REPUBLIC OF KENYA

WORLD BANK

MINISTRY OF TRANSPORT, INFRASTRUCTURE, HOUSING AND URBAN DEVELOPMENT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY REPORT FOR THE PROPOSED CONSTRUCTION OF MITUBIRI SANITARY LANDFILL IN MURANG'A COUNTY OF THE NAIROBI METROPOLITAN REGION

May 8, 2018

SGS

CERTIFICATION

SGS Kenya Limited was commissioned by the Ministry of Transport, Infrastructure, Housing and Urban Development to undertake Environmental and Social Impact Assessment for the proposed development of Mitubiri Landfill in Murang'a County. Thisreport has been prepared in accordance with the Environmental Management and Coordination Act CAP 387 and The Environmental (Impact Assessment and Audit) Regulations, 2003 for submission to the National Environmental Management Authority (NEMA).

SGS Kenya Limited submits this Environmental and Social Impact Assessment Study Report to NEMA Kenya. To the best of our knowledge, all the information in this report is true and correct.

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DISCLAIMER

This EIA Study is strictly confidential to Ministry of Transport, Infrastructure, Housing and Urban Development and any use of the materials thereof should strictly be in accordance with the agreement between Ministry of Transport, Infrastructure, Housing and Urban Development (the Client) and SGS Kenya Limited 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. It provides information on the proposed project as at the time of the EIA Study report.

ACKNOWLEDGEMENT

The EIA Experts are grateful to the project proponent for commissioning us to conduct this Environmental Impact Assessment Report in respect of the proposed project. We would like to acknowledge with great appreciation all those neighbors who participated in the public consultation process for their cooperation throughout the exercise.

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ACRONYMS AND ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
bgl	below ground level
CIDP	County Integrated Development Plan
Db	Decibels
DoNMED	Directorate of Nairobi Metropolitan Development
EA	Environmental Audit
EHS	Environment, Occupational Health and Safety
EIA	Environmental Impact Assessment
EMC	Environmental Management and Coordination
EMCA	Environment Management & Coordination Act, 1999
ERSWEC	Economic Recovery Strategy for Wealth and Employment Creation
ESMMP	Environmental and Social Management & Monitoring Plan
GPS	Geographical Positioning Coordinates
Ha	Hectares
HDPE	High Density Polyethylene
LFG	Landfill Gas
M	Meters
M^2	Meters squared
MCA	Member of County Assembly
MoTIH&UD	Ministry of Transport, Infrastructure, Housing & Urban Development
MSW	Municipal Solid Waste
NaMSIP	Nairobi Metropolitan Services Improvement Project
NEMA	National Environment Management Authority
NIUPLAN	Nairobi Integrated Urban Development Master Plan for the City of Nairobi
NMR	Nairobi Metropolitan Region
OHS	Occupational Health & Safety
OSHA	Occupational Safety & Health Act
PPC	Public Participation & Consultation
SDGs	Sustainable Development Goals
ToR	Terms of Reference
USD	United States Dollar
WB Op	World Bank Operational Procedures

EXECUTIVE SUMMARY

Introduction:

Nairobi metropolitan region is experiencing increased environmental pollution mainly due to inadequate disposal of solid waste. In order to address this inadequate waste management and as part of the national solid waste management strategy 2014, the Government of Kenya, through the Ministry of Transport, Infrastructure, Housing and Urban Development initiated the design of a sanitary landfill under the ongoing Nairobi Metropolitan Services Improvement Project (NaMSIP) supported by World Bank. According to the World Bank screening approach, construction of such a facility is classified under Category A and must be preceded by development of a comprehensive Environmental and Social Impact Assessment (ESIA) study as recommended also by the National Environment Management and Co-ordination Act, Cap 387and Operational Procedures of the World Bank, mainly OP4.01.

A sanitary landfill is a pit with a protected bottom where solid municipal waste is buried in layers, compacted (pressed down to make it more solid), and covered. At a proper sanitary landfill, there are no nuisance impacts of constant burning, smoke, flies, vectors, windblown litter, and unsightly rubbish heaps.

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 project are identified, assessed and mitigation measures proposed and develop an environmental and social management plan to aid in managing the potential impacts appropriately.

This ESIA study report has been prepared from both primary and secondary data involving field visits and surveys, laboratory analysis, public consultations and secondary data involving the review of information in previous reports and studies, initial ESIA prepared as an integral part of proposed project, hydro-geological report, feasibility study and conceptual designs and meteorological reports

The proposed facility will be located approximately 67 kilometers from the city of Nairobi in Mitubiri Sub-location, Kimorori-Wempa Ward in Maragua Sub-County, Murang'a County. The site selection was based on World Bank's criteria on sanitary landfill design and selection and also standard multi-criterion analysis presented in Landfill Site Identification Report[1].

[1]As presented in ESIA project Report for proposed Landfill KE517E (Seureca), April 2016.

Scope of the ESIA:

This ESIA Study Report has been prepared in accordance with the Environmental Management and Coordination Act (EMCA) of cap 387 and its Legal Notice 101 of June 2003, World Bank Operational Policy for category "A" projects and client expectations as stipulated in the Terms of Reference (see Annex 1) issued under this contract.

Objectives of the ESIA:

The main objective of this ESIA Study report is to identify and examine potential environmental and social impacts associated with the construction operation and decommissioning of the proposed project. It aims to recommend appropriate environmental and social mitigation and management measures for the project and define the institutions responsibilities for implementing these measures. Thus, a core outcome of the Study is an Environmental and Social Management Plan (ESMP) for the project.

Study Approach and Methodology

Specific regulations and guidelines governing solid waste landfills are yet to be formulated; however, World Bank operational policies and systematic investigative and reporting methodology specified for conducting Project Report Studies and Legal Notice 101 of EMCA were adopted in this Study. Baseline data on project design was generated through baseline measurement, discussion with the client and review of project documentation. Opinions formed were revalidated through field work entailing site investigations and interviews with potentially affected people and secondary stakeholders.

To identify, predict, analyze and evaluate potential impacts that may emanate from the project, diverse study methods and tools including use of checklists, questionnaires, expert opinions, observations and review of information in previous reports and studies and environmental baseline monitoring and field surveys were employed. An Environmental and Social Management Plan comprising of an impact mitigation plan and modalities for monitoring and evaluation were then developed to guide environmental management during all phases of project development.

Once approved by the Ministry of Transport, Infrastructure, Housing and Urban Development, and NEMA, the study report will be disclosed prior to appraisal as required and accruing comments will be used to finalize the report.

The Study Team:

This ESIA Study was undertaken by a firm of experts namely; SGS Kenya Limited in a joint venture with VDP SL.R of Italy and reviewed by the NaMSIP team and the World Bank.

Policy, Legal and Regulatory Framework:

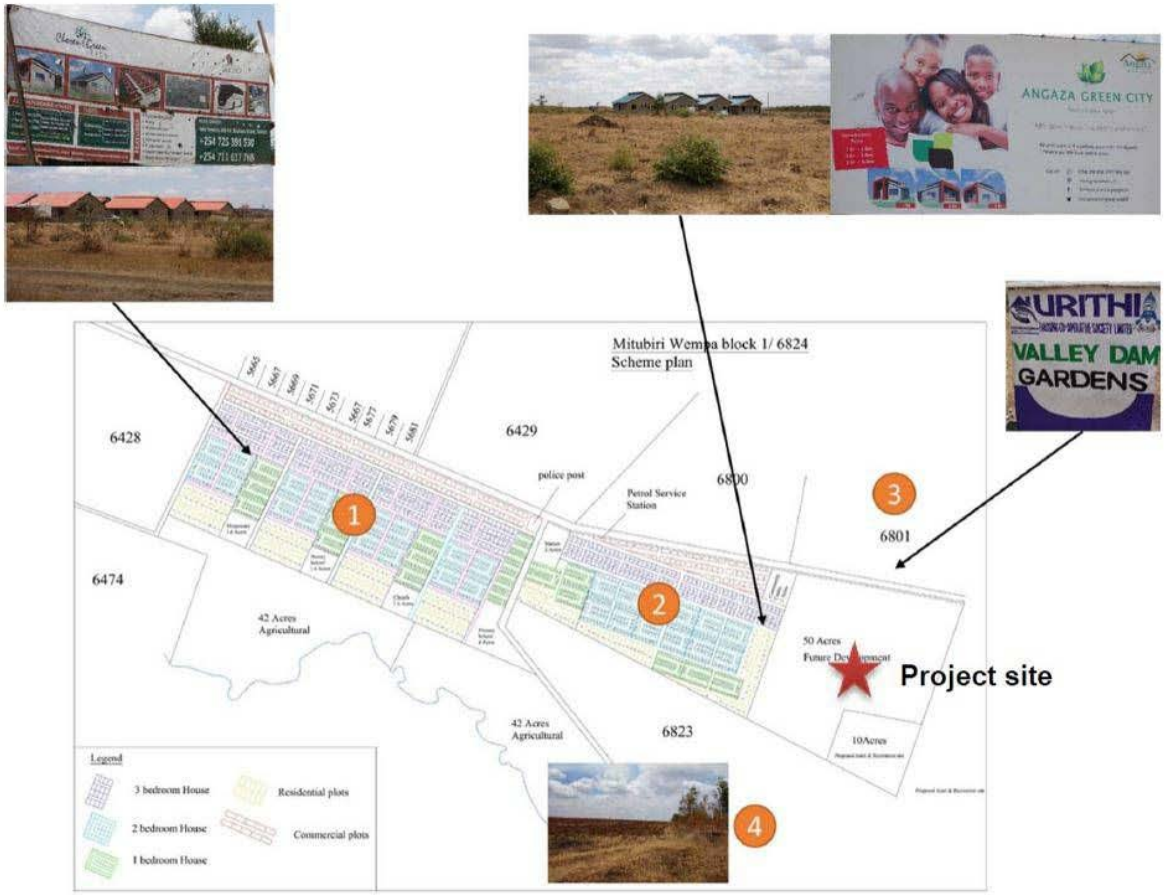
This Study Report has been developed to ensure that the proposed project conforms to the requirement of World Bank's operational policy and the national policy aspirations towards securing sustainable development. Specifically, this Report has been developed to ensure compliance with requirements of the Environmental Management and Coordination Act (EMCA, 2015)-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) and the Legal Notice 101 (Regulations for Environmental Assessment and Audit) of June 2003. The entire study process has been designed to:

a) 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
b) comply with international requirements as a condition of accessing international financing from the World Bank/IFC guidelines such as:
   OP 4.01 Environmental Assessment;
   OP 4.04 Natural Habitats;
   OP 4.09 Pest Management;
   OP 4.11 Physical Cultural Resources (PCR);
   OP 4.12 Involuntary Resettlement;
   OP 4.10 Indigenous People;
   OP 4.36 Forests;
   OP 4.37 Safety of Dams;
   OP 7.50 Projects on International Waterways;
   OP 7.60 Projects in Disputed Areas.

Project Description:

The proposed project is aimed at addressing the challenge of inadequate solid waste management faced by Murang'a County. The project site lies in a 50 acres piece of land south of Murang'a County with a buffer zone of 250m all round (as required by World Bank EHS Guidelines) and is 12 Km from Kabati town.

The area is predominated by the Eucalyptus-grassland/shrub-grassland cover type while pineapple plantation is the second largest land use in the area and is mostly distributed in the southern part of the proposed landfill site covering 1185 ha within 5 km buffer. Close to the pineapple plantation, is the distinct areas with shrubs or secondary plantation that covers approximately 896 ha. Eucalyptus-grassland/shrub-grassland cover type represents areas with human settlement with small farms surrounded by the vegetation types. In addition, no settlement is found in the proximity of the proposed site. However, a Land Subdivision Scheme has been issued for parcel 6824. This scheme is yet to be approved by the County Government of Murang'a and therefore it is not binding[2]. Although some residential units have already been built next to the proposed landfill site as shown in the following below;



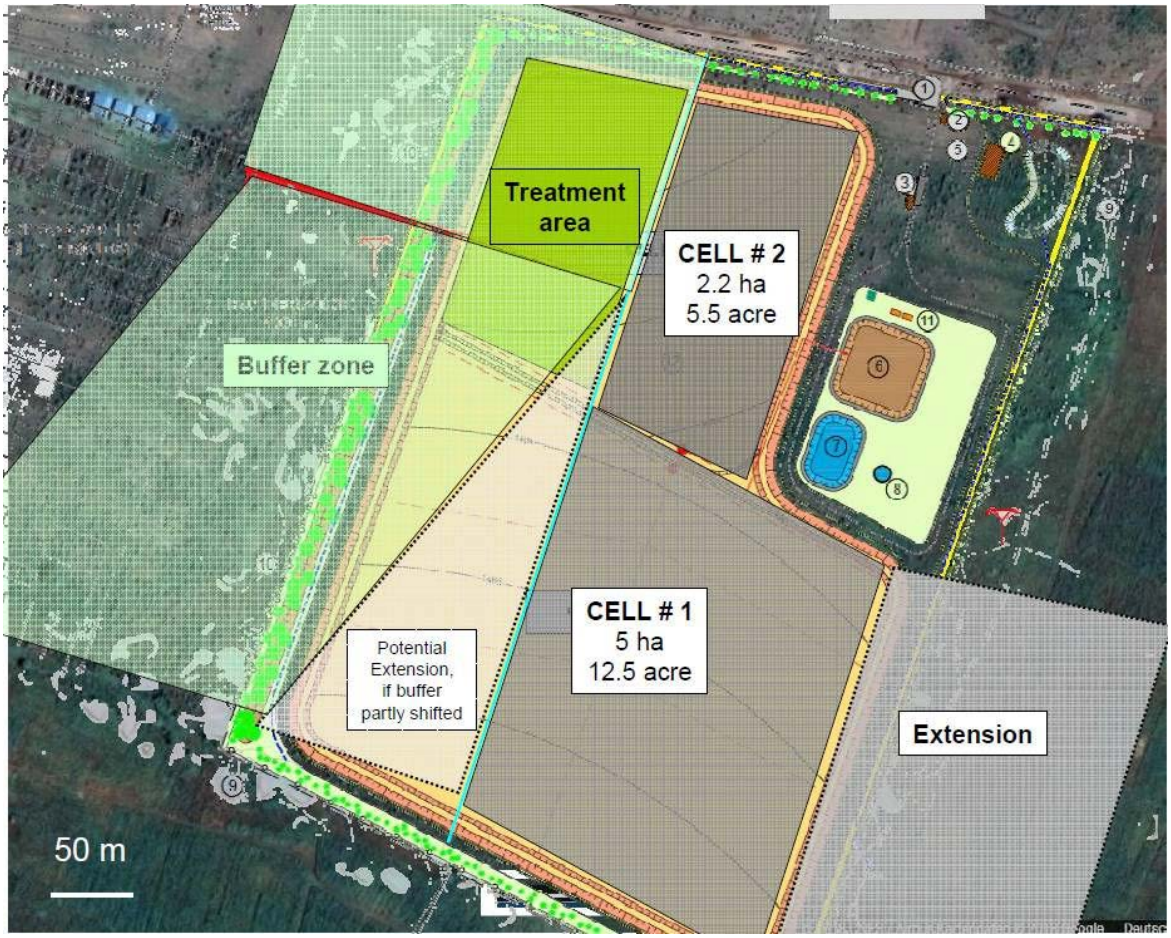
Land Use Plan Mitubiri Wempa Block

As reported in the feasibility study report, the proposed solid waste management system will consist of a new sanitary landfill, project perimeter fencing, access road, gatehouse, weighbridge, drainage, offices and overall site infrastructure. In phases, portions of the site will be constructed in two separate cells, each with a recommended minimum lifetime of 5 years.

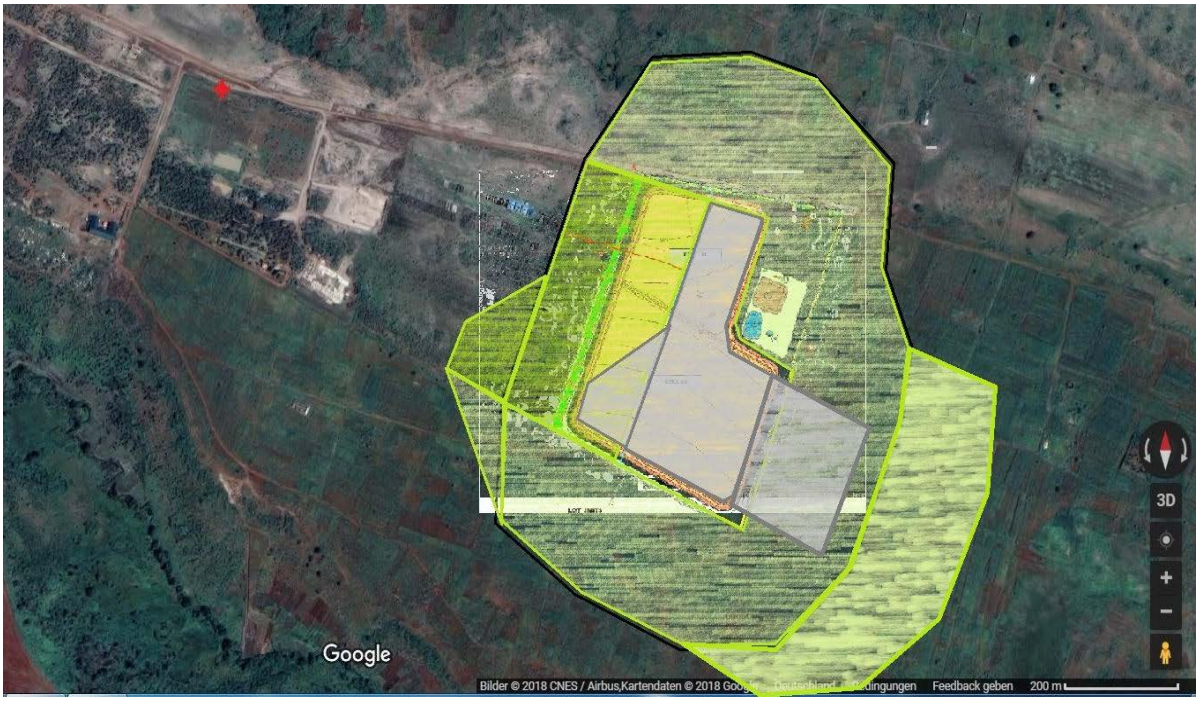
[2] Final Feasibility Study Report, KE517E (Seureca), April 2016

The design of the waste cells will comply with acceptable international standards on environmental protection that considers ground water protection and leachate control.

A base lining system which consists of double layers of 1.5 mm High Density Polyethylene (HDPE) and woven and non-woven geo-textile to protect HDPE sheet and bentonite liner will be installed to provide an effective containment system for waste leachate. A soil cover with a thickness of 15 cm will also be placed and compacted daily on the surface of the waste layer. The engineering measures recommended to collect the leachate include a drainage layer of perforated pipes specially designed for gravity flow of leachate towards low points for further treatment. The pipes will be embedded in the lowest elevation areas of the cells bottom which will provide enough inclination to collect the liquid in the pipes. The sanitary landfill further includes degassing systems composing of 13 wells in phase I(cell #1) and 27 wells in phase II (Cell #2), that is roughly 4 wells per hectare or one well for 2,500 m^2 (collection radius of 30 m).



Landfill Site Map



Layout of site- focus on Buffer Zone

Environmental and Social Baseline

This ESIA study report presents environmental and socio-economic baseline data for the proposed project area. The baseline environmental data considered are;

Physical Environment

- Topography
- Altitude
- Rainfall
- Wind
- Temperature
- Hydrogeology and geologic environment

From the hydro-geological report, the project area geology is dominantly tuffaceous volcanics and basaltic rocks. The site straddles two geological map sheets – Geology of Fort Hall Area and Geology of the Machakos-Thika Area. The rocks are principally trachytic tuffs and agglomerates underlain by basalts and basaltic agglomerates. The essential characteristic of importance to the landfill site is that these rocks are the weaker of the volcanic rock series, being easily weathered. The hydro-geological report further states that such weathering increases porosity of the rock thereby reducing its ability to confine groundwater and formation of leaky aquifer systems. Such aquifers demand a fair degree of leachate management.

The regional groundwater flow mechanism is driven by recharge on the Eastern slopes of the Aberdares Range and a south-easterly flow towards the Athi River basin discharge system.

- Topography

The slope in steep areas in Murang'a range from 17 to 80 degrees. Gentle slopes and plain areas, less than 6.3 degrees, are distributed in the south and part of eastern side of the county. Nearly two third of the county is rugged and this occur in the west, north, north East and central area of the county. The Southern areas are plain with undulating landscape. The proposed project is in the south on a plain area lying between two drainage channels.

- Altitude

The elevation of Murang'a County range from a minimum of 1051m in South East and a maximum 3884m in West and North West. The proposed project site is located within elevation range of 1460-1468m. Steep areas occur in the western and northern side of Murang'a County.

- Rainfall

Murang'a County receives an estimated mean annual precipitation of 1550mm. Some areas receive as little as 866mm and others a maximum of 2386mm mean annual precipitation.

- Wind

The average annual wind rose was generated from seven-year meteorology data (2010 - 2016).The wind rose revealed the following wind motion trends: The winds predominantly flow from the East-North-Eastern quadrant and that the wind speeds range from 0.5 – 8.8 m/s.

- Temperature

The mean annual temperature for Murang'a County is estimated at 17.39 $0^{C.}$ The minimum range is 11.1 0^{C} with general low temperature distributed in the western and north-west of the county; especially in Kangema, west of Kigumo and west of Mathioya. Moderate temperature occurs around the central areas of the county; while, the maximum range is estimated at 21.4 0^{C}. Areas with high temperature occur in the eastern side of the county; these include large areas in Maragua, Gatanga, Kiharu, east of Kandara and Kigumo.

Biological environment

The biological components considered here included both the animal and plant diversity. No rare, sensitive or endangered fauna or flora species were observed during the ecological survey to the proposed site that would be negatively impacted by the construction and operation activities of the landfill. A total of 36 species in 21 families were recorded from the two days survey. Of one, vulnerable grey crowned Crane *Balearica regulorum* according to I.U.C.N and one Local /Afro tropic Migrant Red-billed Quelea *quelea*. Among the species noted were 4 water fowl species which are resident to the seasonal wetland.

Socio-Economic Environment

Social baseline considered the following aspects

- Population

Population of MaraguaConstituency, from which the proposed landfill project site is situated, is estimated at 350,000; this is distributed among the eight locations (Administrative units). The location, Mitubiri, at which the project is located, has an estimated population of 19,304. From this population, Nanga Sub location has about 5457, Thuthua 6247 and the Sub location where the project is base, Wempa, has about 7,600.

- Poverty levels

The county has high poverty levels which according to the 2005/2006 Kenya Integrated Household Budget Survey, about 36 per cent of the population live below the poverty line. The poor are not able to access the basic necessities of life such as food, shelter and education

- Education levels

The national literacy rate stands at 71.4 per cent where as that of Murang'a County is 70.1percent. This implies that the literacy rate at the County is lower than the national one. In the County the literacy level for male is 73.9per cent while for the female is 66.7per cent. This shows that literacy rate for male is higher than female. The county gross enrolment rate in primary schools stands at 97.75 per cent while the gross enrolment rate in secondary schools is 71.04 per cent. At the same time, the county transition rate from primary to secondary school is 70.6 per cent. Additionally, the primary school completion rate in the county is 97.13 per cent. This implies that 26.53 points of the primary school pupils who complete primary education do not proceed to secondary school education.

- Health Characteristics

The County has 272 health facilities serving a population of 959,701. It has three level five hospitals, three mission/private hospitals and three nursing homes. There are 21 health centers (public and private), 114 dispensaries (89 public and 25 mission/NGO) and 137 private clinics.
The County has 464 medical personnel working in government health facilities with 312 nurses, 23 doctors, 41 clinical officers, 50 public health officers and 38 laboratory technicians and technologists among others medical personnel and health facilities in the county are inadequate.

- Land Use and Land cover

The area is predominated by the Eucalyptus-grassland/shrub-grassland cover type. This is distributed all over the buffer area covering, approximately 4326 ha within the 5km buffer around the proposed landfill site. Eucalyptus-grassland/shrub-grassland cover type represents areas with human settlement with small farms surrounded by the vegetation types.

This area will, in the near future, be more opened than it is today that its role in supporting biodiversity might be impacted

- Gender roles, access and control of resources by gender

The County gender development index stands at 0.5357 compared to the national indicator which is 0.4924. This is attributed to empowerment of the girl child and promotion of women rights in the county. The county youth development index is 0.6517 compared to the national indicator of 0.5817. This shows that the county is performing better in terms of youth development. This could be attributed to high literacy levels and proximity to urban and major towns where there are ample opportunities for the youth.80 per cent of women constitute the agricultural workforce but only a small percentage of them hold title deeds to land. This imposes a great constraint on their ability to make major land-related investment decisions including obtaining credit using title deeds as collateral.

A detailed description of the Project site and its surrounding area is provided later in this document, as part of the environmental and social baseline chapter four.

Project Justification

The proposed project is essential to assure proper solid waste management within Murang'a County and the surrounding area and to mitigate exposure of the environment and humans to the detrimental effects of solid wastes currently disposed in open dumpsites by containing and isolating the waste**.** Current waste disposal practices have created severe environmental nuisance and degradation with regards to air pollution primarily due to illegal burning of waste and operating the open dumpsite without lining or proper containment of the leachates which poses immense threats to the surface and groundwater. Uncollected and improperly dumped solid wastes along the roads cause nuisance to the residents and sometimes create problems by clogging drainage manholes resulting in frequent floods witnessed during heavy downpour.

Uncontrolled scavenging practices in uncontrolled open dumpsites pose great health risks to the waste pickers. Dumpsites also generate methane, a greenhouse gas that contributes to the adverse effects of climate change. However, a landfill collects approximately 90 percent of this gas to generate electricity which is a green fuel. As such, the project in itself is already an activity in mitigation of existing concerns and this is the prime justification of the proposed investment. In addition, the project also contributes to the Government's Vision 2030 commitments for the Country in the management of solid waste and minimizes emission of greenhouse gases which is a global challenge by incorporating gas collection and venting system in the proposed project.

Public Participation Process

Diverse approaches were applied in stakeholder engagement as follows: -

Semi- structured interviews: semi structured interviews were done with relevant Murang'a County Government departments specifically the Land and Physical Planning, Social Services, Agriculture, Environment, Children Officer, Maendeleo Ya Wanawake representative (Women Representative) Municipal Council, Sub County Commissioner, Maragua, Assistant County Commissioner, Makuyu etc. and with the Real Estate Company Angaza officials who own the portion of the site where the proposed landfill 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: These included discussions with members of the Murang'a County assembly and County executive committee. Focus group discussions with men, women, elderly and the youth from the surrounding community near the proposed landfill were also undertaken. These forums served the purpose of information disclosure to the community concerning the proposed landfill development and provide an opportunity for public participation to identify anticipated positive and negative impacts from the proposed project and also create awareness on the proposed project.

Interviews: Interviews with the local leaders namely MCA, chief and assistant chief, village elder was also organized. These were used as entry points to all communities who were consulted. Additionally, interviews specifically with owners of land who are doing cultivation around the landfill were also undertaken.

Structured questionnaires: - One hundred and fifty-five structured questionnaires were administered randomly in areas around Kenol trading centre and shopping centers along the proposed access road leading to the project site. Additional sixteen structured questionnaires were administered to the immediate neighbors. (The structured questionnaires are hereby attached)

Discussions: Discussions with the waste pickers at the Gikono dumpsite were also done to understand their needs and difficulties of developing alternative livelihood. Also, discussions with the client was done following submission of the Inception and Feasibility Study Reports, consultative forums were held with the client during which, comments on the content, quality and focus of the environmental reports were made. Such comments have subsequently been used to update subsequent reports.

A public meeting was held at Peter Kariuki Secondary School with participation of community members and the local leaders. Mobilization for the public meeting was done through paid-up announcements on two daily newspapers of national coverage, local FM stations, posters, flyers and banners. Local leaders also played a key role in mobilizing community members.

Findings from the Study

The development of the proposed landfill project has the potential to create a range of 'impacts' with regard to the physical, biological and human environment. In this report, the definition of a project impact was adapted from the ISO 14001: 2015 which is defined as**: "Any change to the environment [or social receptors], whether adverse or beneficial, wholly or partially resulting from an organization's environmental [or social] aspects.**

(I) Potential positive impacts anticipated:

The proposed project seeks to improve solid waste management in Murang'a County and mitigate against the current environmental degradation caused by current waste disposal practices. Other positive implications of the project will accrue from its potential to create short-term and long term employment opportunities to both professional staff and workers during the design, construction, operational and decommissioning phases, at construction phase, business people will benefit from opportunities to supply construction material and the project will improve waste management in the County upon commissioning phase as dumpsite will be minimized in the county thus creating a cleaner environment.

Potential adverse impacts anticipated

Impact	Sources of Impacts	Project phase	Mitigation measures	Monitor able indicators
Air; Dust Pollution, and Exhaust emission	Site clearing and excavation activities Truck movements, Heavy equipment and machines	Throughout the project cycle	Use best management practices to minimize dust generation. These include: re-vegetating areas where vegetation has been removed; keep to the minimum areas where earthwork activities will take place, water down haul roads during dry weather conditions Routine maintenance of	Schedule routine servicing of machinery and equipment

Impact	Sources of Impacts	Project phase	Mitigation measures	Monitor able indicators
			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	
Air pollution -Odors and gases (mainly from fugitive methane and carbon dioxide and non-methane organic compounds) -Suspended particulate matter	-From waste and their decomposition -From access road and the landfill site From delivery trucks	Operation	-Watering of bare surfaces or dusty areas -Provision of dust masks for the employees Use best management practices to minimize odor and prevent odor from emanating offsite. Ensure that delivery trucks are covered. These practices will include: applying daily and intermediate soil cover on waste; waste with strong odor to be covered immediately they emptied from delivery vehicles; effectively control and manage leachate treatment plant to minimize odor Use soil to cover the fugitive methane daily Flaring at 750 – 1000	Monitor the dust particles in the air at different times of the day Periodic air quality reports

Impact	Sources of Impacts	Project phase	Mitigation measures	Monitor able indicators
			degrees minimizes methane Compacting waste minimizes odor	
Noise pollution & excessive vibration	Construction and operation of the landfill	Operation	Work hours 8-5pm Quarrying activities acquire permits	Noise and excessive vibration regulations, 2009
Aesthetics/ visual intrusion	Construction and operation of the landfill	Construction and operation	Plant trees and construct berms	Presence of green cover around the landfill
Increase traffic on the access road	Waste trucks delivering the solid wastes	Operation	Expansion and improvement of the access road to bitumen standards	Expanded and improved access road
Surface and Groundwater Pollution;	-Inadequate treatment of leachate at the ponds Accidental leakages form the landfill	Operation	Adoption of good routine operational management will 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. Lining of the landfill to contain leachate Construct interception drains that direct storm water away from the areas where waste is to be disposed. Construct storm water drain around the landfill	Water quality reports According to the EMCA (water quality) regulations 2006, monitoring should be done on quarterly basis

Impact	Sources of Impacts	Project phase	Mitigation measures	Monitor able indicators
			Use appropriate liners to contain leachate	
Social Changes	The high influx of casual workers will cause several social changes	Construction and operation	-The project should engage local men, women and youth for unskilled labor and other opportunities. Avoid child labor as stipulated in the world bank policies -Utilize local goods and services where practical -Educate the workers on HIV/AIDS and other sexually transmitted disease through a training program	Monitor the health seeking behaviors and consumer behaviors Trained number of people and the frequency
Injury and loss of life	Installation of machines, and plants take place human safety is at high risk Landfill operations Dismantling of project installations	Through the project phase	-Provide appropriate PPEs for the workers -Avail first aid kits at workplace -Safe installation of water and electricity supply systems -Provide an appropriate waste disposal system for waste - Train employees on occupational safety and health	-Number of people at site in PPEs -Records of safety and health trainings -First Aid kits on site OSHA, 2007 Construction and operation safety

Impact	Sources of Impacts	Project phase	Mitigation measures	Monitor able indicators
Habitat loss and degradation	The infrastructural development related to the landfill including leachate ponds, access roads, administrative units etc. may lead to degradation or loss biodiversity	Construction	-Disturbance to habitats should be Strictly controlled. -Rehabilitate degraded habitats within the site -Support habitat conservation in nearby areas -Disturbance to habitats should be Strictly controlled. -Rehabilitate degraded habitats within the site -Support habitat conservation in nearby areas	Spatial and temporal turnover in bird community i.e. species richness, diversity and abundance Number of resident and migratory birds in the project area.
Explosions and fires	Self-ignition due presence of Methane gas and other flammable substances	Operation and decommissioning	Develop regular maintenance and monitoring of gas venting system Store all flammable materials in well ventilated rooms; Control the types of waste delivered to site; Develop integrated fire prevention plan; Sufficient water for emergency should be available; Provide sufficient firefighting equipment onsite Train fire marshals and sensitize the workers and the community Keep well stocked first	Inventory record of fire detection and fighting facilities, Evacuation procedures and plans -Records of fire safety training and audits OSHA, 2007

Impact	Sources of Impacts	Project phase	Mitigation measures	Monitor able indicators
			aid box Proper handling and use of tools and machinery	
Soil erosion	Clearing and excavation of the site for the construction of the site office and other structures Storm water	Construction	-Close monitoring of the earth works to minimize surface run-off of solid matter. Re-vegetate open areas -Drainage systems should be well maintained and where practical, fit traps for the solid matter	Assess the surface run-off and siltation in the streams and rivers
Construction debris	Demolition works Restoration of the site	Decommissioning phase	Dispose of as per the waste management regulations, 2006 Planting of adoptable vegetation	Monitoring the air and water (ground and surface) quality for 5years

(ii) Residual impacts

Landfills have minimal residual effects during operation phase. However, the long-term measurable effect of landfills is a very slight increase in chemicals associated with waste in the groundwater directly beneath the areas where waste has been buried.

The other significant residual vector from the landfill is landfill gas and associated occasional odour nuisance. The long-term operation of the project LFG will also be the subject of monitoring, by means of systems specifically designed and installed for this purpose.

(iii) Cumulative impacts:

Cumulative impacts refer to impacts that may be of low significance on their own, but become of high significance when added to similar impacts emanating from various sources in the surrounding area where an activity is undertaken. The activities may be from identified and discussed. In line with the proposed Mitubiri landfill site, possible cumulative impacts that may result are as follows:

- The release of fugitive methane gas into the atmosphere as a greenhouse gas will contribute to the ambient air quality of the project area and beyond, thus contributing to climate change.
- Increased traffic on access road due to movement of trucks during operations.
- The access road may spur strip development in the area with hotels, restaurants, etc.
- Other cumulative impacts that may be anticipated relate to water pollution.

The impacts mentioned above do not only affect the environment within the proposed site or surrounding area in terms of the Biophysical environment, but may also impact on the health of communities

ESMMP:

An Environmental and Social Management and Monitoring Plan (ESMMP) has been developed to improve the overall net positive effect of the project. This Report therefore requires that the ESMMP be integrated into the Design Report with appropriate allocation of funds in the Bills of Quantities. The NaMSIP`s PCT will mount own internal monitoring to ascertain environmental and social sensitivity at all stages of project development.

Cost Estimates

The feasibility assessment estimated the construction cost of the project to be US dollars, eighteen million six hundred and ninety-seven thousand four hundred and eighty **(18 697 480 USD).** Total Cost of Environmental & Social Monitoring Plan is estimated atUS Dollars One Hundred and twelve thousand (**112,000 USD per annum**).

Conclusion and Recommendations

The importance of the proposed project to national development and the local community cannot be overemphasized. 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.

Having considered the information collected, collated and analyzed during the study, it is the Expert ‘s considered opinion that:

- Every Kenyan is entitled to a clean and healthy environment, as such, the project is vital for the improvement of the sanitary conditions in the metropolitan.
- The proposed ESMP is adequate to mitigate the potential negative environmental impacts
- The positive environmental impacts far outweigh the negative ones, which can be contained by the proposed ESMP.
- The proposed project will not compromise the well-being of the neighboring community, ecology or any other conditions.

- The project should be allowed to commence and activities be managed within the provided ESMP. There are various actors with diverse responsibilities depending on the stage of the project.
- The proposed project is a viable venture that should be given due support.

In regard to this ESIA, the following recommendations are given:

- ✓ The proposed project to be implemented in compliance with the relevant legislation and planning requirements;
- ✓ 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
- ✓ The landfill management in partnership with relevant stakeholders should develop elaborate plans and policies for management wastes not accepted landfill as guided by the applicable County and National legislations.
- ✓ An elaborate and effective management structure be in place to to ensure sustainable management of the landfill.
- ✓ 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
- ✓ 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;
- ✓ Standard operational procedures and controls of the landfill 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;
- ✓ The project has attracted high level of community support with terms and conditions on sound management of the landfill;
- ✓ 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.

CHAPTER ONE

1 INTRODUCTION

1.1 Background and Context

The Murang'a Sanitary Landfill, hereafter referred to as proposed project, discussed in this ESIA report forms part of the Nairobi Metropolitan Services Improvement Project (NaMSIP) being implemented by the Ministry of Transport, Infrastructure, Housing and Urban Development, with financial support from the Word Bank.

The NMR has a growing human population and an increase in urbanization which has led to increased waste generation and complexity of the waste streams. This has further been compounded by growing industrialization of the Kenyan economy. As such, there is need of proper and efficient waste management to accommodate the expected population growth and increased waste influx.

The NaMSIP with funding from the World Bank aims at improving Government infrastructure in the Metropolitan Region focusing on the following sectors:

- Solid waste collection and hazardous wastes;
- Municipal services, such as storm water management, water supply and sanitation services, disaster management, and street lighting;
- Public Transport;
- Safety and security;
- Improve coordination and planning at the Metropolitan level

NaMSIP is in line with Kenya Government's Vision 2030 aiming at "creating a globally competitive and prosperous nation with a high quality of life by 2030". This vision 2030 aims to transform Kenya into a newly industrializing, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment.

The present project for integrated solid waste management & investment within the Nairobi Metropolitan Region is part of the NaMSIP.

The assignment requires an integrated approach providing NMR with an adequate response not only the technical aspects of solid waste treatment, but also to the pertaining social and financial components of the sector. Several recent studies have addressed the issue of solid waste management in Nairobi in particular:

- Solid waste management in Nairobi City by JICA in 1998
- Integrated Solid Waste Management Plan for the City of Nairobi by University of Cape Town for UNEP in 2010

- Project for Capacity Development of Solid Waste Management of Nairobi City by JICA in 2010
- Feasibility studies carried out by the former Ministry of Local Government

1.2 The ESIA Report Process

1.2.1 Terms of Reference (TOR) for the ESIA Process

The following terms of reference for the proposed sanitary landfill Project were used by the ESIA expert team.

- 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.
- 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, facilitation of public consultation and conducting interviews with the proposed project beneficiaries.
- Collection of secondary data.
- Maintenance of all correspondences with NEMA relating to the ESIA including improvement orders in close consultation with the client.
- Acquisition of an Environmental and Social Impact Assessment License from NEMA.

1.2.2 Scope of the ESIA Study

The Kenya Government policy on all existing 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 to ensure that significant impacts on the environment are taken into consideration during the design, construction, and operation and decommissioning of the proposed development. This ensures that significant impacts on the environment and the surrounding communities are taken into consideration at all times during the operations of the respective sites.

The ESIA report has been conducted in Compliance with Environmental Impact Assessment Regulation as outlined under the Gazette Notice No. 56 of 13th June 2003 established under the Environmental Management and Coordination Act (EMCA), 2015 of Kenya and **repeal** in 27th May, 2015 and World Bank Operational Policy/Bank Procedures/Good Practice (OP/BP/GP 4.01).

1.2.3 Objectives of the ESIA

The objectives this Environmental and Social Impact Assessment are to:

- Establish the baseline conditions of the study area through a combination of desk review, consultations and site surveys taking account of any committed development projects among others which could change the baseline in the future;
- Identify environmental constraints and opportunities associated with the study area which may influence, or be affected by the proposed Sanitary Landfill;
- Identify and assess predicted environmental impacts which could result from development of the proposed project;
- Identify and incorporate into project design and operation, features and measures to avoid or mitigate adverse impacts and enhance beneficial impacts; and
- Assess the level of significance of all residual effects (direct and indirect, adverse and beneficial, short-term and long-term, permanent and temporary) taking into account of the proposed mitigation measures.

1.3 ESIA Approach and Methodology

This study was undertaken taking into account the requirements of under the EMCA 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 landfill 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 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 study was undertaken through the following stages:

1.3.1 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, the proposed project falls under category of projects to be subjected to ESIA study as provided for by the second schedule of the Environmental Management and Coordination Act of 2015 and Category A under the World Bank Environmental and Social Safeguards Policies as defined in the Bank's Operational Procedures (OPs).

1.3.2 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 so as 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 an EIA study

1.3.3 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.

1.3.4 Site Assessment

A physical inspection of the ground (proposed site and their surrounding environment) was conducted. This was done with an aim of establishing the anticipated positive and negative impacts on the bio-physical environment (hydrology, climatic patterns, ecology and geology), socio-economic 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 vigorous 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. This was done between 19/10/15 and 21/10/15 using the RRA (Rapid Rural Approach). A detailed field study was later conducted for the proposed landfill project between 02/10/15 to 23/12/2015 by Seureca and another stakeholder engagement undertaken in September 2016 by SGS team.
- Evaluating the environmental setting around the proposed site - observations were focused on the topography, land tenure, surface and ground water sources, public amenities, land cover, climate, flora and fauna, soils, etc.
- Evaluate social, economic, physical and cultural settings in the entire project site.

1.3.5 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 impacts 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 sanitary landfill 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 plan comprising of mitigation measures, authority responsible for monitoring and evaluating anticipated impacts, timeframes and environmental costs were developed.

1.3.6 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.

Table 1-1: Summary of Consultations held during ESIA Study

Technique	Participants	Number of participants	Dates
Questionnaires	Local community including immediate neighbors	166	March – April 2018
Key Informant Interview	Immediate neighbors	15	28th April 2018
Focus group discussion	MCA's meeting	53	19th April 2018
	Muranga County Executives	84	22nd February 2018
	Wempa-Kimorori community development project group	12	12th April 2018
	Gikono Waste Pickers	10	28th December 2015
Public meetings	Leaders meeting	18	17th December 2015

Technique	Participants	Number of participants	Dates
	Local community and public	48	21st December 2015
	Visioning	60	19th February 2018
	Local community and the public	200	24th April 2018

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

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 Murang'a County Government departments specifically the Land and physical Planning, Social Services, Agriculture, Environment, Children Officer, Maendeleo Ya Wanawake representative County government, Sub County Commissioner, Maragua, Assistant County Commissioner, Makuyu and Real Estate Company Angaza officials who own the portion of the site where the proposed landfill 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 landfill was also undertaken and interviews with the local administration namely MCA, chief and assistant chief, village elder was also organized. The findings have been presented on chapter 6.

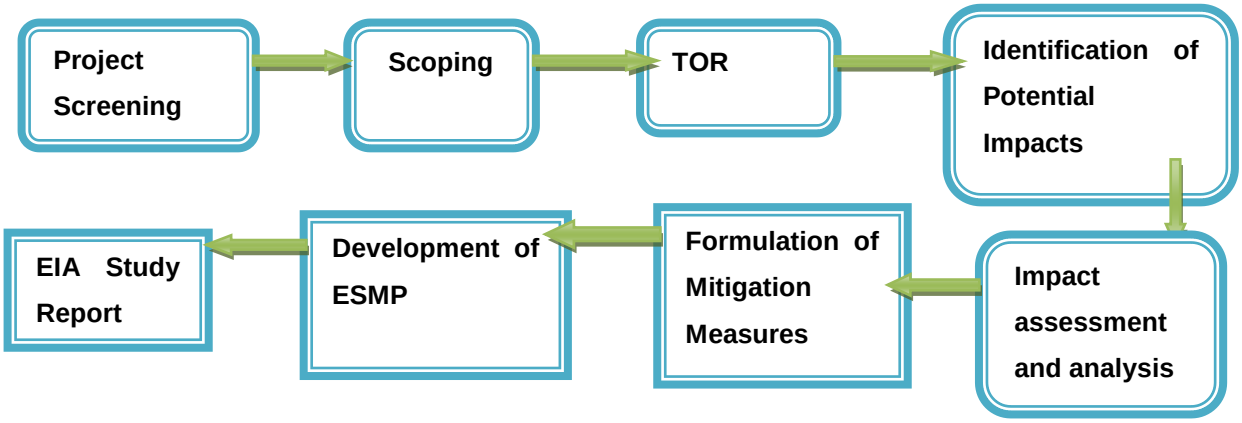


Figure 1-1:Summary of ESIA Process

1.4 Presentation of the Report

The process indicated above culminated with the production of this Study Report designed to ensure that the proposed development project complies with Environmental Management and Coordination Act (EMCA, 2015). The report is recognized in 10 chapters as outlined below:

Chapter 1: Introduction of the project which include project Background, Scope of the ESIA Study, Study Methodology and Presentation of the report.

Chapter 2: Project Description

Chapter 3: Policy, Legal, Regulatory, Institutional and Administrative Framework.

Chapter 4: Baseline Information of the Study Area.

Chapter 5: Alternatives to the Project.

Chapter 6: Public Participation and Consultation process

Chapter 7: Potential Impacts and mitigation measures of the project.

Chapter 8: Environmental and Social Management Plan.

Chapter 9: Environmental and Social Monitoring Plan (ESMP)

Chapter 10: Conclusion and recommendations.

CHAPTER TWO

2 PROJECT BACKGROUND AND DESCRIPTION

2.1 Introduction

This chapter provides a detailed description of the proposed development, including the current solid waste management system, the purpose of the project, its location, detailed specifications, and project alternatives.

2.2 Project background

Current inadequate waste management systems and practices in the region and country at large have led to environmental degradation, proliferation of diseases and ultimate impact on livelihoods. Additionally, improper management of waste poses a threat to Climate Change due to the uncontrolled release of greenhouses gases.

Over the years most local authorities did not prioritize the establishment of proper waste management systems and hence the County Governments inherited this state of affairs. This has led to the current poor state of waste management which includes indiscriminate dumping, uncollected waste and lack of waste segregation across the Country. Disposal of waste in the Country remains a major challenge as most of the counties lack proper and adequate disposal sites. The few counties that have designated sites practice open dumping of mixed waste as they lack appropriate technologies and disposal facilities. There is no single sanitary landfill in Kenya.

2.3 Impacts of current waste management systems

- Air pollution primarily due to illegal burning of waste and bad odor from the uncontrolled release of landfill gas;
- Water pollution from uncontained leachate produced by the decomposition of solid waste in open dumps and peoples littering waste into the nearby rivers and streams and along drainages;
- Presence of dumpsites behind shops and markets in Kenol, Kabati, Kangari among other trading centers
- Uncollected and improperly dumped solid wastes along the roads cause nuisance to the residents and sometimes create problems by clogging drainage manholes resulting in frequent floods witnessed during heavy downpour;
- Uncontrolled scavenging practices in uncontrolled open dumpsites pose great health risks to the waste pickers and animals. Waste pickers sort waste without protection;
- Scavengers may become vectors and potential transmitters of health problems to the people they are in contact with;

- Unsightly heaps of waste in the open dumps impacts negatively in value of property around the sites;
- Waste transportation is largely rudimentary using open trucks, hand carts, donkey carts among others. These poor transportation modes have led to littering, making waste an eye-sore, particularly plastics in the environment; and
- Climate Change due to the uncontrolled release of greenhouses gases

Plate 1: Dumping of wastes at Gikono dumpsite, near proposed site of landfill

2.4 Project Location

The proposed facility will be located approximately 67 kilometers from the city of Nairobi in Makuyu location, Mitubiri Sub-location, Maragua sub-County, Murang'a County. The site coordinates are lat 1° 00'09.18"S, longitude 37°11'59. 70"E and it is at an elevation of about 1462 meters above the sea level. The site is accessible by road from Kabati using a murram road which is about 6km from the main Kabati paved road.

Plate 2: Picture showing the proposed site and an access road leading the project

Source: field survey 2018

2.4.1 Definition of project area base map extent

To ensure complete satellite imagery dataset was acquired for the compilation of the project area base map, a 25 square kilometers Area of Interest (AOI) was curved out with the proposed project site at the center.

High-resolution satellite imagery has been used in the spatial planning domain and has proved effective as base information for digitization/extraction of topographic vector data in the compilation of spatial planning base map. However, the high-resolution satellite imagery provides the topographic detail data without the height dimension i.e. ground contours.

The height data was sourced separately and coupled with the high-resolution satellite imagery to give full three-dimensional base map information for town spatial planning.

After the project area was defined, the satellite imagery data specifications were drawn as procurement controls. These specifications were largely guided by the following factors:

- Requisite spatial resolution (at least 0.5 meter or better)
- Minimal cloud cover

Map 2-1:High resolution satellite image of proposed site

2.4.2 Compilation of the study area base map

The acquired high-resolution satellite images were used as source information to compile topographic base map of the study area.

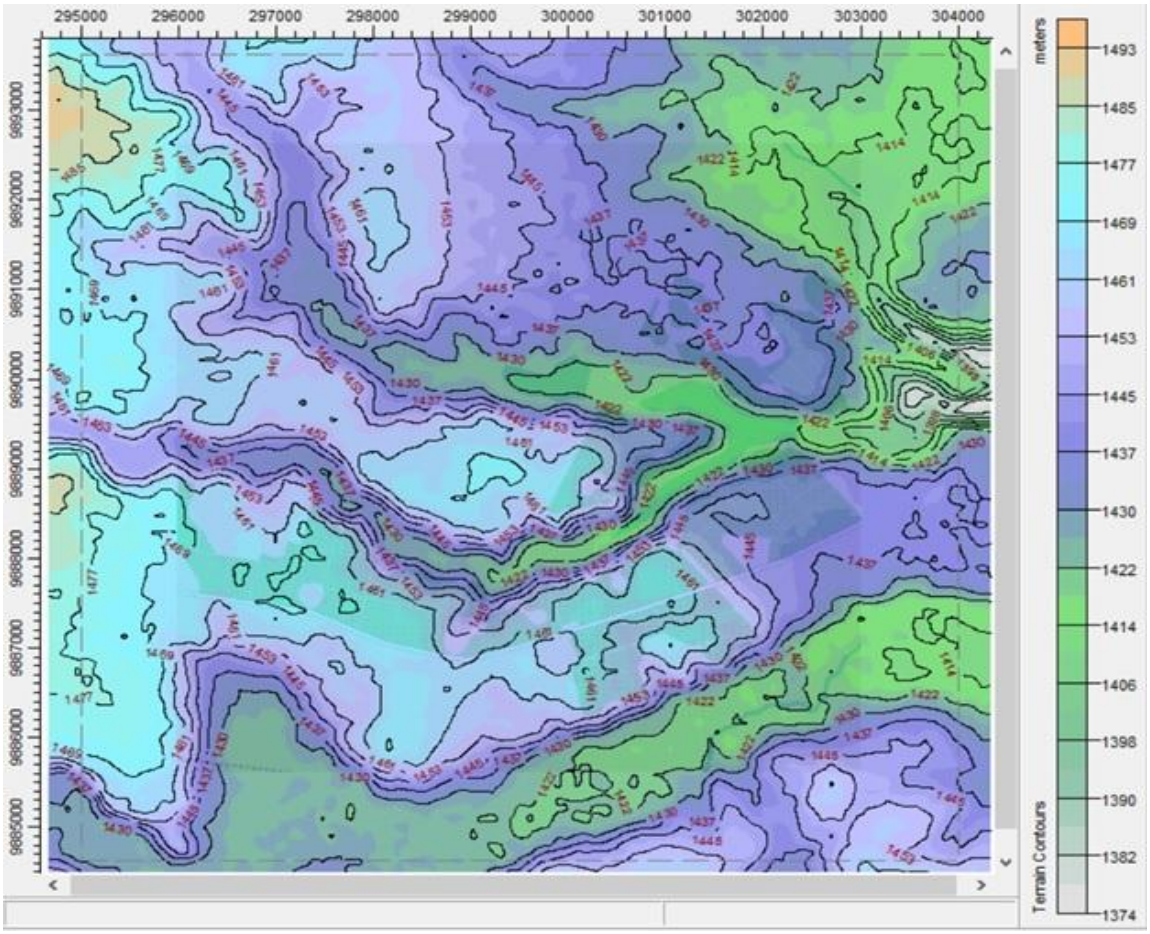
Geographic Information System (GIS) databases of the following topographic layers were designed in shape file format in ArcGIS 10 software:

- Buildings/Institutions/Settlements/Industries/ commercial centers
- Transport network – Roads
- Agricultural areas / Irrigated Farms
- Wetlands/Rivers
- Dams
- Forests / Tree Plantations

The GIS database of the above topographic layers was developed as an existing development base map. This data was handy in geographic analysis and visualization of the following aspects of the project area:

- Settlement patterns
- The existing transport networks
- The topography across the project area
- The environmentally sensitive areas i.e. wetlands, rivers, swamps, forests etc.

The project area base map is presented under Annex 5.



Map 2-2: Topography of the project area

2.5 Project Components

2.5.1 Site selection

Site selection process was carried at the beginning of the project using a four-step approach summarized below:

Phase one- Negative Mapping: This phase involved mapping out areas unsuitable for landfill development. From this phase it was found that 34, 000 Km^2 of Nairobi Metropolitan Area are unsuitable for Landfill development and therefore are to be excluded in the selection process.

Phase two- Positive Mapping: In this phase, the areas identified as suitable in phase one were evaluated for suitability using criteria which are rated and weighted by order of importance. The phase 2 evaluation ranked 1, 038 Km2 in the suitable areas as best for the landfill.

Phase three-Identification of Potential sites: In this phase, the candidate sites identified in phase 2 were subjected to physical review/inspection and verification of land availability and actual uses of the respective sites. It was found that land is scarce in NMR and potential sites were not numerous as earlier anticipated. Following the findings of this phase, the criteria on the size of land were reviewed to allow consideration of many sites as necessary. During this phase, fourteen (14) possible sites were identified and studied. Some were disqualified from further studies, as some inadequacies were revealed. From the 14 sites, nine (9) sites were analyzed and compared.

Phase four- Evaluation of Candidate Sites: The 14 sites identified in phase three were further evaluated considering the main criteria presented in section 2.7.2 below for landfill implementation.

2.5.1.1 Selection Criteria

Defining criteria is the most important step in landfill site selection process. For this project, exclusion criteria were utilized in site selection process. Exclusion criteria are defined relative to specific situation and they represent restriction criteria. According to exclusion criteria, areas that should not be further analyzed are discarded, i.e. areas that will be analyzed and evaluated in consecutive phases (phase 2, 3, and 4 above) singled out. After that, in cooperation with County governments within NMR, the sites identified in phase 2 were nominated for which a multi-criteria evaluation (phase 3 and 4) was carried out.

The following factors were considered in the selection of the site:

- Context and location;
- Suitability of the site with regards to phase 1 and 2 studies (negative and positive mapping);
- Land availability and ownership
- Available foot print;
- Road accessibility;
- Distance to settlement;
- Rail accessibility
- Geological and Hydrological context;
- Distance to airport;
- Actual land use

Based on the landfill identification report (2015), the following three sites were recommended namely; Kiambu site, New Machakos town and Mitubiri Wempa Site.

i. Kiambu site

It was noted that this site is close to the “center” of waste production, but is still isolated from populated areas.

The location and the topography of the site are very suitable for a landfill implementation and the first hydrogeology assessment shows that the underground context is favorable.

Currently, the County has set aside this site for solid waste treatment. Considering its location, this site can be considered for the treatment of the waste of Kiambu County and part of the waste from Nairobi. However, the ownership and the administrative procedures launched by the County for retrieving and rezoning the land needs to be documented before further studies on this site can been done.

ii. New Machakos town

According to the landfill identification report (2015), this site can be considered a good choice for landfill implementation. Considering its location this site can be considered for the treatment of waste produced by the Machakos County. However, the first hydrogeological assessment showed that the thickness of the soil in this area is very thin, on top of hard bedrocks. As this type of geology can be challenging for landfill implementation, the report recommended that an additional geological survey be realized before going any further with this site.

iii. Mitubiri Site.

The landfill identification report noted that the site is also a good choice for landfill implementation as it is isolated from populated areas. The site can be accessed through a murram road which is about 10 kms from the main Kabati tarmac road. The size of the site that the land owners are willing to sell is a real advantage and could allow the development of a large landfill. Considering its location this site can be considered for the treatment of waste produced by Murang'a South.

Based on the following World Bank's sanitary landfill site selection criteria, Mitubiri site was found to be suitable due to;

- Adequate land area and volume to provide sanitary landfill capacity to meet projected needs
- No environmentally significant wetlands of important biodiversity or reproductive value are present within the potential area of the landfill cell development.
- No known environmentally rare or endangered species breeding areas or protected living areas are present within the site boundaries.
- No significant protected forests are within 500 meters of the landfill cell development area
- No major lines of electrical transmission or other infrastructure (i.e., gas, sewer, water lines) are crossing the landfill cell development area
- No underlying underground mines which could be adversely affected by surface activities of landfilling, or minable resources, which could be rendered less accessible by landfilling, unless the owner(s) gives explicit consent.

However, it is established that there are residential developments within 250 meters from the perimeter of the proposed landfill cell development and the therefore proponent has made plans to acquire additional land to create a sufficient buffer zone.

2.5.2 Capacity of the Proposed Landfill Facility

Preliminary feasibility study provided waste estimates over 2018– 2028 period, taking into consideration increase in population and improved waste management in the metropolitan region as presented in table 2-1 below. Considering the limited size of the proposed sanitary landfill; the final feasibility study should incorporate an optimal specific waste catchment area to be served by the proposed project.

Table 2-1: Estimated Solid Waste Volumes from Murang'a County

Year	Quantity of waste (Tons /day)
2015	307
2016	325
2017	335
2018	369
2019	371
2020	372
2021	384
2022	411
2023	423
2024	435
2025	449
2026	462
2027	463
2028	477

Source: Feasibility study report, KE517E(Seureca), February 2016

Table 2-2: Proposed land utilization footprint

Function	Area in Sq. meters	% of Land available
Total available surface	192 600	100%
Waste storage cells	72843	38%
Treatment Area and Potential Extension	54 157	28%
Protection and buffering zone for drainage, vegetation and fencing	38 250	20%
Platforms and roads	20 600	11%
Fresh water and sedimentation pond	3 200	2%
Leachate collection pond	2700	1%
Technical pumps wells and flares	500	0.3%
Buildings	350	0.2%

Source: Feasibility study report, KE517E (Seureca), February 2016

2.5.3 Land acquisition

The proposed site sits on a block of 121.3 hectares of private land located in Mitubiri/Wempa/Block 1/6824. **The land is under freehold tenancy implying that the land is in perpetuity.** The title name in the land registry is "freeholder", owning the "title absolute" registered in the name of CHOSEN BUILDERS INVESTMENTS LIMITED according to the land search document dated May 2015. They were issued with the title deed on the 30th of April 2015. The National Government has secured 50 acres and will purchase an additional 20 acres to be used as buffer zone from the private owner. The process of land acquisition will be guided by the provisions of the land Act (Cap 295). A Land Subdivision Scheme has been issued for parcel MITUBIRI/WEMPA BLOCK 1/ 6824. This scheme is yet to be approved by the County Government of Murang'a and therefore it is not binding. However, some residential houses have already been developed next to the proposed landfill site. However, the residential houses were developed after the site was identified for the proposed project.[3]

[3]As presented in *Feasibility study report, KE517E(Seureca), February, 2016*

2.5.4 Design of the waste cells

The waste storage cells occupy the majority of the land. The design of these cells will comply with the international standards in terms of environmental protection. The main technologies employed in the design include: -

- State-of-the-art bottom liner systems;
- Modern leachate collection, treatment, landfill gas collection and monitoring;
- Groundwater monitoring;
- Engineered final cover layer.

Design of the waste cells will be from top to bottom. The vertical design will consist of final cover that allows efficient landfill gas collection and prevents infiltration from rain water and bottom layer of a landfill consisting of drainage layer, which allows collection of leachate for further storage and treatment; and a barrier layer made of a composite liner system, which acts as confinement between the waste deposit and the substratum.

The drainage layer will consist of (from top to bottom):

- A geo-textile filter to prevent contamination or plugging of the drainage system by solids;
- A layer of sand or gravel or a thick plastic mesh 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.

The barrier layer will consist of (from top to bottom):

- A protective non-woven geo-textile to prevent punctures in the HDPE sheet;
- A sheet of HDPE (at least 1.5 mm thick);
- A second woven geo-textile to protect the HDPE liner, (Sometimes, clay can be added when available and when additional protection is required);
- Bentonitic complex (bentomats)
- The natural substratum prepared and graded according to the project profile.

The proposed layout design and facilities is presented in figure 2-1. The buffer zone measuring 250m wide (minimum width) will be used as a stockpiling for excavated soil material and it will include a protective dike with vegetation. This is recognition that there are human settlements located within 1 Km from the project site.

The landfill design layout is as shown below that comprises of the following key areas;

1. Entrance gate
2. Guard
3. Weighbridge and cabin
4. Administration building

5. Parking
6. Leachate pond
7. Fresh water pond
8. Well
9. Fence
10. Protective dike with vegetation
11. Leachate treatment plant
12. Leachate collection system
13. Landfill gas collection system
14. Landfill gas flare

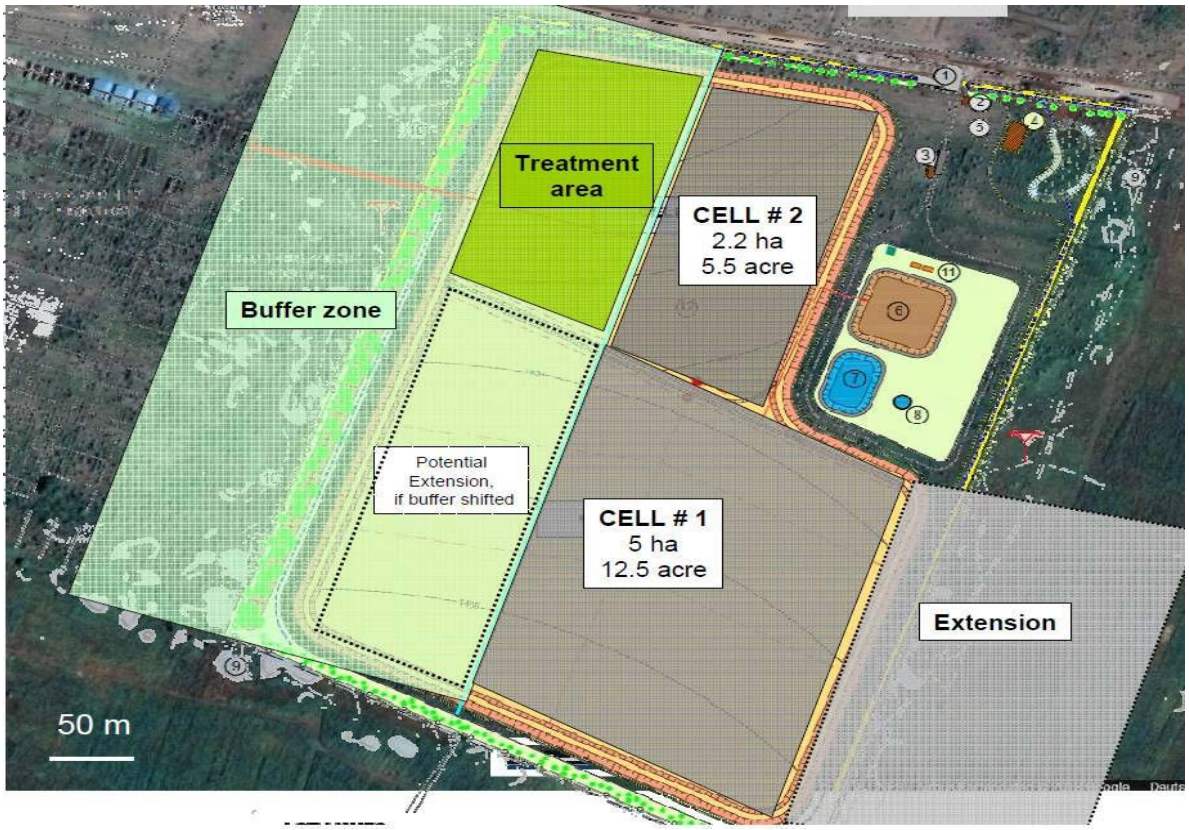


Figure 2-1: Proposed Sanitary Landfill layout design

2.5.5 Buffer Zone

As required by the World Bank EHS Guidelines, the landfill will have a protective buffer zone of 250m all round from the cell's perimeter. This is illustrated in the following diagram;

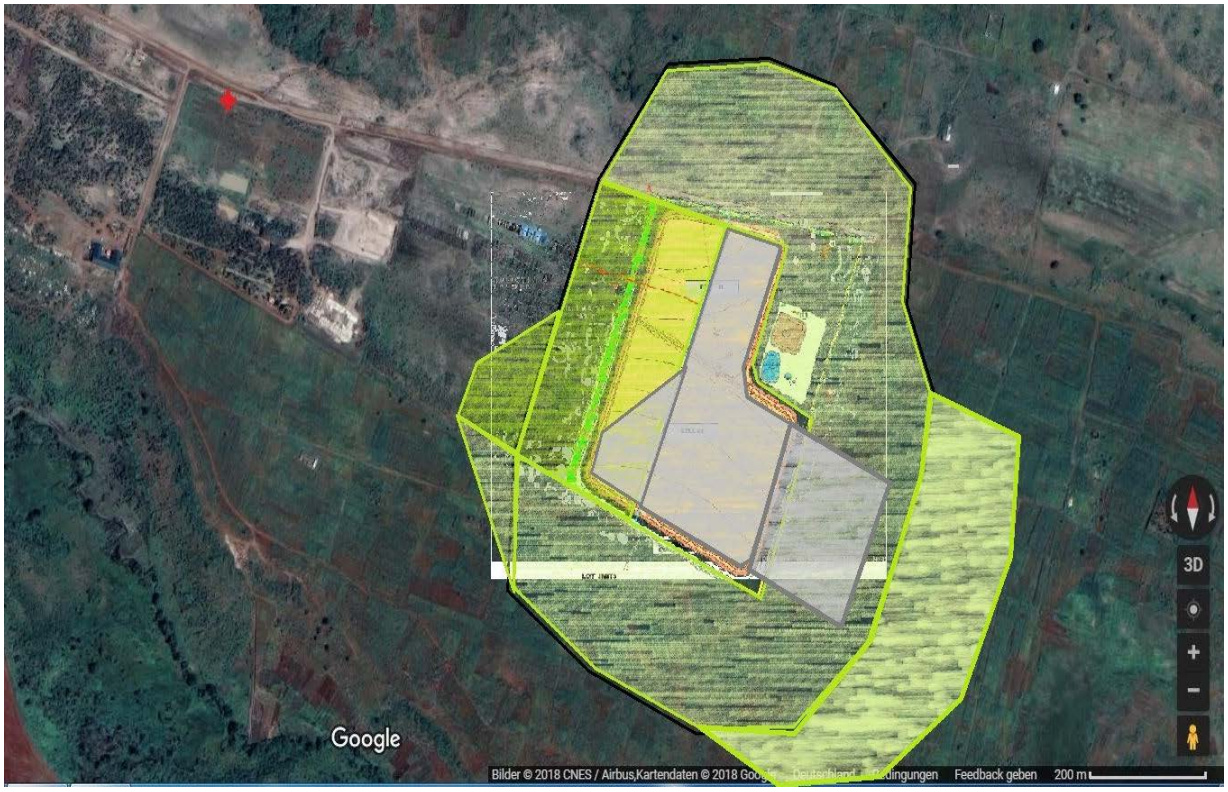


Figure 2-2: Layout of Site- Focus on Buffer Zone

2.5.6 Proposed LFG collection

Simulation of LFG generation for the proposed landfill assumed the following

- Proportion of carbon in waste: 350 kg per ton of waste
- Proportion of LFG actually collected: 40 %
- LFG half-life: 3 years
- LFG peak production: 1 year
- Biodegradability: 0.5

From the above, peak LFG production of 2000m^3/hour is expected to occur at the closure of the facility.

The Landfill Gas (LFG) collection system is composed of 13 wells in phase I(cell #1) and 27 wells in phase II (Cell #2), that is roughly 4 wells per hectare or one well for 2,500 m^2 collection radius of 30 m). Figures 2-3 and 2-4 present the implantations of the wells on the layout of the site and the design and a schematic diagram of proposed vertical LFG collection wells respectively.

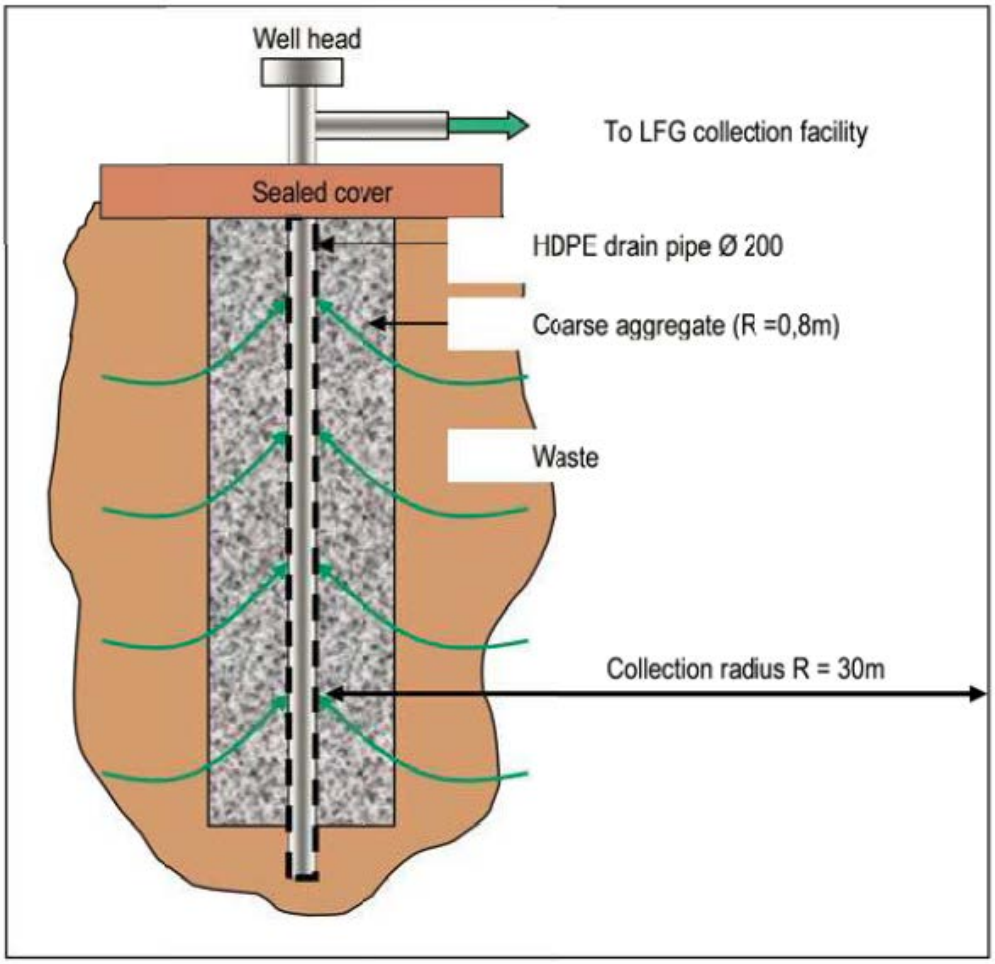


Figure 2-3: Layout of vertical landfill gas collection well

2.5.7 Proposed LFG treatment

The solution proposed is simple and inexpensive. It consists of an enclosed flare that encloses the flame in an insulated cylindrical shroud. Shrouded landfill gas flares have exit temperatures of around 760°C or 14000 °F – well above the dioxin formation range (which ends around 400°C or 752°F). Figure 2-4 is an example of enclose flare system. Based on the air dispersion model the recommended stack height for LFG flaring is 10m (refer to Annex 12)

Maintenance is limited and monitoring may be automated. However, flaring provides no opportunities for energy recovery and is included in the project for safety purposes when dumping excess gas is required.

Figure 2-4: Example of an enclosed flare system

Source: Feasibility study report, KE517E (Seureca), February 2016

2.5.7.1 Possible LFG use

Once the LFG gas is collected, the feasibility study proposes that the gas may be used in various processes including energy recovery applications as presented in the table below. Each technology is reviewed considering its relevance in the context of Mitubiri along with the objectives of the project. Synergies with neighboring development of housing and commercial and industrial activities could be a unique opportunity to connect the landfill with its human environment by providing energy to the community.

Table 2-3: The Relevance of Energy recovery technologies to project area

Technology	Applicability
Flaring	
Flaring	+
Heating Applications	
Use for industrial boilers	0
Space heating and cooling	++
Industrial heating/co-firing.	0
Power Generation	
Processing in internal combustion engines (ICE)	0
Processing and use in reciprocating internal combustion (RIC) engines (i.e., stoichiometric combustion or lean combustion)	0
Processing and use in gas or steam turbines	0
Processing and use in fuel cells	0
Feedstock in Chemical Manufacturing Processes	
Conversion to methanol (and optional subsequent industrial or vehicular fuel use)	0
Conn version to diesel fuel (and subsequent use as vehicular fuel)	0
Purification to Pipeline-Quality Gas	
Utilization as vehicular fuel	0
Incorporation into local natural gas network	+
Heat-Recovery from Landfill Flares	
Using organic Rankine cycle	0
Using stirling cycle engines	0

Source: Feasibility study report, KE517E(Seureca), February, 2016

2.5.8 Leachate Treatment System

2.5.8.1 Leachate production

Considering the fairly high level of rainfall (1550 mm per year) and high evaporation, within the project area; the volume of leachate is expected to range between 4,000 and 5,000 m^3 per year.

The design capacity for leachate collection pond is based on a 3-month capacity, taking into account the most unfavorable seasons in February, March and April with the highest potential rainfall. The minimum lifetime of the site is 10years. The capacity takes into account cumulative leachate production, rainfall with no or little recirculation.

The preliminary calculations during the feasibility study resulted to a volume capacity of 4,300 m^3. In a conservative approach and to prevent overflowing, a capacity of 5,000 m^3 was proposed which includes period with high rainfall events at the leachate treatment system.

Potential methods for leachate treatment reviewed in the feasibility study included:

- Recirculation of leachate through the landfill
- Disposal off-site to sewer for treatment as an admixture with domestic sewage and physical-chemical treatment
- Membrane filtration
- Reverse osmosis
- Anaerobic biological treatment
- Aerobic biological treatment
- Constructed wetlands

2.5.8.2 Proposed Methods for handling leachate

Feasibility study proposed leachate recirculation, off-site disposal of leachate in waste water treatment and on-site reverse osmosis as the best possible solutions. However, due to high technology, high cost and high operation / maintenance system associated with reverse osmosis plant, the project settled on anaerobic/aerobic system combined with conventional wastewater ponds.

On-site treatment

The leachate treatment system will comprise of a leachate storage pond whose design capacity is based on 3 months of leachate production to accommodate for any excess production or contingencies in the treatment process, and variations of the surface in operation.

The corresponding volume to be stored will be about 5000 cubic meters. The leachate will be treated on-site in ponds. The treatment will ensure that the resultant effluent is within permissible levels of specified parameters before discharge. The proposed method of treatment is anaerobic biological treatment or aerobic treatment combined with conventional wastewater ponds.

2.5.9 Infrastructure

2.5.9.1 Access roads

The access road to the landfill is already under construction. The new improved road will be ready for use when the landfill operation starts. The access road is 11 Km in length which is partly tarmacked.

The untarmacked part will be fully tarmacked and the other tarmacked part will be rehabilitated. The ESIA of the Mitubiri landfill access road has already been done and approved.

Plate 3: Photo showing a section of the access road leading to the proposed site

2.5.9.2 Weighbridge

The site will be equipped with 2 weighbridges, in order to accommodate all the trucks coming to the landfill. One will be dedicated for the entrance of the vehicle and the other for the vehicles exiting the site.

2.5.9.3 Mobile Equipment

The site will be equipped with one compactor, one dozer, one front loader, one excavator and three trucks for moving the waste from the reception area inside the land fill, compacting and leveling the waste and for applying the daily cover.

2.5.10 Monitoring

The site will be monitored during its operation phase and after closure. The groundwater will be monitored by 3 piezometers, one upstream and two downstream. Three boreholes have been provided.

2.5.11 Project construction inputs, activities and materials

A summary of construction activities and input quantities is presented in Table 2-4 below.

Table 2-4: Project Components and Construction Inputs

Project component	Activity/Materials	Quantities
Cells	Excavation to projected cell bottom formation level and transport of the excavated materials	32250m^3
	Grading inner sides of the berms	9000 m^2
	Grading cell bottom	67800m^2
	Placement of bentonitic complex, BENTOMAT	113 000m^2
	Placement of 2.5mm HDPE liner	
	Placement nonwoven geo-textile as liner upper protection	300g/m^2
Water and treated leachate storage pond	Bulk excavation, forming and compaction of embankments	8 000 m^3
Leachate collection	Placing 0.3 m layer of basalt aggregate 40/80 m	33 900 m^3
	Drainage connection pit + pumps	2
	Placement of HDPE 2.5mm membrane and nonwoven geo-textile for UV protection for leachate storage pond and water storage pond	4 500 m^2
	Installation of HDPE drain pipe DN 300	2 200 m
Leachate storage pond and treatment	Bulk excavation under pond, forming and compaction of embankments with excavated materials	8 000 m^3
	Leachate treatment plant	1
LFG Collection and Treatment	LFG wells and connection pipes	135 000 U
	Flare (700 Sm3/h) with blower, flame arrester	2 U
Final Cover	Placement of foundation layer for final cover	67 500 m^3
	Soil for final cover	40 500 m^3
	Seeding and planting	135 000 m^2
Leachate Recirculation System	Recirculation kit: Electrical and pumps	1 each
	Supply HDPE piping DN 300	2 700 m
	Supply and placement of aggregate for recirculation trench	5 000 m^3
Monitoring & Testing	Test patches	20 each
	Piezometers	In place
Fire Safety	Fire post	4 No.

Project component	Activity/Materials	Quantities
	Connection pipe	1 250
	Inlet with floater	1 Each
	Pumping station	1
Utilities	Installation and connection to electrical network	
	Connection to drinking water supply or tank	
Internal roads	Excavation to formation level	2 200 m^3
	Backfilling and compacting material for sub-base level	1 800 m^3
	Backfilling and compacting material for the creation of technical platforms and peripheral roads	35 000 m^3
	Concrete pavement	19 000 m^2
Miscellaneous equipment and buildings/installations	Fencing and entrance gate	
	Weighbridges (1 cabin + 2 bridges)	1 each
	Administration building (200 sqm)	200 m^2
	Road signs	12
	Information boards	2

Source: Feasibility study report, KE517E (Seureca), February, 2016

2.5.12 Proposed Project operation

The general operation steps are summarized in Table 2-5 and the proposed staffing is presented in figure 2.5

Table 2-5: Proposed General operation of the landfill

Services	Detailed description
1 – Reception 	The weighbridge operator will check that the truck is authorized and registered as a customer The driver will proceed slowly onto the weighbridge until he comes to a complete stop.
2 – Weighting 	The driver will give the weighbridge operator the information required about the waste collected (type of waste, waste origin). The weighbridge operator will register the information on the weighbridge data management system. **The weighbridge will monitor the total weight of the truck when the truck enters the WMA and when it leaves. Total weight of the waste is then calculated based on the weighbridge monitoring.**
3 – Unloading 	An operator indicates to the drive the unloading platform. The engine driver will check that the waste unloaded is authorized.
4 – Compaction 	Waste acceptance rates at the working face should be controlled so as to ensure that there is no excessive build-up of waste in the working area. This will enable the engineer to deal with the waste as it arrives. The engine, as it pushes the waste to its final point of disposal, will mix, track over, and crush or shred it.
5 – Daily cover	At the end of each working day, a layer of cover is applied on the top of waste in the landfill cell.

Source: Feasibility study report, KE517E (Seureca), February, 2016

2.5.12.1 Operation and Staffing

The number of employees is estimated to be 30 personal as per feasibility study report, KE517E (Seureca), February 2016. However, the number will go up in the addition of administration employees, environmentalist/safety personnel and social staff which were not taken into consideration by the feasibility study. The following figure 2-5 is a brief representation of the proposed organization of operation staffing

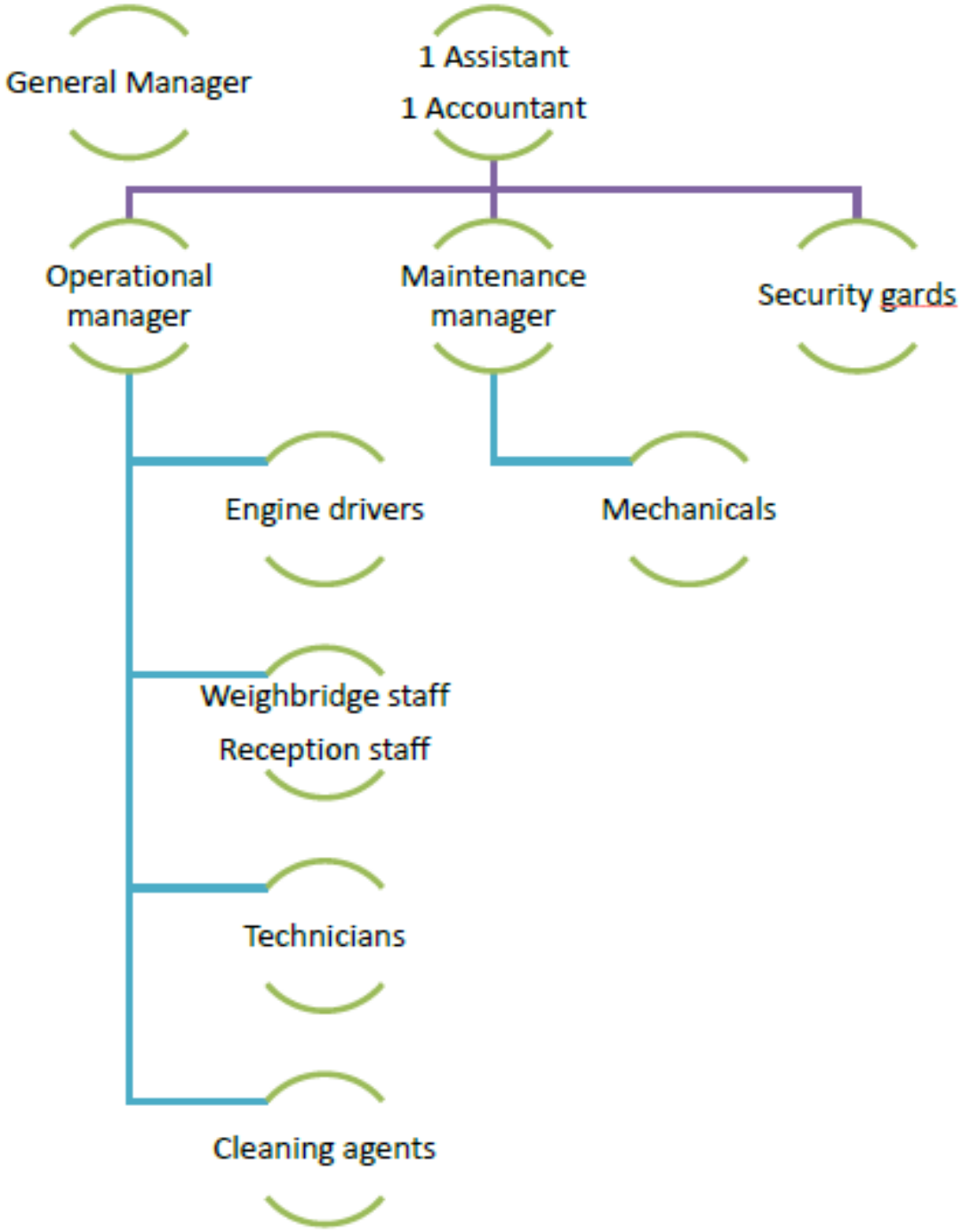


Figure 2-5: Proposed Organization of operation staffing

Source: Feasibility study report, KE517E(Seureca), February, 2016

2.6 Project cost

The feasibility assessment estimated the construction cost of the project to be US dollars, eighteen million six hundred and ninety-seven thousand four hundred and eighty **(18 697 480 USD)** andoperation cost at one million nine hundred and thirty thousand two hundred and ninety five **(1 930 295 USD.).**

The operation cost represented by the leachate treatment via reverse osmosis may change because cheaper treatment methods such as anaerobic, aerobic and conventional waste water ponds will be used. The following table 2-6 shows the budgetary cost of the project.

Table 2-6: Budgetary Cost

8. BUDGETARY COSTS ESTIMATES

This chapter presents a first gross estimation of the cost for investment and operation. The price will be refined in the next phase of the project.

8.1. INVESTMENTS

ITEMS	UNITS	QUANTITY	UNIT COST US $	TOTAL US $
GENERAL ITEMS				
Mobilization and demobilization of plant, equipment and personnel to the site	u	1	50 000,00	50 000
Subtotal General Items				**50 000 USD**
EARTHWORKS				
Clearing of vegetation (trees)	Each	1 500	6,00	9 000
Extract and transport natural selected material (black cotton soil) from project area on an average depth of 0.5m, transport material to a distance of 400 m maximum and compact for formation of protective berm	m³	71 000	20,00	1 420 000
CELL #1				
Excavation to projected cell bottom formation level and transport of excavated material to a distance of 400m maximum and compact for formation of cell berm	m³	31 500	20,00	630 000
Excavation to projected cell bottom formation level and transport of excavated material to a distance of 400m maximum and stockpiled	m³	14 800	20,00	296 000
CELL #2				
Excavation to projected cell bottom formation level and transport of excavated material to a distance of 400m maximum and compact for formation of cell berm	m³	29 750	20,00	595 000

Excavation to projected cell bottom formation level and transport of excavated material to a distance of 400m maximum and stockpiled	m^3	53 750	20,00	1 075 000
Grade inner sides of berms	m^2	9 000	3,00	27 000
Grade cell bottom	m^2	113 000	2,00	226 000
Supply and place bentonitic complex (BENTOMAT®)	m^2	130 000	14,00	1 820 000
Supply and place 1.5mm HDPE liner	m^2	130 000	9,00	1 170 000
Supply and place nonwoven geotextile as liner upper protection (300g/m^2)	m^2	130 000	3,00	390 000
Water and treated leachate storage pond - bulk excavation, form and compact embankments	m^3	8 000	15,00	120 000
Leachate storage pond	m^3	8 000	15,00	
Bulk excavation under pond, form and compact embankments with excavated material				120 000
Subtotal Earthworks				7 898 000 USD
LEACHATE COLLECTION				
Supply and place 0.3 m layer of basalt aggregate 40/80 m	m^3	33 900	25,00	847 500
Drainage connection pit + pumps	u	2	8 000,00	16 000
Supply and place HDPE 1.5mm membrane and non woven geotextile for UV protection for leachate storage pond and water storage pond	m^2	4 500	10,00	45 000
Supply and place HDPE drain pipe DN 300	ml	2 200	60,00	132 000
Subtotal Leachate Collection				1 040 500 USD
LEACHATE TREATMENT				
Leachate treatment plant	Each	1	950 000,00	950 000
Subtotal Leachate Treatment				950 000 USD
LFG COLLECTION AND TREATMENT				
LFG wells and connection pipes	u	135 000	8,00	1 080 000
Flare (700 Sm3/h) with blower, flame arrester	u	2	160 000,00	320 000
Subtotal Cover				1 400 000 USD

FINAL COVER				
Supply and place foundation layer for final cover	m^3	67 500	4,00	270 000
Soil for final cover	m^3	40 500	5,00	202 500
Seeding and planting	m^2	135 000	1,00	135 000
Subtotal Cover				**607 500 USD**
SURFACE DRAINAGE				
Trench drain	ml	1 500	10	15 000
Subtotal Surface Drainage				**15 000 USD**
LEACHATE RECIRCULATION SYSTEM				
Recirculation kit : Electrical and pumps	Each	1	92 000,00	92 000
Supply HDPE piping DN 300	ml	2 700	45,00	121 500
Suply and place aggregate for recirculation trench	m^3	5 000	25,00	125 000
Subtotal Leachate Recirculation System				**338 500 USD**
MONITORING & TESTING				
Test patches	Each	20	250,00	5 000
Piezometers	ml	In place		-
Environmental sampling and testing	Each	40	50,00	2 000
Topographic survey	Each	1,00	7 000,00	7 000
Subtotal Monitoring & Testing				**14 000 USD**
FIRE SAFETY				
Fire post	Each	4	800,00	3 200
Connection pipe	ml	1 250	25,00	31 250
Inlet with floater	Each	1	400,00	400
Pumping station	Each	1	12 000,00	12 000
Subtotal Fire Safety				**46 850 USD**
UTILITIES				
Supply and install connection to electrical network	m	500	100,00	50 000
Connection to drinking water supply or tank	m	500	45,00	22 500
Plantations and greening	Each	1	15 000,00	15 000
Misc.finishing works	Each	1	20 000,00	20 000

Subtotal Utilities				**107 500 USD**
INTERNAL ROADS				
Excavation to formation level	m^3	2 200	8,00	17 600
Backfill and compact material for sub-base level	m^3	1 800	10,00	18 000
Backfill and compact material for the creation of technical platforms and peripheral road	m^3	35 000	15,00	525 000
Concrete pavement	m^2	19 000	55,00	1 045 000
Subtotal Internal Roads				**1 605 600 USD**
MISCELLANEOUS EQUIPMENT AND BUILDINGS				
Fencing and entrance gate	ml	1 750	195,00	341 250
Weighbrige (1 cabin + 2 bridges)	Each	1	145 000,00	145 000
Administration building (200 sqm)	m^2	200	400,00	80 000
Subtotal Miscellaneous Equipment				**566 250 USD**
SIGNAGE				
Road signs	Each	12	350,00	4 200
Information boards	Each	2	2 000,00	4 000
Subtotal Signage				**8 200 USD**
Subtotal CAPEX				**14 647 900 USD**
CONTINGENCIES 20%			**0,20**	**2 929 580 USD**
MOBILE EQUIPMENT				
DOZER	Each	1	350 000,00	350 000
COMPACTOR	Each	1	400 000,00	400 000
EXCAVATOR	Each	1	250 000,00	250 000
TRUCKS	Each	3	100 000,00	300 000
LOADER	Each	1	220 000,00	220 000
Subtotal Mobile equipment				**1 120 000 USD**
TOTAL CAPEX				**18 697 480 USD**

Source: Feasibility study report, KE517E(Seureca), February, 2016

2.7 Storm Water Management

Recurrence of storm events may result to catastrophic failures such as flooding of the landfill or failure of leachate storage ponds. Storm water can also contribute sediment to the environment if the catchment area is erodible due to a lack of vegetative cover. By retaining and re-establishing as much vegetative cover in the catchment area as possible, potential for erosion is minimized.

The need for sediment control features will depend on:

- The topography and how this will influence water velocity
- The nature of the water environment into which the eventual discharge from the site will flow
- The typical intensity of storm events
- The extent of vegetative cover on the catchment area.

Storm water management design for the proposed Mitubiri landfill project incorporates interception drains that direct storm water away from the areas where waste is to be disposed.

From the hydrogeological report it is recommended that capping of the landfill will be done with appropriate material. The other aspect of surface water control is to construct storm water drain around the landfill site, especially the upslope sides. To prevent storm water from transporting leachate, an impermeable boundary shall be built to appropriate depth around the landfill.

2.8 Waste Characterization

Traditionally, municipal waste has been classified in to three classes; residential, commercial and industrial. Information and data on the physical composition of solid wastes are important in the selection and operation of equipment and facilities, disposal strategy and disposal process. Material presented at Murang'a landfill will be sorted at site to remove and recover recyclable material prior to deposition in the landfill. Waste pickers will be engaged in the recovery of valuable waste. Mitubiri landfill will be a sanitary landfill for municipal waste and only non-hazardous waste will be allowed in the landfill.

Signs advising which wastes may be deposited at the landfill will be provided. Signs will also be provided to show where recyclable/ valuable materials from waste may be placed.
To prevent illegal dumping, the landfill staff will be vigilant to ensure that only permissible wastes is accepted and deposited at the landfill. This shall be achieved through visual inspection, controlled access and tracking records. Facilities such as elevated mirrors, viewing platforms or video cameras will be used to screen incoming waste loads. Records of these inspections shall be kept to prevent illegal dumping. Owners of rejected wastes will be advised on the appropriate measures to be undertaken based on existing legal frameworks on solid waste management.

2.9 Decommissioning

The project is expected to have an operational life of approximately 20 years. Project will then be subject to the requirements of a Site Closure and Restoration Plan (SCRP), which will be developed prior to commencement of operation in consultation with the project proponent. The SCRP should ensure that proponent leaves the site in no worse environmental condition than when it was first occupied and thereby having no significant environmental impacts during decommissioning.

The proponent is expected to adopt appropriate mitigation measures during the operational life of the Project to ensure there will be no deterioration of the site. The proponent should continue monitoring leachate generation even after closure.

CHAPTER THREE

3 POLICY LEGAL AND INSTITUTIONAL FRAMEWORK

3.1 Introduction

Murang'a Sanitary Landfill will be administered and implemented in accordance with the provisions of the Kenyan policy, administrative and legal framework and in conformance with international best practices. The legislative and legal framework applicable to the implementation of the proposed project is outlined in the following sections.

3.2 The Policy Framework

3.2.1 The National Poverty Eradication (NAPEP) and the Poverty Reduction Strategies Paper (PRSP)

The NAPEP had an objective of reducing the incidences of poverty in both rural and urban areas by 50% by the year 2015 as well as strengthening the capabilities of the poor and the vulnerable groups to earn an income. It also aimed at narrowing the gender and geographical disparities and creating a healthy, educated population and was prepared in line with the goals and commitments of the World Summit for Social Development, WSSD of 1995. This paper provided a general direction in poverty reduction and since there is no later version after 2015, the proposed project will apply these strategies which were developed for implementation between 1995-2015.

Relevance to the proposed project

Furthermore, the output of the project is in line with the focuses of the WSSD themes of poverty eradication, reduction in unemployment, social integration of the disadvantaged people and the creation of an enabling economic, political and cultural environment.

3.2.2 Nairobi Metro, 2030

Nairobi Metro 2030 was developed in the year 2008 to provide a guide for the NMR 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 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 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.

Relevance to the proposed project

Succ*ess 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 landfill will provide a better waste management approach with improved health, income and overall economic growth of Murang'a County.*

3.2.3 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.

Relevance to the proposed project

So as to realize this strategy, development of proposed sanitary landfill will be one of the stepping stones needed for realization of the strategy.

3.2.4 Sessional Paper No 6 of 1999 on Environment and Development

This is the official statement on national policy on environment and was released in 1996 following recommendations of the National Environment Action Plan (NEAP) of 1994. The NEAP process had been launched earlier in 1992 following the Country's participation in the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro during which Kenya alongside other nations became a signatory to Agenda 21, which called on all nations to pay closer attention to environmental management at national level. Through this Sessional Paper, the Kenya Government guarantees every citizen the right to a clean and healthy environment and commits to pursue a policy strategy of integrating environmental sensitivity into national development planning process.

The goal of this policy paper is to harmonize environment and development goals to ensure sustainability. It provides comprehensive guidelines and strategies for government action regarding the environment and development. The broad policy objectives of the Sessional Paper No I of 1996 areas listed below:

- Optimal use of natural land and water resources in improving the quality of human environment;
- Sustainable use of natural resources to meet the needs of the present generations while preserving their ability to meet the needs of future generations;
- Integration of environmental conservation and economic activities into the process of sustainable development;
- Meeting of national goals and international obligations by conserving bio-diversity, arresting desertification, mitigating effects of disasters, protecting the ozone layer and maintaining an ecological balance on earth.
- Among other provisions, Sessional Paper No. 1 of 1996 also sets out sectoral priorities for environmental sustainability which in most cases have been operationalized through formulation of guidelines for quality and environmental management in respective sectors. The Environment Management and Coordination Act (EMCA, 2015) has since been enacted to secure implementation of the national policy on environment.
- Ensuring that all development projects at the inception stage and programs, as well as policies consider environmental considerations.
- Ensuring that an ESIA report is prepared for any undertaking or development project before implementation.
- Coming up with effluent treatment standards that will conform with acceptable health guidelines
- The paper encourages better planning in rural and urban areas in provision of needs i.e. water, drainage system, waste disposal facilities et al.

Relevance the proposed project

Natural resources will be highly utilized during construction phase and the biodiversity will be tampered hence the need to the policy. *The planning stage of the project has put all this into consideration through this ESIA study which has proposed mitigation of adverse impacts to ensure a clean environment is maintained.*

3.2.5 Sessional Paper No. 3 of 2009 on National Land Policy

The National Land Policy was formulated with the aim of securing rights over land and provide for sustainable growth, investment and reduction of poverty in line with Government overall development objectives. The policy will offer a framework of policies and laws designed to ensure the maintenance of a system of land administration and management that will provide:

- All citizens with opportunity to access and beneficially occupy and use land
- Economically viable, socially equitable and environmentally sustainable allocation and use of land;
- Efficient, effective and economical operation of land markets;
- Efficient and effective utilization of land and land-based resources; and
- Efficient and transparent land dispute resolution mechanisms.

Relevance to the proposed project

The project will involve utilization of land and land-based resources hence compliance with the policy will ensure economically viable, socially equitable and environmentally sustainable allocation and use of land and its resources.

3.2.6 Draft National Climate Change Framework Policy

Kenya has shown commitment to protect the climate system for the benefit of the present and future generations by supporting the United Nations Framework Convention on Climate Change (UNFCCC) process; ratifying the Kyoto Protocol in 2005; and contributing to continental and regional climate change initiatives. Further, the country's Constitution has set out a legal commitment to attain ecologically sustainable development; hence providing a basis to address the challenge of climate change while striving to attain its development goals through the Kenya Vision 2030.

The Policy's focus is on the inter link between sustainable national development and climate change is critical because climate change adversely impacts key sectors that are important to the economy and society: Environment, Water and Forestry; Agriculture, Livestock and Fisheries; Trade; Extractive industries; Energy; Physical Infrastructure; Tourism and Health. This Policy was developed to facilitate a coordinated, coherent and effective response to the local, national and global challenges and opportunities that climate change presents. This will be achieved through the adoption of a mainstreaming approach that ensures integration of climate change considerations into the development planning process, budgeting, and implementation in all sectors and at all levels of government. This Policy therefore aims to enhance adaptive capacity and build resilience to climate variability and change, while promoting low carbon development pathways.

Relevance to the proposed project

The project will involve the minimization of methane which is a greenhouse gas that contributes to climate change hence compliance with the policy.

3.2.7 National Environment Policy, 2013

The National Environmental Policy, 2013 sets out important provisions relating to the management of ecosystems and the sustainable use of natural resources, and recognizes that natural systems are under intense pressure from human activities particularly for critical ecosystems including forests, grasslands and arid and semi-arid lands. Section 5.9.1 of the Policy identifies energy as essential for socio-economic development. The Government has made deliberate efforts to provide power to remote areas in Kenya to spur development and improve livelihoods. Energy policies in the Country must ensure a robust and efficient system that is secure and efficient. The Policy has given the following provisions for environmental management of projects in the energy sector:

- Provide a framework for an integrated approach to planning and sustainable management of Kenya's environment and natural resources
- Strengthen the legal and institutional framework for good governance, effective coordination and management of the environment and natural resources.
- Ensure sustainable management of the environment and natural resources, such as unique terrestrial and aquatic ecosystems, for national economic growth and improved livelihoods
- Promote and support research and capacity development as well as use of innovative environmental management tools such as incentives, disincentives, total economic valuation, indicators of sustainable development, Strategic Environmental Assessments (SEAs), Environmental Impact Assessments (EIAs), Environmental Audits (EA) and Payment for Environmental Services (PES)
- Promote and enhance cooperation, collaboration, synergy, partnerships and participation in the protection, conservation, sustainable management of the environment and natural resources
- Promote domestication, coordination and maximization of benefit from Strategic Multilateral Environmental Agreements (MEAs)

Relevance to the proposed project

The project is utilizing natural resources to construct the landfill and ESIA as an environmental tool has been applied in providing environmental sustainability of the natural resources.

3.2.8 Sustainable Development Goals (SDGs)

The SDG No. 1 aims at eradicating hunger and ensuring food security of all people.

Relevance to the proposed project

The project will create employment and hence contribute to the improved standard of living which has a positive impact on the Country's food security index. The SDG No. 7 on environmental sustainability also guides this project.

3.3 Legal and Regulatory Framework

3.3.1 The Constitution of Kenya

Article 42 of the Bill of Rights of the Kenyan Constitution provides that 'every Kenyan has the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative particularly those particularly those contemplated in Article 69; and to have obligations relating to the environment fulfilled under Article 70.

Part 2 of Chapter 5 of the constitution is directed to Environment and Natural Resources. Article 69 in Part 2 provides that the state shall;

- Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources,
- Encourage public participation in the management of, protection and conservation of the environment.
- Ensure ecologically sustainable development and use of natural resources.
- Establish systems of environmental impact assessment, environmental audit and monitoring of the environment.
- Eliminate processes and activities that are likely to endanger the environment.
- Utilize the environment and natural resources for the benefit of the people of Kenya.

Further, Article 70 states that if a person alleges that a right to a clean and healthy environment recognized and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress.

The sub-project should ensure compliance with the constitution in so far as equitable sharing of the resources, between the stakeholders. Further, the project should ensure the sustainability of livelihoods and biological resources within the project areas are protected. Any development proposals should also be cognizant of the increased powers under the Constitution given to communities and individuals to enforce their rights through legal redress.

Relevance to the proposed project

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.

3.3.2 Environmental Management and Coordination Act (EMCA), CAP 387

This is an act of parliament that provides for the establishment of an appropriate legal and institutional framework for the management environment of the environment and for matters connected therewith and incidental thereto. The Act further aims to improve the legal and administrative co-ordination of the diverse sectoral initiatives in the field of environment so as to enhance the national capacity for its effective management. In addition, the Act seeks to harmonize all the 77-sector specific legislation touching on the environment in a manner designed to ensure protection of the environment.

As the principal environmental legislation in Kenya, EMCA sets the legal framework for environmental management basically as follows: -

(i) Requirement for Environmental Impact Assessments for all new projects

Section 58 of the Environmental Law requires that notwithstanding any approval, permit or license under this Act or any other law in force in Kenya, any person being a proponent of a project, shall before financing, commencing proceeding with carrying out, executing or conducting or causing to be financed, commenced, proceed carried out, executed or conducted by another person for any undertaking specified in the second schedule to this Act, submit a project report to the Authority in the prescribed form, giving the prescribed information and shall be accompanied by the prescribed fee.

(ii) Requirement for Annual Environmental Audits

Section 68 and 69 of EMCA requires all on-going projects to conduct an EA with a view to finding out if the processes and activities have any negative impacts on the environment and to propose any mitigation measures to counter such impacts. EA are further expounded in Regulation 35 (1) and (2) of Legal Notice 101 of June 2003.

(iii) Gazettement of Environmental Regulations:

Under EMCA 2015, NEMA has gazetted legal tools that govern how EIAs are conducted and general environmental protection. The Proposed landfill project by the NaMSIP has been screened against these tools with results presented in the table below, detailing the analysis of the trigger mechanism and modalities for mitigation.

Table 3-1: Analysis of the Project Triggers to the EMCA and Its Tools

EIA and EA Regulations	**Triggered**	**Comments**
Waste Management regulations, 2006	Triggered	Waste will be generated at all stages of the project
Water Quality regulations, 2006	Trigged	Water for construction will be drawn from rivers and treated leachate discharged into a water body
Conservation of Biodiversity regulations, 2006	Trigged	This will be triggered by excavation of the landfill and operation activities.
Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009	Triggered	Activities during all phases of the project are likely to generate noise affecting both workers and adjoining settlements
Environmental Management and Coordination (Fossil Fuel Emissions) Regulations, 2006	Triggered	Machinery will be powered by fossil fuels and must adhere to these regulations
Environmental Management and Co-ordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations, 2009	Triggered	Treated leachate will be discharged into a water body within the specified effluent standards

These guidelines are captured in the Contracts for Construction to ensure that contractors are legally bound to undertake mitigation alongside general construction work. The EMCA 2015 Tools likely to be triggered by the development of landfill are briefly reviewed below.

3.3.3 Environmental (Impact Assessment and Audit) Regulations, 2003 (Legal Notice 101-Kenya Gazette Supplement No. 56 of 13th June 2003)

The Act further requires that EIA be executed in accordance with the Guidelines for Conducting EIAs and Environmental Audits (Kenya Gazette Supplement No. 56 of 13th June 2003) as published by the National Environmental Management Authority (NEMA).

The Environmental (Impact Assessment and Audit) Regulations, 2003, provide the basis for procedures for carrying out Environmental Impact Assessments (EIAs) and Environmental Audits (EAs).

Regulation 3 requires that these regulations shall apply to all plans, policies, programs, projects and activities specified in Part IV, V and the Second Schedule of the Act. In addition, Regulation 4(1) indicates that no proponent should implement a project:

- Likely to have a negative environmental impact;
- For which an environmental impact assessment is required under the Act or these Regulations; unless an EIA has been concluded and approved in accordance with these Regulations.

These guidelines also prescribe the Format and content of EIA Study Reports among other requirements.

Relevance to the proposed project

The project is likely to cause negative impacts in the environment which proposed mitigation measures have been indicated in this ESIA. The ESIA has been prepared in accordance to the guidelines provided for in these regulations.

3.3.4 Environmental Management and Co-ordination Act (Waste Management) Regulations, 2006

These are described in Legal Notice No. 121 of the Kenya Gazette Supplement No. 69 of September 2006. They apply to all categories of wastes provided in the Regulations which include: Industrial wastes; Hazardous and toxic wastes; Pesticides and toxic substances; Biomedical wastes; Radio-active substances. They also outline the requirements for handling, storing, transporting, and treatment /disposal of all waste categories as provided therein.

The project is likely to generate significant amounts of wastes across all phases involved, therefore the proponent shall comply with the requirements by applying the Reduce, Reuse and Recycle strategy in addition to the following;

- Should not dispose any waste on the highway, street road, recreational area and public places;
- Segregate waste and group them according to their similarity, e.g. plastics, toxic, organic etc;
- Ensure all waste is disposed in designated dumping and are approved by the Local Authority;
- All waste handlers engaged by the proponent should be licensed by NEMA and possess all relevant waste handling documents such as waste transport license, tracking documents, license to operate a waste yard, insurance cover vehicle inspection documents among others;

- Label all hazardous waste as specified in section 24(1-3) of the regulation;

Relevance to the project

Waste generation during all phase of the project will be managed according to these regulations. Transportation of waste should be done as per this regulation. The regulations. Permits for waste transportation and handling will be obtained from NEMA. Solid municipal wastes will be the only wastes acceptable at the sanitary landfill. All other categories of waste will be managed off-site by licensed waste handlers.

3.3.5 Environmental Management and Coordination Act (Water Quality) Regulations, 2006

These are described in Legal Notice No. 120 of the Kenya Gazette Supplement No. 68 of September 2006. They apply to drinking water, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife and water used for any other purposes. They include the following: Protection of sources of water for domestic use; Water for industrial use and effluent discharge; Water for agricultural use. These Regulations outline:

- Quality standards for sources of domestic water;
- Quality monitoring for sources of domestic water;
- Standards for effluent discharge into the environment as indicated in table 3-2 Monitoring guide for discharge into the environment;
- Standards for effluent discharge into public sewers;
- Monitoring for discharge of treated effluent into the environment.

Table 3-2: Kenya discharge Guidelines for Waste water

Parameter	Discharge in public sewers (mg/l)	Discharge into water bodies (mg/l)
PH	6.0 – 9.0	6.0 – 9.0
BOD5 (20oC)	500	20
COD	1000	50
Suspended Solids	500	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

Parameter	Discharge in public sewers (mg/l)	Discharge into water bodies (mg/l)
Faecal Coliforms	No limits	1000/100ml for large water bodies, otherwise <10/ml)
Sulphates	-	500
Dissolved Oxygen	No limits	2
Phenols	-	2
Cyanides	-	0.1
Chlorides	-	1000
PCB	-	0.003
Colour	No limits	5 Hazen Units
Odour	No limits	Not objectionable

Sources: Department of Water Development

Relevance to the project

Discharge of effluent from construction machineries is anticipated during implementation phase of the project, Compliance to the regulation will be required throughout the project by both the contractor. The proposed project should abide the provisions of the regulations in respect to management of waste water and water resources in the entire project cycle.

3.3.6 The Environmental Management and Coordination (air quality) Regulations, 2014

These regulations 2014 provide for the prevention, control and abatement of air pollution to ensure clean and healthy ambient air. They apply to all internal combustion engines and all premises, places, processes, operations, or works. They include the following: general prohibitions on air pollution, priority air pollutants, air quality, suspended particulate matter and odor guideline. The regulations also address the permissible levels of the priority pollutants and controlled areas.

Sources of pollution are categorized as stationary and mobile sources in addition to occupational air quality. Pollution from stationary sources include the emissions, air quality at property boundary provides fugitive emission control plan and reduction measures. While pollution from mobile sources manage emission from vehicles, inspection of the motor vehicles and reduction measures of these emissions. Occupational air quality includes occupational exposure of air pollutants, variation of exposure and exposure to hazardous substances.

These regulations require licensing of any activities that cause air pollution, measurement, analysis, inspection, monitoring and reporting of the pollutants.

Relevance: ***to the project***

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. The workers exposure to occupational air pollutants is managed by the regulations. The motor vehicles transporting raw materials, wastes, and soil to the site will adhere to these regulations. The air quality will be monitored in the operation phase and five years after decommissioning and will adhere to these regulations.

3.3.7 The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 Legal Notice No. 61

The regulation provides the guidelines for the acceptable level of noise and vibrations during the construction and operation phases of the project. Section 5 consist of warnings on operating beyond the permissible noise levels while section 6 gives guidelines on the control measures for managing excessive noise and the I Schedule indicate the permissible sources and zones. Institutions and places of worship are considered as silent zones which are permitted exposure to sound level limits of not exceeding 40 dB (A) during the day and 35dB (A) during the night. In addition, a day starts at 6.01 a.m. to 8.00 p.m. while night starts from 8.01 p.m. to 6.00 am. Construction sites near the silent zones are allowed maximum noise level of 60 dB (A) during the day and night levels are maintained at 35 dB (A). The time frame for construction sites are adjusted and the day is considered to start at 6.01 a.m. and ends at 6.00 pm while night duration from 6.01 p.m. to 6.00 a.m.

Part III of the regulation gives guidelines on noise and vibration management from different sources. Sections 11, 12 and 13 of this part give guidelines on noise and vibration management from machines, motor vehicles and night time construction respectively. Section 15 requires owners of activities likely to generate excessive noise to conduct an ESIA to be reviewed and approved by NEMA.

It is anticipated that the proposed project will generate excessive noise and/or vibration from the constructions equipment, vehicles, it is therefore, recommended that the construction team develops mitigations to reduce noise propagation in the project area. The following table 3-3 show the comparison between the acceptable WHO and NEMA standards.

Table 3-3 Comparison between WHO and NEMA Noise Guidelines

Specific Environment	Critical Health Effects	LAeq dB(A) WHO	Time base (hours)	LAeq dB(A) NEMA	Time base (hours)
Outdoor living area	Serious annoyance Moderate annoyance	55 50	16 16	45 35	14 14

Specific Environment	Critical Health Effects	LAeq dB(A) WHO	Time base (hours)	LAeq dB(A) NEMA	Time base (hours)
Indoor dwelling Inside bedroom	Speech interference Sleep disturbance	35 30	16 8	-	-
Outdoor bedroom	Sleep disturbance	45	8	35	-
School classroom Indoor	Speech and communication	35	During class time	Day 60 Night 35	14 14
School playground outdoor	Annoyance External	55	During play	45	Day
Hospital, treatment room indoor	night time daytime	30 30	8 16	-	-
Industrial, Commercial and traffic areas	Hearing impairment	70	24	60	12
Ceremonies, festivals entertainment events	Hearing impairment	100	4	-	-

Relevance to the project

Noise emanating from construction machineries, equipment and workers is anticipated during construction phase of the project. Compliance to the regulation will be required throughout the project by both the contractor and landfill management. The noise has potential to cause nuisance to the workers and the few residences within a radius of 500m from the site.

3.3.8 The Traffic Act Cap. 403, Revised 2010

The traffic act governs the use of motor vehicle and the use of Kenyan road by vehicles and other road users such as pedestrians. 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 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 Licences (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 to the proposed project

The vehicles and drivers involved in the proposed project will comply to the provisions of the act, i.e. registration, inspection, licensing, maintain weight limits, and installation of speed governors.

3.3.9 Legal Notice No. 217 The Traffic Act Cap. 403

This notice require 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 competent speed limiter.

3.3.10 The Water Act, 2002

The purpose of the Act is to provide for the management, conservation, use and control of water resources and management of water supply and sewerage services. Section 94 of the Act makes it an offence to throw or convey or cause or permit to be thrown or conveyed, any rubbish, dirt, refuse, effluent, trade waste or other offensive or unwholesome matter or thing to water resources in such a manner to cause, or likely to cause pollution of the water resources.

Relevance to the proposed project

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 and will be obtained from WRMA.

3.3.11 The Penal Code (Cap. 63)

Section 191 – Fouling water

It requires that any person or institution should not voluntarily corrupt or foil water for public springs or reservoirs, rendering it less fit for its ordinary use otherwise the person or the institution is guilty of an offence. The management shall therefore, ensure that no foul water of any public spring or reservoir is rendered unfit for the purpose for which it was ordinarily used for by the community.

Section 192 – Dwellings and Neighborhood

It states that; “a person who makes or vitiates the atmosphere in any place to make it noxious to health of persons/institutions in dwelling or business site in the neighborhood or those passing along public way commits an offence. The operation phases of the project shall ensure that health of persons in dwellings in the neighborhood is protected.

Section 193 - Offensive Trade

The proponent shall control loud noises or offensive and unwholesome smells by applying top cover on all exposed solid waste at the end of each operating day so as not to interfere with the common rights of the people within the surrounding. This offence is punishable for common nuisance.

Relevance to the proposed project

Water is significant to the proposed project hence the penal code will be adhered to ensure all the springs and other water resources are protected from pollution. Ambience of the air will be monitored at the project site to ensure the health of the workers and the community is not affected by the project. Moreover, the motor vehicles transporting wastes will covered to ensure the noxious smell do not get to the public. The offensive and unwholesome smells will be controlled by applying top cover on all exposed solid waste at the end of each operating day.

3.3.12 The Occupational Safety and Health Act, 2007

Part II of the Act states that the purpose of the Act is to secure safety, health and welfare of persons at work and protect persons other than persons at work against risks to safety and health arising out of work, or relating to the activities of persons at work. Part 11 section 6(1-6) provides for what occupiers of the premises ought to do to ensure safety, health and welfare at work for all persons working there.

Section 7 Part II spells out what the duty of the occupier is as far as preparing a safety and health policy statement. Section 13 (1a-e) provides for the duties of the employee while at work place while Section 14 to 16 highlights the duty to report any dangerous situation, duty not to interfere with or misuse things provided in pursuant to certain provisions and the prohibition against creation of hazardous situations. The offences committed are also highlighted and clearly spelt out.

Part VI Section 52 of states that sufficient and suitable sanitary conveniences for persons employed in the factory / work places shall be provided, maintained and kept clean and effective provision shall be made for lighting the conveniences and where persons of both sexes are, such conveniences shall afford proper separate accommodation for persons of each sex.

Part VII Section 56 provides that;

- Every flywheel directly connected to any prime mover and every moving part of any prime mover, shall be securely fenced, whether the flywheel or prime mover is to be situated in an engine –house or not.
- Head and tailrace of every water wheel and of every water turbine shall be securely fenced.
- Every part of electric generators, motors and rotary converters and every flywheel directly connected thereto shall be securely fenced unless it is in such a position or of such construction as to be safe to every person employed or working in the premises as it would be if securely fenced.

Section 57 of the same Section provides that; every machine intended to be driven by mechanical power shall be provided with an efficient starting and stopping appliance, the control of which shall be in such a position as to be readily and conveniently operated by the person operating the machine.

Part VII Section 60 states that all fencing or other safeguards provided in pursuance of the foregoing provisions shall be of substantial construction, constantly maintained, and kept in position while the parts required to be fenced or safe guarded are in motion or in use except when any such parts are necessarily exposed for examination and for any lubrication or adjustments shown by such examination to be immediately necessary. Section 91(1) states that every occupier shall provide and maintain an adequate supply of wholesome drinking water at suitable points conveniently accessible to all persons employed

Part IX Section 89(1), requires preventive measures to be put in place during operation of the project to prevent fumes and exhaust gases going into the atmosphere.

The project should also comply with the provisions of the Factories and Other Places of Work (Safety and Health Committee) Rules LN No. 31/2004, The Factories and Other Places of Work (First-Aid) Rules L No. 160/1977 and The Factories and Other Places of Work (Fire Risk Reduction) Rules L.No 59, 2007, Noise prevention rules 2005, LN No.25, Factories and other places of work (Hazardous substances rules 2007 LN No.60)

Relevance to the Project

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.

3.3.13 Land Acquisition Act (Cap. 295)

This Act provides for the compulsory or otherwise acquisition of land from private ownership for the benefit of the public. Section 3 states that when the Minister is satisfied on the need for acquisition, notice will be issued through the Kenya Gazette and copies delivered to all the persons affected. Full compensation for any damage resulting from the entry onto land to things such as survey upon necessary authorization will be undertaken in accordance with section 5 of the Act. Likewise, where land is acquired compulsorily, full compensation shall be paid promptly to all persons affected in accordance to sections 8 and 10 along the following parameters;

- Area of land acquired,
- The value of the property in the opinion of the Commissioner of land (after valuation),
- Amount of the compensation payable,
- Market value of the property,
- Damages sustained from the severance of the land parcel from the land,
- Damages to other property in the process of acquiring the said land parcel,
- Consequences of changing residence or place of business by the land owners,
- Damages from diminution of profits of the land acquired.

Part II of the Act allows for the temporary acquisition of land for utilization in promotion of the public good for periods not exceeding 5 years. At the expiry of the period, the Commissioner of Land shall vacate the land and undertake to restore the land to the conditions it was before. Any damages or reduction of value shall be compensated to the land owners.

Relevance to the project

The project site is an empty piece of land that was acquired through the proper legal process. The procedure of compulsory acquisition and development control should be adhered to and PAPs fully compensated where applicable.

3.3.14 The Lands Act, 2012

The Act was enacted by Parliament to give effect to Article 68 of the Constitution, to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land based resources, and for connected purposes. The Act applies to all land declared as (a) public land under Article 62 of the Constitution; (b) private land under Article 64 of the Constitution; and (c) community land under Article 63 of the Constitution and any other written law relating to community land. The Act guarantees security of tenure for land under (a) freehold; (b) leasehold; (c) such forms of partial interest as may be defined under the Act and other law, including but not limited to easements; and (d) customary land rights, where consistent with the Constitution and guarantees equal recognition and enforcement of land rights arising under all tenure systems and non-discrimination in ownership of, and access to land under all tenure systems.

Relevance to the project

The proposed project is on a private land which was acquired in line with the land laws. Please refer to the attached land agreement.

3.3.15 Public Health Act (CAP 242)

Part IX, section 115 of the Act states clearly that no person or institution shall cause nuisance or condition liable to be injurious or dangerous to human health, injury to workers who are exposed to potentially harmful substances and conditions. Section 129 states that it shall be the duty of every Local Authority to take all lawful, necessary and reasonably practicable measures for preventing any pollution dangerous to health of any water supply in which the public within the district has a right to use and does use drinking or domestic purposes. Section 136 states that all collections of water, sewage, rubbish, refuse and other fluids which permit or facilitate breeding or multiplication of pests, shall be deemed to be nuisances and are liable to be dealt with as provided in the Act.

Relevance to the project

The Act is applicable in the entire project cycle thus compliance with the act will be crucial for health of neighborhoods and to conserve the environment in the area. Discuss pest control, is responsible. 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.

3.3.16 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 work place 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 to the project

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.

3.3.17 National Gender and Equality Commission Act, 2011

The Commission was established through an Act of parliament and is mandated but not limited to perform the following functions: (a) promote gender equality and freedom from discrimination in accordance with Article 27 of the Constitution; (b) monitor, facilitate and advise on the integration of the principles of equality and freedom from discrimination in all national and county policies, laws, and administrative regulations in all public and private institutions; (c) co-ordinate and facilitate mainstreaming of issues of gender, persons with disability into the overall national development framework.

Relevance to the project

The provisions of this Act shall be invoked in the implementation of the project, especially in ensuring gender equity, by offering opportunities to women in employment.

3.3.18 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 to the project

The proposed project should adhere to this Act; by ensuring that NO sexual offences 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.

3.3.19 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 EIA 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 part development plan of the proposed landfill site and ensure that no encumbrances or encroachment face the project site.

Relevance to the project

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: "What the authorities would deem fit based on the generic planning standards. The county government is a key stakeholder that has contributed to the development of the landfill plans.*

3.3.20 The Environment and Land Court Act No.19 of 2011:

This law was assented to on 27thAugust 2012 and commenced on 30th August 2012 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. Section 13 (1) of the Act gives the Court original and appellate jurisdiction to hear and determine all disputes in accordance with Article 162(2) (*b*) of the Constitution and with the provisions of this Act or any other written law relating to environment and land. 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, choices in action or other instruments granting any enforceable interests in land; and
- any other dispute relating to environment and land.

Relevance to the project

This statute is deemed relevant to all development proposed for implementation in Kenya as it provides for legal recourse for disputes relating to environment and land. This is therefore, a great resource to any developer where applicable.

3.3.21 Land Planning Act, Cap 303

Section 9 of the subsidiary legislation (the development and use of land Regulations 1961) under which it requires that before the Local Authority submits any plans to the cabinet secretary for approval, steps should be taken as may be necessary to acquire the owners of any land affected by such plans. Particulars of comments and objections made by the landowners should be submitted to the Lands and Environment Court or to other local/traditional decision-making bodies to reduce conflict of interest with other socio-economic activities.

Relevance to the project

All the applicable land laws will be adhered to especially with regards to Angaza Green city developed at the boundary of the proposed landfill project area.

3.3.22 The Urban Areas and Cities Act, 2012

This Act provides legal basis for classification of urban areas (City) when the population exceeds 500,000; a municipality when it exceeds 250,000; and a town when it exceeds 10,000) and requires the city and municipality to formulate County Integrated Development Plan (Article 36 of the Act). Under Article 36, the integrated development plan so developed is required to be the central pillar in public administration of the city or municipality this forming the basis for:

- the preparation of environmental management; preparation of valuation rolls for property taxation plans;
- provision of physical and social infrastructure and transportation;
- preparation of annual strategic plans for a city or municipality;
- disaster preparedness and response;
- overall delivery of service including provision of water, electricity, health, telecommunications and solid waste management; and
- The preparation of a geographic information system for a city or municipality.

The strategy plan as stated above denotes an annual plan to be adopted in the county assembly following the integrated development plan, and the Act requires the board of town committee to formulate the strategy plan soon after the adoption of the integrated development plan (Article 39).

The integrated development plan as stipulated in the Act should reflect:

- vision for the long-term development of the city or urban area;
- An assessment of the existing level of development;
- Any affirmative action measures to be applied; development priorities and objectives;
- Development strategies which shall be aligned with any national or county sectoral plans and planning requirements;
- A spatial development framework;
- Operational strategies; and
- Applicable disaster management plans;
- A regulated city and municipal agricultural plan;
- A financial plan and;
- The key performance indicators and performance targets (Article 40).

The integrated development plan thus formulated should be submitted to the county executive committee, and the committee should submit the plan to the county assembly with an opinion within 30 days (Article 41).

Relevance to the project

The Landfill project should adhere with the urban area and other cities act and it should be integrated in the County Integrated Development plan, and comply with all the regulations set in the Act.

3.3.23 The Climate Change Act, 2016

This is an Act of Parliament that provides for a regulatory framework for enhanced response to climate change; to provide for mechanism and measures to achieve low carbon climate development, and for connected purposes. In Section 19, the Act requires that a county government shall, in performance its functions, integrate and mainstream climate change actions, interventions and duties set out in this Act, and the National Climate Change Action Plan into various sectors. Section 20 of the act requires NEMA to integrate climate change risk and vulnerability assessment in all forms of assessment, in liaison with lead agencies for technical advice.

Relevance to the project

The operation of the project will contribute towards reduction of greenhouse gases through capture and flaring that destroys methane. The Act requires periodic monitoring of the GHGs and adhering to monitoring obligations towards reducing the associated climate change risks.

3.3.24 The Wildlife Conservation and Management Act, 2013

This Act became operational on 10 January 2014. The act in its Sixth Schedule list various animal and tree species that are nationally considered as critically endangered, vulnerable, nearly threatened and protected. It also lists in its seventh schedule, national invasive species for which control is required. Section 48 restricts activities involving the above listed species without a permit from KWS. KWS can make recommendations to the responsible cabinet secretary, to prohibit carrying out any activity which in nature that may negatively impact on the survival of species listed in sixth schedule; or is specified in the notice or prohibit the carrying out of such activity without a permit issued by KWS.

Relevance to the project

Though no species of special conservation concern have been documented on the site, the proposed project where applicable, may develop appropriate management measures to avoid spread of invasive species.

3.3.25 Guidelines for E-Waste Management in Kenya

The E-Waste Management Guidelines have been developed with the strategic objective of providing a framework for the development of regulations and policies in Kenya. The Specific objectives of the guidelines include:

- To enhance environmental protection from e-waste.
- To establish a basis for a policy and regulatory frameworks on e-waste management.
- To raise public awareness on sustainable management of e-waste in Kenya.

Included in the guidelines are approaches to enhance environmental protection; policy and regulatory frameworks; environmental awareness; categories of e-waste and target groups; e-waste treatment technologies; and disposal procedures.

Chapter eight of the Guidelines for E-Waste Management in Kenya outlines the Guidelines for e-waste disposal sites as follows;

- Disposal should be done in specialized cells or sections in a licensed landfill site.
- Owners / operators of disposal sites shall be licensed by NEMA and Local Authorities.
- Owners / operators must demonstrate technical knowledge and understanding of the hazardous nature of e-waste.
- Disposal sites shall be published after licensing for the general public is aware of the existence of the same.
- Disposal shall be paid for and the disposer shall be issued with a certificate of safe disposal.
- Disposers shall keep a record of the amounts and categories of waste which NEMA may access upon request or during inspection of e-waste handling facilities.
- Incineration of unusable disposable parts is not recommended in the country due to the unsuitability of existing incineration facilities. In future, development of incinerators will include compulsory installation of waste gas purification systems to deal with dioxins and furans in incineration flue gas.
- Burying is strictly prohibited as contaminants may easily leach into the soil and pollute both soil and groundwater resources.

Relevance to the project

The regulations are relevant to the project due to its nature of operation to protect the environment. The waste will be sorted at the site and the e–waste will be given out to the licensed recyclers. Therefore, the guideline should be adhered to during the project cycle of the project.

3.3.26 Health Care Waste Management Plan 2016–2021

The Health Care Waste Management Plan was developed due to the complexity and risks associated with health care waste handling, storage, collection, transportation, treatment and disposal of Health Care Waste. This waste can be potentially harmful to public health and the environment and may still be infectious.

Relevance to the project

The proposed landfill will not receive health care wastes. The health facilities are expected to adhere to the waste management regulations. Therefore, the plan does not apply to this proposed project.

3.3.27 Intergovernmental Relations Act, 2012

The Intergovernmental Relations Act of Parliament to establish a framework for consultation and cooperation between the national and county governments and amongst county governments; to establish mechanisms for the resolution of intergovernmental disputes pursuant to Articles 6 and 189 of the Constitution, and for connected purposes. The objects and purposes of this act are to:

- Provide a framework for consultation and cooperation between the national and county governments;
- Provide a framework for consultation and cooperation amongst county governments;
- Establish institutional structures and mechanisms for intergovernmental relations;
- Provide a framework for the inclusive consideration of any matter that affects relations between the two levels of government and amongst county governments;
- Give effect to Articles 187 and 200 of the Constitution, in respect of the transfer of functions and powers by one level of government to another, including the transfer of legislative powers from the national government to the county governments; and
- Provide mechanisms for the resolution of intergovernmental disputes where they arise.

Relevance to the project

The project area is under the jurisdiction of Murang'a County Government. It will be necessary for the NMR to work with of Murang'a County Government Administration, and neighboring counties with potential to share in the usage of the facility.

3.3.28 Malaria Prevention Act, Cap 246

This is an act of parliament, which enables health authorities to take measures for prevention of Malaria. Section 5 of the act prohibits operations that obstruct flow of water into or out of any drainage without the approval of the health authorities. It states that

“ No person shall, within an area subject to the control of a health authority, build or maintain a dam or other construction so as to obstruct the flow of water into or out of a drain under the control of the health authority, nor by any means alter the level of any water so as to reduce its flow, nor construct any steps, bridge or platform over a drain under the control of the health authority without the consent in writing of that health authority; and the health authority may cause any such dam or other construction, or any steps, bridge or platform so built or constructed without written consent to be demolished, altered, re-made or otherwise dealt with, as it may think fit, at the expense of the person building or constructing it, and any money becoming due from a person under this section shall be a civil debt recoverable summarily. ”

Relevance to the project

The proposed landfill will involve modifying natural drainage pattern with potential of increasing suitable breeding grounds for malaria transmitting mosquitoes. The proponent shall be required to obtain requisite approvals and maintain the drainage system within the project area for removal of water from any land around the project to prevent larvae breeding.

3.3.29 Employment Act

This is an Act of parliament that applies to all employees employed by any employer under a contract of service. The Act came in operation in June 2008. 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 Minister or his capacity to benefit from the instructions received.

Relevance to the project

The proponent in conjunction with the contractor will need to understand and abide by the requirements of the Act during all phases especially regarding protection of child rights.

3.3.30 The Murang'a County Ward Development Act, 2014

The objectives and purpose of this Act is to devolve the county resources to the ward level, to address the very local problems at the village level, to ease giving services to the general population of Murang'a County, to alleviate poverty and create employments in the general population of Murang'a County. The provisions of this Act shall apply, as more specifically provided for in the Act, and shall ensure that a specific portion of the Murang'a County annual budget is devolved to the 35 Wards for purposes of infrastructural development, wealth creation and in the fight against poverty at the Ward level. Moreover, to enhance the Act of rights enshrined for in the Constitution of Kenya, 2010.

Relevance to the project

The local community grievances can be channeled through the provisions of this act. Moreover, employment of the workers from the local community should adhere to this Act.

3.4 The Institutional Framework

3.4.1 Institutional Framework under EMCA, Cap 387

The Government in 2001, established the administrative structures to implement EMCA, Cap 387 as follows: -

3.4.1.1 The National Environment Council

The National Environment Council (the Council) is the body responsible for policy formulation and directions for the purposes of the Act. The Council also sets national goals and objectives, determines policies and priorities for the protection of the environment.

3.4.1.2 The National Environmental Management Authority

EMCA Cap 387 allows for formation of the National Environmental Management Authority (NEMA) as the body charged with overall responsibility of exercising general supervision and co-ordination over all matters relating to the environment and to act as the principal instrument of government in the implementation of all policies relating to the environment. The Authority shall therefore, review the study report for the proposed project, visit the project site to verify information provided in the report and issue an ESIA license if it considers that all the issues relevant to the project have been identified and mitigation measures to manage them proposed.

3.4.1.3 National Environmental Complaints Committee

Under EMCA Cap 387, the Committee has been established to provide an administrative mechanism for addressing environmental harm. The Committee whose membership include representatives from the Law Society of Kenya, NGOs and the business community has the mandate to investigate complaints relating to environmental damage and degradation.

3.4.2 The Ministry of Transport Infrastructure, Housing and Urban Development

The Ministry of Transport, Infrastructure, Housing and Urban Development, through the NaMSIP PCT has administrative jurisdiction over the ESIA process and will also act custodian of the ESMMP emanating from this study.

3.4.3 Water Resource Authority (WRA)

WRMA is a national organization with the mandate of regulation of water resources issues such as water allocation, source protection and conservation, water quality management and pollution control and international waters. The services provided by WRA include:

- Planning, management, protection and conservation of water resources.
- Planning, allocations, apportionment assessment and monitoring of water resources.
- Issuance of water permits.
- Water rights and enforcement of permit conditions.
- Regulation of conservation and abstraction structures.
- Regulation and control of water use.
- Coordination of the Water resources management plan.

WRMA sub-regional office at Murang'a and regional office at Embu will be responsible for issuance of water rights and enforcement of any conditions attached. Similarly, WRMA will oversee the monitoring of water quality during the project's operation phase.

3.4.4 Directorate of Occupational Safety and Health

Directorate of Occupational Safety and Health Services (DOSHS) is a government agency responsible for enforcement of Occupational Safety and Health throughout the country for the protection of workers and the public at all work places in line with OSHA, 2007. The facility will require registration as a work place from the Murang'a County DOSHS offices.

3.4.5 County Government of Murang'a

Murang'a County is the project host county will have various inputs in the project implementation in line with constitutional functions assigned to county governments. The functions of the county government relevant to the proposed project, as outlined in the Fourth Schedule, Constitution of Kenya 2010 are as follows:

- Provision of essential services such health services, county transport, education;
- Control pollution and disasters management;
- Monitor cultural activities, public entertainment and public amenities;
- County planning and development;
- County public works and services;
- Implementation of specific national government policies on natural resources and environmental conservation; and
- Encourage public participation in county governance and development

The County government of Murang'a is thus expected to help in coordinating various project related activities as far as general environmental conservation and public participation are concerned. This will be better achieved through the County Ministry of Environment, Water and Natural Resources.

3.5 World Bank Policies and guidelines

3.5.1 World Bank's Safeguards

The proposed project by the Ministry of Transport, Infrastructure, Housing and Urban Development, Nairobi Metropolitan Development under the NaMSIP by the virtue of source of funding becomes a subject to the World Bank requirements for impact assessment. Therefore, this ESIA Report has been formulated to address and cater for both Kenyan and World Bank requirements for impact assessment. World Bank projects and activities are governed by Operational Policies which ensures environmental and social are evaluated in decision making, help reduce and manage the risks associated with a project or program and provide a mechanism for disclosure of information and consultation. The World Bank Operational Policies on environmental and social safeguards) include:

- OP 4.01 Environmental Assessment;
- OP 4.04 Natural Habitats;
- OP 4.09 Pest Management;
- OP 4.11 Physical Cultural Resources (PCR);
- OP 4.12 Involuntary Resettlement;
- OP 4.10 Indigenous People;
- OP 4.36 Forests;

- OP 4.37 Safety of Dams;
- OP 7.50 Projects on International Waterways;
- OP 7.60 Projects in Disputed Areas.

The table below shows the applicability of World Bank Operational Safeguards as it applies to this proposed project.

Table 3-4: Applicability of WB OPs

OP	Title	Triggers	Comments
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- the area is predominatelyinhabited by Kikuyu community who are not classified as indigenous people.
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. However, to manage “chance finds” an appropriate procedure is included in this ESIA. Such procedure to be followed by contractors during the construction phase.
4.12	Involuntary Resettlement	Not Triggered	Not applicable. The landfill site will not displace any PAP, Angaza green, and no socio-economic activities are likely to change. However, where applicable a RAP is recommended.
4.36	Forests	Not	Not applicable. The policy is not applicable to the

OP	Title	Triggers	Comments
		Triggered	project- the ecological study indicates absence of forests cover hence this policy
4.37	Safety of Dams	Not Triggered	Not applicable. The project will not involve construction of dams
4.50	Projects on International Waterways	Not Triggered	Not applicable. The policy is not on any waterway
4.60	Projects on Disputed Areas	Not Triggered	Not applicable. The proposed project site was legally purchased.

Under OP4.01, 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 EA.
- **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.

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

Guidance Published in May 1996 by the World Bank as an Urban Infrastructure Note, updated November 2004.

3.5.2 World Bank Guidance on Sanitary Landfill Siting and Design Criteria

This guidance published in May 1996 by the World Bank as an Urban Infrastructure Note, (updated November 2004) gives guidelines on Air Safety indicating that no siting within 3 km of a turbojet airport and 1.6 km of a piston-type airport. For sites located more than 3 km and less than 8 km from the nearest turbojet airport (or more than 1.6 km and less than 8 km from the nearest piston-type airport), no consideration is to be given unless the aviation authority has provided written permission stating that it considers the location as not threatening to air safety.

3.5.2.1 World Bank Guidance on Sanitary Landfill Siting Criteria

The World Bank recommends the following landfill siting criteria;

- Adequate land area and volume to provide sanitary landfill capacity to meet projected needs for at least 10 years, so that costly investments in access roads, drainage, fencing, and weighing stations are justifiable. For siting purposes, land area requirements shall be estimated based on the landfill cell area required (typically for a depth of 10-25 meters; a final solid waste density of 800-1,000 kg/cubic meter, and a minimum soil to refuse ratio of 1: 6), as well as about 2-4 hectares for the receiving area, 2-4 hectares for the leachate treatment and/or evaporation ponds, and additional 10% land for a landscaped buffer zone.
- Preferably, a site accessible within 30 minutes travel time (a function of road and traffic conditions) is to be sought, even if it means buying land, because of the need to avoid adversely affecting the productivity of collection vehicles. At distances greater than 30 minutes travel, for collection operations to be economic, investment in either large capacity collection vehicles (5 tonnes per load or greater) or transfer stations with large capacity vehicles (20 tonnes or greater) would be necessary.
- If transfer stations are required, the landfill should be accessible within 2 hours of travel time (one-way) by transfer trucks from the transfer station. Otherwise, for longer distances, transfer by rail or barge directly to the landfill site needs to be considered. Siting of rail or barge transfer sites within the refuse collection area may be difficult. Double handling by truck transfer and by rail or barge transfer units should be avoided because of costs.
- Accessible from a competent paved public road which has an adequate width, slope, visibility and construction to accommodate the projected truck traffic. To minimize landfill development costs, the requirement for new access road construction generally should be less than 10 km for large landfills serving metropolitan areas and less than 3 km for small landfills serving secondary cities.
- A gently sloped topography, preferably amenable to development of sanitary landfill by the Cell (Bund) method), with slopes which minimize the need for earthmoving to obtain the correct leachate drainage slope of about 2%.

- Ground-water seasonally high table level (i.e., 10 years high) is at least 1.5 meters below the proposed base of any excavation or site preparation to enable landfill cell development. A minimum depth of 1 meter of relatively impermeable soils above the groundwater's seasonable high level exists (preferably, less than 10-9 meters/second permeability when undisturbed). If these criteria are not met, use of impermeable clay and/or plastic liners may be required to protect groundwater quality.
- Availability on-site of suitable soil cover material to meet the needs for intermediate (minimum of 30 cm depth) and final cover (minimum of 60 cm depth), as well as bund construction (for the Cell method of landfill). Preferably, the site would have adequate soil to also meet daily cover needs (usually a minimum of 15 cm depth of soil). However, daily cover needs can be alternatively met by using removable tarps, other relatively inert materials (i.e., compost residuals), or by removing the previously laid daily soil cover at the start of each day for reuse at the end of the same day. For purposes of siting, assume that at least 1 cubic meter of daily, intermediate, and final compacted soil cover is needed for every 6 cubic meters of compacted refuse. In most developing countries with highly organic wastes and warm climates, compacted refuse (after one year of natural consolidation and decomposition within warm and wet climates) achieves a density of 800-1000 kg/cubic meter.
- None of the areas within the landfill boundaries are part of the 10-year groundwater recharge area for existing or pending water supply development.
- No private or public drinking, irrigation, or livestock water supply wells within 500 meters down gradient of the landfill boundaries, unless alternative water supply sources are readily and economically available and the owner(s) gives written consent to the potential risk of well abandonment.
- No environmentally significant wetlands of important biodiversity or reproductive value are present within the potential area of the landfill cell development.
- No known environmentally rare or endangered species breeding areas or protected living areas are present within the site boundaries. If this criterion is not met, alternative habitats of comparable quality for relocation of the species would need to be available.
- No significant protected forests are within 500 meters of the landfill cell development area.
- No open areas of high winds, otherwise windblown litter will not be readily manageable
- No major lines of electrical transmission or other infrastructure (i.e., gas, sewer, water lines) are crossing the landfill cell development area, unless the landfill operation would clearly cause no concern or rerouting is economically feasible.
- No underlying limestone, carbonate, fissured or other porous rock formations which would be incompetent as barriers
- For leachate and gas migration, where the formations are, should be more than 1.5 meter in thickness and present as the uppermost geologic unit above sensitive ground waters.

- No underlying underground mines which could be adversely affected by surface activities of land filling, or minable resources which could be rendered less accessible by land filling, unless the owner(s) gives explicit consent.
- No residential development within 250 meters from the perimeter of the proposed landfill cell development.
- No visibility of the proposed landfill cell development area from residential neighborhoods within 1 km. If residents live within 1 km of the site, landscaping and protective berms would need to be incorporated into the design to minimize visibility of operations. Curving of the access road is recommended to avoid visibility of the active portions of the landfill from the main road.
- No perennial stream within 300 meters down gradient of the proposed landfill cell development, unless diversion, culverting or channelling is economically and environmentally feasible to protect the stream from potential contamination.

3.6 International Conventions

3.6.1 The Vienna Convention for the Protection of the Ozone Layer

The Vienna Convention for the Protection of the Ozone Layer, 1985 was adopted after consensus was reached on 22nd March 1985. The overall objective of the Vienna Convention is to protect human health and the environment against the effects of ozone depletion.

As a framework convention, it does not establish any specific controls on ozone depleting substances. Instead, it establishes a general obligation upon the parties to protect the ozone layer (article 2) and emphasizes the need for international cooperation. The government of Kenya ratified the treaty on 9 September 1988.

Relevance to the project

The project's will emit volatile organic compounds and nitrogen oxides (NOx) which interact in the presence of sunlight, therefore there is need for the Contractor and operator to ensure regular maintenance of machines and plants equipment to minimize atmospheric emissions that may eventually result in smog which is responsible for the deterioration of the ozone layer.

3.6.2 The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer

The Montreal Protocol on Substances that Deplete the Ozone Layer is a significant milestone in international environmental law. It establishes firm targets for reducing and eventually eliminating consumption and production of a range of ozone depleting substances. These substances are enumerated in Annexes A-E to the Protocol and are to be phased out within the schedule given in article 2A-2I.

Relevance to the project

The proposed project site will generate Dichloro diphenyl trichloroethane (DDT) which is the gas that depletes the ozone layer. The leachate will be managed through treatment to minimize the DDT and hence adherence to this protocol.

3.6.3 The United Nations Convention on Climate Change ("1992 UNFCCC")

The objective of the 1992 UNFCCC is to tackle the negative effects of climate change. The Conventions' stated aim is to stabilize greenhouse gas concentrations at a level that allows ecosystems to adapt naturally to climate change so that food production is not threatened, while enabling economic development to proceed in a sustainable manner (article 2).

Relevance to the project

The proposed project site will generate methane, which is a GHG. However, the capture and flare will be used to minimize the methane and hence adherence to this convention.

3.6.4 The Kyoto Protocol

The Kyoto Protocol was adopted in December 1997 at the Third Conference of the Parties held in Kyoto. The Kyoto Protocol requires stronger commitments from Annex 1 parties to achieve quantified emission reductions within a specific timeframe. These commitments cover the six greenhouse gases listed in Annex A of the Kyoto Protocol (Carbon dioxide, Methane, Nitrous oxide, Hydro chlorocarbons, Perfluorocarbons and Sulphur hexafluoride).

Relevance to the project

The contractor will be required to carry out regular inspection and maintenance of construction equipment to reduce the levels of greenhouse gas emissions into the atmosphere. During operation of the landfill, emission of greenhouse gases like methane will be minimized through capture and flare and emissions from carbon dioxide into the atmosphere will have to be managed through the landscaping of the proposed site after construction.

CHAPTER FOUR

4 ENVIRONMENTAL AND SOCIAL BASELINE

4.1 Introduction

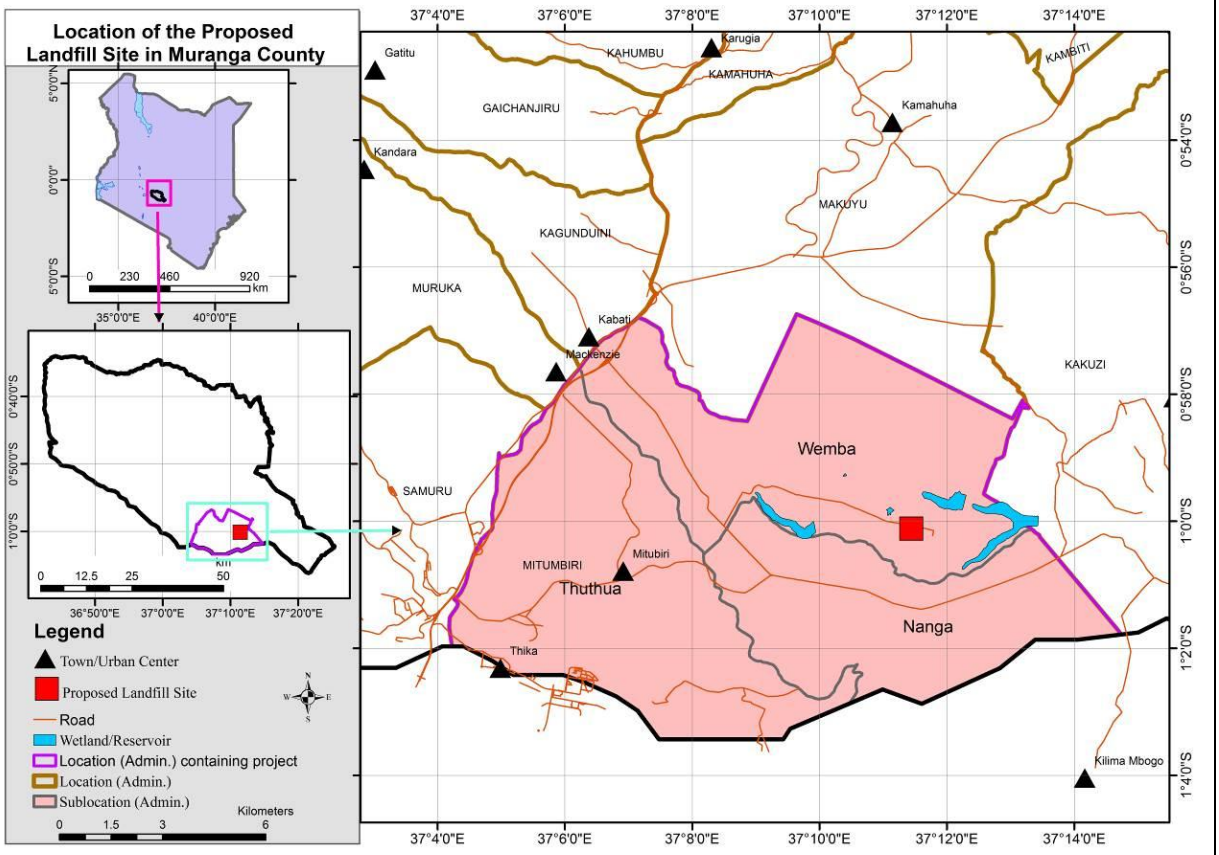
Baseline conditions cover all the biophysical and socio-economic conditions in the project area. Gathering of baseline data is necessary to meet the following objectives:

- To understand key biological, physical, ecological, 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;
- To benchmark future socio-economic changes/ impacts and assess the effectiveness of mitigation measures.

4.2 Environmental and Biological Baseline Profile

4.2.1 Site Location and general characteristics

The proposed landfill project is in Mitubiri Murang'a County. Murang'a County is situated approximately 20km to the north of Nairobi City. The county has an area estimated at 2,567km^2 and is defined by spatial extents, to the North -0.95^{o}S, Southern extent -1.06^{o}S, to the east 37.25^{o}E and to the West 37.07^{o}E. Project site is generally defined by spatial reference -1.00 S, 37.19^{o}E located to the south of Murang'a County (as shown in map 4-1 below).



Landfill site	**Date: September 2017**	SGS
Project: NaMSIP Mitubiri Landfill;	**Scale: On map**	
Location: Mitubiri, Murang'a County		

Map 4-1: Map showing the proposed landfill site in Mitubiri, Murang'a County
Source: SGS Consultant

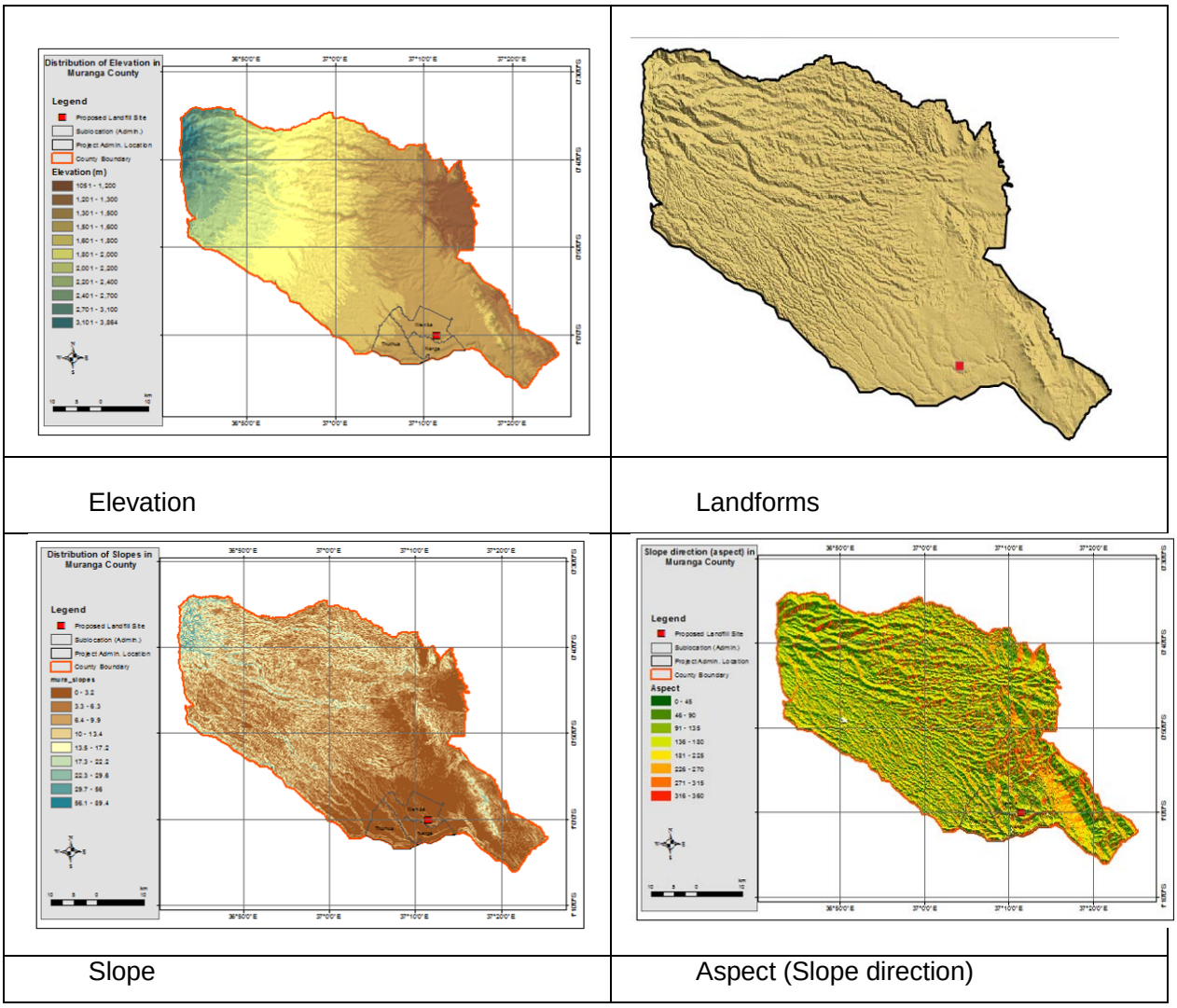
4.2.2 Topography

Elevation: Elevation of Murang'a County range from a minimum of 1051m in South East and a maximum 3884m in West and North West. The proposed project site is located within elevation range of 1460-1468m. (Map4-2).

Slope: Steep areas occur in the western and northern side of Murang'a County. The slope in steep areas range from 17 to 80 degrees. Gentle slopes and plain areas, less than 6.3 degrees, are distributed in the south and part of eastern side of the county.

Aspect: Slopes running to the easterly direction constitute larger area in Murang'a County, about 63% of the total area of the county. Slopes that run to the westerly direction constitute 37% of the county area. They are mainly distributed in the northern areas of the county. The northern slopes run westerly and encounter the easterly running slopes that form a general easterly direction dictating the direction of the drainage pattern in the county (Map 4-2 below).

Landforms: Nearly two third of the county is rugged and this occur in the west, north, north East and central area of the county. The Southern areas are plain with undulating landscape. The proposed project is in the south on a plain area lying between two drainage channels (Map 4-2 below).



Elevation | Landforms

Slope | Aspect (Slope direction)

Figure 4-1: Top left - An elevation distribution across the landscape of Murang'a County. Top right - Landform emphasized by hill shading; smooth areas are plains and rough areas on map are rugged terrains. Bottom left – Slope angle distribution across the county's landscape. Bottom right – Direction a slope faces (aspect).Source: SGS consultant

4.2.3 Drainage system

Drainage systems show pattern of running from the West to the East of Murang'a County as shown in Figure 4-2 below. Major drainage occurs in the northern part of county where Mathioya, Kangema and Kiharu are located. Drainage density is high in the northern part of the county than the south. The highest drainage density is 985m length of drainage system per kilometre square of area which occurs in Mathioya that has an area of 175 km^2 as indicated in Table 4-1 below. Mathioya and Kandara have small area but are well drained, Gatanga is poorly drained in the county. The proposed landfill site is situated in Gatanga where drainage density is low compared to other areas in the county.

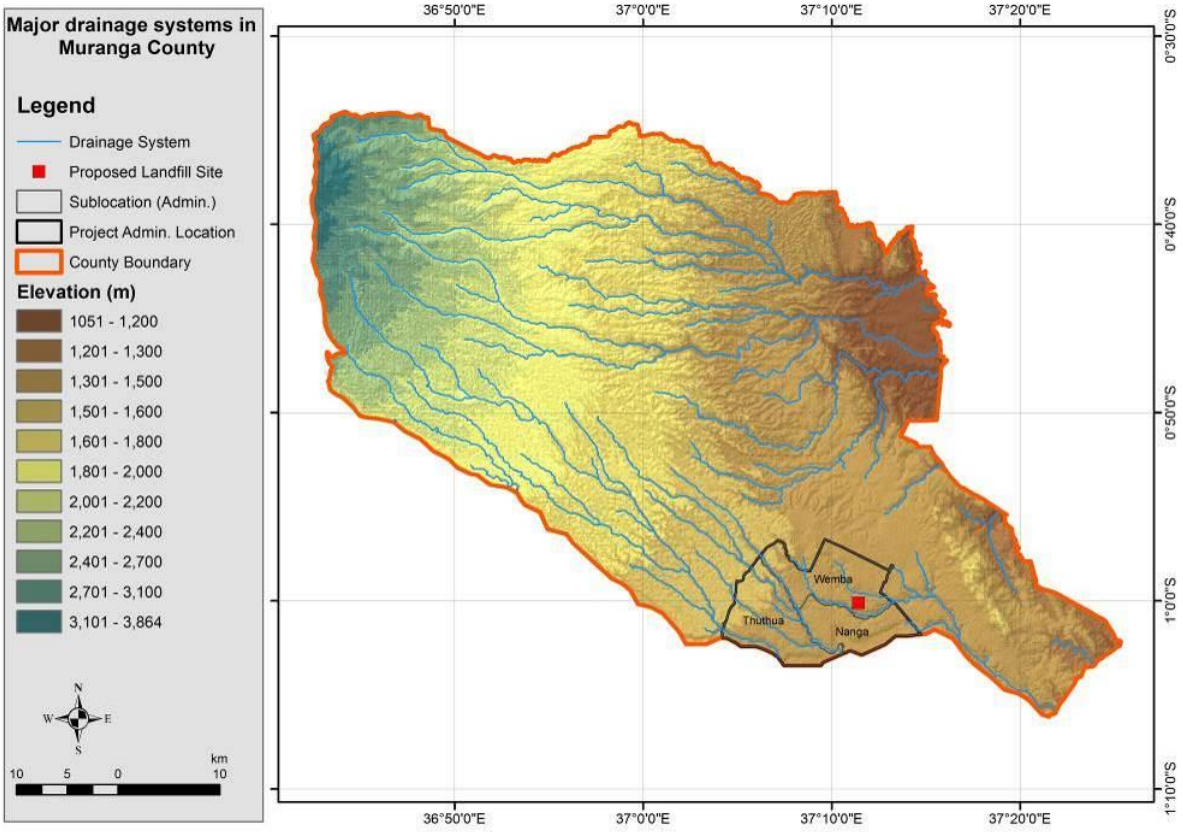


Figure 4-2: Drainage pattern across the county's landscape. Most drainage features run towards the East.

Source: SGS Consultant

Table 4-1: Drainage density (m/km sq) among the seven constituencies in Murang'a Count

Constituency	Drainage Density (m/km sq.)	Area [km sq.]
Mathioya	985	176
Kandara	738	236
Kiharu	621	411
Kangema	588	347

Constituency	Drainage Density (m/km sq.)	Area [km sq.]
Maragua	567	337
Kigumo	512	293
Gatanga	459	768

4.2.4 Climatic and Metrological conditions

4.2.4.1 General Conditions

Meteorological data is essential for the development of a model of atmospheric dispersion that simulates the behaviour of pollutants in the atmosphere. Meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the ventilation potential of the 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.

Murang'a County is divided into three climatic regions that are uniquely distributed; in the western side is predominated by the equatorial type of climate, central area experiences the sub-tropical climate and the eastern side experiences the semi-arid conditions.

Precipitation: Murang'a County receives an estimated mean annual precipitation of 1550mm. Some areas receive as little as 866mm and others a maximum of 2386mm mean annual precipitation. However, the highest and reliable amount of rainfall is recorded in April, estimated at 3352mm. The lowest amounts of monthly precipitation occur in the months of June to September as shown in Figure 4-3 below.

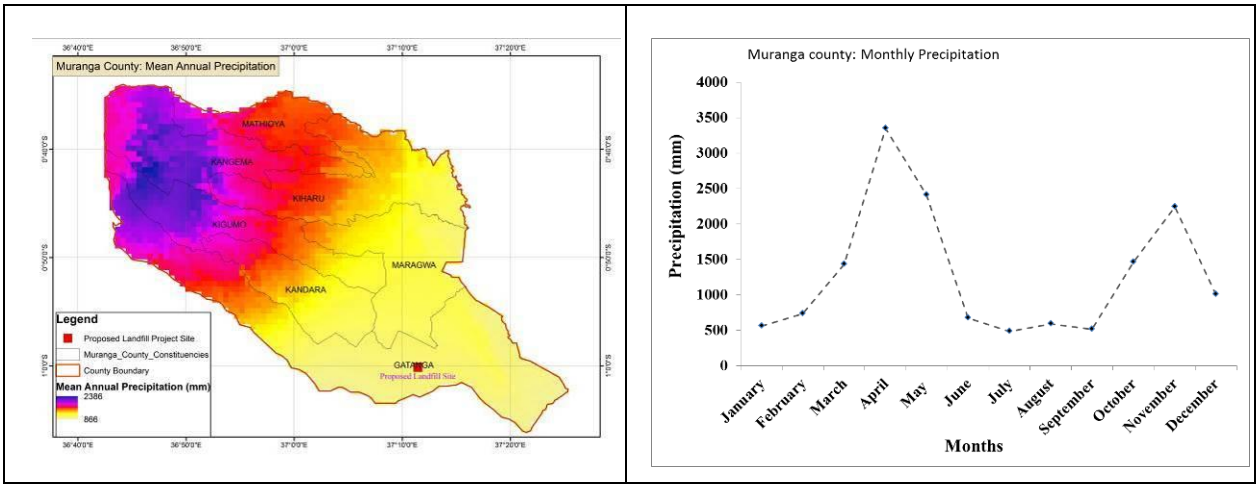


Figure 4-3: Spatial distribution of the Mean Annual Precipitation in Murang'a County (Left) and temporal distribution of precipitation (monthly precipitation) on the right.

Temperature: The mean annual temperature for Murang'a County is estimated at 17.39 ^{o}C. The minimum range is 11.1 ^{o}C with general low temperature distributed in the western and North West of the county; especially in Kangema, west of Kigumo, west of Mathioya. Moderate temperature occur around the central areas of the county; while, the maximum range is estimated at 21.4 ^{o}C. Areas with high temperature occur in the eastern side of the county; these include large areas in Maragua, Gatanga, Kiharu, east of Kandara and Kigumo (as shown in Figure 4-4 below).

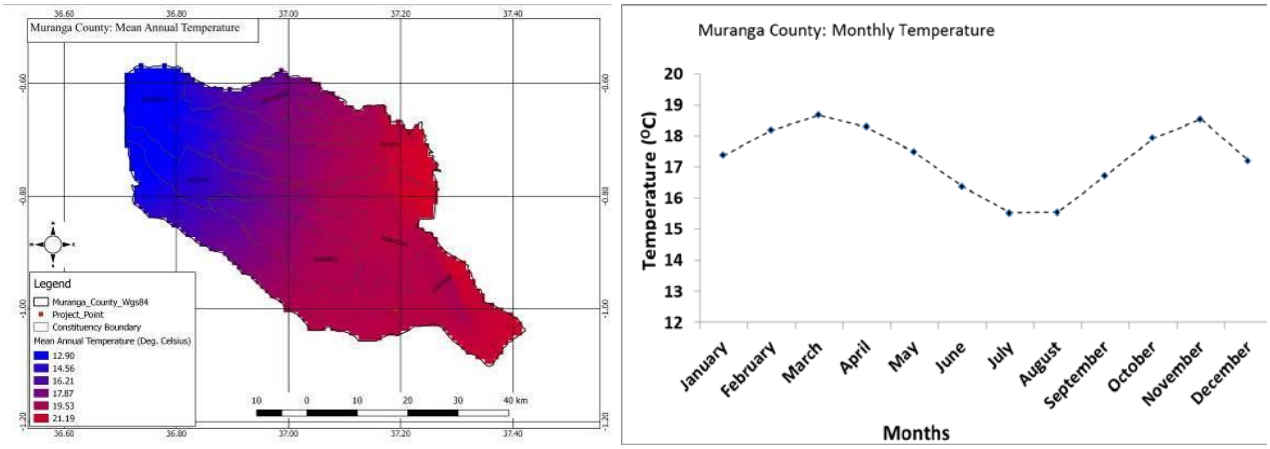


Figure 4-4: Spatial distribution of Mean Annual Temperature in Murang'a County (Mean Annual Precipitation). On the right side is the temporal distribution of rainfall (monthly temperature).

4.2.4.2 Localized conditions

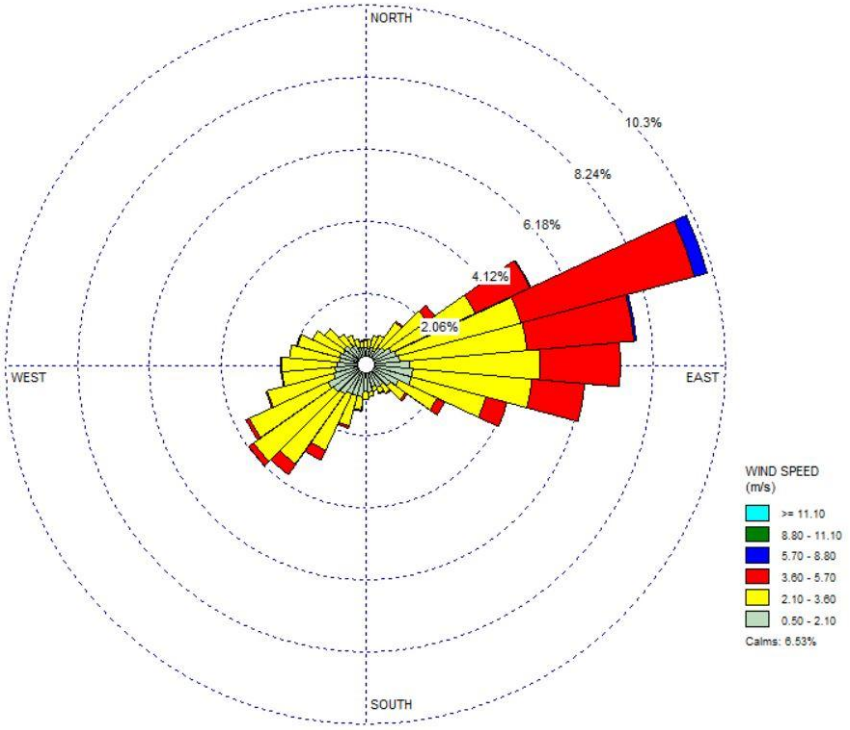
Data for the period January 2010 to December 2016 was acquired from the Pennsylvania State University /National Centre for Atmospheric Research PSU/NCAR mesoscale model known as MM5. The MM5 is a limited-area, non-hydrostatic, terrain- following sigma –coordinate model designed to simulate or predict mesoscale atmospheric circulation.

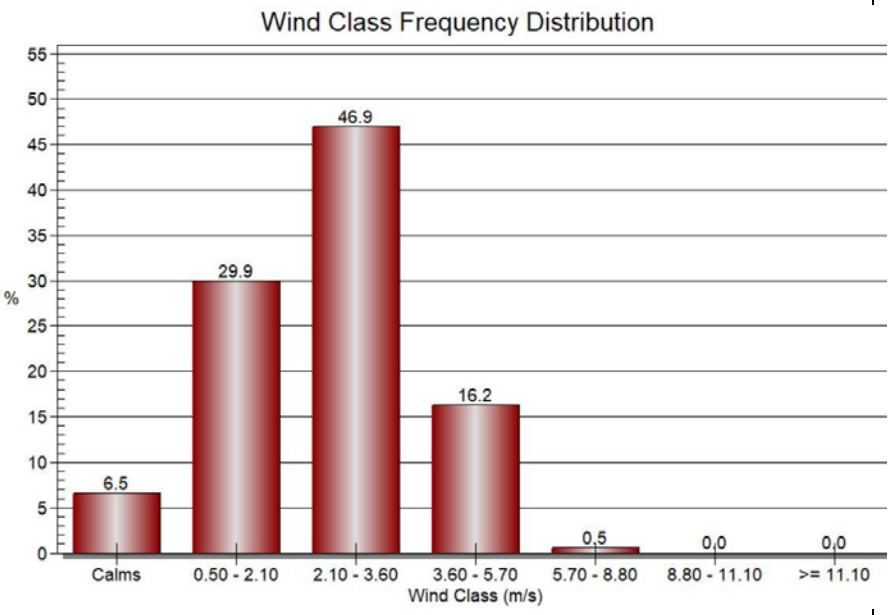
Wind Roses

The model has been prepared with surface data schedules for seven years (temperature, wind speed and direction), considering in this case records from the period (2010 - 2016) as the most appropriate for modeling of the dispersion of pollutants. Wind roses comprise 8 cardinal compass directions to illustrate the directions from and to which wind flow at varying times of the year. The wind roses are also comprised of colored spokes illustrating the relative intensities of various wind speed categories. The colors used in the wind roses in the figures below reflect the different categories of wind speeds and directions. The highest wind speed witnessed in the project area for the seven-year period is in the ranges of 5.7m/s to 8.8m/s. However, the predominant wind speed category is in the ranges of 2.1m/s to 3.6m/s.

Annual average wind roses and statistics

Annual average 24-hour wind movement statistics





The average annual wind rose was generated from seven-year meteorology data (2010 - 2016). This wind rose is generated from the full daily 24 hour met data over the seven-year period.

The wind rose revealed the following wind motion trends:

- The winds predominantly flow from the East-North-Eastern quadrant
- The wind speeds range from 0.5 – 8.8 m/s
- The bar chart shows the relative frequency of wind speed categories over the seven-year period

Annual average daytime wind movement statistics

- The daytime wind speed for the seven-year period (2010-2016) was generated by filtering the source data from 6:00 hrs in

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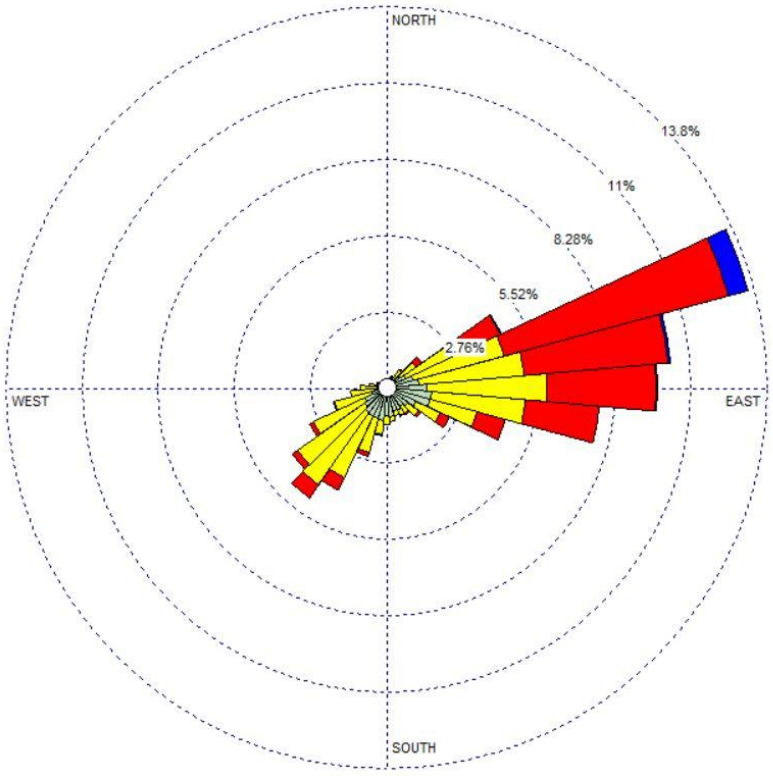
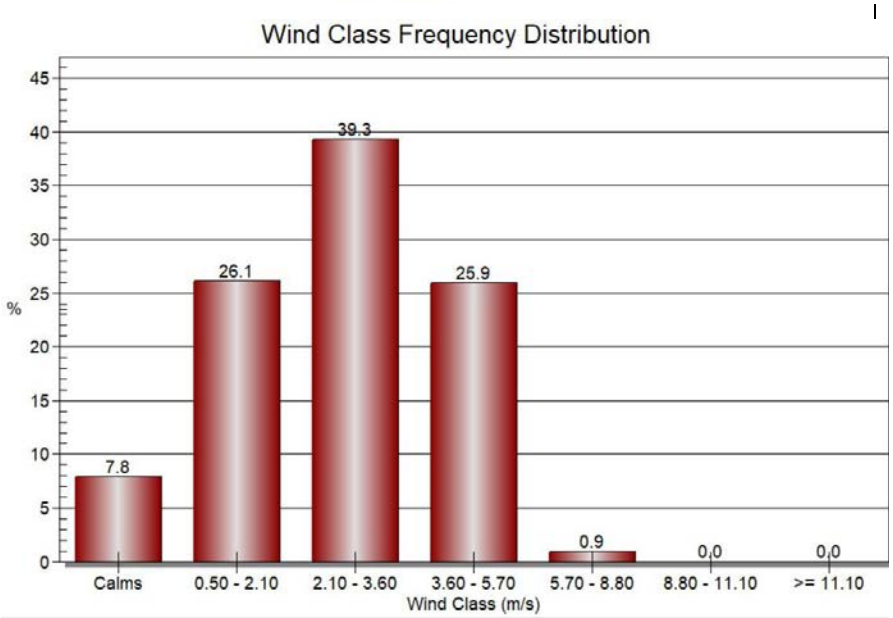
<td> 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<td>the morning to 18:00 hrs in the evening.
● The wind rose revealed the following wind motion trends:
● The winds predominantly flow from the East-North-Eastern quadrant
● The wind speeds range from 0.5 – 8.8 m/s
● The bar chart shows the relative frequency of daytime wind speed categories over the seven-year period</td>
</tr>
<tr>
<td>Annual average nighttime wind movement statistics</td>
<td>● The nighttime wind speed for the seven-year period (2010-2016) was generated by filtering the source data from 18:00 hrs in the evening to 6:00 hrs in the morning.</td>
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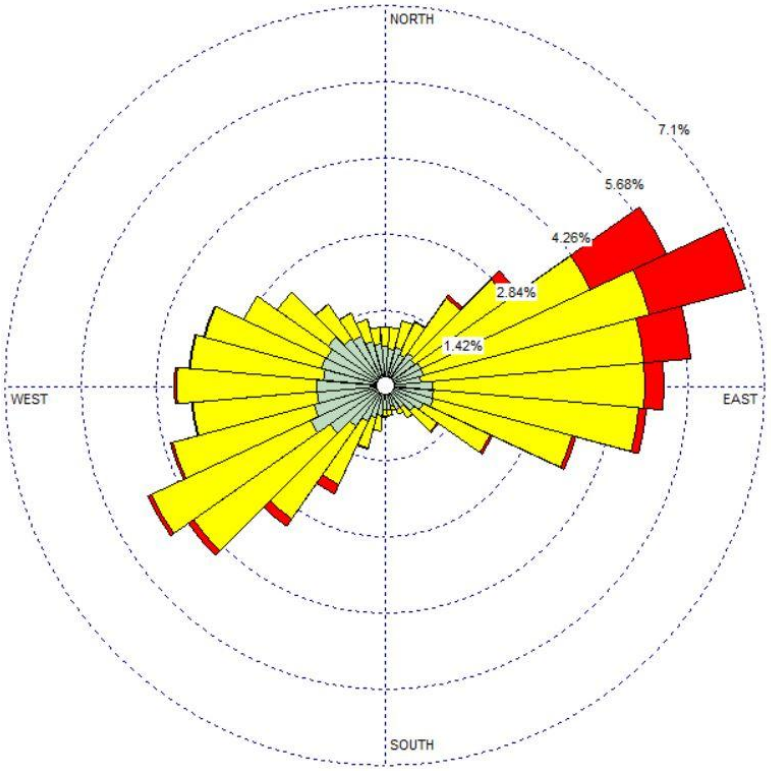
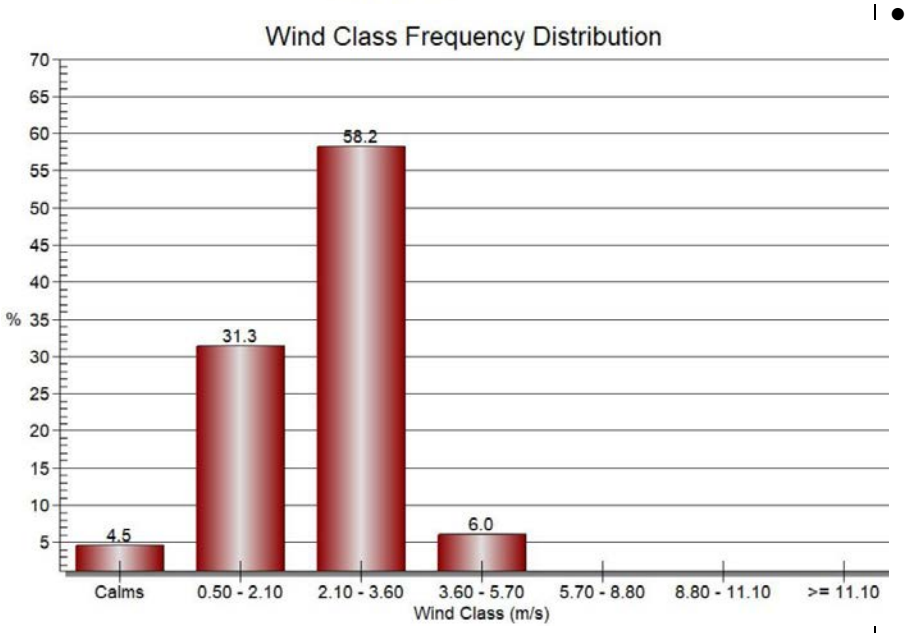
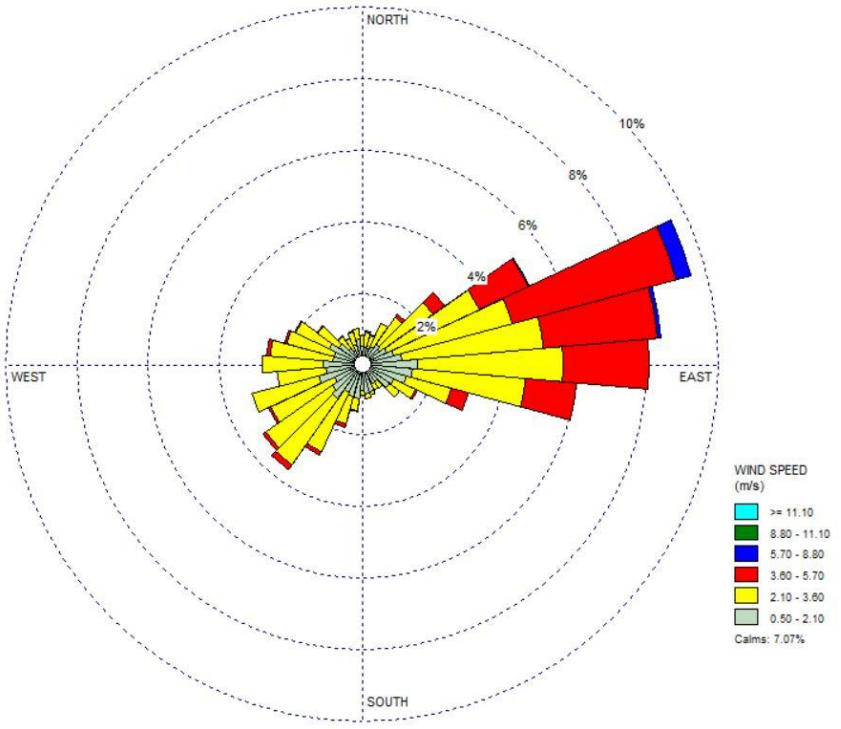
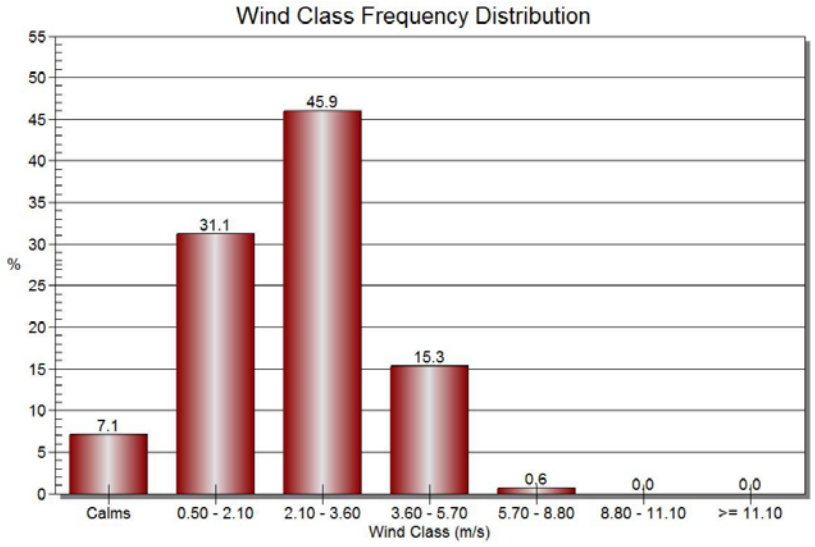


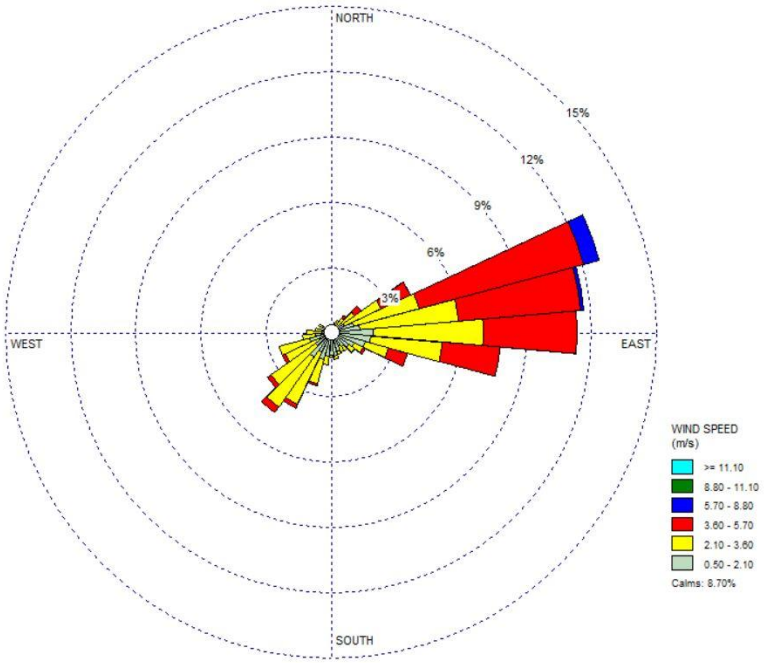


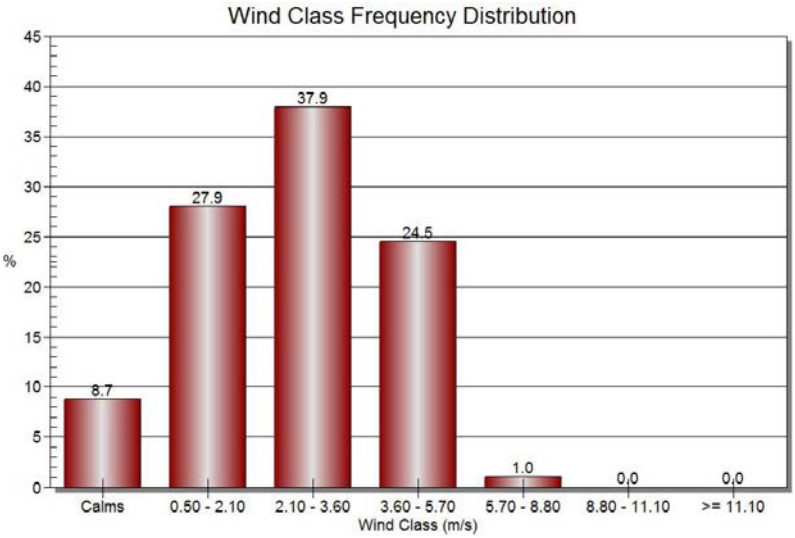
- The wind rose revealed the following wind motion trends:
- The winds predominantly flow from the Northern-Eastern and South-Eastern quadrants
- The wind speeds range from 0.5 m/s to 5.7 m/s
- The bar chart shows the relative frequency of nighttime wind speed categories over the seven-year period
- The winds are relatively calm during nighttime compared to daytime.

Annual average wind roses and statistics

Annual average 24 hour wind movement statistics	The average annual wind rose was generated from one-year meteorology data

 	(2015). This wind rose is generated from the full daily 24 hour met data over the one-year period. The wind rose revealed the following wind motion trends: ● The winds predominantly flow from the North East-East direction ● The prevailing wind speeds range from 5.7 - 8.8 m/s ● The bar chart shows the relative frequency of wind speed categories over the one-year period
Annual average daytime wind movement statistics	The daytime wind speed for the one-year period (2015) was generated by filtering the source data from 6:00 hrs in the morning to 18:00 hrs in the evening.





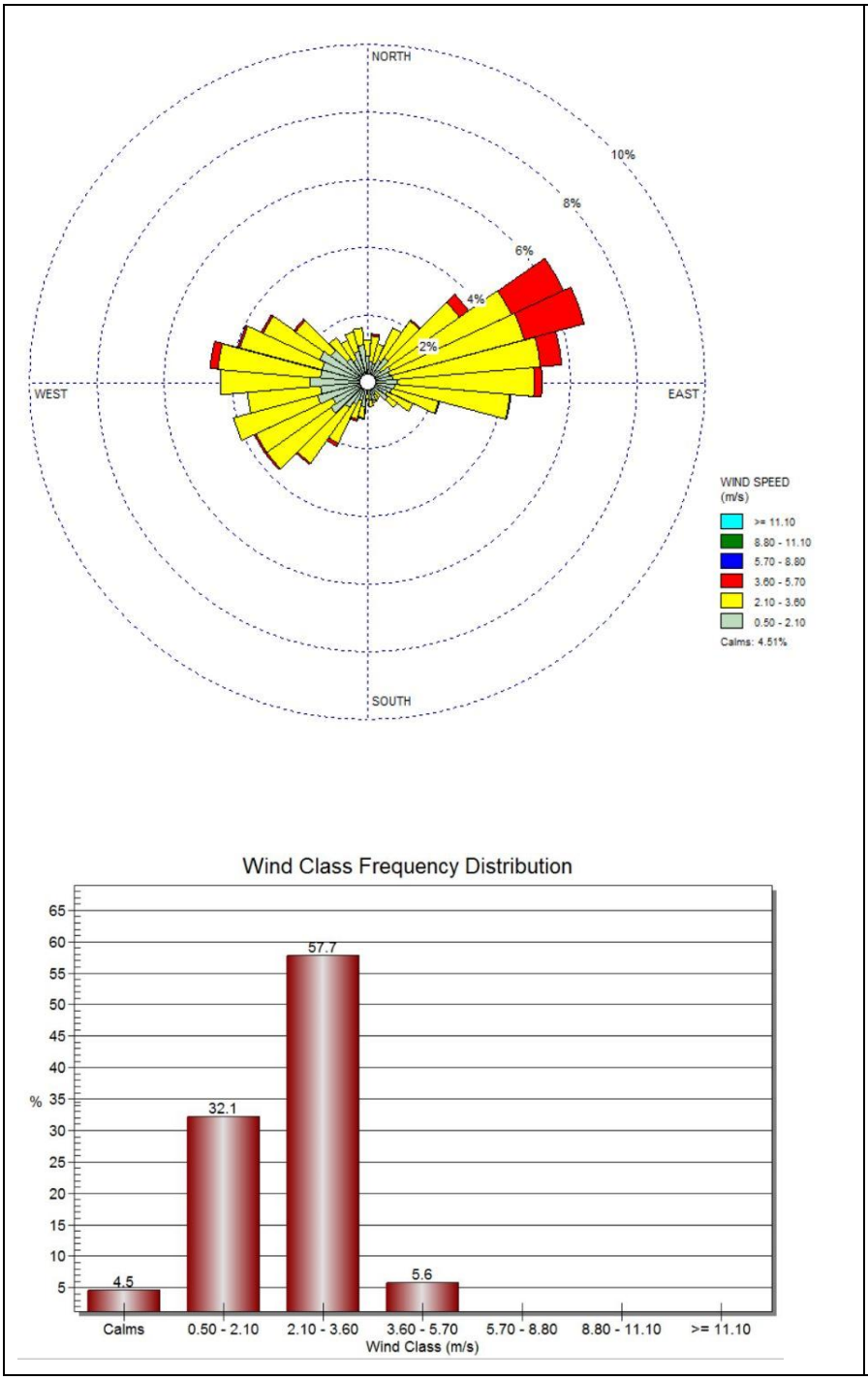
The wind rose revealed the following wind motion trends:

- The winds predominantly flow from the North East-East direction
- The predominant wind speeds range from 5.7 - 8.8 m/s
- The bar chart shows the relative frequency of daytime wind speed categories over the one-year period

Annual average nighttime wind movement statistics

The nighttime wind speed for the one-year period (2015) was generated by filtering the source data from 18:00 hrs in the evening to 6:00 hrs in the morning.

The wind rose revealed



the following wind motion trends:

- The winds predominantly flow from the North East direction
- The predominant wind speeds range from 3.6- 5.7 m/s
- The bar chart shows the relative frequency of daytime wind speed categories over the one-year period
- The winds are relatively calm during nighttime compared to daytime.

Figure 4-5: Wind Rose plots

Atmospheric stability

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 lenth (L_{MO}) 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 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 maximum ground level concentrations or near ground level releases from non-wind sources would predominantly occur during weak wind speeds and stable night time atmospheric conditions. Unstable conditions would result into high concentrations of poorly diluted emissions close to the source for elevated releases. Atmospheric stability is categorized in seven classes as described in table 4 below. The frequency of occurrence of each stability class of the project area is indicated in the table below

Table 4-2: Frequency of Occurrence of each stability

Stability Class Name	Atmospheric Condition	Class Boundaries
Very Unstable	Calm wind, clear skies and hot day conditions	$-200 \leq L < 0$
Unstable	Moderate wind, slightly overcast daytime conditions	$-500 \leq L < -200$
Neutral	High winds or cloudy day and night conditions	$\|L\| > 500$
Stable	Moderate wind, slightly overcast night-time condition	$200 < L \leq 500$
Very Stable	Low winds, clear skies, cold night-time conditions	$0 < L \leq 200$

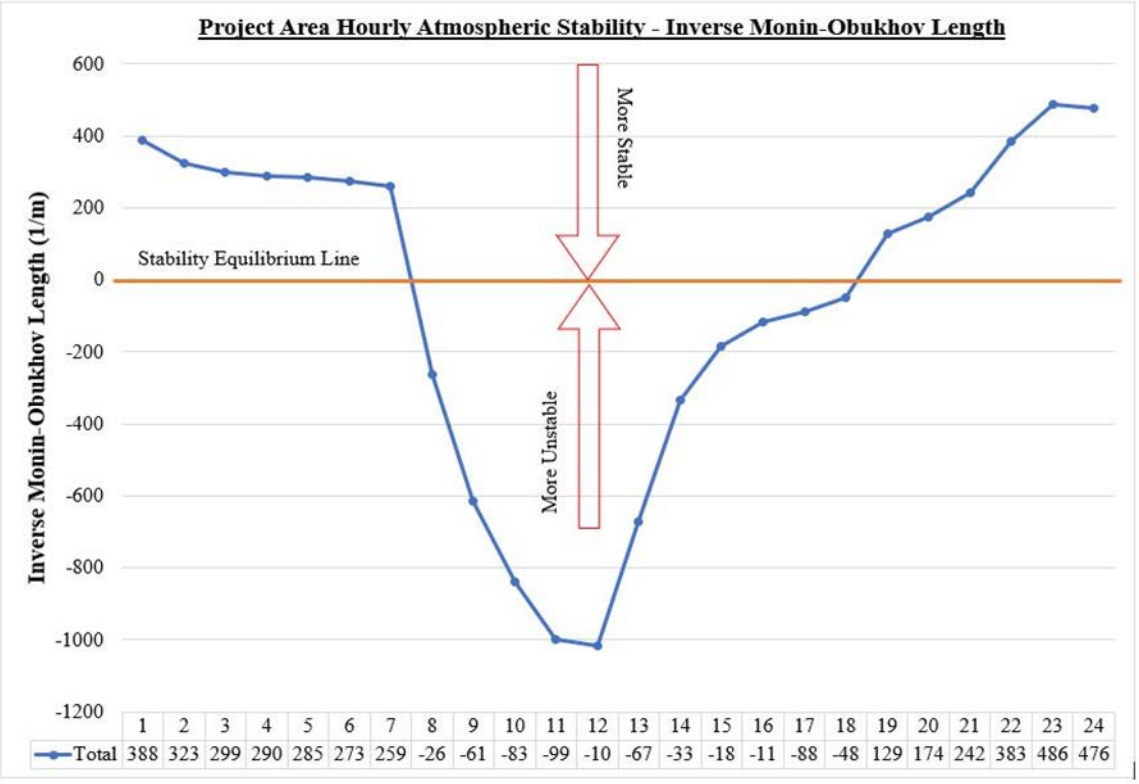
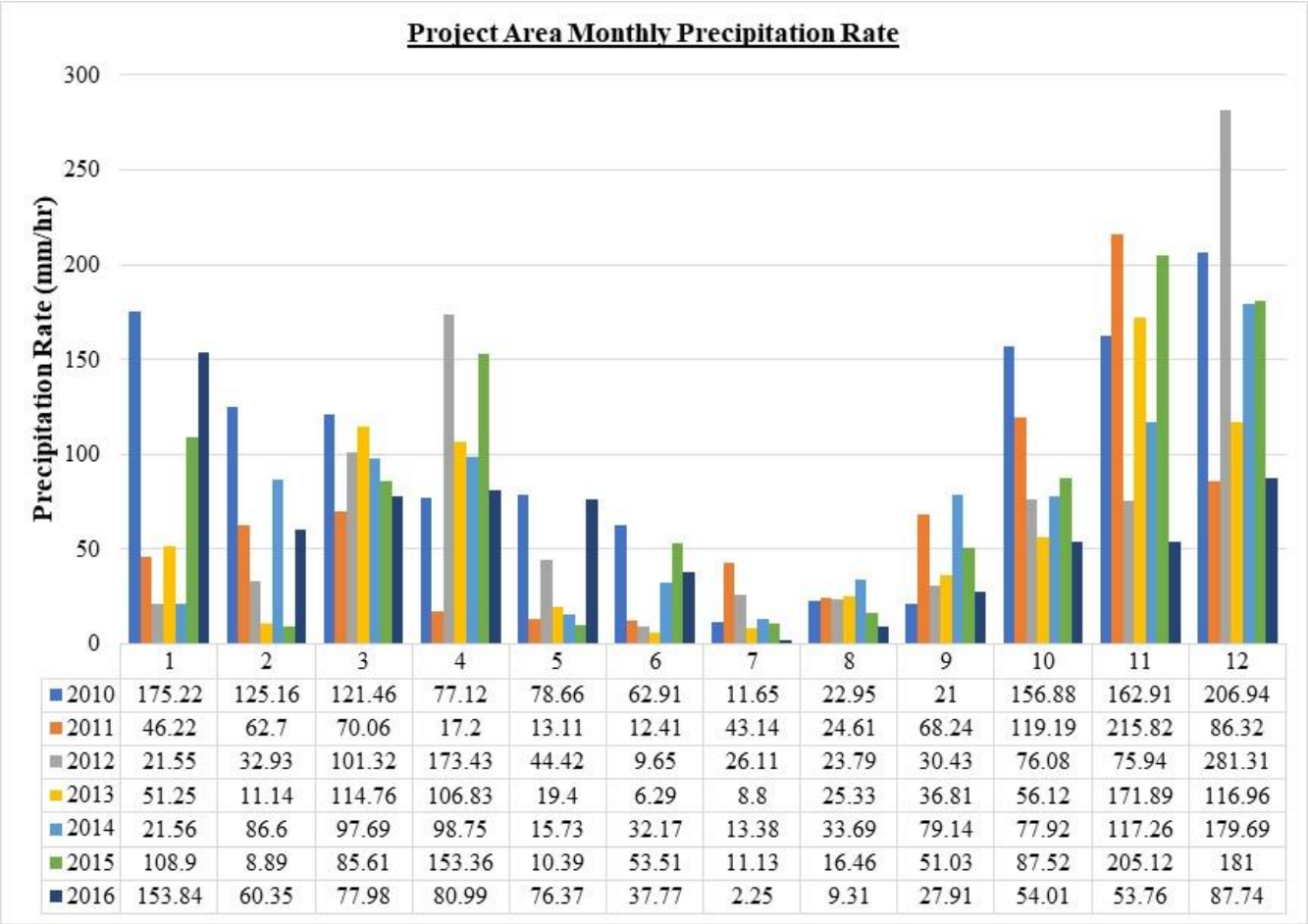


Figure 4-6:: Project area hourly atmospheric stability

Rainfall

Rainfall pattern is very important in air pollution assessments as it represents an effective removal mechanism for atmospheric pollutants and suppresses dust generation. Average monthly rainfall for the project area (January 2010 - December 2016) is presented in graph 4-2



	1	2	3	4	5	6	7	8	9	10	11	12
2010	175.22	125.16	121.46	77.12	78.66	62.91	11.65	22.95	21	156.88	162.91	206.94
2011	46.22	62.7	70.06	17.2	13.11	12.41	43.14	24.61	68.24	119.19	215.82	86.32
2012	21.55	32.93	101.32	173.43	44.42	9.65	26.11	23.79	30.43	76.08	75.94	281.31
2013	51.25	11.14	114.76	106.83	19.4	6.29	8.8	25.33	36.81	56.12	171.89	116.96
2014	21.56	86.6	97.69	98.75	15.73	32.17	13.38	33.69	79.14	77.92	117.26	179.69
2015	108.9	8.89	85.61	153.36	10.39	53.51	11.13	16.46	51.03	87.52	205.12	181
2016	153.84	60.35	77.98	80.99	76.37	37.77	2.25	9.31	27.91	54.01	53.76	87.74

Figure 4-7: Project Area Monthly Precipitation Rate

4.3 Hydrogeology

The hydrological survey conducted during the feasibility study, ***KE517E(Seureca), February 2016*** reported that Mitubiri area is generally marked by unfavorable hydro geological conditions, which are determined by a combination of largely impermeable bedrock, generally thin soils, and lack of recharge due to a structural rainfall deficit. However, the prospects for groundwater development are fair along the faults and general lines of weakness. Here, weathering has not only resulted in secondary porosity, but has also created a storage media in the regolith, saprolite and saprock. Along the streams recharge is provided by the infiltration of surface discharge, and underflow through the alluvium, faults and the weathered zones.

In the study area the volcanic rocks are underlain by Basement System formations. Aquifers are encountered in weathered tuffs and highly fractured/weathered basalts. The underlying fresh Basement is in most cases dry and significant volumes of groundwater can only be expected in fracture zones (cracks, joints, fissures, and faults).

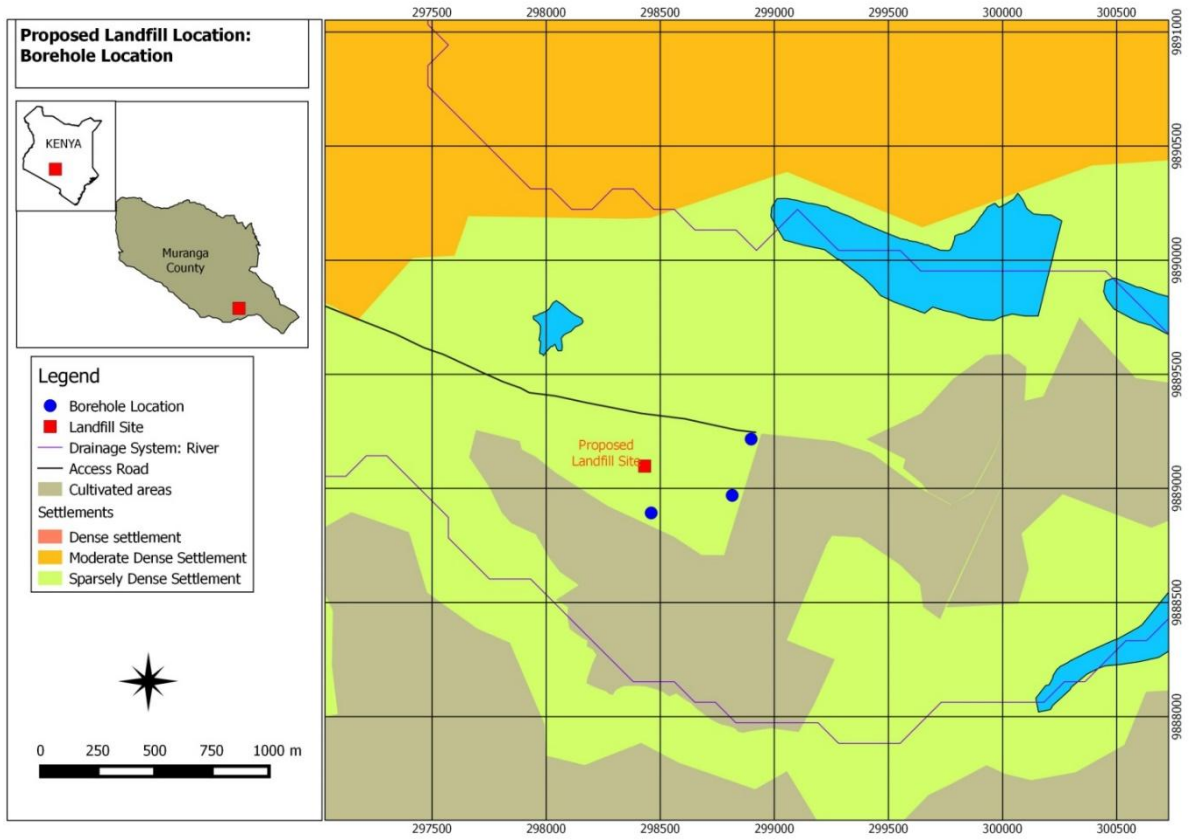
The study area has two main volcanic formations, Basaltic Agglomerates and Kapiti Phonolites. Kapiti Phonolite sheet overlies the folded Precambrian Basement rocks. The Kapiti is a dense, light to dark-grey colored volcanic rock, characterized by large phenocrysts of feldspar and waxy looking nepheline, set in a fine-grained, dark groundmass. The highly variable thickness of these phonolites is to a large extent determined by the pre-volcanic land surface. In the study area, the phonolites are encountered between 90mbgl and 159mbgl. The formation directly lies on the Basement System. Basaltic Agglomerates Series: this series includes a succession of basaltic agglomerates containing both porphyritic feldspar basalts and melanocratic basalts. In the study area, basalts are generally found between the Kapiti Phonolites and the overlying younger tuffs and agglomerates of the Upper Athi Series. The formation is exposed in the study area.

4.3.1 Ground water occurrence in the study area

Three boreholes were analyzed within a radius of 3km from the study area. Data from these boreholes were sampled from the Ministry of Water data base. The success rate of the existing boreholes is medium: Abandoned dry boreholes are generally rarely reported. The failed drilling attempts (if present, around the study site) can however be attributed to both insufficient drilling depth and poor construction works.

Plate 4: Piezometer PZ_1 drilling
Source: Feasibility study report, KE517E(Seureca), February 2016

Shallow aquifers from the study area are abstracted between 26m to 34m bgl (below ground level) mainly within the highly weathered tuffs and Basalts. Deep confined aquifers are encountered at 58m bgl. Water Rest Levels in the study area range between 16mbgl and 24m bgl. The following figure shows the borehole location drilled at the site.



Borehole locations	**Date: September 2017**	
Project: NaMSIP Mitubiri Landfill;	**Scale: On map**	
Location: Mitubiri, Murang'a County		

Figure 4-8: Borehole Location

Table 4-3: Hydrological data from boreholes in the vicinity of the project area

BH[1]	Owner[2]	Dist.[3]	T. Depth[4]	WSL[5]	WRL[6]	Yield[7]
C-No.		**Km**	**(m bgl)**	**(m bgl)**	**(m bgl)**	**(m^3/hr)**
C 403	Mitubiri Movement Ltd	2	159	-	-	9
C 1119	Mitubiri Ranch	3	40	34, 26	16	2.8
C 1894	Movement Ltd, Mitubiri	2	68	58	24	3.5
	Range		**68-159**	**26-58**	**16-24**	**2.8-9**
	Average		**89**			**5.1**

Source: Final feasibility study report KE517E(Seureca), February, 2016

Notes

- Ministry of water resources Borehole Identification Number
- Borehole owner
- Distance from the proposed site
- Total drilled depth in meters below ground level
- Water struck level in meters bgl
- Static Water Level, depth of piezometric surface, or water table, in m bgl
- Tested yield in m3/hr

4.3.2 Recharge

The mechanism of the recharge pathway to and the rate of replenishment of, the aquifers which underlie the study area has not been fully established. The broad patterns of recharge can be described. The original source of recharge water is known to be rainfall. There are two possible recharge mechanisms:

- Direct recharge from surface,
- Indirect or lateral recharge via faults or other aquifers.

***Direct Recharge*:** The volcanic aquifers are most likely to be recharged indirectly, although the faults which are located downstream of the two waterfalls will in all probability enhance local direct recharge to local volcanic aquifers.

***Indirect Recharge*:** The recharge pathway is lateral - that is, the movement of water in saturated aquifers follows gravity, so water travels from the north and west and percolates through successive formations to the east until it arrives at in the study area. To a certain extent this is supported by the relatively high concentrations of ions in the two volcanic waters. These indicate long retention and travel times through these aquifers.

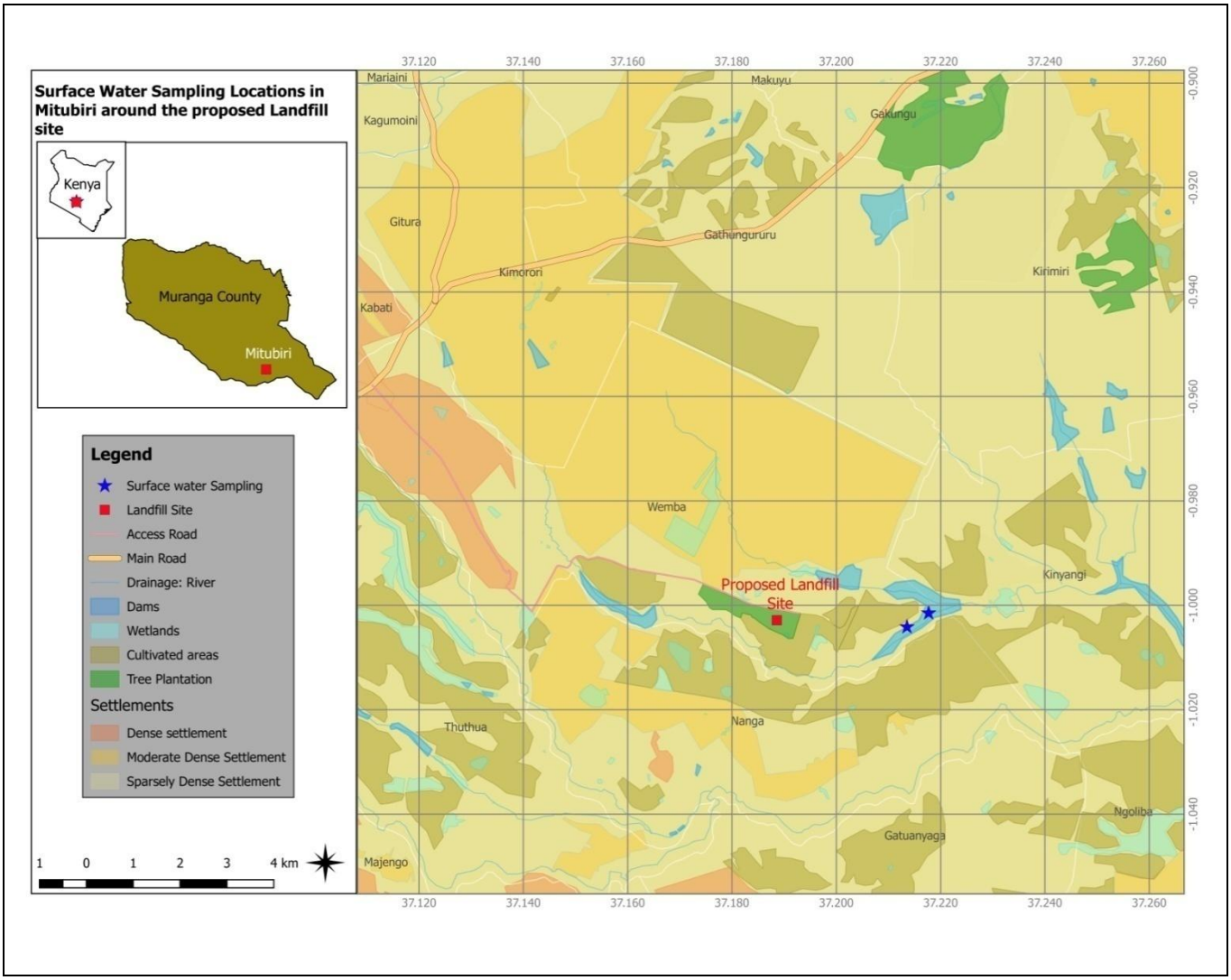
4.3.3 Discharge

Volcanic aquifers in the study area discharge under gravity to the east, but also lose significant volumes of water to abstraction - i.e., pumped boreholes. Aquifer discharge probably occurs as spring flow and base flow to streams and rivers tributary to the nearby rivers.

PZ drillings results conducted on site as per the Feasibility study report, KE517E(Seureca), February, 2016.

4.3.4 Surface water

Baseline sampling and analysis of existing surface water was undertaken at proposed project nearby dam and river. Dam water Samples were collected at location: 1° 00'14.97"S, 37°12'48.74"E and 1° 00'05.39"S, 37°13'03.71"E. river water sample was collected at point 0° 59'41.37"S, 37°15'15.66"E. The laboratory results are appended in this report. (Annex 11) The following figure is a map of the surface sampling location/point



Surface Water Sampling locations	**Date :September 2017**	
Project : NaMSIP Mitubiri Landfill;	**Scale :On map**	
Location : Mitubiri, Murang'a County		

Figure 4-9: Surface Water Sampling Point/Locations

4.4 Geology

Geophysical survey conducted during the feasibility study, ***KE517E(Seureca), February, 2016*** reported that Mitubiri area features two main volcanic formations, Basaltic Agglomerates and Kapiti Phonolites.

Kapiti Phonolite sheet uncomfortably overlies the folded Precambrian Basement rocks. The Kapiti formation is a dense, light to dark-grey colored volcanic rock, characterized by large phenocrysts of feldspar and waxy looking nepheline, set in a fine-grained, dark groundmass. The highly variable thickness of these phonolites is to a large extent determined by the pre-volcanic land surface. In the study area, the phonolites are encountered between 90m bgl and 159mbgl (as depicted from the geological logs). The formation directly lies on the Basement System.

Basaltic Agglomerates Series: this series includes a succession of basaltic agglomerates containing both porphyritic feldspar basalts and melanocratic basalts. In the study area, basalts are generally found between the Kapiti Phonolites and the overlying younger tuffs and agglomerates of the Upper Athi Series. The formation is exposed in the study area.

4.4.1 Geophysical Survey at the proposed site

The feasibility study reported that the survey comprised of resistivity surrounding (also called vertical electrical sounding or VES). The resistivity of each geological series was studied by measuring the electrical potential distribution produced at the surface by an electric current that is passed through the underlying formations. Geophysical surveys were conducted along transverse lines spaced not more than 200 m apart and was designed to characterize the integrity of the confining layer underlying the shallow aquifer and identify main lithology i.e. weathered bedrock and depth to bedrock.

A total of 13 VES soundings were carried out in 3 East-West lines from North to South, each line was spaced at intervals of 100 m.

Results in the Northern section showed low resistivity at the top indicating wet topsoil except in the Northeast part with high resistivity indicating dry topsoil between 0 and 1 m. Homogenous resistivity between 1 and 3 m and between 3 to 20 m indicates in concordance with geology, fractured rocks. Below 20 m, the low resistivity should indicate presence of aquifer, which is correlated to the result of the geotechnical survey.

Results in central section of the site indicated shallow topsoil with variation in moisture levels. Geologic formation can be fractured and water can occur with low resistivity in the bedrock between 5 and 10 m depth in the Western part.

In the Southern section, topsoil seems to be dryer. Bedrock is weathered and water is found in the east between 5 to 10 m and after 30 m.

All geophysics results were correlated with data obtained from drillings.

4.4.2 Test Pits

The feasibility study indicated that excavation of trial pits was performed by hand. The work included clearing and excavating a total of 23 trial pits within the proposed property limits to a depth of 1.0 to 3.0 meters with a density of around 1 test pit for each hectare. Lithologic data was recorded along with exact location. The proposed site is divided into three sections as indicated in figure 4-10.

North of the site : the soil is composed of black cotton soil (test pits N° 1 to N°14). The surface is approximately half the site at elevation between 1463 m and 1465 m above sea level	
Southeast of the site, topsoil is represented by a lateritic formation (Test pits N°15 to N°21) at elevation between 1466 and 1467 m	
Southwest of the site, the soil is composed by red soil (test pits N° 22 to N°25) at elevation comprised between 1467 and 1470	

Plate 5: **Test Pit at the proposed site**

Source: Feasibility study report, KE517E(Seureca), February, 2016

4.4.3 Core drilling

A total of twelve core drillings were performed over the surface of the site (CS1 to CS12). Drilling locations were defined based on 4 East-West rows of 3 drillings from North to South. The depth of these boreholes ranged from 6 meters and 7 meters.

Two boreholes were drilled below 10 meters deep to measure the thickness of the weathered. The survey reported that drilling results confirmed that the site may be divided into 3 distinctive sections.

Plate 6: Core drilling at the project site

Source: Feasibility study report, KE517E (Seureca), February 2016

4.4.3.1 Cross sections

Geological cross-sections representing the intersection of the geological formations with a vertical plane of a certain orientation was conducted. Drilling locations were defined based on 4 East-West rows of 3 drillings from North to South (CS1-CS12) as shown in Figure 4-10. The depth of these boreholes ranged from 6 meters and 7 meters.

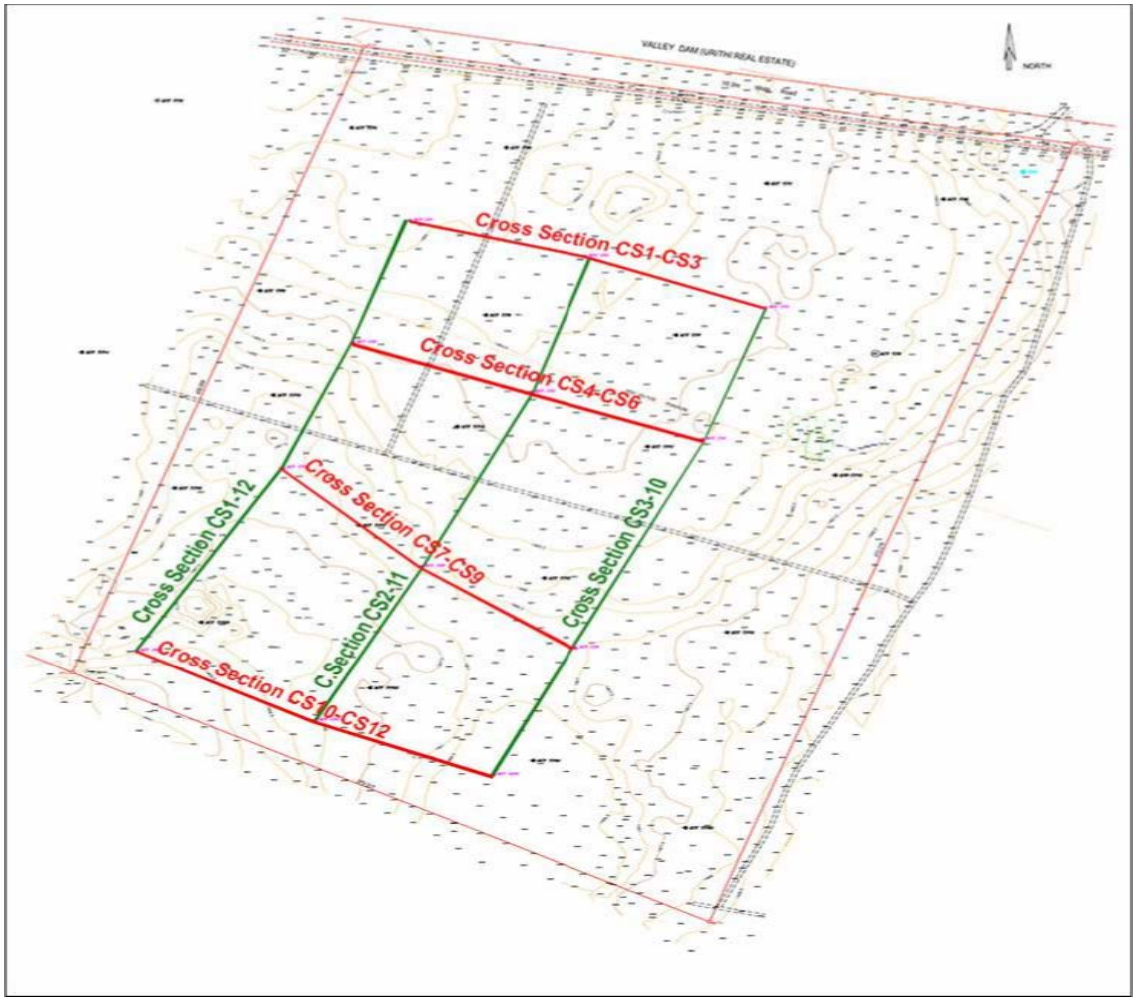


Figure 4-10: Location map of cross-sections

Source: Feasibility study report, KE517E(Seureca), February, 2016

Geological cross-sections representing the intersection of the geological formations with a vertical plane of a certain orientation was conducted.

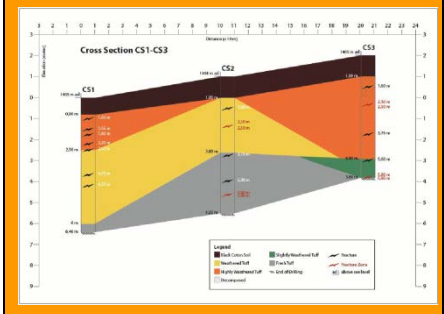
The lithology obtained as presented in the feasibility study for the proposed project is summarized below:

- North part of the site has soft ground made of black cotton soil (CS1 - CS6), a level of lateritic soil to the southeast (CS7 - CS10) and red soil to the southwest of the site (CS11 - CS12). The soft ground has an average depth of one meter.
- The rock is made of a single lithology composed of tuff with several levels of weathering.

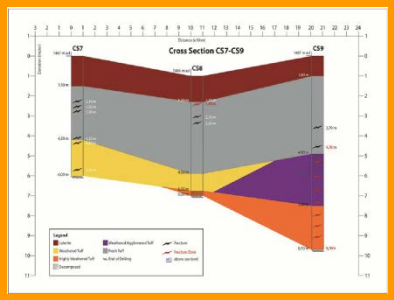
In the northern part of the land, tuff is weathered, sometime highly weathered at the surface. The central portion is less weathered and fresh tuff is found between 3, 60 m and 7, 10 m. In the central part, the fresh tuff is located uniformly at the surface between 4, 20 m and 4, 90 m. weathered tuff is found below and weathering is more pronounced in the east.

In the southern part of the site, altered tuff is found at the surface especially in the west (CS12) where it is completely decomposed.

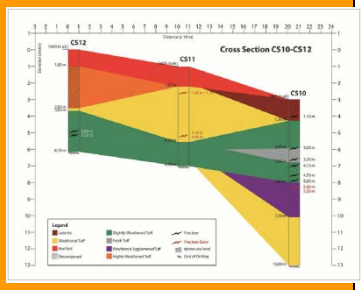
In the north-south cross-sections (CS1-CS12, CS2-CS11 and CS3-CS10), the lens fresh tuff is found in the area where the topography is steep and allows the flow of water. A central area where the rock is fresh or slightly altered is expected (Figure 4-11). The most altered parts are in areas with a flat topography in the wetland zone (CS3 and CS6). There is also a highly altered zone south west of the site in the nearest part of the cultivation areas where rock is covered with red soil. The rock is generally quite fractured with sometimes fracture zones of several decimeters.



Cross section CS1-CS3

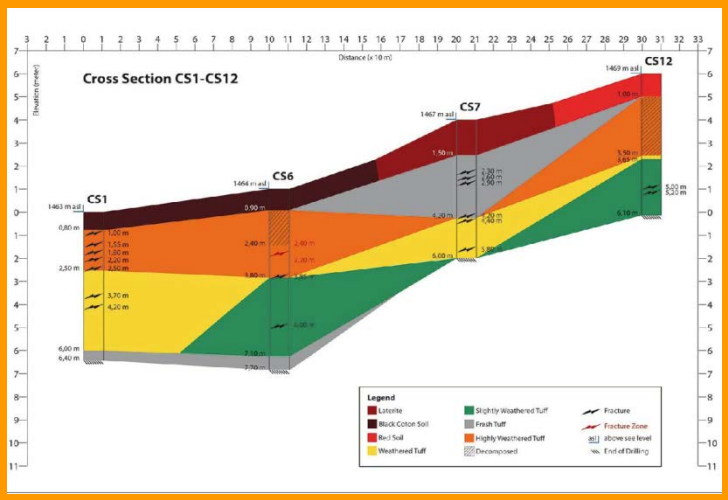


Cross section CS7-CS9



Cross section CS10-CS12

CS7, CS8&CS9(from top to bottom)



Cross section CS1-CS12

Figure 4-11: Geological cross-sections of study area

Source: Feasibility study report, KE517E(Seureca), February 2016

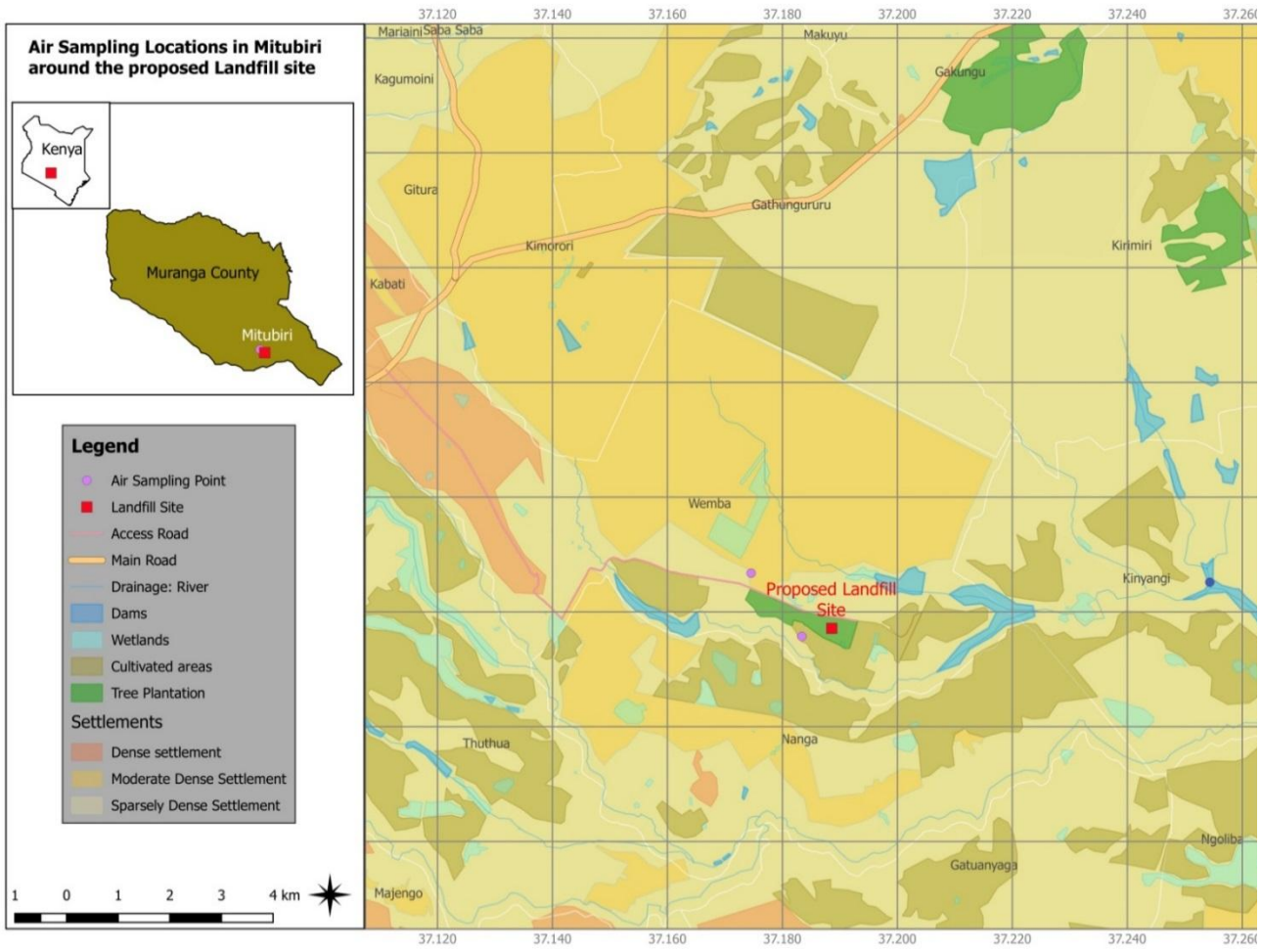
4.4.4 Ambient Air quality

The proposed project site is located within an agricultural- rural set up and there are no industrial or commercial activities that could cause significant air pollution. Air quality survey was undertaken at the project site to determine the baseline air quality. The survey analyzed air contaminants of concern; particulate matter PM_{10}, sulphur dioxide (SO_2) and Nitrogen dioxide (NO_2). The results obtained were well within WHO and Kenyan standards; Environmental Management and Coordination (Air Quality) Regulations 2014. 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 4-4: Results of Air Quality Spot Sampling Assessment

Site / Location	GPS Coordinates	Parameter	Results	Kenyan limits	IFC/WB/ Guidelines	EU standards* / WHO Guidelines
Unit			**ug /m^3**	**ug /m^3**	**ug /m^3**	**ug /m^3**
Mitubiri Landfill	1° 00'15.37"S, 37° 11'0.18"E	PM 10	28	70	50	50
		NO_X	0.33	150	200	-
		SO_2	48.4	125	125	125
		NH_3	BDL	100	-	-
		H_2S	<0.05	50	20	125 / 20
	0° 59'35.68"S 37° 10'28.39"E	PM 10	32	70	50	50
		NO_X	0.28	150	200	-
		SO_2	52.6	125	125	125
		NH_3	BDL	100	-	-
		H_2S	<0.05	50	20	125 / 20

BDL-below detection limit Source: SGS Kenya Consultant



Mitubiri Air Sampling locations	**Date: September 2017**	
Project: NaMSIP Mitubiri Landfill;	**Scale: On map**	
Location: Mitubiri, Murang'a County		

Figure 4-12: Air Quality Sampling Points/Locations

4.4.5 Ambient Noise Levels

The ambient noise levels of 48.4 dB (A) and 52.6 dB (A) were measured from two points at the site: 1° 00'15.37"S, 37° 11'0.18"E and 0° 59'35.68"S 37° 10'28.39"E. 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.

4.4.6 Traffic

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 collection.

4.5 Biological Environment

4.5.1 Habitat Description

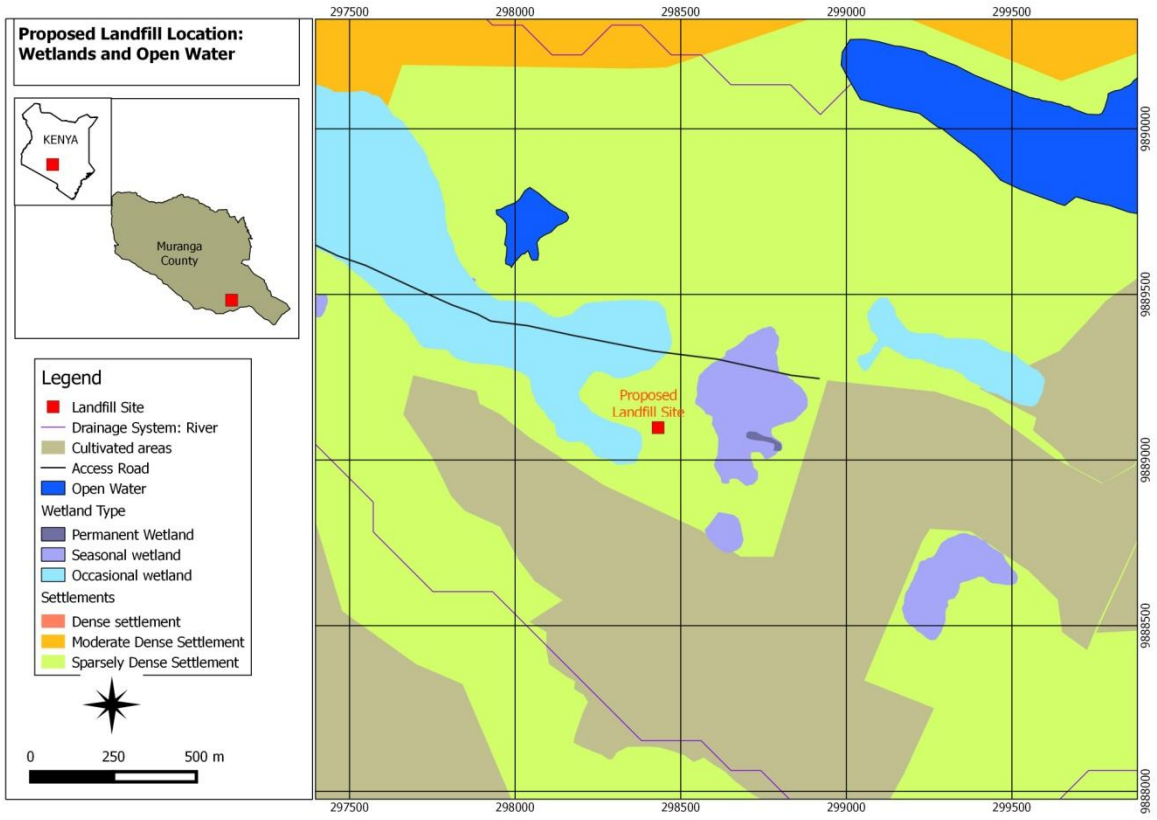
During this study, ecological assessment was carried out at the proposed Landfill site to provide description of baseline ecological conditions. The study found high frequency of appearance of *Acacia* and *Commiphora* species in the area suggesting that the area is very close to semi-arid condition. 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 swampy, bushed grassland and agro-biodiversity consisting of small vegetable farms. The swamp is permanent, constantly fed from underground springs as accounted for by a local resident.

The grassland-bush land type of habitat is apparently encroached from within and at the periphery. Eucalyptus trees has predominated the local bushed-grassland creating a bushed-grass-eucalyptus habitat. Part of the project site has seasonal wetland where Swamp Rice (*Leersia hexandra*) is dominant. The source of water for the seasonal wetland is a spring which has been opened by excavation around to tap more water for use during dry season. At slight distance from the site, there are open waters which developed due to damming of some rivers/stream that created reservoirs surrounding the elevated plain where the proposed site of the project is situated. Plate 7 shows the location of the open waters rivers/streams and wetlands in the project site.

Eucalyptus plantation (coppice)	Grassland habitat
	
Grassland habitat	Wetland (spring) habitat

Plate 7: Typical habitats within and adjacent areas of the proposed landfill site


Plate 8: Permanent pond charge by spring used for extraction of water for watering vegetables. On the right hand, a farmer has dug a hole to collect groundwater for use in his farm



Wetland and open waters location	**Date :September 2017**	SGS
Project : NaMSIP Mitubiri Landfill;	**Scale :On map**	
Location : Mitubiri, Murang'a County		

Figure 4-13: Map showing location of open waters and wetlands

4.5.2 Plant Diversity

An estimated 50 species of plants were recorded within the proposed project site and its adjacent areas. The proposed landfill site is predominated by *Eucalyptus globulus* (Blue Gum) that were planted but current are coppicing. Besides this exotic species, the common indigenous woody plant species is predominated by *Acacia hockii*, *Commiphora*, *Combretum* and *Erythrina* species (Plate 9). 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. Major threats to the plants around this area are habitat degradation, bush-fire and habitat clearing for charcoal.

Erythrina abyssinica

Euphorbia candelabrum

Combretum sp….

Balanites aegyptica

Acacia hockii

Neoboutonia macrocalyx

Plate 9: Selected indigenous plant species within and in adjacent areas

4.5.3 Avifauna Species

A total of 36 species in 21 families were recorded from the two days survey. Of one, vulnerable grey crowned Crane *Balearica regulorum* according to I.U.C.N and one Local /Afro tropic Migrant Red-billed Quelea *quelea*. Among the species noted were 4 water fowl species which are resident to the seasonal wetland.

Seasonal wetland is rich in bird species which is demonstrated by the immense bird species and individuals that were trapped on the mist net (as illustrated in plate 10 and 11). Over 150 individual bird species were trapped in the mist nets in less than 15 minutes but were released quickly due to lack of man power to ring the birds within convenient time to avoid causing stress on birds.

Out of these, 22 individuals were ringed from 15 species. In the net most commonly caught individual were from Ploceidae family which feeds in the social grouping like the Widow birds. The rare individual to spot in the bush was Siffling Cisticola *Cisticola brachypterus* and Dark-capped Yellow Warbler *Chloropeta natalensis.*

From the data collected the area is rich in avifauna in terms of species and abundance, but they have not been clearly documented. Therefore the survey calls for more detail survey which can thoroughly survey the entire area and document it (**Zimmerman, et al 1996).**

Plate 10: Different passerine Birds species caught in the Mist Net

Family **Nectariniidae:** Purple-banded Sunbird

Cinnyris bifasciatus

Family **Columbidae** Red-eyed Dove

Streptopelia semitorquata

Family Motacillidae**:** Yellow-throated Longclaw *Macronyx croceus*

Family **Ploceidae** White-winged Widowbird *Euplectes albonotatus*

Plate 11: Some selected bird species caught with mist net in the wetland

4.5.4 Reptiles and Amphibians

A total of eight species of reptiles and amphibians were recorded within the proposed landfill project site. These include seven amphibians (as shown in plate 12 & 13) and one snake was documented in the area (Table 4-5).

Habitats of the amphibians have been recorded to include streams, shallow marshes, lakes, swamps. Species recorded are adapted to various ranges of habitats; for instance,***Hoplobatrachus occipitalis*** is adapted to living in many habitats from dry savannahs to disturbed forest, moving using logging roads and rivers to penetrate deep into lowland forest. This species is documented as an invasive into forested areas where forests have been disturbed. *H. occipitalis* breeds in small to medium-sized temporary waters, but not in permanent waters, since it cannot compete with fish. It is a potential human food eaten west and Central Africa.

Xenopus victorianusis a water-dependent species occurring in heavily modified anthropogenic habitats except in large rivers, and water bodies with predatory fish. The species is highly opportunistic species, and colonizes newly recreated, apparently isolated, water bodies with ease. It is very successful and adaptable, and is not facing any significant threats

The area is accounted to have Python that reside in the bushed-grassland. Local resident account for one individual python that was recently killed (approximately 2 weeks before field survey was carried but buried).

According to anecdotal information from Victor Wasonga (herpetology expert from the National Museums of Kenya), pythons (male and female) normally live together or in close range. This implies, there is a possibility of finding another individual python in the area close to where the other one was killed.

Table 4-5: Checklist of reptiles and amphibians

#	Common Name	Scientific Name	IUCN Red list of threatened species	Population Trend
1	Central African Rock Python	*Python sebae*	No entries found	
2	Eastern Groove-Crowned Bullfrog	*Hoplobatrachus occipitalis*	Least Concern	stable
3	Lake Victoria Clawed Frog	*Xenopus victorianus*	Least Concern	increasing
4	Natal Puddle Frog	*Phrynobatrachus natalensis*	Least Concern	stable
5	Upland Puddle Frog	*Phrynobatrachus keniensis*	Least Concern	unknown
6	Mascarene Ridged Frog	*Ptychadena mascareniensis*	Least Concern	unknown
7	Savanna Ridged Frog	*Ptychadena anchietae*	Least Concern	unknown
8	Desert Toad	*Sclerophrys xeros*	No entries found	

Plate 12: Eastern Groove-crowned Bullfrogs observed in the main pond during the day

	
Lake Victoria Clawed Frog	Eastern Groove-Crowned Bullfrog
	
Mascarene Ridged Frog	Desert Toad

Plate 13: Selected photos of some recorded amphibians

4.5.5 Mammals

Two (2) species of shrews (white toothed shrew), represented by one individual each were recorded in the rapid survey. Olivier's white toothed shrew, *Crocidura olivieri* was captured in the swampy tall grass where as a female Macarthur's shrew *Crocidura macarthuri* was recorded in the grass/bush habitat (as shown in Plate 14).

Shrews

While *C. olivieri* is both habitat and food generalist feeding on many invertebrates including worms in and outside the swamp, *C .macarthuri* is habitat restricted to bushed grass habitats in all its range in Africa. The latter though classified as Least Concern is further noted by IUCN (2016), as habitat restricted and locally threatened by habitat conversion especially into farms (Hutterer, R. & Oguge, N. 2008. *Crocidura macarthuri*. C. olivieri is classified in IUCN Redlist as Least Concern and widespread in all its range.

Rodents

Five rodent species were recorded in the rapid survey. This includes:

- Unstriped grass rat, Arvicanthis nairobae
- Striped grass rat, Lemniscommys striatus
- Multimammate rat, Mastomys natalensis
- Pigmy mouse, Mus minutoides
- Tatera gerbil, Gerbilliscus cf robustus

Arvicanthis nairobae is endemic to Kenya occurring only in central Kenya and only restricted to grass habitats. *Lemniscomys striatus* is widespread in Africa and found in both grass and bushed grass habitats in its range. Tatera gerbil and Pigmy mouse are equally widespread in typical wet and dry savanna habitats especially open wooded/bushed grassland.

Mastomys natalensis however is a widespread, generalist rodent and often becoming pests in crop fields in many parts in Kenya. The species is widespread in Africa.

Remark: *Crocidura macarthuri, Arvicanthis nairobae* and *Gerbilliscus robustus* are likely victims of the habitat conversion to landfill.

Hiding place for Bush Duiker

Unstriped grass rat, *Arvicanthis nairobae*

Multimammate rat, *Mastomys natalensis*

Striped grass*, Lemniscomys striatus*

Tatera gerbil, *Gerbilliscus robustus*

Plate 14: Selected photographs of rodents and activity of Common Bush Duiker

4.5.6 Fish Diversity

Presence of two fish species are accounted for in the dam in the project vicinity; Catfish species is popularly known to exist by the local residents. Description provided for other species probably identifies a species in the *Cyprinid* family. Fish species are not diverse in the area but dominated by two species only.

4.5.7 Species Richness

In summary, Plant species constitute the richest taxa in the area. Birds are on the other side very high among the faunal species. The richness in bird is contributed by the presence of wetland that act as foraging grounds for most of the species (graph4-2). Rodents constitute the highest number of species in the area, about five species were recorded in the area, one antelope and African Hare. The rapid survey conducted reveals the area is very rich in species of birds, probably more than what is recorded. Fish are however poorly documented in the area.

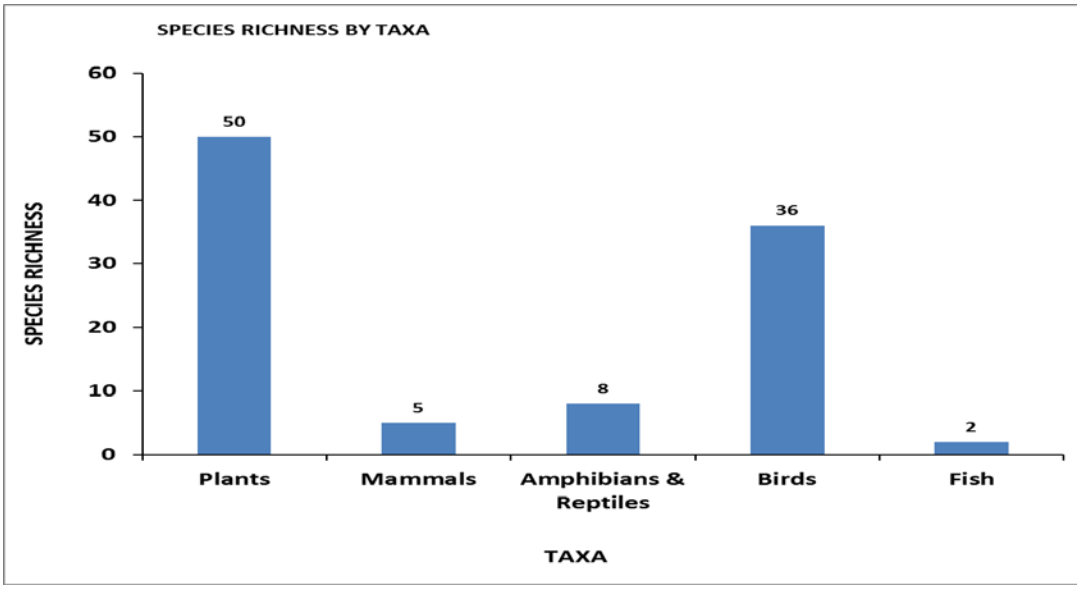


Figure 4-14:Species aggregated by major taxa

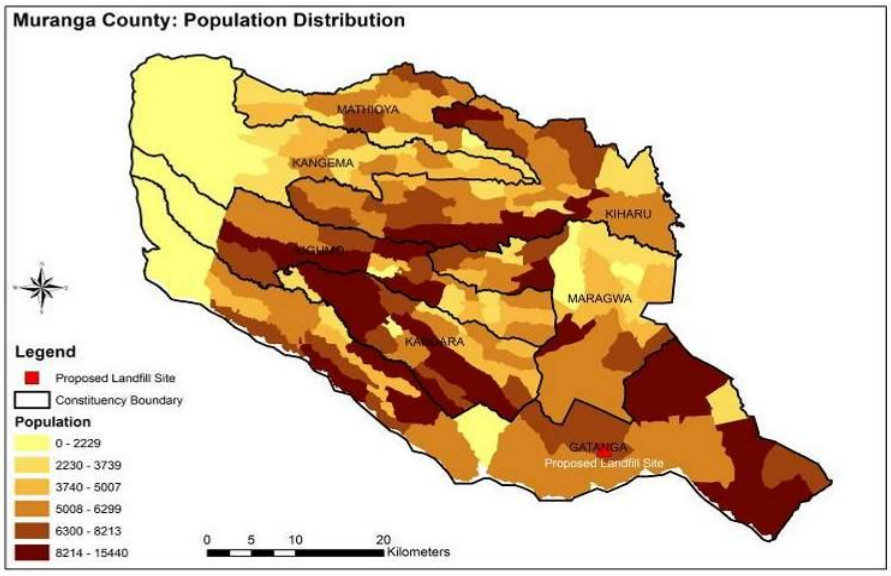
4.6 The Socio-Economic Profile

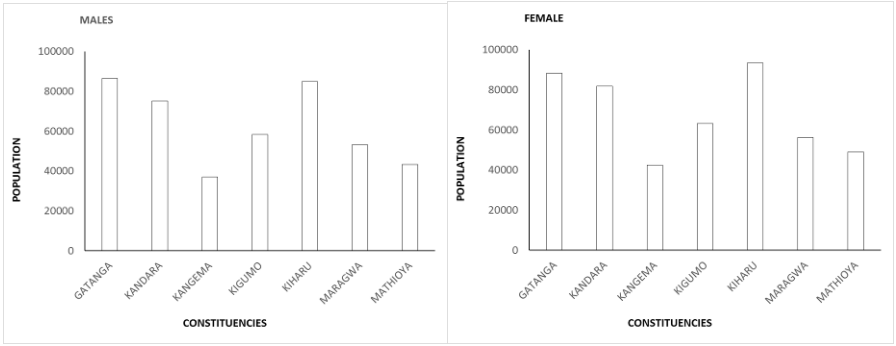
This section provides information on the social and socio-economic baseline conditions in the proposed Project area. The information presented has been obtained during a desktop study mostly from Murang'a County Integrated Development Plan 2013-2017 and site visits.

4.6.1 Human Population

According to population census of 2009, total population of Murang'a County generated from the census statistics shows the county has a total of 912,843 people. Thus, population density in the county is estimated at 356 persons per km^2. The lowest population in sub location is 2,229 and highest is 15,440. Female population is relatively higher than males at constituency and county levels of consideration. Majority of population in Murang'a County hail from Kiharu (20%), Gatanga (19%) and Kandara (17%); Kangema constituency has only 8% of the county's population.

Population of Gatanga constituency, from which the proposed landfill project site is situated, is estimated at 350,000; this is distributed among the eight locations (Administrative units). The location, Mitubiri, at which the project is located, has an estimated population of 19,304. From this population, Nanga Sub location has about 5457, Thuthua 6247 and the Sub location where the project is base, Wempa, has about 7,600. (Figure 4-15).


Muranga County: Population Distribution
MATHIOYA
KANGEMA
KIHARU
KIGUMO
MARAGWA
KANDARA
GATANGA
Proposed Landfill Site
Legend
Proposed Landfill Site
Constituency Boundary
Population
0 - 2229
2230 - 3739
3740 - 5007
5008 - 6299
6300 - 8213
8214 - 15440
0 5 10 20
Kilometers


MALES
POPULATION
100000
80000
60000
40000
20000
0
GATANGA
KANDARA
KANGEMA
KIGUMO
KIHARU
MARAGWA
MATHIOYA
CONSTITUENCIES
FEMALE
POPULATION
100000
80000
60000
40000
20000
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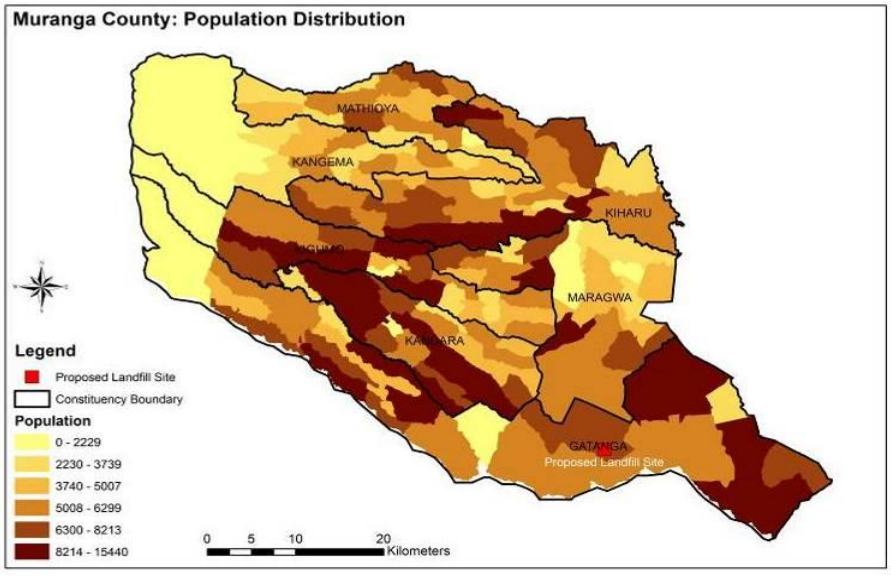
GATANGA
KANDARA
KANGEMA
KIGUMO
KIHARU
MARAGWA
MATHIOYA
CONSTITUENCIES


Muranga County: Population Distribution
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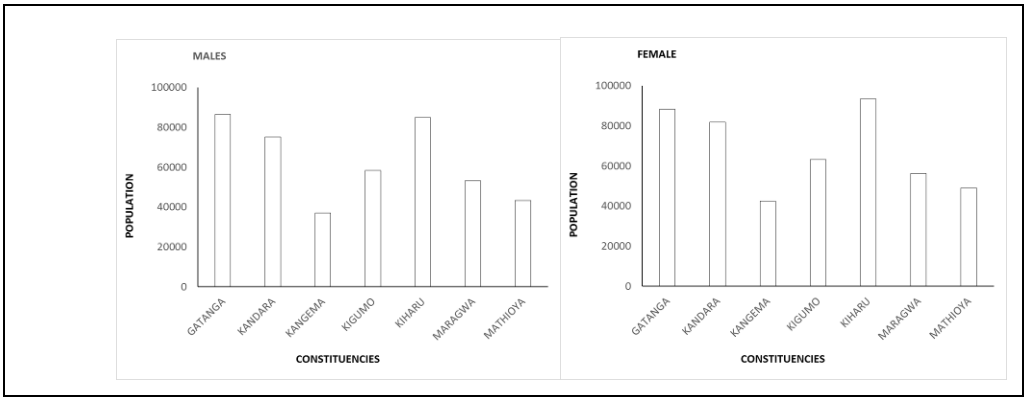

Figure 4-15: Spatial distribution of population (total) in Murang'a County at a resolution of sub location. Bottom left – distribution of male population. Bottom right – distribution of female population.

4.6.2 Land Use Land Cover

The area is predominated by the Eucalyptus-grassland/shrub-grassland cover type. This is distributed all over the buffer area covering, approximately 4326 ha within the 5-km buffer around the proposed landfill site (Fig. 4-22). Pineapple plantation is the second largest land use in the area and is mostly distributed in the southern part of the proposed landfill site covering 1185 ha within 5 km buffer. Close to the pineapple plantation, is the distinct areas with shrubs or secondary plantation that covers approximately 896 ha (Fig. 4-22). Eucalyptus-grassland/shrub-grassland cover type represents areas with human settlement with small farms surrounded by the vegetation types. This area will, soon, be more opened than it is today that its role in supporting biodiversity might be impacted

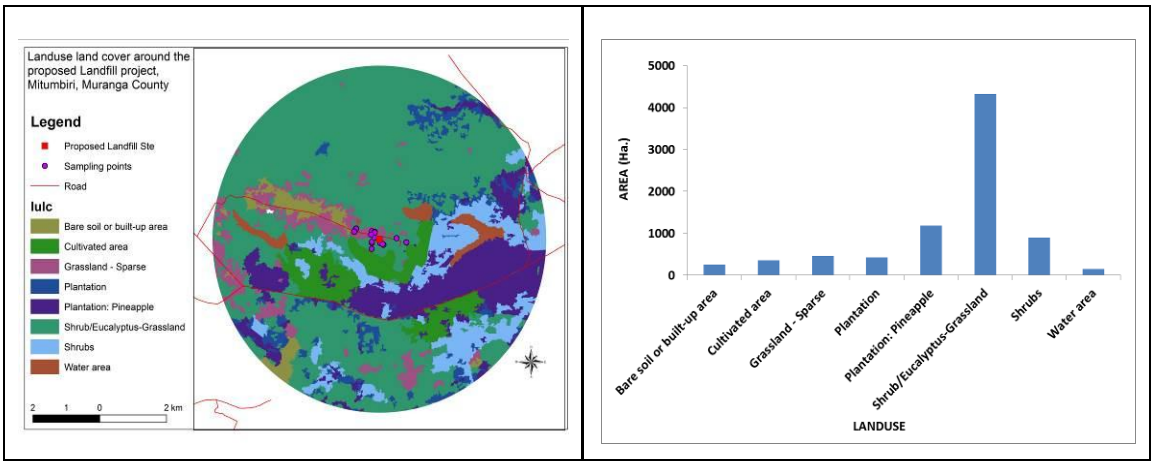

Figure 4-16: Land use types across the landscape of 5 km radius (buffer) from the proposed landfill site in Mitubiri, Murang'a County

Note:

The Landsat image for the year 2014 February was used for generating Land Use Land Cover (LULC) for the proposed landfill site and 5 km buffer in Mitubiri, Murang'a County. Unsupervised classification was used in ENVI 4.7 for automatic image processing into 8 classes. Google earth images were used for validation of features on ground due to its high resolution on the area of study.

4.6.3 The County Perspective

Murang'a County displays very dense rural settlements in which land subdivision into narrow strips of land are very common. Since most of the county consists of ridges and valleys, land parcels are mostly subdivided in such a way that each parcel has access to a road on one side and a river/stream on the opposite side. Subdivision into sizes that are not agriculturally viable is not uncommon. Some of the subdivisions do not meet the requirements for registration hence are not registered.

There is a total of 513 market centers in the county. Major shopping centers include Kahati, Kahuro, Kandara, Kangari, Kangema, Kamahuha, Kenol, Kigumo, Kiriaini, Kirwara, Makuyu, Maragua and Saba Saba. 89% of the population in the County is rural based while 11% is urban, thus making agriculture the main economic activity in the county. Under the Urban Areas and Cities Act, 2011, Murang'a town which hosts the County Headquarters has been classified as a township while other town centers have been unclassified. Previously three of the centers were classified as towns (Murang'a, Maragua and Makuyu towns) and three as urban centers (Kabati, Kangari and Kiriaini). The population of the town consists mainly of a young population with more than 50% of the people being below the age of 30 years.

4.6.4 Education Status of the People

The national literacy rate stands at 71.4 per cent where as that of Murang'a County is 70.1per cent. This implies that the literacy rate at the county is lower than the national one. In the county, the literacy level for male is 73.9per cent while for the female is 66.7per cent. This shows that literacy rate for male is higher than female.

At the national level, the net Primary school enrolment rate stands at 92.9 per cent whereas the county net Primary school enrolment rate stands at 93.85 per cent. This shows that the net Primary school enrolment at the county level is higher than at the national level. Again, at the county, net set secondary school enrolment rate is 67.2 percent for both boys and girls.

The county gross enrolment rate in primary schools stands at 97.75 per cent while the gross enrolment rate in secondary schools is 71.04 per cent. At the same time, the county transition rate from primary to secondary school is 70.6 per cent. Additionally, the primary school completion rate in the county is 97.13 per cent. This implies that 26.53 points of the primary school pupils who complete primary education do not proceed to secondary school education. This could be attributed to inadequate day secondary schools to cater for those who qualify to join secondary schools but they cannot afford boarding secondary schools.

The county has 989 pre-schools, 616 primary schools, 263 secondary schools, 48 youth polytechnics, one technical institute (Michuki Technical Institute), two colleges (Murang'a Teachers Training college and Kenya Medical Training College) and one University (Murang'a University College).

This implies most of the county population can make informed decisions on matters affecting their socio-economic livelihoods.

4.6.5 Housing

In Murang'a County, about 40 per cent of the households live in stone/brick walled houses, 24.3 per cent in mud/wood walled houses while 2.19per cent live in grass straw/tin walled houses. Most housing units in the county are roofed with corrugated iron sheets (94.38 per cent), while makuti and grass roof constitute 0.18per cent of the households. Most of these housing units have earth floor (60.04 per cent), followed by cement floor at 38.85per cent. The county has 1,924 Low Grade, 232 Middle Grade, and 184 High Grade government housing units which are not adequate for the government officers deployed in the county.

4.6.6 Energy access

The energy subsector promotes environmental friendly, sustainable and renewable sources of energy. There are 33,861households out of 255,696 households (13%) with electricity connections. A negligible number, less than 1per cent of households use solar energy. Other main sources of energy commonly used in the county are fire wood, paraffin, charcoal, LPG gas and biogas.

4.6.7 Mean Holding Size

The county has a total area of 2,558.9Km^2, of which 11.2Km^2 is water mass. The arable land is, 2,135 Km^2 while non-arable land is 163.3 Km^2. The gazetted forest covers an area of 254.4 Km^2 is Gazetted forest land while approximately 20 Km^2 is urban area.

The average farm size under large scale holdings is 16 acres. Total acreage under food crop farming is 329,234 acres while that under cash crop farming is 177,636 acres. The land under soil conservation is 33,254 acres; under farm forestry is 270,879 while area under organic farming is 385,364.5 acres.

The main land use activities in the county are: cash crop farming, subsistence farming, livestock keeping, fish farming, housing and forestry. Over 80 per cent of the households in the county depend on agriculture and related activities. The main challenges are that agricultural land is limited and the supply of farm inputs is irregular particularly for non-cash crop growers who are not members of cooperative societies. Prices of the inputs are high and the distribution not well coordinated. Shortages of inputs lead to low productivity in maize, beans, Irish potatoes and cabbages. These being the main staple food crops in the county the socio-economic welfare of the populace is affected since there is always a shortage of these commodities.

Cattle fodder is in short supply due to inadequate rainfall and also because land is scarce. Manufactured feeds for cattle and poultry are too expensive for farmers and this affects the county economy.

Murang'a County is food insecure in terms of staple food and sometimes relies on relief food supplies especially in areas at the lower side of the county like Makuyu, Kambiti, Maragua ridge, Muthithi, Gaichanjiru, Kakuzi, Ithanga and Githuuri Locations.

4.6.8 Incidence of Landlessness

Majority of the county population own land. Incidence of landlessness is approximately 0.2per cent. This is as a result of concerted efforts by the government to resettle the landless at Maranjau area in Kambiti Location of Maragua constituency.

4.6.9 Community Organizations/Non-State Actors

Majority of the county's population is organized into community self-help groups, and both producer and marketing cooperative societies. There are a number of other non-state actors operating in the county including local and international Non-Governmental Organizations whose objective is to improve the socio-economic well-being of the local people.

There are 10 active NGOs' operating in the county. Their activities are pegged on the improvement of social and economic wellbeing of the entire population of the county. The key NGOs operating in the county include: Vihda association, G.I.Z, Africa now and YARD, among others. The county has 1,832 registered self-help groups of which 676 are youth groups and 1,156 are women groups. These groups operate with a view to pooling their resources to uplift the economic and social welfare of the members.

There is lack of integration in the implementation of most programmes and projects in the county. Currently most sector programmes are planned and implemented independently leading to uncoordinated project implementation and wastage of scarce resources. In addition, the devolved funds programmes fall under different acts of parliament - e.g. the CDF Act, the Local Government Act among others - making project implementation and coordination less efficient in achieving the stated objectives.

4.6.10 Gender Issues

Gender disparities are minimal in primary and secondary education where enrolments are 50per cent for both boys and girls. Women have been discriminated against when it comes to access to ownership of property and finances. 80 per cent of women constitute the agricultural workforce but only a small percentage of them hold title deeds to land. This imposes a great constraint on their ability to make major land-related investment decisions including obtaining credit using title deeds as collateral. Young people are involved in various economic activities.The main economic activities are business (own shops), *boda boda* riding and employment in companies. The challenges faced include lack of capital to start/expand the businesses, high cost of business licenses, high interest charged on loans and discrimination by the older people in terms of age. Owing to the high levels of unemployment among the young people, the government, private sector as well as civil society organizations have drawn attention on job creation and empower the youth to earn decent livelihoods.

4.6.11 Poverty

The county has high poverty levels which according to the 2005/2006 Kenya Integrated Household Budget Survey, about 36 per cent of the population live below the poverty line. The poor are not able to access the basic necessities of life such as food, shelter and education. The food poor constitute 36 per cent of the population with the vulnerable groups that is hardest hit by poverty being women, the unemployed youth, widows and orphans, neglected retired old people, the street children and those living in the marginal areas of the county.

Poverty in the county manifests itself in many ways including inaccessibility to health services, food insecurity, inadequate potable water, lack of good and proper clothing, inaccessibility to proper education and landlessness. The main causes of poverty in the county include the poor physical infrastructure that increases the cost of accessing and marketing of agricultural produce; and low returns from coffee, tea and milk which make it difficult for most of the agricultural community to meet their basic needs. Other causes include: lack of industries; stringent collateral requirements and high interest rates by banks; high prices of farm inputs resulting in low application by farmers; collapse of the major cooperative societies and exploitation of farmers by middlemen.

4.6.12 HIV and Aids

HIV and AIDS pandemic poses a serious threat to the development of the county as the prevalence rate stands at 5.9per cent as reported by National AIDs Control Council in 2015. The scourge is on the increase virtually in all the constituencies of the county. AIDS related deaths are common and those mainly affected are those within the productive age group of 15-49 years of age. Also, the number of HIV/AIDS orphans is on the increase. HIV/AIDS in the county is also linked to peer pressure and ignorance of the youth based on age and sex distribution and commercial sex due to economic hardships.

4.6.13 Main crops

The major cash crops in the County include tea, coffee, avocado, mangoes, macadamia and horticulture crops, among others. Horticultural crops include tomatoes, cabbages, kales, spinach and French beans while food crops include maize, beans, bananas, sweet potatoes and cassava.

The acreage under food crops and cash crops are 329,234 and 177,636 respectively. The acreage under food crop is almost twice that of cash crop. Food crop farming is practised in all parts of the county but cash crop farming is practiced in upper zones and in some lower zones of the county.

The agricultural sector accounts for 57 per cent of the labor force in the county. The sector however faces numerous challenges from increasing population and sub-division of land to uneconomical sizes.

4.6.14 Average farm sizes

The average farm size for most of the county's households is 1.4 acres. As a result of this, farmers are not able to produce large quantities of crops to warrant large storage facilities at household level. Nevertheless, the average large-scale farm size is 16 acres which are commonly found in the lower parts of the county and in tea, coffee, pineapples, mangoes and flower estates.

4.6.15 Fishing activities

There are no large water masses in the county and therefore fishing is practiced in the farms. By 2013, there were 2,380 households practicing fish farming with 2,520 fish ponds covering an area of 714,000 m^2. The main fish species reared are Tilapia and Cat fish.

4.6.16 Main Livestock Breed

The main livestock bred in the county are cattle, pigs, goat, sheep, rabbits and chicken. Exotic cattle breeds are found in the upper parts of the county while indigenous cattle breeds are found in the lower parts of the county. Dairy and indigenous goats are spread all over the county but they thrive well in the lower parts. Pigs are of different varieties and reared all over the county due to readily available market offered by Farmers' Choice. Rabbits and chicken are reared in response to demand for white meat.

4.6.17 Environmental degradation in the county

The main environmental pollutants in the county are identified as agrochemicals from agricultural activities and factories, vehicle exhausts, quarrying activities and emissions of Green House Gases (GHGs) into the atmosphere through natural causes and human induced activities and solid wastes from markets and towns. The GHGs disrupt atmospheric balance and global warming therefore heating the earth surface.

Solid wastes include: plastic, polythene papers, glass, human waste, animal waste, organic plant matter, synthetic material, rubber and medical waste. Dumping and management of solid waste to the environment remains a major challenge for the County. Human waste disposal is a challenge in the county as it is only Murang'a Town which is served by a sewerage treatment plant.

4.6.18 Water and Sanitation

4.6.18.1 Water Resources and Quality

Murang'a County's water resources are rivers, shallow wells, springs, dams, boreholes and roof catchment. There are 10 permanent rivers, 400 shallow wells, 75 springs, 30 dams and 100 bore holes that supply water for domestic and agricultural use in the county. All these sources supply 60 per cent of the county population with clean and safe drinking water.

4.6.18.2 Water supply schemes

The county has 27 water supply schemes and about 16 irrigation schemes. Water supply schemes are managed by three different entities. There are some which are managed by the water companies, the department of water and some others are managed by the community members through water project committee. The irrigation schemes, which are managed by the community members, got funding from community own initiatives as well as government and development partners' support.

4.6.19 Solid Waste and Sanitation

Solid Waste management is the mandate of the individual counties in the Metropolitan regions and in the entire country. However, according to NEMA Kenya most counties have not prioritized the establishment of proper waste management systems and hence allocated meagre resources for its management. Additionally, the counties lack technical and institutional capacities to manage solid waste. This has led to the current poor state of waste management which includes indiscriminate dumping, uncollected waste and lack of waste segregation across the country (The National Solid Waste Management Strategy 2015).

According to UNEP/NEMA (2003) domestic solid waste contributes 68% of the total solid waste generated in towns in Kenya; while non- domestic solid waste from industrial, markets, roads & other activities contributed a combined total of about 32% of the total solid waste generated, broken down as follows; Industrial: 14 %; roads: 8 %; hospitals: 2 %; markets: 1 %; and 7 % from other sources.

A study undertaken by UN Habitat for Nairobi indicated that about 30-40% of the waste generated is not collected and less than 50% of the population is noted served. In Murang'a County, dumping and management of solid waste remains to be challenge. Human waste disposal is a challenge in the county as it is only Murang'a Town which is served by a sewerage treatment plant. Makuyu, Maragua, Kangari and Kangema Towns as well as Kiria-ini, Kahatia, Kandara, Kenol and Kigumo Markets are in dire need of solid waste management facilities (First Integrated Development Plan 2013-2030, Murang'a County). About 99.78 per cent of the households use toilet facilities. Out of these, 4.97 per cent use flush toilets, 3.97 per cent use VIP latrines and the others use ordinary pit latrines. The majority of people living in the market and trading centres use ordinary pit latrines.

4.6.20 Health Access And Nutrition

4.6.20.1 Health Access

The County has 272 health facilities serving a population of 959,701. It has three level five hospitals, three mission/private hospitals and three nursing homes. There are 21 health centers (public and private), 114 dispensaries (89 public and 25 mission/NGO) and 137 private clinics.

The County has 464 medical personnel working in government health facilities with 312 nurses, 23 doctors, 41 clinical officers, 50 public health officers and 38 laboratory technicians and technologists among others medical personnel and health facilities in the county are inadequate.

CHAPTER FIVE

5 ANALYSIS OF ALTERNATIVES

5.1 Overview

This section reviews alternatives considered during planning of the project, and gives the basis as to why the proposed project has been selected, including any environmental and social considerations. The aim of this analysis is to establish whether there are reasonable alternatives which could be pursued which meet the project's objectives with less impact on the environment, and if there are, to explain what other factors determined the choice of proposal.

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.

In respect to the Proposed Project, a number of types of alternatives can be considered:

5.2 Solid waste management and treatment alternatives

The overall aim for solid waste management is protection of human health and the environment in a manner that is affordable, environmentally friendly and socially acceptable. To achieve this adoption of the principle of integrated solid waste management is recommended.

The solid waste management hierarchy is an integrated approach to protecting and conserving the environment through implementation of various approaches of sustainable waste management as shown in figure 5-1. It establishes the preferred order of solid waste management alternatives as follows: waste reduction, reuse, recycling, resource recovery, incineration, and land filling as the last option.

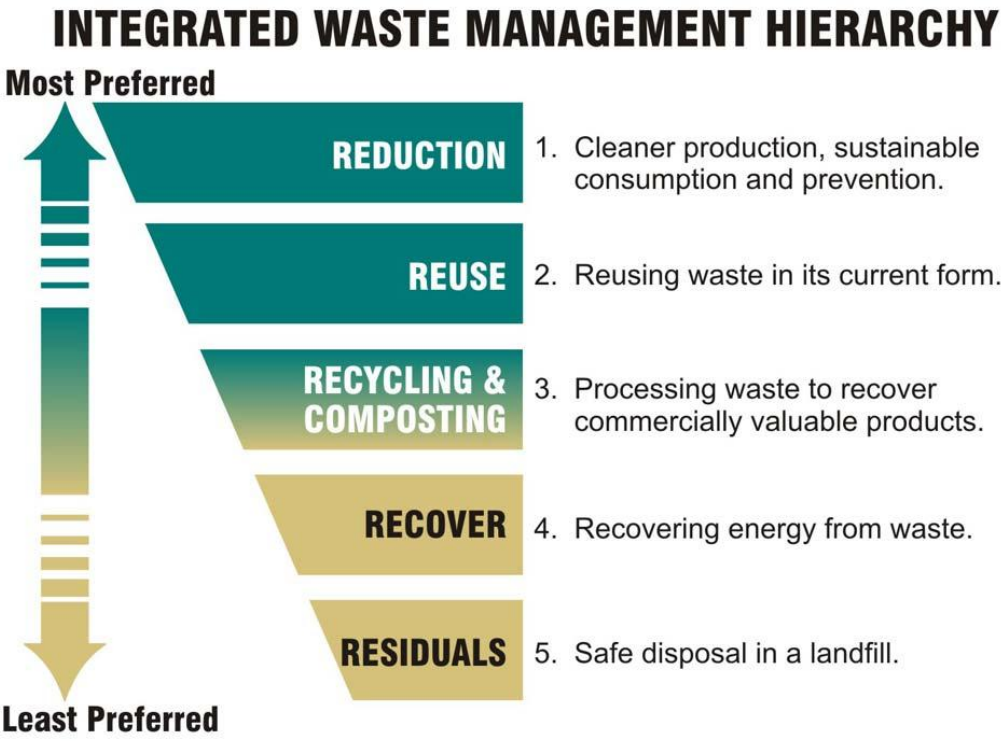

Figure 5-1: Integrated Waste Management Hierarchy

5.2.1 Waste avoidance and reduction

Waste avoidance and reduction is the foundation of the waste hierarchy and is the preferred choice for waste management measures. The aim of waste avoidance and reduction is to achieve waste minimization and therefore reduce the amount of waste entering the waste stream. The aim of waste avoidance and reduction is to achieve waste minimization and therefore reduce the amount of waste entering the waste stream. However, waste minimization programs are not possible to envisage zero waste generation in the foreseeable future.

5.2.2 Recovery, re-use and recycling

Recovery, re-use and recycling comprise the second step in the waste hierarchy. Recovery, reuse and recycling are very different physical processes, but have the same aim of reclaiming material from the waste stream and reducing the volume of waste generated that moves down the waste hierarchy. Recycling prevents wastage of potentially useful materials, reduces the consumption of fresh raw materials and energy usage in addition to reducing pollution. This can only reduce the amount of waste being disposed and with the increase in urbanization and industrialization the quantities of waste requiring final disposal will increase substantially over the next years and the quantity of additional waste generated will outstrip the rate at which recyclable materials are recovered.

5.2.3 Disposal

Disposal is any operation that involves the dumping and incineration of waste without energy recovery. Before final disposal, a considerable amount of pretreatment may be necessary to change the characteristics of the waste in order to reduce the quantity or harmfulness of the waste. Engineered landfills are the safest form of waste disposal but the least preferred option in the waste hierarchy. It is only recommended when other alternatives have been exhausted or are not practicable or applicable.

5.2.4 Treatment

A range of treatment technologies have been developed to extract value from waste and minimize the quantities of waste that are delivered for final disposal. Commercially-proven technologies include composting, anaerobic digestion/bio-gas and waste to energy, including incineration.

5.2.4.1 Composting

Composting is the biological decomposition of biodegradable solid waste under controlled aerobic conditions to produce compost. Compost is used as an organic fertilizer in agricultural production. It is a low capital investment and a more sustainable means. It however still requires waste size reduction and some degree of waste separation/processing and more expensive than a sanitary landfill.

5.2.4.2 Biological treatment

This is a natural process that occurs where plant and animal materials (biomass) are broken down in the presence of micro-organisms. Biological treatment of waste can either be anaerobic or aerobic. In anaerobic treatment, waste is broken down in the presence of micro-organisms and in the absence of air while in the aerobic treatment, biological degradation of organic waste take place in the presence of oxygen. Useful products are derived from these two processes mainly biogas which produces electricity and organic fertilizer.

However, MSW waste applications is limited to source separated or segregated organic materials and has a greater application experience to sewage sludge.

In this regard, the alternative solid waste treatment systems are capable of meeting the basic objective of the proposed project in a more environmentally friendly and acceptable way.

However, waste avoidance and waste minimization programs, combined with materials recovery, recycling and re-use, cannot eliminate waste in its entirety; all alternative treatment systems are limited to a portion of the waste stream and generate residues that ultimately require disposal to landfill and the costs of the alternative waste treatment are higher than for land fill.

With this regard, an engineered sanitary landfill is the most practical and feasible option for solid waste management in the metropolitan considering the delineated options.

5.2.5 Analysis of project sites alternatives and inherent factors

An analysis of different project sites was conducted at the beginning of the project and was presented in the report: "Landfill site identification"[4].

Fourteen (14) sites were identified during the initial phase and studied. Some were disqualified from further studies, as some inadequacies were revealed. From the 14 sites, nine (9) sites were analyzed and compared. Table 5-1 presents the summary of the study carried out.

Table 5-1: Summary of analysis of different project sites

No	Description of the site	County	Basis for disqualification
1	Agricultural land near Kiambu town	KIAMBU	Land ownership was not clear Ground waters seasonally high table level (i.e., 10 Year high) is at least 1.5 meters below the proposed base of any excavation or site preparation to enable landfill cell development.
2	Existing dumpsite – Thika town	KIAMBU	High soil permeability, Black Cotton Soil crack during dry season forming conduit that could form channels through which the leachate could contaminate groundwater
3	Private land near Makuyu (Kakosi)	MURANG'A	There were difficulties to establish the ownership of this land and the County representatives recommended that this site was dropped of the study
4	Public land near Megg properties	MURANG'A	This site was dropped because missing tile a settlement around it

[4]As presented in Landfill Identification Report KE517E (Seureca), June,2015

No	Description of the site	County	Basis for disqualification
5	Land near Gikono existing dumpsite	MURANG'A	The site was rejected because it was opposed by Murang'a county
6	Quarry near Gikono (belongs to Urithi Sacco)	MURANG'A	Unavailability of land
7	Ruai	NAIROBI	This site was dropped because it had land dispute ownership
8	Dedicated site in Machakos new town	MACHAKOS	The site was dropped because high permeability
9	Mitubiri Wempa/BLOCK 1	MURANG'A	This site was selected because it met the minimum requirements discussed in section 2.5
10	Makutano Farm	MURANG'A	Makutano Farm, was dropped because it was sold off to other interested party
11	Ichagaki area	MURANG'A	The site was dropped because it was close to human settlement
12	Near Ngong town	KADJIADO	Site Near Ngong Town, was dropped because no response was given by Kajiado county
13	Kay quarry in Mavoko	MACHAKOS	Kay Quarry located near the Kay quarry, which is near Mlolongo, in the Machakos County, was dropped because it was too close to JKIA (Jomo Kenyatta International Airport)
14	Matuu site	MACHAKOS	This site was dropped because of missing information

The sites have been evaluated considering the main criteria (as discussed in section 2.7. Site selection) for landfill implementation and also presented in the landfill identification report. This evaluation recommended the site of Murang'a as the best option for landfill implementation

5.2.6 Zero or No Project Alternative

The No Project option in respect to the proposed project implies that the status quo is maintained including the current waste disposal practices. Current waste disposal practice in open unmanaged and unsecured dumpsites poses a high potential for environmental impacts including contamination of groundwater resources through uncontrolled discharge of leachate and air pollution as a result of methane which is also ozone depleting.

Burning of waste in uncontrolled dumpsite also generate emission of particulates that also contain toxic substances. Additionally, the communities and residents living near the open dumpsites are impacted by bad odor generated by decomposing waste which also attracts vectors like rodents and flies. There is also limited control over illegal dumping. The No Project Option is the least preferred 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. Thus, from the analysis above, it becomes apparent that the No Project alternative is no alternative to the local people, Kenyans, and the Government of Kenya.

5.2.7 Public Relocation/Loss of Land

The land for the proposed project is privately owned and registered. The land has been identified and will be acquired as per the land Act (Cap 295).

The national government owns the land where the proposed landfill will be constructed while the Murang'a County Government will manage the landfill. No person will be relocated to pave way for the project as the proposed site unoccupied. Additionally, the project will ensure that its activities, to the extent possible, avoid the natural and socio-economic environment.

5.2.8 Analysis of landfill waste treatment and disposal technology alternatives

5.2.8.1 Leachate treatment and disposal

Potential methods for leachate treatment reviewed in the feasibility study include:

Recirculation of leachate through the landfill

This leachate treatment method involves the recirculation of collected leachate back through the landfill to encourage more decomposition of some of the soluble organic compounds by the bacteria present in the landfill.

Other than through evaporation and use of absorptive capacity of the landfill waste, this method does not reduce leachate volume for disposal. The technology is expensive

Disposal off-site to sewer for treatment as an admixture with domestic sewage and physical chemical treatment

This technology involves transfer of leachate as an admixture to an existing domestic sewage and physical chemical treatment Plant. The nearest sewerage treatment plant is located In Thika town. This method can be preferred for its easy maintenance and low operating costs. However, it requires agreement between Murang'a and Kiambu Counties.

Membrane filtration

A membrane is a thin layer of semi-permeable material that separates substances when a driving force is applied across the membrane. Membrane processes are increasingly used for removal of bacteria, microorganisms, particulates, and natural organic material, which can impart color, tastes, and odors to water and react with disinfectants to form disinfection byproducts. This technology is characterized by high capital and maintenance costs.

Reverse osmosis

Reverse osmosis effectively removes natural organic substances, pesticides, cysts, bacteria and viruses. Refers Osmosis is particularly effective when used in series with multiple units. However, the technology suffers from high capital and operating costs. The membranes also are prone fouling and thereby reducing their effectiveness

Aerobic biological treatment

Aerobic treatment allows reducing organic pollutants and is able to accomplish nitrification processes. It exhibits rapid removal kinetics, low sensitivity for the presence of toxic substances and considerable efficiency in ammonia stripping. As disadvantages, there is a remarkable production of excess sludge and great energy costs due to the high amount of oxygen required.

Anaerobic biological treatment

Anaerobic and anoxic processes are based on the activity of microorganisms able to break down organic matter within the environment with no dissolved oxygen. Notwithstanding the several benefits of the anaerobic treatment, the application processes are limited, mainly due to the low growth rate of anaerobic microorganisms. These processes do not require aeration systems, and thus treatment costs are contained, also allowing energy recovery by biogas collection and exploitation.

Constructed wetlands

Constructed wetlands for leachate treatment involve the use of engineered systems that are designed and constructed in order to use natural processes. Indeed, these systems are designed to mimic natural wetland systems, utilizing wetland plants, soil, and associated microorganisms to remove contaminants from wastewater effluents. In tropical regions Construed wetlands should achieve not only pollutant removal but also landfill leachate volume-saving, reducing environmental pollution and preventing the uncontrollable dispersion of polluted leachate So, the potential for the application of wetland technology in developing countries is enormous as most of the emerging cities worldwide have warm tropical and subtropical climates that are conducive for higher biological activity and productivity. Furthermore, tropical and subtropical regions are known to sustain a rich diversity of biota that may be used in wetlands, guaranteeing a better performance of wetland systems.

5.2.8.2 Conclusion

The project feasibility study proposed leachate recirculation, off-site disposal of leachate in waste water treatment and on-site reverse osmosis as the best possible solutions. However, due to high technology, high cost and high operation / maintenance system associated with reverse osmosis plant, the project settled on anaerobic/aerobic system combined with conventional wastewater ponds.

5.2.9 Land fill gas collection and disposal alternatives

5.2.9.1 LFG- Waste to energy

Using the landfill gas in electricity generation typically requires more in-depth treatment. Treatment systems are divided into primary and secondary treatment processing. Primary processing systems remove moisture and particulates. Gas cooling and compression are common in primary processing. Secondary treatment systems employ multiple cleanup processes, physical and chemical, depending on the specifications of the end use. Based on the feasibility study further studies can be conducted to ascertain viability of this alternative

5.2.9.2 LFG- Capture and bottle

In anaerobic conditions, as is typical of landfills, methane and CO2 are produced in a ratio of 60:40. Methane (CH4) is the important component of landfill gas as it has a calorific value. This gas can be captured, processed and bottled to serve local market in the LPG. Viability of the proposal depends on the volume produced and capacity in terms of resources of the proponent to utilize this technology. However, the proponent can conduct further studies to evaluate viability of this alternative.

5.2.9.3 Capture and flaring

Landfill gas can also be extracted through horizontal trenches instead of vertical wells. Both systems are effective at collecting. Landfill gas is extracted and piped to a main collection header, where it is sent to be treated or flared. If gas extraction rates do not warrant direct use or electricity generation or any other alternative use, the gas can be flared off.

5.2.9.4 Conclusion

Based on the feasibility studies alternative proposed is simple and inexpensive. It consists of an enclosed flare that encloses the flame in an insulated cylindrical shroud. Shrouded landfill gas flares have exit temperatures of around 760°C or 14000 °F – well above the carbon formation range (which ends around 400°C or 752°F). Maintenance is limited and monitoring may be automated. However, flaring provides no opportunities for energy recovery and is included in the project for safety purposes when dumping excess gas is required.

CHAPTER SIX

6 CONSULTATION AND PUBLIC PARTICIPATION

6.1 Approach to consultation and public participation

The consultation and public participation is a key component of the ESIA. The participation of various stakeholders greatly contributes to the success of any proposed project. This involves gathering environmental information, i.e. baseline data, potential impacts and mitigation measures from stakeholders to ensure a comprehensive ESIA report is produced. The objectives of consultation and public participation are to inform the affected community and the leaders about the project. The process seeks views, concerns and opinions of the community and to address impacts and mitigation of the adverse impacts. The process also enhances social aspects by finding out places of cultural or religious importance to the communities and their correlation to the proposed project.

This process also contributes to the general acceptability of the proposed project especially by the locals. Public consultation is a process within the ESIA process under EMCA Cap 387 and EIA/EA regulations, 2003 undertaken during scoping, baseline studies, impact analysis and review. This exercise encompasses all stakeholders including the interested and affected parties. The participation was mainly undertaken through questionnaires, interview sessions, public meetings, and focus group discussions with the various stakeholders.

At the project report level, reconnaissance visits were done to get an understanding of the general social and environmental issues of concern that are evident in the various sites for the proposed land fill project. This was done between 19/10/15 and 21/10/15. This was done using the RRA (rapid rural approach). A detailed field study was later conducted for the proposed landfill project between 02/10/15 to 23/12/2015. This was done to ascertain baseline conditions of the project areas and collect socio economic data from both primary and secondary stakeholders within the project areas.

In the process of developing this subsequent study report, public consultation processes for the proposed Mitubiri landfill Project was executed in three approaches, interviews and public barazas with the community and its leaders were held with their questionnaires being uniquely designed, to suit the data needs. Focus group discussions were also held with the MCAs at Utalii Hotel, Nairobi and with the County executive committee group at Kenya School of Monetary Studies.

A reconnaissance and actual site visit was held during the months of November and December 2017 respectively and additional visits were held in the Months of January, February and March

which was crowned with a public baraza on April 24th, 2018 at the Peter Kariuki (PK) Secondary School approximately 2 kilometers from the proposed project site. Due to heavy rains the roads to the proposed site were impassible, including no bridge to connect the 2 sub-locations in Wempa County Assembly Ward. For these reasons, it was resolved that Peter Kariuki Secondary was the most appropriate site for the CPP. The occasion was graced by the local politicians, national leaders, their administration, local community, religious leaders and the people affected by the project. This activity was undertaken by the ESIA Experts to collect data needed for the EIA process to be completed. Public participation included the local administration, the community and other key stakeholders at the project site. Stakeholders represented the political county assembly leaders of the wards involved, the local administrative leaders, the Chiefs, Sub Chiefs and community Representatives and project personnel. All the views of the participants are captured and analyzed to provide data for the EMSP.

6.2 Analysis of the consultation public participation process

6.2.1 Consultative forum with County Assembly members (MCA)

A consultative forum was held on 19th April 2018 at Utalii Hotel with representation of members of the Murang'a County assembly, representatives of the County Executive Committee and Ministry of Transport, Infrastructure, Housing & Urban Development generated the following views and concerns

Plate 15: Participants at a consultative forum held at Utalii hotel on 19th April 2019

Table 6-1: Concerns and views from Members of Murang'a County Assembly

Issues Raised	Responses
Socio-economic issues	
Is there a cost benefit analysis done on the project that will identify specific economic benefits of the project? For instance, we need to know the number of jobs opportunities expected to emanate directly from the project.	Theproposed project will create approximately 200 jobs for the local community
There was a request to extend the current access road to Kakangu area and rehabilitation of other routes that lead to the site.	Namsip will discuss the matter with World bank.
Can the proponent support school projects within the area and development sewerage plant within the area?	Namsip project will support other development projects within the metropolitan region
Environmental issues	
Is there a buffer zone for the landfill?	Creation of a buffer zone is a World Bank requirement and was considered in the original project design Negotiations with neighboring land owners will be done to ensure that 250m buffer zone is obtained.
What mitigation measures having been proposed to prevent underground water pollution?	The project design has put in place measures leachate and landfill gas (LFG) monitoring to avoid air, soil and water pollution.
How will the solid waste be transported given the fact that, currently, the county government is using old lorries with waste spilling off as they are transported?	Municipal waste will be transported on closed trucks based as per Solid waste management rules 2006. NaMSIP will buy equipments and machineries to manage waste during the operation.
Environmental Health issues are a potential threat posed by the landfill operations and yet there are few health facilities, which can manage potential health crisis coupled by population increase.	As part of corporate social responsibility, the proponent should support expansion of the existing health centre at Gikono. NaMSIP will look at possibility of supporting the expansion of the dispensary at Gikono area.

Issues Raised	Responses
How will the Landfill gas be handled?	LFG will be flared
Will the landfill handle liquid waste?	Mitubiri landfill will not handle liquid waste
Despite the fact there are mitigation measures in place to control odors what measures have been put in place to control escape odor.	With effective buffer zone and regular soil cover odor will be controlled. Air modeling will inform other mitigation measures to be employed
Will PPEs be provided to garbage collectors given the fact that currently the county government does not offer any PPEs to waste collectors?	During construction and operation phase a health and safety policy will be formulated to ensure workers are using personal protective equipment.

6.2.2 Consultative meeting with Wempa – Kimorori Community Project

The Wempa-Kimorori Community Development Project (WEKICODEP) had earlier written a letter to the Cabinet Secretary (CS) Ministry of Transport Infrastructure Housing and Urban Development raising concerns on the proposed Mitubiri Sanitary landfill in Murang'a and it is against this background that NaMSIP organized for consultative meeting to discuss the issues raised by the group. The meeting was held on 12th April 2018 at Ambank House. The sought clarity and explanations on the following issues;

-Environmental health issues;

-Social impacts due to influx of people

-Rationale behind choosing the proposed site

-Clarity on the proposed landfill operations and management

-Impacts of the proposed project on the Economy

Minutes for this meeting are presented under Annex 6

6.2.3 Consultative meeting with Murang'a County Executive Committee members

A consultative meeting was held on 22nd February 2018 at Kenya School Monetary Studies with the members of the Murang'a professional group with aim of addressing key concerns raised by the group. Some of the issues raised by the group included

- ✓ Project sustainability
- ✓ Lack of disclosure
- ✓ Selection criteria
- ✓ Landfill management
- ✓ Mitigation against soil, water and air pollution.

Minutes for this meeting are presented under Annex 6

6.2.4 Key information Views and concerns

The immediate neighbours (within 1Km) were consulted since they are the people affected by the proposed project. This consultation was held on 28th February 2018 at their farms near the proposed site. They raised the issues below:

Positive Impacts

- The proposed project will create employment to the community especially the youth.
- The proposed project will attract infrastructure development and hence more business opportunities for the community.
- The land value will increase due to the complementary infrastructure development like construction of the road opening up the area.
- The solid waste menace will be eradicated by proper disposal of wastes in the landfill.
- The proposed project site is away from the farms and rivers hence no interference to crops, livestock and water.

Negative Impacts

- Air pollution from the odour at the land fill site
- Water contamination from the leachate leaking underground
- Soil contamination due to seepage of the leachate into the ground

Proposed Mitigation Measures

- Lining the base of the landfill to protect percolation of the contaminants
- Plant trees to minimize the odour from the landfill reaching the community
- Fencing the site enhances security for the the community hence livestock and crops farming will not be affected

Project Misconceptions

- The compositing will be a source of manure hence the soil will be more fertile.
- Odour will cause diseases
- Fodder for the animals will be destroyed

In conclusion, mitigation measures against the negative impacts and the misconceptions have further been proposed under the ESMMP.

6.2.5 Public consultation at Peter Kariuki Secondary School on 24th April 2018

The public Baraza had in attendance 166 participants, moreover with the help of the field officers from within the project area, 155 questionnaires were administered to the local community.

The analysis of the comments and views gathered from the questionnaires are represented below.

Table 6-2: Categories of participants at the Public Meeting

Category of Participants	Total No. of participants
Community	166
Local Authority	40
Institutions	10
TOTAL (Estimates)	**216**

Proportion of the male to female is not the actual representation of the population. The actual population has 51% male and 49% female. However, with the assumption that men are the primary decision makers in Murang'a more male than female, provides a goods basis for the project to be accepted by the community. In addition, men are the heads of most households as revealed by the findings of the public participation, hence with 78 percent male representation, the overall acceptability of the project is almost guaranteed.

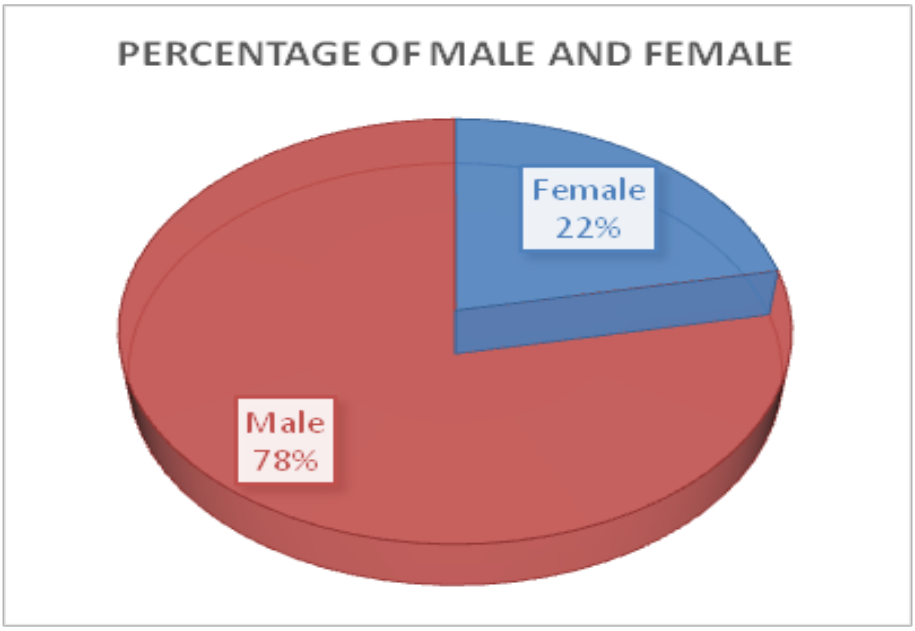

Figure 6-1: Percentage of male and female

Majority of the participants were residence of Wempa County Assembly Ward which will host the proposed project if permission is granted.

The respondents reside in various parts of Murang'a County with over 70% from Wempa County Assembly Ward (CAW) where the proposed project site is located. Another 7% are residence of Kenol while residence of other areas like Kamacharia, Makuyu, Kangangu, Nzabuka, Gaichanjiru and Sabasaba are about 7%. The percentage of male to female is significant in Wempa CAW compared to other areas. This increases the acceptability of the proposed project in the local areas considering, men are also the head of the households.

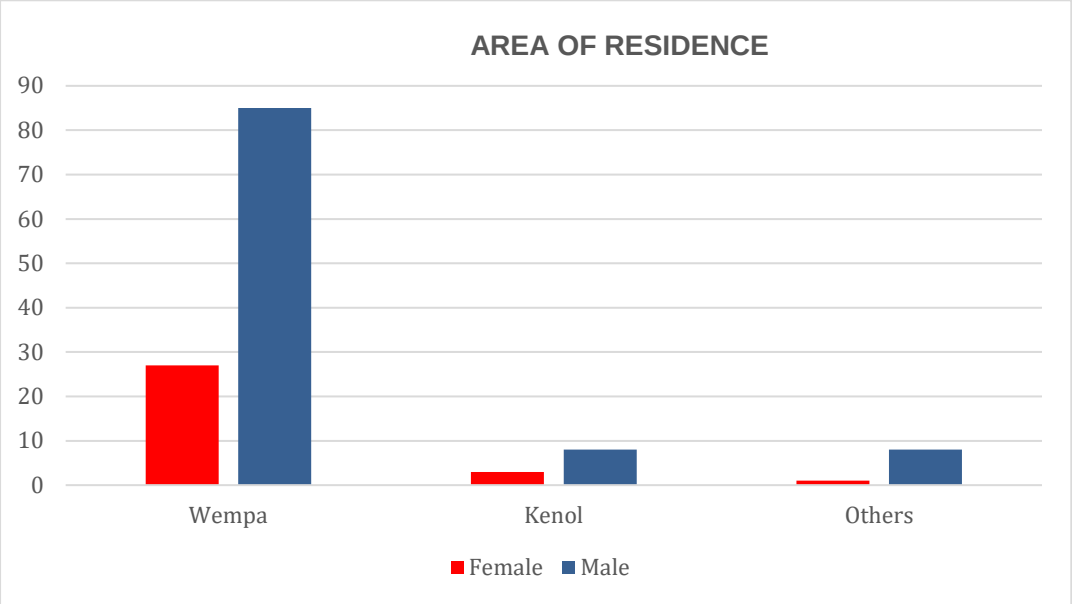

Figure 6-2: Area of Residence

6.3 Socio-Economic Activities

There is no dominant economic activity practiced in the area. However, farming and business have approximately 30% each. Closely followed by employment at 25% which implies that, the people of Murang'a are quite balanced and diverse hence the different disposal approaches and the need to unify to a more appropriate technique like the use of a landfill. Hence, NaMSIP has had the advantage of buying a portion of land from a farmer as indicated in the ESIA report. Those in formal employment have also largely contributed in educating and creating awareness to the community about the benefits and demerits the project hence increasing the acceptability of the project by the community.

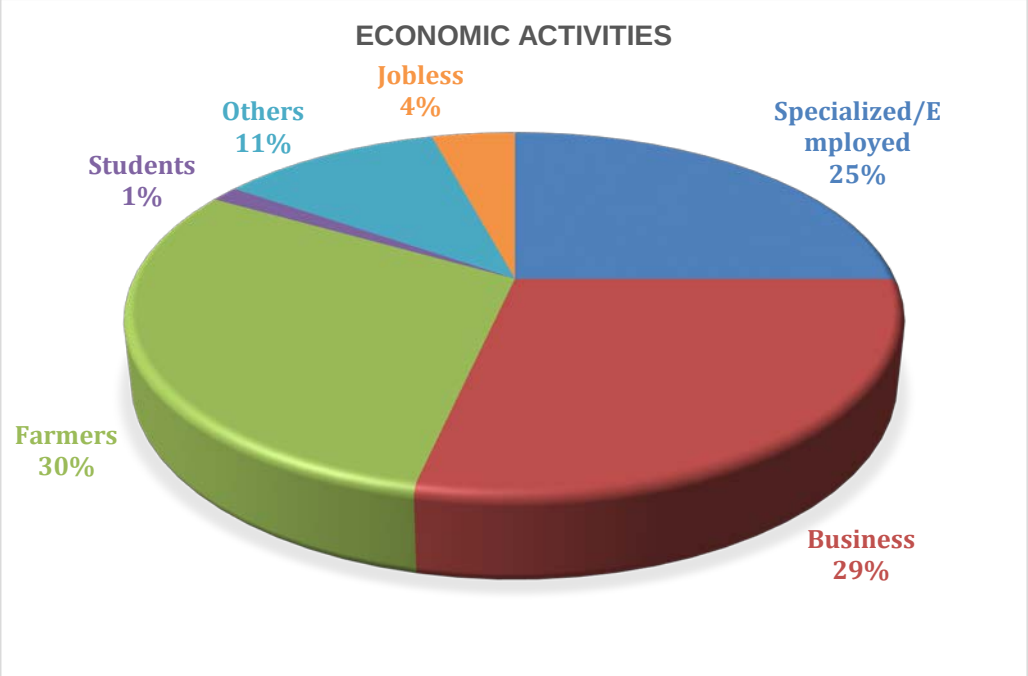

Figure 6-3: Economic Activities

6.4 Waste Management

Waste within Murang'a County is managed through various methods as indicated in below. It's quite clear that conventional approaches are common like burning, using a pit and a combination of the two. About 33% of the wastes are absolutely collected by the municipal and 35% collected by the municipal in combination with burying in the pit and burning. Murang'a County needs to expand the collection of wastes. The proposed landfill will support management of the wastes and hence improve coverage for collection.

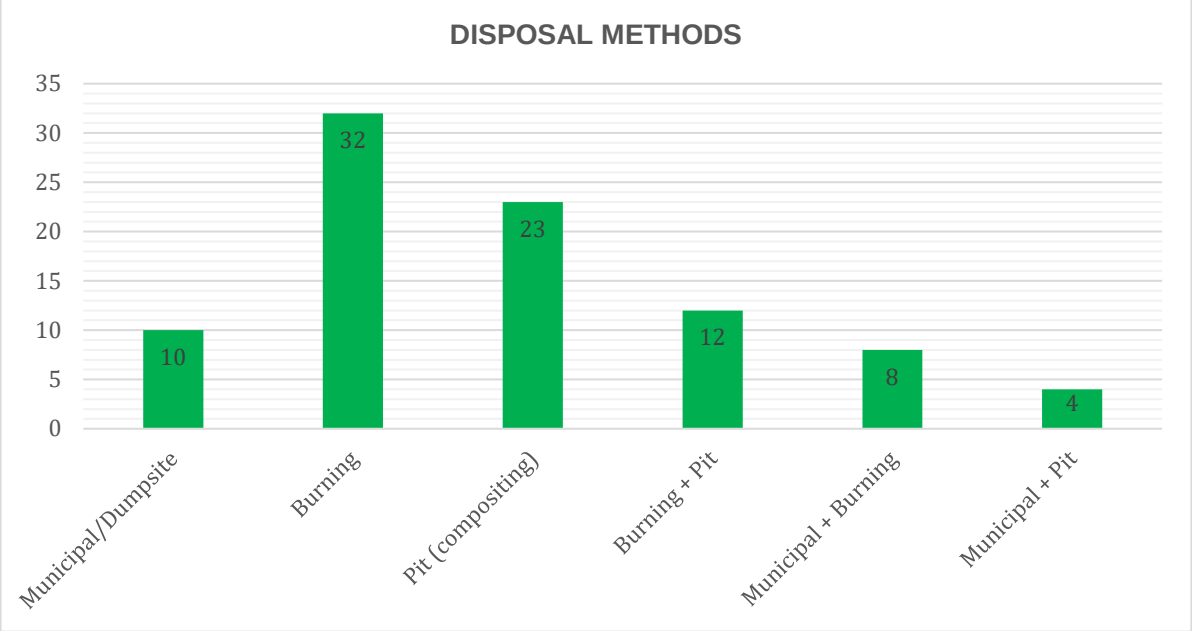

Figure 6-4:: Disposal Methods

It is also important to understand the sources of wastes to inform the waste management approaches that the people of Murang'a should embrace. As indicated by the participants, about 90% of wastes come from household wastes which are commonly the solid wastes that are disposed in the landfills. In addition, 85% of the households generate 0-5 kilograms of wastes on daily basis. This is a significant amount of waste hence proper management should be done to improve the health of the environment and the people.

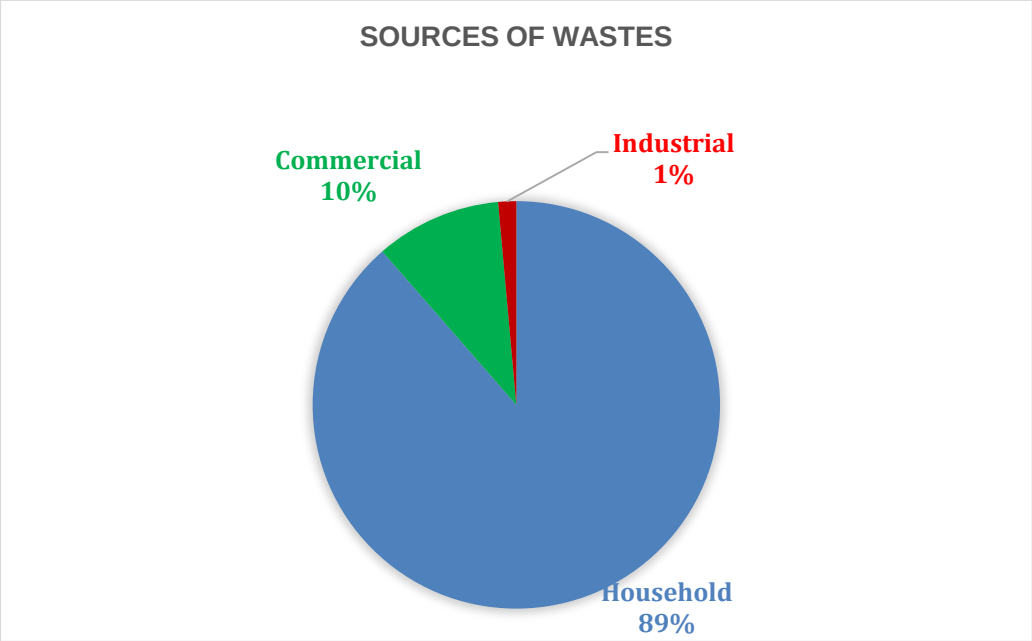

Figure 6-5: Sources of Solid Waste

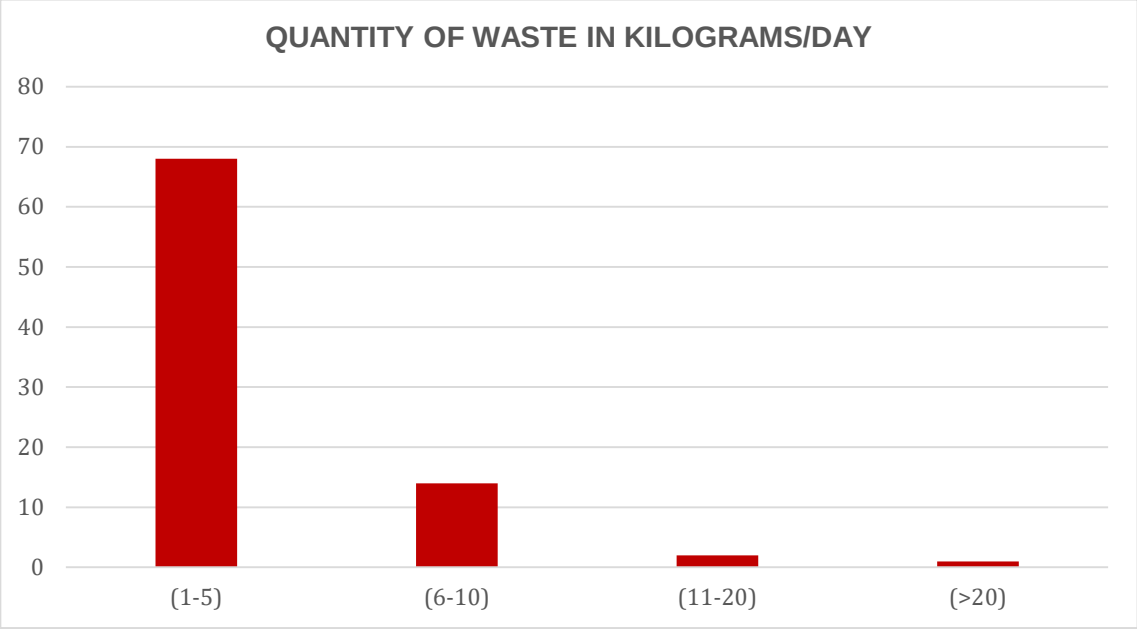

Figure 6-6: Quantity of Waste in Kilograms/Day

6.5 Anticipated Impacts and Mitigation Measures

The anticipated impacts include both positive and negative like creating employments taking the key interest of the community while loss of vegetation, water and air pollution. This will be mitigated by allowing the re-vegetating the proposed project area and lining the base and sides of the landfill. Air pollution will be managed through monitoring to ensure only permissible levels are emitted within the proposed landfill.

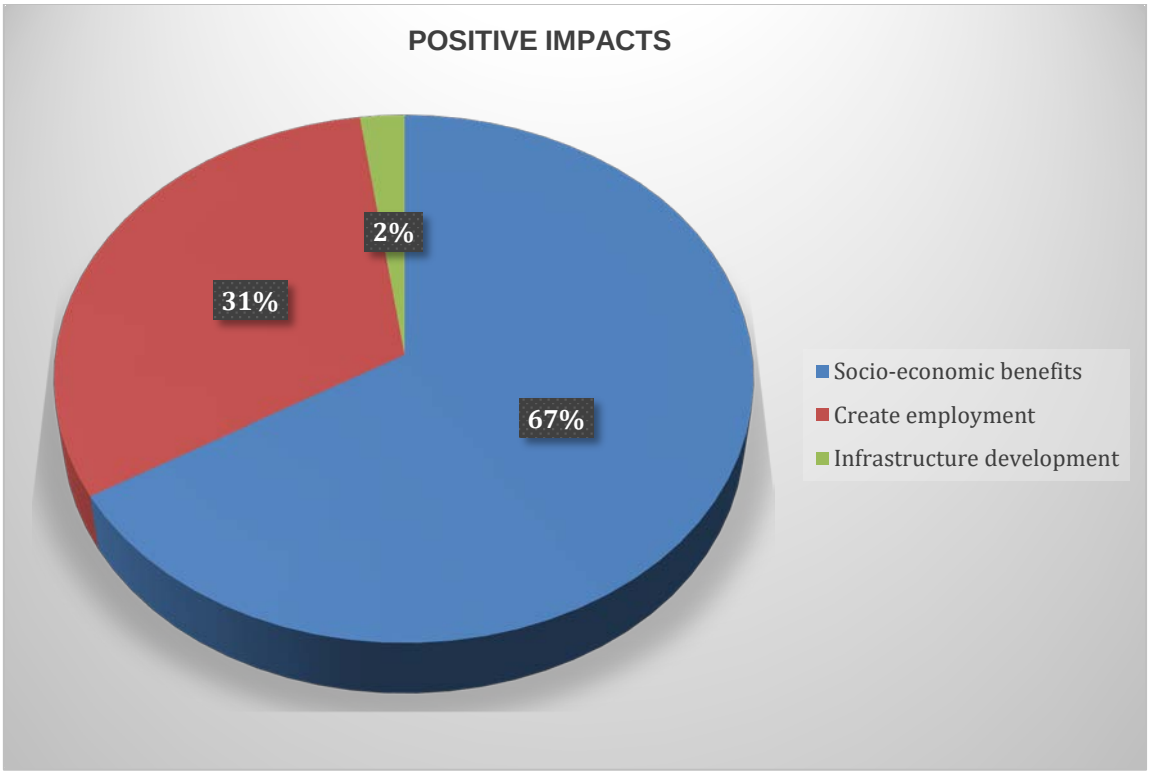

Figure 6-7: Positive Impacts

The socio-economic benefits take the lead in the positive impacts and may be assumed to be creation of employment and infrastructure development among others. The respondents were certain about the benefits that will be accrued from proposed project which increases acceptance levels.

On the other hand, the respondents anticipated air pollution either from the methane that will be released from the landfill or the odour from the waste. This implies that proper mitigation is required to ensure permissible air levels within the proposed site. Soil pollution, water contamination and loss of forest cover, flora and fauna are interrelated impacts that arise from the penetration of leachate to the ground surface. This has been well mitigated in the ESMMP in addition the respondents also suggested the lining of the landfill which is also in our report. There were negative impacts of little significance like depreciation of land value, displacement and compensation. This will also be assessed and well managed in the ESMMP.

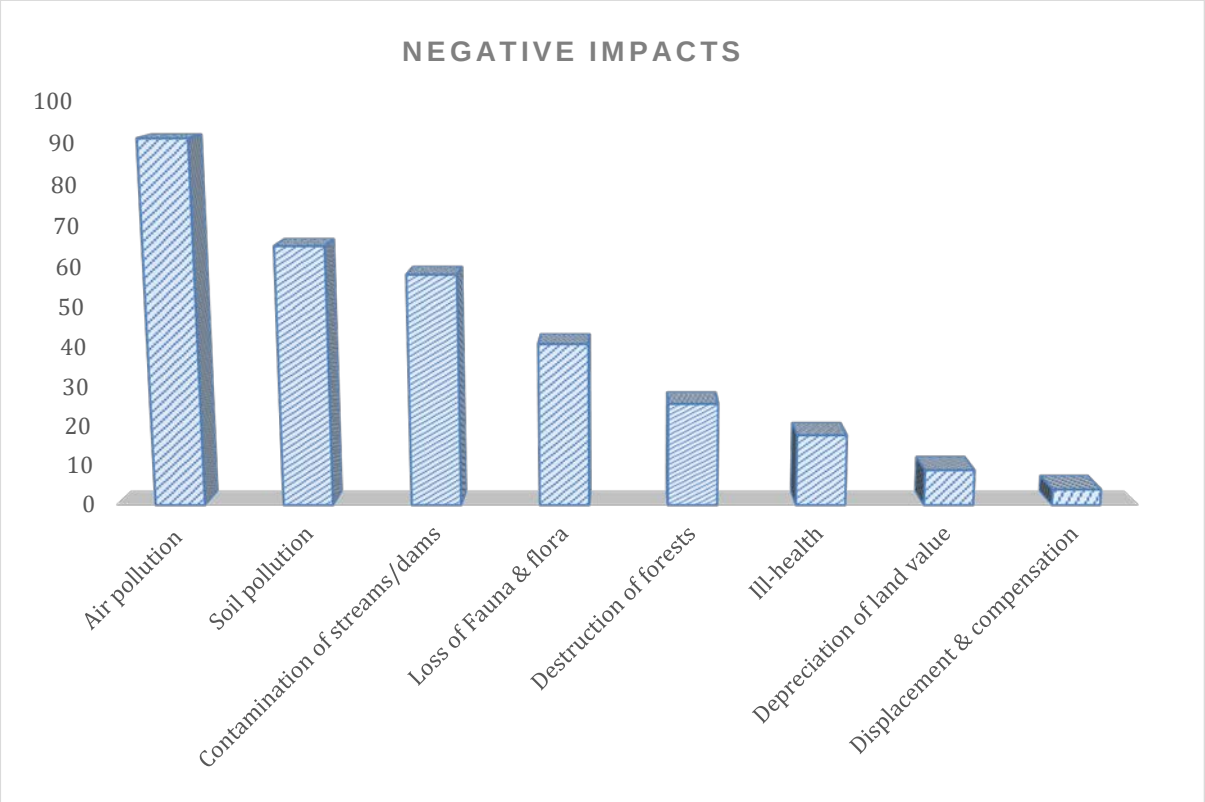

Figure 6-8: Negative Impacts

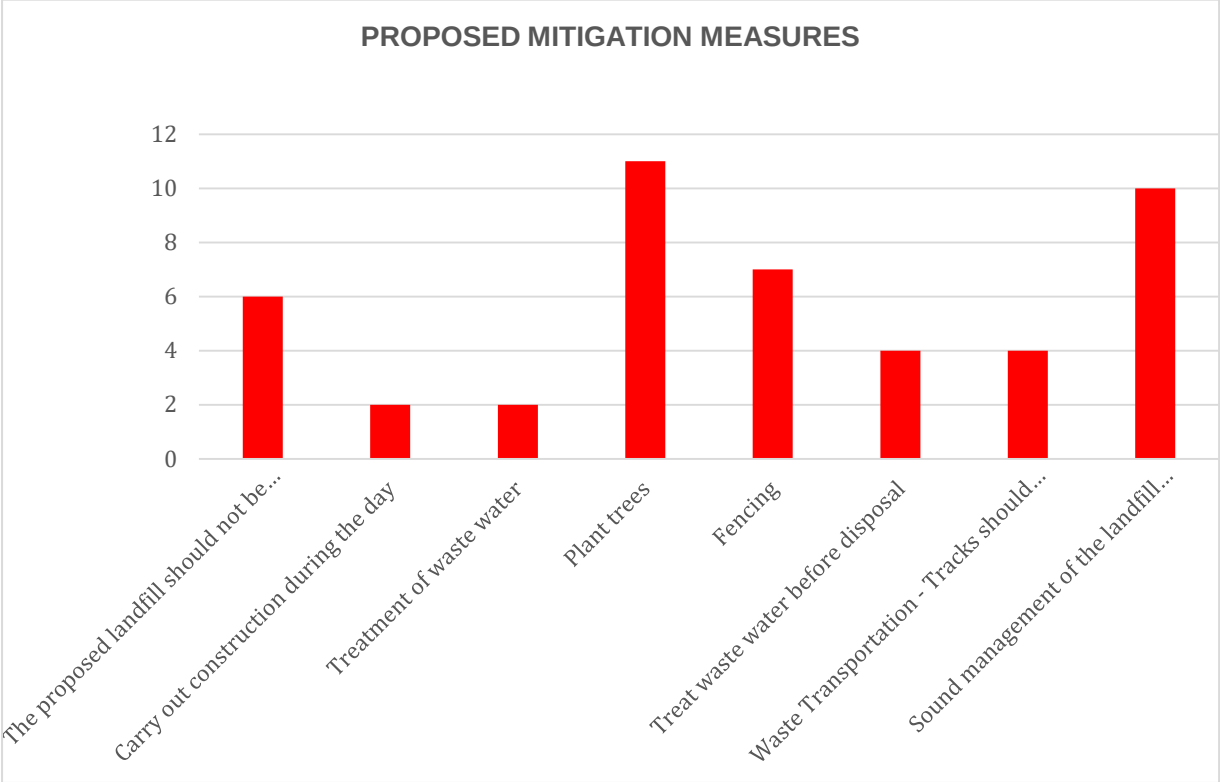

Figure 6-9: Proposed Mitigation Measures

6.6 Findings of CPP

Public consultations results indicated that the community had positive attitude towards the proposed project and approved it with minimal concerns due to the positive socio-economic impacts benefits to the people living in this area. Employment was a predominant benefit to the community with complementary activities like development of infrastructure like road upgrades, distribution of water and collection of solid wastes from individual homes and businesses. There were insignificant environmental impacts due especially in the operation phase like soil and air pollution, contamination of water resources and the mitigation measures were proposed by the participants. The participants need more sensitization for better understanding of the mitigation measures.

6.7 Proposed Mitigation Measures from CPP

Proposed mitigation included, planting of trees, fencing the landfill and having sound landfill management. These were high in priority and they have also been captured in the ESMMP. Relocation of the landfill to an inhabited area, treatment of waste water, covering the waste trucks and construction to be undertaken during the day were also proposed as mitigation measures and the ESMMP has captured practical suggestions.

6.8 Conclusion of CPP

The proponent intends to implement the proposed landfill project while applying the mitigation measures in the most practicable way. In conclusion, the participants had no significant opposition to the development and did not foresee it as a major threat to their environment and livelihoods. They recommend approval by NEMA subject to sound and sustainable environmental and socio-economic management.

CPP report, questionnaires, minutes and reports of consultative meetings are presented under Annex 6 of this report.

CHAPTER SEVEN

7 ENVIRONMENTAL AND SOCIAL IMPACTS ASSESSMENT AND MITIGATION MEASURES

7.1 Introduction

This chapter presents assessment of the potential impacts of the proposed Construction of Sanitary land fill. Impact assessment seeks to establish the potential environmental and socio-economic effects of the Proposed Development and assess these effects against the current baseline. The effects of the Proposed Development are considered at defined spatial levels according to the nature of the effect considered.

This ESIA uses a systematic, evidence-based approach in order to evaluate and interpret the potential impacts of sanitary land-filling 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."*

7.2 Basis of Assessment

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 Four: Policy and Institutional Framework.

7.3 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 method. 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.

7.4 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 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.

7.5.1 Severity and enhancement

The severity or enhancement of each potential impact has been rated using the following criteria:

Table 7-1: 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. Ecosystems 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 7-2: *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	Inconvenience but with no consequence on long-term livelihoods, culture, quality of life, resources, infrastructure	Event resulting in annoyance, minor injury or illness that does not require hospitalization

Severity	Duration	Extent	Ability to Adapt	Socio-cultural Outcome	Health Outcome
			of life and health.	and services.	
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
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 7-3: 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	Direct benefits to species or resources will provide significant opportunities for	Benefits will pertain to species, habitats and natural resources that are degraded, or are sensitive, rare, or

Severity/Enhancement	Duration	Extent	Degree of Change	Focus/sensitivity
		habitat, e.g., regional corridor)	sustainability.	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 7-4: 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	Benefits will pertain to vulnerable groups and those that would have otherwise have been 'losers' as a result of the

Severity/Enhancement	Duration	Extent	Degree of Change	Focus/sensitivity
			secondary benefits and significantly improving livelihoods for themselves and others	Project.
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.

7.5.2 Likelihood Criteria

Likelihood of the event occurring is comprised of the following categories:

- Low likelihood – Rare (e.g., few or no occurrences in Project-related to water dam);
- Medium likelihood – Uncommon (e.g., documented occurrences in Project-related to water dam);

- High likelihood – Common (e.g., occurs with implementation of water dam).
- Below are the levels of significance assigned to predicted impacts of the proposed project:
- Positive Impacts- results in benefits to the resource or receptors;
- Negligible Impacts- the receptor or resource will not be affected in any way or the predicted effect is indistinguishable from natural background variations
- Minor Impact- one where effect will be experienced, but the impact magnitude is sufficiently small either with or without mitigation; and well within accepted standards, and/or the receptor is of low sensitivity/value
- Moderate Impacts- one within accepted limits and standards. They may cover a broad range, from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit.
- Major Impact- one where accepted limits and standards may be exceeded or large magnitude impact occur to highly valued or sensitive resource/receptor.

7.5.3 Positive environmental impacts of the proposed landfill project; General environmental quality

The proposed project will ensure proper solid waste management within the metropolitan region and mitigate exposure of the environment and humans to the detrimental effects of solid wastes currently disposed in open dumpsites by containing and isolating waste. The project will offer employment opportunities throughout the project cycle and improve public health through improved waste disposal

7.5.4 Negative Impact Assessment and analysis and mitigation

Sanitary land filling of waste can pose adverse negative impacts to the environmental resources if not properly planned, designed, constructed and operated to meet the intended objectives. Major adverse impacts of solid waste landfilling are discussed below:

7.6 Impacts and Mitigation Measures

7.6.1 Ambient Air Quality impacts

Construction Phase

The construction activities are anticipated to result in increase in generation of short-term fugitive dust and combustion emissions. The primary sources of fugitive emissions will include construction activities especially stripping/clearing of vegetation, grading and excavation; and increased traffic on unpaved roads.

The amount of dust generated will depend on construction activities, soil type, and moisture content, and wind speed, frequency of precipitation, vehicle traffic, vehicle type, and roadway characteristics. Fugitive dust will be greater during drier period in areas of fine textured soils.

The sources of combustion emissions (e.g., SO_2, NOx, CO, and particulates) will be mainly operations of diesel powered construction equipment: excavator, wheel loader, trucks, motor grader and compactor.

Operation Phase

During the operation phase, air quality impacts are anticipated combustion gases (carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NOx) and volatile organic compounds (VOCs) to be generated mainly by garbage delivery trucks. Dust generation will be minimal since the access road to landfill will be tarmacked. The impact on dust and mal oduor will impact on workers and visitors.

Mitigation measures

- Waste Minimization of dust generation by sprinkling dusty roads with water
- Choose working hours and use larger vehicles to reduce noise and air pollution levels due to traffic
- Application of daily cover soil to prevent odor emission and airborne waste
- Limiting the entry of hazardous/toxic waste
- Provision of appropriate PPEs to workers

7.6.1.1 Impacts of Landfill Gas

Landfill gas results from the decomposition of organic solid waste due to the anaerobic environment of the landfill. This would generate gases such as methane, carbon dioxide and other minor constituents including Non-Methane Organic Carbons (NMOC) or Volatile Organic Carbons (VOC), ammonia and hydrogen sulfide. Therefore, landfill gas could cause negative impacts on the environment, which include;

- Explosion due to methane build up which could find its way outside the landfill
- Ammonia, VOCs and hydrogen sulfide cause nuisance to surrounding areas
- Greenhouse gases generation e.g. methane and carbon dioxide could be added to the environment
- Acidification of the groundwater due to migration of the landfill gas through the soil. Carbonic acid is produced by the reaction between carbon dioxide in soil and ground water. Carbon dioxide is relatively dense gas that tends to move downwards
- Flaring/combustion of landfill gas causes air emissions of CO2, CO, NOx, PM and trace gases that impact the air quality in adjacent areas.

Mitigation Measures:

- Placing of gas vents and construction of the gas compression station with adequate capacity to receive the maximum flow of gas.
- Performing trials to collect the gas early during the landfill operation and before the cell is completely filled. This can significantly reduce odour impact.
- Keeping the integrity of the system by lining system and final cover of the landfill properly by ensuring adequate placing, adhering to waste filling plan, avoid overloading landfill cells and regular evacuation of leachate and gas
- Adhering to strict maintenance schedule for the degassing system should be prepared and followed by the project operator.

Monitoring Activities:

- Keep records of collected gas through the degassing system
- Measurement and analysis of ambient air quality at the landfill borders on biannual basis
- Measurement and analysis of ambient air quality at the nearest settlement
- Measurement and analysis of acidity and hardness of groundwater taken from monitoring wells

7.6.2 Noise impacts and mitigation

Construction noise

During construction, noise and vibrations is expected to be generated from such activities as the use of machinery/equipment including bulldozers, generators, tippers and the heavy trucks delivering construction materials. This contributes to increased levels of noise and vibration within the construction site and the surrounding area. Therefore, elevated noise levels within the site can affect project workers and the community within the vicinity of the project site. The impact significance is expected to be moderate.

Mitigation measures

Noise and vibration during construction will be minimized in the project site and surrounding areas with by:

- strictly adhering to designated working hours (7am to 7pm);
- sensitizing construction truck drivers and equipment operators to switch off idle engines;
- by using modern, well-maintained and regularly serviced vehicles;
- ensuring that all generators and heavy-duty equipment be insulated or placed in enclosures to minimize ambient noise levels.

Operational noise

Noise and vibrations will be generated by vehicle transporting waste on the site and along the site access road and during deposition, leveling and compaction of waste.

Mitigation measures

Significant impacts on the acoustic environment will be mitigated by:

- by using modern, well-maintained and regularly serviced vehicles;
- ensuring that all generators and heavy-duty equipment be insulated or placed in enclosures to minimize ambient noise levels and located offsite from sensitive receptors;
- ensuring that land filling operation like waste placement are well planned and scheduled

Considering the mitigation measures in place, the impact significance of noise and vibration is expected to be moderate.

7.6.3 Impact on soil, ground and surface water contamination

7.6.3.1 Impact from Leachate generation

Land fill operation generates leachates which have potential of causing soil, groundwater and surface water contamination. The impact significance is major due to the sensitive resource receptor

Landfill leachates contain dissolved constituents derived from the degradation of the disposed waste. It also may contain some suspended solids, including pathogens. Leachate and runoff from waste storage and processing areas may contain organic material (biochemical oxygen demand (BOD), phenols, nitrates, phosphorous, dissolved metals, and other contaminants (IFC, 2007). If not collected and treated, leachate can migrate from the landfill and contaminate soil, groundwater, and surface water. Hydrological model generated drainage terrains that would direct leachates from the landfill site to downstream. The nearest reservoir to the proposed site for landfill is estimated at 1.2 km by drainage channel. This would potentially be the first reservoir to be impacted by leachate migration during the operation. The potential impact of leachate on the reservoir would be felt in terms of eutrophication (nutrient loadings) and ecotoxication of heavy metals.

The feasibility designs have proposed technical solutions to ensure protection of the receptors from contamination. This includes, impermeable lower layer that prevents the leakage and infiltration of leachate from the landfill into the natural receptors, resulting in its pollution. Drainage systems that will channel leachates in a controlled manner from the cells to the treatment system have been included in the design. The design capacity did put into consideration the unfavorable rainy months.

Trench drains that will minimize the inflow of storm water into the site have been provided in the designs; this will minimize percolation of water into the cells thus minimizing the quantity of leachates generated. Ground water monitoring wells have also been installed.

Mitigation measures

The designs already proposed engineering mitigation measures for landfill to contain the leachates in the landfill (using impermeable layer of plastic material) and collect it for treatment before disposal as per Kenyan and international regulations. These measures will extremely lower the risk of leachate seepage to groundwater; it will also protect soil and surface water from leachate contamination;

Adoption of good routine operational management will 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 and rigorous program of water quality monitoring should be carried out to ensure that any impacts are identified and immediately addressed.

The adoption of the mitigation measures in the design and the ones proposed in this report (anaerobic/aerobic system combined with conventional wastewater ponds proposed in section 2.5.7 will lower the impact level to minor impact during the operation of the project.

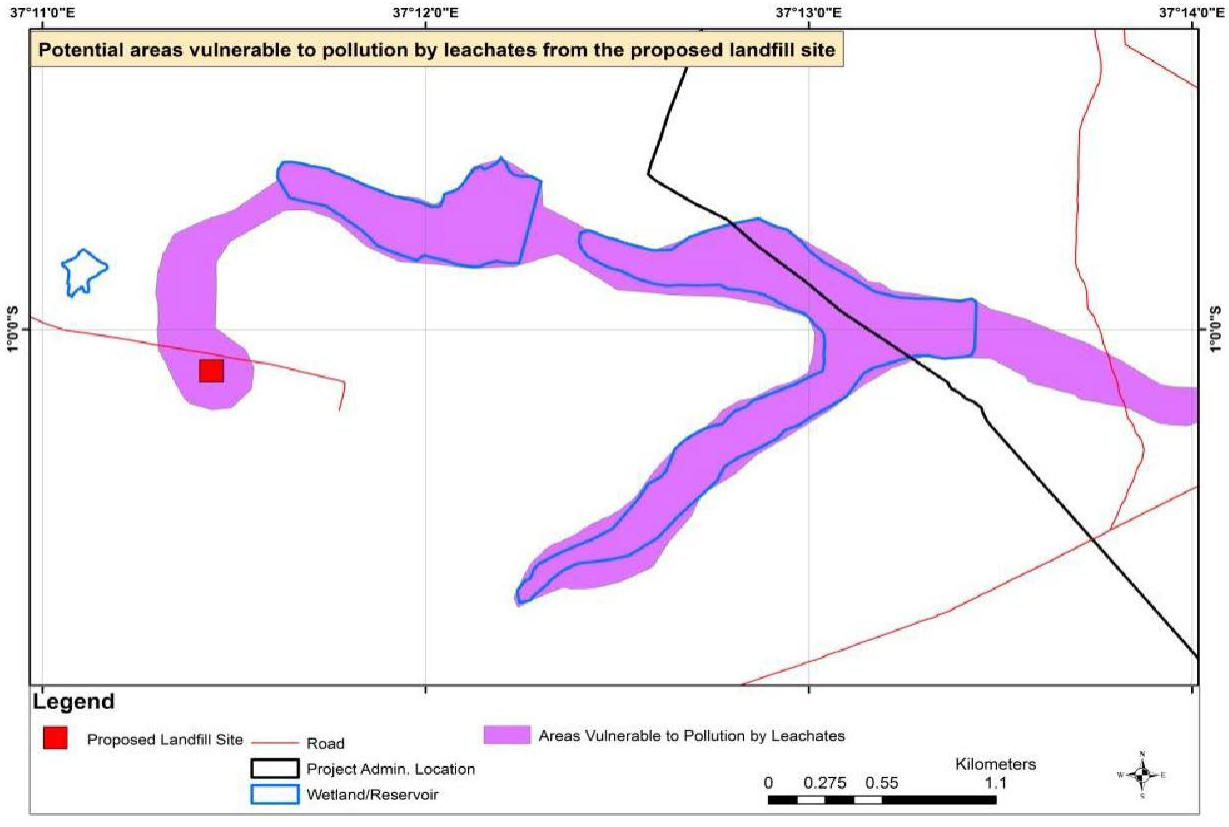

Figure 7-1: Potential receptors of leachate pollution

7.6.4 Impact of erosion and soil contamination

Movements of heavy trucks along the murram road and around the landfill area during transportation and offloading will potentially increase surface runoff from soil compaction and erosion of the soil erosion on site. Soils on site would be loosened by pressure from the wheels of the trucks as well as site clearance and excavation activities of the land fill construction and expose them for easy erosion by wind and runoff during rainy season. Soil particles eroded can be transported by local drainage system deposited some on streams and further downstream on reservoir where they are deposited as sediments. Soil heaps which are used in covering landfills can easily be eroded by runoffs when they are not protected. The impact significance of soil erosion is moderate before mitigation measures.

The heavy machinery, vehicles and equipment will require repairs and maintenance including washing. This may lead to spillage of oil during changing and repairs, generation of waste like engine filters, grease, and scrap materials may lead to soil contamination at the project site. The impact of soil contamination is moderate before mitigation measures.

Mitigation measure

The contractor will put in place measures aimed at minimizing soil erosion and soil contamination from the project site during construction. These measures will include silt traps, barriers, vegetation planting, terracing and leveling the project site to reduce run-off velocity and increase infiltration of rainwater into the soil. In addition, construction vehicles will be restricted to designated areas to avoid soil compaction within the project site, while any compacted areas will be ripped to reduce run-off. Care shall be exercised when handling fuel and oil on site to avoid spillage of such material to the ground and all machineries shall be in good working condition and well maintained to avoid any leakages. The impact significance after the mitigation measures will be minor

7.6.5 Impact on ecology and mitigation measures

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.

7.6.5.1 Impacts of clearing vegetation and excavation on ecological habitat

This will lead to potential loss of ecological habitats. The main habitats occurring across the landscape will be affected adversely by excavation activity during construction process.

These include the grassland, bushes and wetlands distributed within the project footprint. Wetland, especially serve a very important role in the area due to water provision to the wildlife and is used by seed eating birds for foraging more importantly during dry season. Once the project is implemented, habitats for grass and bush dependent species will be highly fragmented. Thus, the construction of the proposed landfill will impact the existing habitats. The impact significance before mitigation measures on ecological habitat is major.

Mitigation measures

One of the wetland habitat served by a spring to the east of the proposed project site should be preserved. This will ensure wildlife population that will be fragmented across the landscape get water during dry season. Areas with grass or bushes should be protected within a radius of 3km from the proposed project sites

The impact significance after the mitigation measure will be moderate.

7.6.5.2 Potential human-wildlife conflicts and illegal hunting of the Common Bush Duiker

The proposed site is an area that had an impact from Eucalyptus plantation but has recovered to bushed-grassland that is local fauna inhabit. Destruction of the bushed-grassland will reduce significantly a contiguous habitat that provide foraging and home to the Common Bush duiker, African Hare and passerine birds such as Quelea and others. With the reduced amount of foraging resources, the animal will adapt to the new condition by raiding crops and this would cause conflict between farmers and the wildlife. Passerine birds like the Quelea can intensively raid cereal crops severely affecting the production in the neighborhood. Common Bush Duiker and the African Hare, on the other hand, would raid on young crops for forage. In this context, there is high likelihood that farms will be raided by the animals for forage will call for killing of the animals in order to protect their crops. The conflict is envisaged to occur seasonally, especially with the seasonal migration of Quelea. While, the residential fauna would raid crop for forage but their population will be reduced by farmers after few years of operation of the project eliminated.

African Rock Python (*Python sebae*) is widespread in Africa but their population is decreasing due to reduction of their habitats and hunting for their skin. Reduced habitat for the python would increase chances of the animal raiding on the local domestic animals, which will call for its killing.

Reduction of habitat by the project and the current land use around the area would immensely reduce cover for the species in the area. Being a target for bush meat, the environment will make the species vulnerable to hunting since it will be easy to locate its hiding areas. Local decline of the Common Bush Duiker has been reported in areas where hunting has been very intensive.

From this project, it is envisaged that the species population will be affected severely by hunting at local level. The impact significance on human-wildlife conflicts and illegal hunting is rated as moderate before mitigation measures.

Mitigations measures

- Wildlife conservation and protection awareness should be raised in the neighbouring areas
- Python should be relocated to protected areas, even though it is important to note that it is not listed as threatened species in the IUCN red list. This would be done to avoid creating precedence of killing such animals without taking early measures.
- One of the wetland habitat served by a spring to the east of the proposed project site should be preserved. This will ensure wildlife population that will be fragmented across the landscape get water during dry season.
- Areas with grass or bushes should be preserved within a radius of 3km from the proposed project sites.
- Tall grasses and bushes should be preserved on part of farms around the proposed project sites.

The impact significance on human-wildlife conflicts and illegal hunting is rated as minor after mitigation measures.

7.6.5.3 Impact of leachate on eutrophication and aquatic ecotoxication in reservoir

The loading of nutrients (N & P) into reservoir would potentially trigger growth of planktonic algae that might upset oxygen demand in water. The algal blooms would in turn contribute to high load of organic matter in the reservoir that creates more demand for oxygen. Aquatic species would be affected by limited oxygen in causing death of population of fish and benthic invertebrates. This impact is however, possible only when leachates are not contained and allowed to migrate by surface into the water bodies. In a normal prescription of landfill design, leachate migration is taken care of in the design. However, when the management of the landfills is not adhered to leachate can flow with runoffs in the water bodies.

Ecotoxication in the aquatic would be caused by migration of heavy metals and hydrocarbon variables through underground seepage and surface runoffs. Heavy metals can affect fish or wetland birds by bioaccumulation in their organs. Therefore, the unmitigated impact of leachate on eutrophication and aquatic Ecotoxication in reservoirs is major before mitigation measures.

Mitigation measures

Mitigation is as earlier proposed will lower impact significance to minor impact.

7.6.6 Traffic impact and mitigation

The access road to the landfill is already under construction. The new improved road will be ready for use when the landfill operation starts. Owing to the terrain of the road, there is an opportunity to improve its drainage during construction. Trucks carrying wastes will benefit from reduced fuel consumption, which translates into economic savings for vehicle owners. Construction materials for earthwork will be sourced offsite. This will increase traffic flow along site access roads during construction from vehicles ferrying construction materials. Upon completion, there can be possibility of frequent road accidents associated with speeding on smooth roads. Haulage of waste on the road by uncovered trucks may spill wastes on the road thereby blocking drainage structures necessitating frequent repairs by the client. Additionally, waste disposal trucks will increase traffic congestion due to increased traffic flow as the proposed project will be a county sanitary landfill. The impact significance before mitigation measures is expected to be moderate impact. Due to safety concerns, noise, road grime and the increased cost of road maintenance, development of business units, and movement of trucks on local roads may create concerns among stakeholders. Increased business units such as recreational and accommodation facilities may increase the level of susceptibility to infections such as STIs including HIV and AIDs and other social ills within the project.

Mitigation measures

- The contractor during construction shall provide safe points for pedestrian and vehicular crossing at designated points with safety signage displayed at strategic points
- Proactive warning signs shall be erected in the case of traffic disruption or diversion and along access roads.
- Develop disaster management plan in partnership with county authorities
- The Proponent in partnership with government and non-state actors shall provide voluntary counseling and testing for HIV/AIDS to incoming construction personnel. He will also strengthen advocacy through awareness training in HIV/AIDS and other STIs; encourage the use of preventive measures like condoms by availing condom dispensers to project staff and visitors. Communication materials on HIV and Aids management shall be displayed strategically within the project area
- All relevant national legislation, including the OSHA 2007 and related regulations, shall be adhered to ensure that health and safety of proximate communities and the public at large are not threatened during construction and operational phases of the Project.
- The Proponent shall rollout and implement a documented emergency response plan.
- The Contractor shall respect the property and rights of neighbouring landowners and occupiers at all times and shall treat all persons with deliberate courtesy.
- The proponent should liaise with government authorities to ensure that new business units do not encroach on the road reserve

- The contractor shall prevent littering and the random discard of any solid waste on or around the construction site
- Design of the site layout to ensure that trafficked areas, such as the location of parking, the entrance gate and the weighbridge, are away from dangerous areas. The layout will also ensure smooth flow of traffic within the project
- Any particularly dangerous areas, such as disposal areas for leachate ponds, should have signs to indicate the danger posed.

7.6.7 Public health and safety impacts and mitigation measures

Odors from leachate and other decaying waste material are produced at sanitary landfills, particularly when waste high in organic material is disposed, however, it is possible and quite feasible to prevent odors from being a problem to workers and downwind to neighbouring residents. The facility may create some dust resulting from vehicle movements especially during the dry seasons. However, there is provision for dust suppression in the design and operating plan. This involves the gravel surfacing of the access road and service roads within the site, as well as using water to suppress dust that does arise.

The sanitary landfill also has potential to impact on public's and workforce health and safety. Most potential impacts are associated with the disposal sites. Impacts that may arise due to transfer and transportation of waste may be managed by worker health and safety procedures, which will apply to workers on all aspects of the project. These impacts include:

- exposure to toxic chemicals through air, water and soil;
- exposure to infection and biological contaminants;
- stress related to odor, noise, vermin and visual amenity;
- exposure to risk of fires, explosions, subsidence, spills and accidents;
- increased incidence of respiratory ailments caused by transport emissions and smoke;
- vermin attracted to the site (birds, rodents and insects) can act as disease vectors;
- Contamination of drinking water by leachate which can cause severe damage in a variety of ways depending on the nature of the contaminant.
- Exposure to risks to workers if municipal waste is mixed with hazardous waste especially if they come into direct contact with the waste,
- Exposure to road accidents due to increased traffic flow to the area

7.6.7.1 The impact significance of the project on public health and safety is major impact before mitigation measures.

Mitigation measures

The operational practices that are proposed by the conceptual design to minimize the potential risks for human health as a result of the sanitary landfill include the following:

- Applying adequate cover material sufficiently, frequently and effectively. There shall be ample supply of soil (clay, silt, sand and mixtures thereof) existing on the site, which can be used as cover material. The methods for applying daily cover, intermediate cover (when an individual cell is non-active for a period of time), and final cover (when the cell or landfill is permanently closed) will help in reducing obnoxious odors.
- Additionally, it is recommended that the active face (area of uncovered wastes placed during the daily operation) of the landfill at any given time be minimized.
- Provision of relevant and effective PPEs to workers likely to be exposed to occupational hazards
- Strict control over entry and exit to the site;
- Control of vermin, insects and birds by compaction of deposited waste and use of daily cover;
- Control of vermin, insects and birds by adoption of cellular filling practices;
- Ensuring protective clothing is worn by personnel when working on-site;
- Provision of first aid facilities; and
- Periodical health checks for personnel.
- proper safety and precautionary procedures need to be followed including training and awareness creation;
- Programs for workers on safe waste handling and hazards protection measures, provision of adequate water and soaps for bathing and adequate bathrooms to enable them day to day bathing after work;
- Reduce traffic accidents by placing road signage and control access roads and maintaining roads;

7.6.8 Fire safety impacts and mitigation

Landfill fires can cause significant impacts on local air quality through odour and smoke. They can also spread outside the landfill, triggering a grass or bushfire. Subterranean landfill fires may burn for many years before they are detected. The smell of smoke or the presence of carbon monoxide in the landfill gas may be the first sign that a landfill is burning and, in some cases, the surface of the landfill may collapse as a result of the fire creating a subsurface cavity. Once started, landfill fires are difficult to extinguish, so the primary objective should be to prevent a fire from starting.

In case of deep-seated fires, key elements will be to minimize oxygen ingress to the fire by capping off the area and surcharging the area with claylike material.

Mitigation measures

- ✓ Open fire should not be allowed in the landfill.
- ✓ Equipment to extinguish a fire shall be readily available at any time to enable a prompt response to any part of the premises.
- ✓ From the project designs, water supply from a dam has been provided for specifically for prompt firefighting on-site.
- ✓ There will be no storage of flammable substances and fuels nor servicing of vehicles and equipment at the Landfill Facility
- ✓ The proponent will develop an elaborate fire management plan in conjunction the Murang'a fire department in order to enhance their capacity to respond to fire incidences. The fire management plan shall include programs for carrying out fire drills, statutory fire safety trainings, developing and reviewing evacuation procedures, fire policy and audits.

7.6.9 Cumulative and residual impacts

Landfills have minimal residual effects during operation phase. However, the long-term measurable effect of landfills is a very slight increase in chemicals associated with waste in the groundwater directly beneath the areas where waste has been buried.

The other significant residual vector from the landfill is landfill gas and associated occasional odour nuisance. The long-term operation of the project LFG project will also be the subject of monitoring, by means of systems specifically designed and installed for this purpose.

Cumulative impacts from this project will result to an influx of people from other locations that will have identified opportunities to set up secondary businesses including shops and hotels among others. Potential cumulative impacts on air quality would principally result from the landfill gas in combination with traffic using the access road. There are no other industrial processes close to the site that might contribute to effects on air quality. The potential for cumulative impacts to the water environment is predominantly associated with surface water run-off entering watercourses, which, if not managed, could cause pollution or flooding.

Mitigation measures

The hydrogeological report recommends capping of the landfill with appropriate material and construction of storm drain around the landfill site, especially the upslope sides.

To prevent storm water transporting leachate, an impermeable boundary should be built to appropriate depth around the landfill.

Development of appropriate buffer zones around the site as will be informed by the final detailed design processes including the air quality study/modeling.

The proponent shall liaise with the Murang'a county government authority to ensure that development of secondary businesses within the project area conforms with county's physical development plans to avoid unsustainable pressure on existing infrastructure.

7.7 Social impact assessment and management measures

7.7.1 Overview of Social Impacts Analysis Process

The socio-economic impact assessment identifies and evaluates the significance of impacts associated with the proposed Landfill Project, including:

- The identification of all socio-economic impacts (direct and indirect, positive and negative) that are linked to the Proposed Sanitary Landfill Project.
- The measurement (and where possible, monetization) of socio-economic impacts, including the following:
  - ✓ The numbers and characteristics of people and companies affected (number of people living within 5km from the site, those living along the travel route of the waste trucks and/or those subjected directly to changes in their socioeconomic conditions and living environment);
  - ✓ Changes in people's access to, or changes in the status of: employment, commercial, recreational, cultural and social services and facilities;
  - ✓ Direct loss of land, or change in people's access to their livelihoods areas;
  - ✓ Social patterns and linkages: changes in how the people will engage with the project and possible risks and mitigation; and
  - ✓ General amenity (perceived and actual) and change in the physical conditions that affect the quality of the life of the surrounding communities; local content (hiring and sourcing) and opportunities.

The socio-economic impact assessment assesses the significance of potential direct impacts based on probability, magnitude and receptor sensitivity.

Probability: The likelihood that the impact will occur, and degrees of uncertainty, based on the following criteria:

Table 7-5: Showing the Probability

PROBABILITY	VALUE
Highly likely - almost certain to occur or may have already occurred	3
Likely - some substantiated evidence that the impact is likely to occur, or has previously occurred in a similar context.	3
Possible - could occur without intervention	2
Unlikely - some evidence that impact could occur, no such incident in the region but may have occurred elsewhere	1
Highly unlikely- no evidence to suggest impact will occur	1

- ***Magnitude:*** Determined based on:
- ***Spatial Scope:*** The geographical scope of the impact relative to local users and business establishments receptors:

Table 7-6: Showing the Scope

SCOPE	VALUE
Local – effects extending to the stakeholders in the immediate areas	1
Regional – effects extending to the entire county; and	2
National - effects extending to Kenya.	3

- T***iming and Duration:*** The likely timing and duration of the impact (including whether the impact would be temporary or permanent in nature) and how this links to activities undertaken;
- ***Receptor Sensitivity:*** The groups of people or populations most likely to be affected and, in particular, whether impacts are likely to be disproportionately experienced by ***vulnerable groups***.

Significance is based on judgment considering the likelihood and magnitude of the impact and the sensitivity of the population or group of people that may be affected. The significance of impact (considering existing controls) is categorized as follows:

- ***Major Positive*** – a substantial positive change.
- ***Positive*** - some positive change.
- ***Negligible*** -very little change or no change.
- ***Negative*** - measurable negative change.
- ***Major Negative*** - considerable negative change.

Any impact classified as “Major Negative” is considered to be significant and requires additional mitigation. Impacts of “Negligible”, “Major Positive” or “Positive” significance are not considered to require mitigation.

Indirect impacts i.e. induced effects, cannot be readily assessed using the same approach. A qualitative assessment is therefore made based on judgment and considering existing controls.

7.7.2 Trans-boundary and Cumulative Impacts

Trans-boundary impacts are impacts that occur outside the jurisdictional borders of a project’s host country.

Potential Sanitary Landfill project trans-boundary impacts are considered to include:

- Social and economic issues surrounding the sourcing of labor, goods and services from the international market; and
- GHG emissions to air.

Cumulative impacts arise from:

- Interactions between separate project-related residual impacts; and
- Interactions between project-related residual impacts in combination with impacts from other projects and their associated activities.

These can be either additive or synergistic effects, which result in a larger (in terms of extent or duration) or different (dependent on impact interaction) impacts when compared to project related residual impacts alone.

7.7.3 Perceived Social Impacts

The stakeholders within the project area were asked to complete a questionnaire and highlight the impacts they perceived would arise from the proposed landfill project. The respondents were then asked to rank the impacts they highlighted in order of what they perceived to be most significant. Majority of the respondents (90%) felt that the establishment of the landfill would have significant impacts, while majority of the respondents felt that impact of the project would be negative.

The perceived positive impacts were largely related to economic growth, while the negative impacts focused on the respondents’ access to natural resources. The respondents ranked the impacts in order of significance. The positive social impacts identified were;

- Create employment and business opportunities - The creation of the proposed Sanitary Landfill will generate job opportunities through local sourcing and hiring.

- Cleaner environment- Commissioning of the project could lead to cleaner environment around the project leading to the population growth in the Kangangu/Mitubiri sub location project area, which may lead to increased economic activity, leading to socio-economic development.
- Better road access; Access to market will be created for business operating in the area.

The respondents identified positive economic impacts and ranked them as follows;

- Employment creation - The proposed expansion activities would generate indirect and direct employment in the region, for instance, workers will be required in site preparation and construction activities.
- Boost local business - The project may bring about a boost to local business through the purchase of local foodstuff and other commodities for use in day-to-day operations.
- Economic growth - It is expected that through the operations at the project site it will have various vendors thus increasing the local businesses within that area by making it attractive to local and regional investment.

The respondents identified the following negative impacts and ranked them as follows;

- Location; The proponent should identify an area that will not affect the community and if there is any need to move any persons they are compensated.
- Lack of community engagement; Involve the local community during the construction of the landfill.
- Local Content; The proponent and contractors should ensure to hire locals during the construction phase and source construction materials locally. Lack of employment for their youths would not be seen positively.
- Lack of Knowledge on the Project; although 40% of the locals know about the project it was felt that there was need for the proponent to educate the local communities and businesses on what a landfill is and the processes that go into designing, constructing and operating a Landfill.
- Infrastructure; the proponent will need to maintain or upgrade the road to ensure easy access for the residents and neighboring businesses.

7.7.4 Predicted Impacts of Project on Key Socio-Economic Factors

7.7.4.1 Population/ Demographic movement

The proposed creation of the proposed Sanitary Landfill may cause an increase in workers in the project area. The construction team and crews will be based in the project area for some time, which will cause a temporary increase in population. This may lead to an influx of business persons seeking to provide goods and services for profit and workers going to work at the project site which may in turn boost local business.

This is likely to affect the residents living in the area, as this is a highly residential area. The area is likely to Experience an influx of people who will be working on the project.

Impact Mitigation

Sanitary Landfill should ensure that interactions with the local residents and their workforce are monitored and engage the local leaders whenever there is conflict.

7.7.4.2 Economic Environment

The proposed Sanitary Landfill project may cause a slight shift in livelihood activities carried out.

- There may be an increase in (un)skilled employment as the local public may find work with the construction and operational team.
- There could be an increase in the number or people engaging in trading and business activity as demand for commodities increases.
- Possible increase in sexual activities and commercial sex workers
- The project may also influence the economic environment in a negative way;
- Unequal distribution of employment opportunities which may lead to conflicts;
- Loss of current livelihoods to the existing businesses i.e. waste pickers.

Impact Mitigation

- The proposed Sanitary Landfill should ensure that there is equity in employment
- The proposed Sanitary Landfill should ensure that the livelihood of the local community are not negatively impacted
- The proponent should ensure that local community are prioritized when employment opportunity arise
- The proponent should prioritize the current local waste pickers during hiring of new workers at the project site
- Public Organizations and Local Institutions

There are several local institutions in the project area, including local government, flower farm, horticulture farm, gated residential communities and churches which influence the way in which the public live, security and social behavior. The project may impact the public organizations and local institutions positively in the following ways;

- The proponent could partner with local or public institutions to facilitate development in areas of interest;
- The project may impact local institutions and public organizations negatively through:
- The air, noise and waste pollution from the activities could disrupt their operations which could make some of them move to less stressful areas to do their business.

Impact Mitigation

The proposed Sanitary Landfill management should consult with public organizations and local institutions in planning its activities

- Social dynamics and potential sources of conflict

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. E.g. incidence of gender based violence, new infections of STDs, theft of personal property and gang related robberies.

Mitigation

The discretion of County Government should be used when offering employment. The proponent should encourage the pursuit of AID/HIV sensitization and cultural tolerance.

- HIV/AIDS and Sexually Transmitted Infections (STIs)

There is likelihood that there may be increase spread of sexually transmitted diseases and HIV/AIDS due to the influx of immigrant workmen interacting with the local people. The teams working on the project, as well as the greater number of drivers, who are expected to serve the project in various capacities, can also cause social upheaval among communities neighboring the site.

Mitigation measures during construction

- Initiate a sensitization and awareness campaign on HIV/AIDS and STDs to be done to workers and local community;
- Reduce risk of transfer through provision of male and female condoms for all workers;
- Provide free STI and HIV/AIDS screening, diagnosis, counseling for workers and local people near the site

Mitigation measures during operation

- During operations, the site management shall ensure that a continuous sensitization and awareness program on health issues related to STDs and HIV/AIDS at the landfill site maintained and conducted regularly, e.g. installing posters at the site
- Crime Management, Child protection, Gender equity and sexual harassment

The laws of Kenya prohibit contractors from “employing children in a manner that is economically exploitative, hazardous, and detrimental to the child’s education, harmful to the child’s health or physical, mental, spiritual, moral, or social development. It is also important to be vigilant towards potential sexual exploitation of children, especially young girls.

The contractor should adopt a 'Child Protection Code of Conduct'; that all staff of the contractor must sign, committing themselves towards protecting children, which clearly defines what is and is not acceptable behavior.

Crimes might occur in the project area during the project cycle such as theft of tools/equipment or individual property, fighting, petty crimes such as pick pocketing, drug abuse and alcoholism among others.

There is a potential of gender inequality occurring during project cycle through unequal distribution of work, discrimination against women, and unequal pay for women, lack of provision of separate facilities for women, among others. Sexual harassment against women might also happen because of mixing of women and men at the work site.

Mitigation Measures (design)

- Proper design incorporating lighting to enhance security at the site
- Provision for fencing along the property boundary should be part of the design to control entry and exit points

Mitigation measures during construction

- 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
- The client and the contractor shall adopt a 'Child Protection Code of Conduct' which sets stringent standards for personal behavior so as to avoid child exploitation and abuse.
- The Contractor shall require his employees, sub-contractors, sub-consultants, and any personnel thereof engaged in construction works to individually sign and comply with this Code of Conduct.
- Removing any employee who persists in any misconduct or lack of care, carries out duties incompetently or negligently, fails to conform to any provisions of the contract, or persists in any conduct which is prejudicial to safety, health, or the protection of the environment.
- Taking all reasonable precautions to prevent unlawful, riotous or disorderly conduct by or amongst the contractor's personnel, and to preserve peace and protection of persons and property on and near the site.
- Prohibiting alcohol, drugs, arms, and ammunition on the worksite among personnel.
- The contractor and Supervision Consultant should register in a log all events of a criminal nature that occur at the worksite or are associated with the civil works activities.
- The contractor and Supervision Consultant should report all activities of a criminal nature on the worksite or by the contractor's employees (whether on or off the worksite) to the police and undertake the necessary follow-up. Crime reports should include nature of the offense, location, date, time, and all other pertinent details.

- Sensitize the construction workers, locals, and security to be on the lookout on suspicious activities near the site
- The contractor's responsibility for workers' conduct within the worksite should include but not limited to:
- 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 should be set up for the workers
- Liaise with the administration units (County and sub county governments, Police, DO, chiefs, etc.) to provide regular surveillance and patrols to protect workers and shoppers during operation

7.7.5 Residual Impact Analysis

Table 7-7: Residual Impact Analysis

Parameter	Impacts	Magnitude		Probability	Receptor sensitivity	Impact Significance
		Spatial scope	Timing and Duration			
Social Characteristics	Infrastructural Development	Regional	Long-term	Possible	Youth, Elderly, Children	Negligible

CHAPTER EIGHT

8 THE ENVIRONMENTAL/SOCIAL MANAGEMENT PLAN

8.1 Purpose of ESMP

The purpose of the Environmental/Social Management Plan is to initiate a mechanism for implementing mitigation measures for the potential negative environmental and social impacts and monitor the efficiency of these mitigation measures based on relevant environmental indicators. The proposed project in itself is considered as an environmental and social improvement project in comparison with the current solid waste management practices. The project design has incorporated significant measures directed specifically towards major environmental protection and the minimization and/or mitigation of potential environmental impacts.

The ESMP assigns responsibilities of actions to various actors and provides a timeframe within which mitigation measures can be implemented further. It also provides a checklist for project monitoring and evaluation.

8.2 Objectives of ESMP

The objectives of this 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 community with evidence of the management of the project in an environmentally acceptable manner.

The ESMP outlined below will address the identified potential negative impacts and mitigation measures of the proposed project.

8.3 Roles and Responsibilities

The Contractor 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 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 has 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 table 8-1 summarizes the environmental and social management plan for the proposed project. The estimated costs for the various mitigation measures have been provided where possible. It will be noted that most of these measures will be part of the project's operational costs.

Table 8-1: Environmental & Social Management Plan for the Proposed Mitubiri Landfill Project

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
Construction phase					
Air Pollution	Dust	Use best management practices to minimize dust generation. These include: re-vegetating areas where vegetation have been removed; keep to the minimum areas where earthwork activities will take place, dust suppression on roads during dry weather conditions and pavement, speed limits. Construct buffer zone with protective berms	**Throughout project life**	Proponent and contractors	Within the general responsibilities of the construction supervisor – no significant material additional costs
	Exhaust emission	Maintain 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	**Throughout project life**	Contractors Site operators	Covered in construction cost
Noise and excessive vibration	Noise pollution	▪ strictly adhering to designated working hours (day time); ▪ sensitizing construction truck drivers and equipment operators to switch off idle engines; ▪ by using modern, well-maintained and regularly serviced vehicles; ▪ Ensuring that all generators and heavy-duty equipment be insulated or placed in enclosures to minimize ambient	Throughout project life	Contractor Site management landfill management	200,000 annually NEMA approved consultants / Daily monitoring

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
		noise levels. ▪ Adhere to the Environmental Management and Coordination (Noise and Excessive Pollution) (Control Regulations 2009**)**			by site management
Surface and Groundwater pollution	Erosion and sedimentation	Develop traps, barriers, vegetation planting, terracing and leveling the project site to reduce run-off velocity. Construction vehicles to be restricted to designated areas to avoid soil compaction within the project site, while any compacted areas will be ripped to reduce run-off. Develop a site-specific construction environmental management plan (CEMP)	During construction	Contractor Approval by project supervisor's management	Variable
Ecology	Potential loss of ecological habitats from clearing vegetation and excavation of soil	-Disturbance to habitats should be strictly controlled. Rehabilitate degraded habitats within the site and ▪ support habitat conservation in nearby areas Protect wetland habitat ▪ Ensure proper management of the landfill to avoid effluent discharge into the environment Re-vegetation of the project site after construction plant adoptable and sustainable tree species	During construction	Landfill management Proponent and contractors	No additional cost is anticipated
	Impact of leachate on	Ensure nearby water sources are not polluted by leachate	Throughout the life of the	Landfill management	No additional cost is

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
	eutrophicatio n and aquatic Ecotoxication in reservoir		project		anticipated
Traffic impacts	Congestion and accidents	▪ Develop a Traffic Management Plan to manage the following; ▪ Strict traffic regulations should be put in place ▪ Traffic signs should be posted along site access roads. ▪ Design of the site layout to ensure that trafficked areas, such as the location of parking, the entrance gate and the weighbridge, are away from dangerous areas. The layout will also ensure smooth flow of traffic within the project ▪ Any particularly dangerous areas, such as disposal areas for leachate ponds, should have signs to indicate the danger posed. ▪ Speed limits should adhered to along the access roads	During construction	-Contractors -Landfill management	Covered in construction cost
Storm Water Run-off Management	Environmental health risks due to polluted water accessing	▪ Provide proper storm water drainage from the paved roads. ▪ Construct interception drains that direct storm water away from the areas where waste is to be disposed ▪ Provide regular inspection and maintenance of the drains.	During construction	Proponent and contractors	Covered in construction cost

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
	public drainage systems	▪ Provide tanks for rain water harvesting			
Public and workers health and safety	Health and Safety Risks. Loss of life, injury or damage to private property Workers health and safety Immigration and accumulation of rodents at the landfill site	▪ Developing standard operating procedures for landfill management; ▪ Enclosing waste on transit; ▪ Implement all necessary measures to ensure health and safety of workers and the general public during operation of the project as stipulated in OSHA 2007; ▪ Ensuring strict access to site to authorized personnel only ▪ Compacting and applying cover on waste daily to minimize odor and prevent attraction of vermins and insects. ▪ Develop pest management plan	Throughout project life	Landfill management and contractors	Covered in construction cost
Social aspect	Grievances	▪ Regular documentation of responses to questions and grievances submitted by the community adjacent to the	Throughout the project life	Landfill management	No additional cost is

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
	Social misconception and conflicts	project. ▪ Creation of awareness on what and how the land fill operates. ▪ Avail a copy of ESIA report at the land fill offices access to the local community who might have concerns with the operation of the landfill. ▪ Develop and implement stakeholder engagement plan ▪ Apply the world bank grievance mechanism in conflict management		and contractor	anticipated
	Local Content	▪ Review the number of locally sourced materials including workforce to protect the proponent's social license to operate.	Throughout the project life	Contractor & Proponent	No cost is anticipated
	HIV/Aids	Develop a continuous awareness campaign and training plan for the workers and neighbors (stakeholders).	Throughout project life	Contractor	2,000,000
Population/ Demographic movement and employment	Conflict due to competition of employment opportunities with local population and the influx	Prioritizes job opportunities for the local community first then compensate the deficit with the influx population.	Throughout the project cycle	Landfill management	No cost additional cost is anticipated

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
	population.				
	Security and Crime, Child protection, Gender equity and Sexual harassment	▪ 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 ▪ 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	Throughout project life	Contractor & landfill management	No cost is anticipated

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
		▪ 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			
"Chance Finds" (Materials of heritage value)	The contractor should implement the Chance Finds Procedure if cultural heritages is discovered	Constant monitoring during excavation	Construction phase	Contractor, proponent, NCG	No cost implication
Operation Phase					
Air Pollution	Dust	Dust suppression on roads during dry weather conditions and pavement, speed limits.	Throughout project life	Site management	Within the general

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
					responsibilities of the operations supervisor – no significant material additional costs
	Exhaust emission	Maintain 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	**Throughout project life**	Site management	Covered in operation cost
	Landfill Gas	● Placing of gas vents and construction of the gas compression station with adequate capacity to receive the maximum flow of gas. ● Keeping the integrity of the system by lining system and final cover of the landfill properly by ensuring adequate placing, adhering to waste filling plan, avoid overloading landfill cells and regular evacuation of leachate and gas ● Adhering to strict maintenance schedule for the degassing system should be prepared and followed by the project operator	Throughout project operation life	Proponent Site management	Covered in and operation cost
	Odour	Use best management practices to minimize odor and	Operational	Proponent	Covered in

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
		prevent odor from emanating offsite. These practices will include: applying daily and intermediate soil cover on waste; waste with strong odour to be covered immediately they emptied from delivery vehicles; effectively control and manage leachate treatment plant to minimize odor. Adhere to air quality regulations. Maintenance of the buffer zone and protective berms	phase and post closure	Site management	operation cost
Noise and excessive vibration	Noise pollution	▪ strictly adhering to designated working hours (day time); ▪ sensitizing construction truck drivers and equipment operators to switch off idle engines; ▪ by using modern, well-maintained and regularly serviced vehicles; ▪ Ensuring that all generators and heavy-duty equipment be insulated or placed in enclosures to minimize ambient noise levels. ▪ Adhere to the Environmental Management and Coordination (Noise and Excessive Pollution) (Control Regulations 2009**)**	Throughout project life	Site management landfill management	200,000 annually NEMA approved consultants/ Daily monitoring by site management

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
Surface and Groundwater pollution	Leachate generation	▪ Adoption of good routine operational management will 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; ▪ Develop 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	Quarterly storm water analysis Quarterly leachate discharge analysis Quarterly ground water analysis (4 monitoring wells)	landfill management	520,000 annually
	Erosion and sedimentation	Develop traps, barriers, vegetation planting, terracing and leveling the project site to reduce run-off velocity. Waste transporting vehicles to be restricted to designated areas to avoid soil compaction within the project site, while any compacted areas will be ripped to reduce run-off.	Operation	Landsite management Approval by project supervisors	Variable

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
	Impact of leachate on eutrophicatio n and aquatic Eco-toxication in reservoir	Ensure nearby water sources are not polluted by leachate	Throughout the life of the project	Landfill management	No additional cost is anticipated
Hazardous waste	Illegal dumping	Put in place signage indicating which wastes may be deposited at the landfill will be provided. Train landfill workers on waste identification and sorting Controlled access and tracking Inspection through use of viewing platforms, visual inspection and or video cameras.	operation	-Landfill management	Covered in operation cost
Traffic impacts	Congestion and accidents	▪ Strict traffic regulations should be put in place ▪ Any particularly dangerous areas, such as disposal areas for leachate ponds, should have signs to indicate the danger posed. ▪ Speed limits should adhere to along the access roads	operation	-Contractors -Landfill management	Covered in operation cost
Explosions and fires	Destruction of property and	▪ Develop regular maintenance and monitoring of gas venting and leak detection system	Air quality monitoring for	Landfill management	40,000 per month

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
	environment by fire or explosion	▪ Control the types of waste delivered to site by coming up with a waste segregation plan ▪ Emergency sufficient water should always be available; ▪ Provide sufficient firefighting equipment onsite and train fire marshals	fugitive methane	Approved fire safety advisors	
Storm Water Run-off Management	Environmental health risks due to polluted water accessing public drainage systems	▪ Provide regular inspection and maintenance of the drains.	operation	Landfill management	Covered in operation cost
Public and workers health and safety	Health and Safety Risks. Loss of life, injury or damage to private property Workers	▪ Developing standard operating procedures for landfill management; ▪ Enclosing waste on transit; ▪ Implement all necessary measures to ensure health and safety of workers and the general public during operation of the project as stipulated in OSHA 2007; ▪ Ensuring strict access to site to authorized personnel only ▪ Compacting and applying cover on waste daily to	Throughout project life	Landfill management and contractors	Covered in operation cost

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
	health and safety Immigration and accumulation of rodents at the landfill site	minimize odor and prevent attraction of vermins and insects.			
Social aspect	Grievances Conflicts	▪ Regular documentation of responses to questions and grievances submitted by the community adjacent to the project. ▪ Creation of awareness on what and how the land fill operates. ▪ Avail a copy of ESIA report at the land fill offices access to the local community who might have concerns with the operation of the landfill. ▪ Implement stakeholder engagement plan ▪ Apply the world bank grievance mechanism in conflict management	Throughout the project life Throughout the project life	Landfill management and contractor Landfill engagement	100,000 per month
	HIV/Aids	Develop a continuous awareness campaign and training plan	Throughout	Contractor	2,000,000

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
		for the workers and neighbors (stakeholders).	project life		
Population/ Demographic movement and employment	Conflict due to competition of employment opportunities with local population and the influx population.	Prioritizes job opportunities for the local community first then compensate the deficit with the influx population.	Throughout the project cycle	Landfill management	No cost additional cost is anticipated
	Security and Crime, Child protection, Gender equity and Sexual harassment	▪ Liaise with the administration units (County and sub county governments, Police, chiefs, etc.) to provide regular surveillance and patrols to protect workers ▪ 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 ▪ 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 ▪ Implement a Gender Action plan to include at minimum,	Throughout project life	Contractor & landfill management	No cost is anticipated

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
		in conformance with local laws and customs, equal opportunity employment, gender sensitization ▪ Grievance redress mechanisms including non-retaliation ▪ The contractor to have and enforce a Code of Conduct in regard to Gender equity and Sexual harassment			
Decommissioning Phase (Site restoration and rehabilitation)					
Air Pollution	Dust	Dust suppression on roads during dry weather conditions and pavement, speed limits.	Decommissioning	Landfill management contractors	Within the general responsibilities of the decommissioning supervisor – no significant material additional costs
	Exhaust emission	Maintain heavy equipment used at the Site and waste hauling vehicles to ensure their exhaust emissions meet the emissions standards prescribed in EMC (Air Quality) Regulations, 2014	Decommissioning	Landfill site management contractors	Covered in decommissioning cost
	Odour	Maintain buffer zone and protective berms	Decommissioning	Site management	Covered in decommissioning cost

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
Noise and excessive vibration	Noise pollution	▪ strictly adhering to designated working hours (day time); ▪ sensitizing truck drivers and equipment operators to switch off idle engines; ▪ by using modern, well-maintained and regularly serviced vehicles; ▪ Ensuring that all generators and heavy-duty equipment be insulated or placed in enclosures to minimize ambient noise levels. ▪ Adhere to the Environmental Management and Coordination (Noise and Excessive Pollution) (Control Regulations 2009**)**	Decommissioning	Site management landfill site management	200,000 annually NEMA approved consultants / Daily monitoring by site management
Surface and Groundwater pollution	Leachate generation	▪ Develop rigorous program of water quality monitoring	Quarterly storm water analysis Quarterly leachate discharge analysis Quarterly ground water analysis (4 monitoring wells)	landfill management	520,000 annually Variable

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
Traffic impacts	Congestion and accidents	▪ Develop a Traffic Management Plan to manage the following; ▪ Strict traffic regulations should be put in place ▪ Traffic signs should be posted along site access roads. ▪ Speed limits should adhere to along the access roads	Construction and operation phase	-Contractors -Landfill management	Covered in construction cost
Explosions and fires	Destruction of property and environment by fire or explosion	▪ Develop regular maintenance and monitoring of gas venting and leak detection system ▪ Develop integrated fire prevention plan; ▪ Emergency sufficient water should be available; ▪ Develop a disaster management plan	Air quality monitoring for fugitive methane	Landfill management and contractors	40,000 per month
Public and workers health and safety	Health and Safety Risks. Loss of life, injury or damage to private property Workers health and safety	▪ Implement all necessary measures to ensure health and safety of workers and the general public during operation of the project as stipulated in OSHA 2007; ▪ Ensuring strict access to site to authorized personnel only ▪ Develop pest management plan	Decommissioning	Landfill management and contractors	Covered in operation cost
Social aspect	Grievances	▪ Regular documentation of responses to questions and grievances submitted by the community adjacent to the	Decommissioning	Landfill management	No additional cost is

Aspect	Potential impact	Recommended Mitigation Measures	Duratiom	Responsible Party	Estimated Cost (USD)
	Conflicts	project. ▪ Creation of awareness on what and how the land fill operates. ▪ Apply the world bank grievance mechanism in conflict management		and contractor	anticipated
	Local Content	▪ Review the number of locally sourced materials including workforce to protect the proponent's social license to operate.	Decommissioning	Contractor & Proponent	No cost is anticipated
	HIV/Aids	Develop a continuous awareness campaign and training plan for the workers and neighbors (stakeholders).	Decommissioning	Contractor	1,000,000

Total Cost of Environmental & Social Management Plan is estimated at Eighty eight thousand dollars (USD 88,000).

The Contractor has the key responsibilities regarding compliance to the above ESMP but it is critical for the proponent to ensure adequate monitoring and evaluation for the Contractor for no non-conformances.

8.4 Environmental and Social Management Plan Review

The Proponent will need to review the ESMMP every 6 months 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 landfill site. The Proponent should also conduct an Annual Environmental Audit to assess the implementation of the ESMP.

CHAPTER NINE

9 THE ENVIRONMENTAL AND SOCIAL MONITORING PLAN

9.1 Introduction

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. In the context of the proposed project, design has made provisions for an elaborate operational monitoring framework for the following among others:-

9.2 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 a human activity beyond a specified standard of regulation level.

9.3 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 sanitary landfill Project. It is therefore recommended that the ministry ensures annual EA is carried out.

Table 9-1: Environmental and Social Monitoring Evaluation Plan for Proposed Sanitary landfill Project

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
Air Quality	Visual assessment of dust: routine and, if necessary, in response to a complaint	Construction site	Monitoring of PM10. 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	Landfill boundary	● Wind direction and speed (m/s) ● Air temperature (^{0}C) ● Air humidity (%) ● Precipitation (mm/min); ● Hydrogen-sulphide (µgH2S/m3) Mercaptans (µgC2H5SH/m3)	Operation	Twice in a year (during dry and rainy seasons)	Landfill management	250,000
	● Flow rate to be measured	landfill gas monitoring	Amount and quality of landfill gas	Operation	Not less than twice a year	Landfill management	500,000

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
	using flow meters; ● Sampling and analysis of air samples	wells	(laboratory analysis of: Methane (CH4), Carbon dioxide (CO2), Nitrogen (N2) and Oxygen (O2)				
	● Odour assessment	Sensitive receptors such as neighbouring residential areas and villages	Concentration and substance of Odour emitting from landfill	Operation phase	Since the odour is not quantifiable, there is no prescribed frequency of monitoring. Generally, the odour should be monitored daily or as-and-when necessary, as long as it is not having a major impact on the surrounding.	Proponent	Included in operation cost of the landfill
Water Resource	● Sampling and analysis of	Nearby surface	River water The following	Operation	Quarterly	Proponent, WRMA, County	400,000

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
	quality of water	water bodies- rivers and dams	parameters are to be monitored: ● pH, ● temperature, ● electrical conductivity, ● Ammonia (as N), ● Total oxidised Nitrogen (as N), ● Total organic carbon, ● metals (calcium, magnesium, sodium, potassium, iron, manganese, cadmium, chromium (total), copper, nickel, lead, zinc, arsenic, boron and mercury),			Environmental Officer	

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
			● 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	Nearby boreholes	Groundwater	Operation	Quarterly	Landfill management	600,000
	● monitoring precipitation	Project site	Precipitation/rainfall	Operation phase	Daily	Landfill management	50,000
Noise Quality	Monitor noise levels during	● At the sources;	Noise and vibration Levels	Constructio n	At the start of each new construction	Contractor Proponent	100,000

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
	construction	● Along perimeter of constructio n site; ● At the sensitive receptors such as nearby villages			activity		
	Monitor noise levels during operation phase	● At the sources; ● Along perimeter of constructio n site; ● At the sensitive receptors such as	Noise and vibration levels	Operation phase	Once in a year	Proponent	80,000

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
		nearby villages					
Waste (solid and liquid)	Visual inspection, disposal records	Working area	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	Out flow point	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	Landfill management	To be included in operation costs of the Landfill

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
					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**		

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
	Sampling and analysis	Discharge point of treatment facility	Amount and quality of effluent discharged	Operation phase	the frequency should correspond to the frequency of the leachate monitoring activities	Landfill management	To be included in operation costs of the Landfill
Hazardous wastes	Tacking of wastes	Waste sorting area	Type of wastes	Operation	Upon of every receipt of wastes at landfill sites by delivery trucks	Landfill management	To be included in operation costs of the Landfill
Flora and Fauna	Ecological assessment for nearby river	Downstream and upstream of the project site	Macrophytes, algae, fish, protected species)	Operation phases	Quarterly	Landfill management	400,000
Environmental Inspections/Auditing	Inspection of equipment and processes	Construction site	Integrity of equipment and adherence to procedures	Construction /operation phases	As part of regular, monthly inspections	Landfill management and Proponent	Included in construction and operation costs.
Grievances Mechanism	Monitor issues raised through the Grievance Mechanism	Number of, and type of complaints	n/a	Construction and operation phases	Continuously through construction and operation phases of the project	Contractor and Proponent	To be included in construction and operation costs

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
		received on any project-related activity Number of complaints resolved, not resolved (with reasons why not resolved)					
Population/ Demographic movement and employment	Conflict Complains	Project area	Number of locals employed versus others from elsewhere Complains from the local	Project cycle	continuous	Landfill management andcontractor	No additional cost
Public and workers health and safety	Health and Safety Risks and property damage	Project site	Number of occupational health and safety incidences	Throughout the project cycle	Continuous	Landfill management Contractor	No additional cost

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
			reported or any property damaged				
	HIV/Aids	Workers at the project location	New infections Social survey on social behaviour that might led to new infection	Throughout the project cycle	Continuous/regular	Landfill management Contractor	100,000 per annum
Security and Crime, Child protection, Gender equity and Sexual harassment	Insecurity Child labor Workplace harassment	Number of insecurity incidence and harassment complaints received on any project-related activity Any child reported working in the project Number of	Complaint registered Police occurrence book entry register reports from the project site	Throughout the project cycle	Continuous,	Landfill management, security agency in the project site, Project Landfill management, County government	No additional cost

Aspect/Issue	Monitoring Activity	Monitoring Location	Monitoring Parameters	Phase	Monitoring Duration/Frequency	Responsible Party	Cost Estimate KES
		complaints resolved, not resolved (with reasons why not resolved)					
Chance Finds		Project site	Discovery of archaeological sites, historical sites, remains and objects	excavation or construction	Continuous during excavation	Contractor/Landfill management	No additional cost

Total Cost of Environmental & Social Monitoring Plan is estimated at Twenty four thousand Eight Hundred (USD24800).

CHAPTER TEN

10 CONCLUSION AND RECOMMENDATIONS

10.1 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 solid wastes currently disposed in 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 the different stages of the proposed project on 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 Actors 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. 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.

Having considered the information collected, collated and analyzed during the study, it is the Expert ‘s considered opinion that:

- Every Kenyan is entitled to a clean and healthy environment as stipulated in Article 42 of Kenya Constitution 2010 therefore, the project is vital for the improvement of the sanitary conditions in Murang’a County.
- 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 project should be allowed to commence and activities be managed within the provided ESMMP.
- The proposed project is a viable venture that should be given due support.

10.2 Recommendations

- ✓ The proposed project to be implemented in compliance with the relevant legislation and planning requirements;
- ✓ 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
- ✓ The landfill management in partnership with relevant stakeholders should develop elaborate plans and policies for management wastes not accepted landfill as guided by the applicable County and National legislations.
- ✓ An elaborate and effective management structure be in place to ensure sustainable management of the landfill.
- ✓ 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
- ✓ 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;
- ✓ Standard operational procedures and controls of the landfill 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;
- ✓ The project has attracted high level of community support with terms and conditions on sound management of the landfill;
- ✓ 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.

REFERENCES

Guidelines for E-Waste Management in Kenya by, ©National Environment Management Authority, 2011

Kenya gazette supplement Acts 2000, Environmental Management and Coordination Act Number 8 of 1999. *Government printer, Nairobi*

Kenya gazette supplement Acts *Land Planning Act (Cap. 303) government printer, Nairobi*

Kenya gazette supplement Acts *Local Authority Act (Cap. 265) government printer, Nairobi*

Kenya gazette supplement Acts Penal Code Act (Cap.63) *government printer, Nairobi*

Kenya gazette supplement Acts *Physical Planning Act, 1999 government printer, Nairobi*

Kenya gazette supplement Acts *Public Health Act (Cap. 242) government printer, Nairobi*

Kenya gazette supplement number 56. Environmental Impact Assessment & Audit

Regulations 2003.*Government Printer,* Nairobi.

The Environmental Management & Coordination Act 1999 (EMCA 1999).

Japan International Cooperation Agency (JICA); 2009; Integrated Solid Waste Management in Nairobi: D*eveloping a support structure to turn Solid Waste into Resource – A strategic analysis*

National Environment Management Authority (2015); National Waste Management Strategy; Republic of Kenya

The World Bank Operations Manual: Operational Policies (OP)/Bank Procedure (BP) 4.01: Environmental Assessment

ANNEXES

Annex 1: NEMA Approved Terms of Reference

Annex 2: Summarized Bills of Quantities

Annex 3: Certificate of Official Land Search

R.L. 27

REPUBLIC OF KENYA

THE REGISTERED LAND ACT

(CAP 300)

CERTIFICATE OF OFFICIAL SEARCH

TITLE NO. RUIRU/WEMPAR BLOCK 1/6824 .... 5/15

On the ......28TH...... day of ..MAY.. 20..15.. the following were the subsisting entries on the register of the above-mentioned title:

PART A – Property Section (Easements, etc)

Nature of Title: ABSOLUTE

Approximate area: 21.31HA (ONE TWO ONE POINT THREE ONE HA)

PART B – Proprietorship Section

Name and Address of the Proprietor:–

30-4-15 – CHOSEN BUILDERS INVESTMENTS LIMITED

— " — TITLE DEED ISSUED

Inhibitions, Cautions and Restrictions: –

RIGHTS UNDER SEC. 87 RESERVED

PART C – Encumbrances section (Leases, Charges, etc)

30-4-15 – CHARGE TO FAMILY BANK LIMITED TO SECURE A SUM OF KSHS 408,000,000/= RIGHTS UNDER SEC. 82 AND 83 RESERVED

The following applications are pending:

....

The certified copies requested are attached.

The minimum fee KSh. 500 (Five hundred only)

Dated this ..28TH.. day of ..MAY.., 20 15..

Land Registrar

To: The Land Registrar,

........THIKA........ District Land Registry

P. O Box: ....

KSh. .... attached hereto.

....

Signature of the applicant or his advocate

TO BE SUBMITTED IN DUPLICATE

GPK (SP) 7691—100m—03/2012

Source: Feasibility study report, KE517E(Seureca), February, 2016

Annex 4: Site Analysis and Evaluation Criteria

Annex 5: Mitubiri Base Map

Annex 6: Record of Consultation and Public Forums Held

Annex 7: Landfill Ecological Report

Annex 8: Landfill Area Hydrogeological Report

Annex 9: Sample Chance Find Procedures

Sample Chance Find Procedures

Chance find procedures are an integral part of the project ESMMP and civil works contracts. The following is proposed in this regard:

- If the Contractor discovers archeological sites, historical sites, remains and objects during excavation or construction, the Contractor shall:
- Stop the construction activities in the area of the chance find;
- Delineate the discovered site or area;
- Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a night guard shall be arranged until the responsible local authorities or the Ministry of State for National Heritage and Culture take over;
- Notify the supervisor, Project Environmental Officer and Resident Engineer who in turn will notify the responsible local authorities and the Ministry of State for National Heritage and Culture immediately (within 24 hours or less).
- Responsible local authorities and the Ministry of State for National Heritage and Culture would then be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. This would require a preliminary evaluation of the findings to be performed by the archaeologists of the National Museums of Kenya. The significance and importance of the findings should be assessed according to the various criteria relevant to cultural heritage, namely the aesthetic, historic, scientific or research, social and economic values.
- Decisions on how to handle the find shall be taken by the responsible authorities and the Ministry of State for National Heritage and Culture. This could include changes in the layout (such as when finding irremovable remains of cultural or archeological importance) conservation, preservation, restoration and salvage.
- Implementation for the authority decision concerning the management of the finding shall be communicated in writing by relevant local authorities.
- Construction work may resume only after permission is given from the responsible local authorities or the Ministry of State for National Heritage and Culture concerning safeguard of the heritage.

Annex 10: Grievance Redress Mechanisms

Grievance Redress Mechanisms

Process	Description	Time frame	Other information
Identification of grievance	Face to face; phone; letter, e-mail; recorded during public/community interaction; others	1 Day	Email address; hotline number
Grievance assessed and logged	Significance assessed and grievance recorded or logged (i.e. in a log book)	4-7 Days	Significance criteria: Level 1 –one off event; Level 2 – complaint is widespread or repeated; Level 3- any complaint (one off or repeated) that indicates breach of law or policy or the ESIA provisions
Grievance is acknowledged	Acknowledgement of grievance through appropriate medium	7-14 Days	
Development of response	Grievance assigned to appropriate party for resolution Response development with input from management/ relevant stakeholders	4-7 Days 7-14 Days	
Response signed off	Redress action approved at appropriate levels	4-7 Days	Project staff at project proponent to sign off
Implementation and communication of response	Redress action implemented and update of progress on resolution communicated to complainant	10-14 Days	
Complaints Response	Redress action recorded in grievance log book Confirm with complainant that grievance can be closed or determine what follow up is necessary	4-7 Days	
Close grievance	Record final sign off of grievance If grievance cannot be closed, return to step 2 or refer to sector minister or recommend third-party arbitration or resort to court of law.	4-7 Days	Final sign off on by project proponent

Annex 11: Water Analysis Report (DAM and River)

Water Analysis report (DAM and River)

SGS

Date: 15/09/2016

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NAIROBI
ARDHI HOUSE 1ST NGONG AVENUE
KENYA

Analysis Report MA16-04641.002

PRODUCT DESCRIPTION:	RIVER WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE RIVER WATER SAMPLE

SGS Kenya Ltd. makes no representation and assumes no responsibility for the reliability of analysis by a Sub-Contract Laboratory. The laboratory analysis for the Sub-Contract Laboratory tests are provided by:
S - Subcontracted to SGS ISO 17025 Laboratory

TESTS	METHOD	RESULT	UNITS
Tri-Allate	SGS TW 43	<0.01	mg/l
Triazophos	SGS TW 43	<0.01	mg/l
Trichlorfon	SGS TW 43	<0.01	mg/l
Tridemorph	SGS TW 43	<0.01	mg/l
Trifloxystrobin	SGS TW 43	<0.01	mg/l
Triflumizole	SGS TW 43	<0.01	mg/l
Triflumuron	SGS TW 43	<0.01	mg/l
Trifluralin	SGS TW 43	<0.01	mg/l
Triforine	SGS TW 43	<0.01	mg/l
Vamidothion	SGS TW 43	<0.01	mg/l
Vernolate	SGS TW 43	<0.01	mg/l
Vinclozolin	SGS TW 43	<0.01	mg/l
Zetacypermethrin	SGS TW 43	<0.01	mg/l
Zinophos	SGS TW 43	<0.01	mg/l
Ziram	SGS TW 43	<0.01	mg/l
S - Total Organic Carbon	DIN EN 1484	2.60	mg/l
S - Molybdate Reactive Phosphorus	EN ISO 6878	<0.02	mg/l

End of Analytical Results

Authorised Signatory	*Technical Signatory*	*Technical Signatory*
Walter Ogara - Multi-Lab Manager	Florah Mshimba-Chemist	Caroline Chege-Chemist

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TESTS	METHOD	RESULT	UNITS
Tecnazene	SGS TW 43	<0.01	mg/l
Teflubenzuron	SGS TW 43	<0.01	mg/l
Terbacil	SGS TW 43	<0.01	mg/l
Terbufos	SGS TW 43	<0.01	mg/l
Terbuthylazine	SGS TW 43	<0.01	mg/l
Terbutryn	SGS TW 43	<0.01	mg/l
Tetrachlorvinphos	SGS TW 43	<0.01	mg/l
Tetraconazole	SGS TW 43	<0.01	mg/l
Tetradifon	SGS TW 43	<0.01	mg/l
Tetramethrin	SGS TW 43	<0.01	mg/l
Thiabendazole	SGS TW 43	<0.01	mg/l
Thiacloprid	SGS TW 43	<0.01	mg/l
Thiamethoxam	SGS TW 43	<0.01	mg/l
Thiodicarb	SGS TW 43	<0.01	mg/l
Thiometon	SGS TW 43	<0.01	mg/l
Thiram	SGS TW 43	<0.01	mg/l
Tolclofos-methyl	SGS TW 43	<0.01	mg/l
Tolylfluanid	SGS TW 43	<0.01	mg/l
Triadimefon	SGS TW 43	<0.01	mg/l
Triadimenol	SGS TW 43	<0.01	mg/l

Authorised Signatory — Walter Ogara - Multi-Lab Manager

Technical Signatory — Florah Mshimba-Chemist

Technical Signatory — Caroline Chege-Chemist

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TESTS	METHOD	RESULT	UNITS
Pyriproxyfen	SGS TW 43	<0.01	mg/l
Quinalphos	SGS TW 43	<0.01	mg/l
Quinoxyfen	SGS TW 43	<0.01	mg/l
Quintozene	SGS TW 43	<0.01	mg/l
Rotenone	SGS TW 43	<0.01	mg/l
S 421	SGS TW 43	<0.01	mg/l
Simazin	SGS TW 43	<0.01	mg/l
Spirotetramat	SGS TW 43	<0.01	mg/l
Spiroxamine	SGS TW 43	<0.01	mg/l
Sulfotep	SGS TW 43	<0.01	mg/l
Sum Aldrin/Dieldrin/Endrin	SGS TW 43	<0.01	mg/l
Sum Chlordane	SGS TW 43	<0.01	mg/l
Sum DDD/DDE/DDT	SGS TW 43	<0.01	mg/l
Sum Endosulfan	SGS TW 43	<0.01	mg/l
Sum HCH	SGS TW 43	<0.01	mg/l
Symetrin	SGS TW 43	<0.01	mg/l
Tau fluvalinate	SGS TW 43	<0.01	mg/l
Tebuconazole	SGS TW 43	<0.01	mg/l
Tebufenozide	SGS TW 43	<0.01	mg/l
Tebufenpyrad	SGS TW 43	<0.01	mg/l

Authorised Signatory — Walter Ogara - Multi-Lab Manager

Technical Signatory — Florah Mshimba-Chemist

Technical Signatory — Caroline Chege-Chemist

92016 0928 0000067921

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TESTS	METHOD	RESULT	UNITS
Procymidone	SGS TW 43	<0.01	mg/l
Profenofos	SGS TW 43	<0.01	mg/l
Profluralin	SGS TW 43	<0.01	mg/l
Prometon	SGS TW 43	<0.01	mg/l
Prometryne	SGS TW 43	<0.01	mg/l
Propamocarb	SGS TW 43	<0.01	mg/l
Propargite	SGS TW 43	<0.01	mg/l
Propazine	SGS TW 43	<0.01	mg/l
Propham	SGS TW 43	<0.01	mg/l
Propiconazole	SGS TW 43	<0.01	mg/l
Propoxur	SGS TW 43	<0.01	mg/l
Propyzamide	SGS TW 43	<0.01	mg/l
Prothiofos	SGS TW 43	<0.01	mg/l
Pyraclostrobin	SGS TW 43	<0.01	mg/l
Pyrazophos	SGS TW 43	<0.01	mg/l
Pyrethrins	SGS TW 43	<0.01	mg/l
Pyridaben	SGS TW 43	<0.01	mg/l
Pyridaphenthion	SGS TW 43	<0.01	mg/l
Pyrifenox	SGS TW 43	<0.01	mg/l
Pyrimethanil	SGS TW 43	<0.01	mg/l

Authorised Signatory | *Technical Signatory* | *Technical Signatory*

Walter Ogara - Multi-Lab Manager | Florah Mshimba-Chemist | Caroline Chege-Chemist

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TESTS	METHOD	RESULT	UNITS
Pebulate	SGS TW 43	<0.01	mg/l
Penconazole	SGS TW 43	<0.01	mg/l
Pencycuron	SGS TW 43	<0.01	mg/l
Pendimethalin/Stomp	SGS TW 43	<0.01	mg/l
Permethrin	SGS TW 43	<0.01	mg/l
Permethrin I	SGS TW 43	<0.01	mg/l
Permethrin II	SGS TW 43	<0.01	mg/l
Pesticide residues	SGS TW 43	<0.01	mg/l
Phenthoate	SGS TW 43	<0.01	mg/l
Phorate	SGS TW 43	<0.01	mg/l
Phosalone	SGS TW 43	<0.01	mg/l
Phosmet	SGS TW 43	<0.01	mg/l
Phosphamidon	SGS TW 43	<0.01	mg/l
Phoxim	SGS TW 43	<0.01	mg/l
Picoxystrobin	SGS TW 43	<0.01	mg/l
Piperonyl-butoxide	SGS TW 43	<0.01	mg/l
Pirimicarb	SGS TW 43	<0.01	mg/l
Pirimiphos-ethyl	SGS TW 43	<0.01	mg/l
Pirimiphos-methyl	SGS TW 43	<0.01	mg/l
Prochloraz	SGS TW 43	<0.01	mg/l

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Metolachlor	SGS TW 43	<0.01	mg/l
Metribuzin	SGS TW 43	<0.01	mg/l
Mevinphos	SGS TW 43	<0.01	mg/l
Monilate	SGS TW 43	<0.01	mg/l
Monocrotophos	SGS TW 43	<0.01	mg/l
MSMA	SGS TW 43	<0.01	mg/l
Myclobutanil	SGS TW 43	<0.01	mg/l
Nitrofen	SGS TW 43	<0.01	mg/l
Nuarimol	SGS TW 43	<0.01	mg/l
Omethoate	SGS TW 43	<0.01	mg/l
Orthophenylphenol	SGS TW 43	<0.01	mg/l
Oxadixyl	SGS TW 43	<0.01	mg/l
Oxamyl	SGS TW 43	<0.01	mg/l
Paclobutrazol	SGS TW 43	<0.01	mg/l
Paraoxon (etil)	SGS TW 43	<0.01	mg/l
Paraoxon-methyl	SGS TW 43	<0.01	mg/l
Paraquat	SGS TW 43	<0.01	mg/l
Parathion	SGS TW 43	<0.01	mg/l
Parathion-methyl	SGS TW 43	<0.01	mg/l
PCBs	SGS TW 43	<0.01	mg/l

Authorised Signatory | *Technical Signatory* | *Technical Signatory*

Walter Ogara - Multi-Lab Manager | Florah Mshimba-Chemist | Caroline Chege-Chemist

Date: 15/09/2016

SGS Kenya Limited Laboratory Services
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MINISTRY OF LAND ,HOUSING & URBAN DEVELOPMENT
P.O BOX 30450-00100
NAIROBI
ARDHI HOUSE 1ST NGONG AVENUE
KENYA

Analysis Report MA16-04641.002

PRODUCT DESCRIPTION:	RIVER WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE RIVER WATER SAMPLE

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S - Subcontracted to SGS ISO 17025 Laboratory

TESTS	METHOD	RESULT	UNITS
Linuron	SGS TW 43	<0.01	mg/l
Lufenuron	SGS TW 43	<0.01	mg/l
Malaoxon	SGS TW 43	<0.01	mg/l
Malathion	SGS TW 43	<0.01	mg/l
Mecarbam	SGS TW 43	<0.01	mg/l
Mefenoxam	SGS TW 43	<0.01	mg/l
Mepanipyrim	SGS TW 43	<0.01	mg/l
Mepronil	SGS TW 43	<0.01	mg/l
Metalaxyl	SGS TW 43	<0.01	mg/l
Metalaxyl-M	SGS TW 43	<0.01	mg/l
Metamitron	SGS TW 43	<0.01	mg/l
Metazachlor	SGS TW 43	<0.01	mg/l
Methacrifos	SGS TW 43	<0.01	mg/l
Methamidophos	SGS TW 43	<0.01	mg/l
Methidathion	SGS TW 43	<0.01	mg/l
Methiocarb	SGS TW 43	<0.01	mg/l
Methiram	SGS TW 43	<0.01	mg/l
Methomyl	SGS TW 43	<0.01	mg/l
Methoxychlor	SGS TW 43	<0.01	mg/l
Metobromuron	SGS TW 43	<0.01	mg/l

Authorised Signatory | *Technical Signatory* | *Technical Signatory*

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TESTS	METHOD	RESULT	UNITS
Heptachlor	SGS TW 43	<0.01	mg/l
Heptachlor epoxide	SGS TW 43	<0.01	mg/l
Heptachlorepoxide-cis	SGS TW 43	<0.01	mg/l
Heptachlorepoxide-trans	SGS TW 43	<0.01	mg/l
Heptenophos	SGS TW 43	<0.01	mg/l
Hexachlorobenzene (HCB)	SGS TW 43	<0.01	mg/l
Hexaconazole	SGS TW 43	<0.01	mg/l
Hexaflumuron	SGS TW 43	<0.01	mg/l
Hexythiazox	SGS TW 43	<0.01	mg/l
Hydramethylnon	SGS TW 43	<0.01	mg/l
Imazalil	SGS TW 43	<0.01	mg/l
Imidacloprid	SGS TW 43	<0.01	mg/l
Indoxacarb	SGS TW 43	<0.01	mg/l
Iprodione	SGS TW 43	<0.01	mg/l
Iprovalicarb	SGS TW 43	<0.01	mg/l
Isocarbophos	SGS TW 43	<0.01	mg/l
Isofenphos	SGS TW 43	<0.01	mg/l
Kresoxim-methyl	SGS TW 43	<0.01	mg/l
Leptophos	SGS TW 43	<0.01	mg/l
Lindane	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Fludioxonil	SGS TW 43	<0.01	mg/l
Flufenoxuron	SGS TW 43	<0.01	mg/l
Fluquinconazole	SGS TW 43	<0.01	mg/l
Flusilazole	SGS TW 43	<0.01	mg/l
Flutonil	SGS TW 43	<0.01	mg/l
Fluvalinate	SGS TW 43	<0.01	mg/l
Folpet	SGS TW 43	<0.01	mg/l
Fonofos	SGS TW 43	<0.01	mg/l
Fosthiazate	SGS TW 43	<0.01	mg/l
Furfural	SGS TW 43	<0.01	mg/l
gamma-BHC	SGS TW 43	<0.01	mg/l
gamma-Cyhalothrin	SGS TW 43	<0.01	mg/l
Glufosinateammonium	SGS TW 43	<0.01	mg/l
Glyphosate	SGS TW 43	<0.01	mg/l
Halfenprox	SGS TW 43	<0.01	mg/l
HCH (alfa)	SGS TW 43	<0.01	mg/l
HCH (beta)	SGS TW 43	<0.01	mg/l
HCH (delta)	SGS TW 43	<0.01	mg/l
HCH (gamma)	SGS TW 43	<0.01	mg/l
HCH sum no Lindane	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Fenarimol	SGS TW 43	<0.01	mg/l
Fenazaquin	SGS TW 43	<0.01	mg/l
Fenbuconazole	SGS TW 43	<0.01	mg/l
Fenchlorphos	SGS TW 43	<0.01	mg/l
Fenhexamid	SGS TW 43	<0.01	mg/l
Fenitrothion	SGS TW 43	<0.01	mg/l
Fenothrin	SGS TW 43	<0.01	mg/l
Fenoxycarb	SGS TW 43	<0.01	mg/l
Fenpropathrin	SGS TW 43	<0.01	mg/l
Fenpropidine	SGS TW 43	<0.01	mg/l
Fenpropimorph	SGS TW 43	<0.01	mg/l
Fenpyroximate	SGS TW 43	<0.01	mg/l
Fenson	SGS TW 43	<0.01	mg/l
Fenthion	SGS TW 43	<0.01	mg/l
Fenthion-Sulfone	SGS TW 43	<0.01	mg/l
Fenthion-Sulfoxide	SGS TW 43	<0.01	mg/l
Fenvalerate	SGS TW 43	<0.01	mg/l
Fipronil	SGS TW 43	<0.01	mg/l
Flocoumafen	SGS TW 43	<0.01	mg/l
Flucythrinate	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Endosulfan (beta)	SGS TW 43	<0.01	mg/l
Endosulfansulfate	SGS TW 43	<0.01	mg/l
Endrin	SGS TW 43	<0.01	mg/l
Endrin Aldehyde	SGS TW 43	<0.01	mg/l
Endrin Ketone	SGS TW 43	<0.01	mg/l
EPN	SGS TW 43	<0.01	mg/l
Epoxiconazole	SGS TW 43	<0.01	mg/l
EPTC	SGS TW 43	<0.01	mg/l
Esfenvalerate	SGS TW 43	<0.01	mg/l
Ethephon	SGS TW 43	<0.01	mg/l
Ethiofencarb	SGS TW 43	<0.01	mg/l
Ethion	SGS TW 43	<0.01	mg/l
Ethofumesate	SGS TW 43	<0.01	mg/l
Ethoprophos	SGS TW 43	<0.01	mg/l
Ethoxyquin	SGS TW 43	<0.01	mg/l
Etofenprox	SGS TW 43	<0.01	mg/l
Etridiazole	SGS TW 43	<0.01	mg/l
Etrimfos	SGS TW 43	<0.01	mg/l
Famoxadon	SGS TW 43	<0.01	mg/l
Fenamiphos	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Dichlofluanid	SGS TW 43	<0.01	mg/l
Dichlorvos	SGS TW 43	<0.01	mg/l
Dicloran	SGS TW 43	<0.01	mg/l
Dicofol	SGS TW 43	<0.01	mg/l
Dicrotophos	SGS TW 43	<0.01	mg/l
Dieldrin	SGS TW 43	<0.01	mg/l
Diethofencarb	SGS TW 43	<0.01	mg/l
Difenoconazole	SGS TW 43	<0.01	mg/l
Diflubenzuron	SGS TW 43	<0.01	mg/l
Diflufenican	SGS TW 43	<0.01	mg/l
Dimethoate	SGS TW 43	<0.01	mg/l
Dimethomorph	SGS TW 43	<0.01	mg/l
Dimethrin	SGS TW 43	<0.01	mg/l
Diniconazole	SGS TW 43	<0.01	mg/l
Dioxathion	SGS TW 43	<0.01	mg/l
Diphenylamine	SGS TW 43	<0.01	mg/l
Disulfoton	SGS TW 43	<0.01	mg/l
Ditalimfos	SGS TW 43	<0.01	mg/l
Diuron	SGS TW 43	<0.01	mg/l
Endosulfan (alpha)	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Cyhalothrin (lambda)	SGS TW 43	<0.01	mg/l
Cymoxanil	SGS TW 43	<0.01	mg/l
Cypermethrin	SGS TW 43	<0.01	mg/l
Cyproconazole	SGS TW 43	<0.01	mg/l
Cyprodinil	SGS TW 43	<0.01	mg/l
Cyromazine	SGS TW 43	<0.01	mg/l
Dazomet	SGS TW 43	<0.01	mg/l
DDD, o,p,	SGS TW 43	<0.01	mg/l
DDD, p,p,	SGS TW 43	<0.01	mg/l
DDE, o,p,	SGS TW 43	<0.01	mg/l
DDE, p,p,	SGS TW 43	<0.01	mg/l
DDT	SGS TW 43	<0.01	mg/l
DDT, o,p,	SGS TW 43	<0.01	mg/l
DDT, p,p,	SGS TW 43	<0.01	mg/l
delta-BHC	SGS TW 43	<0.01	mg/l
Deltamethrin	SGS TW 43	<0.01	mg/l
Demeton-S-Methyl	SGS TW 43	<0.01	mg/l
Diazinon	SGS TW 43	<0.01	mg/l
Dichlobenil	SGS TW 43	<0.01	mg/l
Dichlofenthion	SGS TW 43	<0.01	mg/l

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15092016 0928 0000067921

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TESTS	METHOD	RESULT	UNITS
Chlorfenson	SGS TW 43	<0.01	mg/l
Chlorfenvinphos	SGS TW 43	<0.01	mg/l
Chlorflurenol	SGS TW 43	<0.01	mg/l
Chloropham	SGS TW 43	<0.01	mg/l
Chlorothalonil	SGS TW 43	<0.01	mg/l
Chlorpropham	SGS TW 43	<0.01	mg/l
Chlorpyrifos	SGS TW 43	<0.01	mg/l
Chlorpyrifos-ethyl	SGS TW 43	<0.01	mg/l
Chlorpyrifos-methyl	SGS TW 43	<0.01	mg/l
Chlozolinate	SGS TW 43	<0.01	mg/l
Clofentezine	SGS TW 43	<0.01	mg/l
Clothianidin	SGS TW 43	<0.01	mg/l
Coumaphos	SGS TW 43	<0.01	mg/l
Crotoxyphos	SGS TW 43	<0.01	mg/l
Cyanofenphos	SGS TW 43	<0.01	mg/l
Cyazofamid	SGS TW 43	<0.01	mg/l
Cycloate	SGS TW 43	<0.01	mg/l
Cycloxydim	SGS TW 43	<0.01	mg/l
Cyfluthrin (beta)	SGS TW 43	<0.01	mg/l
Cyhalothrin	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Bromacil	SGS TW 43	<0.01	mg/l
Bromophos(-methyl)	SGS TW 43	<0.01	mg/l
Bromophos-ethyl	SGS TW 43	<0.01	mg/l
Bromopropylate	SGS TW 43	<0.01	mg/l
Bromuconazole	SGS TW 43	<0.01	mg/l
Bupirimate	SGS TW 43	<0.01	mg/l
Buprofezin	SGS TW 43	<0.01	mg/l
Bifenthrin	SGS TW 43	<0.01	mg/l
Cadusafos	SGS TW 43	<0.01	mg/l
Captafol	SGS TW 43	<0.01	mg/l
Captan	SGS TW 43	<0.01	mg/l
Carbendazim	SGS TW 43	<0.01	mg/l
Carbofuran	SGS TW 43	<0.01	mg/l
Carbophenothion	SGS TW 43	<0.01	mg/l
Carboxin	SGS TW 43	<0.01	mg/l
Chinomethionat	SGS TW 43	<0.01	mg/l
Chlordane	SGS TW 43	<0.01	mg/l
Chlordane-cis	SGS TW 43	<0.01	mg/l
Chlordane-trans	SGS TW 43	<0.01	mg/l
Chlorfenapyr	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Aldrin	SGS TW 43	<0.01	mg/l
alpha-BHC	SGS TW 43	<0.01	mg/l
alphaCypermethrin	SGS TW 43	<0.01	mg/l
Ametryn	SGS TW 43	<0.01	mg/l
Amitraz	SGS TW 43	<0.01	mg/l
Aspon	SGS TW 43	<0.01	mg/l
Atraton	SGS TW 43	<0.01	mg/l
Atrazine	SGS TW 43	<0.01	mg/l
Azadirachtin	SGS TW 43	<0.01	mg/l
Azinphos-ethyl	SGS TW 43	<0.01	mg/l
Azinphos-methyl	SGS TW 43	<0.01	mg/l
Azoxystrobin	SGS TW 43	<0.01	mg/l
Benalaxyl	SGS TW 43	<0.01	mg/l
beta-BHC	SGS TW 43	<0.01	mg/l
beta-Cyfluthrin	SGS TW 43	<0.01	mg/l
Bifenox	SGS TW 43	<0.01	mg/l
Bifenthrin	SGS TW 43	<0.01	mg/l
Binapacryl	SGS TW 43	<0.01	mg/l
Bitertanol	SGS TW 43	<0.01	mg/l
Boscalid	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Iron as Fe	APHA 3120 B	0.04	mg/l
Manganese as Mn	APHA 3120 B	0.03	mg/l
Cadmium as Cd	APHA 3120 B	Not detected	mg/l
Chromium as Cr	APHA 3120 B	<0.007	mg/l
Copper as Cu	APHA 3120 B	<0.006	mg/l
Nickel as Ni	APHA 3120 B	<0.015	mg/l
Lead as Pb	APHA 3120 B	Not detected	ppm
Zinc as Zn	APHA 3120 B	<0.002	mg/l
Arsenic as As	APHA 3120 B	Not detected	mg/l
Boron as B	APHA 3120 B	0.04	mg/l
Sodium as Na	APHA 3120 B	68.16	mg/l
Mercury as Hg	SGS TW 12	Not detected	mg/l
2,4-D	SGS TW 43	<0.01	mg/l
Acephate	SGS TW 43	<0.01	mg/l
Acetamiprid	SGS TW 43	<0.01	mg/l
Acrinathrin	SGS TW 43	<0.01	mg/l
Alachlor	SGS TW 43	<0.01	mg/l
Aldicarb	SGS TW 43	<0.01	mg/l
Aldicarb-Sulfon	SGS TW 43	<0.01	mg/l
Aldicarb-Sulfoxid	SGS TW 43	<0.01	mg/l

Authorised Signatory — Walter Ogara - Multi-Lab Manager

Technical Signatory — Florah Mshimba-Chemist

Technical Signatory — Caroline Chege-Chemist

Date: 15/09/2016

SGS Kenya Limited Laboratory Services
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MINISTRY OF LAND ,HOUSING & URBAN DEVELOPMENT
P.O BOX 30450-00100
NAIROBI
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KENYA

Analysis Report MA16-04641.002

PRODUCT DESCRIPTION:	RIVER WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE RIVER WATER SAMPLE

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S - Subcontracted to SGS ISO 17025 Laboratory

TESTS	METHOD	RESULT	UNITS
Total coliform count	ISO 9308-2	>1800	MPN/100ml
Faecal coliform count	ISO 9308-2	110	MPN/100ml
pH	APHA 4500 H+	7.59	
Temperature		23.4	°C
Dissolved Oxygen	APHA EXT	6.70	mg/l
Conductivity at 25 °C	SGS TW 15	919.0	µS/cm
BOD 5 @ 20oC	APHA 5210 B	10	mg/l
Chemical Oxygen Demand	APHA 5220 D	23.68	mg/l
Total Suspended Solids	APHA 2540 C	8	mg/l
AMMONIA as N	APHA-4500- NH3 F	Nil	mg/l
Alkalinity Total	APHA 2320A	565	mg/l
Sulphate (SO4--)	APHA-4500-S04	3.29	mg/l
Nitrate as NO3-	APHA-4500-NO3	Nil	mg/l
Chloride (Cl-)	APHA-4500-CL B	42.11	mg/l
Fluoride as F-	APHA 4500 F- C	1.54	mg/l
Nitrite as NO2	APHA-4500-NO2	Nil	mg/l
Total Cyanide	APHA 4500 CN- C&D	Nil	mg/l
Calcium as Ca	APHA 3120 B	67.38	mg/l
Magnesium as Mg	APHA 3120 B	27.97	mg/l
Potassium as K	APHA 3120 B	1.34	mg/l

Authorised Signatory — Walter Ogara - Multi-Lab Manager

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Technical Signatory — Caroline Chege-Chemist

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Analysis Report MA16-04641.001

PRODUCT DESCRIPTION:	DAM WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE DAM WATER SAMPLE

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S - Subcontracted to SGS ISO 17025 Laboratory

TESTS	METHOD	RESULT	UNITS
Tri-Allate	SGS TW 43	<0.01	mg/l
Triazophos	SGS TW 43	<0.01	mg/l
Trichlorfon	SGS TW 43	<0.01	mg/l
Tridemorph	SGS TW 43	<0.01	mg/l
Trifloxystrobin	SGS TW 43	<0.01	mg/l
Triflumizole	SGS TW 43	<0.01	mg/l
Triflumuron	SGS TW 43	<0.01	mg/l
Trifluralin	SGS TW 43	<0.01	mg/l
Triforine	SGS TW 43	<0.01	mg/l
Vamidothion	SGS TW 43	<0.01	mg/l
Vernolate	SGS TW 43	<0.01	mg/l
Vinclozolin	SGS TW 43	<0.01	mg/l
Zetacypermethrin	SGS TW 43	<0.01	mg/l
Zinophos	SGS TW 43	<0.01	mg/l
Ziram	SGS TW 43	<0.01	mg/l
S - Total Organic Carbon	DIN EN 1484	4.40	mg/l
S - Molybdate Reactive Phosphorus	EN ISO 6878	0.04	mg/l

Authorised Signatory — Walter Ogara - Multi-Lab Manager

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Analysis Report MA16-04641.001

PRODUCT DESCRIPTION:	DAM WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE DAM WATER SAMPLE

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S - Subcontracted to SGS ISO 17025 Laboratory

TESTS	METHOD	RESULT	UNITS
Tecnazene	SGS TW 43	<0.01	mg/l
Teflubenzuron	SGS TW 43	<0.01	mg/l
Terbacil	SGS TW 43	<0.01	mg/l
Terbufos	SGS TW 43	<0.01	mg/l
Terbuthylazine	SGS TW 43	<0.01	mg/l
Terbutryn	SGS TW 43	<0.01	mg/l
Tetrachlorvinphos	SGS TW 43	<0.01	mg/l
Tetraconazole	SGS TW 43	<0.01	mg/l
Tetradifon	SGS TW 43	<0.01	mg/l
Tetramethrin	SGS TW 43	<0.01	mg/l
Thiabendazole	SGS TW 43	<0.01	mg/l
Thiacloprid	SGS TW 43	<0.01	mg/l
Thiamethoxam	SGS TW 43	<0.01	mg/l
Thiodicarb	SGS TW 43	<0.01	mg/l
Thiometon	SGS TW 43	<0.01	mg/l
Thiram	SGS TW 43	<0.01	mg/l
Tolclofos-methyl	SGS TW 43	<0.01	mg/l
Tolylfluanid	SGS TW 43	<0.01	mg/l
Triadimefon	SGS TW 43	<0.01	mg/l
Triadimenol	SGS TW 43	<0.01	mg/l

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Analysis Report MA16-04641.001

PRODUCT DESCRIPTION:	DAM WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE DAM WATER SAMPLE

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S - Subcontracted to SGS ISO 17025 Laboratory

TESTS	METHOD	RESULT	UNITS
Pyriproxyfen	SGS TW 43	<0.01	mg/l
Quinalphos	SGS TW 43	<0.01	mg/l
Quinoxyfen	SGS TW 43	<0.01	mg/l
Quintozene	SGS TW 43	<0.01	mg/l
Rotenone	SGS TW 43	<0.01	mg/l
S 421	SGS TW 43	<0.01	mg/l
Simazin	SGS TW 43	<0.01	mg/l
Spirotetramat	SGS TW 43	<0.01	mg/l
Spiroxamine	SGS TW 43	<0.01	mg/l
Sulfotep	SGS TW 43	<0.01	mg/l
Sum Aldrin/Dieldrin/Endrin	SGS TW 43	<0.01	mg/l
Sum Chlordane	SGS TW 43	<0.01	mg/l
Sum DDD/DDE/DDT	SGS TW 43	<0.01	mg/l
Sum Endosulfan	SGS TW 43	<0.01	mg/l
Sum HCH	SGS TW 43	<0.01	mg/l
Symetrin	SGS TW 43	<0.01	mg/l
Tau fluvalinate	SGS TW 43	<0.01	mg/l
Tebuconazole	SGS TW 43	<0.01	mg/l
Tebufenozide	SGS TW 43	<0.01	mg/l
Tebufenpyrad	SGS TW 43	<0.01	mg/l

Authorised Signatory | *Technical Signatory* | *Technical Signatory*

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DATE SAMPLED:	17/08/2016
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TESTS	METHOD	RESULT	UNITS
Procymidone	SGS TW 43	<0.01	mg/l
Profenofos	SGS TW 43	<0.01	mg/l
Profluralin	SGS TW 43	<0.01	mg/l
Prometon	SGS TW 43	<0.01	mg/l
Prometryne	SGS TW 43	<0.01	mg/l
Propamocarb	SGS TW 43	<0.01	mg/l
Propargite	SGS TW 43	<0.01	mg/l
Propazine	SGS TW 43	<0.01	mg/l
Propham	SGS TW 43	<0.01	mg/l
Propiconazole	SGS TW 43	<0.01	mg/l
Propoxur	SGS TW 43	<0.01	mg/l
Propyzamide	SGS TW 43	<0.01	mg/l
Prothiofos	SGS TW 43	<0.01	mg/l
Pyraclostrobin	SGS TW 43	<0.01	mg/l
Pyrazophos	SGS TW 43	<0.01	mg/l
Pyrethrins	SGS TW 43	<0.01	mg/l
Pyridaben	SGS TW 43	<0.01	mg/l
Pyridaphenthion	SGS TW 43	<0.01	mg/l
Pyrifenox	SGS TW 43	<0.01	mg/l
Pyrimethanil	SGS TW 43	<0.01	mg/l

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PRODUCT DESCRIPTION:	DAM WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
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S - Subcontracted to SGS ISO 17025 Laboratory

TESTS	METHOD	RESULT	UNITS
Pebulate	SGS TW 43	<0.01	mg/l
Penconazole	SGS TW 43	<0.01	mg/l
Pencycuron	SGS TW 43	<0.01	mg/l
Pendimethalin/Stomp	SGS TW 43	<0.01	mg/l
Permethrin	SGS TW 43	<0.01	mg/l
Permethrin I	SGS TW 43	<0.01	mg/l
Permethrin II	SGS TW 43	<0.01	mg/l
Pesticide residues	SGS TW 43	<0.01	mg/l
Phenthoate	SGS TW 43	<0.01	mg/l
Phorate	SGS TW 43	<0.01	mg/l
Phosalone	SGS TW 43	<0.01	mg/l
Phosmet	SGS TW 43	<0.01	mg/l
Phosphamidon	SGS TW 43	<0.01	mg/l
Phoxim	SGS TW 43	<0.01	mg/l
Picoxystrobin	SGS TW 43	<0.01	mg/l
Piperonyl-butoxide	SGS TW 43	<0.01	mg/l
Pirimicarb	SGS TW 43	<0.01	mg/l
Pirimiphos-ethyl	SGS TW 43	<0.01	mg/l
Pirimiphos-methyl	SGS TW 43	<0.01	mg/l
Prochloraz	SGS TW 43	<0.01	mg/l

Authorised Signatory — Walter Ogara - Multi-Lab Manager

Technical Signatory — Florah Mshimba-Chemist

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Analysis Report MA16-04641.001

PRODUCT DESCRIPTION:	DAM WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE DAM WATER SAMPLE

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TESTS	METHOD	RESULT	UNITS
Metolachlor	SGS TW 43	<0.01	mg/l
Metribuzin	SGS TW 43	<0.01	mg/l
Mevinphos	SGS TW 43	<0.01	mg/l
Monilate	SGS TW 43	<0.01	mg/l
Monocrotophos	SGS TW 43	<0.01	mg/l
MSMA	SGS TW 43	<0.01	mg/l
Myclobutanil	SGS TW 43	<0.01	mg/l
Nitrofen	SGS TW 43	<0.01	mg/l
Nuarimol	SGS TW 43	<0.01	mg/l
Omethoate	SGS TW 43	<0.01	mg/l
Orthophenylphenol	SGS TW 43	<0.01	mg/l
Oxadixyl	SGS TW 43	<0.01	mg/l
Oxamyl	SGS TW 43	<0.01	mg/l
Paclobutrazol	SGS TW 43	<0.01	mg/l
Paraoxon (etil)	SGS TW 43	<0.01	mg/l
Paraoxon-methyl	SGS TW 43	<0.01	mg/l
Paraquat	SGS TW 43	<0.01	mg/l
Parathion	SGS TW 43	<0.01	mg/l
Parathion-methyl	SGS TW 43	<0.01	mg/l
PCBs	SGS TW 43	<0.01	mg/l

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Analysis Report MA16-04641.001

PRODUCT DESCRIPTION:	DAM WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE DAM WATER SAMPLE

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S - Subcontracted to SGS ISO 17025 Laboratory

TESTS	METHOD	RESULT	UNITS
Linuron	SGS TW 43	<0.01	mg/l
Lufenuron	SGS TW 43	<0.01	mg/l
Malaoxon	SGS TW 43	<0.01	mg/l
Malathion	SGS TW 43	<0.01	mg/l
Mecarbam	SGS TW 43	<0.01	mg/l
Mefenoxam	SGS TW 43	<0.01	mg/l
Mepanipyrim	SGS TW 43	<0.01	mg/l
Mepronil	SGS TW 43	<0.01	mg/l
Metalaxyl	SGS TW 43	<0.01	mg/l
Metalaxyl-M	SGS TW 43	<0.01	mg/l
Metamitron	SGS TW 43	<0.01	mg/l
Metazachlor	SGS TW 43	<0.01	mg/l
Methacrifos	SGS TW 43	<0.01	mg/l
Methamidophos	SGS TW 43	<0.01	mg/l
Methidathion	SGS TW 43	<0.01	mg/l
Methiocarb	SGS TW 43	<0.01	mg/l
Methiram	SGS TW 43	<0.01	mg/l
Methomyl	SGS TW 43	<0.01	mg/l
Methoxychlor	SGS TW 43	<0.01	mg/l
Metobromuron	SGS TW 43	<0.01	mg/l

Authorised Signatory | *Technical Signatory* | *Technical Signatory*

Walter Ogara - Multi-Lab Manager | Florah Mshimba-Chemist | Caroline Chege-Chemist

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Analysis Report MA16-04641.001

PRODUCT DESCRIPTION:	DAM WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG'A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE DAM WATER SAMPLE

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TESTS	METHOD	RESULT	UNITS
Heptachlor	SGS TW 43	<0.01	mg/l
Heptachlor epoxide	SGS TW 43	<0.01	mg/l
Heptachlorepoxide-cis	SGS TW 43	<0.01	mg/l
Heptachlorepoxide-trans	SGS TW 43	<0.01	mg/l
Heptenophos	SGS TW 43	<0.01	mg/l
Hexachlorobenzene (HCB)	SGS TW 43	<0.01	mg/l
Hexaconazole	SGS TW 43	<0.01	mg/l
Hexaflumuron	SGS TW 43	<0.01	mg/l
Hexythiazox	SGS TW 43	<0.01	mg/l
Hydramethylnon	SGS TW 43	<0.01	mg/l
Imazalil	SGS TW 43	<0.01	mg/l
Imidacloprid	SGS TW 43	<0.01	mg/l
Indoxacarb	SGS TW 43	<0.01	mg/l
Iprodione	SGS TW 43	<0.01	mg/l
Iprovalicarb	SGS TW 43	<0.01	mg/l
Isocarbophos	SGS TW 43	<0.01	mg/l
Isofenphos	SGS TW 43	<0.01	mg/l
Kresoxim-methyl	SGS TW 43	<0.01	mg/l
Leptophos	SGS TW 43	<0.01	mg/l
Lindane	SGS TW 43	<0.01	mg/l

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PRODUCT DESCRIPTION:	DAM WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE DAM WATER SAMPLE

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TESTS	METHOD	RESULT	UNITS
Fludioxonil	SGS TW 43	<0.01	mg/l
Flufenoxuron	SGS TW 43	<0.01	mg/l
Fluquinconazole	SGS TW 43	<0.01	mg/l
Flusilazole	SGS TW 43	<0.01	mg/l
Flutonil	SGS TW 43	<0.01	mg/l
Fluvalinate	SGS TW 43	<0.01	mg/l
Folpet	SGS TW 43	<0.01	mg/l
Fonofos	SGS TW 43	<0.01	mg/l
Fosthiazate	SGS TW 43	<0.01	mg/l
Furfural	SGS TW 43	<0.01	mg/l
gamma-BHC	SGS TW 43	<0.01	mg/l
gamma-Cyhalothrin	SGS TW 43	<0.01	mg/l
Glufosinateammonium	SGS TW 43	<0.01	mg/l
Glyphosate	SGS TW 43	<0.01	mg/l
Halfenprox	SGS TW 43	<0.01	mg/l
HCH (alfa)	SGS TW 43	<0.01	mg/l
HCH (beta)	SGS TW 43	<0.01	mg/l
HCH (delta)	SGS TW 43	<0.01	mg/l
HCH (gamma)	SGS TW 43	<0.01	mg/l
HCH sum no Lindane	SGS TW 43	<0.01	mg/l

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DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
SAMPLE RECEIVED:	22/08/2016
ANALYSIS STARTED:	22/08/2016
MARKS:	CONDITION OF THE SAMPLE:DELIVERED IN A STERILIN PLASTIC BOTTLE DAM WATER SAMPLE

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TESTS	METHOD	RESULT	UNITS
Fenarimol	SGS TW 43	<0.01	mg/l
Fenazaquin	SGS TW 43	<0.01	mg/l
Fenbuconazole	SGS TW 43	<0.01	mg/l
Fenchlorphos	SGS TW 43	<0.01	mg/l
Fenhexamid	SGS TW 43	<0.01	mg/l
Fenitrothion	SGS TW 43	<0.01	mg/l
Fenothrin	SGS TW 43	<0.01	mg/l
Fenoxycarb	SGS TW 43	<0.01	mg/l
Fenpropathrin	SGS TW 43	<0.01	mg/l
Fenpropidine	SGS TW 43	<0.01	mg/l
Fenpropimorph	SGS TW 43	<0.01	mg/l
Fenpyroximate	SGS TW 43	<0.01	mg/l
Fenson	SGS TW 43	<0.01	mg/l
Fenthion	SGS TW 43	<0.01	mg/l
Fenthion-Sulfone	SGS TW 43	<0.01	mg/l
Fenthion-Sulfoxide	SGS TW 43	<0.01	mg/l
Fenvalerate	SGS TW 43	<0.01	mg/l
Fipronil	SGS TW 43	<0.01	mg/l
Flocoumafen	SGS TW 43	<0.01	mg/l
Flucythrinate	SGS TW 43	<0.01	mg/l

Authorised Signatory | *Technical Signatory* | *Technical Signatory*

Walter Ogara - Multi-Lab Manager | Florah Mshimba-Chemist | Caroline Chege-Chemist

Date: 15/09/2016

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MINISTRY OF LAND ,HOUSING & URBAN DEVELOPMENT
P.O BOX 30450-00100
NAIROBI
ARDHI HOUSE 1ST NGONG AVENUE
KENYA

Analysis Report MA16-04641.001

PRODUCT DESCRIPTION:	DAM WATER
SAMPLED BY:	SGS
DATE SAMPLED:	17/08/2016
SAMPLING LOCATION:	MURANG`A LAND FILL
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TESTS	METHOD	RESULT	UNITS
Endosulfan (beta)	SGS TW 43	<0.01	mg/l
Endosulfansulfate	SGS TW 43	<0.01	mg/l
Endrin	SGS TW 43	<0.01	mg/l
Endrin Aldehyde	SGS TW 43	<0.01	mg/l
Endrin Ketone	SGS TW 43	<0.01	mg/l
EPN	SGS TW 43	<0.01	mg/l
Epoxiconazole	SGS TW 43	<0.01	mg/l
EPTC	SGS TW 43	<0.01	mg/l
Esfenvalerate	SGS TW 43	<0.01	mg/l
Ethephon	SGS TW 43	<0.01	mg/l
Ethiofencarb	SGS TW 43	<0.01	mg/l
Ethion	SGS TW 43	<0.01	mg/l
Ethofumesate	SGS TW 43	<0.01	mg/l
Ethoprophos	SGS TW 43	<0.01	mg/l
Ethoxyquin	SGS TW 43	<0.01	mg/l
Etofenprox	SGS TW 43	<0.01	mg/l
Etridiazole	SGS TW 43	<0.01	mg/l
Etrimfos	SGS TW 43	<0.01	mg/l
Famoxadon	SGS TW 43	<0.01	mg/l
Fenamiphos	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Dichlofluanid	SGS TW 43	<0.01	mg/l
Dichlorvos	SGS TW 43	<0.01	mg/l
Dicloran	SGS TW 43	<0.01	mg/l
Dicofol	SGS TW 43	<0.01	mg/l
Dicrotophos	SGS TW 43	<0.01	mg/l
Dieldrin	SGS TW 43	<0.01	mg/l
Diethofencarb	SGS TW 43	<0.01	mg/l
Difenoconazole	SGS TW 43	<0.01	mg/l
Diflubenzuron	SGS TW 43	<0.01	mg/l
Diflufenican	SGS TW 43	<0.01	mg/l
Dimethoate	SGS TW 43	<0.01	mg/l
Dimethomorph	SGS TW 43	<0.01	mg/l
Dimethrin	SGS TW 43	<0.01	mg/l
Diniconazole	SGS TW 43	<0.01	mg/l
Dioxathion	SGS TW 43	<0.01	mg/l
Diphenylamine	SGS TW 43	<0.01	mg/l
Disulfoton	SGS TW 43	<0.01	mg/l
Ditalimfos	SGS TW 43	<0.01	mg/l
Diuron	SGS TW 43	<0.01	mg/l
Endosulfan (alpha)	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Cyhalothrin (lambda)	SGS TW 43	<0.01	mg/l
Cymoxanil	SGS TW 43	<0.01	mg/l
Cypermethrin	SGS TW 43	<0.01	mg/l
Cyproconazole	SGS TW 43	<0.01	mg/l
Cyprodinil	SGS TW 43	<0.01	mg/l
Cyromazine	SGS TW 43	<0.01	mg/l
Dazomet	SGS TW 43	<0.01	mg/l
DDD, o,p,	SGS TW 43	<0.01	mg/l
DDD, p,p,	SGS TW 43	<0.01	mg/l
DDE, o,p,	SGS TW 43	<0.01	mg/l
DDE, p,p,	SGS TW 43	<0.01	mg/l
DDT	SGS TW 43	<0.01	mg/l
DDT, o,p,	SGS TW 43	<0.01	mg/l
DDT, p,p,	SGS TW 43	<0.01	mg/l
delta-BHC	SGS TW 43	<0.01	mg/l
Deltamethrin	SGS TW 43	<0.01	mg/l
Demeton-S-Methyl	SGS TW 43	<0.01	mg/l
Diazinon	SGS TW 43	<0.01	mg/l
Dichlobenil	SGS TW 43	<0.01	mg/l
Dichlofenthion	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Chlorfenson	SGS TW 43	<0.01	mg/l
Chlorfenvinphos	SGS TW 43	<0.01	mg/l
Chlorflurenol	SGS TW 43	<0.01	mg/l
Chloropham	SGS TW 43	<0.01	mg/l
Chlorothalonil	SGS TW 43	<0.01	mg/l
Chlorpropham	SGS TW 43	<0.01	mg/l
Chlorpyrifos	SGS TW 43	<0.01	mg/l
Chlorpyrifos-ethyl	SGS TW 43	<0.01	mg/l
Chlorpyrifos-methyl	SGS TW 43	<0.01	mg/l
Chlozolinate	SGS TW 43	<0.01	mg/l
Clofentezine	SGS TW 43	<0.01	mg/l
Clothianidin	SGS TW 43	<0.01	mg/l
Coumaphos	SGS TW 43	<0.01	mg/l
Crotoxyphos	SGS TW 43	<0.01	mg/l
Cyanofenphos	SGS TW 43	<0.01	mg/l
Cyazofamid	SGS TW 43	<0.01	mg/l
Cycloate	SGS TW 43	<0.01	mg/l
Cycloxydim	SGS TW 43	<0.01	mg/l
Cyfluthrin (beta)	SGS TW 43	<0.01	mg/l
Cyhalothrin	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Bromacil	SGS TW 43	<0.01	mg/l
Bromophos(-methyl)	SGS TW 43	<0.01	mg/l
Bromophos-ethyl	SGS TW 43	<0.01	mg/l
Bromopropylate	SGS TW 43	<0.01	mg/l
Bromuconazole	SGS TW 43	<0.01	mg/l
Bupirimate	SGS TW 43	<0.01	mg/l
Buprofezin	SGS TW 43	<0.01	mg/l
Bifenthrin	SGS TW 43	<0.01	mg/l
Cadusafos	SGS TW 43	<0.01	mg/l
Captafol	SGS TW 43	<0.01	mg/l
Captan	SGS TW 43	<0.01	mg/l
Carbendazim	SGS TW 43	<0.01	mg/l
Carbofuran	SGS TW 43	<0.01	mg/l
Carbophenothion	SGS TW 43	<0.01	mg/l
Carboxin	SGS TW 43	<0.01	mg/l
Chinomethionat	SGS TW 43	<0.01	mg/l
Chlordane	SGS TW 43	<0.01	mg/l
Chlordane-cis	SGS TW 43	<0.01	mg/l
Chlordane-trans	SGS TW 43	<0.01	mg/l
Chlorfenapyr	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Aldrin	SGS TW 43	<0.01	mg/l
alpha-BHC	SGS TW 43	<0.01	mg/l
alphaCypermethrin	SGS TW 43	<0.01	mg/l
Ametryn	SGS TW 43	<0.01	mg/l
Amitraz	SGS TW 43	<0.01	mg/l
Aspon	SGS TW 43	<0.01	mg/l
Atraton	SGS TW 43	<0.01	mg/l
Atrazine	SGS TW 43	<0.01	mg/l
Azadirachtin	SGS TW 43	<0.01	mg/l
Azinphos-ethyl	SGS TW 43	<0.01	mg/l
Azinphos-methyl	SGS TW 43	<0.01	mg/l
Azoxystrobin	SGS TW 43	<0.01	mg/l
Benalaxyl	SGS TW 43	<0.01	mg/l
beta-BHC	SGS TW 43	<0.01	mg/l
beta-Cyfluthrin	SGS TW 43	<0.01	mg/l
Bifenox	SGS TW 43	<0.01	mg/l
Bifenthrin	SGS TW 43	<0.01	mg/l
Binapacryl	SGS TW 43	<0.01	mg/l
Bitertanol	SGS TW 43	<0.01	mg/l
Boscalid	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Iron as Fe	APHA 3120 B	0.37	mg/l
Manganese as Mn	APHA 3120 B	0.05	mg/l
Cadmium as Cd	APHA 3120 B	Not detected	mg/l
Chromium as Cr	APHA 3120 B	<0.007	mg/l
Copper as Cu	APHA 3120 B	<0.006	mg/l
Nickel as Ni	APHA 3120 B	<0.015	mg/l
Lead as Pb	APHA 3120 B	Not detected	ppm
Zinc as Zn	APHA 3120 B	0.01	mg/l
Arsenic as As	APHA 3120 B	Not detected	mg/l
Boron as B	APHA 3120 B	<0.005	mg/l
Sodium as Na	APHA 3120 B	5.10	mg/l
Mercury as Hg	SGS TW 12	Not detected	mg/l
2,4-D	SGS TW 43	<0.01	mg/l
Acephate	SGS TW 43	<0.01	mg/l
Acetamiprid	SGS TW 43	<0.01	mg/l
Acrinathrin	SGS TW 43	<0.01	mg/l
Alachlor	SGS TW 43	<0.01	mg/l
Aldicarb	SGS TW 43	<0.01	mg/l
Aldicarb-Sulfon	SGS TW 43	<0.01	mg/l
Aldicarb-Sulfoxid	SGS TW 43	<0.01	mg/l

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TESTS	METHOD	RESULT	UNITS
Total coliform count	ISO 9308-2	>1800	MPN/100ml
Faecal coliform count	ISO 9308-2	1600	MPN/100ml
pH	APHA 4500 H+	6.32	
Temperature		23.1	°C
Dissolved Oxygen	APHA EXT	1.40	mg/l
Conductivity at 25 °C	SGS TW 15	134.2	µS/cm
BOD 5 @ 20oC	APHA 5210 B	17.5	mg/l
Chemical Oxygen Demand	APHA 5220 D	31.74	mg/l
Total Suspended Solids	APHA 2540 C	14	mg/l
AMMONIA as N	APHA-4500- NH3 F	0.68	mg/l
Alkalinity Total	APHA 2320A	70	mg/l
Sulphate (SO4--)	APHA-4500-S04	0.82	mg/l
Nitrate as NO3-	APHA-4500-NO3	Nil	mg/l
Chloride (Cl-)	APHA-4500-CL B	25.74	mg/l
Fluoride as F-	APHA 4500 F- C	0.58	mg/l
Nitrite as NO2	APHA-4500-NO2	Nil	mg/l
Total Cyanide	APHA 4500 CN- C&D	Nil	mg/l
Calcium as Ca	APHA 3120 B	8.06	mg/l
Magnesium as Mg	APHA 3120 B	2.72	mg/l
Potassium as K	APHA 3120 B	3.68	mg/l

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Annex 12: Air Dispersion Modelling-Mitubiri