (SEAL), a subsidiary of SEURECA-VEOLIA of France and Development Environergy Services Limited (DESL) of India, herein referred to as the 'were commissioned by the Kenya Electricity Generating Company PLC (KenGen) hereafter referred to as "The Proponent" to prepare this Terms of Reference (TOR) to provide the guidelines for undertaking an Environmental-Socio-Economic Impact Assessment (ESEIA) study report for the proposed development of a Waste to Energy Plant in Ruai, Nairobi County. The proponent KenGen in Partnership with the Nairobi Metropolitan Services (NMS) proposes to establish a waste to energy power plant adjacent to Ruai Wastewater treatment plant whose land is owned by Athi Water Works Development Agency (AWWDA) on Latitude: 37.062759, Longitude: -1.208027, Located along Kangundo road in Ruai Area, Kasarani constituency, Nairobi County in a bid to manage the municipal solid waste (MSW) generated in Nairobi and adjoining counties in the Nairobi Metropolitan Region (NMR).

By the Enactment of EMCA, 1999, CAP 387 of Laws of Kenya, National Environmental Management Authority (NEMA), under Legal Notice 101 (Regulations for Environmental Assessment and Audit) of June 2003, classifies projects into low (project with minimal or no adverse impact on the environment or society), medium (project may have adverse impacts on the environment or society, but these impacts are less significant & are site-specific) and high (project is likely to have significantly wide range of adverse impacts on the environment or society that are irreversible, complicated, or unprecedented, and difficult to assess) risk facilities: Waste to Energy Power Generation (redeploying waste from landfill for use in energy generation using Combustion-incineration technologies) is a prescribed activity as per the second schedule in section 58, of Environment Management and Coordination Act (EMCA), CAP 387 among other enacted laws as a high risk project due to the changes in land use for the installation of incinerators and high voltage electrical transmission lines.

Under these laws, any activity out of character with its surrounding which is likely to cause substantial impact to the environment in areas such as waste disposal, sustainable resource use, ecosystem's maintenance, social environment, land use and water extraction; an Environmental Impact Assessment (EIA) report is required to assess such impacts and propose mitigation measures.

By the Enactment, the Project Proponent is required to submit an EIA report to NEMA for approval before commencing implementation of the project. By this report the relevant government authorities are able to monitor impacts within the lifespan of the project on the immediate environment, so as to enable major stakeholders of the project including the Government agencies to manage the environment for the wellbeing of the community.

This TOR has been prepared based on the scoping result, field visits and information collected from both primary and secondary sources including information provided by the Project Proponent. The Terms of Reference (TOR) for conducting the EIA Study are based on the General Guidelines for Conducting EIAs in Kenya as per Environment (Impact Assessment and Audit) Regulations, 2003, which operationalizes the **Environmental Management and Coordination Act (EMCA), CAP 387,** the Client Guidelines and World Bank Operational Policy for category A projects.

2.1 SCOPE AND OBJECTIVES OF THE ESIA STUDY

The ESIA study will be carried out in compliance with the Government of Kenya's Environmental Management and Co-ordination Act (EMCA) of 1999, CAP 387. The ESIA shall also be carried out in accordance with all applicable Kenyan sectoral laws and regulations that govern environmental and social matters.

The main objective of the ESIA will be to identify and assess the potentially significant existing and future adverse environmental and social impacts associated with the proposed project, as well as those groups that will be affected by such risks and effects, and to determine the measures needed to prevent or minimize and mitigate the adverse impacts, and identify potential environmental and social opportunities, including those that would improve the environmental and social sustainability of the Project.

The assessment process will be commensurate with, and proportional to, the potential impacts and issues of the Project. The assessment will cover, in an integrated way, all relevant direct and indirect environmental and social impacts and issues of the Project and the relevant stages of the project cycle (e.g. pre-construction, construction, operation, and decommissioning or closure and reinstatement). The Environmental and Social Assessment will also determine whether further studies are required, focusing on specific risks and impacts, such as climate change, human rights and / or gender.

The ESIA will also consider the role and capacity of third parties such as (sub) contractors to the extent that they pose a risk to the Proponent's control and influence over third party actions. Based on the environmental and social risks and impact identified, the ESIA will propose environmental and social management measures.

Specific Objectives of the ESIA will include the following: -

- To describe the site and its environmental status.
- To assess the socio-economic status of those who will be directly and indirectly affected by the facility.
- To collect baseline information of the project area with regards to climate, water, soils, roads, population, social economic factors and biological environment (fauna and flora),
- To review relevant legislations for such projects,
- To collect views of the affected public and other interested stakeholders with regard to the presence of the facility.
- To determine land use conflicts that may result between the facility and its neighborhood land uses,
- To determine the potential significant impacts of the project,
- To propose alternatives to the project and/or project location and clean technologies,
- To propose mitigation measures for the significant negative impacts,
- To develop an EMP for the project.

The proposed development, including proposed environmental and social impact mitigation measures will be reviewed and evaluated in relation to established environmental and social standards in order to determine whether the project is acceptable and in compliance with applicable norms.

2.2 An outline of the methodology

The nature of commissioning of an Integrated Solid Waste Management facility calls for a full ESIA study to ensure public support, completeness and comprehensiveness of the report.

During the assessment, the following steps will be followed:

- Environmental screening that identified the project as among those requiring EIA under schedule 2 of EMCA, CAP 387 of Laws of Kenya,
- Environmental scoping to provide the key environmental issues,
- Desktop studies for background information,
- Public participation with stakeholders using interviews, questionnaires, focused group discussions,
- Detailed project concept discussion with project proponent i.e. Kengen & NMS;
- Project Technology assessment and its alternatives.
- Topographical surveys.
- Hydro-Geotechnical surveys.
- Water, soils, noise and air quality analysis.

CHAPTER 2: PROJECT DESCRIPTION

2.1. PROBLEM STATEMENT

Municipal solid waste (MSW) is defined as waste collected by municipalities or on their order. It includes waste originating from households, commercial activities, office buildings, institutions such as schools and government buildings, and small businesses that dispose of waste at the same facilities used for waste collected by municipalities.

The generation of MSW directly reflects wasted resources. MSW is collected from generating sources and trucked to landfills, composters or incinerators. Although some of the landfills are managed to mitigate impacts on the environment, there is still the potential to contaminate surface and groundwater, soil and air. In addition, landfills use large tracts of land, which in densely populated areas are becoming a rare commodity and environmentally unsustainable. Incinerators, which require less land, inevitably cause the depreciation of the surrounding land value due to lowered air quality. Additionally, the solid wastes typically have a high-density (288kg/m^3) reflecting a high organic content and are both corrosive and abrasive. This density increases during the rainy seasons, with increased moisture content, making the situation even worse. The density will vary depending upon the season, but a local survey estimated the average on-truck density at 576kg/m^3 and average landfill density without any compaction at 1,152kg/m^3.

The worsening situation of solid waste management in Kenya is exacerbated by the high rate of urbanization (4.3%) coupled with the growth of spontaneous settlements, which are both un-serviced and highly inaccessible thus proposal by government to enhance waste management through a holistic waste management project that caters for from the key aspect of collection using locating static compactors in informal settlements should capture all MSW.

Kenya's population in 2019 was estimated to be 47,925,301 with an average annual growth rate at 1.93%. The country's urban population is estimated at 16,441,258 (35.8%) with urbanization rate of 4.34% and rural population of 29,484,043 or 64.2% forming the majority of the population. The Nairobi area as a city has a population of 3,538,369 with the metropolitan area estimated to have a population of 7,547,547 persons.

Per JICA, 2015, Kenya's total population generate 5,173,983 tons of municipal solid waste (MSW); 2,300,000 tons of agricultural waste; 3,600,000 tons of liquid and solid industrial waste from the leather, paper, textile, printing and dying sector; 339,277 construction and demolition wastes; 50,000 tons of used cooking oil; 10,170 tons of waste motor and lubricating oils; 84,194 tons of medical and clinical waste; 910 tons of obsolete or out of date pesticides; 510,000 tons of hazardous waste; 1,345,000 tons of sewage solids; that aggregate to a total of 14,413,534 tons annually. Most of this waste is landfilled at various poorly planned waste management sites around the country.

In Nairobi County, Dandora dumpsite, the main landfill site is a sad picture of a multiple tragedy. The City Council of Nairobi decommissioned the dumpsite in 2012, after 8 years of planning. However, conflict between the council and the Kenya Airports Authority over the relocation of the dumpsite to Ruai has brought the process to a grinding halt. The community sees no easy end to this largest and most flagrant violation to human rights and environmental health in the county. The dumpsite exists in contravention of several provisions to the Constitution of Kenya.

2.2 Justification of the Project

The project involves implementation of a Presidential Decree on solid waste management plan in accordance with the provisions of the constitution of Kenya 2010 for access to a clean and healthy environment to every citizen, which is considered a basic human right. The eighth Sustainable Development Goal emphasizes the provision of safe clean water and a safe environment. Furthermore, Vision 2030 social pillar targets the implementation of an integrated solid waste Management system which this project seeks to achieve.

According to the Presidential Decree (this requires to be detailed further in terms of decree No. & dates), there is a need to rehabilitate, restore and manage the Nairobi River Ecosystem in order to provide for improved livelihoods and enhanced biodiversity and sustainable supply of water for domestic, industrial and recreation purposes. Therefore, decommissioning of Dandora dumpsite by establishing a waste to energy power plant that shall utilize the municipal solid waste at Dandora and waste from new sources through the transfer stations will contribute to the establishment of new and sustainable environmental management with regards to the waste management of the city and its metropolis areas.

2.3. DANDORA DUMPSITE CLOSURE AND RESTORATION PLAN

Dandora dumpsite is Nairobi's principal dumping site established in 1977 sprawls over 28 Hectares and handles all the wastes generated by Nairobi City (receiving over 1500 tonnes of waste on a daily basis). Poor waste management has significant consequences on socio-economic

The dumpsite is an environmental hazard from the careless dumping of Solid wastes ranging from sanitary pads to syringes, plastics, rubber, lead based paints, slippers and many other toxic chemicals which pollutes both surface and underground waters from leachate formation that end up into the Nairobi River which passes through Dandora. Inhabitants bathe and drink this water contaminated with germs, dirt and bacteria and that is very poisonous for their health and wellbeing creating health and environmental risks. Shallow aquifers are vulnerable to leachate contamination. Consumption of leachate-polluted water is a known source of gastrointestinal illness, reproductive problems and neurological disorder (WHO report, 2006). As air and water from rain mix with the decomposed waste materials, contaminants from the solid wastes are extracted into the liquid phase to form leachate.

The characteristics and volume of leachate produced in a dumpsite depend on the composition of the waste materials, availability of moisture, and the local temperature conditions. Landfill leachate is one of the main sources of groundwater and surface water pollution if it is not properly collected and treated and safely disposed as it may percolate through soil reaching water aquifers. The constantly burning mountainous garbage heap produces acidic fumes of Sulphur, lead and other heavy metals not only causing serious air pollution and acid rain but the noxious fumes also affect the respiratory system of the inhabitants. Houses nearing the site are filled with smoke making it hard to breathe.

Indiscriminate dumping at the site goes on due to lack of an alternative site and the dumpsite beneficiaries who are totally against its relocation. Attempts to relocate has been strongly opposed by those benefiting from it as well as opposition by residents of proposed sites under the not in my backyard realm. By 2011, the dumpsite was deemed full and yet it continues to operate and the site fully utilized economically by scavengers for daily income through waste materials collection for re-use and recycling. However, the group are exposed to significant health implication from pollutants emissions onsite. Several studies have been commissioned to assess the impact of the dumpsite on the environment showing dangerously high levels of heavy metals in the surrounding environment and in the body of local residents. Lead and cadmium levels were 13,500 ppm and 1,058 ppm respectively, compared to the action levels in the Netherlands of 150 ppm/5ppm for these heavy metals. The Stockholm Convention on hazardous pollution, which Kenya has ratified, requires actions aimed at eliminating these pollutants. The promise to act was agreed by the government, interested stakeholders and the civil society. Many global Non-Government Organizations (NGOs) have called upon Kenyan government representatives and stakeholders to honor the of the Convention and keep the promise of reduction and elimination of such harmful pollutants.

While some critics will defend the habit, it is a disastrous short term solution to a larger, complex and longer social and economic problem. Public participation will be at the core of the decommissioning of the facility , relocation and set up of a waste to energy plant in its place. The local communities and various interested and affected stakeholders (IAPs) understand their role as participants in the change process to decommission to the landfill and set up the waste to energy plants. The national and county government in liaison with various IAP's have put in the past put forward a number of proposals to solve the problem. It included closing the dumpsite, re-cultivation, relocation of waste management, and proper recycling facilities. Fortunately, the developments of those ideas have been embraced as a presidential legacy flagship project thereby gaining both financial and political goodwill for the reclamation and rehabilitation of the dumpsite into a recreational park while setting up Material Recovery Facility in the sub counties for waste recovery for reuse, recycling, composting and incineration for energy generation through development of a waste to energy plant and associated infrastructure

2.4. ENERGY NEED BACKGROUND

The Kenyan Government envisages an energy sector that is well supplied by intermix of energy source that is adequate, affordable and quality energy services. To meet these, very broad energy policy objectives calls have been made for the delivery of cost effective and environmentally sound energy service to all sectors of the economy. In endeavoring to provide clean energy services then, security of supply, affordability and sustainability are considered as pivotal pillars for an energy system development.

Kenya's cheapest source of power is hydro but it is affected by erratic weather attributed to climate change which greatly affects the efficiency and reliability of power generation and subsequent electricity supply capacity in Kenya. The government in its efforts to power the country's Vision 2030 development blue-print for economic growth has set strategic diversification of electricity generation

source as a key goal to achieve sustainable development. Diversifying Kenya's energy mix is of great importance, as over-reliance on hydropower and fossil fuels leaves the nation vulnerable to drought-induced power outages and increasing energy costs from volatile fuel prices. expected to create an enabling environment for the long term government goals such as the Big Four Agenda by adopting modern energy services which are crucial to human well-being and to a country's economic development- a correct path to achieve the United Nations' sustainable development goal number seven which focuses on the provision of sustainable, affordable, reliable and modern energy for all.
Nairobi like other developing world cities is characterized by rapid population growth, and urbanization. With a population of nearly 4 million people the amount of solid waste generated is ever increasing. The surrounding metropolis towns are fast growing and do not have proper disposal facilities.

The problems associated with solid waste management are a direct result of lack of waste management policy instruments and framework. Local authorities had a monopoly control over sanitation and solid waste management services in Kenya, largely under the local government act (CAP 265), and public health act (CAP 242), this was until the enactment of the Environmental Management and Coordination Act (1999). Both Acts however, neither set standards for the service nor require waste reduction or recycling. The Acts also do not classify waste into municipal, industrial, and hazardous types or allocate responsibility over each type.

The Waste to Electricity (WtE) project for Nairobi and the larger Metropolis is more than just a power production project to compliment other on-going power production plant development that have been proposed by the government of Kenya to increase the level of electric power fed into the national grid; it's also envisaged to tackle the health, sanitation and environmental issues that currently plague the waste management system in Nairobi and neighboring counties.

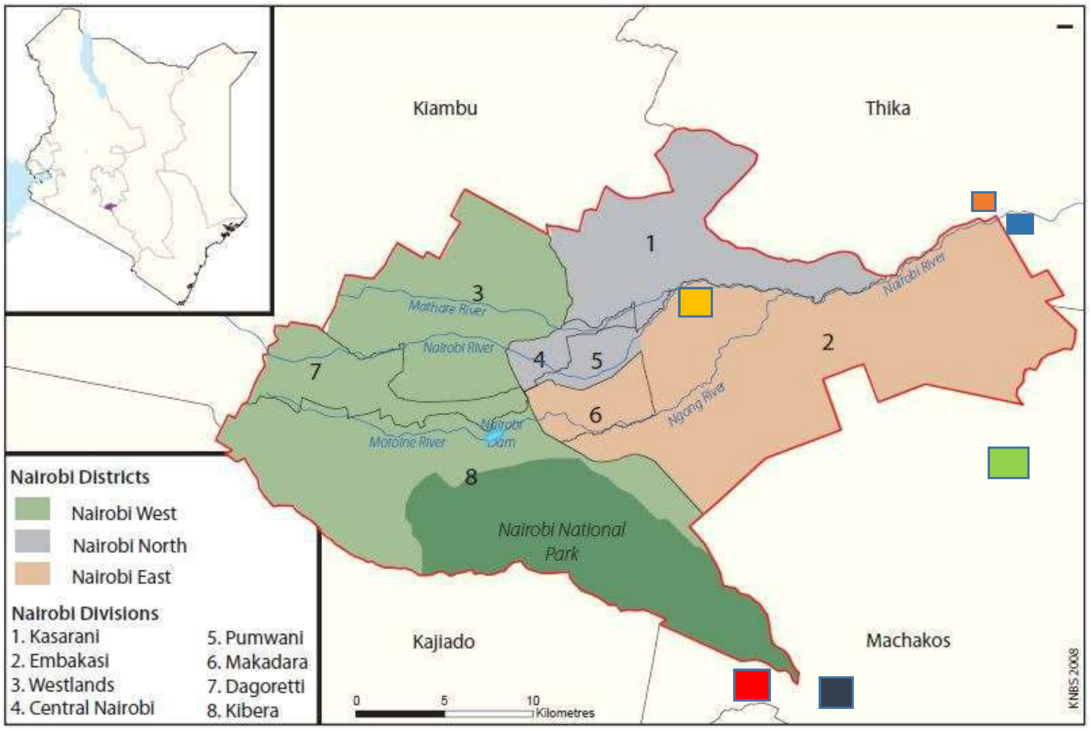
2.5. PROJECT LOCATION

The proposed project location is within a section Ruai Sewage Treatment Plant land which occupies approximately 4,000 acres. The area is 30 km east of Nairobi City Centre off Kangundo road, east of the city along eastern bypass at Ruai in Nairobi East District, Embakasi Constituency. (Figure 1).

The nearest habitat is Ruai settlement, which is at a distance of about 1.5 km from the site. Ruai STP River Bank is located far west from the Nairobi city center a considerable distance from any school, hospital, forests, cultural sites and other habitat zones. The site is free of any noxious/ pungent fumes or any waste deposits. RAP may not be required for development of the WtE plant at this site. The site is located approximately 100n meters from the Nairobi River (Perennial River) which would provide water supply to the WtE facility. In addition, the site is located within the Ruai WWTP facility which could serve as an additional source of water. Both the WWTP and the Nairobi River were observed to have moderate to low turbidity and color.

The site has access to excellent road networks. The exterior of the WWTP boundaries are connected via public roadways. In between the WWTP ponds, narrow paths are present which are used for internal movements. However, a small road construction (50-100m in length) may be required to improve the access to the sites.

The geographic location of the Project Area is presented in Figure 1 below.



Colour Code	*Site name*	*GPS Coordinates*
	Dandora Dump Site	-1.243811° N, 36.899602° E.
	Ruai STP End	-1.217428° N, 37.069816° E.
	Ruai STP River Bank	-1.206570° N, 37.062759° E.
	Near Athi river substation (Triumph power)	-1.459027° N, 36.952297° E.
	Athi river Near Gulf power plant	-1.457722° N, 37.002139° E.
	Export Processing Zone- 1 (EPZ-1)	*-1.356614° N, 37.059258° E.*

Figure 1: The geographic location of the Project Area- Nairobi's three districts and eight divisions (source: city of Nairobi Environmental Outlook- UNEP/GRID-Sioux falls.

2.6. Land Ownership

The proposed project location land Ruai STP River Bank, is currently owned by the Nairobi County Council with the land reference number LR No. 12979/1. Land is under the custody of Athi Water Works Development Agency (AWWDA). The project proponents Kengen & NMS have entered into an agreement (as attached) under the liaison of concerned ministry of Energy, Water and Lands and Physical planning for utilization by the project.

	GPS Coordinates
P1	284707.00, 9866166.20
P2	284548.78 , 9866436.21
P3	284155.55 , 9865843.21
P4	283997.39 , 9866113.11

Figure 2: Geographic Location LR No. 12979/1 of the proposed Waste to Energy Plant (source: google Maps)

The project scope are considered to be as follows:

• Construction of the Project, including site establishment, earthworks, on-site and off-site haul roads and construction of Associated Facilities, as well as construction of the WtEP itself

The establishment of waste transfer stations within the greater metropolis of Nairobi consisting of 3No counties of Kajiado, Machakos and Kiambu.

• Collecting municipal solid waste (MSW) from waste transfer stations and transporting these to the WtEP

• The component operations of the WtEP (waste receiving and storage, combustion and boiler, flue gas treatment, residue handling and energy recovery)

• Transportation of residues to landfill

• Associated Facilities, comprising Overhead Transmission Lines from electricity evacuation (OHTL).

2.7 PROJECT DESIGN AND TECHNOLOGY

The proposed WtEP development will utilize Dandora Dumpsite's existing and newly collected Municipal solid waste (MSW) from the wider Nairobi Metropolis transfer stations as a fuel feedstock for power generation through combustion and is expected to generate electricity that will be directly fed into the national power grid. The capacity of the WtEP will be 3000tonne/day and will produce up to 90 MW of electrical energy that will be fed into the national grid. It is planned that the WtEP will work 24 hours daily, and 8,000 hours annually. The remaining 760 hours per year consists of time required for maintenance and planned/unplanned shutdowns.

MSW is available to be sent to the WtEP and it is therefore anticipated that the WtEP will work at full capacity. There will be no municipal solid waste storage at the Project Site. Municipal solid waste to be delivered to the WtEP will be transported on a daily basis, with a total of 352 vehicles are expected to be used.

The waste will be combusted by grate system. Combustion technology with grate systems is a common thermal disposal method for MSW. In this method, the waste is directly combusted without pre-treatment. Semi-trailers bringing municipal solid waste to the WtEP will enter a tipping hall and deposit the waste in a bunker. There will be cranes for moving waste from the bunker to the feed port. The cranes will also create a continuous mixing process in the storage reservoirs to prevent water from leaching to the bottom and in order to produce a homogeneous waste fuel. Waste will be transferred from the waste bunker to the waste feed hopper for measurement. The hopper will be square in cross-section and designed to prevent blocking. Total waste feed will be 1,000,000 tonnes/year as per the proposed plant design capacity.

The waste will be combusted across three process lines using grate combustion. After the combustion process, gases will be directed to the waste heat boiler to produce steam. Steam at 40 bar pressure and 400°C temperature will be sent to the turbine for electricity generation. Air cooled condensers will be used for the cooling of the steam-water mixture that exits the turbines. All electricity produced at the WtEP will be exported to the national electricity grid via Dandora's 400.2 MVA, 220/132kV at a distance of 23 km away.

A Flue Gas Treatment System will be implemented. Scrubbers will be installed for SO_2 treatment, and for the removal of SO_2 in the flue gas, dry hydrated limestone and carbon will be used. For NOx removal, a Selective Non-Catalytic Reduction (SNCR) system will be used. There is the potential to convert this to a Selective Catalytic Reduction (SCR) system if required. Bag filters will be used to reduce emission of fly ash. For HCl and HF emissions, acid and alkali scrubbers will be used and Volatile Organic Compounds will be removed from flue gas by activated carbon. Dioxin and furan emissions will be controlled by maintaining the combustion temperature and adding activated carbon in the flue gas treatment system. A Continuous Emission Monitoring system will be installed to monitor all emissions. Compliance reporting from the monitoring will done on quarterly basis to oversight authority in NEMA and DOSH as required for ambient air quality.

Odor generation will only occur in the bunker area where the waste is temporarily stored. This odor will be eliminated by maintaining negative pressure by drawing in air for use as a primary air source for the combustion process. The bunker area will be covered.

Feedstock assessment report findings by the team of experts constituted as part of project feasibility studies will inform the size of the Waste to Electricity (WtE) power generating facility as the volumes of waste produced, collected and delivered to the facility from waste transfer stations by Nairobi Metropolitan Services (NMS) and similar service providers from the larger Metropolis area. As the collection and delivery services efficiency increases so shall be the amount of fuel feedstock available for the power plant power generation.

2.7.1 Technology

2.7.1.1 Hot Air Combustion System Which Achieves Low Air Ratio Combustion

The proposed waste to energy (WtE) plant shall utilize the waste collected from Nairobi city. The waste collected by Nairobi Metropolitan Services (NMS) will be feedstock for the WtE plant. Feedstock assessment report findings by the team of experts constituted as part of project feasibility studies which govern the size of the waste to energy (WtE) power generating facility. The quantity of waste received at the plant depends upon the waste collected (collection efficiency) and delivered to the facility from waste transfer stations by NMS. The plant is based on the well proven combustion technology and is expected to generate electricity that will be directly fed into the national power grid.

One para for the capacity of the plant will be added after project configuration (lab reports awaited)

- Pre-processing section

The mixed collected waste is first pre-treated prior to combustion. Pre-treatment is required mainly to remove the inert, moisture and compostable fraction from mixed waste to make the quality refuse derived fuel for combustion. Waste is tipped off in the MSW storage pit and retention of approximately 8 to 10 days is given for stabilization. During this period, leachate is seeped and collected in the leachate pit which will be treated in the dedicated leachate treatment plant. Simultaneously, the waste is mixed with help of the grab crane to make it more homogenous. After the stabilization, the dumped waste will be subjected to a screening section where unwanted metallic parts and inert shall be removed. Compostable fraction less than 25 mm shall be separated out and will be composted. Being having the high moisture the mixed waste can be further passed through the dewatering screw process where further moisture removal takes place to make the required quality fuel for the combustion. The processed waste fuel is stored in a storage pit and fed to the feed hopper via grab cranes. Odor generation will only occur in the bunker area where the waste is temporarily stored. This odor will be eliminated by maintaining negative pressure by drawing in air for use as a primary air source for the combustion process. The pre-processing section and bunker area will be enclosed.

- Incinerator section

The waste will be combusted by grate systems. Combustion technology with grate systems is a common thermal disposal method for MSW domestic waste. The waste is fed to the incinerator feed hopper through grab cranes. The feed hopper will be designed to have a waste column in the waste chute which allows a continuous feed to the grate in the combustion chamber. The operation of a movable grate is through a hydraulic system and speed is controlled/set using automatic combustion control operation. The lower part of the waste column in the feed chute is pushed to the grate by hydraulically operated ram feeders.

After the combustion process on the grate, gases will be directed to the waste heat boiler to produce steam. The furnace of the incinerator consists of water-cooled membrane wall structure that maximizes waste heat recovery. The furnace wall is lined up with highly heat resistant refractory materials. The feed water is evaporated based upon the natural circulation process. The water and steam circuit basically covers three main parts:

- Economizer
- Boiler drum and evaporator
- Super-heater

The feed water extracts heat from the flue gas in a convective path. Feed water is heated up to 10°C below the boiling point of feed water at required pressure. The economizer is located at the outlet of the furnace and multi pass for maintaining the variation of the flue gas outlet temperature of the boiler margin in the design of economizer (feed-water preheater). The feed water for economizer is diverted to a heat exchanger installed inside the steam boiler drum which leads to heating of the feed water by saturated steam or saturated water of the boiler drum. This results in an increase of the flue gas temperature at the outlet of the boiler.

The feed water is converted to steam (saturated in steam drum) in the evaporator and steam boiler drum. The evaporation takes place on the principle of natural circulation. The saturated steam is separated from the water in the boiler drum, which is located at the top of the waste heat boiler. The water from the boiler drum is sent to different water wall membranes and evaporator via down comers. The super-heaters are coil type heat exchangers which are used to convert saturated steam to superheated steam generated in the boiler. The main steam temperature is controlled by spraying the feed water in the attemperator (connecting pipes) which is installed between super heater coils. The purpose of a super heater is to raise the temperature and to cool the super heater coils.

The superheated steam temperature of 400°C is selected to limit the tube metal temperature for minimizing the harmful effect of chlorine in fuel. At the bottom of the grate, combustion air is supplied for drying and combustion purposes. The combustion air system can be divided into two streams, primary air and secondary air.

- **Primary air system:**

Primary combustion air is sucked from the upper part from MSW/refuse pit to minimize the odorous air, and supplied to the bottom of the grate via primary air fan maintaining required pressure into the furnace. Primary air is preheated up to required temperature by steam coil air primary pre-heater. The air distribution is split into sections for uniform distribution of combustion air on the grate. The amount of air supplied to each section is adjusted and set individually using automatic combustion control.

- **Secondary air system:**

Secondary air is puffed inside the furnace through the secondary air nozzles mounted on the furnace wall. It also protects the furnace from inside against the abnormal high temperature. Secondary air volume requirement inside the furnace is determined by the oxygen content at the economizer outlet and based on the actual temperature measured at furnace walls. Secondary air is preheated to prevent excessive temperature reduction of the furnace inside and to supply the additional combustion air into the furnace. The process is also controlled in a way that legal requirements say residence time, oxygen content and temperature of the flue gas at minimum 850℃ with residence time more than 2 seconds.

- **Flue gas cleaning system**

Combustion of this waste fuels results in generation of a mixture of gases termed as flue gas consisting of water vapor, carbon dioxide and excess air which includes acid gases like HCL, HF, HI, SO_2, NO, organic substances, heavy metals and fly ash particles. The dioxin and furans are formed by burning chlorine-based chemical compounds with hydrocarbons. A dedicated flue gas treatment system will be implemented. Scrubbers will be installed for SO_2 treatment, and for the removal of SO_2 in the flue gas, dry hydrated limestone and carbon will be used. For NOx removal, a selective non-catalytic reduction (SNCR) system will be used. Bag filters will be used to reduce emission of fly ash. For HCl and HF emissions, acid and alkali scrubbers will be used and volatile Organic compounds will be removed from flue gas by activated carbon. Dioxin and furan emissions will be controlled by maintaining the combustion temperature and adding activated carbon in the flue gas treatment system. A continuous emission monitoring system will be installed to monitor all emissions. Compliance reporting from the monitoring will be done on a quarterly basis to oversight authority in NEMA and DOSH as required for ambient air quality.

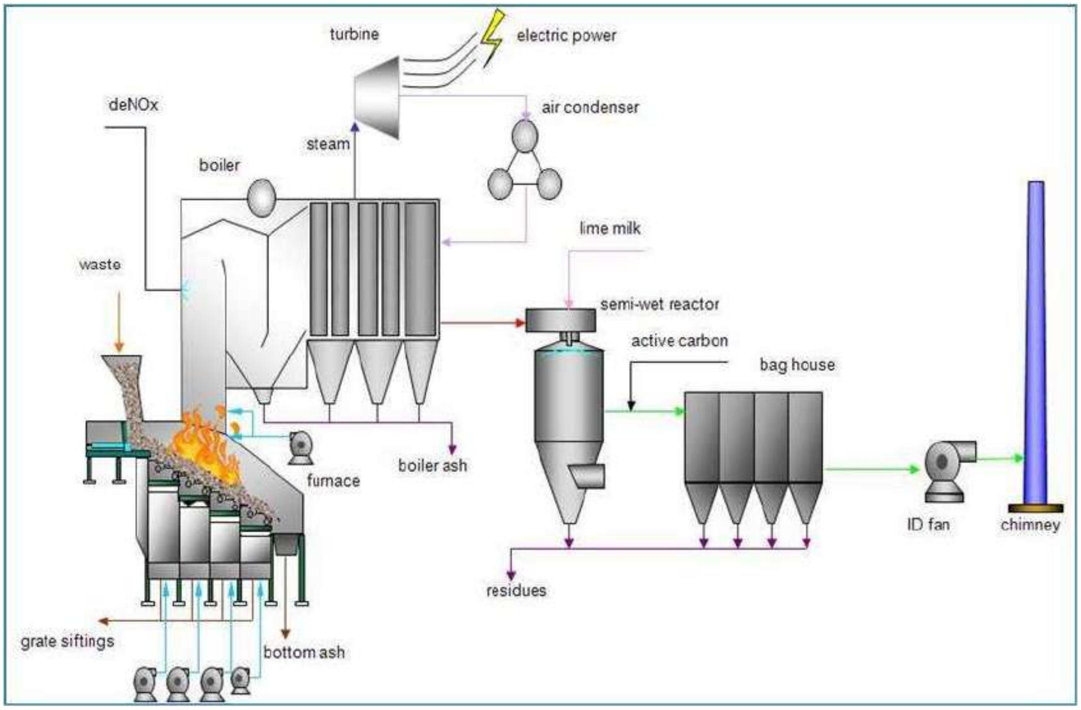


Figure 3: Typical incineration line

Flue gas passed through the bag filter is sent through the stack (chimney) by the induced draft fan and discharged outside the system.

- **Ash handling system**

After thermal processing, approximately 10-20% (by weight) of the waste remains from municipal solid waste incineration as bottom ash and fly ash as byproducts. Bottom ash is mainly made up of all the unburnt fractions of the waste, which are found at the furnace exit in the form of solid products with a grey appearance. Fly ash includes boiler ash, fly ash from flue gas filtration, calcium or sodium residues from flue gas treatment, filter cakes from flue gas cleaning.

The bottom ash is typically classified as non-hazardous waste, the pre-treatment of this ash follows the steps like screening, metal recovery, maturation and valorization. After the pre-treatment it can be disposed of in inert waste landfill as well as used in foundation material in road construction or in brick making. Fly ash contained toxic elements. According to Fabricius and al. (2020) and Quina et al. (2008) , the main chemical elements in fly ash come from non-recyclable waste incinerators are Pb, S, K, Hg, Zn, Cd, Cr, Ni, Na and Ca. Therefore, fly ashes are usually classified as hazardous waste. The treatment of fly ash follows the following steps such as recovery which includes metal recovery and salt recovery, stabilization through lime and solidification. Fly ash considered as hazardous waste should be located on stable land that can support the weight of the landfill over an extended period, with a preference for low permeability soil which must be fully isolated from natural hydrology.

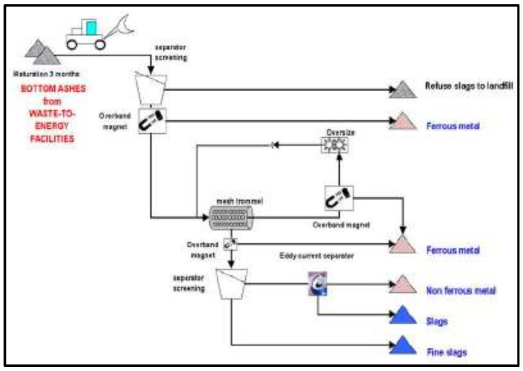


Figure 4: Bottom ash pre-treatment diagram

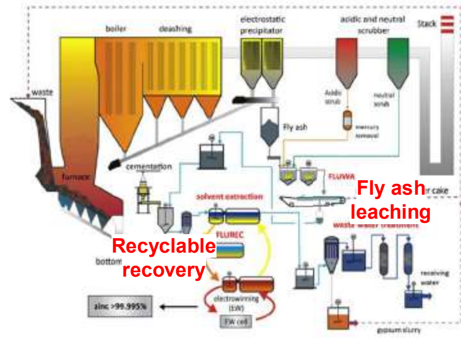


Figure 5: General process of metal separation from fly ash

- **Steam turbine section**

Steam at 40 bar pressure and 400°C temperature will be sent to the turbine for electricity generation. The steam is generally extracted from a point where parameters required for the air pre-heater and the deaerator are met, while the leftover steam goes to the exhaust stage where it passes on to the condensing system. The drains at each point are collected in a common header and finally to the vessel depending on the location of the outlet and the pressure at which it is extracted. The steam turbo-generator comprises a steam turbine, gear box, generator, condensing system, lube-oil system, electrical items and its accessories.

- **Steam condensate system**

Air cooled condensers will be used for the cooling of the steam-water mixture that exits the turbines. An air cooled exchanger is used to cool the steam exhaust of the turbine with ambient air. The basic components are tube bundles served by axial flow fans, fan drives, speed reducers, and an enclosure with supporting structure. Air cooled exchangers are classed as forced draft when the tube bundle is located on the discharge side of the fan, and as induced draft when the tube bundle is located on the suction side of the fan. The heat transfer device is the tube bundle which is an assembly of side frames, tube supports, headers and fin tubes. Fins are normally used with the tubes to provide an extended surface on the air side, in order to compensate for the relatively low heat transfer coefficient of the air to the tube.

- **Leachate treatment system**

The leachate generated during stabilization and pre-processing processes is characterized by high chemical and biological oxygen demand (COD, BOD) and often consists of high concentrations of organic contaminants, heavy metals, toxic materials, ammonia and inorganic materials as well as refractory compounds. There are many different methods currently being used to treat the leachate. Most of these methods are adapted for wastewater treatment processing and Out of the many methods, some of them have been listed below:

- Biological treatment processes: aerated lagoon, membrane bioreactor, etc.

- Chemical treatment processes: oxidation with ozone, UV, hydrogen peroxide, …
- Physico-chemical treatment processes: coagulation, flocculation, precipitation, activated carbon, etc.
- Membrane treatment processes: reverse osmosis, Nano filtration, etc.

Biological processes methods include the activated sludge process (ASP), sequencing batch reactors (SBR), membrane bioreactors (MBR), aerobic lagoons and constructed wetlands. Some of the techniques used for treatment are recirculation, activated sludge, trickling filters, stabilization ponds and sequencing batch reactors. Physicochemical treatment processes which use some of the techniques which are filtration, activated carbon adsorption, coagulation/flocculation, air stripping. The combination of physical-chemical and biological processes gives the best results in terms of pollutants removal. So it is preferred to implement a hybrid process involving both biological and physicochemical methods for leachate treatment.

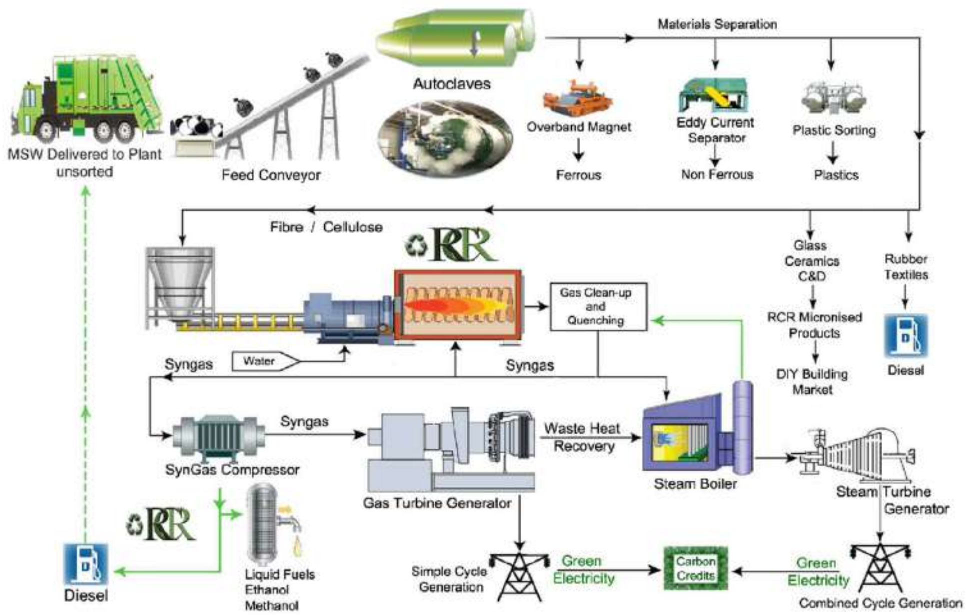


Figure 6: Summary of schematic process flow of the W-t-E power plant activities.

2.1.1. Name of Project

Establishment of a Waste to Energy Power Plant in Nairobi City County.

2.1.2. Project Proponent

The project proponent is Kenya Electricity Generating Company PLC (KenGen) in Partnership with the Nairobi Metropolitan Services (NMS)

2.1.3. Objective of the Project

The proposed project has the overall objective of contributing to increased renewable energy use pledged to stimulate economic growth and accelerate job creation to improve the economic wellbeing of its shareholders' earnings through reduction of electricity cost by ensuring availability, reliability and efficiency of power supply by utilizing Dandora Dumpsite's Municipal solid waste

(MSW) as a fuel feedstock for power generation and in the process attain waste management controls over the environmental hazard that is Dandora Landfill and reclaim and rehabilitate the land for other sustainable uses such as a nature park in the bid to mitigate the environmental and health risks associated with the dumpsite.

In summary, Reclamation and Restoration of Dandora Dumpsite by the construction of the Municipal waste to energy power plant facility in Nairobi City is to mitigate the environmental pollution occurring due to the waste disposal problem while resolving the problem of waste processing by introducing a waste to energy plant is an effective resolution to the problem that will reduce volume of waste.

2.1.4. Major Activities of the Project

Project Life-cycle and phases

Pre-Construction/ Project Planning Phase

Consists of all the planning, feasibility studies, Environmental and Social Impact Assessments, permits and license applications, establishment of a management team to oversee the project phases, financial budgets and expenditure forecasts.

Other issues that must be handled in this phase include the drawing of contractual agreements such as; power purchase agreements (PPAs), Memorandum of understanding (MOUs) between departments, Terms of Reference for service providers, land lease agreements, Dandora Dumpsite Decommissioning by relocating all waste disposal to the new power plant for power generation.

Construction Phase

A range of civil, structural and mechanical/electrical engineering activities will take place. These includes:

clearing the lands ready for construction works

- Foundation works;
- Drainage works;
- Construction of internal roads, hard standings etc;
- Erection of fences;
- Landscaping works;
- Construction of floors and bases;
- Erection of buildings;
- Installation of utility and telecommunication services;
- Installation of waste processing equipment;
- Installation of weighbridge;
- Installation of ancillary equipment;
- Installation of power generation equipment; and
- Construction of chimneys.

Operation Phase

During the operational phase the activities will relate to the receipt and processing of waste to reduce mass and volume and the production of energy. These include:

activities.

- Vehicle movements into and out of the facility;
- Reception of waste;
- Drying of waste;
- Extraction of recyclable materials;
- Separation of organic fraction;
- Combustion of dried waste;
- Anaerobic composting of organic fraction;
- Production of energy from incineration of dried waste;
- Production and combustion of bio-gas from anaerobic composting to produce energy;
- Treatment of gases from incineration of dried waste;
- Disposal of bottom and fly ash from incineration of dried waste;
- Disposal of process waters;
- Disposal of contrary material unsuitable for processing;
- Sale and transfer of extracted recyclable materials; and
- Maintenance activities.

Decommissioning Phase

During the decommissioning phase the activities will relate to shut-down and, possible, removal of the waste processing equipment and associated buildings. These include:

- Shut-down and mothballing of energy generating plant;
- Shut-down and mothballing of waste processing equipment;
- Remediation works;
- Removal of plant and equipment;
- Demolition of buildings; and
- Restoration and landscaping works.

2.1.5. EIA Consultant

Licensed NEMA consultant, Geoffrey Nagillah Makanga and Ibrahim Adan (EIA / EA Expert Reg. No. 2330 and 1608) is working with a team of experts with a proven track record of excellence focusing mainly on environmental management and physical planning. The team has undertaken numerous development projects since its inception for individual as well as corporate local and international clients, providing top-quality environmental impact assessments and environmental management plans.

2.2. Scope of Work

The Environmental Impact Assessment will include but not necessarily be limited to:

1. Project Description-technology, components & Processes involved, Ownership, its purpose, justification-benefits, Capacity and Overall Budget.
2. Project Environment & Social Baseline data- gathering tools and processes appropriate for the selected site.

3. Applicable relevant Policies, Legislative & regulatory frameworks, local & International performance standards and best practice guidelines for the proposed project.
4. Analysis of project Alternatives- No alternative (status Quo), Alternative site, Alternative Design and or Technology.
5. Public participation-approach and methodology
6. Environmental & Social Impacts assessments and mitigation measures- Assessment, identification, classification criteria, analysis process and mitigation measures.
7. Environmental and social management plan (ESMP)-Purpose and objectives, impacts and mitigation Guidelines, roles & responsibilities, monitoring frequencies, associated cost budgets.
8. Environmental and social Monitoring Plan (ESMP)- monitoring indicators, compliance and effects of monitoring.
9. Conclusions and Recommendations associated with the proposed project implementation in compliance with all the relevant legislation and planning requirements of Kenya at all times and that all suggested mitigation measures in the ESMP be implemented during the entire project cycle.

To ensure that a thorough environmental impact assessment is carried out, the following tasks are necessary:

2.3. Context, Components and Activities of the Project

To provide a comprehensive description of the project and the surrounding environment specifying any information necessary to identify and assess the environmental effects of the project. This includes project objectives and information on, rationale for the project and background, the nature, location/existing setting, timing, duration, frequency, general layout including relocation of people and any additional impacts on the surroundings communities, pre-construction activities, construction methods, works and duration, and post construction plans.

A description of raw material inputs, technology and processes to be used as well as products and by-products generated, should be provided. Note areas to be reserved for construction and areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment. The EIA study shall include an assessment of the context, components and activities of the project.

This includes among others:

- *Context*: Description and assessment of the *location* of the land, the *land use characteristics*, including the planned use of the land and description of the existing land use and their patterns within 2-km radius from the boundary of the Project Area and *project characteristic*
- *Activities*: Description and assessment of the specific phases and activities; including timing and location, for:

a) *Pre-construction (planning) phase* (Plan preparation and seeking of the appropriate approvals from the relevant authorities, baseline condition appraisal),
b) *Construction phase* (base camp establishment, site clearance, acquisition and transportation of building materials, construction of the power plant);

c) *Occupation phase* (running and managing the facility as per the laid down rules and procedures; and
d) Decommissioning /abandonment phase (demolition of facility).

CHAPTER 3: PROJECT ENVIRONMENT

This section describes the baseline conditions in the study area and provides summarized information on the physical, biological and socio-economic environment. The purpose of this chapter is to facilitate the evaluation of impacts assessed in the following stage.

The following sites have been visited for selection of the most suitable project location however, the selection criteria involve official clearance and approval by the KCAA/KAA with respect to the flight paths etc.

3.1 DESCRIPTION OF THE ENVIRONMENT/BASELINE STUDIES DATA COLLECTION AND INTERPRETATION

Climate

Climate in Nairobi is tropical. The rainfall is bimodal with long rains occurring between March and May while the short rains are in August to November. The rainfall ranges between 750mm to 1500 mm, with a mean annual rainfall of 1750mm. The temperature varies from 17^{0}C to 27^{0}C. June and July are the months with lowest temperature while the hottest months are January, September with temperatures from 25^{0}C to 27^{0}C.

Relief, Soil and Drainage in the Area

The area is drained by Athi River and its tributaries which flow north eastwards and eastwards. Athi River which drains this area has several seasonal tributaries which have water during the rain seasons and immediately after, otherwise they are normally dry most part of the year. The geology of the area mainly comprises Nairobi volcanic covered by black cotton clay soils. The area is generally flat with Nairobi River forming the north Eastern boundary of the land

Economic Activity

Ruai area is part of the extensive savanna land, with mainly short grass and scattered drought tolerant trees, due to limited rains. The population of the area has shot up drastically because of the opening of the Eastern by-pass, thereby having residential buildings nearly on all sides of the project area. It is only along the Nairobi River (near the final effluent outlet) and eastern side where individual houses are far from the treatment plant. The land surrounding the treatment plant is heavily under cultivation for food crops. Some of the farmers use the wastewater for irrigation. There are cows, goats and sheep grazed nearby the treatment plant which belongs to the residents and visiting (nomadic) Maasai.

Population in the Area

The area is moderately populated and the trends indicate a high population growth rate. The constituency has a total population of 925,775 with 468,097 males and 457,678 females. It has a total of 296,942 households.

Description and assessment of the location of the land, the land use characteristics, including the planned use of the land and description of the existing land use and their patterns within 2-km radius from the boundary of the Project area and project characteristic. The environmental and socio-economic baseline is intended to provide a measure of the existing environmental and socio-economic situation against which future changes due to the projects can be monitored. The aim of this study is to collect information at household level, community level and from stakeholders for the purposes of Socio economic survey and collection of Baseline information for the proposed WtE project. Baseline is important to give an overall evaluation of the existing environmental conditions, including a historical meteorological evaluation to include but not be limited to characteristics and analysis, values and functions of the area, as follows:

i.) Physical environment

ii.) Biological environment

iii.) socio-economic and cultural constraints

The methodologies employed to obtain baseline and other data to be clearly detailed. Baseline data included but not limited to:

Physical

a) A description of the existing soil and geology, landscape, aesthetic values and hydrology. Special emphasis should be placed on storm water run-off, leachate and drainage patterns. Any slope stability issues that could arise should be thoroughly explored.
b) Water quality of the existing river, site ponds, any streams in the vicinity of the development.
c) Terrestrial ecosystem, including but not limited to any wetlands and other ecologically sensitive areas with indication of their function and value in the project area.
d) Noise levels of undeveloped site and the ambient noise in the area of influence
e) Obvious sources of existing pollution and extent of contamination
f) Availability of solid waste management facilities.

Biological

Present a detailed description of the flora and fauna (terrestrial and aquatic if applicable) of the area, with special emphasis on rare, threatened, endemic, protected and endangered species. Migratory species, wild food crop plants and presence of invasive alien species should also be considered.

Socio-Economic & Cultural

Present and proposed land use; transportation of heavy equipment, road widening and associated traffic considerations particularly in the construction phase of the project, planned development activities; issues relating to squatters and relocation; public health and safety. The historical importance (heritage, archaeological sites and feature) and other material assets of the area should also be examined. While this analysis is being conducted, it is expected that an assessment of public perception of the proposed development be conducted. This assessment may vary with community structure and may take multiple forms such as public meetings and/or questionnaires/surveys.

Methodology for Socio-economic Baseline Survey.

a) Secondary Data Collection and Stakeholders Consultation:

The study shall begin by carrying out a desk study to comprehensively review both secondary data, planning and development reports on the proposed site at Ruai waste water treatment site. The team will undertake a thorough desk review of all the relevant documents, policies, strategies and other related sector documents with an objective of having a clear background understanding of the assignment. Secondary data will also be collected during the desk review. Meetings and visits will be arranged and conducted with relevant offices of the waste management departments of NMS, Public Health Offices Statistics, Department of Social Services, Youths department, County Commission offices.

b) Primary Data Collection and Community Meetings

A Participatory approach will be adopted for collecting primary data, and this requires development of the data collection tools. The tools used for primary data collection will be both qualitative and quantitative tools designed to capture the status of the households before the interventions. Questionnaires will be utilized in collecting quantitative data from target respondents. Key Informant guides, Focused Group Discussions FGD guide and an observation checklist will be utilized in collecting qualitative information from purposively and randomly selected respondents in each of the project sites.

With the support of the NMS and local administrative leaders' community meetings will be organized. The community sensitization meetings/barazas are organized by the local County administration officials in order to initiate community dialogue. Further informal discussions will be held with community members during the FGD.

c) Sampling Framework for the Survey

In Sampling we are proposing to use the following methods:

- ✔ Purposeful/ convenience sampling - The sample will be picked from all the lowest administrative units which may be in the Estate /sub location in the Ruai target area in order to have representatives drawn from the whole project area.
- ✔ Random sampling - To access the members of the community we shall use a simple random sampling method after obtaining the relevant information at the literature review stage. Random and convenient sampling will be used when conducting the interviews.

d) Data Evaluation

Specific Evaluation Methods for data collection to be used are as outlined below: -

- ✔ Structured interviews

a. Structure interviews will be used to collect data from Households

- ✔ Semi structured Interviews

a. Semi structured interviews will be used with key informants and focused group discussions.

b. Key informant include Water departments, Public Health Offices Statistics, Department of Social Services, Youths department

c. FGDs will be organized for various target groups like men, women, youths and people with disabilities drawn from project areas.

The following key informants will be approached to provide relevant socio-economic information for the project areas. The corresponding survey tools/ questionnaires are listed below:

- ✔ Individual households (Individual Interview questionnaire)
- ✔ Local administrator (Chief)
- ✔ Sub- county education officer
- ✔ Sub-county/ Environmental officer

- ✔ Sub-county/ health officer.

e) Triangulation and Validation of Data

All data collected will be collected and cleaned ready for analysis. It will be triangulated for accuracy of facts. Appropriate software will be used to analyze the data, from which a report will be written.

- ✔ Observations - Non-obtrusive observations will be used together with the other methods to validate information collected. The data collectors will note down key factors observed.

f) The Survey Process

The following process will be adopted by the survey:

	Activity
1	Literature Review
2	Develop and Review Tools
3	Recruit and train the survey team
4	Field work/ pre-test the tools ● Household Interview ● Key informants' interviews ● Observations ● Focused Group Discussions
5	Data Analysis, Collation and Report Writing
6	Final Reports Presentation

Table 1: ESIA Study Project Activities

3.2 Policy, Legislative and Regulatory Considerations

Outline the pertinent regulations and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. The Framework will identify and describe how and to what extent applicable laws, regulations and standards apply to the Project.

We will also review and describe the pertinent policies, regulations, and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, siting, land use control, land acquisition, rights to land, compensation, resettlement, etc.

The Final EIA reports for each of the projects will ensure compliance with Environmental Management and Coordination Act, 2015 and the environmental (Impact assessment and Audit) regulations, 2003 on presentation and submission to NEMA, Kenya. As per the regulation, we shall submit 12 copies of the EIA report to the authority for approval. The approval procedure is illustrated in the Impact Assessment and Audit regulation of 2003 under sections 19-23 which we intend to follow diligently.

3.3 Identification and Assessment/Analysis of Potential Impacts

Examine and identify the major potential environmental and public health issues of concern and indicate their relative importance to the development project. These should include the occupational exposure, health and safety measures and population exposure in the appropriate study area(s) and changes and or enhancement in emergency response plan. Identify potential impacts as they relate to, (but are not restricted by) the following:

- ✔ Landscape impacts of landfill rehabilitation, excavation and construction

- ✔ loss of and damage to geological and paleontological features
- ✔ habitat loss and/or fragmentation
- ✔ pollution of potable, surface or groundwater
- ✔ air pollution
- ✔ socio-economic and cultural impacts
- ✔ landscape, architecture and archaeology of the site
- ✔ risk assessment
- ✔ noise and vibration
- ✔ solid waste disposal
- ✔ water and soil pollution
- ✔ change in land use
- ✔ visual impacts – aesthetics
- ✔ impact on traffic and the transportation of heavy equipment to the site

Distinguish between significant positive and negative impacts, direct and indirect, long term and immediate impacts to include discussion on site restoration and residual impacts and the proposed mitigation measures. Identify avoidable as well as irreversible impacts. Cumulative impacts of this and other proposed and/or existing developments will be explored.

Characterize the extent and quality of the available data, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies, which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts will be represented in matrix form.

The entire impact assessment process is divided into parts:

1) Identification and assessment of the nature, extent and duration of impacts (before mitigation). The potential impacts will be identified and analyzed from the application of standardized international best practice methods of environmental impact assessment. Some of these methods of impact assessment may include:

- ✔ Ad-hoc methods
- ✔ Application of expert judgment
- ✔ Interaction matrices
- ✔ Systematic and sequential approaches
- ✔ Spatial analysis methods (including GIS)

In addition to these methods, potential impacts will be assessed by drawing from the experiences and opinions of local people, important stakeholders such as Government agencies and through the review of environmental literature and data collected that is relevant to the Project area.

2) After identification of potential impacts, the significance of the impact will be assessed through consideration of:

- ✔ Spatial scale of the impact (site, local, regional);

- ✔ The duration of impacts (short, medium, long term);
- ✔ Magnitude of the impact (small, moderate, large);
- ✔ Whether impacts are temporary or permanent;
- ✔ Baseline environmental and social environments;
- ✔ Legislative and policy implications.

3) An assessment of the likelihood that a particular impact will occur and the severity of the consequences if it were to occur.

Where significant project impacts on critical cultural heritage are unavoidable, we, assisted by the Client, will seek to obtain the Free, Prior and Informed Consent (FPIC) of the Affected Communities.

The Projects are however unlikely to cause temporary and permanent replacement of households.

The project will mainly have positive impacts while mitigation measures will be proposed and designed for the anticipated negative impacts.

The positive impacts are both short term and long term and include the following:

Long term positive Impacts

i. Creation of job opportunities in the facility

ii. Improved health of the population living around the Dandora dumpsite through reduced cases of respiratory and water borne diseases

iii. Improved water quality in Nairobi river and other surface streams

iv. Improved solid waste management for Nairobi County and its environs

v. Improved aesthetic value of Dandora area due to waste relocation to be used in power generation.

vi. Reduced pollution to downstream ecosystems

vii. Reduced health hazards to downstream communities in Athi catchment

viii. Demonstration (model process) for commissioning of similar sites in other counties in the country

ix. Creation of job opportunities during implementation and operational phases

x. Improved physical infrastructure in the project area in Ruai

xi. Improved security for Dandora and its surroundings

xii. Reduced pollution on the cultivation of food crops in the riverine area irrigated with effluent from dumpsite into Nairobi river

xiii. Creation of conducive living and learning environment and habitation of neighboring schools, churches and communities

xiv. Reduced scavengers' in Dandora area

xv. Increase in the power fed to the national grid

Short- term positive Impacts

i. Expand opportunities for small scale businesses in the area

ii. Creation of job opportunities during construction and implementation phases.

The negative impacts are both short and long term

Long term Negative Impacts

i. Loss of dumpsite linked livelihood

ii. Emission of gases

iii. Contamination of surface and ground water by leachates

iv. Disruption of social networks

Short term Negative Impacts

i. Disruption of socio economic activities if any in Ruai site area

ii. Destabilization of bird community at the site

iii. Influx of heavy trucks and machinery in the area disrupting traffic flow in Ruai

iv. Loss of vegetation established in the area for the waste to energy power plant

v. Soil erosion in exposed and destabilized slopes

vi. Atmospheric pollution by dust particles and greenhouse gases

vii. Elevated noise and vibrations in the project environment

viii. Temporary influx of people in the area from outside environs

3.4 PROJECT ALTERNATIVES

The objective of alternative analysis will be to define the merits and demerits of realistic alternatives, thereby providing decision makers and the public with a clear basis for choosing between options. We will systematically compare feasible alternatives for the proposed project, technology, design, and operation-including the "without project" situation--in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. Assessment will occur in parallel with development of the designs, to allow maximum exchange between the Environmental expert and the design engineers.

For each of the alternatives, the analysis shall quantify the environmental costs and benefits to the extent possible, and attach economic values where feasible.

This will include analysis of

(i) costs and benefits of environmental impacts;

(ii) costs, benefits, and cost-effectiveness of mitigation measures; and

(iii) discussion of impacts that have not been expressed in monetary values, in quantitative terms where possible.

We will examine following alternatives to the extent possible with the available data, and compare with the proposed project in terms of potential environmental impacts, possible mitigation measures, cost, suitability etc.:

- without a project situation.
- alternative designs.
- alternative sites

Under this task, an analysis of alternatives will be carried out in reasonable detail to enable the decision makers to determine the preferred option. Alternatives will be compared in terms of potential environmental impacts, costs, suitability under local conditions, institutional, training and monitoring requirements. When describing the impacts, we will differentiate between irreversible or unavoidable impacts and which can be mitigated. To the extent possible, quantification of the costs and benefits of each alternative will be made, including the estimated costs of any associated mitigating measures.

3.5 PUBLIC PARTICIPATION/CONSULTATION PROGRAMME

Objective of Task: The objective of this task is to hold structured and comprehensive consultations with Interested and Affected Parties (IAPs) likely to be impacted by the project. Initial desk top study will be undertaken to identify stakeholders affected and interested in the project and perform a SWOT analysis of the identified groups. This analysis shall be based on the power/interest grid as depicted below. The scope of public participation in the project shall involve informing, consultation, comments in project reports and co-management or self-management depending on how the stakeholders agree on project ownership.

Stakeholder participation is done to: assess their views and perceptions on the potential impacts of the project as well as inform and educate stakeholders about the proposed Waste to Energy Plant and its consequences. The involvement of the public and relevant authorities is an integral part of the project management ideals because public input helps to ensure that important social and environmental issues are not overlooked.

The Consultant will undertake stakeholder consultation forums to discuss the design details and obtain their views and opinions on the same, At least ***three (3) consultative meeting*** *will be held,* ***(In compliance with the prevailing MOH covid-9 pandemic protocols and Management regulations necessary to contain the spreading.)*** *in which we will need proponent's representation.*

Methodology: The Consultant will identify the level and type of participation that is most effective to enable identified stakeholders to engage in the process at a level that is suited to their needs and resources.

Sub-tasks: In order to accomplish this task, the Consultant will:

a) Develop a suitable programme for carrying out the public consultation;
b) Develop suitable questionnaires or other information-gathering tools prior to the public consultation; these questionnaires will be approved by the project proponent prior to their use ensuring quality control and relevancy.
c) Hold 3No. consultations with the relevant IAPs and stakeholders through public meetings organized in Ruai site.
d) Document a summary of the views of the public.

Figure 7: Stakeholder Analysis Power/Interest Grid

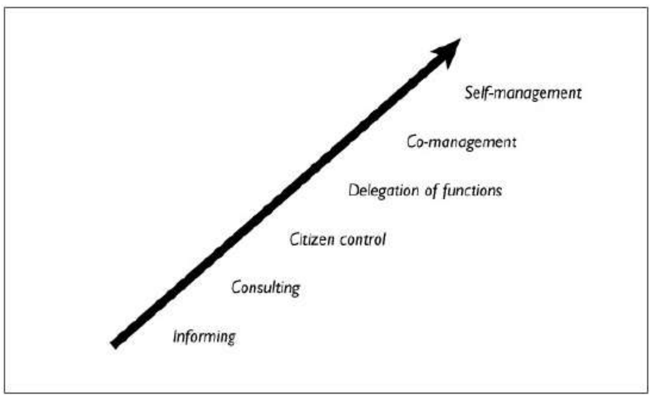


Figure 8: Public Participation Scope of the Project

Therefore, public participation for the project will achieve the following aspects;

- ✔ Document the public participation programme for the project.
- ✔ Describe the public participation methods, timing, type of information to be provided to the public, and stakeholder target groups.
- ✔ Summarize the issues identified during the public participation process
- ✔ Discuss public input that has been incorporated into the proposed project design; and environmental management systems.

3.6 Mitigation & Emergency Preparedness and Response

Prepare guidelines for avoiding or reducing (e.g. restoration and rehabilitation), as far as possible, any adverse impacts due to proposed usage of the site and utilizing existing environmental attributes for optimum development. The potential impacts in the area should be addressed. Quantify and assign financial and economic values to mitigating methods. Indicate the emergency preparedness and response plans for dealing with risks and hazards identified as above. Identify, assess and recommend appropriate and practical mitigation measures to remove or minimize the adverse environmental impacts identified. Identify, assess and recommend impact monitoring programs and compliance auditing programs.

The extent to which the different mitigation measures will reduce the scale of impacts arising from the project will be evaluated, and unavoidable residual impacts identified.

A range of mitigation options will be proposed for implementation during the planning and design process, taking into consideration:

- ✔ Concerns and suggestions raised during the community consultation process.
- ✔ Baseline biophysical and socio-economic conditions.
- ✔ Identified environmental and social constraints.
- ✔ Potential benefits to the local community.
- ✔ Any impacts associated with the implementation or operation of proposed mitigation measures.
- ✔ Development of an Environmental and Social Monitoring and Management Plan (ESMP).

After completion of the EIA study, the E.I.A consultant shall prepare a comprehensive report and undertake a presentation of the EIA report to NEMA.

3.7 Design of Monitoring and Evaluation Plans and the ESMP

The Environmental and Social Management and Monitoring Plan (ESMP) will be the most important output from the ESIA process. The ESMP is the synthesis of all proposed mitigation and monitoring actions, set to a timeline with specific responsibility assigned and follow-up actions defined. It will address issues related both to the construction and operation phases of the project.

Our Environmental expert will undertake a review to ensure that the following are addressed in the ESMP:

The Environmental and Social Management Plan (ESMP) includes, as appropriate:

- ✔ Current environmental and social issues and parameters to be mitigated;
- ✔ Mitigation measures;
- ✔ Countermeasures;
- ✔ Lines of responsibility;
- ✔ Cost of undertaking the environmental and social mitigation measures;
- ✔ Time frame in which these mitigation measures will be handled.

The Environmental and Social Monitoring Plan (ESMP) includes, as appropriate:

- ✔ Clearly defined measurable environmental indicators;
- ✔ A sampling design (frequency, intensity) sufficient to provide the information necessary to answer questions;
- ✔ Analytical system quality assurance and quality controls are effective
- ✔ Information for reporting monitoring results in place;
- ✔ A clear description of responsibility and designation within the management plan;
- ✔ Draw up of a time and task-based implementation schedule, in tabular form.

The ESMP will be divided into two broad components, one dealing with the natural environment and the other with the social environment. The social component will address resettlement and economic impacts, and will be prepared as a stand-alone document. It is known as a Resettlement Action Plan or a Resettlement and Rehabilitation Action Plan (RAP).

We will include specific clauses in our report to ensure that environmental mitigation measures are implemented correctly. We will endeavor to allocate responsibility for undertaking monitoring, as well as the reporting procedure, in the ESMP section of the environmental impact statement.

3.8 Resettlement Action Plan

The objective of the RAP is to determine the number of persons living or operating along the proposed alignment. Specific objectives of this RAP include:

- ✔ Development of the list of the affected persons in order to determine those likely to be adversely affected by the project works, the severity and extent of the impacts. An assessment of the impacts on their assets, infrastructure, and livelihoods within the project areas will be made including their income and assets survey.
- ✔ Development of the list of the poor and vulnerable groups so as to develop strategy to ensure that they proactively benefit from the project.
- ✔ Adequately consult and actively involve all the stakeholders
- ✔ Review the legal and other institutional frameworks governing resettlement as outlined in the African Development Bank policies and Kenyan law
- ✔ Develop mitigation measures in consultation with the affected people.
- ✔ Prepare detailed entitlement matrix and an implementation plan,
- ✔ Prepare an estimate resettlement budget,
- ✔ Put in place a Monitoring and Evaluation and reporting system for the Resettlement Plan.

The RAP study will commence with the review of available literature concerning similar studies and a reconnaissance visit to the proposed sites. RAP considerations as well as ESIA parameters will play a major role in the Project works.

In addition, literature review will be undertaken to provide background information as well as an overview of the guidelines, manuals, practices, policy, legal and institutional framework for the proposed Project at both local and international level. These will include but may not be limited to;

- ✔ The constitution of Kenya.
- ✔ The national land policy.
- ✔ World bank safeguard policy documents.
- ✔ Kenya resettlement policy documents.
- ✔ Social protection policy documents.

Baseline data for the proposed project will be collected and reviewed with the aim of understanding the household and community characteristics of the PAPs. Based on the baseline data, the social-economic setting of the entire Project will be established. Such baseline data will include but not necessarily limited to the following:

- ✔ Demography.
- ✔ Socio-economic activities.
- ✔ Cultural issues.

- ✔ Communal property.
- ✔ Administrative boundaries.
- ✔ Government and public assets.
- ✔ Main physical features.
- ✔ Gender and vulnerability issues.
- ✔ Land ownership.
- ✔ Area of affected land and related land-use.
- ✔ Area of affected buildings and other fixed-assets.

Desktop research will be used to obtain information on RAP processes and social settings of the investigated area. Appropriate field kits and tools including questionnaires, data collection forms etc. will be developed.

We shall carry out a detailed inventory of project-affected persons and prepare an entitlement matrix.

Sub Task

Carry out census	This will involve a comprehensive PAP socio-economic survey carried out in tandem with the land/property assessments, so that as soon as an affected property is identified by the surveyors, the enumerators are able to conduct the socio-economic survey on that household. The findings will be presented as a socio-economic profile of the PAP within the project area. It will involve interviews of each of the PAP households, Consultations with the Public and Local Authorities and Participation of the PAPs in group discussions.
Valuing Affected Asset	The valuation process for compulsory acquisition is guided by Land Act, 2012 part VIII that deals with compulsory acquisition of interest in land when it is required for public purposes or in the public interest. Attention in determining the value for compensation includes carrying out surveys to establish which properties (land and buildings, businesses, trees and crops) lie within the zone affected by the sewerage project. The exact number of PAPs affected and the types of properties affected will be determined. In order to complete the RAP, field survey is a necessity to gather the information on any aspects that may influence land prices and property values. The compensation matrix and cut off dates shall be established.
Budget	We will prepare a detailed entitlement matrix for each PAP. The entitlement matrix will present the types of losses and the forms and amounts of compensation actions that will be taken for each type of loss.
Prepare RAP -Scope of RAP	The scope of the RAP is to ensure that Policy on Involuntary Displacement is adhered to. The Policy requires that if more than 200 persons are negatively affected through involuntary displacement by implementation of a project funded by the Bank, a Resettlement Plan should be prepared. The resettlement plan will be time specific with an appropriate budget incorporated as an integral part of the project design. The Plan shall give details of the compensation for loss of assets, livelihoods and infrastructure and rehabilitation support for those losing their means of livelihoods because of the project. This category will be identified through household survey and assets inventory. Due consideration will also be given to all legal instruments and national policies that govern the payment of compensation for loss of assets and rights as a result of compulsory acquisition of land

	with attendant consequences of involuntary displacement in favor of public purposes. These will be harmonized with the guidelines of the lenders that takes precedence over national policies to ensure that project affected persons are left better off after the effects of the project improvement, ownership of assets notwithstanding. Criteria for the eligibility of displaced persons will be established and potential PAPs confirmed by the national and county government authorities. A methodology for valuing losses will be developed, so that the land and/or properties to be acquired for the purposes of the project (including crops and trees) can be classified and valued. Estimated gross replacement cost methodology will be used and estimated values categorized separately for houses, structures, crops and trees and other assets. Estimated compensation list for the affected persons will be developed, and annexed to the report All compensation activities and activities related to other forms of assistance that may be necessary will be cost. The main area of concern on relocation will be the businesses on the reserves, which is the source of livelihood of a big population in commercial centers. Among the activities being undertaken during the RAP Study are: ▪ Socio-economic survey. ▪ PAP Study Design and Procedure. ▪ Sensitization Meetings. ▪ Stakeholder Consultations and Sites inspection. ▪ PAP Census Data collection and Community Consultation methods. ▪ Administering questionnaires. ▪ Open discussion groups ▪ Observations/photography. ▪ Capture of gender and vulnerability issues. ▪ Public Participation and Consultation. ▪ Property Ownership Data Collection Methods.

Table 2: ESIA Study tasks

3.9 NEMA APPROVAL

The Consultant will present the report and submit to NEMA for approval. We will be responsible for making any modifications that NEMA may demand before approval of the assessment report.
Section 22: *Public hearing* of the Regulations states "Upon receipt of both oral and written comments as specified by section 59 and 60 of the EMCA, CAP 387 of Laws of Kenya, the Authority may hold a public hearing"

The regulations concerning public hearing, provides the following recommendations:

- Presiding over the public hearings by a suitably qualified person appointed by the Authority;
- Publicizing of the date and venue of the public hearing at least one week prior to the meeting through

  -Notice in at least one daily newspaper of national circulation and one newspaper of local circulation;

-At least two announcements in the local language of the community and the national language through radio with a nationwide coverage;

- Conducting of the public hearing at a venue convenient and accessible to people likely to be affected by the project;
- Provision of opportunity to the proponent to make presentation and to respond to presentations made at the public hearing;
- The presiding officer shall in consultation with the Authority determine the rules of procedure at the public hearing;
- Compilation of a report on the views presented at the public hearing by the presiding officer on conclusion of the hearing, and submission of the report to the Director General, NEMA within 14 days from the date of the public hearing.

CHAPTER 4: PROJECT ORGANISATION AND MANAGEMENT

Management Structure

The following specialists and personnel will perform data collection, analysis, and interpretation of results:

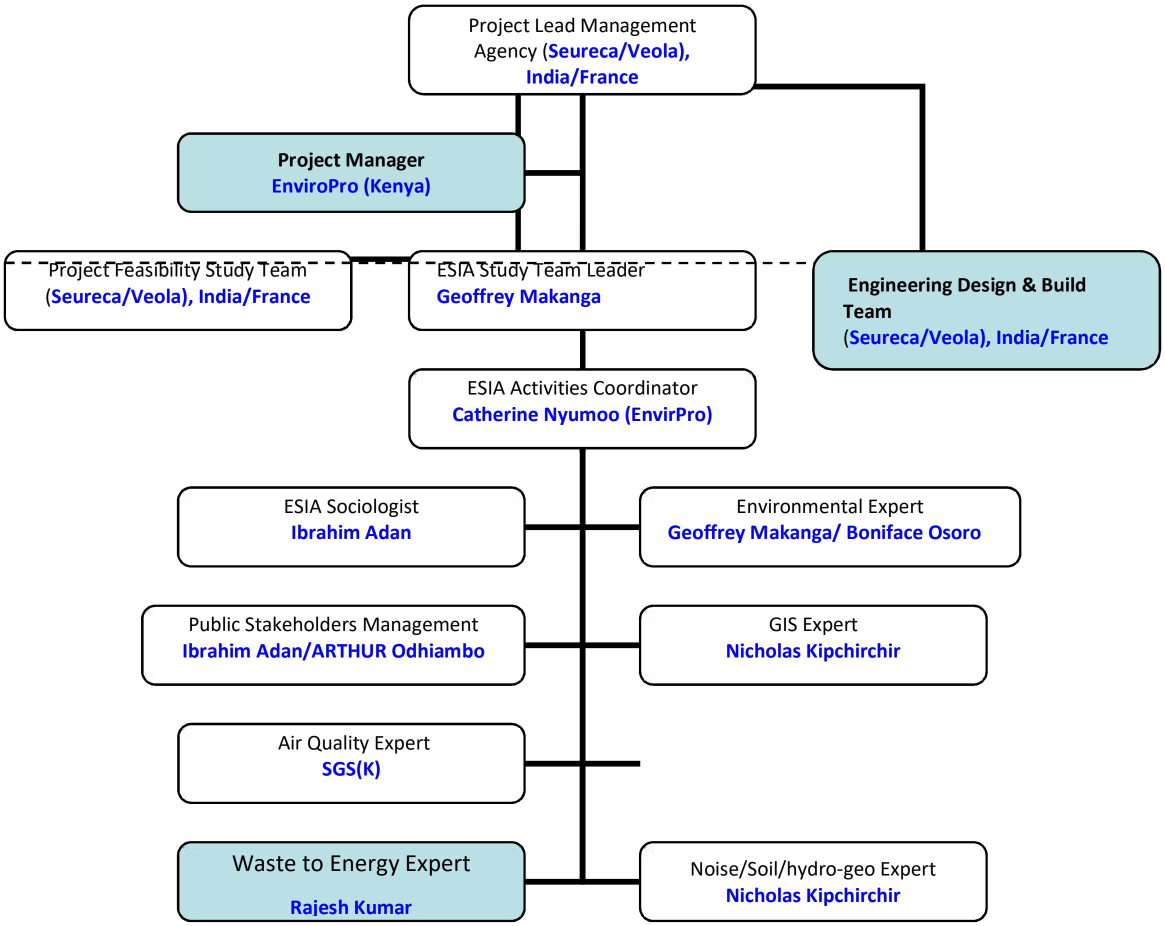


Figure 9: project organogram

	Position	Name
1	Lead EIA Expert	Geoffrey N. Makanga
2	Lead Social Expert	Ibrahim Adan
3	Associate EIA Expert	Arthur Ouma
4	Associate EIA Expert	Bonface Osoro
5	Waste Management Expert	Catherine Nyumoo
6	Waste to Energy Expert	Rajesh Kumar
7	Air/Noise/Soil/hydro-geo Expert	Nicholas Kipchirchir
8	Sanitation Engineer	Marie Gouttebroze
9	Chemical Engineer	Damien Rambault

Table 3: *List of planning and participating Consultants*

Harish KUMAR
Team Leader

Having total 17+ years of experience with relevant exp as project manager for-
- Engg. & project mgt consultancy services of WtE project @ 3,700 t/d (3 projects)
- Feasibility study of WtE project @ 6,200 t/d (3 projects)
- Detailed project report of WtE project@ 5,450 t/d (5 projects)
- Detailed project report of ISWM project@ 2,600 t/d (3 projects)
- Due-diligence of WtE project@ 5,300 t/d (5 projects)

Emmanuel CORBEL
Project Coordinator

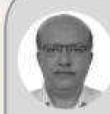
Having 14+ years of experience having contract management experience-
- Design & preparation of plan for drainage & sanitation master plan (3 projects)
- Design review, tender docs, supervision for Dam construction work
- Detailed design & tender doc for wastewater treatment plants

Rajesh KUMAR
Waste-to-Energy Specialist

Having total 27+ years of experience with relevant exp. for-
- Construction supervision and O&M of WtE project@1,300 t/d (1 project)
- Engg. & project mgt consultancy services of WtE project @ 2,400 t/d (2 projects)
- Feasibility study of WtE project @ 6,200 t/d (3 projects)
- Detailed project report of WtE project@ 2,700 t/d (2 projects)
- Detailed project report of ISWM project@ 2,600 t/d (3 projects)

Kishor G. GAIKWAD
Electrical Engineer

Having total 13+ years of experience in power transmission network-
- Design & engg of 330 kV DC transmission line & tower (1 project)
- Design & engg of 220 KV transmission line (1 project)
- Transmission line survey & specifications for 400 kV (4 projects)



Devendra K. UTREJA
Civil Engineer

Having total 27+ years of experience in civil design of power plants-
- Structural & foundation design of WtE projects (3 projects)
- Structural & foundation design of thermal power plants (~20 projects)
- Civil design of ash handling & water treatment plants (~ 10 projects)

Damien RAMBAULT
Chemical Engineer

Having total 26+ years of experience in hazardous waste management-
- Technical & regulatory assistance for implementation of waste incineration (5 projects)
- Technical support & operation of hazardous waste treatment facilities (12 projects)

Nisha MENON
Financial Analyst/ Economist

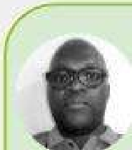
Having total 27+years of experience with relevant exp in financial modelling for WtE projects-
- Technical advisory for structuring & execution of ISWM & WtE project (2 projects)
- Feasibility study & detailed project reports (10 projects)
- Due-diligence of WtE projects (3 projects)

Sunil SENAPATI
Mechanical Engineer

Having total 10+ years of experience with relevant exp-
- Engg & project management consultancy services of WtE project @ 600 t/d (1 project)
- Feasibility study & detailed project report of WtE project (4 projects)

Marie GOUTTEBROZE
Sanitation Engineer

Having total 17+ years of experience with relevant exp as waste & landfill expert-
- Integrated solid waste management project (3 projects)
- Feasibility studies, plan, design of waste management projects (5 projects)
- Feasibility studies & design of landfills (8 projects)



Geoffrey N. MAKANGA
Environmentalist

Having total 10+ years of experience in environmental engg of RE sector-
- ESIA and lead expert of solar PV plants (3 projects)
- Design engg & lead ESIA expert of hydro power plants (4 projects)

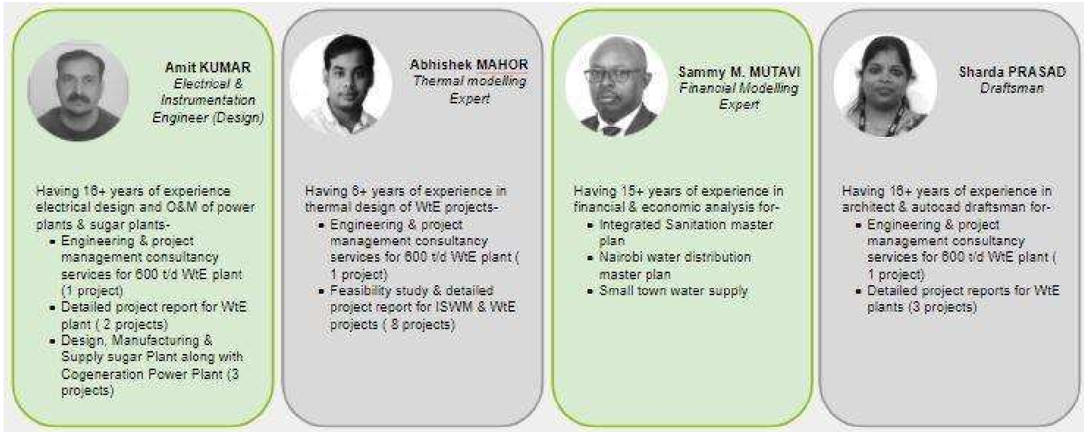


Figure 10: Summary of the Technical expert personnel on team

CHAPTER 5: THE ESIA REPORT

5.1. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORTING

The final output will be the final Environmental Impact Assessment Report. The report shall be in the English Language, clear and concise and in a format acceptable to NEMA. The report will be that of a fully-fledged Environmental Impact Assessment Study Report in compliance with the Environmental Management and Coordination Act of 1999 (Amendment 2015) and other international institutions requirements for Environmental Impact Assessment Report.

All findings will be presented in the EIA report. The report will contain an introduction explaining the need for, and context of the project. The report should, at a minimum, cover the following basic aspects: The ESIA report will contain all findings, conclusion, recommendations and a summary, stating the following:

a) Executive summary
b) Policy, Legal institutional and Administrative Framework
c) Methodology
d) the nature of the project;
e) the location of the project including the physical area that may be affected by the project's activities;
f) the objective of the project;
g) the activities that shall be undertaken during the project construction, operation and decommissioning phases;
h) the design of the project;
i) the materials to be used, products and by products including waste to be generated by the project and methods of their disposal;
j) the potential environmental impacts of the project and the mitigation measures to be taken during and after implementation of the project
k) an action plan for the prevention and management of possible accidents during the project cycle;
l) a plan to ensure the health and safety of the workers and neighboring communities;
m) the economic and socio-cultural impacts to the local community and the nation in general;
n) Environmental Management Plan
o) the project budget; and
p) Conclusions and Recommendations
q) Appendices (e.g. List of people who prepared the EIA references, minutes of inter-agency meetings, minutes of consultation meetings and so on)
r) References.

5.2. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) FOR THE PROPOSED PROJECT

The objectives of the ESMP are:

- To provide evidence of practical and achievable plans for the management of the proposed project.
- To provide the Proponent and the relevant Lead Agencies with a framework to confirm compliance with relevant laws and regulations.
- To provide the community with evidence of the management of the project in an environmentally acceptable manner.

This ESMP is prepared for the three project stages where potential significant negative impacts manifest.

These are:

a. Construction Phase ESMP
b. Operation Phase ESMP and
c. Decommissioning Phase ESMP.

5.3. THE ENVIRONMENTAL MANAGEMENT & MONITORING PLAN FOR THE PROPOSED PROJECT

provides a logical framework within which identified negative environmental impacts can be mitigated and monitored.

Baseline study	IMPACT	MITIGATION/ ENHANCEMENT
1) Air Quality;	Reduced methane and carbon dioxide quantities at Dandora and Ruai sites form the gasification plant. Odors and smell impacting residents on transportation routes. Odors and smell from project site Smoke and particulate matter from incineration. Methane and carbon dioxide leaks from gasification process Dust during construction phase and from vehicles during operations - impact mainly on workers	Gradual expansion of facility to produce more green energy Carbon trading for greater economic and social benefits Covering of vehicles carrying wastes to sites Ensuring minimal wastes feedstock on facility e.g. one or two days; ensuring waste feedstock site is hygienic and sanitary Having a long chimney and or installing a scrubber Regular and scheduled checks for leaks and their immediate repair Improving the unpaved road sections; gas masks for staff; watering where and when necessary
2) Ecology (Flora & Fauna) and Nature Conservation;	Clearing of vegetation during construction. Potential influx of birds and flies during operations Potential negative impacts on livestock and wildlife feeding (can impact on behavior) and diseases from eating of strewn wastes Potential impacts on water bodies	Limited clearing of vegetation during construction excavation. Setting up an on-site nursery complete with indigenous trees and other useful plants and vegetation for re-vegetation and beautification around the project site. Ensuring landfill is sanitary Covering of vehicles transporting wastes Ensuring animals have no access to waste feedstock through covering or otherwise. Ensuring that waste-feedstock area is raised and walled to mitigate against being washed away by water

3) Geology and Hydrogeology;	No adverse impacts unless there is excavation to create a landfill for waste storage purposes Impact on surface water – Athi river and wetlands - arising from water logging and carrying away of wastes from site to these water bodies	Ensure feedstock area is raised and walled to mitigate against run-off washing away wastes to water bodies; feedstock area should be paved to avoid seepage; leachate should be collected and disposed
4) Ground Contamination;	Adjacent sewerage treatment plant may pose a risk to groundwater contamination. Tests to be done to validate contamination levels if any. Ground contamination from leeching	Ensure wastes do not reach treatment ponds. Ensure feedstock area is raised and walled to mitigate against run-off washing away wastes to water bodies; feedstock area should be paved to avoid seepage; leachate should be collected and disposed
5) Surface Water Drainage;	Impact on surface water – Athi river and wetlands - arising from water logging and carrying away of wastes from site to these water bodies	Ensure feedstock area is raised and walled to mitigate against run-off washing away wastes to water bodies; feedstock area should be paved to avoid seepage; leachate should be collected and disposed
6) Landscape and Visual Intrusion;	Visual intrusion from facility and chimney(s) Visual intrusion from waste mounds if they occur Visual intrusion from emigrant birds and animals arising from the facility Potential impacts from power pylon from facility to national grid.	Lower chimney or use of scrubber Ensure waste mounds do not arise – having just enough (one/two days) feedstock Mitigate against bird's immigration by having site sanitary Using the Danube tower or similar design which has a lower profile and thus reduced visual impact
7) Land-Use;	Area is largely residential and the facility would inform and change residential patterns and form of houses plus economic class in the immediate vicinity of the waste plant Little impact on livestock rearing as land-use in the larger area No impact on agricultural land-use.	Site must have high sanitary standards so as not to significantly affect residential land use.
8) Noise and Vibration;	Noise from construction and vehicles transporting wastes. Potential noise from the facility's machinery.	Transportation during the day. Use of mufflers or machinery within Kenyan noise standards.
9) Transport;	Cumulative impact on traffic congestion construction and operations. Possible adverse impacts on access murram road from vehicles.	Delivering wastes to site off peak hours. Improving murram road to sites.
10)Water resources, supply and use	Potential impacts on surface and ground water form leeching and or run- off.	Ensure feedstock area is raised and walled to mitigate against run-off washing away wastes to water bodies; feedstock area should be paved to avoid seepage; leachate should be collected and disposed

11) Climate Change	The facility will reduce overall greenhouse gases in Dandora and Ruai (one operational) areas, the country and the world as a whole and thus ameliorate climate change impacts	Gradual expansion of facility to produce more green energy Carbon trading for greater economic and social benefits
12) Energy & Telecommunication	Improved power supply in the area and country Improved green energy production in the country Potential significant adverse impacts on aircraft flying to JKIA as a result of possible birds emigration to site.	Mitigate against birds immigration by having site sanitary
13) Waste as a fuel feedstock	Reduction in illegal dumpsites and clean-up of existing ones because waste will be viewed not just as waste but as a valuable fuel feedstock. Minors may be involved in the waste collection and separation process due to their eagerness to participate and cheap labor they offer. Creation of solid waste cartels who will muscle their way into communities claiming ownership of wastes.	Only registered and approved waste transporters will be allowed to deliver waste, handle and sell waste as a fuel feedstock. Creation of a set of rules that all who are involved in the waste chain must abide by. Strict fines and penalties to be enforced.

Table 4: *Proposed Project's EMMP*

5.4. APPLICATION FOR EIA LICENSE

Based on the ToR, we will assist the client on the processes and procedures to submit an application to NEMA and obtain the required permits and licenses, mainly in EIA approval and land acquisition. Ten hard copies and an electronic copy of the study report will be submitted to the National Environment Management Authority for Licensing.

CHAPTER SIX

6. RISK MANAGEMENT AND QUALITY ASSURANCE

The following is an inventory of the risks associated with the project. Each identified risk is accompanied by an approach to mitigate the risk.

Risk	Approach/ Mitigation
Lack of buy-in from key contacts	Early engagement with key contacts at the outset of the project; Provide background and explain project.
Unavailability of contacts at key times	Strong project planning
Unavailability of key staff	Wide pool of international experienced staff to draw from within Seureca/Veola.
Mismatch between actual 'real-life' situation and the design in the PDD	Site visit to assure that real-life situation is understood and that the ESIA is matched to the actual situation Involvement of Seureca/Veola experts with extensive experience with Landfill gas project combined with extensive knowledge of the UNFCCC procedures
Project not validated	- Use best practices for the completion of the design documents; - Substantiate each claim with detailed proof; - Ensure a good match of the information in the design documents and the actual project; - Establish good working relationships with the various project stakeholders.
ESIA not approved by NEMA	- Use best practices for the completion of the design documents; - Respond timely if questions arise from the stakeholders such as NEMA/KCAA/Public leaders etc

Table 5: *Risks and their approaches and mitigations*

CHAPTER 7: WORK SCHEDULE

The EIA study report for the WtE Power Plant development shall be completed within a period of twenty-four (24) weeks from the time of TOR approval.

7.1 TASKS AND DELIVERABLES

7.1.1 PLAN OF APPROACH

ESIA Desktop Review

↓

Site Reconnaissance

↓

Site Environmental Measurements

↓

Public Stakeholder Meetings

↓

Report Drafting

↓

Review & Quality Assurance

↓

Report Submission to NEMA for licensing consideration

Figure 11: Activity process flow diagram

ESIA Work Plan

Deliverables	Activity	Weeks											
		2	4	6	8	10	12	14	16	18	20	22	24
Deliverable 1. Timeline work plan	Consultations with Project proponent												
	Literature survey												
Deliverable 2. Full ESIA study report	Writing of **Project Brief** for NEMA authorization to conduct full **study report**												
	Preparation and approval of TORs by NEMA												
	Screening and scoping studies												
	Public Participation												
	Writing of study Report and submission to NEMA												
Deliverable 3. An ESIA licence from NEMA	Public disclosures through local dailies and Kenya Gazette												
	Submission of copies of public disclosures to NEMA												
	Review of comments from Public by NEMA												
Issuance of approval letter and conditions	Issuance of approval letter and conditions												

Table 6: *Programmes of works (schedule)*

Project Work Plan

Activity	Remarks	
ESIA and RAP	Team Leader	Team Leader
	Others	Socio- economist, Environmental Expert, Sanitation Engineer
	Task Duration	Stage I: 6 Months Stage II: 36 Months
	Key Deliverables	▪ ESIA study. ▪ ESMP. ▪ RAP report. ▪ Consultant CV. ▪ ToR for ESIA study. ▪ Notice advertisement, announcements publicizing the projects.
	Primary Objectives	✔ Identify and propose mechanisms to manage environmental impacts, risks, and liabilities. ✔ Identify any permits or licenses that would be required for the design, construction, operation, maintenance, and closure phases of the project. ✔ Describe the environmental planning and permit procedures that may be required for the project. ✔ Detail the compliance with legislation, conditions of permits, and licenses. ✔ Describe the monitoring requirements and explain how to manage the process.
	Task Distribution	<u>Stage I: Design and Tendering</u> ▪ Environmental Assessment Study ➢ Review of policy, legal and institutional framework. ➢ Establishment of the prevailing baseline conditions. ➢ Carry out the EIA, ESIA, ESMP. ▪ RAP study ➢ Carry out census. ➢ Valuing Affected Asset. ➢ Budget. ➢ Prepare RAP where applicable. ➢ Obtain consent for land subdivision and transfer. ➢ Allocation of new numbers. ➢ Assessment of stamp duty. ➢ Issuing title deeds. <u>Stage II: Works Supervision</u> ▪ Construction Works Supervision. ▪ Provision of Support Services to the Client,

Table 7: *Schedule of Works with outlined responsibilities*

CV for Proposed STUDY Staff

1.1 Harish KUMAR, Team Leader

Proposed Position: Team Leader
Name of Firm: Development Environergy Services Limited
Name of Staff: Harish KUMAR
Profession: Mechanical Engineer with extensive experience in Waste-to-Energy project implementation
Date of Birth: 15-Jul-78
Years with Firm/Entity: 12 years **Nationality:** Indian
Membership in Professional Societies:
Member of International Association of Engineers (IAENG), Hong Kong
Detailed Tasks Assigned:

- Overall coordination with Client, consortium partners and different stakeholders for all tasks
- Planning inception activities, inception mission, inception workshop and preparation of inception report summarizing technical, financial, economic legal and social issues, project scope validation, project description and additional scope of work requirements (Task-1)
- Leading and overseeing the resource assessment study, the project configuration and analyses the alternatives waste to energy technologies apt for Nairobi waste covering waste combustion, power generation, flue gas treatment, condensate circuit, cooling circuit, leachate and effluent disposal etc (Task-1 and 2)
- Leading activities related to the sitting study and finalization of project site for WtE (Task-2 and 3)
- Leading all activities related to selection of major equipments, development of plot plan layout, project risks and mitigation measures (Task-5)
- Due-diligence of relevant laws, rules and regulations, examination of institutional strategies (Task-7)
- Providing key inputs for transmission system, ESIA, economic and financial analysis, investment memorandum (Task-4, 6 and 8)
- Planning of workshop activities (Task-9)
- Finalization of inception report, interim reports, draft feasibility report and final feasibility reports

Key Qualifications:
Mr. Harish KUMAR, Senior Consultant, DESL is a mechanical engineering graduate having certification of Primavera with over 17 years of professional experience. Presently, he spearheads the engineering services vertical at DESL that is involved in project management services, basic engineering, detail engineering of renewable energy (including waste-to-energy-WtE) projects, feasibility studies, procurement services, site supervision, due-diligence activities. He has been involved in more than 25 solid waste management projects worldwide and possesses wide exposure of project management and engineering consulting services. His work in the WtE field includes basic and detailed engineering, conceptual engineering, process design and calculations, piping engineering, study of power systems, study of waste pre-processing, project management, contract management, erection and commissioning supervision of power plants, and much more. He has worked in India, Indonesia, Malawi, Ivory Coast, Nepal, Belgium, China, Germany. He is also proficient in feasibility studies, business plans, technology selection, comparative assessment of EPC, techno-economic analysis, detailed project report, operation and maintenance aspects of incineration based WtE projects.

An illustrative list of waste-to energy projects, in which he has been involved include:

City	Waste Quantity (t/d)	WtE (MW)	Role	Work carried out
Operational projects/Projects in advanced stage of completion				
Sonepat, India	600	10	Team leader	Feasibility study, design and engineering, EPC management, Project will be operational from March-21
Ghazipur, India	1,300	12	Team leader	As above, the project is operational from 2015.
Okhla, India	1800	16	Team leader	As above, the project is operational from Q1 of 2012.

Feasibility Studies and design of waste-to-energy power plants				
Jamaica (2020)	2,500	40	Team member	Project scheduled to commence in Jan-21
Amritsar, India (2020)	600	10	Team leader	Feasibility study in progress
Guwahati, India (2020)	850	12	Team leader	Feasibility study completed
Ghaziabad, India (2018)	900	12	Team leader	Feasibility study completed
Indore, India (2018)	1,000	20	Team leader	Feasibility study completed
Nagpur, India (2017)	800	11.5	Team leader	Feasibility study completed
Lucknow, India (2017)	1,500	20	Team leader	Feasibility study completed
Gurugram, India (2017)	1,200	15	Team leader	Feasibility study completed
Gwalior, India (2017)	1,000	15	Team leader	Feasibility study completed
Guntur, India (2016)	1,000	15	Team leader	Feasibility study completed
Visakhapatnam, India (2016)	1,100	15	Team leader	Feasibility study completed
Jalandhar, India (2013)	1,000	12	Team leader	Feasibility study completed

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
Madan Mohan Malaviya Engineering College, Gorakhpur University, Gorakhpur, India	Bachelors in Mechanical Engineering	2002

Employment Record:

From	To	Employer	Positions Held
2008	Till date	Development Environergy Services Ltd.	Sr. Consultant, Consultant, Associate Consultant
2006	2008	ISGEC, Noida	Sr. Engineer, Engineer-1
2004	2006	BILT, Unit-Sewa, Jeypore, Orissa	Executive
2002	2004	ABC Paper, Hoshiarpur, Punjab	Assistant Engineer

Relevant project experience includes the following:

Name of Assignment	*Waste-to Energy* *# 1 Appointment of consultant for preparing Feasibility Report for setting up of Waste to Energy Plant for South Delhi Municipal Corporation*
Year	2017
Location	Delhi, India
Client	South Delhi Municipal Corporation (SDMC)
Main project Features	The present municipal solid waste (MSW) generation in the SDMC area is approximately 3,500 TPD, part of it is dumped at Okhla sanitary landfill without processing. For dealing with unprocessed quantity of waste, SDMC intends to establish a waste-to-energy (WtE) plant at Tekhand, Okhla. SDMC engaged DESL for preparation of Feasibility Report for setting up the WtE plant with 2,000 TPD processing capacity.
Positions Held	Team Leader

Activities Performed	● Pre-bid stage: Assistance in preparation of RFP/tender documents ● Post bid stage: Bid evaluation and review of documents submitted by bidders ● Technology review for pre-processing section, combustion technology, air pollution control (APC) technology, waste disposal and leachate treatment for all the bidders and highlight the critical issues, if any ● Visit to proposed site location for physical assessment and connectivity for raw water source, power evacuation etc. ● Visit to bidder's operating plant for physical assessment of technology and submission of report
Name of Assignment	*Waste-to-Energy* *#2 Engineering and project management consulting services for 1300 TPD MSW project*
Year	2011-15
Location	Ghazipur, New Delhi
Client	IL&FS
Main project Features	The assignment includes engineering and project management consulting services for setting up a 1300 TPD MSW energy project at Ghazipur in New Delhi under the public private partnership (PPP) model.
Positions Held	Team Leader
Activities Performed	● Overall project coordination for a 12 MW Waste to Energy project ● Preparation of concept notes on various combustion technologies (Reciprocating Grate/ Vibrating Grate) available for RDF combustion. Based on techno-economic evaluation, vibrating grate recommended ● Preparation of concept note on various technologies (Water Cooled or Air Cooled) available for steam condensation. Lifecycle costing was done for both technologies and air cooled condenser recommended for the project ● Ensuring quality and timely delivery of documents required for project execution ● Regular progress monitoring and taking corrective actions for meeting deadlines ● Periodic site visits for progress, monitoring and resolution of issues, if any ● Periodic progress report to management highlighting the key concerns with correcting action points *The plant is operational since 2015*
Name of Assignment	*Waste-to-Energy* *#3 Engineering and project management consultancy services for integrated MSW processing complex*
Year	2009-11
Location	Okhla, Delhi
Client	Timarpur-Okhla Waste Management Co. Pvt Ltd
Main project Features	Consultancy services from concept to commissioning of the waste-to-energy power plant and RDF process at Okhla in New Delhi.
Positions Held	Team Member
Activities Performed	● Review of resource assessment study carried out prior to bidding ● Field visit and partial validation of the assessment report ● Analysis of quality reports from the perspective of technology options and compliance with MSW rule 2000 ● Review of different MSW based WTE projects-global and Indian scenario and techno- economic assessment analysis ● Visit to several MSW WTE projects in India, France and China and evaluation of critical success and failure factors and making recommendations on technology selection ● Preparation of concept note on technologies (RDF Preparation or Incineration) ● Preparation of schematic, list of equipments and their specifications for electrical system of entire plant ● Preparation of control and instrumentation philosophy for all control systems ● Project management services including monitoring of complete project activities, project reporting and tracking, etc ● Construction management services *The plant is operational since 2012 and consumes 33% of city's solid waste*
Name of Assignment	*Waste-to-Energy*

	#4-6 Preparation of detailed project reports for three waste to energy projects being developed under the SBM mission (3 independent assignments)
Year	2016
Location	Guntur, Visakhapatnam, Tirupati (Andhra Pradesh)
Client	Jindal Urban Waste Management Limited
Main project Features	JUIL engaged DESL to prepare DPR for the WtE project at Guntur, Visakhapatnam, Tirupati
Positions Held	Team Leader
Activities Performed	● Development of conceptual model for preparation of RDF from MSW, evaluation of various options and preparation of recommendation note on technology configuration ● Design and engineering of the material recovery facilities ● Preparation of technical specifications of major equipment ● Preparation of financial analysis for 25 years of plant operation ● Environmental Management Plan (Monitoring plan, Quick response mechanism, maintenance plan for plantation and green belt, Health and safety plan, Pollution control units and their operational plan) ● Vendor consultation ● Project costing
Name of Assignment	*Waste-to-Energy* *#7 Engineering and project management services for setting up an integrated solid waste management project at Sonepat, Haryana*
Year	2017-20
Location	Haryana, India
Client	JBM Environment Management Pvt. Ltd.
Main project Features	JBM Environment Management Pvt. Ltd. (JBM EMPL) is in the process of setting up an integrated solid waste management (ISWM) facility including collection and transportation, waste to energy plant and scientific landfill (SLF) at Sonepat (Haryana). DESL was engaged in providing engineering and project management services for setting up the proposed facility.
Positions Held	Team Leader
Activities Performed	Leading the team to carry out the following activities: ● Basic engineering ● Collection and transportation of waste ● Detailed engineering– Procurement Support ● Preparation of tender documents ● Selection of party documents that include preparation of list of possible vendors and preparation of qualification criteria for selection of party/parties ● Procurement assistance ● Detailed Engineering-Implementation support ● Project Management ● Technical support to client for getting various permits and clearances ● Site deputation for day to day progress monitoring and circulating daily progress reports and coordination with various stakeholders involved ● Preparation and submission of final report *The pre-commissioning of the plant is planned in January 2021 and will be fully operational by March 2021.*
Name of Assignment	*Waste-to-Energy* *#8-12 Various Feasibility Studies and Detailed Project Report (DPR) for Integrated Solid Waste Management / Waste to Energy projects*
Year	2017-18
Location	India
Client	Multiple projects as listed below; ● Preparation of DPR Report including WTE, ISMW, Study of Existing C&T and Survey/Test for 1,000 t/d, 20 MW for Indore Project, Indore MSW Management Pvt. Ltd., 2018, India ● Preparation of detailed project report for a 500 t/d integrated SWM Project, JBM Environment Management Pvt. Ltd. (A JBM Group Company), 2017, India ● Preparation of detailed project report (DPR) for 1000 t/d Integrated Solid Waste Management at Gwalior, Ecogreen Energy Pvt. Ltd. (EEPL), 2017, India

	● Preparation of detailed project report (DPR) for 1500 t/d Integrated Solid Waste Management Project at Lucknow, Ecogreen Energy Pvt. Ltd. (EEPL), 2017, India ● Preparation of detailed project report (DPR) for 1,200 t/d Waste to Energy project in Gurugram, Ecogreen Energy Pvt. Ltd. (EEPL), 2017, India
MAIN PROJECT FEATURES	Feasibility Studies and DPR for I-SWM and WTE projects
POSITIONS HELD	Team Leader
ACTIVITIES PERFORMED	Led the team to carry out following activities: ● Deputing and coordinating site visit team for: ○ Review of land availability of infrastructural facilities ○ Assessment of present collection and handling facilities ○ Assessment of requirement of logistics for setting up the project ● Review of nature and sources of pollutants and broad indication of pollution mitigation measures ● Finalization of concept drawings and details of sanitary landfill (SLF) ● Technology evaluation for disposal of waste ● Recommendations on possibility and suitable options for proper and efficient waste management ● Preparation of conceptual configuration of the project ● Preparation of DPR as per the standard requirement, compliance of RFP, Concession Agreement (CA), and letter of intent (LOA) of financial institution ● Conceptual engineering, basic Engineering ● General process flow diagram, water balance diagram, layout, electrical single line diagram, master P&ID ● Data Sheets for budgetary offers for major equipment ● Boundary system analysis, space estimation and availability, disposal of ash, manpower requirement, permits and clearances ● Study of existing C&T system in the catchment area ● Month on month maintenance schedule for the proposed project ● Estimation of capital cost and manufacturing expenses ● Preparation of financial analysis for 20 years of plant operation ● Preparation of environmental management ● Preparation of a disaster management plan
NAME OF ASSIGNMENT	***#13-15 Experience in Africa***
YEAR	2010 onwards
LOCATION	Ivory Coast, Malawi
CLIENT	Multiple clients
MAIN PROJECT FEATURES	Feasibility study and engineering consulting for biomass based and cogeneration plants
POSITIONS HELD	Team member
ACTIVITIES PERFORMED	Multiple projects listed below; ● Assessment of potential and preparation of detailed project report for a grid connected 20 MW biomass power project at Biokala, Dalkia Technical Services Department, Ivory Coast, 2010 ● 23 MW Palm based power plant in Ivory Coast, Biokala, Ivory Coast, 2012-13 ● Consultancy Services to undertake assessment of bagasse cogeneration prospects in Malawi, Ministry of Natural Resources Energy and Mining, Malawi, 2015-16

Languages:

Language	Speaking	Reading	Writing
English	Good	Good	Good
Hindi	Good	Good	Good

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

 Signature of staff member	**Date:** 10-Dec-20

Full Name of Staff Member: Harish KUMAR
Full Name of Authorized Representative: R RAJMOHAN

1.2 Rajesh KUMAR, Waste-to-Energy Specialist

Proposed Position: Waste to Energy Specialist
Name of Firm: Development Environergy Services Ltd.
Name of Staff: Rajesh KUMAR
Profession: Power Plant Designer
Date of Birth: 07-May-73
Years with Firm/Entity: 5 years **Nationality:** Indian
Membership in Professional Societies:
International Association of Engineers (IAENG), Hong Kong

Detailed Tasks Assigned:

- Finalization of data collection formats, guide the team for resource assessment study, project configuration, inception workshop, waste characterization study etc (Task-1)
- Lead and guide the team for the selection of waste to energy technologies, technology for waste processing system, flue gas cleaning system, burner management system, emission management system, bed ash and fly ash treatment and safe disposal system (Task-2)
- Finalization of selection criteria for siting study, recommendation on plant capacity, technology, ranking of candidate project sites (Task-2 and 3)
- Lead the field team for waste sampling and siting study (Task-1 and 3)
- Conceptual design of waste to energy, guide the designer for preparation of options for plant layout, capture all project risks and mitigation strategies (Task-5)
- Identification of best international practice of relevant laws, rules and regulations for solid waste recycling, transfer, treatment, power generation, disposal etc (Task-7)
- Estimation of project cost and explore the budgetary quote for major equipments (Task-8)
- Lead the workshops and presentation for waste estimation, design and selected technology (Task-9)
- Preparation of of inception report, interim reports, draft feasibility report and final feasibility report

Key Qualifications:
Mr. Rajesh KUMAR, Consultant, DESL holds diploma in mechanical engineering and certification from Primavera, with over 25 years of industrial experience in design, engineering, project management, project execution and operation in power plants including biomass and Waste-to-Energy plants. He has rich experience in power project implementation, including detailed engineering, equipment procurement assistance, quality management, supervision of erection and commissioning, project Execution, 3D modeling, CAD (designing, analysis). He has experience of over 9 years in solid waste management and waste to energy.

He was deployed on site for Ghazipur 12 MW waste to energy project as senior designer and was responsible for procurement, construction, commissioning and operational services for the plant which is now operational since 2015. He led the design of packages for boiler, flue gas cleaning system, ash and fuel handling and MSW pre-processing. He was responsible for evaluation and selection of technology, procurement and successful erection and commissioning.
He is currently responsible for the project execution activities, site progress and other supervision activities of waste to energy projects in Haryana, India which deals with project management and detailed engineering activities as Owner's Engineer for EPC based execution.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained

Industrial Training Institute, Sonipat, Haryana	Mechanical Draughtsman	1992

Employment Record:

From	To	Employer	Positions Held
2016	Till date	Development Environergy Services Ltd.	Associate Consultant
2012	2016	IL&FS Environment Infrastructure, Delhi	Sr. Designer
2011	2012	Uttam Sucrotech International, Noida	Project Manager
2010	2011	Dalkia Renewables, Delhi	Dy. Manager (Engineering and Control)
2009	2010	Satia Paper, Muktsar, Punjab	Manager (Projects and Development)
2008	2009	DSCL Energy Services Ltd., New Delhi	Designer
2002	2007	Satia Paper, Muktsar, Punjab	Mechanical Engineer
1996	2002	Belliss India Ltd., Delhi	Designer
1993	1996	Studds Ltd., Faridabad, Haryana	Designer

Relevant project experience includes the following:

Name of Assignment	*Waste to Energy* *#1 Engineering and project management services for setting up an integrated solid waste management project at Sonepat, Haryana*
Year	2017-20
Location	Haryana, India
Client	JBM Environment Management Pvt. Ltd.
Main project Features	DESL was engaged in providing engineering and project management services for setting up 600 t/d waste management facility with 10 MW waste to energy
Positions Held	Team Member (WtE expert)
Activities Performed	● Site visits for assessment of landfill site, waste segregation and transport system ● Plant and equipment layout as per available space ● Detailed engineering– Procurement Support ● Preparation of tender documents ● Finalization of data sheets for trommel, shredder, ballistic separator, magnetic separator. ● Project schedule preparation and weekly update ● Evaluation of technical bids ● Technical comparison and selection of parties ● Procurement assistance ● Administering site supervisory activities to ensure safety and quality of the project *The pre-commissioning of the plant is planned in January 2021 and will be fully operational by March 2021.*
Name of Assignment	*Waste to Energy* *# 2 Technical assistance for preparing RFP document / bid management / technical evaluation for setting up of waste to energy plant*
Year	2017
Location	Delhi, India
Client	South Delhi Municipal Corporation (SDMC)
Main project Features	The present municipal solid waste (MSW) generation in the SDMC area is approximately 3,500 TPD, part of which is dumped at Okhla dumpsite without processing. For dealing with unprocessed quantity of waste, SDMC intends to establish a waste-to-energy (WtE) plant at Tekhand, Okhla.
Positions Held	Team member (WtE expert)
Activities Performed	● Bid evaluation and review of documents submitted by bidders ● Technology review for pre-processing section, combustion technology, air pollution control (APC) technology, waste disposal and leachate treatment for all the bidders and highlight the critical issues, if any

	● Visit to proposed site location and interaction with SDMC officials for finalization of project deliverables
NAME OF ASSIGNMENT	*Waste to Energy* *# 3 to 7 Feasibility study and DPR for integrated SWM and Waste-to-Energy projects*
YEAR	2017-18
LOCATION	India
CLIENT	Multiple listed below; ● Preparation of DPR including WTE, ISMW, Study of Existing C&T and Survey/Test for 1,000 t/d, 20 MW for Indore Project, Indore MSW Management Pvt. Ltd. (A part of Essel Infra Projects Limited), 2018, India ● Preparation of detailed project report (DPR) for 1000 t/d Integrated Solid Waste Management project at Gwalior, Ecogreen Energy Pvt. Ltd. (EEPL), 2017, India ● Preparation of detailed project report (DPR) for 1500 t/d Integrated Solid Waste Management Project at Lucknow, Ecogreen Energy Pvt. Ltd. (EEPL), 2017, India ● Preparation of detailed project report for a 500 t/d integrated SWM Project, JBM Environment Management Pvt. Ltd. (A JBM Group Company), 2017, India ● Preparation of detailed project report (DPR) for 1,200 t/d Waste to Energy project in Gurugram, Ecogreen Energy Pvt. Ltd. (EEPL), 2017, India
MAIN PROJECT FEATURES	Feasibility study and DPR for integrated SWM and WtE projects
POSITIONS HELD	Team member
ACTIVITIES PERFORMED	● Site visit along with the client for review of land and availability of infrastructural facilities ● Preparation of process flow sheet-end to end covering MSW receiving logistics, handling and pre-processing facilities ● Concept drawings and details of sanitary landfill ● Plant configuration for pre-processing facilities and power plant island ● Technology evaluation for disposal of waste ● Preparation of a generic and modular layout ● Potential assessment-power export ● Boundary system analysis, space estimation and availability, disposal of ash, manpower requirement, permits and clearances ● Study of existing collection and transportation system ● Estimation of energy generation potential ● Preparation of data sheets for budgetary offer for major equipment ● Preparation of month-on-month maintenance schedule for the plant ● Assessment of manpower requirement based on production requirements and proposed facilities for the purpose of estimating annual wage bill ● Estimation of operating and maintenance expenses
NAME OF ASSIGNMENT	*Waste to energy* *#8 Procurement, construction, commissioning and operational services for 12 MW solid waste based Power Project at Ghazipur, New Delhi*
YEAR	2012-15
LOCATION	Ghazipur, New Delhi, India
CLIENT	IL&FS Environmental Infrastructure and Services Ltd., New Delhi
MAIN PROJECT FEATURES	Setting up of 12 MW WtE plant in Ghazipur, Delhi (PPP)
POSITIONS HELD	Senior designer
ACTIVITIES PERFORMED	● Handling end-to-end management of Boiler, Flue Gas Cleaning, Ash Handling and Fuel Handling package ● Involved in RDF plant for Pre-processing, Dryer and Dryer Gas cleaning and Air Density Separation system ● Plant and equipment layout as per available space ● Coordinating with supplier and erection team for timely dispatches of material

	● Quality checks at site and workshop ● Delivering and implementing the project as per scheduled deadlines and maintenance support ● Administering Site Supervisory Staff so as to ensure safety and quality of the project ● Manpower planning and benchmarking ● Cost control and invoice management *The plant is operational since 2015*
NAME OF ASSIGNMENT	*Experience in Africa* *#9 EPC Services for 31 MW power plant at Wonji Shoa Sugar Factory*
YEAR	2011-12
LOCATION	Ethiopia
CLIENT	Wonji Shoa Sugar Factory
MAIN PROJECT FEATURES	EPC Services for 31 MW power plant
POSITIONS HELD	Project Manager
ACTIVITIES PERFORMED	● Project Planning and Control ● Project schedule preparation, daily and weekly updates ● Track of materials needed and ordered ● Track of Inspections and dispatches ● Documentation control for project ● Document transmittals ● Work Scheduling for Draughtsman/Designers

Languages:

Language	Speaking	Reading	Writing
English	Good	Good	Good
Hindi	Good	Good	Good
Punjabi	Fair	Good	Fair

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

Signature of staff member	**Date:** 10-Dec-20

Full Name of Staff Member: Rajesh KUMAR
Full Name of Authorized Representative: R RAJMOHAN

1.3 MARIE GOUTTERBROZE, SANITATION ENGINEER

Proposed Position: Sanitation Engineer
Name of Firm: SEURECA
Name of Staff: Marie GOUTTEBROZE
Profession: Solid waste management expert
Date of Birth: 1981
Years with Firm/Entity: 15+ years with the group **Nationality:** French
Membership in Professional Societies: NA
Detailed Tasks Assigned:

- Review of previous studies, desk research for waste treatment technologies etc, technical inputs for project configuration (Task-1)
- Detailed technical assessment of Dandora landfill site in terms of quantification of legacy waste, feasibility of Dandora dumpsite as waste to energy project site (Task- 1, 2 and 3)

- Support to waste to energy specialist for technical assessments relating to waste characterization, quantity assessment and projection, site survey and suitability assessment and technical options analysis for waste combustion and disposal (Task-2 and 5)

Key Qualifications:

Ms. Marie GOUTTEBROZE, from SEURECA, has over 17+ years of professional experience with a Master's degree in Urban Management - Specialized in Environmental Services for cities and Master of Environmental Engineering Science. She has worked in around 10 countries including France, Zambia, Kenya, Oman, Djibouti, Togo, Cambodia, Georgia, Indonesia and Ghana. She has also worked as Operations manager (in charge of a landfill, composting plant and a Material Recovery Facility) in Veolia. She has worked on the implementation of an integrated solid waste management system in various countries, and in low income communities. She has technical experience on the waste value chain (collection, transfer, recycling, treatment). She also worked on the institutional and regulatory aspects on waste management projects.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
University of Marne la Vallée – Franc	Masters in Urban Management (Specialized in Environmental Services for cities)	2006
Ecole des Mines - Alès (Engineering school)	Masters in Engineering	2004
University of New South Wales-Sydney	Master of Environmental Engineering Science	2004

Employment Record:

From	To	Employer	Positions Held
2014	Till date	Seureca	Project Manager, Solid Waste
2011	2014	Veolia	Expert, Solid Waste
2009	2011	Veolia	Contract manager, Solid Waste
2007	2009	Veolia	Operations manager (in charge of a landfill and a composting plant)
2005	2006	Veolia	Operations manager (in charge of a landfill and a Material Recovery Facility)
2003	2005	EGIS	Deputy Project Engineer

Relevant project experience includes the following:

Name of Assignment	***# 1 Feasibility studies, plans, final designs and bidding documents for integrated solid waste management investments for the Nairobi Metropolitan Region***
Year	2014-15
Location	Kenya
Client	Ministry of Land, Housing and Urban development of Kenya
Main project Features	Technical expertise on landfill operation and design
Positions Held	Landfill expert / Deputy Team leader
Activities Performed	Project Management and coordination of all experts inputs, Assessment of the future volume of waste within the metropolitan region, Coordination of the feasibility study for comparative study of different potential localizations (including technical, environmental and urban planning assessment), coordination and validation of the feasibility study and conceptual and process design, approval of the Environmental Impact Assessment
Name of Assignment	***#2 Integrated City Wide Sanitation Plan, Feasibility Study Detail Design of Waste Water Management System for Three Towns (Gambella, Semera-Logia and Asosa)***
Year	2020
Location	Ethiopia

Client	Ministry of Water, Irrigation and Energy - Water Development Commission (World Bank)
Main project Features	The overall consultancy objective is to conduct assessment, feasibility study and detail design of wastewater management schemes, enabling realization of citywide inclusive sanitation system
Positions Held	Waste Expert
Activities Performed	● Overall assessment of the waste management system in the 3 cities - general organization for solid waste management; regulatory and institutional framework, financial and contractual aspect ● Evaluation of the operations efficiency ● Identify and evaluate various technical alternatives adapted to the local context and to the challenges identified in the first phase of the project. ● Preparation of a solid waste management development plan (with short, medium and long term objectives).
Name of Assignment	*#3 Technical Assistance for an Integrated Solid Waste Management - Samarkand*
Year	2019-22
Location	Samarkand - Uzbekistan
Client	State Unitary Enterprise Moroqand Obod / AFD
Main project Features	The integrated SWM project in the City of Samarkand includes to: (i) improve solid waste collection; (ii) upgrade solid waste disposal in Samarkand; (iii) enhance solid waste recycling and valorization; (iv) provide institutional strengthening along with technical assistance and support to local authorities to be able to plan and monitor solid waste operations; (v) increase awareness of solid waste issues among the population
Positions Held	Waste Expert
Activities Performed	● Development and implementation of regional solid waste management strategy; ● Support, development and implementation of procedures for waste management information system; ● Waste management planning and implementation; ● Health and safety and environmental management.
Name of Assignment	*#4 Preliminary and Detail design, preparation of the tender documents for the creation of a waste pretreatment and transit station*
Year	2018
Location	France
Client	Défense Environnement Service
Main project Features	Creation of a platform from transit, gathering and pretreatment of waste. The aim of this zone is to sort waste according to its nature (metallic waste, E-waste, End-of-life vehicles, plastic…) and to its potential valorization and to prepare the waste in order to optimize the transport to the final treatment/recycling facilities
Positions Held	Waste expert and Project manager
Activities Performed	Overall management of the project, technical requirement specifications (nature and quantity of the waste, flux considered, assessment of the potential sites : availability of land, access to the site, nature of the site); preliminary design (preparation of options for the design and operation of the platform, evaluation of the applicable constraints under the French Regulation on Classified Installation for Environmental Protection, preparation of conceptual layouts, definition of the equipment and site layout, brief economic analysis); Detailed design (definition of the site operation and arrangement; definition of the works to be realized, ground plan, definition of the OPEX and CAPEX, planning for the overall project)
Name of Assignment	*#5 Drainage and Solid Waste Management Technical Assistance for Lusaka City Council*
Year	2016-18
Location	Zambia
Client	Millennium Challenge Account Zambia Limited (MCA-Z)
Main project Features	Task #1: Institutional Evaluation, Situation Assessment and Options Analysis for Strategic Solid Waste and Drainage Operations and Maintenance Management

	Task #2: Technical Assistance Task #3: Stormwater Management Master Plan
Positions Held	Project Manager and Waste expert
Activities Performed	Review of the institutional and legal framework of solid waste management, assessment of the financial framework of LCC and review of the budget for SWM, stakeholders' consultations, assessment of LCC capacity in Solid Waste Management, proposition of options and strategies for SWM in term of institutional structure, operation and finance, recommendations and roadmap for institutional strengthening activities, Preparation of a Solid Waste Improvement Plan, Preparation of OandM manual for the landfill site, Environmental Management Plan for all waste activities, Preparation of technical specifications for waste management service contracts (collection, landfill operation) and construction contracts (rehabilitation and construction of landfills)
Name of Assignment	*#6 Water management and supply, waste and sanitation improvement*
Year	2015-16
Location	Angkor Park, Cambodia
Client	APSARA (Authority for the Protection of the Site and Development of the Angkor Region)
Main project Features	Master plan of water supply, wastewater and solid waste management in the 112 villages of the park.
Positions Held	Waste expert
Activities Performed	Characterization of the typology of the villages and selection of pilot villages, Assessment of the current waste management conditions in the pilot villages, Definition, comparison and selection of development scenarios for improving the waste management for the 112 villages
Name of Assignment	*#7 Technical Assistance to Veolia Africa for the preparation of the technical and financial proposal for the construction and operation of Akepe Landfill*
Year	2015
Location	Togo
Client	Veolia
Main project Features	Construction and operation of a Landfill in Akepe (Lome : around 300.000t/year) and optional construction and operation of a Refuse-Derived Fuel (RDF) facility
Positions Held	Landfill expert/ Project manager
Activities Performed	Project Management and coordination, Technical validation of the landfill and the RDF facility designs (including leachate collection and treatment and landfill gas collection and recovery), selection of suppliers and equipment, evaluation of the operational cost (business plan), staff planning

Languages:

Language	Speaking	Reading	Writing
English	Excellent	Excellent	Excellent
French	Excellent	Excellent	Excellent

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

Signature of staff member	**Date:** 10-Dec-20

Full Name of Staff Member: Marie GOUTTERBROZE
Full Name of Authorized Representative: Christophe LACARIN

1.4 Damien RAMBAULT, Chemical Engineer

Proposed Position: Chemical Engineer
Name of Firm: SEURECA
Name of Staff: Damien RAMBAULT
Profession: Hazardous Waste Expert
Date of Birth: 1967
Years with Firm/Entity: 26 years with the group **Nationality:** French
Membership in Professional Societies:

- SYPRED (Syndicat professionnel pour le recyclage et l'élimination des déchets dangereux) - Professional Union for the Recycling and Elimination of Hazardous Waste
- FNADE (Fédération Nationale des Activités de Dépollution et de l'Environnement) - National Federation of Pollution Control and Environment Activities
- FEAD (European Waste Management Association)

Detailed Tasks Assigned:

- Review of previous studies, desk research for waste treatment technologies etc, technical inputs for project configuration (Task-1)
- Process design for waste treatment, combustion of waste, treatment of flue gas, selection of nos. of line, finalization of throughput for incinerator etc (Task2 and 5)

Key Qualifications:
Damien RAMBAULT has been working in hazardous waste management for 26 years. He has a rich experience, both operational (operational services for nine (9) years, site management for five (5) years) and functional (technical and regulatory support) in the treatment of hazardous waste, covering the following typologies of sites and hazardous waste: sorting, transit and grouping of waste, packaged hazardous waste; aqueous waste in the organic physico-chemical and biological treatment; landfill gas management; acid or alkaline waste by mineral physico-chemical treatment; and organic waste, liquid or solid, by incineration. As director of a hazardous waste treatment facility, he was responsible for the day-to-day coordination of the various operational (operations and laboratory) and administrative (commercial, financial) departments and for reporting to the group.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
Université Montpellier 2	PhD in Chemistry	1993
ENSCM Ecole Nationale Supérieure de Chimie de Montpellier	Chemical Engineer	1989

Employment Record:

From	To	Employer	Positions Held
2020	Till date	SEURECA	Hazardous Waste Project Manager (Waste Management Department)
2017	2020	SARPI Veolia	Technical and regulatory expert on hazardous waste, Technical and innovation department
2012	2017	SARPI Veolia	Director of a waste treatment facility
2002	2011	SARPI Veolia	Safety advisor
1997	2001	SARPI Veolia	Manager (Logistic department)
1994	1996	SARPI Veolia	Assistant manager (Waste deconditioning department)
1991	1993	Shell Research	Engineer on a CIFRE contract as part of a PhD thesis

Relevant project experience includes the following:

Name of Assignment	*#1 Technical and regulatory assistance for the implementation of the BREF for waste incineration*
Year	2020
Location	France

CLIENT	SARPI VEOLIA
MAIN PROJECT FEATURES	As a consequence of the Industrial Emissions Directive (IED), the revision of the BREF (Best available technique REFerence document) for waste incineration made the Best Available Techniques (BAT) conclusions and the Associated Emission Levels (BATAEL) mandatory
POSITIONS HELD	Technical and regulatory expert
ACTIVITIES PERFORMED	● Analysis and interpretation of the new version of the BREF for waste incineration applicable to hazardous waste incineration facilities (6 sites) ● Analysis of byproducts if any and if they can be used for other operations ● Treatment and management of fugitive emissions ● Preparation of an audit document to position each facility in relation to these new BATs ● Evaluation of the gaps and definition of the action plan for compliance ● Drafting of the regulatory file for positioning in relation to BATs
NAME OF ASSIGNMENT	***#2 Technical and regulatory assistance for implementing the BREF for waste treatment to hazardous waste treatment facilities other than incineration***
YEAR	2019
LOCATION	France
CLIENT	SARPI VEOLIA
MAIN PROJECT FEATURES	As a consequence of the Industrial Emissions Directive (IED), the revision of the BREF (Best available technique REFerence document) for waste treatment made the Best Available Techniques (BAT) conclusions and the Associated Emission Levels (BATAEL) mandatory.
POSITIONS HELD	Technical and regulatory expert
ACTIVITIES PERFORMED	● Analysis and interpretation of the new version of the BREF for waste treatment, applicable to hazardous waste treatment facilities, other than incineration on the SARPI VEOLIA perimeter (26 sites) ● Analysis of by products and if they can be used for other operations ● Treatment and management of fugitive emissions ● Preparation of an audit document to position each facility in relation to these new BAT ● Evaluation of the gaps and definition of the action plan for compliance ● Drafting of the regulatory positioning file in relation to BAT
NAME OF ASSIGNMENT	***#3 Managing hazardous waste treatment facility***
YEAR	2012-17
LOCATION	France
CLIENT	SITREM
MAIN PROJECT FEATURES	To ensure the operational management of a hazardous waste treatment facility by coordinating the actions of the various operational departments (laboratory, operation) in order to guarantee compliance with the conditions of the permit, in particular the good quality of aqueous and gaseous discharges from the treatment facilities.
POSITIONS HELD	Director of a waste treatment facility
ACTIVITIES PERFORMED	● Pilot the operational part of a hazardous waste treatment facility (including analysis of by products and if they can be used for other operations and analysis of calorific value of waste if can be used as fuel) ● Ensuring regulatory compliance of a hazardous waste treatment facility (including treatment of fugitive emissions) ● To ensure customer relations and develop the customer portfolio of a waste treatment facility ● To ensure the financial profitability of a waste treatment facility ● Safety management ● Environmental management system ● Renovation project of the treatment facility ● Obtaining regulatory administrative authorizations related to the operation and town planning authorizations for the renovation of a waste treatment facility ● Financial follow-up of the project for the complete reconstruction of a hazardous waste treatment facility

Languages:

Language	Speaking	Reading	Writing
English	Good	Good	Good
French	Excellent	Excellent	Excellent
Spanish	Good	Good	Good

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

To be added Signature of staff member	Date: 10-Dec-20

Full Name of Staff Member: Damien RAMBAULT
Full Name of Authorized Representative: Christophe LACARIN

1.5 Kishor Gulabrao GAIKWAD, Electrical Engineer

Proposed Position: Electrical Engineer
Name of Firm: Development Environergy Services Ltd.
Name of Staff: Kishor Gulabrao GAIKWAD
Profession: Electrical engineer for industrial and power generation projects
Date of Birth: 20-Jun-83
Years with Firm/Entity: Intermittent, project based **Nationality:** Indian
Membership in Professional Societies: -

Detailed Tasks Assigned:
- Explore electricity market overview and demand analysis as per national master plan (Task-1)
- Team member of field mission for data collection for transmission network/substations (Task-3)
- Analysis of selected transmission line routes, load flow analysis, analysis of existing substation, space and bay availability and expansion possibility (Task-4)
- Conceptual design and preparation of technical specification of substation and transmission line (Task-5)
- Preparation of transmission line survey report and interim report for conceptual design and specifications

Key Qualifications:
Mr. Kishor Gulabrao GAIKWAD is an electrical engineer) from Mumbai University. He has more than 13 years of relevant professional experience and his expertise includes power transmission network analysis, design, grid interconnection analysis, transmission line survey, design, specification, selection of appropriate voltage. load flow analysis, fault current analysis, transient analysis, grid interconnection from power to substation, transmission and distribution network analysis. Design of cable selection, specifications, laying layout, joint etc for EHV substation. He is currently involved in preparation of detailed project reports for transmission lines and substations.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
Mumbai University, Mumbai, India	Bachelors in Electrical Engineering	2006

Employment Record:

From	To	Employer	Positions Held
2010	Till date	Takalkar Power Engineers and Consultants, Vadodara, Gujarat, India	General Manager
2007	2010	Power Consultants and Agencies Vadodara, Gujarat, India	Senior Engineer

Relevant project experience includes the following:

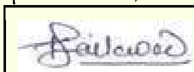
NAME OF ASSIGNMENT	*#1 Pre bid and Post bid consultancy work for 110 kV transmission, Rwanda*
YEAR	2016-17
LOCATION	MUSHA-GABIRO
CLIENT	Joint venture NPD and Patronics, **Kigali-Rwanda (East Africa)**
MAIN PROJECT FEATURES	Pre bid and Post bid consultancy work for 110 kV transmission lines through Musha-Gabiro to Rulindo including foundation design
POSITIONS HELD	Team leader
ACTIVITIES PERFORMED	● Carry out survey and prepare transmission line survey report ● Design of transmission network with technical specifications ● Load flow analysis ● Preparation of bill of materials ● Foundation design
NAME OF ASSIGNMENT	*#2 Design and Engineering for 330 kV D/C Transmission Line and Tower*
YEAR	2017-18
LOCATION	**Nigeria**
CLIENT	Skipper Limited, Kolkata, India
MAIN PROJECT FEATURES	Survey, design, specifications of 330kV double circuit transmission line,
POSITIONS HELD	Team member
ACTIVITIES PERFORMED	● Transmission line survey and preparation of survey report ● Design and preparation of technical specification of substation and transmission line ● Load flow analysis
NAME OF ASSIGNMENT	*#3 Technical Consultancy Services for AEML's 220 kV Transmission Lines*
YEAR	2019-20
LOCATION	Mumbai
CLIENT	Adani Electricity Mumbai Ltd.
MAIN PROJECT FEATURES	Technical consulting services for AEML's 220 kV transmission line modification works for the NHSRCL (Bullet Train) project.
POSITIONS HELD	Team leader
ACTIVITIES PERFORMED	Acting as a team leader, providing all sorts of technical support to the client for smooth execution of projects. ● Design of towers and foundation ● Validation of vendor documents and technical support / guidance to vendors ● Analysis of selected transmission line routes and load flow analysis
NAME OF ASSIGNMENT	**#4 Survey and finalization of technical specification for 400kV D/C Transmission line of 115 Kms from Vadodara to Dahej**
YEAR	2014-15
LOCATION	Vadodara, Gujarat, India
CLIENT	M/s Inabesea Bharat
MAIN PROJECT FEATURES	Survey and finalization of technical specification for 400kV D/C Transmission line
POSITIONS HELD	Project Head
ACTIVITIES PERFORMED	● Transmission line survey and preparation of survey report ● Design and preparation of technical specification of substation and transmission line ● Load flow analysis
NAME OF ASSIGNMENT	*#5 Pre-bid Survey*
YEAR	2012-13
LOCATION	Hyderabad, India
CLIENT	LandT, IDPL, Chennai, India
MAIN PROJECT FEATURES	Pre-bid Survey of 765kV D/C Vemagiri – Khammam (50 Kms) and Khammam – Hyderabad transmission line and for 765kV D/C (250+250 Kms).
POSITIONS HELD	Team Leader
ACTIVITIES PERFORMED	● Transmission line survey and preparation of survey report

	● Design and preparation of technical specification of substation and transmission line ● Load flow analysis
Name of Assignment	*#6 Transmission line route survey*
Year	2014-15
Location	Jharsuguda, Orissa
Client	Vedanta Power Limited
Main project Features	Route Survey For 400 kV Extension LILO-1 and LILO-2 Transmission Lines from The Existing LILO Point to PGCIL Pooling Station from the IPP project at Jharsuguda, Orissa
Positions Held	Team Leader
Activities Performed	● Interconnection grid connection analysis ○ Analysis of selected transmission line routes ○ Load flow analysis ○ Analysis of existing substation, space and bay availability and expansion possibility ● Design and preparation of technical specification of substation and transmission line
Name of Assignment	*#7 Detailed survey and cadastral survey of D/C transmission line*
Year	2012-13
Location	Navsari, Mumbai
Client	Torrent Power Limited
Main project Features	Dahej-Vadodara 400 kV double circuit line and Navsari-Bhestan 220 kV D/C Transmission line associated with DGEN thermal power plant
Positions Held	Team Leader
Activities Performed	● Survey planning and execution ● Interconnection grid connection analysis ○ Analysis of selected transmission line routes ○ Load flow analysis ○ Analysis of existing substation, space and bay availability and expansion possibility ● Design and preparation of technical specification of substation and transmission line

Languages:

Language	Speaking	Reading	Writing
English	Good	Good	Good
Hindi	Good	Good	Good

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

 **Signature of authorized signatory**	**Date: 10-Dec-20**

Full Name of Staff Member: Kishor Gulabrao GAIKWAD
Full Name of Authorized Representative: R RAJMOHAN

1.6 Sunil Sekhar SENAPATI, Mechanical Engineer

Proposed Position: Mechanical Engineer
Name of Firm: Development Environergy Services Ltd.
Name of Staff: Sunil Sekhar SENAPATI
Profession: Power Plant Engineer
Date of Birth: 11-May-86
Years with Firm/Entity: 7 years **Nationality:** Indian

Membership in Professional Societies:

- Certified Energy Auditor, (CEA-27552), Bureau of Energy Efficiency, India, 2018
- Certified Energy Manager (CEM®- 96550), Association of Energy Engineers, 2019

Detailed Tasks Assigned:

- Preparation of data collection formats etc; Waste projection for project tenure, preparation of power generation scheme, finalization of nos. of lines, capacity estimation (Task-1)
- Establish technical requirements and feasibility of power plant, capacity finalization, equipment selection, layout options analysis, guide draftsman for equipment placement, drawings for the waste logistics inside the plant, waste storage and feeding, incinerator, flue gas cleaning system, power house building etc (Task-5)
- Basic design, technical specification, performance guarantee parameter of power plant
- Preparation of organization structure and staffing, roles and responsibility (Task-7)
- Development of implementation programme for the project, finalization of EPC mode or project contract package mode; preparation of implementation schedule, estimation of person-months, expenditure disbursement schedule (Task-8)
- Support team leader for preparation of interim reports and draft feasibility report

Key Qualifications:

Sunil Sekhar SENAPATI, DESL has over 10 years of experience in mechanical engineering design and consulting for power plants. He has been involved in basic design and preparation of technical specifications for waste to energy power plants. He has experience in calculation of balances and preparation of various basic engineering diagrams such as process flow diagram (PFD), heat and mass balance diagram (HMBD), basic engineering of mechanical systems including fuel, ash, steam and water systems, piping isometrics; preparation of BOM and BOQ and tender documents, vendor consultation.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
Indira Gandhi Institute of Technology, BPUT Odisha	Bachelors in Mechanical Engineering	2010

Employment Record:

From	To	Employer	Positions Held
2013	Till Date	Development Environergy Services Ltd.	Associate Consultant, Senior Analyst
2010	2013	Pranat Engineers Pvt. Ltd, Delhi	Assistant Manager

Relevant project experience includes the following:

NAME OF ASSIGNMENT	***Experience in Africa*** ***#1 Feasibility Assessment for Daraju Industries Ltd., Nigeria***
YEAR	2018
LOCATION	Nigeria
CLIENT	Daraju Industries Ltd. (DIL)
MAIN PROJECT FEATURES	DIL engaged the services of DESL for carrying out a feasibility study for waste heat utilization projects. The objective is to recover part of the heat wasted during various manufacturing processes that can be used for different applications with attractive financial return.
POSITIONS HELD	Team member
ACTIVITIES PERFORMED	● Interaction with field engineers on the proposed options and obtaining feedbacks ● Carrying out basic engineering and identifying constraints ● Preparation of the layout for retrofitting of the WHU devices based on different options ● Development of the solution option (s) to address the constraints ● Pressure profiling of the proposed systems under different options ● Review engine and fan characteristics graphs to assess impact on capacity and efficiency

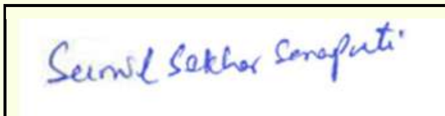
	● Assessment of the net gain from the proposed WHU project under different options ● Freezing of options for feasibility analysis
NAME OF ASSIGNMENT	*Waste to Energy* *# 2 Preparation of detailed project report and Engineering and project management services for setting up an integrated solid waste management project at Sonepat*
YEAR	2018-20
LOCATION	Sonepat, Haryana
CLIENT	JBM Environment Management Pvt. Ltd.
MAIN PROJECT FEATURES	DESL was engaged in providing engineering and project management services for setting up 600 t/d waste management project including 10 MW waste to energy facility
POSITIONS HELD	Team Member (Mechanical Engineer)
ACTIVITIES PERFORMED	● Preparation of technical drawings ● Preparation of piping and instrumentation (PandI) diagrams for major systems and utilities ● Preparation of design basis documents for equipment/packages ● Carrying out required detailed engineering and preparation of technical data sheets for individual packages ● Troubleshooting, resolving, design/engineering and interface related issues during erection, commissioning and stabilization period of project, etc. *The pre-commissioning of the plant is planned in January 2021 and will be fully operational by March 2021.*
NAME OF ASSIGNMENT	*Waste to Energy* *# 3 900 t/d waste to Energy (WtE) Project at Ghaziabad*
YEAR	2018
LOCATION	Ghaziabad, Uttar Pradesh
CLIENT	Accord Hydroair Pvt. Ltd.
MAIN PROJECT FEATURES	Accord Hydroair Pvt. Ltd. (AHPL) is in the process of setting up a waste to energy project at Ghaziabad for 900 t/d of municipal solid waste (MSW). AHPL engaged services of DESL for preparing a detailed project report for this proposed facility.
POSITIONS HELD	Team Member (Mechanical Engineer)
ACTIVITIES PERFORMED	● Heat and Mass Balance Diagram (Model for iteration) ● Process flow diagram ● Water balance diagram ● Master P&ID ● Technical specifications for main plant and machinery ● Project implementation schedule ● Procurement plan including identification of contract packages ● Base cost estimate
NAME OF ASSIGNMENT	*Waste to Energy* *#4 Preparation of DPR including WTE, ISWM, Study of Existing C&T and Survey/Test for 1,000 t/d, 20 MW for Indore Project*
YEAR	2018
LOCATION	Indore, India
CLIENT	Indore MSW Management Pvt. Ltd. (A part of Essel Infra Projects Limited)
MAIN PROJECT FEATURES	DESL was engaged in preparation of a detailed project report (DPR) as well as study of existing collection and transportation (C&T) and survey of the waste generated in the city
POSITIONS HELD	Team Member
ACTIVITIES PERFORMED	● Monitoring of the work carried out by teams deployed at the site for C&T study, waste characterization and topographical survey and soil investigation ● Preparation of technical drawings ● Preparation of technical chapters for the report ● Preparation of general process flow diagram; water balance diagram; layout; electrical single line diagram; master P&ID

	● Preparation of a generic and modular layout
Name of Assignment	*Waste to Energy* *#5 , #6, #7 Preparation of detailed project reports for three waste to energy projects at Guntur, Visakhapatnam and Tirupati (3 independent assignments)*
Year	2016
Location	Guntur, Visakhapatnam, Tirupati (Andhra Pradesh)
Client	Jindal Urban Waste Management Limited
Main project Features	JUIL engaged DESL to prepare DPR for the WtE project at Guntur (1000 t/d), Visakhapatnam (1100 t/d), Tirupati (450 t/d)
Positions Held	Team member
Activities Performed	● Preparation of PFD's ● Preparation of technical specifications ● Preparation of technical drawings
Name of Assignment	*Waste to Energy* *#8 Bid management services for 3000 TPD integrated solid waste management project at MCGM, Mumbai*
Year	2016
Location	India
Client	Ecogreen Energy Private Ltd, Gurgaon
Main project Features	A request for proposal was issued by the Municipal Corporation of Greater Mumbai (MCGM) for designing, building and operating a 3,000 TPD, solid waste to energy plant at Deonar, New Mumbai. DESL was engaged by Ecogreen Energy Pvt. Ltd.for preparation of bid documents.
Positions Held	Team Member
Activities Performed	● Preparation of Bid documents ● Preparation of the technical drawings ● Preparation of various information required for bidder's qualification for the proposed WtE plant

Languages:

Language	Speaking	Reading	Writing
English	Good	Good	Good
Hindi	Good	Good	Good
Odia	Good	Good	Good

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

 **Signature of staff member**	**Date: 10-Dec-20**

Full Name of Staff Member: Sunil Sekhar SENAPATI
Full Name of Authorized Representative: R RAJMOHAN

1.7 Devendra Kumar UTREJA, Civil Engineer

Proposed Position: Civil Engineer
Name of Firm: Development Environergy Services Ltd.
Name of Staff: Devendra Kumar UTREJA
Profession: Civil designer
Date of Birth: 26-Feb-64
Years with Firm/Entity: Intermittent, project based since last 4 years **Nationality:** Indian

Membership in Professional Societies: -

Detailed Tasks Assigned:

- Team member of field mission for siting study (Task-2)
- Guide the geotechnical and soil investigation team (Task-3)
- Review and provide the expert comments on topographical and geotechnical study report (Task-3)
- Conceptual design of civil foundation and structure as per the detailed site investigation reports; preparation of layout drawings, different plans and sections of major buildings, preparation of bird eye view (Task-5)
- Preparation of bill of quantities and related cost for civil foundations and structures (Task-8)

Key Qualifications:

Mr. DK UTREJA, is a civil engineer with a Master's degree in soil mechanics and foundation engineering from Indian Institute of Technology (IIT), Delhi. He has been heading a civil and structural engineering consulting firm for the last 28 years rendering services in the power plants, waste to energy plants, material handling plants, ash handling plants, water/sewage treatment plants, commercial complexes, underground structure such as tunnels, large industrial sheds, distilleries, refineries, sugar plants, communication towers, sea intake line and pump house, temporary works for metro railways etc. He has successfully completed 500 projects of various nature of industrial application. His competencies include strategic planning of projects from inception to completion upto preparation of as-built drawing, interfaces between various activities related to electrical, mechanical, process, HVAC and instrumentation engineering. Mr Utreja is proficient in use of software like BIM, STAAD Pro including finite element analysis, devising the detailed and abstract estimates, bill of quantities for estimation and tendering purpose.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
Indian Institute of Technology (IIT) Delhi	Master of Technology (Soil Mechanics and Foundation Engineering)	1989
Delhi College of Engineering	Bachelor of Engineering (Civil)	1985

Employment Record:

From	To	Employer	Positions Held
1991	Till Date	RDA Civil Engineering Systems Pvt Ltd.	Director
1988	1991	Civil Engineering Systems	Partner
1985	1988	Simplex Concrete Piles Pvt. Ltd.	Assistant Engineer

Relevant project experience includes the following:

NAME OF ASSIGNMENT	***#1 Feasibility study for 600 t/d waste to energy plant (10 MW)***
YEAR	2020-Ongoing
LOCATION	Amritsar, Punjab, India
CLIENT	DESL for Averda Waste Management
MAIN PROJECT FEATURES	The objective of the assignment is to process MSW (600 t/d) using appropriate technology, carrying out bioremediation of the accumulated waste and closure of the old MSW dump site. This would be in accordance with MSW (Handling and Management) Rule 2016 to ensure that the project meets stipulated pollution norms and guidelines for the MSW that is handled and managed.
POSITIONS HELD	Civil/ Structural Engineer
ACTIVITIES PERFORMED	Responsible for siting study, preparation of specifications for geotechnical and topographic studies, selection of bore holes, suggest the remediation of dumped waste at landfill, innovative design of foundation for WtE plant equipment, preparation of bill of quantities for civil items etc.
NAME OF ASSIGNMENT	***#2 Civil and structural design for secured hazardous waste landfill for refinery***
YEAR	2016
LOCATION	Panipat, Haryana

Client	Indian Oil Corporation Limited
Main project Features	Refinery expansion project
Positions Held	Civil/ Structural Engineer
Activities Performed	Responsible for optimising civil design. Major activities included the review of soil investigation studies, design of civil foundations and structural details, landfill design and design of allied infrastructure buildings.
Name of Assignment	***#3 600 t/d waste to energy plant and sanitary landfill***
Year	2018-20
Location	Sonepat, Haryana, India
Client	DESL (for JBM Environment Management Pvt. Ltd).
Main project Features	The 600 t/d, 10 MW project comprises civil study for MSW pit, Power house, ACC ,Boiler and other structures required for power plant
Positions Held	Civil/ Structural Engineer
Activities Performed	Involved in the feasibility of selection of waste to energy plant and sanitary landfill, review of the all the studies conducted for soil investigations, guide the geological expert for selection of bore holes, right selection of foundation design after review the geological study and topographic survey, design of foundations for all equipments such as ramp for vehicle movement, tipping hall, municipal waste pit, incinerator, steam turbine, air cooled condenser, water treatment plant etc.
Name of Assignment	***# 4 - 12 MW waste to energy plant in Sri Lanka***
Year	2017-18
Location	Sri Lanka
Client	ISGEC
Main project Features	The project comprises of MSW pit, Power house ,ACC ,Boiler and other structures required for Power plants
Positions Held	Civil/ Structural Engineer
Activities Performed	Involved in review of specifications for soil investigation works, selection of type of foundation as per the geotechnical studies for the waste to energy equipment.
Name of Assignment	***# 5 Material handling for 3X500 MW thermal power plant***
Year	2008 to 2011
Location	India
Client	National Thermal Power Corporation Ltd.
Main Project Features	The project has Wagon Tippler, an underground structure for unloading of railway wagons which is 20 m deep below ground level. The project has a crusher house 40 m high with Transfer points which are 75 to 80 m tall structures
Positions Held	Civil/ Structural Engineer
Activities Performed	Involved in review of soil investigation reports, civil foundation and structural design for Track Hopper, Crusher Houses (2 Nos.), , Double Conveyor Tunnels, Conveyor Galleries, etc. Wagon Tippler, Crusher House on Pile Foundations, Double Conveyor Tunnels, Stacker Reclaimer, Roads & Drains, Junction House (13.5m x 16.0m x 75m ht) Underground Transfer Points 4 Nos., Electrical Control Room, Pump Houses, Coal Stock Yard with drains. etc
Name of Assignment	***# 6 Ash handling system for Mauda Thermal Power Project (2x500MW -Unit –I and II)***
Year	2017
Location	India
Client	National Thermal Power Corporation Ltd.
Main Project Features	The project has Ash silos of capacity 1000 MT and pipe racks
Positions Held	Civil/ Structural Engineer
Activities Performed	Involved in review of soil investigation reports, civil foundation and structural design for ash conditioner water tank, ash slurry pump house, B.A. slurry pipeline, boiler area, drain sump silo area, guard room, HCSD disposal pipe line, HCSD

	pump house, inplant BA slurry pipeline, mixing tank, pipe rack, transport air compressor, vacuum pump etc
NAME OF ASSIGNMENT	*#7 to #13 Water treatment plants for power plants*
YEAR	2002 to 2020
LOCATION	India
CLIENT	Multiple power plants
MAIN PROJECT FEATURES	Civil and structural design of water treatment plants for the following: ● 1x30 MW Captive Power Plant Jamshedpur (Jharkhand) ● Harduaganj Thermal Power Project (2x250MW) ● Aravali Super Thermal Power Project Jhajjar (3X500MW), ● National Capital Thermal Power Project Stage –II (2X490MW), Dadri, ● Vindhyachal Super Thermal Power Project Stage-IV (2X500MW), ● 210MLD UASB STP at Bingawan, Kanpur, U.P, ● 4X135 MW Phase-II Captive Power Project at Dongamahua Raigarh
POSITIONS HELD	Civil Engineer
ACTIVITIES PERFORMED	Involved in review of soil investigation reports, civil foundation and structural design for Coagulant Tank, DM Exchanger, Regeneration & DM Pump House, Cascade Aerator, Central Monitoring Basin & Sump cum pump house, channel, Chemical House, Coal Decanted Water Sump & Pump House for P.T. Plant, Coal Slurry Settling Pond & Coal decanted water Sump for PT Plant, DM Water Storage Tank, Filter House & Filter Water Reservoir, Lab-DM- AC Plant Building, Clarifier Water Tank & Pump House, Waste Service Water Sump, Chlorination Building, Crane Girder, Desalting Basin & Raw Water Pump House, Filter Backwash Pit, Sump cum pump house, Flash Mixer, Flocculator and Tube Settler, Degasser Area, Raw Water Pump House, Switchgear & Control Room, Clarifier, Acid Alkali Storage Tank, Clarifier Water Tank, DM Plant Exchanger Area, Lime Tank, Neutralization Pit etc

Languages:

Language	Speaking	Reading	Writing
English	Good	Good	Good
Hindi	Good	Good	Good

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

 **Signature of staff member**	**Date: 10-Dec-20**

Full Name of Staff Member: Devendra Kumar UTREJA
Full Name of Authorized Representative: R RAJMOHAN

1.8 NISHA MENON, FINANCIAL ANALYST/ ECONOMIST

Proposed Position: Financial Analyst/ Economist
Name of Firm: Development Environergy Services Ltd.
Name of Staff: Nisha MENON
Profession: Investment analysis of power projects
Date of Birth: 04-May-1970
Years with Firm/Entity: 20 years **Nationality:** Indian
Membership in Professional Societies:

- Society of Energy Engineers and Managers, India
- Solar Energy Society of India
- Society of Power Engineers, India

Detailed Tasks Assigned:
Financial modelling of the WtE Project, including life cycle cost assessment for estimation of LCOE and determination of fund flow based on the implementation schedule (Task-3 and Task-8)
Economic analysis model for the WtE Project (Task-8)
Development of a preliminary value-for-money analysis for PPP option (Task-8)
Preparation of financial investment memorandum (Task-8)

Key Qualifications:
Ms. Nisha MENON, Chief Consultant, DESL, a mechanical engineer with a master's degree in energy management and Diploma in Business Finance has over 27 years of experience in energy management and renewable energy (including waste to energy) project development. She is conversant with methods of financial and economic analysis including review of cost estimates, financing plans, development of financial models, techno-economic analysis, and sensitivity analysis as per norms of Indian and International financial institutions. She has been part of the lender's due diligence team for power sector projects (in generation, transmission, distribution) financed by the Asian Development Bank in Bangladesh, Sri Lanka, Nepal, Pakistan and China, leading to deals for over US$ 2.2 billion. She was team member of an activity under the World Bank funded NamSIP project, under which feasibility studies were prepared for several demand side and supply side interventions for clean energy in the five counties in the Nairobi Metropolitan Region. She is currently the project manager for an engagement to provide transaction advisory services for an integrated solid waste management project including a 40 MW waste-to-energy project in a Carribean country.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
ICFAI University	〈-Level Diploma in Business Finance	2006
Bharathidasan University, India	Master's in Energy conservation and management	1994
Bharathidasan University, India	Bachelor's in Mechanical engineering	1992

Employment Record:

From	To	Employer	Positions Held
2000	Till Date	Development Environergy Services Ltd.	Chief Consultant, Principal Consultant, Senior Consultant, Consultant, Senior Analyst, Analyst
1997	2000	Winrock International	Project Officer
1994	1997	IREDA Ltd	Asst. Technical Officer, Executive Trainee

Relevant project experience includes the following:

NAME OF ASSIGNMENT	*Waste-to Energy* *# 1 Transaction advisor for the structuring and execution of an ISWM PPP Project*
YEAR	2021-22
LOCATION	Jamaica

CLIENT	Development Bank of Jamaica
MAIN PROJECT FEATURES	Preparation of business case and transaction structure for the proposed PPP Project. Support for transaction execution
POSITIONS HELD	Project Manager, Financial Expert
ACTIVITIES PERFORMED	Initial due diligence of options and evaluation of at least three PPP models. Detailed financial model for the finalized PPP model, verify compliance with PPP assessment criteria including macro-economic impact, value for money, fiscal impact and affordability and preparation of project information memorandum. Participation in market sounding activities. Evaluation of bids for confirming and validating the value for money analysis.
NAME OF ASSIGNMENT	*Waste-to Energy* *# 2 Preparation of detailed project reports for integrated solid waste management / waste- to-energy projects*
YEAR	2010 onwards
LOCATION	India
CLIENT	Multiple projects as listed below; ● Waste to energy plant at Old Chandrapur Thermal Power Station area by Assam Power Generation Corporation Ltd., 2020 ● 500 TPD integrated solid waste management facility by JBM Environment Management (P) Ltd., at Sonepat, 2019 - *The plant is expected to be fully operational by March 2021* ● 1,000 TPD (20 MW) integrated solid waste management project at Indore by Indore MSW Management (P) Ltd. 2017 ● 1200 TPD integrated solid waste management project at Gurugram by Ecogreen Energy (P) Ltd., 2017 ● 1500 TPD integrated solid waste management project at Lucknow by Ecogreen Energy (P) Ltd., 2017 ● Waste to energy projects at three (3) locations in Andhra Pradesh (Tirupati (6MW), Visakhapatnam (15 MW) and Guntur (15 MW)) by Jindal Urban Infrastructure Ltd., 2016 ● 200 TPD integrated waste to fuel plant in Varanasi by Indian Oil Corporation Ltd., 2016 ● 21 MW integrated MSW to energy project by Jindal Urban Infrastructure Ltd.at Okhla, New Delhi (2010) - *The plant is operational since 2011*
MAIN PROJECT FEATURES	Feasibility studies and detailed project reports for integrated solid waste management / waste- to-energy projects
POSITIONS HELD	Financial Expert
ACTIVITIES PERFORMED	● Review of a) investment estimates b) structuring working capital requirements based on the project implementation agreements (PPP agreement, power purchase agreement), c) financial model and projections d) risk analysis ● Assessment of completeness of investment estimates including land requirements, water availability, provisions for environmental compliance, and costs of obtaining various permits and clearances ● Develop a detailed financial model for the proposed viable option ● Explore financing options and identify potential lenders ● Review and recommendations on carbon financing
NAME OF ASSIGNMENT	*# 3 Due diligence of Waste-to-Energy Projects*
YEAR	2010 onwards
LOCATION	India
CLIENT	Multiple projects as mentioned below; ● 1,500 TPD (15 MW) waste to energy project by A2Z Maintenance and Engineering Services (Lender/ Client- IL&FS Financial Services Ltd., 2015) ● 15 MW Waste based power Plant (Lender/ Client- Yes Bank and Axis Bank., 2013) ● Lenders Engineering Services for the Timarpur Okhla Waste Management Ltd.'s project in New Delhi (Lender/ Client- ICICI Bank., 2010-11)
MAIN PROJECT FEATURES	Due diligence of Waste-to-Energy Projects
POSITIONS HELD	Financial expert/ Project Manager

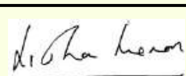
ACTIVITIES PERFORMED	● Pre-approval stage ○ Validation of project viability and financial analysis ○ Review of investment estimates, review of revenue model and project financial analysis ○ Review of project facilities, equipment supply, construction schedule, project cost estimate, performance guarantee, performance testing criteria ● Implementation stage ○ Periodic monitoring and draw down certification ● Post implementation and commissioning ○ Witnessing performance testing, Project completion report and annual performance reports
NAME OF ASSIGNMENT	*Other Power Sector Projects* *# 4 Financial due diligence of electricity sector investments*
YEAR	2004-2017
LOCATION	Sri Lanka, Pakistan, Bangladesh, China
CLIENT	Asian Development Bank
MAIN PROJECT FEATURES	● Green Power Development and EE Improvement Investment Program, Sri Lanka, 2016 - US$ 260 Million investments in electricity transmission, distribution and smart grids ● Multitranche Financing Facility for the Power Transmission Enhancement Investment Program-II, Pakistan, 2016 - US $ 120 Million in eight transmission upgradation projects ● Preparation of Tranche 3 Project under Bangladesh Power System Expansion and Efficiency Improvement Investment Program, Bangladesh, 2015 - US $ 1,130 Million investments in gas based power generation plant, 132 kV transmission lines, large scale prepaid metering project and distribution system upgrades, rehabilitation, extension and rural electrification ● Energy Access and Efficiency Improvement Project II, Nepal, 2011 for a US$ 100 million loan for three major transmission network projects ● Power System Efficiency improvements Project II, Bangladesh, 2012 - US$ 325 Million loan for three topping cycle power plants and 3 transmission lines ● Power System Efficiency Improvement Project, Bangladesh, 2010-11- S $ 300 Million loan for a 425 MW combined cycle power plant and three renewable energy projects ● Gansu Heihe Hydropower Development Project, China, 2006-07 - US$ 70 million loan for the 65 MW Dagushan Hydropower Project and 45 MW Erlongshan Hydropower Project.
POSITIONS HELD	Financial Analyst
ACTIVITIES PERFORMED	● Financial analysis of sub-projects including preparing project cost table, prepare financing plan; carrying out in-depth financial analysis of the proposed investment components including preparing cash flow forecasts ● Identify all risks to project revenues and costs, conduct relevant sensitivity analysis, and identify potential risk mitigation strategies and approaches; ● Financial management assessment of implementing agency , including a review of corporate planning and budgetary control, financial management accounting and reporting, internal control and audit systems, and data processing, to identify any financial issues that could affect project implementation and/or sustainable operations of project investments and suggest mitigation strategies; reviewed financial statements to assess its historical financial performance, retail tariff levels, and capital structure and ensure that it can generate sufficient internal funds to ensure the sustainability of ongoing operations; prepared pro forma financial statements and identified appropriate financial performance indicators
NAME OF ASSIGNMENT	*Experience in Africa* *# 5 Consulting Services for undertaking feasibility study, design and bidding documents for Energy Assessments in the five counties within Nairobi Metropolitan Region*

Year	2015
Location	Kenya (5 counties within the Nairobi Metropolitan region; Nairobi City, Kiambu, Kajiado, Machakos and Murang'a)
Client	Ministry of Land Housing and Metro Development, Nairobi Metropolitan Development
Main project Features	The Ministry of Land, Housing and Urban Development (MoLHandUD) received the assistance of the World Bank through the Nairobi Metropolitan Services Project (NaMSIP) which included a component to support institutional reform and planning to assist in the areas of capacity enhancement and urban planning. One of the objectives was to identify opportunities for enhancing energy generation (for example solid waste management measures, among others) if any, and propose modalities for the implementation of the proposed measures. I
Positions Held	Team member
Activities Performed	● Feasibility studies for utilization of market waste for biogas generation in three counties ● Preparation of design and bidding documents
Name of Assignment	*Experience in Africa* *# 6 Consultancy Services to carry out power cogeneration feasibility study*
Year	2014-15
Location	Malawi
Client	Ministry of Natural Resources Energy and Mining
Main project Features	Project structuring in two private sector sugar mills, facilitation of dialogue between the Government, Regulator (MERA), electricity supplier (ESCOM) and the private developer (Illovo Sugar) for cogeneration implementation in two sugar mills
Positions Held	Power Economist
Activities Performed	Financial and economic analysis, review of the tariff setting process and calculating LCOE,

Languages:

Language	Speaking	Reading	Writing
English	Excellent	Excellent	Excellent
Hindi	Good	Good	Good
Malayalam	Good	Fair	Fair
Tamil	Good	Fair	Fair

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.



Signature of staff member

Date: 10-Dec-20

Full Name of Staff Member: Nisha MENON
Full Name of Authorized Representative: R RAJMOHAN

1.9 Geoffrey Nagillah MAKANGA, Environmentalist

Proposed Position: Environmentalist
Name of Firm: Seureca East Africa Ltd.
Name of Staff: Geoffrey Nagillah MAKANGA
Profession: Renewable Energy ESIA Consultant
Date of Birth: 26/05/1984
Years with Firm/Entity: Intermittent, project based **Nationality:** Kenyan
Membership in Professional Societies:
- Certified Energy Manager and Auditing (International)-92577
- Registered Environmental Audit Lead Expert (NEMA)-2330

- Registered Member Kenya Engineering Technology Registration Board (KETRB)-P.Eng. Tech M.I.E.T (PET00199)
- Registered Member Engineers Board of Kenya – B14382
- Registered Member Institution of Engineering Technologists and Technicians of Kenya-1403
- Registered Member Environment Institute of Kenya; Registered Hydrologist, Hydrological Society of Kenya. Reg. No. RO-00010/08/2014

Detailed Tasks Assigned: Environmental impact analysis (Task 6A)

Key Qualifications:

Geoffrey has Master's in Business Administration-Strategy and BS (Hons.) Water and Environmental engineering with about 10 year working experience in the RE sector. He has extensive working experience as an environmental and social expert in infrastructure projects with specialization in conducting ESIA/ EIA/ SIA studies and preparing ESIA/ EIA/ ESMP / EMMP/ RAP/ EHS reports. He has proven experience in conducting feasibility studies especially in Solar PV and Small Hydropower Plant projects.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
United States International University Africa (USIU), Africa	Master's in Business Administration - Strategy	2018
Egerton University, Kenya	BS (Hons.) Water and Environmental Engineering	2009

Employment Record:

From	To	Employer	Positions Held

NAME OF ASSIGNMENT	**#1 Proposed Water Supply project for UNMISS and UNICEF, Juba, South Sudan**
YEAR	2018
LOCATION	Juba, South Sudan
CLIENT	SMEC International Pty Limited
MAIN PROJECT FEATURES	Water Supply project
POSITIONS HELD	ESIA Specialist
ACTIVITIES PERFORMED	• Policy, legal and regulatory framework; Socio-Economic Survey; Public consultations and disclosure; Occupational, health and safety risk; Social Impact assessments; Develop an Environmental and Social Management Plan (ESMP); • Compile and submit a full ESIA study report to NEMA in accordance with the Environmental (Impact Assessment and Audit) Regulations
NAME OF ASSIGNMENT	**#2- Floating Solar PV Potential at KenGen's three main Hydropower Reservoirs located in Kamburu, Kiambere and Turkwel.**
YEAR	2020
LOCATION	Kamburu, Kiambere and Turkwel.
CLIENT	KenGen
MAIN PROJECT FEATURES	Floating Solar PV on Hydropower Reservoirs
POSITIONS HELD	ESIA Lead Expert
ACTIVITIES PERFORMED	• Review of relevant legislative frameworks, regulatory and policy framework influencing the project. • Description of the proposed project • Project Screening/ Identification of probable impacts of the proposed development on the environment.

	● Propose sufficient mitigation measures for anticipated negative impacts through an ESMP ● Consideration of the viable project alternatives
NAME OF ASSIGNMENT	**#3and4 Proposed 10 MW and 40 MW solar PV**
YEAR	2017-18
LOCATION	Kenya
CLIENT	● 10 MW at Tractor Village, Meru County by Solarion Investment Limited, 2017 ● 40 MW at Ngaremara ward, Meru County by Orion Solar Ltd., 2018
MAIN PROJECT FEATURES	Stakeholders management and land negotiations
POSITIONS HELD	Design Engineer and ESIA Lead Expert
ACTIVITIES PERFORMED	Conducted ESIA study with the Environmental (Impact Assessment and Audit) Regulations, 2003; Identify, evaluate, investigate, measure, interpret and track Environmental System Analysis and risk Management. Development of Environmental Management and Monitoring Plan (EMMP), Resettlement Action Plan (RAP) and Environment, Health and Safety (EHS) which is an essential tool in developing rules that will regulate environmentally instigated impacts and occupational safety measures during construction.
NAME OF ASSIGNMENT	**#5 - 4.6 MW Musembe-Nzoia SHP, Trucks City Ltd., 2017** **#6 - 1.5 MW Tindinyo on R. Yala, Small Hydro Electric Power Project, Tindinyo Falls Resort Ltd., 2012** **#7 - 4.5 MW Musembe Nzoia, Trucks City Limited, 2017-18** **#8 - 200kW mini hydro power EIA for Thiwasco, 2018-19**
YEAR	Multiple (mentioned above)
LOCATION	Kenya
CLIENT	Multiple (mentioned above)
MAIN PROJECT FEATURES	Hydropower
POSITIONS HELD	Design Engineer and ESIA Lead Expert
ACTIVITIES PERFORMED	● Socio-Economic Survey; Develop an Environmental and Social Management Plan (ESMP); ● Compile and submit a full ESIA study report to NEMA in accordance with the Environmental (Impact Assessment and Audit) Regulations, 2003 for NEMA Approval; ● Identify, evaluate, investigate, measure, interpret and track Environmental System Analysis and risk Management. Development of Environmental Management and Monitoring Plan (EMMP), ● Resettlement Action Plan (RAP) and Environment, Health and Safety (EHS) which is an essential tool in developing rules that will regulate environmentally instigated impacts and occupational safety measures during construction and the operation phases of the proposed project; Acquisition of permits and licenses; ● Land Negotiation and acquisition
NAME OF ASSIGNMENT	**#9- Power Africa Power Projects**
YEAR	2013-16
LOCATION	East Africa- Uganda, Tanzania and Rwanda
CLIENT	Financial Inclusion for Rural Microenterprises (FIRM) programme under USAID-Kenya
MAIN PROJECT FEATURES	Renewable Energy Power Projects
POSITIONS HELD	Lead Project Technical Engineer and ESIA Specialist Advisor
ACTIVITIES PERFORMED	● 3.2MW Nyabuhuka- Mujunju SHP- Kabarole District, Uganda ● 3.9MW and 15.8MW Ngenge HP- Kapchorwa District, Uganda ● 10MW Rukarara and 2.8MW Mushishito SHP, on Gikingoro, Rwanda ● Kilimbi I- 540 kW, Kilimbi IIand III- 1.108MW, Nyamasheke District, Rwanda

	● 4.5MW Amahoro Nyundo3 SHP, Ruhengeri/Gakenke, Rwanda ● 2x5MW EA Power SHP, on Kiwira River, Mbeya Region, Tanzania ● 14.6MW Nakatuta SHP, on R. Ruvuma, Songea rural district, Tanzania ● 8MW Kikuletwa II SHP on R. Kikuletwa, Kilimanjaro Region, Tanzania ● ESIA and Full Feasibility Design

Languages:

Language	Speaking	Reading	Writin
English	Excellent	Excellent	Excelle
Swahili	Excellent	Excellent	Excelle

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

To be added **Signature of staff member**	**Date:** 10-Dec-20

Full Name of Staff Member: Geoffrey Nagillah MAKANGA
Full Name of Authorized Representative: Christophe LACARIN

1.10 Emmanuel CORBEL, Project Coordinator

Proposed Position: Project Coordinator
Name of Firm: Seureca East Africa Limited
Name of Staff: Emmanuel CORBEL
Profession: Project Manager/Team Leader/ Technical Manager
Date of Birth: 1981
Years with Firm/Entity: 7 years **Nationality:** French (Resident in Kenya)
Membership in Professional Societies:

- Association des Professionnels (AdP – Villes en Développement)
- Association des Ingénieurs Européens ((EURopean Engineer – Register N°31309)
- Engineers and scientists of France – Register N°389736

Detailed Tasks Assigned:

- Support for organizing the stakeholder consultations
- Coordination with consortium partners, sub-consultants and client for day to day activities for smooth execution of feasibility study
- Lead the field mission and facilitate the field team for data collections, waste sample collection, siting study, geotechnical & field investigation studies
- Support of organizing the inception workshop and capacity building workshop

Key Qualifications:
Mr. Corbel has professional experience of more than 14 years. He has a masters degree in contract management of urban infrastructure (water and wastewater, solid waste, energy). Currently he is working for SEURECA Consulting Engineers as Project Manager/Team Leader/ Technical Manager and is responsible for leading water and sanitation engineering teams involved in: master planning, design, works supervision, bid proposal and contract management. He has completed training in PMP Prep Training 2020 from Project Management Institute - PMI and FIDIC Training: the practical use of the FIDIC Conditions of Contract, Claim Management and Dispute resolution.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
Institut d'Etudes Politiques (IEP) de Rennes (Sciences PO)	M.Sc. in Contract Management of Urban Infrastructures (water and wastewater, solid waste, energy)	2005

Ecole IMT Mines Albi	M.Sc. in Civil and Integrated Urban Water Management Engineering	2004

Employment Record:

From	To	Employer	Positions Held
2013	Till date	SEURECA Consulting Engineers	Project Manager/ Team Leader/ Technical Manager
2012	2012	SGI International	Project Manager/Team Leader
2006	2012	Artelia Group	Project Manager/Hydraulic Expert

Relevant project experience include the following:

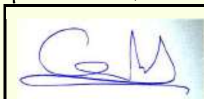
NAME OF ASSIGNMENT	*#1 Preparation of conceptual design, design & build tender documents (FIDIC YELLOW BOOK) and supervision of the design and works for Kapenguria and Chepareria towns sewerage project*
YEAR	June 2018 to date
LOCATION	Kenya
POSITIONS HELD	Project Manager and Team Leader
ACTIVITIES PERFORMED	● Provision of leadership, direction and guidance to the consultant's team in order to achieve the project objectives ● Leading the team in preparation of performance specifications, conceptual designs and tender documents for design and build contract for three sewerage systems. ● Liaison with all relevant stakeholders to ensure smooth implementation of all activities under the project. ● Review of all project reports prior to submission to the client ● Contract administration and construction supervision and performance control during the defects liability period
NAME OF ASSIGNMENT	*#2 Integrated sanitation master plan for Eldoret and selected satellite towns*
YEAR	2016-17
LOCATION	Kenya
MAIN PROJECT FEATURES	Developing a sanitation master plan for Eldoret Town and selected satellite towns (35 targeted towns within Uasin Gishu County) over 25 years and to cover all urban areas including the ones which will not be covered by conventional sewer systems, but need other kinds of sanitation management to assure that at least basic sanitation services are provided in urban areas
POSITIONS HELD	Team Leader and Project Manager
ACTIVITIES PERFORMED	● Condition surveys and environmental audit of existing facilities ● Immediate urgent works: detailed design and tender document ● Sanitation system analysis for the study's area ● Feasibility studies for sludge and treated effluents reuse, opportunities for renewable energies ● Integrated Sanitation Master Plan including pollution control strategy for industries ● Preliminary design for the infrastructure associated with the medium term works of the preferred strategy including 110 km of sewer network and Waste Water Treatment plant with a capacity of 25,000 m3/d.
NAME OF ASSIGNMENT	*#3 Consultancy services for study and design of storm water drainage system and preparation of Drainage & Sanitation Development Plan (DSDP) for Mtwara Mikindani Municipality for a period of 2020-2040*
YEAR	2019-2020
LOCATION	Tanzania
CLIENT	World Bank
MAIN PROJECT FEATURES	Study and design of storm water drainage system and preparation of drainage & sanitation development plan
POSITIONS HELD	Team Leader and Sanitation engineer

Activities Performed	● To develop an integrated Drainage and Sanitation Development Plan (DSDP) focusing on storm-water drainage, wastewater collection and treatment and faecal sludge management for the period from 2020 to 2040; ● To examine, propose and study/design a "priority project" (with approximate duration of 5 years, consisting of at least five sub-projects identified by the DSDP), to be presented by the Client to donors for potential future financing and implementation.
Name of Assignment	*#4 Design review, preparation of tender documents and supervision of construction works for Kipkarren Dam treatment works and associated pipelines*
Year	2017-Till Now
Location	Kenya
Main project Features	Design Review, Preparation of Tender Documents and Supervision of Construction
Positions Held	Team Leader – Water Supply Engineer – FIDIC RED BOOK
Activities Performed	● Detailed design review, tender documentations and tendering of works ● Familiarize with the Kipkarren Dam safety report and the AfDB project documents such as Resettlement Action Policy (RAP) and Environmental and Social Management Framework (ESMF) ● Design review the existing detailed design for Kipkarren Dam treatment works and pumping station ● Conduct design review of the associated pipework - provide specifications for the specific items of works ● Prepare bills of quantities with work quantity estimates to be used for tendering the works ● Prepare bidding documents including instruction to bidders, detailed engineering plans and drawings, technical specifications, model contract, special conditions of contract, and bills of quantities. ● Assess the capacity available in ELDOWAS against the human resource requirement for the effective operation of the proposed facilities and make appropriate training recommendations that would create the necessary capacity ● Contract administration and construction supervision and performance control during the defects liability period

Languages:

Language	Speaking	Reading	Writing
English	Excellent	Excellent	Excellent
French	Excellent	Excellent	Excellent
Portuguese	Excellent	Excellent	Excellent

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.



Signature of staff member

Date: 10-Dec-20

Full Name of Staff Member: Emmanuel CORBEL
Full Name of Authorized Representative: Christophe LACARIN

1.11 Sammy M. MUTAVI, Financial Modelling Expert

Proposed Position: Financial Modelling Expert
Name of Firm: Seureca East Africa Limited (SEAL) Associate
Name of Staff: Sammy M. MUTAVI
Profession: Investment Manager (SEAL Associate)

Date of Birth: 1971
Years with Firm/Entity: Intermittent, project based **Nationality:** Kenyan
Membership in Professional Societies: Certified Financial Analyst

Detailed Tasks Assigned:

- Support for data collection and validation of the financial and economic analysis model (Task 8)
- Review of policies and regulations (Task-7)
- Lead the analysis of Value for Money demonstration on both qualitative and quantitative terms (Task 8)

Key Qualifications:
Mr. Mutavi has over 15 years of extensive experience in financial and economic analysis including project management gained over the years working with leading asset management and engineering firms. He has worked on the preparation of financial models and business plans in the infrastructure sector in Kenya, Tanzania, Ethiopia and Mozambique. His main areas of competence are in investment analysis/programme modelling, financial analysis of infrastructure projects, rural based public water project's socio-economic viability including testing for tariff sensitivity, capital markets analysis, business and capital acquisition, preparation of financial aspects of business plans and models, private sector experience together knowledge of money markets, banking and the investor climate.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
University of Nairobi, Kenya	Master's in Economics	1998
Egerton University, Kenya	Bachelor's in Economics	1995

Employment Record:

From	To	Employer	Positions Held
2000	Till date	Zimele Asset Management	Investment Manager

Relevant project experience include the following:

NAME OF ASSIGNMENT	***#1 - Integrated Sanitation Master Plan for Eldoret and Selected Satellite Towns***
YEAR	2016-Till date
LOCATION	Kenya
CLIENT	ELDOWAS
MAIN PROJECT FEATURES	Integrated Sanitation Master Plan
POSITIONS HELD	Financial Expert
ACTIVITIES PERFORMED	• Analysis of utility financial situation. • Development of tariff study for ELDOWAS (WSP) • Prepare a utility financial model for the Master Plan forecast (ELDOWAS). • Development of investment programme
NAME OF ASSIGNMENT	***#2 - Nairobi Water Distribution Master Plan***
YEAR	2015-2017
LOCATION	Kenya
CLIENT	Athi Water Works Development Agency
MAIN PROJECT FEATURES	Preparation of water distribution master plan
POSITIONS HELD	Financial Expert
ACTIVITIES PERFORMED	• Collation and development of water and wastewater asset infrastructure unit cost data • Development of tariff study • Analysis of utility financial situation (financial statements) • Prepare utility financial model (Nairobi Water and Sewerage Company)

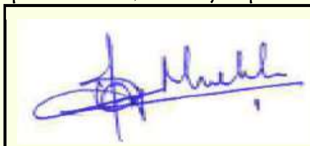
	● Development of investment programme ● Provision of on-the job training to counterpart staff in Financial/Investment assessment
Name of Assignment	*#3 - Small Towns Water Supply Project*
Year	2014-2016
Location	Uganda
Client	NWSC
Main project Features	Design of Water and sanitation systems
Positions Held	Financial Expert
Activities Performed	● Prepare costing at feasibility study and detailed design stages for water infrastructure investment ● Utility financial analysis (Analysing financial statement for recommendations on financial management) ● Tariff study
Name of Assignment	*#4 - Mombasa Wastewater Revenue Generation Business Model*
Year	2010
Location	Kenya
Client	CWWDA
Main project Features	Business model and tarif study
Positions Held	Economist/Financial Expert
Activities Performed	● Evaluate wastewater business in Mombasa Water ● Recommend revenue improvement strategies with wastewater (including tariff studies and recommendations) ● Carry out baseline survey on sewer network coverage and asset infrastructure ● Review customer database and customer profiles
Name of Assignment	*#5 - Small Towns Water Supply*
Year	2007-10
Location	Tanzania
Client	MoW
Main project Features	Business model and tariff study
Positions Held	Financial Expert
Activities Performed	Preparation of financial models based on existing towns business plans, for predictions on the impact of new supply schemes on the economic viability of the towns supply schemes.

Languages:

Language	Speaking	Reading	Writing
English	Excellent	Excellent	Excellent
Kiswahili	Excellent	Excellent	Excellent

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

 **Signature of staff member**	**Date: 10-Dec-20**

Full Name of Staff Member: Sammy M. MUTAVI
Full Name of Authorized Representative: Christophe LACARIN

1.12 Abhishek MAHOR, Mechanical Engineer (Thermal Modelling)

Proposed Position: Mechanical Engineer (Thermal Modelling)
Name of Firm: Development Environergy Services Limited
Name of Staff: Abhishek MAHOR
Profession: Senior Analyst
Date of Birth: 1992
Years with Firm/Entity: 6 years **Nationality:** Indian
Membership in Professional Societies: Certified energy auditor from Bureau of Energy Efficiency, Govt. of India.
Detailed Tasks Assigned:

- Preparation of heat and mass balance diagram
- Support for all technical activities
- Support for research and analysis

Key Qualifications:
Abhishek MAHOR, DESL has over 6 years of experience in mechanical engineering design, power plant consulting and waste to energy projects. He has been involved in basic design and preparation of technical specifications for waste to energy power plants. He has experience in calculation of balances and preparation of various basic engineering diagrams such as process flow diagram (PFD), heat and mass balance diagram (HMBD), basic engineering of mechanical systems including fuel, ash, steam and water systems, piping isometrics; preparation of BOM & BOQ & tender documents, vendor consultation.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
Maulana Azad National Institute of Technology, Bhopal	Bachelors in Mechanical Engineering	2014

Employment Record:

From	To	Employer	Positions Held
2014	Till date	Development Environergy Services Limited	Sr. Analyst, Analyst, Project An

Relevant project experience include the following:

Name of Assignment	*Waste to Energy* *# 1 Preparation of detailed project report and Engineering & project management services for setting up an integrated solid waste management project at Sonepat*
Year	2018-20
Location	Sonepat, Haryana
Client	JBM Environment Management Pvt. Ltd.
Main project features	DESL was engaged in providing engineering & project management services for setting up 600 t/d waste management project including 10 MW waste to energy facility
Positions Held	Team Member (Mechanical Engineer)
Activities Performed	• Preparation of technical drawings • Preparation of piping & instrumentation (P&I) diagrams for major systems and utilities • Preparation of design basis documents for equipment/packages

	● Carrying out required detailed engineering and preparation of technical data sheets for individual packages ● Troubleshooting, resolving, design/engineering and interface related issues during erection, commissioning and stabilization period of project, etc. *The pre-commissioning of the plant is planned in January 2021 and will be fully operational by March 2021.*
Name of Assignment	*Waste to Energy* *#2 900 t/d waste to Energy (WtE) Project at Ghaziabad*
Year	2018
Location	Ghaziabad, Uttar Pradesh
Client	Accord Hydroair Pvt. Ltd.
Main project Features	Accord Hydroair Pvt. Ltd. (AHPL) is in the process of setting up a waste to energy project at Ghaziabad for 900 t/d of municipal solid waste (MSW). AHPL engaged services of DESL for preparing a detailed project report for this proposed facility.
Positions Held	Team Member (Mechanical Engineer)
Activities Performed	● Heat & Mass Balance Diagram (Model for thermal iteration) ● Process flow diagram ● Water balance diagram ● Master P&ID (Process and Instrumentation Diagram)
Name of Assignment	*Waste to Energy* *#3 Preparation of DPR including WTE, ISWM, Study of Existing C&T and Survey/Test for 1,000 t/d, 20 MW for Indore Project*
Year	2018
Location	Indore, India
Client	Indore MSW Management Pvt. Ltd. (A part of Essel Infra Projects Limited)
Main project Features	DESL was engaged in preparation of a detailed project report (DPR) as well as study of existing collection & transportation (C&T) and survey of the waste generated in the city
Positions Held	Team Member
Activities Performed	● Monitoring of the work carried out by teams deployed at the site for C&T study, waste characterization and topographical survey & soil investigation ● Preparation of technical drawings ● Preparation of technical chapters for the report ● Preparation of general process flow diagram; water balance diagram; layout; electrical single line diagram; master P&ID ● Preparation of a generic and modular layout
Name of Assignment	*Waste to Energy* *#4 , #5, #6 Preparation of detailed project reports for three waste to energy projects at Guntur, Visakhapatnam & Tirupati (3 independent assignments)*
Year	2016
Location	Guntur, Visakhapatnam, Tirupati (Andhra Pradesh)
Client	Jindal Urban Waste Management Limited
Main project Features	JUIL engaged DESL to prepare DPR for the WtE project at Guntur (1000 t/d), Visakhapatnam (1100 t/d), Tirupati (450 t/d)
Positions Held	Team member
Activities Performed	● Preparation of PFD's ● Preparation of technical specifications

	● Preparation of technical drawings
NAME OF ASSIGNMENT	*Waste to Energy* *#7 Bid management services for 3000 TPD integrated solid waste management project at MCGM, Mumbai*
YEAR	2016
LOCATION	India
CLIENT	Ecogreen Energy Private Ltd, Gurgaon
MAIN PROJECT FEATURES	A request for proposal was issued by the Municipal Corporation of Greater Mumbai (MCGM) for designing, building and operating a 3,000 TPD, solid waste to energy plant at Deonar, New Mumbai. DESL was engaged by Ecogreen Energy Pvt. Ltd.for preparation of bid documents.
POSITIONS HELD	Team Member
ACTIVITIES PERFORMED	● Preparation of Bid documents ● Preparation of the technical drawings
NAME OF ASSIGNMENT	*Experience in Africa* *#8 Consultancy services to undertake assessment of bagasse cogeneration prospects in Malawi*
YEAR	2015-16
LOCATION	Malawi
CLIENT	Ministry of Natural Resources Energy & Mining
MAIN PROJECT FEATURES	The objectives of the assignment were to assess the power cogeneration potential in the sugar processing industry, assess the technical, economic and financial viability of bagasse to power cogeneration facilities and build capacity through training and study tour in private and public sectors in the field of bagasse to power cogeneration
POSITIONS HELD	Team member
ACTIVITIES PERFORMED	● Preparation of project configuration, heat and mass balance diagram ● Preparation of enquiry document and technical specifications ● Preparation of process and instrumentation diagram and process flow diagram ● Vendor Management, review of technical offers received

Languages:

Language	Speaking	Reading	Writing
English	Excellent	Excellent	Excellent
Hindi	Excellent	Excellent	Excellent

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

Signature of staff member	**Date:** 10-Dec-20

Full Name of Staff Member: Abhishek MAHOR
Full Name of Authorized Representative: R RAJMOHAN

1.13 AMIT KUMAR, ELECTRICAL & INSTRUMENTATION ENGINEER (DESIGN)

Proposed Position: Electrical & Instrumentation Engineer (Design)
Name of Firm: Development Environergy Services Limited
Name of Staff: Amit KUMAR
Profession: Associate Consultant
Date of Birth: 02/02/1983
Years with Firm/Entity: 1 year **Nationality:** Indian
Membership in Professional Societies:
Detailed Tasks Assigned:

- Preparation of single line diagram
- Conceptual design of power evacuation system
- Engineering of HV & LV system
- Procurement specifications of electrical equipments
- Engineering for Control & instrument package including DCS

Key Qualifications:
Mr. Amit KUMAR, Associate Consultant, DESL, has more than 16 years of experience in operation & maintenance and electrical designing. He has rich experience in project cost estimation for electrical systems, electrical designing for electrical power distribution systems, earthing system design, calculations, etc. He has expertise in power flow analysis, voltage drop analysis, load flow analysis, fault analysis. He has a gripped command on ETAP (electrical system simulation software).

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
Institute Management Technology & Science, Delhi, India	Bachelor's Degree in Electrical Engineering	2014
K.L. Polytechnic, Roorkee, India	Diploma in Electrical Engineering	2002

Employment Record:

From	To	Employer	Positions Held
2020	Till date	Development Environergy Services Ltd.	Associate Consultant
2014	2019	ISGEC Heavy Engineering Ltd., Noida, India	Dy. Manager (Electrical)
2014	2014	Walchandnagar Industries Limited, Pune	Manager Electrical
2011	2014	Uttam Sucrotech International(P)Ltd., Noida	Manager Electrical
2009	2011	Transtech Green Power(P) Ltd.	Dy. Manager (Electrical)
2007	2009	Gularia Chini Mills, Gularia	Sr. Engineer(Electrical)
2006	2007	Dalmia Chini Mills Ltd., Nigohi	Electrical Engineer
2003	2006	Uttam Sugar Mills Ltd., Haridwar	Asst. Engineer Electrical

Relevant project experience include the following:

NAME OF ASSIGNMENT	*Waste to Energy* *# 1 Preparation of detailed project report and Engineering & project management services for setting up an integrated solid waste management project at Sonepat*
YEAR	2020
LOCATION	Sonepat, Haryana
CLIENT	JBM Environment Management Pvt. Ltd.

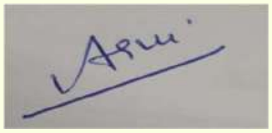
MAIN PROJECT FEATURES	DESL was engaged in providing engineering & project management services for setting up 600 t/d waste management project including 10 MW waste to energy facility
POSITIONS HELD	Team Member (Electrical Engineer)
ACTIVITIES PERFORMED	● Data collection of power distribution network, single line diagram of power distribution network, ETAP study of power distribution, fault calculations, power flow ● Electrical designing for electrical power distribution system ● Conducting and participating in technical discussion/meetings with client ● Designing of electrical equipments i.e. high voltage panels, distribution and convertor transformers, Low voltage panels, VFD panels, bus ducts, lighting panels, ● Illuminations designing for plant ● Earthing system design, calculations ● Technical specifications of electrical equipment, technical vetting of technical offers, drawing approval ● Inspection/factory acceptance test and clearance for the material dispatch *The pre-commissioning of the plant is planned in January 2021 and will be fully operational by March 2021.*
NAME OF ASSIGNMENT	*Waste to Energy* *#2 DPR for 10 MW waste energy power plant*
YEAR	2020
LOCATION	Assam, India
CLIENT	Assam Power Generation Corporation Limited
MAIN PROJECT FEATURES	Assam Power Generation Corporation Limited (APGCL) intends to set up a Waste to Energy (WtE) project at old Chandrapur Thermal Power Station (CTPS), near Guwahati in Assam, India. The estimated waste generation in the city is around 580 t/d. APGCL engaged DESL for preparation of Detailed Project Report (DPR) of the proposed WtE Facility. The objective of this assignment is to assess the potential of power generation from municipal solid waste by using modern technologies.
POSITIONS HELD	Team Member (Electrical Engineer)
ACTIVITIES PERFORMED	● DPR for 10 MW waste energy power plant ● Power generation, distribution, transmission design ● Aux power consumption calculation. ● Technical specifications of electrical equipments ● Technical specification of power evacuation sub station ● Estimation for the electrical system
NAME OF ASSIGNMENT	*Power Plant Consulting* *#3 Consultancy and Engineering for 28 MW Expansion Project Kuantum Papers Limited*
YEAR	2019-20
LOCATION	Punjab, India
CLIENT	Kuantum Papers Ltd.
MAIN PROJECT FEATURES	20+8 MW Biomass blended fuel based cogeneration thermal power plant for paper mill Project is brownfield and expansion is done to meet the additional steam and power requirement of the process side.
POSITIONS HELD	Team Member (Electrical Engineer)

Activities Performed	● Data collection of power distribution network, single line diagram of power distribution network, ETAP study of power distribution, power flow, Load sharing between Turbines in auto mode ● Electrical designing for electrical power distribution system ● Designing of electrical equipments i.e. high voltage panels, distribution and convertor transformers, Low voltage panels, VFD panels, bus ducts, lighting panels ● Designing of 20 MW and 8 MW power plant electrical system ● Synchronizing electrical system with an existing 10MW Power turbine
Name of Assignment	*Cogeneration Plant* *#4 Design, Manufacturing & Supply of 6,000 TCD Sugar Plant along with 21 MW Cogeneration Power Plant*
Year	2018-19
Location	Sumbawa, Indonesia
Client	PT. Muria Sumba Manis
Main project Features	The project was based on design of 6,000 TCD sugar plant along with 21 MW, 11 kV cogeneration power plant including supervision of erection, commissioning, operation & maintenance of the plant
Positions Held	Deputy Manager (Electrical)
Activities Performed	● Data collection of power distribution network, single line diagram of power distribution network, ETAP study of power distribution, fault calculations, power flow ● Project cost estimation for electrical system at proposal stage ● Electrical designing for electrical power distribution system ● Fault level calculations, power flow analysis, voltage drop analysis of Electrical system through ETAP software. ● Designing of electrical equipments i.e. high voltage panels, distribution and convertor transformers, Low voltage panels,VFD panels, bus ducts,lighting panels, ● Technical specifications of electrical equipment, technical vetting of technical offers, drawing approval
Name of Assignment	*Experience in Africa* *#5 Design, Manufacturing & Supply of 6,500 TCD Sugar Plant along with 31 MW Cogeneration Power Plant including Supervision of Erection & Commissioning and Operation & Maintenance of the plant*
Year	2012-13
Location	Ethiopia
Client	Wonji Shoa Sugar Factory
Main project Features	The project was based on design of 6,500 TCD sugar plant along with 31 MW, 11/132 kV cogeneration power plant including supervision of erection, commissioning, operation & maintenance of the plant
Positions Held	Manager (Electrical)
Activities Performed	● Designing of 6500 TCD sugar plant with 31 MW power plant electrical system, ● Designing of HV & LV distribution network ● Designing of distribution transformers ● Designing of HV panels, LV Panels, AC drives, MCC panels.

Languages:

Language	Speaking	Reading	Writing
English	Good	Good	Good
Hindi	Excellent	Excellent	Excellent

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

 Signature of staff member	**Date:** 10-Dec-20

Full Name of Staff Member: Amit KUMAR
Full Name of Authorized Representative: R RAJMOHAN

1.14 SHARDA PRASAD, DRAFTSMAN

Proposed Position: Draftsman
Name of Firm: Development Environergy Services Limited
Name of Staff: Sharda PRASAD
Profession: Assistant designer
Date of Birth: 02/02/1985
Years with Firm/Entity: 4 years **Nationality:** Indian
Membership in Professional Societies: NA
Detailed Tasks Assigned:

- Preparation of different layout options with pros & cons
- Selection of best layout option
- Placement of equipment in layout
- Preparation of plan & section of major buildings
- Preparation of bird eye of selected layout options

Key Qualifications:
Ms. Sharda Prasad, Assistant designer, DESL, has more than 16 years of professional experience as architect and Auto CAD draughtsman with specialization in drawing of housing project factory, pharmaceutical, iron, paper mill, school & institutional building and hostel. She has rich experience of preparation & presentation of drawing in AutoCAD, interior layout, drawings for municipal approval, shop drawing, section elevations and all types of detail drawing.

Education:

School, College and/or University Attended	Degree/Certificate or Other Specialized Education Obtained	Date Obtained
Jija Bai I.T.I. Siri Fort, New Delhi	Diploma in Draughtsman	2002

Employment Record:

From	To	Employer	Positions Held
2017	Till date	Development Environergy Services Ltd., New Delhi	Assistant designer
Feb 2015	Jul 2015	Vyom	Manager-Architecture
2013	2015	Voyants Solution Pvt. Ltd.	Architectural Assistant

2011	2013	Vijay Gupta Associate	Assistant Architect
2005	2011	Dinesh Mehta Associates Pvt. Ltd.	Sr. Draughtsman
2002	2005	Nexus Creation	Architectural Draughtsman

Relevant project experience include the following:

NAME OF ASSIGNMENT	*Waste to Energy* *# 1 Preparation of detailed project report and Engineering & project management services for setting up an integrated solid waste management project at Sonepat*
YEAR	2018-20
LOCATION	Sonepat, Haryana
CLIENT	JBM Environment Management Pvt. Ltd.
MAIN PROJECT FEATURES	DESL was engaged in providing engineering & project management services for setting up 600 t/d waste management project including 10 MW waste to energy facility
POSITIONS HELD	Team Member (Draftsman)
ACTIVITIES PERFORMED	● Preparation of layout for processing plant, SLF on AutoCAD ● Preparation of options for plant layout on AutoCAD ● Preparation of drawings for plan & elevation, admin block, RDF storage, TG house, store & workshop, RO plant, etc. on AutoCAD ● Preparation of SLDs on AutoCAD *The pre-commissioning of the plant is planned in January 2021 and will be fully operational by March 2021.*
NAME OF ASSIGNMENT	*Waste to Energy* *#2 Preparation of detailed project report on generation of electricity from MSW at old Chandrapur thermal power station*
YEAR	2020
LOCATION	Assam, India
CLIENT	Assam Power Generation Corporation Limited
MAIN PROJECT FEATURES	Assam Power Generation Corporation Limited (APGCL) intends to set up a Waste to Energy (WtE) project at old Chandrapur Thermal Power Station (CTPS), near Guwahati in Assam, India. APGCL engaged DESL for preparation of DPR of the proposed WtE Facility. The objective of this assignment is to assess the potential of power generation from municipal solid waste by using modern technologies.
POSITIONS HELD	Team Member (Draftsman)
ACTIVITIES PERFORMED	● Preparation of plant layout on AutoCAD ● Preparation of single line diagram on AutoCAD ● Preparation of process flow diagram on AutoCAD
NAME OF ASSIGNMENT	*Waste to Energy* *#3 Preparation of DPR including WTE, ISWM, Study of Existing C&T and Survey/Test for 1,000 t/d, 20 MW for Indore Project*
YEAR	2018
LOCATION	Indore, India
CLIENT	Indore MSW Management Pvt. Ltd. (A part of Essel Infra Projects Limited)
MAIN PROJECT FEATURES	DESL was engaged in preparation of a detailed project report (DPR) as well as study of existing collection & transportation (C&T) and survey of the waste generated in the city
POSITIONS HELD	Team Member
ACTIVITIES PERFORMED	● Preparation of PFD on AutoCAD ● Preparation of single line diagram on AutoCAD

	● Preparation of plant layout on AutoCAD
NAME OF ASSIGNMENT	*Biogas Plant* *#4 Engineering & consulting services for preliminary design for Al Aweer-STP biogas based power generation plant for Dubai municipal facility*
YEAR	2017
LOCATION	UAE
CLIENT	Veolia Middle East, UAE
MAIN PROJECT FEATURES	VME engaged DESL for providing engineering and consulting services for preliminary design of the power plant.
POSITIONS HELD	Team member
ACTIVITIES PERFORMED	● Preparation of plant layout on AutoCAD ● Preparation of architectural views on AutoCAD ● Preparation of single line diagram on AutoCAD ● Preparation of PFD and P&ID on AutoCAD
NAME OF ASSIGNMENT	*Power Plant Consultancy* *# 4 Detail engineering activities for 4 MW back pressure TG set*
YEAR	2017
LOCATION	Gujarat, India
CLIENT	Gujarat Fluorochemicals Ltd
MAIN PROJECT FEATURES	GFL has decided to install a 4 MW back pressure TG set and additional condensate polishing unit (CPU). DESL was engaged in providing engineering and project management services for the above project.
POSITIONS HELD	Team member (Draftsman)
ACTIVITIES PERFORMED	● Preparation of plant layout on AutoCAD ● Preparation of single line diagram on AutoCAD ● Preparation of PFD and P&ID on AutoCAD ● Preparation of piping / isometric drawings on AutoCAD
NAME OF ASSIGNMENT	*Solid Waste Management* *#5 Preparation of detailed project report (DPR) for solid waste processing plant in Nagpur*
YEAR	2017
LOCATION	Nagpur, India
CLIENT	Essel Infra Projects Limited
MAIN PROJECT FEATURES	Essel Infra Projects Limited (EIPL), is setting up waste to energy plant and sanitary landfill (SLF) at Nagpur in Maharashtra for processing approximately 1,000 tons/day of solid waste. EIPL engaged DESL for preparation of detailed project report (DPR) for the project
POSITIONS HELD	Team Member
ACTIVITIES PERFORMED	● Preparation of plant layout on AutoCAD ● Preparation of single line diagram on AutoCAD

Languages:

Language	Speaking	Reading	Writir
English	Good	Good	Gooc
Hindi	Excellent	Excellent	Excelle

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

 Signature of staff member	**Date:** 10-Dec-20

Full Name of Staff Member: Sharda PRASAD
Full Name of Authorized Representative: R RAJMOHAN

1.15 Catherine Karimi Nyumoo, ESIA Activities Coordinator / Waste Management Expert

Profession: Renewable Energy, waste Management Expert

Date of Birth: 23/08/1986

Years with Firm/Entity: Intermittent, project based **Nationality:** Kenyan

Cell: +254 721 629 179 | Email: catherinenyumoo@gmail.com | Nairobi, Kenya

PROFESSIONAL PROFILE

A uniquely agile, resourceful and qualified professional boasting 8+ years of experience with success in optimizing productivity, efficiency and service quality across business environments, developing new business ideas, and leading high-impact projects. Adept at providing innovative collateral support to realize brand objectives through effective training and development, providing quality customer service, mediating between multi-purpose project teams resulting in original, timely and cost-effective project completions. Strength leading in complex environments while mentoring and motivating individuals from diverse backgrounds, encouraging them to take positive actions and be accountable for their work. A highly ethical, visionary leader and a networking guru who makes the most of interpersonal and communication skills to coordinate cross-functional departments and forge lasting beneficial professional relationships to promote operational excellence.

My Professional Strengths:

- Strategic Planning and Development: able to develop and implement new initiatives, strategies, policies and procedures to ensure smooth operational performance.
- Project Management: expertly manages diverse project load within different phases of development, providing administration support to promote excellence while observing aggressive schedules and budgetary constraints.
- Financial Acumen: prolific at preparing, forecasting and managing business related budgeting and accounts processes.
- Critical Assessment & Creative Thinking: able to deduce high-profile project needs, uncovering discrepancies and conducting surveillance in a comprehensive and efficient manner within standard protocols.
- People and Team management: an astute leader prolific in providing guidance to teams, able to build, grow and foster efficiency and productivity, contributing to the success of cross-functional teams in the development and execution of strategy and solutions.
- Technical expertise: expertly manages multi-unit operations while integrating new technologies to automate and enhance the efficiency of daily functions. Extensive expertise in MS Office Suite.
- Problem Solving: possesses analytical and creative skills to identify challenges, implement solutions while monitoring and evaluating their effectiveness.

- Savvy Communication & Negotiation skills: a savvy team player, skilled in presentation of data, and maintaining quality service and integrity in client relations management.

PROFESSIONAL EXPEREINCE

Head of Project Management | June 2020 – Date

EnviroPro Kenya Limited

Key Contributions:

- Implementing project management methodology to design, develop and execute Waste Management recycling initiative, hazardous waste Management and programs.
- Providing project management oversight services for The Center of Public Administration Services
- commercial and Government Entities
- Managing a variety of projects related to hazardous waste management, contamination assessments, site investigations, and environmental compliance.
- Supporting the response to environmental compliance issues, including accident/ incident investigation, agency requests and unscheduled incidents.
- Conducting Environmental Performance Reviews and other environmental compliance audits
- Conducting business development and marketed environmental services to agencies, municipalities, industry and others.
- Supporting business development with proposal preparation, technical support, cost estimates, and negotiations.
- Performing estimating, budgeting, subcontractor coordination, contract negotiation and business
- development functions.
- Supporting business development efforts including extensive proposal writing.
- Developing and implementing complex environmental projects while managing environmental reserves (approximately 50 million over 3 years).
- Working as a project manager on various environmental projects such as environmental restoration and emergency response.
- Overseeing preparation of contract plans and specifications for public environmental projects.

Country Manager | March 2016 - March 2020

ENVIROSERV LIMITED KENYA

Led the organizations expansion in Kenya; led all operations to ensure the profitability of the company's affiliate in the larger East Africa. Moved to all other countries to train and work on building a bigger brand in the whole continent.

Key Contributions:

- Managed environmental projects and mitigation for various state and federal agencies Uganda and Kenya
- Redesigned contracted work processes, administrative procedures, and/or materials to control and eliminate environmental and safety hazards.
- Evaluated budget requirements, established reporting procedures, coordinated equipment use, and directed daily operations at environmental sites
- Insured that contract manager, facility and regulatory agencies comments and concerns were
- addressed/incorporated into the plans.

- Advised customers on incidents involving violation mitigation assistance and correspondence with
- regulatory agencies.
- Evaluated results and made recommendations as necessary for maintaining compliance with regulatory agencies.
- Characterized, segregated, packaged and transported customer waste in accordance with all EPA, DOT and OSHA regulations.
- Analyzed occupational safety and health (OSHA) hazards and standards and developed methods of control.
- Maintained job specifications and monitored worker exposure required by OSHA and NIOSH regulations and standards.
- Implemented safety protocols and programs to ensure compliance with OSHA requirements.
- Managed consultant contracts, including RFPs, scopes of service, fees and budgets, and oversight of project deliverables.
- Cost planning, risk management and total oversight of all projects.
- Managed key Intertek accounts with operational, financials and program delivery oversight
- Liaised with head office in Johannesburg and writing up quarterly/annual reports.
- Researched the country thoroughly and adapted strategies accordingly in a marketing and new technologies to be used in the oil and gas sector.
- Monitored performance at all levels and scheduling training as required.
- Implemented an effective brand strategy and ensuring consistency.
- Built professional relationships with staff and clients.
- Maintained a good image of the organization at all times.

Projects Involved as the Country Manager:

- Solid waste Management Training (Luanda) Technology Presence to Waste To energy
- Project manager: Tank Cleaning Project, the project involved cleaning of petroleum tanks. That my team carried out safely no error occurred it was done in record time of 2 days
- Project manager: Environmental Clean-up and Restoration of a contaminated site (KM 256 Thange). The project involved recovery of the spilled product and bioremediation of the contaminated soils and clean-up of the contaminated water

Manager | 2012 – 2015

SMS GREENCARE LTD

Key Contributions:

- Oversaw the daily administrative work in setting up and running the company.
- Governed strategy formulation and implementation, identification and evaluation of viable environmental and infrastructural projects.
- Collaboration with the various partners ministries, government agencies and consultancies in setting up projects, design of various projects and maintenance of the projects during and after commission.

Projects Involved in:

- Waste disposal facilities encompassing waste recovery strategies for various counties within the country and setting up a commercial biomedical / hazardous waste incinerator plant in the country.
- Design team management and resources mobilization.

- Design of a waste mall facility incorporating various waste treatment methods for different waste streams in one location, hence centralizing waste management services for the Nairobi Metro district in Kenya.
- Representation in many forums to speak on waste to energy and metropole waste management.

Administrator | 2009 - 2012

GREENCARE KENYA LTD

Served as the Company Administrator managing various resource constraints to achieve organizational goals and satisfy customer needs using project management models in evaluation, development, and processes management.

Key Contributions:

- Managed the marketing of various portfolios, liaised with various partners, and responded to client's enquiries.
- Managed the various teams in the field undertaking different operations, site visits, and project monitoring.
- Contributed in various forums on issues of waste and energy management as the company liaison officer to NEMA and the Nairobi city council.

EDUCATION

Higher Diploma on Environmental Studies Hazardous | Ongoing

Dartmouth University - Waste Management | Project management | Several certifications on Hazardous waste Management | WTE (Waste to energy) | Waste Management in Oil And gas

Bachelor's Degree Maj Int Relations Min, Environmental Studies | 2013

United States Internal University

A LEVEL, 4 Principal passes and a subsidiary pass | 2005 – 2006

St Lawrence Schools and Colleges - Paris Palais Campus

1.15 IBRAHIM ADAN Social Scientist

Position-relevant Experience	13 years
Nationality Tel: Email:	Kenyan 0723 66 55 99 ibrahim@eneinternationalconsult.com
Membership in Professional Societies	– Lead Negotiator for Kenya at UNFCCC to Response Measures Article – Participant of Katowice Committee of Experts Meetings as a party observer. – Member of International Occupational and Safety Auditors. – PECB Nordic Certified Management System Auditor. – Member of Kenya Energy Renewable Association (KEREA). – Member Institute of Environment in Kenya (IEK) Reg. No. 1608. – Member of International Association of Impact Assessors (IAIA). – Member of Eastern Africa Association of Impact Assessors (EAIA).
Registration with licensing bodies to practice	– Lead auditor ISO 14001/ISO 45001 on environment and occupational health and safety system. – Registered Lead Environmental Impact Assessor / Environmental Audit Expert with the National Environmental Management Authority (NEMA) of Kenya (Reg. No. 1608).

Key Qualifications	MSc in Energy and Environment, BSc in Environmental Planning and Management. I have 13 years of work experience fully - and eagerly - dedicated to environmental management with particular interest in climate change and sustainability at the international level with special focus on developing countries. I am a regular participant at climate and energy forums such as UNFCCC COPs and the Vienna Energy Forum as I follow on the mechanisms to support the transition of developing countries towards low carbon technologies and solutions. I'm presently representing Kenya as a lead negotiator on Response Measures Aspect of UNFCCC negotiation on climate change. I also have experience structuring programs and projects for the carbon markets and for development cooperation. I have experience in the design of policy, strategies, financing and institutional arrangements for the deployment of environmental management including aspects such as renewable energy and energy efficiency. As a senior HSE officer, I have extensive engagement with stakeholder's management all over the country in particular 14No counties where pipeline traverses from Mombasa, Kwale, Kilifi to Kisumu. This works entails engaging community leadership at national and county level on environmental issues along the pipeline for safe operations thereby reducing adverse environmental footprint of the pipeline. Community engagement annually as part of our annual environmental audits along the pipeline through community barazas delineating projects impact. I have clear understanding of occupational health safety issues, climate Policy in Developing Countries, Clean Energy Financing and Adaptation to Climate Change. I am excellent team player that can work either from remote locations or from home. Specialties: Sustainable energy (energy efficiency and renewable), climate change mitigation strategies, feasibility studies, policy design and evaluation, climate negotiations, carbon markets, clean energy financing, stakeholder engagement, capacity building and training. Experience in the environmental and energy sector, primarily in the African context, for clients ranging from international development agencies through to small and medium enterprises. Key skills include Project Management, Project Development, Environmental and Social Impact Assessment (ESIA), Environmental Monitoring, Energy Auditing, Environmental Management Systems, Development of Training Programmes, Resettlement Action Plans, as well as the negotiation, management and delivery of Consultancy Projects. Ibrahim has carried out occupational health safety audit, ESIA Studies and Environmental Audits in Kenya for various infrastructural projects including major road projects, energy projects, dams and housing developments. He has also carried out Environmental Risk and Impact Assessment studies in the Petroleum Sub-Sector for over 100 sites in Kenya. He is well versed with the relevant Legislations, Legal notices and Guidelines in both the environment and health and safety sector, as well ICAO Environmental and Social Guidelines, European Union (EU) Environmental Protection Requirements and Standards, as well as the African Development Bank (AfDB), Canadian International Development Agency (CIDA) Guidelines and the World Bank (WB) Safeguard Policies and Guidelines. Also possesses good knowledge of ISO standards including ISO 14001, OSHAS 18001, and ISO 9002 as a certified lead auditor.

Education			
General Education			
From	To	University/Institution	Qualification Achieved

2016	Ongoing	NEBOSH International Diploma/Shields	**Ongoing student** for NEBOSH International Diploma in Occupational Health and Safety.
2016	Ongoing	NEBOSH International Diploma/Shields	**Ongoing student** for NEBOSH National Diploma in Environmental Management
2009	2010	University of Twente, The Netherlands,	MSc in Environmental and Energy Management
2002	2006	Kenyatta University, Kenya,	BSc (Hons) Environmental Studies (Planning and Management).
		Specialized Education	
From	To	Course Provider	Qualification Achieved
December 2018, 2019 & 2020		UNFCCC COP 24& 25 & various committee activities Participant (2020 meetings were all virtual)	Policy issues on climate change
Jan 2018	Jan 2018	PECB NORDIC, Sweden	Certified Management Systems Auditor
2018	July 2018	Waste (Oilfield, Waste Oil, etc) management in petroleum sector	SmartKoncept Technology Under Kenya Petroleum Technical Assistance Project (KEPTAP)
2017	March 2017	Environment & Social Risk Management in Oil & Gas Industry	HSE International LLC Under Kenya Petroleum Technical Assistance Project (KEPTAP)
2016	May 2016	Total Safety Leadership: From Accidents to Zero	Fleming International
2015	2015	PECB/MMCL	Lead Auditor –ISO 14001& 45001
2014		Dataline International	40hr HSE Committee training
2014		International Safety Training Centre	Incident Investigation Management
2009	2010	Centre for studies in technology and sustainable development, Twente University, The Netherlands.	Energy Management and Cleaner Production in Small and Medium Scale Industries
2010		UNEP RISO, ITC and Twente University, The Netherlands.	Formulating Proposal for Small scale CDM Projects,

Employment Record

Dates	Employer	Position	Location and Assignment
2016 – to date	Kenya Pipeline Company	Senior Environment Officer	Location: Kenya Assignment - Developing policies, strategies and codes of practice on

			environmental management within the company. - Reducing company climate emission footprints. - Undertaking statutory environmental impacts assessment and audits. - Accident/Incident Investigation of breaches of environmental guidelines, hazard mapping. - Training of staff, contractors and student interns on environment policy & management. - Budget development and preparing requisition. - Environmental site restorations of contaminated sites. - Develop Environmental Management Systems like ISO 14001,45001 on Health Safety & Environmental Management. - Risk Assessment of pipeline infrastructure. - Undertaking environmental monitoring and inspections on air quality, soil, solid waste, noise, wastewater discharge from company premises as per EMCA, 1999, legal notices. - Provide advice to management, departments and the public on health, safety and environmental matters such as the management, re-use or disposal of hazardous and non-hazardous materials generated by the company. - Coordinate and respond to emergencies, such as oil and waste spills. - Environmental restoration coordinator in cases of petroleum product spills.
2007 – 2016	Kenya Pipeline Company	HSE Officer	Location: Kenya Assignment - Undertaking statutory Health, Safety and environmental impacts assessment and audits. - Develop Request for Proposals for Environmental Impact Assessment and Audits. - Tender evaluations for safety and environmental activities bids. - Budget development and preparing requisition. - Training of staff, contractors and student interns on health, safety and environment policy. - Accident/Incident Investigation of breaches of health, safety and environmental guidelines, hazard mapping. - Undertaking environmental monitoring and inspections on air quality, soil, solid waste, noise, wastewater discharge from company premises as per EMCA, 1999, legal notices. - Developing policies, strategies and codes of practice on environmental management within the company. - Develop Environmental Management Systems like ISO 14001, OHSAS 18001. - Provide advice to management, departments and the public on health, safety and environmental matters such as the management, re-use or disposal of hazardous and non-hazardous materials generated by the company. - Coordinate and respond to emergencies, such as oil and waste spills. - Environmental restoration coordinator in cases of petroleum product spills.

I, the undersigned, certify that these data correctly describe me, my qualifications, and my experience.

Signature of the staff member:	Date :