

# **ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR THE PROPOSED 80MW THERMAL POWER PLANT AT THIKA**



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**MAY 2011**

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**ABBREVIATIONS AND ACRONYMS**

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AIDS	-	Acquired Immune Deficiency Syndrome
ASALs	-	Arid and Semi-arid lands
ASL	-	Above Sea Level
CBOs	-	Community Based Organizations
CEMP	-	Construction Environment Management Plan
DCC	-	Diesel Combined Cycle
DDPs	-	District Development Plans
DEMC	-	District Environmental Management Committee
DHP	-	Designated Health Practitioner
DO	-	District Officer
DWO	-	District Water Officer
EA	-	Environmental Audit
EIA	-	Environmental Impact Assessment
EHS	-	Environmental Health and Safety
EMCA	-	Environmental Management Coordination Act
EMP	-	Environmental Management Plan
EMS	-	Environment Management System
EPA	-	Environmental Protection Agency
ERC	-	Energy Regulatory Commission
ESIA	-	Environmental and Social Impact Assessment
ESAP	-	Environmental and Social Action Plan
ESMP	-	Environmental and Social Management Plans
FGD	-	Flue Gas Desulfurization
FPE	-	Free Primary Education
GDP	-	Geo-Data-Base
GoK	-	Government of Kenya
GPS	-	Geographical Positioning System
Ha	-	Hectares
HFO	-	Heavy Fuel Oil

HIV	-	Human Immuno-deficiency Virus
Hr	-	Hour
HSE	-	Health Safety and Environment
IPP	-	Independent Power Producer
ISO	-	International Standards Organization
Km	-	Kilometres
kV	-	Kilo Volt
KPLC	-	Kenya Power and Lighting Company
LCP	-	Local control panel
MoH	-	Ministry of Health
MoE	-	Ministry of Energy
MSD	-	Medium Speed Diesel
MW	-	Mega Watts
MWe	-	Mega Watts equivalent
NEAP	-	National Environment Action Plan
NEMA	-	National Environmental Management Authority
NGOs	-	Non-Governmental Organizations
OSHA	-	Occupational Safety and Health
PCC	-	Public Complaints Committee
PPE	-	Personal Protective Equipments
PRSP	-	Poverty Reduction Strategy Paper
RBCA	-	Risk Based Corrective Action
SCADA	-	Supervisory Control and Data Acquisition
SERC	-	Standards and Enforcement Review Committee
STIs	-	Sexually Transmitted Infections
TOR	-	Terms of Reference
TPH	-	Total Petroleum Hydrocarbons
WHO	-	World Health Organization

## EXECUTIVE SUMMARY

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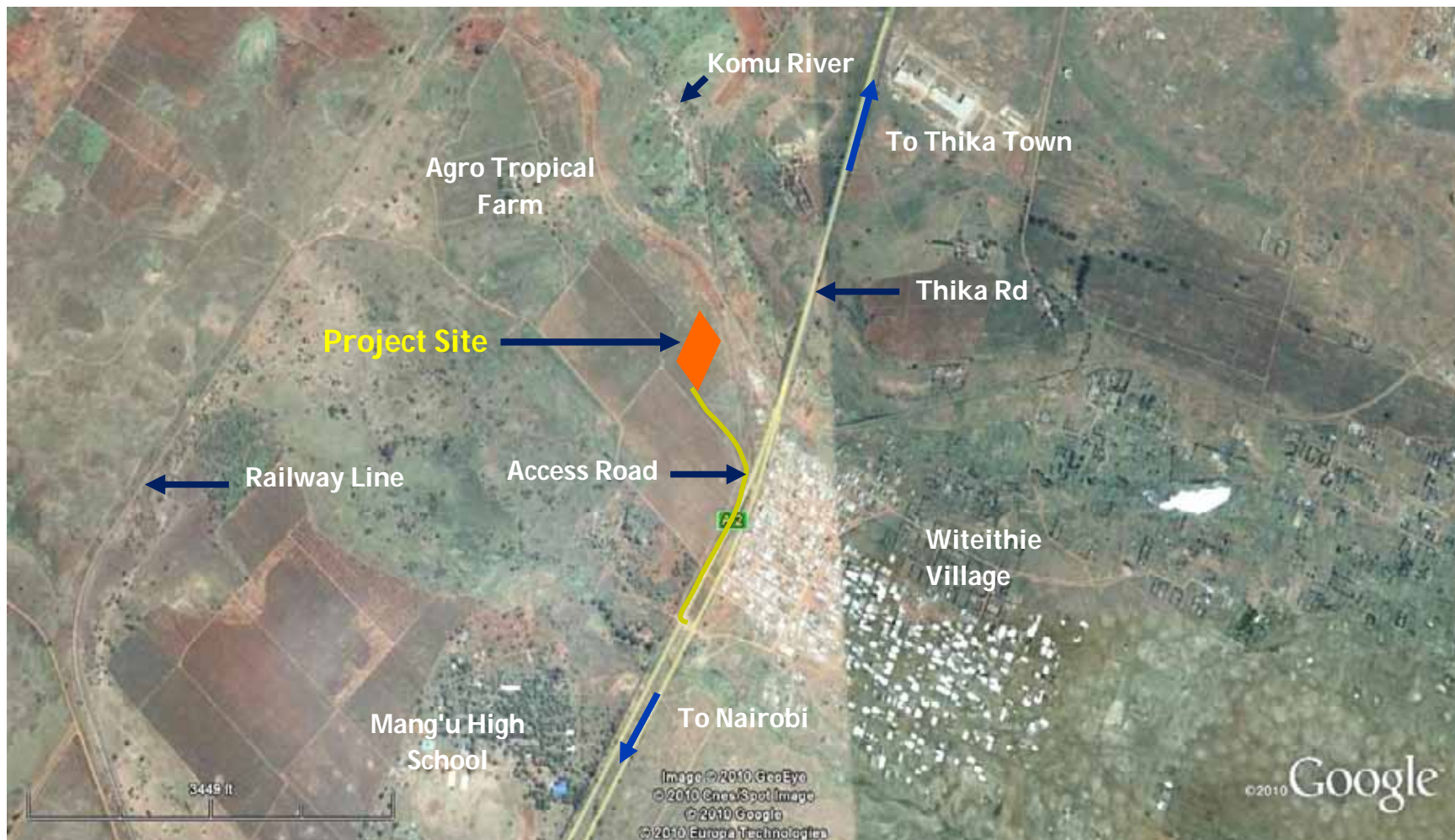
### Introduction

The Kenya Power and Lighting Company (KPLC) have awarded Malec PowerGen Ltd, an independent power producer, a contract for installation of a Medium Speed Diesel (MSD) thermal power plant to generate 80 MW of electricity at a site in Thika. The proposed site is along Nairobi-Thika Highway, about 38 km from Nairobi City Centre and 6 km to Thika Town (Figure 1). The site is on plot number L.R. 8380/2, measuring approximately 4 ha (10 acres) next to Mang'u High School and opposite Witeithie Village.

In Kenya, all new projects are required to undertake Environmental Impact Assessment (EIA) study at the planning stage to ensure that all significant environmental impacts are taken into consideration at the implantation stage. Thermal power plants are categorized by the Environmental Management and Coordination Act (EMCA) of 1999 in the Second schedule and, therefore, require a full EIA study. The Enviroplan & Management Consultants were appointed to conduct the Environmental Impact Assessment of the proposed MSD Power Project. The scope of the assessment covers preconstruction phase, construction works of the proposed development which include ground preparation, civil works, structural works, Installation of the generators, installation of service lines as well as the utilities required, operational and decommission phases of the thermal power plant. The study is to be carried out within the Legal Framework and Policies in Kenya as stipulate in the EMCA (1999). This EIA Study report presents the EIA process, findings and Environmental and Social Management Plans (ESMP) for the proposed power plant. The National Environment Management Authority (NEMA) is the lead agency in Kenya responsible for authorization of this project in consultation with other relevant lead agencies such as the Energy Regulatory Commission (ERC). The output of the study work is a comprehensive Environmental Impact Assessment Project Report for the purposes of seeking a

NEMA license that will approve the project construction and operation.





**Figure 1 Satellite Image of the proposed Thermal Power Plant Site at Thika**

## **Study Objectives**

The study objectives were to:

1. Conduct an Environmental and Social Impact Assessment to identify both positive and negative impacts of the proposed project and propose most appropriate interventions during construction, operation and decommissioning of the project.
2. Collect baseline socioeconomic data of the project area and potential impact expected from project construction, implementation, operation, and decommissioning.
3. Develop an Environmental Monitoring Program during construction and operation and present plans to minimize, mitigate, or eliminate negative effects and impacts.
4. Describe Environmental Management Plan implementation mechanisms; review the power plant design and its compliance to environmental requirements.
5. Identify and contact stakeholders to seek their views on the proposed project.

## **Project Description**

The proposed site for the power plant is at Thika on 4 ha Plot No. L.R. 8380/2 located on the opposite side of Nairobi – Thika Highway from Witeithie (Figure 1). The site was part of a 60 ha farm owned by Agro Tropical Ltd site and purchased by KPLC on a willing buyer, willing seller basis. Subsequently, KPLC has obtained a Change of User from agricultural to commercial (See Appendix 2.1). The project site was a coffee farm; however, on selling the plot, the vendor uprooted the coffee and the site is now vacant (Plate 1). Consequently, implementation of the project will not involve relocation of people.



**Plate 1 Coffee Bushes on the Proposed Thermal Plant Site, that were later uprooted**

#### **Technical Specifications**

The Thika Power Plant will consist of five MAN 4-stroke medium speed diesel engines 18V48/60 and a steam turbine with a combined capacity of 80 MW, transformers, cables, switchgear, protection and metering equipment. Generation will be at 15 kV for step-up to 132 kV by a sub-station that will be constructed for the subsequent transmission of the generated electricity. The design and selected equipment with adequate redundancy will provide dependable power with high reliability. The design is utilized in such a way that the units will remain running even after a fault in the integrated network system, and thus can be re-synchronized very quickly.

A Black Start diesel generator of 700 kVA capacity have been included for start up in the event of a total system collapse. A Diesel Combined Cycle (DCC) unit has been included that is capable of supplying a further 7MW net output from exhaust gases. This will make the plant more fuel efficient and save KPLC and the electricity consumer additional fuel costs. The plant shall be environmentally sensitive and will include a Sludge Treatment and

Incinerator for disposal of liquid and solid wastes.

Fuel will be delivered to site by road tankers and pumped into three 45,000 m<sup>3</sup> storage tanks with a 30 day fuel reserve. The plant is capable of converting to gas fuel, at a cost, should the need arise. Costs of plant conversions have not been included in the capacity charge.

The project life is envisaged in three phases; namely, construction, operation and decommissioning.

### **EIA NEMA Process and Timing**

To ensure sustainable use of natural resources, the Government of Kenya has developed Environmental Impact Assessment (EIA) procedures and guidelines for all projects carried out in the country. In 1994, the government developed the National Environment Action Plan (NEAP) to combine economic development with environmental conservation through:

- ✓ Integration of environmental principles into development planning.
- ✓ Promotion of environmental sound usage of renewable and non-renewable resources.
- ✓ Establishment of an institutional framework for the coordination, monitoring and enforcement of environmental legislation as well as providing the manpower to do so.

In 1996, the Physical Planning Act was legislated and aims to provide for the preparation and implementation of physical development plans (Mumma, 1998). The act empowers local authorities to review project applications and to grant permission for developments. A separate act, the Environmental Management and Coordination Act (NEMA), was enacted in 1999 with the aim of identifying projects and programmes, plans and policies for which environmental impact assessment, environmental audits and environmental monitoring must be conducted under the Act.

This study was carried out through desk study and field investigations. During the field investigation, reconnaissance survey was conducted to gather

information on biophysical and socioeconomic aspects of the area and its environs. In order to address these issues the study team adopted a participatory approach where the communities were consulted in addition to reviews and references to sources of information including legal statutes, design and relevant project documents. Among the key activities undertaken during the assessment were:

1. Interviews and consultations with the immediate neighbours.
2. Physical inspection of the proposed site.
3. Evaluation of the activities around the site and the environmental setting of the wider area, through physical observations, baseline studies and monitoring of soil, air and water.

Following notification, Public consultations with the affected and interested neighbours to the thermal power plant were conducted. The approach adopted included administration of questionnaires to individuals and group participation in public meetings.

### **The Terms of Reference (TOR) for the EIA**

This EIA was required to carry out the following tasks:

1. Establish the suitability of the site for the set up of a MSD Power Plant at Thika.
2. A concise description of the national environmental legislative and regulatory framework, baseline information, and any other relevant information related to the project.
3. A description of the technology, procedures and processes to be used, in the implementation of the project.
4. A description of materials to be used in the construction and implementation of the project, the products, by-products and waste to be generated by the project.
5. A description of the potentially affected environment.
6. Conduct specialized baseline surveys on air, water, soil and noise pollution in the proposed project area.



7. Assessment of ground and surface water sources for the proposed thermal power
8. A description of environmental effects of the project including the social and cultural effects and the anticipated direct, indirect, cumulative, irreversible, short-term and long-term effects.
9. To recommend a specific environmentally sound and affordable wastewater management system.
10. Provide alternative technologies and processes available and reasons for preferring the chosen technology and processes.
11. Analysis of alternatives including project site, design and technologies.
12. Development of an Environmental and Social Management Plan (ESMP) proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment, including the cost, timeframe and responsibility to implement the measures.
13. Provide an action plan for the prevention and management of the foreseeable accidents and hazardous activities in the course of project construction, operation and decommissioning.
14. Propose measures to prevent health hazards and to ensure safety in the working environment for the employees and the neighboring community.

### **Project Alternatives**

#### **No Option Alternative**

The Kenya Electricity Generating Company Limited (KenGen) is currently able to generate about 85% of the total demand. Independent power producers (IPPs) contribute the balance of 15%. KenGen is working towards enhancing its capacity through hydro-plants and geothermal sources among other initiatives. However, additional sources will still be required to meet the anticipated growth in demand and provide diversification of technology and fuels especially in the short to medium term. Not constructing the power plant would mean that benefits, including improved electric power supply and the associated national economic benefits, would not transpire. At the

same time, the negative impacts associated with the project would not materialize. Hence the 'No Action' alternative is not feasible for Kenya.

### **Options for Power Generation**

Generation capacity in Kenya is presently provided by hydropower (62%), conventional thermal power (26%) and geothermal power (12%). At present the total installed capacity in Kenya and interconnected to the transmission and distribution systems amounts to 1219 MW (effective 1045 MW) with a peak demand of 976 MW. While KenGen is working towards enhancing its capacity through refurbishment of its hydro-plants, extending geothermal sources and completion of an investment program that will integrate the existing gas turbine (64 MW) and diesel plants (72 MW) at Kipevu into a combined cycle facility providing an additional 30 MW, there is still need for additional generation sources to meet the anticipated demand associated with the prevailing national economic growth in order to provide system stability and maintain reliability requirements. A number of options to address the predicted shortfall in electricity are considered here:

1. Demand management options
2. Fuel diversification options
3. Technology options
4. Location options

The choice of location of the plant for the Thika plant is a balance between proximity to the industrial set-up in Thika town and cross to the electricity grid and key load centre.

### **Specialist Studies Findings**

#### **Air and Noise Quality Report**

The results obtained from the baseline analysis of the air quality should form a basis of future monitoring after installation/construction of the power plant.

1. Measured air pollutants levels for particulate matter (PM<sub>10</sub>), and gases (NO<sub>2</sub>, CO and SO<sub>2</sub>) were all within or below the recommended limits as per WHO and United States EPA.
2. The ambient air around the sampling site is clean and meets the National regulation requirements.

### **Noise level Simulation**

The simulated noise levels meets the World Health standards, that is, not exceeding 70 dB (A), for the surroundings to the facility. However, within the facility the noise levels would occasionally be on the verge of exceeding the limits especially under stable atmospheric conditions at night. This would require mitigation measure by way of insulating the buildings on the leeward (generally westward) side of the facility. The prevailing wind at the site is generally easterly. Any future noise level mitigations measures will consider building located to the west of the facility.

### **Air Pollution**

Supplied data has been reviewed, air pollution levels have been modeled, and the air pollution impacts of the new plant on the surrounding area have been predicted using a computer based 2-D model. It is predicted that, provided the source strength provisions in the project specifications are complied with, air pollution levels will not exceed WHO guidelines at the western site boundary while the eastern site boundary will not be adversely affected by the plant. Air pollution levels are therefore predicted to comply with all applicable legislative requirements.

Air pollutant concentrations should be measured at monitoring sites that are representative of population exposures. Air pollution levels may be higher in the vicinity of specific sources of air pollution from power plants and so protection of populations living in such situations may require special measures to bring the pollution levels to below the guideline values.



### **Soil Analysis**

Total petroleum hydrocarbons (TPH) were less than 500 mg/kg (µg/g). Therefore, full analysis in terms of assessing BTEXs and PAHs was not required.

### **Water Quality**

Physical and chemical water quality analyses were conducted on samples from Komu and Ndarugu Rivers in the vicinity of the proposed thermal power plant, at the University of Nairobi Public Health Engineering Laboratories. Analysis was carried out using standard methods.

Results indicate significant colour, turbidity, conductivity and solids (total and dissolved) which is characteristic of the type of strata and organic matter it traverses. However, the observed hardness is not significant and the water may be classified as moderately soft (50 - 100 CaCO<sub>3</sub> mg/l) mainly calcium hardness. The water shows very low concentrations of nutrients (phosphate and nitrates) suggesting limited contamination from agricultural sources. Similarly, the water had low concentrations of metals such as copper, manganese, iron and chromium indicating absence of industrial pollution.

### **Environmental and Socio-Economic Impacts**

The positive impacts identified include the following:-

1. Employment opportunities during construction, operation and decommissioning phases.
2. Strengthening and enhancing power supply and reliability in the region.
3. The local economy will benefit from the presence of migrant workers who will seek services and goods that can be availed locally.
4. The power supply will improve the education and health standard since primary, secondary and health facilities will be able to attract and retain qualified personnel. Similarly, students will be able to devote more time to study at night as opposed to during the daylight only.

5. Open up the area to internet services where residents will have access to information.
6. With the establishment of the plant, the value of land will increase thus benefiting the land owners in the vicinity of the project.
7. A strong power transmission back-bone will enhance development of Information Communication Technology (ICT) facilities in key centres around the proposed thermal power plant.
8. Small scale traders and businesses in centres located around the thermal power plant will flourish from the increased volume of trade due to increased demand of basic commodities and services such as food, construction materials and accommodation during construction stage.

### **Negative Impacts**

The Consultant identified several negative impacts likely to arise during the proposed project's cycle. These included the following:

1. Hazardous wastes arising from various materials used in the construction.
2. Workers accidents during construction
3. Air pollution from the construction machinery.
4. Loss of vegetation cover and habitat.
5. Soil disruption arising from excavation of foundation.
6. Increased cases of sexually transmitted infections (STIs) due to the influx of migrant workers and the resulting changes in sexual behaviours.
7. Pollution of surface water by dumping of construction wastes.
8. Noise and vibration due to movement of vehicles and machinery.
9. Disruption of traffic due to movement of heavy machinery such as excavators.
10. Competition for water resources.

### **Significance of an ESMP**

Environmental and Social Management Plan (ESMP) for development projects provides a logical framework within which identified negative environmental impacts can be mitigated and monitored. In addition the ESMP assigns responsibilities of actions to various actors and provides a timeframe within which mitigation measures and monitoring can be done. ESMP is a vital output of an Environmental Impact Assessment as it provides a checklist for project monitoring and evaluation. The ESMP covers all aspects of planning, construction, operation and decommissioning of the project, which are relevant to the project and its' environ. It is essential to implement the ESMP right from the planning stage and then continuing it throughout the construction, operation and decommissioning stages (See Tables 1, 2 and 3). Therefore the main objective of the ESMP is to identify the project specific activities that would have to be considered for investigation of the significant adverse impacts, mitigation measures and action required.

**Table 1 Environmental and Social Management Plan during Construction**

(Sheet 1 of 4)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (Kshs)
Extraction site impacts to ensure efficient use of raw materials in construction	<ul style="list-style-type: none"> <li>Source building materials from local suppliers who use environmentally friendly processes in their operations.</li> <li>Ensure accurate budgeting and estimation of actual construction material requirements to ensure that the least amount of material necessary is ordered.</li> <li>Ensure that damage or loss of materials is kept minimal through proper storage.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent /contractor</li> <li>Project Engineer/Architect</li> </ul>		Periodic and surprise checks	
Loss of vegetation cover	<ul style="list-style-type: none"> <li>Ensure proper demarcation and delineation of the project area to be affected by construction works.</li> <li>Introduction and maintenance of vegetation (trees, shrubs and grass) on open spaces and around the site</li> <li>Design and implement an appropriate landscaping programme to help in re-vegetation of part of the project area after construction.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent /contractor</li> <li>Project Engineer/Architect</li> </ul>		Periodic and surprise checks during construction	
Air pollution by dust and VOCs generated during construction process.	<ul style="list-style-type: none"> <li>All personnel working on the project will be trained prior to starting construction on methods for minimizing air quality impacts during construction.</li> <li>Construction heavy earth moving vehicle drivers will be under strict instructions to minimize unnecessary trips, refill petrol fuel tanks in the afternoon and minimize idling of engines.</li> <li>Careful screening of construction site to contain and arrest construction-related dust.</li> <li>Exposed stockpiles of e.g. dust and sand, will be enclosed, covered, and watered daily, or treated with non-toxic soil binders.</li> <li>All workers will be required to wear protective gear while on site.</li> <li>Ensure construction machinery and equipment are well maintained to reduce exhaust gas emission</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Ministry of Health: provincial public health officer</li> <li>NEMA inspectors</li> <li>Ministry of Labour</li> </ul>	Periodic Activities	Periodic and surprise checks	100 000 per month over the construction period

**Table 1 Environmental and Social Management Plan during Construction**

(Sheet 2 of 4)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (KShs)
Pollution from Hazardous waste	<ul style="list-style-type: none"> <li>Handling of the materials using the material safety data provided by the manufacturers</li> <li>Appoint a safety officer to ensure that proper disposal guideline are observed</li> <li>Ensuring that maintenance and/or piece of work carried out on any piece of equipment or construction work is undertaken by qualified personnel</li> <li>In case of spillage emergency spillage control measures to be instituted</li> <li>Containerization of any wastes and disposal through a licensed waste handler.</li> </ul>	<p>Proponent/contractor</p> <p>Ministry of Health: provincial public health officer</p> <p>NEMA inspectors</p>	Periodic inspection	Periodic and surprise checks	100 000 per month
Noise and vibration by construction activities.	<ul style="list-style-type: none"> <li>Use of equipment designed with noise control elements will be adopted where necessary.</li> <li>Trucks used at construction site shall be routed away from noise sensitive areas where feasible.</li> <li>Idling time for pick-up trucks and other small equipment will be minimized to limited time.</li> <li>All workers operating in noisy areas or operating noisy equipment will be provided with earpieces to protect against extreme noise.</li> <li>Comply with L.N. 25: Noise prevention and control rules, 2005</li> </ul>	<p>Project proponent/contractor</p> <p>Divisional Public Health Officer</p> <p>Ministry of Labour Workers</p> <p>NEMA inspectors</p>	Routine Activities	Periodic and surprise checks	40 000 per month over the construction period
Traffic and Transport	<ul style="list-style-type: none"> <li>Vehicle comply with axle load limits</li> <li>Take advantage of off-peak hours</li> <li>Well trained and experienced drivers</li> </ul>	Contractor		Periodic and surprise checks	

**Table 1 Environmental and Social Management Plan during Construction****(Sheet 3 of 4)**

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (Kshs)
Workers accidents and hazards when handling hazardous wastes.	<ul style="list-style-type: none"> <li>Adequate collection and storage of waste will be provided on site, and safe transportation to, and display methods at designated areas.</li> <li>All receptacles for storing hazardous wastes shall be adequately covered.</li> <li>All employees will be required to wear protective gear when handling hazardous wastes.</li> <li>All workers will be adequately insured against unforeseen accidents.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Provincial Public Health Officer</li> <li>Ministry of Labour</li> <li>Workers</li> <li>NEMA inspectors</li> </ul>	Routine Activities	Periodic and surprise checks	50 000 per month
Generation of solid waste	<ul style="list-style-type: none"> <li>Wastes to be collected regularly to control air pollution and vermin/insects etc.</li> <li>Receptacles will be provided for waste storage prior to collection.</li> <li>Resource recovery will be encouraged once the project takes off so as to shrink waste stream and recover non-recyclables.</li> <li>Refuse collection vehicles will be covered to prevent scatter of wastes by wind.</li> <li>Wastes will be collected by a licensed operator to avoid illegal final dumping at unauthorized sites.</li> <li>All persons involved in refuse collection shall be in full protective attire.</li> </ul>	<ul style="list-style-type: none"> <li>Proponent</li> <li>Hired private contractor</li> <li>Provincial Public Health Officer</li> <li>NEMA inspectors</li> </ul>	Routine Activities	Periodic and surprise checks	10 000 per month

Table 1 Environmental and Social Management Plan during Construction

(Sheet 4 of 4)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (Kshs)
Workers accidents during construction process.	<ul style="list-style-type: none"> <li>All workers will be sensitized before construction begins, on how to control accidents related to construction.</li> <li>A comprehensive contingency plan will be prepared before construction begins, on accident response.</li> <li>Accordingly, adherence to safety procedures will be enforced.</li> <li>All workers to wear protective gear during construction, including helmets.</li> <li>Construction work will be limited to daytime only</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Divisional Public Health Officer</li> <li>Ministry of Labour</li> <li>Workers</li> <li>NEMA inspectors</li> </ul>	Routine Activities	Periodic checks	40, 000 per month
Inadequate human waste disposal by workers during construction process	<ul style="list-style-type: none"> <li>As provided for by the Building Code, a temporary latrine will be provided on site to be used by construction workers</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>Contractor</li> <li>Ministry of Health</li> <li>Ministry of Labor</li> <li>NEMA inspectors</li> </ul>	Periodic Activities	Periodic checks	50,000 one time
Increase in STI infections	<ul style="list-style-type: none"> <li>Sensitization of local communities and staff working on the project on dangers of free lifestyle</li> </ul>	<ul style="list-style-type: none"> <li>Proponents</li> <li>Ministry of Health</li> </ul>	Voluntary periodic random screening  Secondary data from health institutions	yearly	Part of project budget

**Table 2 Environmental and Social Management Plan during Operation**

(Sheet 1 of 2)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (Kshs)
Solid waste generation	<ul style="list-style-type: none"> <li>Use of an integrated solid waste management system i.e. through several options including of Source reduction Recycling ,Composting and reuse and Incineration</li> <li>Ensure that wastes generated at the plant are efficiently managed through recycling, reuse and proper disposal procedures.</li> <li>A private solid waste handler to be contracted to handle solid waste including sludge.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent /contractor</li> <li>Project Engineer/Architect</li> </ul>	Periodic Activities	Periodic and surprise checks	Part of the operation and maintenance budget
Release of sewage into the environment	<ul style="list-style-type: none"> <li>Proponent to construct onsite sewage treatment facility that treats wastewater to meet the set NEMA guidelines.</li> <li>Contaminated water to be treated prior to disposal</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent /contractor</li> <li>Project Engineer/Architect</li> </ul>	Periodic Activities and audits		Wastewater facilities to be constructed as part of the initial costs and maintained by Proponent.
Air pollution	<ul style="list-style-type: none"> <li>Drivers of heavy earth moving vehicles will be under strict instructions to minimize unnecessary trips, refill petrol fuel tanks in the afternoon and minimize idling of engines.</li> <li>All workers on the site will be required to wear protective clothing while on duty.</li> <li>Suitable wet suppression techniques need to be utilized in all exposed areas</li> <li>Use of low sulphur fuel to run the engines to be encouraged</li> <li>The stack chimney of the generators will be constructed to a height of at least 30 metres and stack emissions regularly monitored using the inbuilt monitoring system.</li> <li>Set up an air quality monitoring station at about 10 Km west of site to collect SO<sub>2</sub> and NO<sub>x</sub> data.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Ministry of Health: provincial public health officer</li> <li>NEMA inspectors</li> <li>Ministry of Labour</li> </ul>	Periodic Activities	Periodic and surprise checks	10 000 per month
Traffic and Transport	<ul style="list-style-type: none"> <li>Limit delivery to off-peak hours to reduce disruption of transport links, delays and congestion</li> <li>Provide warning lights and other signs to reduce risk of accidents along delivery roads and at the site</li> <li>Keep the earth access load dump to reduce dust</li> </ul>	<ul style="list-style-type: none"> <li>Contractor</li> <li>Proponent</li> </ul>		Periodic and surprise checks	



	• Option of railway transport to be explored				
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**Table 2 Environmental and Social Management Plan during Operation**

(Sheet 2 of 2)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (Kshs)
Pollution from Hazardous waste	<ul style="list-style-type: none"> <li>Handling of the materials using the material safety data provided by the manufacturers</li> <li>Appoint a safety officer to ensure that proper disposal guideline are observed</li> <li>Ensuring that maintenance and/or piece of work carried out on any piece of equipment or construction work is undertaken by qualified personnel</li> <li>In case of spillage emergency spillage control measures to be instituted</li> <li>Containerization of any wastes and disposal through a licensed waste handler.</li> <li>Adhere to L.N. 121: Waste Management Regulations</li> </ul>	<ul style="list-style-type: none"> <li>proponent/contractor</li> <li>Ministry of Health: provincial public health officer</li> <li>NEMA inspectors</li> </ul>	Periodic inspection	Periodic and surprise checks	20 000 per month
Workers accidents	<ul style="list-style-type: none"> <li>All workers will be sensitized and trained on occupational safety and health issues and on how to control accidents related to construction.</li> <li>A comprehensive contingency plan will be prepared before begins, on accident response.</li> <li>Accordingly, adherence to safety procedures will be enforced.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Divisional Public Health Officer</li> <li>Ministry of Labour</li> <li>Workers</li> <li>NEMA inspectors</li> </ul>	<ul style="list-style-type: none"> <li>Routine Activities</li> </ul>	Periodic checks and Accident audits	40 000 per quarter
Noise and vibration pollution	<ul style="list-style-type: none"> <li>Installation of silencers on the generators</li> <li>Provision of personal protective equipment for workers in</li> <li>Do annual noise measurements.</li> <li>Do employee medical examination</li> <li>Comply with L.N. 25:Noise prevention and control rules, 2005 and L.N. 61: Noise and vibration pollution regulation, 2009</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Divisional Public Health Officer</li> <li>Ministry of Labour</li> <li>Workers</li> <li>NEMA inspectors</li> </ul>			

**Table 3 Anticipated Environmental and Social Impacts and Mitigation Measures at Decommissioning of Project Construction (Sheet 1 of 2)**

Undesirable Impacts	Mitigation Measures	Responsibility for Mitigation	Estimated Cost (Kshs)
Air pollution during demolition process.	<ul style="list-style-type: none"> <li>The demolition exercise will be limited at day time only</li> <li>All personnel working on the project will be trained prior to commencing the demolition exercise on methods for minimizing negative impacts on air quality.</li> <li>Construction vehicle drivers will be under strict instructions to minimize unnecessary trips, refill petrol fuel tanks in the afternoon and minimize idling of engines.</li> <li>All active demolition areas will be watered at least twice a day to reduce dust.</li> <li>All trucks hauling demolition debris/wastes shall be covered.</li> <li>Careful screening to contain and arrest demolition related dust will be adopted</li> <li>Exposed demolition debris of e.g. dust and sand, will be enclosed, covered, and watered daily before transported to disposal site.</li> <li>All workers on the site will be required to wear protective gear while on duty</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>NEMA inspectors</li> <li>Contractor</li> </ul>	800,000
Noise pollution by disassembly activities.	<ul style="list-style-type: none"> <li>Portable barriers will be installed to shield compressors</li> <li>Use of equipment designed with noise control elements will be adopted where necessary.</li> <li>Trucks used during demolition exercise on site shall be routed away from noise sensitive areas in the neighbourhood, where feasible.</li> <li>Idling time for pick-up trucks and other small equipment will be minimized to limited time.</li> <li>Use of very noisy equipment will be limited to daytime only.</li> <li>All workers operating in noisy areas or operating noisy equipment will be provided with earpieces to protect against extreme noise.</li> <li>The demolition exercise will be limited at day time only</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>NEMA inspector</li> <li>Contractor</li> </ul>	600,000

**Table 3 Anticipated Environmental and Social Impacts and Mitigation Measures at Decommissioning of Project Construction (Sheet 2 of 2)**

Undesirable Impacts	Mitigation Measures	Responsibility for Mitigation	Estimated Cost (Kshs)
Demolition debris and related wastes	<ul style="list-style-type: none"> <li>Private contractor will be engaged to collect demolition debris/wastes</li> <li>All debris/wastes to be collected regularly to control air pollution and injury etc</li> <li>A licensed operator to avoid illegal final dumping at unauthorized sites will collect demolition debris.</li> <li>All persons involved in refuse collection shall be in full protective attire.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>NEMA inspectors</li> <li>contractor</li> </ul>	4,000,000
Workers accidents during demolition process.	<ul style="list-style-type: none"> <li>All workers will be sensitized before the exercise begins, on how to control accidents related to the demolition exercise</li> <li>A comprehensive contingency plan will be prepared before demolition begins, on accident response.</li> <li>Adherence to safety procedures will be enforced at all stages of the exercise</li> <li>All workers, pursuant to labour laws, shall be accordingly insured against accidents.</li> <li>All workers will be provided and instructed to wear protective attire during demolition, including helmets.</li> <li>Demolition work will be limited to daytime only avoid workers accidents due to poor visibility</li> <li>Provision of mobile clinics</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>Provincial Public Health Officer</li> <li>Ministry of Labour</li> <li>NEMA inspectors</li> <li>Contractor</li> </ul>	1,000,000

## **Conclusion and Recommendations**

The EIA has analyzed potential environmental and social impacts of implementing the power plant during construction and operational phase based on both the requirement of the EMCA (1999). The study has demonstrated that with relatively easy and cost effective mitigation measures, the environmental and social impacts can be kept at acceptable levels. Therefore, it is concluded that with implementation of the mitigation measures developed in the ESMP and adherence to the ESAP, the project development will not pose any serious adverse and negative environmental impacts. Eventually, it will be possible to successfully mitigate the impacts related to the development.

Following the EIA study, the following recommendations were made;

1. The proponent to implement the mitigation guideline provided in the ESMP. Specifically, key negative impacts that require careful management during the plant construction and operation phases include:
  - Putting in place contractual agreement with sub-contractors regarding environmental management and mitigation measures.
  - Sinking a bore hole to avoid increased water strain on the Municipal council water supply and embrace water re-cycling during plant operations.
  - Traffic management should be enhanced. Vehicle engines should be adequately maintained to reduce exhaust emissions and preferably proponent should offer technical assistance on routine vehicle maintenance to the truck operators.
  - Undertaking sensitization and awareness training to all employees and sub-contractors on workers Health and Safety including the HIV/AIDS pandemic.
  - Capacity development and training should also be focused on the local work force.

2. Monitoring be planned and implemented for auditing and improving on the ESMP and ESAP; conditions to be monitored to include but not limited to those mentioned in 1 above.
3. That National Environmental Management Authority does consider and approve the project and grant the required Environmental Impact Assessment License to the proponent.

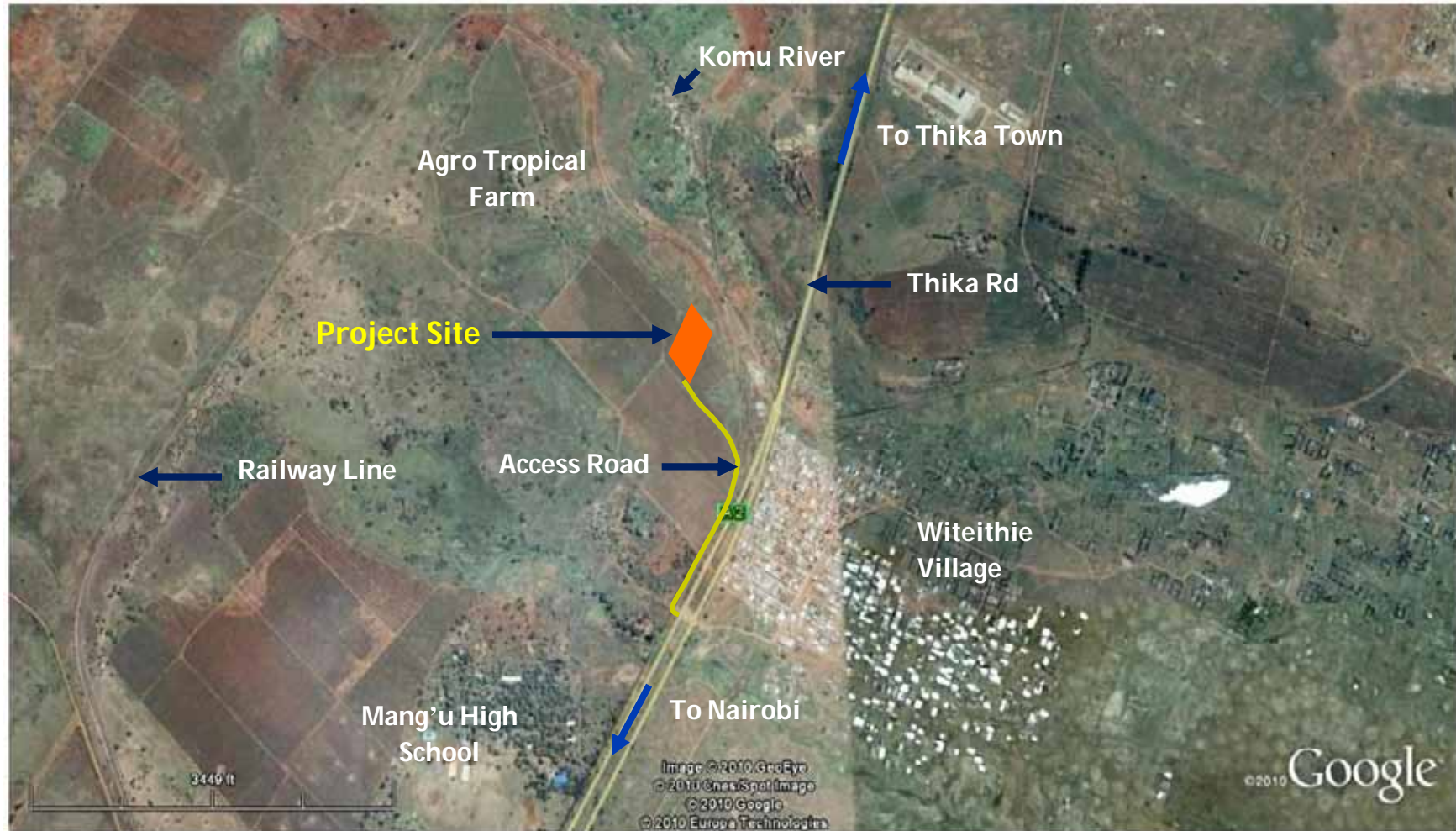
## CHAPTER 1: INTRODUCTION

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### 1.1 Project Background

Kenya is currently experiencing a shortage of power supply due to adverse weather, inadequate investment in the power generation and rapid economic growth. The Government of Kenya through the Ministry of Energy and Kenya Power and Lighting Company Limited (KPLC) have decided to boost the country's electricity generation capacity by constructing Medium Speed Diesel (MSD) Thermal Power Plants to produce 240 MW of electricity at three sites within the environs of the Nairobi Metropolis. The Kenya Power and Lighting Company (KPLC) have awarded Malec PowerGen Ltd, an independent power producer, a contract for installation of a MSD thermal plant to generate 80 MW of electricity at one of the sites in Thika. The proposed site is along Nairobi-Thika Highway, about 38 km from Nairobi City Centre and 6 km to Thika Town (Figure 1.1). The site is on plot number L.R. 8380/2, measuring approximately 4 ha (10 acres) next to Mang'u High School and opposite Witeithie Village.

In Kenya, all new projects are required to undertake Environmental Impact Assessment (EIA) study at the planning stage to ensure that all significant environmental impacts are taken into consideration at the implementation stage. Power generation plants are listed in the second schedule of projects that are required to have an EIA by the Environmental Management and Coordination Act (EMCA) of 1999. The Enviroplan & management Consultants were appointed to conduct the Environmental Impact Assessment of the proposed MSD Power Project. The scope of the assessment covers preconstruction phase, construction works of the proposed development which include ground preparation, civil works, structural works, installation of the generators, installation of service lines as well as the utilities required, operational and decommission phases of the thermal power plant. The study is to be carried



**Figure 1.1 Satellite Image of the proposed Thermal Power Plant Site at Thika**



out within the Legal Framework and Policies in Kenya as stipulated in the EMCA (1999). The output of the study work is a comprehensive Environmental Impact Assessment Project Report for the purposes of seeking a NEMA license that will approve the project construction and operation.

## **1.2 Project Description**

The Thika Power Plant will consist of five MAN 4-stroke medium speed diesel engines 18V48/60 and a steam turbine with a combined capacity of 80 MW, transformers, cables, switchgear, protection and metering equipment. Generation will be at 15 kV for step-up to 132 kV by a sub-station that will be constructed for the subsequent transmission of the generated electricity.

The plant will power the engines using Heavy Fuel Oil (HFO) fuel with low sulphur content of 1.9%. Fuel will be delivered to site by road tankers and stored within the plant in 3 above-ground storage tanks of 4500 m<sup>3</sup> capacity each. The engines shall be cooled using treated water. Exhaust gases from the engines will be discharged into the atmosphere at the required height of 30 m through exhaust gas stack pipes fitted with silencers. The transmission of vibration and structure borne noise is minimized by having the engine generator set flexibly mounted on spring packages on a concrete foundation. The engine generator sets shall be installed in a sound-proof engine hall so as to be isolated from the other structures. The advanced technology to be used shall be with minimal external noise, vibration and air pollution.

## **1.3 Project Justification**

Kenya has an installed electrical power generation capacity of 1219 MW comprising: 677 MW hydropower, 127 geothermal, 5.1 MW wind, 383.5 MW thermal and 35.4 MW non-firm imports from Uganda. The national electrification rate averages at 20% whereby 51% of urban households are connected to the national grid as compared to only 8% of the rural households. Electricity is mainly used for lighting. Hydro power remains the largest single source. With 56% of grid connected electricity being generated by hydro power, cuts are common during the dry seasons when the river regimes are at



their lowest. In recent times, as the reserve margins have decreased with increased demand and more erratic rains, the seasonal breakdowns have become more frequent. Furthermore, the recipients at the end of the lines often suffer voltage drops that trigger power outages. This has caused the need for standby generators in the country, which in 2007 were estimated at approximately 100 MW in capacity.

The main player in the energy generation industry in Kenya is the Kenya Electricity Generating Company Limited (KenGen) which is responsible for all public electrical generation facilities and accounts for 85% of all installed power generation capacity. KenGen generates most of its power from hydro-dams and to a smaller extent, geothermal sources. Due to inadequate power capacity within the country, a number of Independent Power Producers (IPPs) have been licensed to undertake power generation activities to supplement existing power generation capacity. These include Iberafrica, Westmont Power, Or power 4 and Tsavo Power, OrPower4 Inc, Mumias Sugar Company and Rabai Power Ltd.

The Kenya Power and Lighting Company (KPLC) have the mandate for power distribution in the country. KPLC have contracted Malec PowerGen Ltd., an Independent Power Producer to install a MSD thermal plant in Thika generating 80MW. The Energy Regulating Commission has factored in the project as one of the 'Committed Generation Project' to be commissioned in year 2011. Therefore, this project is incorporated in the national energy framework and enjoys the support of the key players in the industry.

#### **1.4 The EIA Study Objectives**

The EIA study objectives were to comply with the NEMA's requirements for full EIA study terms of reference. The EIA study objectives included:

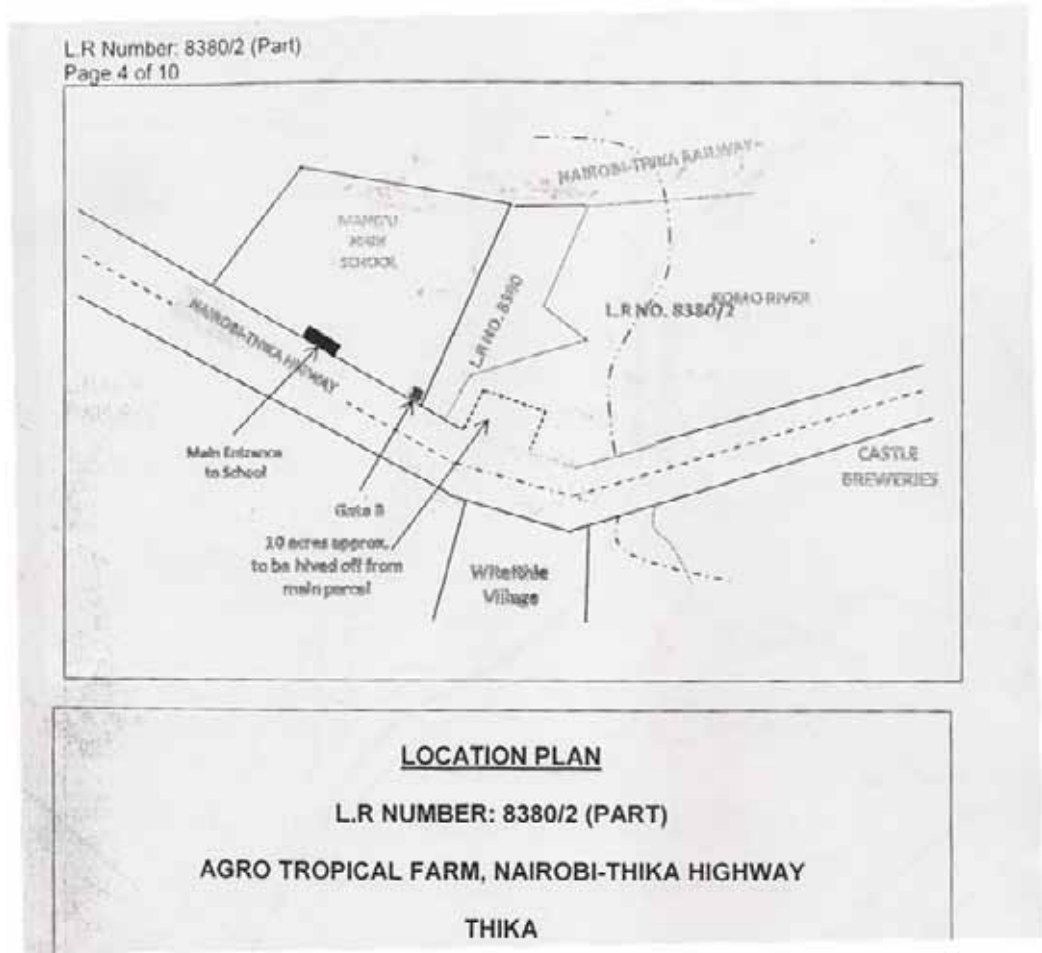
1. Conduct an Environmental and Social Impact Assessment to identify both positive and negative impacts of the proposed project and propose

most appropriate interventions during construction, operation and decommissioning of the project.

2. Collect baseline socio-economic data of the project area and potential impact expected from project construction, implementation, operation, and decommissioning.
3. Develop an Environmental Monitoring Program during construction and operation and present plans to minimize, mitigate, or eliminate negative effects and impacts.
4. Describe Environmental Management Plan implementation mechanisms; review the power plant design and its compliance to environmental requirements.
5. Identify and contact stakeholders to seek the views on the proposed project.
6. Facilitate public open/public meetings for the stakeholders to air their views.

## **1.5 Overview of the Proposed Site**

The proposed site for the power plant is in Thika on 4 ha (10 acres) Plot No. L.R. 8380/2 located on the opposite side of Nairobi – Thika Highway from Witeithie (Figure 1.2 and Plate 1.1). The site was part of a 60 ha farm owned by Agro Tropical Ltd site and purchased by KPLC on a willing buyer, willing seller basis. Subsequently, KPLC has obtained a Change of User from agricultural to commercial (See Appendix 2.4). Because the plot is currently vacant and is an industrial designated area, implementation of the project will not involve relocation of people. The project site was a coffee farm (Plate 1.2); however, on selling the plot, the vendor uprooted the coffee and the site is now vacant.



**Figure 1.2 Location plan for the Proposed Thermal Plant at Thika**



**Plate 1.1 View of Witeithie Village next to the Nairobi – Thika Highway and the Proposed Power Plant Site on the Left.**

## **1.6 Scope of the Project**

The full project cycle covers construction, operation and decommissioning. The construction activities will involve site preparation (clearance of existing vegetation, preparation of a site office and stores and fencing to avoid intrusion), disposal of excavation and site clearance wastes, landscaping, and earth moving and filling. Other activities will cover procurement of construction materials and delivery to the site, civil, mechanical, electrical, and building works and removal of construction wastes. Installation works will cover generators, transformers, cabling, fuel storage tanks and piping of fuel lines. Testing of the plant will then be conducted before commission of the plant.

All construction activities including ground preparation, earth moving, materials delivery, building, walling, roofing and the installation of amenities (power, water, communication equipment, etc.), fittings (doors, windows, safety provisions, etc.) will be carried out by competent personnel obtained through respectable contractors/sub-contractors to ensure consistent high standard of finish and providing superb value for money.



**Plate 1.2 Coffee Bushes on the Proposed Thermal Plant Site, that were later uprooted**

The MSD power plant will be constructed using common construction materials and construction procedures that are not expected to compromise the safety of the neighboring communities as well as the surrounding environment.

The following inputs will be required for construction:

1. Raw construction materials e.g. sand, cement, natural building stone blocks, hardcore, and gravel.
2. Timber (e.g. doors and frames, fixed furniture, etc.).
3. Paints, solvents, white wash, etc.,
4. Generator Sets.
5. A construction labour force (of both skilled and unskilled workers).

### **1.7 Project Budget**

The estimated project cost is approximately \$123,000,000 (One hundred and twenty-three million US dollars) covering:

- a. Equipment procurement, transport and installation.
- b. Construction costs including materials and labour.
- c. Professional services.

## CHAPTER 2: ANALYSIS OF PROJECT ALTERNATIVES

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### 2.1 No Option Alternative

The Kenya Electricity Generating Company Limited (KenGen) is currently able to generate about 85% of the total demand. Independent power producers (IPPs) contribute the balance of 15%. KenGen is working towards enhancing its capacity through hydro-plants and geothermal sources among other initiatives. However, additional sources will still be required to meet the anticipated growth in demand and provide diversification of technology and fuels especially in the short to medium term. Not constructing the power plant would mean that benefits, including improved electric power supply and the associated national economic benefits, would not transpire. At the same time, the negative impacts associated with the project would not materialize. Hence the 'No Action' alternative is not feasible for Kenya.

### 2.2 Options for Power Generation

Generation capacity in Kenya is presently provided by hydropower (62%), conventional thermal power (26%) and geothermal power (12%). At present the total installed capacity in Kenya and interconnected to the transmission and distribution systems amounts to 1219 MW (effective 1045 MW) with a peak demand of 976 MW. While KenGen is working towards enhancing its capacity through refurbishment of its hydro-plants, extending geothermal sources and completion of an investment program that will integrate the existing gas turbine (64 MW) and diesel plants (72 MW) at Kipevu into a combined cycle facility providing an additional 30 MW, there is still need for additional generation sources to meet the anticipated demand associated with the prevailing national economic growth in order to provide system stability and maintain reliability requirements. A number of options to address the predicted shortfall in electricity are considered here:

5. Demand management options
6. Fuel diversification options
7. Technology options
8. Location options

### **2.3 Demand Management Options**

Concern about the negative impacts of emergency power plants such as those run by Aggreko is promoting the use of independent power producers. The cost of generating power using MSD engines is relatively more economical than the emergency power generated using diesel fuel. In addition to considering new generation capacity, the electricity sector in Kenya has been considering measures that can be taken to manage existing demand and to reduce system losses. Demand management options include:

1. Technical and commercial reduction
2. Time of day pricing

#### **2.3.1 Technical and Commercial Pricing**

Kenya losses about 21% of the electricity produced through transmission losses and illegal connections. Losses arise from two main factors. These are;

1. KPLC's transmission system, which because of its age accounts for the largest fraction of the total loss.
2. Theft of power that mainly takes the form of illegal connections to the national grid.

As a result of high losses, the Energy Sector Recovery Project was initiated in 2004. This project has a distribution, reinforcement and upgrade component. Planned technical improvements include re-stringing of conductor lines, installation of capacitors and construction of additional feeders and substations. Commercial improvements include introduction of electronic meters, improvement of meter reading accuracy, fraud control and resolution of billing anomalies. As a result of this project, system losses are expected to be reduced to about 15% by 2008/9. This demand management option can be



seen as a medium to long term solution and is not likely to provide an adequate solution to electricity shortages in the short term.

### **2.3.2 Time of Day Pricing**

Consumption patterns in Kenya show that demand for electricity among industrial consumers first peaks to 700 MW in the morning, then drops slightly at midday, reaches 1082 MW during prime time and drops back by 700 MW by 10:30 pm. The large variation in load indicates that there is the potential for significant reduction in peak load by instituting lower pricing during the off-peak period. Owing to the very low per capita consumption of electricity at the low voltage level, it is only economical to install time of day pricing on medium and high voltage customers. Medium voltage customers tend to be industrial customers, many of whom have the ability to shift high power demand batch manufacturing processes out of peak demand periods thereby reducing overall power costs to them, as power will be priced lower during off peak periods. KenGen is spearheading the initiative to avert the possibility of taxing customers with a Kshs 1 billion bill from leasing an emergency generator to hedge against dwindling reserve.

The plan to persuade companies to reduce electricity consumption is facing some resistance. Most of the large companies that would be covered by this power-saving initiative say the proposed rebate of Kshs 2 for every unit of electricity consumed against the current power tariff is not enough. The manufacturers claim the rebate would not cover an increase in labour costs of shifting production between 11 pm and 6 am. The level of compensation for manufacturers will be finalized when it is known how many companies will participate in the programme.

Therefore, the demand management options contribute to a reduction in losses throughout the system. However, they are not sufficient on their own to meet the chronic shortage in electricity supply predicted in the Kenya

interconnected system. As a result, KPLC has investigated the installation of new power generation capacity.

## **2.4 Power Trade/Regional Interconnections (Regional Catchment)**

While many power generation projects from different sources are underway, the country can benefit immensely by tapping power from the region. Currently, Ethiopia is installing large power generation capacity through hydro electric power stations. The Southern Africa region also has excess capacity through hydro electric dams in Zambia and Mozambique. On the other hand, the Democratic Republic of Congo has huge potential for power generation in River Zaire. By drawing from this large pool of power the country would benefit from resource complementarities, security of supply and least costs supplies. Currently, the following interconnection projects have been muted;

1. Kenya – Ethiopia interconnection
2. Kenya – Uganda interconnection
3. Kenya –Tanzania interconnection
4. East African Power Pool (EAPP)

Regional interconnection may indeed be the long term solution for power supply in the country. However, realising the supply will involve drawn out negotiations, international treaties, and infrastructure development implies that for the short and medium requirements this is not a viable option.

## **2.5 Fuel Type Options**

Electricity generation options can be considered by fuel type. This might be nuclear, geothermal, hydro, solar, wind, coal, oil, gas or some combination of the above. The plant may be leased, rented or purchased and may be located on land or water. The current status of the various fuel type options available in Kenya are outlined herein;

**2.5.1 Nuclear Power**

At present there are nuclear power reactors operating in 30 countries worldwide. These reactors supply about 16% of the world's electricity. Only two nuclear power plants are operational in Africa, both in South Africa. Nuclear power is a sophisticated technology that requires a correspondingly sophisticated infrastructure. This requires careful planning, preparation and investment over a 10 to 15 year period. Presently Kenya does not have the necessary experience, materials, fuels, funding or infrastructure to pursue this option although the idea is being formulated.

**2.5.2 Geothermal Power**

Kenya is endowed with geothermal resources mainly located in the Rift Valley. Geothermal energy is generated using natural steam tapped from volcanic-active zones. Some 127MW is fed into the national grid from three plants located at Olkaria; this is expected to increase to 576 MW within the next 20 years. The estimated potential of geothermal energy in Kenya is more than 2000MW when generated using conventional flash-steam condensing turbines. The generation potential may exceed 3000MW if combined cycle and binary systems were to be used. The geothermal exploration and developments project are now ongoing. KenGen has conducted surface scientific studies in Suswa, Longonot, Eburru and Menengai. Six exploratory wells were drilled at Eburru. More exploration work is now ongoing in the Lake Baringo area. The various geothermal prospects provide varying benefits and costs but none are achievable within the short to medium term.

**2.5.3 Hydropower**

Kenya has limited number of rivers which originate from the highland areas and flow into the Indian Ocean, accounting for most of the potential for hydropower. The country has a total estimated potential water-power resource of 1100 MW and the total installed capacity of hydropower in Kenya is 677 MW. Given the severe seasonal water fluctuations in the River Tana catchment area, the effective potential development on River Tana is around 540 MW,

although the estimated potential is 835 MW. Kenya is highly dependent on hydroelectricity which provides about 70% of all electricity output. Five major stations in the Tana River basin supply power to Kenya. These are Kindarua (44 MW), Gitaru (225 MW), Kamburu (94 MW), Masinga (40 MW) and Kiambere (144 MW). The Turkwel Gorge hydroelectric station in the Turkana district has an installed capacity of 106 MW. The hydro power project of Sondu Miriu (60 MW) has been completed, but has not been commissioned yet due to low water levels while Sangoro Power Plant in the same system is expected to generate 20 MW by November 2011. An additional 35 MW is imported from Owen falls dam in Uganda. Variable hydrology in Kenya means that there is a high risk associated with hydropower production, particularly since most of the power is generated within one catchment.

There are a number of sites suitable for small hydropower projects which are suitable to rural energy demand patterns. The current known potential for mini and micro hydro is estimated to be 300 MW. A number of pilot projects in the area of mini and micro hydropower have been implemented to assess the viability of such systems and create the impetus for accelerated exploitation of the mini/micro hydropower source. KPLC is looking at diversifying the hydropower sector by looking at rivers in Western Kenya which may not be as badly affected by variable hydrology. Further hydropower generation in the short term is not an option.

#### **2.5.4 Wind Power**

Wind power generation represent a huge potential for generation of renewable power in Kenya. Already a 5 MW wind farm has been commissioned at the Ngong Hills near Nairobi. According to the Energy Regulatory Commission, another wind farm of 300 MW capacity by an IPP is planned for Turkana in Marsabit County. Wind generation is encumbered by inordinately long roll out periods, large capital outlays and lack of transmission infrastructure to the national grid. Therefore, while wind power presents a huge potential for the

medium to long term, it is not available to meet the increasing short term demand.

#### **2.5.5 *Solar Power***

Solar power is sustainable and available throughout Kenya. The technology is well proven especially for home or single building applications. However, power production is limited to daytime when the sun is shining. Additionally, the electricity production is expensive. Therefore, solar power may only provide a limited short term power solution.

#### **2.5.6 *Thermal Power***

Thermal generation of power can be through coal, liquid fuels such as Diesel Oil (DO) and Heavy Fuel Oil (HFO) or natural gas. In Kenya, coal and natural gas are not available. Liquid fuels on the other hand are imported as crude oil for refinery at the Kenya Petroleum refineries at Mombasa or imported as refined fuel. Thermal power generation has serious disadvantages including the production of CO<sub>2</sub>, a greenhouse gas, high Sulphur levels and greater costs than most other fuels. However, thermal production involves compact and reliable generators that can be installed within a short time frame. Therefore, thermal generation is available to meet short term demand including emergency supplies. Currently, installed thermal power generation includes, Kipevu II, 70 MW; Aggreko, 140 MW; and Rabai, 88.6 MW. Other Energy Regulating Commission committed thermal power plants include, Athi River, Thika and Naivasha MSD; 200 MW and Kipevu III, 120 MW.

### **2.6 *Proposed Thermal Power Plant Site at Thika***

The proposed thermal power project involves installation of power generation units at Thika. The proposed units are compact and would be delivered by sea to the Port of Mombasa and then by road to Thika where they will be installed, tested and commissioned. Within the implementation time frame of 18 months, the project will inject 80 MW to the national grid and will come in handy in

bridging the existing gap between supply and demand. Already, the Energy Regulating Commission has factored in the project as one of the 'Committed Generation Project' to be commissioned in year 2011. Therefore, the project enjoys the support of the key players in the industry.

Hence, by locating the project in the vicinity of Thika town (which is a major industrial zone) the power will be supplied directly to the point of high demand thereby reducing transmission losses.

## **CHAPTER 3: LEGISLATIVE AND INSTITUTIONAL FRAMEWORK FOR ESIA**

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### **3.1 Introduction**

Kenya has a policy, legal and administrative framework for environmental management. Under the framework, the National Environment Management Authority (NEMA) is responsible for ensuring that environmental impact assessments (EIA's) are carried out for new projects and environmental audits on existing facilities as per the Environmental Management and Coordination Act (EMCA) 1999. Projects subject to this requirement are specified in the Second Schedule of the EMCA, 1999.

EIA's are carried out in order to identify potential positive and negative impacts associated with the proposed project with a view to taking advantage of the positive impacts and developing mitigation measures for the negative ones. The guidelines on EIA's are contained in Section 58 to 67 of the Act. According to section 68 the environmental management and coordination Act (EMCA)1999, the authority shall be responsible for carrying out environmental audits on all activities that are likely to have a significant effect on the environment.

Environmental auditing (EA) is a tool for environmental conservation and has been identified as a key requirement for existing facilities to ensure sustainable operations with respect to environmental resources and socio-economic activities in the neighborhood of the facilities. The government has established regulations to facilitate the process on EIA's and environmental audits. The regulations are contained in Kenya Gazette Supplement No. 56, legislative, Supplement No.31, Legal Notice No.101 of 13<sup>th</sup> June 2003 and Environmental (Impact Assessment and Audit) (Amendment) Regulations, 2009.

## **3.2 Environment Policy and Institutional Framework**

### ***3.2.1 The World Commission on Environment and Development***

The Commission commonly referred to as “the Brundtland Commission” focused on the environmental aspects of development, in particular, the emphasis on sustainable development that produces no lasting damage to biosphere, and to particular ecosystems. In addition, environmental sustainability is the economic and social sustainability. Economic sustainable development is development for which progress towards environmental and social sustainability occurs within available financial resources. While social sustainable development maintains the cohesion of a society and its ability to help its members work together to achieve common goals, while at the same time meeting individual needs for health and well-being, adequate nutrition, and shelter, cultural expression and political involvement.

### ***3.2.2 The Rio Declaration***

Agenda 21 – a programme of action for sustainable development worldwide, the Rio Declaration on Environment and Development was adopted by more than 178 governments at the United Nations Conference on Environment and Development, known as the Earth Summit, held in Rio de Janeiro, Brazil from 3<sup>rd</sup> to 14<sup>th</sup> June 1992. Principle No. 10 of the declaration underscore that environmental issues are best handled with participation of all concerned citizens at all the relevant levels. At the national level, each individual shall have appropriate access to information that is concerning environment that is held by public authorities. States shall encourage and facilitate public participation by making information widely available.

Effective access to judicial and administrative proceedings, including redress and remedy shall be provided. The foregoing discussion is relevant to the proposed development because EMCA demands that public must be involved before any development project that is likely to have adverse impacts to the environment is initiated by a proponent. The Act has further established Public Complaints Committee (PCC) where the issues raised by the public in regard to any proposed development can be addressed.



**3.2.3 Sessional Paper No. 6 of 1999 on Environment and Development**

Every person in Kenya is entitled to a clean and healthy environment and has a duty to safeguard and enhance the environment. As envisioned in Sessional Paper No. 6 of 1999 on Environment and Development, Kenya should strive to move along the path of sustainable development to meet the needs of the current generation without compromising the ability of the resource base to meet those of future generations. The overall goal is hence to integrate environmental concerns into the national planning and management processes and provide guidelines for environmentally sustainable development. The policy paper emphasizes that environmental impact assessment must be undertaken by the developer as an integral part of a project preparation. It also proposed for periodic environmental auditing to investigate if developer is fully mitigating the impacts identified in the assessment report.

**3.2.4 The National Environmental Action Plan (NEAP)**

The NEAP for Kenya was prepared in 1994. It was a deliberate policy to integrate environmental considerations in the country's social and economic development process. The integration was achieved through multi-sectoral approach and a comprehensive framework to ensure that environmental management and conservation of natural resources is an integral part of societal decision-making process.

**3.2.5 The Poverty Reduction Strategy Paper (PRSP)**

The PRSP has the twin objectives of poverty reduction and economic growth. The paper articulates Kenya's commitment and approach to fighting poverty, with the basic rationale that the war against poverty cannot be won without the participation of the poor themselves. The proposed project, during and after implementation, will offer jobs to many Kenyans as a way of contributing to this noble objective of reducing poverty.

### **3.3 Relevant Kenyan Legal Legislation**

#### ***3.3.1 Environment Management and Co-ordination Act***

The Environment Management and Co-ordination Act 1999, is the legislation that governs Environmental Impact Assessment (EIA) studies in Kenya. The Ministry of Energy is carrying out an EIA as per the second schedule of this Act. This schedule lists the projects required to undergo EIA studies in accordance with section 58(1), (2), (3) and (4) of the act.

The Act set-ups the National Environmental Management Authority (NEMA) whose objective and purpose is to perform general supervision and coordination over all matters relating to the environment and to be the principal instrument of the Government in the implementation of all policies relating to the environment. With the introduction of Environment Impact Assessment and Audit Regulations, (2003) issued through the Kenya Gazette Supplement No. 56 of 13 June 2003, the submission of environmental reports became mandatory. According to these regulations no proponent shall implement a project likely to have a negative environmental impact or one for which an Environmental Impact Assessment has been concluded and approved in accordance with these regulations.

#### ***3.3.2 The Energy Act 2006***

The Energy Act of 2006 replaced the Electric Power Act of 1997 and The Petroleum Act, Cap 116. The Energy Act, amongst other issues, deals with all matters relating to all forms of energy including the generation, transmission, distribution, supply and use of electrical energy as well as the legal basis for establishing the systems associated with these purposes. The Energy Act, 2006, also established the Energy Regulatory Commission (ERC) whose mandate is to regulate all functions and players in the Energy sector. One of the duties of the ERC is to ensure compliance with Environmental, Health and Safety Standards in the Energy Sector, as empowered by Section 98 of the Energy Act, 2006.

In this respect, the following environmental issues will be considered before approval is granted:

1. The need to protect and manage the environment, and conserve natural resources;
2. The ability to operate in a manner designated to protect the health and safety of the project employees; the local and other potentially affected communities.

Licensing and authorisation to generate and transmit electrical power must be supported by an Environmental Impact Assessment Report (EIA) approved by NEMA.

**Part IV Section 80(1)** provides that a person shall not conduct a business of importation, refining, exportation, whole sale, retail, storage or transportation of petroleum, except under and in accordance with the terms and conditions of a valid licence.

**Part IV Section 90 (1)** stipulates that a person intending to construct a pipeline, refinery, bulk storage facility or retail dispensing site shall before commencing such construction, apply in writing to the Energy Regulatory commission for a permit to do so. The application shall: specify the name and address of the proposed owner; be accompanied by three (3) copies of plans and specifications and be accompanied by an Environmental Impact Assessment (EIA) Report.

**Part IV section 91(1)** stipulates that the Energy Regulatory Commission shall, before issuing a permit under section 90, take into account all relevant factors including the relevant government policies and compliance with Environment Management and Coordination Act, 1999 and in particular EIA report as per Impact Assessment and Audit Regulations 2003, the Physical Planning Act, 1996 and the Local Government Act.

**Part iv section 100 (1)** provides that it is an offence if a person being the owner or operator of a refinery, pipeline, bulk liquefied Petroleum gas or natural gas facility, service station, filling station or storage depot, fails to

institute appropriate environmental, health or safety control measures. The offence if convicted, he/she shall be liable to a fine not exceeding two million shillings or to a maximum term of imprisonment of two years, or to both.

### **3.3.3 *The Water Act (Act No.8 of 2002)***

This is an Act of Parliament to provide for the management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water; to provide for the regulation and management of water supply and sewerage services; to repeal the Water Act (Chapter. 372 of the Laws of Kenya) and certain provisions of the Local Government Act; and for related purposes. In addition to this act and in furtherance of the said related purposes the Minister of Water and Irrigation, through the powers conferred to him by Sections 47(6) and 110(1) of the Water Act, 2002, made the Water (Water Services Levy) Regulations, 2008. This sought to impose a levy of one per cent (1%) of all sales of water services to consumers by each water service provider operating under the Act.

The Water Act, in general, gives provisions regarding the ownership of water, institutional framework, national water resources, management strategy, and requirement for permits, state schemes and community projects. Part IV of the Act addresses the issues of water supply and sewerage. Section 59 of the Act states that the National Water strategy shall contain details of:-

- ✓ Existing water services.
- ✓ The number and location of persons who are not being provided with basic water supply and basic sewerage.
- ✓ Plans for the extension of water services to underserved areas.
- ✓ The time-frame for the plan; and
- ✓ An investment programme.

The proposed project area is drained by rivers Ndarugu and Komu which are a source of water to many people. Construction of thermal power plant may

have a bearing on the water quality due to the presence of hazardous materials used in the process. Disturbance of soil may also lead to erosion which has negative impact on the quality of the natural streams. It is imperative therefore that the execution of the proposed project take utmost care of this valuable resource and in accordance to the Water Act 2002 during construction and operation phases.

#### ***3.3.4 Occupational Safety and Health Act 2007(CAP 15)***

This Act came into operation in the year 2008. The Act applies to all workplaces where any person is at work, whether temporarily or permanently. The purpose of the act is to secure the safety, health and welfare of persons at work and protect persons other than persons at work against risks to safety and health arising out of, or in connection with, the activities of persons at work.

Section 19 of the Act provides that an occupier of any premises likely to emit poisonous, harmful, injurious or offensive substances, into the atmosphere shall use the best practicable means to prevent such emissions into the atmosphere; and render harmless and inoffensive the substances which may be emitted. Section 16 provides that no person shall engage in any improper activity or behaviour at the workplace, which might create or constitute a hazard to that person or any other person.

#### ***3.3.5 Agriculture Act (Chapter 318 of the Laws of Kenya)***

This statute seeks to promote and maintain a stable agriculture, to provide for the conservation of the soil and its fertility and to stimulate the development of agricultural land in accordance with the accepted practices of good land management and husbandry. The Minister administering the Act, after concurrence with the Central Agricultural Board and consultation with the District Agricultural Committee, can impose land conservation orders on lands to control cultivation, grazing and clearing. These controls may be necessary to

protect the land against soil erosion, to protect fertility, and to maintain catchments.

Local authorities are generally empowered to administer these sections of the Act and the District Agricultural Committee is entitled to make regulations relating to these controls.

Agricultural Rules are prescribed under the Act, whereby vegetation clearing in steep slopes areas or adjacent watercourses, without authorization, is controlled.

### ***3.3.6 Physical Planning Act (No. 6 of 1996)***

This Act of Parliament provides for the preparation and implementation of physical development plans and for connected purposes. Section 36 of this Act provides for Environmental impact assessments and states that:-

If in connection with a development application a local authority is of the opinion that proposals for industrial location, dumping sites, sewerage treatment, quarries or any other development activity will have injurious impact on the environment, the applicant shall be required to submit together with the application an environmental impact assessment report.

### ***3.3.7 Land Acquisition Act (Chapter 295 of the Laws of Kenya.)***

The Land Acquisition Act makes provisions for the compulsory acquisition of land for the public benefit. Under the Act the Commissioner of Lands may in writing authorize any person, together with servants and workmen, to enter upon any land specified in a notice and to survey the land and to do all things which may be reasonably necessary to ascertain whether the land is suitable for the purpose for which it may be required.

Where land is acquired compulsorily under this Act, full compensation shall be paid promptly to all persons interested in the land. In Kenya there are a large number of enactments all governing land and transactions in land. Thus the substantive land law is to be found in two different statutes while the adjectival

land law is to be found in five different statutes not forgetting the customary land law of the various tribes in Kenya.

#### ***3.3.7.1 Systems of Substantive Land Law***

There are two systems of substantive land law in Kenya these are:

1. The Indian Transfer of Property Act 1882 as amended by the 1959 Amendment Act. This Act sought to amend the law relating to the transfer of property by act of parties, whereby the transfer of property means an act by which a living person conveys property, in present or in future, to one or more other living persons, or to himself, or to himself and one or more other living persons.
2. The Registered Land Act (Chapter 300 of the Laws of Kenya.) The intention of this Act of Parliament is to make further and better provisions for the registration of title to land, and for the regulation of dealings in land so registered, and for purposes connected therewith.

#### ***3.3.7.2 Conveyance systems***

There are three systems of conveyance and these are those applicable to land registered under,

- The Government Lands Act (Chapter 280 of the Laws of Kenya). This Act of Parliament seeks to make further and better provision for regulating the leasing and other disposal of Government lands. The Land Titles Act (Chapter 282 of the Laws of Kenya). This Act of Parliament seeks to make provision for the removal of doubts that have arisen in regard to titles to land and to establish a Land Registration Court.
- Registration of Titles Act (Chapter 281 of the Laws of Kenya): This is an act of parliament to provide for the transfer of land by the registration of titles. Section 32 provides that no instrument, until registered in the manner prescribed in the act shall be effectual to pass any land or any interest therein, or render the land liable as security for

the payment of money, but upon the registration of an instrument in the manner prescribed the land specified in the instrument shall pass, or, as the case may be, shall become liable as security in the manner and subject to the agreements, conditions and contingencies set out and specified in the instrument, or declared by this Act.

- Registered Land Act (Chapter 300 of the Laws of Kenya.) This is an Act of Parliament intended to make further and better provision for the registration of title to land, and for the regulation of dealings in land so registered, and for purposes connected therewith.
- Registration Systems:
  - ✓ The five registration systems are those under: -
  - ✓ The Government Lands Act (G.L.A.)
  - ✓ The Registration of Titles Act (R.T.A)
  - ✓ The Land Titles Act (L.T.A)
  - ✓ The Registration of Documents Act (Chapter 285 of the Laws of Kenya): This is an Act of Parliament to provide for the registration of documents. It states that: all documents conferring, or purporting to confer, declare, limit or extinguish any right, title or interest, whether vested or contingent to, in or over immovable property (other than such documents as may be of a testamentary nature) and vakallas shall be registered. It should be noted that this Act isn't peculiar to Land Law, as documents completely unrelated to land can be registered under it.
  - ✓ The Registered Land Act (R.L.A).

### **3.3.7.3 Land Ownership**

Absolute or complete ownership in land vests in the state. Under the Government Lands Act the Commissioner of Lands, on behalf of the Republic of Kenya grants leases of town plots for any term not exceeding ninety-nine(99) years and of agricultural land for a term not exceeding nine hundred and ninety-nine(999) years.



The grantee (the person receiving the land) becomes the owner and subject to the terms and conditions of the lease he possesses the bundle of the rights of ownership. The 999-year leases can be converted into freehold leases and the 99-year leases into 999-year leases. On conversion or expiry of the Lease, a new grant may be issued under The R.L.A or the R.T.A. All un-alienated land other than trust land and all reversion of Government leases are vested in the Government, other lands whether held on freehold or leasehold are vested in the grantees as owners having the rights over them.

The power of the State to qualify (extinguish) property rights in the public interest is embodied in Section 75 of the Constitution. The section however makes the exercise of that power subject to due process (this includes the payment of prompt and adequate compensation) Section 117 of the Constitution further provides that an Act of Parliament may empower a county council to set apart trust land for the use and occupation of any person or persons for a purpose which is likely to benefit the residents of that area. Section 117(4) stipulates that the setting apart of such land is void unless the law under which it is made makes provision for the prompt payment of full compensation. The Trust Land Act, in Sections 7 to 13, makes provisions for the setting apart of land and payment of compensation with regard thereto. All land in urban areas of Kenya and much of the land in rural areas has a registered title. The title to land is either freehold or leasehold. The development and use of freehold title is controlled by land planning regulations which are administered by both the Central Government and the Local Authority in which the Land is situated. A local Authority is either a County Council or a Municipal Council whose activities are established and controlled by the Local Government Legislation.

Leasehold land is held on leases from the Central Government or, less frequently, from the Local Authority and such lease will contain provisions governing the development of the land and the use to which the land can be put. The leases frequently contain provisions against any dealing with the land without the consent of the landlord. The Central Government administers its

land through a Department of Lands which is headed by a Commissioner of Lands.

### ***3.3.8 The Public Health Act (Chapter 242)***

This Act of Parliament makes provisions for securing and maintaining health. It contains directives that affect human health. Section 3 of the Act establishes the Central Board of Health which shall consist of the Director of Medical Services (who shall be chairman), a sanitary engineer, or such person as may be appointed by the Minister to perform the duties of sanitary engineer, a secretary, and such other person or persons not exceeding six (three of whom shall be medical practitioners) as are appointed from time to time by the Minister.

There are provisions within the Act to deal, in a general way, with water, air and noise quality as they pertain to human health. An environmental nuisance is defined and includes the emission from premises of wastewaters, gases and smoke which could be regarded as injurious to health. The owner and/or occupier of premises responsible for such nuisances are liable to prosecution under the Act.

### ***3.3.9 Local Government Act (Chapter 265)***

This is an Act of parliament, which provides for the establishment of authorities for local government; to define their functions and to provide for matters connected therewith and incidental thereto. The Act is connected with a wide range of matters that affect the day-to-day activities of individuals and organizations.

Section 163A of this Act gives the local authority the power to grant business permits. It states that a local authority may on receipt of an application under this Act grant a business permit to allow the conduct of a business or trade, including a profession or occupation within its area. Provided that in the case of a business, trade, profession or occupation regulated by the provisions of any other written law, a person shall prior to the submission of an application for a business permit pursuant to this subsection, satisfy all the requirements of

that other written law. Section 163 is another important part of the Act it gives every town council and urban council power, to control or prohibit all businesses, factories and workshops which, by reason of smoke, fumes, chemicals, gases, dust, smell, noise, vibration or other cause, may be or become a source of danger, discomfort or annoyance to the neighborhood, and to prescribe the conditions subject to which such businesses, factories and workshops shall be carried on.

Section 145 of the Act is concerned with the miscellaneous powers of local authorities subsection (w) empowers local authorities to take measures that may be necessary or desirable for the preservation or protection of wildlife, and provide amenities for the observation of wildlife. Section 146(d) empowers a local authority, with the consent of the Minister to make grants for the establishment and maintenance of game parks and other related facilities. Section 147(d) controls the cutting of timber and the destruction of trees and shrubs.

Under section 265(1) of the Act, any officer of a local authority duly authorized in writing shall, on producing, if so required, some duly authenticated document showing his authority, have a right to enter any premises at all reasonable hours for the purpose of ascertaining whether there is, or has been, on, or in connection with, the premises, any contravention of this Act or of any by-laws, whether made under this Act or any other written law, being provisions which it is the duty of the local authority to enforce.

#### **3.3.10 The Penal Code (Cap. 63)**

The chapter on “Offences against Health and Conveniences” contained in the Penal Code enacted in 1930 strictly prohibits the release of foul air into the environment, which affects the health of other persons. Any person who voluntarily violates the atmosphere at any place, to make it noxious to health of persons in general dwelling or carrying out business in the neighbourhood or passing along public ways is guilty of misdemeanour, i.e. imprisonment not exceeding two years with no option of fine. Under this code, any person who for the purpose of trade or otherwise makes loud noise or offensive awful

smell in such places and circumstances as to annoy any considerable number of persons in the exercise of their rights, commits an offence, and is liable to be punished for a common nuisance, i.e. imprisonment not exceeding one year with no option of fine.

#### ***3.3.11 Kenya Electricity Grid Code & Kenya Safety Code***

The Kenya Electricity Grid Code sets out detailed arrangements for the regulation of the Kenyan electricity supply industry and is enforceable under the Electric Power Act (No. 11 of 1997). The Kenya Safety Code recognizes the Factories Act (1962) which requires an employee to use any means or appliance provided by the employer for securing safety and also not to willfully do anything to endanger himself or others.

#### ***3.3.12 Way leaves Act (Chapter 292)***

This Act of Parliament provides that any person in the service of the government and any contractor executing any work for the Government, together with his agents and servants, may at any time enter upon any land for the purpose of surveying, setting out and marking the line of any intended sewer, drain or pipeline, or for the purpose of inspecting, repairing, removing, re-laying or cleansing any sewer, drain or pipeline the property of the Government, or for any other purpose under this Act.

#### ***3.3.13 Noise and Excessive Vibration Pollution (Control) Regulations, 2009***

The act prohibits excessive noise and vibration. It states that no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment.

In this case the construction of the proposed transmission line will involve a lot of noise and vibration and in which case these must be observed to be at the required level and time. In determining whether noise is loud, unreasonable, unnecessary or unusual, the following factors may be considered:

- (a) Time of the day

- (b) Proximity to residential area
- (c) Whether the noise is recurrent, intermittent or constant
- (d) The level and intensity of the noise
- (e) Whether the noise has been enhanced in level or range by any type of electronic or mechanical means
- (f) Whether the noise can be controlled without much effort or expense to the person making the noise.

Motor vehicles used during the construction should adhere to the regulations which prohibit excessive noise. The provision of the act on motor vehicle states that no person shall operate a motor vehicle which-

- a) produces any loud and unusual sound; and
- b) Exceeds 84 dB(A) when accelerating.
- c) No person shall at any time sound the horn or other warning device of a vehicle except when necessary to prevent an accident or an incident.
- d) The provisions of the Traffic Rules shall apply to this Regulation.

Any person carrying out construction, demolition, mining or quarrying work shall ensure that the vibration levels do not exceed 0.5 centimetres per second beyond any source property boundary or 30 metres from any moving source.

#### ***3.3.14 The Environment Impact Assessment and Audit Regulations 2003***

The Environmental Impact Assessment (EIA) is a critical examination of the effects of a project on the environment. The goal of an EIA is to ensure that decisions on proposed projects and activities are environmentally sustainable. An EIA is conducted in order to identify impacts of a project on the environment, predict likely changes on the environment as a result of the development, evaluate the impacts of the various alternatives on the project and propose mitigation measures for the significant negative impacts of the project on the environment.

The EIA also generates baseline data for monitoring and evaluating impacts during the project cycle as well as highlighting environmental issues with a view to guiding policy makers, planners, stakeholders and government agencies to make environmentally and economically sustainable decisions. It seeks to minimize adverse impacts on the environment and reduces risks. EIA also identifies measures to mitigate the negative impacts while maximizing on the positive ones.

Environmental Audit (EA) is the systematic documentation, periodic and objective evaluation of activities and processes of an ongoing project. The goal of EA is to establish if proponents are complying with environmental requirements and enforcing legislation. The purpose of EA is to determine the extent to which the activities and programs conform to the approved environmental management plan. A comprehensive EA ensures a safe and healthy environment at all stages of project operations and decommissioning.

#### ***3.3.15 Waste Management Regulations, 2006 (Legal Notice No.121)***

Waste Management Regulations are meant to streamline the handling, transportation and disposal of various types of waste. The aim of the Waste Management Regulations is to protect human health and the environment. Currently, different types of waste are dumped haphazardly posing serious environmental and health concerns. The regulations place emphasis on waste minimization, cleaner production and segregation of waste at source.

The regulations have classified various types of waste and recommended appropriate disposal methods for each waste type. Under the Waste Management Regulations, NEMA licenses transporters, incinerators, landfills, composers, recyclers and transfer stations. Facilities to be licensed include local authorities, transporters and handlers of various types of waste. The licensing employs a risk-based approach by concentrating on facilities considered to pose a high risk to the environment.

The Waste Management Regulations also provide an opportunity for investment in various aspects of waste management. A copy of the regulations

is available at [www.nema.go.ke](http://www.nema.go.ke). Hard copies can also be purchased from the government printers.

### **3.3.16 *The Employment Act, 2007***

An Act of Parliament to repeal the Employment Act, declare and define the fundamental rights of employees, to provide basic conditions of employment of employees, to regulate employment of children, and to provide for matters connected with the foregoing.

### **3.3.17 *Trust Land Act (Chapter 288)***

This is an Act of Parliament which makes provision for Trust land. Section 38(1) of the Act provides that a way leave license may be granted to any person empowering him and his servants and agents to enter upon Trust land vested in the council and to lay pipes, make canals, aqueducts, weirs and dams and execute any other works required for the supply and use of water, to set up electric power or telephone lines, cables or aerial ropeways and erect poles and pylons therefore, and to make such excavations as may be necessary for the carrying out of any such purposes, and to maintain any such works as aforesaid.

Section 8 of the Act provides that where land is set apart, full compensation shall be promptly paid by the Government to any resident of the area of land set apart who:

- Under African customary law for the time being in force and applicable to the land has any right to occupy any part thereof; or
- Is, otherwise than in common with all other residents of the land, in some other way prejudicially affected by the setting apart.

Subsidiary legislation is to be found in the form of THE TRUST LAND (WAY LEAVES FOR ELECTRIC LINES) RULES. In these Rules a way leave license granted under section 38(of the Trust Land Act) for the purpose of erecting or laying an electric line over or under land shall be in the form in the Schedule to these Rules, or as near thereto as possible, regard toing had to the circumstances and requirements of each case.

Before granting any such way leave license, the council shall satisfy itself that compensation in respect of disturbance or of any other loss or expenses likely to be caused by the erection or laying of the electric line has been or will be paid to those concerned in like manner and to the same extent as if the land had been set apart under the Act and as if the compensation were being paid under section 8 of the Act.

No such way leave license shall be valid for a longer period than the period of validity of the relevant license issued under the Electric Power Act.

The annual fee to be paid for such a way leave license shall be assessed at 25 cents per annum per pole or pylon, or, where the electric line is laid underground, Sh. 5 per mile.

**3.3.18 *Land (Group Representatives) Act (Chapter 287 of the Laws of Kenya)***

This is an Act of Parliament to provide for the incorporation of representatives of groups who have been recorded as owners of land under the Land Adjudication Act, and for purposes connected therewith and purposes incidental thereto.

**3.4 World Bank Safeguard Policies**

The objective of the world Bank policies is to prevent and mitigate undue harm to people and their environment in the development process. Safeguard policies also provide a platform for the participation of stakeholders in project design and have been an important instrument for building a sense of ownership among local populations. In essence, the safeguards ensure that environmental and social issues are evaluated in decision making, help reduce and manage the risks associated with a project or program, and provide a mechanism for consultation and disclosure of information. The safeguards are listed in Table 3.1.



**Table 3.1 World Bank Environmental and Social Safeguards and their Policy Objectives**

<b>OP/BP</b>	<b>Safeguard</b>	<b>Policy objectives</b>
4.01	Environmental Assessment	Help ensure the environmental and social soundness and sustainability of investment projects.  Support integration of environmental and social aspects of projects in the decision-making process.
4.04	Natural Habitats	Promote environmentally sustainable development by supporting the protection, conservation, maintenance, and rehabilitation of natural habitats and their functions.
4.12	Involuntary Resettlement*	Avoid or minimize involuntary resettlement and, where this is not feasible, assist displaced persons in improving or at least restoring their livelihoods and standards of living in real terms relative to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.
4.20	Indigenous Peoples*	Design and implement projects in a way that fosters full respect for indigenous peoples' dignity, human rights, and cultural uniqueness and so that they (1) receive culturally compatible social and economic benefits, and (2) do not suffer adverse effects during the development process.

\*Safeguards most likely to apply in post-disaster situations.

### **3.5 Environmental Standards**

#### **3.5.1 Performance Standards by IFC**

The "Equator Principles" constitutes a financial industry benchmark for determining,

assessing and managing social and environmental risk in project financing. The principles apply to all new projects with total project capital costs of US\$10 million or more and across all industrial sectors. In addition, while the Principles are not intended to be applied retroactively, they apply to all project financings covering expansion or upgrade of an existing facility where changes in scale or scope may create significant environmental and/or social impacts, or significantly change the nature or degree of an existing environment.

The International Finance Corporation (IFC) World Bank group uses 10 principles, 4 exhibits and 8 standards to ensure that the projects they finance are developed in a manner that is socially responsible and reflect sound environmental management practices. Thus, the project is expected to abide by the IFC requirements as well as the Kenyan regulations.

**The Ten (10) ‘Equator Principles’ required for Projects Proposed for Financing by IFC are;**

- 1) Review and Categorization
- 2) Social and Environmental Assessment
- 3) Applicable Social and Environmental Standards
- 4) Action Plan and Management System
- 5) Consultation and Disclosure
- 6) Grievance Mechanism
- 7) Independent Review
- 8) Covenants to abide by laws, regulations and permits
- 9) Independent Monitoring and Reporting and
- 10) Reporting annually on the principles implementation processes and experience

**The Four (4) Exhibits are;**

- 1) Categorization of projects depending on the magnitude of impacts understood as a result of assessment.
- 2) Illustrative list of potential social and environmental issues to be addressed in the Social and Environmental Assessment documentation

- 3) IFC Performance Standards on Social and Environmental Sustainability and
- 4) Industry-Specific Environmental, Health and Safety (EHS) Guidelines

**The Eight (8) IFC Performance Standards on Social and Environmental Sustainability are;**

- 1) Social and Environmental Assessment and Management Systems
- 2) Labor and Working Conditions
- 3) Pollution Prevention and Abatement
- 4) Community Health, Safety and Security
- 5) Land Acquisition and Involuntary Resettlement
- 6) Biodiversity Conservation and Sustainable Natural Resource Management
- 7) Indigenous Peoples and
- 8) Cultural Heritage

Details of the principles, exhibits and standards are available in the IFC guidelines under websites: [www.ifc.org/enviro](http://www.ifc.org/enviro) and [www.equatorprinciples.com](http://www.equatorprinciples.com).

### **3.5.2 Air Quality**

The primary emissions to air from the combustion of fossil fuels or biomass are sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), particulate matter (PM), carbon monoxide (CO), and greenhouse gases, such as carbon dioxide (CO<sub>2</sub>). The amount and nature of air emissions depends on factors such as the fuel (e.g., coal, fuel oil, natural gas, or biomass), the type and design of the combustion unit (e.g., reciprocating engines, combustion turbines, or boilers), operating practices, emission control measures (e.g., primary combustion control, secondary flue gas treatment), and the overall system efficiency.

No air quality limits are available for Kenya. Therefore, the World Bank guidelines shall be applicable in this project. The World Bank Group Pollution Prevention and Abatement Handbook (PPHA, 1998) provides emission limits for thermal plants at referenced conditions of 15% oxygen, dry as shown in Table 3.2.

**Table 3.2 World Bank Emission Limits for Diesel Driven Thermal Power Plants**

Parameter	Emission Limit (g/Nm <sup>3</sup> )
Oxides of Nitrogen	2.0 (dry at 15% oxygen) for engine driven power plants
Sulphur Dioxide	2.0 (dry at 15% oxygen) for engine driven power plants
Particulate matter	0.05

The maximum emissions levels are normally acceptable to the World Bank Group in making decisions regarding the provision of World Bank Group assistance for new fossil fuel fired thermal power plants or units of 50 MW or larger (using conventional fuels). The emissions levels have been set so they can be achieved by adopting a variety of cost-effective options or technologies, including the use of clean fuels or washed coal. For example, dust controls capable of over 99% removal efficiency, such as electrostatic precipitators (ESPs) or bag houses, should always be installed for coal-fired power plants. Similarly, the use of low- NO<sub>x</sub> burners with other combustion modifications such as Low Excess Air (LEA) firing should be standard practice.

The range of options for the control of sulfur oxides is greater because of large differences in the sulfur content of different fuels and in control costs. In general, for low-sulfur (less than 1% S), high-calorific-value fuels, specific controls may not be required, while coal cleaning, when feasible, or sorbent injection (in that order) may be adequate for medium-sulfur fuels (1–3% S). FGD may be considered for high-sulfur fuels (more than 3% S). Fluidized-bed combustion, when technically and economically feasible, has relatively low SO<sub>x</sub> emissions. The choice of technology depends on a benefit-cost analysis of the environmental performance of different fuels and the cost of controls. Any deviations from the following emissions levels must be described in the World Bank Group project documentation.

**3.5.2.1 Air Emission**

The maximum emissions levels given here can be consistently achieved by well-designed, well-operated, and well-maintained pollution control systems. In contrast, poor operating or maintenance procedures affect actual pollutant removal efficiency and may reduce it to well below the design specification. The maximum emissions levels are expressed as concentrations to facilitate monitoring. Dilution of air emissions to achieve these guidelines is unacceptable. Compliance with ambient air quality guidelines should be assessed on the basis of Good Engineering Practice (GEP) recommendations. The plant should not use stacks heights less than the GEP recommended values unless the air quality impact analysis has been taken into account.

All of the permissible emissions levels should be achieved for at least 95% of the time that the plant or units is operating, to be calculated as a proportion of annual operating hours. The remaining 5% of annual operating hours is assumed to be for start up, shutdown, emergency fuel use and unexpected incidents.

**3.5.2. 2 Key Issues concerning the guidelines**

The key production and emissions control practices that will lead to compliance with the World bank guidelines are summarized below taking into account environmental and social factors.

- Choose the cleanest fuel economically available (natural gas is preferable to oil, which is preferable to coal).
- Give preference to high-heat-content, low-ash, low-sulfur coal (or high-heat-content, high- sulfur coal, in that order) and consider beneficiation for high-ash, high-sulfur coal.
- Select the best power generation technology for the fuel chosen to balance the environmental and economic benefits. The choice of technology and pollution control systems will be based on the site-specific environmental assessment.

- Designing stack heights according to Good International Industry Practice (GIIP) to avoid excessive ground level concentrations and minimize impacts, including acid deposition.
- Keep in mind those particulates smaller than 10 microns in size are most important from a health perspective. Acceptable levels of particulate matter removal are achievable at relatively low cost. Consider cost-effective technologies such as pre-ESP sorbent injection, along with coal washing, before in-stack removal of sulfur dioxide. Use low-NO<sub>x</sub> burners and other combustion modifications to reduce emissions of nitrogen oxides.
- Before adopting expensive control technologies, consider using offsetting reductions in emissions of critical pollutants at other sources within the air shed to achieve acceptable ambient levels.
- Use SO<sub>x</sub> removal systems that generate less wastewater, if feasible; however, the environmental and cost characteristics of both input and wastes should be assessed case by case.
- Manage ash disposal and reclamation so as to minimize environmental impacts especially the migration of toxic metals, if present, to nearby surface and groundwater bodies' addition to the transport of suspended solids in surface runoff. Consider reusing ash for building materials.
- Consider recirculation cooling systems where thermal discharge to water bodies may be of concern.
- As stated in the General EHS Guidelines, emissions from a single project should not contribute more than 25% of the applicable ambient air quality standards to allow additional, future sustainable development in the same air-shed.

### **3.5.3 Noise levels**

Principal sources of noise in thermal power plants include the turbine generators and auxiliaries; boilers and auxiliaries, such as coal pulverizers; reciprocating engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors;

transformers; circuit breakers; and cooling towers. Thermal power plants used for base load operation may operate continually while smaller plants may operate less frequently but still pose a significant source of noise if located in urban areas.

Noise abatement measures should achieve levels shown in Table 3.3 or a maximum increase in background levels of 3 decibels (measured on the A scale) {dB (A)}. Measurements are taken at noise receptors located outside the project property boundary.

**Table 3.3 Allowable Maximum Noise Levels**

<i>Receptors</i>	<i>Maximum allowable log equivalents(hourly measurements), in dB(A)</i>	
	<i>Day</i> <i>(07:00-22:00)</i>	<i>Night</i> <i>22:00-7:00</i>
<i>Residential</i>		
<i>Institutional &amp;</i>		
<i>Educational</i>	55	45
<i>Industrial/</i>		
<i>Commercial</i>	70	70

Additional recommended measures to prevent, minimize and control noise from thermal power plants include:

- i. Siting new facilities with consideration of distances from the noise sources to the receptors (e.g., residential receptors, schools, hospitals, religious places) to the extent possible. If the local land use is not controlled through zoning or is not effectively enforced, examine

whether residential receptors could come outside the acquired plant boundary. In some cases, it could be more cost effective to acquire additional land as buffer zone than relying on technical noise control measures, where possible.

- ii. Use of noise control techniques such as: using acoustic machine enclosures; selecting structures according to their noise isolation effect to envelop the building; using mufflers or silencers in intake and exhaust channels; using sound absorptive materials in walls and ceilings; using vibration isolators and flexible connections (e.g., helical steel springs and rubber elements); applying a carefully detailed design to prevent possible noise leakage through openings or to minimize pressure variations in piping;
- iii. Modification of the plant configuration or use of noise barriers such as berms and vegetation to limit ambient noise at plant property lines, especially where sensitive noise receptors may be present.

Noise propagation models may be effective tools to help evaluate noise management options such as alternative plant locations, general arrangement of the plant and auxiliary equipment, building enclosure design, and, together with the results of a baseline noise assessment, expected compliance with the applicable community noise requirements.

#### **3.5.4 Water Quality**

Steam turbines used with boilers and Heat Recovery Steam Generators (HRSG) used in combined cycle gas turbine units require a cooling system to condense steam used to generate electricity. Typical cooling systems used in thermal power plants include:

- Once-through cooling system where sufficient cooling water and receiving surface water are available.
- Closed circuit wet cooling system.
- Closed circuit dry cooling system (e.g., air cooled condensers).



Combustion facilities using once-through cooling systems require large quantities of water which are discharged back to receiving surface water with elevated temperature. Water is also required for boiler makeup, auxiliary station equipment, ash handling, and FGD systems. The withdrawal of such large quantities of water has the potential to compete with other important water uses such as agricultural irrigation or drinking water sources. Withdrawal and discharge with elevated temperature and chemical contaminants such as biocides or other additives, if used, may affect aquatic organisms, including phytoplankton, zooplankton, fish, crustaceans, shellfish, and many other forms of aquatic life. There may be special concerns about the potential impacts of cooling water intake structures located in or near habitat areas that support threatened, endangered, or other protected species or where local fishery is active.

Measures to prevent, minimize, and control environmental impacts associated with water withdrawal should be established based on the results of a project EA, considering the availability and use of water resources locally and the ecological characteristics of the project affected area. Recommended management measures to prevent or control impacts to water resources and aquatic habitats include:

- i. Conserving water resources, particularly in areas with limited water resources, by use of a closed-cycle, recirculation cooling water system (e.g., natural or forced draft cooling tower), or closed circuit dry cooling system (e.g., air cooled condensers) if necessary to prevent unacceptable adverse impacts. Cooling ponds or cooling towers are the primary technologies for a reticulating cooling water system.
- ii. Reduction of maximum through-screen design intake velocity to 0.2 m/s to avoid aquatic organisms being trapped.
- iii. Reduction of intake flow to levels for freshwater rivers or streams to a flow sufficient to maintain resource use (i.e., irrigation and fisheries) as well as biodiversity during annual mean low flow conditions.

- iv. If there are threatened, endangered, or other protected species or if there are fisheries within the hydraulic zone of influence of the intake, reduction of impingement and entrainment of fish and shellfish by the installation of technologies such as barrier nets (seasonal or year-round), fish handling and return systems, fine mesh screens, wedge wire screens, and aquatic filter barrier systems.

### **3.5.5 Waste Management**

#### **3.5.5.1 Solid waste**

According to World Bank guidelines, solid wastes including ash and FGD sludge, that do not leach toxic substances or other contaminants of concerns to the environment may be disposed in landfills or other disposal sites provided that they do not impact nearby water bodies, where toxics or other contaminants are expected to leach out, they should be treated by e.g. stabilization before disposal.

In addition, the Environmental Management and Coordination (Waste Management) regulations (2006) of Kenya list the following as the responsibilities of the waste generator:

1. No person shall dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle.
2. Any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed off such waste in the manner provided for under these regulations.
3. No person shall engage in any activity likely to generate any hazardous waste without a valid Environmental Impact Assessment license issued by Authority under the provisions of the Act.

#### **3.5.5.2 Effluents**

Effluents from thermal power plants include thermal discharges, wastewater effluents, and sanitary wastewater.

In general, thermal discharge should be designed to ensure that discharge water temperature does not result in exceeding relevant ambient water quality temperature standards outside a scientifically established mixing zone. The mixing zone is typically defined as the zone where initial dilution of a discharge takes place within which relevant water quality temperature standards are allowed to exceed and takes into account cumulative impact of seasonal variations, ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations.

The wastewater streams in a thermal power plant include cooling tower blow down; ash handling wastewater; wet FGD system discharges; material storage runoff; metal cleaning wastewater; and low-volume wastewater, such as air heater and precipitator wash water, boiler blow down, boiler chemical cleaning waste, floor and yard drains and sumps, laboratory wastes, and back flush from ion exchange boiler water purification units. The characteristics of the wastewaters generated depend on the ways in which the water has been used. Contamination arises from demineralizers; lubricating and auxiliary fuel oils; trace contaminants in the fuel (introduced through the ash-handling wastewater and wet FGD system discharges); and chlorine, biocides, and other chemicals used to manage the quality of water in cooling systems. Cooling tower blow down tends to be very high in total dissolved solids but is generally classified as non-contact cooling water and, as such, is typically subject to limits for pH, residual chlorine, and toxic chemicals that may be present in cooling tower additives (including corrosion inhibiting chemicals containing chromium and zinc whose use should be eliminated).

The EHS management system requires that for any facilities installed,

- The quality, quantity, frequency and sources of liquid effluents in its installations must be understood. This includes knowledge about the locations, routes and integrity of internal drainage systems and discharge points.

- There should be planning and implementation of the segregation of liquid effluents principally along industrial, utility, sanitary, and stormwater categories, in order to limit the volume of water requiring specialized treatment. Characteristics of individual streams may also be used for source segregation.
- Opportunities to prevent or reduce wastewater pollution through such measures as recycle/reuse within their facility, input substitution, or process modification (e.g. change of technology or operating conditions/modes) must be identified.
- Assess compliance of their wastewater discharges with the applicable:  
(i) discharge standard (if the wastewater is discharged to a surface water or sewer), and (ii) water quality standard for a specific reuse (e.g. if the wastewater is reused for irrigation).

Additionally, the generation and discharge of wastewater of any type should be managed through a combination of:

- Water use efficiency to reduce the amount of wastewater generation
- Process modification, including waste minimization, and reducing the use of hazardous materials to reduce the load of pollutants requiring treatment
- If needed, application of wastewater treatment techniques to further reduce the load of contaminants prior to discharge, taking into consideration potential impacts of cross-media transfer of contaminants during treatment (e.g., from water to air or land).

### **3.6 Environmental Conventions and Treaties**

#### **3.6.1 *Convention on Biological Diversity (1992)***

This was ratified on 11<sup>th</sup> September 1994. See the Rio Declaration. Section 3.2.2.

**3.6.2 *Montreal Protocol, 1987***

The Montreal Protocol on Substances that deplete the ozone layer (1987) was ratified on November 9, 1988. This treaty was designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion.

**3.6.3 *United Nations Convention to combat Desertification (1994)***

An agreement to combat desertification and mitigate the effects of drought through national action programs that incorporate long term strategies supported by international cooperation and partnership arrangements.

**3.6.4 *United Nations Framework Convention on Climate Change (1992)***

International environmental treaty produced at the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, held in Rio de Janeiro in 1992. The treaty is aimed at reduced emissions of greenhouse gas in order to combat global warming.

**3.6.5 *Bamako Convention (1991)***

This is a treaty of African nations prohibiting the import of any hazardous (including radioactive) waste.

**3.6.6 *Kyoto Protocol (2004)***

The protocol details an amendment to the international treaty on climate change, assigning mandatory emission limits for the reduction of greenhouse gas emissions to the signatory Nations.

## CHAPTER 4: METHODOLOGY FOR THE EIA STUDY

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### 4.1 EIA NEMA Process Background

To ensure sustainable use of natural resources, the Government of Kenya has developed Environmental Impact Assessment (EIA) procedures and guidelines for all projects carried out in the country. In 1994, the government developed the National Environment Action Plan (NEAP) to combine economic development with environmental conservation through:

- a) Integration of environmental principles into development planning.
- b) Promotion of environmental sound usage of renewable and non-renewable resources.
- c) Establishment of an institutional framework for the coordination, monitoring and enforcement of environmental legislation as well as providing the manpower to do so.

In 1996, the Physical Planning Act was legislated and aims to provide for the preparation and implementation of physical development plans (Mumma, 1998). The act empowers local authorities to review project applications and to grant permission for developments. The Environmental Management and Coordination Act (EMCA), was enacted in 1999 with the aim to identify projects and programmes, plans and policies for which environmental impact assessment, environmental audits and environmental monitoring must be conducted under the Act.

In accordance with the Kenyan EIA process before commencement of an environmental assessment the Terms of Reference (ToR) must be developed in consultation with the relevant authorities in the Scoping Process. At a regional level, a number of committees are in place in each District, with their brief being to guide and coordinate development in the various Districts. The District Executive Committee (DEC) which consists of all civil servants, the District Development Committee (DDC) which consists of the DEC together with local leaders and politicians, and the District Environmental Management

Committee (DEMC) which consists of technical officers and local experts all operates in harmony.

The EIA in this project was structured to cover the requirements under the EMCA, 1999 as well as the Environmental Impact Assessment and Audit Regulations, 2003 and the IFC requirements. It involved largely an understanding of the project background, the preliminary designs and the implementation plan as well as commissioning.

In addition, baseline information was obtained through physical investigation of the site and its' environ, informal interviews with a random sample of people from the surrounding community, use of public participation forms, site checklist, photography and discussions with other stakeholders.

The key activities undertaken during the assessment were:

- a) Continuous discussions with the stakeholders and accessing relevant sources of information on the proposed project details, the site planning and implementation plan.
- b) Physical inspection of the proposed site, photography and interviews with people in the immediate neighborhood. A public participation form was used to record their opinion regarding the project.
- c) Evaluation of the activities around the site and the environmental setting of the wider area. This was achieved through existing information, literature and physical observations, review of available documentation, reporting, review and submissions.

## **4.2 The EIA Process**

An outline of the basic EIA steps that were followed during this assessment is as follows:

### **4.2.1 Screening**

The environmental and social impacts assessment and prediction is precisely aimed at identification of possible negative and positive impacts including opportunities for enhancement of positive impacts. Screening is the first step in

EIA Study. It enables the project developers to decide early at planning and design stage whether an EIA study will be required or not. It involves environmental screening of the project using criteria such as World Bank Guidelines. Through initial evaluation considering; location, size, scope, importance, sensitivity and expected environmental and social impacts, the project is allotted an environmental category A, B or C. Considering the above criteria, the present project falls under category B for which a limited scale environmental and social impact assessment is required. Conclusively, screening of adverse environmental and social issues is carried out for planning of the environmentally and socio-economically viable mitigation measures and their inclusion in the environmental management plan.

#### **4.2.2 Scoping**

If the project screening indicates that an ESA study is required, the next important task is "Scoping". The aim of scoping is to ensure that the ESA study addresses all key environmental and social issues of importance to the decision makers. It involves deliberations of environmental issues with the project stakeholders including project developers, decision makers, the regulatory agency, concerned government and semi-government departments, scientific institutions, local community leaders, local NGOs and other affected parties to ensure that all environmental and social issues and concerns are discussed and key environmental and social impacts identified. The scoping also enables the ESA Study Team to discuss and record views, comments and observations of the project stakeholders regarding negative and positive projects impact and mitigation measures for negative environmental and social impacts.

The scoping process involved discussions with the project proponent as well as data/information gathering from the site investigation and documentation review, the proposed project was evaluated and rapid assessment of the site and its' environ undertaken.



#### **4.3 Scope of the Environmental Impact Assessment**

The scope of the assessment covers preconstruction phase, construction works of the proposed development which include ground preparation, civil works, structural works and installation of the generators, installation of service lines as well as the utilities required, operational and decommission phases of the thermal power plant. The output of this work is a comprehensive Environmental and Social Impact Assessment Project Report for the purposes of seeking a NEMA license that will approve the project construction and operation. Additionally, the report should satisfy the Financial Institutions (EPFI) guidelines commonly referred to as the Equator Principles.

#### **4.4 IFC Guidelines on ESIA Studies**

The IFC's Policy and Performance Standards on Social and Environmental Sustainability include eight performance standards which define the client's roles and responsibilities for managing their projects and the requirements for receiving and retaining IFC support. The eight performance standards are summarized as follows:

- 1. Social and Environmental Assessment and Management System** - identifying of risks and impacts of proposed projects, it also aims at ensuring that affected communities are appropriately engaged on issues that could potentially affect them.
- 2. Management System** - the client should establish management programs to address identified impacts and risks in favour of the avoidance and prevention of impacts over minimization, mitigation, or compensation, wherever technically and financially feasible, otherwise, provide mitigation measures and actions.
- 3. Action Plan** - mitigation measures actions plan to reflect and address the outcomes of consultation on social and environmental risks and adverse impacts and the proposed measures and actions to address the issues.

4. **Organizational Capacity** -The client will establish, maintain, and strengthen an organizational structure that defines roles, responsibilities, and authority to implement the management program, including the action plan.
5. **Training** - The client will train employees and contractors with direct responsibility to the activities relevant to the projects social and environmental issues.
6. **Community Engagement** - When local communities may be affected by risks or adverse impacts from a project, the engagement process will include consultation to build and maintain over time a constructive relationship with these communities, free of external manipulation, interference, or coercion and intimidation, and conducted on the basis of timely, relevant, understandable and accessible information.
7. **Disclosure** - Disclosure of relevant project information helps affected communities understand the risks, impacts and opportunities of the project. Where the client has undertaken a process of Social and Environmental Assessment, the client will publicly disclose the Assessment document.
8. **Consultation** - If affected communities may be subject to risks or adverse impacts from a project, the client will undertake a process of consultation in a manner that provides the affected communities with opportunities to express their views on project risks, impacts, and mitigation measures and allows the client to consider and respond to them.

#### 4.5 EIA Study Approach

Based on the detailed review of the project, an approach and methodology were formulated for achieving the study objectives. These are described as follows:

1. A multidisciplinary integrated approach - All relevant disciplines falling under the project were represented in constitution of the EIA team.
2. Close consultations with the Client - The proponent was to provide all relevant information regarding the proposed project design.
3. In depth review of background reports.
4. Consultation with the key stakeholders, including opinion leaders, community leaders and government officials. The specific stakeholders were arrived at by conducting an in depth stakeholder analysis.
5. The experience of the project team in implementation of similar projects.
6. Simple, practical and economical measures and options.
7. Collection and use of primary and secondary data.
8. Baseline studies on soil, water, ambient air and noise studies.

The study was conducted in accordance with the Environmental Assessment and Audit Regulations promulgated in 2003 as set out by the Environmental and Management and Coordination Act (EMCA, 1999). A comprehensive participatory process was adopted to ensure active participation of members of the public to sensitize them on the government proposal and consequently have them express their views on the project. The members of public were also involved since they will be affected by the construction of the project either positively or negatively. All relevant stakeholders were consulted through formal, informal interviews and discussions.

#### **4.6 Establishment of Baseline Conditions**

The environmental and social impacts assessment and prediction is based on the pre-existing of baseline conditions. Therefore, a survey of the baseline conditions was carried out covering social economic analysis of the project vicinity, physical inspections and observations.

A survey and analysis of prior environmental and socio-economic conditions were conducted at the project site and surrounding areas. The purpose of the

study was to identify possible health and environment impacts and setting of a baseline for future audits. The survey and analysis carried out are as described in the following sections:

#### **4.6.1 *Socio-Economic Conditions***

The existing socio-economic conditions were obtained from both primary and secondary data. The data covered the population, human settlement, economic activities, physical features and natural environment including, topography climate, geological setting, and soils; water sources, transport and industry.

#### **4.6.2 *Sampling and Testing***

Environmental sampling and analysis on; air, water, noise and soil were carried out at the site. Soil samples were obtained from the site and tested for contamination by petroleum hydrocarbon at Jomo Kenyatta University of Agriculture and Technology laboratory which is accredited by NEMA. Water samples were tested at the Public Health Engineering laboratory, University of Nairobi. On site monitoring of baseline gaseous pollutants and noise levels was carried out by the Institute of Nuclear Science of the University of Nairobi.

The testing and analysis was based on set Kenya procedures and/or other international standards. The quality assurance (QA) and Quality Control included Trial Blanks (TB) 1 per cooler and Blind Duplicates (BD), 10 % of samples collected per analytical method.

#### **4.6.3 *Soil Sample Analysis***

An investigation on the contamination status of site soils was undertaken to determine the levels of Total Petroleum Hydrocarbons (TPH), BTEX and PAHs. Soil samples were collected from different trial holes on site using standard soil sampling procedures. To avoid organic material breakdown, soil samples were immediately wrapped in aluminium foils. Groundwater was not encountered within the investigation depth. The analysis carried out on soil provided baseline data in total petroleum hydrocarbons and compared with guideline values (Table 4.1).

**Table 4.1 Oil Industry Guidelines for TPH**

- 
- |  |
|--|
| 1. TPH $\leq$ 500 mg/kg, assess on regular basis.                                  |
| 2. TPH between 1000 - 5000 mg/kg, monitoring and remediation of contaminated soil. |
| 3. TPH greater than 5000 mg/kg, require full analysis.                             |
- 

**4.6.4 Air Particulate Matter**

A dichotomous PM10 sampler model 241 was used to collect two size fractionated aerosol samples (PM<sub>2.5</sub> and PM<sub>2.5</sub><10) during the sampling exercise. The sampler inlet was placed at heights of 2 meters from the ground and the flow rate adjusted to approximately 16.7 L/min. The sampling duration was 8 hours each day. The filter loading were determined gravimetrically using a 10µg sensitivity Ainsworth (Type 24N) weighing balance in an air-conditioned room at 50% relative humidity and at temperature of 20°C. The filter load densities were determined from results of volume of air sampled and the weights of the filter loads determined.

**4.6.5 Gaseous Pollutants**

Measurements of gaseous pollutants; NO<sub>2</sub>, CO and SO<sub>2</sub> were obtained by using Nitrogen Dioxide meter data logger model Z-1400XP, Carbon monoxide meter Data logger model Z-500 XP and Sulphur Dioxide meter data logger model Z-1300XP respectively. Gaseous concentrations levels were determined from measurements of data taken at intervals of 10 seconds continuously for 8 hours each day at the sampling site.

**4.6.6 Noise levels**

Noise levels were measured using a digital sound level meter model HP-882A with a measurement range of 30 – 130 decibel and accuracy of  $\pm 1.5$  dB. Readings were obtained at 8 different points three times every day. The spatial noise distribution is represented by Figure 1 in Appendix 3.3. The Figure is aligned to the location of the site covering an area of about 0.25 km<sup>2</sup>.

#### **4.6.7 Water Quality Analysis**

Physical and chemical water quality analyses were conducted on water samples from Komu and Ndarugu rivers in the vicinity of the proposed Thika Thermal Power Plant, at the University of Nairobi Public Health Engineering Laboratories, using standard methods.

#### **4.7 Development of the EIA Study Report**

The compilation of the EIA report entailed the following:

- Review of the project objectives, justification and implementation process.
- Review of the legislative and institution framework.
- Information from the public consultations.
- Information from specialist studies on; Air and Noise Quality Reports; Air Quality Modeling; Noise Level Simulations; Soil Analysis and Results; Water Quality Report; Traffic and Transport
- Compilation of findings to ensure all issues are covered
- Assessment and evaluation of the likely impacts.
- Development of environmental and social mitigation measures for the adverse impacts.
- Development of an Action Plan
- Compilation of full EIA study report for the project.

## CHAPTER 5: ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

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### 5.1 Introduction

The proposed project site location is along Thika Road just next to Mang'u High School and opposite Witeithie market centre, some 38 km North East of Nairobi and some 6 km South West of Thika Town in Central Kenya. The Town is on the A2 road 45 km North East of Nairobi. The town had a population of 88,265 (1999 census) and is growing rapidly, as is the entire greater Nairobi Metropolis area. Thika District had been projected to have a population of approximately 710,000 people by 2010, as per the Thika District Strategic Plan of 2005- 2010. It is home to the Chania Falls and the Thika Falls, while Ol Donyo Sabuk National Park lies to its south east. The District is poised to form part of the larger Nairobi Metropolitan that is envisaged in Kenya's Vision 2030.

Thika is connected to Nairobi through dual carriage highway which is being upgraded to an expressway and by the Nairobi Nanyuki railway line. It is also connected to most urban centers in Central, Eastern Kenya and to the North Eastern town of Garissa by bitumen roads. The town also has a well-maintained road network. The economic activities of the town include agriculture, particularly in the horticulture and coffee industry. Other industries include textile (cotton), food processing (pineapples, macadamia nuts and wheat), tannery, motor vehicle assemblies, tobacco processing, bakeries and stone quarries. Hundreds of small scale industries and at least twenty major factories exist in and around Thika town.

In addition to Thika being a rich agricultural district, it is one of the leading industrial Districts in the country. Large industries include food processing, vehicles manufacturing/assembling and metal industries. The agricultural

sector has industries such as coffee processing, fruit canning and juice extraction, flour milling, processing of tobacco products among others. Thika town has industries for assembling vehicles, vehicle body building and manufacturing of various metal products. There are quite a number of textile industries although most of them collapsed in the 1990's. Industries for producing medicines also exist in Thika. Small scale industries exist in the form of metal manufacturing that fabricate a variety of products.

## **5.2 District Profile**

### **5.2.1 Population**

As per the 1999 Population and Housing Census, Thika District had a population of 645,713 persons with an estimated growth rate of 2.8 percent. This population was projected to increase to 701,664 in 2002 and 828,531 in 2008, assuming that constant fertility rate and the same growth rate prevail. However, with HIV/AIDS pandemic, which is at approximately 34 percent prevalence rate of the total population, the trend is expected to rise but at a decreasing rate. The district has a large proportion of youthful population. The demand for facilities such as schools, hospitals and recreation facilities is already high and is poised to increase further in future. There is therefore need to check the population growth through intensification of family planning campaigns so that available resources can be directed to the stimulation of industrial activities instead of being allocated for social investments to cater for the rising population. All forms of poverty including food and absolute poverty are being experienced and indeed, poverty incidence is taking an upward trend due to factors such as rising unemployment, collapse of agricultural sectors, collapse of industries, poor infrastructure and rise in HIV/AIDS cases. The poverty prevalence stands at 48.4 percent.

### **5.2.2 Human Settlement**

At inception Thika District was a sisal plantation that stretched all the way from Nairobi to parts of Machakos District. This attracted job seekers who eventually settled in the district. The pineapple farms and major industries also contributed to human settlement. White settlers also settled in the area during



the pre-independence period. The district is densely populated but with diverse distribution varying from one division to the other and from region to region. The settlement pattern is mainly determined by climatic conditions among other factors. The highest population density is in Thika Town. High population density has put pressure on land leading to its subdivision.

#### **5.2.3 *Economic Activities***

Economic activities in Thika District include agriculture, industrial, commercial and small scale entrepreneurship. Agricultural activities include: coffee, macadamia nuts and pineapple farming. Other horticultural activities include flower farming and food crop farming through irrigation. Large industries include food processing, vehicles manufacturing/assembling and metal industries. Thika District has numerous public and private schools and now hosts a University. The town and other urban centres have many large and small entrepreneurship shops. The building construction industry is also quite active.

#### **5.2.4 *Waste Management***

Thika town is under the Thika Municipal Council which manages waste collection and disposal. However, there are many logistical challenges for the council including resource capacity against the rising population. Thus private waste disposal companies have come in to fill the gap, especially in the residential areas. The council has a designated waste disposal site on the outskirts of the town. Other urban areas beyond the jurisdiction of Thika Municipal Council are managed by the Thika County Council. Such areas have got fewer wastes as compared to the Municipal Council areas. Most of the wastes generated are a conglomeration of solid wastes that are not sorted out. Hospitals and some industries have their own incinerators for burning solid wastes. Thika town has a good sewage system for disposal of liquid waste.

### **5.3 Natural and Physical Environment**

#### **5.3.1 Topography**

Thika district lies between latitudes 3°53N and 1° 45N South of Equator and longitudes 36° 35N and 37° 25N East. The elevation of Thika is 1531 meters in altitude. The district covers an area of 1,960.2 sq Km<sup>2</sup>. It borders Nairobi City to the south, Kiambu District to the west, Maragua District to the north and Machakos District to the east. The landscape is generally level save for a few ridges and depressions in wetlands. Part of the proposed project site land is a gentle slope with red clay soil. Some sections bear visible surface rock where quarry stone mining is practiced.

#### **5.3.2 Drainage**

The most important surface water bodies are the Nairobi, Athi and Thika rivers which receive water throughout the year from streams rising further west, on the high ground at the edge of the Rift Valley. All the other rivers are intermittent, flowing only during times of flood. Another important feature of the soils on the plains south of Thika is the development of mound topography. The low mounds on the plains are extremely abundant near Juja. They are usually about 20 to 50 m in diameter, at 50 to 100 m intervals, and develop a stronger growth of vegetation than the surrounding depressions. In the Juja region the mounds occur in crude radiating patterns and are not haphazard in their arrangement. On top of the mounds, the underlying rock surface, usually composed of cemented material is exposed or is covered by only a few inches of soil. In between the mounds the soil is much deeper. The mound topography can be attributed to the production and swelling of montmorillonite by weathering in the underlying rock. In the present area, the mounds and depressions probably owe their shape to the action of drainage along the channels, which may have originated due to subsidence along polygonal joint systems in the underlying rocks.

#### **5.3.3 Climate**

##### **5.3.3.1 Average Daily Temperatures**

The average daily temperature throughout the year (See Table 5.1) varies slightly from month to month with average temperatures of around 17 °C during the months of July and August to about 20 °C in March. But, the daily range is much higher, with the differences between maximum and minimum temperatures each day around 10 °C in May and up to 15 °C in February. Between the months of June to September, southeast winds prevail in the coastal parts of Kenya and last up to several days without a break. The clouds cause day temperatures to remain low and most times the maximum temperature stay below 18 °C. The minimum temperatures also remain low during cloudy nights, usually hovering around 12 °C. Clear skies in January and February also bring colder nights. The highest temperature reached in Thika is 30.0°C and the lowest being 4.0°C.

**Table 5.1 Average Daily Temperatures in Thika**

Months	Mean Maximum °C	Mean Minimum °C	Mean Range °C
<b>January</b>	<b>26.8</b>	<b>13.1</b>	<b>13.7</b>
<b>February</b>	<b>28.0</b>	<b>13.4</b>	<b>14.6</b>
<b>March</b>	<b>27.4</b>	<b>14.4</b>	<b>13.0</b>
<b>April</b>	<b>24.6</b>	<b>14.3</b>	<b>10.3</b>
<b>May</b>	<b>24.1</b>	<b>14.2</b>	<b>9.9</b>
<b>June</b>	<b>23.1</b>	<b>12.6</b>	<b>10.5</b>
<b>July</b>	<b>22.3</b>	<b>11.5</b>	<b>10.8</b>
<b>August</b>	<b>22.7</b>	<b>11.8</b>	<b>10.9</b>
<b>September</b>	<b>25.3</b>	<b>12.2</b>	<b>13.1</b>
<b>October</b>	<b>26.2</b>	<b>13.7</b>	<b>12.5</b>
<b>November</b>	<b>23.6</b>	<b>14.4</b>	<b>9.2</b>
<b>December</b>	<b>25.1</b>	<b>13.8</b>	<b>11.6</b>
<b>Year</b>	<b>24.9</b>	<b>13.3</b>	<b>11.6</b>

#### 5.3.3.2 Average Rainfall

With the routinely high relative humidity figures, it is not surprising that the Thika climate is one that produces much rain annually. In fact, from the past 50 years, the annual rainfall has ranged from 500 to 1500 mm, with the average at about 900 mm. The bulk of these rain falls in one major and one minor monsoon seasons respectively.

The major monsoon season occurs within the months of March to May and locally referred to as the “Long Rains”. The minor monsoon seasons emerges within the October to December Months, and is termed the “Short Rains”. That

is what the meteorologists as a whole know about the monsoon season. What they do not know is exactly when these seasons start. There is usually not an indication of when these rainy seasons start, since it is difficult to determine when one starts and the other ends. But two rainy seasons are available with an annual total of 888 mm for the 50 year period (Table 5.2).

**Table 5.2 Average Monthly Rainfall in mm based on 50 Years Record**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
48	48	115	195	137	42	15	21	24	52	114	77

#### **5.3.3.3 Average Winds**

Winds along the surface are predominantly easterly throughout the entire year. They are shifted to Northeast between October and April, and they are shifted Southeast between May and September. Right before the “Long Rains” season, the strongest winds occur, reaching speeds of 20 to 25 miles per hour. During the rest of the year, winds are usually at speeds of 10 to 15 miles per hour. During the night, the winds are calm.

#### **5.3.4 Geological Setting**

In the North Machakos-Thika area, in contrast to the area south of Machakos, there is less hilly terrain made up of ancient rocks than what is concentrated in the east side of the area. More than half the area has a rather monotonous topography underlain by volcanic rocks of relatively recent age. The volcanic area is, however, of importance as the volcanic rocks yield constructional materials, notably building-stone in the Thika to Juja area. The area consists of flat volcanic plains in the west and generally hilly country to the east, formed by dissection of the sub-Miocene and end-Cretaceous peneplains. The north-western end of the lava-capped Yatta Plateau passes across the area east of Ol Donyo Sabuk and the surface on which the lava rests is believed to represent a

remnant of the sub-Miocene bevel. The rocks exposed consist of horizontal Tertiary lavas, pyroclastics and sediments in the west, and folded Basement System gneisses and schists to the east.

The Basement System rocks are metamorphic and have been in places granitized to a considerable degree with the production of granitoid gneisses. Soil types in the area are dependent on drainage; black-cotton soils developed in poorly drained regions while sandy soils and murrums form in well drained regions.

#### **5.3.5 Soils and Geology**

In Thika District in general, the rocks exposed consist of horizontal Tertiary lavas, pyroclastics and sediments in the west and folded Basement System gneisses and schist to the east. The Basement System rocks are metamorphic and have been in places granitized to a considerable degree with the production of granitoid gneisses. Soil types in the area are dependent on drainage; black-cotton soils develop in poorly drained regions while sandy soils and murrums form in well drained regions.

The proposed project area consists of red soils suitable for farming and brick-making.

### **5.4 Water sources**

The proposed project will require approximately 80 m<sup>3</sup> /hr for cooling purposes. For this reason it is necessary to obtain adequate water from the area. Among the options available are as follows:

#### **5.4.1 Thika Water and Sanitation Company (THIWASCO)**

THIWASCO has the capacity to supply the required cooling water to the treatment plant. Already, there exists a 150 mm pipeline connection to Witeithie village. The water is treated to drinking water standards and therefore many not require further treatment. However, the cost of the water would be a major recurrent cost item even when supplied in bulk. It is

recommended that the use of the water from this source be limited to domestic purposes within the plant.

#### **5.4.2 *Ndarugu River***

Ndarugu River (plate 1.6) is a perennial river located 3.5 km from the proposed site. The water requires only minimum treatment (Appendix 3.5). Abstracting water from this source will require construction of a pumping station, a 3.5 km rising main and a water treatment plant.

#### **5.4.3 *Borehole***

There are two boreholes in the neighbourhood of the proposed site for the Thika Thermal Power Plant. One borehole serves Mang'u High School and is 1.5 km from the site. The other borehole belongs to THIWASCO and is located 1.3 km from the site. The two boreholes are therefore more than the recommended 800 m distance between boreholes. Thus, sinking of a bore to supplement the water supplies is eminent.



**Plate 6.1 Ndarugu River located 3.5 km from the Proposed Site**

## **5.5 Transport**

Thika is well served with good communication and transport network mainly road and railway. The Town is connected to the Nairobi city through the dual carriageway Nairobi – Thika highway that is currently being upgraded to an eight lane expressway with associated service (Figure 6.2). It is strategically connected to Central, Eastern and North-Eastern provinces of Kenya. Road transport is much more prevalent than rail transport. Thika town is on the road leading to the Northern Kenya frontier Districts of Isiolo, Marsabit and Moyale. This road is also part of the Trans-Africa Great North Road that connects Cairo in Egypt to Cape Town in South Africa.





**Plate 6.2 Nairobi – Thika Dual carriage highway through the proposed site**

The railway line from Nairobi to Nanyuki runs through Thika Town where a station is located. Air transport for Thika is provided by the Jomo Kenyatta International Airport in Nairobi.

## **5.6 Industry**

In addition to Thika being a rich agricultural district, it is one of the leading industrial districts in the country. Large industries include food processing, vehicles manufacturing/assembling and metal industries. The agricultural sector has industries such as coffee processing, fruit canning and juice extraction, flour milling, processing of tobacco products and many others. Thika town has industries for assembling vehicles, vehicle body building and manufacturing of various metal products. There are quite a number of textile industries although most of them collapsed in the 1990's. Pharmaceutical Industries also exist in Thika. Small scale (juakali) industries exist in the form of metal fabricators that produce a variety of products.

## **5.7 Environmental Baseline Conditions**

### ***5.7.1 Soil Petroleum Hydrocarbons***

Soil samples from the project site were investigated at Jomo Kenyatta University of Agriculture and Technology laboratory for contamination by petroleum hydrocarbon. Tests were carried out to determine the concentrations of TPH, benzene and toluene. The results (Appendix 3.4) revealed concentrations of petroleum hydrocarbons were negligible at approximately 0.1 mg/kg. Because the TPH concentrations are less than 5,000 mg/kg (Table 4.1), full analysis to assess BTEXs and PAHs was not required. Whereas the released petroleum products do not pose any immediate health risks, the presence of hydrocarbons in the soil need to be monitored. Oil industry guideline for TPH in soil, referred to as 'Risk Based Corrective Action' (RBCA), was adopted to determine the required action to minimise exposure in soil. The soil contamination level is below the oil industry guideline for RBCA. Assessment on regular basis, ongoing monitoring and remediation of contaminated soils should be instituted. Monitoring wells if installed to below UST's bottom level will aid in easy sampling for possible contamination through accumulated ground water. The impact posed by lead levels is mitigated by shift to sale of unleaded petrol.

### ***5.7.2 Air Particulate Matter***

Two size fractionated aerosol samples ( $PM_{<2.5}$  and  $PM_{2.5<10}$ ) were collected during the sampling exercise, and average particulate concentration determined. Results of the measurements (Appendix 3.1) showed that the total particulate matter is  $64.9 \mu\text{g}/\text{m}^3$ . Therefore, the existing particulate matter ( $PM_{10}$ ) concentration is less than the maximum limit of  $150 \mu\text{g}/\text{m}^3$  set by WHO (1987) and EPA (1999).

### ***5.7.3 Gaseous Pollutants***

Measurements of gaseous pollutants revealed that average gases concentrations were generally low compared to the recommended levels by WHO and EPA.

2. NO<sub>2</sub> maximum measured value was 400 ppb and the maximum 8 hour average was 35 ppb. The average result is within the one-hour maximum exposure of between 100 – 1170 ppb as cautioned by WHO (1999).
3. CO maximum measured concentration was 3500 ppb and an 8 hour average maximum of 104 ppb. Maximum allowable concentrations as set by United States EPA are 35 ppm for 1 hour and 9 ppm for 8 hours.
4. Highest SO<sub>2</sub> measured concentration was 200 ppb and the 8 hour calculated average was 76 ppb. The average value is less than the safe level set by United States EPA (1999) of 140 ppb (averaged over 24 hours)

Air pollution levels during the operation of the power plant were modeled, and the air pollution impacts of the new plant on the surrounding area using a computer based 2-D model (Appendix 3.2). It was predicted that, provided the source strength provisions in the project specifications are complied with, air pollution levels will not exceed WHO guidelines at the western sector of the plant while the eastern sector will not be adversely affected by the plant. Air pollution levels are therefore predicted to comply with all applicable legislative requirements.

#### **5.7.4 Noise levels**

Noise levels measured in 6 sites ranged between 43.7 – 73.2 dB with an 8 hour average of 54.0 dB. This average value is however less than the 24 hour exposure level of 70dB as recommended by US EPA.

Noise modeling for the proposed plant was carried out and is presented in Appendix 3.4. The spatial noise distribution meets the Kenyan Regulatory Noise standards within the environs of the facility.

#### **5.7.5 Water Quality**

Physical and chemical water quality analyses were conducted on samples from Komu and Ndarugu Rivers in the vicinity of the proposed Thika Thermal

Power Plant, at the University of Nairobi Public Health Engineering Laboratories. Results indicate significant colour, turbidity, conductivity and solids (total and dissolved) which is characteristic of the type of strata and organic matter it traverses. However, the observed hardness is not significant and the water may be classified as soft (20 - 100 as  $\text{CaCO}_3$  mg/l) mainly calcium hardness. The water shows very low concentrations of nutrients (phosphate and nitrates) suggesting limited contamination from agricultural sources. Similarly, the water had low concentrations of metals such as copper, manganese, iron and chromium indicating absence of industrial pollution.

## CHAPTER 6: PUBLIC PARTICIPATION AND CONSULTATION

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### 6.1 Introduction

World Bank/ IFC requirements for Public Consultation were used as the primary point of reference. The requirements with respect to public consultation and disclosure in environmental assessment for projects are set out in Performance Standard 1: Social and Environmental Assessment and Management Systems. Section 19 defines Community Engagement as “ongoing process involving the client’s disclosure of information”. When local communities may be affected by risks or adverse impacts from a project, the engagement process will include consultation with them. The purpose of community engagement is to build and maintain over time a constructive relationship with these communities. Community engagement will be free of external manipulation, interference, or coercion and intimidation and conducted on the basis of timely, relevant, understandable and accessible information.”

### 6.2 Stakeholders Analysis

The consultant undertook a stakeholder analysis to identify the potentially affected groups by the project. This analysis identified the following groups that were consulted during public consultations:

- Witeithie community
- Mang’u high school administration
- Agro Tropical Ltd (owners of the farm adjacent to the site)

In addition a number of lead agencies were identified and consulted in the process; they include:

- Provincial Administration – Chief, Komu Location
- Thika County Council
- Thika Town Council
- District Agricultural Office, Thika
- Thika Water and Sanitation Company (THIWASCO).

### **6.3 Public Consultation Meetings**

Public consultations for the proposed Thika Thermal Plant were carried out through public consultative meetings and administration of questionnaires to individuals. A public consultation meeting was held at Witeithie outside the Administration Police Camp on October 17, 2010 (Plate 6.1 and 6.2). Witeithie is the nearest settlement, located some 500 m from the site. The meeting was attended by the local Provincial Administration including the Komu Location Chief, Witeithie sub-location Sub-chief and the Consultant's representatives.

During the consultative meeting, the Consultant's representatives explained the purpose of the meeting to those present. They then described the proposed thermal plant and enumerated potential positive and negative social and environmental impacts. Members of the public were then invited to raise their concerns. Minutes of the meeting, attendance list and sample questionnaire are presented in Appendix 1.

#### **6.3.1 Issues Raised during Public Consultations**

Issues arising from the public consultation in regard to the proposed thermal plant are highlighted here as follows:

1. Proper mechanisms should be put in place to ensure noise reduction during operation of the plant.
2. The Proponent should ensure that only local youth are employed during constructions.
3. The Company should extend its corporate social responsibility (CRS) for the project by putting up street lighting in the Witeithie area to boost security.
4. That they be assured that there will be no demolitions of houses and relocation of people to create a Right of Way (RoW) for power lines during construction of the thermal plant. The Consultant confirmed that the project will use existing power lines only.



**Plate 6.1 A Member of the Public makes Contribution during the Meeting**



**Plate 6.2 Consultants Representative Explains the MSD Project to Members of the Public**

### **6.3.2 Issues Raised by Lead Agencies**

The lead agencies listed in section 6.2 raised several concerns (Appendix 1.3) regarding the proposed thermal plant. These concerns are summarised hereunder:

1. There would be increased traffic at the access road to Agro Tropical Limited Farm while heavy traffic could block the gate to Mang'u High School staff quarters.
2. Dust along the access road could lead to diseases.
3. Immigrant labour could spread diseases and introduce new habits.
4. Air pollution could affect the coffee crop, soils and may cause corrosion to buildings.
5. There would be noise and vibration from the engines.
6. Oil spillage could pollute the river and may affect groundwater.
7. Handling of by product generated from the use of diesel fuel.
8. Water used for cooling would reduce available water resources.

## **6.4 Implication of the Public Consultation**

Several issues emerged from the consultation and their implications are discussed in following subsections.

### **6.4.1 Traffic, Dust and Immigrant Labour during Construction**

The project site shares the same exit from Thika Road with Mang'u High School staff quarters and Agro Tropical Ltd Farm. Increase in traffic at this exit and at the access road will only be significant during the construction phase. This EIA will recommend in the EMP the provision of workers to direct traffic at the exit and along the access path so as prevent inconvenience to other road users. The EMP will also address the generation of dust along the access road through upgrading and watering.

### **6.4.2 Air Pollution**

Air pollution from the thermal plant engines is a major concern to most of the lead agencies. The proposed power plant will use the latest technology to reduce emission of air pollutants. Results on air quality modeling and



emissions were presented in Chapter 5 and Appendix 3.2. The air modeling predicted maximum daily average SO<sub>2</sub> concentrations using fuel containing 0.5% sulphur within the WHO AQG (20 µg/m<sup>3</sup>) and both interim targets (IT1 125 µg/m<sup>3</sup>, IT2 50 µg/m<sup>3</sup>). Significant reductions in area of impact and frequency of exceeding were predicted for fuel with lower sulphur contents. This EIA recommends assessment and monitoring of the air emissions (at a 10 km distance to the site due West) on regular basis during the operational life of the plant and remediation measures to be instituted whenever the emission standards are exceeded.

#### ***6.4.3 Noise and Vibration from Engines***

Noise and to some extent, vibrations are also of major concern especially to those in the immediate neighbourhood of the project site. Chapter 7, Section 7.9 describes the techniques that will be used to minimize noise levels and details the necessary intervention. The design of the power plant incorporates noise levels at the fence line recommended by WB.

#### ***6.4.4 Oil Spillage and By-products***

The ESIA has described in Chapter 8 the procedures for dealing with oil spillage and by products.

#### ***6.4.5 Competition for Water Resources***

The proposed plant will require up to 80 m<sup>3</sup>/hr of cooling water in addition to a limited quantity for domestic purposes. The water will be sourced locally from one or a combination of the three sources described in Chapter 5; namely, Thika Water and Sanitation Company (THIWASCO), Ndarugu River and a borehole to be sunk. Water recycling will also be done in the cooling system. This EIA recommends that a study be carried out to establish the optimal source or combination of sources taking users of water into consideration in consultation with the Water Resources Management Authority (WRMA).

## CHAPTER 7: TECHNICAL SPECIFICATIONS

### 7.1 Introduction

The power plant will comprise of five MAN 4-stroke medium speed diesel engines 18V48/60 and a steam turbine with a combined capacity of 87 MW, transformers, cables, switchgear, protection and metering equipment. Generation will be at 15 kV and stepped-up to 132 kV by an adjacent sub-station that is under construction for subsequent transmission of the generated electricity.

The equipment will be supplied by MAN B&W Augsburg and will be installed by Malec. The power plant will be operated by Malec Power Gen Limited.

### 7.2 Power Generation Equipment

#### 7.2.1 *MSD Engines*

The MSD will comprise of 5x18.9 MW MSD Model MAN 18V48/60 turbocharged Diesel engines delivering 16 MWe net each at site conditions. Thus producing the plant shall provide 80 MW of power to be evacuated to the grid.

#### 7.2.2 *Heat Recovery Unit*

Complete Diesel Combined Cycle (DCC) system comprising:

- One 7 MW 2-stage steam turbine manufactured by MAN
- Matching electric generator
- Air cooled condenser
- Waste heat recuperation boilers (installed on diesel gensets) with all associated piping/accessories
- Control System.

#### 7.2.3 *Auxiliary Equipment*

Ancillary equipment associated with the power production are as follows:

- BLACKSTART diesel generator unit, 700 KVA.

- Station cranes and lifting equipment.
- Neutral earthing switch gear
- Two auxiliary transformers

### **7.3 Fuel**

The plant will power the engines using Heavy Fuel Oil (HFO) fuel with low sulphur content of 1.9 %. Fuel will be derived to the site by trucks at the rate of one truck per hour and stored within the plant. A truck weighing station will be located near the plant entrance ahead of the unloading bay. A three lane unloading area is provided, with three HFO, two lube oil and one Diesel Oil (DO) unloading pumps. Transfer pumps will be provided to deliver the fuel from the storage tanks to the engines.

### **7.4 Fuel and Lubricants Storage Tanks**

The fuel will be stored in tanks located in a tank farm. HFO will be stored in 3 No. 4,500 m<sup>3</sup> above-ground storage tanks. The new lube oil will be stored in an 80 m<sup>3</sup> storage tank while maintenance oil will be stored in a 40 m<sup>3</sup> tank. Three 500 m<sup>3</sup> storage tanks will be provided each for sludges, HFO and DO. The fuel tanks will be mounted on spill containment ditches to facilitate monitoring of leaks.

### **7.5 Sludges**

The supplied engine fuel is not completely pure and may contain water and solids that may endanger the operation of the engine. These impurities settle in the HFO storage tanks and are drawn off to the 500 m<sup>3</sup> storage tanks. These sludges are treated in a sludge treatment unit next to the sludge tank. The treated sludge is evacuated together with other solid wastes by the independent contractor.

### **7.6 Cooling Water**

The engines will be water cooled. The cooling water will be treated in a treatment plant situated next to the control building stored in water in a storage

tank next to the engines. Water recycling will also be effected to reduce the quantity abstracted.

### **7.7 Fire Fighting Water Unit**

Water for firefighting will be stored in a tank next to the water treatment plant and the fire room. As a standard operation procedure, a monitoring and check list procedure will be instituted to ensure that the storage tank will always be full.

### **7.8 Engine Exhausts**

Exhaust gases from the engines will be discharged into the atmosphere at the required height of 30 m through exhaust gas stack pipes. Six stacks of internal diameter 1.7 m will be provided. The stacks will be fitted with silencers to reduce noise.

### **7.9 Vibration and Noise Control**

The transmission of vibration and structure borne noise is minimized by having the engine generator set flexibly mounted on spring packages on a concrete foundation. The engine generator sets shall be installed in a sound-proof engine hall so as to be isolated from the other structures. The advanced technology to be used shall be with minimal external noise, vibration and air pollution.

### **7.10 Buildings**

#### **7.10.1 Engines Room**

The steam turbine room will be equipped with a 20 ton crane. The room will be provided with two number 98,500 m<sup>3</sup>/h engine room ventilators and 3000 m<sup>3</sup>/h M-Annex ventilator at the rear. Two 4.5 m wide maintenance bays will be provided between the diesel engine and the steam turbines.

**7.10.2 Control Room**

The control Room building will have a plinth area of 800 m<sup>2</sup> in 3 levels. It will house the control room, offices and electric room.

**7.10.3 Workshop House**

A 600 m<sup>2</sup> area workshop building will be constructed to house the following facilities:

- Injection testing
- Electrical/instrument
- Lathe machine
- Laboratory
- Offices
- Bathrooms including toilets, showers and changing rooms for both men and women.
- Spare part stores

**7.10.4 Administration Building**

The administration building will be situated next to the entrance. It will have a plinth area of 400 m<sup>2</sup> area in two levels. The lower level will comprise a cafeteria, kitchen, bathrooms and two offices. The upper floor will be mainly administration offices.

**7.11 Perimeter Wall**

The entire compound will be enclosed in a reinforced concrete (RC) perimeter wall. Because of the slope of the land, the wall on the upper part of the plot will be an earth retaining wall. Several other earth retaining walls will be provided within the property as necessary.

## CHAPTER 8: HSE MANAGEMENT PLAN

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### 8.1 Introduction

The Occupational Safety and Health Act 2007(CAP 15) came into operation in the year 2008. The Act applies to all workplaces where any person is at work, whether temporarily or permanently. The purpose of the act is to secure the safety, health and welfare of persons at work; and protect persons other than persons at work against risks to safety and health arising out of, or in connection with, the activities of persons at work. Section 19 of the Act provides that an occupier of any premises likely to emit poisonous, harmful, injurious or offensive substances, into the atmosphere shall use the best practicable means to prevent such emissions into the atmosphere as to affect the environment and render harmless and inoffensive the substances which may be emitted. Section 16 provides that no person shall engage in any improper activity or behaviour at the workplace, which might create or constitute a hazard to that person or any other person.

The IFC Performance Standard 4 on Community Health, Safety and Security recognizes that projects can increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failures and releases of hazardous materials. Communities may also be affected by impacts on their natural resources, exposure to diseases and the use of security personnel. It is the responsibility of the client in the proposed project to avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances. The client should also ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.

### 8.2 HSE Specification for Thermal Plants

IFC the World Bank group developed HSE guidelines (2008) for thermal plants. A summary of key issues of concern are given here (section 8.2). For details of HSE

description and specifications, reference can be made on;

[www.ifc.org/ifcext/sustainability.nsf/Content/EnvironmentalGuidelines](http://www.ifc.org/ifcext/sustainability.nsf/Content/EnvironmentalGuidelines)

Chapter 3 of the report also gives the numerous conventions and regulations to HSE. Chapter 9 and 10 also details the impacts and mitigation measures necessary for the HSE issues.

#### **8.2.1 Environment**

Environmental issues in thermal power plant projects primarily include the following:

- Air emissions
- Energy efficiency and Greenhouse Gas emissions
- Water consumption and aquatic habitat alteration
- Effluents
- Solid wastes
- Hazardous materials and oil
- Noise

#### **8.2.2 Occupational Health and Safety**

Occupational health and safety risks and mitigation measures during construction, operation, and decommissioning of thermal power plants are similar to those at other large industrial facilities. In addition, the following health and safety impacts are of particular concern during; construction, operation and de-commissioning of thermal power plants:

- Heat
- Noise
- Confined spaces
- Electrical hazards
- Fire and explosion hazards
- Chemical hazards
- Dust
- Non-ionizing radiation

### **8.2.3 Community Health and Safety**

Many community health and safety impacts during the construction, operation, and decommissioning of thermal power plant projects are common to infrastructure and industrial facilities. In addition to these and other aspects, the following community health and safety impacts may be of particular concern for thermal power plant projects:

- Water Consumption;
- Traffic Safety.

## **8.3 Accident Prevention Rules and Safety Program**

This plan covers the requirements of the accident prevention rules and safety program to be applied to the contraction work for Malec Group Limited that will be performed by the Construction subcontractor under the supervision of Malec. Group Limited (Hereinafter called Contractor). The primary purpose of this plan is to provide a guideline for preventing any accidents which may injure Employees or damage property of the Owner, Contractor and his Contraction Subcontractors (hereinafter called Subcon) at the construction site. Construction Subcons shall abide by all safety rules and other regulations imposed at the site by the Laws of the Kenya and the provisions of applicable laws, rules and regulations, including rules and procedures as applicable from IFC.

### **8.3.1 Organization**

The safety requirements stipulated in this plan shall be strictly met and maintained by the safety organization at construction site.

### **8.3.2 Safety Committees**

Contractor shall organize a safety committee consisting of Contractor's Site Manager, Contractor's Safety Manager and the Subcon's Field Safety Manager.

#### **Safety Committee shall:**

- Monitor and ensure the operation of safety program in a proper manner.
- Direct, coordinate and orient the safety activities.



- Promulgate the spread of policy, objectives, rules and/ or regulations.
- Look for, detect and identify risky conditions.
- Perform a thorough investigation of all accidents and review the recommendations to avoid any repetition of the accident.

**Contractor's Site Manager shall;**

- Have the prime responsibility for ensuring the site safety.
- Establish a realistic safety policy and safety targets for the site.
- Promote the setting up of safety plan, regulations and rules and of a safety training plan, etc.
- Organize and preside over safety committee.
- Direct the Subcon's construction Manager, Field Safety Manager and other managers in carrying out their duties and responsibilities.

**Contractor's Safety Manager shall:**

- Chair a weekly safety committee meeting.
- Coordinate the safety activities between the Owner and Construction Subcon.
- Review and approve the Construction Subcon's safety program and procedures, advise and recommend any corrective actions necessary.
- Conduct periodic safety audits to ensure that the established safety program is implemented in a proper manner for construction work.

**Subcon's construction Manager shall:**

- Be responsible for all safety activities, including fire prevention during the construction period.
- Organize the safety committee.
- Submit a safety program including safety measures for the work to the Field Safety Manager prior to commencement of the work.
- Establish, implement and maintain the safety program through the Safety Supervisor and Workers
- Conduct independent audits to assure conformance with the established safety

program and determine the effectiveness of individual elements of the program.

**Subcon's Field Safety Manager shall:**

- Conduct daily safety report to Contractor.
- Conduct a safety program under the direction of the Construction Manager.
- Patrol the work site periodically to verify that the work is carried out under safe conditions, with no violations of safety requirements.
- Advise promptly the Construction Supervisors and Workers of corrective action when any unsafe conditions or violations are observed.
- Check each work procedure from the safety point of view and advise the Construction Supervisors before commencement of work and or while working
- Submit accident report to Contractor Safety Manager and Owner's representative.
- Maintain the published safety literature, safety regulations, codes and other communications in accordance with contract. Advise management of compliance and conditions requiring attention.
- Make thorough analysis of the statistical data through inspection, delineate problem areas, and make recommendations for solutions.
- Check on the use of all types of Personal Protective Equipment (PPE), evaluate effectiveness and suggest improvements.

**Subcon's Supervisor/ Foreman shall:**

- Organize sites so that the work is carried out in accordance with the safety standards required for the minimum risk to employees and property.
- Know the safety requirements stipulated in the safety program.
- Give precise instructions as to the requirements for correct work method.
- Coordinate with his Subcons to avoid any confusion about areas of responsibility.
- Make sure that suitable personal protective equipment is available and in use.

- Ensure that new employees are properly instructed in precautions to be taken before they are allowed to start work.

**Subcon workers shall:**

- Do nothing to endanger oneself or co-workers.
- Use the correct tools and equipments for the job.
- Keep tools in good condition.
- Use proper personal safety equipment provided at all times.

## **8.4 Safety Reports/Meetings and Notices**

### **8.4.1 Accident Reports**

All accidents are to be immediately reported orally to the supervisor in the cases described below and will be followed by a written report.

- All fatal injuries.
- All injuries requiring first aid treatment.
- All damages, to the Owner's or Contractor's properties.
- All fires.
- All releases or spills of hazardous materials.

A written accident report shall describe in detail the circumstance and include the results of the accident investigation and analysis. This report describes the accident classification, cause, time, date, location, etc. Written incident reports shall be submitted to Safety Manager and Owner's representative through Contractor within 12 hours. A daily first aid record must be kept on all employees requiring first aid treatment.

### **8.4.2 Safety Committee Meeting**

A safety committee meeting shall be held on a weekly basis and chaired by the Contractor's Safety Manager and attended by all Safety Committee members. All Safety Committee members prior to holding a meeting shall conduct a joint site safety inspection and the inspection results shall be discussed at the meeting.

#### **8.4.3 Notice for Corrective Actions**

If the Construction Subcon fails or refuses to fulfill his safety responsibility or to correct unsafe conditions or practices, he will be ordered by Contractor to take the necessary corrective action. When any negligence of safety and/ or unsafe practices is detected, Contractor shall immediately advise and or instructs the Construction Subcon to correct them.

If the Construction subcon fails to heed the instruction or advice or neglects fire precautions described in the work permit, Contractor shall issue the letter of instruction for corrective action to the Construction Subcon. The unsafe work will be stopped. The work will not commence again until corrective action has been taken. Daily safety tour shall be made by Subcon's Field Safety Manager who will record and submit a copy of the daily safety check list to the Contractor's safety Manager.

#### **8.5 Safety Orientation and Education**

It is mandatory for each employee to attend the Safety Orientation program on his first day of work. No worker will be permitted to work on the site without attending the Safety Orientation Program and attached safety requirements.

The orientation will be given by the Subcon's Field Safety Manager and must include followings:

- Brief explanation of the program.
- Safety/ Security control policy.
- Outlines of applicable regulations and requirements for the project.
- Emergency procedures.
- First aid services.
- Each worker's responsibilities.

Biweekly Monday morning (2 times per month) before start of work a safety education is held by the Subcon's Field Manager for all workers and staffs and the

record of safety education shall be kept and maintained by the Sub contractor.

Every morning before start of work a safety talk session is held by the Supervisor with the foremen of each work place to instruct and discuss:

- Work procedures.
- Safety instructions for using equipment and tools.
- Particular hazardous conditions and precautions to be taken.
- Workmen's health conditions and other required information.

A written record will be maintained on all employees stating that they have received the safety training and fully understand the rules and regulations. This form will be signed and dated by each employee and kept on file in the subcon's safety Department for auditing and other relevant purposes.

Periodic updating of the safety training procedure and requirements is provided for supervisors and foremen every two or three months.

## **8.6 Thermal Plant Regulations**

### **8.6.1 Employee Requirements.**

All employees must be in good physical condition, i.e. appear healthy, have adequate hearing and sight, possess all limbs, do not suffer from dizziness, etc.

### **8.6.2 Vehicles and Equipment**

Employees will comply with all safety rules and signs regarding traffic and vehicle use. Vehicles must be parked only in areas approved by Contractor. If these areas include factory roadways, vehicles must only park on the sidewalk that traffic signs allow parking. Without such traffic signs, parking is prohibited. This is to permit access of emergency vehicles at all times.

Speed limit within the site is controlled according to site and road condition, but must not exceed maximum 35 Km/hr. All equipment, machinery and tools for use on the job site must be approved by Contractor and shall be subject to initial and periodic

inspection by Contractor, Any equipment, machinery and tools, which have not been approved, must be removed from the site. The engines of all vehicles and equipment should be stopped during refueling.

#### **8.6.3 Alcohol and/ or Controlled Drugs**

Alcoholic drinks and / or Controlled Drugs are not to be used or allowed on the site at any time. Anyone found under the influence of, or in possession of alcohol or Drugs will be immediately removed from the site and refused future access.

#### **8.6.4 Smoking**

Smoking is not permitted except in specified areas of workshops and buildings, Temporary buildings used may be marked smoking areas under special permits. Smoking in vehicles on the site is not permitted. Smoking is not permitted in any building under construction. Smoking is not allowed in the plant except certain designated area. Matches and lighters are not allowed in the plant. Cigarette butts should be discarded only in proper receptacles.

#### **8.6.5 Safety Signs**

Contractor's Subcons and all personnel shall observe the requirements of all safety signs on site. Contractor, Subcons and all personnel will not remove any safety chain Barrier, tag, marking or sign unless so directed by the proper authority.

#### **8.6.6 Holographic Equipment and Radios**

Holographic equipment (camera, video, etc.) are not permitted on the site without prior approval in writing from Owner. The use of transistor radios, two- way radios, mobile telephones and pack linksystem inside the plant is not permitted until approved by Contractor and Owner.

#### **8.6.7 Time Keeping**

When Subcon wishes to work before or after regular hours, weekends and or Public Holidays, he must have authorization from Contractor.

### **8.7 Environmental Control**

The Construction Subcon is responsible for the environmental control specified for the job site including all equipment and machines used. Do not dispose of any used oil or liquid waste direct to the ground, pit or storm drain. Dispose of these materials only in properly labeled containers.

### **8.8 Personal Safety Equipment**

Each Construction Subcon is totally responsible for providing personal protective equipment for the protection of their employees as needs or requested. It is also the Construction Subcon's responsibility to ensure that his employees are well trained and use properly the personal safety equipment at all time in the site and out of site while working. All tools and equipment are required to be maintained in good working condition. The Safety Supervisor shall inspects all tools and equipment periodically.

#### **8.8.1 Head Protection**

Safety hats or helmets are rigid headgear made of various materials and designed to protect the head from impact, flying particles, electric shock, or any combination of the accessories. Each helmet has two parts, a shell and a suspension cradle. Any modification of the safety helmet, especially punching holes in shell, is prohibited.

#### **8.8.2 Eye and Face Protection**

Protection of the eyes and face from physical or chemical agents are of prime importance in an industrial environment. And also, due to intensive sun exposure, uncontrolled dust and high humidity, locally used cotton Scarf should be issued to open area workers during construction period.

Selection of the type of protection will depend on the properties of possibly imposed hazard, but it should be borne in mind that all eye protection and most face protection devices must be considered as optical instruments. They must be selected, fitted, and used with regard to both the type of hazard and the optical condition of the user.

Industrial grade safety glasses (with shield) are required at all times during working hours in shop or in construction site during; Excavation; Driving nails; Grinding; Drilling etc.

#### **8.8.3 Hand protection**

The kind of gloves used depends primarily upon the material or equipment being handled. Gloves should not be used near rotating machinery as they can be caught and trap the hand. Suitable gloves should be worn on most construction work.

#### **8.8.4 Foot Protection**

The safety shoe or boot is fitted with a metal toecap. The toecap is capable of withstanding both compression and impact loads. Safety footwear for construction work must be able to withstand a compressive load of 1,100 kg and an impact load of 33 kg. Foot guards must be worn when using jack hammers, tampers and similar equipment.

#### **8.8.5 Safety Belts (or Harness), Lifelines and Lanyards**

The safety gear should be worn while working under elevation of 3 m high from the ground or platform level. Lifelines, safety belts, and lanyards shall be used only for worker safeguarding. Any lifeline, Safety belt, or lanyard actually subjected to in-service loading, as distinguished from static load testing, shall be immediately removed from service and shall not be used again for worker safeguarding. Lifelines shall be secured above the point of operation to an anchorage or structural member. Safety belt lanyard shall be a minimum of 14mm nylon, or equivalent, with a proper length of falling distance not greater than 1.8 m.

#### **8.8.6 Safety Net**

When workplaces are more than 7.5 meters above the ground or water surface or other surface and ladders, scaffolds, catch platforms, temporary floors, safety lines or safety belts are not being used, safety nets must be hung with sufficient clearance to prevent contact with the surfaces or the structures below. Nets must



extend 2.5 meters beyond the edge of the work surface where employees are exposed and must be installed as close under the work surface as practical but in no case more than 7.5 meters below such work surfaces.

#### **8.8.7 Respiratory Protection**

Where industrial processes create atmospheric contaminant, which may be hazardous to the health of employees, the first consideration always should be the application of engineering measures to control release of the contaminants. In some cases, engineering control measures are not practical and the worker should therefore be supplied with personal respiratory protective equipment. Ventilators, fans, air moves, dust mask or a combination of these should be used in dusty atmospheres. Users of dust masks, breathing air masks and respirators must be fit- tested and trained in their use.

### **8.9 Signs, Signal and Barricades**

#### **8.9.1 Accident Prevention Signs, Tags and Markings.**

When hazardous work is to be performed the appropriate signs and symbols must be posted prior to starting work and must be removed or covered promptly when the hazards no longer exist. Danger signs must be used only where an immediate hazard exists. Caution signs must be used only to warn against potential hazards or to caution against unsafe practices.

Accident prevention signs, tags and markings are used as a temporary means of warning employees of an existing hazard, such as defective tools, equipment, etc., until the defective equipment can be repaired or removed.

#### **8.9.2 Warning Barricades**

Warning barricades will be erected before work begins or as soon as specific hazard is identified (in some situations a rigid guardrail will be needed). Warning barricades must be erected and maintained at least two (2) meters from the edge of an excavation or opening.

### **8. 10 Fire Protection**

All employees must know where fire extinguishers are and how to use them. Flammables shall be stored in properly labeled containers. Accumulation of trash, oily rags, combustible materials and similar fire hazards of any nature will not be permitted. All welding and cutting torches must be equipped with flame valve and standard operational gauges. All alleyways, driveways, roads, stairway, ladder and transformers shall be kept clear of hazardous material and equipment. Refueling of petrol and diesel equipment shall be done only in prescribed areas and with approved equipment. Employees shall take all measures to minimize spills and to clean up immediately and spills which may accidentally occur. Refueling equipment with the engine running is prohibited.

The Construction Subcon shall install and maintain fire extinguisher and firefighting equipment to be available all times at the construction site and site office. There must be a fire extinguisher, water hose or other fire control equipment easily accessible for each welding, cutting, burning or other such operation.

During any hot work operation, a pressurized fire hose and dry chemical power fire extinguisher must be provided at place of hot work. All Contractor's personnel shall be properly trained and know how to use such extinguishers and fire hose.

### **8.11 First Aid**

Construction Subcon shall provide First Aid facilities for his employees on the site. In the event of accident, all possible efforts to keep on lookers from the scene must be made. The only employees required in such areas are those directly engaged in assisting in the emergency.

### **Shock**

Any person who has suffered a severe injury or even someone who has narrowly escaped injury is likely to be suffering from shock. It is essential that persons administering first aid be aware of the symptoms of shock and take action to treat these symptoms in addition to the other injuries sustained.

### **Artificial Respiration**

Electric shock, gassing, drowning, or suffocation may cause breathing to stop. Artificial respiration must be started immediately and continued until the patient recovers or until professional medical aid takes over. If you are alone, do not leave the patient to seek help until his normal breathing has resumed.

### **Chemicals**

Actions to be taken in the event of worker accidentally comes into physical contact with dangerous chemicals are as follows;

- If splashed by chemical, goggles should be left in place until chemicals have been washed off. Unless chemicals have entered the eyes under the goggles, eye protection should be removed only after the chemicals have been washed from the surrounding area.
- The eyes should be washed with clean water for at least 15 minutes. Chemicals on the skin should be washed off with water using a safety shower where available. When it is necessary to remove clothing, it should be removed while under shower or water spray medical attention is essential in these cases.

### **Head Injuries**

Action in cases of head injury is to get the patient under medical care without delay. No head injury should be regarded lightly. Every patient who has had even a mild injury to the head is liable to develop complications, which can be serious. Treatment shall be as follows;

- Loosen all tight clothing around neck, chest, and waist.
- Check to see if the patient is breathing and initiate artificial respiration, if required.
- Ensure that his throat and air passages are clear of secretions, foreign bodies and false teeth.
- Check for other injuries
- Arrange for the patient to be carefully transported to a hospital.

### **Bleeding**

Every effort should be made to stop bleeding by direct pressure such as by applying a sterilized pad or dressing. The wound should be firmly bandaged. Applying mild pressure on the artery between the wound and the heart may control arterial bleeding.

### **Fractures**

Where a fracture is suspected, the limb must be immobilized. If possible, the injured part should be elevated to reduce discomfort and swelling.

## **8. 12 Terminologies Related to HSE**

**Accident:** An unplanned or undesired event that can result in harm to people, property or the environment.

**Exposure:** The measurement of time during which the subject is at risk from a hazard.

**FAT:** Factory Acceptance Testing

**Fatality:** Death due to a work related incident or illness regardless of the time between injury or illness and death.

**Harm:** Includes death, injury, physical or mental ill health, damage to property, loss of production, or any combination of these.

**Hazard:** A source or a situation with a potential to cause harm, including human injury or ill health, damage to property, damage to the environment, or a combination of these.

**Housekeeping:** Maintaining the working environment in a tidy manner.

**HSE:** Health, Safety and Environment.

**Incident:** An event that:

- Results in death or injury to person where the injury requires medical attention (including first aid);
- Results in injury/damage to persons, property or process;
- Is not in compliance with statutory requirements, safe work procedures or in-house guidelines.

**Interface Document:** A document that clearly identifies how the contractor's HSE expectations and the subcon's HSE management systems will be interlinked during the work programme.

**Lost Time Injury (LTI):** Work related injury or illness that renders the injured

person unable to perform any of their duties or return to work on a scheduled work shift, on any day immediately following the day of the accident.

**Medical Treatment Case (MTC):** Work related injury or illness requiring more than first aid treatment by a physician, dentist, surgeon or registered medical personnel.

**MSDS:** Material Safety Data Sheet

**Near Miss:** A Near Miss is an event where no contact or exchange of energy occurred and thus did not result in personal injury, asset loss or damage to the environment.

**Personal Protective Equipment (PPE):** All equipment and clothing intended to be utilised, which affords protection against one or more risks to health and safety. This includes protection against adverse weather conditions.

**Restricted Work Case:** Work related injury or illness that renders the injured person unable to perform all normally assigned work functions during a scheduled work shift or being assigned to another job on a temporary or permanent basis on the day following the injury.

**Risk:** A measure of the likelihood that the harm from a particular hazard will occur, taking into account the possible severity of the harm.

**Risk Assessment:** The process of analysing the level of risk considering those in danger, and evaluating whether hazards are adequately controlled, taking into account any measures already in place.

**Risk Management:** The process of identifying hazards, assessing risk, taking action to eliminate or reduce risk, and monitoring and reviewing results.

**Training:** The process of imparting specific skills and understanding to undertake defined tasks.

**Unsafe act or condition:** Any act or condition that deviates from a generally recognized safe way or specified method of doing a job and increases the potential for an accident.

**SWL:** Safe Working Load.

**Work Programme:** The work being undertaken by a site on behalf of the Company.

**Worksite:** The premises where any building operations or works of engineering construction related to the work program are being carried out.

## **CHAPTER 9: ENVIRONMENTAL AND SOCIAL IMPACTS OF THE PROJECT**

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### **9.1 Introduction**

This section identifies and discusses both negative and positive impacts associated with the proposed MSD Power Project, at Thika. The impacts are identified according to project phases; namely, construction, operational and decommissioning phases.

The project being a national development agenda in the energy sector has immense benefits that could save the country losses in terms of power rationing due to long drought duration which affects the country regularly. However poor planning of the project could also affect the environment that supports millions of Kenyans through the potential hazards that the project could pose to the public like pollution of water and atmospheric resources. The project impacts are classified as positive or adverse. However the study goes further to categorize the impacts in terms of their magnitude, significance, time of occurrence, extent, reversibility and scope of the impacts.

### **9.2 Positive Impacts during Construction Phase**

The construction phase of the proposed MSD Power Project will have several positive impacts on the community, nation and the environment. These positive impacts are discussed herein;

#### **9.2.1 *Employment Opportunities***

During construction of MSD Power Project, employment opportunities will be created especially for casual workers from the local community. Creation of employment opportunities has both economic and social benefit. Economically, existing excess unskilled labour will be used in economic production; socially, the young and energetic but otherwise unemployed people will be engaged in productive employment other than remaining idle.

Employees with diverse skills are also expected to work on the site during the construction period. Furthermore, unskilled employees will gain some skills.

**9.2.2 *Gains in the Local and National Economy***

There will be gains in the local and national economy during the construction of the proposed MSD Power Project, through consumption of locally available materials such as timber, sand and cement. The consumption of these materials in addition to fuel oil and others will attract taxes including value added tax (VAT) and income tax which will be payable to the national government. The cost of the materials will be payable directly to the suppliers.

**9.2.3 *Provision of Market for Supply of Building Materials***

The project will require supply of large quantities of building materials most of which will be sourced locally from the surrounding areas. This provides ready market for building material suppliers such as quarrying companies and hardware stores. The demand for the building materials will in turn spur other economic activities.

**9.2.4 *Informal Sectors Benefits***

During construction phase of MSD power project, the informal sectors are likely to benefit temporarily from the operations. This will involve kiosk operators who will be selling food to the workers on site and will finally promote Jua Kali (informal sector) entrepreneurs in the project area.

**9.2.5 *Environmental Benefits***

MSD power project has a potential for contributing to the good of the environment of the area. The completed thermal plant will supply an additional 80 MW to the National grid which will enable KPLC to connect more consumers leading to a substantial reduction in reliance on other sources of energy e.g. charcoal and firewood that have impacts on the forest cover and greenhouse.

### **9.3 Negative Impacts during Construction Phase**

The following negative impacts are expected to be associated with the construction of the proposed MSD power plant.

#### **9.3.1 Noise pollution**

The proposed area is relatively tranquil. The construction works of the proposed MSD power project is most likely to be a noisy operation due to the moving construction machines and vehicles. Also, the construction workers who will be working in the site will generate some noise as they are communicating to one another. This will be a potential source of disturbance at the site and surrounding neighbourhood of the proposed MSD power project.

#### **9.3.2 Generation of Exhaust Emissions**

Exhaust emissions are likely to be generated by the construction equipment during the construction phase of proposed MSD power project. Motor vehicles that will be used to ferry construction materials would cause air quality impact by emitting pollutants through exhaust emissions. The impacts will not be significant.

#### **9.3.3 Dust Emissions**

Particulate matter pollution is likely to occur during the site clearance, excavation and spreading of the topsoil during construction of proposed MSD power project. There is a very small possibility of PM<sub>10</sub> suspended and settleable particles affecting the site workers and even neighbours' health. This is minimal given the construction method of minimum excavation and nil cart away of soil.

#### **9.3.4 Disposal of Excavated Soil**

Though little excavation is likely to take place at the proposed MSD power project site, the excavation works to level the site will result in the generation of small amounts of excavated material. But there will be no cart away of excavated material.



**9.3.5 Increased water demand**

During the construction phase of the proposed MSD power project, both the construction workers and the construction works will create additional demand for water in addition to the existing demand. Water will be mostly used in the mixing of concrete for civil construction works and for wetting surfaces or cleaning completed structures. It will also be used in the washrooms at the construction site and also during the running period of the project.

**9.3.6 Workers accidents and hazards during construction**

During construction of the proposed MSD Power Project, it is expected that construction workers especially unskilled temporary employees are likely to have accidental injuries as a result of exposure to workplace hazards. Because of these intensive engineering and construction activities including erection of steel structures, welding, metal grinding and cutting and concrete work among others, construction workers will be exposed to risks of accidents and injuries. Injuries can result from trips & falls and other physical and mechanical hazards.

**9.3.7 Energy Consumption**

The proposed MSD Power Project will consume fossil fuels (mainly diesel) to run transport vehicles and construction machinery. Fossil energy is non-renewable and its excessive use may have serious environmental implications on its emission as smoke, availability, price and sustainability.

**9.3.8 Extraction and Use of Building Materials**

Building materials such as hard core, ballast, cement, rough stone and sand required for the construction of the proposed MSD Power Project will be obtained from nearby quarries and hardware stores. Sand harvesters extract sand from rivers and land. Small quantities of these materials will be required for construction of the buildings, the availability and sustainability of such resources at the extraction sites will be negatively affected as they are not renewable in the short term. In addition, the sites from which the materials will be extracted may be significantly affected in several ways including landscape changes, displacement of animals and vegetation, poor visual quality and

opening of depressions on the surface leading to human and animal health impacts.

#### **9.3.9 Solid Waste Generation**

During construction of the proposed project, solid waste will be generated. These include packaging materials, plastics, scrap metal and timber remains among others. Dumping around the site will interfere with the aesthetic status of the area. This has a direct effect to the surrounding community. Disposal of the same solid wastes off-site could also be a social inconvenience if done in the wrong places. The off-site effects could be aesthetic, pest breeding, pollution of physical environment, invasion of scavengers and informal recycling communities.

#### **9.3.10 Possible Exposure of Workers to Diseases**

Workers are likely to be exposed to diseases from building materials during the construction phase of the proposed MSD Power Project. It is therefore recommended that before the construction phase of thermal power Project commences, there is need for the materials to be well inspected according to the occupational health and safety standards and worker encouraged to use personal protective equipments. Employees who are new to the area may spread or acquire Sexually Transmitted Infections including HIV/AIDS in view of the prevailing prevalence rate in the district.

#### **9.3.11 Increased Storm Water Runoff from New Impervious Areas**

Construction of the proposed MSD Power Project buildings and pavements within the proposed project site will lead to additional runoff through creation of impervious areas and compaction of soils. Impervious areas and compacted soils generally have higher runoff coefficients than natural area and increased flood peaks are a common occurrence in developed areas.

#### **9.3.12 Soil Erosion**

There are possibilities of soil erosion occurring during the construction of the proposed MSD Power Project especially during rainy and windy seasons. The impact will however be minimal as the area to be disturbed is small. Roadways

and footpaths will be paved with impervious material to minimize soil erosion. Drainages will be constructed to control storm rain water.

#### ***9.3.13 Oil Spills***

The machines on site may be containing moving parts which will require continuous lubrication to minimize the usual corrosion, wear and tear. This will contaminate the soil. Likewise, moving vehicles on site may require oil change.

#### ***9.3.14 Destruction of existing vegetation***

The construction process of the proposed MSD Power Project buildings will involve clearing of the existing vegetation cover consisting of mainly shrubs. The developer intends to replace this with trees and grass in the lawns and land boundaries around the project area.

#### ***9.3.15 Surface and ground water Hydrology and Water Quality Degradation***

Changes in surface hydrology alter the flow of water through the landscape. Construction of impervious surfaces such as parking lots, roads and buildings increase the volume and rate of runoff, resulting in habitat destruction, increased pollutant loads and flooding. Contaminated soil or ground water in the project area could be disturbed by excavation resulting in a potential transfer of the contamination to surface waters. Oil spills during construction could introduce contaminants into subsurface which may end-up into ground water. Development activities such as MSD Power Project development as well as the spill-over effects of development such as increased demand for water use and increased auto use can impact water quality by contributing sediment, nutrients, and other pollutants to limit water supplies, increasing the temperature of the water and the rate and volume of runoff.

#### ***9.3.16 Fire Outbreaks***

Due to various construction activities at the proposed MSD power plant project, fire outbreaks can occur. Handling of inflammable products increases fire risks.

**9.3.17 Traffic Impacts**

During construction, movement of trucks carrying heavy construction equipment, excavated materials for disposal, construction materials and heavy plant, will cause several adverse impacts including, road blockage, slow traffic, noise and dust.

**9.4 Positive Impacts during Operation Phase**

Like construction phase, there are positive impacts associated with the proposed MSD Power Project during operation phase. These positive impacts are discussed herein.

**9.4.1 Increase in electricity supply**

In Kenya the electricity demand by far outstrips the electricity supply. This is because the country normally experience drought spell which has lead reduction in water volumes in hydropower generation dams that produce the electricity. The project aims to provide an additional 80 MW to the National grid. With additional electricity in the national grid, more investors are expected to be attracted due to the reliable supply of electrical energy.

**9.4.2 Employment Opportunities**

Employment opportunities are one of the long-term major positive impacts of the proposed MSD Power Project. This will occur during the operation and maintenance of the MSD Power Project. Other sources of employment will involve direct technical service provision to the MSD Power Project e.g. electrical engineers, mechanical engineers, drivers among others. There could be other indirect sources of employment e.g. businesses associated with the project.

**9.4.3 Increase in Revenue**

There will be positive gain for the revenue system arising from the sale of the electricity power from the proposed MSD Power Project to Government, the fuel provider, project operator and KPLC which in turn will be supplied to various customers who will be paying taxes to the Government. Again the value of land will increase, implying increased income and revenue.

**9.4.4 Improved Security**

With the establishment of the proposed MSD Power Project, the level of security will be improved around the project area. This is as a result of more security lights and security personnel being employed to guard the MSD Power Project. The project site will also be well fenced. Hence if the level of security is increased, the residents will feel more secure than before.

**9.5 Negative Impacts during Operation Phase**

The following are the negative impacts that are associated with the proposed MSD Power Project during the operation phase.

**9.5.1 Waste Generation**

The proposed Project is expected to generate some amounts of wastes during its operation phase. The bulk of the solid waste generated during the operation of the project will consist of drums, used oil, paper, plastic, glass, metal, textile and inorganic wastes. Such wastes can be injurious to the environment. Some of these waste materials especially the plastic/polythene are not biodegradable hence may cause long-term injurious effects to the environment.

**9.5.2 Fuel Oil Consumption**

The proposed MSD Power Project shall consume large amount of diesel in the process of generating electricity. Since fuel oil is produced mainly through non renewable resources, this will have negative impacts on these non renewable resources base and their sustainability.

**9.5.3 Increased Population around the Project Area**

With the construction and operation of the proposed Project there will be mushrooming of businesses within the proposed project area and operated by persons who (in some instances) were not resident in the area. This will in turn increase the population in the project area.

**9.5.4 Water Use**

Activities during the operation phase of the proposed Project will involve the use of substantial quantities of water initially, but after that recycled water and roof rain water shall be used. 4 no. bore wells shall be dug and a water

treatment plant constructed for treatment of all water from various sources. The bore well shall supplement the municipal water hence avoid increasing the strain on water resources in the area.

#### **9.5.5 Increased Pressure on Infrastructure**

The proposed Project will have a potential of increasing pressure on existing infrastructure such as roads and water among others. This is because of increased use of water and increased human and vehicle traffic in the project area.

#### **9.5.6 Air Pollution**

Operational phase of the proposed project will affect air quality. Particulate emissions represents the main pollutant of concern, with gaseous emissions such as oxide of Sulphur (SO<sub>x</sub>), oxides of Nitrogen (NO<sub>x</sub>) and carbon monoxide (CO) potentially significant due to combustion of the generator fuel. Measurements were made on air samples from the proposed project area and were found to be far much below the limits.

Air pollution levels were modeled and the air pollution impacts of the new plant on the surrounding area using a computer based 2-D model (Appendix 3.2). It was predicted that, provided the source strength provisions in the project specifications are complied with, air pollution levels will not exceed WHO guidelines at the western sector of the plant while the eastern sector will not be adversely affected by the plant. Air pollution levels are therefore predicted to comply with all applicable legislative requirements. Air pollutant concentrations should be measured at monitoring sites that are representative of population exposures. Air pollution levels may be higher in the very close vicinity to the power plants, especially on the western sector of the plant. Hence protection of populations living in such locations may require special measures to bring the pollution levels to below the guideline values.

Air sampling and tests for pollutants will be done periodically during the operation of the project. The operation of the plant might have some impact on the health of the people working or living in the area.

**9.5.7 Increased Storm Water Flow**

The building roofs and pavements of the proposed MSD Power Project will lead to increased volume and velocity of storm water or run-off flowing across the area covered by the proposed Project during operation phase. This will lead to increased amounts of storm water in the area and this may lead to soil erosion.

**9.5.8 Water Pollution**

During the operation phase of the proposed Project, if the sites for dumping solid wastes are not well taken care of, they may cause contamination of ground water sources. There is need therefore for the project proponent to put in place an efficient waste management scheme that will prevent the accumulation of uncontrolled waste, as well as an efficient collection system and off-site disposal. Oil spills might also lead to contamination of wetlands and ground water sources.

**9.5.9 Noise Pollution**

Noise pollution from the operation of the generators for the proposed MSD Power Project is inevitable. Noise measurements have been made before commencement of the project construction and the levels were found to be negligible (Appendix 3.1). During the operation of the power plant, Witeithie Village situated to the south east of the proposed site, will not be affected by noise emitted by the plant. The eastern sector of the proposed plant will experience significantly less noise pollution because of the prevailing wind direction in an east-west direction.

Noise modeling for the proposed plant was carried out and is presented in Appendix 3.4. The spatial noise distribution meets the Kenyan Regulatory Noise standards within the environs of the facility. Within the facility the noise levels may occasionally tend to almost exceed the limits especially under stable atmospheric conditions at night. This would require the necessary mitigation measures. The generator sets which emit most of the noise will be

housed in a sound and vibration proof building, hence low noise emissions. During the project operation phase periodic noise audits will be performed.

#### **9.5.10 Vibration**

During the operational phase of the proposed Project, the generators will create a low level ground vibration within the surrounding areas. Although not expected to be significant due to the damping effects of the generator basal material used, it will be monitored periodically.

#### **9.5.11 Oil Spills Hazards**

Potential oil spills and accidents during oil transportation, storage and operations of the generators of the proposed power plant project may occur. In the case of oil spill the relatively lighter, more volatile, mobile, and water soluble compounds in diesel will tend to evaporate fairly quickly into the atmosphere or migrate to groundwater. When exposed to oxygen and sunlight, most of these compounds will tend to break down relatively quickly. Accidental oil spills can occur due to leakage from the storage tanks or site oil pipelines. Poor maintenance of machines can also lead to oil spills. A small amount of used oil may drip from spent oil filters. Test for hydrocarbons were made from soil sampled from the proposed project site. This soil was found to be environmentally clean. Annual tests will be done on soil samples during the project operation.

#### **9.5.12 Visual Impacts**

The plant might present unwanted visual impacts, both by its physical presence and profile against the surrounding area and by visual impacts of the plume (particularly during periods of poor atmospheric dispersion) and secondary formation of aerosols that can reduce visibility on a more regional scale. Large structures such as stacks and fuel tanks towers may also adversely impact the visual quality of the area.

There will be minimum regular traffic during operation. However, the HFO will be delivered by heavy trucks which could cause noise pollution to neighboring Witeithie residents if delivery is carried out at night.



**9.6 Positive Impacts during Decommissioning Phase**

The following positive impacts are associated with the proposed MSD Power Project during the Decommissioning phase:

**9.6.1 Site Rehabilitation**

Upon decommissioning of the proposed MSD Power Project rehabilitation of the project site should be carried out to restore the site to its original status or to a better state than it was originally. This will include replacement of topsoil and re-vegetation which will lead to restoration of the visual quality of the area.

**9.6.2 Employment Opportunities**

For demolition to take place properly and in good time, several people will be involved. As a result several employment opportunities will be created for the demolition staff during the demolition phase of the proposed MSD Power Project.

**9.7 Negative Impacts during Decommissioning Phase**

The following are the negative impacts that are likely to be associated with the proposed MSD Power Project during its decommissioning phase.

**9.7.1 Noise and Vibration**

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

**9.7.2 Solid Waste Generation**

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

**9.7.3 Dust**

Some dust will be generated during demolition works of the proposed MSD Power Plant. This will affect demolition staff as well as the neighbours.

**9.7. Traffic Impacts**

During decommissioning movement of trucks carrying heavy demolition equipment, demolished materials for disposal and heavy plant, will cause several adverse impacts including, road blockage, slow traffic, noise and dust. Personnel to controlled traffic and damping dusty surfaces will be used and affected.

## CHAPTER 10: MITIGATION MEASURES AND MONITORING PROGRAMMES

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### 10.1 Mitigation of Negative Impacts during Construction

The following measures can be considered as mitigation measures of the negative impacts associated with the proposed MSD Power Plant during construction phase.

#### 10.1.1 *Minimization of Noise and Vibration*

The project proponent shall put in place several measures that will mitigate noise pollution arising during the construction phase. The following noise-suppression techniques will be employed to minimize the impact of temporary construction noise at the project site.

- Install portable barriers to shield compressors and other small stationary equipment where necessary.
- Install sound barriers for pile driving activity.
- Use quiet equipment (i.e. equipment designed with noise control elements).
- Co-ordinate with relevant agencies regarding all construction.
- Limit vehicles to a minimum idling time and observe a common-sense approach to vehicle use and encourage drivers to switch off vehicle engines whenever possible.
- Compliance with the recently issued Noise and Vibration Regulations of 2009 is expected at all the phases of the project.

#### 10.1.2 *Generation of Exhaust Emissions*

In order to control exhaust emissions that are likely to occur during the construction of the proposed MSD Power Plant, the following measures shall be implemented during construction.

- Vehicle idling time shall be minimized

- Alternatively fuelled construction equipment shall be used where feasible
- Equipment shall be properly tuned and maintained
- Proper planning of transportation of materials to be used during construction of the project done to ensure that vehicles are filled to capacity in order to reduce the number of trips done or the number of vehicles on the road.
- Consider offering technical assistance on routine engine maintenance to SME truck operators/contractors.
- Only trucks with engines maintained to reduce exhaust emissions will be permitted to deliver fuel and other supplies.

#### ***10.1.3 Dust Emissions and Air quality***

Controlling dust emissions that is likely to take place during construction phase of the proposed MSD Power Plant is essential in order to minimize environmental pollution. It is recommended that a standard set of feasible dust control measures be implemented for all construction activities. Emissions of other contaminants (NO<sub>x</sub>, CO<sub>2</sub>, SO<sub>x</sub>, and diesel related PM<sub>10</sub>) that would occur in the exhaust from heavy equipment are also included. The project proponent is committed to implementing measures that shall reduce air quality impacts associated with construction. During construction, any stockpiles of earth should be enclosed/covered/watered during dry or windy conditions to reduce dust emissions.

During construction, sprinkle the construction area with water to keep dust levels down. Construction trucks removing soil from the site, delivering sand and cement to the site should be covered to prevent material dust into the surrounding areas. The following methods shall be enhanced;

- All personnel working on the project will be trained prior to starting construction on methods for minimizing air quality impacts during construction. This means that construction workers will be trained regarding the minimization of emissions during construction and

vehicle speed limits be maintained in order to control dust levels to a minimal.

- Specific training will be focused on minimizing dust and exhaust gas emissions from heavy construction vehicles. Drivers of vehicles used during construction will be under strict instructions to minimize unnecessary trips and minimize idling of engines.
- Dust masks should be provided to all personnel in areas prone to dust emissions throughout the period of construction.
- Maintain all machinery and equipment in good working order to ensure minimum emissions including CO<sub>x</sub>, NO<sub>x</sub>, SO<sub>x</sub> and suspended particulate matter.

#### ***10.1.4 Excavated Soil during Construction***

The Excavated soil during the construction of the proposed MSD Power Plant will not be disposed. It's recommended that part of the topsoil excavated from the proposed construction site be re-spread for landscaping.

#### ***10.1.5 Minimization of increased Water Demand***

The proponent of the proposed MSD Power Plant shall ensure that water is used efficiently at the site by sensitizing construction staff to avoid irresponsible water use. A bore-hole shall be dug so as not to strain the existing water sources i.e. municipal water, which is sometimes unreliable.

#### ***10.1.6 Minimization of Worker Accidents and Hazards***

To reduce the workers accidents and hazards during the construction phase of the proposed MSD Power Plant, the contractor and proponent are expected to adhere to the provisions of the Occupational Safety and Health Act, 2007 and its subsidiary legislation. It is the responsibility of the project proponent and contractor to provide a safe and healthy environment for construction workers as outlined in the EMP. An EMP Response and Evacuation Plan must be in place in addition to safety education and training being provided to the employees.

#### ***10.1.7 Reduction of Energy Consumption***

The project proponent and contractor shall ensure responsible electricity use at the construction site through sensitization of staff to conserve electricity by switching off electrical equipment or appliances when they are not being used. In addition, proper planning of transportation of materials will ensure that fossil fuels (diesel, petrol) are not consumed in excessive amounts. Complementary to these measures, the proponent shall monitor energy use during construction and set targets for reduction of energy use.

#### ***10.1.8 Reduction of Impacts at Extraction Sites***

The proponent of the proposed MSD Power Plant will source building materials such as sand, ballast and hard core from registered quarry and sand mining firms whose projects have undergone satisfactory environmental impact assessment/audit and received NEMA approval. Since such firms are expected to apply acceptable environmental performance standards, the negative impacts of their activities at the extraction sites are considerably well mitigated. To reduce the negative impacts on availability and sustainability of the materials, the proponent will only order for what will be required through accurate budgeting and estimation of actual construction requirements. This will ensure that materials are not extracted or purchased in excessive quantities. Moreover, the proponent will ensure that wastage, damage or loss (through runoff, wind, etc) of materials at the construction site is kept minimal, as these would lead to additional demand for and extraction or purchase materials.

In addition to the above measures, the proponent shall consider reuse of building materials and use of recycled building materials. This will lead to reduction in the amount of raw materials extracted from natural resources as well as reducing impacts at the extraction sites.

**10.1.9 Solid Waste during Construction Phase**

It is recommended that demolition and construction waste be recycled or reused to ensure that materials that would otherwise be disposed off as waste are converted for productive uses. The proponent is committed to ensuring that construction materials left over at the end of construction will be used in other projects rather than being disposed off. In addition, damaged or wasted construction materials including cabinets, doors, plumbing and lighting fixtures, marbles and glass will be recovered for refurbishing and use in other projects. Such measures will involve the sale or donation of such recyclable/reusable materials to construction companies, local community groups, institutions and individual residents or home owners.

The proponent shall put in place measures to ensure that construction materials requirements are carefully budgeted for and to ensure that the amount of construction materials left on site after construction is kept minimal. It is further recommended that the proponent should consider the use of recycled or refurbished construction materials. Purchasing and using once-used or recovered construction materials will lead to financial savings and reduction of the amount of construction debris disposed of as waste.

Additional recommendations for minimization of solid waste during construction of the proposed thermal power plant include:-

- Use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time
- Provision of facilities for proper handling and storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements
- Purchase of perishable construction materials such as paints incrementally to ensure reduced spoilage of unused materials
- Use of building materials that have minimal packaging to avoid the generation of excessive packaging waste

- Use of construction materials containing recycled content when possible and in accordance with accepted standards.
- Adequate collection and storage of waste on site and safe transportation to the disposal sites and disposal methods at designated area shall be provided.

#### ***10.1.10 Possible exposure of workers to diseases***

Possible exposure of workers to diseases from building materials at construction site shall be mitigated by compliance with occupational health and safety standards. Again, contractors must carry out HIV/AIDS awareness training to all employees and subcontractors.

#### ***10.1.11 Minimization of Storm Water Run-off and Soil Erosion***

The proponent of MSD Power Plant will put in place measures aimed at minimizing soil erosion and associated sediment release from the project site during construction. These measures will include terracing and leveling the project site to reduce run-off velocity and increase infiltration of rain water 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. Increased runoff from paved grounds and expansive roofs causing extreme flooding and overflows of drainage systems shall be mitigated. Surface runoff and roof water shall be harvested and stored in underground reservoir for reuse. A storm water management plan that minimizes impervious area infiltration by use of recharge areas and use of detention and/or retention with graduated outlet control structures will be designed. Additionally;

- Excavations at the site will be restricted to the sections where the plant will be erected. Excavated earth will be held away from trenches and on locations of the site not susceptible to surface runoff of storm water. The earth removed for external disposal will require to be deposited on sites without the risk of being washed down during rains and where it



will not compromise other land use activities in those areas. Caution will be required during construction at times of heavy rains.

- Re-vegetate exposed areas around the site so as to mitigate erosion of soil by storm water runoff.
- The final site grade should facilitate drainage and avoid flooding and pooling. A site drainage plan should be developed to protect against erosion.
- Installation of drainage trenches, construction of runoff and retention ponds is necessary.
- Minimization of disturbances and scarification of the surface should be observed to reduce erosion impacts.
- All slopes and working surfaces should be returned to a stable condition and topsoil on the final site be graded and planted as appropriate.

#### ***10.1.12 Controlling Oil Spills during Construction Phase***

The proponent of the proposed MSD Power Plant will control the dangers of oil spills during construction by proper maintenance of machinery in specific areas designated for this purpose hence might not be a serious impact as a result of the construction of MSD Power Plant.

#### ***10.1.13 Minimization of Vegetation Disturbance***

Clearance of part of the vegetation (mainly grass and shrubs) at the Proposed MSD Power Plant site to pave way for construction will be inevitable. However, the project proponent will ensure proper demarcation of the project area to be affected by the construction works. This will be aimed at ensuring that any disturbance to flora is restricted to the actual project area and avoid spill-over effects to the neighbouring areas. In the same vein, there will be strict control of construction vehicles to ensure that they operate only within the area to be disturbed by access routes and other works. Another important measure aimed at reducing disturbance of vegetation in the proposed project area will be preservation of indigenous trees within the site. In addition, the

proponent will be involved in re-vegetation of some of the disturbed areas through implementation of a well designed landscaping programme.

#### ***10.1.14 Hydrology and Water Quality Degradation***

Several measures shall be put in place to mitigate the impacts that are likely to lead to Hydrology and water quality degradation at the proposed MSD Power Plant. The project proponent will prepare a hazardous substance control and MSD response plan that will include preparations for quick and safe clean up of accidental spills. It will prescribe hazardous-materials handling procedures to reduce the potential for a spill during construction and will include an MSD response programme to ensure quick and safe cleanup of accidental spills. The plan will identify areas where refueling and vehicle maintenance activities and storage of hazardous materials, if any, will be permitted. Trial holes digging will be conducted before construction begins and soil profile history will be provided to construction crews to inform them about soil conditions and potential hazards. Oil absorbent material, tarps and storage drums will be used to contain and control any minor releases of engine and other equipment oil.

#### ***10.1.15 Traffic Impacts***

Movement of heavy plant will be limited to off-peak hours between 10:00 am and 4:00 pm during the day under proper traffic management. Night delivery will not be allowed to prevent noise pollution to the residents of the neighboring Witeithie Township and Mang'u high School. Dust will be controlled by watering the earth access road to bind the dust particles.

### **10.2 Mitigation of Negative Impacts during the Operation Phase**

Impacts anticipated during the operation phase can be mitigated as discussed in herein;

#### ***10.2.1 Ensuring Efficient Solid Waste Management***

The project proponent of the proposed Power Plant will be responsible for efficient management of solid waste generated by the project during its

operation. In this regard, the proponent will provide waste handling facilities such as labeled waste bins and skips for temporarily holding solid waste generated at the site. In addition, the project proponent will ensure that such are disposed off regularly and appropriately. It is recommended that the proponent puts in place measures to ensure that the MSD Power Plant operating personnel manage the waste efficiently through segregation, recycling, reuse and proper disposal procedures. The proponent will put in place an integrated solid waste management system and give priority to reduction at source of the materials. This option will demand a solid waste management awareness programme in the management and the operator employees' manual. Solid wastes shall be disposed off in a manner that is acceptable to NEMA and Environmental Regulations.

#### ***10.2.2 Ensure Efficient Energy Consumption***

To ensure efficient energy consumption during the operation phase of the proposed plant, the proponent plans to install an energy-efficient lighting system at the site. This will contribute immensely to energy saving during the operational phase of the project. In addition, the plant operators shall be sensitized to ensure energy efficiency in their domestic operations. To complement these measures, it will be important to monitor energy use during the operation of the proposed MSD Power Plant and set targets for efficient energy use.

#### ***10.2.3 Ensure Efficient Water Use***

The proponent of the proposed power plant will install water-conserving automatic taps and toilets. Moreover, any water leaks through damaged pipes and faulty taps will be fixed promptly by qualified staff. In addition, the plant operators of the proposed MSD Power Plant will be sensitized to use water efficiently. The project will adopt the policy of water reuse/recycle especially for cooling purposes of the plant.

#### **10.2.4 Air Pollution**

The proponent of the proposed power plant will ensure minimal CO<sub>x</sub> and SO<sub>x</sub> emissions through timely and frequent service and maintenance of the generators. This will improve combustion of fuel which will make the generators more efficient and reduce emissions. For reduction of oxides of sulphur, a desulphurization process, which usually involves using crushed limestone to react with sulphur dioxide in the hot flue gases, can reduce sulphur dioxide emissions by as much as 90 per cent. The proponent will ensure that the fuel oil used in the generators shall have a low sulphur content of not more than 1.9%. One way of NO<sub>x</sub> reduction is injecting water directly into the combustion chamber, humidifying the charge air, or mixing the water with diesel fuel.

- No burning of any waste materials whatsoever should be permitted within the site both during construction and operation;
- Use of low sulphur fuel will help in minimizing SO<sub>x</sub> emissions. In addition the proponent has proposed to reduce SO<sub>x</sub> emissions by installing desulphurization equipment in the plant.
- Nitrogen oxide emission should be controlled through burner management and water injection to the combustion turbines. Smoke treatment (denitrification); choice of combustion technology; Burners/low-NO<sub>x</sub> combustion chambers; water or steam injection.
- Particulate emissions should be reduced through good combustion control to minimize the products of incomplete combustion. Reduction of ash content in fuels: choice of combustion technology, electrostatic precipitators, bag filters, control of combustion conditions operating measures (including stack cleaning).
- The MSD Plant operator will be required to install and operate dedicated stack gas samplers or analyzers and report both summary data and violations of standards or limits.
- Annual source testing will also be routinely required to confirm continued compliance with emission limits.

### **10.2.5 Oil Spills**

To prevent oil spills and environmental contamination, the power plant and pipelines should be designed with spill prevention and detection systems to protect the environment. With spill prevention and protection measures there should be no adverse effects to the ground and surface water and soil. Appropriate protection devices against accidental discharge of toxic substances (bases/airtight tanks for machines, reservoirs etc.) should be provided.

Storage and liquid impoundment areas for fuels, raw and in-process material solvents, wastes and finished products should be designed with secondary containment (e.g. dikes) to prevent spills and the contamination of soil, ground and surface water.

All the fuel above ground storage tanks should have secondary containment with sufficient volume to contain a spill from the largest tank in the containment structure. The containment area should have a means of removing accumulated water. A retention area should be designed that surrounds the fuel storage tanks.

The plant operator should provide containers for the storage of chemical and lubricating products. Drains should be routed through a site/water separator. A spill and MSD response plan would be developed and put in place prior to commencement of construction.

A written MSD response plan should be prepared and retained on the site and the workers should be trained to follow specific procedures in the event of a spill. The project proponent will orientate the workers on site on their specific EHS policies to prevent incidents and accidents from oil spill.

Frequent inspection and maintenance of facility can minimize spilling from the transfer pipeline.

The proponent will collect the waste oil or used oil and lubricants from maintenance of operational equipment for proper disposal. In the Environmental Management Plan (EMP), disposal of used oil will be the responsibility of the project proponent. The proponent will identify a reputable company to handle disposal of oil and oil filters.

Fuel suppliers, normally proposes to enclose fuel tanks in an earth bund wall and the floor lined with plastic sheets to prevent accidental contamination of soils and groundwater. At the off loading area, they propose to mitigate leakage by constructing a sump for temporal containment when fuel is off loaded. It is proposed that the operator uses rail transport for fuel in order to minimize chances of oil spillage on the roads.

#### ***10.2.6 Visual Impacts***

The visual negative impacts can be mitigated through landscaping the area with trees to screen the project stacks and fuel tanks by the proponent of the proposed power plant.

#### ***10.2.7 Minimization of Sewage Release***

The project proponent will ensure that there are adequate means for handling the sewage generated at the proposed MSD Power Plant. It will also be important to ensure that toilets are kept clean and properly maintained. Onsite wastewater treatment plant to be installed to treat domestic wastewater generated from the facilities. The wastewater discharged to conform to discharge guidelines set out by NEMA.

#### ***10.2.8 Fire Suppression***

The proposed power plant must have fire fighting equipments of high standards and in key strategic points spread all over the project site. Fire pumps, hydrants, sprinkler/water spray systems, hose houses, dry chemical systems, carbon dioxide systems, detection/alarm systems, portable fire extinguishers among others shall be installed at the site. A fire evacuation plan

must be posted in various points of the construction site including procedures to take when a fire is reported. All workers must be trained on fire management and fire drills undertaken regularly.

#### ***10.2.9 Flue Gas***

To mitigate the effects of flue gas affecting the micro-climate of the area, the exhaust gas stacks (chimney) of the generators will be to at least 30 m high. This will enable plume dispersal high preventing smoke and heat from affecting the surrounding area. Again it will be used to predict impact.

#### ***10.2.10 Workers Health and Safety***

All workers entering the MSD power plant site must be equipped with appropriate and adequate PPE including ear muffs, safety footwear, overalls, gloves, dust masks, among others. The PPE should be those meeting the international standards of PPE. Personal protection gear must be provided and its use made compulsory to all. The entire workforce of the plant should be trained in the use of protective gear, handling of chemical products and acid storage cells, electric safety equipment, procedures for entering enclosed areas, fire protection and prevention, disaster response and evacuation procedures. Employees shall undergo periodic health and safety training. Safety signs shall be posted where necessary. Machines and Equipments must be operated only by qualified staff and a site supervisor should be on site at all times to ensure adherence. The project operator must develop a Workplace Health and Safety Policy Manual for which all the workers should be conversant and comply with. The project operator should appoint a responsible person from the management team to be in charge of workplace Safety, Health and Environmental issues. Chapter 8 has detailed the requirements of the HSE management plan to be followed by all suppliers, sub-contractors and contractors among others. The proponent/operator should develop a Disaster Response Plan for handling any emergencies arising thereof during the project implementation phase.

**10.2.11 Hazardous waste**

The amount of hazardous waste created will be very low and possibly originate from maintenance sources. The waste would consist primarily of spent lubricants and their containers, spent oil filters, used rags and spent clean-up solvents. The used oil filters should be segregated and stored in a place with a drip collection mechanism before they are collected by the disposal agent for proper disposal. Additionally;

- The proponent should ensure that the filters are properly disposed and should apply the principle of cradle to grave.
- The mitigation measure is to provide training to site operation staff and to properly handle and dispose hazardous wastes using acceptable methods. Hazardous wastes on the site shall be clearly marked out and the entire workforce trained to recognize the danger signs and familiarize themselves with procedures to be followed before entering hazardous areas.

**10.2.12 Noise and Vibration**

Noise and vibration are expected during the operation phase of the project. Mitigation is through installation of generators in suitable structures with inbuilt sound and vibration absorption mechanisms.

**10.2.13 Traffic Impacts**

Delivery of fuel by heavy trucks will be limited to day time hours to prevent noise pollution and nuisance to the neighboring residencies. Again, traffic control and management will be effective and efficient during this period.

**10.3 Mitigation of impacts during the decommissioning Phase**

The negative impacts of the decommissioning phase of the proposed power plant can be mitigated as follows:



**10.3.1 Minimization of Noise and Vibration**

Significant impacts on the acoustic environment will be mitigated by the project proponent of the proposed power plant shall put in place several measures that will mitigate noise pollution arising during the decommissioning phase. The following noise-suppression techniques will be employed to minimize the impact of temporary destruction noise at the project site.

- Install portable barriers to shield compressors and other small stationary equipment where necessary.
- Limit vehicles and other small equipment with engines to a minimum idling time and observe a common-sense approach to vehicle use, and encourage workers to shut off vehicle engines whenever possible.
- Demolish mainly during the day, a time with minimal noise disturbance.

**10.3.2 Efficient Solid Waste Management**

Solid waste resulting from demolition or dismantling works associated with the proposed MSD Power Plant during decommissioning phase will be managed as follows:

- Use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of demolition waste generated during decommissioning phase
- Provision of facilities for proper handling and storage of demolition materials to reduce the amount of waste caused by damage or exposure to the elements
- Adequate collection and storage of waste on site and safe transportation to the disposal sites and disposal methods at designated area shall be provided.

**10.3.3 Reduction of Dust Concentration**

High levels of dust concentration resulting from demolition or dismantling works will be minimized as follows:

- Watering all active demolition areas as and when necessary to lay dust.

- Cover all trucks hauling soil, sand and other loose materials or require all trucks to maintain at least two feet of freeboard.

## **CHAPTER 11: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)**

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### **11.1 Significance of an ESMP**

Environmental and Social Management Plan (ESMP) for development projects provides a logical framework within which identified negative environmental impacts can be mitigated and monitored. In addition the ESMP assigns responsibilities of actions to various actors and provides a timeframe within which mitigation measures and monitoring can be done. ESMP is a vital output of an Environmental Impact Assessment as it provides a checklist for project monitoring and evaluation. The ESMP covers all aspects of planning, construction, operation and decommissioning of the project, which are relevant to the project and its' environ. It is essential to implement the ESMP right from the planning stage and then continuing it throughout the construction, operation and decommissioning stages. Therefore the main objective of the ESMP is to identify the project specific activities that would have to be considered for investigation of the significant adverse impacts and the mitigation measures required.

### **11.2 Description of the ESMP Developed for the Thika Power Plant**

The ESMP outlined here (Tables 11.1, 11.2 and 11.3) has addressed the identified potential negative impacts and mitigation measures of the proposed power project during its construction, operational and decommissioning phases, based on the chapters on Environmental Impacts and Mitigation Measures of the expected negative impacts and in line with the IFC performance standards. Rough estimates of the costs of mitigation measures have been proposed.

Technical methods will be used to prevent, control and reduce negative impacts from the power plant project and associated activities in accordance

with best available technology and working practices. Efforts will be made to maximize positive benefits and the environmental carrying capacity. Social, economic, cultural and public health approaches will be implemented to minimize negative impacts and enhance positive benefits for the local people in the vicinity of the project area.

To insure an integrated internal and external management of identified environmental impacts the project proponent plans to use the following institutional approaches:

- Coordination and cooperation with appropriate governmental, municipal, local communities and other agencies and firms to ensure sound environmental management of project activities.
- Regularly updating information to improve the intention and understanding of regulations and laws at the national and local levels so that project proponent activities conform to existing laws and regulations.
- Regular reporting on environmental performance.

Table 11.1 Environmental and Social Management Plan during Construction

(Sheet 1 of 4)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (Kshs)
Extraction site impacts to ensure efficient use of raw materials in construction	<ul style="list-style-type: none"> <li>Source building materials from local suppliers who use environmentally friendly processes in their operations.</li> <li>Ensure accurate budgeting and estimation of actual construction material requirements to ensure that the least amount of material necessary is ordered.</li> <li>Ensure that damage or loss of materials at the construction site is kept minimal through proper storage.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent /contractor</li> <li>Project Engineer/Architect</li> </ul>		Periodic and surprise checks	
Loss of vegetation cover	<ul style="list-style-type: none"> <li>Ensure proper demarcation and delineation of the project area to be affected by construction works.</li> <li>Introduction of vegetation (trees, shrubs and grass) on open spaces and around the project site and their maintenance.</li> <li>Design and implement an appropriate landscaping programme to help in re-vegetation of part of the project area after construction.</li> <li>Improve the aesthetic appearance.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent /contractor</li> <li>Project Engineer/Architect</li> </ul>		Periodic and surprise checks during construction	
Air pollution by dust and VOCs generated during construction process.	<ul style="list-style-type: none"> <li>All personnel working on the project will be trained prior to starting construction on methods for minimizing air quality impacts during construction.</li> <li>Construction heavy earth moving vehicle drivers will be under strict instructions to minimize unnecessary trips, refill petrol fuel tanks in the afternoon and minimize idling of engines.</li> <li>Careful screening of construction site to contain and arrest construction-related dust.</li> <li>Exposed stockpiles of e.g. dust and sand, will be enclosed, covered, and watered daily, or treated with non-toxic soil binders.</li> <li>All workers will be required to wear protective gear</li> <li>Ensure construction machinery and equipment are well maintained to reduce exhaust gas emission</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Ministry of Health: provincial public health officer</li> <li>NEMA inspectors</li> <li>Ministry of Labour</li> </ul>	Periodic Activities	Periodic and surprise checks	100 000 per month over the construction period

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Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (KShs)
Pollution from Hazardous waste	<ul style="list-style-type: none"> <li>Handling of the materials using the material safety data provided by the manufacturers</li> <li>Appoint a safety officer to ensure that proper disposal guideline are observed</li> <li>Ensuring that maintenance and/or piece of work carried out on any piece of equipment or construction work is undertaken by qualified personnel</li> <li>In case of spillage emergency spillage control measures to be instituted</li> <li>Containerization of any wastes and disposal through a licensed waste handler.</li> </ul>	Proponent/contractor  Ministry of Health: provincial public health officer  NEMA inspectors	Periodic inspection	Periodic and surprise checks	100 000 per month
Noise and vibration by construction activities.	<ul style="list-style-type: none"> <li>Use of equipment designed with noise control elements will be adopted where necessary.</li> <li>Trucks used at construction site shall be routed away from noise sensitive areas where feasible.</li> <li>Idling time for pick-up trucks and other small equipment will be minimized to limited time.</li> <li>All workers operating in noisy areas or operating noisy equipment will be provided with earpieces to protect against extreme noise.</li> <li>Comply with L.N. 25: Noise prevention and control rules, 2005</li> </ul>	Project proponent/contractor Divisional Public Health Officer Ministry of Labour Workers NEMA inspectors	Routine Activities	Periodic and surprise checks	40 000 per month over the construction period
Traffic and Transport	<ul style="list-style-type: none"> <li>Vehicle comply with axle load limits</li> <li>Take advantage of off-peak hours</li> <li>Well trained and experienced drivers</li> </ul>	Contractor		Periodic and surprise checks	

Table 11.1 Environmental and Social Management Plan during Construction

(Sheet 2 of 4)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (Kshs)
Workers accidents and hazards when handling hazardous wastes.	<ul style="list-style-type: none"> <li>Adequate collection and storage of waste will be provided on site, and safe transportation to, and display methods at designated areas.</li> <li>All receptacles for storing hazardous wastes shall be adequately covered.</li> <li>All employees will be required to wear protective gear when handling hazardous wastes.</li> <li>All workers will be adequately insured against unforeseen accidents.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Provincial Public Health Officer</li> <li>Ministry of Labour</li> <li>Workers</li> <li>NEMA inspectors</li> </ul>	Routine Activities	Periodic and surprise checks	50 000 per month
Generation of solid waste	<ul style="list-style-type: none"> <li>Wastes to be collected regularly to control air pollution and vermin/insects etc.</li> <li>Receptacles will be provided for waste storage prior to collection.</li> <li>Resource recovery will be encouraged once the project takes off so as to shrink waste stream and recover non-recyclables.</li> <li>Refuse collection vehicles will be covered to prevent scatter of wastes by wind.</li> <li>Wastes will be collected by a licensed operator to avoid illegal final dumping at unauthorized sites.</li> <li>All persons involved in refuse collection shall be in full protective attire.</li> </ul>	<ul style="list-style-type: none"> <li>Proponent</li> <li>Hired private contractor</li> <li>Provincial Public Health Officer</li> <li>NEMA inspectors</li> </ul>	Routine Activities	Periodic and surprise checks	10 000 per month

**Table 11.1 Environmental and Social Management Plan during Construction**

(Sheet 4 of 4)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (Kshs)
Workers accidents during construction process.	<ul style="list-style-type: none"> <li>All workers will be sensitized before construction begins, on how to control accidents related to construction.</li> <li>A comprehensive contingency plan will be prepared before construction begins, on accident response.</li> <li>Accordingly, adherence to safety procedures will be enforced.</li> <li>All workers to wear protective gear during construction, including helmets.</li> <li>Construction work will be limited to daytime only</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Divisional Public Health Officer</li> <li>Ministry of Labour</li> <li>Workers</li> <li>NEMA inspectors</li> </ul>	Routine Activities	Periodic checks	40, 000 per month
Inadequate human waste disposal by workers during construction process	<ul style="list-style-type: none"> <li>As provided for by the Building Code, a temporary latrine will be provided on site to be used by construction workers</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>Contractor</li> <li>Ministry of Health</li> <li>Ministry of Labor</li> <li>NEMA inspectors</li> </ul>	Periodic Activities	Periodic checks	50,000 one time



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Increase in STI infections	<ul style="list-style-type: none"> <li>Sensitization of local communities and staff working on the project on dangers of free lifestyle</li> </ul>	<ul style="list-style-type: none"> <li>Proponents</li> <li>Ministry of Health</li> </ul>	<p>Voluntary periodic random screening</p> <p>Secondary data from health institutions</p>	yearly	Part of project budget
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Table 11.2 Environmental and Social Management Plan during Operation

(Sheet 1 of 2)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency of Monitoring	Estimated Cost (Kshs)
Solid waste generation	Use of an integrated solid waste management system i.e. through several options including of Source reduction Recycling, Composting and reuse and Incineration Ensure that wastes generated at the plant are efficiently managed through recycling, reuse and proper disposal procedures. A private solid waste handler to be contracted to handle solid waste including sludge.	<ul style="list-style-type: none"> <li>Project proponent /contractor</li> <li>Project Engineer/Architect</li> </ul>	Periodic Activities	Periodic and surprise checks	Part of the operation and maintenance budget
Release of sewage into the environment	Proponent to construct onsite sewage treatment facility that treats wastewater to meet the set NEMA guidelines. Contaminated water to be treated prior to disposal	<ul style="list-style-type: none"> <li>Project proponent /contractor</li> <li>Project Engineer/Architect</li> </ul>	Periodic Activities and audits		Wastewater facilities to be constructed as part of the initial costs and maintained by Proponent.
Air pollution	Drivers of heavy earth moving vehicles will be under strict instructions to minimize unnecessary trips, refill petrol fuel tanks in the afternoon and minimize idling of engines. All workers on the site will be required to wear protective clothing while on duty. Suitable wet suppression techniques need to be utilized in all exposed areas Use of low sulphur fuel to run the engines to be encouraged The stack chimney of the generators will be constructed to a height of at least 30 metres and stack emissions regularly monitored using the inbuilt monitoring system. Set up an air quality monitoring station at about 10 Km west of site to collect SO <sub>2</sub> and NO <sub>x</sub> data.	<ul style="list-style-type: none"> <li>Project proponent/contract or</li> <li>Ministry of Health: provincial public health officer</li> <li>NEMA inspectors</li> <li>Ministry of Labour</li> </ul>	Periodic Activities	Periodic and surprise checks	10 000 per month
Traffic and Transport	<ul style="list-style-type: none"> <li>Limit delivery to off-peak hours to reduce disruption of transport links, delays and congestion</li> <li>Provide warning lights and other signs to reduce risk of accidents along delivery roads and at the site</li> <li>Keep the earth access load dump to reduce dust</li> <li>Option of railway transport to be explored</li> </ul>	<ul style="list-style-type: none"> <li>Contractor</li> <li>Proponent</li> </ul>		Periodic and surprise checks	

Table 11.2 Environmental and Social Management Plan during Operation

(Sheet 2 of 2)

Possible Impacts	Proposed Mitigation Measures	Responsibility for Mitigation	Means for Monitoring	Frequency for Monitoring	Estimated Cost (Kshs)
Pollution from Hazardous waste	<ul style="list-style-type: none"> <li>Handling of the materials using the material safety data provided by the manufacturers</li> <li>Appoint a safety officer to ensure that proper disposal guideline are observed</li> <li>Ensuring that maintenance and/or piece of work carried out on any piece of equipment or construction work is undertaken by qualified personnel</li> <li>In case of spillage emergency spillage control measures to be instituted</li> <li>Containerization of any wastes and disposal through a licensed waste handler.</li> <li>Adhere to L.N. 121: Waste Management Regulations</li> </ul>	<ul style="list-style-type: none"> <li>proponent/contractor</li> <li>Ministry of Health: provincial public health officer</li> <li>NEMA inspectors</li> </ul>	Periodic inspection	Periodic and surprise checks	20 000 per month
Workers accidents	<ul style="list-style-type: none"> <li>All workers will be sensitized and trained on occupational safety and health issues and on how to control accidents related to construction.</li> <li>A comprehensive contingency plan will be prepared before begins, on accident response.</li> <li>Accordingly, adherence to safety procedures will be enforced.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Divisional Public Health Officer</li> <li>Ministry of Labour</li> <li>Workers</li> <li>NEMA inspectors</li> </ul>	<ul style="list-style-type: none"> <li>Routine Activities</li> </ul>	Periodic checks and Accident audits	40 000 per quarter
Noise and vibration pollution	<ul style="list-style-type: none"> <li>Installation of silencers on the generators</li> <li>Provision of personal protective equipment for workers in</li> <li>Do annual noise measurements.</li> <li>Do employee medical examination</li> <li>Comply with L.N. 25:Noise prevention and control rules, 2005 and L.N. 61: Noise and vibration pollution regulation, 2009</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent/contractor</li> <li>Divisional Public Health Officer</li> <li>Ministry of Labour</li> <li>Workers</li> <li>NEMA inspectors</li> </ul>			

**Table 11.3 Anticipated Environmental and Social Impacts and Mitigation Measures at Decommissioning of Project Construction** (Sheet 1 of 2)

Undesirable Impacts	Mitigation Measures	Responsibility for Mitigation	Estimated Cost (Kshs)
Air pollution during demolition process.	<ul style="list-style-type: none"> <li>The demolition exercise will be limited at day time only</li> <li>All personnel working on the project will be trained prior to commencing the demolition exercise on methods for minimizing negative impacts on air quality.</li> <li>Construction vehicle drivers will be under strict instructions to minimize unnecessary trips, refill petrol fuel tanks in the afternoon and minimize idling of engines.</li> <li>All active demolition areas will be watered at least twice a day to reduce dust.</li> <li>All trucks hauling demolition debris/wastes shall be covered.</li> <li>Careful screening to contain and arrest demolition related dust will be adopted</li> <li>Exposed demolition debris of e.g. dust and sand, will be enclosed, covered, and watered daily before transported to disposal site.</li> <li>All workers on the site will be required to wear protective gear while on duty</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>NEMA inspectors</li> <li>Contractor</li> </ul>	800,000
Noise pollution by disassembly activities.	<ul style="list-style-type: none"> <li>Portable barriers will be installed to shield compressors</li> <li>Use of equipment designed with noise control elements will be adopted where necessary.</li> <li>Trucks used during demolition exercise on site shall be routed away from noise sensitive areas in the neighbourhood, where feasible.</li> <li>Idling time for pick-up trucks and other small equipment will be minimized to limited time.</li> <li>Use of very noisy equipment will be limited to daytime only.</li> <li>All workers operating in noisy areas or operating noisy equipment will be provided with earpieces to protect against extreme noise.</li> <li>The demolition exercise will be limited at day time only</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>NEMA inspector</li> <li>Contractor</li> </ul>	600,000

THIKA 80 MW MSD THERMAL POWER PLANT

Traffic and Transport	<ul style="list-style-type: none"> <li>Carry out fuel deliveries during the day to avoid noise and nuisance to the residents of the neighbouring Witeithie Township</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> </ul>	
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**Table 11.4 Anticipated Environmental and Social Impacts and Mitigation Measures at Decommissioning of Project Construction** (Sheet 2 of 2)

Undesirable Impacts	Mitigation Measures	Responsibility for Mitigation	Estimated Cost (Kshs)
Demolition debris and related wastes	<ul style="list-style-type: none"> <li>Private contractor will be engaged to collect demolition debris/wastes</li> <li>All debris/wastes to be collected regularly to control air pollution and injury etc</li> <li>A licensed operator to avoid illegal final dumping at unauthorized sites will collect demolition debris.</li> <li>All persons involved in refuse collection shall be in full protective attire.</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>NEMA inspectors</li> <li>contractor</li> </ul>	4,000,000
Workers accidents during demolition process.	<ul style="list-style-type: none"> <li>All workers will be sensitized before the exercise begins, on how to control accidents related to the demolition exercise</li> <li>A comprehensive contingency plan will be prepared before demolition begins, on accident response.</li> <li>Adherence to safety procedures will be enforced at all stages of the exercise</li> <li>All workers, pursuant to labour laws, shall be accordingly insured against accidents.</li> <li>All workers will be provided and instructed to wear protective attire during demolition, including helmets.</li> <li>Demolition work will be limited to daytime only avoid workers accidents due to poor visibility</li> <li>Provision of mobile clinics</li> </ul>	<ul style="list-style-type: none"> <li>Project proponent</li> <li>Provincial Public Health Officer</li> <li>Ministry of Labour</li> <li>NEMA inspectors</li> <li>Contractor</li> </ul>	1,000,000

## **CHAPTER 12: ENVIRONMENTAL AND SOCIAL ACTION PLAN (ESAP)**

### **12.1 Introduction**

As part of corporate commitment to managing project in a responsible, safe and sustainable manner such that protection of the environment and safety of people take priority, Malec Group Limited has prepared an Environmental and Social Action Plan (ESAP) that describes the environmental and social management measures that will guide the project implementation. The ESAP has been prepared in accordance with the environmental and social review procedure set out in the EMCA (1999) and International Finance Corporation (IFC) principles and standards and specifically principle 4 on action plan and management system. The ESAP incorporates all mitigation measures required to ensure that all environmental regulations are met. It also incorporates mitigation measures that have been agreed following extensive consultations with a wide range of interested parties. It includes the specific mitigation measures identified in the ESIA and details the organization/body responsible for the action, the period for which the action should be taken, and the need for short, medium or long term monitoring.

### **12. 2 Principles necessary for the ESAP**

The following principles were adopted in preparation of the ESAP:

- (i) Compliance with relevant legislation, standards, codes and practices in the application of safe technologies;
- (ii) Minimization of impacts on the environment and human beings;
- (iii) Performance of all activities in a safe and effective manner;
- (iv) Maintenance of all equipment in good operating condition for the protection of the  
health and safety of all persons; and
- (v) Conserve the environment and property.

Ultimately, this Environmental and Social Action Plan (ESAP) has been developed to address key problem areas identified for the Thika Thermal Power Plant to substantially decrease environmental pollution and to improve quality output, cost and energy efficiency of the Power Plant.

**Table 12.1 Description of the Environmental and Social Action Plan and Management**



	Description of Environmental / Social Action	Environmental and Social Risks/Benefits	Reference Standards (i.e. legislative, best practice)	Investment Needs / Resources	Targeted Completion Date / Time Frame	Indicators / Status	
12.2 Environmental Management							
	Promote and enhance integrated quality, environmental, health and safety management system	Integrated control over quality, environmental and health and safety issues; continuous improvement	IFC standards and exhibit III; ISO 9001, ISO 14001 and OHSAS 14001 standards National regulation: LN: 101	Internal resources	2011 Following Plant Commission (FPC)	ISO 9001, ISO 14001, OHSAS 18001 compliance and certification	-
	Definition of new environmental aspects/impacts to be monitored during construction	Effective monitoring of potential environmental aspects associated to the construction	ISO 14001; National regulation: LN: 101	Internal resources	2011 (FPC)	Updated environmental aspects identification	-
12.3 Environment							
	Enforce noise mitigation measures (noise mufflers, traffic and protective housing for generators, installation of equipment inside closed structures, sound insulation)	Reduction of noise impacts on the surrounding properties, to comply with regulations and minimize the risk of claims from neighbours	World Bank guidelines and Standard 3 ISO 19011 National Regulations: LN 25; LN 61	The investment need is already included in the Investment Programme	2011 (FPC); Maintain throughout the project cycle	Noise levels below regulatory limits and permissible levels	N m m a d t s
	Ongoing monitoring of the content of solid particles in the atmosphere, VOCs and meteorological conditions of the subsidence construction area	Monitoring to exercise control and prevent impact on the environment	WHO air quality guidelines; National Regulations: LN 24; LN 60; Best practices	The investment need is already included in the Investment Programme	2011 (FPC); Maintain	Register with updated data about solid particles in the atmosphere, radioactivity and meteorological conditions regarding subsidence construction area	P u e r B

	Geodetic survey including; excavated grounds, vegetation disturbance and oil spills of the subsidence construction area	Monitoring to exercise control and prevent impact on the environment	IFC standards; National Regulation: LN 121 Best practices	The investment need is already included in the Investment Programme	2011 (FPC); Maintain	Geodetic data, soil and vegetative parameters regarding subsidence construction area	P u e r B
	Monitoring of water quality in the subsidence construction area	Monitoring of water quality to exercise control and prevent impact on the environment	National Regulations: LN 120 Best practices	The investment need is already included in the Investment Programme	2011 (FPC); Maintain	Water quality data regarding subsidence construction area	P u e r B
	Separate system for leachate collection and for the drainage of water accumulating on the surface in the subsidence construction area	Protection of surface water and groundwater	National Regulations: LN 120; LN 121  Best practices	The investment need is already included in the Investment Programme	2011 (FPC); Maintain	Separate collection of leachate and superficial water in the subsidence construction area	-

#### 12.4 Health and Safety

Monitoring of subcontractors' compliance with health & safety requirements	Periodic surveys to verify subcontractors' compliance with H&S policy/procedures and contract requirement	OSHE 1800;1 WHO air quality guideline; IFC standards 3 and 4: National Regulations: LN 24; LN 3; LN 56 and LN 60  Best practices	Internal resources	2011 (FPC); Maintain throughout the project cycle	Number of inspections performed. Number of non compliances detected (e.g. subcontractors not wearing required PPEs or not using required protective equipment	P u e r B
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Qualified subcontractors – insert in the register of qualified subcontractors a penalizing system for those found not to be compliant with H&S requirements	Control and improvement of H&S operations executed in the Plant	ISO 10012; Best practices	Internal resources	2011 (FPC); Maintain	Updated register of qualified subcontractors	-
Health & Safety monitoring - creation of a register including also near-misses events, STIs and subcontractors' accidents from equipment, machinery and vehicles/trucks.	Monitoring of happened accidents and of critical situations/events that could lead to accidents.	National Regulations: LN 31; Public health Act (chap 242); Best practices	Internal resources	2011 (FPC); Maintain throughout the project cycle	Number of accidents and STIs cases per typology of gravity and place of occurrence (both for power plant employees and subcontractors)  Number of near-misses events per typology of gravity and place of occurrence (both for power plant employees and subcontractors)	P H st e r B

## 12.5 Social

Definition of a formal procurement policy	Even if anti-bribery recommendations are present in contracts, definition of a clear and shared procurement company policy	ISO 10014; Best practices	Internal resources (HR department)	2011 (FPC); Update continuously	Procurement policy accessible to employees, clients and contractors	-
Development of a Stakeholder Engagement Plan	Definition of a clear framework for stakeholder engagement and consultation	IFC Principle 5	Internal resources/ external consultants	2011 (FPC)	Stakeholder Engagement Plan agreed with the Bank	-
Creation of a Stakeholder register	Systematic identification of all stakeholders involved, to be used for defining communication strategies	IFC Principle 6; ISO 10013 Best practices	Internal resources (PR department)	2011 (FPC); Maintain	Updated stakeholders register available (including stakeholders involved in the Unit 6 project)	-

Creation of a register of external communications, including the minutes of the meetings held with the public	Systematic collection and analysis of communications with external stakeholders, in order to provide more effective response to all enquiries	IFC Principle 5 Best practices	Internal resources	2011 (FPC); Maintain	Updated external communication register available	-
Creation of grievance management system	Grievance system accessible and monitored, in order to prevent possible problems with internal and external stakeholders	IFC Principle 6	Internal resources (allocate HR and PR staff to grievance management)	2011 (FPC); Maintain throughout the project cycle	Grievance system regarding both community and workers  Total number of community grievances, and number of unresolved grievances  Total number of labour grievances, and number of unresolved grievances	P u e r B

**Key:**

PR – Public Relation

HR – Human Resource

ISO 9001: Quality Management Systems

ISO 14001: Environmental Management System

OHSAS 18001: Occupational Health and Safety Management System

ISO 19011: Quality and Environmental Management Systems Auditing

ISO 10013: Quality Management System Documentation

ISO 10014: Financial and Economic Benefits

## CHAPTER 13: CONCLUSIONS AND RECOMMENDATIONS

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### 13.1 Conclusions

This EIA study report includes the following components:

1. A description of the EIA process;
2. An outline of the baseline, environment and detailed description of the proposed activity;
3. A presentation of the process and findings for the screening of alternatives;
4. The key issues of concerns raised by stakeholders during the public participation and consultation;
5. Findings of the specialist studies undertaken during the EIA and
6. Firm of Expert's assessment of the potential impacts, mitigation, ESMP and ESAP during the preconstruction and construction, operational as well as closure phases of the proposed power plant.

The Thika 80 MW MSD Power project is one of the committed power generation projects that are expected to meet Kenya's short to medium term power needs. Notably, the implementation of the project will not involve relocation of people. The project, which includes the construction and operation of the power plant, is envisaged to bring regional and national economic benefit to Kenyans through improved electricity availability. It is anticipated that it will be possible to successfully mitigate impacts associated with the development. In particular, the power plant will be designed, constructed and operated according to the latest industry standards under total quality management systems. The ESIMP includes plans to be formulated during the detailed design phase and has been developed as part of the EIA to manage potential impacts. Programs and plans developed and implemented through the ESIMP will be monitored and audited to ensure compliance.

The EIA has analyzed potential environmental and social impacts of implementing the power plant during construction and operational phase based on both the requirement of the EMCA (1999) and those of the IFC's Policy and Performance Standards on Social and Environmental Sustainability. The study has demonstrated that with relatively easy and cost effective mitigation measures, the environmental and social impacts can be kept at acceptable levels. Therefore, it is concluded that with implementation of the mitigation measures developed in the ESMP and adherence to the ESAP, the project development will not pose any serious adverse and negative environmental impacts. Eventually, it will be possible to successfully mitigate the impacts related to the development.

### **13.2 Recommendations**

Following the EIA study, the following recommendations were made;

1. The proponent to implement the mitigation guideline provided in the ESMP. Specifically, key negative impacts that require careful management during the plant construction and operation phases include:
  - Putting in place contractual agreement with sub-contractors regarding environmental management and mitigation measures.
  - Sinking a bore hole to avoid increased water strain on the Municipal council water supply and embrace water re-cycling during plant operations.
  - Traffic management should be enhanced. Vehicle engines should be adequately maintained to reduce exhaust emissions and preferably proponent should offer technical assistance on routine vehicle maintenance to the truck operators.
  - Undertaking sensitization and awareness training to all employees and sub-contractors on workers Health and Safety including the HIV/AIDS pandemic.
  - Capacity development and training should also be focused on the local work force.

2. Monitoring be planned and implemented for auditing and improving on the ESMP and ESAP; conditions to be monitored to include but not limited to those mentioned in 1 above.
3. That National Environmental Management Authority does consider and approve the project and grant the required Environmental Impact Assessment License to the proponent.

## LIST OF REFERENCES

- 1 2002-2008 District Development plan for Thika District
- 2 Kenya Vision 2030. A Globally Competitive and Prosperous Kenya. 2007
- 3 Energy for development. The potential role of renewable energy in meeting the Millennium Development Goals. Christopher Flavin and Molly Hull Aeck, World Watch Institute
- 4 Agriculture Act (Chapter 318 of the Laws of Kenya)
- 5 Electric Power Act (Act No. 11 of 1997)
- 6 Physical Planning Act (Cap. 286)
- 7 Environmental Management and Coordination Act No. 8 of 1999.
- 8 Legal Notice No. 101: The Environmental (Impact Assessment and Audit) Regulations, 2003.)
- 9 The Energy Act, 2006
- 10 The Forests Act (Chapter 375 of the Laws of Kenya.)
- 11 Land (Group Representatives) Act (Chapter 287 of the Laws of Kenya)
- 12 The Public Health Act (Cap. 242)
- 13 The Local Government Act (Cap. 265)
- 14 Occupational Health and Safety Act, 2007
- 15 Sessional Paper No. 6 of 1999 on Environment and Development
- 16 The National Environmental Action Plan (NEAP)
- 17 The National Shelter Strategy to the Year 2000
- 18 The National Poverty Eradication Plan (NPEP)
- 19 The Poverty Reduction Strategy Paper (PRSP)
- 20 The Rio Declaration on Environment and Development
- 21 The World Commission on Environment and Development
- 22 Wildlife (Conservation and Management) Act Chapter 376 of the Laws of Kenya
- 23 Way leaves Act (Chapter 292 of the Laws of Kenya)
- 24 IFC World Bank Regulations on Thermal Plants, 2006
- 25 IFC HSE Guidelines, 2008.



## **APPENDIX 1. PUBLIC CONSULTATION**

### **Appendix 1.1 Minutes of Public Consultation Meeting Held at Witeithie on 17/10/2010**

1. The meeting was called to order at 3.40 pm by the Witeithie Sub-location Sub-Chief.
2. The Komu Location Chief welcomed all those present for the meeting and invited one of the E.I.A Consultant's representatives to explain to the locals present the purpose of the meeting.
3. Members of the Public Raised the following issues and concerns
  - i. Proper mechanisms be put in place to ensure noise is reduced
  - ii. Local youth be employed during constructions
  - iii. The company extends its corporate responsibility by putting street lights in the Witeithie Area to boost security
  - iv. That they be assured that there will be no demolitions of houses and relocation of people to create a right of way (RoW) for power lines during construction of the thermal plant. The Consultant confirmed that the project did not involve construction of power lines.

There being no other issue, the meeting ended at 5.30.

**Appendix 1.2 List of Attendants at Witeithie Public Consultation Meeting**

**PUBLIC CONSULTATION MEETING ATTENDANCE LIST FOR THIKA THERMAL POWER PLANT**

MATELEC Power Generating Company is proposing to construct a Thermal Plant in Thika. As one of the one of the potentially affected stakeholder, it is a requirement by Environment Management Coordination Act 1999, Environmental Impact Assessment (EIA) and Environmental Audit Regulations 2003 and the Equator Principles that your views and concerns be incorporated in the project planning, implementation, and operation and decommissioning.

SNo.	Name	ID/No.	Signature	Address
1	CHIEF Koro Loc. MR. MURURI			
2	ASS. CHIEF WTE. MR. MURURI			
3	SR. NJIROGE WITEITHIE			
4	KENNETH NYAGIA			
5	JOHN MIHARI			
6	BISHOP SAMUEL KURITA			
7	GILAD'S GITUNGO			
8	MOSES WAKUNA			
9	JOEL NGANGA			
10	JOASH MAKORI			
11	P. Omondi			
12	MYRANNO JOSEPH			
13	EDWARD MURURI			
14	John Ndegwa			
15	Swanson Akhenge			
16	Abiko Abiga	01623677	Abiga	
17	Kagwira Jackson			
18	John Karaya			
19	Daniel Wanjiku			
20	Samuel Gituru			

District: THIKA WCSI Division: JUJA Location: Koro  
 Sub location: WITEITHIE Village: WITEITHIE  
 The meeting ended: \_\_\_\_\_  
 Secretary: \_\_\_\_\_  
 Community Representative: KENNETH NYAGIA - 0721 859 157  
 Consultant Representative: \_\_\_\_\_  
 Date: \_\_\_\_\_

ASS. CHIEF  
 WITEITHIE  
 17/10/2010

**PUBLIC CONSULTATION MEETING ATTENDANCE LIST FOR THIKA THERMAL POWER PLANT**

MATELEC Power Generating Company is proposing to construct a Thermal Plant in Thika. As one of the one of the potentially affected stakeholder, it is a requirement by Environment Management Coordination Act 1999, Environmental Impact Assessment (EIA) and Environmental Audit Regulations 2003 and the Equator Principles that your views and concerns be incorporated in the project planning, implementation, and operation and decommissioning.

SNo.	Name	ID/No.	Signature	Address
1	Serah Wangiri			
2	Jane Wangiri			
3	Hannah Gatete			
4	Ann Kariki			
5	HARRISON MUDAPURU			
6	MOSSE KISUMU			
7	PATRICK THUA			
8	James Simeu			
9	L. W. Njeri			
10	James Mwangi			
11	JOSEPH GICHINGA			
12	JABO O. NYAKUBA			
13	CHARLES WANGIRI			
14	EVANCE MUDAPURU			
15	EMILY NJERI	222503		
16	Jane Wangiri			
17	Pastor Wangiri			
18				
19				
20				

District: Thika West Division: NIA Location: KINDU  
 Sub location: WILDFIRE Village: WILDFIRE  
 The meeting ended: .....  
 Secretary: JOSEPH GICHINGA  
 Community Representative: JOSEPH GICHINGA  
 Consultant Representative: ASS. CHIEF  
 Date: 17/12/2010

## Appendix 1.3 Sample Questionnaires to the Lead Agencies

**THIKA THERMAL POWER PLANT ESIA PUBLIC CONSULTATION – LEAD AGENCIES**

MATELEC Power Generating Company is proposing to construct a Thermal Plant in Thika. As one of the potentially affected stakeholder, it is a requirement by Environment Management Coordination Act 1999, Environmental Impact Assessment (EIA) and Environmental Audit Regulations 2003 and the Equator Principles that your views and concerns be incorporated in the project planning, implementation, and operation and decommissioning. This questionnaire is therefore administered to collect these views and concerns to form part of Environmental and social Impact Assessment (ESIA). Kindly, answer the question below as correctly as possible. Thank you for your cooperation.

**General Information**

Enumerator's Name: \_\_\_\_\_

Respondent's Name: JOHN MWANGI MAINA

Telephone No: 0720 586053

Designation: \_\_\_\_\_

Date: 23/10/2010

Signature: JS

Location: KOIRO Division: SUSA District: THIKA WEST

**Demographic data**

1. Head of Household Name: JOHN MWANGI MAINA

2. Sex: Male: ☒ Female: \_\_\_\_\_

3. Tribe: KIKUYU Occupation: LABOURER

4. Total Household Members: 6

**Education Level** **Number of Members**

1. Primary: 4

2. Secondary: \_\_\_\_\_

3. College/University: \_\_\_\_\_

**Housing Topology**

1. Permanent ( )

2. Temporary ☒ ( )

3. Semi-permanent ( )

4. Others: \_\_\_\_\_

Page 1

Land Tenure System

Under what type of tenure do you use this land?

1. Freehold (registered) ( )
2. Freehold (unregistered) ( )
3. Leasehold ( )
4. Tenancy ✓ ( )
5. Customary/communal ( )
6. Do not know ( )

Comments

How do you think the proposed project will affect you and your family?

1. ....
2. The project will effect me
3. and my family. It will create
4. an employment.
5. ....

What are your main concerns regarding the proposed thermal power plant?

1. It will <sup>help</sup> our area with lights.
2. ....
3. ....
4. ....
5. ....

How do you suggest that these concerns be addressed?

1. To be addressed in chiefs barazas.
2. ....
3. ....
4. ....
5. ....

What are the positive impacts you anticipate from the proposed thermal power project?

1. It may pollute our a bit area
2. a bit.
3. ....
4. ....
5. ....



What are the negative impacts you anticipate from the proposed thermal power project?

1. It may cause air pollution -
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_

Suggest ways through which the positive impacts can be enhanced

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

Suggest ways through which the negative impacts can be avoided, reduced or mitigated

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_

I approve/Disapprove the proposed thermal Power Project: I Approve -

Signature: [Signature] Date: 23/10/2010

Page 3

THIKA THERMAL POWER PLANT ESIA PUBLIC CONSULTATION – LEAD AGENCIES

MATELEC Power Generating Company is proposing to construct a Thermal Plant in Thika. As one of the key lead agencies, it is a requirement by Environment Management Coordination Act 1999, Environmental Impact Assessment (EIA) and Environmental Audit Regulations 2003 and the Equator Principles that your views and concerns be incorporated in the project planning, implementation, and operation and decommissioning. This questionnaire is therefore administered to collect these views and concerns to form part of Environmental and social Impact Assessment (ESIA). Kindly, answer the question below as correctly as possible. Thank you for your cooperation.

Lead Agency: Agro Tropical Estates  
 Respondent's Name: David Wachira  
 Telephone No: 0715324897  
 Designation: Farm Manager  
 Date: 26/11/2010  
 Signature: [Signature]

Comments and concerns

How do you think the proposed project will affect the operations of your organization?

1. Increase of traffic in our area/road.
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

What are your main concerns regarding the proposed thermal power plant?

1. My main concern is my coffee crop & the soil
2. air pollution & noise
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

How do you suggest that these concerns be addressed?

1. look for a way of reducing the effects.
2. \_\_\_\_\_
3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

What are the positive impacts do you anticipate from the proposed thermal power plant?

1. Somehow raise the value of the farm

2. I hope it will increase security

3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

What negative impacts do you anticipate from the proposed thermal power plant?

1. Traffic increase

2. air pollution

3. Noise

4. \_\_\_\_\_

5. \_\_\_\_\_

Suggest ways through which the positive impacts can be enhanced

1. The project should connect us

2. with power

3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

6. Suggest ways through which the negative impacts can be avoided, reduced or mitigated

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

6. I approve/disapprove the proposed project \_\_\_\_\_

Signature [Signature] Date: 26/11/2010

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THIKA THERMAL POWER PLANT ESIA PUBLIC CONSULTATION – LEAD AGENCIES

MATELEC Power Generating Company is proposing to construct a Thermal Plant in Thika. As one of the key lead agencies, it is a requirement by Environment Management Coordination Act 1999, Environmental Impact Assessment (EIA) and Environmental Audit Regulations 2003 and the Equator Principles that your views and concerns be incorporated in the project planning, implementation, and operation and decommissioning. This questionnaire is therefore administered to collect these views and concerns to form part of Environmental and social Impact Assessment (ESIA). Kindly, answer the question below as correctly as possible. Thank you for your cooperation.

Lead Agency: MANGU HIGH SCHOOL  
 Respondent's Name: James Murang'i T.  
 Telephone No: 067-24146  
 Designation: Deputy Principal  
 Date: 30th November, 2010  
 Signature: [Signature]

Comments and concerns

How do you think the proposed project will affect the operations of your organization?

1. - Heavy traffic could block the gate
2. to the staff quarters during transp-
3. ortation of construction material.
4. - Dust level may lead to air
5. borne diseases.

What are your main concerns regarding the proposed thermal power plant?

1. - Increase in level of environmental
2. pollution that is air, waste
3. water corrosion to buildings
4. and oil spillage
5. - May affect the bore hole

How do you suggest that these concerns be addressed?

1. - Wet the ground while transporting
2. material for construction
3. - Ensure waste water is treated
- before disposal back to the environment

4. Reduce the pollutants in emissions  
 5. Use other sources of water other than borehole eg City Council or pump water from the river.

What are the positive impacts do you anticipate from the proposed thermal power plant?

1. May provide a learning environment to students  
 2. Management may undertake C.S.R by sponsoring students or other activities  
 3.   
 4.   
 5.

What negative impacts do you anticipate from the proposed thermal power plant?

1. Air pollution  
 2. Water pollution  
 3. Increased traffic  
 4. It will affect the ecology of the area.  
 5. Increased Noise level


Suggest ways through which the positive impacts can be enhanced

1. The facility should be available for students to visit.  
 2. The management should extend the facility for the plant to the neighborhood.  
 3.   
 4.   
 5.

6. Suggest ways through which the negative impacts can be avoided, reduced or mitigated

1. As Above  
 2.   
 3.   
 4.   
 5.

6. I approve/disapprove the proposed project \_\_\_\_\_

Signature:  Date: 30/11/2010

**DEPUTY PRINCIPAL**  
**MANG'U HIGH SCHOOL**  
 P.O. Box 314 - 01000, THIKA  
 Tel: 067-24146

Page 2

THIKA THERMAL POWER PLANT ESIA PUBLIC CONSULTATION – LEAD AGENCIES

MATELEC Power Generating Company is proposing to construct a Thermal Plant in Thika. As one of the key lead agencies, it is a requirement by Environment Management Coordination Act 1999, Environmental Impact Assessment (EIA) and Environmental Audit Regulations 2003 and the Equator Principles that your views and concerns be incorporated in the project planning, implementation, and operation and decommissioning. This questionnaire is therefore administered to collect these views and concerns to form part of Environmental and social Impact Assessment (ESIA). Kindly, answer the question below as correctly as possible. Thank you for your cooperation.

Lead Agency: COUNTY COUNCIL OF THIKA

Respondent's Name: MENYA A.

Telephone No: 1251 731 683 365

Designation: PLANNING

Date: 23/11/18

Signature: [Signature]



Comments and concerns

How do you thin the proposed project will affect the operations of your organization?

1. The project may increase the Council's revenue base
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

What are your main concerns regarding the proposed thermal power plant?

1. The main concern is air pollution
2. How will the project handle the byproduct waste generated from the use of diesel?
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

How do you suggest that these concerns be addressed?

1. Employ modern technology to deal with air pollution and the waste that will be generated from operations of the plant
2. \_\_\_\_\_
3. \_\_\_\_\_

4. \_\_\_\_\_
5. \_\_\_\_\_

What are the positive impacts do you anticipate from the proposed thermal power plant?

1. Employment Creation
2. Increase in power generation hence minimal black-outs
3. Attract investors to the area due to proximity to power supply
4. \_\_\_\_\_
5. \_\_\_\_\_

What negative impacts do you anticipate from the proposed thermal power plant?

1. Air pollution due to toxic gases
2. Noise pollution
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

Suggest ways through which the positive impacts can be enhanced

1. Employment of the local people will help in economic development of the area
2. Ensure community participation to cultivate a sense of ownership of the project among the local people. This will also help to minimize Vandalism e.t.c
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

6. Suggest ways through which the negative impacts can be avoided, reduced or mitigated


1. Employ modern technology to mitigate against air pollution e.g air filters
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

6. I approve/disapprove the proposed project \_\_\_\_\_

Signature:  Date: 03/11/10

## THIKA THERMAL POWER PLANT ESIA PUBLIC CONSULTATION – LEAD AGENCIES

MATELEC Power Generating Company is proposing to construct a Thermal Plant in Thika. As one of the key lead agencies, it is a requirement by Environment Management Coordination Act 1999, Environmental Impact Assessment (EIA) and Environmental Audit Regulations 2003 and the Equator Principles that your views and concerns be incorporated in the project planning, implementation, and operation and decommissioning. This questionnaire is therefore administered to collect these views and concerns to form part of Environmental and social Impact Assessment (ESIA). Kindly, answer the question below as correctly as possible. Thank you for your cooperation.

Lead Agency: Municipal Council of Thika  
 Respondent's Name: W. M. Gichotho  
 Telephone No: 0720716027  
 Designation: Administration Officer  
 Date: 23/11/2019  
 Signature: 

## Comments and concerns

How do you think the proposed project will affect the operations of your organization?

1. more business activities will be sustained.
2. Regular power cuts will be reduced.
3. Street lighting service will be improved and
4. electric security of residents.
5. Investors will be attracted to this area.

What are your main concerns regarding the proposed thermal power plant?

1. Should be environmental friendly.
2. Emission of pollutants should be controlled
3. Will the project support the council in any way?
4. Is the will the plant become a substantial problem
5. to water supply. Will the plant be a constraint to  
(Increase demand for resources) resources.

How do you suggest that these concerns be addressed?

1. The project should partner with the Council in providing
2. The project should partner with the Council in
3. upgrading / ensuring of water supply.



4. \_\_\_\_\_
5. \_\_\_\_\_

What are the positive impacts do you anticipate from the proposed thermal power plant?

1. Enhanced business operations
2. Employment creation.
3. Improvement of living standards of people.
4. Enhanced security.
5. \_\_\_\_\_

What negative impacts do you anticipate from the proposed thermal power plant?

1. Pollution as a result due to emissions
2. Use of resources - water supply to the plant.
3. Noises and vibrations
4. Spread of disease introduced by immigrants to this area.
5. Introduction of new habits by immigrants.

Suggest ways through which the positive impacts can be enhanced

1. Power to be supplied to surrounding areas
2. Provision of social amenities like hospitals etc
3. Provision of street lighting and flood lights
4. \_\_\_\_\_
5. \_\_\_\_\_

6. Suggest ways through which the negative impacts can be avoided, reduced or mitigated

1. Adopting new and good housekeeping measures
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

6. I approve/disapprove the proposed project \_\_\_\_\_

Signature



MUNICIPAL COUNCIL OF THIKA  
P. O. Box 248-01000, THIKA  
KE 21001

Date

23/11/2010

## THIKA THERMAL POWER PLANT ESIA PUBLIC CONSULTATION – LEAD AGENCIES

MATELEC Power Generating Company is proposing to construct a Thermal Plant in Thika. As one of the key lead agencies, it is a requirement by Environment Management Coordination Act 1999, Environmental Impact Assessment (EIA) and Environmental Audit Regulations 2003 and the Equator Principles that your views and concerns be incorporated in the project planning, implementation, and operation and decommissioning. This questionnaire is therefore administered to collect these views and concerns to form part of Environmental and social Impact Assessment (ESIA). Kindly, answer the question below as correctly as possible. Thank you for your cooperation.

Lead Agency: Ministry of Agriculture  
 Respondent's Name: SILVER NJOJO MUGO (Environment Officer)  
 Telephone No: 0722 66 5540  
 Designation: S.A.O  
 Date: 26/11/2010  
 Signature: [Signature]

## Comments and concerns

How do you think the proposed project will affect the operations of your organization?

1. - Reduce power blackouts hence increasing
2. efficiency and productivity.
3. - Increase the development of other industries
4. thus increasing improving the economy of
5. the local farmer.

What are your main concerns regarding the proposed thermal power plant?

1. - Noise from the diesel engine.
2. - Air pollution and water pollution
3. - Vibrations as a result of the engine used
4. - Soil pollution
5.

How do you suggest that these concerns be addressed?

1. - Use of low noise production machine.
2. - Design a good waste management system
3. to reduce pollution
4. - Collaborating with the local community
5. in tree planting as a way of reducing
6. reducing LRS air and water pollution.

Page 1

4. - Construct water harvesting structures to reduce over use of ~~river~~ river & piped water.

5. - Construct a wet land through which waste water can be cleaned naturally before discharge to the water course.

What are the positive impacts do you anticipate from the proposed thermal power plant?

1. - Development of Cottage industries - job creation.

2. - Community lighting - reduce road insecurity.

3. - Increased economy due to better living standards.

4. \_\_\_\_\_

5. \_\_\_\_\_

What negative impacts do you anticipate from the proposed thermal power plant?

1. Noise, water & soil pollution - hence low productivity both agriculturally and socially.

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

Suggest ways through which the positive impacts can be enhanced

1. - Provision of power to low earning commercially members at a subsidized rate.

2. - Street lighting to provide security.

3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

6. Suggest ways through which the negative impacts can be avoided, reduced or mitigated

1. - Planting of trees to reduce air and water pollution.

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

6. I approve/disapprove the proposed project - approved

Signature [Signature] Date 26/11/2010.





**JOMO KENYATTA UNIVERSITY  
OF  
AGRICULTURE AND TECHNOLOGY**

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY  
TEL. 067-52711 EXT. 4420

10<sup>th</sup> December, 2010

Our Ref. JKU/FST/020/072

Dr. Gatari  
University of Nairobi  
Dept of Nuclear Centre  
P.O. Box 29053-00625  
Nairobi

**RE: CERTIFICATE OF ANALYSIS OF HYDROCARBONS, BENZENE AND  
TOLUENE**

The table below shows the results of Laboratory analysis of soil samples as per your request.  
Total Hydrocarbons was done by Gas Chromatography and Benzene/Toluene was done by  
Liquid Chromatography.

S/No	Parameter	Sample Identity					
		Loc. A	Loc. B	Loc. C	Loc. E	Loc. D	Loc. F
1	Total Hydrocarbons (µl/g)	0.1	0.1	0.1	0.1	0.4	0.1
2	Benzene (µg/g)	nd	nd	nd	nd	nd	nd
3	Toluene (µg/g)	22.1±0.2	20.4±0.1	14.5±0.3	13.6±0.2	17.9±0.4	14.6±0.3

**KEY:**

nd: means not detected

Analyst-In-Charge: P.N. Karanja Signed: \_\_\_\_\_

Date: 10-12-2010

Checked by: Prof. G.M. Kenji Signed: \_\_\_\_\_

Date: 14-12-2010

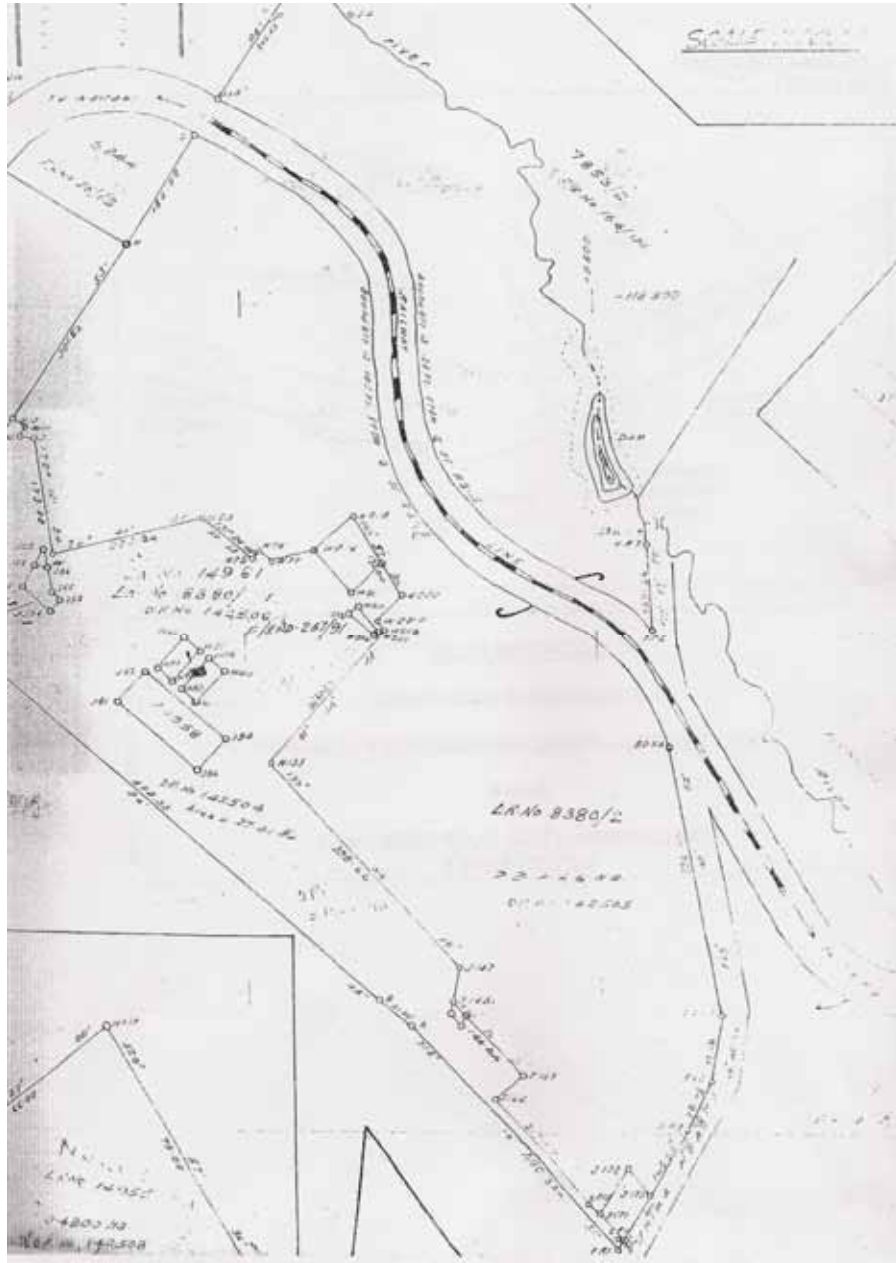
**JOMO KENYATTA UNIVERSITY  
OF  
AGRICULTURE AND TECHNOLOGY**



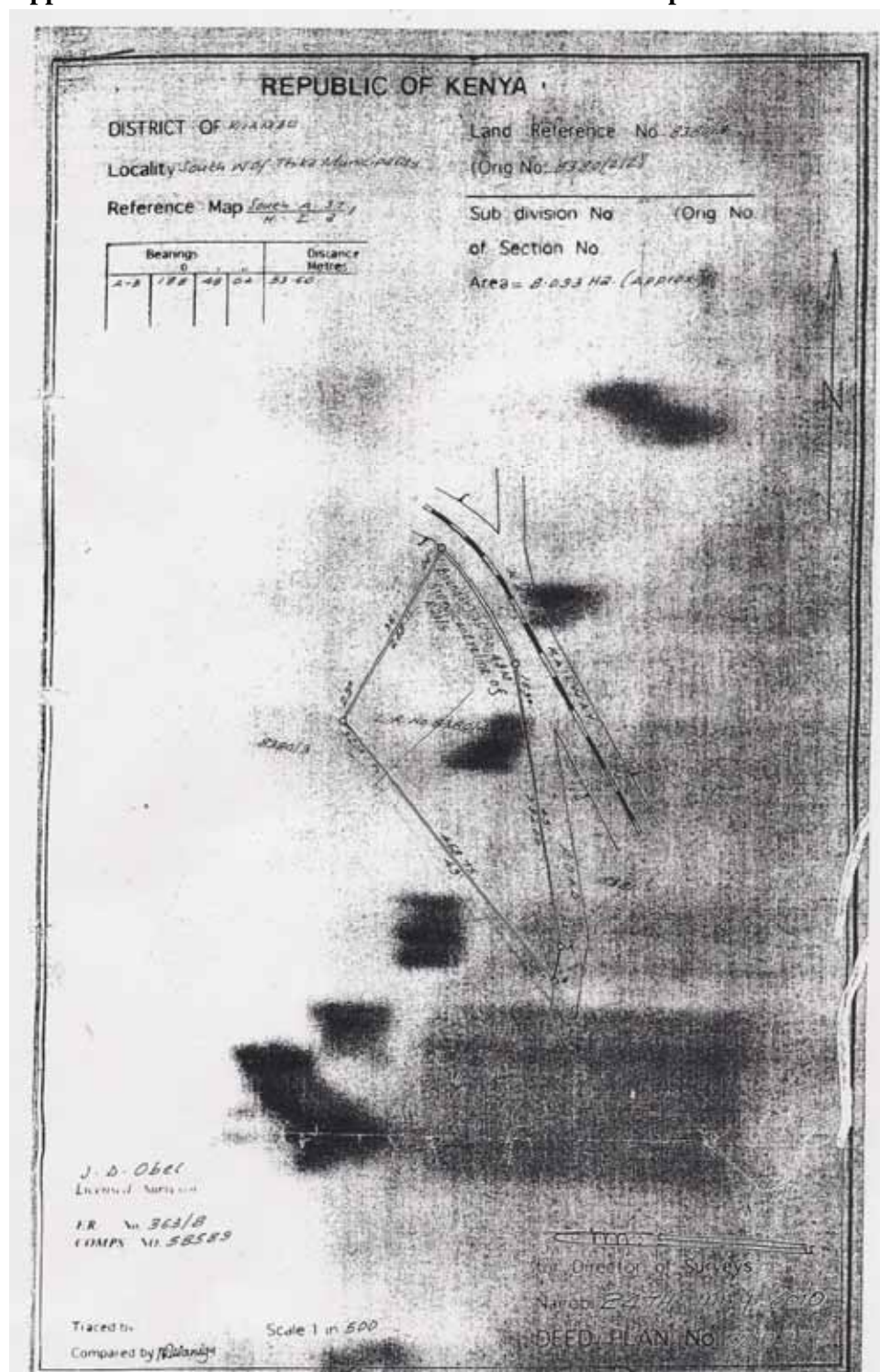
DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY  
P. O. Box 62000, NAIROBI, KENYA.  
Motto: Setting trends in higher education, research and innovation



**Appendix 2.2 Deed Plan for the land from which Power Plant Plot was hived**



Appendix 2.3 Deed Plan for the KPLC Land for the Proposed Power Plant





## **APPENDIX 3. SPECIALIST STUDY REPORTS**

### **Appendix 3.1 Air and Noise Quality Report**

#### **Report on the Assessment of Air Pollution and Noise Monitoring at the Proposed Site for MSD Thermal Power Plant at Thika**

**INSTITUTE OF NUCLEAR SCIENCE & TECHNOLOGY**

**UNIVERSITY OF NAIROBI**

**October, 2010**

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## **1.0 INTRODUCTION**

In this report we present results for the spot check assessment of air pollution at proposed Thermal Power Plant site in Witeithie urban centre which was done on 22<sup>nd</sup> & 23<sup>rd</sup> October 2010.

The site located near Juja town, approximately 35 km north of Nairobi city. The anticipated power plant is expected to generate about 80MW of electricity.

### **1.1 Problem statement**

In order to comply with construction/building regulations by NEMA on Environmental Impact Assessment (EIA), MATELEC POWER GENERATING COMPANY LTD consulted the Institute of Nuclear Science and Technology to carryout assessment of air pollutants; Gases (**NO<sub>2</sub>, NO, SO<sub>2</sub>, CO**), Particulate matter (**PM<sub>10</sub>**) and Noise levels at the proposed site. The data collected will serve as baseline data before the commencement of the construction work.

### **1.2 Objectives**

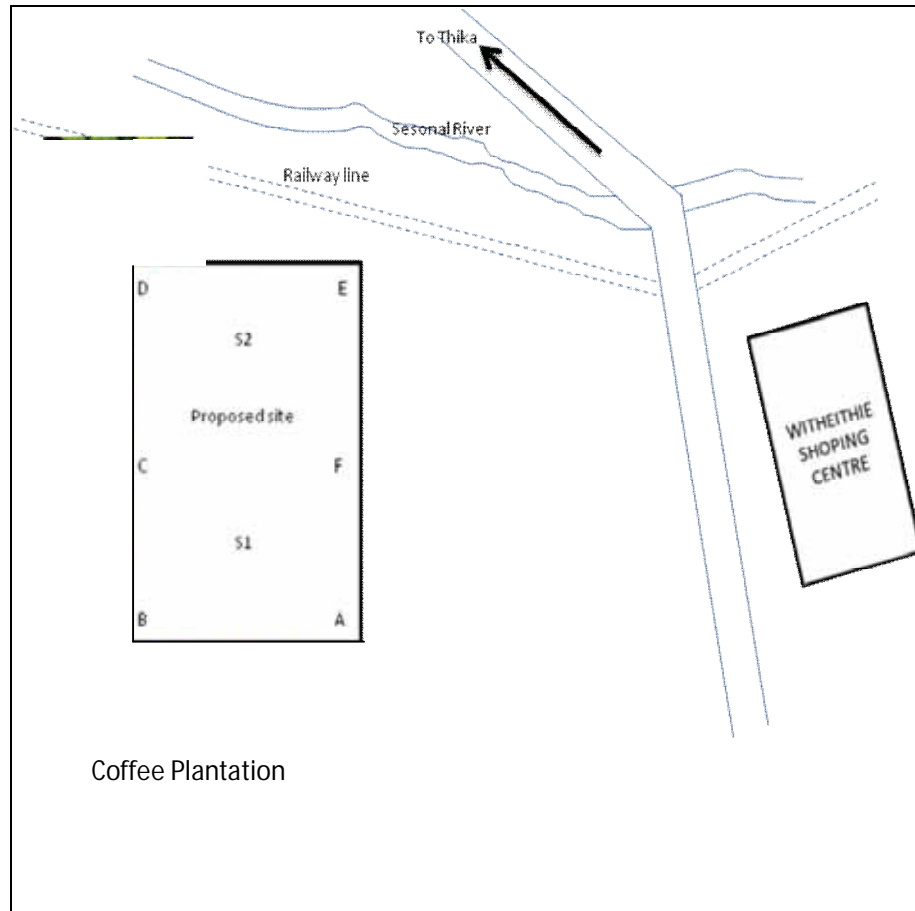
The objectives of the exercise were to measure;

- Concentration of particulate (PM<sub>10</sub>)
- Levels of pollutant gases namely; CO<sub>2</sub>, NO, NO<sub>2</sub> and SO<sub>2</sub>
- Ambient noise levels

## **2.0 METHODOLOGY**



Sampling was done for two consecutive days at two different points within the proposed construction site as shown in Figure 1 below.



*Key:*

- A, B, C, D, E & F indicate Noise level measurement points
- S1 & S2 indicate actual sampling points

**Figure 1. Sketch of the sampling site**

## 2.1 Air Particulate Matter

A Ghent PM<sub>10</sub> sampler with Stacked Filter Units (SFU) was used to collect two size fractionated aerosol samples (PM<sub><2.5</sub> & PM<sub>2.5<10</sub>) during the sampling exercise. The sampler inlet was placed at heights of 2 meters from

the ground and the flow rate adjusted to approximately 16.7 L/min. Sampling duration was 8 hours each day.

The filter loading were determined gravimetrically using a 10 $\mu$ g sensitivity Ainsworth (Type 24N) weighing balance in an air-conditioned room at 50% relative humidity and at 20°C. The filter load densities were determined from results of volume of air sampled and the weights of the filter loads determined.

## 2.2 Gaseous Pollutants

Measurements of gaseous pollutants; NO, NO<sub>2</sub>, CO and SO<sub>2</sub> were obtained by using Nitric Oxide meter data logger model Z-700XP, Nitrogen Dioxide meter data logger model Z-1400XP, Carbon monoxide meter Data logger model Z-500 XP and Sulphur Dioxide meter data logger model Z-1300XP respectively. Gaseous concentrations levels were determined from measurements of data taken at intervals of 10 seconds continuously for 8 hours each day at the sampling site.

## 2.3 Noise levels

Noise levels were measured using a digital sound level meter model HP-882A with a measurement range of 30 – 130 decibel and accuracy of  $\pm 1.5$  dB. Readings were obtained at 6 different points three times every day (Figure 1).

## 3.0 RESULTS

Tables 1, 2 & 3 show the summary of average results for Particulates, Gases and Noise levels measured during the sampling period.

**Table 1: Average results of Particulate measurements ( $\mu$ gm-3)**

Fraction	PM ( $\mu$ g/M <sup>3</sup> )
Fine (PM <sub>2.5</sub> )	15.5
Coarse (PM <sub>2.5&lt;10</sub> )	49.4

<b>Total (PM<sub>10</sub>)</b>	64.9
--------------------------------	------

**Table 2: Concentration levels for gaseous air pollutants; NO<sub>2</sub>, NO, SO<sub>2</sub> and CO in ppb.**

<b>Gas</b>	<b>Average conc'n (ppb)</b>	<b>Maximum conc'n (ppb)</b>
SO <sub>2</sub>	76	200
NO	1318	3300
NO <sub>2</sub>	35	400
CO	104	3500

**Table 3: Results for noise levels (dB)**

<b>Statistics</b>	<b>dB</b>
Average	54.0
Max	73.2
Min	43.7

### **Observations**

Based on the results of these measurements, the following observations were made:

- The total particulate matter (PM<sub>10</sub>) concentration was less than maximum limit of 150 µg/m<sup>3</sup> set by WHO (1987) and EPA (1999).

- Gases' average concentrations were generally low compared to the recommended levels by WHO and EPA.
  - \* NO<sub>2</sub> maximum measured value was 400 ppb and the maximum 8 hour average was 35ppb. The average result is within the one-hour maximum exposure of between 100 – 1170 ppb as cautioned by WHO (1999).
  - \* CO maximum measured concentration was 3500 ppb and an 8 hour average maximum of 104 ppb. Maximum allowable concentrations as set by United States EPA are 35 ppm for 1 hour and 9 ppm for 8 hours.
  - \* Highest SO<sub>2</sub> measured concentration was 200 ppb and the 8 hour calculated average was 76 ppb. The average value is less than the safe level set by United States EPA (1999) of 140 ppb (averaged over 24 hours).
  
- Noise levels measured in 6 sites ranged between 43.7 – 73.2 dB with an 8 hour average of 54.0 dB. This average value is however less than the 24 hour exposure level of 70dB as recommended by US EPA.

#### **4.0 CONCLUSIONS.**

- Measured air pollutants levels for Particulate matter (PM<sub>10</sub>), Gases ( NO, NO<sub>2</sub>, CO & SO<sub>2</sub>) and Noise were all within or below the recommended limits as per WHO & United States EPA.
  
- The ambient air around the sampling site is clean and meets the National regulation requirements.

#### **5.0 RECOMMENDATIONS**

- A similar exercise to be carried out again after one month to compare the results.

## 6.0 REFERENCES

Air Pollution Monitoring at Voucher Processing Centre, Industrial Area, Nairobi. September, 1997. A GEOMAX – Consulting Engineers Project

Environmental Survey at Westlands Roundabout on 22 June 2005. A JICA-NCC project.

Digital sound meter operation manual MODE:882A

Environmental Survey For A Road Construction Project in Kileleshwa, Lavington, Riverside Drive and Yaya Centre – Sub Urban in Nairobi Between 7<sup>th</sup> – 17<sup>th</sup> February, 2006 – A JICA-NCC Project.

KARUE J. M., A.M. KINYUA and A. H. S. EL-BUSAIDY (1992). Measured Components in Total Suspended Particulate Matter in A Kenyan Urban Area. Atmospheric Environment Vo. 26 No.4, pp. 505-511.

KINYUA A.M., MANGALA, M.J., GATEBE, C.K., KAMAU, G.N. KWACH R., MUGERA W.G., KORIR I AND MUKOLWE E.A (1998). Suspended Particulate Matter in Nairobi and the Impact on Health. Proceedings of the Kenya Meteorological Society (KMS) Workshop, Nairobi. Pp. 416-420.

Site Environmental Investigation for the Proposed Interim Building for the United States Embassy in Nairobi, December 1998. A MORRISON KNUDSEN INC. PROJECT # 4989

UNEP (1996). Air Quality Management and Assessment capabilities in 20 major cities. WHO/EOS 95.7 UNEP, Nairobi, pp245.

UNEP/GEMS (1991). Urban Air pollution (UNEP Library No.4). Nairobi, pp36.

UNEP/WHO (1992). Urban Air Pollution in Megacities of the World, Blackwell Publishers, UK, pp 230.

## Appendix 3.2 Air Quality Modeling

### EXPECTED PLANT EMISSIONS

<b>MAN Diesel</b> Project. No.	Date	Revision	Project	Engine Configuration
5301111	14.12.10	2.0	Thika	5x 18V 48/60 + DCC
Author <b>Zerr</b>		Department <b>PE21</b>	Subject <b>Expected Exhaust Gas</b>	
<b>Fuel</b>				
Type			HFO	
wt%		Sulphur	1.8	
wt%		Nitrogen	0.3	
wt%		Ash	0.02	
<b>Reference conditions</b>				
°C		25	Air temperature	
°C		-	Water temperature before charge air cooler	
mbar		848	Air pressure	
%		50	Relative humidity	
%		Engine output	100	
kW/cyl.		956	Mechanical engine output	
min <sup>-1</sup>		Speed	500	
°C		Charge air temperature	46	
<b>Exhaust Gas Parameters</b>				
°C		163	Temperature after heat recovery boiler	
t/h		115,6	Mass flow	
m³/h		170605	Volumetric flow @ above exhaust gas temp.	
Nm³/h		Norm volumetric flow	89406	
<b>Exhaust Gas Emissions</b>				
O <sub>2</sub>		vol %, dry	11.7	
CO <sub>2</sub>		vol %, dry	7.0	
NO <sub>x 1)</sub>		g/kWh, mech	14.7	
mg/Nm³, dry @ 15%O <sub>2</sub> *)			2000	
CO		g/kWh, mech	0.8	
mg/Nm³, dry @ 15%O <sub>2</sub> **)			105	
HC		g/kWh, mech	0.9	
mg/Nm³, dry @ 15%O <sub>2</sub> **)			125	
SO <sub>2 2)</sub>		g/kWh, mech	7.6	
mg/Nm³, dry @ 15%O <sub>2</sub> *)			1050	
t/dMWel.			0.2	
TSP 3)		mg/Nm³, dry @ 15%O <sub>2</sub> **)	50	
<b>all values for guidance only, not guaranteed, except values with addition *), **)</b>				
*) Tolerance: ± 5%				
**) Tolerance: ± 20%				
Note: Measuring instrument tolerance not chargeable upon MAN Diesel SE;				
O <sub>2</sub> , NO <sub>x</sub> , CO, HC measurement acc. to ISO-8178; reference condition Nm3: 1013 hPa; 0°C				
1) calculated as NO <sub>2</sub>				
2) The SO <sub>2</sub> -content in the exhaust gas is valid for fuel with sulphur content as specified above; 94% electr. plant efficiency assumed				

3) Total solid particulates (TSP)=soot+ash, without condensed or adsorbed water, hydrocarbons and sulfates, measurement acc. VDI-2066 equivalent to PM, US EPA method 17. The TSP content in the exhaust gas is valid for fuel with an ash content as specified above.

## AIR QUALITY SIMULATIONS

### 1. SCOPE OF STUDY

The site will be required to comply with various air pollution limits, which are discussed below. This assessment aims to

- (i) Model existing source strength and to predict boundary air pollution levels before and after the proposed installation of a medium speed diesel (MSD) thermal plant to generate 80 MW of electricity at the site at Thika,
- (ii) Verify compliance with the limits, and
- (iii) Provide the operator with air pollution simulation maps of the site and adjoining land area within a radius of 20km for mitigation purposes. This will help quantify the mitigation measure if any.

### 2. ASSESSMENT CRITERIA

#### 2.1 World Health Organization

In the World Health Organization (WHO) document ‘WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide Global update 2005’, guideline limit values for in reducing the health impacts of air pollution specific environments are provided. Air pollution levels below the limits are considered necessary to minimize any temporary or long-term adverse health effect attributable to exposure to the air pollutants. The values form the basis of many international environmental air quality limits and are summarized in Table 1, below.

### 3. METHODOLOGY

#### 3.1 Supplied Data

The following data has been supplied by manufacturer of the plant:

Air pollution data relating to all the sources strengths;

- $\text{SO}_2$  - 1050mg/ m<sup>3</sup>
- $\text{NO}_x$  - 2000mg/ m<sup>3</sup>

**Table 1 WHO Guidelines**

<b>Pollutant</b>	<b>Short term exposure <math>\mu\text{g}/\text{m}^3</math></b>	<b>Long term exposure <math>\mu\text{g}/\text{m}^3</math> annual mean</b>
<b>PM<sub>2.5</sub>:</b>	24 (24-hour mean)	10
<b>PM<sub>10</sub></b>	50 (24-hour mean)	20
<b>SO<sub>2</sub></b>	20 (24-hour mean)	
<b>NO<sub>2</sub></b>	200 (1 hour mean)	40
<b>CO</b>	7000 (24 hour mean)	
<b>HC</b>		17 (life time)

- Particulate Matter(PM)= 50mg/ m<sup>3</sup>
- Hydro carbons 180ppm v/v = 125 mg/m<sup>3</sup>
- CO - 105ppm v/v
- TSP – 50 mg/ m<sup>3</sup>

### 3.2 Air pollution Model

Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model, the computer-based air pollution modelling package used for Modeling can provide an accurate representation of air pollution levels. The HYSPLIT is a system for computing both simple air parcel trajectories and complex dispersion and deposition simulations. In this case the model calculation method is a hybrid between the Lagrangian approach, which uses a moving frame of reference as the air parcels move from their initial location, and the Eulerian approach, which uses a fixed three-dimensional grid as a frame of reference.

The pollutant concentrations are calculated on a fixed grid. Simulation output results are complex air pollution concentration contour patterns. Calculations are performed on ground based data, archive meteorological data from the runs the Global Data Assimilation System (GDAS) ran 4 times a day, i.e., at 00, 06, 12, and 18 UTC. The GDAS is ran by United States National Weather Service's National Centers for



Environmental Prediction (NCEP). NCEP post-processing of the GDAS converts the data from spectral coefficient form to 1 degree latitude-longitude (360 by 181) grids and from sigma levels to mandatory pressure levels. The archive data file contains the data in synoptic time sequence, without any missing records. Therefore it is possible to position randomly to any point within a data file.

Wind circulation patterns determine the transport and dilution of air pollutants. The Site of the proposed power plant is characterized by four weather seasons which dictate the dispersion and transport of pollutant patterns over the site through the distinct wind pattern. Assumed representative dates for each season were chosen as follows, and their corresponding wind frequency patterns computed using wind rose:

**Table 2: Selected Representative Days for the Four Seasons at the Proposed Site**

Season	Months	Representative days
Hot season	Dec. – Feb (DJF)	Jan 8, 2010
Long rain	March - May (MAM)	April 8, 2010
Cold season	June – Aug. (JJA)	July 8, 2010
Short Rains	September – November (SON)	Oct 8, 2010

### 3.3 Dispersion Calculation

The Hysplit model is a hybrid technique to compute pollution dispersion using both Lagrangian and Eulerian approaches. A Lagrangian model can compute air concentrations through either of two assumptions. In a puff model, the source is simulated by releasing pollutant puffs at regular intervals over the duration of the release. Each puff contains the appropriate fraction of the pollutant mass. The puff is advected according to the trajectory of its center position while the size of the puff (both horizontally and vertically) expands in time to account for the dispersive nature of a turbulent atmosphere. In a Lagrangian particle model, the source can be simulated by releasing many particles over the duration of the release. In addition to the advective motion of each particle, a random component to the motion is added at each step according to the atmospheric turbulence at that time. In this way a cluster of

particles released at the same point will expand in space and time simulating the dispersive nature of the atmosphere. In a homogeneous environment the size of the puff (in terms of its standard deviation) at any particular time should correspond to the second moment of the particle positions. A hybrid approach is incorporated into this version of the model, in which the calculation uses particle dispersion in the vertical direction and puff dispersion in the horizontal. Regardless of which approach is used, stability and mixing coefficients are computed from the meteorological data.

#### 4. BACKGROUND AIR POLLUTION CLIMATE

The background pollution levels are assumed to be very low. This is because the proposed site is in a rural setting, many kilometers away from any major pollution source.

#### 5. SIMULATED AIR POLLUTION LEVELS

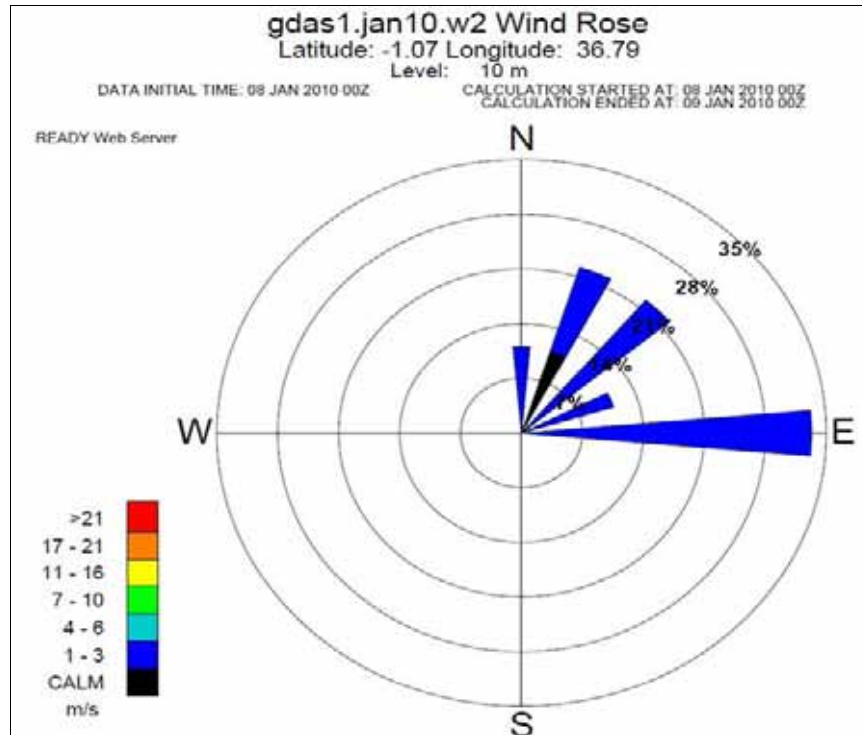
##### 5.1 Wind patterns

The prevailing wind speed is a determinant of the location and spread of air pollution from any source. The frequency distribution of wind speed and direction is analyzed using Frequency wind rose. The wind Roses representing the four seasons within the period January 2010 to December 2010 illustrate the frequency of the prevailing wind speed and direction during each of the seasons. Figures 1 to 4 may be summarized as follows:

**Table 3: Frequency of the Prevailing Wind at the Proposed Site**

Season	Prevailing wind direction (frequency)	Prevailing wind speed (m/s)
Short rains	East South East (ESE)	1-3
Hot	East North East (ENE)	1-3
Long rains	East North East (ENE)	1-3
Cold	East North East (ESE)	1-3

Figures 1a to 1d illustrate Frequency Wind Roses computed using gridded model data for the location of the plant within the meteorological model domain. Wind

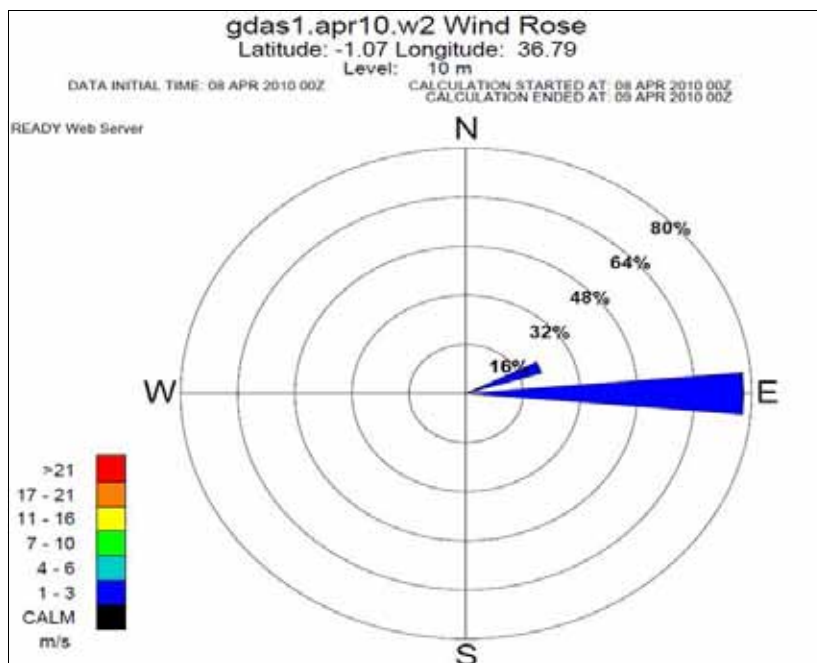


**Figure 1a : Frequency wind rose for January 8, 2010**

roses typically show the frequency of wind direction at a single location on a 16-point compass over an extended period of time. In addition, rings are plotted that represent the wind speed frequency for seven wind speed classes identified by color. The wind rose can be helpful in predicted when conditions might be favorable for poor air quality episodes at the location given that certain wind directions and speeds transport more pollutants to an area than other wind directions and speeds. It may be observed from the four wind roses that the plant will transport and disperse air pollutants to the Southwest and Northwest sectors of the plant.

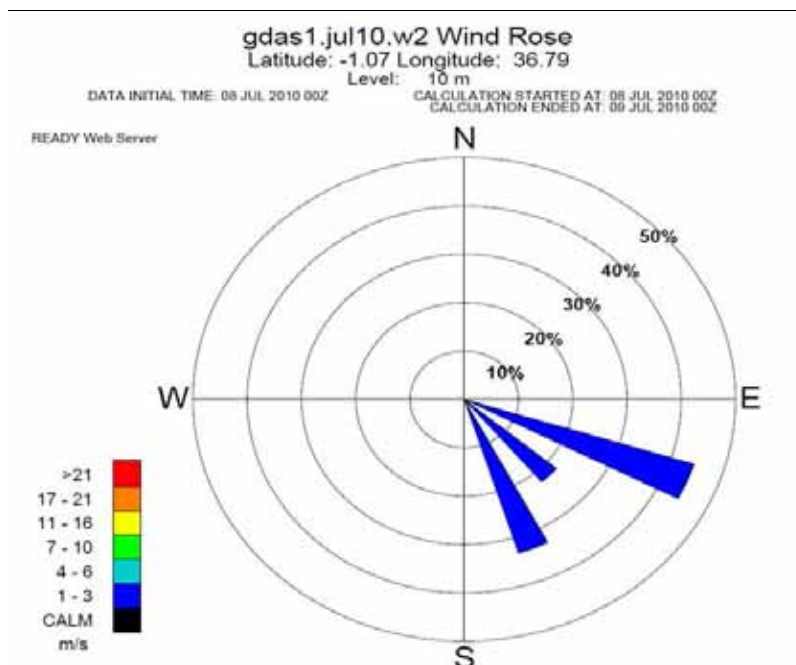
Figure 1a indicated that the Hot season centered around January is characterized by North easterly winds. This implies that the sector to the north east of the proposed site is expected to receive virtually no air pollutants from the plant. On

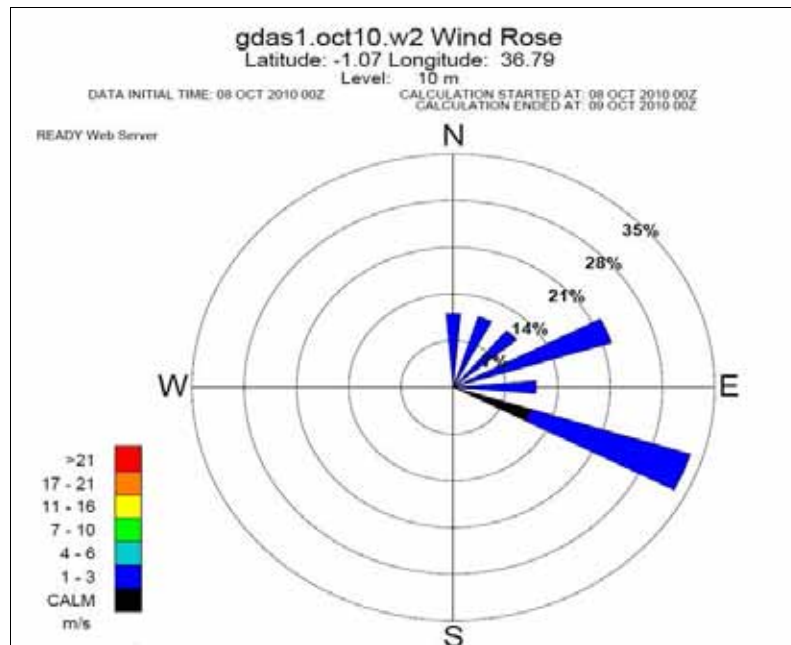
the centrally, the South western sector would receive maximum concentration during this season



**Figure 1b: Frequency wind rose for April 8, 2010**

The long rains season experiences easterly winds as shown in Figure 1b. therefore, the western sector of the plant will experience maximum air pollution deposition during this season.

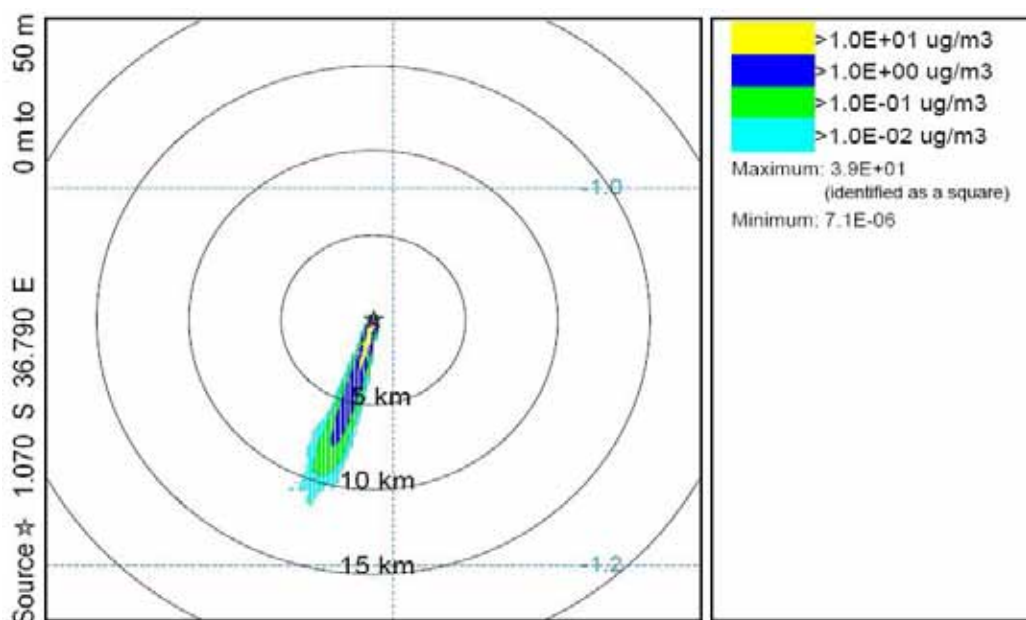


**Figure 1c: Frequency wind rose for July 8, 2010****Figure 1d: Frequency wind rose for October 8, 2010**

It may be noted that the eastern sector of the proposed plant will not significantly be exposed to the effluents from the plant in view of the prevailing wind direction for all the four seasons. Therefore the residents of the Witeithie village, situated to the south east of the proposed site, will not be affected by air pollution emitted from the plant.

## 5.2 Air pollutants

Four scenarios are simulated for each pollutant, namely: the dispersion and transport patterns of the given pollutant for a representative day of each of the four seasons indicated in Table 2 above. A continuous emission of any of the pollutants from the plant would spread generally westward of the plant to a distance of about 10 kilometers. An example of such spread is given by Figures 2a-2d, showing the dispersion and transport patterns of SO<sub>2</sub>.



**Figure 2a: Dispersion patterns of SO<sub>2</sub> in January 2010**

A continuous release of 1050 mg/ m<sup>3</sup> of SO<sub>2</sub> by the plant would result to a spread of the pollutants towards the south west (Figure 2a) to a distance of about 10 km. The levels of the pollutant concentration vary steadily and are within the accepted WHO standards.

The prevailing wind during the long rains season renders the plume to disperse westwards of the plant site (Figure 2b). The spread also reaches a distance of about 10 km and the concentrations are within the acceptable limits.

Figure 2c shows that during the cold season of June to August, the air pollutants are dispersed to the north west in line with prevailing wind. However, the spread is less than 10 km far from the plant. Figure 2d shows even a more diminished pattern in that the pollutants do not spread beyond 2 km. The concentrations as different distance are the subject on the next discussion.

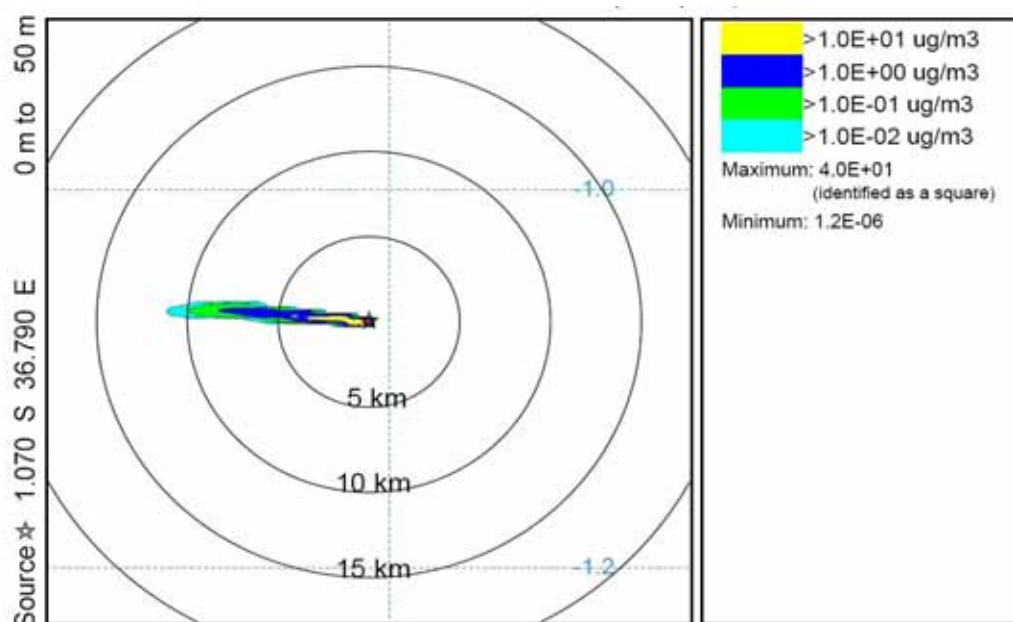


Figure 2b: Dispersion patterns of SO<sub>2</sub> in April 2010

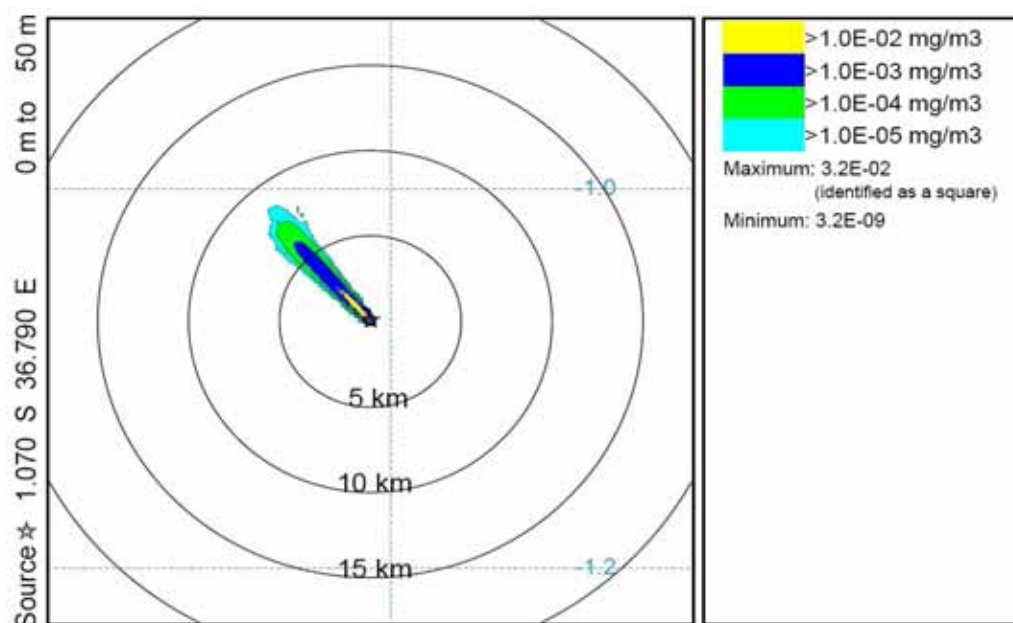
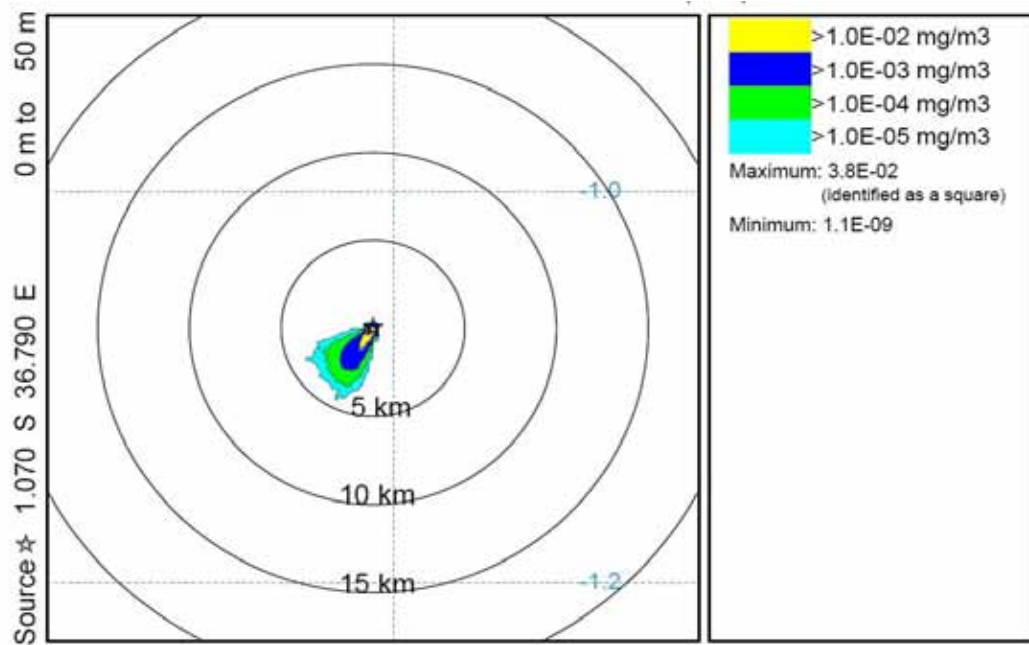


Figure 2c: Dispersion patterns of SO<sub>2</sub> in July 2010



**2d: Dispersion patterns of SO<sub>2</sub> in October 2010**

**Figure 2: Dispersion Patterns of SO<sub>2</sub> in All the Four Seasons.**

The source strength is 3,780,000 mg/m<sup>3</sup>, averaged over 100m. Continuous emission is computed by integrating from 0300 08 to 0400 (UTC) with the release starting at 0300 (UTC).

The Table 4 below presents a summary of the results from the different scenarios. For each scenario, the maximum level Centre line concentration is shown;

It is noted from Table 4 that the emissions are higher the closer one gets to the proposed plant. However, the levels are far below the WHO limits. The concentrations do not go above 2µg/m<sup>3</sup> at the surface around the plant, within a radius of the entire 10 km affected by the emissions. This implies that the good air quality in the vicinity of the proposed site will not be compromised by the plant's operations



**Table 4 Model Calculations of Maximum Centre Line Pollutants Concentration**

Pollutant	Season	Centre Line Concentration (mg/m <sup>2</sup> /S) at the Ground Level Downwind at Distance					
		500m	1km	5km	10km	15km	20km
CO	October	1x10 <sup>0</sup>	1x10 <sup>-1</sup>	0	0	0	0
	July	1x10 <sup>0</sup>	1x10 <sup>-1</sup>	1x10 <sup>-1</sup>	0	0	0
	April	1x10 <sup>0</sup>	1x10 <sup>0</sup>	1x10 <sup>-1</sup>	1x10 <sup>-3</sup>	0	0
	January	1x10 <sup>0</sup>	1x10 <sup>0</sup>	1x10 <sup>-1</sup>	1x10 <sup>-3</sup>	0	0
NO	October	1x10 <sup>1</sup>	1x10 <sup>0</sup>	0	0	0	0
	July	1x10 <sup>1</sup>	1x10 <sup>1</sup>	1x10 <sup>0</sup>	0	0	0
	April	1x10 <sup>2</sup>	1x10 <sup>1</sup>	1x10 <sup>1</sup>	1x10 <sup>-1</sup>	0	0
	January	1x10 <sup>1</sup>	1x10 <sup>1</sup>	1x10 <sup>0</sup>	1x10 <sup>-2</sup>	0	0
HC	October	1x10 <sup>0</sup>	1x10 <sup>-1</sup>	0	0	0	0
	July	1x10 <sup>0</sup>	1x10 <sup>0</sup>	1x10 <sup>-1</sup>	0	0	0
	April	1x10 <sup>-0</sup>	1x10 <sup>-0</sup>	1x10 <sup>-1</sup>	1x10 <sup>-3</sup>	0	0
	January	1x10 <sup>-0</sup>	1x10 <sup>-0</sup>	1x10 <sup>-1</sup>	1x10 <sup>-3</sup>	0	0
SO <sub>2</sub>	October	1x10 <sup>1</sup>	1x10 <sup>1</sup>	0	0	0	0
	July	1x10 <sup>1</sup>	1x10 <sup>1</sup>	1x10 <sup>0</sup>	0	0	0
	April	1x10 <sup>1</sup>	1x10 <sup>1</sup>	1x10 <sup>0</sup>	1x10 <sup>-2</sup>	0	0
	January	1x10 <sup>1</sup>	1x10 <sup>1</sup>	1x10 <sup>0</sup>	1x10 <sup>-2</sup>	0	0
TSP	October	1x10 <sup>-1</sup>	1x10 <sup>-1</sup>	0	0	0	0
	July	1x10 <sup>-1</sup>	1x10 <sup>-1</sup>	1x10 <sup>-1</sup>	0	0	0
	April	1x10 <sup>0</sup>	1x10 <sup>-1</sup>	1x10 <sup>-1</sup>	1x10 <sup>-3</sup>	0	0
	January	1x10 <sup>-1</sup>	1x10 <sup>-1</sup>	1x10 <sup>-1</sup>	1x10 <sup>-3</sup>	0	0

## **6. CONCLUSION**

Supplied and modeled data has been reviewed and analyzed, air pollution levels have been modelled, and the air pollution impacts of the new plant on the surrounding area have been simulated using a computer based 2-D model. It is predicted that, provided the source strength provisions in the project specifications are complied with, air pollution levels will not exceed WHO guidelines at the western sector of the plant while the eastern sector will not be adversely affected by the plant. Air pollution levels are therefore predicted to comply with all applicable legislative requirements. Air pollutant concentrations should be measured at monitoring sites that are representative of population exposures. Air pollution levels may be higher in the very close vicinity of specific sources of air pollution from power plants, especially on the western sector of the plant, and so protection of populations living in such locations may require special measures to bring the pollution levels to below the guideline values.

## **Appendix 3.3 Noise Level Simulations**

### **1. SCOPE OF STUDY**

The site will be required to comply with noise level limits, which are discussed below. This assessment aims to

- (iv) Model existing noise levels after the proposed installation of a medium speed diesel (MSD) thermal plant to generate 80 MW of electricity at the site at Thika, putting into consideration the pre-installation noise levels
- (v) Verify compliance with the limits, and
- (vi) Provide the operator with sound level simulation maps of the site and adjoining area within a radius of 10 km for mitigation purposes. This will help quantify the requisite mitigation measure.

### **2. ASSESSMENT CRITERIA**

#### **2.1 National Noise Standards**

The Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations, 2009 sets out maximum permissible noise levels in the First schedule of the Regulation for various zones (Table 1).

### **3. METHODOLOGY**

#### **3.1 Supplied Data**

The Figure 1 below has been supplied by manufacturer of the plant. The projected noise levels have a maximum level depicted by the blue color, reaching about 75 dB.

#### **3.2 Noise pollution modeling**

The noise sources from the proposed plant could be considered as being made up from a line of point sources for each of which the inverse square law applies. The line is considered to run across the blue shaded strip of the plant (Figure 1 above). The blue strip is characterized by production of 75 dB of noise. Assuming that the line is radiating in cylindrical form, then the surface

area of a cylinder is proportional to its radius. Sound intensity will therefore decrease directly with distance from a line source.

**Table 2 : Maximum permissible noise levels**

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

**Time Frame**

Day: 6.01 a.m. – 8.00 p.m. (Leq, 14 h)

Night: 8.01 p.m. – 6.00 a.m. (Leq, 10h)

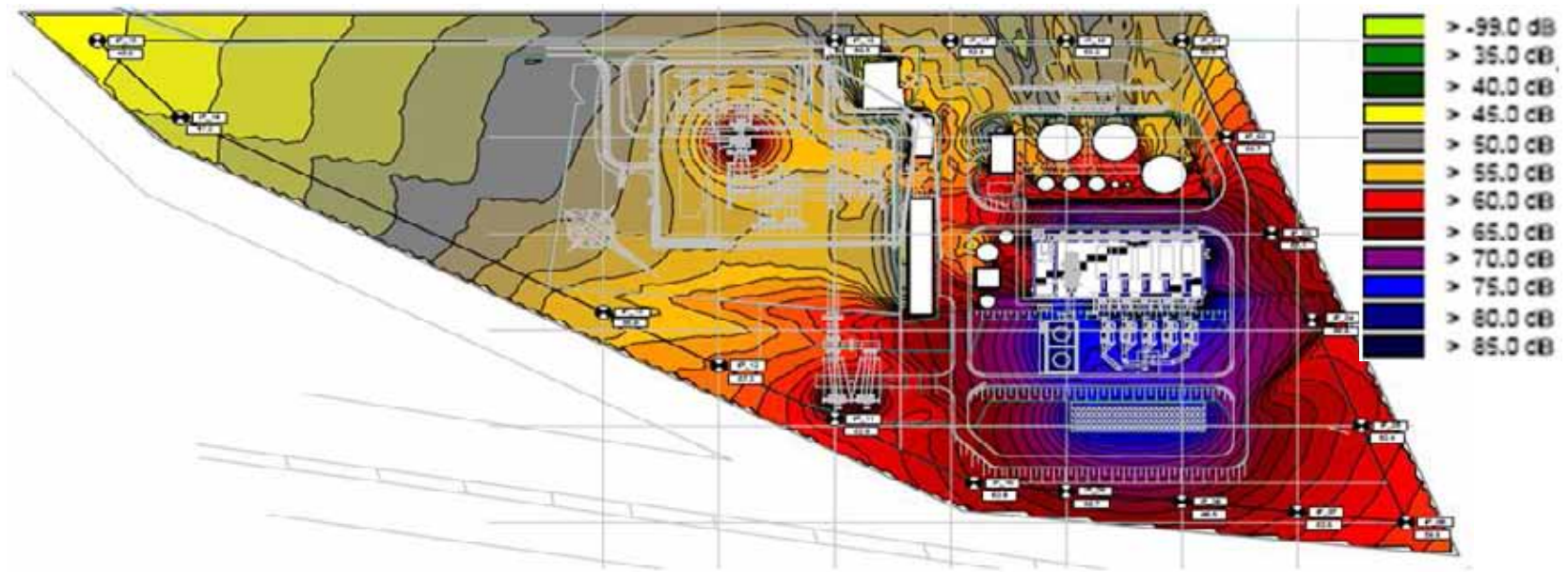
Since the surface area of a cylinder of radius  $r$  and length  $l$  is  $2\pi rl$ , it can be proved that the ratio of sound intensity level for two perpendicular distances  $R$  &  $r$  from the line is given by :

$$L_r - L_R = 10 \log_{10} (R/r)$$

If  $R = 2r$ , then

$$\begin{aligned} L_r - L_{2r} &= 10 \log_{10} (2) \\ &= 3dB \end{aligned}$$

.(1)



**Figure 1 Manufacturer Supplied Noise Levels Assuming Zero Background Noise**

It can be seen that there is only 3 dB reduction for a doubling of the distance from the line source. The noise levels are modeled by putting in cognizance the supplied information.

### 3.3 Noise Calculations

Power house walls and roof will be made of 100 kg/m<sup>3</sup> rock wool panels with a 12cm thickness and 0.7mm steel sheet from both sides. According to the supplier, 8cm thickness of rock wool panels attenuates the noise by 35dB, therefore the maximum noise will be equivalent to the arithmetic difference between 75 dB and 35 dB.

The difference would otherwise be computed as follows:

Let the subscripts t, b, and s represent the total, background, and the source, respectively. Then,

$$L_{p,b} = 10 \log_{10} (P_b / P_o)^2$$

$$L_{p,s} = 10 \log_{10} (P_s / P_o)^2$$

and

$$L_{p,t} = 10 \log_{10} [\log^{-1} (L_{p,b} / 10) + \log^{-1} (L_{p,s} / 10)] \quad (2)$$

Re-arrange Equation (2),

$$\log^{-1} (L_{p,t} / 10) = \log^{-1} (L_{p,b} / 10) + \log^{-1} (L_{p,s} / 10)$$

or,

$$L_{p,s} = 10 \log_{10} [\log^{-1} (L_{p,t} / 10) - \log^{-1} (L_{p,b} / 10)] \quad (3)$$

Therefore, the supplied noise level data at each grid point of the plant is recalculated using equation 3 above.

#### 4. BACKGROUND NOISE CLIMATE

The noise levels before installation of the plant are summed with the expected noise levels after the installation. This is done as follows:

For the addition of the 2 sound pressure levels, the total sound pressure level ( $L_{pt}$ ) is given by:

$$L_{pt} = 10 \log_{10} \left[ \sum_{i=1}^n \log^{-1} (L_{pi}/10) \right] \quad (4)$$

#### 5. SIMULATED NOISE LEVELS

##### 5.1 Wind patterns

The prevailing wind speed spatial distribution of air noise from any source. The frequency distribution of wind speed and direction is analyzed using Frequency wind rose. The wind Roses representing the four seasons within the period January 2010 to December 2010 illustrate the frequency of the prevailing wind speed and direction during each of the seasons. Figures 1 to 4 may be summarized as follows:

**Table 3 Frequency of the prevailing wind at the proposed site**

Season	Prevailing wind direction (frequency)	Prevailing wind speed (m/s)
Short rains (Oct. – Dec.)	East South East (ESE)	1-3
Hot (Jan. - Feb.)	East North East (ENE)	1-3
Long rains (March – May)	East North East (ENE)	1-3
Cold (Jun.- Aug.)	East North East (ESE)	1-3

Figures 1a to 1d show the Frequency Wind Roses computed using gridded model data for the location of the plant within the meteorological model domain. Wind roses typically show the frequency of wind direction at a single location on a 16-point compass over an extended period of time. In addition, rings are plotted that represent the wind speed frequency for seven wind speed classes identified by color. The wind rose can be helpful in projecting the spread of noise from the line source.





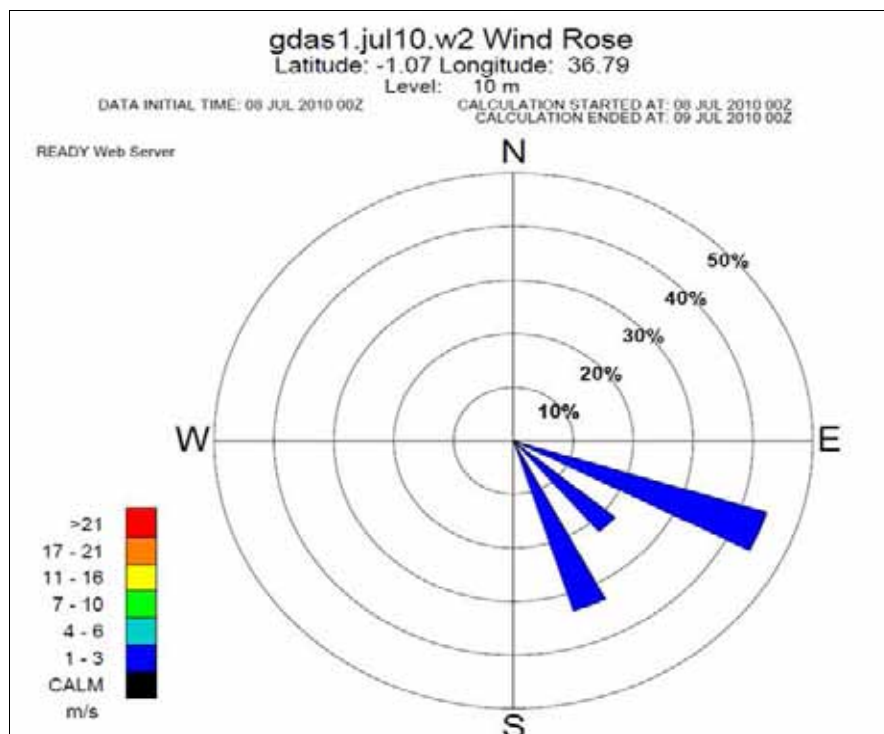


Figure 1c: Frequency Wind Rose for July 8, 2010

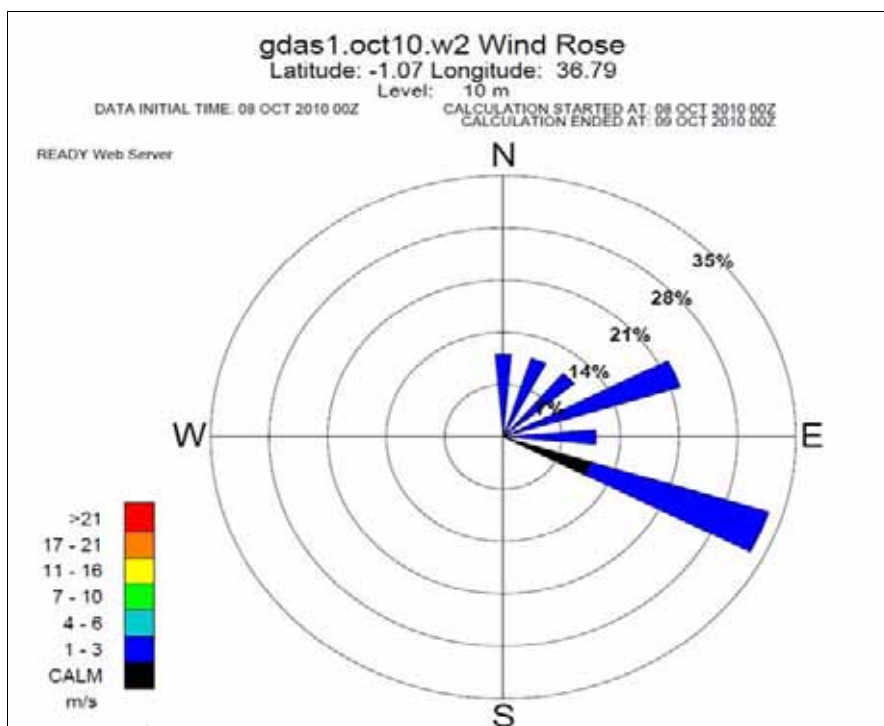


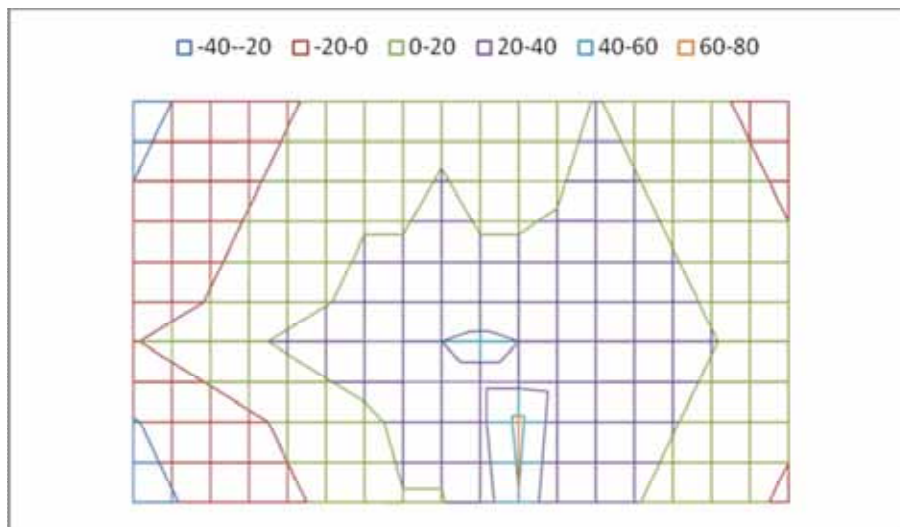
Figure 2d: Frequency Wind Rose for October 8, 2010

It may be noted that the eastern sector of the proposed plant will experience significantly less noise pollution in view of the prevailing wind direction for all the four seasons. Therefore the residents of the Witeithie village, situated to the south east of the proposed site, will not be affected by noise emitted by the plant.

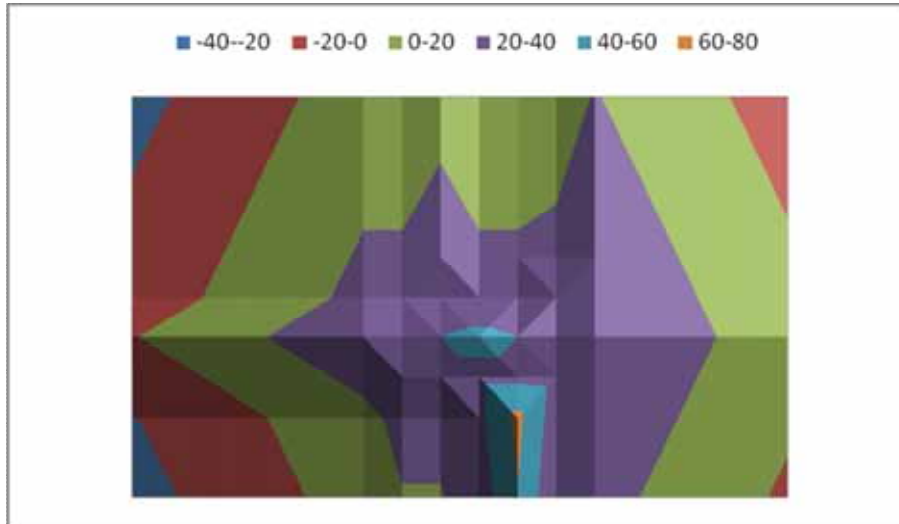
## 5.2 Noise level simulations

The net noise level, after accounting for the sound filtration and pre-installation noise as explained above, is simulated using equation (1) above. A line 200m long and running across the blue strip in Figure 1 is assumed to be the line source of the noise. The cylindrical noise distribution around this line is calculated (Figure 3).

It is observed from Figure 3 that an area of about 1/2 hectare centered around the line source will be characterized by noise levels ranging from 40 – 60 dB. However, the rest of the surrounding area will experience noise levels which are within the limits.



**Figure 3a Limits Simulated Noise Levels around the Proposed Site**



**Figure 3b Zones of Simulated Noise Levels around the Proposed Site**

Figure 3a and 3b: Simulated noise levels around the proposed site. The values are in dB with the centre of the graph being the line source representing the blue strip in Figure 1 above. Figure 3b is a full colour representation of the scenarios.

## 6. CONCLUSION

The spatial noise distribution meets the Kenyan Regulatory Noise standards within the environs of the facility. However, within the facility the noise levels may occasionally tend to almost exceed the limits especially under stable atmospheric conditions at night. This would require the necessary mitigation measures.

### **Appendix 3.4 Soil Analysis and Results**

#### **METHODOLOGY**

##### **Extraction Method**

10g of the soil were weighed and extracted with 100ml of acetone for 30 min on a shaker. The extract was filtered and concentrated on a rotary vacuum evaporator to 5 ml. aliquot of 1.0 µl of this concentrate was injected into the GC for Total Petroleum hydrocarbons (TPH) determination and 20 µl used for HPLC determination of Toluene and Benzene.

##### **GC Conditions**

Column: Glass Packed With Dega 15%

Injection/Detector Temp.: 220°C

Column Temp. Prog.:

Column Initial Temp. 50 °C

Column Initial Time 2.0 Min

Column Prog.Rate: 5 °C Per Min

Column Final Temp.: 200 °C

##### **HPLC Conditions**

Column: Wakosil C18, 4.6 X250 Mm

Mobile Phase: Acetonitrile: Water 60/40

Uv Detector At 254nm



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TEL. 067-52711 EXT. 4420

10<sup>th</sup> December, 2010

Our Ref. JKU/FST/020/072

Dr. Gatari  
University of Nairobi  
Dept of Nuclear Centre  
P.O. Box 29053-00625  
Nairobi

**RE: CERTIFICATE OF ANALYSIS OF HYDROCARBONS, BENZENE AND  
TOLUENE**

The table below shows the results of Laboratory analysis of soil samples as per your request. Total Hydrocarbons was done by Gas Chromatography and Benzene/Toluene was done by Liquid Chromatography.

S/No	Parameter	Sample Identity					
		Loc. A	Loc. B	Loc. C	Loc. E	Loc. D	Loc. F
1	Total Hydrocarbons (µl/g)	0.1	0.1	0.1	0.1	0.4	0.1
2	Benzene (µg/g)	nd	nd	nd	nd	nd	nd
3	Toluene (µg/g)	22.1±0.2	20.4±0.1	14.5±0.3	13.6±0.2	17.9±0.4	14.6±0.3

**KEY:**

nd: means not detected

Analyst-In-Charge: P.N. Karanja Signed:  Date: 10-12-2010

Checked by: Prof. G.M. Kenji Signed:  Date: 14-12-2010

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### Appendix 3.5 Water Quality Report

Physical and chemical water quality analyses were conducted on a sample from Komu and Ndarugu Rivers in the vicinity of the proposed Thika Thermal Power Plant at the University of Nairobi Public Health Engineering Laboratories. Analysis was carried out using standard methods.



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KENYA

#### ANALYSIS ON WATER SAMPLES CHEMICAL ANALYSIS FOR WATER SAMPLES

SAMPLE DESCRIPTION: **Komu River - Thika**

SAMPLED BY: **CLIENT**

PARAMETER	RESULT	REMARKS
pH	7.40	
APPARENT COLOUR, °H	270	
TRUE COLOUR, °H	250	
CONDUCTIVITY, µS/cm	425	
TURBIDITY, F.T.U	53	
CALCIUM HARDNESS AS CaCO <sub>3</sub> , mg/ l	11	
TOTAL HARDNESS as CaCO <sub>3</sub> , mg/ l	19	
TOTAL ALKALINITY as CaCO <sub>3</sub> mg/ l	141	
CARBONATE ALKALINITY, Mg / l	0	
IRON, mg/ l	1.6	
FLUORIDES, mg/ l	0	
SULPHATES, mg/ l	100	
PHOSPHATES, mg/ l	0.02	
SILICA, mg/ l	150	
Dissolved Oxygen, P.M.M.	4.0	
Nitrates, mg/l	0.7	
Manganese, mg/l	0	
CHLORIDES, mg/ l	130	
CHROMIUM, mg/ l	0.04	
COPPER, mg/ l	0.03	
AMMONIA mg/L	-	
NITRITES mg/L	-	
DISSOLVED SOLIDS, mg/ l	520	
SUSPENDED SOLIDS, mg/ l	120	
TOTAL SOLIDS, mg/ l	700	
BIOCHEMICAL OXYGEN DEMAND, mg/ l	-	
CHEMICAL OXYGEN DEMAND, mg/ l	-	
RESIDUAL CHLORINE mg/ l	-	



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KENYA

**CHEMICAL ANALYSIS FOR WATER SAMPLES**

**SAMPLE SOURCE & DESCRIPTION:**

RIVER WATER - NDAUUGU

**SAMPLED BY:** CLIENT

**CLIENT:**

PARAMETER	RESULT	REMARK
pH	7.26	
APPARENT COLOUR °H	80	
TRUE COLOUR °H	70	
CONDUCTIVITY $\mu\text{S}/\text{CM}$ , mg/l	72	
TURBIDITY, F.T.U	45	
CALCIUM HARDNESS AS $\text{CaCO}_3$ , mg/l	8	
TOTAL HARDNESS AS $\text{CaCO}_3$ , mg/l	20	
TOTAL ALKALINITY AS $\text{CaCO}_3$ , mg/l	30	
CARBONATE ALKALINITY, mg/l	0	
IRON, mg/l	0.2	
FLUORIDES, mg/l	0.1	
SULPHATES, mg/l	30	
PHOSPHATES, mg/l	0.02	
SILICA, mg/l	20	
DISSOLVED OXYGEN, p.p.m	5.5	
NITRATES, mg/l	40	
MANGANESE, mg/l	0	
CHLORIDES, mg/l	39	
CHROMIUM, mg/l	0	
COPPER, mg/l	0.02	
TOTAL COLIFORM/100ml	-	
TOTAL FAECAL COLIFORM/100ml	-	
DISSOLVED SOLIDS, mg/l	120	
SUSPENDED SOLIDS, mg/l	40	
TOTAL SOLIDS, mg/l	160	
BIOCHEMICAL OXYGEN DEMAND, mg/l	-	
CHEMICAL OXYGEN DEMAND, mg/l	-	
RESIDUAL CHLORINE, mg/l	-	
GENERAL REMARKS use.		

Results indicate significant colour, turbidity, conductivity and solids (total and dissolved) which is characteristic of the type of strata and organic matter it traverses. However, the observed hardness is not significant and the water may be classified as moderately soft (50 - 100 as  $\text{CaCO}_3$  mg/l) mainly calcium hardness. The water shows very low concentrations of nutrients (phosphate and nitrates) suggesting limited contamination from agricultural sources. Similarly, the water had low concentrations of metals such as copper, manganese, iron and chromium indicating absence of industrial pollution. These results will form part of the baseline conditions.

### **Appendix 3.6 Traffic and Transport**

#### **Introduction**

The project site is located 38 km north east of Nairobi along the Nairobi - Thika Highway along Most vehicular traffic to the site is expected to follow the Nairobi – Thika Highway except possibly for disposal of excavated material and supply of quarried construction material. The pre-construction traffic the Nairobi – Thika Highway comprises personal cars, commuter vehicles, and trucks ferrying goods and farm produce to and from the Nairobi to the Central Kenyan Region. The type of vehicular traffic of concern expected during the construction, operation and decommissioning stages is as follows:

#### **Construction**

1. Heavy construction equipment delivery trucks
2. Excavated materials disposal trucks
3. Materials delivery trucks
4. Heavy plant haulage trucks

#### **Operation**

1. HFO Fuel delivery trucks

#### **Decommissioning**

1. Heavy construction equipment delivery trucks
2. Demolition waste haulage trucks
3. Heavy plant haulage trucks

The impacts from this traffic and recommended mitigation measures are discussed here below.

### **Issue I: Transport of HFO, Supplies and Waste**

#### **Impact 1: Disruption of traffic along the main HFO transport route**

The impact of one tanker per hour (in each direction) varies according to the position along the route. To deal with a linear impact it is necessary to take the area in which



the highest impact is to occur, namely the area nearest the Nairobi City Centre. The section has the highest volume of traffic and most serious congestion problems.

Hourly traffic for the Nairobi-Thika Highway in 2009 at Ruaraka, about 10 k m from the Nairobi Central Business District is shown in Figure A3.5. The total vehicular traffic varies between 1000 and 3000 vehicles per hour. Heavy vehicles that include commuter vehicles or Matatus, buses and trucks are relatively constant throughout the day varying 600 and 1200 vehicles per hour. Delivery of heavy fuel oil to the proposed power plant will generate about one heavy truck per hour while waste and supplies may generate one truck each per week. Therefore, it is evident that operation of the power plant will not have significant impact on the traffic on the Nairobi – Thika Highway.

Mitigation measures that could be incorporated to ensure a continued limited impact include the use of transport routes outside peak times and normal working hours. Hence to ensure minimal impact from other plant related traffic, vehicle movements should be planned to coincide with off-peak periods.

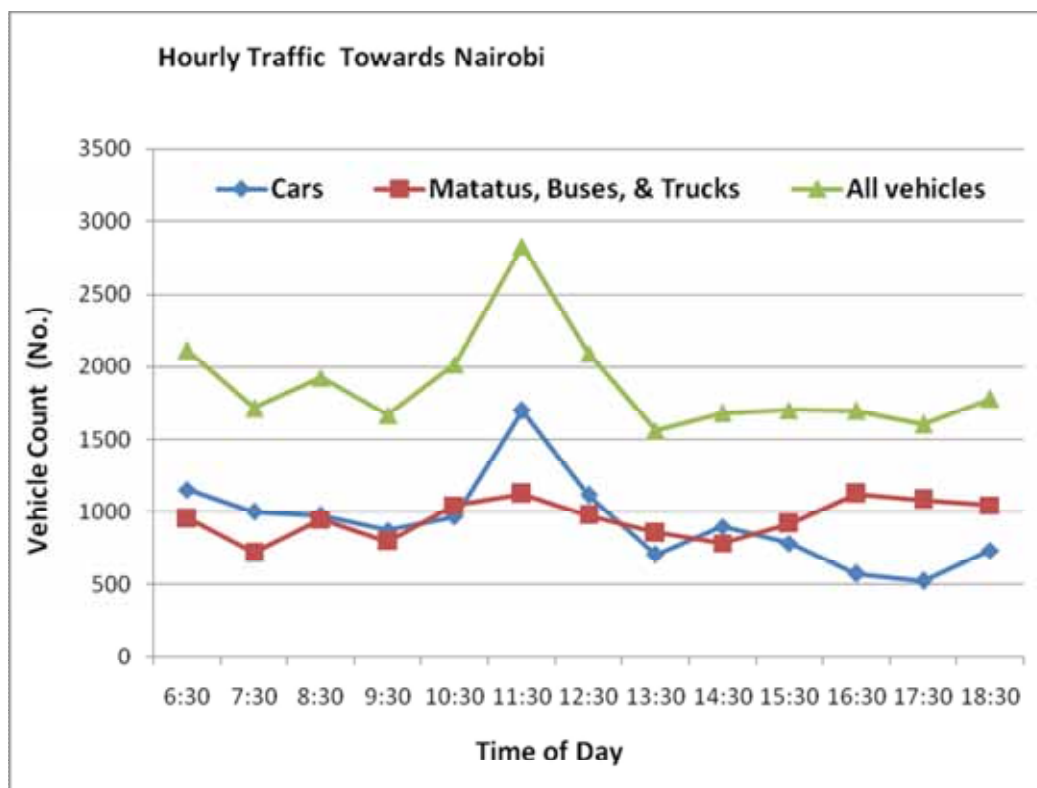
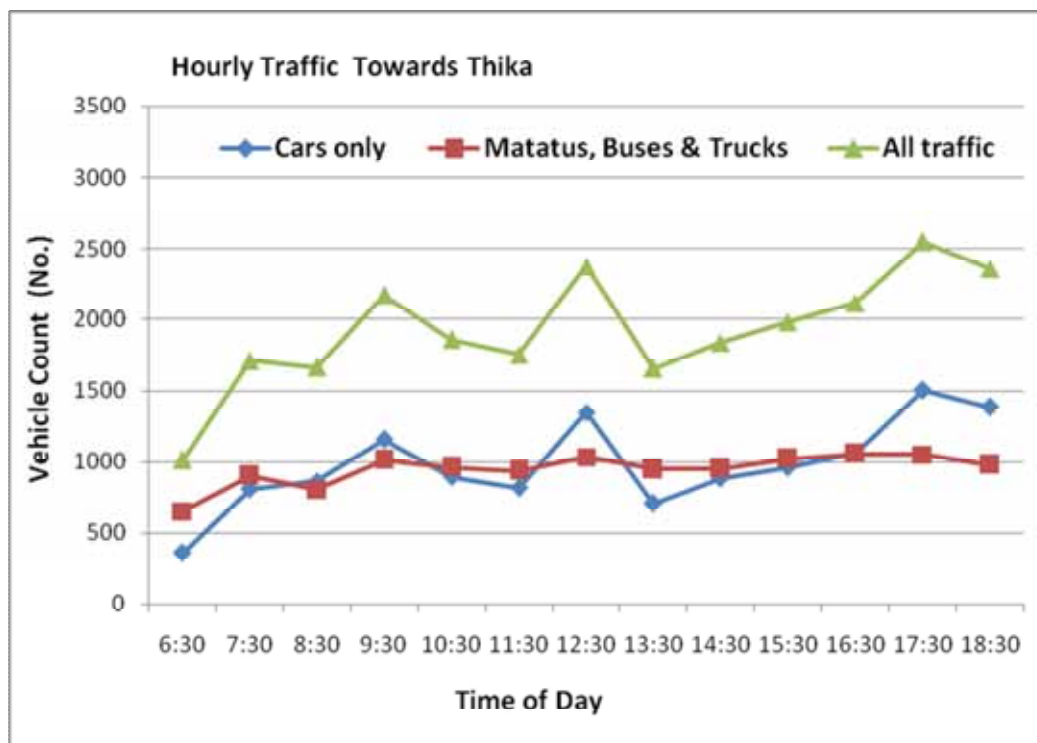
#### **Impact 2: Damage of road network from the junction to the site**

The transport of FHO will require one truck in each direction every hour, this may cause some damage to the present road network.

Mitigation measures to reduce the potential damage to the roads include the use of appropriate vehicles for transportation. Axle loads must be within the Kenya legislation and within the design limits of the road surfaces. Drivers and machinery operators should aim to stick within the prescribed speed limits and drive conservatively.

#### **Impact 3: Risk of Accidents and Injury or loss of life**

There is high incidence of traffic accidents in Kenya, mostly as results of *matatus* and *boda boda* (public transport) and careless pedestrians. The route from the junction to the site passes through a number of built up residential areas and past factories. There is high risk of traffic accidents during the life of the plant.



**Figure A3.5 Nairobi - Thika Highway Hourly Traffic at Ruaraka on 09/07/2009**

Mitigation measures to reduce the potential for traffic accidents should include the enforcement of strict speed limits. There should be driver testing and training to ensure the highest level of skills. Use should be made of traffic calming / control measures such as speed bumps and rumble strips in areas of high risks. Traffic warning signs should be erected at strategic locations. Vehicles should wherever possible restrict movement to off peak periods.

#### **Impact 4: Production of fugitive dust from road entrance**

The constant flow of traffic at the junction to the site (1.3 km) will cause entrainment of fugitive dust.

Three types of measures may be taken to reduce emissions from the unpaved road access road: (a) measures aimed at reducing the extent of unpaved roads e.g. paving, (b) traffic control measures aimed at reducing the entrainment of material by restricting traffic volumes and reducing vehicle speeds and (c) measures aimed at binding the surface material or enhancing moisture retention, such as wet suppression and chemical stabilization (EPA, 1987).

#### **Impact 5: Impact on ecological function**

The constant movement of tankers, particularly at night has the potential to impact on the local ecology. A large number of animals are killed at night as they cross roads under dynamic traffic. Reptiles and birds are particularly prone to this impact.

Mitigation to prevent animal mortality includes; driver training, reduced speeds, alertness and general awareness.

### **Issue II: Pollution from Tanker Traffic**

#### **Impact 1: Impact of noise on human health**

The noise associated with 30 ton tankers has the potential to impact on human health. Movement of heavy vehicles at night may impact heavily on the sleeping patterns of local community.

There are standard mitigation measures to ensure that vehicle noise is kept within acceptable limits. Vehicles should be well maintained and serviced with standard exhaust and muffler. Drivers should stick to designated speed limits. Roads should be kept in good conditions.

**Impact 2: Impact of exhaust emissions on human health**

The exhaust emissions associated with HFO tankers has the potential to impact on human health.

There are standard mitigation measures to ensure that vehicle emissions are kept within acceptable limits. Vehicles should be well maintained and serviced with standard exhaust and muffler. Recommended fuels should be used.

## **APPENDIX 4. EIA TERMS OF REFERENCE (TOR)**

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This EIA was required to carry out the following tasks:

1. Establish the suitability of the site for the set up of a MSD Power Plant at Thika.
2. A concise description of the national environmental legislative and regulatory framework, baseline information, and any other relevant information related to the project.
3. A description of the technology, procedures and processes to be used, in the implementation of the project.
4. A description of materials to be used in the construction and implementation of the project, the products, by-products and waste to be generated by the project.
5. A description of the potentially affected environment.
6. Conduct specialized baseline surveys on air, water, soil and noise pollution in the proposed project area.
7. Assessment of ground and surface water sources for the proposed thermal power
8. A description of environmental effects of the project including the social and cultural effects and the anticipated direct, indirect, cumulative, irreversible, short-term and long-term effects.
9. To recommend a specific environmentally sound and affordable wastewater management system.
10. Provide alternative technologies and processes available and reasons for preferring the chosen technology and processes.
11. Analysis of alternatives including project site, design and technologies.

12. Development of an Environmental and Social Management Plan (ESMP) proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment, including the cost, timeframe and responsibility to implement the measures.
13. Provide an action plan for the prevention and management of the foreseeable accidents and hazardous activities in the course of project construction, operation and decommissioning.
14. Propose measures to prevent health hazards and to ensure safety in the working environment for the employees and the neighbouring community.