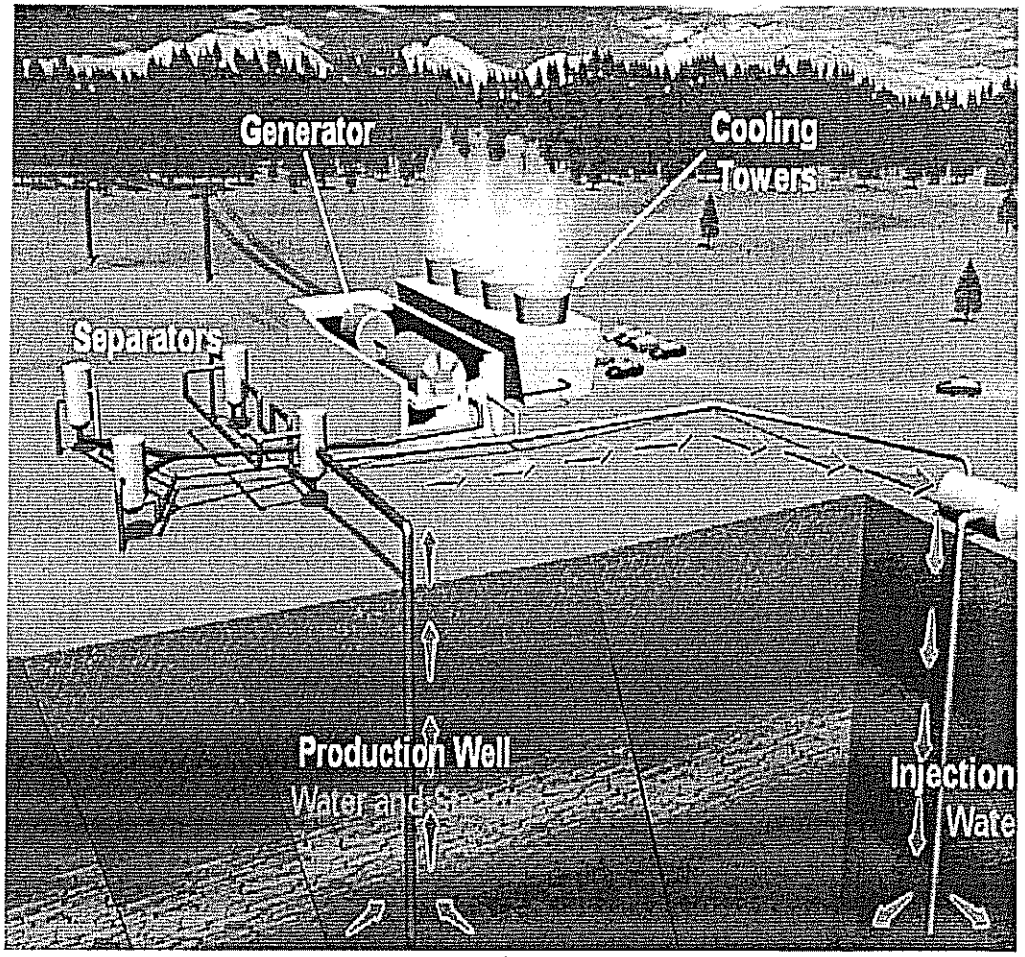
KenGen

Kenya Electricity Generating Company Ltd.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROJECT REPORT



PROPOSED 70 MW OLKARIA I ADDITIONAL UNIT 6 GEOTHERMAL POWER PLANT

FEBRUARY 2013

Proponent:	Kenya Electricity Generating Company Limited (KenGen)
Activity:	Environmental & Social Impact Assessment for the Proposed Construction of 70MWe Olkaria I Additional Unit 6 Geothermal Power Plant
Report Title:	Environmental & Social Impact Assessment Project Report for the Proposed Construction of 70MWe Olkaria I Additional Unit 6 Geothermal Power Plant at the Greater Olkaria Geothermal Field in Naivasha District.

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EXECUTIVE SUMMARY

Kenya Electricity Generating Company (KenGen) is the leading electric power producer in Kenya, producing about 75% of electricity consumed in the country. The company uses various sources to generate electricity ranging from hydro, thermal, wind and geothermal.

The company proposes to construct a 70 MW geothermal power plant in its license area of Olkaria. Olkaria geothermal field is located approximately 120 kilometres from Nairobi, the capital city of Kenya. The proposed project is geared towards meeting the Vision 2030 Governments' Medium Term target of generating 1,600 MWe of geothermal energy by 2016 and eventually 5,000 MWe by 2030 (GoK, 2011). Currently electricity generation from geothermal sources stands at 260MWe hence the need for fast tracking the process

The company has commissioned the undertaking of an environment and social impact assessment for the project in order to meet the legal requirements of section 58 of the Environmental Management and Coordination Act number 8 of 1999. The ESIA is being undertaken by a multidisciplinary team of experts lead by a NEMA registered lead expert. The study will establish the baseline condition, anticipate the potential impacts both positive and negative, consult the stakeholders and propose mitigation measures to make the project environmentally friendly and sustainable.

Nature of the Proposed Project: The proposed project entails construction of a 70 MWe geothermal power plant and the associated infrastructure. The project proponent is Kenya Electricity Generating Company Ltd (KenGen).

Project Location: The proposed project will be located next to Olkaria I Units 4 & 5 which is currently under construction. Administratively, the site is located in Olkaria sub-location, Hell's Gate location, Naivasha division in Naivasha District, Nakuru County.

Components of the Proposed Power Plant: The main power plant system will consist of the following components:

- Production Wells
- Separators
- Steam turbine & generator
- Condenser
- Hot well pump
- Gas extraction system
- Cooling water system- Cooling Tower

Proposed Power Generation Technology: The proposed power plant will use single flash steam cycle technology which is recommended for the high enthalpy resources at Olkaria, i.e. where the enthalpy is in the range of 1800-2000 kJ/kg.

Project Objective: The objective of the proposed project is to contribute towards meeting the growing electricity demand thereby stimulating economic development in line with Vision 2030.

ESIA Objective: The overall objective of Environmental and Social Impact Assessment (ESIA) is to ensure that environmental concerns are integrated in all development activities in order to

contribute to sustainable development. Section 58 of the Environmental Management and Coordination Act of 1999 requires that projects listed in the second schedule of the undergo ESIA, this report has been prepared with the objective of meeting this requirement.

Potential Positive Impacts: The proposed project will result to the following positive impacts:

- Creation of job opportunities during construction & operation phase
- Enhancement of business opportunities during construction phase
- Contribution towards meeting electricity demand by injecting an additional 70MWe to the grid
- Revenue generation through sell of electricity and Clean Development Mechanism (CDM)
- Support of local development through Community Development Carbon Fund (CDCF) for the proposed power plant
- Promotion of direct uses of geothermal energy
- Skills transfer

Public Consultations for the proposed project: Public consultation for the proposed project was achieved by holding three stakeholder consultative meetings mentioned below:

i. Public baraza held at the Maasai Cultural Centre on 19th February 2013
ii. Public baraza held at Kamere Trading Centre on 19th February 2013 and
iii. Key stakeholders meeting held at Olkaria Social hall on 20th February 2013

The stakeholders supported implementation of the proposed project on condition that KenGen was going to implement the Environmental Management Plan.

Environmental Impact Assessment (EIA) License Application Fee: The EIA license application fee to be paid to National Environment Management Authority (NEMA) will be Kenya shillings one million only (Ksh.1,000,000).

Summary of Potential Negative Environmental Impacts and Mitigation Measures: The anticipated negative environmental impacts are those associated with:

- ✓ Dust Emissions during the construction phase
- ✓ Noise hazards
- ✓ Wildlife disturbance
- ✓ Spread of contagious diseases
- ✓ Gaseous emissions
- ✓ Waste generation
- ✓ Increased traffic
- ✓ Land disturbance
- ✓ Accidental spillage of hazardous materials
- ✓ Emission of hydrogen sulphide
- ✓ Generation of solid waste
- ✓ Conflicts arising from the projects
- ✓ Spread of HIV/AIDS
- ✓ General Health & Safety risks
- ✓ Fire risks
- ✓ Loss of vegetation cover

- ✓ Increased water consumption
- ✓ Strain on local infrastructure

The report has incorporated an Environmental Management and Monitoring Plan to mitigate against all the potential negative environmental impacts associated with implementation of the proposed project. Update of the air dispersion model for Olkaria I unit 4 & 5 will be undertaken to include the emissions from the proposed additional power plant.

Note: The project will not result to displacement of people and therefore no resettlement action plan will be required

ACRONYMS

AIDS	Acquired Immunodeficiency Syndrome
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbon
CPP	Consultation & Public Participation
CSR	Corporate Social Responsibility
CT	Current Transformer
CO_2	Carbon dioxide
CH_4	Methane
dB(A)	Decibel Absolute
DC	Direct Current
DEM	Digital Elevation Models
DO	District Officer
ECD	Early Childhood Development
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
EA	Environmental Assessment
EMCA	Environmental Management and Coordination Act
EMS	Environmental Management System
ERC	Energy Regulatory Commission
GDM	Geothermal Development Manager
GoK	Government of the Republic of Kenya
GIS	Geographical Information Systems
GHG	Green House Gas
Ha	Hectares
HF	Hydrogen Fluoride
HIV	Human Immunodeficiency Virus
IAEA	International Atomic Energy Agency
H_2S	Hydrogen Sulphide
ITCZ	Inter Tropical Convergence Zone
ISO	International Organisation of Standardization
IUCN	International Union for Conservation of Natural Resources
KenGen	Kenya Electricity Generating Company Ltd
KEBS	Kenya Bureau of Standards
KWS	Kenya Wildlife Service
KV	Kilo Volt
KeRRA	Kenya Rural Roads Authority
KES	Kenya Shilings
KPLC	Kenya Power and Lighting Company Ltd
KWS	Kenya Wildlife Service
LCPDP	Least Cost Power Development Plan
LNRA	Lake Naivasha Riparian Association
LNGG	Lake Naivasha Growers Group
MD	Managing Director
µg/kg	micro gram per kilogram
MWe	Mega Watt of Electricity
m.a.s.l	Metres above sea level
N_2	Nitrogen
NCG	Non Condensable Gases

NEMA	National Environment Management Authority
NGO	Non Governmental Organization
NIOSH	National Institute of Occupational Safety and Health
OW	Olkaria Well
PDD	Project Design Document
PIT	Project Implementation Team
PPM	Parts Per Million
PRA	Participatory Rural Appraisal
T/H	Tonnes per hour
TDS	Total Dissolved Solids
QMS	Quality Management System
RRA	Rapid Rural Appraisal
SCC	Stakeholders Coordination Committee
SOx	Oxides of Sulphur
SAR	Synthetic Aperture Radar
UNFCCC	United Nations Framework Convention on Climate Change
UNU-GTP	United Nations University – Geothermal Training Program
UNEP	United Nations Environmental Programme
VT	Voltage Transformer
VOC	Volatile Organic Carbon
WHO	World Health Organization
WRMA	Water Resources Management Authorit

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Chapter 1: INTRODUCTION

1.0 Background

Kenya Electricity Genera ting Company (KenGen) is the leading electric power producer in Kenya, producing about 75% of electricity consumed in the country. The company uses various sources to generate electricity ranging from hydro, thermal, wind and geothermal.

The company proposes to construct a 70 MWe geothermal power plant in its licensed area of Olkaria. Olkaria geothermal field is located approximately 120 kilometres from Nairobi, the capital city of Kenya.

KenGen currently owns and operates two Geothermal Power Stations at Olkaria namely Olkaria I and Olkaria II. Olkaria I Power Station has three units namely Unit 1, 2 and 3 which were commissioned in 1981, 1982 and 1985 respectively. Each of these three units produces 15 MWe. Olkaria II Power Station has three units each generating 35 MWe. Unit 1 and Unit 2 of Olkaria II were commissioned in September 2003 whereas Unit 3 was commissioned in June 2010.

The company has also installed two well head generators producing 5MWe and 2.3MWe at Olkaria and Eburru Geothermal Fields respectively. KenGen has an ambitious strategy to increase its geothermal power generation capacity by 1260 MWe by 2018. Currently two projects to generate 280 MWe are under construction i.e. Olkaria I unit 4 & 5 and Olkaria IV, ESIA licenses were granted for the two projects. The company proposes to construct a 70 MW geothermal power plant to be known as Olkaria I unit 6 adjacent to Olkaria I unit 4 & 5.

The company has commissioned the undertaking of an Environment and Social Impact Assessment (ESIA) for the proposed project in order to meet the legal requirements of section 58 of the Environmental Management and Coordination Act number 8 of 1999. The ESIA is being undertaken by a multidisciplinary team of experts led by a NEMA registered lead expert. The study has established the baseline condition, anticipated the potential impacts both positive and negative, consulted the stakeholders and proposed mitigation measures to make the project environmentally friendly and sustainable.

The team of experts has communicated its findings to the company and will submit the ESIA project report to National Environment Management Authority for review and licensing.

1.1 Nature of the Proposed Project and its Objective

The proposed project will entail construction of a 70 MWe geothermal power plant adjacent to Olkaria I unit 4 & 5 and the associated infrastructure. Geothermal power plants are considered to be green energy projects that contributes to reduced emissions of green house gases to the atmosphere.

The objective of the proposed project is to adequately harness steam that will be used for the generation of 70MWe of geothermal energy daily in line with Kenya's vision 2030. Geothermal energy is cheap compared to expensive thermal energy thus will contribute to making our economy competitive. The other key objectives of the project are:

- To generate 70MW of electricity from geothermal sources

- To diversify sources of energy in order to minimize the over reliance on hydro and thermal sources of energy
- To mitigate against climate change by harnessing power from geothermal sources that emit less green gas emissions than the other sources
- To reduce the countries import bill in the long term by saving on monies used to import the expansive fossil fuels
- To earn revenue for the company and the government through taxes
- To create employment for the local communities and Kenyan's at large
- To generate least cost power that will make our economy competitive

1.2 Project Justification

The proposed project is geared towards meeting the Vision 2030 Governments' Medium Term target of generating 1,600 MWe of geothermal energy by 2016 and eventually 5,000 MWe by 2030 (GoK, 2011). Currently electricity generation from geothermal sources stands at 209.3 MWe hence the need for fast tracking the process.

Kenya's blue print on energy, Least Cost Power Development Plan (LCPDP), envisions that Kenya's electricity peak demand will increase from 1,302 MWe in 2011 to 15,026 MWe by 2030 in line with Vision 2030 which envisages energy as a key enabler for economic growth across the country. As a result, the governments' strategy is to change the base load electricity supply from hydro, which is affected by droughts, to geothermal that is reliable and cost effective (GoK, 2011).

Geothermal energy is cheaper compared with expensive thermal plants and is expected to save the country billions of foreign exchange used to import fuel. The geothermal energy is considered to be a green source of energy as it emits less green house gases to the atmosphere compared with other sources of energy.

1.3 Screening of the Proposed Project

Section 58 of the Environmental Management and Coordination act of 1999 requires projects listed in the second schedule of the act to undergo Environment Impact Assessment. According to this schedule, the proposed 70MWe geothermal power project falls under category 9. Under this category, ESIA study is required for Electrical infrastructure including the following:

a) Electricity generation stations;
b) Electrical transmission lines;
c) Electrical sub-stations;
d) Pumped-storage schemes

This ESIA project report has been prepared for submission to National Environment Management Authority (NEMA) in compliance with the above mentioned legal requirement.

1.4 Objective of conducting the ESIA

The overall objective of Environmental and Social Impact Assessment (ESIA) is to ensure that environmental concerns are integrated in all development activities in order to contribute to sustainable development. The specific objective of conducting the ESIA with respect to the proposed project was to:

- Examine the likely adverse environmental aspects and associated impacts
- Propose appropriate mitigation measures for the significant negative impacts and
- Develop an Environment Management Plan (EMP) with mechanisms for monitoring and evaluating compliance and environmental performance.

The ESIA project report has been prepared as per the Environmental Impact Assessment and audit guidelines of 2002 with an objective of meeting the requirement of section 58 of the Environmental Management and Coordination Act of 1999.

1.5 Scope of the ESIA

The ESIA was undertaken with respect to implementation of the proposed Olkaria I unit 6 Geothermal Power Project which shall comprise construction and operation of a 70MWe Power Plant. The main power plant System consists of:

- Production Well
- Separator
- Steam turbine & generator
- Condenser
- Hot well pump
- Gas extraction system
- Cooling water system- Cooling Tower

The ESIA report was prepared as per the guidelines provided under the Environmental (Impact Assessment and Audit) Regulations, 2003. The guidelines provide that the ESIA report has to capture the following salient features:

a. Description of baseline environmental conditions of the area
b. Description of the proposed project and associated activities
c. Description of the national environmental legislative and regulatory framework
d. The objectives of the project
e. The products, by-products and waste generated by the project
f. Identification and discussion of any significant impacts to the environment anticipated from the proposed project
g. Description of appropriate mitigation measures proposed for the negative environmental impacts
h. Provision of an environmental management plan
i. Alternative technologies and processes available and reasons for preferring the chosen technology and processes
j. Analysis of alternatives including project site, design and technologies and reasons for preferring the proposed site, design and technologies and
k. Public consultation with various stakeholders.

1.6 ESIA Methodology

The ESIA study was conducted in accordance with the draft environment impact and audit guidelines of 2002. The Environment and Social Impact assessment entailed the following steps:

- Preliminary meetings with the KenGen project team based at Olkaria Geothermal Project
- Data collection and documentation review

- Site inspections and discussion with project engineers
- Field survey to collect baseline information through direct observations, interviews and photography
- Holding public barazas in surrounding villages of Olkaria Nucleus and Kamere
- Holding a key stakeholders consultative meeting with lead agencies, non-governmental organization and the neighboring flower farms management
- Data analysis
- Compilation of the ESIA report as per the Environmental Impact (Assessment/Audit) Regulations of 2003.

1.7 Structure of the report

The ESIA project report has been prepared as per the following chapters;

Executive Summary: A summary of the report with brief description of the project, the objectives, justifications, anticipated environment and social impacts and the proposed mitigation measures.

Chapter 1: Introduction: This chapter provides description of the profile project proponent, description of the proposed project, objectives, history, project location, objective of the ESIA, scope of the ESIA, methodology and the report format.

Chapter 2: Project Description: this chapter describes the status of the project, details of the proposed project with both inputs and outputs, cost of the project, designs and implementation strategies.

Chapter 3: Alternatives to the project: This chapter gives alternatives energy sources for electricity generation, the different power generation options, different technologies in geothermal power generation among others.

Chapter 4: Legal and other requirements/institutional framework: This chapter examines the legal and regulatory framework applicable to this project and the institution framework that oversees this laws. the chapter also look at the procedures of various donors on environment and social impact assessment.

Chapter 5: Baseline conditions: The chapter examines the baseline environment of the proposed project location and the surrounding areas e.g. climate, soils geology, vegetation fauna, land use, socio-economic data among others

Chapter 6: Public Consultations and Disclosure: this chapter describes the public consultations barazas and meetings and the analysis of the comments by the various stakeholders

Chapter 7: Environmental Impacts and Mitigation Measures: The chapter analysis the anticipated positive and negative impacts associated with the project and the proposed mitigation measures

Chapter 8: Environmental Management and Monitoring Plan: This chapter describes the formulated environmental management and monitoring plan for the proposed project

Chapter 9: Conclusions and Recommendations: The conclusion presents briefly the environmental and social acceptability of the project

References: All materials and secondary data are acknowledged in the references

Appendixes: The appendix includes minutes of the public barazas, stakeholder meetings and the project design

1.8 ESIA Team Members

1. Elizabeth Gachau -Lead Expert EIA/EA
2. Hussein Ali Somow- Lead Expert EIA/EA
3. Philip Barasa- Lead Expert EIA/EA
4. Beatrice Kipng'ok- Sociologist
5. Stephen Mbatha- Project Engineer
6. Kizito Opondo- Geochemist
7. William Kimote- Operations Engineer

CHAPTER 2: PROJECT DESCRIPTION

2.0 Project Overview

The project site is within the Greater Olkaria Geothermal Area in the Hell's Gate National Park. Administratively, the project is in Hell's Gate Location, Olkaria Sub-location, Naivasha District, approximately 40KM from Naivasha town.

KenGen has assessed that there is sufficient geothermal resource available from the combined Olkaria East, Olkaria North-East and Olkaria Domes fields to support operation of 280 MWe (nominal) of generation. Half of that capacity is located in a new power plant designated as Olkaria I Additional Units 4 & 5 and the other half in a separate power plant designated as Olkaria IV, located at the Domes Field.

The Olkaria I Additional Units Project is located in the Hell's Gate National Park and expected to produce 140 MWe when the current construction is complete. Further studies established that an additional 70 MWe can be produced in Olkaria I making the total output from the Olkaria I Additional Unit to be 210 MWe. The power plant once complete will consist of three units i.e. Unit 4, 5 and 6 each producing 70 MWe.

2.1 Capital Cost of Proposed Plant

Table 1 below shows estimated capital cost for the proposed project,

Table 1: Estimated Project Cost

Generation unit/power plant	Postulated Capacity (MWe)	Average Well Capacity (MWe)	CAPEX [Million USD]
Olkaria I Unit 6	70	6	248.8

2.2 Scope of Works

The work to be carried out for the project shall include all works required to provide a complete and safe operational power plant. The Works shall be supplied "turnkey" by the Project, whose services shall include, but are not limited to:

- Design, procure and engineering of all works within the contract scope
- Project and construction management, quality assurance, planning and cost control
- Value Engineering, Hazards Operability (HAZOP) and other workshops as identified or required

- Procurement, construction and installation of the plant, materials and associated facilities
- Construction testing, commissioning, start-up, functional and performance tests
- Remedying of defects, preparation and delivery of drawings, design and construction documentation, quality documentation, test records, operation and maintenance manuals
- Obtaining all necessary permits including, but not limited to, pressure vessel and piping system permits.
- Training of KenGen operating and maintenance personnel
- All necessary temporary construction facilities and utilities
- Provide maintenance data for KenGen to input into the maintenance system
- Post construction clean-up, restoration and landscaping of the site temporarily occupied by the Contractor
- Provision of spare parts, special tools and test equipment.

2.3 Major Works

The major works for the project will entail:

2.3.1 Earthworks and Site Preparation

The Contractor shall take over the site as is and shall carry out site works, the minimum of which shall include:-

- Clearance of vegetation and trees and execution of bulk earthworks
- Clearance of any accumulated vegetation after the completion of bulk earthworks.
- Final earthworks, shaping, trimming and grading of the sites to formation levels, cutting into the hillsides to depths where foundation conditions are capable of supporting the major plant and buildings, and forming the remainder of the platform by placing and compacting excavated material.
- The balance of the cut material will be placed in designated soil disposal areas.
- Slope stabilization and protection works as required.
- Earthworks related to underground services, comprising water distribution, sewerage and septic tank, fire main loop and hydrants, drains for storm water, telephone and local power supply.

- The project shall provide landscaping as follows:
    - All un-paved areas within the Permanent Works in consideration of the local environment
    - Soil shall be analyzed and appropriate supplementary additions such as compost, shall be provided as appropriate for all species planted.
    - Unpaved areas shall be provided with topsoil and grassing to 80 per cent of the area.

2.3.2 Buildings and Building Services

Buildings and parts of buildings and exterior equipment shall be designed and constructed to have a clean, uncluttered and harmonious appearance in keeping with their function. Attention shall be given to indigenous Kenyan and local building styles and building techniques.

While these are not to be inappropriately used or copied, the design of buildings shall sensibly reflect and be empathetic to such local styles and techniques.

In selecting exterior building materials and construction details account shall be taken of the long term weathering effects of the local climate and of the need to reduce ongoing maintenance costs.

As a minimum, the following buildings and common services shall be required;

- Turbine hall
- Control room
- Electrical annex
- Mechanical and Electrical Workshops
- Fire protection and fighting systems
- Chemical storage facility
- Cooling Water Treatment building or shelter
- Central Air Conditioning & H_2S Filtration Plant
- Lighting and power room
- Communications systems room

2.3.3 Structures and Platforms

As a minimum, the following structures shall be supplied;

- Foundations for the complete Works
- Cooling tower basin(s)
- Oil containment facilities and
- Fire walls for transformers.

2.3.4 Mechanical Works

As a minimum, the following systems and plant items shall be supplied;

- Common systems (one for the entire Works) that may be included in each Portion as appropriate to support the operation of the relevant turbine generator unit
- Utility and instrument air system including air requirements of the substation and steamfield
- Fire suppression, detection and alarm systems
- Air conditioning systems for the electrical annex, including inlet filtration
- System to remove H_2S
- Ventilation and extraction systems for workshops
- Passive ventilation system for the turbine hall
- All permanent cranes and lifting facilities including the turbine hall overhead crane, required to perform all ongoing operation and maintenance of the Works.

2.3.5 Electrical Works

As a minimum, the following electrical equipment and plant items shall be supplied:

- 11 kV generator circuit breaker including current transformers (CTs) and voltage transformers (VTs)
- 11 kV isolated phase bus duct system including (CT) and (VT) disconnector and earth switches
- 11 kV/220 kV generator transformer
- 11 kV/3.3 kV unit main transformer
- 3.3 kV/415 V unit auxiliary transformer
- 110 V DC systems for emergency lube oil pump

2.3.6 Steamfield Works

The project will involve the construction of steamfield cross country piping, piping support stanchions, separator stations, pre-commissioning and commissioning of the data network interface, steamfield control and instrumentation systems interface and commissioning.

2.4 Labour, Materials & Equipment for Construction

2.4.1 Labour

The project will utilize manpower during planning, construction and when under operation. The power plant will directly employ both skilled and unskilled manpower on temporally and permanent terms. The total projected number of employees is approximately six hundred (600).

2.4.2 Construction Materials

Table2 below shows the materials that will be used for the power plant construction;

Table 2: List of Materials for Construction

No.	Material	Source
1	Sand	Local
2	Cement	Local & imported
3	Building Stones	Local
4	Reinforcing Steel bars	Imported
5	Aggregate	Local
6	Steel structures	Imported
7	Roofing sheets	Local
8	Steam pipes	Imported

2.4.3 Construction Equipment and machinery

Table 3 below shows the list of equipment and machinery to be used for the power plant construction.

Table 3: Construction Equipment and Machinery

#	Equipment/Machinery	Source
1.	Excavators	Local
2.	Dozers	Local
3.	Dump Trucks	Local

4.	Graders	Local
5.	Vibrating Rollers	Local
6.	Water Boozers	Local
7.	Piling Rigs	Local
8.	Car Mixers	Local
9.	Concrete Mixers	Local
10.	Mobile Cranes	Local
11.	Loaders	Local
12.	Fork Lifts	Local
13.	Batching Plants	Local
14.	Truck Cranes	Local
15.	Air Compressors	Local
16.	Rammers	Local
17.	Compactors	Local

2.5 Inputs of the Proposed Additional Unit 6

2.5.1 Main Steam Supply

The steam supplied is considered to be consisting of the following:

a) Fluid Steam,

b) Geothermal Gases and

c) Impurities

a) Fluid Steam

The desired supply of steam is 577.5 tonnes/hour (t/h) at a design pressure of 13.8 barg for 70 MWe. Olkaria I Additional Unit 6 will be designed similar to Olkaria I Units 4&5. Therefore, its specific steam consumption rates will be 7.5 Tonnes /h per Mega Watt. The 70 MW plant will require a steam supply of **525t/h** and an additional 10% reserve steam **(52.5t/h)** will be required to take care of startup requirements as shown in table 4 below.

Table 4: Steam Requirement for Additional Unit 6

Specific steam Consumption tonnes/hr/MW	Plant rating MW	Steam required by the plant t/hr	Required 10% reserve steam at start up t/hr	Total steam required t/hr
7.5	70	525	52.5	577.5

b) **Geothermal Gases**

The geothermal gases consist of mainly Non-Condensable Gases (NCG) which make up between 0.30 – 0.34 % by weight of the main steam. Table 5 below shows gases contained in geothermal steam.

Table 5: Gases Contained in Geothermal Steam

No.	Gas
i	Carbon Dioxide (CO2):
ii	Hydrogen Sulfide (H2S):
iii	Sulphite SO2:
iv	Hydrogen (H2):
v	Oxygen & Argon:
vi	Nitrogen (N2):
vii	Methane (CH4):
viii	Ammonia (NH3):
ix	Hydrogen Chlorine (HCl):
x	Hydrogen Fluoride (HF):

c) **Impurities in Steam**

The following impurities are found in steam

Sodium < 1.0 (3) Parts per million (ppm)

Chloride < 1.0 (3) ppm

Silica < 1.0 (3) ppm

Iron < 1.0 (3) ppm

Total Dissolved Solids (4) < 5.0 (3) ppm

2.5.2 Raw Water Supply

Raw water for the project will be supplied from Lake Naivasha. The water will mainly be used for the construction works and supply of the cooling circuit in the initial start up of the proposed power plant. About 1,500m^3 of raw water is required at the initial start up to make the power plant operational after completion. Minimal amount of water may be required during the cleaning of the cooling circuit.

Raw water is normally pumped and stored in the existing water tank whose capacity is four million litres at elevation of 2160 meters above sea level for geothermal projects activities. The

available minimum raw water pressure is 10 barg and available maximum pressure 15 barg. Raw water for the project shall be taken from the pipe work fed from the existing storage tanks. Pipe work from the interface point to the Power Plant boundary shall, as far as practical, be buried.

2.5.3 Potable Water Supply For the plant

A water treatment facility has been provided in previous projects, capable of supplying sufficient potable water for the needs of the proposed plant. The clean water flow requirements for the project are a maximum 100 litres per day with a maximum peak flow of 5 litres per minute. Drinking water shall comply with Kenya's Drinking Water Quality and Effluent Monitoring guideline (Water Service Regulatory Board).

The plant shall be sized to provide adequate Potable water for up to 30 people per day. The potable water shall be used for:

- Drinking
- Washing
- Cleaning
- Showers
- Toilets

2.5.4 Lubricating Oil

The power plant will utilize lubricating oil which is used to lubricate mainly the bearings of steam turbine and generator. The volume requirement of the plant lubricating oil is approximately 208 litres per month.

2.5.5 Chemical Dozing & other inputs

An approximate 150 kg of Soda Ash (sodium carbonate) will be used per day to dose the condensate produced by the proposed unit in order to maintain a pH value of 7-9. Water for the new cooling towers will be shock-dozed with sodium hypochlorite (approximately 100 litres will be required per day) and biocide (approximately 100 litres will be needed per month) to prevent algae and other bacteria clogging up the cooling tower fins. Some water from the cooling tower will also be cold re-injected and will also be neutralized with Soda Ash.

Other chemical to be used on site will include diesel oil for the standby generator, silica gel for dry air going into the transformers, greases and lubricants for the maintenance of the plant and equipment, paints detergents and solvents.

2.6 Outputs of the Proposed Additional Unit 6

2.6.1 Brine

The geothermal fluid from the wells consists of water and steam. this fluid is a two phase fluid which is separated into steam and water components. the separated water has chemical constitutes (solutes) that determine its chemical composition. The chemical constitutes (solutes) are concentrated in the separated water which is one of the phases. This defines the brine generated from the geothermal fluids. This defines the brine generated from the geothermal fluids. In the Olkaria North East field (steam supply to the Olkaria II power plant) the separated water is re-injected 100% to replenish the reservoir and to prevent environmental pollution. All the brine generated from the proposed power plant will be re-injected.

2.6.2 Gases

The composition for Non-Condensable Gases is as per table 6 below. The volumes emitted are as a per cent weight of dry steam.

Table 6: Composition of Non-Condensable Gases

No.	Gas	Per cent
1	Carbon Dioxide (CO_2)	85 - 93
2	Hydrogen Sulfide (H_2S)	4 - 6.8
3	Sulphite (SO_2)	0 - 1.7
4	Hydrogen (H_2)	0.1 - 0.25
5	Oxygen & Argon	0.02 - 1.0
6	Nitrogen (N_2)	0.8 - 2.0
7	Methane (CH_4)	0.05 - 0.75
8	Ammonia (NH_3)	0.025 - 0.1
9	Hydrogen Chlorine (HCl)	0 - 0.2

10	Hydrogen Fluoride (HF)	0 - 0.1

The non-condensable gases are extracted by gas extraction system after steam runs the turbine. The extracted gases are released in the cooling tower plume.

2.6.3 Condensates

When steam is cooled, it condenses to form water. The condensate lost through evaporation under the average meteorological condition in Olkaria is around 60%. It should be noted that the evaporation is proportional to the total flow through the turbine and is not related to the power output of the plant. The amount of water loss (condensate) through evaporation in the cooling tower is approximately 396m^3/hr for a 70MWe geothermal power plant. The condensate to be discharged from the cooling tower for re-injection is approximately 120M^3/hr.

2.6.4 Lube Oil

Lubricating oil will be replaced or replenished as part of the operation and maintenance procedures. This is done periodically as need arises and the oil is removed from the power plant system and stored in storage containers for disposal. The quantity of the lubricating oil from the plant depends on the design of the power plant. The proposed design will include centrifuge oil cleaning mechanism where oil is filtered and cleaned for reuse in the lubricating system. The system is enclosed and does not require replacement of oil. Oil is only replenished due to losses resulting from evaporation. The consumption rate of replenishing oil is approximately 208 litres per month.

2.6.5 Contaminated (Oily And Chemical) Water

There could be cases of contaminated water due to plant maintenance activities or from the chemical pre-treatment facility. The contaminated water shall be collected and passed through an oil/water separator prior to discharge into the storm water drainage. The oil/water separator shall separate oil from water such that the quality of effluent from the separator is suitable for discharge into storm water drainage, with the concentration of oil in the effluent not exceeding 10 mg/litre. The oil/water separator shall be provided with efficient means of removing oil including access for maintenance requirements.

2.6.6 Plant Sanitary Sewer

Foul water discharge from kitchen, toilets, wash hand basins and showers shall be discharged into a foul water drainage system. Foul water drainage shall comply with the guidelines and requirements of relevant codes and standards of international and local authorities having jurisdiction. Under no circumstances shall process effluents, storm water or contaminated water be discharged into the foul water drainage system.

The velocity of flow in the pipes shall not be less than 0.75 m/s for self-cleansing, with an upper limit of 3.0 m/s. Flow in closed sewer pipes should not be full bore and should be designed for a maximum 2/3 flow.

2.7 Power Plant Design System

The main power plant system consists of the following components as per figure 1 below:

1. Separators
2. Steam turbine & generator
3. Condenser
4. Hotwell pump
5. Gas extraction system
6. Main cooling water system- Cooling Tower

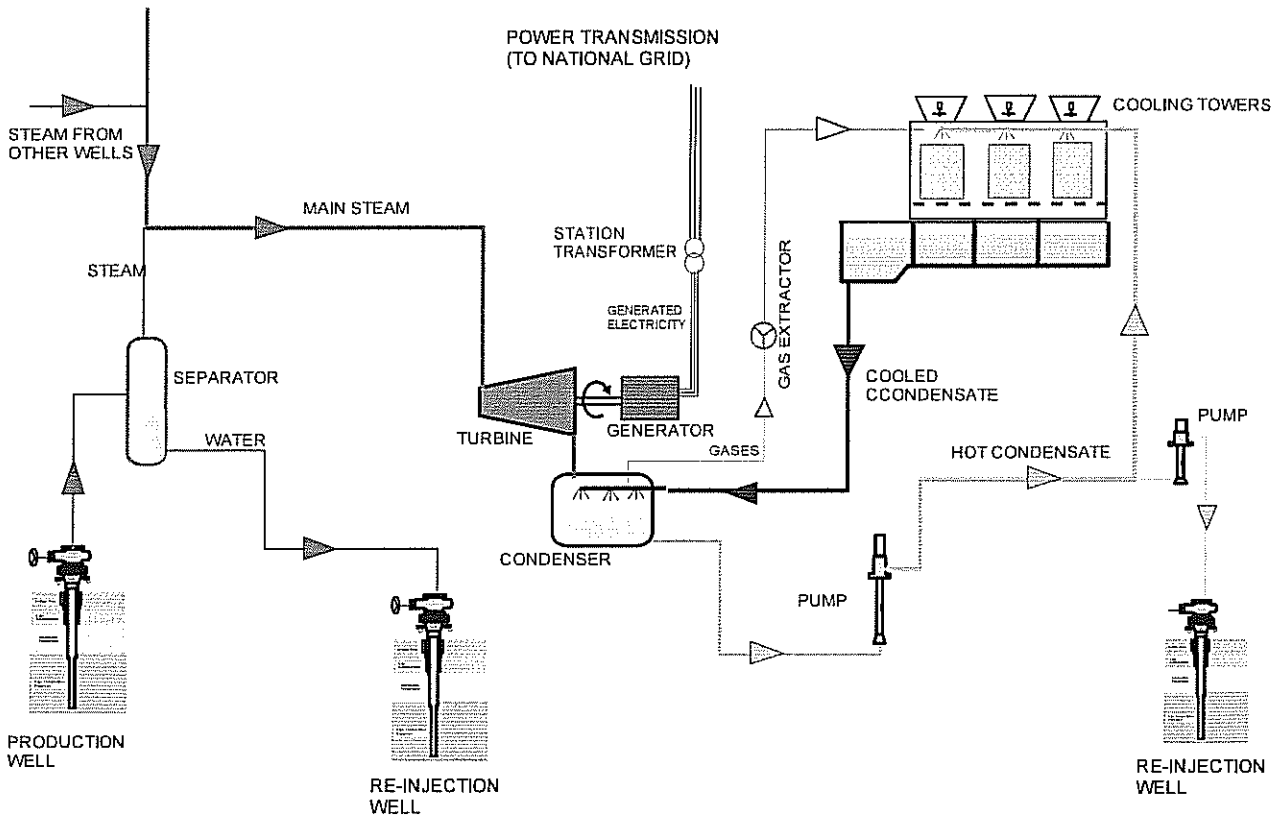


Figure 1: Schematic Flow Process for Single Flash Geothermal Power Plants

2.7.1 Separator

The geothermal fluid is separated into vapour and liquid in a steam separator. Because the Olkaria field is a wet steam field, steam field separators are required. It is planned that the separator stations are located adjacent to the production well pad to reduce pressure losses. Separators can be both vertical and horizontal. In older conventional designs of steam supply systems in geothermal fields throughout the world, the separators have been of the vertical centrifugal type.

2.7.2 Steam turbine

The steam turbine is the most important part of a geothermal power plant. In the conceptual design of a steam power plant, the quality of the steam is considered as well as the input and output enthalpy.

The detailed design for a steam turbine is the responsibility of the steam turbine manufacturer.

Steam flowing from the separators enters the steam turbine in a single-flash cycle. The steam is supplied to the turbine rotor via nozzles in a tangential direction at higher velocity. The turbine rotor is subjected to an axial thrust as a result of pressure drops across the moving blades and changes in the axial momentum of the steam between the entrance and the exit, and then passed through the rotor shaft as useful power output of the turbine. The capacity of the turbine is a fundamental factor in the design of a geothermal power plant.

The turbine material is carefully selected for resistance to corrosion due to the presence of hydrogen sulphide and salt (chloride), and scale components such as silica oxide, aluminium oxide, and sulphur oxide in a single-flash cycle. The blade material is also resistive to erosion due to the presence of condensate or brine and solid particles such as corrosion products. However, the best way to avoid the appearance of corrosion and erosion is to keep steam impurities out of the turbine.

The turbine for the project shall normally operate with constant steam supply pressure however, there may be circumstances under which the steam supply pressure will not be constant and the turbine will be required to operate in pressure control mode. It is expected that the power plant will be run as a base load plant, but the turbine shall be capable of operating under dispatch mode with varying load demand.

2.7.3 Condenser

The primary purpose of the condenser is to condense the exhaust steam from the turbine. The circulating water system supplies cooling water to the turbine condensers and thus acts as the unit by which heat is rejected from the steam cycle to the environment. The circulating system is efficient but also has to conform to thermal discharge regulations. Its performance is vital to the efficiency of the power plant itself because a condenser operating at the lowest temperature possible results in maximum turbine work and cycle efficiency and in minimum heat rejection.

The project shall have one direct contact type condenser in accordance with specifications for receiving exhaust steam from each of the steam turbine-generator unit. The Condenser shall be designed to minimize the dissolved gas content in the condensate exiting the condenser hotwell. Sampling connections shall be provided for water leaving the condenser and gas cooler in the discharge pipework from the hotwell pumps.

2.7.4 Hotwell Pumps

Brine from the condenser is pumped to the cooling tower by hotwell pumps. Multiple canned type, vertical, direct- driven centrifugal or mixed flow pumps with a combined duty of 100 per cent shall be provided to extract cooling water and condensate from the condenser Hotwell and return it to the cooling tower. The pumps shall be rated such that they meet the plant requirements under all operating conditions.

The pumps shall be complete with check valves, isolation valves, bearing and seal water filtration equipment and all other necessary auxiliaries.

2.7.5 Gas Extraction System

It is well known that gases in geothermal steam influence the design of the main part of the power plant equipment such as the turbine, condenser, cooling tower, and gas extraction system. This is due not only to corrosion problems but also to the high volume of gases in the turbine and condenser.

The project will use a hybrid gas extraction system that shall be provided, comprising first stage (and intermediate stage if required) steam jet ejectors and last stage liquid ring vacuum pumps plus associated inter and after condensers and coolers draining to the main condenser or cooling tower as appropriate, plus associated auxiliaries. The system shall be designed to extract non-condensable gases from the main condenser gas cooler section and to discharge the gas into the cooling tower plume above the fan level.

2.7.6 Cooling Water System – Cooling Tower

A cooling tower is an evaporative heat transfer device in which atmospheric air cools warm water, with direct contact between the water and the air, by evaporating part of the water. Wet cooling towers have a hot water distribution system that showers or sprays the water evenly over a lattice work of closely set horizontal slats or bars called fill or packing. The fill thoroughly mixes the falling water with air moving through the fill as the water splashes down from one fill level to the next due to gravity. Outside air enters the tower via louvers in the form of horizontal slats on the side of the tower. The slats usually slope downward to keep the water in. The intimate mix between water and air enhances heat and mass transfer (evaporation) which cools the water. The cold water is then collected in a concrete basin at the bottom of the tower where it is pumped back to the condenser.

The Project shall provide a complete cooling water system including cooling tower and auxiliary cooling system. The main cooling water system will serve as the cooling water supply for the steam turbine condenser and gas extraction system intercoolers and, via the auxiliary cooling water supply pumps. The gland steam condenser (if required), drains flash vessel, gas extraction system condensers and liquid ring vacuum pumps, lube oil system coolers, generator air coolers and air compressors.

A mechanical induced- draft cooling tower per generating unit shall be provided to dissipate the heat rejection load of each unit, including the turbine/generator main condenser, gas extraction system condensers, the turbine unit auxiliary cooling load and any other heat loads from the Power Plant. The cooling tower shall comprise a number of cells modularized such that one complete cell, including the associated Non Condensable Gas dispersion system can be pulled out. The cells can be taken out of service for safe cleaning or maintenance whilst the balance of the cells remains in operation. The cooling tower shall be designed in accordance with the Cooling Tower Institute (CTI) standards.

CHAPTER 3: ANALYSIS OF PROJECT ALTERNATIVES

3.1 Alternative Sites

The project site is Olkaria area within the Hell's Gate National Park in Naivasha District. The area is generally undulating characterized by several streams valleys draining the area. The most conspicuous physiographic features are several hills of lava flows which surround the project area.

Geothermal resources are found only in limited sites in Kenya concentrated mostly along the Rift Valley. Geothermal exploration for the proposed site has been undertaken for years and it has been established that the Greater Olkaria Geothermal Field has the potential steam to generate approximately 1000 MWe. Other potential geothermal sites are Menengai, Bogoria, Longonot, Eburru and Suswa are at the initial stages of exploration. In this scenario, the proposed site is the most ideal for the proposed project.

3.1.1 Site Coordinates

The proposed project site coordinates are approximately E 02°02'25" and N 99°16'84" in the Hell's Gate National Park.

3.1.2 Hell's Gate National Park

The Hell's Gate National Park is controlled and administered by the Kenya Wildlife Service (KWS). All Works associated with this project will comply fully with the requirements of KWS where it impacts upon operation of the National Park. KenGen and KWS have a Memorandum of Understanding (MoU) on how to coexist. This project will be implemented in accordance to this MoU.

3.2 Operational Areas

There are operational areas near the project site, these being Olkaria I and Olkaria II geothermal power plants and associated steamfield and transmission facilities and sites under the control of the KenGen. These operational areas are controlled by KenGen, Kenya Power Company Limited and Kenya Wildlife service.

The project Operational Areas include, but are not limited to the following:

- The sites of the Olkaria I and Olkaria II Power Plants contained within the perimeter fences, which are under the control of KenGen

- Substations associated with the Olkaria I and Olkaria II Power Plants within perimeter fences, which are under the control of Kenya Power Company Limited
- The wellpads and process areas of the Olkaria I and Olkaria II steam fields each within perimeter fences, which are under control of KenGen
- The steamfield cross country steam, brine and condensate pipework with associated access tracks etc within the general areas of the Hell's Gate National Park, which are under control of KenGen and Kenya Wildlife Service
- The electrical transmission system within the general area of the Hell's Gate National Park which is under control of Kenya Power Company Limited, KenGen and the KWS
- The electrical transmission system within a wayleave traversing private land from the boundary of Hell's Gate National Park.

Figure 2 below is the map showing the location of the Proposed Olkaria I additional unit 6

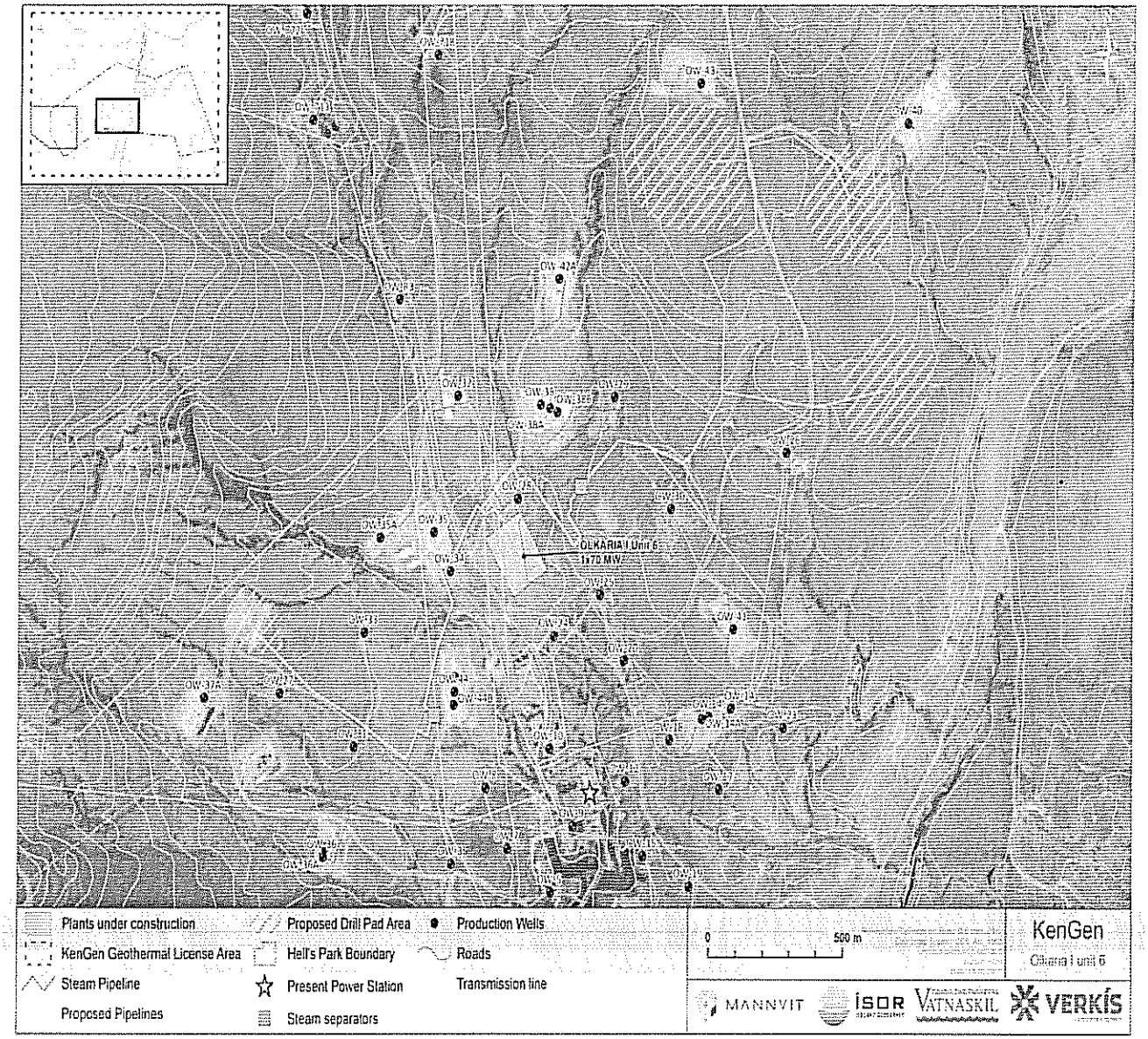


Figure 2: Map Showing Olkaria I Unit 6 Site

MAP OF OLKARIA I UNIT 6 LOCATION

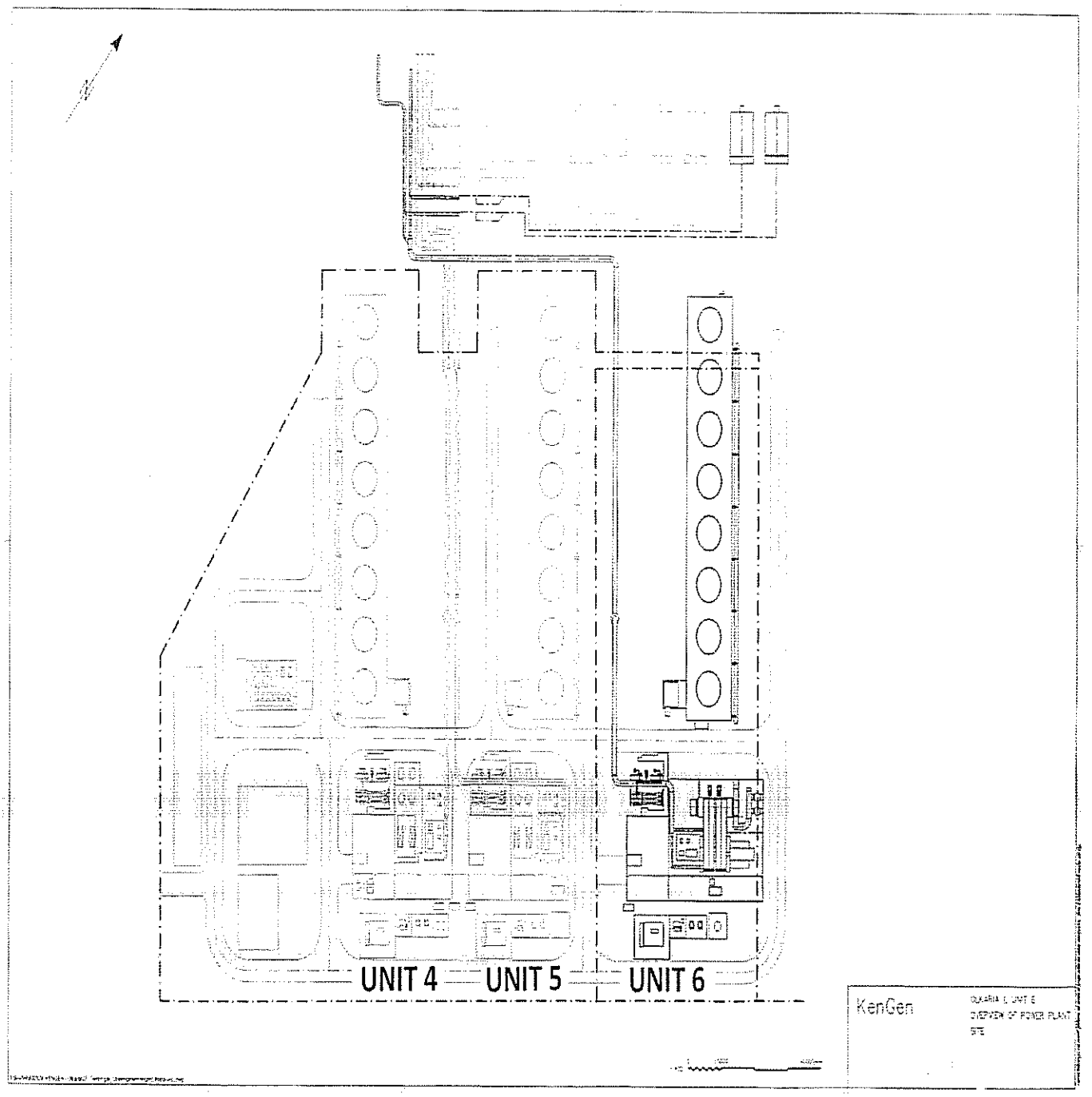


Figure 3: Proposed Layout of Olkaria I unit 6

3.3 Choice of Site

Reasons for site choice

1. The design of Olkaria I units 4 & 5 power plant location has site provision designated for an additional unit 6.
2. There is excess steam in Olkaria I Additional Units. About 83 MW of steam is available.
3. Steam is readily available from already drilled wells around the site to run the power plant.
4. There is a sub-station under construction on the site which the unit can be connected to.
5. There are contractors on site constructing Olkaria I units 4 & 5 power plants. The contractors on site can be engaged and the company can save on costs such as mobilization.
6. There are available resources at site to be shared such as control room, water, steam pipes, brine re-injection systems, access roads etc.

3.4 Forms of Energy for KenGen

The project proposes to use geothermal form of energy. Table 7 below provides a comparison of the different forms of energy the company uses and their suitability for the Olkaria site.

Table 7: Analysis of forms of Energy

#	Form Of Energy	Comparison
1	Geothermal	Ideal for Olkaria as the resource is abundant
2	Hydro	It is affected by hydrology and not ideal for Olkaria
3	Wind	Requires constant blowing of wind throughout the year. Not ideal for Olkaria field.
4	Thermal	Uses fossil fuel and therefore not clean energy. Not ideal for the Olkaria site

Advantages of Geothermal Energy

1. Geothermal energy is generally considered environmentally friendly and does not cause significant amounts of pollution.
2. Geothermal reservoirs are naturally replenished and therefore renewable.
3. Harnessing geothermal energy does not involve any fuels, which means less cost fluctuations and stable electricity prices.

4. Excellent for meeting the base load energy demand (as opposed to other renewable energy forms such as wind and solar).
5. It makes small footprint on land.
6. Recent technological advancements (e.g. enhanced geothermal systems) have made more resources exploitable and lowered costs of energy.
7. There is massive potential of geothermal resource making it the ideal form of energy.

3.5 Alternative Technologies for Geothermal Power Plants

Geothermal power plants can be divided into two main groups, steam cycles and binary cycles. Typically the steam cycles are used at higher well enthalpies and binary cycles for lower enthalpies.

The steam cycles allow the fluid to boil, and then the steam is separated from the brine and expanded in a turbine. Usually the brine is rejected to the environment or re-injected. The brine can be flashed again at a lower pressure if double flash system is used.

A binary cycle uses a secondary working fluid in a closed power generation cycle. A heat exchanger is used to transfer heat from the geothermal fluid to the working fluid, and the cooled brine is then rejected to the environment or re-injected.

3.5.1 Steam Cycle Power plants

Geothermal Steam Cycle Power plants are similar to other steam turbine thermal power stations. Heat from a fuel source (in geothermal case, the earth's core) is used to heat water or another working fluid. Flash steam cycle plants are the most common type of geothermal power generation plants in operation today, which use water at temperatures greater than 182 °C (455 K; 360 °F) that is pumped under high pressure to the generation equipment at the surface. The working steam is then used to turn a turbine of a generator, thereby producing electricity. The fluid is then cooled and returned to the heat source.

3.5.2 Binary Geothermal Power Plant

A binary cycle power plant is a type of geothermal power plant that allows cooler geothermal reservoirs to be used than with dry steam and flash steam plants. With binary cycle geothermal power plants, pumps are used to pump hot water from a geothermal well, through a heat exchanger, and the cooled water is returned to the underground reservoir. A second "working" or "binary" fluid with a low boiling point, typically a butane or pentane hydrocarbon, is pumped at fairly high pressure (500 psi (3.4 MPa)) through the heat exchanger, where it is vaporized and then directed through a turbine. The vapor exiting the turbine is then condensed by cold air radiators or cold water and cycled back through the heat exchanger.

A binary vapor cycle is defined in thermodynamics as a power cycle that is a combination of two cycles, one in a high temperature region and the other in a lower temperature region. The plant configurations are designed to take maximum advantage of the available geothermal energy resources at each site, and provide various binary plants implementations for:

- Low-temperature geothermal fluid or steam,
- Separated brine after first or second flash

3.5.2.2 How binary cycle works

- The fluid is extracted from an underground reservoir and flows from the wellhead through pipelines to heat exchangers in the energy converters.
- Inside the heat exchangers, the geothermal fluid heats and vaporizes a secondary working fluid, an organic fluid with a low boiling point.
- The organic vapors drive the turbine and then are condensed in a condenser, which is cooled by air or water.
- The turbine rotates the generator.
- The condensed fluid is recycled back into the heat exchangers by a pump, completing the cycle within the closed system.
- The cooled geothermal fluid is re-injected into the reservoir.

3.5.2.3 Benefits of the binary cycle

The following summarizes the benefits of the combined cycle:

1. More thermal efficiency for the geothermal power plant;
2. Greater reliability for the geothermal power plant;
3. No scaling problem in the turbine in this new geothermal cycle;
4. Increased raw efficiency of power plant;
5. Longer life time span for the steam turbine;
6. More production than using only a single flash.

3.5.2.4 Limitations

1. High initial project cost
2. More maintenance costs
3. Binary cycles operate at lower enthalpies (temperatures)
4. Highly skilled & trained manpower required for installation and running the plant

3.6 Recommendation for Olkaria I unit 6 Design

Single flash Steam Cycle is recommended for the high enthalpy resources at Olkaria, i.e. where the enthalpy is in the range of 1800-2000 kJ/kg, Single flash Steam Cycle is recommended. The specific reasons for choosing single flash for Olkaria I unit 6 Design are:

i) The risk of well enthalpy turning out to be different than planned because of well drilling and plant building being done simultaneously.

ii) The risk of well enthalpy changing when utilization of the reservoir starts.

iii) The second separator stage is usually at pressures below silica saturation limit. This calls for acid or inhibitor dosing and has potential to cause increased maintenance cost or operational problems.

CHAPTER 4: LEGAL AND OTHER REQUIREMENTS/INSTITUTIONAL FRAMEWORK

4.1 General Overview

Kenya has various legal provisions for managing natural resources. Among these, the Environmental Management and Co-ordination Act (EMCA), 1999 is the umbrella legal framework under which the environment is managed. Kenya is also a signatory to various international environmental laws including the Ramsar Convention, the Vienna Convention, United Nations Framework Convention on Climate Change, the Montreal protocol and the Kyoto Protocol. The applicable legal provisions that will impact on the proposed power plant are discussed below.

4.2 The Constitution of Kenya, 2010

According to article 42 of the Kenyan Constitution, every person has the right to a clean and healthy environment, which includes the right:
(*a*) to have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69; and
(*b*) to have obligations relating to the environment fulfilled under Article 70.

The obligations contemplated under article 69 of the constitution and which the Kenyan Government shall endeavour to fulfill through participation of the citizens and organizations includes: achieving and maintaining a tree cover of at least ten per cent of the land area of Kenya; encouraging public participation in the management, protection and conservation of the environment and eliminating processes and activities that are likely to endanger the environment;

Article 70(1) provides a locus standi to a person who alleges that a right to a clean and healthy environment recognised and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened. Such a person may apply to a court for redress in addition to any other legal remedies that are available in respect to the same matter.

4.3 Environmental Management and Coordination Act (EMCA), 1999

Section 3 of EMCA, 1999 provides that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. The entitlement to a clean and healthy environment includes the access by any person in Kenya to the various public elements or segments of the environment for recreational, educational, health, spiritual and cultural purposes. In case the right to a clean and healthy environment is infringed, the act empowers such a person to apply to the High court for redress.

Section 58 (1) obligates project proponents to carry out Environmental Impact Assessment (EIA) for projects listed under the second schedule to the act and submit to NEMA the respective reports for review and approval. Pursuant to section 63, the Authority may, after being satisfied as to the adequacy of an EIA study, evaluation or review report, issue an EIA licence on such terms and conditions as may be appropriate and necessary to facilitate sustainable development and sound environmental management.

According to section 68, the owner of the premises or the operator of a project for which an EIA report has been made shall keep accurate records and make annual reports to the

Authority describing how far the project conforms in operation with the statements made in the report submitted under section 58.

4.3.1 The Environmental Management and Co-ordination (Water Quality) Regulations, 2006

It is an offence under Regulation No. 4 (2), for any person to throw or cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance in or near it, as to cause pollution.

Regulation No. 11 further makes it an offence for any person to discharge or apply any poison, toxic, noxious or obstructing matter, radio active waste or other pollutants or permit the dumping or discharge of such matter into the aquatic environment unless such discharge, poison, toxic, noxious or obstructing matter, radioactive waste or pollutant complies with the standards for effluent discharge into the environment.

Regulation No. 14 (1) requires every licensed person generating and discharging effluent into the environment to carry out daily effluent discharge quality and quantity monitoring and to submit quarterly records of such monitoring to the Authority or its designated representatives.

4.3.2 The Environmental Management and Co-ordination (Waste Management) Regulations, 2006.

Regulation No. 4 (1) makes it an offence for any person to dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle.
Regulation 5 (1) provides categories of cleaner production methods that should be adopted by waste generators in order to minimize the amount of waste generated and they include:

I. Improvement of production process through-
   - Conserving raw materials and energy
   - Eliminating the use of toxic raw materials and wastes
   - Reducing toxic emissions and wastes

II. Monitoring the product cycle from beginning to end by-
   - Identifying and eliminating potential negative impacts of the product
   - Enabling the recovery and re-use of the product where possible, and
   - Reclamation and recycling and

III. Incorporating environmental concerns in the design and disposal of a product

Regulation 6 requires waste generators to segregate waste by separating hazardous waste from non-hazardous waste for appropriate disposal.
Regulation 15 prohibits any industry from discharging or disposing of any untreated waste in any state into the environment.

Regulation 17 (1) makes it an offence for any person to engage in any activity likely to generate any hazardous waste without a valid Environmental Impact Assessment license issued by NEMA. Regulation 18 requires all generators of hazardous waste to ensure that every container or package for storing such waste is properly labeled.

4.3.3 The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009.

According to regulation 3 (1), 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. Regulation 4 prohibits any person to *(a)* make or cause to be made excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment; or *(b)* cause to be made excessive vibrations which exceed 0.5 centimetres per second beyond any source property boundary or 30 metres from any moving source.

Regulation 5 further makes it an offence for any person to make, continue or cause to be made or continued any noise in excess of the noise levels set in the First Schedule to these Regulations, unless such noise is reasonably necessary to the preservation of life, health, safety or property.

First (1st) Schedule:

Table 8: Maximum Permissible Noise Levels

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

Time Frame:

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

Regulation 12 (1) makes it an offence for any person to operate a motor vehicle which- *(a)* produces any loud and unusual sound; and *(b)* exceeds 84 dB(A) when accelerating. According to subregulation 2 of this regulation, 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.

Regulation 13 (1) provides that except for the purposes specified in sub-Regulation (2) thereunder, no person shall operate construction equipment (including but not limited to any pile driver, steam shovel, pneumatic hammer, derrick or steam or electric hoist) or perform any outside construction or repair work so as to emit noise in excess of the permissible levels as set out in the Second Schedule to these Regulations.

Second

Table 9: Maximum Permissible Noise Levels for Construction Sites

(Measurement taken within the facility)

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

Time Frame:

Day: 6.01 a.m. – 6.00 p.m. (Leq, 14 h)
Night: 6.01 p.m. – 6.00 a.m. (Leq, 14 h)

Regulation 16 (1) stipulates that where a sound source is planned, installed or intended to be installed or modified by any person in such a manner that such source shall create or is likely to emit noise or excessive vibrations, or otherwise fail to comply with the provisions of these Regulations, such person shall apply for a licence to the Authority. According to regulation 18 (6) this license shall be valid for a period not exceeding seven (7) days.

Regulation 19 (1) prohibits any person to carry out activities relating to fireworks, demolitions, firing ranges or specific heavy industry without a valid permit issued by the Authority. According to sub-regulation 4, such permit shall be valid for a period not exceeding three months.

4.4 The Energy Act, 2006

Section 27 (1) of this act requires KenGen to have a licence for generation of electrical energy. According to section 38 (1), a person shall not carry out any electrical installation work unless the person is licensed by the Energy Regulatory Commission (ERC) as an electrician or an electrical contractor. Section 103 (1) provides that the Minister shall promote the development

and use of renewable energy technologies, including but not limited to biomass, biodiesel, bioethanol, charcoal, fuelwood, solar, wind, tidal waves, hydropower, biogas and municipal waste. Under subsection 2, the Minister may perform such functions and exercise such powers as may be necessary under this Act to promote the development and use of renewable energy, including but not limited to:
(a) formulating a national strategy for coordinating research in renewable energy;
(b) providing an enabling framework for the efficient and sustainable production, distribution and marketing of biomass, solar, wind, small hydros, municipal waste, geothermal and charcoal;
(c) promoting the use of fast maturing trees for energy production including biofuels and the establishment of commercial woodlots including peri-urban plantations;
(d) promoting the use of municipal waste for energy production,
(e) promoting the development of appropriate local capacity for the manufacture, installation, maintenance and operation of basic, renewable technologies such as bio-digesters, solar systems and hydro turbines;
(f) promoting international co-operation on programmes focusing on renewable energy sources;
(g) harnessing opportunities offered under clean development mechanism and other mechanisms including, but not limited to, carbon credit trading to promote the development and exploitation of renewable energy sources;
(h) promoting the utilization of renewable energy sources for either power generation or transportation;
(i) promoting co-generation of electric power by sugar millers and sale of such electric power through the national grid directly to the consumers;
(j) promoting the production and use of gasohol and biodiesel.

4.4.1The Energy (Energy Management) Regulations, 2012

This is a subsidiary legislation to the Energy Act, 2006. According to regulation 5, KenGen is required to designate an energy officer who shall be responsible for the development and implementation of energy efficiency and conservation. Pursuant to regulation 6, KenGen will be required to cause an energy audit of the facility to be undertaken by a licensed energy auditor at least once every three years and submit the report to the Energy Regulatory Commission (ERC). Regulation 8 requires KenGen to implement appropriate energy conservation measures vis-a-vis the energy investment plan.

4.5 Geothermal Resources Act (Cap 12)

Section 7 (1) of this act requires KenGen to be in possession of a geothermal resources licence over part of the entire geothermal resources area and to comply with the terms and conditions of the license. Section 14 provides that the holder of such a licence may for the purposes of generating, transmitting or supplying electrical power-
(a) extract, take, use and apply geothermal resources on or under any land which is the subject of licence;
(b) erect, construct, provide and use such works and appliances as may be necessary for the purpose of generating electricity, and in connection with the transmission, use, supply and sale of electricity
Subject to section 8 (1) of the act, the licence confers upon KenGen the right-

(a) to enter upon the land being the subject of the licence to bore and to extract geothermal resources and to do all such things as are reasonably necessary for the conduct of those operations;
(b) in so far as it may be necessary for and in connection with the operations referred to in paragraph (a)-
(i) to drill and construct all necessary boreholes;
(ii) to erect, construct and maintain houses and buildings for his own use and for use by his employees;
(iii) to erect, construct and maintain plant, machinery, buildings and other erections as may be necessary;
(iv) to utilize the geothermal resources;
(v) subject to the Water Act, to reclaim and utilize any water; and
(vi) to construct and maintain roads and other means of communications and conveniences;
(c) to take and use or apply the geothermal resources for any purpose specified in the licence.

According to section 16, the holder of a license shall be liable for any loss, damage or injury to any person or property resulting from his works or operations, whether as a result of negligence or otherwise.

4.5.1 The Geothermal Resources Regulation, 1990

Pursuant to regulation 13 of Geothermal Resources Regulation, 1990, all geothermal operations shall be conducted in a workman-like manner and comply with the following requirements -
(a) as far as reasonably practicable -

i. prevent the unnecessary waste of or damage to geothermal or other energy and mineral resources;
ii. protect the quality of surface waters, air, and other natural resources, including wildlife, soil, vegetation and natural history;
iii. protect the quality of cultural resources, including archaeological, historical, scenic and recreational resources;
iv. accommodate other land users;
v. protect human and wildlife resources from unacceptable levels of noise;
vi. prevent injury to life; and
vii. prevent damage to property;

(b) sites selected for the construction of drilling sites, roads, sumps, steam transmission lines and other construction attendant to geothermal operations shall be evaluated for stability and in unstable earth conditions shall be avoided where they could affect the integrity of the facility;
(c) operations shall be conducted in a manner which minimizes erosion and disturbances to natural drainage;
(d) the licensee shall conduct all operations in such manner as to afford reasonable protection of fish, wildlife, and natural habitat.

Regulation 18 (1) provides that all licensees, which includes KenGen, shall maintain, at the site of works, and present on demand by any person authorized by the Minister -

a. a register of the progress of operations specifying all important matters relating to operations and, in particular, the characteristics of casing, the cementation effected, production tests and like matters as well as all occurrences and accidents,
b. geological and geophysical records and logs of all past and current bores;

c. a record of the physical and chemical characteristics of fluids emitted from past and current bores;
d. a register giving the names of all persons employed; and
e. such other matters as may be prescribed.

4.6 The Local Government Act (Cap 265) Revised Edition 2010

According to section 163 (e), Every Municipal Council shall subject to any other written law relating thereto, have 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 neighbourhood, and to prescribe the conditions subject to which such businesses, factories and workshops shall be carried on.

4.7 Occupiers Liability Act (Cap 34)

Section 1(4) stipulates that in determining whether the occupier of premises has discharged the common duty of care to a visitor, regard is to be had to all the circumstances, so that (for example) -

(a) where damage is caused to a visitor by a danger of which he had been warned by the occupier, the warning is not to be treated without more as absolving the occupier from liability, unless in all the circumstances it was enough to enable the visitor to be reasonably safe; and

(b) where damage is caused to a visitor by a danger due to the faulty execution of any work of construction, maintenance or repair by an independent contractor employed by the occupier, the occupier is not to be treated without more as answerable for the danger if in all the circumstances he had acted reasonably in entrusting the work to an independent contractor and had taken such steps (if any) as he reasonably ought in order to satisfy himself that the contractor was competent and that the work had been properly done.

4.8 The Forest Act, 2005

According to section 21 of the act, all forests in Kenya other than private and local authority forests are vested in the State, subject to any rights of user in respect thereof, which by or under this Act or other written law, have been or are granted to any other person. Pursuant to section 31 of the act, every local authority shall cause housing estate developers within its jurisdiction to make provision for the establishment of mini-forests at the rate of at least five percent (5%) of the total land area of any housing estate intended to be developed. Section 34 (2) provides that any person who fells, cuts, damages or remove, trades in or exports or attempts to export any protected tree, species or family of trees or regeneration thereof or abets in the commission of any such act commits an offence.

4.9 The Work Injury Benefits Act, 2007

According to section 7 (1) of the act, every employer is required to obtain and maintain an insurance policy, with an insurer approved by the Minister in respect of any liability that the employer may incur under the act to any of his employees. In addition, every employer carrying on business in Kenya shall within the prescribed period and in the prescribed manner register with the Director - section 8 (1). Pursuant to section 10 (2) of the act, it is the duty of

every employee to ensure his/her safety at the place of work and hence where an accident, not resulting in serious disablement or death, is caused by the deliberate and willful misconduct of the employee, such an employee is not entitled to compensation. However, according to section 12 if an employee is injured in an occupational accident or contracts an occupational disease while the employee, with the consent of the employer, is engaged in any organized first aid, ambulance or rescue work, fire-fighting or other emergency service, the accident or disease is for the purposes of this Act, deemed to have arisen out of and in the course of the employee's employment. In a circumstance where an accident occurs in the course of employment, section 21 makes it a requirement for a written or verbal notice of such an accident to be given by or on behalf of the employee concerned to the employer who shall send a copy of the notice to the Director within twenty four hours of its occurrence in the case of a fatal accident.

In line with section 22 (1), an accident that has occurred should be reported to the Director by the employer in the prescribed manner within seven days from the date of receiving a notice of the accident or having learned that an employee has been injured in an accident. Similarly, it is the responsibility of the employee to report to his/her employer the occurrence of an accident not later than 12 months from the date of such an accident or else the right to benefits, in accordance with section 27 (1), shall lapse if the accident is not reported within such a period of time (12 months). According to section 46 (1), the employer shall be responsible for availing necessary means of transport where an employee is injured in an accident, which necessitates his conveyance to a hospital medical facility and from a hospital or medical facility to his residence.

4.10 The Occupational Safety and Health Act, 2007

Under section 6 of the act, every occupier is obliged to ensure safety, health and welfare of all persons working in his workplace. The occupier shall achieve this objective by preparing and as often as may be appropriate, revising a written statement of his general policy with respect to the safety and health at work of his employees and the organization and arrangements for the time being in force for carrying out that policy (Section 7). He is also required to establish a safety and health committee at the workplace in a situation where the number of employees exceeds twenty (section 9) and to cause a thorough safety and health audit of his workplace to be carried out at least once in every period of twelve months by a registered safety and health Advisor (Section 11). In addition, any accident, dangerous occurrence, or occupational poisoning which has occurred at the workplace needs to be reported to the occupational safety and health officer of the respective area by an employer or self-employed person (section 21).

According to section 44, potential occupiers are required to obtain a registration certificate from the Director for all premises intended for use as workplaces. Such places shall be maintained in a clean state during the operation phase (section 47). To ensure machinery safety, every hoist or lift – section 63 and/or all chains, ropes and lifting tackles – section 64 (1d), shall be thoroughly examined at least once in every period of six months by a person approved by the Director of Occupational Health and Safety Services. Similarly, every steam boiler - section 67 (8) and/or steam receiver - section 68 (4) and all their fittings and/or attachments shall be thoroughly examined by an approved person at least once in every period of twelve months whereas every air receiver shall be thoroughly cleaned and examined at least once in every period of twenty four months or after any extensive repairs - section 69 (5). According to section 71 (3), every refrigeration plant capable of being entered by an employee also needs to be examined, tested and certified at least once in every period of twelve months by an approved person.

In relation to fire safety, section 78 (3) requires spillage or leaks of any flammable liquid to be contained or immediately drained off to a suitable container or to a safe place, or otherwise treated to make it safe. Furthermore, a clear and bold notice indicating that smoking is prohibited should be conspicuously displayed in any place in which explosive, highly flammable or highly combustible substances, are manufactured, used, handled or stored-section 78 (5). In addition, necessary precautions for dealing with fire incidents should be implemented including provision of means for extinguishing fire and means for escape, in case of fire, for the persons employed in any workplace or workroom – section 81. As far as disaster preparedness and emergency response program is concerned, section 82 (1) makes it a mandatory requirement for every occupier of a workplace to design evacuation procedures to be used during any emergency situation and to have them tested at regular intervals.

To promote health and safety of employees who are at risk of being exposed to chemical substances, section 84 (3) and 85 (4) requires every employer to maintain at the workplace material safety data sheets and chemical safety data sheets respectively for all chemicals and other hazardous substances in use and ensure that they are easily available to the employees. The employers' positive contribution towards the welfare of the employees include provision and maintenance of adequate supply of wholesome drinking water - section 91 and a first aid box or cupboard of the prescribed standard – section 95 at suitable point (s) conveniently accessible to all employees.

Other precautionary measures include: issuance of a permit to work to any employee, likely to be exposed to hazardous work processes or hazardous working environment, including such work processes as the maintenance and repair of boilers, dock work, confined spaces, and the maintenance of machinery and equipment, electrical energy installations, indicating the necessary precautions to be taken – section 96 (1); provision and maintenance for the use of employees, adequate, effective and suitable protective clothing including suitable gloves, footwear, goggle and head coverings in any workplace where employees are likely to be exposed to wet, injurious or offensive substance – section 101 (1).

4.10.1 The Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005 – Legal Notice N0.25

According to Rule 5, where noise in a workplace exceeds the continuous equivalent of eighty five dB (A) the occupier must develop and implement an effective noise control and hearing conservation programme which must be in writing and should address:

a) Noise measurement
b) Education & training
c) Engineering noise control
d) Hearing protection
e) Posting of notices in noisy areas
f) Annual programme review

Rule 8 provides that all noise measuring equipment should be regularly calibrated, maintained, inspected and operated according to manufacturer's instructions. Rule 10(2) requires occupiers to carry out regular inspection and maintenance of machines and installations to ensure that noise emission is prevented or controlled.

Rule 13 provides that where the noise level is above ninety (90) dB(A), the employer shall:
-Post a sign at the entrance to and in every room or conspicuous place, clearly and prominent marked "DANGER HEARING PROTECTION MUST BE WORN"
-Supply hearing protection to all persons required to enter such an area
-Ensure that all workers and any other person entering this area wear hearing protectors

4.10.2 The Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007

Rule 6(1) requires occupiers to ensure that highly flammable substances are stored:

a) In suitable fixed storage tanks in safe positions, or
b) In suitable closed vessels kept in a safe position in the open air, and where necessary, protected against direct sunlight; or
c) In suitable closed vessel kept in a storeroom which is either in a safe position or in a fire resisting structure;

Rule 23(1) requires fire drills to be conducted at least once in a year and records kept available for inspection. According to Rule 24, KenGen will be required to identify a location in the workplace where every worker shall assemble in the event of fire. Rule 29 obligates KenGen to Provide means of extinguishing fire at the workplace.

4.10.3 The Factories and Other Places of Work (Hazardous Substances) Rules 2007

Rule 12 (3) provides that every employer who uses any hazardous substances at work shall be in possession of a copy of material safety data sheet for each type of substance in use at his premises. Rule 13 (1) stipulates that every employer shall ensure that the quantity of waste from hazardous substances in his use are kept at reasonable minimum levels and that such waste is disposed of in a manner less harmful to human and the environment.

Rule 15 (1) provides that every employer shall facilitate the training of his worker on safety by a) instructing the workers how to obtain and use the information provided on labels and chemical safety data sheets and b) using the chemical data sheets along with information specific to the workplace, as a basis for the preparation of instructions to workers, which should be written if appropriate.

4.10.4 The Factories (Building Operations and Works of Engineering Construction) Rules, 1984.

Rule 7 requires every contractor who employs more than twenty persons to appoint a safety supervisor who should be experienced in the works being carried out at the site. Rule 48 (1) prohibits any timber or material with projecting nails to be placed or be allowed to remain in any place at a site where they are a source of danger to persons employed. Rule 55 (C) provides that properly maintained scaffolds or; where appropriate, ladders or other means of support which shall be sufficient and suitable for the purpose shall be provided, placed and kept in position for use where work cannot be safely done on or from the ground or from part of a building or other permanent structure.

Rule 109 (1) prohibits any crane, crab or winch to be used unless it has been tested and thoroughly examined by a competent person within the previous four years and no pulley block, gin wheel or sheer legs shall be used in the raising or lowering of a load weighing one tone or more unless it has been tested and thoroughly examined by a competent person.

Rule 132 provides that where a contractor has more than five persons in his employment on a site, he shall provide and keep clean and in good repair a sufficient number of suitable first aid boxes, which shall, while work is going on, be reasonably accessible to all positions on the site where persons in his employment are working.

4.11 The Public Health Act (Cap. 242)

Section 115 of the act prohibits causing nuisance or other condition liable to be injurious or dangerous to health. Section 118 provides a list of nuisances which includes any noxious matter, or waste water, flowing or discharged from any premises, wherever situated, into any public street, or into the gutter or side channel of any watercourse, irrigation channel or bed thereof not approved for the reception of such discharge.

4.11.1 The Public Health (Drainage and Latrine) Rules

Rule 85 provides that every owner or occupier of every workshop, workplace or other premises where persons are employed shall provide proper and sufficient latrines for use by employees. Rule 87 requires every contractor, builder or other person employing workmen for the demolition, construction, reconstruction or alteration of any building or other work in any way connected with building to provide in an approved position sufficient and convenient temporary latrines for use by such workmen. Rule 91 provides that no person shall construct a latrine in connection with a building other than a water closet or a urinal, where any part of the site of such building is within 200 feet of a sewer belonging to the local authority which is at a suitable level, and where there is sufficient water supply.

4.12 The Water Act 2002

Section 18 of this Act provides for national monitoring and information systems on water resources. Following on this, sub-Section 3 mandates the Water Resources Management Authority to demand from any person or institution, specified information, documents, samples or materials on water resources.

According to section 94 of the Act, it is an offence to throw or convey or cause or permit to be thrown or conveyed, any rubbish, dirt, refuse, effluent, trade waste or other offensive or unwholesome matter or thing into or near to water resource in such a manner as to cause, or be likely to cause, pollution of the water resource or side channel of any watercourse, irrigation channel or bed thereof not approved for the reception of such discharge.

4.12.1 Water Resources Management Rules, 2007, Legislative Supplement No.52.

Rule 23 (1) stipulates that any person whose works or water use activity falls within Category A is required to notify the Authority, prior to construction or installation of works. Rule 81

prohibits pollution of water by discharging or applying any poisonous, toxic, noxious or obstructing matter, radioactive waste or other pollutants into any water resource unless such discharge meets the permissible water quality standards recommended by Water Resources Management Authority (WRMA). Rule 88 provides that No person shall willfully and deliberately allow any substance to spill out into any water resource or onto land where such spillage may or is likely to contaminate any body of surface or groundwater.

4.13 The 1971 Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat.

The aim of Ramsar Convention is to stop the loss of wetlands and to promote their conservation and wise use as a means of achieving sustainable development. The convention provides that each state party shall designate at least one wetland for inclusion in a List of Wetlands of International Importance ("Ramsar List") and ensure the maintenance of the ecological character of each Ramsar site {article 2 (1)}.

Lake Naivasha is a Ramsar Site and since KenGen abstracts water from the lake for its activities, there is need to contribute towards its conservation.

4.14 The 1985 Vienna Convention for the protection of the Ozone Layer

The Vienna Convention for the Protection of the Ozone Layer, 1985 was adopted after consensus was reached on 22nd March 1985. The overall objective of the Vienna Convention is to protect human health and the environment against the effects of ozone depletion. As a framework convention, it does not establish any specific controls on ozone depleting substances. Instead, it establishes a general obligation upon the parties to protect the ozone layer (article 2) and emphasizes the need for international cooperation.

KenGen will be required to contribute towards protection of the ozone layer.

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

The Montreal Protocol on Substances that Deplete the Ozone Layer is a significant milestone in international environmental law. It establishes firm targets for reducing and eventually eliminating consumption and production of a range of ozone depleting substances. These substances are enumerated in Annexes A-E to the Protocol and are to be phased out within the schedule given in article 2A-2I. The 1987 Montreal Protocol's "Phase-Out" Timetable is as indicated in the table 10 shown below:

Table 10: Montreal Protocols "Phase-Out" Timetable of Substances that Deplete Ozone Layer

Substance	Industrial Countries' Reduction (%)	Developing Countries' Reduction (%)
CFCs	100% in 1996	0% in 1999
		20% in 2003
		50% in 2005
		85% in 2007
		100% in 2010
Halons	100% in 1994	0% in 2002
		50% in 2005
		100% in 2010

Carbon Tetrachloride	100% in 1996	85% in 2002
		100% in 2010
1,1,1-trichloroethane	100% in 1996	0% in 2003
		30% in 2005
		70% in 2010
		100% in 2015
HBFCs	100% in 1996	100% in 1996
HCFCs	0% in 1996	0% in 2016
	35% in 2004	100% in 2040
	65% in 2010	
	90% in 2015	
	100% 1n 2030	
Methyl Bromide	0% in 1995	0% in 2002
	25% in 1999	20% in 2005
	50% in 2001	100% in 2015
	70% in 2003	
	100% in 2005	
Bromochloromethane	100% in 2002	100% in 2002

Source: UNEP, 2006

The project proponent should ensure that the air conditioning system conforms to the requirements of this protocol.

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

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

Measures to prevent emission of greenhouse gases should be put in place.

4.16.1 The Kyoto protocol

The Kyoto Protocol was adopted in December 1997 at the third Conference of the Parties held in Kyoto. The Kyoto Protocol requires stronger commitments from Annex 1 parties to achieve quantified emission reductions within a specific timeframe. These commitments cover the six greenhouse gases listed in Annex A of the Kyoto Protocol (Carbon dioxide, Methane, Nitrous oxide, Hydrochlorocarbons, Perfluorocarbons and Sulphur hexafluoride). Each Annex 1 partys' particular 'quantified emission reduction target' is listed in Annex B.

4.2 KenGens' Capacity to Ensure Compliance with Legal and Regulatory Requirements

KenGen is fully committed to long-term environmentally sustainable development that is consistent with National and International standards. In line with this commitment, the company maintains and continually improves its Quality Management System (QMS) and Environmental Management System (EMS) based on ISO 9001:2008 and ISO 14001:2004 standards respectively.

The proposed project will be implemented in conformance with the existing documented QMS and EMS procedures. It will be the responsibility of the Project Implementation Team (PIT) to ensure that this is achieved. PIT will comprise of a team from KenGen, Kenya Power Company, Kenya Electricity Transmission Company Ltd, Project Consultants and the Ministry of Energy. In particular, KenGen PIT team will comprise of the project engineers and Environment Safety and Health personnel. Issues to do with implementation of the Environmental Management Plan will be discussed in toolbox meetings which will be held at the project site.

4.3 Plan for Compliance with Legal and Regulatory Requirements

Table 11 below provides the plan for compliance with legal and regulatory requirements during construction and operation phase of the proposed project.

Table 11: PLAN FOR COMPLIANCE WITH LEGAL AND REGULATORY REQUIREMENTS

OCCUPATIONAL SAFETY AND HEALTH ACT, 2007			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
9	Establish a safety and health committee at the workplace in a situation where the number of employees exceeds twenty	Incorporate staff from the power plant in the existing safety and health committee	KenGen
		Establish health and safety committees	Contractors
11	A thorough safety and health audit of the workplace to be carried out at least once in every period of twelve months by a registered safety and health Advisor	Safety and health audit for the proposed power plant to be carried out annually during operation phase of the project	KenGen
21	Report any accident, dangerous occurrence, or occupational poisoning which has occurred at the workplace to the occupational safety and health officer of the respective area	All accidents and/or incidents occurring at the construction site during construction phase and at the power plant during operation phase should be documented and reported to the District Occupational Health and Safety Officer, Naivasha	KenGen and Contractors
44	Obtain registration certificates from the Director for all premises intended for use as workplaces.	• Apply for registration certificates for the construction sites and site offices to the District Occupational Health and Safety Officer, Naivasha	Contractors
		• Apply for registration certificate for the power plant during operation phase	KenGen
47	All workplaces to be maintained in a clean state	Maintain the construction site and site offices in a clean state	Contractors
		Maintain the power plant in a	KenGen

		clean state	
OCCUPATIONAL SAFETY AND HEALTH ACT, 2007			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
49	Every workplace should be provided with adequate ventilation	Provide adequate ventilation in contractors site offices	Contractors
		Provide adequate ventilation in the design of the power plant during construction phase of the proposed project	KenGen
50	Every employer shall provide adequate and suitable lighting at every workplace	Provide adequate lighting in contractors site offices during construction phase of the proposed project	Contractors
		Provide adequate lighting in the power plant during operation phase	KenGen
52	Every employer should provide sufficient and suitable sanitary conveniences for employees and maintain them clean	Provide suitable washrooms for use by employees and employ someone to clean them regularly during construction and operation phase of the proposed project	Contractors and KenGen
64 (1d)	All chains, ropes and lifting tackles shall be thoroughly examined at least once in every period of six months by a person approved by the Director of Occupational Health and Safety Services.	All chains, wire ropes and cranes should be inspected by an approved government inspector twice in a year during construction and operation phase of the proposed power plant	Contractors and KenGen
69 (5)	Every air receiver shall be thoroughly cleaned and examined at least once in every period of twenty four months or after any extensive repairs	All air receivers should be inspected by an approved government inspector once in a period of two years during operation phase of the project	KenGen
74 (1)	All goods stored in a workplace shall be stored or stacked in	Materials in the stores should be well stacked to prevent fall	Contractors and KenGen

	such a manner as to ensure their stability and prevent any fall or collapse of stack	hazard	
OCCUPATIONAL SAFETY AND HEALTH ACT, 2007			
Relevant Section	**Relevant Section**	**Relevant Section**	**Relevant Section**
78 (3)	Spillage or leaks of any flammable liquid to be contained or immediately drained off to a suitable container or to a safe place, or otherwise treated to make it safe.	• Maintain appropriate spill response kits at the construction site • Spillage and leaks of flammable liquid including lubricants should be contained immediately	Contractors
		Maintain appropriate spill response kits at the power plant during maintenance operations	KenGen
81	Necessary precautions for dealing with fire incidents to be implemented including provision of means for extinguishing fire and means for escape, in case of fire, for the persons employed in any workplace or workroom	Appropriate firefighting equipment and emergency exits to be installed and appropriately marked at the contractors site offices during construction phase	Contractors
		Appropriate firefighting equipment and emergency exits to be incorporated in the design of the proposed power plant	KenGen
82 (1)	Design evacuation procedures to be used during any emergency situation and have them tested at regular intervals.	Document evacuation procedures for fire, flood and hydrogen sulphide incidents and have them tested at least once in a year during construction phase	Contractors
		Document evacuation procedures for potential hazards like fire, flood and hydrogen sulphide and have them tested at least once in a year during operation phase	KenGen
84 (3)	Ensure availability at the workplace of Material Safety Data Sheets for all chemicals and other hazardous	Material safety data sheets for all hazardous materials should be maintained at the point of use during construction and	Contractors and KenGen

	substances in use and have them easily available to the employees.	operation phase of the proposed project	
OCCUPATIONAL SAFETY AND HEALTH ACT, 2007			
Relevant Section	**Relevant Section**	**Relevant Section**	**Relevant Section**
91	Every occupier to provide and maintain an adequate supply of wholesome drinking water at suitable and accessible points	Wholesome drinking water should be provided at strategic points during construction & operation phase of the proposed project	Contractors and KenGen
95	Provide a first aid box or cupboard of the prescribed standard at suitable point (s) conveniently accessible to all employees in every workplace	First aid boxes to be provided at strategic points where they can be easily accessible during construction and operation phase	Contractors and KenGen
96 (1)	Issue permit to work to any employee, likely to be exposed to hazardous work processes or hazardous working environment, including such work processes as the maintenance and repair of boilers, dock work, confined spaces, and the maintenance of machinery and equipment, electrical energy installations, indicating the necessary precautions to be taken	Use of permit to work to be enforced during construction and operation phases	Contractors and KenGen
101 (1)	provide and maintain for the use of employees, adequate, effective and suitable protective clothing including suitable gloves, footwear, goggle and head coverings in any workplace where employees are likely to be exposed to wet, injurious or offensive	Staff to be provided with appropriate personal protective clothing during construction and operation phase	Contractors and KenGen

	substance		
102 (2)	Where electric arc welding is carried on, effective provision for screening or preventing employees from being exposed to electric arc flash should be provided	Welding screens to be provided for use by staff during construction and operation phase of the proposed project	Contractors and KenGen

The Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005 –Legal Notice NO.25

Relevant Section	**Relevant Section**	**Relevant Section**	**Relevant Section**
5	Where noise in a workplace exceeds the continuous equivalent of eighty five dB (A) the occupier must develop and implement an effective noise control and hearing conservation programme which must be in writing and should address: g) Noise measurement h) Education & training i) Engineering noise control j) Hearing protection k) Posting of notices in noisy areas l) Annual programme review	An effective noise control and hearing conservation programme should be implemented both during construction and operation phase of the proposed project	Contractors and KenGen
6 (2) (i)	Carry out measurements of noise at least once in every period of twelve months in order to determine the	Noise monitoring programme should be developed during construction and operation phase of the proposed project	Contractors and KenGen

	prevailing noise conditions		
7 (3)	All workers exposed to noise should be fully trained on the hazards involved, and instructed in the measures available for the prevention, control and protection against noise exposure	Training of staff and awareness creation to be carried out during operation phase of the proposed power plant	KenGen
8	All noise measuring equipment should be regularly calibrated, maintained, inspected and operated according to manufacturer's instructions	The noise level meters used for taking noise measurement during construction and operation phase should be regularly calibrated	Contractors and KenGen
The Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005 –Legal Notice N0.25			
Relevant Section	**Relevant Section**	**Relevant Section**	**Relevant Section**
10 (2)	Carry out regular inspection and maintenance of machines and installations to ensure that noise emission is prevented or controlled	Inspection and maintenance of machines and installations to be carried out as scheduled during construction and operation phase	Contractors and KenGen
12	Where noise cannot be controlled by engineering measures and exceeds ninety dB(A), the employer shall: a) Provide and maintain suitable hearing protection to the affected workers; and b) Ensure that the hearing protection is always worn correctly	Ear muffs and ear plugs to be provided to staff and visitors entering the power plant during operation phase of the proposed project	KenGen
13	Where the noise level is above ninety (90) dB(A), the employer shall: -Post a sign at the entrance to	Appropriate warning signs shall be posted at the entrance to the power plant during operation phase of the proposed project	KenGen

	and in every room or conspicuous place, clearly and prominent marked "DANGER HEARING PROTECTION MUST BE WORN" -Supply hearing protection to all persons required to enter such an area -Ensure that all workers and any other person entering this area wear hearing protectors		

The Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007			
Relevant Section	**Relevant Section**	**Relevant Section**	**Relevant Section**
6 (1)	Ensure that highly flammable substances are stored: d) In suitable fixed storage tanks in safe positions, or e) In suitable closed vessels kept in a safe position in the open air, and where necessary, protected against direct sunlight; or f) In suitable closed vessel kept in a storeroom which is either in a safe position or in a fire resisting structure; or g) In the case of a workroom where the aggregate quantity of highly flammable substances does not exceed 50 litres, in suitable closed vessels kept in a suitable placed cupboard or bin which is a fire resisting structure	Highly flammable substances for use during construction and operation phase of the proposed project should be stored safely	Contractors and KenGen
17 (1)	Provision of an emergency exit of at least 90 cm wide, in every workroom	Incorporate emergency exits in the design of the proposed Power plant	KenGen
17 (3)	Every fire exit door, gangway and exit staircase should be free of obstruction	All emergency exits provided in the proposed power plant should be kept free of obstruction during operation phase of the proposed project	KenGen
17 (4)	Every emergency exit to be distinctively and conspicuously marked in green letters of at least 15 cm in height	All emergency exits to be clearly marked during operation phase of the proposed project	KenGen

The Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007			
Relevant Section	**Relevant Section**	**Relevant Section**	**Relevant Section**
17 (5)	Ensure that every emergency exit route is clearly marked in writing or by signs indicating the direction of exit and that a drawing or map showing evacuation routes is posted in prominent positions in the workplace	A map showing evacuation routes within the proposed power plant should be conspicuously posted during operation phase of the proposed project	KenGen
20 (1)	Establish a fire fighting team that shall consist of:- -at least two persons where the number of workers is not more than ten -at least three persons, where the number of workers is between eleven and twenty five -at least five, where the number of workers is more than twenty five	An adequate team of fire marshals should be constituted and trained during operation phase of the proposed project	KenGen
21 (4)	Every member of the fire fighting team to undertake the basic fire safety training course within three months from the date of appointment into the fire fighting team	Training of designated fire marshals to be carried out during operation phase of the proposed project.	KenGen
21 (5)	Every member of the fire fighting team to undertake fire fighting refresher course at least once in every two years	Refresher course for the designated fire marshals to be carried out after every two years during operation phase	KenGen
23 (1)	Fire drills to be conducted at least once in a year and records kept available for inspection	Conduct fire drills annually during operation phase and maintain the reports at the	KenGen

		proposed power plant	
The Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007			
Relevant Section	**Relevant Section**	**Relevant Section**	**Relevant Section**
24	Identify a location in the workplace where every worker shall assemble in the event of fire	Emergency assembling points to be designated and marked outside the construction site and contractors offices during construction phase	Contractors
		Emergency assembling points to be designated and marked outside the proposed power plant during operation phase	KenGen
26 (1)	Provide suitable means of alerting persons in the workplace, in the event of a fire, and such means shall be made known to all workers	Fire alarm system to be provided in the design of the power plant	KenGen
28	Provide and maintain fire detection appliances	Smoke detectors to be provided in the design of the proposed power plant	KenGen
29 (1)	Provide means of extinguishing fire at the workplace	Fire protection equipment including portable fire extinguishers, sprinkler systems, hose reels and hydrants should be provided at the contractors offices during construction phase and at the proposed power plant during operation phase	Contractors and KenGen
29 (2)	The position of the means of extinguishing shall be distinctively and conspicuously marked	The positions of fire extinguishers should be well marked during construction and operation phase of the proposed project	Contractors and KenGen
29 (3)	Any portable fire extinguisher should be mounted at an easily accessible height of not less than 60 centimeters from the	All portable fire extinguishers should be mounted on the wall where they can be easily accessed	Contractors and KenGen

	floor		
The Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007			
Relevant Section	**Relevant Section**	**Relevant Section**	**Relevant Section**
30 (2) (a)	All means of extinguishing fire to be inspected and tested at least once in a period of one year	All fire protection equipment should be serviced annually during construction and operation phase	Contractors and KenGen
36	Fire safety audit to be undertaken by a fire safety auditor at least once in a year	Fire audit for the proposed power plant to be carried out annually by an approved fire auditor	KenGen
The Factories and Other Places of Work (Hazardous Substances) Rules, 2007			
Relevant Section	**Relevant Section**	**Relevant Section**	**Relevant Section**
8 (3)	Provide personal protective equipment to employees handling hazardous materials	Appropriate personal protective equipment to be provided to all staff during construction and operation phase of the proposed power project	Contractors and KenGen
12 (3)	Provide material safety data sheets for each type of hazardous material in use	Material safety data sheets for hazardous materials to be maintained at the point of use during construction and operation phase of the proposed power project	Contractors and KenGen
Environmental Management and Coordination Act (EMCA), 1999			
Section	**Requirement**	**Recommendation**	**Responsibility**
3	every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment.	Ensure a clean and healthy environment during construction and operation phase of the proposed project	Contractors & KenGen
46 (2)	Every District Environment Committee shall take measures, through	The company should intensify its efforts of promoting social afforestation both during	KenGen

	encouraging voluntary self-help activities in their respective local community, to plant trees or other vegetation	construction and operation phase of the proposed power project	
Environmental Management and Coordination Act (EMCA), 1999			
Relevant Section	**Requirement**	**Recommendation**	**Responsibilit**
68	The owner of the premises or the operator of a project for which an Environmental Impact Assessment study report has been made shall keep accurate records and make annual reports to the Authority describing how far the project conforms in operation with the statements made in the Environmental Impact Assessment study report submitted under section 58(2).	Annual environmental audits for the proposed power plant should be carried out annually and reports submitted to NEMA during operation phase	KenGen
87 (1)	No person shall discharge or dispose of any wastes, whether generated within or outside Kenya, in such manner as to cause pollution to the environment or ill health to any person.	Adequate measures to prevent environmental pollution should be put in place during construction and operation phase of the proposed project	Contractors and KenGen
93 (1)	No person shall discharge any hazardous substance, chemical, oil or mixture containing oil into any waters or any other segments of the environment contrary to the provisions of this Act or any regulations thereunder.	All hazardous waste including oily rags and used oil should be segregated, stored safely and finally disposed through NEMA licensed hazardous waste handlers during construction and operation phase of the proposed project	Contractors and KenGen

Environmental Management & Co-ordination (Impact Assessment and Audit) Regulations, 2003.			
34	Ongoing projects are required to be subjected to an environmental audit.	Environmental audit for the proposed power plant should be carried out annually and reports submitted to NEMA	KenGen
Environmental Management and Co-ordination (Waste Management) Regulations, 2006			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
4	prohibits dumping of waste in public places except in designated receptacles	Suitable solid waste containers and designated central collection points should provided during construction and operation phase of the proposed project	Contractors and KenGen
6	A waste generator must collect, segregate (hazardous waste from non-hazardous) and dispose waste in such a facility that shall be provided by the relevant local authority.	Segregation and appropriate disposal of waste should be carried out during construction and operation phase of the proposed project	Contractors and KenGen
Environmental Management and Coordination, (Water Quality) Regulations 2006			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
4 (2)	It is an offence for any person to throw or cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance in or near it, as to cause pollution.	Appropriate measures to prevent environmental pollution should be put in place during construction and operation phase of the proposed project	Contractors and KenGen
24	No person shall discharge or apply any poison, toxic, noxious or obstructing matter, radioactive wastes, or other pollutants or permit any person to dump or discharge	Appropriate measures to prevent environmental pollution should be put in place during construction and operation phase of the proposed project	Contractors and KenGen

	any such matter into water meant for fisheries, wildlife, recreational purposes or any other uses unless such discharge complies with the standards set out in the Third Schedule to these Regulations.		
The Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations, 2009			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
12 (1)	It is an offence for any person to operate a motor vehicle which- *(a)* produces any loud and unusual sound; and *(b)* exceeds 84 dB(A) when accelerating.	An inspection and maintenance schedule for all vehicles should be put in place during construction and operation phase of the proposed project	Contractors and KenGen
12 (2)	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.	Unnecessary hooting of vehicles during construction and operation phase should be prohibited	Contractors and KenGen
The Water Resources Management Rules, 2007 (Subsidiary Legislation to the Water Act No. 8 of 2002			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
81 (1)	No person shall discharge or apply any poisonous, toxic, noxious or obstructing matter, radioactive waste or other pollutants or permit any person to dump or discharge such matter into any water resource unless the discharge of such poisonous, toxic, noxious or obstructing matter, radioactive waste or pollutant has been treated to permissible standards authorized by the Authority.	Appropriate measures to prevent environmental pollution should be put in place during construction and operation phase of the proposed project	Contractors and KenGen
88 (1)	No person shall willfully and	All hazardous waste including	Contractors and

	deliberately allow any substance to spill out into any water resource or onto land where such spillage may or is likely to contaminate any body of surface or groundwater.	used oil should be segregated, stored safely and disposed through NEMA licensed hazardous waste handlers during construction and operation phase of the proposed project	KenGen

Public Health Act (Rev. 1986) Cap 242

Relevant Section	Requirement	Recommendation	Responsibility
115	Makes it an offence to cause nuisance or create unhygienic conditions in such quantity or manner as to be offensive or injurious or dangerous to health.	Measures to prevent nuisance or unhygienic conditions such as dust emission should be put in place during construction and operation phase of the proposed project	Contractors and KenGen

Local Government Act (rev. 2010) Cap 265

Relevant Section	Requirement	Recommendation	Responsibility
163 (6)	A local authority may cancel a business permit where, upon receipt of a written report from an inspector appointed under this Act or any other written law, finds that the business or trade to which it relates endangers the health or safety of the persons residing in the neighbourhood.	Appropriate measures to prevent negative impacts during construction and operation phase of the proposed project should be put in place	Contractors and KenGen

The Water Act (2002)

Relevant Section	Requirement	Recommendation	Responsibility
94	Makes it an offence to pollute any water resource.	Appropriate measures to prevent environmental pollution should be put in place during construction and operation phase of the proposed project	Contractors and KenGen

The Work Injury Benefits act, 2007			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
7 (1)	Every employer is required to obtain and maintain an insurance policy, with a reputable insurance company in respect of any liability that the employer may incur under the act to any of his employees	Appropriate insurance cover for construction and power plant staff should be obtained during construction and operation phase of the proposed project	Contractors and KenGen
The Work Injury Benefits act, 2007			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
45 (1)	An employer shall provide and maintain such appliances and services for the rendering of first aid to his employees in case of any accident	Adequate number of first aid kits should be maintained at the construction site and the proposed power plant during construction and operation phase	Contractors and KenGen
Occupiers Liability Act (Cap 34)			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
2	Requires an occupier of premises to owe the "common duty of care" to all visitors	Adequate measures to ensure health and safety of staff and visitors during construction and operation phase should be put in place	Contractors and KenGen
4	In determining whether the occupier of premises has discharged the common duty of care to a visitor, regard is to be had to all the circumstances, so that (for example) - (a) where damage is caused to a visitor by a danger of which he had been warned by the occupier, the warning is not to be treated without more as absolving the occupier from liability, unless in all the	• All visitors to the construction site and the power station should be subjected to mandatory safety induction prior to access • The contractors to be employed during construction phase of the proposed project should be competent enough in discharging their duties	KenGen and contractors

	circumstances it was enough to enable the visitor to be reasonably safe; and (b) where damage is caused to a visitor by a danger due to the faulty execution of any work of construction, maintenance or repair by an independent contractor employed by the occupier, the occupier is not to be treated without more as answerable for the danger if in all the circumstances he had acted reasonably in entrusting the work to an independent contractor and had taken such steps (if any) as he reasonably ought in order to satisfy himself that the contractor was competent and that the work had been properly done.		
The constitution of Kenya, 2010			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
Article 42	every person has the right to a clean and healthy environment, which includes the right: (*a*) to have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69; and (*b*) to have obligations relating to the environment fulfilled under Article 70.	Appropriate measures to ensure a clean and healthy environment should be put in place during construction and operation phase of the proposed project	Contractors and KenGen
The Energy Act, 2006			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
27 (1)	a licence or licences as the case may be, shall be required for the: (a) generation, importation or	Apply to the Energy Regulatory Commission (ERC), for a licence to generate electrical energy from the proposed power plant during operation phase	KenGen

	exportation, transmission or distribution of electrical energy; or (b) supply of electrical energy to consumers: Provided that for undertakings involving a capacity not exceeding 3,000 kW, the provisions of subsections (2), (3) and (4) shall apply.		
The Energy Act, 2006			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
38 (1)	a person shall not carry out any electrical installation work unless the person is licensed by the ERC as an electrician or an electrical contractor.	All electrical contractors for the proposed power project should be licensed by ERC as electrical contractors	Contractors
Geothermal Resources Act (Cap 12)			
16	the holder of a geothermal resources license shall be liable for any loss, damage or injury to any person or property resulting from his works or operations, whether as a result of negligence or otherwise.	Due diligence shall be exercised when carrying out operations during construction and operation phase of the proposed project	Contractors and KenGen
The Geothermal Resources Regulation, 1990			
Regulation 13	all geothermal operations shall be conducted in a workman-like manner in order to: i. prevent the unnecessary waste of or damage to geothermal or other energy and mineral resources; ii. protect the quality of surface waters, air, and other natural resources, including wildlife, soil, vegetation and natural	Appropriate measures to promote energy conservation and to ensure health and safety should be put in place during construction and operation phase of the proposed power project	Contractors and KenGen

	history; iii. protect human and wildlife resources from unacceptable levels of noise; iv. prevent injury to life; and v. prevent damage to property;		
The Factories (Building Operations and Works of Engineering Construction) Rules, 1984.			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
Rule 7	requires every contractor who employs more than twenty persons to appoint a safety supervisor who should be experienced in the works being carried out at the site.	A responsible person should be appointed to manage all safety issues at the construction site	Contractors
Rule 48 (1)	prohibits any timber or material with projecting nails to be placed or be allowed to remain in any place at a site where they are a source of danger to persons employed.	Timber or any other material with projecting nails should be removed from the construction site	Contractors
Rule 55 (C)	provides that properly maintained scaffolds or; where appropriate, ladders or other means of support which shall be sufficient and suitable for the purpose shall be provided, placed and kept in position for use where work cannot be safely done on or from the ground or from part of a building or other permanent structure.	Properly maintained scaffolds and ladders shall be used when working at heights during construction and operation phase	Contractors and KenGen
109 (1)	prohibits any crane, crab or winch to be used unless it has been tested and thoroughly examined by a competent person within the previous four years and no pulley block, gin wheel or sheer legs shall be used in the raising or lowering of a load weighing	All lifting equipment should be tested and thoroughly examined by an authorized person	KenGen and Contractors

	one tone or more unless it has been tested and thoroughly examined by a competent person.		
Rule 132	provides that where a contractor has more than five persons in his employment on a site, he shall provide and keep clean and in good repair a sufficient number of suitable first aid boxes, which shall, while work is going on, be reasonably accessible to all positions on the site where persons in his employment are working.	Adequate number of first aid kits should be provided during construction and operation phase	KenGen and Contractors
Wildlife (Conservation and Management) Act (Cap 376)			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
13	It prohibits the following: 1. unlawful persons from hunting any animal in a National Park 2. conveying into a National Park, or being within the area thereof, while in possession of, any weapon, ammunition, explosive, trap or poison without authorization 3. (b) Cutting, injuring or setting fire to any vegetation in a National Park, or allowing any fire lighted by a person or his servants to enter a National park (i) Clearing, cultivating or breaking up for cultivation any land in a National Park	• Poaching of wild animals shall not be allowed • Carrying of weapons, explosive, ammunition or trap into the park without authorization shall not be allowed • Unnecessary destruction of vegetation in the park shall not be allowed during construction and operation phase of the proposed project	Contractors and KenGen
The Wildlife (Conservation and Management) (National Parks) Regulations-(Regulation under section 16 of the act)			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**

5	the following are prohibited acts. (1) Except with the special permission of the Director or an officer of the Service duly authorized, no person shall - *(a)* enter or leave any National Park elsewhere than at a place approved by the Director as an entrance or exit; or *(b)* be within any National Park unless he is in a stopping place, or unless he is in a motor vehicle designed to travel on not less than four wheels; or *(c)* be within any National Park or any portion thereof between the hours of 7.15 p.m. and 6 a.m.; or *(d)* drive, or cause to be driven, a motor vehicle at a speed greater than 40 km an hour; or *(e)* cause a vehicle to be stopped on any road in such a manner as to obstruct or impede the passage of any other vehicles; or *(f)* drive or cause to be driven, a motor vehicle than on open and maintained roads; or *(g)* alight from or get out of, or stand up in/on a motor vehicle, except in a stopping place; or *(h)* display any notice or	• Entry and exit to and from the park shall be through the KWS Olkaria gate • Motor cycles shall not be allowed within the park • Park speed of 40km/hr shall be observed • Drive vehicles on designated access roads • Ferrying of workers behind trucks shall not be allowed • Any person carrying out trade within the park shall be required to obtain approval from KWS	Contractors and KenGen

	advertisement within a National Park, or on any boundary of a National Park; or *(i)* collect any money from members of the public, or sell any goods, or offer any goods for sale, or purchase any goods or carry on any trade, within a National Park.		
The Wildlife (Conservation and Management) (National Parks) Regulations-(Regulation under section 16 of the act)			
Relevant Section	**Requirement**	**Recommendation**	**Responsibility**
Regulation 6	Except with the special permission of the Director or an officer of the Service, or of a duly authorized agent of the Director, no person, while within any National Park shall - *(a)* discard any refuse or litter; or *(b)* in any other way disfigure the National Park or part thereof; or *(c)* unnecessary cause or make any noise or do any act which is likely to disturb or annoy any other person.	• Sound management of waste is required • Unnecessary hooting of vehicles during construction and operation phase should be avoided	KenGen and Contractors
Grass Fires Act (Cap 327)			
3 (2)	It provides that no person shall willfully or negligently kindle any fire which by spreading may damage or destroy the property of any other person.	Lighting of fire should be controlled and appropriate fire fighting equipment should be maintained on site during construction and operation phase of the proposed project	KenGen and Contractors
THE ENERGY (ENERGY MANAGEMENT) REGULATIONS, 2012			

6 (1)	The owner or occupier of a facility shall cause an energy audit of the facility to be undertaken by a licensed energy auditor at least once every three years.	An energy audit for the proposed power plant shall be carried out at least once in a period of 3 years and submit to ERC during operation phase of the proposed project	KenGen
8 (1)	The owner or occupier of a facility shall take measures to realize at least fifty percent of the identified and recommended energy savings specified in the energy investment plan by the end of three years and thereafter at every audit reporting date.	Appropriate energy conservation measures shall be implemented during operation phase of the proposed project	KenGen

CHAPTER 5: BASELINE INFORMATION

5.1 Project Location

The proposed Olkaria I Unit 6 will be located next to Olkaria I Units 4 & 5 which is currently under construction. The proposed site is located within the Hell's Gate National Park which was gazetted in 1984. The park was gazetted after geothermal development had already started. The first two units of the Olkaria geothermal power plant were commissioned in 1981 and 1982 respectively. Administratively, the site is located in Olkaria sub-location, Hell's Gate location, Naivasha division in Naivasha District, Nakuru County.

The Olkaria geothermal field is located 6 km to the south of Lake Naivasha in Kenya's Rift Valley, and occupies a circular area of about 68.25 km^2.

5.2 Climate

Lake Naivasha and its environs fall under Eco-climatic Zone IV which is described as environmentally fragile and prone to land degradation. The mean minimum monthly temperature in the project area has been recorded to range from 15.9 - 17.8°C with a mean of 16.8°C. The mean monthly maximum temperatures range from 24.6-28.3°C. July is the coldest month while the hottest month is February.

The monthly distribution of rainfall is governed by the movement of Inter-Tropical Convergence Zone (ITCZ). This results in a bimodal pattern of rainfall distribution with long rains in March, April and May while the short rains are received in the months of October and November. Generally, the floor of the Rift Valley has lower rainfall than the flanking highlands. This area experiences a double rain shadow effect from the west and east flanking escarpments (Mau and Aberdare Range / Kinangop respectively). Rainfall in the project area and its environs is generally low, recording an average of 634 mm annually. Evaporation exceeds precipitation almost throughout the year. It ranges from approximately 1,700 mm per year in areas around the lake to approximately 1,000 mm per year on higher ground, with variations from year to year.

Since 1984, KenGen has been collecting rainfall information at four sites close to the project site namely X-2 , Olkaria I Administration offices, Olkaria North East and Lake View Estate near the geochemistry and environmental labs . The average rainfall totals at these sites are 724, 715, 703 and 695 mm for X-2, Olkaria I administration offices, Olkaria North East and Lake View respectively. Thus there is little variation in the annual rainfall totals.

5.3 Hydrology and the water balance

The proposed site is approximately 6 km to the south of Lake Naivasha which is the largest water body in the area comprising of four lakes: Lake Naivasha, (145 Km^2), Crescent Island (2.1 Km^2), Oloiden (5.5 Km^2), and Sonachi (0.6 Km^2). The lakes are hydrologically connected either at the surface or by groundwater flow. The Crescent Island, the deepest part of the Lake (18 m depth) can be connected to the main lake, depending on lake levels. Oloiden is a smaller

lake to the south end of Lake Naivasha, and depending on lake levels, can be distinct from the main lake. The main lake is shallow (max. 8 m). Further, Crater Lake or Sonachiis located near the south-western part of Lake Naivasha, is independent from the main lake.

The main Lake is fed by two perennial rivers namely the Malewa and Gilgil rivers discharging 80% and 20% respectively, of the total flow. The Karati river drains the area east of the lake, being ephemeral and flowing approximately two months per year. The area south of Lake Naivasha does not produce much runoff reaching the lake. The drainage from the Mau Hills and Eburru to the west infiltrates before it reaches the lake.

The Lake exhibits a dynamic behavior. Its water level follows the long cycles of wetter and dry periods with an amplitude of about 12 m over the last 100 years. The lake fluctuates with time. According to Harper et al (1990), the lake level fluctuations have not been found to show any direct relationship with local rainfall, except that periods of exceptionally high rainfall when the level rises. Annual evaporation always exceeds rainfall (Ase et al.,1986). However, Vincent et al, (1979) suggested that the lake's level rise is an indicator of the long term pattern of high altitude climate, particularly the penetration of equatorial westerlies and the influence on land above 2500 masl. Evidence of this hypothesis came from the monthly correlation of lake level changes with precipitation data from high altitude meteorological stations (at 2700m), and the correlation of lake level with the altitude of the snow of the Lewis Glacier on Mt Kenya.

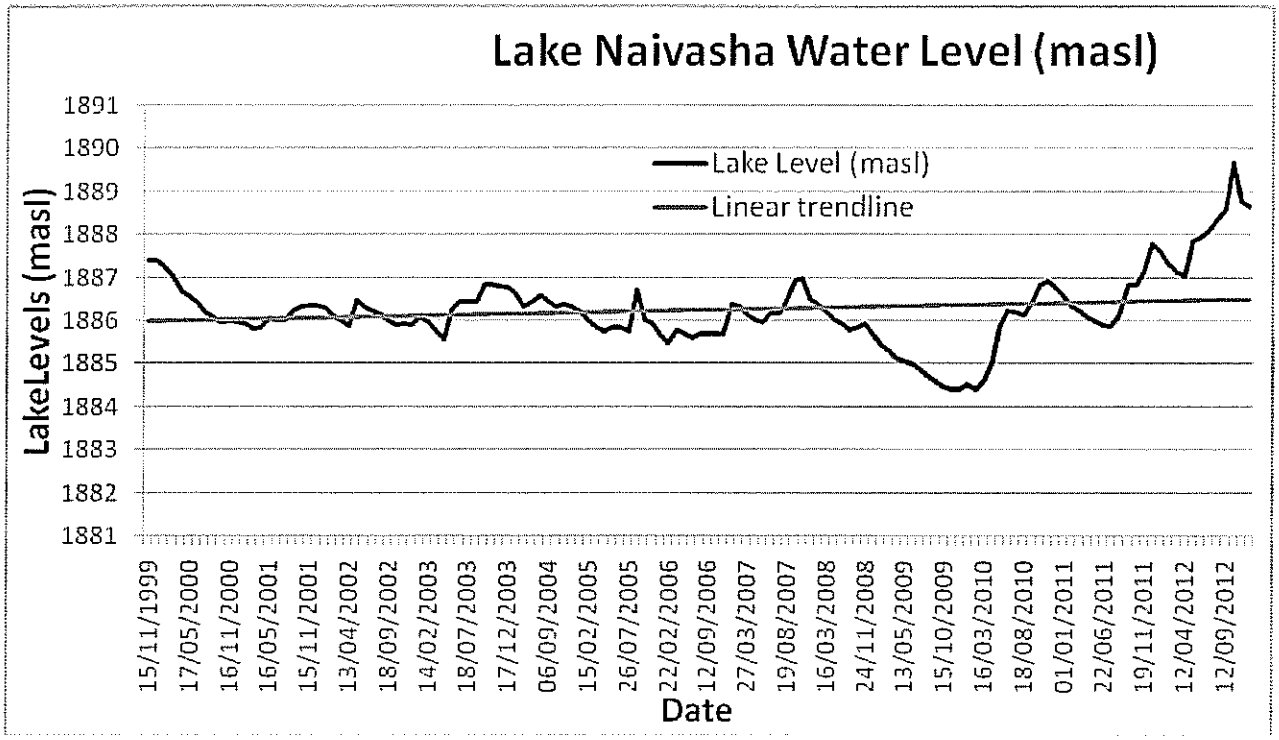


Figure 4: Lake Naivasha Water Level (masl)

Source of data: Environment Section, Olkaria Geothermal Project

The lake level follows a gentle upward trend as per the data collected between November 1999 and December 2012 (figure 4). The highest level of 1889.69 masl was recorded in December

2012 while the lowest level of 1884.40 masl was recorded in February 2010. The lake level fluctuated by ~ 5.29 m recorded between the period November 1999 and December 2012

Although the lake has no surface outlet, it is thought to have some underground outflow and this explains the freshness of the lake water.

The water balance of the lake has been calculated with a water balance model (Mmbuie, 1999). The water balance is calculated for the period 1934-1983 (Table 12), representing the period when water abstraction was minimal.

Table 12: Lake Naivasha Water Balance (1934-1983), Mmbuie, 1999)

Rain	Surface water flow	Evaporation	Groundwater flow
95	220	260	55

From the water balance, evaporation accounts for most of the water lost from the lake. Abstraction could contribute minimal water losses from the Lake Naivasha

5.4 Lake Naivasha Water Quality

Sampling was done at Lake Naivasha near Kamere beach. Full chemical analysis was undertaken as per the recommended procedures for water quality testing. The results were compared against drinking water quality standards provided by Kenya Bureau of Standards (KEBS). From the result shown in Table 13 below, the water is well mineralized, however with high colour and turbidity exceeding the recommended standards.

In order to make the water wholesome full treatment is recommended. The treatment will entail sedimentation to allow for suspended particles to settle, followed by coagulation with aluminum sulphate to coagulate fine particles, this will be followed by filtration and finally disinfection with chlorine in order to kill microorganism. In order to ensure safety of the users at all times, a minimum of 0.2 ppm of free chlorine should be maintained at the consumer tap.

Table 13: Water Quality Results for Lake Naivasha

Parameters	**Units**	**Results**	**Recommended Drinking Water Quality Standard (KEBS)**
pH	PH scale	7.06	6.5 -8.5
Colour	Mgpt/l	20	15
Turbidity	N.T.U	16.29	5
Permanganate Value (20min boiling)	MgO_2/l	-	1.0
Conductivity	µS/cm	317	500
Iron	mgFe/l	0.25	0.3
Manganese	mgMn/l	0.10	0.1
Calcium	mgCa/l	8	250
Magnesium	mgMg/l	5.76	100
Total Hardness	mg$CaCO_3$/ I	48	500
Total alkalinity	mg$CaCO_3$/ I	160	500
Chloride	mgCl/l	18	250
Fluoride	mgF/l	0.88	1.5
Nitrite	mgN/I	<0.001	3
Nitrate	mgN/I	0.30	10
Ammonia	mgN/I	0.37	0.5
Sulphate	mgSO_4/I	1	400
Orthophosphate	mgP/I	0.08	4
Total Suspended Solids	Mg/I	31	30
Free Carbon Dioxide	mgCO_2/I	6	

Total Dissolved Solids	Mg/I	220	1200

Source: Water Quality Analysis Report by WRMA, Nakuru (16/7/2012)

5.5 Water abstraction from Lake Naivasha

Lake Naivasha bears tremendous importance in the project area as a source of freshwater. The wetland associated with the lake provides a habitat for a wide range of aquatic flora and fauna. The water from the lake and the associated aquifers is utilized for, among others, domestic use, watering of livestock, irrigation of agricultural land, construction, geothermal drilling and process activities.

According to Sayeed (2001), the total area of irrigated land stands at 5,000 ha, as shown in Table 14. However, Lake Naivasha Growers Group (LNGG) estimates the total irrigated area to be much less, probably ranging between 1,500-2,000 ha.

Table 14: Water Abstractions for Different Crops

Crops Irrigated	Area (ha) Irrigated	Irrigation Application (m^3/ha/day)	Total Irrigation Application (m^3/yr)
Flower (open)	952.2	63.34	22,014,007
Flower (greenhouse)	613.6	50.0	11,198,200
Vegetables	1623.1	34.67	20,539,600
Fodder	756.4	16.58	4,577,506
Wheat	164.3	25.12	1,506,434
Grass	561.3	16.58	3,396,819
Macadamia nuts	360.7	3.34	439,729
Total Agricultural Crops	5031.6	29.95	63,672,295
Water Abstraction other than Irrigation	**1,508,439**		
Total Water Abstraction	**65,180,734**		

Source: Sayeed (2001)

Abstraction of water for irrigation is taken through pumping directly from the lake, and accounts for 97.7% of the water abstracted from the lake. The most important issue with regard to water resources of Lake Naivasha is the sustainable rate of water abstraction from the lake. In 1990 the total abstraction of water from the lake estimated on the basis of power consumption in pumping was 59.3 x106 m^3 (Sinclair Knight et al, 1994).

Olkaria Power Project abstracts water from the lake for use in drilling wells and for other uses in the power station operations, as well as for domestic use in the company offices and the housing estates. The highest volume of water has been abstracted between the years 2008-2012, which marked the climax of geothermal drilling activities at Olkaria. However, this has been supplemented through the use of brine for drilling.

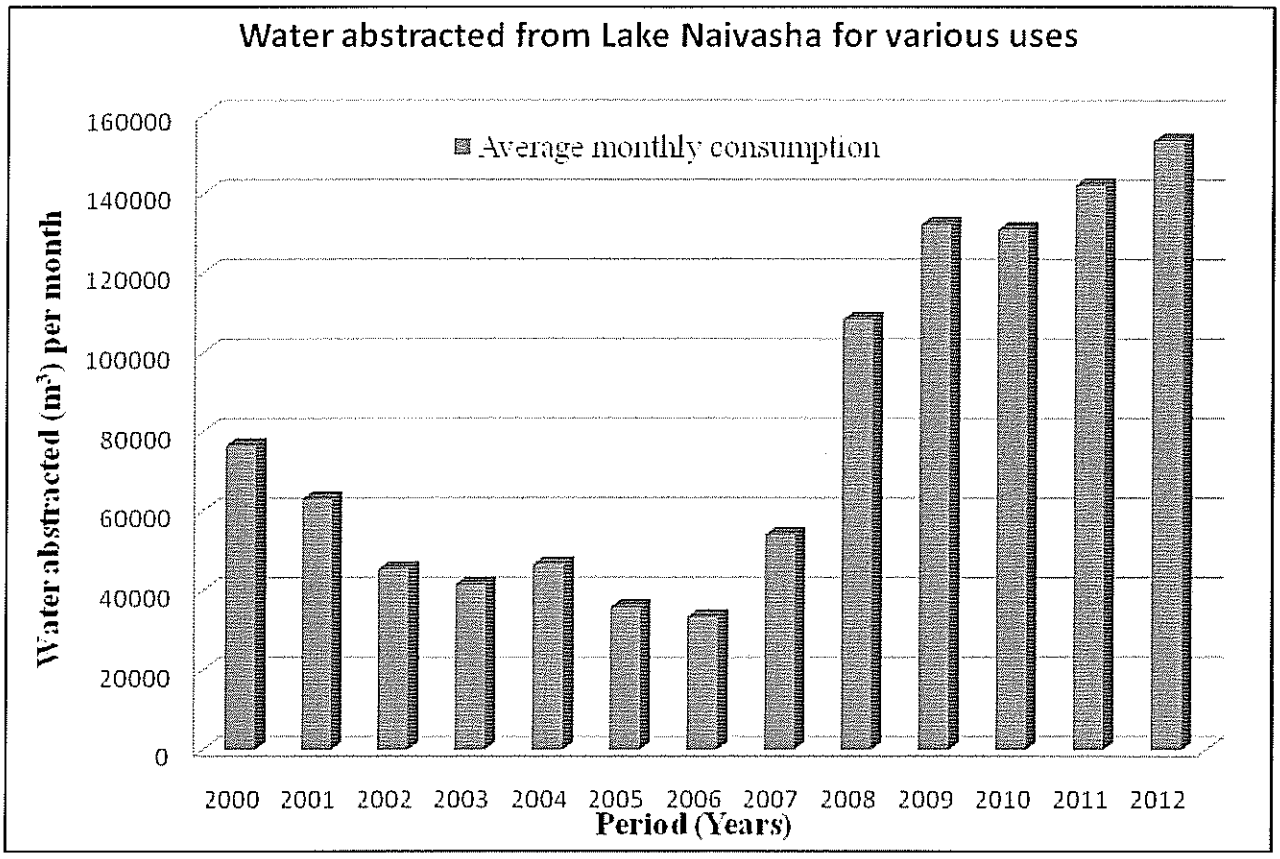


Figure 5: Monthly Abstraction from Lake Naivasha for Various Usess at Olkaria

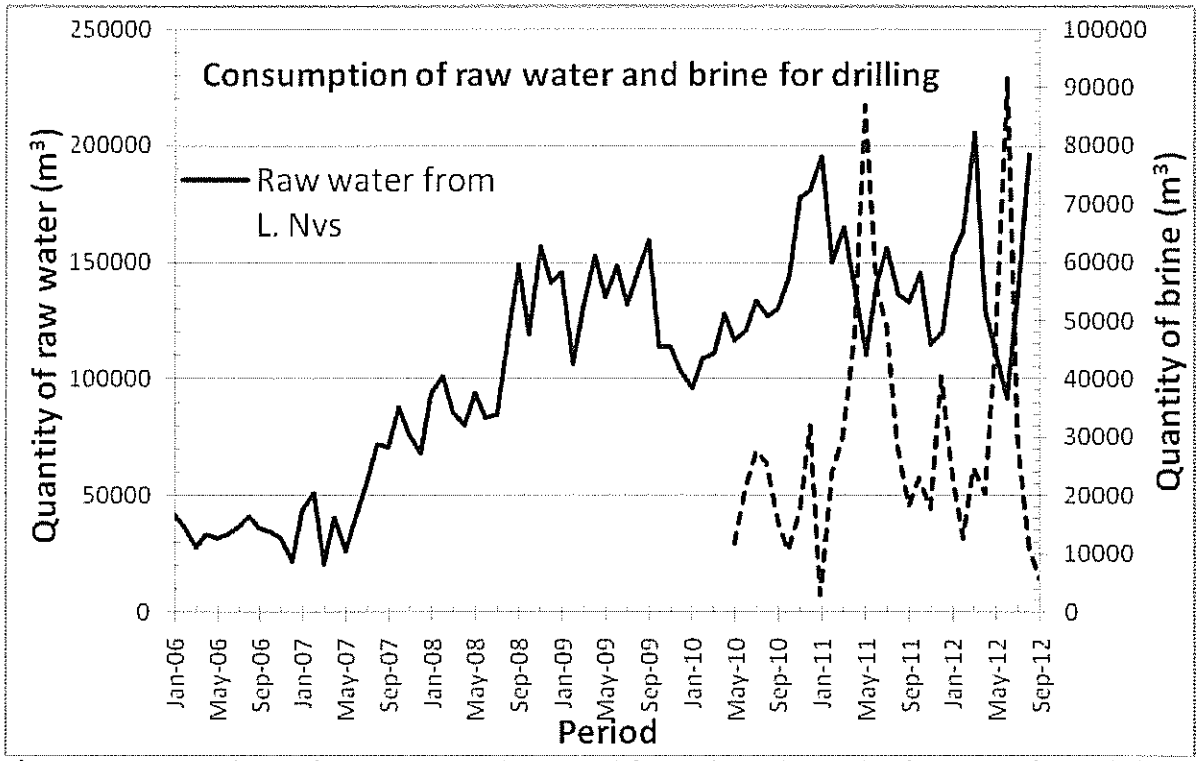


Figure 6: Comparison of Raw Water Abstracted from the Lake and Brine Used for Drilling

Brine has been used for drilling purposes so as to supplement the raw abstracted water abstracted from the lake since 2010. This has drastically reduced our abstraction rates from the Lake, considering that geothermal drilling activities have increased. Water recycling techniques while drilling have also been incorporated.

In the proposed project, raw water from the lake will only be used during construction phase of the project and for the initial start up of the power plant . Thereafter, steam will be condensed from the condenser for use at the cooling towers and hence little raw water will be required from the lake for running of the power plant. Except in cases when maintaining the cooling towers which may be undertaken at least once in every two years. It is important to note that some of the production wells for Unit 6 have already been drilled while some are being drilled

5.6 Hydrogeology of Lake Naivasha

Ground water is recharged laterally from the high rift flanks and axially along the floor southwards. The rift flanks, the grid faulting and tectono-volcanic axis along the rift floor

control the hydrogeology of the rift valley. The grid faulting acts as a channel for ground water or they provide barriers to lateral flow. Thus faulting causes the groundwater to flow from escarpments to the center and then follow longer flow paths reaching greater depths, and aligning their flow to Lake Naivasha. Water table is deeper towards the south (Lagat, 2003).

Though the rocks, particularly lacustrine sediments are very porous (Thompson and Dodson 1963), the water table is deep of between 100-266m. The region is water scarce area and the available water could be saline when found (Randel and Johnson, 1991). Research carried out indicates that geothermal reservoir cannot co-exist with groundwater. Thus, at Olkaria geothermal field, no groundwater exists.

5.7 Topography

The project area, including Lake Naivasha and environs, is situated in the floor of the Great Rift Valley. The Lake Naivasha basin covers an area of 3,400 km^2 and the lake itself stands at around 1,885 metres above sea level (masl). The lake basin is bound to the west by the Mau Escarpment (3,080 masl), and to the south and south east by the Olkaria and Longonot Mountains. To the east of the lake basin is the Kinangop Plateau. The Nyandarua (Aberdare) Range (3,900 masl) lies to its north and north east and the Eburru volcanic pile flanks the western side of lake basin. The general topography of the study area is characterised by a wide range of features associated with volcanic activity. They include craters, remnants of preexisting craters, fault scarps, fissures and steam jets.

The Olkaria area where the geothermal station is located comprises volcanic features that consist of steep sided domes formed from pyroclastic rock and lava flows. The domes enclose an approximately circular depression that has been cut by the Ol Njorowa Gorge, which was formed by out flowing water from Lake Naivasha. The Olkaria I and II Power Stations are located in the centre of the depression. Within this complex, there are several small valleys that drain the upper slopes and discharge runoff and sediments to the foot slopes and plains below.

To the north of Olkaria, the topographical features are dominated by depressions of four water bodies including the Crescent Island, the main Lake, Lake Oloidien and Crater Lakes.

5.8 Geology

The geology of Lake Naivasha area has been described by Thompson and Dodson (1958). The geology is dominated by the formation of the Great Rift Valley when the volcanic material of Pleistocene Age was extruded forming the base material. Subsequent sedimentation and additional volcanic activity have resulted in a mixture of sedimentary material consisting of sands, clays, and air fall pyroclastics including pumice. Recent lava material is still visible on the surface towards the south of the Olkaria field.

Along the floor of the Rift Valley, the most common rocks are basically quaternary deposits mainly the pyroclastic rocks, which consist of tuffs and ashes. The tuffs are usually medium to pale grey in colour but are sometimes green, yellow, pink or purple, occasionally calcified and brown when weathered. The tuffs are quarried for building purposes. The lavas are also a major geological feature of the Rift Valley. They range from under saturated basic rocks (tephrites) to acid rocks (rhyorites and obsidians) with numerous gradations in between.

Close to the project area, the geology is complex and usually consists of several geological formations. Around the Olkaria area, rocks are volcanic with lake and fluvatile sediments. The volcanic rocks in the area consist of tephrites, basalts, trachytes, phonolites, ashes, tuffs, agglomerates and the acid lava rhyolite, commendite and obsidian. The lake beds are mainly composed of reworked volcanic material or sub-aqueously deposited pyroclastics. Figure 7 below shows the geological map of Olkaria area.

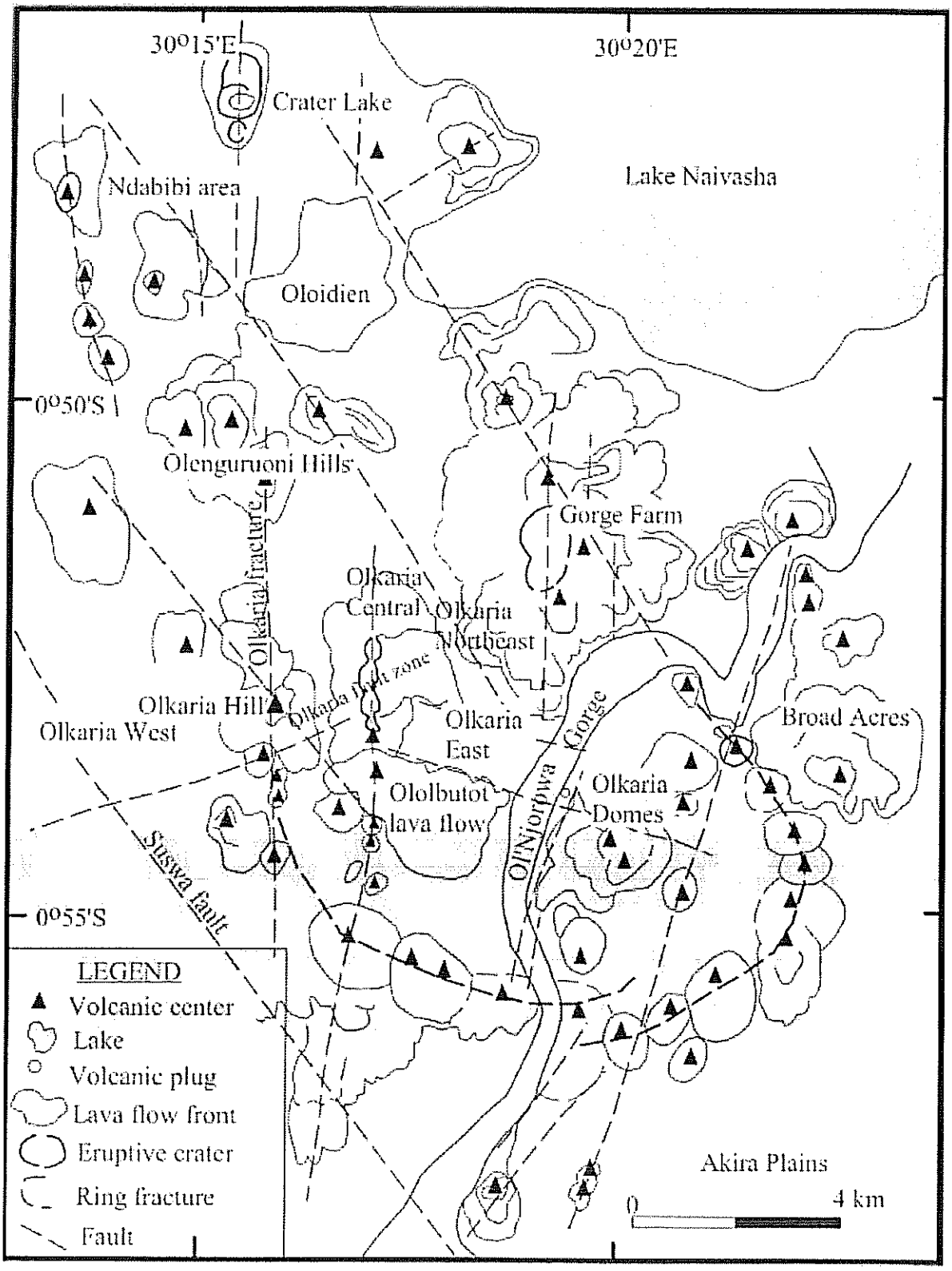


Figure 7: Geological Map of Olkaria

5.9 Soils

The intricate soil structure and striking differences in physical properties including its colour is a by-product of the interaction of climate, geology, geomorphology and altitude. The soils are of volcanic origin, mainly of mixed assemblage of acid and basic lavas. Superficial soils occur in the fault troughs of the grid-faulted area. The soils in Lake Naivasha are very porous resulting in the aridity of the land. Sombroek et al. (1982) on basing his classification on soil texture has divided these soils into osols, cambisols, planosols and phaezeoms.

Where pyroclastics are of very recent volcanic activity the soils present are very deep, dark reddish-brown to dark brown well drained andosols. They are very friable and smeary with a texture of clay loam to clay, with thick acid humic topsoil. The planosols and phaezeoms soils are found on the plateaus of 8 per cent average slope on a high level flat to gently undulating structural plain. These soils are developed on volcanic ashes and pyroclastics of recent volcanoes.

The poorly drained planosols are mottled clay under silty loam layer. The well drained phaezeoms are a complex of deep of 80-120 cm thick soils to very deep of 120-180 cm of very dark grayish brown to black that are firm and moderately calcareous cracking clays. Cambisols are found on the minor hill scarps. They are mainly clay loam in texture and well drained with a few outcrops.

Thus the soils of the Lake Naivasha basin are volcanic in origin, mainly derived from mixed assemblage of acid and basic lavas. The lake sediments are composed of a mixture of volcanic ash, reworked volcanic material and autochthonous organic matter. Along the south eastern shore of Lake Naivasha, diatomite up to 1-2 metres thick is present, while in the north and north-eastern shores, silts, clays and recent deposits are common.

5.9.1 Soil Contamination

The Environmental Section at Olkaria has monitored concentrations of elements of environmental significance in soil since 1993. The analysis for elements of significance in soil is carried out on a quarterly basis. Considering the period of September to December 2011, the results are as summarized in Table 15 below:

Table 15: Range of Chemical Elements of Environmental Significance in Soil, 2011

Location	Ba (ppm)	B (ppm)	Cd (ppm)	Cu (ppm)	Pb (ppm)	Li (ppm)	Zn (ppm)
OW-10	0.0561		0.0231	0.0181	0	0.654	0.642
Oserian Jetty	0.554		0.00161	0.0031	0.217	0.568	0.324
Naivasha G.K. Prisons	0.09	0	1.22	4.75	2.29	0	4.49
Kamere Beach	1.07	0	1.215	1.56	0	0	0

River Gilgil	1.19	0	1.35	0.89	0	0	5.66
River Malewa	0.37	0	1.72	0.68	0	0	5.36
WB guidelines	**100**		**0.1**	**0.5**	**0.1**		**1**
NEMA guidelines	**10**		**2**	**0.01**	**1.5**		**5**

Source: KenGen Olkaria Geothermal Power Project, Environment Section

The results of soil samples taken from well OW-10 which is within the Olkaria geothermal field was found to be within the guidelines of WB and NEMA. The limits of Cu and Pb at Naivasha G.K. prisons were above the recommended limits. This may be attributed to agricultural and industrial activities in the lake basin that may influence the concentration of various elements in the soil.

5.10 Chemical Environment

5.10.1 Air Quality

Carbon dioxide and methane are greenhouse gases that have global climate impacts. Apart from being a greenhouse gas, carbon dioxide combines with moisture in the air to form carbonic acid, which is a weak acid. Depending on the amount of the acid formed, pH values of rainwater may be lowered. Normal precipitation has pH values between 5.6 and 5.65 due to the presence of carbon dioxide in the atmosphere. Long exposure of high concentration of carbon dioxide has serious impact on human beings. Studies have shown that exposure of various concentrations of carbon dioxide have effects on human breathing (Kubo at al, 1999), as summarized in Table 16 below:

Table 16: Effects of Carbon dioxide on Human Health (After Kubo et al, 1999)

Concentrtions (ppm)	Effects
10,000 - 20,000	Long term exposure to such levels can cause increased calcium depositions in the body tissues and may cause mild stress and behavioral change.
50,000	Shortness of breath, dizziness mental confusion, headache and possible loss of consciousness.
100,000	Normally, one losses consciousness and eventually death if no action is taken

The Olkaria geothermal power stations operate by collecting steam from the geothermal fields. The steam is used to drive turbines which generate the electrical energy. The used steam is discharged as liquid water and vapour. The water vapour is harmless in the atmosphere, but associated with the steam are non-condensable gases including carbon dioxide (CO_2), methane (CH_4) and hydrogen sulphide (H_2S). The CO_2 and CH_4 which are minimal do not pose a threat to ambient air quality, although they are, along with water vapour, green house gases. Annual carbon dioxide emission from the present 45 MWe is estimated at ~ 21,850 tonnes, compared to a coal-fired power plant of the same rating which releases 140,200 tonnes of the gas to the atmosphere (Tole, 1990).

Hydrogen Sulphide

Hydrogen sulphide is a colourless flammable gas, which is denser than air and liquefies at -60° C. It is soluble to both polar (water) and non-polar (organic) solvents. It is a very reactive gas and hence oxidizes rapidly in air and solution. It reacts readily with most metals causing corrosion on them. Because of its density, hydrogen sulphide settles at the lowest points e.g in gullies and valleys. This can allow a buildup of dangerous concentrations of hydrogen sulphide. Within power plants, high concentrations of hydrogen sulphide may occur in cellars that are part of the well head or sump(Sinclair Knight and partners, 1994). Hydrogen sulphide is a noxious and potentially poisonous gas with odour of rotten eggs. Natural occurrences of hydrogen sulphide are estimated to contribute ~ 90% of global emissions while the remaining 10% is emitted from industrial wastes. Air quality criteria, has been formulated by regulatory bodies in other countries to maintain acceptable environmental quality.

Non-condensable gases from high temperature geothermal power plants contain ~ 5% hydrogen sulphide and 95% carbon dioxide. When they are ejected into the atmosphere, these gases are at higher temperature than ambient air. Hot non-condensable fumes are lighter than normal air, and this helps the gases to mix rapidly with ambient air. Therefore hydrogen sulphide emitted from the gas ejectors does not preferentially settle out from the plume any more than other gases in air. The only time hydrogen sulphide settles down more preferentially than other gases in the air, is in enclosed area, where there is no wind.

The toxic effects of hydrogen sulphide human and animals vary according to dosage and these are summarized in Table 17 below.

Table 17: Effects of Hydrogen Sulphide on Health (Sinclair Knight and Partners, 1994)

Concentrations (ppm)	Effects
Below 1	Offensive odour
1 – 10	Occupational exposure limit. Breathing apparatus required.
10 – 20	Ceiling of occupation exposure limit. Worker must wear breathing apparatus.
20 – 100	Loss of sense of smell in 2 - 15 minutes. May burn throat and chest. Causes headache and nausea, coughing and skin irritation.
100 – 200	Sense of smell lost rapidly, burns eyes, and throat.
200 – 500	Loss of reasoning and balance. Respiratory disturbance in 2 - 5 minutes. Prompt resuscitation.
500 – 700	Immediate unconsciousness with one sniff. Causes seizures, loss of control of bowel and bladder. Breathing will stop and death will result if no resuscitation is done.

The toxic effects of hydrogen sulphide have been classified into three categories, acute, subacute and chronic. Acute intoxication refers to effects of a single exposure to a massive dose of hydrogen sulphide of the order of 1000 ppm and above. At this concentration, hydrogen sulphide
exerts an effect on the whole nervous system by inhibiting the enzyme cytochrome oxidase, which is involved in the aerobic metabolic pathway (Sinclair Knight and partners, 1994). The

WHO recommended exposure limit for staff working 8 hours per day for 5 days in a week is 10 ppm.

The effects of hydrogen sulphide on vegetation are not well documented largely because, in contrast to animals, there appear to be a wide variation in response across species (Sinclair and Knight, 1994). Sulphide taken up by plants is primarily metabolized to sulphate; or incorporated
into plant proteins and as in the case of sulphur dioxide, low concentrations may have a growth stimulation or fertilizing effect. At higher concentrations, hydrogen sulphide can cause leaf lesions, defoliation and reduced growth, with young plants being the most susceptible. The effects of hydrogen sulphide on aquatic animals have been evaluated by Axtmann (1971), who recommended that concentrations in water of less than 0.006 ppm were safe.

Oxidation of H2S in the atmosphere results in the formation of SO2, which forms acid precipitation in the presence of moisture. Acid rain is defined as precipitation with the pH values
of less than 5.8. Acid rain could contribute to change in soil pH and acidification of surface waters e,g lakes leading to reduction in phyloplakton biomass and fish stocks

KenGen has been monitoring hydrogen sulphide concentrations within and near our operations since 1997. There are about 40 H_2S monitoring sites at Olkaria I and Olkaria II, and the monitoring is conducted at least three times in a week. Table 18 illustrates the results of H_2S monitoring at Olkaria.

Table 18: Results of Hydrogen Sulphide Monitoring at Olkaria

Hydrogen Sulphide monitoring at Olkaria II & its environs (from 2003 to 2012)										
	Compressor rm	**Maintenance office**	**Hot well unit 2**	**Cooling tower 3**	**Olk II PS**	**Adm block**	**Control rm**	**Main oil pump**	**Turbine**	**KWS Gate**
Counts	871	510	881	513	528	897	611	362	363	507
Max	2.5	1.3	5.1	3.7	2.1	1.5	1.7	5.2	2.7	3.7
Min	0	0	0	0	0	0	0	0	0	0
Hydrogen Sulphide monitoring at Olkaria I & its environs (from 1997 to 2012)										
	Mv-rig w/shop	**Olk I PS**	**GIS lab**	**Seal pit 1**	**Ow -10**	**Scientific labs**	**Lake view**	**Lake Side**	**Ejector I**	**Turbine I**
Counts	1391	1125	456	1261	1405	1076	503	504	341	341
Max.	2	4.4	1.4	6.1	2.5	3.1	0.1	0	1.4	1.2
Min.	0	0	0	0	0	0	0	0	0	0

Source: KenGen Olkaria Geothermal Power Project, Environmental Section

Some of the sites such as KWS Gate, Lake side, Lake View as well as well OW-10 are located in areas that are accessible to the public. In general, all the monitoring sites recorded low concentrations of H_2S, sometimes below the 50% detection limit of 0.0046 ppm. All emissions recorded in and around the power station were less than 10 ppm which is the WHO threshold limit value (TLV) for hydrogen sulphide (ie. the permissible concentration in the workplace, assuming an 8 hour shift over a 5 day week, World Bank guidelines indicate 10 ppm).

Generally, H_2S concentrations at Olkaria II are lower in comparison to Olkaria I power plant. This is attributed to the facts that Olkaria II power plant has employed newer technology as compared to Olkaria I power plant that was installed in 1980s. The proposed Olkaria I Unit 6 will employ latest technology and hence will have minimal emissions.

Geothermal Brines.

Geothermal brines from the Olkaria East and Olkaria North East production fields have the following typical chemical composition. The chemical composition is from selected wells proposed for steam supply to Olkaria I Unit 6 as per table 19 below.

Table 19: Typical Composition of Brines from Proposed Olkaria East and Olkaria North East Production Fields (in ppm)

Well No	Sector	pH	Na	K	Mg	Ca	Li	SiO_2	B	Cl	SO_4	CO_3	F
OW-11A	Olkaria East	9.65	1066.5	296.2	0.027	1.08	3.29	1380	7.80	1465.2	193.6	308.7	60.3
OW-39	Olkaria East		Drilling in progress										
OW-40V	Olkaria East		Drilling in progress										
OW-46	Olkaria East	6.76	447.1	80.0	1.41	14.0	1.11	674	2.5	299.7	356.1	224.3	25.89
OW-46A	Olkaria East		Heating up (waiting discharge tests)										
OW-47	Olkaria East	7.38	384.5	45.25	0.306	3.91	1.24	657.5	2.84	307.4		456.6	30.5
OW-717	Olkaria North East		Discharge tests in progress										
OW-731	Olkaria North East	9.91	901.3	215.5	0.341	0.663	2.799	887	3.12	756.4	145.9	565.8	276.

OW-732B	Olkaria North East		Heating up (waiting discharge tests)										
)W-733	Olkaria North East	9.43	773.2	132.3	0.392	1.76	2.05	496	3.47	761.8	185.6	219.3	152.(
OW-733A	Olkaria North East	10.17	915.2	155.1	0.14	1.099	2.362	645	4.45	854.5	176.8	231.4	190.(
)W-733B	Olkaria North East		Drilling in progress										

The separated water from the Olkaria geothermal wells have very high concentrations of fluoride (refer to table above). Permissible levels of some the constituents in drinking water are fairly low e.g chloride (Max, 250 ppm), Flouride (Max,1.5 ppm). High concentrations of fluoride in drinking water affects young children's teeth and skeletal development. Disposal of separated brine into surface water ways and ground water should be avoided as this could have an impact on both aquatic life and for domestic usage.

Heavy metals accumulation can be toxic to both plants and animals when accumulated along the food chain. In the Olkaria geothermal project, trace metals monitoring is regularly carried out, at a frequency of once every quarter for selected sampling sites. Most of the trace metals analyzed in the separated brine in Olkaria exhibit low concentrations that fall below the maximum permissible levels of National Environment Management Authority (NEMA) standards. Results for concentration levels of trace metals monitored in 2012 are shown in figure 8 below.

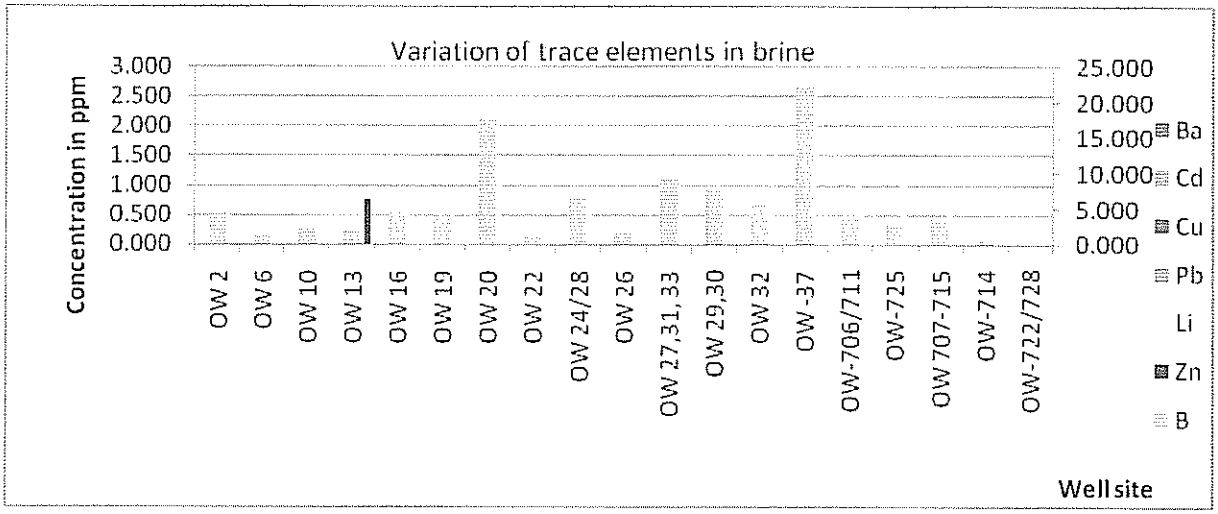


Figure 8: Concentration of Trace Metals in Brine from Olkaria Geothermal Field

Exceptions like the concentrations of boron in the brines are above the NEMA standards for drinking water quality guidelines. High concentrations of boron can be toxic to plants. Boron toxicity in plants occurs due to cumulative effects. Different plants have different tolerance levels to boron. In Table below is a comparison of some trace element concentrations in the brines from Olkaria and the NEMA standards for discharge into the environment.

Table 20: Comparison of Measured Highest Mean Brine Trace Elements in the Olkaria Geothermal Brines and the NEMA Standards for Discharge into the Environment

Elements	Highest Measured concentration(ppm)	NEMA Standards(ppm)
Boron	**22.5**	**1.0**
Cadmium	**0.009**	**0.01**
Copper	**0.07**	**1**
Lead	**0.003**	**0.01**
Lead	**0.76**	**0.01**

The most acceptable form of fluid disposal is by deep re-injection, although this may also have environmental impacts such as increase in micro-seismic activity. To minimize discharge into surface and ground water resources, separated water (brines) and condensate is re-injected.

5.11 Noise Quality

The operating power plant generates noise from two main sources namely the cooling towers and the plant or building housing the turbines. High noise levels may also be reported during well discharge testing that normally runs for a maximum of 30 days.

Noise data monitoring is carried out on a weekly basis at Olkaria (5 times per week). Noise measurement at Olkaria I has been in existence since 1985 while at Olkaria II, noise measurement has been in existence since 2003. There are about 36 noise monitoring sites at Olkaria I and Olkaria II. Some of the areas such as Lake View and Lake Side are residential. A summary of noise data in absolute decibels (dB(A)) is presented in Table 21 below:

Table 21: Noise Levels at Olkaria and its Environs

Noise measurements at Olkaria II & its environs (from 2003 to 2012)								
Date	Maintenance office	Cooling tower 3	Adm open office	KWS Gate	Main oil pump	Turbine	Gv/msv	Olk II PS
Counts	501	513	472	746	356	356	355	494
Max	89	94	88	97	97	99	99	99
Min	50	69	41	20	69	57	63	8
Noise measurements at Olkaria I & its environs (from 1995 to 2012)								
Date	Liaison office	Gis office	Compressor	Turbine 2	Turbine 3	X-2 camp	Lake Side	Lake View
Counts	463	465	340	341	164	148	544	542
Max	84	82	97	99	95	62	75	78
Min	50	40	68	72	77	23	20	20

Source: KenGen Olkaria Geothermal Power Project, Environmental Section

According to NEMA regulations on noise and excessive vibration, the first schedule indicates that the maximum permitted levels at residential areaa during the day is 45 dB(A) and 50 dB(A) for indoor and outdoor respectively. In the second schedule, the maximum permissible noise limits at construction sites during the day is 75 dB(A) at industrial areas and 60 dB(A) at residential areas.

The table 22 below summarizes World Bank and WHO noise exposure limit standards at workplace and at residential areas.

Table 22: World Bank and WHO Noise Exposure Standards

Receptor	**Maximum allowable L_{eq}^{*} (hourly) in dB (A)**			
	World Bank		World Health Organization	
	Day time (07:00 to 22:00 hrs)	Night time (22:00 to 07:00 hrs)	Day time (07:00 to 22:00 hrs)	Night time (22:00 to 07:00 hrs)
Residential, institutional and educational	55	45	50	45
Industrial and commercial	70	70	85	85

*L_{eq} is the equivalent continuous sound pressure level

Gas emission from the existing KenGen Olkaria I power station predominantly consists of carbon dioxide (95.1%) and hydrogen sulphide (4.4%). The other gases which include hydrogen,
methane nitrogen and oxygen form 0.5% (wt/wt) of the total non- condensable gas fraction. Total
geo-gas forms about 2% of geothermal effluent (Sinclair Knight and partners, 1994). This is discharged to the atmosphere.

5.12 Flora

The prominent vegetation types around the Olkaria geothermal project are: woodland, bush-land and wetlands with vegetation dominated by *Tarchonanthus camphorates* and *Acacia species.*

a) Woodland

This is land supporting a stand of trees up to 20 m in height with an open or continuous, but not thickly interlaced, canopy. Woodland vegetation in the project area is rare. A good representation is, however, found to the north of the Lake Naivasha area. This woodland is dominated by the *Acacia xanthophloea* with trees up to 35 m tall.

b) Bushland

Bushland comprises an assemblage of trees and shrubs, which withstand seasonal drought. A bushland community is dominated by plants of shrubby habit although trees are always conspicuous. Trees, however, do not exceed 10m in height except for occasional emergents. Bushland is the most extensive vegetation of the project area. It is found in the Hell's Gate National Park and other areas in the Naivasha basin where the land use is basically ranching. The bushland in this area is dominated by the *Tarchonanthus camphoratus* (called "leleshwa" by the Maasai). *Tarchonanthus camphoratus* covers extensive areas of the Rift Valley basin and at times is the only surviving woody plant in the severely eroded areas. The *Tarchonanthus camphoratus* bushland in many places is interspersed with *Acacia drepanolobium*, a plant with large inflated galls which shelter colonies of ants, *Crematogaster mimosae.* The galls produce a low whistling sound when the wind blows and hence the plant is referred to as whistling thorn.

Common grasses in the bushland community of the project area include *Cymbopogon nardus*, *Setaria sphacelata*, *Themeda triandra*, *Eragrostis cilianensis*, *Hyparrhenia hirta*, *Cynodon dactylon*, *Pennisetum clandestinum*, and *Digitaria abyssinica* among other grasses.

The vegetation of the Olkaria area is predominantly a bushland community although local differences on vegetation types have been reported. In 1992, the flora of the project area was reported to comprise seven major vegetation groups including bushland, bushed grassland, shrubbed grassland, grassland, rock outcrops and barren land (Sinclair Knight et al, 1994).

c) Introduced vegetation around the power stations

Although the project area is part of the Hell's Gate National Park, several exotic trees, shrubs and ornamentals have been introduced especially in the area around the offices and power stations. The most common of the introduced plants include the species of *Bourgainvillea* spp.

Oleander, *Terminalia mantally* (Terminalia), *Callistemon citrinus* (Bottle brush), *Cassia spectabilis* (Cassia), *Eucalyptus saligna* (Blue gum), *Schinus molle* (Pepper tree), *Acalypha* spp (Acalypha), *Euphorbia pulcherrima* (Poinsettia), *Hibiscus rosa-sinensis* (Chinese rose) and, *Euphorbia splendens* (Crown of thorns) among other exotics. There are also native plants introduced from other parts of the country around the power stations that are not among the normal flora of the project area. The common native trees are *Croton megalocarpus*, *Albizia gummifera*, *Spathodea nilotica* and *Trichilia emetica*.

Olkaria Power Station supports a tree nursery that raises seedlings for planting around the power stations and for the support of afforestation extension programme in instititutions and surrounding farms and beyond. Around the nursery there is a plantation area covered by trees planted by distinguished visitors. Adjacent to the nursery, a planted forest has been established with a mixed tree composition of both exotic and indigenous tree species of *Eucalyptus saligna*, *Grevillea robusta*, *Cupressus lusitanica*, *Croton megalocarpus*, *Schinus molle*, *Cordia abyssinica* and *Acacia xanthophloea*.

d) Wetlands

The wetlands in the project area are associated with Lake Naivasha and the brine ponds found in Olkaria I Power Station. Lake Naivasha is predominantly fringed by *Cyperus papyrus* while *Typha domingensis* is also found in some areas. There is large development of both submerged and floating aquatic plants. The former is dominated by *Ceratophyllum demersum*, *Najas pectinata* and *Potamogeton* spp. while the latter are dominated by the water hyacinth (*Eichhornia crassipes*).

The brine ponds associated with Olkaria I have been colonised by *Typha domingensis* that forms a well-developed fringing vegetation around the ponds perimeter and the channels leading to the ponds. Several sedges including *Cyperus immensus*, *C. papyrus*, *C. laevigatus* and other members of Cyperaceae are also associated with the brine ponds.

A summary of the main flora found in the area is shown in Table 23 below.

Table 23: Vegetation Types Around Hell's Gate National Park

Vegetation Category	Species found
Grass	*Cynadon dactylon*
	Digitaria scalarum
	Themeda triandra
	Digitaria milanjiana
Low shrubs	*Felicia muricata*
	Indigifera tanganyikensis
	Harpachne schimperi
	Justicia sp
	Euphorbia inaequilatera
Scrub (woody species which rarely exceed 4m)	*Tarchonanthus camphorates*
	Acacia drepanalobium
	Rhus natalensis
	Solanum incanum
Vegetation in Gorges	*Shefflara abyssinica*
	Cussonia arborea
	Ibis multiflora
	Euphorbia kibwenzinsis
	Dodonea viscose

Source: KWS Office, Hells Gate National Park (July, 2012)

5.13 Fauna Species

Common fauna include buffalos, giraffes, warthogs, zebras, grants gazelle, baboons, monkeys, snakes, waterbuck and more than 80 species of birds.

According to the 2011 census of mammals within Hells Gate National Park and its neighbourhood, the species identified and their respective numbers in the months of February, May and November, are as detailed in Table 24 below:

Table 24: **Types of Mammals and Their Numbers Within & Around Hell's Gate National Park (KWS, 2011)**

Species	February 2011	May 2011	November 2011
Baboon	54	209	177
Buffalo	107	104	18
Dik-dik	34	13	24
Eland	19	71	16
Giraffe	48	23	68
Grant Gazelle	84	107	132
Guinea Fowl	216	98	175
Hartebeest	15	36	20
Hyena	0	3	0
Impala	105	136	145
Klipspringer	0	1	11
Mongoase	0	0	5
Mountain Reedbuck	1	11	5
Ostrich	0	3	0
Rock Hyrax	0	11	8
Silver Backed Jackal	3	4	1
Steenbok	0	1	0
Thomson Gazelle	116	181	127
Vervet Monkey	37	0	0
Warthog	153	101	215
Waterbuck	0	1	0
Zebra	204	245	267

TOTAL	1096	1358	1414

Source: KWS Office, Hells Gate National Park (July, 2011)

According to the 2011 census results, the total number of mammals within and around Hells Gate National Park has been increasing.

Lake Naivasha is home to large numbers of hippopotamus.

5.14 Avifauna and Fish Species

Lake Naivasha has noteworthy avian fauna. An estimated 495 bird species either reside in or pass through the Naivasha area; this estimate represents one of the highest counts in Kenya. Some of the Kenyas' largest congregations of waterfowl also occur at the lake; between 1991 and 1997, an average of 22,000 water birds gathered there.

Fish Fauna and Fisheries Species

The lakes aquatic fauna is Spartan. Its fishery is dominated by introduced species, including three species of fish (*Oreochromis leucostictus, Tilapia zillii and Micropterus salmoides*) and a crayfish (Procambarus claykii). (IUCN/LNRA (2005).

(B) HUMAN ENVIRONMENT

5.15 Economic Activities Around Lake Naivasha Basin

Most of the lake's riparian land is under private stewardship, in many places by large-scale horticultural and floricultural farms. Farms cover an estimated 50Km^2 of land and yield net returns of some US$63 million per year. These farms employ an estimated 30,000 people who are attracted to the area from all over Kenya. Virtually all of these farms are irrigated using water from Lake Naivasha. The Lake Naivasha Grower's Group (LNGG) represents 25 commercial farms around the lake, which combined, cover 1,252 ha. There are an estimated 14 additional farms with an area of some 260 ha. In total, therefore there are about 1,500 ha of commercially irrigated land around Lake Naivasha, 500 ha of which are under green houses.

An additional and important economic activity in the basin is geothermal power generation. The current installed generation capacity at the Greater Olkaria field is as indicated in Table 25 below.

Table 25: Installed Geothermal Generating Capacities at Olkaria Field

Company	Power Plant	Installed Generation Capacity (MWe)
KenGen	Olkaria I Units 1,2 & 3	45
KenGen	Olkaria II Units 1,2 & 3	105
KenGen	Pilot Well head Generator	5.0
Orpower 4 Inc.	Olkaria III	48
Oserian Development Company	For internal use	4
TOTAL		**207**

KenGen is currently constructing the 280 MW Olkaria I Units 4 & 5 and Olkaria IV Units 1 & 2 which will be commissioned in September, 2014. Orpower, an Independent Power Producer will also inject an additional 52 MW into the national grid in 2013. In addition, other Independent Power Producers (IPP"s) have been licensed to develop Suswa and Longonot geothermal prospects. The geothermal power projects are expected to create additional employment opportunities within the project's area of influence and to spur economic growth in Kenya.

5.16 Population and Demographic Characteristics

According to the 2009 census, the population of Naivasha area and its environs is as illustrated in table 26 below:

Table 26: Population Distribution by Some Administrative Units in Naivasha, August 2010

Sub location	Male	Female	Total Population 2009	Households	Area/Square	Density
Hell's Gate	32,565	32,081	64,646	22,147	436.7	148
Olkaria	13,011	12,426	25,437	9,194	345.5	74
Malewa	4,432	4,267	8,699	2,845	152.9	57
Kongoni	2,054	2,050	4,104	1,209	86.3	48
Maiella	4,416	4,804	9,220	2,124	41.9	220
Moi Ndabi	2,936	2,840	5,776	1,564	167.9	34
Ndabibi	4,527	3,871	8,398	2,361	131.7	64

Source: Government of Kenya, 2009 Kenya Population and Housing Census

The neighborhood of the Olkaria Geothermal Project is scarcely populated. The population currently comprise of the Maasai community, residents of Kamere and employees of KenGen, neighbouring flower farms, KWS and contractors.

5.17 Migration and settlement

Naivasha district has one of the highest rates of external and internal migration in the country. External migration involves movement of people from other districts into Naivasha in search of employment while internal involves movement of people from one division to another within the District.

Many of the migrants have moved into towns within the District. Increased floricultural, horticultural and geothermal activities have contributed to the migration of people in such for employment. As a result, the urban population growth rates for some of the urban centres in the District are higher than the national urban growth rate. Naivasha recorded a growth rate of 15.3 % between 1989-1999. These high urban growth rates have also increased the demand for services such as education, water, sanitation, health, housing and other services, which has put a strain on the local authorities who are responsible for these services.

As a result of the migration trends, the District's population has been increasing steadily, resulting in the establishment of new settlements. These centre's namely; Kasarani, Karagita, DCK, Kongoni and Kamere Estate, are inhabited by people from a mixture of tribes from different parts of Kenya, many of whom are working at the numerous flower and horticultural farms and at KenGen.

5.18 Health Services

5.18.1 Health Facilities

There are 62 health facilities in Naivasha District of which 26 are public (GIBB Africa, 2012). The health facilities around Olkaria area include Oserian, Mvuke (KenGen) and the Karuturi dispensaries. Since access to these facilities is restricted to the Company's' employees, the local community travels as far as Naivasha town to access medical services from the Naivasha General Hospital and other private facilities like Mt. Longonot Hospital. Access to the health facilities is usually hampered by lack of means of transport since public service vehicles are not allowed in the park.

5.18.2 Disease Prevalence

According to records spanning for 5 years from the Ministry of Health (Naivasha District Hospital), the highest prevalent diseases are respiratory diseases with 81,288 cases having been reported. This is due to the fact that cold and flu are common and are classified as respiratory diseases. The respiratory diseases are followed by malaria, with 53, 823 cases having been reported. The top 10 disease prevalence in the District are as indicated in the figure below:

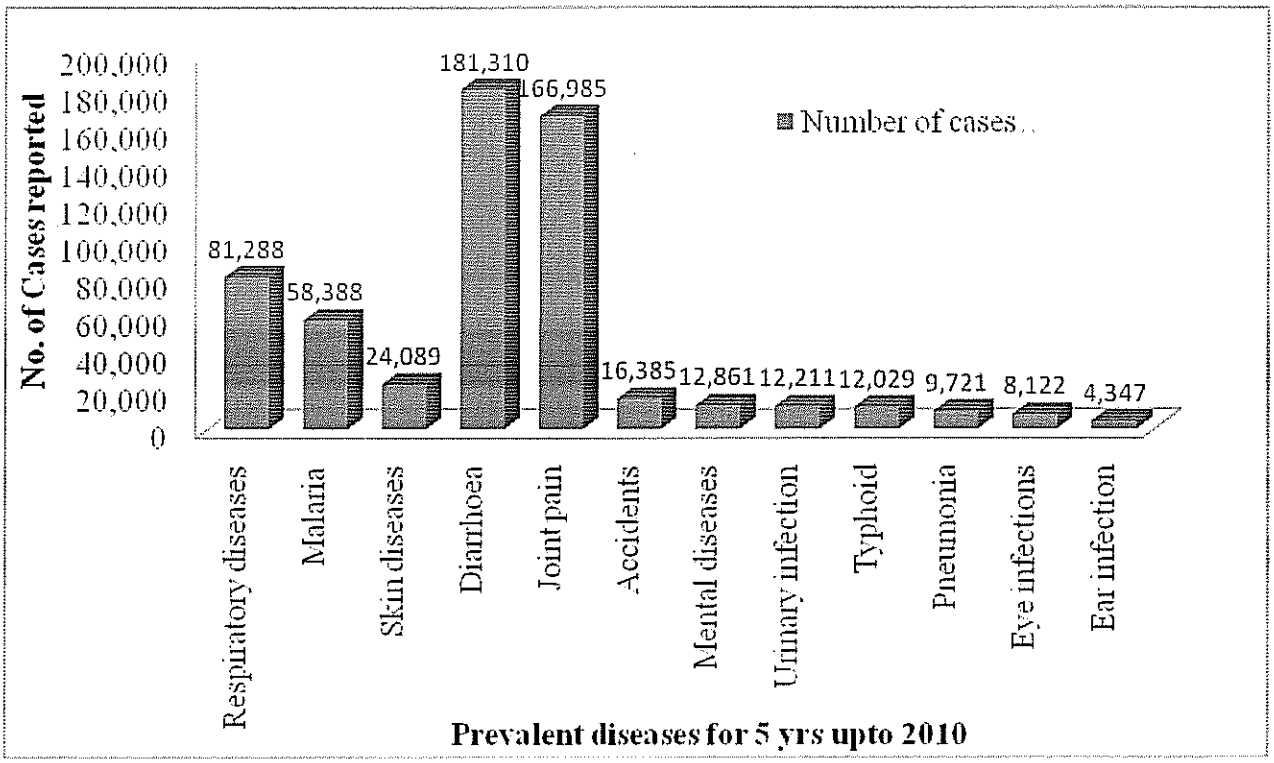


Figure 9: Top ten Disease Prevalence in Naivasha District

Source: Medical Officer of Health, Naivasha (2012)

5.18.3 HIV/AIDS Prevalence

The prevalence rate of HIV/AIDS in the district is 5.3% as per the District's Medical Officer of Health office in Naivasha. Table 27 below shows the number of patients under HIV/AIDS care in the district.

Table 27: HIV/AIDS Prevalence in the Project Area

	Adults	Children	Total
Patients under care	6,215	749	6,964
Patients on ARVS	2,194	332	2,526
Total	8,409	1,081	9,490

Source: Ministry of Public Health and Sanitation, 2009

5.19 Educational Facilities

Schools around Lake Naivasha are divided among four zones: Naivasha, Maragisho, Longonot and Maiella zones. Olkaria area falls under Maiella Education Zone. Currently the zone has 21 public and 18 private schools respectively. The number of Early Childhood Development (ECD) Centre stands at 251. Olkaria primary school, which is located at the Cultural Centre, is the nearest school to the site.

5.19.1 Olkaria Primary School

The school has both Early Childhood Development (ECD) and a Primary school. The population of students is 46 distributed as detailed in Table 28 below:

Table 28: Student Population at Olkaria Primary School

Class	Number of Classrooms	Student Population
ECD	1	20
1	1	13
2	1	7
3	1	6
Total		**46**

Source: Primary Data collected on 20th June, 2012

The school has only two teachers.

5.20 Existing infrastructural services

The major highway serving the Naivasha district and the surrounding area is the Nairobi-Naivasha road that passes 30 km to the north of the Olkaria geothermal plant. The project area is accessed by the Moi south road which is tarmac and motorable all year round. KenGen has actively participated in the rehabilitation of this road.

To the north of the project area is the Moi North, a murrum/earth road that serves the area north and west of Lake Naivasha. The project area is served by several airstrips many of them private facilities associated with flower, ranching, hotel and tourism activities around Lake Naivasha. The project area and surroundings have electric power connection with the exception of some villages and market centres.

5.21 Tourism

Tourism is an important activity around Lake Naivasha. Conditions that favour tourism in the project area include proximity to Nairobi, uniqueness of geothermal power generation and the presence of Hell's Gate and Longonot National Parks. Some of the tourist attraction to Hell's Gate National Park includes geothermal operations, game viewing, camping, nature trails, rock climbing, biking, filming, bird watching and hippo viewing at Lake Naivasha. The number of visitors to the park has been expanding (Figure 10). Revenue collection from tourists has also increased. It is postulated that most of the tourists who come to the Park are mainly attracted by the Olkaria geothermal power plant, which is the largest geothermal power plant in Africa. For instance, in the period January to June 2012, a total of 16,750 tourists entered Hell's Gate National ark through Olkaria KWS Gate, of whom majority were primary/secondary school and colleges students.

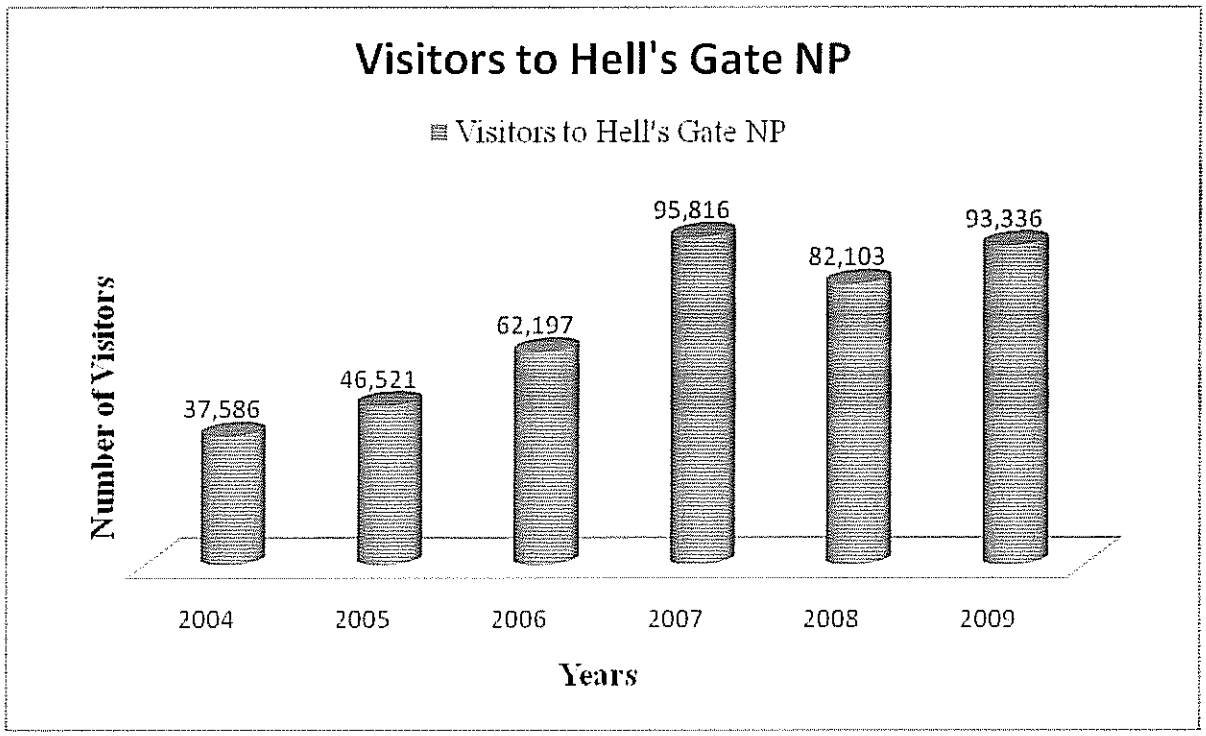


Figure 10: Visitors to Hell's Gate National Park, 2004-2009

Source: KWS, Hell's Gate-Mt Longonot ecosystem management plan from 2010-2015

5.21 Land tenure

The project area lies within Hell's Gate National Park, where Olkaria I (Units 1-3) and Olkaria II (Units 1-3) Geothermal Power Plants exist. The Park was gazette in 1984, and KenGen has had a Memorandum of Understanding (MoU) with KWS since 2004. KenGen has leased approximately 1,064.36 hectares of land from KWS for geothermal development.

5.22 Land use

The Olkaria area and its environs support multiple land use systems consisting of ranching, flower and horticultural farming, tourism, wildlife conservation, human settlement, infrastructure and other uses. The major companies involved in flower cultivation include Oserian Development Company, Sher Karuturi, Homegrown, Finlays and Plantations among others.To the south and southeast of the Olkaria Geothermal Project, are situated large tracts of land covering mainly the Kedong and Longonot Ranches, which primarily rear cattle. These ranches form important dispersal areas for wildlife from the Hell's Gate and Longonot National Parks. Other important ranches around the project area include Oserian, Kongoni and Ndabibi farms.

5.23 Energy

Electricity is the main source of energy for lighting in the vicinity of the proposed project. Most institutions and residential houses have been connected to the power grid. However, some of the unplanned low income housing at Kamere, Kwa Muhia and DCK are not connected. In KenGen staff houses, electricity and liquefied petroleum gas (LPG) is the main source of energy for cooking while in the upcoming low class houses which form the majority the main source of energy for cooking includes kerosene, charcoal and wood fuel. The increase in population is a major threat to the forestry resource close to the project area.

5.24 Archeological Sites

There is no archeological site near the project site. The nearest archeological site is Gamble's Cave and Nderit Drift area near Nakuru. Other areas of archeological importance are located at Kariandusi near Lake Elementaita and Hyrax Hill near Nakuru.

6.0 STAKEHOLDER CONSULTATIONS AND PARTICIPATION

It is a mandatory requirement under Legal Notice No. 101 of EMCA 1999 for all environmental assessment process in Kenya to incorporate public consultation. The aim is to ensure that all stakeholders' interests are identified and incorporated in project development, implementation and operations.

6.1 The need for public consultation and participation

ESIA process is largely determined by effective Consultation and Public Participation (CPP) which basically provides the cornerstone for project planning and successful implementation. Consultation and Public Participation helps to:

i) Facilitate involvement and participation of project affected persons throughout the project cycle.

ii) Ensure a sense of responsibility and commitment towards implementing the Environmental Management Plan (EMP).

CPP should be undertaken mainly during project planning, implementation and decommissioning phases. It should involve the affected persons, lead agencies, private sector, among others. The methodology for CPP may include: Meetings and technical workshops with affected communities; interpersonal contacts; dialogue with user groups and local leaders; Concernnaires/surveys/interviews; and Participatory Rural Appraisal or Rapid Rural Appraisal (PRA/RRA) techniques. It is the responsibility of the project proponent to adequately ensure effective distribution of the information to the affected persons to mitigate against unnecessary delays in decision making and project implementation.

6.2 Objectives of Public Participation

Public participation is essential for good governance and may empower local communities. Public consultation and participation in ESIA is multi-purposive, aiming specifically to:

- Invite the affected and interested members of the public into the decision-making process to foster justice, equity and collaboration
- Inform and educate the stakeholders including the proponent, public, lead agencies and NEMA on the planned interventions and its consequences;
- Gather data and information from the local community about their human (including cultural, social economic and political dimensions) and biophysical environment, as well as about the relations (Including those related to traditional and local knowledge) they have with their environment
- Seek input from the public on the planned interventions, including its scale, timing and ways to reduce its negative impacts, to increase its positive outcomes or to compensate impacts, which may not be mitigated and
- Contribute to better analysis of the proposed project leading to more creative development, more sustainable interventions and consequently greater public acceptance and support than would otherwise be the case

6.3 Public Consultation with Respect to the Proposed Project

Public consultations and participation for the proposed Olkaria 1 Unit 6 Geothermal Power Project involved two public *barazas* held at the Maasai Cultural Centre and Kamere Trading Centre on 19th February 2013. A one day workshop for key stakeholders including representatives of lead agencies, local community, neighboring flower farms, Non Governmental Organizations (NGO), NEMA and other interest groups was also successfully held at Olkaria Lakeview Social Hall on 20th February 2013.

Table 29: Summary of Public Consultative Meetings

Type of Meeting & Date	Total Number of Participants who attended	Category of Participants
Presentation done internally to proponent (KenGen) staff on 18th February 2013.	16	Geothermal Resource Development, Geothermal Operations, Environment and CDM, Projects Execution departments
Public Baraza of 19th February 2013 at Maasai Cultural Centre	66	District Officer Central, Assistant chief, local community (Maasai Cultural Center, Narasha, Olo Nong'ot, Olo Mayiana Ndogo, Olo Sinyat villages) and KenGen team
Public Baraza of 19th February 2013 held at Kamere Trading Center	57	District Officer Central Division, Chief, Assistant chief, local community and KenGen team
Stakeholders workshop on 20th February 2013 held at Olkaria Lakeview Social Hall	34	Senior District Officer, District officers Central and Kongoni, Chief, Assistant Chief, KWS representative, Oserian Development Company, Representatives of Lake Naivasha Riparian Associations, Ministry of Health, Ministry of Public Works, Kenya Forest Service, Ministry of Lands, Water Resources Management Authority (WRMA), Naivasha Municipal Council, NEMA and KenGen team led by Geothermal Development Manager

6.4 Results of the public consultation process

A summary of the results of public consultations and participation is provided in the table 30 below.

Table 30: Summary of Public Consultations Outcomes

Type of Stakeholder	Underlying Needs	Underlying Fears	Current Status
Local Community at Olkaria Maasai Villages	- There is need to address dust emission on the current 10km road being constructed to Olkaria IV	- The dust has caused a lot of health problems especially in children in the neighboring nursery school. -The medical bills for treatment of respiratory disease has gone high because of dust.	-The contractors have been severally warned against neglecting their obligation. -KenGen is enforcing implementation of the EMP. - Water supply from KenGen is constant -The number of water boozers and frequency of sprinkling have been increased to
	- KenGen should conserve the environment rather than destroy it because it leads to further degradation of land	There was a concern that the trees which the community planted at a designated area around the Maasai Cultural Center have been destroyed by KenGen during drilling operations	- The ESIA of Olkaria 1 unit 4&5 recommended that the local community be relocated to another area to pave way for drilling activities at the area. KenGen is fully committed to rehabilitate the area once the drilling activities are completed. KenGen will plant indigenous trees to replace those which might have been destroyed while undertaking drilling activities
	-Need for social investment projects for the community	- The community were concerned that KenGen is not delivering on the promises they give to the community. -This includes bursary awards for the top 3 pupils of the neighboring schools. -KenGen has not supported the neighboring schools like Narasha and Olo Nong'onot an they are suffering most	- KenGen has continued to support the local community through a bursary scholarship for needy bright students putting into consideration gender issues and merit (i.e. 3 students to secondary and 3 to universities) -The CSR office is also doing a lot of projects supporting the community like water projects, renovation of schools etc

		from the impacts	
	Few community members given opportunities for permanent employment.	-Casual employment is temporary and will not help the community in the long run	- KenGen advertises the jobs to the public and people are recruited through a competitive process without discrimination Local communities are sometimes given priority and many have benefitted from this flexibility of KenGen
	Speeding of trucks in the project area	The community animals have been killed and school children are in danger	-KenGen is enforcing the traffic rules and the EMP. -Contractors have been warned on this matter -A speed limit of 40KM/hr has been set
TYPE OF STAKEHOLDER	**UNDERLYING NEEDS**	**UNDERLYING FEARS**	**CURRENT STATUS**
Kamere residents	- The residents requested KenGen to look into employment process for non-skilled labor as it was allegedly marred with cases of discrimination and sexual harassment	- If this is not being addressed it will lead to people not supporting the projects, -Unemployed idle people pose security risks	- KenGen has incorporated the residents in the stakeholder Coordination Committee to distribute the project opportunities among all the stakeholders and these issues can be addressed in the SCC meeting
	-KenGen should consider building a health Centre and a school at Kamare. Alternatively the current KenGen dispensary should be serve both the public and KenGen employees	-The rising population at Kamere occasioned by demand for labor due to geothermal activities and therefore need for housing has caused strain to the facilities, -Increased diseases prevalence and a deteriorating hygienic conditions	- KenGen has opened up Mvuk primary school to the public and the residents are some of the beneficiaries of the services - KenGen will pursue the issue of provision of heath care facility together with the relevant ministry.
	There are several request which were presented by the community, market stalls, flash lights, water, and access roads	-The area has no market stalls, access roads are eroded, water from the lake is unsafe and lack of security lights poses a security risk to the residents who are also a source of labor	-KenGen will construct flash light at Kamere Trading Center - A meeting to discuss these issues was scheduled for Thursday 21st February 2013 at Kamere Trading Center

		for geothermal projects	
TYPE OF STAKEHOLDER	**UNDERLYING NEEDS**	**UNDERLYING FEARS**	**CURRENT STATUS**
Government ministries, Representatives of neighboring flower farms, Lake Naivasha Riparian Association and the provincial administration	-To ensure the project will have minimal impacts on other land users in the area -The project meets the legal and regulatory requirements	- Increased abstraction of water from the lake -The Hells Gate National park may lose habitat for the wild animals	- The proposed plant will not require a lot of water during the operations phase and this will not vary the current abstraction limit. -KenGen is constantly adopting modern technologies that use less water and advances in technology have led to other alternative sources of water e.g use of brine.
	-Solid waste disposal i.e. KenGen should be concerned with how the waste is dumped and what happens after dumping	- The dumpsites are constantly becoming a challenge	-KenGen does segregation of waste and allows only those transporters who are licensed by NEMA to collect waste and dump in licensed sites -KenGen will explore further on the principle of 3R's (reduce, recycle and reuse) to minimize the impact of these waste to the environment.
	-How can you make geothermal energy sustainable?	-Geothermal resource can be depleted and that will have effects on the growth in the energy sector	-Re-injection is the solution for sustainability of geothermal reservoirs. -KenGen currently re-injects upto 40% but working towards 100% re-injection by adopting emerging technologies.

TYPE OF STAKEHOLDER	UNDERLYING NEEDS	UNDERLYING FEARS	CURRENT STATUS
Government ministries, Representatives of neighbouring flower farms, Lake Naivasha Riparian Association and the provincial administration	-Implementation plan of the project showing timelines of when it is expected to start and completed.	-There is need for monitoring to ensure adherence in implementation of the EMPs	-The ESIA report will be circulated to all the stakeholders and the details contained in the report outlined the implementation plan
	-The cumulative impact of all the projects on health especially with regards with gaseous emissions like H_2S and how does the company plan to mitigate against this.	-H_2S gas has harmful effects on health especially when it is beyond the WHO limits. This needs to be handled with care.	-The company is planning to carry out a strategic environmental assessment to assess the cumulative effects of the geothermal operations in the area. This will cover all areas of concern including gaseous emissions, flora and fauna, environmental issues etc.

TYPE OF STAKEHOLDER	UNDERLYING NEEDS	UNDERLYING FEARS	CURRENT STATUS
Government ministries, Representatives of neighbouring flower farms, Lake Naivasha Riparian Association and the provincial administration	-Model that has been used to show the positives impacts outweigh the negatives.	-There is need to understand the impacts especially the negative ones to mitigate	-All the environmental impacts of the projects can be mitigated against. The project positive impact is much more than the negative impacts
	-An ecological survey should be done to find the cumulative impact of the projects to flora and faunas.	-It this is not done it leads to imbalance of the ecosystem	-This is being done periodically jointly by KenGen and KWS. The report is available to the interested stakeholders.
	-What are these abatement measures for air emissions?	-Gaseous can be harmful to health and need to be constantly monitored.	-Different gases require different ways of mitigations. Geothermal development emits low levels of gases unlike coal or thermal. KenGen constantly monitors the levels and the data is available. H_2S levels is within the range recommended by the WHO which is not harmful to people.
	-There is a lot of erosion on the roads, how is KenGen	-If not addressed can lead to adverse destruction of the environment.	-KenGen is handling the issues and the right measures are

	intending to mitigate against this?		being in place. KenGen will tarmac the roads and firm up the embankments to prevent erosion.
	-How is KenGen mitigating against destruction of vultures nest at the drilling sites? The noise at the wells during discharge is too loud and scares away the vultures. The top of the silencer tower where the vulture rests are not safe for them.	-If not handled this type of vultures will soon be extinct.	-The geothermal technology has changed and the one currently adopted has reduced noise levels to much less than before. KenGen will revisit the issue of mounting spikes on the silencer heads to prevent the vultures from resting on them.
	-The rate of geothermal expansion is very high and is likely to impact on the wildlife; KenGen should put a mechanism in place to mitigate against this. The increase in the number of people has scared away the wild animals.	Wildlife is a source of revenue for the country. If the parks are interfered with the animals will migrate or the population will be reduced and this will deny this country the much desired revenue.	-KenGen acquired more land for drilling and has continued to open up the place for animals because it will not be fenced. The animals have jointly been mapped out by KenGen and KWS staff to make sure the routes of the animals are not interfered with. The steam pipes are designed to accommodate this.
	-The contractor presence in the park has led to increased poaching and	-This will lead to extinction of some rare species in the park	KenGen has put a lot of measures to ensure that the contractor staff do not interfere with the park.

	charcoal burning and KenGen should intervene on this.		Contractors are required to issue their staff with identification cards
	-The truck drivers are over speeding at the park.	The community complained that their animals were being Killed and their children at risk from these speeding trucks	-Contractors have been warned against this and informed to adhere to speed limits 40KM/hr.This will continuously be enforced. Protective services and traffic Marshals are working together on this. Speed bumps will be erected once the road is tarmacked
	-Re-injection of brine into the system assists in generation of more energy. How is KenGen handling this?	If not done the reservoir will be dry and there will no more energy from geothermal	-KenGen is currently re-injecting 40% of brine and is working towards increasing the re-injection
	-How is KenGen prepared to handle changes brought about by the new constitution especially the devolved government?	-KenGen should comply with the new constitution which requires that communities benefit from the resources in harnessed from their region.	-The current Energy bill has captured this and KenGen will have to implement it once it is passed into law.

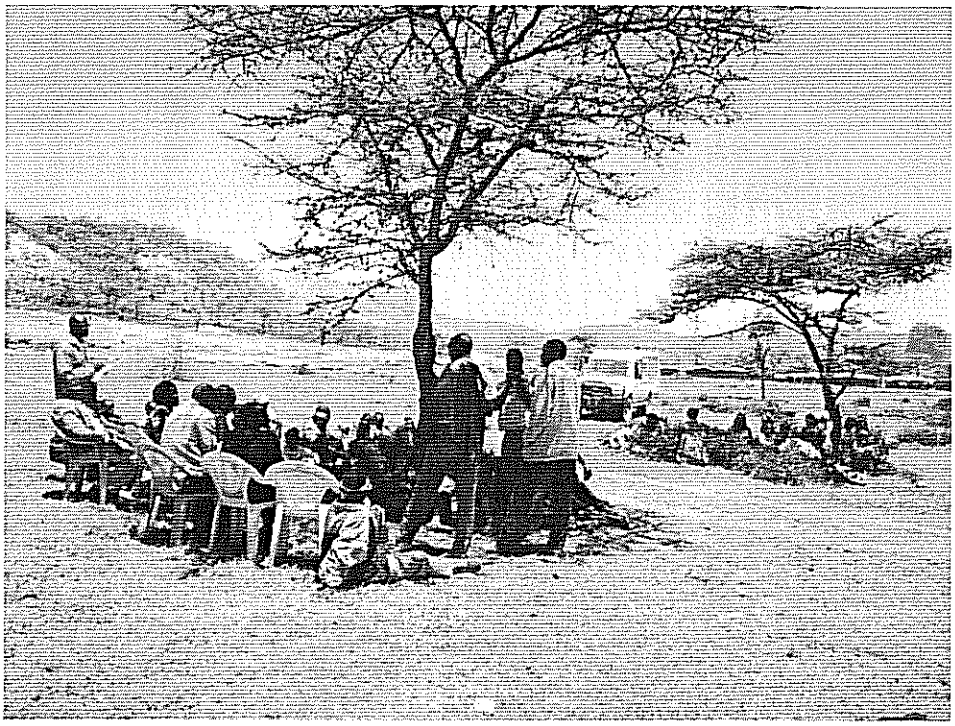


Plate 1: Public Baraza at the Maasai Cultural Centre in Progress

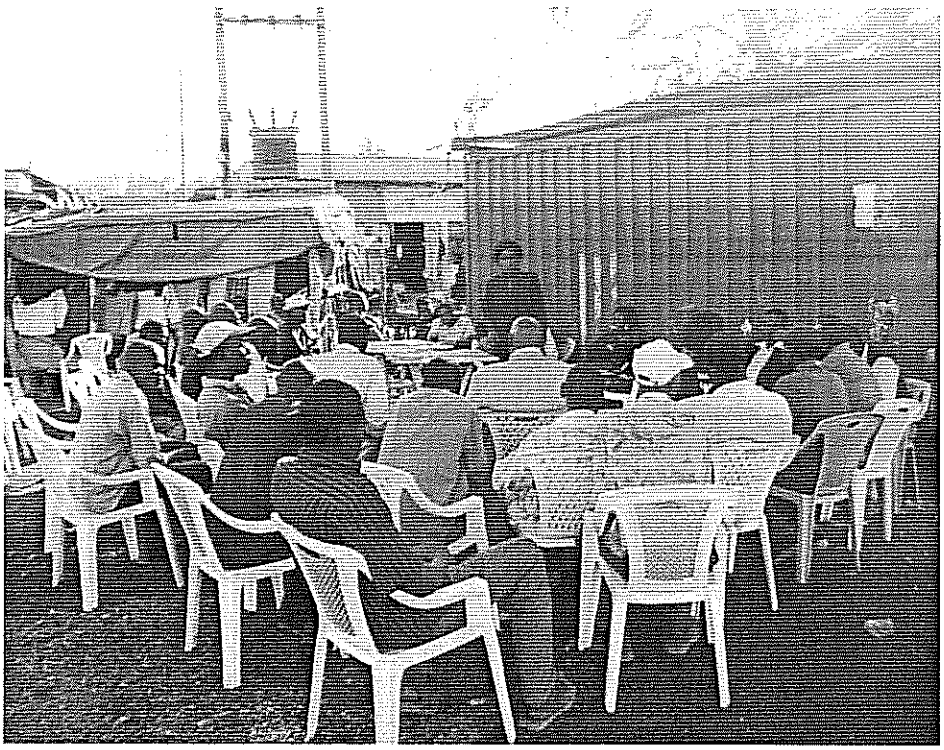


Plate 2: Public Baraza at Kamere Trading Centre

Plate 3: Lead EIA/Audit Expert Addressing the Public Baraza at Kamere Trading Centre

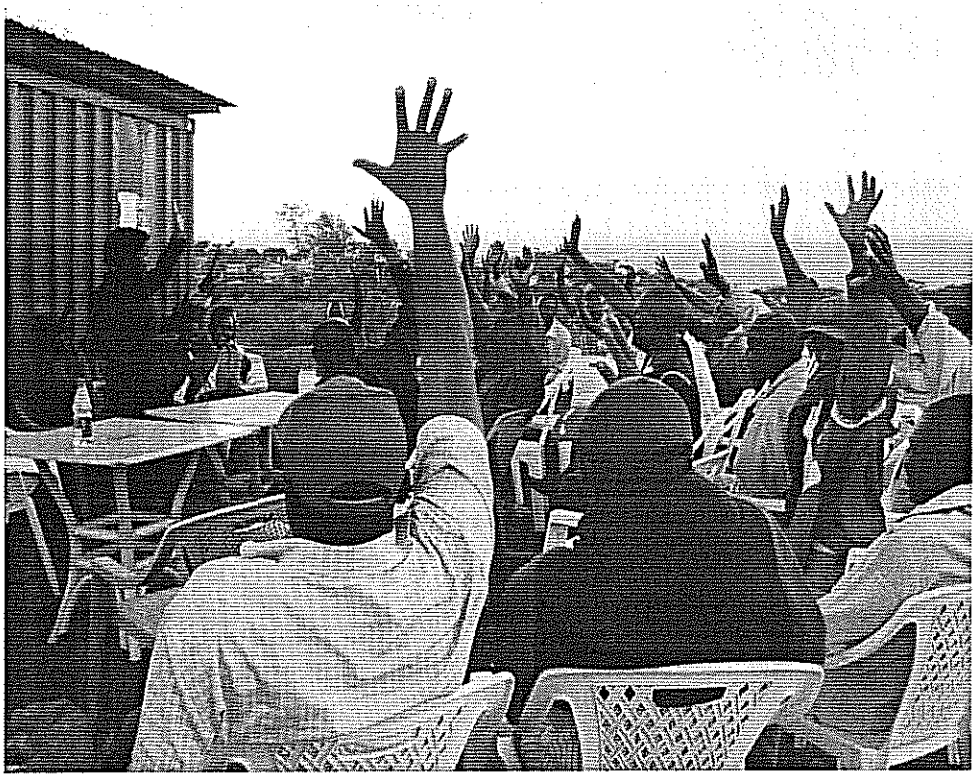


Plate 4: The Local Community Raising Hands in Support of the Proposed Project During the Public Baraza Held at Kamere Trading Centre

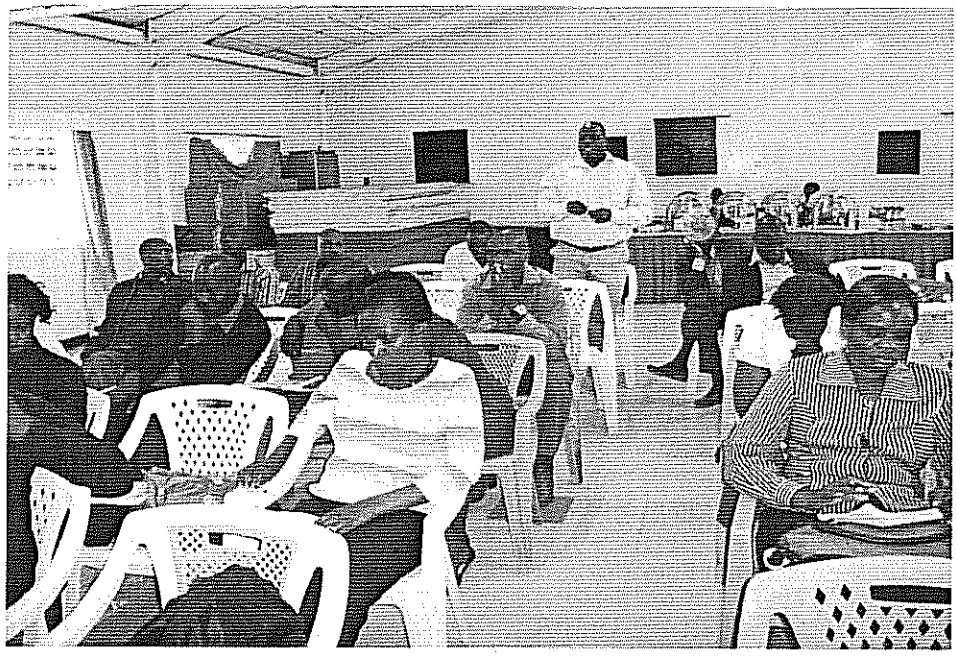


Plate 5: Key Stakeholders Meeting in Progress at Olkaria Social Hall

Plate 6: Key Stakeholders Meeting in Progress at the Olkaria Social Hall

CHAPTER 7: POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

This section provides a summary of the potential environmental impacts associated with the proposed project during the construction, operation and decommissioning phases, along with mitigation measures for management of negative impacts.

7.0 Potential environmental impacts and Mitigation Measures

For geothermal energy utilization developments, which mainly depend on the subsurface conditions and the properties of the fluids produced, the main phases of development are basically the same:

- Exploration (including drilling);
- Production drilling and testing;
- Construction of surface facilities;
- Operation

The scope of this environmental and social impact assessment cover the construction and operational phases of the geothermal power plant. AN ESIA for the drilling of the geothermal wells had been carried out and licensed by NEMA.

The development will utilize resource temperatures of more than 250 ° C. This is a high temperature geothermal resource. The choice of technology for utilization depends on the resource temperature and for high temperature resources, the most efficient turbines are direct contact condensing turbines. The direct contact condenser in which water is directly sprayed onto the steam is a cheaper option, but dissolves some of the geothermal gases into the cooling tower. Typical condenser conditions could raise the temperature of the cooling water by 15 to 20 ° C. The amount of cooling water could be 30-50 times the steam flow. A simplified process flow of a typical single flash condensing geothermal power plant is shown in Figure below.

Geothermal power generation creates much lower emissions of greenhouse gases than most other technologies. In any comparison it is important to consider the entire production cycle is considered, i.e. all phases before, during and after power plant operation. Geothermal power plants have particularly low CO_2 emissions compared to other technologies; when CO_2 abatement is concerned.

Effects on the environmental can be quite different, as they depend on the power plant type, size and on the locally produced geothermal fluid. In general, environmental effects increase with increasing scale of geothermal development and, in particular, with increasing fluid production. The various environmental aspects that are likely to be of impact with the expansion of are discussed below.

7.1 Land disturbance (Land aesthetics)

The various activities for the development of the will require land surface. Land requirements for the extension of the additional unit will require very minimal new land. The existing

installations for Olkaria I units 4 and 5 will serve as the extension of Olkaria I Additional Unit 6. The construction and operation of the Olkaria I Additional Unit 6 geothermal power plant is expected to impact both positively and negatively on the environment.

Some vegetation will be cleared to pave way for installation of the steam supply pipeline from the well pads to the power plant. Uncontrolled removal of vegetation has the potential of accelerating soil erosion. It can also lead to the destruction of important nesting sites for birds and a reduction of the habitat for wild animals. The cleared area for construction of the power plant has the potential of resulting to visual intrusion.

Geothermal power plants impose minimal visual impacts on their surroundings when compared to typical fossil-fuel plants. Some of the key visual quality effects related to geothermal development are the presence of glaring steam pipes. The glaring effect can scare away wild animals and result to a negative perception of the company by tourists visiting the park.

Land disturbance results to sprouting of invasive species of plants like *Datura stramonium, Nicotiana glauca and Ricinus cumunis* which can interfere with animal habitat.

7.1.1 Mitigation Measures

- The disturbance on land can be minimized by making fewer roads in the project area
- Other activities like disturbed areas my require rehabilitation
- Multiple wells on one drill pad
- For the power house no new land will be required
- No new roads will be required for . Existing roads for Olkaria I Unit 4& 5 will serve this expansion.
- Proper routing of the steam pipeline to avoid wildlife sensitive areas
- The area around the power plant site should be landscaped and trees and grasses native to park will be planted towards the end of the construction phase
- Confine vegetation clearing within the demarcated area for the steam pipeline route
- Appropriate soil erosion control measures to be adopted especially at the power plant site during construction phase
- Camouflaging of the steam pipe lines with colours that blend into the surrounding landscape.
- Low relief buildings for power house and cooling tower
- Monitoring program for invasive species to be developed
- Control spread of invasive species by uprooting and destroying

7.2 Chemical Impacts on The Environment

Some of the more common chemical contaminants which can be released into the environment during geothermal development and exploitation are summarised in the Figure 11 below.

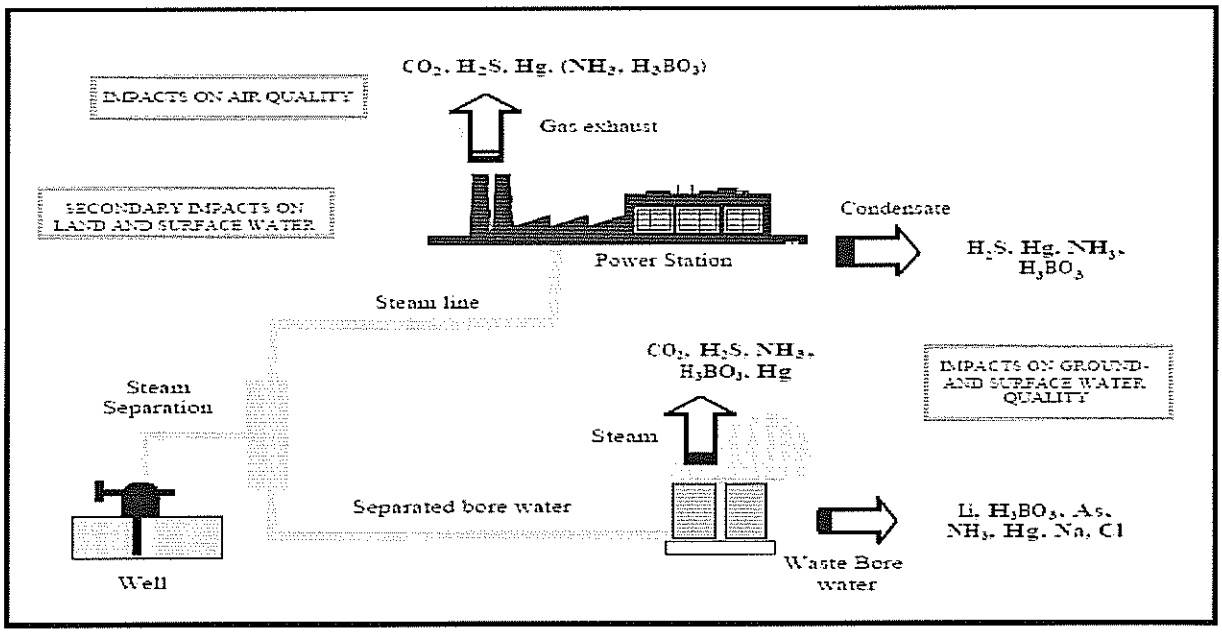


Figure 11: The Main Contaminants in Gas, Steam and Fluid Discharge in the Receiving Environments which are Likely to be Impacted for a Model Developed Field (from Brown, 2005)

Air, surface water and groundwater can be contaminated by the chemicals in geothermal fluids. The effects of these contaminants on human health, domestic animals, crops and aquatic and terrestrial wildlife can be of particular concern. Other chemicals may be added to geothermal fluids during the exploitation of a geothermal field for energy use. Biocides, caustic soda, sulphuric acid and many other toxic or corrosive chemicals are used to prevent bacterial growth or scaling problems.

7.2.1Mitigation Measures

- The brine from the separator will be re-injected 100% into the reservoir
- The condensate will also be re-injected into the reservoir
- All chemicals used will have safety data sheets
- Chemical spill response plans will be formulated and tested
- Chemicals shall be stored in bunded areas with enough room to contain any accidental spillage

7.3 Atmospheric Emissions

Emissions of sulphur dioxide (SO_2), Oxides of Nitrogen (NOx), Volatile Organic Compounds (VOC's) and Carbon Monoxide (CO) originate from stationery sources such as generators and mobile sources such as cars, earth moving equipment and trucks during plant construction.

During geothermal power plant operations exhaust emissions released into the atmosphere has the potential of contributing to greenhouse gas effects (global warming). The main gases emitted from geothermal steam are carbon dioxide and hydrogen sulphide , with very low levels of (NOxs), (SOxs), (VOC's) and (CO). In addition, when the gaseous emissions are continuously inhaled, they become a source of nuisance to the workers and exacerbate respiratory ailments to the worst extent.

In the development of geothermal steam will be conveyed to the power plant from wells that have been drilled or are being drilled in Olkaria East and Olkaria North East production fields. Typical steam composition of selected wells drilled in Olkaria East and Olkaria North East for steam supply to is shown in table 31 below.

Table 31: Gas Composition of Steam in a Few Selected Wells the Proposed Project

Well		CO2	H2S	CH4	H2	N2	Remarks
		mmol/Kg steam t.d					
OW-11A	Olkaria East	96.34	0.38	1.02	1.025	22.79	
OW-39	Olkaria East						Drilling in progress
OW-40V	Olkaria East						Drilling in progress
OW-46	Olkaria East	85.49	0.09	1.57	1.57	11.56	
OW-46A	Olkaria East						Heating up (waiting discharge tests)
OW-47	Olkaria East	128.66	0.06	2.29	2.29	4.50	
OW-717	Olkaria North East						Drilling in progress
OW-731	Olkaria North East	80.91	0.18	4.33	4.33	11.43	
OW-732B	Olkaria North East						Heating up (waiting discharge tests)
OW-733	Olkaria North East	84.43	0.17	0.63	0.63	16.73	
OW-733A	Olkaria North East	98.94	0.10	1.86	1.86	8.39	
OW-733B	Olkaria North East						Drilling in progress

Other gases that occur in trace amounts consist of methane, hydrogen, nitrogen, and other trace gases. The gaseous composition of non condensable gases in the steam from the Olkaria East and Olkaria North East production fields is ~ 0.3 %. These reservoirs have very low gas levels (UNFCC CDM-PDD, Olkaria geothermal expansion, 2006). Electricity generation from geothermal resources involves much lower greenhouse gas (GHG) emission rates than that from fossil fuels. Studies undertaken by the International Atomic Energy Agency (IAEA, 1989,1992), suggest that replacing one kilowatt-hour (kWh) of fossil power with a kilowatt-

hour of geothermal power reduces the estimated global warming impact by approximately 95%.

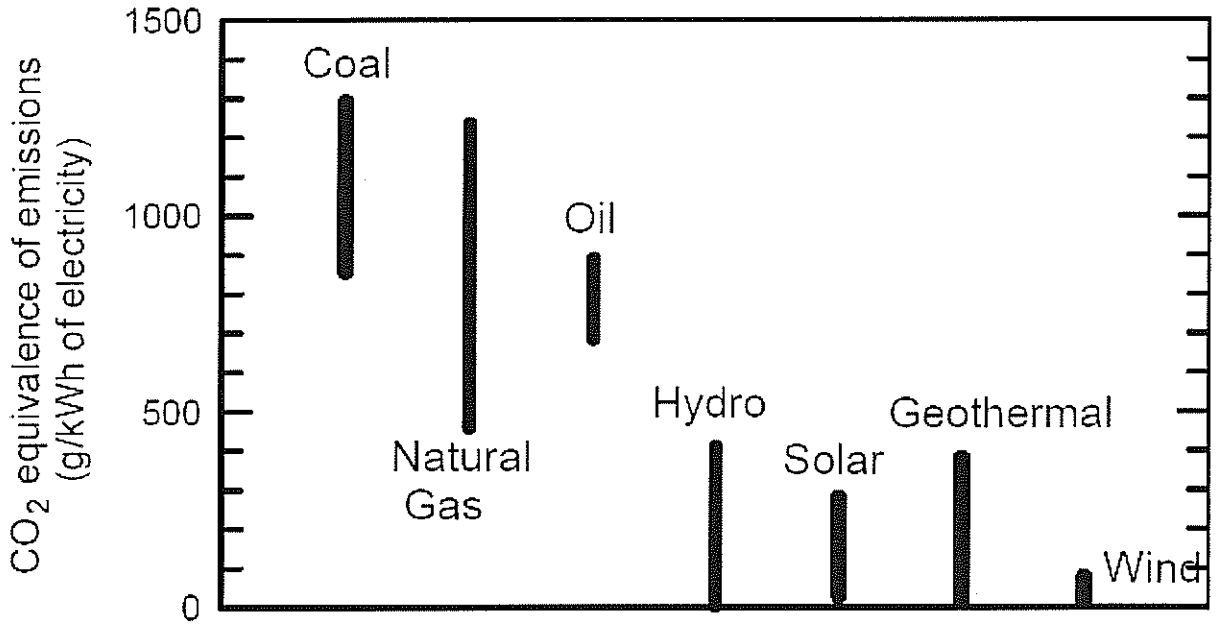


Figure 12: Relative Amounts of Greenhouse Gas Emission from Various Types of Electricity Generation Methods, Data Depressed as CO2 Equivalents from Geothermal Energy News (May 1998) and Geothermal Data Adjusted on the Basis Data from ETSU (1998).

Air quality can be affected through discharge of gaseous contaminates from wells (during drilling and testing), steam condensate pots, silencers and gas ejectors of the power station.

The impact of the release of non-condensable gases into the environment was assessed. The amount of steam required for running Olkaria I Unit 6 will be approximately 525 t/hr consisting of approximately (-) 0.3 % non-condensable gases of which ~ 95 % is carbon dioxide (CO_2) a green house gas (GHG) which contribute to global warming. Olkaria I Additional Unit 6will run as a base load power plant. Assuming the plant generates power for three hundred and sixty five days (365) a year the mount of CO_2 released from will be ~ 13,107 tonnes/year. Compared to other forms of electricity generation e.g. coal fired power plants of similar size this level of CO_2 emissions is low.

Wells supplying steam to Olkaria III power plant e.g wells OW-301 and OW-308 which would generate ~ 146,292 tonnes/year (Tole and collegues, 2000) operated by Orpower 4 Inc. the development of expansion would contribute much lower amounts of Carbon dioxide gas emissions.

7.3.1. Mitigation Measures

- Carbon dioxide gas will be dissolved at the cooling tower plume and re-injected with the condensate

- Emissions will be sampled on regular basis and calculations to find the total emissions from the plant done for CDM purposes

- Recondition engine exhaust systems
- Proper engine tune-up
- Use of properly maintained plant and machinery
- Generators to be positioned away from main work areas

7.4 Hydrogen Sulphide Gas

Hydrogen sulphide (H_2S) is produced naturally and as a result of human activity (WHO, 2003). Geothermal development is associated with emissions of hydrogen sulphide; the most important points of emission in plants are chimneys for venting non-condensable gases, cooling towers, silencers and traps in the vapour duct (Nyagah, 2006). H_2S gas is denser than air and can accumulate in low-lying areas such as cellars and basements, and can be imperceptible at lethal concentrations (Hunt, 2001). The measurement units for H_2S in the air are parts per million (ppm) or milligrams per cubic metre (mg/m3). Toxic effects of H_2S vary according to the dosage and are classified in scientific literature (WHO, 1981) into three categories, namely acute, sub-acute and chronic.

Hydrogen sulphide gas concentrations from wells in Olkaria East and Olkaria North East fields are generally low. The total hydrogen sulphide gas produced by the Olkaria East production wells supplying steam to the existing Olkaria I 45 MWe power plant is ~ 890 tonnes/year (Tole and colleagues, 2000) while estimates of hydrogen sulphide from Olkaria West is much lower. H2S emissions from Olkaria I and Olkaria II power stations were monitored from April 1997 and September 2003 to April 2012, respectively. The highest recorded value of H_2S at Olkaria II was the hotwell pumps of unit II of 5.1 ppm while at Olkaria I, the highest recorded value was 6.1 ppm at the seal pit of Unit I. H_2S concentrations at Olkaria I and Olkaria II power stations were below the Ameriacan National Institute of Occupational Safety and Health (NIOSH) standards of 10 ppm averaged over a 24- hour period for employees working eight hours per day for five days in a week.

Marani (1995) shows decreases of hydrogen sulphide (H_2S) concentrations downwind by a factor of 16 per KM in the first kilometer, and about 30 per km over the next 12 km. Ndetei (2010) used AERMOD an air dispersion model for modeling the dispersion of H_2S in Olkaria I and Olkaria II. Results from the modeling indicate that high concentrations of H_2S would occur closest to the Olkaria I and II power plants with the highest concentrations being ~ 0.963 ppm averaged over 1 hour at Olkaria I. At a distance of about 500 meters east of the Olkaria I plant the H_2S plume decays and the concentration decreases to about 0.172 ppm. At an averaged 8 hour periods the concentrations of H_2S is much lower being highest near the Olkaria I power plant (~0.211 ppm) with dispersion to the north east being low 600 meters from the station (0.043 ppm). For the 24 hour averaging the concentrations were even lower.

Ndetei (2010) air dispersion modeling predicted there would be no significant impacts due to H_2S emissions to the neighbouring communities outside the boundaries of 0.106 ppm even with the addition of Olkaria IV power plant. The addition of Olkaria I Unit 6 would therefore not add any significant H_2S emissions to the existing power plant of Olkaria 1 units 4 and 5.

7. 4.1 Mitigation Measures

- Hydrogen sulphide gas should be monitored continuously in different areas of the power plant and corrective action taken where the maximum recommended occupational limit of 10ppm is exceeded
- Use of appropriate warning signs
- Use of permit to work when working in confined space
- Gas detectors are required for people working in confined areas
- Training of staff on hydrogen sulphide response and evacuation
- Where limits are exceeded hydrogen sulphide abatement mechanisms can be implemented through scrubbing

- Metallic structures should be painted to protect the structures from corrosion as result of oxidation of H_2S

7.5 Waste heat

All heat – power conversion systems produce waste heat, which can attain significant portions. This applies to geothermal power generation as well. The fraction of the waste heat is dependent on the conversion technology/power plant type. Geothermal power plants release considerably larger waste heat quantities, due to the lower conversion efficiency, than other power plant types except for thermal and Binary power plants. A comparison with other technologies is given in Figure 13 below.

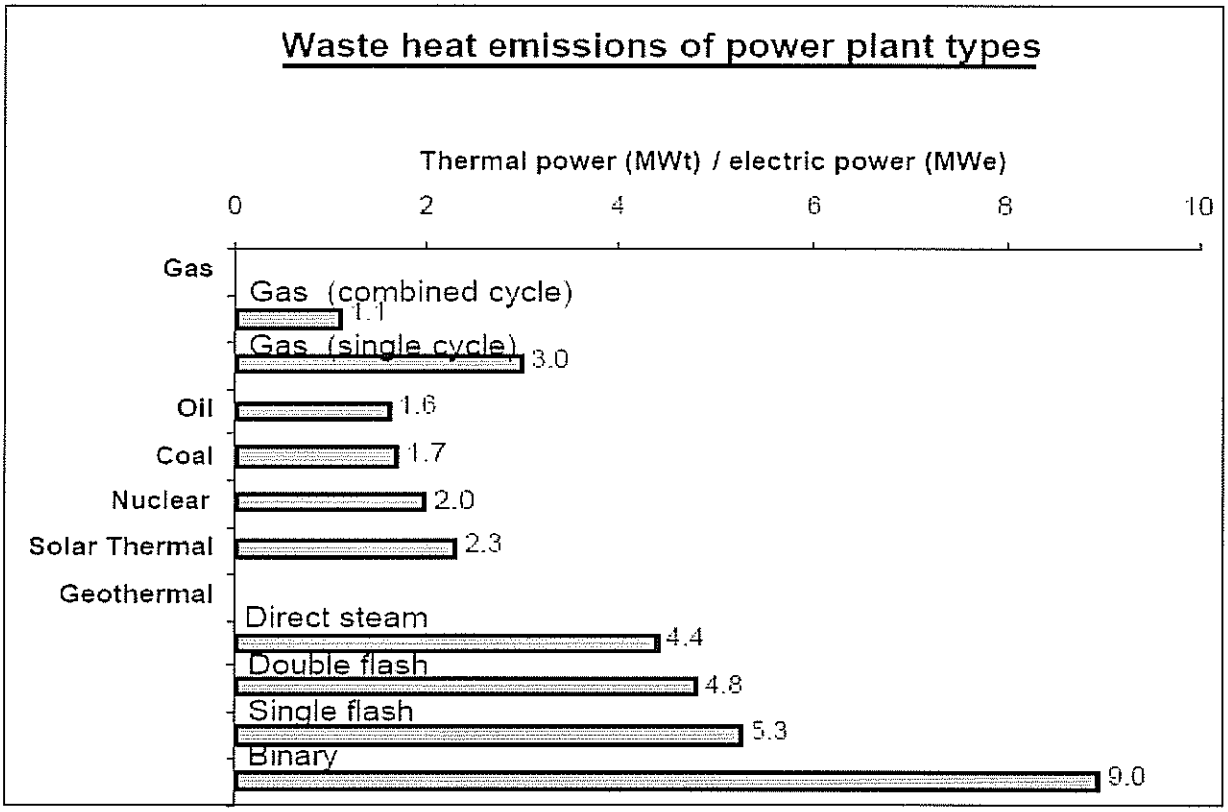


Figure 13: Waste Heat (MWt) per Unit Electric Capacity (MWe) of Geothermal Power Plants, in Comparison with Other types of Power Generation (From Dipopo, 1991) Modified

The waste heat due to power generation ultimately ends up in the atmosphere or the hydrosphere. Local conditions like the microclimate (e.g around cooling towers) can significantly be influenced.

The extension of the would contribute additional heat at the plant sites and pipeline transmission facilities. A change in the general microclimate around the Olkaria East Production field is bound to be influenced by the increase in evaporative effects. The main areas of heat release will be around the power plant, the transmission pipelines and separated water.

7.5.1 Mitigation Measures

- Solutions to heat discharge areas into the atmosphere/hydrosphere would require disposal methods that dissipate the heat or find use for the heat.

- Reinjection into the subsurface is the most often used technique to dispose heat in separated waters. Cooled fluids after the steam power generation cycle can be re-injected into the geothermal reservoir.

- Waste heat can be utilized in a more purposeful way e.g in combined heat and plant (Co-generation) and or utilization can be cascaded. Examples of cascaded use for the heat are found from Oserian Development Company and at the Direct Use and Demonstration Centre's Spa.

- In the case of extension, separated waters and power plant blow down (formed after cooling steam upon power generation cycle) will all be re-injected.

- All pipe work for steam , two-phase and separated water have to be lagged .

7.6 Land subsidence

The withdrawal of fluid from the geothermal reservoir can result in the reduction of formation of pore pressure which my lead to compaction in rock formation of having high compressibility and result in subsidence at the surface. Horizontal movements also occur. Such ground movements can have serious consequences for the stability of pipelines, drains and well casings in a geothermal field. At the Wairakei Geothermal Field, New Zealand subsidence experienced in the field resulted in maximum vertical displacement of over 15 meters in some parts of the field (Hunt, 2000). Subsidence has been recorded in other high temperature geothermal fields in the world e.g Cerro Prieto (Mexico), Ladarello fields. Figure 8 shows the effects of subsidence at the Wairakei Geothermal Field, New Zealand.

A field under exploitation will have mass removed from its reservoir. Large scale exploitation of geothermal reservoirs leads to large scale withdrawal of mass during exploitation which would cause the formation of two phase. As production increases the two phase zone my increase. Since production began in Olkaria East for the production of the 45 MWe microgravity monitoring has been done since 1983. A network of thirty three (33) microgravity bench marks was established for microgravity monitoring out which 31 are currently in use (Ogada, 2010). Results of the monitoring indicate there has been minimum effects of mass withdrawal on ground deformation. This is shown in Figure 14 below for selected bench marks in the Olkaria East production field.

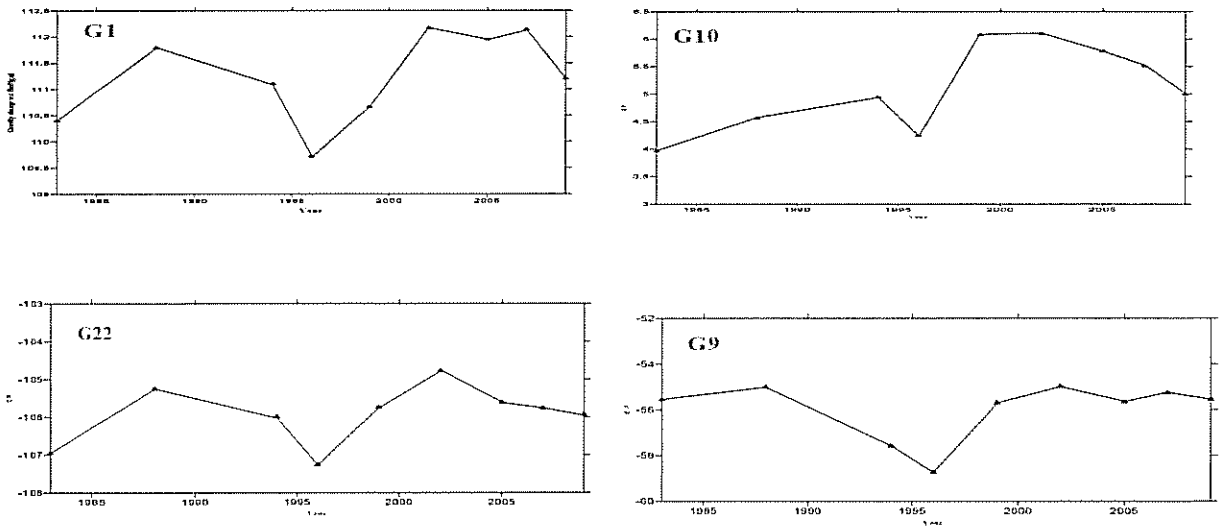


Figure 14: Gravity Changes at Selected Benchmarks in Olkaria East Field

Note: The gravity decreases during the early stages of production as the 2-phase zone expanded, followed by gravity increases as the deep water level rose as the rocks became re-saturated as a result of cold down flows (no corrections for subsidence). Pressure declines in the reservoir, as result of mass withdrawal and net mass withdrawal and net mass loss. These are important causes of environmental changes at or near surface.

During operation of the there will be increased mass withdrawal from the Olkaria East production field.

7.6.1Mitigation Measures

- Implement monitoring programmes for subsidence, ground deformation and inflation.
- To mitigate against mass withdrawal re-injection of the separated water will be necessary to create pressure support in the reservoir. This reduces pressure declines in the reservoir.
- Implement microgravity monitoring by using the existing benchmarks in Olkaria East and improve the monitoring by use of Digital Elevation Models (DEM) and Synthetic Aperture Radar (SAR) Interferometry.

7.7 Noise Impacts

Noise is associated with both auditory and non-auditory impacts. Exposure to noise levels of relatively high degrees can lead to direct hearing loss or hearing impairment (Ismail et al., 2009). The non-auditory impacts include annoyance and disruption of basic activities such as sleep, rest, communication, concentration, and might affect health and physiological well-being (WHO, 1999);

The main areas of noise during the project may result from construction activities of the power house/plant and plant operations. During operations of the power plants noise levels may vary from different areas of the plant e.g turbine halls, cooling towers, compressor rooms and vacuum pumps. During the construction of the , noise associated with construction activities such as earthworks, vehicular movement is bound to be high. Noise levels measured at the construction activities at the current site for Olkaria I Unit 4 & 5 were in the range of ~ 51 to 78 dB (A).

Noise levels for the Olkaria I and II power plants have been monitored regularly since 1985 and 2003 respectively. High noise levels are encountered in the turbine halls, compressor rooms, cooling towers and gas ejectors. At Olkaria I power plant with the current operation , the turbine hall on occasions records the highest noise levels, higher than 85 dBA (Ndetei, 2010) which is above the occupational health and safety limits for 8 hr exposure (WHO). Noise levels were highest in

the turbine halls, compressor rooms, cooling towers , and vacuum pumps of Olkaria I and II power plants, ranging between 68 to 99 dBA .

During the actual expansion and operation of the , noise levels would be expected to be in the same range to the noise levels experienced at the Olkaria II turbine halls, compressor rooms, vacuum pumps and cooling towers. Moving away from the source of noise, noise levels decay with measurements often below 75 dB (A) at the administration block and the KWS monitoring sites. Noise levels in areas of residence e.g Lake View Estate are much lower ~ 50 dB (A) (Ndetei, 2010) .

The ESIA report for Olkaria I unit 4&5 recommended resettlement of the local community at the Maasai Cultural Centre due to high noise levels during operation phase and consequently a Resettlement Action Plan was prepared and is being implemented. The will have been resettled by the time of commissioning the plant .

7.7.1 Mitigation Measures

- ✓ Workers in noisy areas should put on Personal Protective Equipment (PPE) e.g ear muffs and plugs
- ✓ Monitoring of noise should be adapted for during operations.
- ✓ Continued noise monitoring at the current monitoring sites for Olkaria I and Olkaria II
- ✓ Carrying out regular maintenance of equipment and machinery during both construction and power plant operations
- ✓ Abatement methods could be instituted to muffle noise
- ✓ Use of signage to raise awareness in noisy areas of operation
- ✓ Noise levels can be mitigated in the original design and use of acoustics barriers
- ✓ Noise reduction in the control room and the general powerhouse design.

7.8 Hydrology and water consumption

Construction activities are likely to result to increased consumption of water abstracted from Lake Naivasha as a result of cumulative effect. Leaking pipes, running taps left unattended to and misuse of water are likely to exacerbate the problem. Increased water consumption can result to negative reactions from other water users and to the worst extent conflicts.

An important aspect of the hydrology of the project area is the withdrawal of geothermal fluids on Lake Naivasha. The impact of geothermal fluid withdrawal during exploitation on the lake Naivasha water is unknown. Abstraction of Lake Naivasha water would lead to lowering of the lake water level which would have some potential impacts on the lake. Sinclair Knight Mertzet al (1994) viewed that the amount of water abstracted by the geothermal project from Lake Naivasha for plant operations would minimally affect the lake water levels.

Due to increased drilling activities water abstraction from Lake Naivasha for all uses by KenGen increased between 2008 and 2012 with a peak of ~ 200,000m3 per/month. Water usage for drilling activities has been supplemented by use of brine to conserve the use of lake water.

Cooling water requirements are only at plant start up as the cooling circuit is a closed loop with minimal water losses. The Operations of the expanded plant on its own would have minimal impact on the amount of water used in the plant operations.

7.8.1 Mitigation Measures

- All water supplied to the construction site and power plant operations should be metered
- Water consumption records should be maintained at the site by the project engineer
- All water supply lines should be inspected on a regular basis for leakages
- Any water leakages along the pipeline should be reported and fixed as soon as possible
- Reuse of water where feasible should be encouraged
- The reliance on lake water for plant operations can be reduced by introducing measures such as rain water harvesting and storage,
- Recirculation of the condensate, treatment of separated brine which can be used for makeup water

7.9 Wastewater disposal

Large volumes of separated water and condensate will be generated during the operation of the power plants. Separated water will consist of brines while the condensate will form from the power plant blow down, condensate drain pots and steam traps. In the brine, the chemical composition consists of high concentrations of components like chloride fluoride, sodium, potassium boron etc. The brines to be separated for power plant have high concentrations of the solutes. The chloride concentrations range between 400 to 1200 ppm while fluoride and boron are in the range of ~ 25 to 280 ppm and 2.5 to ~ 8 ppm respectively. The values for these constituents are above the recommended values for drinking water quality by the World Health Organization (WHO). Due to potential toxicity and contamination of the surface environment, brine disposal will be by re-injection

The condensate from Olkaria I and II power plants is highly acidic due to the dissolution of non condensable gases contained in the steam. These gases are mainly carbon dioxide and hydrogen sulphide. Other volatiles contained in the condensate are compounds with low vapor pressure e.g mercury and arsenic. Mercury concentrations in the brines and condensate of Olkaria East and Olkaria North East fluids are in the range ~. The main sources of condensate formed is from the power plant blow down and drain pots along steam lines. For safe disposal of condensate formed along the drain pots this will need to be contained to avoid surface run off

7.9.1 Mitigation Measures

- Separated brine and condensate blow down from the power plants will all be re-injected into deep wells
- Condensate formed from drain pots along the steam lines will be collected in sumps and pumped into brine re-injection lines
- Brine leakages could be collected in sumps and pumped into re-injection lines or used to supplement water for drilling activities.

7.10 Dust Emissions

Clearing of vegetation, excavation of soil with earth moving equipment, loading and offloading of loose materials from trucks and concrete mixing using concrete batching plants and concrete mixers are likely to result to dust emission. The loose nature of soil within Olkaria Geothermal Field is likely to worsen the situation especially during the dry season. Dust or particulates released into the atmosphere are likely to cause significant environmental impacts such as soiling of property or vegetation around the area, impaired visibility and public nuisance during construction. During plant construction the impact could be more pronounced and felt by he work force.

7.10.1 Proposed Mitigation Measures

- Water sprinkling of all exposed surfaces as frequent as possible throughout construction phase
- Trucks transporting materials within the park should not exceed the park speed limit of 40km/hr
- Trucks ferrying loose materials to and from the site should be covered to prevent the materials from being blown by wind
- Trucks should not be loaded to the brim to avoid loose materials from spilling on the road especially where we have speed bumps
- Any loose material that spills on the tarmac road should be immediately removed
- Provide personal protective equipment to construction workforce including dust masks, eye goggles and coveralls
- All spoil material to be dumped at the existing quarry
- Loose construction materials to be stockpiled and protected from wind erosion
- Incorporate appropriate dust control measures in the concrete batching plant

7.11 Soil erosion

Considering the loose nature of soil within Olkaria, clearing of vegetation for construction of the power plant and installation of the steam pipeline has the potential of resulting to wind and water borne erosion. During rainy season, soil from the construction site is likely to be washed by storm water runoff to the nearby gully resulting to destruction of animal habitat through sediment deposition.

7.11.1 Proposed Mitigation Measures

- Landscaping of all disturbed areas upon completion of construction phase
- Planting of existing species of trees and grass in all disturbed areas in the park
- All loose soil to be properly stock piled and protected from rain.
- Building of gabions on unstable slopes to slow down erosion

7.12 Oil , fuel Storage and Hazardous Materials Handling

Hazardous materials likely to be stored and used at the power station include lubricants and caustic soda. These materials are hazardous in nature and can therefore result to adverse human health and environmental pollution if not properly handled.

Use of generators and earth moving equipment will necessitate refueling and sometimes servicing from the construction site. During plant operations lubricating oils will be required. Refueling and servicing of equipment on site can result to accidental spillage of used oil and fuel on the ground surface. This can cause soil and surface water contamination.

7.12.1 Proposed Mitigation Measures

- Develop spill response and management plan
- Maintain spill response kits at the site
- Use of drip trays during minor servicing of equipment
- Drums containing fuel and used oil should be stored on water proofed surface and protected from direct sunlight and rainfall
- Used oil should be kept in suitable containers and sold to licensed waste oil handlers
- Oil and Lubricants containment areas
- Maintain a file on material safety data sheets
- Provide and enforce use of personal protective equipment
- Storage of the materials as per manufacturers recommendations
- Incorporate oil/water interceptors in the design of the storm water drain

7.13 Solid Waste Disposal

The type of waste likely to be generated during construction operation phases of the proposed project include the following: sewage, waste water, spoil, used oil, empty cement bags, empty paint containers, timber, scrap metals, rags, polythene papers and cable cuttings. Indiscriminate disposal of waste water, sewage and used oil has the potential of contaminating soil and surface water resources as a result of cumulative effect. Besides pollution, waste can also cause aesthetic degradation and nuisance to employees and visitors to the site. When empty containers accumulate water during rainy season, they serve as a collateral harbor of mosquitoes which would contribute to spread of malaria and/or public nuisance.

7.13.1 Proposed Mitigation measures

- Provide suitable and well labeled solid waste containers
- Segregate waste at the point of generation
- Reduce generation of waste at the source
- Reuse of top soil for landscaping of the site
- Scrap metals and empty paint containers to be temporary accumulated at a safe place on site for reuse or for selling to licensed scrap metal dealers
- Used oil to be stored in closed containers placed on concrete floor under a shed

- Used oil to be sold to NEMA licensed used oil handlers
- Sewage and waste water to be disposed in suitable sanitary facilities to be provided on site
- Timber to be accumulated safely for future reuse or donation to the local community as part of KenGens' Corporate Social Responsibility
- Empty polythene papers and cement bags to be reused where feasible and the balance to be accumulated safely for disposal by licensed waste contractors

7.14 Spread of HIV/AIDS and other Contagious Diseases

During construction phase, there will be an influx of skilled and unskilled workers at the construction site. When workers engage in risky behaviours either amongst themselves or with the local community there exists the potential of spreading HIV/AIDS and other contagious diseases. The diseases can have far reaching effects to the local community.

7.14.1 Proposed Mitigation Measures

- Sensitization of workers and the local community on the need to refrain from risky behaviours
- Education and awareness creation to be carried out in conjunction with the Ministry of Public Health and Sanitation as well as Ministry of Health
- Provision of condoms at strategic locations in the workplace e.g in the sanitary facilities
- Appropriate posters for creating awareness on HIV/AIDs and other contagious diseases should be conspicuously displayed at the construction site
- All contractors to adhere to KenGens' Drugs and Substances Abuse Policy
- Workers residential camp shall not be constructed at the site instead workers should be transported to and from Naivasha town

7.15 Increased traffic along access roads

During the construction phase of the power plant vehicular traffic is bound to increase . This is due increased transportation reuirements for construction materials, e.g gravel, ballast, sand, turbine plant generators etc from the source to the construction site. This has the potential of building up traffic along the access main roads. Since the access road pass through Hells Gate National Park, the impact will be most felt at the KWS Olkaria gate especially during rush hours (at 8.00am and 5.00pm). This can result to loss of time by other road users and accidents through over speeding.

7.15.1 Proposed Mitigation Measures

- Sensitization of all truck drivers on park rules
- All truck drivers to observe and adhere to existing road signs
- All truck drivers to abide by the defined park speed limit of 40km/hr
- Delivery of materials to the site to be scheduled at off peak hours
- Use traffic signals or flagmen to manage traffic flow to and from the construction site
- Comply with the Traffic (Amendment) Act, 2012

- Develop an inventory of all vehicles being used by contractors and avail a copy to the Senior Warden, Hells Gate National park
- Rehabilitation of access road within the park

7.16 Health and Safety Issues

During construction phase, the public and workers are likely to be exposed to risks such as handling of hazardous materials, food poisoning, attack by wild animals, noise and accidents involving falling objects from high levels. This has the potential of resulting to nuisance, injuries and/or occupational ailments.

7.16.1 Proposed Mitigation Measures

- Restrict access to the construction sites by unauthorized persons
- Provide staff with personal protective equipment including coveralls, gloves, helmets and safety boots
- Provision of adequate number of standard first aid kits.
- Maintain emergency response procedures and plans at the site throughout the construction phase of the project
- Maintain a records of incidents and accidents
- Each contractor to appoint a health and safety coordinator
- Conduct mandatory safety inductions for all visitors to the site
- Document and display at the site emergency phone contacts for the nearest ambulance service provider, police post, dispensary as well as KenGens' Project Engineer
- Obtain indemnity cover for all the workers on site
- Provision of wholesome drinking water to workers
- Use of permits to work during electrical installations, working in confined space and hot works (welding)
- Maintain a register of workers on site
- Hold pre-job safety meetings with new workers to discuss safety issues pertinent to the job, such as site specific emergency plans and job-specific hazards.
- Hold monthly meetings to discuss general safety concerns, review incidents, and determine actions needed to implement job safety.
- The first aid kits should be under the responsibility of trained first aiders
- Erect appropriate safety reminder signs at strategic points
- Designate cafeterias where food will be prepared and sold to the workforce
- The cafeterias should be maintained in a hygienic state and the food vendor should ensure that his/her employees undergo medical examination at least once in a period of six months
- Provision of personal protective equipment
- Statutory inspection of all lifting equipment and air receivers
- Installation of appropriate safety signage
- Training of staff on fire fighting, first aid and hydrogen sulphide response and evacuation
- Installation of fire protection system

- Inspection of fire fighting equipment
- Conduct fire drills
- Conduct statutory audits (fire audit, occupational health and safety audit, energy audit and environmental audit)

7.17 Fire Risks

There exist the potential of fire outbreak during construction phase of the proposed project. Fire can emanate from the Kitchen at the contractors'/Engineers' site office and/or the storage area for the fuel and used oil. The impact will be loss of life, vegetation and property.

7.17.1 Proposed Mitigation Measures

- Provide fire breaks around the site offices
- Provide appropriate firefighting equipment
- Train workers on fire fighting
- Ensure inspection of the fire equipment
- Designate a smoking zone
- Post No smoking signs at the storage area for the fuel and/or oil

7.18 Insecurity Risks

The proposed project will attract many people who will be interested to get employment. Influx of workforce during the construction phase is likely to result to theft of property from KenGen facilities, contractors' offices and the local community. The impact would be conflicts between KenGen and the local community. This can spoil the company image.

7.18.1 Proposed Mitigation Measures

- Develop an inventory of all vehicles being used by contractors and avail a copy to the Senior Warden, Hells Gate National park
- All vehicles in the inventory should obtain authority to access the park
- All contractors should develop a register of workforce and avail a copy at the Olkaria gate
- All staff should be issued with identification cards
- Screening of people entering the Olkaria gate to ensure only those with appropriate identification cards are allowed in
- All vehicles shall enter and leave through the Olkaria gate
- Inspection of all vehicles entering and leaving the park
- All security incidents shall be reported to the KenGen security office for investigation and appropriate action

7.19 Loss of animal dispersal areas

Laying of steam pipelines has the potential of obstructing animal dispersal areas hence making it difficult for the wild animals to access their habitats and drinking water.

7.19.1 Proposed Mitigation Measures

- Routing of the steam pipeline to be carried out in consultation with KWS in order to avoid major wildlife dispersal areas
- Provision of appropriate animal loops in the design of the steam pipeline
- Land outside the park area purchased by KenGen will be left open for wild animals to habit

7.20 Stakeholders Perception on the overall Impact on the park

During operation phase of the proposed project, there is a likelihood that stakeholders will have an impression that the proposed project has impacted negatively on the park. This can spoil the image of the company.

7.20.1 Proposed Mitigation Measures

Jointly with KWS, KenGen shall be expected to:

- Continue with the joint ecological surveys
- Control spread of invasive species;
- Carry out regular wildlife censuses in the ecosystem.
- Map animal routes
- Mapping of vegetation structure and composition

7. 21 POTENTIAL POSITIVE SOCIO-ECONOMIC IMPACTS

As part of the general principles of the *Earth Charter* (Rio Declaration, 1992), social fundamentals are as valued as ecological and economic ones. In the development of project, impacts on indigenous communities and societies will be taken into consideration and impacts assessed. Acceptance of the development of will depend on the local residents. Prevention or minimization of detrimental impacts on the environment and people as well as the creation of benefits for local communities is indispensable to obtain social acceptance. The social acceptance of the development of the must be considered in all project phases with high priority. The social related aspects of development are elaborated below.

7.21.1 Employment creation

The proposed project has the potential of creating employment opportunities both during construction and operation phases. During construction phase, a big percentage of the unskilled workforce will be drawn from the local community whereas during operation phase of the proposed project skilled workforce which will be sourced competitively will benefit greatly.

7.21.2 Creation of business opportunities

The proposed project has the potential of creating business opportunities to the following groups of people:

- Suppliers of construction materials like sand, cement, paint and ballast etc.
- The various contractors that will undertake power plant construction and installation of the steam gathering system
- Food vendors who will be authorized to sell food to the construction staff at the site
- Landlords with rental houses within the neighbouring estates like Kamere and kwa Muya
- Transport businesses e.g trucks and Passenger Service Vehicles
- KenGen and Kenya Power Company during operation phase of the proposed project

7.21.3 Revenue Generation through Clean Development Mechanism (CDM)

Geothermal power stations emit less green house gases as opposed to thermal power plants hence qualifying for CDM. Once the proposed project has been listed as a CDM project, the Community Development Carbon Fund (CDCF), which is a component of the revenue generated from CDM, will be used to finance community projects around Olkaria Geothermal Field hence contributing to development of the area. For the case of Olkaria II 3rd unit power plant, the CDCF was used to construct a 10km domestic water supply line in Maiella location, class rooms at Olorouwa and Ngaambani primary schools and digging of a community water pan at Olosingate. This implies that both the local community and KenGen will benefit as a result of CDM.

7.21.4 Generation of an additional 70MWe of electricity

The proposed project, upon successful implementation, will contribute towards injection of an additional 70MWe of energy to the national grid hence contributing towards meeting the projected energy demand. This is in line with vision 2030 which envisages energy as a key enabler for economic growth across the country. In the long run, the proposed project will have contributed to the governments' strategy of changing the base load electricity supply from hydro, which is affected by droughts, to geothermal that is reliable and cost effective.

7.21.5 Enhancement of direct uses of geothermal energy

Besides power generation, geothermal energy can also contribute to direct uses including farming, pyrethrum drying, refrigeration, heating of houses, creation of a spa, sauna and swimmimg pool. Pyrethrum drying using geothermal energy is being practised at Eburru whereas at Oserian Development Company, the energy is being used to: heat Greenhouses, refrigerate cut flowers, promote photosynthesis, fumigate soils and sterilize liquid recycled plant fertilizer. KenGen is currently constructing a swimming pool, sauna and a spa at Olkaria in order to showcase the direct uses of geothermal energy. With implementation of the proposed project, the direct uses of geothermal energy at Olkaria and its immediate neighbuorhood is likely to be enhanced.

7.21.6 Tourism

The , an expansion of the Olkaria Geothermal Project falls within the Hell's Gate National park. The park is known for its attractive scenic beauty and avifauna. The Olkaria Geothermal Project is a unique development in a national park, balancing a delicate ecological system with the development of power generation facilities. The presence of the power plants serve as a tourist attraction for the local residents and other interested parties. Lately, a development of

a demonstration centre for direct uses and geothermal spa has been added which will be an additional tourist attraction in the park. Tourism numbers in Hell's Gate National Park have been increasing, with the highest numbers of 95,816 arrivals recorded in the year 2007. With the introduction of the geothermal spa as an additional attraction these numbers are likely to increase

7.21.6.1 Mitigation Measures

- Promote and market the tourism activities in Hell's Gate Nation Park in conjunction with KWS.
- Working with KWS, KenGen could promote guided tours of the geothermal activities and facilities in Olkaria.
- A dedicated function for guided tours should be created within KenGen's structure of the Olkaria Geothermal Project.

7.22 EVALUATION OF SIGNIFICANCE OF THE POTENTIAL ENVIRONMENTAL ASPECTS

Evaluation of significance of the potential environmental aspects associated with implementation of the proposed project was adopted from KenGens' criteria as provided for by the documented procedure on aspect identification in line with the Environmental Management System (EMS) standard. Four parameters were selected to assist in the evaluation. They include frequency and probability of impact to occur, severity and consequence of the impact, geographical dispersion and public image. From the four parameters selected, the maximum score is forty (40). According to this criteria, for an aspect to be termed significant the total score has to be 20 and above. The negative sign before the score indicates that the aspect has the potential of resulting to negative environmental and social impacts.

1. Frequency and Probability of Impact to Occur

- **Score 1**: The impact will only occur on major catastrophe, such as big earthquake, floods, tsunami, etc. or once in a while
- **Score 3**: The impact (may) occur on major accidents or incidents such as fire, explosion, and spillage or once in a while
- **Score 5**: The impact (may) occur due to lack of training, equipment failure or lack of procedures and abnormal conditions or once in a while
- **Score 10**: Impact (may) occur on normal condition or on daily basis.

2. Severity and Consequence of the impact

- **Score 1**: No harm to the environment, human, or equipment
- **Score 3**: There is potential for disturbance to the surrounding environment
- **Score 5**: Impact causes or may cause disruption on the surrounding environment and there is potential for harm to the human health
- **Score 10**: Impact causes or may cause damage or destruction to the surrounding environment and could lead to death of humans

3. Geographical dispersion

- **Score 1**: The impact is only on the spot
- **Score 3**: Dispersion of impact (may) cover the whole project site
- **Score 5**: Dispersion of impact (may) reach beyond the boundary of the project site
- **Score 10**: Dispersion of the impact (may) reach up to regional level.

4. Public Image

- **Score 1**: No impact on the image of the company
- **Score 3**: The impact may cause local issues.
- **Score 5**: The impact (may) cause environmental issues up to the national level and involve the media.
- **Score 10**: The impact (may) cause environmental issues to the international community

Potential Environmental/Social Aspect	Scores					Description of significance
	Frequency & probability of occurrence	Severity & consequence	Geographical dispersion	Public image	Total Score	
CONSTRUCTION PHASE						
Dust	-10	-5	-5	-3	**-23**	**Significant**
Vegetation clearing	-5	-3	-5	-5	**-18**	Not significant
Spread of HIV & other contagious diseases	-10	-10	-10	-3	**-33**	**Significant**
Noise	-10	-5	-5	-3	**-23**	**Significant**
Exhaust emissions						
Spillage of hazardous materials (oil, fuel) on the ground surface	-5	-3	-5	-5	**-18**	Not significant
Waste generation and disposal	-10	-5	-5	-10	**-30**	**Significant**
Increased traffic	-10	-10	-10	-3	**-33**	**Significant**
Cumulative impacts on water abstracted from Lake Naivasha	-10	-3	-10	-3	**-26**	**Significant**
Fire	-3	-10	-5	-3	**-21**	**Significant**
Security issues	-10	-10	-5	-3	**-28**	**Significant**
Visual intrusion	-10	-3	-5	-3	**-21**	**Significant**
Blockage of animal dispersal routes	-10	-3	-1	-10	**-24**	**Significant**
OPERATION PHASE						
Noise	-10	-5	-5	-5	**-25**	**Significant**
Hydrogen sulphide emission	-5	-10	-3	-10	**-28**	**Significant**
Waste generation and disposal	-10	-5	-10	-10	**-35**	**Significant**
Storage and handling of hazardous materials	-5	-10	--5	-5	**-25**	**Significant**
Health and safety aspects	-10	-10	-5	-10	**-35**	**Significant**

8.0 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Environmental Management Plans (EMP's) provide a framework for dealing with risks to the environment and socio-economy during the project lifecycle Environmental management plans are developed to comply with legal or regulatory requirements and also to assist the project with acceptance by local communities and stakeholders. The proposed EMP specifies detailed requirements along with designated roles and responsibilities, to produce an integrated management plan that provides ongoing utility and guidance to the proponent throughout the project's life cycle. Effective monitoring of EMP implementation is a critical measure of success and the proponent should ensure that effective monitoring are done and corrective measures for non conformities implemented.

Note: As the design of the proposed Olkaria I Additional Unit 6 is still in its conceptual stage, it is not possible to allocate specific mitigation measure costs, in general the mitigation costs for such projects amounts to roughly 5% of the total project cost.

8.1 Environmental Management and Monitoring Plan

Anticipated Environment Impacts	Proposed mitigation, monitoring and management measures	Goals	Monitoring Indicators	Monitoring frequency	Responsibility	Costs (KES)
Degradation of the environment in areas where raw materials are sourced	-Source for raw materials from NEMA licensed sites	To protect areas where raw materials are sourced	Copies of NEMA permits and license for the sites	Continuous	KenGen/Contractors	-
Impacts on flora	-Workers to be sensitized against felling of trees and charcoal burning -Clearing of minimal areas as the foundation area has been cleared and compacted under previous project, -landscaping to be done using species already available in the area. -Care should be taken not to introduce alien species to the area	Minimize loss of vegetation, control soil erosion and avoid introduction of alien species	-Sensitization reports -Reports an degraded areas -reports on acreage rehabilitated -Ecological	Weekly during construction and quarterly during operation	KenGen/Contractors	Part of construction cost

			surveys			
Impact on Fauna	-Steam pipes to be laid with consideration of animal movement corridors -Speed bumps to be erected to avoid wild animals being run over -Brine pods should be fenced with materials strong enough to deter animals from access -All staff to be sensitized on desired behaviors when working in parks -	To conserve and protect fauna	-Reports on provision for animals routes -Brine ponds fence - Sensitization reports	Quarterly reports	KenGen/Contractors	Part of construction cost
Water consumption	-Incorporate rain water harvesting in the design of the power house and office block, -Surface runoff should be harvested for use in the power plants	To conserve water resources in the area	-Water abstraction reports -Water harvesting designs	Quarterly water abstraction reports	KenGen/Contractors	Part of construction cost
Dust	-Clearing of minimal areas, -sprinkling of water on exposed area -provision of dust masks to workers and visitors, -Visual inspections of dust levels on daily basis, -speed bumps along the road, -Adopt best practices for loading and offloading loose materials from trucks	Minimize dust hazards	-Reports on visual inspection of dust emissions	Daily basis	KenGen/Contractors	500,000
Noise and excessive vibration	-Works to be done from 0800hrs to 1700hrs, -Equipment to be serviced as per manufacturers recommendation, -Employees working in areas with high noise levels to be provided with PPE's, -Warning signs to be placed in areas, -Switch off engines or reduce idling time	Protect staff and visitors from noise hazards	-Noise maps -Noise warning signs -PPE usage reports -Reports on machines &	Weekly	KenGen/Contractors	Part of construction cost

	when not in use with noise levels beyond 85dBA -Annual audio metric tests for staff working in areas of high levels		equipment servicing against schedules			
Emissions' to air	-All machinery and equipment used in construction to be serviced as per the manufacturers recommendation, -Inspection schedules for machines and equipment should be established and adhered to	To mitigate against air pollution	--Reports on machines & equipment servicing against schedules	Monthly reports inspection reports	KenGen/Contractors	Part of construction cost
Contamination of soil and water by accidental oil and chemical spill	-Oil and chemical spill response plans to be prepared and tested, -Store oil and chemicals in bunded areas, -Safety data sheets to be availed -Drip trays for minor servicing of equipments, vehicles and other machinery	To protect soil and water from contamination	-Chemical & oil spills response plans -Safety data sheets -Spills reports	Monthly	KenGen/Contractors	Part of construction cost
Solid Waste disposal (empty cement bags, sewage, used oil, spoilS)	-Provision of suitable and well labeled solid waste containers, -Waste segregation at the point of generation, -Use of top soil for landscaping, -Waste reduction at the source, -Provide sanitary facilities for sewage and waste water disposal, -Contract NEMA licensed waste handlers to collect waste at defined intervals for appropriate disposal,	To mange waste in environmentally friendly manner	-Waste management infrastructure report -Waste tracking reports	Weekly reports	KenGen/Contractors	Part of construction cost
Conflicts related to allocation of temporary employment opportunities	-Local community to be given preference when it comes to temporary employment placements, -All temporary employment to be done by the Olkaria Stakeholder Coordination Committee	Create harmony between the project and other stakeholders	-Employment reports	Monthly	KenGen/Contractors	Part of construction cost
Spread of	-Sensitize workers and the local	To protect the	-	Annual	KenGen/Contr	300,000 per

HIV/AIDs and other communicable diseases	community on the need to refrain from risky behaviors', -Implement education and awareness program in conjunction with the Ministry of Public Health and Sanitation, -HIV/AIDS awareness creation to form part of the agenda of contractors site meetings, -Workers residential camps shall not be constructed at the site instead workers will be transported to and from residential areas -HIV awareness posters to be displayed at strategic points	health of area residents and workers	Sensitization and awareness reports -Awareness posters	reports	actors	year
Health and safety issues	- Register the place as a workplace with DOSH -Enclosure of construction sites to restrict access by unauthorized persons, -Provide workers with suitable personal protective equipment, -Provide workers with appropriate training e.g in first aid, -Provide standard first aid kits, -Develop and maintain emergency response procedures and plans at the site, -Maintain a record of incidents and accidents at the site, -The contractor to appoint a health and safety personnel, -Conduct mandatory safety inductions for all visitors to the site and new employees, -Obtain indemnity cover for all the workers on site, -Provision of wholesome drinking water, -Use of appropriate permits to work, -Use of scaffolds when working at high levels e.g during construction of the power house,	Ensure safety of staff and visitors at the construction site	-Workplace registration -PPE provision register -Training reports -First aid kits -Records of incidents and accidents -Safety induction reports -Statutory inspection reports (firefighting appliances, cranes, air compressors,	-Inspection schedules to be followed for machinery -Weekly and monthly reports	KenGen/Contractors	Part of construction cost

	-Statutory inspection of equipment like cranes, air compressors, chains and hoists, -Provision of firefighting equipment, -Inspection and maintenance of firefighting equipment Induct new employees on safety -Safety briefing before start of work -Safety signs at strategic places -Food vendors to undergo health check ups		chains & hoists) -Safety signs			
Cultural dilution	-Sensitize staff on need to respect the local community cultures and sensitivities -Hold cultural days to help preserve local cultures -Encourage visitors to visit the Maasai cultural center to promote their incomes	To preserve local cultures and promote the economic empowerment of local communities	-Cultural promotion reports	Annualy	KenGen/Contractors	250,000 per year
Impact on local infrastructure	-Identification of local infrastructure impacted on by the project -Rehabilitation of local infrastructure impacted on by the project -Housing for staff of the power plant upon completion should be considered as the increase in workers has lead to serious impacts on housing facilities in Naivasha	To create harmony with other stakeholders	-Infrastructure status and reports rehabilitation reports	Quarterly	KenGen/Contractors	Part of construction cost
Impacts on the park	-Sensitization of truck drivers on park rules -Drivers to abide by the park speed limits -Comply with traffic (Amendment) act 2012 -Inventory of all vehicles being used by the contractors and Vehicle stickers used to access the park	To conserve the ecological integrity of the park	-Ecological survey reports -Park entry reports	Monthly reports	KenGen/Contractors	Part of construction cost

8.2 Environmental Management and Monitoring During Operation

Anticipated Environment Impacts	Proposed mitigation, monitoring and management measures	Goals	Monitoring Indicators	Monitoring frequency	Responsibility	Costs (KES)
Hydrogen sulphide emissions	-Installation of automatic hydrogen sulphide sensors at strategic locations in the power house, -Proper sitting of the cooling towers, -Establish additional monitoring stations for precipitation chemistry -Collaborate with research institutions to establish impacts of H_2S on flora and fauna	To protect health of staff, visitors and the environment To maintain H2S levels below the WHO standards	-No. of H_2S monitoring points -H2S levels reports	Continuously	KenGen	Part of construction cost 500,000 per year
Waste Generation	-Segregation of the various waste streams, -Disposal of waste through NEMA licensed waste handlers, -Use of septic tanks and soakage pit for sewage and waste water disposal, -Exhaust sewage from the septic tank before it overflows to the ground surface, -No burial or burning of waste on-site, - Adopt the 3Rs approach to waste management (Reduce, reuse, recycle),	To protect the environment , prevent odours, avoid the problem of scavengers and soil/water contamination	-Waste management infrastructure reports -Waste management reports	Continuously with weekly monitoring reports	KenGen	500,000 per year
Disposal of Brine	-Proper sitting of brine ponds, -Reinjection of brine to recharge the reservoir, -Lining of brine ponds with heavy gauge polythene, ballast and hardcore material, -Regular monitoring of the chemistry of brine	Prevent soil and water contamination, prevent animals from drinking brine	-Brine pods monitoring report	Continuously with weekly monitoring reports	KenGen	Part of O & M cost
Accidental spillage of fuel, lube oil and chemicals	- An oil interceptor will be designed with the power plant -Provide secondary containment in all storage areas,	Prevent soil and water contamination	-Oil spills response plans -Oil spills	Quarterly	KenGen	Part of O & M cost

	-Immediate clean-up of spills, -Regular inspection of storage areas to ensure integrity, -Good housekeeping practices -Establishment of appropriate spill response plans and test them		and response reports			
Noise	-Noise mapping, -Regular monitoring of noise levels and implementing corrective actions, -Routine maintenance of the power plant as per the manufacturers specifications, -Installation of appropriate warning signs, -Education and awareness program on noise hazard for workers exposed to noise level above 85 dB(A), -Provision of hearing protectors to staff and visitors during normal operation of the plant -Audiometric tests for staff	Protect visitors and staff from noise hazards	-Noise maps -Noise warning signs - Maintenance schedules status reports	Continuously	KenGen	Part of the project cost 100,000 per year
Water consumption	-Incorporate rain water harvesting in the design of the power house and office block, -Surface runoff should be harvested for use in the power plants -Regular inspection of the water supply line and implementing corrective action -Consider the possibility of air cooling systems -Monitor water usage trend and establish savings that can be made -Accidental leakages and pipe bursts to be addressed immediately	-Minimize abstraction from Lake Naivasha -Conserve water	-Water use should be monitored and trended -	Quarterly	KenGen	Part of construction ost 400,000 per year
Waste water	-Waste water should be disposed off in septic tanks	-Prevent discharge of waste water into the environment	-sewage system inspection report	Quarterly	KenGen	Part of project cost
Fire risks	-Provision of fire protection system comprising of fire water tank, fire	Mitigate against	-Fire	Quarterly	KenGen	Part of

	hydrants, hose reels, portable fire extinguishers, fire engine, fire alarm and sprinklers, -Inspection and maintenance of firefighting equipment at least once in a year, -Establishment of a fire fighting team and training, -Develop fire emergency response plan and procedure -No smoking signs to be displayed in relevant areas -Undertake fire drills at least twice a year	fire risks	marshals training report -Fire fighting equipment -Statutory inspections of fire appliances			construction waste 450,000 per year
General health and safety aspects	-Register the place as a workplace with DOSH, -Statutory inspection of equipment including pressurized vessels and lifting equipment, -Provision of first aid kits, -Relevant training in first aid, -Conduct statutory occupational health and safety audits, -Establish and train environment health and safety committee -Conduct statutory fire audits, -Conduct annual environmental audits, -Provision of full range of personal protective equipment to staff, -Hold risk management meetings at least once in a month, -Use of permit to work -Induct new employees on safety -Safety briefing before start of work -Safety signs at strategic places -Food vendors to undergo health check ups	To ensure safety and health of staff and visitors to the power plant	-Workplace registration certificate -Statutory inspection reports -Training reports -Fire drill reports -Minutes of meetings -PPE status reports	Quarterly	KenGen	2,000,000 per year
Corporate Social Responsibility	-Invest some profits from the power plants in social projects -Support educational tours of the	Create harmony between the	-CSR reports	Continuously	KenGen	To be determined on annual basis

	power plant by the public and school children -Promote the Maasai cultural center through financial and marketing support -Continue with the school scholarships for bright needy students -Display of HIV awareness posters at strategic places	company and its stakeholders				
Impact on Flora	-Continuously sensitization of staff and visitors on behaviors expected when working in parks -No alien species should be introduced to the park -Staff should not be allowed to cut down trees or take any species of plants from the park -Undertake collaborative research on impacts of H_2S emissions on soil quality and vegetation with other stakeholders and mitigate the impacts	Conserve and protect the fauna	-Ecological survey reports -Research reports	Continuously	KenGen	1,000,000 per year
Impact on Fauna	-Speed bumps to be maintained to mitigate against accidents involving animals -Sensitization against poaching of wild animals -Wildlife routes should be kept open throughout	To conserve and protect the fauna	Ecological survey reports	Quarterly	KenGen	
Impacts on parks	-Sensitization of truck drivers on park rules -Drivers to abide by the park speed limits -Comply with traffic (Amendment) act 2012 -Inventory of all vehicles being used by	To conserve the ecological strategy of the Hell's Gate National Park	Ecological survey	Annually	KenGen/KWS	To be negotiated with KWS

	the contractors and Vehicle stickers used to access the park -Continue with the joint ecological surveys with Kenya Wildlife Service					
Waste heat generation	-Insulating of steam pipes -Reinjection of the hot brine -Fencing of brine ponds -Explore possibility of reuse of waste heat	To ensure safety of workers and optimization of heat content in the fluid	-Installed insulation -Steam pipe temperatures	Quarterly	KenGen	Part of project implementation costs

8.3 Environment Management and Monitoring Plan During Decommissioning

The proponent shall undertake and submit a decommissioning plan if their shall be need an environment impact assessment project report shall be submitted to the environment regulator for approval. The plant life is expected to be approximately 30 years with a possibility for redevelopment.

CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

The ESIA team after undertaking the environmental and social impact assessment for the proposed project concludes as follows:

- The proposed project is in character with its surrounding as its sandwiched between geothermal power plants.
- The proposed project will contribute towards provision of reliable electric energy to the country by injecting an extra 70 MWe to the national grid
- The proposed project intends to harness geothermal energy for power production thus reducing the risk of global warming due to its low emissions compared with other sources of energy
- The anticipated environmental and social impacts from the proposed project can all be mitigated and the proponent is committed to implementing the proposed mitigation measures
- The proponent proposes to use latest state of the art technology that is environmentally friendly
- The proposed project enjoys stakeholders support and is acceptable to other land users in the area
- The project proponent has over thirty years experience in managing geothermal power plants

Recommendations

The following are the recommendations of the Environmental and Social Impact Assessment team;

- The proponent is advised to explore opportunities of reusing the waste heat by product from the power generation
- The proponent is advised to research on ways of reducing evaporation from the cooling towers
- The proponent should explore other cooling technologies like air cooling or hybrid cooling systems

- The proponent should invest in building the capacity of staff involved in the implementation of the mitigation measures and monitoring.

- The EIA team recommends that the proposed project be approved subject to the implementation of the Environmental Management and Monitoring Plan

REFERENCES

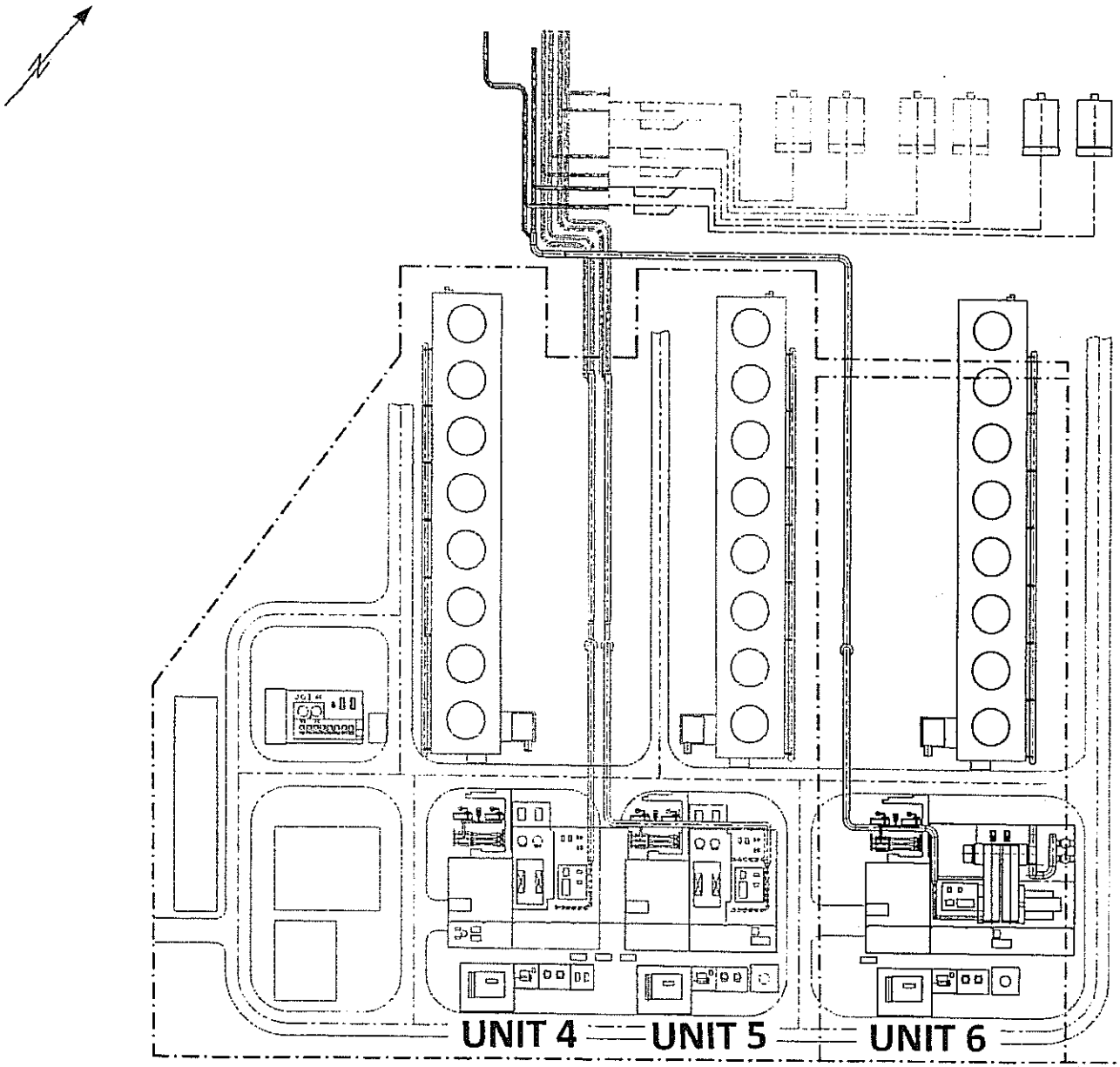
1. Gibb Africa, 2012 Olkaria IV (Domes) Geothermal Project in Naivasha District: Resettlement Action Plan for Olkaria IV Power Station.
2. Gibb Africa, 2009 Olkaria IV (Domes) Geothermal Project in Naivasha District: Resettlement Action Plan for Olkaria IV Power Station.
3. IUCN/LNRA (2005). *Lake Naivasha: Local Management of a Kenyan Ramsar Site.* IUCN Eastern Africa Regional Programme, Nairobi and Lake Naivasha Riparian Association, Naivasha. 78pp
4. Lagat J. (2003) Geology and the geothermal systems of the southern segment of the Kenya rift international geothermal conference, reykjavik, September 2004.
5. Randel R.P and R.W. Johnson 1991 Geology of the Suswa Area Ministry of Environment and Natural resources Mines and geological department Republic of Kenya Nairobi 41p Report number 97
6. Republic of Kenya (2009). Naivasha District Development Plan: 2008-2012.
7. Sinclair Knight and Partners, 1994: *Environmental assessment for north east Olkaria power development project.* Report for the KenGen Company, Ltd., RSP International, Ltd., 800 pp.
8. Thompson. A.O. and R.G. Dodson 1958 Geology of the Naivasha Area Ministry of Natural resources Geological Survey of Kenya department Republic of Kenya Nairobi 52p
9. Ndetei, C., 2010; Noise assessment and H2S dispersion at Olkaria geothermal power plant, Kenya. *Geothermal Training in Iceland 2010 UNU-GTP Report No. 23*
10. Wetangula, G.N., 2011; Olkaria geothermal power plants, Kenya: Preliminary Evaluation of mercury emissions to the atmosphere. *Journal of Environmental Science and Engineering,5, 1414-1426*
11. Brown, K.L. (1995): Impacts on the physical environment. *In: "Pre-Congress Course on: Environmental Aspects of Geothermal Development, World Geothermal Congress 1995, Pisa/I, p. 39-56*
12. DiPippo, R. (1991): Geothermal energy – Electricity generation and environmental impact. *Energy Policy October 1991, 798-807*
13. Hunt, T.M., 2001: *Five lectures on environmental effects of geothermal utilization. UNU-GTP, Iceland, report 1-2000, 109 pp.*
14. Ismail, A.R., Nor, M.J.M., Mansor, M.R.A., Tahir, M.F.M., and Zulkifli, R., 2009: Environmental noise assessment and modelling in Malaysia: A comparative monitoring study. *European J. Scientific Research 30-2,* 236-244.
15. Marani, M. (1995). Spacial - temporal variations of hydrogen sulphide levels around the Olkariageothermal power plant. *M.Phil thesis, Moi University, 182 pp.*
16. Nyagah, E.M., 2006: Hydrogen sulphide dispersion and modelling for Nesjavellir power station using Gaussian and numerical models. Report 15 in: *Geothermal Training in Iceland 2006.* UNU-GTP, Iceland, 291-314.
17. Ogada, C.O., 2010; Microgravity measurement for mass changes at Olkaria East Production Field, *Unpublished KenGen Internal Report*
18. Tole, M. P. (1990). Environmental effects associated with the use of geothermal energy. *Discovery and Innovation.* **2(3)**, 21 - 26
19. Tole, M.P and Colleagues, 2000; Environmental Impact Assessment Olkaria III Geothermal Power Plant, *Unpublished Orpower 4 Inc Internal report*
20. UNFCC CDM-PDD, 2010; Olkaria II Unit III geothermal expansion, *KenGen Internal Report* 21. WHO, 1981: *Hydrogen sulphide.* World Health Organization, Geneva, Environmental health criteria, no. 19.

22. WHO, 1999: *Guidelines for community noise*. World Health Organization, Geneva, 141 pp.
23. WHO, 2000: *Air quality guidelines for Europe* (2nd ed.). WHO regional publications, European
Series no. 91, 273 pp.

24. WHO, 2003: *Hydrogen sulphide: human health aspects*. World Health Organization, Geneva,
Concise international chemical assessment document 53, 35 pp., website:
www.who.int/ipcs/publications/cicad/en/cicad53.pdf

Appendices

1.0 Site layout plan
1.1 Signed minutes of stakeholder meetings
1.2 Attendance register for stakeholder meetings and baraza's



KenGen

OLKARIA I, UNIT 6
OVERVIEW OF POWER PLANT SITE

MINUTES OF THE STAKEHOLDERS MEETING ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED OLKARIA 1 UNIT 6 GEOTHERMAL POWER PROJECT IN HELL'S GATE LOCATION OF NAIVASHA DISTRICT

Date: 20/2/2013

Venue: Olkaria Lakeview Social Hall

Time: 11.00 A.M -1.45 PM

Present

	NAME	DESIGNATION	ORGANIZATION
1.	Michael Kioni	Snr District Officer	OP
2.	Linda Munyao	Environmental Manager	Oserian
3.	Hamish Ker	Special project Director	Oserian
4.	Alusdhimir Liuth	Head of Engineering	Oserian
5.	G.G Muchemi	Geothermal Dev. Manager	KenGen
6.	Kizito Opondo	Chief Resources admin Officer	KenGen
7.	Elizabeth Gachau	Chief Environment & Liason Off	KenGen
8.	Hussein Somoh	Environmental Officer	KenGen
9.	Cornelius Ndetei	Snr Environmental Scientist	KenGen
10.	Philip Baraza	Environmental Officer	KenGen
11.	Geoffrey Chege	Asst Chief	KenGen
12.	Pamela Omolo	Asst D.F.O	KenGen
13.	S.G.N Muthune	D/District Lands Officer	KenGen
14.	Sarah Higgins	LNRA Hon Secretary	RIPARIAN
15.	Grace Karanja	Municipal Env. Officer	MCN
16.	Moses Simiyu	Stakeholder Committee	Kamere
17.	Everlyn Silale	Research Officer	KWS
18.	Julia Kiruri	Asst Tech C Manager	WRMA
19.	Dr. Lenai Ogui	DMOH, Naivasha	MOH
20.	Hussein Guyo	Chief	Hells Gate
21.	Beatrice Kipngok	Sociologist	KenGen

22. Angela Wanyama	District officer, Central	OP
23. Sylvia Baraza	Environmental Officer	NEMA
24. Cliff Barkatch	Environmental Officer	NEMA
25. Adan Abdulahi	District Officer, Kongoni	OP
26. John Kimilu	D/DDO	MO P
27. Peter Muturi	Driver	OP
28. Jackson Sencho	SCC Representative	SCC
29. Elijah Kimondo	SCC Representative	SCC
30. Enbu Ochola	Environmental officer	NEMA
31. Milka Boinet	Environmental Officer	KenGen
32. Joshua Onyancha	Photographer	Naivasha
33. Stephen Mbatha	Project Engineer	KenGen
34. S.N Njoroge	District Works Officer	MOPW

Min 1/02/2013: Opening Remarks

The meeting was opened by a word of prayer by Beatrice Kipng'ok. The Senior District Officer representing the District Commissioner, Naivasha called the meeting to order at 11.10 AM and gave chance to participants for self-introduction. He then welcomed all to the meeting and encouraged full participation by those present.

The Geothermal Development Manager informed the participants that Geothermal Energy has been chosen as the least cost source of power and Kenya's Vision 2030 envisions that geothermal will contribute a higher ratio to the national grid. There is an estimate of around 5,000 MWe geothermal potential in Kenya and the country is keen to exploit it since it is a clean source of energy. KenGen has continued with their ambitious strategy in the last 10 years and currently doing the 280 MWe. There is a plan to also add another 560 MWe in the next five years in the Olkaria Geothermal Field.

Olkaria I Units 4 & 5 has been licensed by the National Environment Management Authority and is currently under construction. The proposed Unit 6 is adjacent to unit 5 and will utilize the area which has already been prepared therefore minimum disturbance to the environment. Unit 6 was decided upon because of the excess steam in Olkaria one field which is able to support this 70 MWe plant. The participants were shown the site layout of the proposed power plant.

Mr Barasa outlined the benefits of the project which included employment creation for skilled and non-skilled people, economic opportunities, growth of the economy, benefits from CDM since it is clean energy and support to the community through more CSR activities.

Mr Hussein Somow, the lead EIA expert took the participants through the detailed Environmental Management and Monitoring Plan for the proposed geothermal power plant project.

Min 2/02/2013: PLENARY SESSION

Oserian Development Company representatives informed the meeting that they had raised concerns with KenGen on some aspects of the project and reported that they had agreed with the Company to hold a joint meeting on Tuesday 26th February 2013.

Julia Kiruri, the Assistant Technical Coordination Manager -Water Resources Management Authority (WRMA)

Concern 1. KenGen has been expanding rapidly in the last few years and lately asked for variation in the water abstraction permit to increase the volume. There is need to give a comprehensive plan to WRMA showing the projects and the amount of water that will be required for WRMA to plan ahead. KenGen has not given the quantities of water that will be required for the proposed project does not clearly show the amount of water required for the plant.

Concern 2: What is the advantage of an air cooling system?

Response: It allows for more condensate to be re-injected into the reservoir and eliminates the use of water. However, the cost of installing and maintaining the air cooling system is high.

Grace, Municipal Council of Naivasha

Concern 3: She was concerned about the management of solid waste currently being generated by the project. She said KenGen should be concerned about where the waste finally gets dumped.

Response: KenGen does segregation of waste and allows only those who are licensed by NEMA to transport waste and dump in licensed sites. KenGen will explore further options on the 3Rs (reduce, recycle and reuse) concepts to minimize the impact of these waste to the environment.

Dr Lenai- Ministry of Health

Concern 4: What is the way forward in the country as far as generation of power is concerned, is it oil, nuclear water or geothermal?

Response: The country adopts an energy mix because of several factors. The country has to depend on several methods in order to satisfy the power demand in the country. Nuclear energy is one of the best sources but the limitation is the cost and the risks involved. Water has become unreliable because of the climatic changes.

Concern: How can you make geothermal energy sustainable?

Response: Re-injection is the solution for sustainability of geothermal reservoirs. KenGen currently re-injects upto 40% but its working towards 100% re-injection by adopting the changing technology.

Concern5: Where is the implementation plan of the project showing timelines of when the proposed project is expected to start and be completed.

Response: The ESIA report is a public document and it can be downloaded from NEMA website or requested from KenGen.

Concern 6: What is the cumulative impact of all the projects on health especially with regards with gaseous emissions like H_2S and how does the company plan to mitigate against this?

Response: The Company is planning to carry out a Strategic Environmental Assessment to assess the cumulative effects of the geothermal operations in the area. This will cover all areas of concern including gaseous emissions, flora and fauna, environmental issues etc.

Concern 7: Which model has been used to show the positives impacts outweigh the negatives?

Response: The findings of the ESIA shows that all the potential negative impacts can be mitigated. The positive impacts of the project far outweigh the negative impacts.

Concern 8: How is KenGen prepared to handle changes brought about by the new Constitution of Kenya with regard to the devolved government?

Response: The current Energy bill has captured this and KenGen will have to implement it once it is passed into law.

Cliff Barkach - NEMA

Concern 9: He recommended that all future stakeholders meetings should commence with a a visit to the project site so that the stakeholders can familiarize themselves with the site.

Response: This is a good proposal and KenGen will consider. The stakeholders are invited to visit the site anytime by making arrangements with the KenGen environmental team.

Concern 10: An ecological survey should be done to determine the cumulative impact of the projects on flora and fauna.

Response: This has been done periodically jointly by KenGen and KWS. The reports are available to the interested stakeholders.

Concern 11: What are these abatement measures for air emissions?

Response: Different gases require different ways of mitigations e.g hydrogen sulphide can be scrubbed. Geothermal development emits low levels of gases unlike coal or thermal. KenGen constantly monitors the levels and the data is available. Hydrogen sulphide (H_2S) levels is within the World Health Organization (WHO) permissible occupational limit for eight hours exposure.

Concern 12: KenGen should track waste disposal methods and sites

Response: KenGen will work closely with the municipal council on this matter. Waste tracking sheets for all waste disposed outside the plant shall be maintained.

Concern 13: Does re-injection of brine into the system assist in generation of more energy?

Response: Re-injection of geothermal fluids at high temperatures help in recharging the reservoir.

Concern 14: Some contractors' employees residing in Kongoni are living in camps for which an ESIA has not been done. KenGen should get involved in this.

Response: The developments outside the project site by the contractor is their responsibility and they should undertake the ESIA for their respective campsites.

Concern 15: Who are the beneficiaries of the geothermal spa?

Response: This will progressively be opened to the public at a small fee

Sammy Njoroge – Public Works Officer

Concern 16: How does KenGen mitigate against the gaseous emissions to the atmosphere?

Response: Different gases require different ways of mitigations e.g hydrogen sulphide can be scrubbed. Geothermal development emits low levels of gases unlike coal or thermal. KenGen constantly monitors the levels and the data is available. Hydrogen sulphide (H_2S) levels is within the World Health Organization (WHO) permissible occupational limit for eight hours exposure.

Sarah Higgins –Honorary Secretary Lake Naivasha Riparian Association

Concern 17: There is a lot of erosion on the roads, how is KenGen intending to mitigate against this?

Response: KenGen is committed to rehabilitating all sections of the road that have been eroded for instance the Company will tarmac the roads and firm up the embankments to prevent erosion.

Concern 18: KenGen has destroyed the vulture nests at the drilling sites, how is KenGen mitigating against this? The noise at the wells during discharge is too loud and scares away the vultures. The top of the silencer tower where the vulture rests are not safe for them.

Response: Destruction of the vulture nests was an accident and the issue was discussed with KWS and addressed. KenGen will revisit the issue of mounting spikes on the silencer heads to prevent the vultures from resting on them.

Evelyn Silali- Kenya Wildlife Services

Concern 19: The rate of geothermal expansion is very high and is likely to impact on the wildlife; KenGen should put a mechanism in Place to mitigate against this. The increase in the number of people has scared away the animals.

Response: KenGen acquired more land for geothermal development from Kedong ranch and provisions shall be made for wild animals to graze in that area. The animal routes have jointly been mapped out by KenGen and KWS staff to make sure they are not interfered with. The steam pipes are designed to allow for animal movements within the geothermal fields and plans are at an advanced stage to camouflage the steam pipes.

Concern 20: The contractor presence in the park has led to increased poaching and charcoal burning and KenGen should intervene in this.

Response: KenGen has put a lot of measures to ensure that the contractor staff do not interfere with the park. Contractors are required to sensitize their staff on the park regulations and issue them with identification cards.

Concern 21: The truck drivers are over speeding in the park.

Response: Contractors have been warned against this and informed to adhere to park speed limit of 40KM/hr. This will continuously be enforced. Protective services and traffic Marshals are working together on this. Speed bumps will be erected once the road is tarmacked.

The Chairman asked the participants to confirm their support for the proposed project subject to the full implementation of the Environmental Management and Monitoring Plan. All the participants confirmed support of the proposed project by show of hands.

There being no other business the meeting adjourned at 2.10 PM by a closing prayer offered by Julia Kiruri.

SIGNED

Chairperson

Sign: ..... Date: 25/02/013

Name: Michael Kioni

Designation: Senior District Officer, Naivasha

Secretary

Sign: ..... Date: 25/02/2013

Name: Beatrice Kipng'ok

Designation: ESIA Sociologist

MINUTES OF THE OLKARIA I UNIT 6 ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT STAKEHOLDERS CONSULTATION MEETING HELD AT THE MAASAI CULTURAL CENTER

DATE: 19TH FEBRUARY 2013

VENUE: MAASAI CULTURAL CENTRE

TIME: 11.00 A.M-12.45PM

PRESENT:

	NAME	DESIGNATION	VILLAGE
1.	Simon Sencho -	Director Cultural Centre	Cultural Centre
2.	Sentero Noosaron	Member	Cultural Centre
3.	Tobiko Nooosaron	Member	Cultural Centre
4.	Kipino Kaliki	Member	Cultural Centre
5.	Orkoskos Parsampula	member	Cultural Centre
6.	Saruni Parsamapula	Member	Cultural Centre
7.	Ekano Sangurunguri	Member	Cultural Centre
8.	Toret Alex Kisani	Member	Olomayana
9.	Loboo Barteiya	Member	Olomayana
10.	Daniel Shaa	Chairman	Cultural Centre
11.	Peter Rikoyian	Member	Olomayana
12.	Joshua Onyancha	Member	Olkaria
13.	Joseph Ibuya	Member	Oloyomana
14.	Simon Nkai	Member	Cultural Centre
15.	Olekool Lopsekey	Member	Olomayani Ndogo
16.	Kodikai Kiraison	Member	Olomayana
17.	Mpoyo Barteiyo	Member	Olomayana
18.	Sadira Sitatia	Chairman	Olomayani Ndogo
19.	Stapuli Sukati	Elder	Olomayani Ndogo
20.	Isaiah Lengutoi	Member	Oloyamana

21. Kimgei Milia	Member	Olomayani Ndogo
22. Mwangi Sururu	Chairman	Olomayana
23. Magadi Parkire	Member	Olsinyati
24. William Kimote	Chief Engineer	KenGen
25. Langun Kisotu	Member	Olomaiyana
26. Olndorok Kisotu	Member	Olonongot
27. Maria Kiroite	Member	Cultural Centre
28. Rael Nosaroon	Member	Cultural Centre
29. Leah Shului	Member	Cultural Centre
30. Joseph Lenguiya	Pastor	Cultural Centre
31. Jonathan Naai	Member	Cultural Centre
32. Jackson Sencho	Member	Cultural Centre
33. Hassan Olentipo	Member	Cultural Centre
34. Dancun Sencho	Chairman	Narasha
35. Yiale Parsampula	Member	Narasha
36. Jackson Torinke	Chairman	Narasha
37. Nkosen Parsumpula	Member	Narasha
38. James Akiru	Member	Oloyamana
39. Karani Isaiah	Member	Olosinyat
40. Jeremiah Leokomon	Member	Olosinyat
41. James Nailaga	Member	Cultural Centre
42. Lekishon Sencho	Member	Cultural Centre
43. Maenga Kisotu	Chairman	Olong'onot
44. Elole Kisotu	Member	Olongonot
45. Sophia Namunyak	Member	Cultural Centre
46. Elizabeth Lolgeti	Member	Cultural Centre
47. Jane Nosaroon	Member	Cultural Centre
48. Alice Lesanchu	Member	Cultural Centre
49. Miriam Kamamia	Member	Cultural Centre

50. Moipen Olekaleke	Member	Olongonot
51. Hapipa Sencho	Member	Cultural Centre
52. Kwanene Kisolu	Member	Olomayana
53. Elizabeth Munyow	Staff	KenGen
54. Angela Wanyama	D.O	Naivasha District
55. Tonkei Sencho	Member	Cultural Centre
56. Stephen Mbatha	Project Engineer	KenGen
57. Hussein Somoh	Lead Expert	KenGen
58. Beatrice Kipngok	Sociologist	KenGen
59. Godfrey Chege	Asst Chief	Olkaria Sub-Loc
60. John Kimandi	Member	Cultural Centre
61. Nchacha Parteiyo	Member	Cultural Centre
62. Josphine Shaa	Member	Cultural Centre
63. Kateri Lenguiya	Member	Cultural Centre
64. Natoi Nosaroon	Member	Cultural Centre
65. Natoi Nosaroon	Member	Cultural Centre
66. Ann Sunkuyia	Staff	KenGen

MIN 1/02/013 Opening Remarks

The meeting was opened with a word of prayer by Pastor Joseph Lenguiya. The assistant chief welcomed all to the meeting and urged the community members to be attentive in order to understand the issues being discussed and later contribute their feedback to the ESIA team.

The DO welcomed all to the meeting and introduced the ESIA team from KenGen. She informed the community that KenGen proposes to expand their energy generation by adding a 6th unit of 70 MWe to Olkaria I power station additional units. She said that EMCA 1999 requires that before any project is undertaken an ESIA has to be done. It is therefore a requirement that stakeholders are consulted in order to understand the project, the environmental impacts and benefits to the community. She informed the members to take the opportunity that will be given to them to raise their concerns and requested them to confine themselves to those issues of the proposed project and not divert to other issues.

The GDM representative, Beatrice Kipngok thanked the community members for turning up for the meeting. She informed them that environmental issues are key to success of any project. The government of Kenya appreciates that and has therefore created a government agency,

Concern: 8. KenGen promised to offer scholarships to three top pupils in the neighboring schools but this has not been done. He suggested the company should consider increasing the number of scholarship with increased developments in geothermal generation.

Response: The scholarship program is still ongoing and the company will consider expanding them in future

Lydia Shaa

Concern: 9. She requested KenGen to employ a nursery teacher for the Cultural Centre and extension of the water pipeline to the cultural Centre.

Response: This issue is being handled by Stakeholder Coordination Committee and it had been raised with the CEO of the company, CSR request should be addressed to the Olkaria CSR committee

Magadi

Concern: 10. The drivers using the road to well number 903 over speed and there is need to erect bumps. He also raised concern on the speed of the truck driver citing their goats were being killed by these speeding trucks. They threatened to close the road if action not taken against the speeding drivers. They also do not receive any compensation for the animals they lose.

Response: KenGen will take up the issue of over speeding since it is an offence for anyone to drive more than 40km/h within the park. Once the road to well number 903 is tarmacked then bumps will be erected.

Finally the community was asked to confirm if they would support the project if the issues they raised were addressed and they all answered in the affirmative.

There being no other business the meeting was closed by a word of prayer by pastor Lenguiya at 1.15p.m

SIGNED

Chairperson

Sign: ..... Date: 25/02/2013

Name: Angela Wanyama

Designation: District Officer, Central Division

Secretary

Sign: ..... Date: 25/02/2013

Name: Beatrice Kipng'ok

Designation: ESIA Sociologist

MINUTES OF THE PUBLIC BARAZA FOR THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED OLKARIA I UNIT 6 GEOTHERMAL POWER PROJECT HELD AT KAMERE TRADING CENTER

Date: 19TH FEBRUARY 2013

Time: 4.45 P.M-7.00 PM

Present

	NAME	ORGANIZATION/RESIDENCE
1.	Johnson Muchai	Kamere
2.	Reuben Mukasia	Kamere
3.	Abel Esala	Kamere
4.	Purity Wanjiku	Kamere
5.	Hussein Guyo	Chief, Hells Gate
6.	Angela Wanyama	D.O Naivasha
7.	Beatrice Kipngok	KenGen
8.	Godfrey Chege	Asst Chief, Olkaria
9.	Philip Baraza	KenGen
10.	Francis Simiyu	Kamere
11.	Richard Wekesa	Kamere
12.	Josphat Muchiri	Kamere
13.	Lisper Nyanchama	Kamere
14.	Jane Nyaga	Kamere
15.	Salima Kawera	Kamere
16.	Dominic Kahugu	Kamere
17.	Daniel Musyoka	Kamere
18.	Job Wanalwa	Kamere
19.	Justine Maro	Kamere
20.	Chanzo Choyi	Kamere
21.	Karuiki Njuguna	Kamere
22.	Alfred Odhiambo	Kamere

23. James Ndangili	Kamere
24. David Sammy	Kamere
25. Elizabeth Gachau	KenGen
26. Rev. Geoffrey Thaitinga	Kamere
27. Mary Kimari	Kamere
28. Jacinta Miringu	Kamere
29. Grace Waithaka	Kamere
30. Moses Natembea	Kamere
31. Rtd Chief Kaara	Naivasha
32. John Nderitu	Naivasha
33. Ignatuis Etangan	Naivasha
34. John Nyanduma	Kamere
35. Nyapara Daniel	Kamere
36. Cllr Palanga Peter	Kamere
37. Chris Mutua	Oserian
38. Alfred Juma	Kamere
39. Josphat Mwangala	Kamere
40. Keneth Waweru	Kamere
41. Peterson Mwangi	Kamere
42. Sangara Onani	Kamere
43. Tom Wechuli	Kamere
44. Samson Wanyama	Kamere
45. Peter Kamande	Kamere
46. Moses Okoth	Kamere
47. Paul Njuguna	Kamere
48. Jaska Atieno	Kamere
49. Christine Njeri	Kamere
50. Joshua Lekooro	Kamere
51. James Nganga	Kamere

52. Jones Nzioka	Kamere
53. Paul Makau	Kamere
54. Arthur Maina	Kamere
55. Moses Simiyu	Kamere
56. Kizito Opondo	KenGen
57. William Kimote	KenGen
58. Hussein Somow	KenGen

Min 1/02/2013: Opening Remarks

The meeting was opened by a word of prayer at 4.45 PM by Pastor Juma. The Chief welcomed all to the meeting and explained the purpose of the meeting. He said NEMA requires that before a project is done the stakeholders are informed of the project impacts both positive and negative and given the opportunity to seek clarifications, ask Concerns and give their comments. He encouraged them to participate fully in the process.

The District Officer (DO) asked the community to raise issues which are related to ESIA of the Olkaria one unit 6 and leave all the other issues for a public baraza which will be held soon.

The Geothermal Development Manager representative Elizabeth informed the community that energy is one of the requirements for economic development since it drives the economy and helps the country to achieve Vision 2030. She said KenGen had done a lot in trying to meet the energy demands of the country. KenGen is proposing to expand Olkaria I power station by adding a 6th unit of 70 MWe. It is a legal requirement that stakeholders be involved, full disclosure done in order for them to raise their concerns for consideration.

Min 2/02/2013: Project Description, Objective and Potential Impacts

Hussein Somow, the lead EIA expert, informed the community that the project is located near Olkaria I power station adjacent to Olkaria I Units 4&5 project site which are under construction. The project is an extension of the two units and therefore there will be minimum disturbance to flora in the area since the place is already cleared.

He outlined the benefits of the project as follows:

i) Creation of employment opportunities for both skilled and non-skilled labor

ii) Economic opportunities for the community for example business during the construction phase

iii) Community project supported by KenGen CSR

iv) Community projects supported by Clean development Mechanism

v) Economic growth in the country

The community members were informed that KenGen has put in place an environmental management plan and is committed to implementing the same. This includes handling of solid waste, protection of flora and fauna; acquiring materials from NEMA licensed quarries, HIV/AIDS awareness to all the stakeholders, transportation of solid waste to be handled by NEMA licensed firms, excavated areas to be rehabilitated, bumps to be erected on roads and all the contractors and workers around the park to be sensitized about the desired behaviors in the park.

Min 3/02/2013: Plenary Session

Purity Wanjiku

Concern: 1. She requested KenGen to consider including representatives of the Kamere plot owners in the Stakeholders Coordination Committee (SCC).

Response: Kamere is already represented by two members in the SCC and any request should be addressed to the SCC for consideration.

Job Wamalwa

Concern: 2. Requested KenGen to consider extending water to the area since the residents fetch water from the lake.

Response: The meeting was informed that all CSR requests should be addressed to the KenGen Olkaria CSR Committee.

Chanzu Choi

Comment: 3. He appreciated what KenGen has done for her neighbors in provision of employment and recommended that the project should be done since it will create more employment.

John Magara

Concern: 4. He said KenGen promises a lot of goodies but delivers very little. KenGen should put up a health Centre for the people of Kamere as well as a primary school. He cited discrimination in employment especially those over 45 years

Response: Mvuke primary school which is close to Kamere and was built by KenGen is now open to the residents and most of them have taken their children to the school. The health Centre request can be pursued later through KenGen Olkaria CSR Committee.

Geoffrey Thaitinga

Concern: 5. Requested KenGen to open up their current health Centre to the public in order for Kamere residents to access health services.

Response: This will be pursued further with the KenGen management and the Ministry of Health.

Concern: 6. He cited many complaints on recruitment, issues of bribery, sexual harassment and discrimination.

Response: An employment subcommittee has been created by KenGen to coordinate the issue of employment. KenGen requested that they report the allegations officially to enable further investigations.

Concern: 7. He requested for security lights for Kamere.

Response: Former MP John Mututho had put forth a request and the company will provide one big flash light at Kamere. A public baraza to discuss this is scheduled at Kamere on Thursday 21/2/2013 and the residents have been invited to attend.

Concern: 8. Repair of access roads within Kamere Trading Center.

Response: The residents were advised to approach the Municipal Council of Naivasha.

Nathan Ngugi

Concern: 9. He requested KenGen to intervene and assist the business women who have been harassed by KWS as they try to sell food at construction sites. KenGen promised that the projects would provide economic activities for them yet these women try to take advantage of these opportunities but they are denied access and are required to pay KES 300 per entry into the park which is too high for them. He cited discrimination of people of a certain community who do not want others to be given these opportunities.

Response: KenGen will look into this issue although there are many challenges as some people who have been helped to get into the park have not respected the KWS rules in the past and end up being poachers and charcoal burners. KWS has now become very strict and they vet all the visitors. KWS is also in business and they get their revenue from the people who visit the park. The meeting was also informed that the contractors were building food stalls for the women to operate from.

Abel Omari

Concern: 10. He requested KenGen to provide garbage collection bins to the residents. He said security in the area had improved unlike before when the containers that KenGen provided were stolen and used as scrap metal. He further requested KenGen to give more employment slots to Kamere residents since the population now is higher than before. He requested the Provincial Administration to consider appointing council of elders at Kamere.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED 70MW OLKARIA I UNIT 6 POWER PROJECT AT OLKARIA IN NAIVASHA DISTRICT

PUBLIC BARAZA.

DATE: 19th FEBRUARY 2013 **VENUE:** MAASAI CULTURAL CENTRE

ATTENDANCE SHEET

NO.	NAME	DESIGNATION	VILLAGE	SIGNATURE
41.	LANGUNA RISOTU	Member	OLOMAYIANA	
42.	OLNDOROK RISOTU	~~Ato~~ Member	OLODONGOT	
43.	MARIA KIRONG	Member	Cultural Centre	
44.	RAEL NOSAROAN	Member	Cultural Centre	
45.	LEAH SANDO	Member	Cultural Centre.	
46.	JOSEPH LENGUNYAU	Ast. Pastor	Cultural Centre	
47.	Jonathan P. Saai	Member	Cultural Centre	
48.	Jackson Sancho	Member	cultural centre	
49.	HASSAN OLENTIPO	Member	Cultural Centre	
50.	JACKSON TORINKE	CHAIRMAN	NKASISHO (Naivasha)	
51.	DANCAN SEENCHO	CHAIRMAN	NKAISISHO (NAIVASHA	
52.	YIALE PARSAMPULA	MEMBER	NAIVASHA	
53.	NKOSEN Parsambula	member	NAIVASHA	
54.	JAMES ARIRU	member.	OLOMAYIANA	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED 70MW OLKARIA I UNIT 6 POWER PROJECT AT OLKARIA IN NAIVASHA DISTRICT

PUBLIC BARAZA.

DATE: 19th FEBRUARY 2013 **VENUE:** MAASAI CULTURAL CENTRE

ATTENDANCE SHEET

NO.	NAME	DESIGNATION	VILLAGE	SIGNATURE
27.	KARANI ISAIAH	Member.	OLOSINYAT	
28.	Jeremiah Ukamon	member.	Olosinyat.	
29.	James Hassan Hailugi	Member	Cultural Centre	
30.	Lekichon Sencho	Member	Cultural Centre	
31.	MAGNGA KISOTU	CHAIRMAN	OLONONGOT	
32.	Oloko KISOTU	Member	OLONONGOT	
33.	SOPHIA NAMUNYAK	member	Cultural center	
34.	ELIZABETH LOIBOTI	Member	cultural centre	
35.	JANE NOSIROOP	Member	Cultural centre	
36.	ALICE LESANCHU	Member	Cultural centre.	
37.	MIRIAM KAMAMIA	Member	Cultural centre	
38.	MOIKEEN OLE KALEKE	Member	OLONONGOT	
39.	HAPIPA SENCHO	Member	Cultural centre.	
40.	Kwanene KISOTU	Member	Olomayiana	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED 70MW OLKARIA I UNIT 6 POWER PROJECT AT OLKARIA IN NAIVASHA DISTRICT

PUBLIC BARAZA.

DATE: 19th FEBRUARY 2013 **VENUE:** MAASAI CULTURAL CENTRE

ATTENDANCE SHEET

NO.	NAME	DESIGNATION	VILLAGE	SIGNATURE
13.	ELIZABETH MUMIPOWI	KENGEN		
14.	ANGELA WANYAMA	D.O. NAIVASHA		
15.	TONKEI SANCHO	Member	Cultural Centre	
16.	STEPHEN MBATHA	Project Engineer		
17.	[illegible]	[illegible]		
18.	BEATRICE [illegible]	Sociologist		
19.	GODFREY N. CHEGE	ASST CHIEF		
20.	JOHN KIMAMANOI	[illegible]	Cultural Centre	
21.	NEFTACHA [illegible]	Member	Cultural Centre	
22.	JOSPHINE SHAA	Member	Cultural Centre	
23.	KATORI LONGUYA	Member	Cultural Centre	
24.	MANGER SANTORO	Member	Cultural Centre	
25.	NAMOI NOSAROUN	Member	Cultural Centre	
26.	ANNE SUMKUYIA	KENGEN (Ingo.)	Kengen	

KENYA ELECTRICITY GENERATING COMPANY LTD

KenGen

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED 70MW OLKARIA I UNIT 6 POWER PROJECT AT OLKARIA IN NAIVASHA DISTRICT

PUBLIC BARAZA.

DATE: 19th FEBRUARY 2013 **VENUE:** KAMERE

ATTENDANCE SHEET

NO.	NAME	DESIGNATION	AREA OF RESIDENCE	SIGNATURE
1.	Boniface Kipyegon	Sociologist	KenGen	[signature]
2.	Johnson Kuria Nduchau	Kamere Lodge Resident	KAMERE ESTATE	[signature]
3.	REUBEN [illegible] [illegible]		KAMERE ESTATE	[signature]
4.	ABEL OCHANJI OYALA	COMMUNITY COMMITTEE	KONGONI	[signature]
5.	Purity Wanjiku	Women A Rep	KAMERE	[signature]
6.	HUSSEIN J. Guyo	Chief Hells Gate	Hells Gate	[signature]
7.	ANGELA WANYAMA	D.O. NAIVASHA	NAIVASHA	[signature]
8.	GODFREY N. CHEGE	ASST CHIEF OLKARIA	Hells Gate	[signature]
9.	PHILIP J. BARASA	GO / LEAD EIA EXPERT	KenGen	[signature]
10.	FRANCIS W. GITHIGA	peace ambassador	KAMERE	[signature]
11.	RICHARD WEKESA	MZEE KANISA	KAMERE	[signature]
12.	Joseph Muchiri	Kijana	Kamere	[signature]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED 70MW OLKARIA I UNIT 6 POWER PROJECT AT OLKARIA IN NAIVASHA DISTRICT

PUBLIC BARAZA.

DATE: 19th FEBRUARY 2013 **VENUE:** KAMERE

ATTENDANCE SHEET

NO.	NAME	DESIGNATION	AREA OF RESIDENCE	SIGNATURE
13.	LISTER NCHANCHAMA		KAMERE ESTATE	[signature]
14.	JANE AMPCH		KAMERE ESTATE	[signature]
15.	SARIMA KAWERA		KAMERE "	[signature]
16.	Dominic Githui Kahugu		KAMERE Estate	[signature]
17.	DANIEL MUSYOKA		KAMERE ESTATE	[signature]
18.	JOB WAMALWA		KAMERE	[signature]
19.	JUSTINE MARO		KAMERE	[signature]
20.	CHANZO CHOTI		KAMERE	[signature]
21.	KARIUKI NJUGUNA		KAMERE	[signature]
22.	ALFRED ODHIAMBO		KAMERE	[signature]
23.	JAMES NDAMBILI		KAMERE	[signature]
24.	David Sammy		KAMERE	[signature]
25.	Elizabeth Mwangi Gachau		Ken Gen	[signature]
26.	REV. GEOFFREY P. W. THATINGA		KAMERE	[signature]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED 70MW OLKARIA I UNIT 6 POWER PROJECT AT OLKARIA IN NAIVASHA DISTRICT

PUBLIC BARAZA.

DATE: 19th FEBRUARY 2013 **VENUE:** KAMERE

ATTENDANCE SHEET

NO.	NAME	DESIGNATION	AREA OF RESIDENCE	SIGNATURE
27.	MARK NJENGA KIMARI	Kiduthia mbugua	MAI MAHIU	
28.	JACINTA NJOKI MAINGU		NAIVASHA	
29.	GRACE H. WANJIRU		NAIVASHA	
30.	Moses Nalombe		Kamere.	
31.	RTD CHIEF KAARA		NAIVASHA	
32.	JOHN NDERITU	Kiduthia mbugua	NAIVASHA	
33.	IGNATIUS ETANGAN		NAIVASHA	
34.	JOHN MAGANA NTANDURU		Kamere	
35.	NTAPALA DANIEL	Nsed Councillor	Ko NAIVASHA Chief	
36.	CLLR PALANGA PETER	CLLR OLKARIA	KAMERE	
37.	CHRIS MUTUA	PLUMBER	OSERIAN	
38.	ALFRED JUMA	PASTOR	KAMERE	
39.	JOSEPHAT MWANGALA		KAMERE	
40.	KENNETH WAWERU	BUSINESSMAN	KAMERE	

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED 70MW OLKARIA I UNIT 6 POWER PROJECT AT OLKARIA IN NAIVASHA DISTRICT

PUBLIC BARAZA.

DATE: 19th FEBRUARY 2013 **VENUE:** KAMERE

ATTENDANCE SHEET

NO.	NAME	DESIGNATION	AREA OF RESIDENCE	SIGNATURE
41.	Peterson M. Mwangi	Chairman Kamere KRSP	Kamere	[illegible]
42.	Sangra Onani	" "	"	[illegible]
43.	Tom Wechuli	KAMERE	KAMERE	[illegible]
44.	Samson Wanyama	KAMERE	Kamere	[illegible]
45.	Peter Kamande	KAMERE	KAMERE	[illegible]
46.	Moses Abala Okoth	KAMERE	KAMERE	[illegible]
47.	Paul Njuguna	KAMERE	KAMERE	[illegible]
48.	JASKA ATIENO	KAMERE	KAMERE	[illegible]
49.	Christine Njeri	KAMERE	KAMERE	[illegible]
50.	Joshua Lekooro	Kamere	Kamere	[illegible]
51.	James Ngang'a	Kamere	Kamere	[illegible]
52.	Jones K. Njenga	Kamere	Kamere	[illegible]
53.	Paul Makau	Kamere	Kamere	[illegible]
54.	Arthur Ngugi Maina	KAMERE	KAMERE	[illegible]

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED 70MW OLKARIA I UNIT 6 POWER PROJECT AT OLKARIA IN NAIVASHA DISTRICT

PUBLIC BARAZA.

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ATTENDANCE SHEET

NO.	NAME	DESIGNATION	AREA OF RESIDENCE	SIGNATURE
55.	Moses Siminyu	Chairperson Kamere	Kamere	[signature]
56.	Rizito M. Opondo	AC	Kamere	[signature]
57.	William Kimote	Chief Eng. Olkaria	Kamere	[signature]
58.	Hussein A Sulemi	Lead Expert	Nairobi	[signature]
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	NAME	DESIGNATION	ORGANIZATION	MOBILE NO.	ID NO.	SIGNATURE
13.	Sarah Higgins	LNRA Hon Sec	LNRA	0723786007	23876900	[signature]
14.	Silas Kariuki	Municipal Ecologist	MCN	0734449000	20392631	[signature]
15.	Moses Simiyu	Kamua	SHE	0722501959	1393235	[signature]
16.	Evelyn Silali	Research	KWS	0723885090	11594703	[signature]
17.	Julia M. Kimeri	WRMA	EATCM	0721714126	23033502	[signature]
18. DR. LENAI J.K, OGUL		MOH	MOH	0721799365	21264995	[signature]
19.	Josline Nyamala		Neema Studio	0723227612	10930810	[signature]
20.	Hussein J. Guyo	Prov. Adm.	Chief	0725826912	10155767	[signature]
21.	Beatrice Kipngeno	Sociologist	KenGen	0720547178	1074992	[signature]
22.	Angela Wanyama	OOP	A.O. NVSHA	0721466139	12745256	[signature]
23.	Parasa Sylviah		NEMA.	0727066867	27131010	[signature]
24.	CLIFF BARKATCH	ENV. OFFICER	N.E.M.A.	0723710827	21796978	[signature]
25.	ADAN ABDULLAHI	OOP	D.O KONGONI	0721671890	22685145	[signature]
26.	MICHAEL K. KOOM	OOP-SDO	AOI NVSA	0723322366	11643803	[signature]
27.	JOHN KIMILY	D/DDO	DDO office/MND	0721-221273	21754261	[signature]
28.	PETER MUTURI	D.C Viewer	OOP	0717430344	20758843	[signature]
29.	JACKSON SONOKO	Member	Com.	0722157955	21477332	[signature]
30.	Elijah Kimondo	Member	Com	0721295862	22163137	[signature]
31.	Enoca Ochale	Member	NEMA	0722-166985	11550163	[signature]
32.	MILKA C. BOINETT	KENGEN	ENV. ASST.	0723496190	23981291	[signature]

	NAME	DESIGNATION	ORGANISATION	MOBILE NO.	ID NO.	SIGNATURE
33.	STEPHEN MBATHA	Project Engineer	KenGen	0722-272581	20549	
34.	S.W. NJOROGE	District WRP Officer	Public Works	0720709341	9129632	
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