KENYA ELECTRICITY GENERATING COMPANY PLC

80.3MWe OLKARIA VII GEOTHERMAL POWER PLANT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY REPORT

The proposed site for Olkaria VII

GPS Coordinates: 0°53'40.1"S 36°18'10.9"E

The Client	Consultant
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May 2024

This Environmental and Social Impact Assessment Report is submitted to the National Environmental Management Authority (NEMA) in conformity with the requirements of the Environmental Management and Coordination Act, 1999 (CAP 387, 2015) and the Environmental (Impact Assessment and Audit) Regulations, 2003.

DECLARATION

This ESIA report has been prepared by a team of experts lead by Prof. Francis M. Muthuri, a National Environmental Management Authority (NEMA) licensed Environmental Expert (Reg. No. 0023) in accordance with the Environmental Management and Coordination Act (EMCA), 1999 and the Environmental Impact Assessment and Audit Regulations, 2003 which requires that all the projects involving the activities listed in the Second Schedule of the Act be subjected to Environmental Impact Assessment (EIA) study and the report submitted to NEMA for consideration.

We, the undersigned, certify that the information contained in this report is accurate and a truthful representation of all findings as relating to the project.

1. ENVIRONMENTAL CONSULTANT

Name: Prof. Francis M. Muthuri NEMA EIA/EA Lead Expert Reg. No. 0023

Signed: ..... **Date:** 2nd May 2024

2. PROPONENT

Kenya Electricity Generating Company (KenGen)

(For and on Behalf of the Proponent)

Kenya Electricity Generating Co. PLC
RECEIVED
09 MAY 2024
Sustainable Development Manager
Official/Stamp

Name: Amos Mbuthi **Designation:** Sustainability Dept Manager

Signed: On this 9th **Day of** MAY **2024.**

ACKNOWLEDGEMENTS

The ESIA Report was done in an endeavour to comply with the Legal requirements as stipulated in section 58 of the Environmental Management and Co-ordination Act (EMCA), 1999. The ESIA Study for Olkaria VII Geothermal Power Plant Project was commissioned by Kenya Electricity Generating Company PLC (KenGen). West Japan Engineering Consultants Inc. (West JEC) carried out the assignment.

The Consultants acknowledge with thanks the support and inputs provided by the staff of KenGen especially the Environmental Unit. We sincerely thank all the organizations and all the individuals consulted during the field study and public consultations in Nakuru, including the Project area (Naivasha) and Nairobi.

0 EXECUTIVE SUMMARY

0.1 Introduction

Kenya Electricity Generating Company PLC (KenGen) is the leading electric power producer in Kenya, accounting for about 60% of the total electric power supplied to the National Grid. The Company has a total installed capacity of 1,904 MWe comprising Hydropower 825.6 MWe, Geothermal 799 MWe, Thermal 254 MWe, and Wind 25.5 MWe. Following the commissioning of Olkaria-I geothermal power plant in 1981, KenGen has succeeded in the construction of several other power generation facilities in the project area including Olkaria-IAU, Olkaria-II, Olkaria-IV, Olkaria-V and sixteen small geothermal wellhead plants, all adding up to close to 799 MWe of installed capacity.

0.2 Project Description

0.2.1 Project location

The proposed Olkaria VII geothermal power project is located in KenGen land LR No. 12859 (Annex 1), within Olkaria Location of Naivasha Sub - County to the south of Lake Naivasha in Nakuru County. The latitude and longitude coordinates of the proposed site is 0°53'40.1"S 36°18'10.9"E.

0.2.2 Project components

The main components of the Olkaria VII geothermal power plant include:

- Power generation plant and accessory facilities;
- Power plant sub-station;
- Steamfield above ground system (SAGS);
- Power transmission line and works to connect to Olkaria-IAU substation;
- Access roads to well pads;
- Power plant site earthworks; and
- Water supply and storage systems.

0.2.3 Project design

The Olkaria VII geothermal power plant has adopted the single flash power plant design which is used in the conversion of geothermal energy into electricity where production wells produce a mixture of steam and liquid in a geothermal system. The main components of the single flash power plant system comprise the following:

- Two-phase fluid production wells;
- SAGS, essentially separator/s and aboveground pipelines;
- Turbine – generator set;
- Condenser;
- Cooling towers; and
- Re-injection wells.

In this system, the power is generated by a generator coupled to the turbine's rotating shaft, its voltage is elevated by the main step-up transformer and evacuated to the national grid through the substation and a transmission line.

The cost for the proposed Olkaria VII Geothermal Power Project is estimated to be US$ 247,511,000.

0.3 Analysis of Alternatives

Analysis of five commercially proven power generation technologies for their adoption in the Olkaria VII geothermal power plant showed that the Single flash cycle condensing steam turbine with wet-cooling tower, is the technology with highest net output (MWe), lowest unit capital cost (USD/kW) and lowest LCOE (US¢/kWh net). Additionally, KenGen has long experience with Single flash cycle condensing steam turbine technology in their Olkaria-II, Olkaria-IAU, Olkaria-IV, and Olkaria-V power plants and has not experienced any major problems with the plant operations and maintenance. Consequently, the Single flash cycle with condensing turbine was the recommended technology for the Olkaria VII geothermal power plant.

0.4 Project Screening and Legal Framework

The screening process for the proposed project was carried out in accordance with the World Bank and NEMA system of environmental social categorization. Olkaria VII geothermal project was screened into Category A - for projects with potential to cause significant adverse social and environmental impacts that are diverse, irreversible and unprecedented to the project area.

The environmental and socio-economic impact assessment (ESIA) of the proposed Olkaria VII geothermal power plant has been carried out in accordance with the NEMA guidelines and the requirements of World Bank and JICA environmental and social framework. The ESIA report has been prepared in accordance with the Environmental (Impact Assessment and Audit) Regulations. 2003.

0.5 Baseline Information

Baseline information of the project area, a vital component of an Environmental and Social Impact Assessment (ESIA) forms the foundation of the project ESIA and is the benchmark against which claims of environmental damage during the construction and operational phases of the project can be assessed.

0.5.1 Physical environment of the project area

Climate

Climatic features in the Rift Valley, including the project area, are closely related to altitudinal changes and variations induced by the local topography. The floor of the Rift Valley experiences higher temperatures than the highlands. The monthly distribution of rainfall in the project area and its environs 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 and December. Generally, the floor of the Rift Valley has

lower rainfall than the flanking highlands. The project area experiences a double rain shadow effect from the west and east flanking escarpments of Mau and Aberdare Range - Kinangop Plateau respectively.

Air dispersion modelling

Work was carried out on air dispersion modelling for the proposed Olkaria-VII geothermal power plant using the AERMOD (version 10.2.0) dispersion model in the estimation of ground level concentration of hydrogen sulphide (H_2S). The air quality modelling considered short and long- term pollutant concentration emanating from the operation of the proposed Olkaria VII Geothermal Power Plant running at full capacity all year round. The modelling demonstrated that the normal operations of the proposed geothermal plant would not lead to any exceedances of Human Health Occupational Exposure Limits stipulated under Factories and other Places of Work (Hazardous Substances) Rules 2007, and meets the NEMA Ambient Air Quality Regulations. The maximum predicted short (24hr) and long term (annual) mean H_2S contribution from the plant at the identified sensitive receptors (Hell's Gate National Park) and Ol Maiyana Community residential area is less than 10%. Hence, the low impact from the proposed facility. The maximum impact of the emissions are predicted to be mainly at the North North Western areas of the proposed power plant, which reflects the annual prevailing wind direction of the meteorological data set. The assessment also indicates that the emissions from the facility have low impact on the nearest sensitive receptors and are below the set limits. Further, most of the air quality sensitive receptors are upwind of the proposed geothermal power plant. Based on the modelled results, the proposed geothermal power plant will comply with the National and International air quality criteria. However, should the model input parameters change in the detailed engineering phase, a model re-run would be required to assure the as built design compliance before commissioning and start-up. The simulated results should be validated by way of actual measurements and monitoring at the predicted fall out areas. Regular monitoring should be done to verify consistency and possible impact on the sensitive receptors and the environment due to abnormal plant operations.

Noise modelling

The noise impact assessment results indicate that levels are below the IFC ambient noise limits for residential, institutional educational areas, which are 55 dB (A) during daytime. The assessment also shows that Factories and Other Places of Work (Noise Prevention and Control) occupational exposure limits will be met at all the selected monitoring locations. The noise monitoring data is mainly from the current KenGen Power generation facilities (occupational), ambient noise at a sensitive receptor represented by data from Ol Maiyana Community monitoring point. The average occupational noise levels are in compliance with Kenyan Factories and other Places of Work (Noise Prevention and Control) Rules 2005 limits of 90 d (BA). The World Bank/IFC stipulates guideline levels of 55 dB (A) and 45 dB (A) for both day and night schedules, respectively. It should be noted that data from Ol Maiyana was used in the assessment of the cumulative impact of noise in other indicated receptors due

to unavailability of background data from the selected receptors. It is therefore recommended that baseline data be obtained at selected receptors for accurate ambient noise estimation. Secondary background noise data was used to provide a general overview of the prevailing noise climate of the proposed development area. A noise monitoring campaign using type 1 noise level meter with octave frequency filter, should be conducted at the identified sensitive receptors to determine the true background/noise climate.

Topography

The general topography of the study area is characterized by a wide range of features associated with volcanic activity and the formation of the Rift Valley. To the north of the project area, is Lake Naivasha which stands at around 1,885 metres above sea level (m asl). To the west of Olkaria area is Mau Escarpment (3,080m asl) and to the south east is Mt Longonot. The Olkaria area 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 OI Njorowa Gorge, which was formed by outflowing water from Lake Naivasha. The proposed project site, Olkaria I and II Power Stations are located in the depression where there are several small valleys that drain the upper slopes and discharge runoff and sediments to the foot slopes and plains below.

Geology

The geology of Lake Naivasha area is dominated by events associated with 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. 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.

Soils

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.

Hydrology

The hydrology of the project area is mainly determined by the arid nature of the prevailing climatic conditions, the drainage patterns and the presence of Lake Naivasha. The mid Rift Valley floor where the project is located is characterized by internal drainage and generally scarce surface and underground water resources. The Rift Valley floor contains several basins of internal drainage including Lakes Naivasha, Nakuru and Elementaita. The principal river in the floor of the Rift Valley drainage basin is

River Malewa which drains into Lake Naivasha. Lake Naivasha is a fresh water lake located in the same basin as other lakes that have saline waters (Lake Oloidien and Lake Sonachi). The water quality of Lake Naivasha is reasonably good with electrical conductivity of approximately 300 uS/cm and a pH is 8. Due to the good quality of the water, the lake has a wide range of uses, including domestic water, watering of animals and irrigation of the flower farms and other farming practices.

0.5.2 Biological Environment

Vegetation

The vegetation of the project area is dominated by the *Tarchonanthus camphoratus* bush referred to as "**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 bushland in many places is interspersed with *Acacia drepanolobium*, a plant with large inflated galls which shelter colonies of ants, *Crematogaster mimosae*. Common grasses are associated with bushland vegetation of the project area include *Cymbopogon nardus*, *Setaria sphacelata*, *Themeda triandra*, *Eragrostis cilianensis*, *Hyparrhenia hirta*, *Cynodon dactylon*, *Pennisetum clandestinum*, and *Digitaria abyssinica* among other common grasses.

Fauna

Wildlife in the project area and surroundings is found in significant numbers in Hell's Gate National Park, Longonot National Park and other areas where the land use (mainly ranching) is compatible with wildlife ecology. This includes the riparian area around Lake Naivasha, private ranches such as Kedong and Longonot Ranches, and the newly established wildlife sanctuaries around the lake. Twenty - eight species of mammals including fourteen large herbivores and three small herbivores have been described in the project area. The most common seen animals are zebra (*Equus burchelli*), kongoni (*Acelaphus buselaphus*), gazelles (*Gazella thomsonii* and *GazelIa grantii*), Impala (*Acepyceros melampus*), dik - dik (*Rhyncotragus kirkii*), giraffe (*Giraffa camelopardis*) and the buffalo (*Syncerus caffer*). A total of 108 bird species within 41 families are documented in the project area. Among the birds in the project area, are two endangered vulture species, the Rupell's Vulture and a White-backed Vulture. Within the bird species are 18 migratory species of which 11 birds visit Kenya and Africa from Europe and Asia and 7 birds are intra-Africa migrants. A total of 30 reptiles have been recorded from the project area including 15 species of snakes. The rock python is known to occur within the bushes and gorges of the project area. Other reptiles of the project area include two species of tortoises and 6 species of lizards. The project area is a suitable habitat for a total of 30 species of invertebrates within six orders and 18 families.

0.5.4 Socio-economic environment

Today the land in the proximity of the project area has become an important centre for flower growing and vegetable production. Tourism is also an important activity in this area and presently several tourist

facilities including hotels and lodges have been developed to cater for the growing tourist industry. Associated with tourism is wildlife protection as practiced by KWS in the Hell's Gate National Park established in 1984 for the conservation of wildlife and preservation of the scenic beauty of the area.

0.6 Stakeholder Consultations

Public and stakeholder consultations were conducted in order to facilitate the ESIA study team to get the stakeholder views on the perceived environmental and social issues of the project area. The most important social issues emanating from the stakeholders was job creation, The great majority of the stakeholders in the areas visited felt that the project should offer employment to the local community once the project commences. They requested for more permanent employment opportunities while most women requested for gender equity in employment. The local community including the women and youth requested to be given business opportunities in the project. This includes being awarded tenders and other services. Some of the youth stakeholders wanted to know if the contractor would offer them internship and training opportunities when the project starts. Several stakeholders raised concerns on the emission of hydrogen sulphide from the power plants. They felt the foul-smelling gas had adverse effects on the health of pregnant women and affects crops and corrodes iron sheet roofs. Complaints were lodged in relation to the effects of the geothermal effluents. Many stakeholders wanted to know the disposal method of the brine from the power plants. They complained that brine was harmful to their livestock and they requested that the area where brine is found should be fenced off. In response a presentative of KenGen indicated that due to its toxicity, brine produced in all the KenGen geothermal power plants is reinjected in designated reinjection wells.

Other stakeholders wanted to know if KenGen will support construction of schools in certain areas. Many stakeholders raised questions on the availability of scholarships for their children. Several stakeholders requested to be supplied with electricity in their homesteads and business premises. They observed that although electricity is generated in their area, they do not enjoy the services and they therefore requested to be provided with power from Olkaria.

0.7 Potential Project Impacts and Mitigation Measures

0.7.1 Positive impacts

The main positive impacts of the proposed geothermal power project include stabilization of electricity in Kenya, potential for carbon market, promotion of economic growth, increased employment opportunities, capacity building and contribution to Government revenue among other positive impacts.

0.7.2 Negative impacts and mitigation measures

Although Olkaria VII geothermal project has potential of realizing tremendous economic benefits, and other positive benefits, as outline above, it has the potential of causing negative impacts on the environment of the project area and beyond. Socio-economic negative impacts likely to arise from the construction, presence and operation of the proposed project include cultural contamination, increased

incidences of diseases, increased insecurity and community conflicts, challenges of labour force management, increased accidents and occupational hazards. Project activities likely to impact negatively on the biophysical environment of the project area will be associated with installation of the geothermal power plant, steam pipelines, power transmission line and access roads. Specifically, negative impacts including loss of habitat and biodiversity will arise from site preparation activities, clearing and trampling of vegetation, excavation of sediments, levelling of landscapes and construction work.

In order to alleviate negative impacts emanating from the implementation of the proposed geothermal project, promote sustainable development and maintain a healthy environment in the project area, mitigation measures have been proposed to reduce or alleviate the identified negative impacts. Salient features of the project negative impacts and their corresponding mitigation measures are summarized in the table below as follows:

Item	Negative Impacts	Mitigation Measures
1	Unplanned catering; services, poor waste management and increased pollution in the project area.	Amelioration of the socio-economic negative impacts and enforcement of proper waste management protocols.
2	Increased cultural contamination	Raise awareness among local communities and enhance measures to protect cultural values.
2	Increased accidents and occupational hazards.	Put in place measures for the prevention of accidents and occupational safety among other mitigation measures.
3	Potential increase in pollution from solid wastes and effluent discharge	Management of labour force including compliance with national and international laws and policies.
4	Increased incidences of diseases including HIV/AIDS and other sexually transmitted diseases (STDs).	Increase awareness and change public attitudes towards HIV/ AIDS and other sexually transmitted diseases (STDs) in order to protect the project workers.
5	Increased exploitation of natural resources including poaching.	Enhance security and put in place measures to reduce utilization of wood resources including charcoal burning especially in the Hell's National Park and surroundings.
6	Increased dust and gaseous emissions with subsequent effect on human health.	Emissions of dust, smoke and other substances should be limited through good practices including watering of dusty roads. Also conduct appropriate selection of construction machinery and provision of appropriate protective devices (masks, helmets and appropriate overalls) to construction workers.
7	Increased noise levels and the effect on project workers, local community, wildlife and other noise receptors.	Noise control measures should be implemented if noise levels in the project area exceed 90 dBA for 8 hours.
8	Vegetation clearing and its impacts on loss of habitat, loss of biomass and negative impacts on terrestrial fauna.	Put in place mechanisms to deter the work force from engaging in poaching, wonton cutting of trees and charcoal burning. Carry out restoration of habitat and biodiversity in the affected areas
9	Increased soil erosion and run-off	Install silt traps, carry out proper terracing and landscaping of the affected area and plant appropriate sediment binding grasses on the exposed slopes and other surfaces.
10	Increased air emissions including hydrogen sulphide levels and its health effects on nearest communities and other receptors	Concentration of hydrogen sulphide prevalent among the receptors in the project area is much lower than the maximum allowable levels (150ug/l) recommended by NEMA and WHO.

		There is therefore a need to raise awareness among the stakeholders on H_2S levels. The project proponent should carry out continuous monitoring of the H_2S. in the project area.
11	Impacts of brine discharge into the environment of the project area	Brine should be re- injected in designated wells. In addition, there is need to put in place mechanisms of securing the brine associated with separator lagoons.
12	Creation of ponding conditions	In order to reduce ponding, measures should be put in place to improve impeded drainage in the project area through landscaping and filling in the created depressions.
13	Negative impacts on the protected area (Hell's Gate National Park) and tourism.	Put in place measures to discourage workers from entering the park, engaging in poaching activities and utilizing park resources such as fire wood.
14	Visual intrusion and aesthetics	Paint the project components including the steam pipeline system with colours that blend with the environment especially shades of pale green, brown and grey.
15	Impacts of construction waste, among other related negative impacts	Put in place procedures for the collection of construction waste and other wastes and carry out subsequent disposal through accepted environmental protocols including burning in an efficient incinerator or disposal in a certified landfill facility.

0.8 Environmental and Social Management Plan

Environmental and social management plan (ESMP) for the proposed project has been prepared to cover all the phases of the project life: design, construction, defects liability, operation and maintenance. The plan describes each of the main mitigation measures to be implemented, their frequency, and who should be responsible during and after construction. Environmental and social monitoring has been developed and included as an integral component of the ESMP for the proposed project. The cost for the implementation of the mitigation/ monitoring activities for the project has been estimated at KSh 132,721,500.

0.9 Conclusions and Recommendations

0.9.1 Conclusions

The following conclusions are drawn with regard to the environmental and social impact assessment of the proposed Olkaria VII geothermal power plant:

- The proposed project will realize significant positive impacts that include stabilization of electricity in Kenya, potential for carbon market, contribution to reduction of carbon emissions, promotion of economic growth in the country, contribution to the Government revenue, increased employment and increased business opportunities among other positive benefits.
- Against the background of project positive impacts, there will be negative impacts associated with the project construction and operation activities including loss of habitat and biodiversity, destruction of floral and faunal communities, soil erosion, increase in dust levels, visual intrusion, increase in health risks, unplanned catering services, poor waste management and poaching, among other negative impacts.

- The increase in number of people in the project area following the commissioning of the project will lead to a number of negative socio-economic impacts including cultural contamination, increased incidences of diseases, insecurity, challenges of labour force management and increased accidents and occupational hazards, among other negative socio-economic impacts.
- The modelling of hydrogen sulphide emissions has demonstrated that the normal operations of the proposed geothermal plant would not lead to any exceedances of human health stipulated under Factories and Other Places of Work (Hazardous Substances) Rules 2007, and meets the NEMA Ambient Air Quality Regulations.
- With regard to the noise modelling assessment, the noise levels are below the IFC ambient noise limits for residential, institutional educational areas, which are 55 dB (A) during daytime. The assessment also indicates occupational exposure limits will be met at all the selected monitoring locations.
- The study has proposed several measures to reduce negative impacts including amelioration of social negative impacts, noise abatement, waste management, reduction of visual intrusion, restoration of habitat and biodiversity, reduction of soil erosion and siltation, prevention of accidents and health hazards and provision of health care services.
- Monitoring has been developed as an important process in the protection of environment of the project area since it will reveal changes and trends brought about by the presence and operations of the installed geothermal power project. In addition, it will ensure that environmental and social mitigation measures identified in the planning stage and incorporated in the project design are being implemented in a sustainable manner.

0.9.2 Recommendations

The Consultant has proposed the following recommendations that will enhance sustainable implementation of the proposed project and protect the environment of the project area:

- The Project Proponent (KenGen) needs to support the implementation of environmental management (including mitigation plan and monitoring) in order to protect the environment of the project area from the negative impacts of project implementation.
- Environmental monitoring should be conducted in the project area in order to detect changes and trends brought about by the presence and operations of the installed project facilities with emphasis on changes in habitat, flora and fauna and environmental attributes such as noise air emissions and brine.
- There is need to rehabilitate all areas affected by proposed power project through terracing, landscaping, grassing and planting of appropriate trees and shrubs in order to restore the

lost biodiversity, curb soil erosion and enhance the aesthetic value of the power plant and surroundings.

- Since many members of the local communities have great expectations and perceive KenGen as an institution to provide job opportunities, there is a need to raise awareness and educate the local community on the Company's role in geothermal power production in order to increase their level of understanding and manage their expectations such as removing any misconceptions they may have on the Company's operations in the project area.
- In order to prevent and control diseases among the project workers and local community, the Contractor needs to raise awareness on communicable diseases such as HIV/ AIDS and supply the project workers with STD prevention devices including the male and female condoms.
- The simulated air emissions and noise assessment modelling results should be validated by way of actual measurements and monitoring at the predicted fall out areas.
- There is need to construct a fence and secure all the brine lagoons in order to prevent both domestic and wild animals from drinking the toxic brine.
- KenGen needs to intensify the Company's tree nursery activities including raising seedlings that are relevant for the rehabilitation of Olkaria environment.

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

°C	Degree Centigrade
AERMOD	American Meteorological Society/United States Environmental Protection Agency Regulatory Model
AQGs	Air Quality Guidelines
AQM	Air Quality Monitoring
AQS	Ambient Quality Standards
Ar	Argon
ASTM	American Society for Testing and Materials
AU	Geothermal Additional Unit
BDL	Below Detection Limit
BPIP	Building Profile Input Program
CEMS	Continuous Emissions Monitoring Systems
CBD	Convention on Biological Diversity
CBO	Community Based Organizations
CDM	Clean Development Mechanism
CFR	Code of Federal Regulation (USA)
CH_4	Methane
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Conservation of Migratory Species
CO_2	Carbon Dioxide
COD	Commercial Operation Date
CSR	Corporate Social Responsibility
dB	Decibels- Unit for Sound Pressure Levels
DEM	Digital Elevation Model
CDE	County Director of Environment
DFIs	Development Financial Institutions
DGs	Gensets
DOSHS	Directorate of Occupational Safety and Health Services
EA	Environmental Audit
EHS	Environmental, Health and Safety
EMC	Environmental Management and Coordination
EMCA	Environmental Management and Coordination Act
EPC	Engineering Procurement Construction
EPRA	Energy and Petroleum Regulatory Authority
ERC	Energy Regulatory Commission
ESF	Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standard
FBO	Faith Based Organizations
FY	Financial Year
GDP	Gross Domestic Product
GHG	Green House Gases
GIS	Geographic Information Systems
GOGA	Greater Olkaria Geothermal Area
GPP	Geothermal Power Plant
GRS	Grievance Redress Mechanism
H_2	Hydrogen gas
H_2S	Hydrogen Sulphide gas
HCl	Hydrogen chloride
HFO	Heavy Fuel Oil
HGNP	Hells Gate National Park

HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IBA	Important Bird Area
ICT	Information and Communications Technology
IFC	International Finance Corporation
ILO	International Labor Organization
IPP	Independent Power Producer
IPP	Indigenous Peoples Plan
ISCST3	Industrial Source Complex Short-Term, Version 3
ISO	International Organization for Standardization
IT	Information Technology
ITCZ	Inter-tropical Convergence Zone
IUCN	International Union of Nature and Natural Resources (The World Conservation Union)
JICA	Japan International Cooperation Agency
JSS	Junior Secondary School
KenGen	Kenya Electricity Generating Company
KETRACO	Kenya Electrical Transmission Company
KFS	Kenya Forest Service
Km	Kilometre
KMFRI	Kenya Marine and Fisheries Research Institute
KNBS	Kenya National Bureau of Statistics
KPLC	Kenya Power and Lighting Company
KRS	Kenya Rift System
kV	Kilo Volt
KWS	Kenya Wildlife Service
LCOE	Levelized Cost of Energy
LCPDP	Low Cost Power Development Plan
Leq	Weighted Equivalent Sound Pressure Levels
LNROA	Lake Naivasha Riparian Owners Association
m	Metre
m asl	Metres above sea level
m2	Metre squared
MM5	Mesoscale model - Fifth generation
MoU	Memorandum of Understanding
MP	Measurement Point
MSDS	Material Safety Data Sheets
MWe	Megawatt
N_2	Nitrogen gas
NAAQS	National Ambient Air Quality Standards
NAIVAWASCO	Naivasha Water and Sanitation Company
NASA	The National Aeronautics and Space Administration
NEAP	National Environment Action Plan
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organizations
NH_3	Ammonia
NMK	National Museums of Kenya
NO2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NPGD	Kenya National Policy on Gender and Development
NQRs	Noise Sensitive Receptors
NR	Noise Rating
O&M	Operation and Maintenance
O_2	Oxygen gas

OD HDPE	Outer Diameter High density polyethylene
OHS	Occupational Health and Safety
OP	World Bank Operational Policies
ORC	Organic Ranking Cycle
OSHA	Occupational Safety and Health Administration
OW	Olkaria Well
PAPs	Project Affected Persons
PAYE	Pay as You Earn
PC	Process Contribution
PEC	Process Environmental Contribution
PFL	Profile Met File
PM	Particulate Matter
PPAs	Power Purchase Agreements
Ppb	Parts per billion
PPE	Personal Protective Equipment
Ppm	Parts per million
PRIME	Plume Rise Model Enhancements
PV	Photovoltaic
RAP	Resettlement Action Plan
SAGs	Steam-field Above Ground System
SFC	Surface met File
SO_2	Sulphur Dioxide
SPLs	Sound Pressure Levels
SRTM	Shuttle Radar Topography Mission
STD	Sexually Transmitted Diseases
ToR	Terms of References
TSP	Total Suspended Particulates
UM	Upper Midland
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
US$	United States Dollar
UTI	Urinary Tract Infections
UTM	Universal Transvers Mercator
VAT	Value Added Tax
VIP	Ventilated Improved Pit Latrine
WB	World Bank
WC	Water Closet
WCMA	Wildlife Conservation and Management Act
WEST JEC	West Japan Engineering Company
WHO	World Health Organization
WRA	Water Resource Authority

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

1 INTRODUCTION

Kenya's power sector has experienced steady growth over the last two decades. In 2021, the installed electricity capacity in Kenya stood at 2,990MWe, a significant growth from 1,800MWe in 2014. The Government of Kenya is presently pursuing efforts that will increase power demand and supply and lower the cost of electricity by injecting cheaper renewable energy sources such as geothermal, wind, solar, and the addition of natural gas into the energy mix while weaning off the more expensive Heavy Fuel Oil (HFO) plants. It is expected that generation will reach 5,000MWe by the year 2030. Currently, 86% of electricity generated in Kenya comes from renewable energy sources following increased investment in the sector (EPRA, 2022). In 2021, 81% of Kenya's electricity generation came from the low carbon sources of geothermal, hydro, wind, and solar power. Over half of this low carbon electricity came from geothermal energy, which Kenya has in abundance. Geothermal power, which is mainly produced by state-owned Kenya Electricity Generating Company (KenGen) accounts for a major portion of the power generated while hydroelectric power as well as solar and wind energy are critical for the stability of the national grid.

1.1 Role of KenGen in Power Production in Kenya

Kenya Electricity Generating Company (KenGen) is a public limited liability company, registered under the Companies Act of the laws of Kenya. The company was incorporated in 1954 with its core business being development, management, and operation of power generation plants. KenGen is listed on the Nairobi Stock Exchange, and it is owned 70% by the Government of Kenya, and 30 % by the public. KenGen is the leading electric power producer in Kenya accounting for close to 60% of the total electric power supplied to the National Grid. The Company has a total installed capacity of 1904MWe comprising hydropower 825.6MWe, geothermal 799MWe, thermal 254MWe, and wind 25.5MWe.

1.2 Geothermal Energy Situation in Kenya

Over 80% of Kenya's electricity is generated from renewable/clean energy sources. Of these sources, geothermal power remains the most significant source with an estimated potential of 10,000MWe. Kenya is the leading African country in the development of geothermal resources and ranks seventh among the geothermal power generating countries of the world. The country exploits close to 950MWe of geothermal energy which accounts for nearly 31% of the total installed power generation capacity in Kenya. Furthermore, the country has an estimated 10,000MWe of untapped geothermal energy resources, spread out across several sites in the Kenya's Rift Valley region, enough to meet five times the country's current monthly averaged power demand. Most of the geothermal power generation is carried out by KenGen. However, several geothermal independent power producers (IPP) are now operating in the sector. They include the U.S. firm Ormat, which produces 150MWe in Olkaria III and the 35MWe Sosian Energy geothermal power plant in the Menengai field (Nakuru) which started supplying electricity to the national grid in 2023. Construction of the second 35MWe geothermal power plant in Menengai by UK firm Globeleq kicked off in June 2023 and is expected to start operations by 2025.

1.2.1 Geothermal power production at Olkaria

Exploration for geothermal energy in Kenya started in the early 1950s. Between 1960 and 1970, extensive surface exploration work was carried out in the Central Rift Valley with support from the United Nations Development Programme (UNDP) and the Kenya Government through various bilateral and multilateral agreements. The above geothermal exploration eventually culminated in the drilling of six deep wells in 1976 and in 1981 the first 15MWe generating unit was commissioned. In order to rationalize development efforts, KenGen has divided the 204km^2 Greater Olkaria Geothermal Area (GOGA) into seven sectors including: Olkaria East, Olkaria West, Olkaria Northwest, Olkaria Northeast, Olkaria Central, Olkaria Domes and Olkaria Southwest. Currently, Kenya has Geothermal installed capacity of 799MWe.

Following the commissioning of the Olkaria-I geothermal power plant in 1981, KenGen has succeeded in the construction of several other power generation facilities in the project area including Olkaria-IAU, Olkaria-II, Olkaria-IV, Olkaria-V and sixteen small geothermal wellhead plants, all adding up to close to 800MWe of installed capacity. However, except the Olkaria IV and Olkaria V Power plants, the other power generation facilities are located inside the limits of the Hell's Gate National Park, which was established as a protected area in 1984. The distribution of installed geothermal power in Olkaria is showed below in Table 1.2-1

Table 1.2-1 KenGen Geothermal Installed Capacity

Sn	Power Plant	Installed Capacity (MWe)	Year of Commissioning
1	Olkaria I	45	1985
2	Olkaria II	105	Units 1&2 commissioned in 2003; Unit 3 was commissioned in 2010
3	Eburru wellhead*	2.5	2012
4	Olkaria IV and Olkaria 1AU	300	2014
5	Olkaria Wellheads	88.5	2017
6	Olkaria V	172	2019
7	Olkaria 1 Unit 6	86	2022
Total		**799MWe**	

Source – KenGen Integrated Annual Report and Financial Statements for the Year ended 30June, 2023; *Mendive et, al., 2012.

Studies estimate that there is still considerable geothermal potential in Olkaria. KenGen plans to install additional generation capacity with the plants listed in Table 1.2-2 below being at advanced development stages. Completion of these power plants will bring the total installed geothermal capacity in the Greater Olkaria zone close to 1000MWe.

Table 1.2-2. KenGen Geothermal Project Pipeline

Sn	Project Name	Capacity (MWe)
1	Olkaria I Rehabilitation	6
2	Olkaria IV and I AU Uprating	40
3	Olkaria PPP (140MW) Project	140
4	Olkaria VII Power Plant	140
Total		**326MWe**

Source – Kenya Electricity Generating Company

1.2.2 Other geothermal power producers at Olkaria

The Olkaria West geothermal field hosts Olkaria-III power plant. This is a 150MWe binary technology plant operated by an IPP, Orpower-4 Inc. which is wholly-owned by Ormat International. In the Olkaria Northwest sector, a Horticulture Company, Oserian Development Company has installed two power plants for internal use: a 2MWe Ormat binary-cycle power plant and a 2MWe backpressure steam turbine.

1.3 Proposed Olkaria VII Geothermal Power Plant

As part of the Company's strategy and in line with the national electricity master plans, KenGen intends to develop Olkaria VII Geothermal Power Plant in the Olkaria field. The estimated equivalent output of the steam available for Olkaria VII is 80.3MWe. Nineteen steam wells have been set aside for proposed geothermal power production as shown below in Table 1.3-1.

Table 1.3-1 Proposed Olkaria VII Geothermal Wells

Sn	Well No.	Steam Output (t/hr@11bar)	Northing	Easting
1	OW – 4V	32.5	9900903.408	199549.785
2	OW –4A	34.1	9900874.174	199571.222
3	OW –4B	39	9900839.746	199585.573
4	OW –45V	51.5	9900640.724	200285.663
5	OW –45A	51.6	9900618.104	200259.697
6	OW –45B	42.9	9900605.089	200220.196
7	OW –48	29.3	9900846.547	198418.742
8	OW –48A	28.6	9900815.141	198411.877
9	OW –39	63.1	9901775.091	198166.3445
10	OW –39B	29.5	9901792.329	198136.63
11	OW –45C	35	9900403.747	200105.138
12	OW –53	36	9900524.114	200918.609
13	OW –53B	40.2	9900544.19	200945.418
14	OW –53C	16.6	9900500.749	200894.561
15	OW –53D	35.8	9900506.147	200822.571
16	OW –804A	27.1	9900201.824	200388.432
17	OW –805	23.6	9899779.926	199314.073
18	OW –805A	43.9	9899813.985	199302.563
19	OW –805B	50.6	9899741.061	199312.855
Total		**730t/hr**		

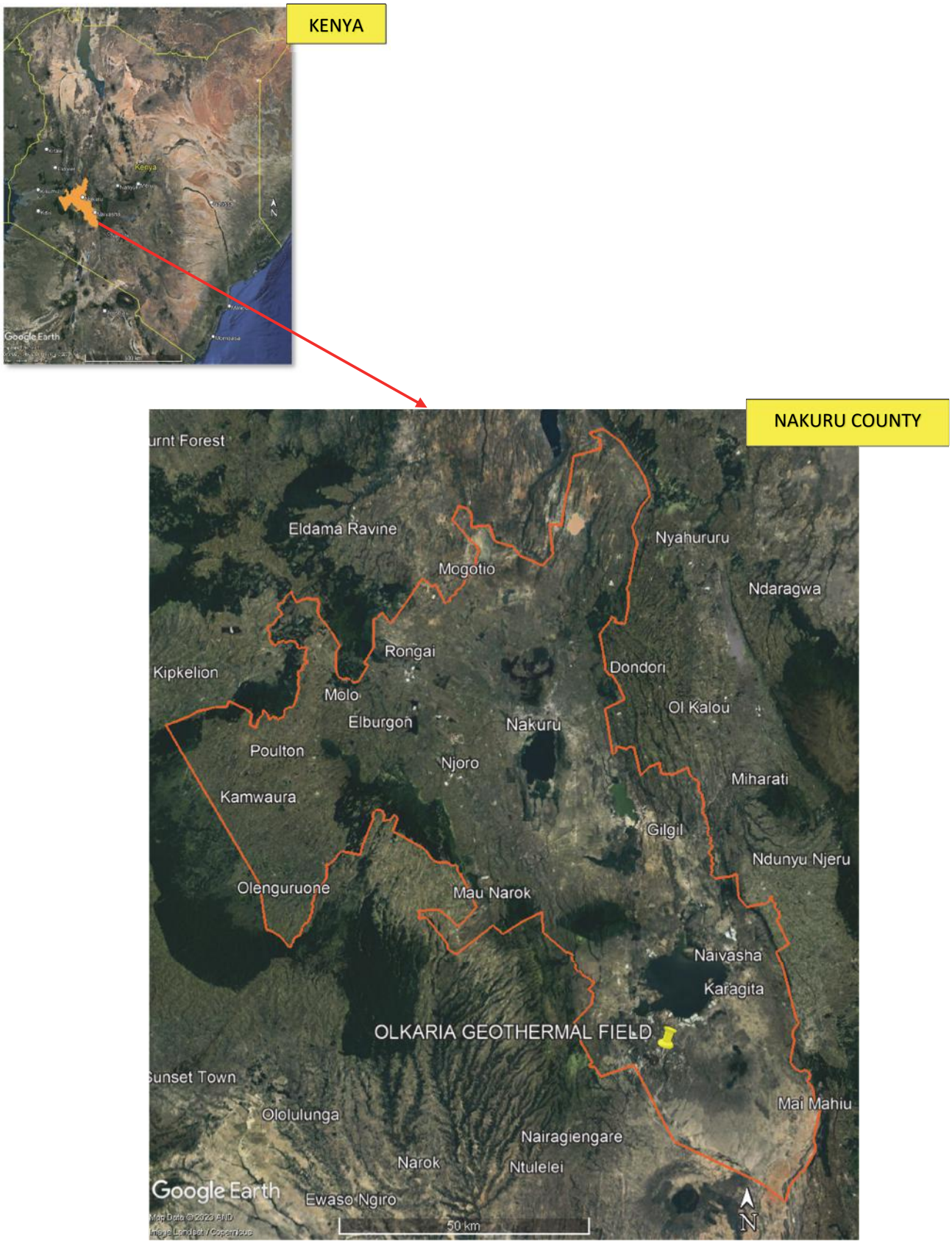
Source – Kenya Electricity Generating Company

1.4 Project Area

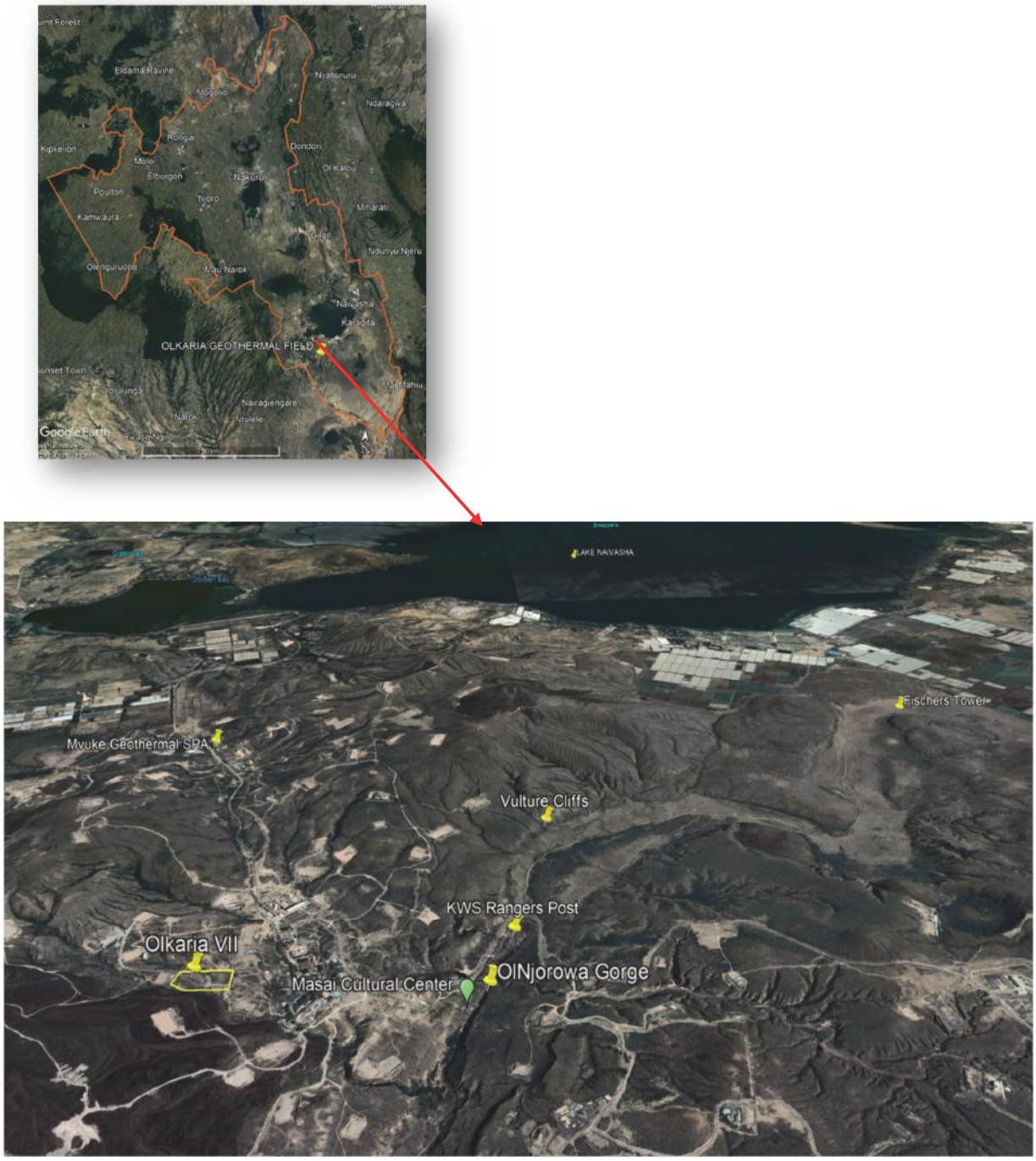
KenGen exploits geothermal resources mainly in Olkaria geothermal field which is located in Nakuru County. Nakuru County is divided into 11 administrative Sub-Counties namely Subukia, Kuresoi South, Molo, Kuresoi North, Gilgil, Nakuru Town East, Nakuru Town West, Rongai, Bahati, Njoro and Naivasha. The Olkaria geothermal field lies within Naivasha Sub-County to the south of Lake Naivasha which includes the Hell's Gate National Park. Naivasha Subcounty is subdivided into eight administrative wards namely Maai Mahiu ward, Olkaria ward, Viwandani ward, Naivasha East ward, Lake View ward, Biashara ward, Maela ward and Hells Gate Ward.

The project area for the Olkaria VII Geothermal Power Project is located approximately 37kms from Naivasha town along the Moi South lake road. The Olkaria VII geothermal power project is within Olkaria

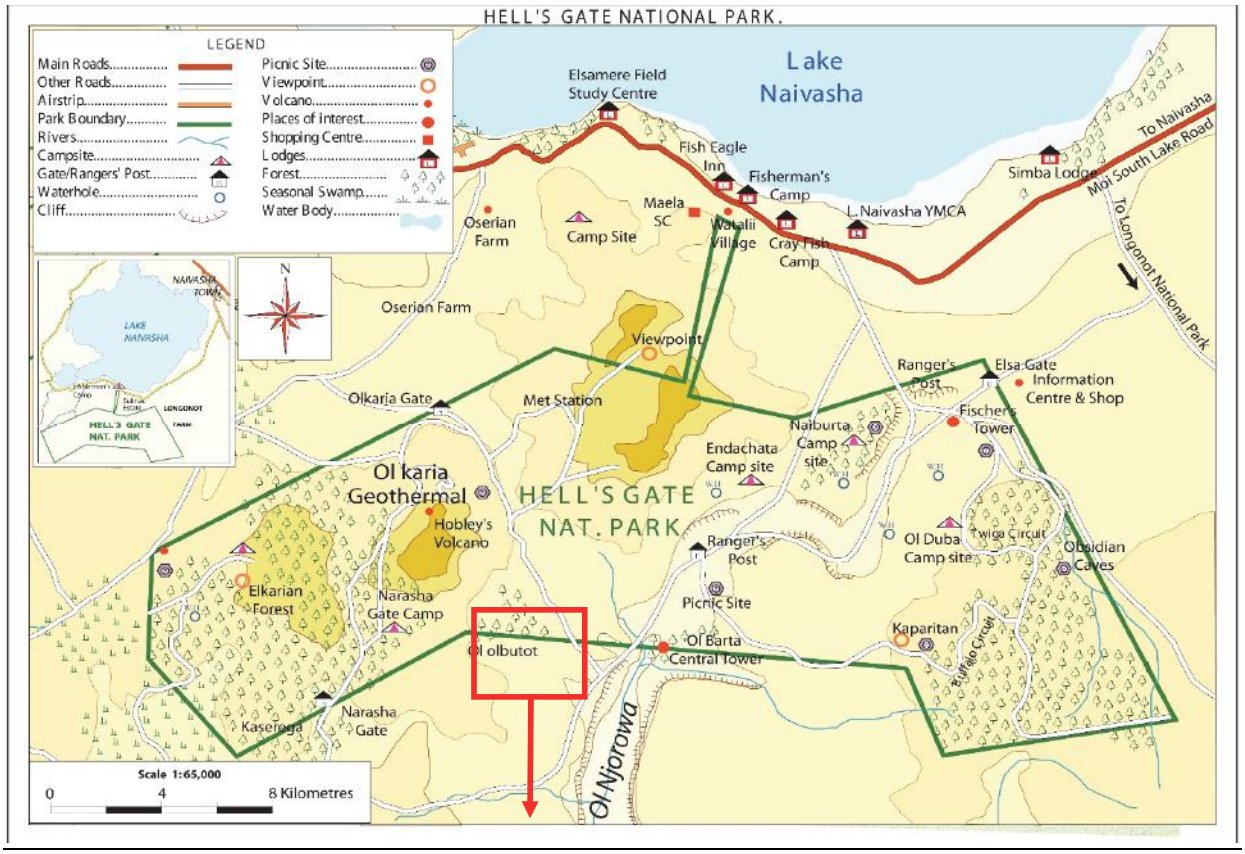
ward inside KenGen owned land No. LR12859 (Annex 1) and GPS coordinates 0°53'40.1"S 36°18'10.9"E, approximately 220 metres to the southern boundary of Hell's Gate National Park as shown below in Map 1.4-1 to Map 1.4-4. Originally, KenGen had proposed seven areas as possible sites for the construction of the Olkaria VII power plant (Map 1.4-4). Through a rigorous selection criterion, Site No. 1 as shown in Map 1.4-5 has been selected for the Construction of Olkaria VII Power Plant.



Map 1.4-1: The project location in Nakuru County

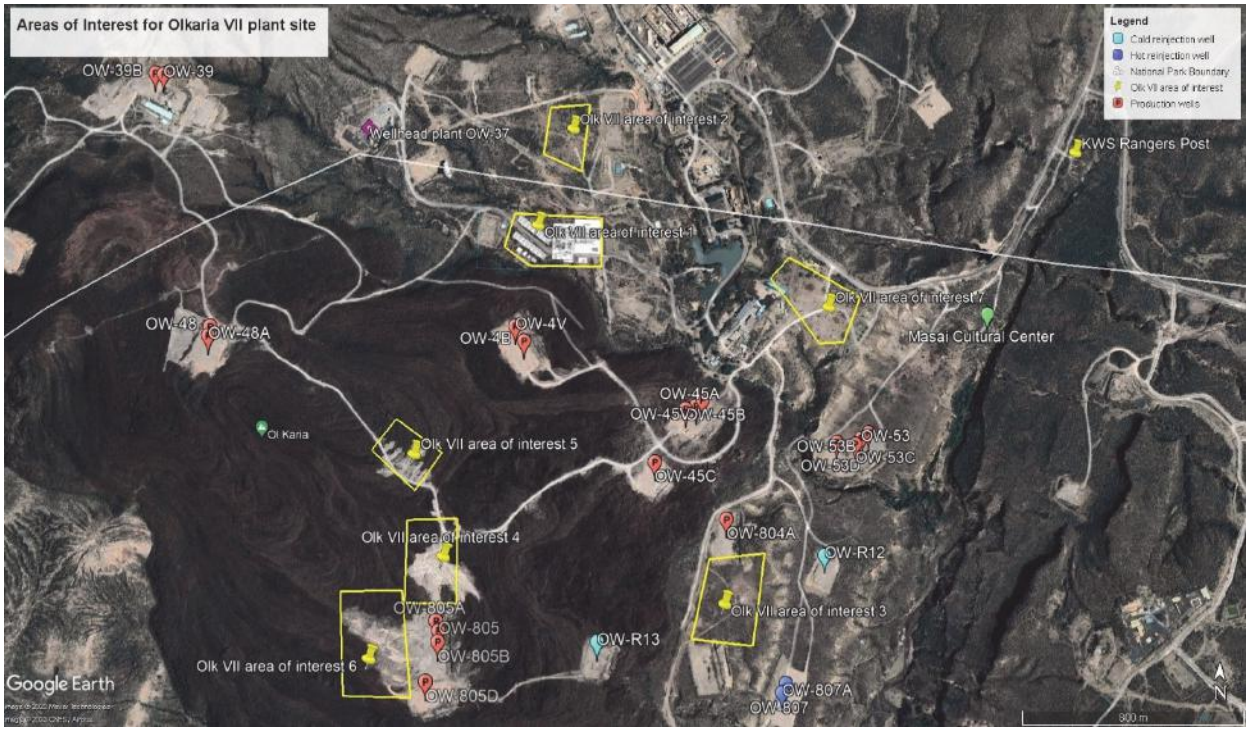


Map 1.4-2 Location of proposed Olkaria VII power plant in Olkaria area

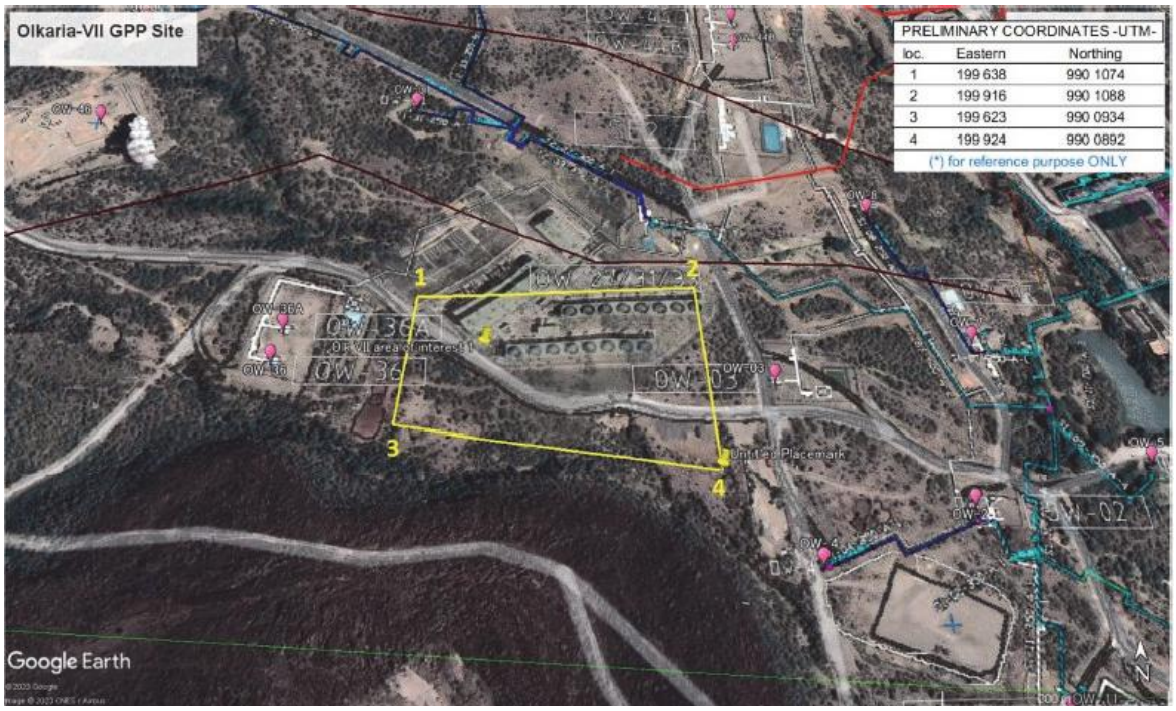


Source: agents.libertyafrica.com modified by author

Map 1.4-3: Hell's Gate National Park and areas of interest for Olkaria VII



Map 1.4-4 Areas of Interest for Olkaria VII Plant Site



Map 1.4-5 Site-1 at its early location and planning stage

1.5 ESIA Objectives and Scope of Work

The main objective of this study is to deliver an ESIA report and subsequent approval from NEMA that will facilitate KenGen in the subsequent steps of constructing and operating the envisioned Olkaria-VII power plant and associated facilities. Although the project is expected to generate positive impacts, it will also cause significant adverse environmental and socio-economic impacts during construction, operation and eventual decommissioning within the project and beyond. Prior to the project execution, the nature of the proposed project was extensively discussed between the Client (KenGen) and the Consultant during the process of project screening and Olkaria VII project was identified as Category A project (in accordance to World Bank Operational Policy 4.01) project and therefore required a full ESIA study.

1.5.1 Specific Objectives of the Study

The specific objectives of the ESIA study are outlined below as follows:

- To describe the nature and location, project components and functions, inputs, outputs, key bio-physical features and biodiversity of the proposed projects and all associated infrastructure;
- To describe the preliminary design of the proposed project;
- To identify and analyse different alternatives to the proposed project on the basis of environmental and social considerations besides the economics;
- To review the international, national and county environmental legislative and regulatory frameworks on the environment and socio-cultural and economic concerns and presenting them in a way that ensures the project meets both local and international financing requirements;

- To undertake site baseline studies on environmental, social and economic aspects;
- To identify the potential environmental impacts of the project and the mitigation measures to be taken on flora and fauna during and after implementation and decommissioning of the project;
- To carry out social analysis including an estimation of the number of persons and structures to be affected by the projects, if any, as well as the identification and estimation of the existing economic activities on the site;
- To carry out assessment of noise, water and air pollution during construction, operation and decommissioning of the project;
- To develop stakeholder engagement plans and undertake comprehensive public participation; and
- To develop Environmental and Social Management and Monitoring Plans (ESMP) for the proposed project.

1.5.2 Scope of the Study

The issues regarding the scope of the ESIA study were addressed during the early stage of the of environmental and social impact assessment of the Olkaria VII project. The salient features of the study as discussed and agreed between the Client (KenGen) and the Consultant are outlined below as follows:

- Preparation of terms of reference (ToR) for the ESIA studies and subsequent approval from NEMA;
- Preparation of scoping report for the project;
- Description of the nature and location, project components and functions, inputs, outputs, key bio-physical features and biodiversity of the proposed projects and all associated infrastructure;
- Analysis of different alternatives to the project available for project siting on the basis of environmental and social considerations besides the economics.
- Description of the preliminary design of the project;
- Review of the international, national and county environmental legislative and regulatory frameworks on the environment and socio-cultural and economic concerns and presenting them in a way that ensures the project meets both local and international financing requirements;
- Undertake site baseline studies on environmental, social and economic aspects;
- Carrying out air dispersion and noise modelling for the proposed project and existing plants and determine the sensitive receptors in the neighbourhood of the project sites and make necessary recommendations;
- Description of the activities that shall be undertaken during the project's construction, operation and decommissioning phases;

- Identification of the potential environmental impacts of the project and the mitigation measures to be taken on flora and fauna during and after implementation and decommissioning of the project;
- Carrying out comprehensive environmental risk assessment for the project site;
- Assessment of project site's environmental restrictions;
- Identification of the materials to be used, products and by-products, including waste to be generated by the project and the methods of their disposal during construction, operation and decommissioning;
- Carrying out assessment of noise pollution during construction, operation and decommissioning of the project;
- Carrying out assessment of water pollution, if applicable, during construction, operation and decommissioning of the projects;
- Carrying out assessment of air pollution during construction, operation and decommissioning of the projects;
- Assessment/determination of land requirements and land agreements for the project;
- Identification of the economic and socio-cultural impacts to the local community and the nation in general;
- Development of a plan to ensure the relocation or resettlement of persons affected by the project, if any;
- Social analysis including an estimation of the number of persons and structures to be affected by the projects, if any, as well as the identification and estimation of the existing economic activities on the site;
- Determination of the employment and economic opportunities that will arise during the implementation of the project;
- Development of plans to ensure the health and safety of the workers and neighbouring communities are taken care of;
- Development of action plans for the prevention and management of possible accidents during the projects cycle;
- Carrying out preliminary analysis of contribution of the projects to Green House Gas (GHG) emissions reduction;
- Integration of climate change vulnerability assessment, relevant adaptation, and mitigation actions into the ESIA studies;
- Development of stakeholder engagement plans and undertake comprehensive public and other stakeholder consultations to ensure inclusive participation during the studies and provide a summary of issues discussed during all the consultations and engagements;
- Developing an Environmental and Social Management and Monitoring Plan (ESMP) for the project;

- Assessment of energy conservation measures during construction, operation, and decommissioning of the plant;
- Presentation of the draft reports to KenGen management for their input/review;
- Incorporation of comments from KenGen; and
- Finalization of the report for submission to NEMA.

Following the agreement on the scope of the ESIA study, the Consultant proceeded to develop the project ESIA Terms of Reference (ToR) for submission and subsequent approval by NEMA (Annex 3).

1.5.3 The ESIA report

Following the completion of the ESIA study, the Consultant compiled a report which covered the following major topics:

- Executive Summary;
- Introduction;
- Project Description;
- Analysis of Alternatives;
- Legal, Regulatory and Administrative Framework,
- Approach and Methodology;
- Baseline Information of the Project Area;
- Consultations with Stakeholders;
- Positive Impacts of the Proposed Project;
- Negative Impacts of the Proposed Project;
- Proposed Mitigation Measures;
- Proposed Environmental and Social Management Plan;
- Proposed Monitoring Plan;
- Gaps in Knowledge and Uncertainties Encountered during the Study;
- Conclusions and Recommendations;
- References; and
- Annexes.

1.6 Project Cost

The project cost for the proposed Olkaria VII Geothermal Power Project is estimated to be US$ 247,511,000 as broken down in Annex 15 Bill of Quantities.

2 PROJECT DESCRIPTION

In this Chapter a project description is made including project components, design and technology utilized in the installation of various project components, procedures employed and processes of plant operations. Other attributes of the Chapter include materials used in the construction phase, products used, and by-products and wastes generated by the project. In addition, analysis of alternatives including project siting are covered.

2.1 Project Components

The main components of the Olkaria VII geothermal power plant include:

- Power generation plant and accessory facilities;
- Power plant sub-station;
- Steamfield above ground system (SAGS);
- Power transmission line and works at Olkaria-IAU substation;
- Access roads to well pads;
- Power plant site earthworks; and
- Water supply and storage systems.

2.1.1 The power plant

The proposed plant layout for the Olkaria geothermal power plant (single flash cycle condensing steam turbine with wet-cooling tower option) is shown in Figure 2.1-1 below. The layout includes several components including the power house, gas extraction system, transformers, power substation, cooling towers, scrubbers, chemical dosing system, water treatment system, fire-fighting system and others. The layout also accommodates a second power generation unit (Unit-2) assumed as feasible future expansion.

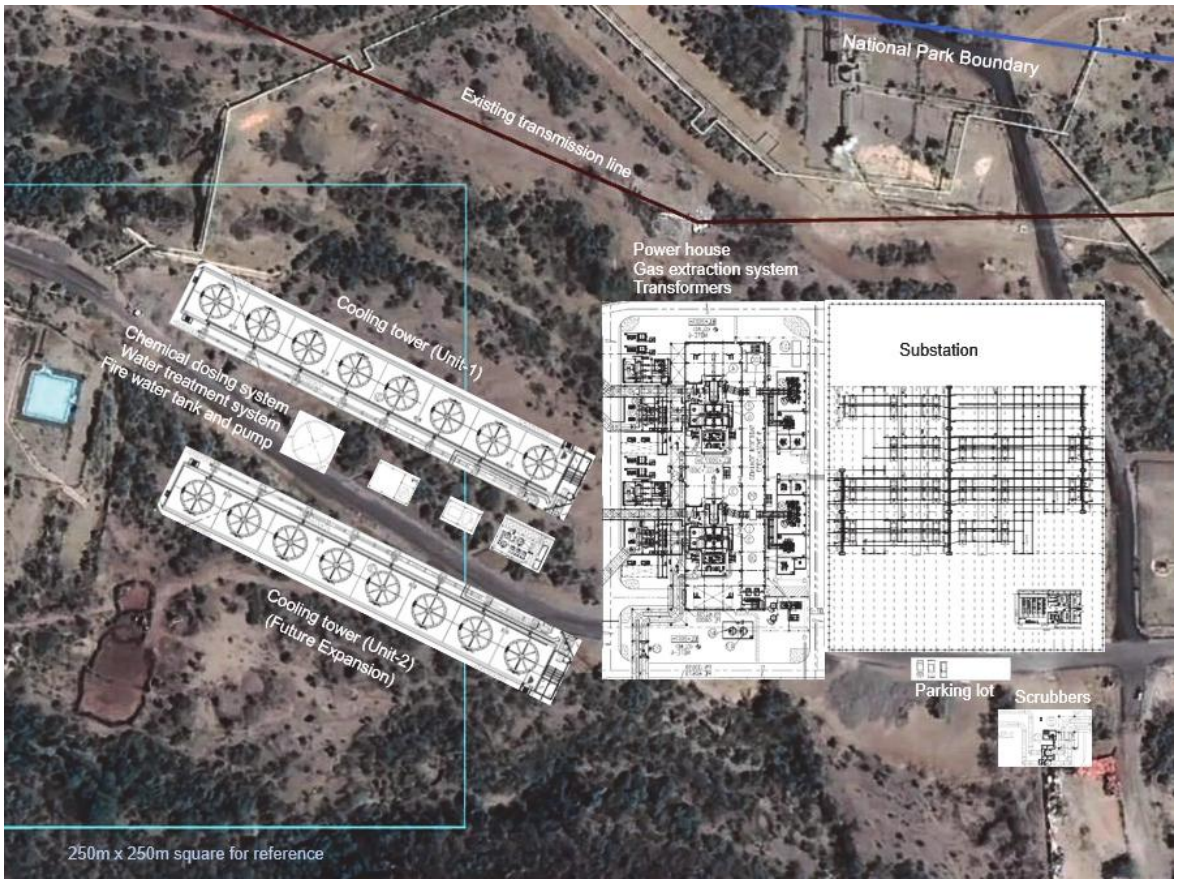


Figure 2.1-1 Conceptual plant layout at Site 1 including future expansion

2.1.2 The steamfield above ground system

The steamfield above ground system (SAGS) refers to the system intended for gathering and hauling fluids for the operation of the geothermal power plant. The SAGS for the project mainly consist of pipelines connected to the production wells which hauls the two-phase fluids to the separators. From the separators the steam is led to the power plant and from here the hot brine and condensates are disposed of at the re-injection wells, as shown in Figure 2.1-2. The wells assigned for the Olkaria VII Geothermal Project include nineteen (19) production wells, seven (7) hot brine re-injection wells and a cold condensate well to be drilled in or near Pad 801. The 19 production wells are grouped into three (3) clusters, with each cluster connected to a singular separator as follows:

- Cluster 1 comprises seven production wells: OW-39B/48/48A/805/805A/805B, interlinked with Separator SV-100, situated in Pad 805;
- Cluster 2, comprising eight wells: OW - 4V/4A/4B/45V/45A/45B/45C/804A, connected to Separator SV-101, positioned in Pad 804; and
- Cluster 3, encompassing the four wells: OW-53/53B/53C/53D, linked to Separator SV-102, located in Pad 53.

Steam pipelines

The steam produced by the above three separators is channelled to the power plant through a network of steam pipelines, transporting the aggregate steam yield from the Separators of the SAGS to the power station. The initial 300 metres of the steam line emerging from each separator has been configured as a scrubbing line segment. Approximately 600 metres from the power plant, a dedicated steam vent station will be designed and constructed. This station serves the purpose of accommodating the venting of surplus steam during instances of load shedding or plant trips. Comprising control valves and rock mufflers, the steam vent station effectively releases excess steam to prevent unwarranted pressure increase within the steam piping system. At the same time, the control vent valves are designed to maintain the steam header pressure.

Re-injection of brine

The brine that is separated at each individual Separator is separately re-injected via gravity into specifically designated hot brine re-injection wells: OW-3, OW-11, OW-805D, OW-807, OW-807A, OW-R12, and OW-R13.

Plant condensate

In line with the zero effluents discharge concept, the management of plant condensate is effectively executed through a pumping system. This system propels the condensate from the power plant to the condensate re-injection wells located in or near Pad 801, situated approximately 5km away from the power plant. In addition, all discharges from the steam traps will be channelled into a dedicated 4" diameter drain piping system running in parallel along the entire extent of the steam lines, that is, connecting from each separator to the power station and to be finally interconnected to end at the thermal pond located at Pad 53. Figure 2.1-2 shows the SAGS distribution within the East Production Sector of the Greater Olkaria geothermal field.

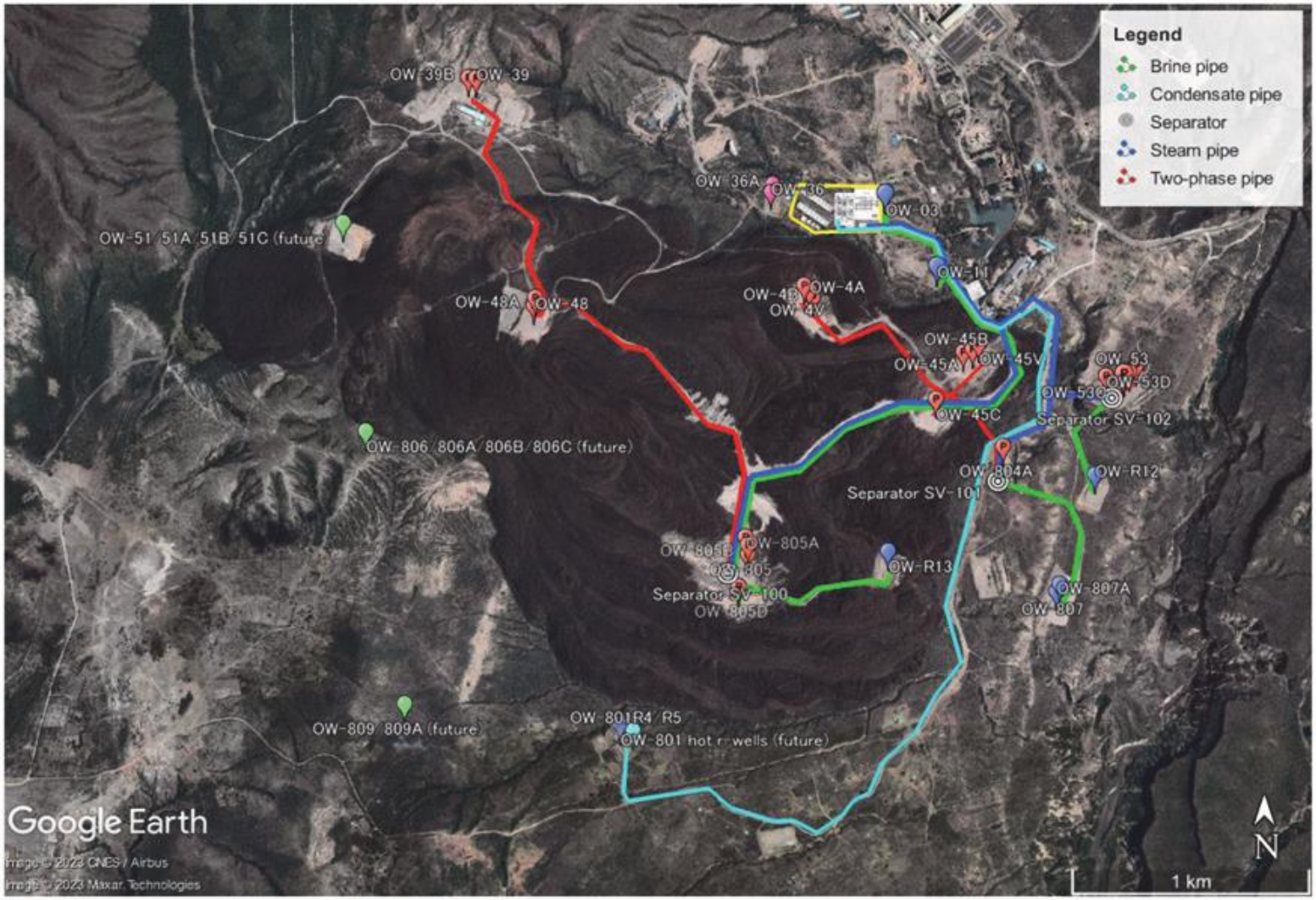


Figure 2.1-2 Proposed SAGS distribution for the Olkaria VII geothermal power plant

2.1.3 Olkaria VII power transmission line

The proposed Olkaria-VII 220kV power transmission line route is shown as red line in Figure 2.1-3. The route avoids the power plant vent station and the corrosive H_2S-rich plume emitted by the plant's cooling towers and, as possible the Hell's Gate National Park area. The route also focuses in minimizing the number of crossing points with the existing 132kV transmission lines. However, four (4) of the towers (Nos. 10, 11, 12 and 13) will be inside of the National Park (above blue line), among those, the No. 12 tower will be the crossover point with the existing 2x132kV transmission lines. The total length of the Olkaria VII 220kV power transmission line will be about 2.7km.

Olkaria VII power substation

The substation for the proposed Olkaria VII power plant will have a similar layout to the Olkaria IAU substation, including spare space for future expansion and for connecting wellhead plants (the existing 13MWe and 20MWe, and a future 58MWe). The planned area allocated for the substation is 101.5m x 133m. The new 220kV transmission line will be connected to the existing Olkaria IAU substation. To this end, a modification of its Control Room will be required. In addition, two line bays along bay control units and a protection panel for 2-line will be installed. The power generated at the 80.3MWe Olkaria- VII power plant will be evacuated to the substation of the Olkaria IAU plant through an 11/220/132kV substation and the 2.7km transmission line described above.

Figure 2.1-3 Proposed 220kV transmission line route from Olkaria VII plant to Olkaria IAU6 plant

2.1.4 Access roads and site earthworks

The Project civil works mainly include earthworks for preparing the site of the proposed Olkaria VII power plant as well as the construction of access roads from the site to the pads of the geothermal wells assigned to the project.

Access roads

There are nine (9) road sections forming the accesses to the pads of wells assigned to the proposed Olkaria VII power plant. From the survey carried out for confirming conditions, it has been established that the existing roads will sufficiently serve to link with the geothermal wells assigned to the proposed Olkaria-VII power plant. Table 2.1-1 below depicts the description of the road alignments. Based on the findings of the field investigations and recommendations based on various design standards, the road network shown in Figure 2.1-4 below connecting the proposed plant site to the geothermal wells was designed.

Table 2.1-1: Proposed roads sections

Road Section	From	To	Approx. length
Alignment 1	Olkaria-I workshop	10km road through the Workshop	0.55km
Alignment 2	From 10km Road	OW-53	0.75km
Alignment 3	Olkaria-I workshop	OW-805 through OW-45 and OW-805	2.75km
Alignment 4	Olkaria-I workshop	OW- 801 through OW 804	3.82km
Alignment 5	Near OW 804	OW-807 through OW R12	0.8km
Alignment 6	OW-45	OW-4	0.69km
Alignment 7	OW-805	OW-39 through OW-48	2.33km
Alignment 8	OW-48	Olkaria-VII through OW-36	1.25km
Alignment 9	OW-2	OW-37 Through OW-7	1.43km

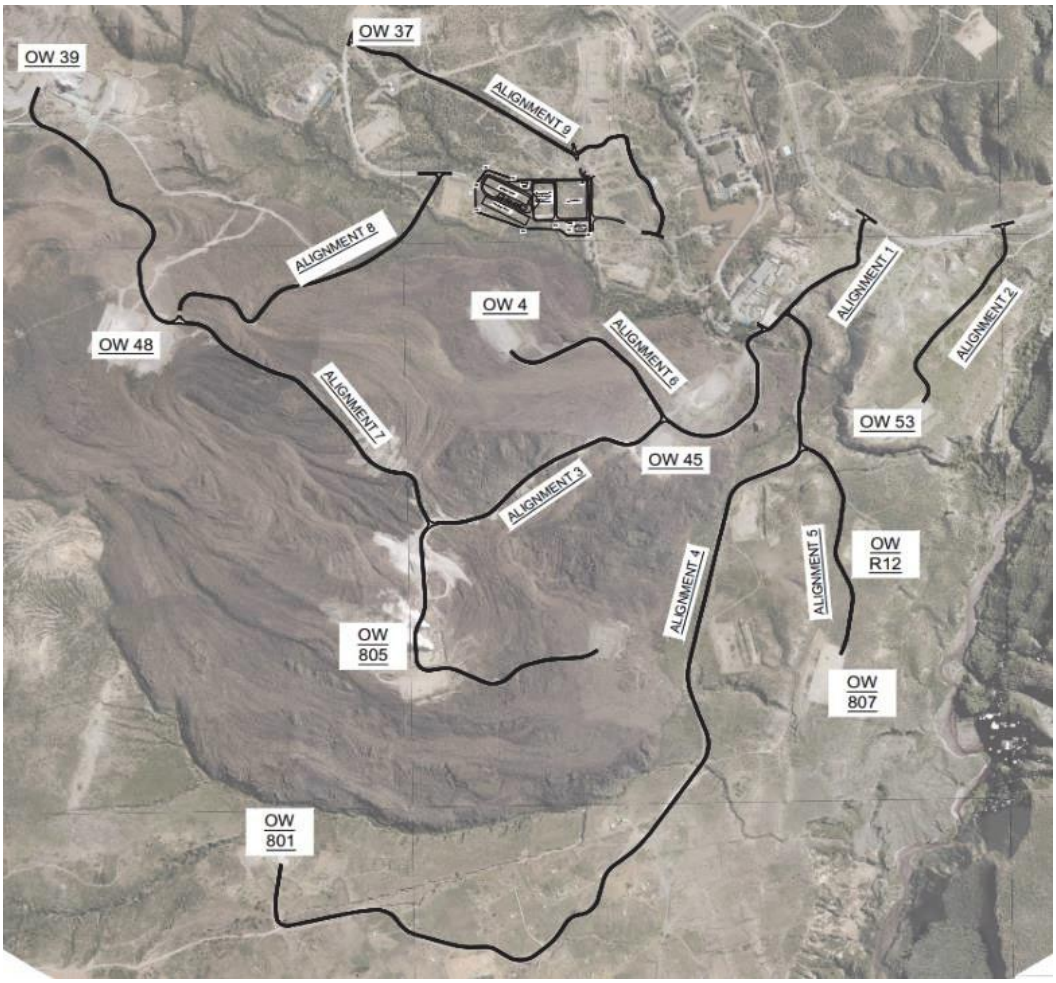


Figure 2.1-4 : Roads access network to the connecting the pad wells to the Olkaria VII power plant site.

Road type

Based on the design vehicle and the anticipated traffic, the cross section and pavement shown in Figure 2.1-5 was adopted for this project. The main features of the access roads are summarized below as follows:

- Road type VII - two-lanes, dust-gravel surface; 8 metres-width, no shoulders
- Design speed - The access road traverses hilly terrain and a design speed of 30-50km/h was adopted; and
- Design Vehicle - A semi-trailer truck (15m overall length) was adopted to cover for maintenance vehicles and construction traffic.

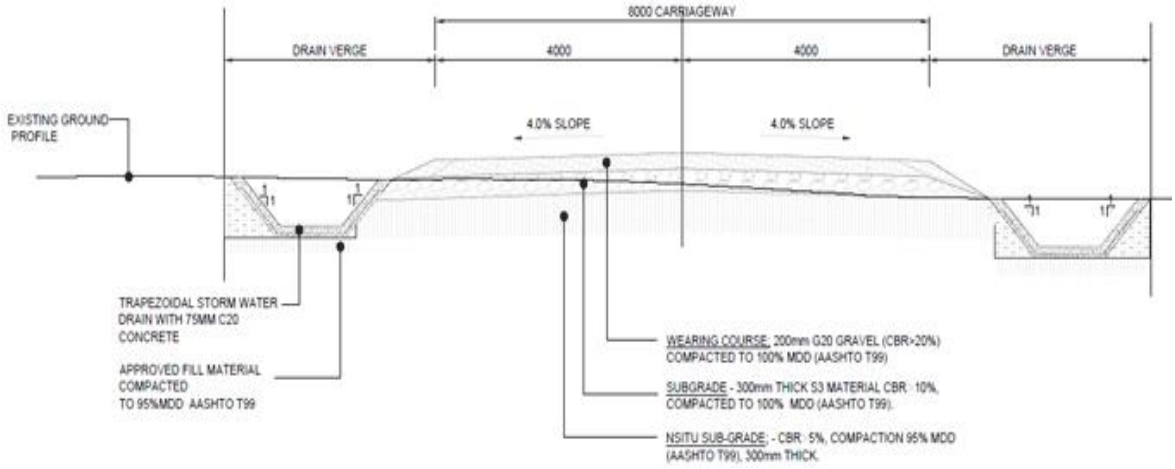


Figure 2.1-5 Cross section of the proposed access roads

Site earthworks

The Olkaria VII power plant site layout and internal roads are shown in Figure 2.1-6 below. The grading of the power plant site will be prepared to provide for a relatively flat working platform. The level of the platform was fixed at 1,965m above sea level (m asl) on the eastern edge to match the levels of the main access road. The site will mainly be cut with slight fills on the eastern side to attain a gradual slope of 1:100 (West to East and North to South) to facilitate self-drainage of the power plant site platform. A cut-off drain is provided on the western side to prevent storm water from accessing the power plant site platform. In addition, an internal drainage system along the internal roads is provided to evacuate any runoff water away from the site plant.

There are two gullies (streams) within the platform area. One cuts through the site and the other passes adjacent to the site on the southern edge. In order to mitigate the risk these streams pose to the power plant the following is considered:

- The gully to the north that cuts across the site will be diverted along the northern and eastern edges of the site platform using a covered drain (single cell 2x1.5m) until it connects to the natural outfall on the southern side;
- With regard to the gully to the south of the platform, the site layout will be adjusted to avoid the gully as much as possible. However, where the "southern" gully meets the one cutting through the site, there will be requirement for some river training to ensure that the risk of water from this gulley affecting the power plant platform is eliminated;
- An internal road network is also provided to connect all the facilities within the plant; and
- The road network has also included provision for parking for both passenger cars and trucks.

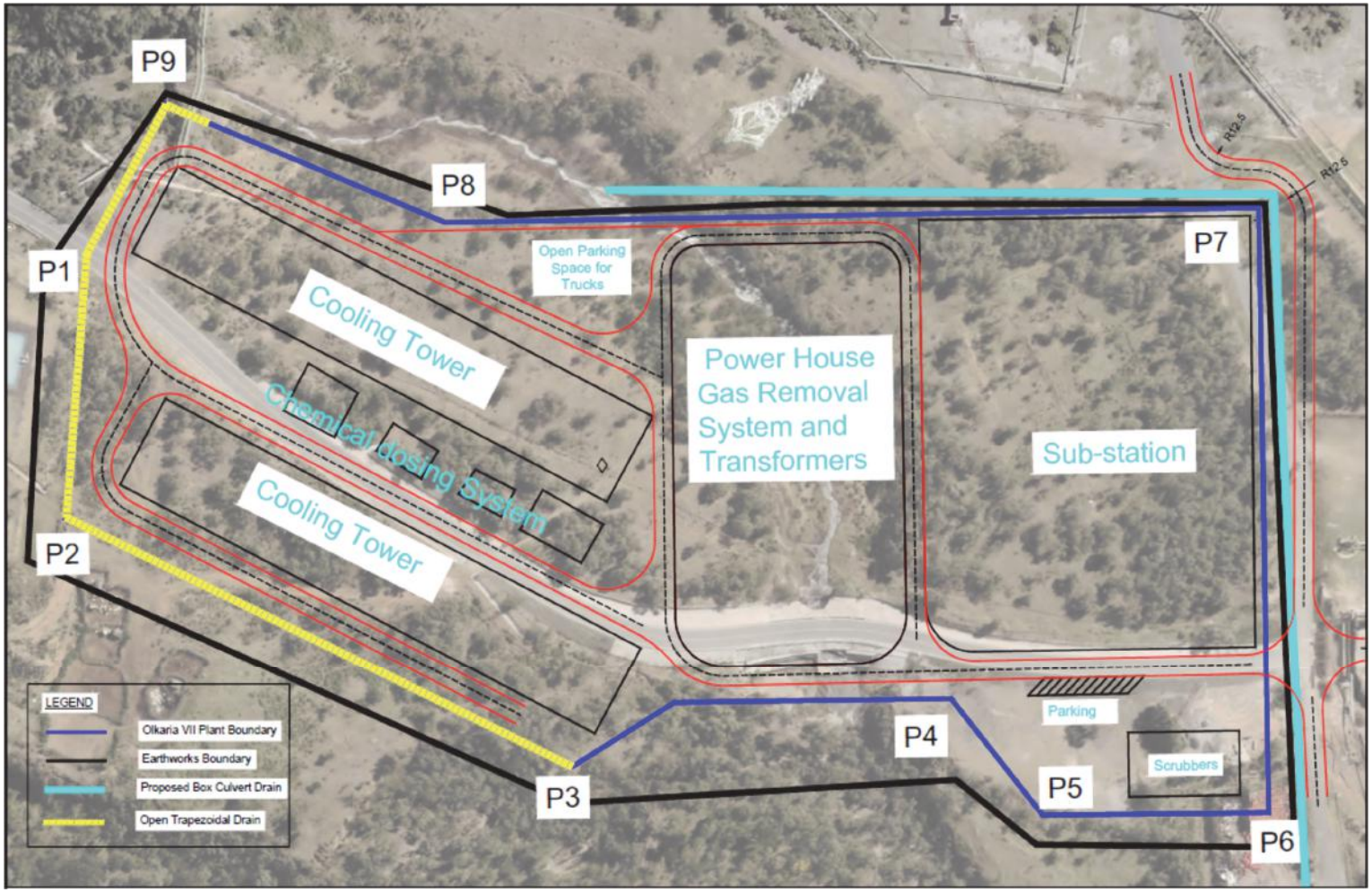


Figure 2.1-6 Olkaria VII power plant site layout and internal roads network

2.1.5 Power plant site water supply and utilization

Raw water supply

Water will be tapped from the existing tanks serving Olkaria I Additional Units and will reach the Olkaria VII Site flowing.by gravity. The water pipeline will be laid along the existing road as shown in the layout of Figure 2.1-7. Upon reaching Olkaria I, the pipeline will veer off the alignment on the road and run adjacent to the steam pipes up to the proposed Olkaria VII Plant site. Water will be carried through a 250 OD HDPE pipeline designed to convey a flow of 312.1m^3/h and giving a residual head greater than 25m at the proposed plant site. This allows to fill the cooling tower system within 14 hours, which is considered a reasonable time.

Water storage and distribution

The incoming raw water will be distributed into 4 main storage tanks as follows:

- Cooling tower(s);
- Fire-fighting water storage tank;
- Service water storage tank, intended for catering daily water requirements including potable (treated) water; and
- The storage tanks for service water and treated potable water which have been designed taking into account daily water requirements and potable water demands of 110m^3/day and 7.1m^3/day respectively.

Potable water

The total domestic water demand for the plant has been estimated at 7.1m^3/day. A potable water treatment plant shall be provided and chlorine will be used as the means of disinfection.

Sanitary wastewater collection and treatment

The sanitary wastewater to be generated has been estimated at 6.02m^3/day. Sanitary wastewater will be collected and discharged into a septic tank with a capacity of 7.5m^3 as onsite treatment method. The effluent from the septic tank will be exhausted when necessary. The sludge accumulated in the septic tank will be removed by means of an exhauster service vehicle and disposed of at Naivasha sewage treatment plant at Naivasha town, approximately 40km away from Olkaria. The design and operations of the septic tank shall meet the relevant laws and regulations enforced in Kenya.

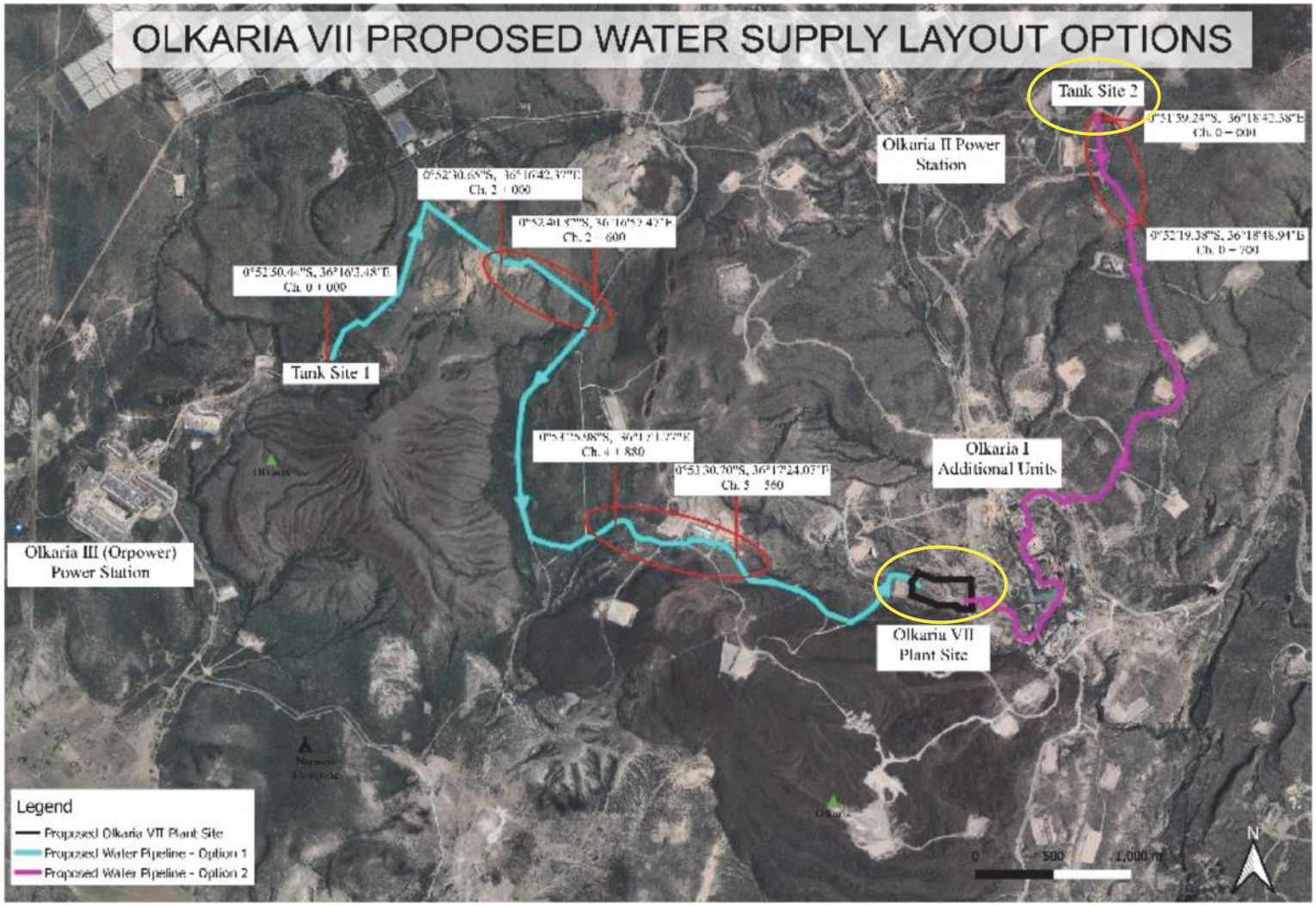


Figure 2.1-7 Raw water will be supplied by gravity from Tank Site-2.

2.2 Design of the Geothermal Power Plant

The Olkaria power plant will adopt the design of single flash power plant. Single flash steam power plants are relatively a common method used to convert the geothermal energy into electricity where production wells produce a mixture of steam and liquid in a geothermal system. A generalized design and the schematic flow process for single flash geothermal power plant is presented in Figure 2.2-1 below. The main components of the single flash power plant system comprise the following:

- Two-phase fluid production wells;
- SAGS, essentially separator/s and aboveground pipelines;
- Turbine – generator set;
- Condenser;
- Cooling towers; and
- Re-injection wells.

As the hot brine of the underground geothermal reservoir flows up through the production wells it experiences a constant enthalpy pressure drop resulting in a saturated flow mixture at the wellhead. This two-phase fluid is piped to a separator where it separates into nearly dry steam and saturated hot liquid. While the hot brine is piped to the re-injection area and re-injected deep into the ground through re-injection wells, the steam is hauled by pipelines to the turbine of the power plant where, passing through sets of rotational blades, expands and gives rotational motion to the turbine's shaft. As the steam passes through the turbine blades, it becomes saturated and is exhausted to the condenser, where, sprayed with cool water flowing by gravity from the cooling towers basin, condenses into hot liquid. The resulting aggregated hot liquid is collected inside the Hot Well Pump pit from where it is pumped back to the cooling tower/s where it is cooled, collected in the cooling towers basin and flows back to condenser, thus completing a water-cooling cycle.

The power is generated by a generator coupled to the turbine's rotating shaft, its voltage elevated by the main step-up transformer and is evacuated to the national grid through the substation and a transmission line.

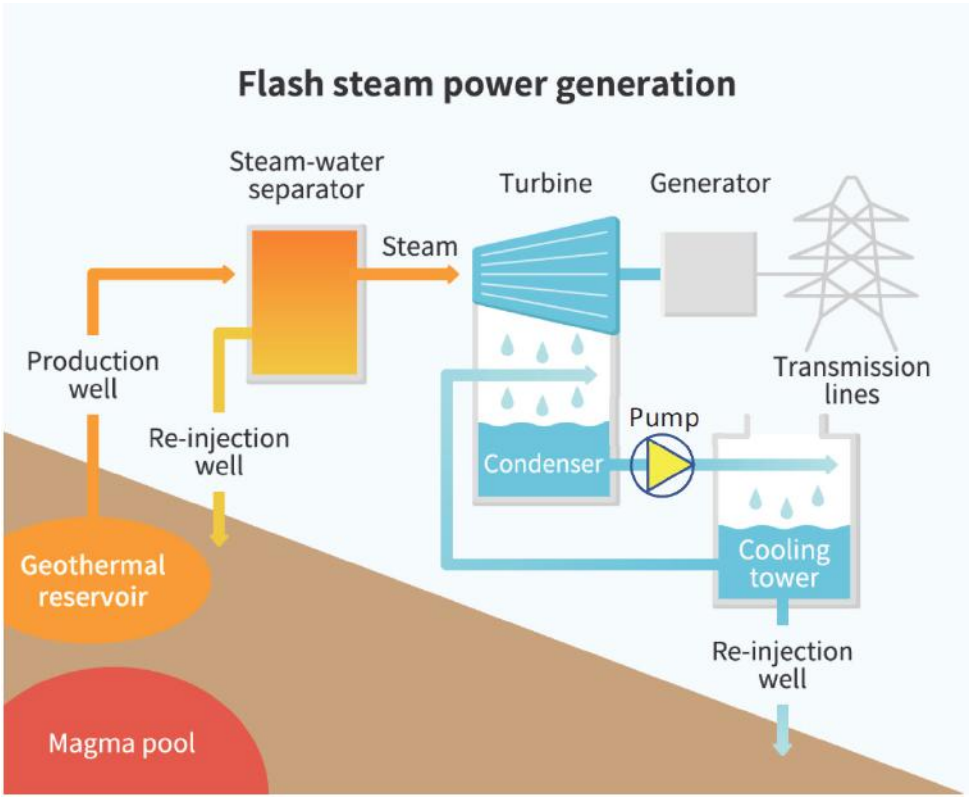


Figure 2.2-1 Design and schematic flow process for single flash geothermal power plant
Source: Geothermal Power Generation | RENOVA, Inc. (renovainc.com)

The power plant layout and the design for the main project components of the Olkaria VII geothermal power plant project are covered in the Sections 2.1.1-2.1.5 above. The various processes associated with the operations of the Olkaria VII geothermal power plant are similar to what has been described above in Section 2.2 - Design of the Geothermal Power Plant and are summarized below as follows:

- The two-phase fluid from the production wells assigned to the Olkaria VII geothermal power plant passes through the separators where the brine is separated from the steam and directed to the re-injection wells;
- From the separators, the steam flows through scrubbers where impurities are removed to prevent damage and corrosion of turbine parts. Subsequently the steam enters into the turbine producing rotational torque in turbine's shaft. The shaft is coupled in tandem with the rotor of the generator and power is generated.
- Saturated steam is exhausted from the turbine and flows into the condenser, where heat is removed from the steam-cycle and back into environment. Condensate flowing from the condenser is then pumped by the Hot Well Pump to the cooling towers.

2.3 Project implementation

The drilling of the nineteen (19) production wells assigned for the Olkaria VII Geothermal Project and seven (7) hot brine re-injection wells was accomplished between years 2013 and 2022 inclusive. However, prior to plant operation, it will be necessary to drill one more hot reinjection well of similar

reinjection capacity of the already drilled well. For cold re-injection, one (1) well located around Pad 801 will be utilized.

The main components relevant with the construction and operation of the Olkaria VII power plant are covered in Section 2.1 - Project Components. Those include the construction and installation of the powerhouse and auxiliary systems, gas extraction system, transformers, cooling towers, scrubbers, chemical dosing system, water treatment system, hot well pumps, and others. In addition, the realization of the project includes the construction of the steamfield above ground system (SAGS), the construction of the transmission line and substations, the development of access roads and water supply with storage systems and site earthworks.

2.4 Process

Geothermal power generation through a single flash cycle with condensing steam turbine described in Section 2.2, is a long-proven generation technology and its feasibility of implementation and economy in Olkaria has been satisfactorily demonstrated by the several facilities operated by KenGen in the Olkaria area. This includes geothermal plants such Olkaria-II, Olkaria-I Additional Units (1AU), Olkaria-IV and Olkaria-V. Alternatives and the analysis of clean power generation from other renewable energy sources is described in Section 2.8.

2.5 Inputs /raw materials

Major consumables relevant to the operation of the proposed Olkaria VII geothermal power plant include geothermal steam, raw water, compounds for chemical anti-scaling dosing and lubricants.

2.5.1 Geothermal steam

The main consumable element for the operation of the Olkaria VII geothermal power plant is geothermal steam, which also contain a variable percentage in weight of gaseous components as well solid impurities. The gaseous component of the geothermal steam (commonly less than 2% in weight) includes variable proportions of non-condensable gases such hydrogen sulphide (H_2S), carbon dioxide (CO_2), hydrogen (H_2), methane (CH_4), nitrogen (N_2), ammonia (NH_3), hydrogen chloride (HCl), oxygen (O_2), argon (Ar) and sulphur dioxide (SO_2). Main impurities found in the geothermal steam include sodium, silica, chlorides, iron and other dissolved solids.

The total available steam flow rate was calculated at 592 t/h based on the deliverability curve of each production well. It was assumed that 477.6 t/h of steam will be utilized to generate 80.3MWe of gross power output accounting for the steam pressure drop along the piping and elements of the SAGS. The power plant will commence its generation with the existing nineteen (19) production wells; other seven (7) make up production wells shall be drilled and added sequentially to maintain the above power output level for 25 years.

2.5.2 Water supply

Raw water is needed during construction works and for operation, initial filling of the water-cooling system, fire-fighting system operation and plant internal service water usage and potable water

consumption. Potable water required for drinking, showering, cleaning and flushing of toilets, will be available from a water treatment facility at the project site.

Raw water will be tapped off from the existing reservoir water tanks serving Olkaria I Additional Units and will reach the Olkaria VII Site flowing by gravity. The incoming raw water will be distributed into four main storage tanks. The storage tanks for service water and treated potable water have been designed taking into account daily water requirements and potable water demands of 110m^3/day and 7.1m^3/day respectively. A potable water treatment plant shall be provided and chlorine used as the means of disinfection.

2.5.3 Chemicals for dosing

If required, caustic soda will be preferably used for reducing the acidity of the condensate resulting from the process. In addition, if required, sodium hypochlorite and a biocide could be added to the cooling condensate to prevent the growth of bacteria and algae on the cooling tower fins.

2.5.4 Oils and lubricants

Oils and lubricants will be required for lubricating bearings of the turbines, generators and other rotating equipment, such pumps.

2.6 Products and by-products

The geothermal resource assessment shows that the power plant can generate 80.3MWe gross power output. The level of power generation has a possible sustainability of 25 years based on the existing available data and assuming 6.01 ton of steam per MWh gross and well productivity decline rate of 2.0% per year. There will be no by-products produced during the generation of power in the power plant.

2.7 Wastes Produced and Methods of Disposal

Several waste products will emanate from the operation process of the power plant. These include cold brine and condensed effluents, non-condensable gases, waste water and, spent oils and lubricants as outlined in the following sections.

2.7.1 Production of brine

According to the steam production forecast, the assumed production of hot re-injection brine in the SAGS is estimated to be between 780 - 960 t/h for 25 years. Seven (7) re-injection wells including OW-805D will be used to re-inject the said hot brine produced at the separators. However, re-injection capacity of the existing seven (7) re-injection wells is estimated at about 870 t/h which is not enough for the amount of brine produced. Therefore, it is necessary to drill one make-up well for re-injection and confirm its re-injection capacity prior to the commencement of plant operation. The cold steam condensates will be re-injected to well(s) in the area of Pad 801.

2.7.2 Silica deposits

The steam condensate contains some dissolved silica, which precipitates in the steam pipelines and shall be periodically removed from those pipelines. The silicate deposits scrapped from the steam pipelines will be disposed-off by burying at the Olkaria dumpsite used for the purpose.

2.7.3 Steam condensate

The steam that condenses after passing through the turbines is expected to be highly acidic due to the presence of carbon dioxide (CO_2) and hydrogen sulphide (H_2S). This steam condensate from Olkaria VII geothermal power plant will be disposed-off as a cold re-injection fluid into deep wells in the area of pad 801 as stated above.

2.7.4 Sludge

A certain amount of sludge consisting of used lubricating oils will be generated at the oil-water separator equipment as part of the plant waste water system. Likewise, sludge originated in algae, bacteria and sulphur components is expected to build up at the cooling towers. This sludge will be dried and encased in concrete and subsequently buried.

2.7.5 Sanitary wastewater

The sanitary wastewater generated by the system is estimated at 6.025m^3/day. Sanitary wastewater will be collected and discharged into a septic tank of capacity of 7.5m^3 as onsite treatment method. Sanitary waste will be contained in the septic tank and exhausted when necessary. The sludge accumulated in the septic tank will be removed by means of an exhauster service vehicle and disposed of to wastewater treatment plant at Naivasha town, approximately 40km from Olkaria.

2.8 Analysis of Alternatives

The possible five alternatives that have been considered for the Olkaria VII geothermal power development project include:

- No project development option;
- Clean energy power intervention options;
- Geothermal power technology alternatives;
- Alternative sites for exploitation of geothermal resources; and
- Environmental classification alternatives.

2.8.1 No project development option

Although this is not a practical option, it was found appropriate to be analysed here in order to draw attention to the implications of a situation where the Olkaria VII geothermal power project is not implemented as planned. Currently, KenGen intends to increase power generation from geothermal resources to address the increasing power supply-demand imbalance in the country and at the same time reduce the carbon emissions associated with conventional power generation. Among the findings made under the Lahmeyer plan (Lahmeyer 2014) and previous power generation expansion plans, geothermal power is the least cost source of baseload energy for the Kenyan power system. The 2x70MWe Olkaria

VII geothermal power project was projected to be online by FY 2026 under Lahmeyer plan, and in FY 2029 under Low-Cost Power Development Plan (LCPDP) 2022 - 2041.

With regard to the implementation of the Olkaria VII geothermal power plant, the Consultant (West JEC Engineers) has analysed the following four scenarios in reference to Task 2 - Kenya's Energy Regulatory Framework and Energy Market Overview – of the Feasibility Study:

- Base case with Olkaria VII (140 MWe), as per LCPDP 2022-2041;
- Advance Olkaria VII (with Olkaria VII (140 MWe) online date by a year i.e., to 2027/28;
- Base case without Olkaria VII (**the no project option**); and
- Base case with only 1x80.3MWe Unit.

The conclusions drawn from the above scenarios are summarized below as follows;

- The Base case with a 140MWe Olkaria VII project, as scheduled in the LCPDP 2022-2041, should contribute to positive power balance from 75MWe in 2029 to 40MWe in 2031.
- Advancing the COD of a 140MWe Olkaria VII project increases the power balance margin in 2027/28 to 223MWe from 80.3MWe. The power balances for years 2029 to 2031 are the same as the base case. However, it is not realistic to put on line the Olkaria plant before 2027 according to the plant construction schedule.
- Assuming the demand projected in LCPDP 2022-2041, in case the 140MWe Olkaria-VII is not implemented, the power system balance will have a deficit of 65 to 100MWe in the years 2029, 2030 and 2031. Hence, the proposed Olkaria VII project is required by the system as scheduled in the LCPDP 2022-2041.

Assuming the demand projected in LCPDP 2022-2041, the Olkaria-VII project, reduced to 80.3 MWe, contributes yet to the power balance in the system with a reserve margin of 15MWe to 20MWe in the years 2029, 2030 and 2031. Additional capacity will be required to cover the shortfall of about 60MWe.

As stated in the above analysis, the no implementation of Olkaria VII geothermal power project option will result in a deficit of 65 to 100MWe in the years 2029, 2030 and 2031. This is likely to have far reaching implications in the country including situations of power shortages, reliance on non-sustainable power sources and slow down on the country's development objectives.

2.8.2 Clean energy power intervention options

As stated above in Chapter 1, the Government of Kenya is presently pursuing efforts that will increase power demand and supply, and lower the cost of electricity by injecting cheaper renewable energy sources such as geothermal, wind, solar, and the addition of natural gas into the energy mix while weaning off the more expensive heavy fuel oil plants. Currently, the country exploits close to 950MWe of geothermal energy which accounts for nearly 31% of the total installed power generation capacity in in the country. The findings of the generation expansion plan as contained in the Lahmeyer Report

(Lahmeyer, 2014), rank geothermal power generation much higher than the rest of sources of the energy mix (hydropower, wind, solar and other energy sources) as seen below:

- Geothermal energy constitutes the main source for base load capacity and will represent one third of the installed generation capacity providing more than half of the annual generated electricity by 2035;
- The second largest share in the long-term energy mix is represented by hydropower (15% in 2035 in the reference scenario, down from a share of some 40% in 2015). Hydro power plants will also play a major role in the provision of flexible capacity to the system for spinning reserve, stability and peaking requirements; and
- In the long-term analysis of the referenced expansion plan, nearly 90% of the power demand is expected to be covered by domestic renewable energy sources (60% by geothermal, 15% by hydropower, 11% by wind, 2% by bio- mass cogeneration and 1% by PV. Power imports and coal-fuelled power will supplement the energy mix at 7% and 4%, respectively.

Based on the above analysis, it is evident that the geothermal energy option is the most plausible alternative when compared with other clean energy options. Furthermore, the country has large untapped geothermal energy resources estimated at 10,000MWe, spreading out across several sites in the Kenya's Rift Valley region and enough to meet four times the country's current monthly averaged power demand.

2.8.3 Geothermal power generation technology alternatives

There are five main types of geothermal power generation technology plants including:

- Dry steam plants;
- Single flash steam plants;
- Double flash power plant;
- Binary steam plants;
- Hybrid steam plants; and
- Combined cycle power plants.

Dry steam power plants

Dry steam plants use steam directly surging from a dry steam geothermal reservoir to turn a turbine-generator set. The steam is dry and, after going through a filter mesh installed for collecting solids which may be eventually being dragged by the steam flow, is directed to drive a turbine coupled to a generator for generating power. If a backpressure turbine is used, dry steam plants emit large amounts of steam and noise; however, if a condensing turbine is used, they emit only minor amounts steam and of gases, similar to the single flash plants covered in next topic. Dry steam was used in the first ever geothermal power plant, originally installed in Larderello Italy but currently dry steam geothermal reservoirs exist only at very few places around the world.

Single flash power plants

Worldwide, most in-operation geothermal power plants are single flash steam plants. In the single flash geothermal power plants, the water-dominated geothermal fluid of the reservoir, at a temperature of more than 180°C, flows upward through the well driven by its own higher pressure becoming a saturated water-steam mixed fluid. Once on the surface, this two-phase fluid is directed into a separator held at lower pressure than the fluid causing the steam to rapidly separate from the liquid, or "flash." While the steam is directed to the powerhouse and subsequently utilized to drive a turbine coupled to a generator, the separated hot water is re-injected back deep into the ground.

As the steam passes through and expands inside the turbine it losses heat and becomes saturated. The saturated steam flows into the condenser where, sprayed with cool water flowing from the cooling tower/s turns into a hot saturated liquid, which is subsequently pumped to be cooled in the said cooling tower.

Double flash power plant

The flash technology can be used in some other ways for generating power. Double flashing is one of these, albeit depends on the resource characteristics and is more expensive than the single flash. A double flash steam geothermal power plant has the same working principles as the single flash power plant except that two separators are used, resulting in high and low-pressure steam flows that drive the steam turbine. Most geothermal power plant developers believe that double flash is more effective than single flash because a larger portion of the steam resource is utilized.

Additionally, a triple flash process, where the power plant utilizes up to three vessels for flashing the working fluid at successively lower pressures, may be implemented in order to extract the energy remaining available in the liquid phase coming from the double flash cycle. However, this possibility is highly dependent on the characteristics of the geothermal resource and there are very few triple-flash geothermal power plants operating worldwide.

Binary cycle power plant

The binary cycle plants utilize geothermal resources of lower temperature than those used by the dry steam, single and double flash geothermal power plants. In a binary cycle geothermal power plant, the energy is extracted from the medium or medium-low temperature geothermal fluid through a secondary fluid of much lower boiling point, such as pentane or butane, and hence the designation "binary". Heat from the geothermal fluid causes the secondary fluid to flash to vapor, which is used to drive a turbine (pentane-driven turbine) which turns a generator to generate power. These power plants, designated as Organic Rankine Cycle (ORC) plants, utilize a closed-loop system and virtually nothing is emitted to contaminate the atmosphere or environment. Considering that moderate-temperature geothermal resources (usually less than 180ºC) are by far the more common worldwide, it is foreseeable that most geothermal power plants in the future will be of the binary-cycle type.

Hybrid steam power plants

Hybrid steam power plants usually start their operating life as flash plants of one or more units configuration. However, it be may be possible to generate additional power through a binary bottoming unit using a heat exchanger to transfer the heat energy from the waste geothermal fluid to the working fluid used in a binary cycle. Consequently, energy remaining in the hot brine leaving the separator of single flash may be harnessed in an ORC (Organic Rankine Cycle) to evaporate a working fluid (typically Pentane) for rotating a generator coupled to a turbine. In the hybrid system, the additional power generated by the binary cycle is obtained without increasing the amount of geothermal fluid being extracted from the reservoir. The hot yet spent brine, as well cold condensate steam effluents, are re-injected into the geothermal field separately.

Combined cycle power plants

Although research on combined cycle power plants is still on-going, there is emerging evidence that integration of steam power technologies with other potential energy resources can offer relevant synergies and optimize the cost and the overall efficiency of the power plants. Common systems that combine geothermal energy with other renewable power technology systems include:

- Geothermal and solar;
- Geothermal and wind; and
- Geothermal in green hydrogen production.

Geothermal and solar power plant

Despite the fact that other renewable energy power plants have shorter construction time and lower investment costs than geothermal power plants (GPPs), they usually have lower enthalpy and their overall efficiency is considered low. In order to increase the overall efficiency of a GPPs, the integration with power plants harnessing energy from different renewable sources is a beneficial option. Geothermal-solar hybrid power generation systems have been found to achieve favourable thermodynamic performances and provide alternative way to improve the energy conversion efficiencies of the geothermal and solar energy systems.

Geothermal and Wind power plant

Although currently not well developed, hybridization of geothermal and wind power systems would be a valuable possibility in the future. Combining the baseload geothermal power with the intermittent wind generation may improve overall performance of both energy sources.

Green hydrogen production power plant

In recent times, governments and industries alike have recognized the incredible potential that hydrogen can play in global decarbonization, especially in the context of transportation fuel. Geothermal power production offers a great benefit to the efficiency of green hydrogen since it runs full time and is not impacted by weather changes (whether or not the sun is shining or wind is blowing). Geothermal power provides consistent, baseload power output capability that makes it a perfect energy provider for green hydrogen generation facilities.

Selection of single flash cycle condensing steam turbine for Olkaria VII project

As part of the feasibility study for this project, the suitability of five commercially proven geothermal power generation technologies was analysed for their adoption for the Olkaria VII geothermal power plant (West JEC Task 2).

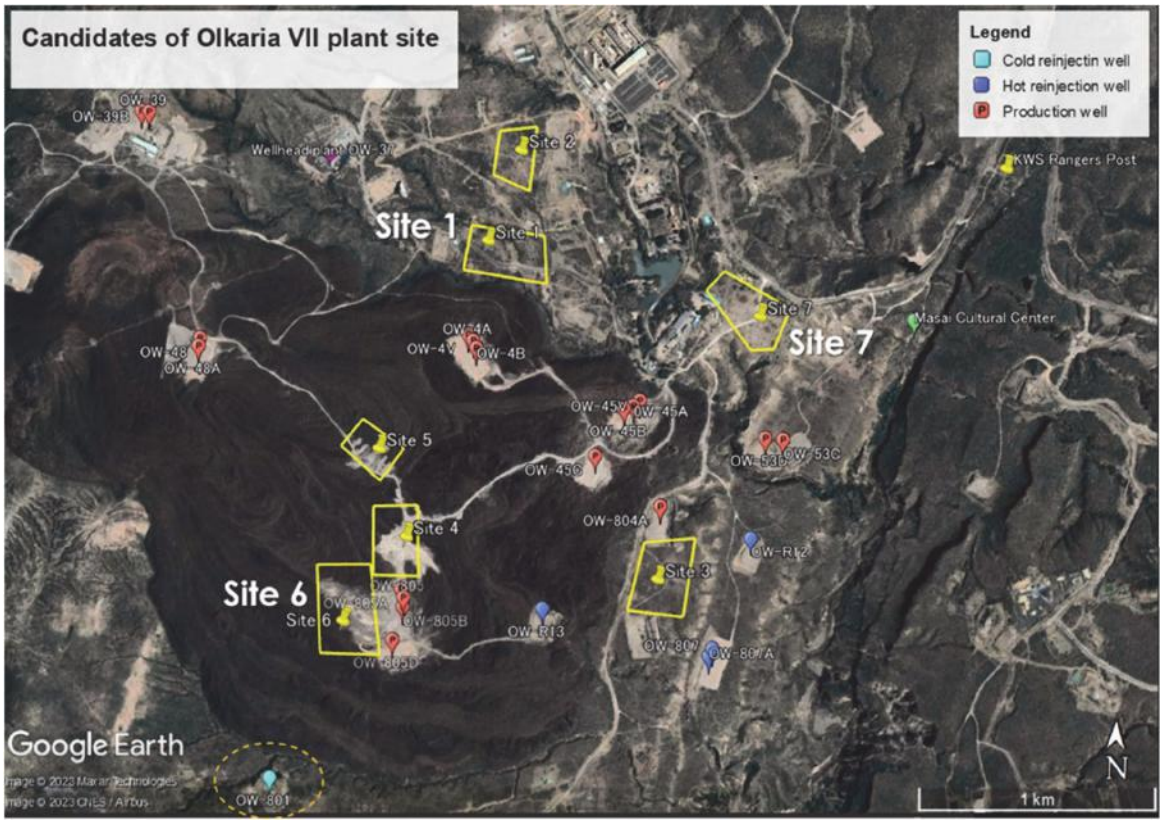
The five geothermal technology options considered were:

- Single flash cycle condensing steam turbine with wet-cooling tower, 1 unit;
- Single flash cycle condensing steam turbine with wet-cooling tower, 2 smaller units;
- Single flash cycle condensing steam turbine with hybrid-cooling tower;
- Combination of backpressure turbine and bottoming ORC; and
- Two-phase binary power plant.

A comparison of technical results and Levelized Cost of Energy (LCOE) for the above five options of generation technology, shows that Option 1 (Single flash cycle condensing steam turbine with wet-cooling tower, 1 unit) is the technology with highest net output (MWe), lowest unit capital cost (USD/kW) and lowest LCOE (US¢/kWh net). Moreover, compared with ORC options and hybrid cooling tower utilization, Option 1 is of less complexity for both steam field and plant operations, therefore, reducing operational performance risks. In addition, KenGen has long experience with single flash technology in their Olkaria-II, Olkaria-IAU, Olkaria-IV, and Olkaria-V power plants and have not experienced any major problems with the plant's operation and maintenance (O&M). Therefore, single flash cycle with condensing turbine became the recommended technology for the Olkaria VII geothermal power plant.

2.8.4 Alternative project sites

During the early stages of the feasibility study, the Consulting team and the Technical team seconded by the project proponent identified seven potential areas for power plant siting. Among others, the basic selection criteria called for a piece of land large enough for hosting the construction of a single unit of 80.3MWe geothermal plant with enough allowance for future expansion with a second unit. Initially, the combined team identified seven (7) potential areas for the Olkaria-VII Plant siting as shown in Map 2.8-1. Following rigorous criteria of selection, the Consultant's team further identified Site 1, Site 6, and Site 7 as the most promising locations. The selection of Site 1 as the most suitable site for the construction of Olkaria-VII plant was achieved by a process of ranking of socio-environmental, technical and economic considerations of each of the three remaining sites (Sites 1, 6 and 7).



Map 2.8-1 Sites considered for the installation of the Olkaria VII power plant

Table 2.8-1 shows the scoring of each of the above three candidate sites (Site 1, Site 6 and Site 7) with regard to the attributes of social-environmental constrictions, volume of civil engineering works, pipelines construction and/or removal, power-transmission line construction and preliminary estimated costs. Each of the above attributes was given a score increasing from 0 to 4 except the socio-environmental impacts in which the score was double factored due to the perceived importance given to environmental considerations within the project area. Consequently, the score of socio-environmental attributes, progressed from 0 in case of unbearable impacts, 2, 4, and 6 for increasingly moderate impacts, and, 8 for the most environmentally friendly conditions. The maximum score attained by the sum of scores on the subjects defined the most plausible site for plant construction.

Table 2.8-1. Ranking Matrix for the selection of the most suitable location for plant siting

SUBJECT	Site 1	Site 6	Site 7
Environmental concerns	**19**	**12**	**11**
Local Community issues	8	2	4
Proximity to the National Park	3	4	2
Visual impacts	3	2	1
Noise pollution	3	2	2
H_2S contamination	2	2	2
Civil engineering	**22**	**17**	**22**
Availability of flat space	3	1	3
Space for future expansion	3	4	3
Drainage - catchment area	**3**	4	3
Easiness of access -murram or tarmac road	4	2	4
Soil stability (erosion, land slide)	3	3	3
Proximity to geological fault	3	1	3
Water supply	3	2	3

Pipelines construction	**5**	**8**	**5**
Interference with existing facilities	3	4	2
Condensate reinjection	2	4	3
Transmission line	**2**	**4**	**3**
Interference/proximity with existing transmission lines and substation	2	4	3
Preliminary Costs (all in million US$)	**1**	**2**	**3**
Cost for environmental mitigation measures	0.2	1.3	0.2
Cost of civil works – earthworks, retaining walls, water storm drains	1.8	4.6	1.3
Cost for pipelines including removal of existing pipes	31.66	26.66	28.48
Cost of additional production wells required for 140MW (net)	88.9	82.2	85.1
Cost for transmission line	5.0	10.8	6.2
Total estimated Cost	**127.6**	**125.6**	**121.8**
Total score	**49**	**43**	**44**

2.8.5 Environmental and social classification alternatives

The screening process for this project was carried out in accordance with the World Bank and NEMA system of environmental social categorization. The World Bank (WB) Environmental Assessment (OP 4.1) Operational Policies require that screening for potential impacts to be carried out early in the project planning cycle in order to determine the level of environmental assessment and mitigation for potential impacts. The WB project screening criteria is mainly based on three main categories as outlined below:

- **Category A –** A project is classified into Category A if it has potential to have significant adverse environmental and socio-economic impacts that are sensitive, diverse or unprecedented. Impacts of Category A projects may affect areas broader than the sites subjected to physical works. This includes projects in sensitive sectors or projects that are located in or near sensitive areas;
- **Category B –** A project is classified into Category B if its potential environmental and social impacts are less adverse than those of Category A projects. Typically, the impacts of Category B projects are site specific, few, if any, of them are irreversible, and mitigation measures are more readily available; and
- **Category C –** A project is classified as Category C if it is unlikely to cause adverse environmental and social impacts.

Discussions between the environmental team of project proponent (KenGen) and the Consulting team culminated in the classification of the Olkaria VII geothermal project into Category A; that is, a category for projects with potential to cause significant adverse social and environmental impacts that are diverse, irreversible and unprecedented to the project area.

3 APPROACH AND METHODOLOGY

3.1 Approach

The Consultant conducted environmental and social impact assessment (ESIA) of the proposed Olkaria VII geothermal power plant in accordance with the NEMA guidelines and procedures as shown in Figure 3.1-1and as per the requirements of World Bank and JICA environmental and social framework. In doing so the Consultant reviewed legal, regulatory and administrative framework in Kenya, described the existing environmental and socio-economic conditions of the project area, identified both negative and positive impacts of the proposed project and proposed measures for the mitigation of negative impacts of implementing the proposed project. In addition, the Consultant developed environmental and socio-economic management and monitoring plans required in addressing any changes and trends brought about by the presence and operations of proposed geothermal plant facility (Olkaria VII), among other relevant ESIA activities.

The ESIA for the proposed Olkaria VII geothermal power plant was carried out by a team of experts as presented in Table 3.1-1 below:

Table 3.1-1: The Team of Consultants that carried out the Olkaria VII ESIA

Member of the Team	Position	Qualification	NEMA Reg No.
Prof Francis M. Muthuri	Team Leader	PhD Botany	0023
Dr. Frida N. Mutui	Environmentalist	PhD Environmental Science	1494
Mr. Philip Otieno Abuor	Noise and Air Quality Expert	B.Sc. (Chem)/Msc-Environmental Science	1710
Ms Dorothy N. Mbuvi	Sociologist	B.A Sociology	N/A
Mr. Stephen Murimi	Technical Assistant	BSc ICT/ Telcom - GIS	N/A

The environmental and social impact assessment (ESIA) for the proposed Olkaria VII geothermal power project was carried out between June and September 2023 within an estimated time of 4.5 months. The project schedule of activities is presented in Annex 6. Ten hard copies and an electronic copy of the ESIA study report as well as an electronic copy of summarized Environmental and Social Management and Monitoring Plan will be submitted to the National Environmental Management Authority (NEMA) for evaluation and subsequent issuance of license for the implementation of Olkaria VII geothermal power plant project.

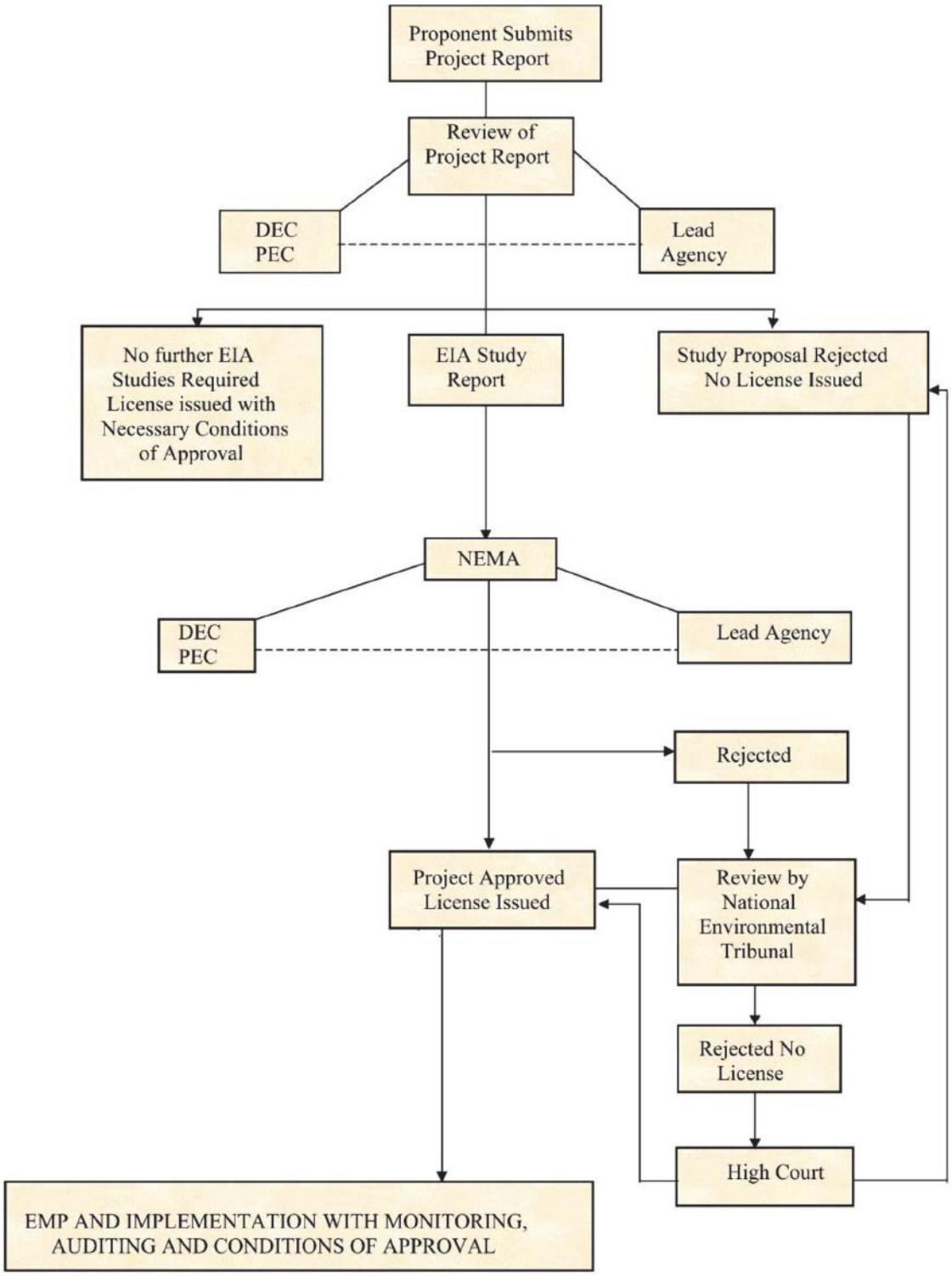


Figure 3.1-1 NEMA Procedures for the Assessment of ESIA
Source: Environment Impact Assessment Guidelines and Administrative Procedures (NEMA, 2002)

3.2 Methodology

Several activities were undertaken in the process of gathering appropriate information necessary for the environmental and socio-economic assessment of the proposed project. The main project ESIA activities included:

- Project screening;
- Review of project documentation;
- Review of existing background literature on the project area as well as on similar projects;
- Project site visits and field investigations;
- Consultations with the public and key stakeholders;
- Sample analysis;
- Data and impact analysis;
- Report compilation; and
- Public disclosure.

3.2.1 Screening

The screening of the Olkaria VII geothermal power project was carried out in accordance with the World Bank and NEMA system of environmental social categorization. The World Bank (WB) Environmental Assessment (OP 4.1) Operational Policies require that screening for potential impacts is carried out early in the project planning cycle in order to determine the level of environmental assessment and mitigation for potential impacts. The WB project screening criteria is mainly based on three main categories as outlined below:

Category A – A project is classified as category A if it has potential to have significant adverse environmental and socio-economic impacts that are sensitive, diverse or unpresented. Impacts of Category A projects may affect areas broader than the sites subjected to physical works. This includes projects in sensitive sectors or projects that are located in or near sensitive areas.

Category B – A project is classified into Category B if its potential environmental and social impacts are less adverse than those of Category A projects. Typically, the impacts of Category B projects are site specific, few if any of them are irreversible, and mitigation measures are more readily available.

Category C – A project is classified as Category C if it is unlikely to have adverse environmental and social impacts.

Pursuant to Section 147 of the Environmental Management and Coordination Act (EMCA) 1999, the Cabinet Secretary, Ministry of Environment and Forestry amended the Environmental (Impact Assessment and Audit) regulations, 2003 by deleting regulation 7 and replacing it with a new regulation 7, vide legal notice of 2019. The NEMA risk-based classification under Kenya Legal Notice 31 of 2019 categorizes a project as follows:

- Low risk projects are the projects that will have no major negative impacts on the surrounding.;

- Medium risk projects – Identified concerns that without mitigation are likely to cause harm to the environment.; and
- High Risk Projects are projects that are highly visible and have sweeping impacts inside and outside the organisation and pose significant threats to the surrounding.

During the early stage of the project ESIA development, the Consultant and project proponent (KenGen) representatives held discussions on project environmental and social categorization. Subsequently, the discussions culminated in the classification of the Olkaria VII project into Category A (World Bank) and High Risk (NEMA), for projects with potential to cause significant adverse social and environmental impacts that are diverse, irreversible and unprecedented to the project area and beyond.

3.2.2 Review of literature

The Consultant made extensive review of the secondary information material pertaining to the characteristics of the project area. In this regard, the Consultant drew on data and available information in published and unpublished works, available relevant reports, technical designs of the proposed project, geographical, geological and hydrological information on the project area, vegetation and wildlife surveys and reports, soil surveys, land use and socio-economic surveys and other sources of information and data. Based on the findings of the review of available literature, the Consultant identified information gaps which were addressed during the field surveys.

3.2.3 Socio-economic field survey

Information on the prevailing socio-economic characteristics of the project area especially for the communities in the vicinity of Olkaria VII and the surrounding areas was gathered during the field survey. This included human population, household characteristics, the occupational distribution and access to socio-economic facilities among other socio-economic attributes. The socio-economic survey to a large extent employed key informant interviews and focus group discussions as the main tools for collecting information. With regard to use of key informant interviews, selected key informants and opinion leaders in the communities of the project area were selected and interviewed during the socio-economic survey. The main objective was to solicit perceived problems and benefits that were likely to be brought about by the development of the proposed project. Focus group discussions were used to gather some relevant information pertaining to specific groups within communities in the project area.

3.2.4 Consultations with key stakeholders

In order to adequately appreciate the views and concerns of stakeholders with regard to the proposed project, a wide range of persons and groups within the project area were marked, identified and consulted during the field survey. Key stakeholders that were consulted during field survey included:

- Local communities in the project area and the surroundings of Lake Naivasha.
- Communities associated with flower growing activities around Lake Naivasha.
- Local Chief and other members of local administration.
- Opinion leaders.

- Government institutions especially in Naivasha sub-County and other relevant institutions in Nakuru County.
- Non-governmental organizations (NGOs).
- The National Environmental Management Authority (NEMA).
- Kenya Energy Generating Company (KenGen).
- Kenya Electricity Transmission Company (KETRACO);
- Lake Naivasha Riparian Owners Association (LNROA), and
- Kenya Wildlife Service (KWS), among other interested parties.

In order to adequately capture the views and concerns of the above stakeholders, the Consultant employed consultative approaches including group discussions and interviews with key informants. The persons met, issues raised including concerns and appreciation for the proposed project was documented and included in the ESIA report.

3.2.5 Environmental field survey

Environmental conditions of the project area were investigated during the field survey made into the project area in June, 2023. During the field survey the Consultant made relevant observations and carried out detailed survey of appropriate environmental attributes of the project area including physical and biological parameters. Photographs of the salient features of the project area were taken where appropriate. Water samples taken from the project area were analysed in NEMA approved laboratory in Nairobi.

3.2.6 Use of environmental checklist

The Consultant used an environmental checklist and survey form (Annex 5) as a guide to collecting field information and identification of impacts in the project area. Attributes of the above checklist, classified under the ecological, physical and socio-economic categories were subjected to impact analysis. Based on the outcome of the analysis, the Consultant categorized elements from the above checklist that are likely to be affected by the presence and operations of the proposed project.

3.2.7 Impact analysis

Following the collection of necessary environmental and socio-economic data and information of the project area, the Consultant embarked on analysis of potential impacts of the proposed project. Towards this objective, the Consultant appreciated that various impacts of the proposed project do not carry the same weight and some impacts had more serious implications than others. Following the identification of both positive and negative impacts, the Consultant proceeded to evaluate their relative significance and ranked their magnitude accordingly. In order to facilitate the impact evaluation, the Consultant developed a matrix where all the identified impacts were ranked. Each cell of the developed matrix contained a relevant magnitude value that indicated severity of a particular impact identified in the project area

3.2.8 Identification of alternatives

The Consultant considered possible alternative options for the proposed development project. Further, the Consultant analysed feasible environmental and socio-economically sound alternatives for the proposed project. This included several aspects including a no project development option, the proposed geothermal power intervention option, other power source alternatives prevailing in the country, geothermal power technology alternatives, alternative sites for the exploitation of geothermal power source in Olkaria and project classification alternatives.

3.2.9 Public disclosure

Upon the completion of compilation of draft ESIA report including Environmental and Social Management and the Monitoring plan, the Consultant organized a national consultative workshop to bring all key players together in order to express their views and concerns on the proposed project and its impacts. The participants of the national workshop discussed the contents of the draft ESIA report and contributed to its finalization. Subsequently, the Consultant incorporated the views of the stakeholders and finalized the ESIA report in readiness for submission to NEMA for evaluation.

4 BASELINE INFORMATION OF THE PROJECT AREA

Description of the existing conditions of the project area is a vital component of an Environmental and Social Impact Assessment (ESIA). It forms a foundation of the project ESIA and is the benchmark against which claims of environmental damage during the construction and operational phases of the project implementation can be assessed. Using the information gathered during the desk and field studies, a description of the salient features of the project area including physical, biological and socio-economic attributes has been carried out and presented in the following sections:

4.1 Physical Environment of the Project Area

In this section of the report, a description of the features of the physical environment of the project area including the climate (rainfall, temperature and wind), topography, geology, soils and hydrology has been done. Special attention has been given to the ambient air parameters which determine the air quality of the project area. In this regard, the air dispersion and noise modelling in the project area has been carried out.

4.1.1 Topography

The project area and environs, is situated on the floor of the Great Rift Valley. The general topography of the study area is characterized by a wide range of features associated with volcanic activity and the formation of the Rift Valley. The floor of the Rift Valley is diverse in structures and topography. Numerous volcanic cones, and craters, scarps and lakes, dot its otherwise monotonous terrain. To the north of the project area, is Lake Naivasha which stands at around 1,885 metres above sea level (m asl) which comprises depressions of three water bodies including the main lake (Lake Naivasha), the Crescent Island and Lake Oloidien. To the west of Olkaria area is Mau Escarpment (3,080 masl) and Eburru pile while to the south east is Mt Longonot.

The Olkaria area 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 OI Njorowa Gorge, which was formed by outflowing water from Lake Naivasha. The proposed project site, Olkaria I and II Power Stations are located in this depression. Within this topographical complex, there are several small valleys that drain the upper slopes and discharge runoff and sediments to the foot slopes and plains below.

The topographic map of the project site is shown in Figure 4.1-1 below. The project site has a gradual slope ranging from 1985m asl to the West to 1,926m asl to the East. The topography of the area is characterised by two gullies (streams), one cuts through the site to the north and the other passes adjacent to the site on the southern edge.

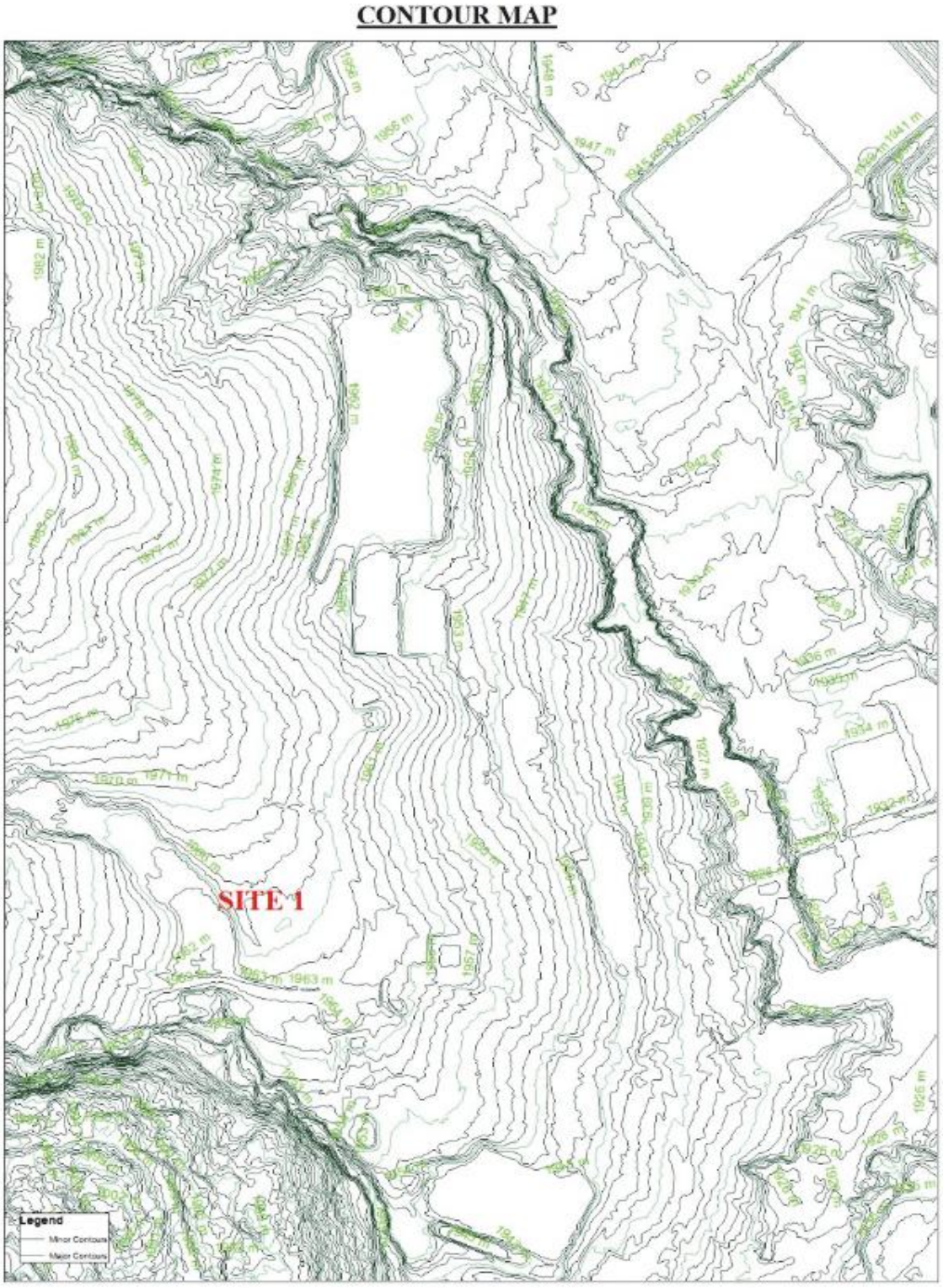


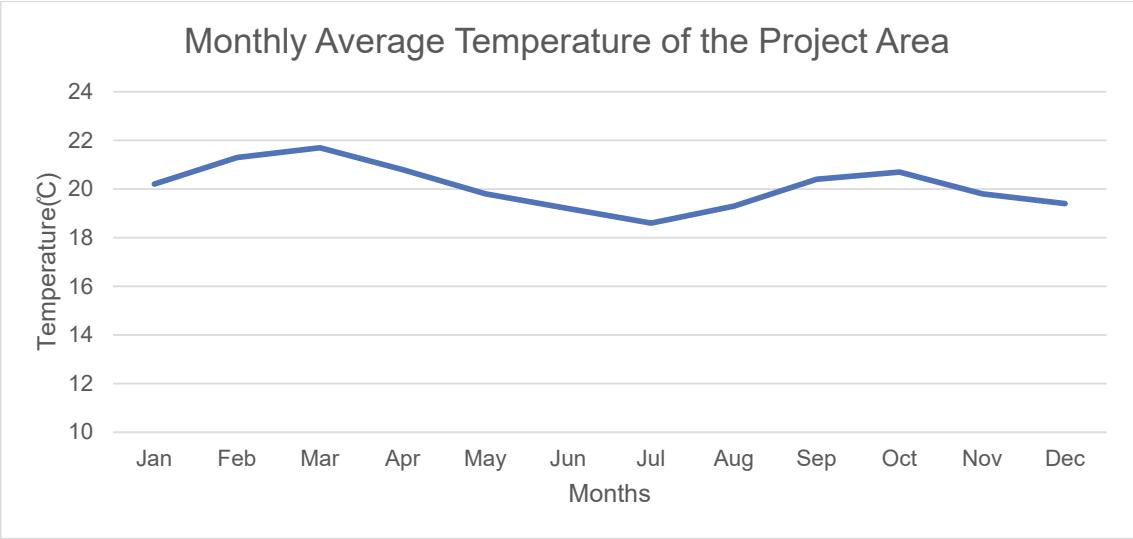
Figure 4.1-1 Topographical map of the proposed Olkaria VII project site.

4.1.2 Climate

Climatic features in the Rift Valley, including the project area, are closely related to altitudinal changes and variations induced by the local topography.

Temperature

The floor of the Rift Valley experiences higher temperatures than the highlands. At Naivasha Town (1,829m asl) the mean monthly temperature has been recorded to range from 15.9-17.8°C with a mean of 16.8°C. The mean monthly maximum temperatures in Naivasha Town range from 24.6-28.3°C. In the project area, July is the coldest month while the hottest month is February. Analysis of mean temperature data recently (2021 - 2022) collected by KenGen in the project area shows that the hottest month in the area is March with a mean temperature of 21.7°C while the coolest month is July with a mean temperature of 18.2°C.

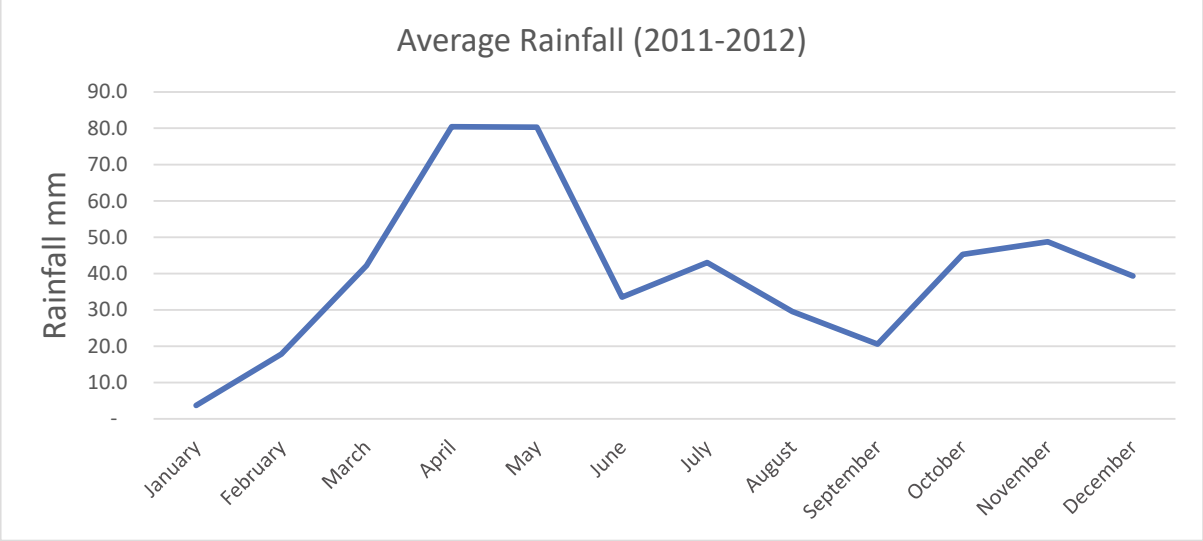


Source: Prepared from KenGen data

Figure 4.1-2 Modelled Temperature distribution in the project area 2019-2021

Rainfall

The monthly distribution of rainfall in the project area and its environs 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, November and December. Generally, the floor of the Rift Valley has lower rainfall than the flanking highlands. This area (floor of the Rift Valley) experiences a double rain shadow effect from the west and east flanking escarpments (Mau and Aberdare Range respectively). Sombroek et al., (1982) classified the area around Lake Naivasha as Agro-climatic Zone V, that is semi-arid. Rainfall in the area is generally low, recording an average of 634mm annually at the Naivasha Town (1,900m asl). Evaporation exceeds precipitation almost throughout the year. It ranges from approximately 1,700mm per year at Lake Naivasha to approximately 1,000mm per year on higher ground, with variations from year to year. The rainfall distribution pattern in the project area (Figure 4.1-3) follows the above trend with the ***long rains*** received in March to May and ***short rains*** received between and October and December.



Source: Prepared from KenGen Data

Figure 4.1-3 Rainfall distribution in the project area

4.1.3 Geology

The geology of Lake Naivasha area has been described by Thompson and Dodson (1958) and more recently by Clarke et al., 1990. It is dominated by the events of the formation of the Great Rift Valley when the volcanic material of Pleistocene Age was extruded and formed the base material. The surface lithologic units expected within the study area are dominated by comenditic lavas, pumice fall and pyroclastics (Figure 4.1-4). A large fraction of the pumice fall and pyroclastic deposits is hypothesized to have originated from Longonot and Suswa volcanoes, lying immediately 20km east and 40km south of Olkaria, respectively. Even though it has not been possible to enumerate systematically the contribution of pyroclastic deposits from each of the three centers, the pyroclastic activity at Longonot is presumed to post-date volcanism at Olkaria. Occurrence of the comendites is restricted to Olkaria and it is the only area in the whole of the Kenya Rift System (KRS) with these rocks on the surface.

Figure 4.1-4 Surface geology (a) tuff at the bridge at Olkaria VII and (b) lava flows to further south

The sub surface geology comprises of The Upper Olkaria Volcanics formation which is underlain by Olkaria basalts. Basaltic lavas are predominant, though alternating with thin horizons of tuffs, minor

trachytes and sporadic rhyolites. The Olkaria basalts are preceded by Plateau Trachytes of Pleistocene age with a thickness of about 1.5km based on borehole data from these fields. The Mau tuffs are the oldest rocks encountered within the area and are of unknown thickness. The lithotypes constituting the Mau tuffs are composed almost exclusively of tuffs with minor interbeds of rhyolites, basalts and trachytes. Pre-Mau volcanics overlie the basement rock. The lithotypes in this series consist notably of phonolites, basalts, trachytes and tuffs. Underlying the Pre-Mau volcanics is a laterally extensive basement system comprising Proterozoic metamorphic amphibolite grade gneisses and schists, accompanied by marble and quartzites of the Pan-Africa basement system. The depth to the basement has been interpreted to be about 5-6 km in the central Kenya Rift.

4.1.4 Soils

The Rift Valley floor is largely covered with sediments that accumulated in the lakes during the Gamblian stage of Pleistocene period. They contain a large proportion of volcanic ejectamenta although some diatomaceous beds are known to occur. Despite their extensive distribution, the Gamblian lake beds are not thick and rarely exceed 100 ft (30m) (Thompson and Dodson, 1958).

The soils of the Lake Naivasha basin including the project area 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.

4.1.5 Hydrology

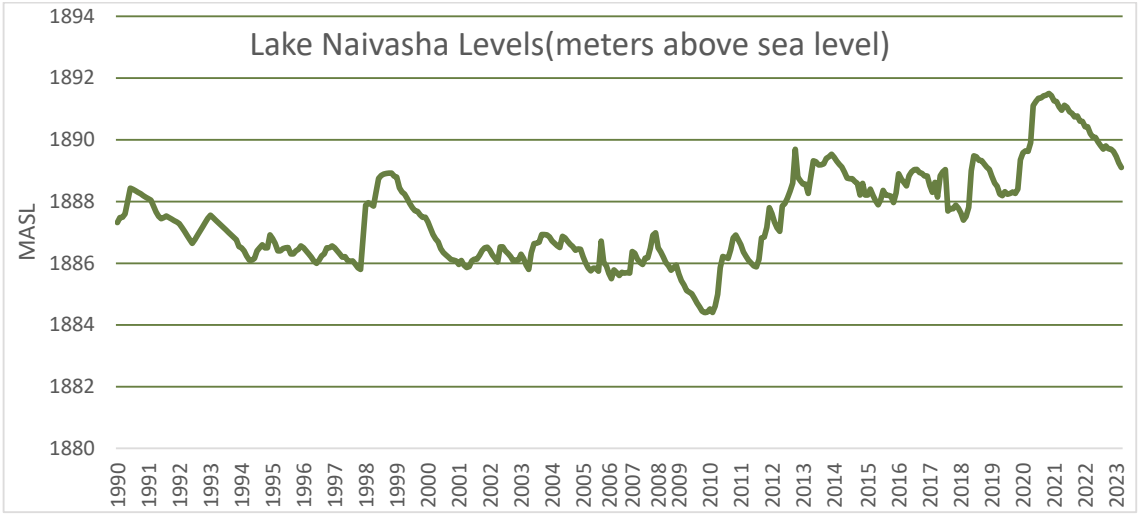
The hydrology of the project area is mainly determined by the arid nature of the prevailing climatic conditions, the drainage patterns and the presence of Lake Naivasha.

Drainage

The mid Rift Valley floor where the project is located is characterized by internal drainage and generally scarce surface and underground water resources. It contains several basins of internal drainage including Lakes Naivasha, Nakuru and Elementaita. Lake Naivasha consists of three morphometrically different bodies of water including the main lake (having a maximum depth of 8m) which includes the Crescent Island lagoon (18m deep), Lake Oloidien to the south of the main lake and a distinct crater lake (Lake Sonachi) located to the southwest of the main lake. The Naivasha basin has a catchment of 2,378km^2 while the Malewa River, the main river in the area has a catchment of 1,730km^2 and provides 90% of the inflow to Lake Naivasha. In addition to major discharge of water from River Malewa, Lake Naivasha receives water inflow from the seasonal rivers of which the most important are rivers Karati and Gilgil. Ground water seepage, particularly, along the north and north-eastern shores contribute a significant influx into the lake as well. Much of the subsurface water outflow from the lake catchment is to the south via Olkaria-Longonot towards Suswa and eventually to Lake Magadi (Clarke et al, 1990).

Lake Naivasha water levels

Lake Naivasha water level undergoes variations in response to river inflow, rainfall over the catchment area and ground water inflows. The lake water levels in the last twenty years are shown in Figure 4.1-5. In the recent past (1990 to 2023), the maximum water level recorded was 1,891.5m asl in 2021 while the minimum level recorded between 1990 and 2023 was reported to be 1,884.5m asl in 2010. Fluctuations in Lake Naivasha levels have tremendous implications in ecology and socio-economic attributes of the project area. Following a recent decline in lake level in 2009 – 2010, the nutrient concentrations in the lake increased with subsequent occurrence of *Microcystis* bloom, a poisonous and potentially lethal algae. As the algae decomposed, the oxygen levels in the lake decreased to anoxic conditions which caused major fish kills in Lake Naivasha. As the volume of in the lake went down, the surface of the lake shrunk and the receding water exposed the fringe vegetation with subsequent mortality of aquatic macrophytes including papyrus (*Cyperus papyrus*) and loss of an important buffer zone between the lake and terrestrial land.

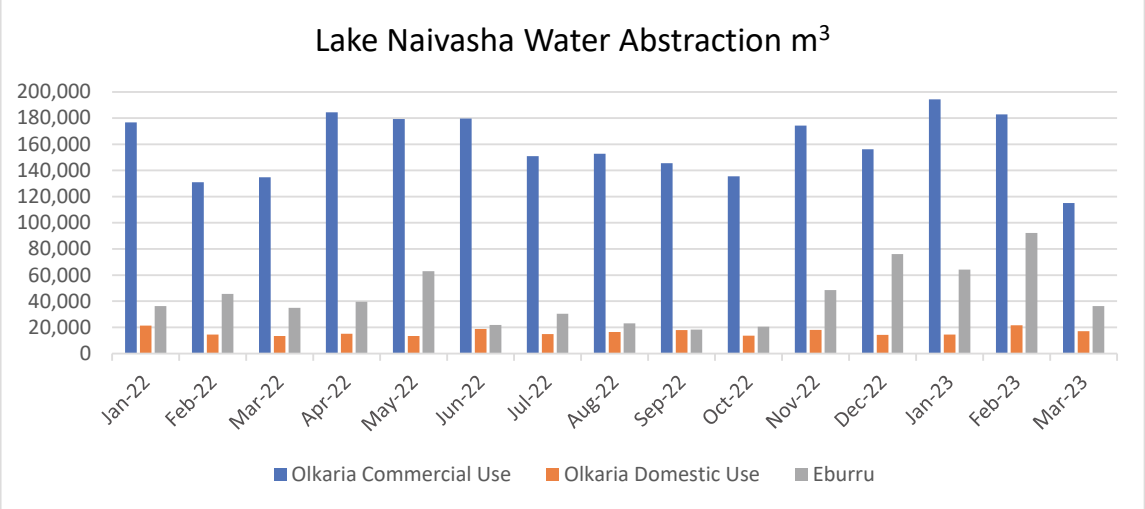


Source: Prepared from KenGen Data

Figure 4.1-5. Lake Naivasha water levels

Lake Naivasha water abstraction

The largest water mass in the project area is contained in Lake Naivasha. As a source of fresh water, in a semi-arid region, Lake Naivasha bears tremendous importance in the project area. The water from the lake and the associated aquifers is utilized for domestic use, watering of livestock, irrigation of flower farms and irrigation in other farming ventures. The current KenGen monthly water abstraction from Lake Naivasha for Olkaria and Eburru geothermal stations are presented in Figure 4.1-6. KenGen abstracts water from the lake for use in drilling wells and other uses in the power station operations, as well as for domestic use in the company offices and the housing estates.



Source: Prepared from KenGen Data

Figure 4.1-6 KenGen water abstraction from Lake Naivasha

Ground water

In addition to water abstraction from Lake Naivasha, ground water resources are also heavily utilized in the Lake Naivasha basin and the project area environs, through pumping from the boreholes around the lake. According to Rural Focus (2002), an estimated 250 boreholes were drilled around the lake by that period. These boreholes had the following characteristics:

- Two main aquifers have been exploited for commercial use;
- They include the lake bed aquifer (for domestic and irrigation uses) and a deep aquifer for geothermal production;
- Along the northern side of the lake from Korongo Farm to Naivasha Town, the lake bed aquifer has been found to be high yielding with water quality ranging from being fresh to partially saline;
- In Ndabibi Farm, ground water is reported to be saline; and
- Along the Moi South Lake Road, groundwater yield is reported to be variable and is of high salinity.

It should be noted that there is a high rate of abstraction of aquifers to the north of the lake that may have reversed the hydraulic gradient so that the flow direction is now from the lake to the north shore. Unlike the boreholes that are relatively shallow, the Olkaria geothermal wells are very deep, usually at a depth of 3000 metres and access very deep geothermal aquifer, which is not connected directly to lake water.

4.1.6 Water quality

Results of water analysis for Lake Naivasha and natural spring water sampled near Rangers Post and steam Well OW-27 are presented in Table 4.1-1 and Figure 4.1-7. The results show that the water quality of Lake Naivasha is reasonably good with electrical conductivity of approximately 300uS/cm, a relatively low pH and low concentrations of chemical composition. Although the electrical conductivity (1,506uS/cm), sodium levels (246mg/l) and Zinc (16.0 mg/l) of the natural spring are

relatively high, the water is still good for domestic purposes. Although water quality parameters from steam well OW-27 are within the WHO maximum allowable levels, analysis of brine conducted between 1993 and 2002 showed high levels of fluorides (at concentrations of 164mg/I) and Arsenic (at concentrations of 0.14mg/I), both of which exceed the recommended World Health Organization permissible limits of 1.7mg/I and 0.05mg/I, respectively (KenGen Environmental Report, 2005).

Figure 4.1-7 Olkaria VII water quality sampling location

Table 4.1-1 Water quality parameters for Lake Naivasha and natural spring

Parameter	Units	Results			Recommendation
		Naivasha, raw Lake water Sampled: 21st Dec, 2022 Reported: 19th Dec, 2022	Spring down Stream water Sampled: 10th July, 2023 Reported:17th July 2023	Well OW-27 Brine analysis sampled 25th January 2020	**WHO**
pH	pH Scale	8.6	8.52	8.00	**6.50 - 8.50**
Colour	mgPt/l / TCU	40	<5		**Max 50**
Turbidity	N.T.U	14	4.33		**Max 5**
Conductivity (25°)	µS/cm	291	1506		**-**
Iron	mg/l	0.1	0.24	0.07	**Max 0.3**
Manganese	mg/l	0.03	<0.02	0.06	**Max 0.5**
Calcium	mg/l	20	10.6	18.05	**Max 200**
Magnesium	mg/l	4.4	2.98		**Max 150**
Sodium	mg/l	28	246		**Max 200**
Potassium	mg/l	12	23.7		
Total Hardness	mg $CaCO_3$/L mg/l	68	38.8		**Max 150**
Total Alkalinity	mg $CaCO_3$/L / mg/l	130	322		
Chloride	mg/l	11	83.9	16.96	**Max 250**
Flouride	mg/l	1.4	1.16	0.38	**Max 1.5**
Nitrate	mg/l	ND	17		**Max 30**
Nitrite	mg/l	<0.1	0.22		**Max 1**
Sulphate	mg/l	<0.3	193	18.67	**Max 400**
Free Carbon Dioxide	mg/l	ND	<0.1		
Total Dissolved Solids	mg/l	180	952		**Max 1500**
Lead	mg/l		<0.01	<0.001	**Max 0.05**
Cadmium	mg/l		<0.01	<0.001	**Max 0.01**
Mercury	mg/l		<0.01	<0.001	**Max 0.001**
Strontium	mg/l		<0.01		**(Complies)**
Boron	mg/l		<0.01	0.007	**Max 2.4**
Zinc	mg/l		16.0	0.19	**Max 1.5**
Selenium	mg/l			0.010	**0.1**
Chromium	mg/l			<0.001	**0.05**
Copper	mg/l			0.10	**1.0**
Arsenic	mg/l			<0.001	**0.01**

4.1.7 Baseline Air Quality

The ambient air quality monitoring data at Olkaria 1 unit 6 and Ol Maiyana areas for the period 2019 – 14th April 2023 was used to assess the background air quality levels for the environment and human health purposes. The concentrations of the hydrogen sulphide (H_2S) values are as summarized in Table

4.1-2 below. The air quality monitoring data shows increasing trends of ambient levels of H_2S for the five years (2019-2023), with the first two years representing mainly the construction period and the last three years of 2021-2023 capturing the plant operation phases. In general, it can be stated that the data collected for the period generally represent good ambient air quality with no exceedances of the H_2S Kenyan Standards.

Table 4.1-2: Summary of Background Air Quality Levels (2019-2023)

Pollutant/Location	Air Quality Level (µg/m^3)						Kenya AQ Criteria (µg/m^3)
H_2S /Within the Power Plants	**2019**	**2020**	**2021**	**2022**	**2023**	**Max**	
	22	64	390	243	399	**399**	**13,939**
H_2S/Gate 2	NR	NR	8	4	NR	**8**	**150**
H_2S / Ol Maiyana	1	1	4	24	20	**24**	**150**

NR: Not Reported

4.1.8 Baseline Noise

The background noise levels measured in the project area were used in assessing the baseline noise conditions. These noise levels were used in combination with the predicted noise levels to be contributed from the proposed project based on the model to determine the expected cumulative noise levels. The noise monitoring data at Olkaria 1 Unit 6 for the period 2019 – 14th April 2023 was used to assess the background noise levels for the environment and human health purposes. The main noise emitting sources are the Power House, the Cooling Towers, AU6 Central and DGs. The noise levels are summarized in the Table 4.1-3 below. The mean environmental noise level data was used for calculating the ambient noise impact, hence considered conservative.

Table 4.1-3: Ambient Noise Levels

Location	Noise Level d(BA)						Kenya Noise Criteria (dBA)
	2019	**2020**	**2021**	**2022**	**2023**	**Mean**	
Power House	NR	NR	78.9	84.9	87.1	**86.5**	**90**
Cooling Tower	NR	NR	76.3	78.6	80.6	**80.6**	
AU6 Central	NR	NR	78.6	77.4	80.5	**80.8**	
DGs	NR	NR	73.5	72.5	NR	**73.0**	
Gate 2	NR	NR	76.3	72.2	NR	**74.7**	
Olo Maiyana	47.4	55.6	41.1	42.8	47.7	**49.4**	**50**

The noise monitoring data is mainly from the current KenGen Power generation facilities (occupational), ambient noise at a sensitive receptor represented by data from Ol Maiyana Community monitoring point. The average occupational noise levels are in compliance with Kenyan Factories and Other Places of Work (Noise Prevention and Control) Rules 2005 limits of 90dB (A). The World Bank/IFC stipulates guideline levels of 55dB (A) and 45dB (A) for both day and night schedules, respectively.

4.2 Biological Environment

This section mainly describes floral and faunal assemblage of the project area and immediate surroundings including the associated habitats. Most of the information used in describing the biological

environment of the project area was derived from Sinclair and Knight in 1994, GIBB Africa, 2014, KenGen monitoring programme and Consultant investigations carried out in June, 2023.

4.2.1 Vegetation of the project area

To a large extent, the vegetation of Lake Naivasha basin including the project area is substantially disturbed by human activities including settlements, urban development, tourist and hotel development, arable farming, ranching, flower farming, hotel development and other forms of development. What has remained of the natural vegetation is basically a mosaic of various vegetation types interspersed with human settlement and farmlands. However, remnants of natural vegetation are found in the Hell's Gate National Park and KenGen land where bushland is the most dominant vegetation type. Lake Naivasha is associated with freshwater wetland which forms a fringing zone around the lake. The wetlands zone gives way to a woodland vegetation as we approach the terrestrial environment.

Figure 4.2-1 Vegetation within Olkaria Geothermal Field and Hells Gate National Park

Bushland

The terrestrial vegetation of the project area comprises seven major vegetation associations including bushland, bushed grassland, shrubbed grassland, grassland, rock outcrops and barren land (Sinclair Knight et al, 1994). Of the above vegetation groups, the bushland is the most dominant vegetation group. Bushland vegetation is 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 emergent such as *Acacia xanthophloea*. Bushland, the most extensive vegetation of the project area, 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 are associated with bushland vegetation of the project area. They include *Cymbopogon nardus*, *Setaria sphacelata*, *Themeda triandra*, *Eragrostis cilianensis*, *Hyparrhenia hirta*, *Cynodon dactylon*, *Pennisetum clandestinum*, and *Digitaria abyssinica* among other grasses. The flora of the Olkaria area consists of eighty five families and a total of three hundred and four plant species as presented in Annex 7 - Flora of Olkaria Area.

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.

Wetlands

The wetlands in the project area are associated with Lake Naivasha and the brine ponds found in Olkaria I power plant. Lake Naivasha is predominantly fringed by *Cyperus papyrus* and other sedges including *Cyperus immensus*. There is large development of both submerged and floating aquatic plants. The former is dominated by *Ceratophyllum demersum, Najas pectinatas* and *Potamogeton* spp. while the latter are dominated by the water hyacinth (*Eichhornia crassipes*). The brine ponds associated with Olkaria I power plant have been colonized 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 and Cyperus laevigatus* and other members of *Cyperaceae* are also associated with the brine ponds.

It should be noted, however, that the decline of Lake Naivasha water level of 2009 – 2010 greatly affected the wetlands of Lake Naivasha. As the lake receded it exposed the fringe vegetation (wetlands zone) with subsequent mortality of aquatic macrophytes including the prominent wetland species, papyrus (*Cyperus papyrus*).

Plants introduced in the project area

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 KenGen offices and power stations. The most common of the introduced plants include the species of *Bourgainvillea* spp. *Oleander*, *Terminalia mantally, Callistemon citrinus* (Bottle brush), *Senna spectabilis*, *Eucalyptus saligna* (Blue gum), *Schinus molle* (Pepper tree), *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 tree introductions include *Croton megalocarpus*, *Albizia gummifera*, *Spathodea nilotica* and *Trichilia emetica*.

The KenGen tree nursery

KenGen supports a tree nursery that raises seedlings for planting around the power stations and for the support of afforestation extension programme in schools, hospitals and surrounding farms and beyond. During the field investigations (July 2023), seedlings found in the nursery see Table 4.2-1 and Figure 4.2-2 were relatively few in number and were represented by only two exotic species of *Grevillea robusta* and *Cuppressus lusitanica*. Around the plant nursery there is a stand of planted trees and shrubs with a mixed composition of both exotic and indigenous species including *Eucalyptus saligna*, *Grevillea robusta*, *Cupressus lusitanica*, *Croton megalocarpus*, *Cordia abyssinica* and *Acacia xanthophloea,* among other trees and shrubs as seen in Table 4.2-1 below.

Table 4.2-1 Trees and Shrubs at the Plant Nursery and KenGen SPA

Trees and Shrubs planted around the KenGen Nursery	Trees planted around the KenGen SPA
Acacia mearnsii	*Melia azedarach*
Acacia melanoxylon	*Dombeya*
Acacia xanthophloea	*Olea africana*
Acrocarpus fraxinifolius	*Olea welwitschia*
Afrocarpus gracilior)	*Olea capensis*
Albizia gummifera	*Afrocarpus gracilior*
Araucaria cunninghamia	*Ficus benjamina*
Bougainvillea glabra	*Felicium decipiensis*
Calondendrum capense	*Prunus africana*
Casuarina equisetifolia	*Walburgia ugandensis*
Croton megalocarpus	*Tarconanthus camphoratus*
Cordia abyssinica	
Cupressus lusitanica	
Daibergia melaxylon	
Dodonaea fioga	
Eucalyptus grandi	
Eucalyptus saligna	
Grevillea robusta	
Jacaranda mimosifolia	
Markhamia lutea	
Olea africana	
Olea welwitschia	
Ploysciας kikuyuensis	
Prunus africana	
Schinus molle	
Spathodea nilotica	
Tarchonanthus camphoratus	
Teclea nobiis	
Terminalia mantally	
Terminalia brownii	
Vitex keniensis	

Source: Field Observation, June 2023.

Source: Field Investigations, June 2023

Figure 4.2-2 Seedling Development at the KenGen Tree Nursery

The vegetation of the project site and environs

To a large extent, the vegetation of the project site is a bushland community dominated by *Tarchonanthus camphoratus* shrubs see Figure 4.2-3. The bushland is also dotted by shrubs of *Acacia drepanolobium* and occasional trees of *Acacia xanthophloea.* The understorey of the shrub layer is colonized by several herbs including *Solanum incanum*, *Nicotiana glauca*, *Sida tenucarpa*, *Ipoestes forscali* and *Psiadia paniculata*, among other herbs. The ground layer is mainly covered by grasses including *Cynodon dactylon* and *Pennisetum clandestinum*. To the south of the project site, however, the vegetation changes from *Tarchonanthus camphoratus* bushland to gorge vegetation dominated by *Rhus natalensis*, *Cussonia hirtii*, *Rumex usambarensis*, *Eucla divinorum* and species of *Dodonea*, *Ficus*, and *Kalanchoe*.

Source: Field Investigations, June 2023

Figure 4.2-3 Undisturbed section of vegetation of the project site

It should be noted, however, the vegetation of the project site has been very much disturbed by past human activities. Vegetation was destroyed during the construction of the road and installation of the steam pipe lines, water pipes and power transmission lines. During the field investigations, it was observed that many of the trees (*Acacia xanthophloea*) and shrubs (*Tarchonanthus camphoratus* and *Acacia drepanolobium*) were cut and used to construct a temporary Maasai livestock kraal (**boma**) as seen in Figure 4.2-4.

Figure 4.2-4 Disturbed vegetation near the temporary Maasai livestock Kraal (Boma)

4.2.2 Fauna of the project area

Wildlife in the project area and surroundings is found in significant numbers in Hell's Gate National Park, Longonot National Park and other areas where the land use (mainly ranching) is compatible with wildlife ecology. This includes the riparian area around Lake Naivasha, private ranches such as Kedong and Longonot Ranches, and the newly established wildlife sanctuaries around the lake.

Mammals

Twenty three species of mammals including fourteen large herbivores and three small herbivores are found in the project area, a list of which is presented in Annex 8 and in Figures 4.2-5 to 4.2-7. The most common animals are zebra (*Equus burchelli*), kongoni (*Acelaphus buselaphus*), gazelles (*Gazella thomsonii* and *Gazella grantii*), Impala (*Acepyceros melampus*), dik dik (*Rhyncotragus kirkii,*), giraffe (*Giraffa camelopardis*) and buffalo (*Syncerus caffer*). Lake Naivasha supports large populations of the hippopotamus (*Hippopotamus amphibius*). Other common animals include the jackal, olive baboon, rock hyrax, hedgehog, aardvark and leopard.

The results of animal census carried out on 19th of February 2011 (Table 4.2-2) covering several wildlife areas including Hells Gate and Mt. Longonot National Parks, Home-grown (Kingfisher) and Gorge Flower Farms are shown in Table 4.2-2. There were a total of 15 mammalian and two avian species recorded during the count. Common Zebra (*Equus burchelli)* was the most abundant wild species, followed by Warthog (*Phacochoerus africanus*) and the African buffalo (*Syncerus caffer),*Thomsons gazelle (*Gazella thomsonii*) and Impala *(Aepyceros melampus)*.

Table 4.2-2 Summary of wildlife species numbers counted in February, 2011

Sn	Species	HNP	Mt Longonot	Homegrown	Gorge Farm	Total
1	Zebra	204	52	52	-	308
2	Warthog	153		18	-	171
3	African Buffalo	107	45	11	-	163
4	Thomson's gazelle	116	22	1	2	141
5	Impala	105	33	2	-	140
6	Giraffe	54	38	-	-	92
7	Baboon	54	-	9	-	63
8	Grant's Gazelle	26	27	8	-	61
9	Eland	19	30	1	-	50
10	Kongoni	15	34	-	-	49
11	Dikdik	36	-	12	-	48
12	Vervet Monkey	37	-	-	-	37
13	Steenbok	-	4	-	-	4
14	Reedbuck	1	-	-	2	3
15	Silver Backed Jackal	3	-	-	-	3
16	Guinea Fowl	216	165	98	50	529
17	White stork	-	35	-	-	35

Table 4.2-3 below presents a summary of comparisons of wildlife census in Hells Gate National Park in April 2010, October 2010 and February, 2011. High numbers of wildlife were recorded during the October 2010 count. This is because September -November is the wet rainy season for the park. Most animals seek refuge outside the park during the dry season.

Table 4.2-3 Seasonal distribution of animals in Hell's Gate National Park

Sn	Species	April 2010	October 2010	February 2011
1	Zebra	372	648	204
2	Thomson's Gazelle	245	499	116
3	Impala	178	408	105
4	Eland	26	120	19
5	Buffalo	72	7	107
6	Grants Gazelle	71	314	26
7	Kongoni	21	24	15
8	Warthog	154	308	153
9	Reedbuck	3	0	1
10	Giraffe	22	61	54
11	DikDik	6	31	36
12	Guinea fowl	12	16	216
13	Baboon	9	15	54
14	Vervet Monkey	-	-	37
15	Silver backed jackal	-	-	3
16	Duiker	-	1	-

Figure 4.2-5 Zebra Herd Grazing within the project area

Figure 4.2-6 A Lone Buffalo taking Shelter from the Sun

Figure 4.2-7 Giraffes grazing in Hell's Gate National Park

Reptiles

A total of 30 reptiles have been recorded from the project area. This includes 15 species of snakes. The rock python is known to occur within the bushes and gorges of the project area. Other reptiles of the project area include two species of tortoises and 6 species of lizards.

Avifauna

Hell's Gate National Park and the surrounding areas have a wide diversity of avifauna. One hundred and eight (108) species of birds were recorded in the Hell's Gate National Park in 1994 (Annex 9). The diverse avifaunal community is attributed to the heterogeneity of the habitats and the close proximity to Lake Naivasha. The cliffs and gorges found in the park are important breeding grounds for some of the bird species, including the vultures and swifts. Among the birds in the project area, are two endangered vulture species, the Rupell's Vulture and a White-backed Vulture. Within the bird species are 18 migratory species of which 11 birds visit Kenya and Africa from Europe and Asia and 7 are intra-Africa migrants. Lake Naivasha is famous for its varied aquatic bird life, supporting more than 80 bird species which are regularly recorded during censuses. There are large concentrations fish eagles (*Haliaeetus vocifer*), kingfishers (*Ceryle rudis* and *Alcedo cristata*), sacred ibises (*Threskiornis aethiopicus*), coots (*Fulica cristata*) and ducks (*Annas* sp). Several bird species found on the lake are threatened. They include the Great Crested Grebe, the African Darter, Great Egret, Saddle-billed stork, White-backed Duck, the Baillons Crake and the African Skimmer.

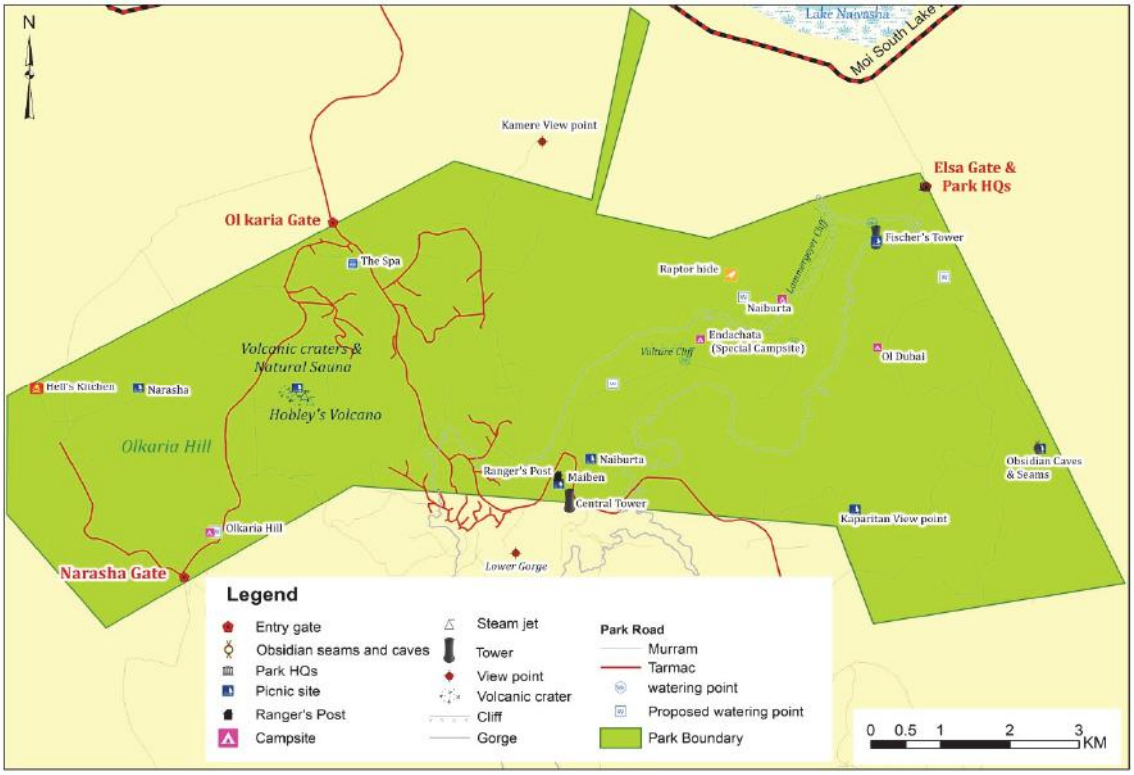
Fish fauna

Prior to 1925, the lake supported a single endemic fish species, a zooplanktivorous small-tooth carp (*Aplocheilichthyes antinori*) that is probably extinct today. Since 1925 there have been several introductions of fish species which currently support the lake fishery. The main introduced fish species are the black bass (*Micropterus salmoides*), two types of cichlids (*Tilapia zilli* and *Oreochromis leucostictus*) and the common carp (*Cyprinus carpio)*. The common carp, which was not among the commercial fisheries in the 1980 and 1990s, now dominates the fisheries of the lake. A fresh water lobster, the Louisiana Red Cray Fish (*Procambarus clarkii*) was introduced in 1970 and has since persisted in the lake.

4.3 Biodiversity Conservation

A large component of the biodiversity of the project area is conserved in the Hell's Gate National Park as shown in

Figure 4.3-1. The information on the biodiversity conservation of the park is mainly derived from the previous and present KWS park management plans (KWS, 2005 and KWS 2019). The name Hell's Gate is derived from the most impressive feature in the park, the Ol Njorowa Gorge, which runs through the middle of the park. The gorge formed the overflow of Lake Naivasha between lower and middle Cambrian times. The Park was gazetted under legal notice number 13 of 2 February, 1984 and covers 68.25km^2.



Source KWS 2019

Figure 4.3-1 Hell's Gate National Park

4.3.1 Objectives of the Hell's Gate National Park

The main role for Hells Gate National Park (HGNP) is the protection, management and preservation of the nationally and internationally significant geomorphological and biological resources of the area. These resources include the Ol Njorowa gorge, Fischer's and the Central Tower and other features which form the physiographic basis of the park, the floral and faunal communities, and the fragile soils of the area. The specific objectives of the park are outlined below as follows:

- To protect and conserve unique geomorphological and biological resources, especially threatened mammal and bird species of HGNP, for the present and future generations;
- To conserve the unique features of scenery including the Ol Njorowa Gorge (Hell's Gate), the Fischer's and Central Towers and the adjacent steam jets and caves which are all popular tourist attractions;
- To conserve and protect the enormous variety of succulent plants and the ***leleshwa*** bushland habitats within and adjacent to the gorge and other parts of the park;
- To conserve and protect the rare and threatened birds which live and breed in the cliffs and edges of the gorge and other wildlife which live in the park's ecosystem;
- To conserve and protect the soils from erosion especially the soils in the gorge that are loose and prone to heavy erosion;
- To provide for good wilderness enjoyment opportunities where tourists can come and walk, climb rocks and experience the impressive and beautiful park's environment;

- To provide educational and research opportunities into the natural resources of the park; and
- To provide opportunities for education and to achieve an increased understanding and appreciation of the natural processes occurring in the park including the prevailing volcanic activities as manifested by steam jets.

4.3.2 Protection of vegetation

The general vegetation of the project area has been described above in Section 4.2.1 - Vegetation of the project area. The distribution of various vegetation types in the park is presented in Figure 4.3-2 Vegetation types in HGNP. The flora of the HGNP falls into two broad physiognomic types namely; plains and high ground vegetation types. The grasslands dominated by red oat grass (*Themeda triandra*) and the whistling thorn bush (*Acacia drepanolobium*) dominates the lower zone up to 1800m. In the high ground (above 1,800m) is the dense *leleshwa* (*Tarchonanthus camphoratus*) bushland. On both sides of the Ol Njorowa Gorge are enormous variety of succulent plant habitats.

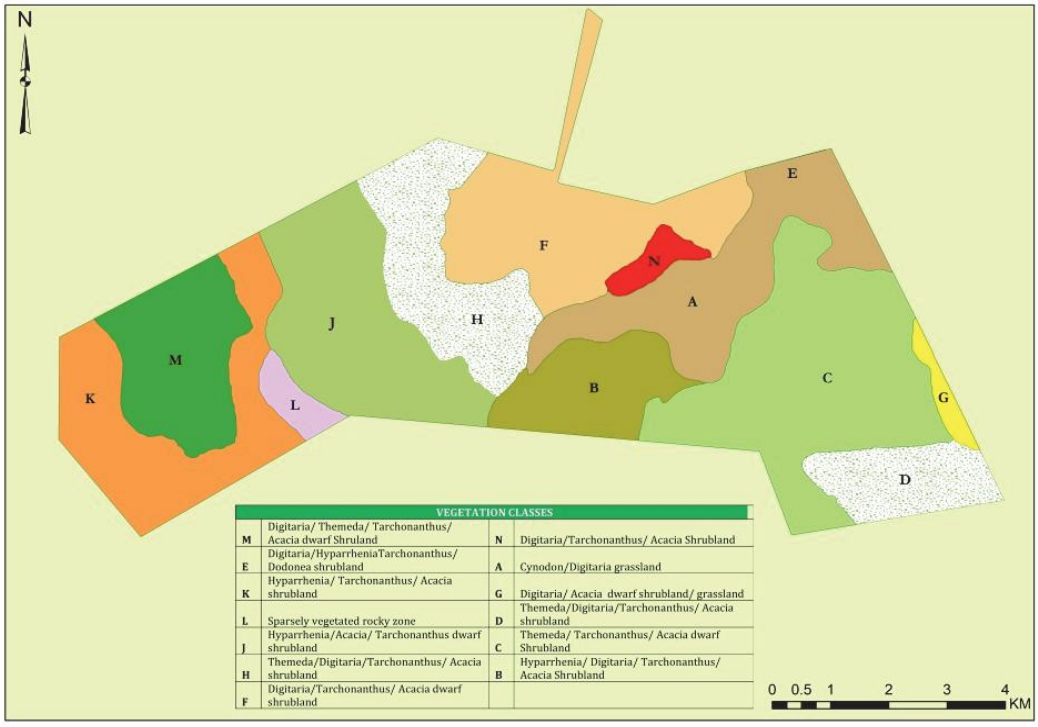
It should be noted that the natural vegetation found in Hell's Gate National Park is now disappearing throughout much of the Rift Valley, due to the advent of human settlement and cultivation. Hence, the need to conserve the remaining vegetation types. The vegetation as the basis of primary production, is of key importance to the function of the ecosystem of the project area. In this regard, the *Acacia drepanolobium* woodland which is the most abundant Acacia species, forms an important source of food for the giraffes and other herbivores. *Tarchonanthus camphoratus* woodland is important as it provides cover and habitat for fauna in the park.

Some plant species including Red stinkwood (*Prunus africana*), East African Sandalwood (*Osyris lanceolata*) found in the park and surrounding areas are of economic and medicinal value to the community. These species are now threatened and therefore attract special conservation concerns as outlined below:

- **Red stinkwood (*Prunus africana*) -** This species is classified as vulnerable by IUCN. High demand for the bark and bark extracts has led to over-exploitation of the natural population. This has resulted in listing it in CITES Appendix II since 16 February 1995. Liquid extracts from *P. africana* bark are used in the treatment of benign prostatic hyperplasia and prostate gland hypertrophy, among many other ailments. Indeed, a detailed survey of this species in the park should be conducted and methods for propagating it at the KenGen tree nursery be developed.
- **East African Sandalwood (*Osyris lanceolata*) –** This is a shrub or small tree found across a vast range of Africa and Asia continents as well as parts of Europe. Although classified by IUCN as Least Concern, there are concerns that subpopulations are being over-exploited in parts of its range due to its scented wood (sandalwood) and essential oil. This species is therefore listed under Appendix II of CITES for its East African subpopulations in Burundi, Kenya, Rwanda, Uganda, and the United Republic of Tanzania. This prevents the

exportation of this species across borders of the countries listed above without an appropriate permit.

- ***Dissotis senegambiensis*** – This is a shrub reaching 120cm in height belonging to the ***Melastomataceae*** family. In HGNP this plant species is found in the eastern part of the park mainly at Hobley's volcano. Although it is not threatened, it is important as it has medicinal properties.



Source: KWS 2019

Figure 4.3-2 Vegetation distribution in the Hell's Gate National Park

4.3.3 Conservation status of the mammal species

Several mammals found in the park and the surrounding areas including the Maasai giraffe, the Chanler's Mountain Reedbuck and the leopard are threatened and therefore require protection.

- **Maasai giraffe (*Giraffa camelopardalis tippelskirchi*) -** Maasai Giraffe is listed by IUCN as Endangered due to an estimated decline of 49-51% over three generations (30 years). They are obligate browsers that occur in areas of savanna in southern Kenya and North and Central Tanzania. The most important contemporary threats to the Maasai giraffe are land use change and poaching. Maasai giraffes are poached for meat and products such as hide, bones and tail hairs. Their numbers in Kenya declined from approximately 32,000 to 12,000, a 63% reduction, from 1977 to 2015.
- **Chanler's Mountain Reedbuck (*Redunca fulvorufula chanleri)* -** The mountain reedbuck (see Figure 4.3-3) is listed as endangered by IUCN. They live on ridges and hillsides in broken rocky country and high-altitude grasslands from 1,500-5,000m asl. One of its preferred habitats in HGNP are the hillsides of Hobley's Volcano shown in Figure

4.3-4. Although population of this species in its range was estimated at 2,900 in 1999, the population has been declining.

Source: KWS 2019

Figure 4.3-3 Mountain Reedbuck

- **Leopard** (***Panthera pardus***) - The Leopard is listed as vulnerable by IUCN. The primary threats to leopards including habitat fragmentation, reduced prey base and conflict with livestock keepers have reduced leopard populations throughout most of their range. The leopard is included in CITES Appendix I. Trade of leopard skins and products is restricted to 2,560 individuals in 11 countries in sub-Saharan Africa.

Figure 4.3-4 Hobleys volcano located within Hells Gate National Park

4.3.4 The Park as Important Bird Area

In an attempt to raise awareness on the threats to birds in Hell's Gate National Park, the profile of the park was enhanced by listing the park as an IBA by Birdlife International in 2014. There are over 100 bird species recorded inside the park as presented in Annex 9. The Park contains Kenya's only nationally protected nesting colony of the Critically Endangered Ruppell's Vultures (*Gyps rueppellii*). Other globally listed species occurring in the park include White-backed Vulture (*Gyps africanus*) - Endangered; and Grey-crested Helmetshrike (*Prionops poliolophus*) - Near Threatened.

- **Ruppell's Vulture (*Gyps rueppelli*) –** Rupell's Vulture (see Figure 4.3-5) was uplisted by IUCN from Endangered to Critically Endangered in 2015 due to severe declines in parts of its range. This species has undergone a rapid decline owing to habitat loss and conversion to agro-pastoral systems, declines in wild ungulate populations, hunting for trade, persecution, collision and poisoning. To minimize collision with power lines it is important to ensure new energy infrastructure is 'vulture-friendly' and modify existing unsafe infrastructure. Hells Gate National Park hosts the only protected Ruppell's vulture colonies in Kenya.

Source: KWS 2019

Figure 4.3-5 Ruppell's Vulture

- **Egyptian Vulture (*Neophron percnopterus*) -** This species (see Figure 4.3-6) forages principally in arid open savannas and river banks. Nesting occurs in cliffs (Figure 4.3-7) or crags, occasionally in trees and it sometimes occupies the old nest of another raptor. The Egyptian Vulture is migratory and most European birds will winter in sub-Saharan Africa between 14° and 17°N. This species faces a number of threats across its range including disturbance, poisoning, electrocution (by powerlines), collisions, reduced food availability and habitat change.

Source: KWS 2019

Figure 4.3-6 Egyptian Vulture

Figure 4.3-7 Vultures' cliffs at the Hells Gate National Park

- **Secretary bird (Sagittarius serpentarius) –** The Secretary bird (see Figure 4.3-8) is classified as Vulnerable by IUCN. Recent evidence suggests that the population of Secretary bird is experiencing a rapid decline due to habitat degradation, disturbance, hunting and capture for trade. The excessive burning of grasslands suppresses populations of prey species, whilst the intensive grazing of livestock degrades otherwise suitable habitat.

Source: KWS 2019

Figure 4.3-8 Secretary bird

- **Grey-crested Helmet-shrike (*Prionops poliolophus)* -** This species is listed as Near Threatened by IUCN. It is thought to have a moderately small population which is experiencing a moderately rapid population decline, owing to the destruction and degradation of its habitat for agriculture.

Table 4.3-1 depicts conservation status of endangered animal species in Hell's Gate National Park and surrounding areas.

Table 4.3-1 Conservation Status of Wildlife in Hell's Gate National Park

Common Name	Scientific Name	IUCN	CITES	CMS	WCMA 2013
Birds					
Ruppell's vultures	*Gyps rueppellii*	CR	Appendix II	Appendix I	NT
Egyptian vulture	*Neophron percnopterus*	EN	Appendix II		EN
White-backed Vulture	*Gyps africanus*	EN			
Secretary bird	*Sagittarius serpentarius*	VU	Appendix II		
Grey-crested Helmet shrike	*Prionops poliolophus*	NT			
Verreaux's eagle	*Aquila verreauxii*	LC	Appendix II	NL	NL
Peregrine falcon	*Falco peregrinus*	LC	Appendix I	Appendix II	NL
Lanner falcon	*Falco biarmicus*	LC	Appendix II	Appendix II (LC)	NL
Mammals					
Masai giraffe	*Giraffa tippelskirchi*	EN			
Chanler's Mountain reedbuck	*Redunca fulvorufula*	EN	NL	NL	NL

Leopard	*Panthera pardus*	VU	Appendix I	Appendix II (VU)	EN
Zebra	*Equus quagga*	NT	NL	NL	NL
Thomson's gazelle	*Eudorcas thomsonii*	NT	NL	NL	NL
Steenbok	*Raphicerus campestris*	LC	NL	NL	NL
Klipspringer	*Oreotragus oreotragus*	LC	NL	NL	NL
Buffalo	*Syncerus caffer*	LC	NL	NL	LC
Grants gazelle	*Nanger granti*	LC	NL	NL	NL
Cokii Hartebeest	*Alcelaphus buselaphus*	LC	NL	NL	NL

Source – KWS 2019

Legend:

- **IUCN** – International Union of Nature and Natural Resources (The World Conservation Union)
- **CR** – Critically Endangered
- **NT** – Near Threatened
- **EN** – Endangered
- **VU** – Vulnerable
- **LC** – Least Concern
- **CITES** – Convention on International Trade in Endangered Species of Wild Fauna and Flora
- **CITES Appendix I** – Includes species threatened with extinction in which trade in the specimens of these species is permitted only in exceptional circumstances
- **CITES Appendix II** – Includes species not necessarily threatened with extinction but in which trade must be controlled in order to avoid utilization incompatible with their survival.
- **CMS** – Convention on the Conservation of Migratory Species of Wild Animals (formerly referred to as Bonn Convention)
- **CMS Appendix I** – **Endangered migratory species** - Comprises migratory species that have been assessed as being in danger of extinction throughout all or a significant portion of their range.
- **CMS Appendix II - Migratory species conserved through Agreements -** The Appendix covers migratory species that have an unfavourable conservation status and that require international agreements for their conservation and management, as well as those that have a conservation status which would significantly benefit from the international cooperation that could be achieved by an international agreement.
- **WCMA** – Wildlife Conservation and Management Act

Birds of Lake Naivasha

Close to Hell's Gate National Park is Lake Naivasha, a Ramsar site and a home to several endangered bird species including the grey crowned crane and Basra reed warbler. Recently, BirdLife International (2024) has provided Important Bird Area factsheet with valuable information on birds of Lake Naivasha and the surroundings as summarized below.

The woodland north of Lake Naivasha around Lake Oloidien provides habitat for *Prionops poliolophus*, which has been recorded here regularly and is known to nest. *Acrocephalus griseldis* is a winter visitor and passage migrant, the exact status of which is unknown. The main lake (Lake Naivasha) supports a diverse waterbird community, with more than 80 species regularly recorded during censuses. Mean numbers during 1991–2001 were 19,600 waterbirds. Depending on water levels, it can be a significant site for *Fulica cristata* (mean 5,050 during 1991–2001), *Platalea alba* (mean 138 during 1991–2001) and *Tachybaptus ruficollis* (mean 650 during 1991–2001). Many species of duck and Palearctic waders also occur in numbers; Palearctic duck are especially abundant in November and February. *Phoenicopterus minor* occurs in small numbers at times, mainly on Lake Oloidien. Lake Naivasha is known for its high density of *Haliaeetus vocifer*, which nest in the surrounding Acacia woodland. Regionally threatened species include *Podiceps cristatus* (most recent Kenyan records are from Lake Oloidien, with seven birds seen in January 1996); *Oxyura maccoa* (regular on Lake Oloidien, with 170 in January 1994 and January 1997); *Anhinga rufa* (one recorded on Lake Oloidien in January 1997); *Casmerodius albus* (regular at Naivasha, which is an important feeding site; 73 counted in January 1997); *Ephippiorhynchus senegalensis* (2–3 birds usually present); *Thalassornis leuconotus* (occasional; 12 counted on Oloidien in January 1994); *Porzana pusilla* (status uncertain); and *Rynchops flavirostris* (irregular visitor). Since 1995 a large nesting colony of *Phalacrocorax carbo* has established itself in the fringing Acacia woodland at Lake Oloidien.

With regard to non-bird biodiversity, Lake Naivasha supports a large population of *Hippopotamus amphibius* (c.300 individuals at present). The snake *Bitis worthingtonii*, endemic to the central Rift Valley above 1,500 m, is recorded from Naivasha.

4.3.5 Challenges facing biodiversity conservation in the Hell's Gate National Park

- **Expansion of geothermal power production -** Construction and operation of geothermal plants constricts wildlife habitat and produce impacts such as air and noise pollution. In addition, breeding sites for threatened bird species have also been disturbed by geothermal well drilling activities.
- **Lack of legal protection for the lower Ol Njorowa Gorge** - Ol Njorowa Gorge is perhaps the most spectacular feature and presents the most enormous attraction of the park. However, most of the extent of the gorge to the south is outside the park. Hence, it is important that negotiations be initiated with Kedong ranch to have the lower gorge given some form of legal protection.

Figure 4.3-9 A section of the Ol Njorowa Gorge within Hell's Gate National Park

- **Loss of Wildlife dispersal area and corridors -** The wildlife from HGNP is dependent on the adjoining Kedong and Oserian Ranches for dispersal. Wildlife herds disperse to these ranches in search of food and water. Kedong provides an ecological linkage between HGNP and Mt. Longonot NP while Oserian provides a link to Lake Naivasha. In view of the importance of maintaining the wildlife dispersal area, KWS should negotiate with the land owners of these Ranches to ensure that land uses in the dispersal areas and corridors are compatible with wildlife conservation.
- **Human-Wildlife Conflict -** The land surrounding the park is privately owned and is used for cultivation of cash crops such as flowers and horticultural crops, human settlements and livestock grazing. However, wildlife in the park wanders onto these farms coming into conflicts with landowners. On the other hand, livestock grazing occasionally occurs in the park causing conflicts with the park's management objectives.
- **Soil Erosion -** Soil erosion, which is exacerbated by the porous and volcanic nature of the soils, is a major threat to ecological integrity in the park. Sound measures for controlling soil erosion are needed.
- **Illegal Settlements -** An illegal settlement has been established in the northern part of the park. This encroachment has been existence for more than a decade and it is now time for a decisive action to be taken to reclaim the encroached area.

- **Water Supply -** There are no permanent natural water sources in the park. Furthermore, most of the rain that falls in the park is flashed off quickly due to the porous nature of the soils. Consequently, water supply for wildlife poses a big challenge.
- **Wild fires -** Fire is a common hazard which often emanate from areas adjacent to the park. These fires can be devastating to the fragile ecological system. Hence, effective fire prevention measures are required to protect the ecosystem against frequent wild fires.

4.4 Socio-economic Environment of the Project Area

The main socio-economic issues covered in this section include the population characteristics of the project area and surroundings, health situation, education profile, employment and economic activities, land tenure, land use, infrastructure and archaeological and cultural sites.

4.4.1 The population of the project area

Demographic data at locational administrative level for the project area were obtained from the 2019 population census extracted from the Kenya National Bureau of Statistics (KNBS), 2019.

Table 4.4-1 Population distribution the project area and surroundings

Sub-Location	Male	Female	Total Population 2019	Households	Area (km^2)	Density
Hells Gate	43,105	42,002	85,110	29,626	424.9	200
Olkaria	12,195	11,712	23,909	8,745	273.2	88
Malewa	5,853	5,442	11,296	3,993	128.7	88
Kongoni	2,234	2,271	4,505	1,377	57.7	78
Maiella	4,416	4,804	9,220	2,124	41.9	220
Moi Ndabi	3,081	2,889	5,970	1,748	32.6	183
Ndabibi	5,099	4,865	9,964	2,846	157.5	63

Source: Kenya National Bureau of Statistics, 2019

The Olkaria geothermal power plant project is located in the Olkaria Location. The population of Olkaria Location consists of Maasai communities and other communities settled in the urban areas of the project area. The population of the area has been increasing steadily due to migration of people in the project area resulting in the establishment of relatively new settlements including centres such as Kasarani, Karagita, DCK, Kongoni and Kamere Estate and Kwa Muhia, among other centres. The above urban centres are inhabited by people from a mixture of tribes of different parts of Kenya, many of whom work at the numerous flower and horticultural farms. The current estimate and distribution of the population in Olkaria Location as given by Chief Damaris Waithera during the stakeholders' consultations on 15th June is presented below in Table 4.4-2.

Table 4.4-2 Current distribution of population in Olkaria Location

Sn	Area	Population Numbers
1	Kamere	23,000
2	Oserian	9,000
3	Kwa Muya	4,000
4	Rift Camp	3,692
5	Kasarani	3,308
6	Majengo	704
7	YMCA	548
8	DCK	350
9	Obonyo	220
10	Amunga	160
11	Kimwata	108
Total Population		**45,090**

Source: Chief Damaris Waithera on 15th June 2023

4.4.2 Health situation

During the stakeholders' consultations, the Public Health Officer Naivasha Sub – county, gave a breakdown of the most common diseases of Naivasha area as upper respiratory diseases, skin infections, malaria, water borne diseases such as typhoid, physical injuries, HIV/AIDS and tuberculosis due to poor housing conditions. At the Rap Land health dispensary in the project area, the most common diseases for the under 5 children were tabulated as follows:

- Respiratory ailments (coughs, asthma, running nose);
- Diarrhoea;
- Pneumonia;
- Skin diseases (fungi, scabies, wounds and cuts);
- Eye infections; and
- Injuries.

Diseases recorded for children over five years and adults at the RAP Land dispensary are listed below as follows:

- Respiratory diseases (tuberculosis, coughing, running nose, asthma etc));
- Joint pains;
- Skin diseases (wounds, cuts, bites, etc.);
- Pneumonia,
- Eye infections;
- Urinary tract infections (UTI);
- Diarrhoea;
- Sexually transmitted diseases (STD);
- Injuries; and
- Dental diseases (mainly fluorosis).

Table 4.4-3 presents comprehensive analysis of health situation in the project area as represented by Rap Land and Mvuke dispensaries. Based on this analysis, the most prevalent disease of the project area is the respiratory diseases.

Table 4.4-3 Analysis of prevalent diseases in the project area

Diseases recorded	2015		2016		2017	
	RAP Land	Mvuke	RAP Land	Mvuke	RAP Land	Mvuke
Respiratory diseases	616	1394	733	1201	342	1151
Diarrhoea	68	115	60	60	55	55
Malaria	17	59	32	62	0	39
Diabetes	0	13	0	12	0	23
Hypertension	0	17	0	13	31	16
Soft Tissue injuries	19	23	15	17	0	23

Source: KenGen, ESIA

4.4.3 Education profile

In the project area, there are several public and privately-run primary schools such as Olkaria Primary School and Mvuke Primary School which have close ties to the project area. Mvuke Primary School is a very important school facility to the community in the project area. It has a large enrolment of a total of 1014 students with 544 girls and 547 boys. Having been sponsored by KenGen since inception, the school enjoys tremendous support from the institution Corporate Social Responsibility CSR). The headmaster, was very hopeful KenGen will continue supporting the school including the recently introduced Junior Secondary School (JSS) programme.

Table 4.4-4 Educational Statistics presents school enrolment for both primary and secondary schools in educational zones of Naivasha Sub- County. In this regard, Olkaria which falls on the Longonot zone. There are three public secondary schools in close proximity to the project area and surroundings including:

- St. Antony Girls Secondary School located at Kwa Muhia.
- Moi -Ndabi Secondary School in Maiella, which has a student population of 116.
- Mirera Secondary School in Karagita with a student population of 925.

The privately owned secondary schools within the project area are Sher Moi Academy, accommodating 168 students and Oserian Secondary School, which has a student population of 165. As part of its Corporate Social Responsibility (CSR) initiative launched in 2005, KenGen has consistently extended scholarship opportunities to the top three academically accomplished and financially disadvantaged students.

Table 4.4-4 Educational Statistics

Sub-county Education Zones	Public Primary and Secondary schools	Student Enrolment		Total Student Enrolment
		Boys	Girls	
Central Zone	15	8,038	7,111	15,149
Longonot zone	16	3,455	3,385	6,840

Maraigushu zone	20	4,611	4,436	9,692
Maiella Zone	21	7,964	7,769	15,733
TOTAL	72	24,068	22,701	47,414

Source: JICA West JEC

4.4.4 Employment and economic activities

Most employment opportunities in the project area are provided by the large-scale flower and horticulture farms around Lake Naivasha. KenGen and other power producers including Oserian Development Company Limited and Orpower engage casual labour force during the construction of the geothermal power plants. These power generating companies also employ watchmen from the local community to provide security during the power plants operation stages. The hotel and tourism industry, ranching, fisheries, conservation, various farming concerns and business sector absorb the rest of labour force in the project area.

The socio-economic activities that provide revenue and employment opportunities to the local community in the project area are presented in Table 4.4-5. The Maasai community is predominantly engaged in pastoralism and livestock husbandry. These activities provide primary revenue streams derived from the sale of livestock-related goods including meat and dairy products. In addition, the Maasai Cultural Centre plays a pivotal role in generating community income through the collection of entrance fees and the sale of culturally significant items.

Table 4.4-5 Socio-economic activities from the local community

Economic activity	Income stream
Livestock rearing	• Sale of livestock; and • Sale of livestock produce.
Tourism at the Maasai Cultural Centre	• Tour guide services by guides; • Sale of handmade beaded jewelery • by women; • Entrance fee into the cultural Centre; and • Overnight hosting of tourists in the Manyattas.
Quarrying of pumice stones	• Selling of pumice stones
Trade in goods	• Conducted by women who sell lessos, ghee, milk and beads
Employment	• Employment mostly as security guards in the neighbouring companies • Employment by KenGen and contractors on permanent and temporary basis for both skilled and unskilled jobs.

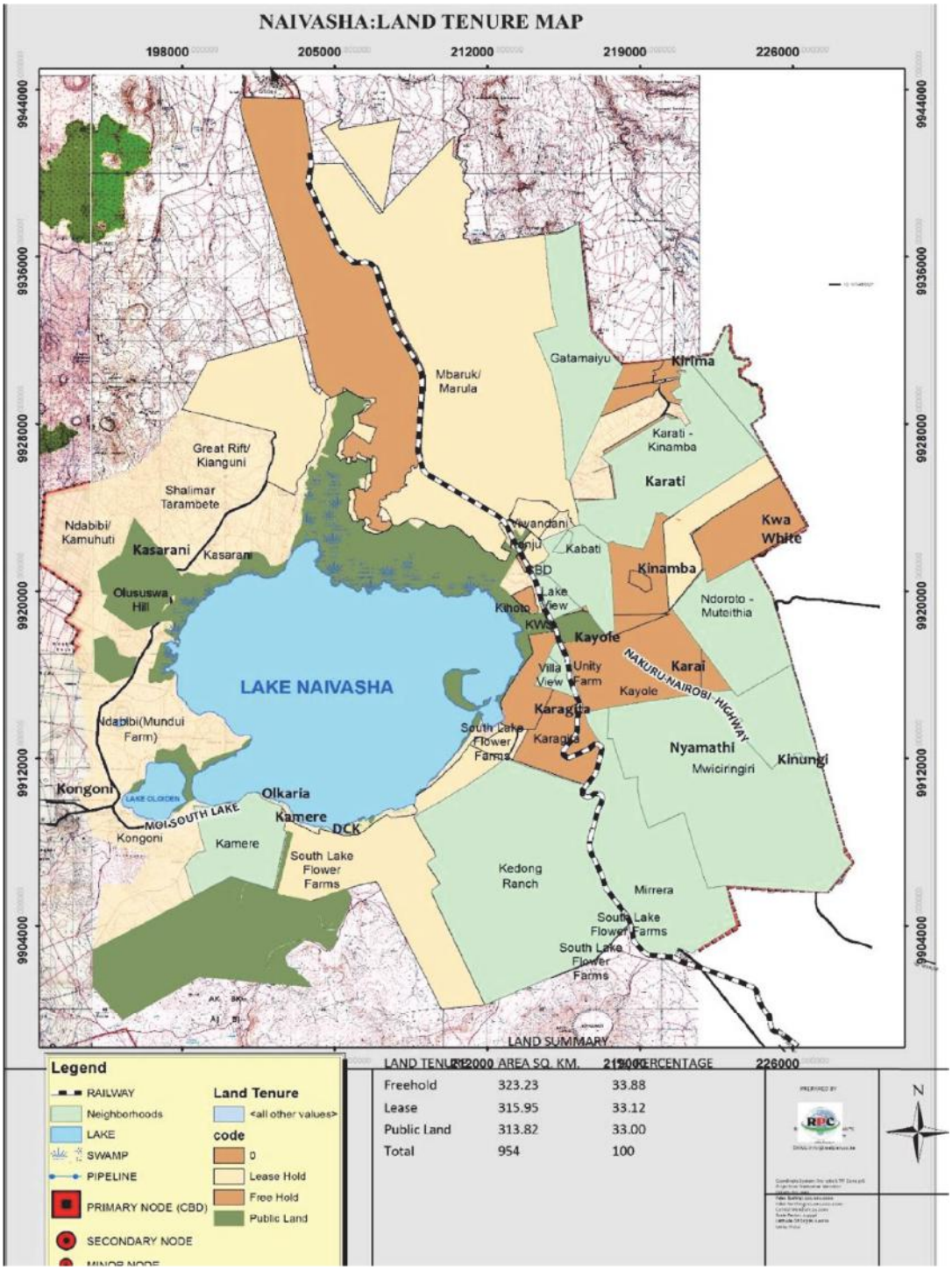
Source: GIBB, 2012

4.4.5 Land tenure

The project area was occupied by the Maasai people for several centuries prior to settlement by the white settlers at the turn of the last century. The land under the Maasai occupation was community owned. This included the rivers, lakes and salt licks. The plains were used for grazing during the wet seasons while the highlands were used for grazing during the dry seasons. Following the building of the Uganda Railway across the Rift Valley in 1900, the Maasai were moved south of the railway in 1905

to make way for European settlement. Much of the land around Lake Naivasha was subsequently settled by the European farmers who practiced mixed livestock and agricultural farming.

Following independence, some of the land within the Naivasha basin and much of the land on the eastern flank of the Rift Valley (especially around Kinangop and Kipipiri) was taken over by the landless local community. Some of the large farms belonging to former settlers were sold to the land buying companies and subsequently subdivided. Map 4.4-1 shows the land tenure system in Naivasha area. Today, the land in this area is under freehold, leasehold and public land tenure systems. The public land is owned by the Government through Government ministries, state corporations, local authorities and other public institutions. Included in this category are the Hell's Gate National Park, Longonot National Park, Lake Naivasha, and land occupied by the Olkaria geothermal power plants and the associated facilities. The rest of land is private land which includes land privately owned and registered with a title deed under freehold or leasehold system. Land under leasehold system includes the ranches (Kedong and Longonot Ranches) and large farms including Kongoni, Oserian and Ndabibi Farms).



Source – Naivasha Town Integrated Strategic Development Plan, 2014-2034.

Map 4.4-1 Naivasha Land Tenure Map

4.4.6 Land use

The natural land potential of the floor of the Rift Valley including the Naivasha Basin has been described by Jaetzold and Schmidt (1983). Accordingly, the project area and surroundings fall under the Upper Midland (UM5-UM6) zone where rainfall is low (600-950mm per year) and unreliable. Traditionally, the main agricultural activity of the area has been ranching. However, the area around Lake Naivasha has now become an important centre for flower and vegetable production in the country

for export to the European market. The favourable climate and soils and ample supply of irrigation water from the Lake Naivasha are ideal conditions for intensive production of cut flowers and horticultural crops such as green beans. Large tracts of land have been cleared to make way for green houses, and expanses of woodland and fringing swamps have been cleared with cultivation sometimes extending right down to the lake edge. Most of agricultural development has been possible due to availability of fresh water from Lake Naivasha.

Lake Naivasha as economic hub in the project area

Lake Naivasha is a prominent feature in the project area. The lake is an economic hub for the Nakuru County and the rest of Rift Valley and the nation in general. The lake fresh water resources support economic activities in the area including floriculture, horticulture, farming, tourism, and power generation among many other activities as outlined below:

- Today the horticulture and floriculture industries are the cornerstone for Kenya's export of sustainably produced products to international markets.
- Lake Naivasha is also the centre of Kenya's geothermal electricity generation which provides 31% of the nation's installed capacity.
- The tourism industry around Lake Naivasha brings $110 - 150 million USD (11 – 15 billion KES) to the country annually.
- The fishing industry is the backbone of the local economy - providing sustenance as well as employment to over 10,000 people directly involved with fishing and fish trading; and
- Lake Naivasha supports small scale farmers, artisans, pastoralists, and small businesses that provide services to the local community.

Flower industry

As stated above, the horticulture and floriculture industries are the cornerstone for Kenya's export of sustainably produced products to international markets. Today, more than 40% of the roses sold in Europe are grown in Kenya - and about half of these are grown in Naivasha. The floral industry directly employs over 30,000 people within Nakuru County and four times that nationwide, and is directly responsible for at least 0.6% of Kenya's GDP.

Fisheries

All the fish species in Lake Naivasha are exotic. Before their introductions, only one endemic fish species *Aplocheilichthys antinorii* existed in the lake and it had no commercial value. According to Muchiri and Hickley (1991), active gillnet commercial exploitation of the fishery resource in Lake Naivasha began in the early 60s. The major fish species targeted in Lake Naivasha were the largemouth black bass *Micropterus salmoides* and two cichlids the bluespotted tilapia (*Oreochromis leucostictus*) and the red-belly tilapia (*Coptodon zilli*) - previously reported as *Tilapia zillii*. A limited riverine fishery that was based on the Straight-fin barb (*Barbus amphigramma*) existed and could be caught occasionally by seining using mosquito nets near the Malewa river mouth. A crustacean species, the red

swamp Louisiana Crayfish (*Procambarus clarkii*) also formed an important export catch in the 70s but it declined and no longer contributes to the annual catches. The common carp (*Cyprinus carpio*) which was not among the commercial fisheries in the 1980 and 1990s, now dominates the fisheries of the lake.

Catch and effort trends in Lake Naivasha have highly fluctuated over time. An increase in annual catch from 62 tonnes (recorded in 1974) to 3424 tonnes (in 2019) correspond with an increase in fishing effort from 8 and 184 boats, respectively. The lowest and highest documented annual catches were 38 and 3424 tonnes in 2003 and 2019, respectively. Since 2014, the fishing effort in Lake Naivasha has steadily increased from 50 to 186 boats by 2021. The fishing industry is the backbone of the local economy – providing sustenance as well as employment to over 10,000 people directly involved with fishing and fish trading. In addition, ten times more people do benefit from the vital contribution that Lake Naivasha fish provides to their diets.

Ranching

To the west, south and east of the Olkaria power stations beyond the boundaries of Hell's Gate National Park, the land is mainly used for ranching. The major ranches are the Kedong Ranch and Longonot Ranch situated to the south and east of the Hell's Gate National Park, and Kongoni Farm to the west of the park. The Kedong and Longonot Ranches have large tracts of land which primarily rear cattle, sheep and goats. These ranches also 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. Although figures on direct employment in the ranching sector around Naivasha were not available, ranching in this area is a key economic component of the livestock sector, which contributes approximately 12% of National Gross Domestic Product (GDP).

Wildlife protection

The Hell's Gate National Park is a unique conservation area gazetted in 1984 for the protection of wildlife and the scenic landscape of the project area. It covers an area of 1,600 ha and contain significant wildlife populations. More information on the role of the Hell's Gate National Park in wildlife protection of the project area has been covered above in Section 4.3 - Biodiversity Conservation.

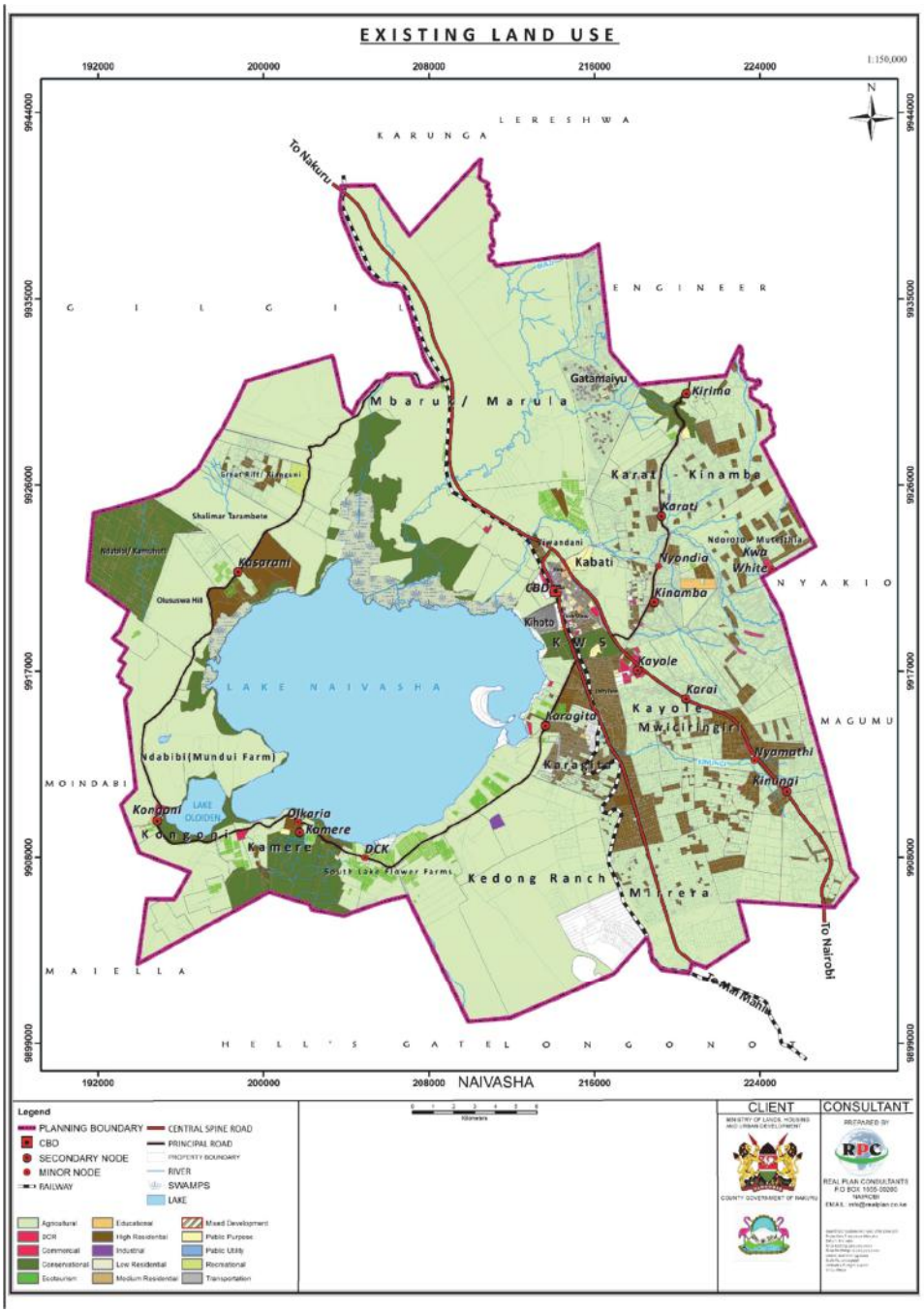
Power generation

The project area is the most intensively utilized area for geothermal power production in Kenya and the whole of Africa Continent. Following the commissioning of the Olkaria-I geothermal power plant in 1981, KenGen has succeeded in the construction of several other power generation facilities in the project area including Olkaria-IAU, Olkaria-II, Olkaria-IV, Olkaria-V and sixteen small geothermal wellhead plants, all adding up to close to 800MWe of installed geothermal power capacity. In addition to geothermal power produced by KenGen, an IPP, Orpower-4 Inc. owned by Ormat International produces 150 MWe of geothermal power through binary technology at Olkaria West geothermal field which hosts Olkaria-III power plant. In the Olkaria Northwest sector, a horticulture concern, the Oserian Development Company has installed two power plants for internal use - a 2MWe Ormat binary-cycle power plant and a 2MWe backpressure steam turbine. As part of the Company's strategy, and in line

with the national electricity master plans, KenGen now intends to develop the proposed Olkaria VII Geothermal Power Plant in the Olkaria field with the estimated power capacity of 80.3MWe.

Tourism development

Tourism is an important activity around Lake Naivasha, as well as in the project area. Presently, several tourist facilities including hotels and lodges have been developed to cater for the growing industry. With spectacular scenery, presence of charismatic wildlife and avifauna, a fine climate, tranquil surroundings and easy access, Naivasha area has become an important centre for local and international tourism. Conditions that favour tourism in the project area include proximity to Nairobi, the presence of Hell's Gate and Longonot National Parks, and the fact that the project area is part of the Rift Valley, which has other tourism sites such as Lake Nakuru National Park, Lake Elementaita and other attractive areas. The presence of Olkaria geothermal power station also serves as a tourist attraction for the local people. In Hell's Gate National Park visitors can view game while around Lake Naivasha, bird watching, hippo viewing and water sports are popular tourist activities.



Source – Naivasha Town Integrated Strategic Development Plan 2014 – 2034

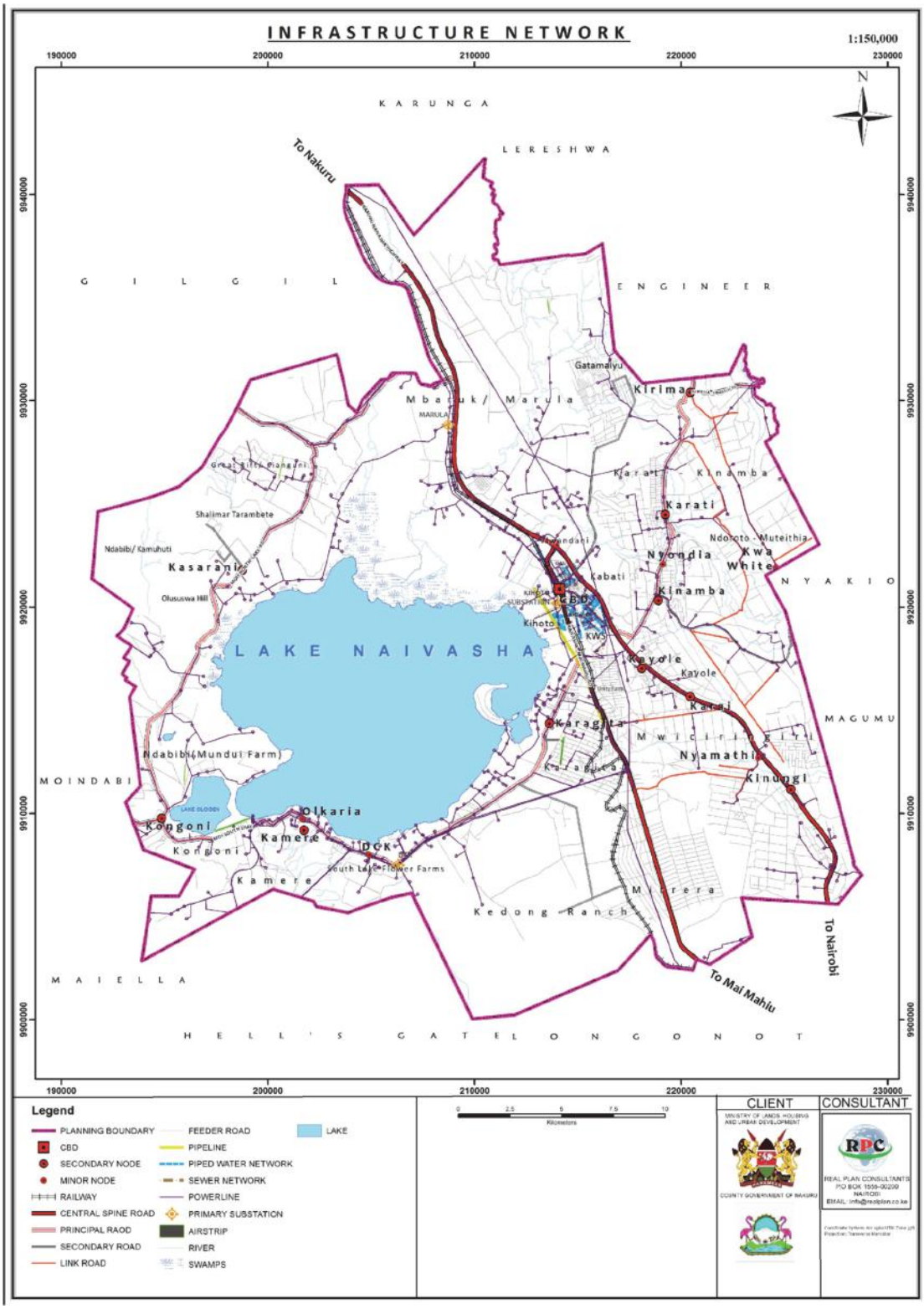
Map 4.4-2 Naivasha land use

4.4.7 Infrastructure

The most common mode of transport is the road system which is used for people and goods transport. Roads of various classes (A, B, C, D and unclassified) exist in Naivasha and surrounding areas. The road category 104 is an international trunk road that connects Naivasha to other towns of international importance such as Nairobi, Mombasa and Kisumu. The Moi South Road (D323), is an important tarmac road that serves the project area. The Gorge Road connects the project area including the Hell's Gate National Park to the Moi South Road. Other notable infrastructural attributes of the area include:

- Air travel facility at the Karagita Airstrip although at present is not operational. Airports serving Naivasha Town are in Nairobi (80km away).
- Naivasha Town and immediate surroundings are well supplied with ICT infrastructure including telephone and mobile phone networks, television, radio transmission stations, print media, internet and postal service.
- In Naivasha town, key water suppliers include NAIVWASCO, private borehole owners and small-scale water vendors. However, in the project area, water for irrigation, power generation, domestic use and other purposes is abstracted from Lake Naivasha.
- Despite availability of Lake Naivasha, water transport services are not available. However, it is anticipated that provision of such services in the area could ease road traffic in future.
- Sewer network covers less than 10% of Naivasha Town and surroundings. The larger population use septic tanks and latrines often hiring exhauster services.

The infrastructure in the project area is shown in Map 4.4 3 below:



Source: Naivasha Town Integrated Strategic Development Plan, 2014 - 2034

Map 4.4-3 Infrastructure network

4.5 Archaeological and Cultural Sites

4.5.1 Archaeological sites

There are no archaeological sites on the Olkaria VII geothermal power project site. The closest archaeological site is located at the Gamble's Cave and Nderit Drift near Nakuru. Other areas of archaeological importance are located at Kariandusi near Elementaita and Hyrax Hill near Nakuru (Sinclair and Knight (1994).

4.5.2 Cultural sites

There are no cultural sites on the Olkaria geothermal power project site. However south of the project area, there are several sacred sites and sites of cultural, medicinal and historical importance as outlined below by Nature Kenya (2023):

- *Enkaibartini* – To the south of the project area, there are three towers with cultural significance for the Maasai, and now for other Kenyans who are familiar with landmarks. They include Fischer's Tower, Central Tower and a third tower in the lower gorge.
- *Olare (orbeben lolchani)* – This is a spring in the gorge, near the Ranger's Post. It was used for the watering of livestock as there are naturally occurring salts in the water. There are also medicinal plants in the area. The entire gorge is a source of medicinal plants, hence known as *orbeben lolchani or* "bag of medicine".
- Ochre deposits – The Maasai use ochre (both red and white ochre) for ceremonies, as well as source of medicine. Other communities (like Samburu), also use it. "Ol Karia" means "ochre" in Maasai. The area has several large ochre deposits, and in the lower gorge is a key deposit used by the Maasai from all over Kenya as well as from Tanzania and other communities.
- Mineral licks – The lower gorge has various mineral rocks that are used as mineral licks for livestock and other animals that occur in the area.
- *Enkapune orpeles* – This is a sacred cave in the lower gorge that is used by the Maasai for prayers and rituals. There are also pottery shards located here and probably is an archaeological site as well.
- *Enchoro Oloontualan* - This is a spring named after a person of the II Tareto age set (1911 – 1929). It is used for purification rituals, and has a number of sacred as well as medicinal plants. The fresh water is good for human and animal consumption. The area is protected by the Maasai.
- *Enchoro Olormampuli* - A spring in the lower gorge, used for human and animal consumption, as the water is fresh. It is named after a person of the II Terito age set (1926-1948). This area is protected by the Maasai.
- Lower gorge dry season grazing and *Ol keri* - This is a vital pastoral area, used for dry season grazing. There areas are also set aside as grazing areas for calves or weak livestock. The above areas are protected by the Maasai, and infringements are punished.

Figure 4.5-1 *Enkaibartani* – Fischers Tower one of the culturally significant towers in the region.

Figure 4.5-2 *Enkaibartani* - Central Tower one of the culturally significant towers in the region.

5 POLICY, LEGAL AND REGULATORY FRAMEWORK

5.1 Introduction

This section has examined relevant standards applicable to the project. Additionally, the section outlines the legal instruments and stakeholder institutions involved in the project. The policy, legal, and regulatory framework refers to the comprehensive set of laws, regulations, policies, and guidelines established under Kenya Government and relevant authorities to govern various aspects of a particular sector or area in this case geothermal development. This framework provides the foundation for decision-making, operations, and interactions within that sector, ensuring compliance, accountability, and the achievement of specific goals. In the context of environmental and social impact assessment (ESIA) and management, a robust framework is essential to guide the evaluation and mitigation of potential negative impacts on the environment and society.

5.2 Milestone to Policy, Legal, and Regulatory Framework in Kenya

This section provides an overview history of the administrative and legal framework that pertains to the project starting with National Environmental Action Plan. The progression from the National Environmental Action Plan (NEAP) in 1994 to the enactment of the Environmental Management and Coordination Act (EMCA) in 1999 marked a significant step forward in Kenya's approach to environmental management and conservation. The NEAP, established in 1994, was a comprehensive blueprint for addressing environmental challenges and promoting sustainable development in Kenya. It was developed to assess and address the country's environmental issues, including pollution, resource degradation, and biodiversity loss. The NEAP aimed to provide a strategic framework for integrating environmental concerns into development planning and decision-making processes. The key objectives of NEAP include:

- Identify environmental challenges and priorities in various sectors.
- Develop strategies and policies for sustainable natural resource management.
- Enhance public participation in environmental decision-making.
- Promote the integration of environmental considerations into development policies and programs.

Environmental Management and Coordination Act (EMCA) - 1999: The Environmental Management and Coordination Act (EMCA) was a landmark legislation enacted in 1999 in Kenya. EMCA provided a legal framework for the effective management, conservation, and sustainable use of the environment and natural resources. It replaced several outdated laws and regulations related to environmental management and consolidated them into a single comprehensive statute.

The Significance: The evolution from NEAP to EMCA was significant because it demonstrated Kenya's commitment to addressing environmental challenges in a systematic and holistic manner. NEAP laid the groundwork for recognizing the importance of environmental conservation, while

EMCA institutionalized these principles into law, ensuring that environmental concerns were taken seriously and legally enforced.

By enacting EMCA, Kenya aimed to streamline environmental management, establish clear guidelines for development projects, and enhance public participation in environmental decision-making. The legislation provided a platform for fostering sustainable development, protecting ecosystems, and mitigating the impacts of human activities on the environment. Overall, the evolution from NEAP to EMCA represented a pivotal moment in Kenya's environmental governance, signalling a more comprehensive and integrated approach to environmental management and conservation.

5.3 Policy Framework

Policy documents outline the overarching principles, objectives, and strategic direction of a particular sector. In the context of ESIA and environmental management, policies might focus on sustainable development, conservation of natural resources, community well-being, and other related goals. The establishment of a policy framework in Kenya holds significant rationale, importance, and objectives across various sectors and aspects of governance. Policy framework in Kenya is of paramount importance due to its ability to guide decision-making, foster economic growth, promote social equity, ensure accountability, and contribute to sustainable development. The rationale behind policies lies in creating a coherent and predictable environment that upholds the rule of law and supports the nation's progress. The objectives encompass strategic direction, regulation, resource allocation, stakeholder engagement, innovation, and risk management. A robust policy framework serves as the cornerstone of effective governance and the foundation for a prosperous and equitable society. Policies address environmental, social, and economic concerns, promoting sustainable development that balances current needs with those of future generations. The main features of environmental policy framework in Kenya are summarized below in Table 5.3-1 Policy Framework.

Table 5.3-1 Policy framework

Policy	Provision	Relevance
Vision 2030	Diversification of Energy Sources: The blueprint aims to diversify Kenya's energy sources to reduce dependence on traditional fossil fuels and increase the share of renewable energy in the energy mix. This includes harnessing solar, wind, geothermal, hydro, and other clean energy resources. Enhanced Energy Access: Vision 2030 aims to improve access to modern and reliable energy services for all Kenyan citizens. This involves increasing electrification rates in rural areas and underserved communities, as well as promoting access to clean cooking technologies. Increased Energy Efficiency: The blueprint prioritizes energy efficiency measures to optimize energy use in various sectors, such as industry, transportation, and buildings. Implementing energy-efficient technologies and practices is crucial for reducing energy consumption and greenhouse gas emissions. Development of Energy Infrastructure: Vision 2030 emphasizes the need for robust energy infrastructure, including power generation, transmission, and distribution systems. The goal is to enhance the reliability and stability of the energy supply. Promotion of Renewable Energy: The blueprint places significant emphasis on expanding the use of renewable energy sources, particularly geothermal, wind, and solar power. Renewable energy development is seen as a key driver of sustainable growth and climate change mitigation. Public-Private Partnerships: Vision 2030 encourages public-private partnerships in the energy sector to leverage private sector expertise, investment, and innovation in achieving energy sector goals.	Vision 2030 is Kenya's long-term development blueprint, which outlines the country's aspirations and goals for socioeconomic transformation by the year 2030. In relation to the energy sector, Vision 2030 sets ambitious targets and strategies to enhance energy security, promote sustainable energy development, and support economic growth.
National Environmental Policy, 2013	The policy promotes the use of environmental and social assessment tools such as ESIA/EA necessary to ensure environmental quality and resource productivity on long term basis. Further it calls for management in use of hazardous and toxic chemicals as well as radiation regulations	The Policy requires the project which is likely to have significant environmental and social impacts to undergo ESIA in order to establish sound environmental management practices.

The National Occupational Safety and Health Policy, 2012	The Policy seeks to reduce the number of work-related accidents and diseases, and equitably provide compensation and rehabilitation to those injured at work or who contract occupational diseases.	The policy requires the provision of appropriate and adequate PPE, avail First Aid services on site as well as development of Safety and Health Emergency Contacts at the site and workplace registration.
Sessional Paper No. 01 of 2017 on National Land Use Policy	The overall goal of the national land use policy is to provide legal, administrative, institutional and technological framework for optimal utilization and productivity of land related resources in a sustainable and desirable manner at national, county and community levels. The Policy is premised on the philosophy of economic productivity, social responsibility, environmental sustainability and cultural conservation. Key principles informing it include efficiency, access to land use information, equity, elimination of discrimination and public benefit sharing. The Policy is cognizant of numerous factors that affect land use in Kenya which include geographic and ecological features, population distribution, social, historical, cultural and economic factors. Other key factors are administrative, institutional and policy instruments, investment, urbanization and land tenure	Key measures shall be taken by the KenGen and all land users. These include, sound land use practices, conservation and enhancement of the quality of land and land-based resources and the proper management of demographic and health parameters. KenGen is expected to put the land to productive use and encourage the application of efficient technology for the intensification of land use. Urban land use will be improved through measures such as establishing transparent, accountable, sustainable, comprehensive and participatory governance structures and decision-making processes
Sessional Paper No. 06 of 1999 on Environment and Development	The comprehensive policy provides a clear direction on how to manage and protect the environment. The Environment Policy deals with emerging national as well as international key issues	KenGen must consider; Biological diversity, Sustainable land use systems, Water resource management, Sustainable fisheries and marine resource management, Pollution control and waste management, Energy (renewable and efficiency), Climate change and variability, Disaster preparedness and risk management, Integrated planning and management, Environmental information management, Environmental education and public participation and Environmental economics.
The Kenya National Policy on Gender and Development (NPGD)	The goal of the policy is to "achieve gender equality and women's empowerment in national development so as to enhance participation of women and men, boys and girls, vulnerable and marginalized groups for the attainment of sustainable development. The policy calls upon the National and County Governments, Constitutional Commissions and Independent Offices, Faith Based Organizations (FBOs) and Civil Society Organizations (CSOs) and the private sector to work together in ensuring its implementation	KenGen to ensure that gender equality and women's empowerment is integrated into sectoral policies, planning and programmes, the policy identifies key thematic areas, namely: labour and employment, education, health, land, housing, agriculture, environment and natural resources, peace and security, governance, power and decision making, information and communications technologies, respect for the human rights, sexual and Gender Based Violence; the girl child and the boy child, intersectional discrimination, media and access to justice.

5.4 Legal Framework

The legal framework in Kenya encompasses a comprehensive network of laws, regulations, policies, and institutions that govern the nation's activities, operations, and interactions. The framework is designed to promote transparency, accountability, justice, and the protection of rights across diverse sectors. At the heart of this legal framework is the Constitution of Kenya, which provides the fundamental principles and values that guide governance, democracy, and human rights. Legal framework in Kenya serves as a vital mechanism for promoting good governance, protecting rights, and fostering a just and equitable society. It reflects the country's commitment to upholding democratic values, facilitating economic growth, and safeguarding the well-being of its citizens.

Regulatory bodies, established by these laws, oversee the implementation and enforcement of regulations within their respective sectors. These bodies play a crucial role in monitoring compliance, issuing licenses, and ensuring that standards are upheld. For example, the National Environmental Management Authority (NEMA) is tasked with overseeing environmental management and conservation as stipulated by the Environmental Management and Coordination Act (EMCA). To enhance the legal framework's effectiveness, policies and guidelines are developed to provide detailed instructions for implementing laws and regulations. These policies facilitate consistent interpretation and application of the law across different scenarios. Furthermore, the legal framework prioritizes justice and access to legal remedies. Kenyan citizens can seek redress through the judicial system, which comprises various courts and tribunals, including the High Court, Court of Appeal, and Supreme Court. The judiciary upholds the rule of law, protects human rights, and ensures that legal disputes are resolved fairly.

5.4.1 Constitution of Kenya 2010

The Constitution sets the foundation for the country's legal system, defining the structure of government, delineating the separation of powers, and ensuring the rule of law. Complementing the Constitution are numerous laws and statutes that address specific areas of interest, including criminal law, property rights, business regulations, environmental protection, labour rights, and more. These laws are enacted by the Kenyan Parliament and other legislative bodies to provide clear guidelines and regulations that citizens, businesses, and organizations must adhere to. The Constitution as the supreme law of Kenya, and it provides the overall legal framework for all activities, including geothermal drilling. While the Constitution does not specifically mention geothermal drilling, it contains several provisions that are relevant to environmental protection, natural resource management, and the rights of communities living in areas where geothermal drilling may take place. In the Constitution of Kenya, 2010 Part II (Environment and Natural Resources), (I) the State clearly undertakes to carry out the following:

- **Environmental Rights:** Article 42 of the Constitution recognizes every person's right to a clean and healthy environment. Geothermal drilling activities must be conducted in a manner that does not harm the environment and ensures the protection of natural resources.

- **Sustainable Development:** The Constitution emphasizes sustainable development in Article 10. Geothermal drilling and development should be carried out in a manner that is economically, socially, and environmentally sustainable, taking into account the needs of present and future generations.
- **Devolution and Community Participation:** Article 174 of the Constitution establishes the principle of devolution, which grants significant powers and responsibilities to county governments. Geothermal resources often exist in areas governed by county governments, and the Constitution recognizes the role of communities in the management of their resources.
- **Protection of Natural Resources:** Article 69 of the Constitution obligates the state to ensure sustainable exploitation, utilization, management, and conservation of natural resources, including geothermal resources.
- **Right to Information:** Article 35 of the Constitution grants citizens the right to access information held by the state and other public entities. This provision is relevant for communities and individuals seeking information about geothermal projects and their potential impacts.
- **Compensation and Fair Benefit-Sharing:** Article 40 of the Constitution protects the right to own property and provides for prompt and just compensation in case of compulsory acquisition of property, including land where geothermal drilling activities occur.
- **Public Participation:** Article 118 of the Constitution requires public participation in matters of governance, including decision-making on matters that may affect communities, such as geothermal projects.

Table 5.4-1 Relevance of the Legal Framework to Olkaria VII Project

Sn	Legal Framework	Relevance to Olkaria VII Project
1.	Environmental Management and Coordination Act (EMCA)	Olkaria VII is conducting EIA studies, mandated to obtaining permits, and enforcing compliance. For KenGen, as an operating entity, the Act mandates the submission of annual EA reports to the National Environmental Management Authority (NEMA) for review and necessary action. This ensures ongoing monitoring and evaluation of the project's environmental performance.
2.	Environmental (EIA and EA) Regulations, 2019	Olkaria VII geothermal project involves the exploration, drilling, and utilization of geothermal resources. The project's potential impacts on the environment, such as land disturbance, water resource utilization, air emissions, and potential disruption to local communities, warrant a thorough assessment and management process.
3.	Energy Act of 2019	The Energy Act provides a framework for licensing power generation projects. The Olkaria VII project, being a power generation project, may need to go through the licensing process outlined in the act. PPA Regulations: The act has provisions related to Power Purchase Agreements (PPAs), which are essential contracts between power generators and off-takers. The Olkaria VII project will need to comply with any relevant PPA regulations. The Energy Act promotes the development and utilization of renewable energy sources. If the Olkaria VII project involves renewable energy generation, the act's provisions for renewable energy development may apply. The act has provisions related to grid connection and integration. The Olkaria VII project's connection to the national grid will need to comply with these regulations. The Energy Act include standards for technical aspects and safety measures in energy projects. The Olkaria VII project will need to adhere to these standards to ensure safe and reliable operations. The act has regulations related to energy efficiency measures. The Olkaria VII project will be subject to energy efficiency requirements or incentives outlined in the act.
4.	Environmental Management and Co-ordination (Water Quality) Regulations, 2006)	Olkaria VII project operations must comply with these pollution control measures to prevent contamination of nearby water sources. Olkaria VII project must obtain the necessary permits to discharge any wastewater safely, ensuring it does not harm the environment or water quality. Olkaria VII project may require regular monitoring and reporting of water quality to ensure compliance with the set standards. Olkaria VII project may need to monitor their operations' effects on water quality and report the findings to NEMA and other relevant authorities. Geothermal drilling activities may involve the use of water for cooling or other purposes, and these activities must adhere to the regulations to prevent over-extraction or depletion of water resources.
5.	Environmental Management and Co-ordination (Waste Management) Regulations, 2006	Olkaria VII, which is part of Kenya's renewable energy development, adopting sustainable waste management practices aligns with the project's overall goals of promoting environmental conservation and responsible resource utilization.

		Given the nature of the Olkaria VII project, which involves geothermal exploration, drilling, and energy production, the management of waste materials is a critical aspect that needs to be addressed responsibly. Olkaria VII project should ensure that waste materials, whether hazardous or non-hazardous, are managed in an environmentally sound manner. This includes proper storage, transportation, treatment, and disposal to prevent pollution and harm to the ecosystem.
6.	Environmental Management and Coordination Act (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009	Given that the Olkaria VII project involves drilling, construction, and geothermal energy generation, there is the potential for noise and excessive vibrations to be produced during these activities. Olkaria VII project will be required take necessary measures to minimize noise and vibration impacts, which may include employing noise barriers, adopting quieter technologies, and implementing proper construction practices. By following the guidelines and standards outlined in these regulations, the project can ensure that noise and vibration pollution are kept within acceptable limits, thereby fostering harmonious coexistence with the surroundings.
7.	Environmental Management and Coordination (Air Quality) Regulations, 2014	Given that the Olkaria VII project involves geothermal exploration, drilling, and energy production activities, there is the potential for emissions and pollutants to be released into the air. Olkaria VII project must meet specific air quality standards and emission limits for various pollutants, including those that may be associated with geothermal activities, such as sulphur dioxide (SO2) and nitrogen dioxide (NO2). Olkaria VII project will be expected to monitor emissions, measuring pollutant levels, and implementing appropriate mitigation measures to prevent excessive air pollution.
8.	Wildlife (Conservation and Management) Act of 2013	While the Olkaria VII geothermal project primarily focuses on energy development, its activities may intersect with wildlife habitats and ecosystems. The act underscores the importance of safeguarding wildlife, especially in cases where development projects may impact natural habitats, migration corridors, and biodiversity Although Olkaria VII is not located in the protected area, it is in close (500m) proximity to the Hells Gate National Park and wildlife will move freely to the project area. Hence a need for the protection of animals from project activities.
9.	Protected Areas Act, 1980; (Revised 2012)	For the Olkaria VII project, adherence to the act is essential to avoid any adverse impacts on these designated areas, including potential disturbances to wildlife, ecosystems, and natural processes. For the Olkaria VII project, this entails conducting thorough studies to assess potential impacts on the environment and biodiversity. If the project's activities have the potential to negatively affect protected areas, appropriate mitigation measures must be implemented to minimize such impacts. Although Olkaria VII is not located in the protected area, it is in close (500m) proximity to the Hells Gate National Park and wildlife will move freely to the project area.
10.	Water Act, 2016	Given that the Olkaria VII project involves geothermal exploration, drilling, and energy production, which may have implications for water resources, adherence to this act is crucial. The Olkaria VII project, which may involve water usage for drilling, cooling, and other activities, must ensure that its water-related operations adhere to the regulations and principles outlined in the Water Act, 2016. Olkaria VII to assess the potential impacts on water sources and take measures to avoid over-exploitation or pollution to ensure their availability for present and future generations. This includes ensuring the protection of water quality, minimizing water consumption, and mitigating any potential negative effects on water sources and aquatic ecosystems.

11	County Governments Act, 2012	Geothermal resources under Olkaria VII fall under the jurisdiction of County government of Nakuru, and they play a role in decision-making and planning for Olkaria VII project. They have authority over land use and environmental approvals that are essential for Olkaria VII project. County government of Nakuru can actively promote and attract investments in Olkaria VII project. It can collaborate with private sector entities, investors, and development agencies to advance geothermal projects. In the context of Olkaria VII project, this engagement is essential to ensure that local communities are informed, consulted, and involved in decision-making processes. County government of Nakuru have a role in revenue sharing and benefit-sharing arrangements related to Olkaria VII project. These arrangements can help ensure that local communities receive a fair share of the benefits from Olkaria VII project.
12	Occupational Safety and Health Act, 2007	Given that the Olkaria VII project involves geothermal exploration, drilling, construction, and energy generation, it is imperative to prioritize the health and safety of all personnel involved. The act outlines specific regulations and guidelines to prevent workplace accidents, injuries, and occupational health hazards. During the construction and operation stages, the project will attract a large work force which will require to be managed in accordance to the OSHA. Olkaria VII project must demonstrate its commitment to the welfare of its workforce and the surrounding community. This includes implementing proper safety measures, providing appropriate training, maintaining a safe working environment, identification and assessment of potential hazards, the establishment of safety committees, and the provision of necessary personal protective equipment (PPE), promoting accident prevention, minimizing occupational health risks, and fostering a culture of safety.
13	Climate Change Act No. 11 of 2016	The Act encourages the development and utilization of low-carbon energy sources, as such as Olkaria VII project development reduces greenhouse gas emissions associated with fossil fuel-based energy generation. Consideration of climate risk assessment in Olkaria VII project should include: Understanding Climate Vulnerability: Climate risk assessment will help identify the vulnerabilities of Olkaria VII to various climate-related hazards, such as extreme weather events, changes in precipitation patterns, and rising temperatures. It also assesses the potential impacts of these hazards on the project's infrastructure, operations, and energy production. Climate Change Adaptation: Climate risk assessment helps in designing Olkaria VII that are resilient to climate change impacts. This involves considerations such as choosing suitable locations for geothermal plants, designing infrastructure to withstand extreme weather events, and incorporating climate projections into project planning. Water Availability and Management: Olkaria VII will require significant amounts of water for cooling and steam production. Climate change can affect water availability and quality. A climate risk assessment helps in understanding water-related risks and developing appropriate water management strategies to ensure sustainable geothermal operations.

		Long-Term Viability: Olkaria VII is expected to have a long lifespan, spanning several decades. Climate risk assessment ensures that the project is designed to withstand future climate conditions to maintain long-term viability and avoid potential stranded assets. Incorporating climate risk assessment into Olkaria VII planning and decision-making will ensure that the project is climate-resilient, contribute to climate change mitigation efforts, and is aligned with the goals of sustainable development. Collaboration with climate scientists, environmental experts, and local stakeholders is crucial to conduct comprehensive and effective climate risk assessments for the project.
14	The Physical and land use planning Act 2019	All applications for development permission be to be made in the Nakuru county in line with the County Spatial Plan. Olkaria VII project requires land for infrastructure, drilling pads, and energy facilities thus compliance with the land use planning regulations is essential. Involving the community in the planning process for Olkaria VII project will foster transparency, minimize conflicts, and enhance the project's social acceptance. By complying with the act's provisions, the project aligns with Kenya's commitment to sustainable land management and development.
15	Land Planning Act Cap. 303	The relevance of the Land Planning Act, Cap. 303 to the Olkaria VII geothermal project lies in its capacity to guide the project's land use planning processes, ensuring that development is carried out in a manner that is both beneficial and sustainable for the environment, communities, and long-term development goals
16	Public Health Act (Cap 242)	Given that the Olkaria VII project involves various activities such as drilling, construction, and energy production, there is a potential for the release of pollutants, emissions, and other factors that could impact public health. The Public Health Act (Cap 242) emphasizes the importance of maintaining hygiene standards, preventing environmental pollution, and controlling disease vectors. Olkaria VII project's responsibility is to manage its operations in a manner that minimizes health risks and promotes a safe working environment by ensuring proper waste disposal, managing potential sources of pollution, and implementing measures to mitigate any health risks associated with project operations, provision of clean water and sanitation facilities, which are essential for the health and well-being of both workers and nearby communities.
17	The Environmental Management and Coordination (Air Quality) Regulations, 2008	Given that the Olkaria VII project involves geothermal exploration, drilling, and energy production, there is a potential for the release of emissions and pollutants into the air. The project must meet established standards for ambient air quality, emission limits, and monitoring requirements to ensure that air pollutants are kept within acceptable levels. Use of appropriate best available technologies to control emissions and mitigate any potential impacts on air quality is expected. Olkaria VII project's responsibility is to provide accurate and timely information to regulatory authorities and the public regarding its air quality management efforts. The regulations specify stack height requirements for geothermal power plants. The height of stacks or chimneys affects the dispersion of emissions into the atmosphere, reducing the potential for localized air pollution. By complying with the Environmental Management and Coordination (Air Quality) Regulations, 2008, the Olkaria VII geothermal project can contribute to maintaining clean and healthy air quality for workers, nearby communities, and the environment. This aligns with Kenya's commitment to sustainable development and responsible environmental stewardship.

18	The Sustainable Waste Management Act, 2022	Olkaria VII project is expected to have 3-year waste management plans and submit annual monitoring reports to NEMA. The project is obligated to identify and eliminate potential negative impacts of their product; enable the recovery and reuse of the product where possible; reclaim and recycle; incorporate environmental concerns in the design, process and disposal of the product as well as collect and segregate hazardous from non-hazardous waste prior to disposal. Disposal should be done in a facility provided by the county government or NEMA. During disposal, they should transfer the waste to a person licensed to transport and dispose of the waste and clean up and restore the site they were using to its natural state. When it comes to their operation premises, the project should provide waste segregation receptacles for organic, plastic and general dry waste.
19	Land and environment Court Act 2012	In the event of disputes or conflicts arising from land use, drilling, construction, and geothermal energy production, the Environment Court provides a specialized forum for resolving these issues in accordance with the law. If the Olkaria VII project faces allegations of non-compliance with environmental requirements, the Land and Environment Court may become involved to address these matters.

5.5 Regulatory Framework

Regulatory framework aims to balance economic development with environmental protection, ensuring that industrial activities are conducted in a sustainable and responsible manner. It establishes the legal basis for regulatory agencies, permits, environmental assessments, and enforcement mechanisms to ensure compliance with environmental standards and regulations. The Environmental and Social Impact Assessment (ESIA) regulatory framework in Kenya provides a structured process for evaluating and addressing potential environmental and social impacts of development projects. It ensures that projects are designed, implemented, and managed in a manner that safeguards the environment, protects communities, and promotes sustainable development. The regulatory framework is primarily governed by the Environmental Management and Coordination Act (EMCA) of 1999 and its subsidiary legislation, as well as guidelines established by the National Environmental Management Authority (NEMA).

5.5.1 National Environmental Management Authority

The National Environmental Management Authority (NEMA) was established as a regulatory body in Kenya to oversee environmental management and protection under the Environmental Management and Coordination Act (EMCA) of 1999 in Kenya. NEMA plays a central role in the administration and coordination of environmental management and protection in the country. Its purpose, structure, and functions are aimed at ensuring sustainable development and safeguarding the environment for present and future generations.

- 2002 – 2006 Formative Years: After its establishment in 1999 under the EMCA, NEMA started to take shape as a regulatory body responsible for overseeing environmental matters in Kenya. During these years, NEMA focused on building its organizational structure, developing its mandate, and establishing its role within the broader framework of environmental management.
- 2007 - 2010: Strengthening Regulations and Capacities NEMA's role as a regulatory authority became more pronounced during this period. The authority worked on strengthening its regulations, guidelines, and standards to address various environmental issues. The focus was on developing a comprehensive regulatory framework to govern environmental impact assessments, waste management, air and water quality, biodiversity conservation, and pollution control.
- 2010 - 2015: Expanding Mandate and Public Engagement: During this phase, NEMA's mandate expanded to include climate change adaptation and mitigation strategies. The authority worked to integrate climate change considerations into its regulatory and management functions. NEMA also emphasized public engagement, launching awareness

campaigns and outreach programs to educate the public about environmental issues and promote sustainable practices.

- 2016 - 2019: Enhancing Enforcement and Collaboration NEMA continued to enhance its enforcement capabilities, cracking down on environmental violations and illegal activities that posed threats to the environment. The authority collaborated more closely with other government agencies, local authorities, and non-governmental organizations to strengthen environmental management efforts across the country.
- 2020 - Present: Embracing Technological Innovations and Sustainability In recent years, NEMA has embraced technological advancements to improve its monitoring and enforcement capabilities. The authority has been working on integrating digital tools and platforms to enhance data collection, analysis, and reporting related to environmental compliance. NEMA has also been active in promoting sustainability, encouraging industries and communities to adopt green practices and reduce their ecological footprint.

Purpose and structure

NEMA's primary purpose is to promote and coordinate sustainable environmental management and conservation in Kenya. It serves as the central agency responsible for overseeing environmental matters, ensuring compliance with environmental laws and regulations, and promoting public awareness and education regarding environmental issues. NEMA is structured to carry out its responsibilities effectively. The key components of its structure include:

Board of Management: NEMA is governed by a Board of Management comprising various stakeholders, including government representatives, experts, and representatives from civil society. The board provides oversight and strategic direction for NEMA's activities.

Director-General: The Director-General is the chief executive officer of NEMA and is responsible for the day-to-day operations and management of the authority.

Departments and Divisions: NEMA is organized into different departments and divisions, each focused on specific aspects of environmental management. These divisions may include Environmental Compliance, Environmental Impact Assessment, Pollution Control, Biodiversity Conservation, and more.

NEMA Functions

NEMA's functions encompass a wide range of activities related to environmental management and conservation, including:

- Environmental Impact Assessment (EIA): NEMA is responsible for overseeing the EIA process for various projects and activities to ensure that potential environmental impacts are assessed and mitigated before project implementation.
- Environmental Audits: NEMA conducts audits to assess the compliance of projects and activities with environmental laws and regulations.
- Licensing and Permits: NEMA issues licenses and permits for various activities that have environmental implications, ensuring that these activities adhere to environmental standards.
- Pollution Control: NEMA monitors and regulates pollution sources, sets emission standards, and takes measures to control pollution.
- Biodiversity Conservation: NEMA is involved in the conservation and management of Kenya's rich biodiversity and protected areas.
- Public Awareness and Education: NEMA promotes public awareness and education on environmental issues, encouraging sustainable practices and behaviours.
- Policy Development: NEMA contributes to the development of environmental policies and guidelines, aligning with national and international environmental priorities.
- Research and Data Collection: NEMA gathers data and conducts research on various environmental aspects to inform decision-making and policy formulation.

NEMA plays a pivotal role in ensuring that Kenya's environmental resources are managed sustainably and that development activities are carried out with minimal negative impact on the environment. It collaborates with various stakeholders, including government agencies, private sector, civil society, and local communities, to achieve its goals of environmental protection and sustainable development. In the 2010s, NEMA's role expanded to address emerging environmental challenges, including climate change, pollution, waste management, and biodiversity conservation. It strengthened collaborations with other government agencies, local authorities, private sector entities, civil society organizations, and international partners to enhance environmental protection and sustainability.

5.5.2 Kenya Wildlife Service

It is a state corporation that was established by an Act of Parliament (Cap 376), now repealed by Wildlife Conservation and Management Act (2013), with the mandate to conserve and manage wildlife in Kenya, and to enforce related laws and regulations. KWS undertakes conservation and management of wildlife resources across all protected areas systems in collaboration with stakeholders. It is our goal to work with others to conserve, protect and sustainably manage wildlife resources. The community wildlife program of KWS in collaboration with others encourages biodiversity conservation by communities living on land essential to wildlife, such as wildlife corridors and dispersal lands outside parks and reserves.

The Kenya Wildlife Service (KWS) plays a significant regulatory role in relation to Environmental and Social Impact Assessments (ESIA) and projects that have the potential to impact wildlife and biodiversity in Kenya. KWS's regulatory role in this context include:

- **Wildlife and Biodiversity Protection:** KWS is primarily responsible for the conservation and management of wildlife and biodiversity in Kenya. This includes protected areas such as national parks, game reserves, and wildlife sanctuaries. When projects are proposed within or near these protected areas, KWS ensures that the potential impacts on wildlife, habitats, and ecosystems are carefully assessed and mitigated through the ESIA process.
- **Review of ESIA Reports:** KWS reviews ESIA reports for projects that have the potential to affect wildlife habitats and biodiversity. This review ensures that proposed projects are in compliance with laws related to wildlife protection and conservation. KWS assesses the adequacy of mitigation measures proposed in the ESIA report to minimize adverse impacts on wildlife and their habitats.
- **Recommendations and Conditions:** Based on their review, KWS provides recommendations and conditions to the National Environmental Management Authority (NEMA) regarding the approval of projects that could impact wildlife. These recommendations often include measures to protect sensitive habitats, migratory routes, and the overall well-being of wildlife populations.
- **Wildlife Corridors and Buffer Zones:** KWS ensures that projects do not disrupt wildlife corridors and buffer zones that are critical for the movement and survival of wildlife. Projects that may interfere with these corridors might need to modify their plans to minimize negative impacts on wildlife migration and ecological connectivity.
- **Endangered Species Protection:** KWS has a vital role in protecting endangered and threatened species. They assess the potential impact of projects on these species and ensure that projects do not contribute to their decline. If a project poses a significant threat to endangered species, KWS may recommend changes or mitigation measures to prevent harm.
- **Public Participation:** KWS encourages public participation in ESIA processes, particularly for projects located near wildlife habitats or protected areas. Public input is crucial for identifying potential impacts and proposing mitigation measures that consider local concerns and traditional knowledge.

5.5.3 Water Resources Authority

Water Resources Authority (WRA) is a state corporation established under Section 11 of the Water Act, 2016. It is mandated through delegated Authority on behalf of the National government to safeguard the

right to clean water by ensuring that there is proper regulation of the management and use of water resources, in order to ensure sufficient water for everyone now and in the future. The Authority has been in existence for 17 years following its establishment under the Water Act, 2002 as Water Resources Management Authority (WRMA). Through ESIA processes, WRA ensures that projects are conducted in a manner that protects water quality, quantity, and ecosystems, while also considering the socio-economic needs of communities that rely on water resources. WRA's regulatory role in this context includes:

- **Water Resource Management:** WRA is responsible for the management, protection, and sustainable use of water resources in Kenya. This includes rivers, lakes, groundwater, wetlands, and other water bodies. When projects are proposed that could impact water resources, WRA ensures that their potential effects on water availability, quality, and ecosystems are thoroughly assessed through the ESIA process.
- **Review of ESIA Reports:** WRA reviews ESIA reports for projects that have the potential to affect water resources. This review assesses the potential impacts of projects on water quantity and quality, including potential contamination, depletion, and changes in flow patterns. WRA evaluates the adequacy of proposed mitigation measures to safeguard water resources.
- **Water Allocation and Permitting:** WRA manages water allocation and permitting processes. For projects that require water use, WRA assesses the potential impact on available water resources and issues permits based on the sustainability of water use. This ensures that projects do not excessively deplete water sources and cause negative impacts on aquatic ecosystems and communities that depend on water.
- **Erosion and Sedimentation Control:** WRA addresses erosion and sedimentation issues caused by construction activities that could degrade water bodies. Projects that are likely to contribute to erosion or sedimentation must incorporate measures to prevent soil runoff and siltation into watercourses.
- **Wetland Protection and Conservation:** WRA is responsible for the protection and conservation of wetlands, which are critical ecosystems that provide various ecological services. Projects near wetlands or that might impact wetland areas are subject to ESIA review to assess potential impacts on these valuable habitats.
- **Public Participation:** WRA encourages public participation in ESIA processes, especially for projects located near water bodies. This engagement ensures that local communities' concerns are considered, traditional knowledge is incorporated, and potential water-related impacts are properly addressed.

- **Water Pollution Control:** WRA monitors and regulates water pollution from industrial, agricultural, and domestic sources. Projects that could contribute to water pollution must incorporate appropriate pollution control measures and technologies.

5.5.4 The Energy and Petroleum Regulatory Authority

The Energy and Petroleum Regulatory Authority (EPRA) is established as the successor to the Energy Regulatory Commission (ERC) under the Energy Act, 2019. The Authority is responsible for the economic and technical regulation of the electric power, renewable and petroleum sub sectors. The mandate of the Authority as provided by the Energy Act 2019 include:

- The generation, importation, exportation, transmission, distribution, supply and use of electrical energy with the exception of licensing of nuclear facilities;
- Importation, refining, exportation, transportation, storage and sale of petroleum and petroleum products with the exception of crude oil;
- Production, conversion, distribution, supply, marketing and use of renewable energy; and
- Exploration, extraction, production, processing, transportation, storage exportation, importation and sale of coal bed methane gas and other energy forms.

The Renewable Energy department is responsible for leading the planning, development, implementation, promotion and execution of structures for the development and regulation of the renewable energy and energy efficiency through research and planning, development of standards and regulations, compliance and enforcement. Geothermal projects involve the exploration, development, and utilization of geothermal resources for energy generation. EPRA's regulatory role in this context include:

- **Licensing and Regulation:** EPRA is responsible for licensing and regulating geothermal exploration, development, and production activities. This includes granting licenses for geothermal exploration and production, ensuring compliance with regulations, and setting technical and environmental standards for geothermal projects.
- **Resource Management:** EPRA oversees the sustainable management of geothermal resources to ensure their long-term viability. This involves setting guidelines for resource exploration, reservoir management, and sustainable production practices to prevent overexploitation and environmental degradation.
- **Safety and Technical Standards:** EPRA establishes safety and technical standards for geothermal projects to ensure the safe operation of facilities, prevent accidents, and protect workers and communities. These standards cover aspects such as drilling, well integrity, and facility design.

- **Compliance Monitoring:** After project approval, EPRA monitors geothermal projects to ensure compliance with the conditions set in the EIA approval and the terms of the license. This includes verifying that the proposed mitigation measures are being effectively implemented to minimize negative impacts.
- **Capacity Building and Technical Support:** EPRA provides technical assistance, capacity building, and guidance to geothermal project developers to ensure that projects are planned and implemented in accordance with best practices and regulatory requirements.

5.5.5 National Museums of Kenya

National Museums of Kenya (NMK) is a state corporation established by an Act of Parliament, the Museums and Heritage Act 2006. NMK is a multi-disciplinary institution whose role is to collect, preserve, study, document and present Kenya's past and present cultural and natural heritage. This is for the purposes of enhancing knowledge, appreciation, respect and sustainable utilization of these resources for the benefit of Kenya and the world, for now and posterity. NMK's mutual concern for the welfare of mankind and the conservation of the biological diversity of the East African region and that of the entire planet demands success in such efforts. In addition, NMK manages many Regional Museums, Sites and Monuments of national and international importance alongside priceless collections of Kenya's living cultural and natural heritage. NMK operates within the legal framework established by relevant laws and regulations that protect cultural heritage, such as the Antiquities and Monuments Act. NMK has the authority to ensure compliance with these laws and take enforcement actions if cultural heritage is threatened or damaged. Overview of NMK's regulatory role in this context include:

- **Protection of Cultural Heritage:** NMK is responsible for safeguarding Kenya's cultural heritage, including archaeological sites, artifacts, and other cultural resources. In the context of geothermal projects, NMK ensures that cultural heritage sites are identified and protected from potential impacts.
- **Archaeological Assessments:** Geothermal projects that have the potential to disturb or impact archaeological sites or cultural resources are required to conduct archaeological assessments. NMK may be involved in reviewing these assessments to ensure that cultural heritage is preserved.
- **Review of Environmental Impact Assessments (EIA):** NMK reviews the cultural heritage component of Environmental Impact Assessment (EIA) reports for geothermal projects. This review ensures that potential impacts on archaeological sites, historic structures, and cultural landscapes are properly identified and addressed in the project's planning and mitigation measures.

- **Mitigation of Cultural Impacts:** NMK may provide recommendations for mitigation measures to minimize the impact of geothermal projects on cultural heritage. This could include adjusting project designs or operations to avoid or minimize disruption to significant cultural sites.

5.5.6 Directorate of Occupational Safety & Health Services

The Directorate of Occupational Safety and Health Services (DOSHS) is a regulatory body in Kenya responsible for promoting and ensuring the health, safety, and well-being of workers in various industries and workplaces. DOSHS operates under the Ministry of Labour and Social Protection. Directorate of Occupational Safety and Health Services (DOSHS) plays a vital role in ensuring that workplaces in Kenya are safe, healthy, and conducive for workers. It establishes regulations, conducts inspections, and promotes best practices to prevent accidents, injuries, and occupational diseases, ultimately contributing to the overall well-being of the workforce. Overview of DOSHS's role and functions include:

- **Promotion of Occupational Safety and Health:** DOSHS is tasked with promoting a safe and healthy working environment for all workers in Kenya. This includes raising awareness about occupational hazards, risks, and best practices to prevent workplace accidents and occupational diseases.
- **Development of Regulations and Guidelines:** DOSHS develops and enforces regulations, guidelines, and standards related to occupational safety and health. These regulations cover various aspects, including workplace design, machinery safety, hazardous substances handling, and personal protective equipment (PPE).
- **Enforcement of Occupational Safety Laws:** DOSHS is responsible for enforcing occupational safety and health laws and regulations across different industries. This includes conducting inspections, investigations, and audits to ensure compliance with safety standards and proper working conditions.
- **Training and Capacity Building:** DOSHS offers training programs, workshops, and seminars to educate employers, employees, and stakeholders about occupational safety and health practices. This aims to enhance the capacity of individuals and organizations to create safer workplaces.
- **Accident and Incident Investigations:** In cases of workplace accidents, injuries, or fatalities, DOSHS conducts thorough investigations to determine the causes and contributing factors. This information is used to prevent similar incidents in the future.

- **Worker Welfare:** DOSHS works to protect workers' rights and well-being by ensuring fair working conditions, reasonable working hours, and adherence to health and safety standards. It also advocates for the provision of appropriate medical care in cases of work-related injuries.
- **Collaboration with Stakeholders:** DOSHS collaborates with employers, employees, trade unions, industry associations, and other relevant stakeholders to develop and implement effective safety and health measures in various workplaces.
- **Licensing and Certification:** Certain industries and activities require licenses or certifications from DOSHS to operate. These licenses often include compliance with specific safety and health requirements.
- **Response to Emergencies:** DOSHS may respond to emergencies related to workplace accidents, hazardous material releases, and other incidents that pose risks to workers' safety and health.

5.6 World Bank Safeguard Policies and Procedures

The undertaking of the ESIA was also guided by World Bank Safeguard Policy OP 4.01 on Environmental Assessment. Using the World Bank Safeguard Policy on Environmental Assessment this project was categorized as A project. A project is classified as category A if it has potential to have significant adverse environmental and socio-economic impacts that are sensitive, diverse or unprecedented. Impacts of Category A projects may affect areas broader than the sites subjected to physical works. This includes projects in sensitive sectors or projects that are located in or near sensitive areas.

There are also several World Bank documents that are relevant to this study. They include:

- OP 4.01 Environmental Assessment;
- OP 4.04 Natural Habitats;
- Environmental Assessment Sourcebook; and
- Pollution Prevention and Abatement Handbook.

Table 5.6-1 World Bank Environmental and Social Standards (ESSs)

Sn	World Bank Environmental and Social Standards (ESSs)	Compliance
ESS1	Assessment and Management of Environmental and Social Risks and Impacts: This standard outlines the process for identifying, assessing, and managing potential environmental and social risks and impacts associated with a project. It emphasizes early identification and integration of mitigation measures into project planning.	The Olkaria VII ESIA team have identified, assessed and proposed possible mitigation measures to be included during project planning.

ESS2	Labor and Working Conditions: This standard focuses on ensuring fair and safe labor practices, including worker rights, health and safety, and appropriate working conditions. It aims to protect workers' rights and promote positive working environments.	KenGen shall ensure fair and safe labor practices including worker rights, health and safety, and appropriate working conditions.
ESS3	Resource Efficiency and Pollution Prevention: emphasizes resource efficiency, pollution prevention, and waste management. It aims to minimize the use of natural resources, reduce pollution, and promote sustainable consumption and production patterns.	The Olkaria VII ESIA team has identified waste management measures as well as sustainable utilization of natural resources.
ESS4	Community Health, Safety, and Security: This standard focuses on safeguarding the health, safety, and security of project-affected communities. It includes measures to prevent and mitigate potential health and safety risks arising from project activities.	There are no Project-affected communities associated with proposed Olkaria VII project.
ESS5	Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement: addresses land acquisition, restrictions on land use, and involuntary resettlement. It outlines principles for fair compensation, livelihood restoration, and meaningful consultation with affected communities.	There is no land acquisition or resettlement for the Olkaria VII project. Refer to section 8.1.8
ESS6	Biodiversity Conservation and Sustainable Management of Living Natural Resources: This standard aims to conserve biodiversity and ensure the sustainable management of natural resources. It focuses on protecting ecosystems, habitats, and endangered species.	The Olkaria VII ESIA team have identified a number of strategies for Biodiversity conservation in the ESIA report.
ESS7	Indigenous Peoples: focuses on the rights, cultural heritage, and livelihoods of indigenous peoples and local communities. It requires meaningful consultation, participation, and the protection of their rights.	There are no indigenous people that will be affected by the Olkaria VII project, however, the ESIA team carried out meaningful consultation and participation of surrounding communities.
ESS8	Cultural Heritage: This standard addresses the preservation of cultural heritage sites and artifacts. It requires identifying, protecting, and preserving cultural heritage during project implementation.	The project location will not interfere with any cultural sites or artefacts.
ESS9	Pest Management: focuses on integrated pest management practices that minimize the use of hazardous chemicals and promote environmentally friendly pest control methods.	All hazardous chemicals will be handled responsibly in accordance to the prescribed procedures, and material safety data sheets (MSDS).
ESS10	Stakeholder Engagement and Information Disclosure: This standard emphasizes engaging stakeholders, providing relevant project information, and fostering open communication. It aims to ensure that affected communities and	The Olkaria VII ESIA team carried out stakeholder engagement and public participation

	stakeholders are consulted, informed, and engaged throughout the project lifecycle.	

5.7 JICA Environmental and Social Guidelines

In the implementation of the Olkaria VII project we shall also be guided by the JICA's Environmental and Social Guidelines which ensures that the projects adhere to environmental and social standards to promote sustainable development and mitigate potential negative impacts on the environment and communities.

Table 5.7-1 JICA Guidelines for Environmental and Social Considerations, January 2022

Item	Relevance to Olkaria VII	Compliance
Environmental Impact Assessment (EIA)	Geothermal projects typically require Environmental Impact Assessments to assess potential environmental impacts. JICA's guidelines emphasize the importance of conducting comprehensive EIAs that consider the potential effects on land, water, air quality, biodiversity, and cultural heritage. The EIA process helps identify measures to minimize adverse impacts and promote sustainable practices.	KenGen engaged WJEC to do the ESIA for Olkaria VII
Stakeholder Engagement	JICA will promotes stakeholder engagement throughout the Olkaria VII lifecycle. Local communities, indigenous peoples, and other stakeholders are consulted to understand their concerns, incorporate their perspectives, and ensure their participation in decision-making processes.	The Olkaria VII ESIA team carried out stakeholder engagement and public participation.
Biodiversity Conservation	JICA's guidelines emphasize the importance of biodiversity conservation and the adoption of measures to protect sensitive ecosystems and species.	The Olkaria VII ESIA team have identified a number of strategies for Biodiversity conservation in the ESIA report.
Climate Change Mitigation	Olkaria VII project is a low-carbon renewable energy source that contributes to climate change mitigation. JICA's guidelines encourage the development of clean energy to reduce greenhouse gas emissions and combat climate change.	Olkaria VII project takes into consideration climate risk assessment in order to identify potential climate related hazards to the projects infrastructure, operations, and energy production.
Land Acquisition and Resettlement	Geothermal projects may involve land acquisition or resettlement of communities. JICA's guidelines require the implementation of appropriate safeguards to address land rights, livelihood restoration, and community well-being during the resettlement process.	There is no land acquisition or resettlement for the Olkaria VII project. Refer to section 8.1.8

Gender and Social Inclusion	JICA emphasizes the consideration of gender and social inclusion in geothermal project planning and implementation. It ensures that women and vulnerable groups have equal access to project benefits and opportunities.	KenGen shall promote equal opportunity in employment, and strive to eliminate discrimination in any employment policy or practise.
Capacity Building and Training	JICA's guidelines emphasize capacity building and training for project beneficiaries and implementing agencies to ensure the sustainability of geothermal projects and local ownership.	KenGen/ contractors shall engage in capacity building and training during implementation of Olkaria VII.
Monitoring and Evaluation	JICA promotes robust monitoring and evaluation of geothermal projects to assess their performance and impacts over time. This helps identify areas for improvement and knowledge sharing for future projects.	Olkaria VII project has put in place robust monitoring and evaluation processes.

5.8 Relevant International Conventions and Agreements

Several international conventions and agreements are relevant to this study. The most notable include Convention on biological diversity (CBD), Convention on the wetlands of international importance, Convention on the conservation of migratory species of wildlife animals, and African convention on the conservation of nature and natural resources, among other conventions as outlined below.

- **Convention on Biological Diversity:** The purpose of this convention is to ensure the conservation and sustainable use of biodiversity. Kenya signed the convention on 5th June 1992 and ratified the same 26th July 1992. The National Environmental Management Authority (NEMA) is the national focal point to this Convention on Biological Diversity. The provisions of this Convention have now been integrated in many laws of Kenya;
- **Wetlands of International Importance as Waterfowl Habitats:** The Convention on Wetlands of International Importance as Waterfowl Habitats is also referred to as Ramsar Convention. Its main objective is to promote conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world. Kenya ratified the Convention on 5th June 1990;
- **Conservation of Migratory Species of Wildlife Animals:** This Convention is also referred to as Bonn Convention. It is intended to ensure that migratory species of wild animals spelt out on Appendix I and II to that convention are protected from extinction. The Convention requires inter-governmental cooperation to ensure that the species are allowed to migrate as their nature

and their habit is preserved. The Convention was adopted on 23rd June 1979 and came to force on 1st November 1983;

- **Convention on International Trade in Endangered Species:** This Convention on International Trade in Endangered Species (CITES) was adopted on 3 March 1973 and came into force on 1st July 1975. The purpose of the Convention is to regulate the international trade in wild plants and animals that are at risk of extinction as a result of trade. The Convention seeks to control trade not only in live species but also in dead specimen and their derivatives. The Kenya Government ratified CITES on 13th December 1978. The lead agency for the CITES in Kenya is the Kenya Wildlife Service (KWS);
- **United Nations Convention to Combat Desertification:** The above Convention was adopted on 17th June 1994 in Paris and came into force on 26th December 19976. Kenya ratified the Convention in 24th June 1997. The purpose of the UNCCD is to address the problem of the degradation of land by desertification and the impact of drought particularly in arid and dry semi-humid areas. NEMA is the focal point for the Convention in Kenya;
- **Convention on the Conservation of Nature and Natural Resources:** The African Convention on the Conservation of Nature and Natural Resources reaffirms the importance of natural resources both renewable and non-renewable, particularly the soil, water, flora and fauna. The main objective is to facilitate sustainable use the above resources. The above Convention was adopted in Algiers on 15th September, 1968 and came into force on 16th June 1969;
- **United Nations Framework Convention on Climate Change:** The primary purpose of the Convention is to establish methods to minimize global warming and in particular the emission of the greenhouse gases (GHG). The UNFCCC was adopted on 9th May 1992and came into force on 21st March 1994. The Convention has been ratified by 189 states. Kenya ratified the Convention on 3O August 1994;
- **The Kyoto Protocol:** The Kyoto Protocol to the United Nations Framework Convention on Climate Change requires signatories to the Convention to reduce their greenhouse emissions levels to 5% below 1990 levels by the year 2012. The Protocol came into force on 16th February 2005, after it received the pre-requisite signatures. However, major countries like United States, China, India, and Australia are not signatories to the Protocol. NEMA is the national focal point for this Protocol;
- **Sustainable Development Goals:** Affordable and Clean Energy. Goal 7 is about ensuring access to clean and affordable energy which is key to the development of agriculture, business, communications, education, healthcare and transportation.

- **Convention for the Protection of World Cultural and National Heritage:** The above Convention was adopted in Paris on the 21st November, 1972. Presently the Convention has 178 signatories. Its primary purpose is to preserve cultural and national which includes monuments, architectural works, cave dwellings, painting and natural formations that are universally outstanding. Kenya ratified the Convention on 15th June, 1991. The national Museums of Kenya is the national focal point for the Convention.
- The proposed project will comply with International and all other stated Environmental and Social Standards including World Bank (WB Environmental and Social standards (ESSs) and JICA (JICA Guidelines for Environmental and Social Considerations, January 2022).

6 STAKEHOLDER CONSULTATIONS AND PUBLIC PARTICIPATION

6.1 Introduction

The basic objective of the consultations is to raise awareness, get feedback from the stakeholders and improve decision-making by tapping on local knowledge and information through the involvement of individuals, groups and organizations with a stake in the proposed project. The public consultation was viewed as an important activity of the ESIA study. It helped the study team to get the stakeholder's views on the perceived environmental and social issues in the project area including their ideas on how the prevailing problems could be mitigated. It is indeed expected that consultations for the proposed project will continue throughout the project implementation phase.

6.2 Methodology

Participatory public consultation for this project was carried out with a wide range of stakeholders in the project area, relevant government institutions, Non-Governmental Organizations (NGO's), Community Based Organizations (CBO's) and other interested parties. In particular, the team held interviews and discussions with the several key Government and parastatal organizations such as:

- Nakuru County Commissioner;
- Deputy County Commissioner;
- Kenya Wildlife Service (KWS);
- Kenya Forest Service (KFS);
- Kenya Marine and Fisheries Research Institute (KMFRI);
- Water Resource Authority (WRA);
- Energy and Petroleum Regulatory Authority (EPRA);
- Kenya Electricity Transmission Company (KETRACO);
- Kenya Power and Lighting Company (KPLC); and
- Kenya Electricity Generating Company (KenGen) among others.

In addition, the team held consultations with private organizations, non-Governmental organizations and Community based organizations including:

- Akiira One Geothermal Company Limited;
- Orpower 4 Inc Ltd;
- Elsamere Conservation Centre;
- Oserian Development Company Ltd/ Bohemian Flowers Limited;
- Kwa Muhia Environmental Group;

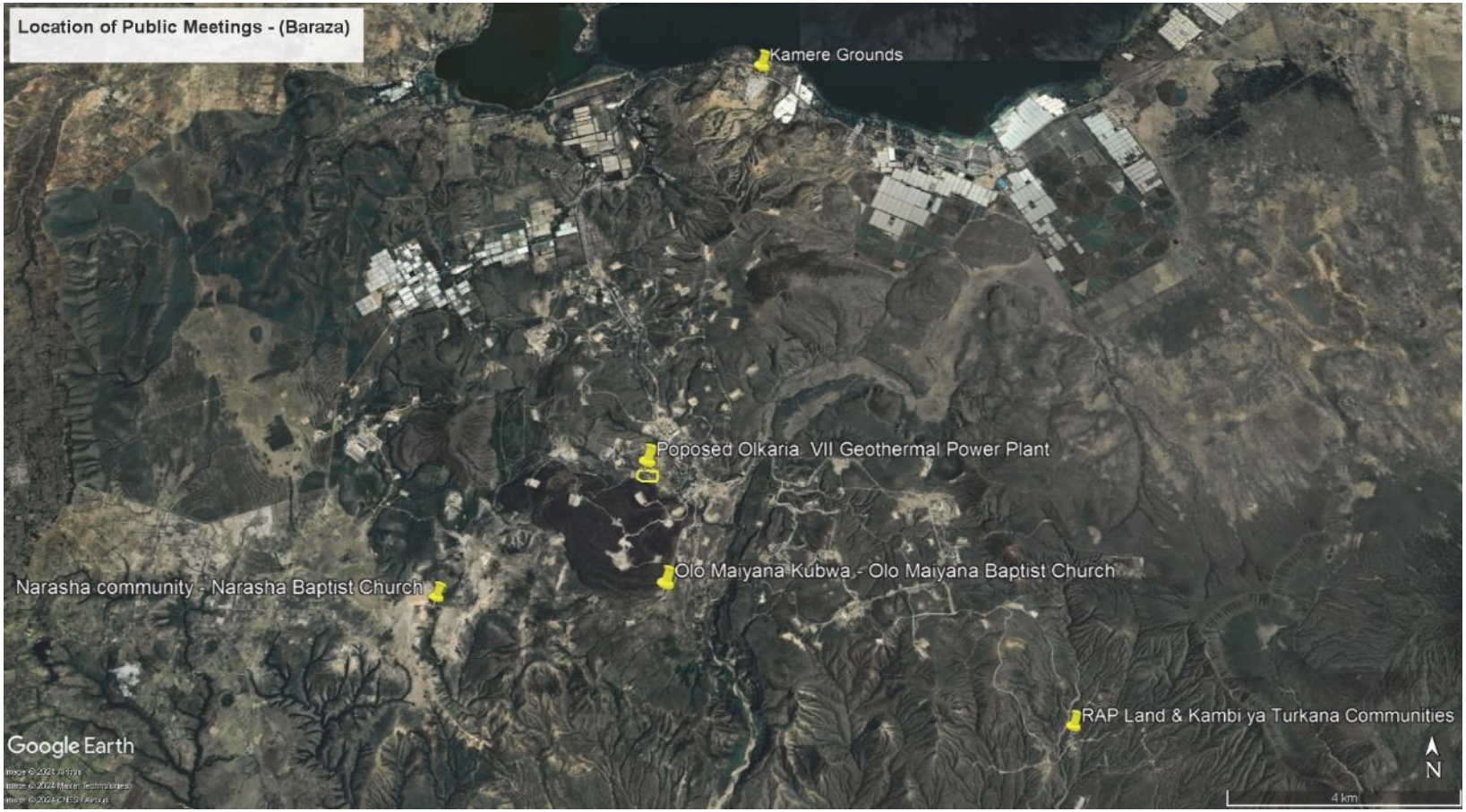
- Lake Naivasha Riparian Owners Association (LNROA);
- Lake Naivasha Growers Group; and
- Lake Naivasha Water Resource Users Association, among others.

The team also held public meetings (**baraza**) and interviews with local communities in the project area that were likely to be affected in one way or another by the proposed project. This included the Assistant County Commissioner, Chief and Assistant Chief of Olkaria location, local community leaders of the larger Kamere mixed community, Narasha Maasai community, Ol Maiyana Kubwa Maasai community, the RAP Land Maasai community and Kampi ya Turkana community.

Table 6.2-1 public meetings (baraza) locations

Place of Residence	GPS location	Meeting Venue	Date	Time
Kamere	0°49'09.1"S 36°19'16.8"E	Kamere Grounds	Wednesday June 28th, 2023	9:00 am
Ol Mayiana Kubwa	0°54'53.91"S 36°18'18.98"E	Baptist Church Grounds	Wednesday June 28th, 2023	2:00 pm
Narasha	0°55'0.51"S 36°16'7.69"E	Community Grounds	Thursday June 29th, 2023	9:00 am
RAP Land & Kambi ya Turkana	0°56'14.22"S 36°22'8.27"E	RAP Land Grounds	Thursday June 29th, 2023	2:00 pm

The map below (Map 6.2-1) shows the GPS locations of where public participation meetings were held within the project area.



Map 6.2-1 Public meetings (baraza) locations

Selected public participation photos

Figure 6.2-1 Ol Maiyana Kubwa Baraza

Figure 6.2-2 Narasha Community Baraza

Figure 6.2-3 RAP Land Community Baraza

6.3 Public Consultation meetings

Strong stakeholder relationships can help to facilitate trust, credibility, understanding, collaboration, and cooperation. Overall, a total of 25 consultation meetings were held over a period of 15 days and 130 stakeholders were consulted. During the public participation meetings, the socially vulnerable people (Women, elderly people, youth and disabled people) were involved in the process. Annex 14 presents the details of the consultations, including the date the consultations were held, number of people met, issues discussed (expressed as appreciation, concerns raised, and remarks made). A summary of the main issues captured in the stakeholder consultations are presented hereunder.

6.3.1 Stakeholder appreciation of KenGen activities in the project area

All the stakeholders interviewed welcomed the proposed Olkaria VII geothermal power project. They appreciated the role KenGen has played in the production of geothermal power and the positive impact the Company has created during the implementation and operation of previous projects. This includes the community development and the protection as well as conservation of the environment in the project area. With regard to the management of Hell's Gate National Park, a key issue of appreciation between KenGen and KWS is the existence of a Memorandum of Understanding (MOU). The MOU has in time facilitated cordial resolution of problems between the two parastatal organizations and improved their relationship. Aspects of KenGen projects in and around the Hell's Gate National Park that attracted KWS appreciation included:

- KenGen Support in provision of water to the wildlife especially during very dry seasons;

- Implementing measures to reduce impacts of geothermal activities including painting of the steam pipelines to reduce visual intrusion and creating loops on the steam pipelines to allow passage of large animals; and
- Some of the KenGen facilities including the SPA do increase tourist attraction of the protected area.

The stakeholders greatly appreciated the support they receive from KenGen in many aspects of development of the project area with particular emphasis on:

- Support for waste management in the project area;
- Roads rehabilitation and watering to kill the dust;
- Providing buses for transportation of children to school;
- Sponsorship of needy but bright students;
- Support in building of schools and health centres;
- Support for environmental protection through planting of trees and prevention of soil erosion;
- Resettlement of the Maasai communities residing in KenGen land;
- Increase in employment opportunities;
- Provision of transport facilities;
- Creation of business opportunities;
- Increased immunization cover of children;
- Maintenance of the roads' infrastructure;
- Education sponsorship to the bright students from the project area; and
- Provision of drinking water to all communities.

6.3.2 Issues Raised by the Stakeholders

The ESIA Consultant's team held different meetings with the key stakeholders to ensure that all interested parties were involved. It is worthwhile to note that all the stakeholders engaged were very positive about the proposed project and they welcomed its installation in the project area. Indeed, the people felt that the proposed project is a blessing to them and it will solve their many challenging problems such as unemployment among others. The project created very high expectations such as employment opportunities, scholarships, electricity connectivity, water projects and access to bursaries among the local community in the project area and its surroundings.

6.3.3 Project perceived benefits

The stakeholders' perceived benefits likely to arise following the implementation of the proposed Olkaria VII power plant project include creation of employment opportunities, promotion of businesses in the project area, generation of electricity, and boosting the national economy, among other benefits.

Employment opportunities

The most important social issues emanating from the stakeholders' consultations is job creation. All the stakeholders in the areas visited agreed that the project should offer employment to the local community once the project commences. They requested for more permanent employment opportunities while most women requested for gender equity in employment. The KenGen staff in attendance during the consultations informed the stakeholders that the proposed project will offer employment opportunities to the local community in accordance to the KenGen guidelines and employment policy. However, the contractor is independent and will decide the kind of opportunities they will offer to the local communities.

Business opportunities

The local community including the women and youth stakeholders requested to be given business opportunities in the project. This includes being awarded tenders and other services. They said this would improve their socioeconomic status. Some of the youth stakeholders wanted to know if the contractor would offer them internship and training opportunities when the project starts. In this regard, the stakeholders were informed that KenGen usually offers tenders to the local community to either supply materials or services in their projects. They were promised that the same will be done in the proposed Olkaria VII geothermal power project.

Supply of electricity

Many stakeholders praised KenGen for championing green energy production. The proposed Olkaria VII geothermal power project is a source of electric energy which is a key component for growth and development in Kenya. Several stakeholders noted that electricity is produced in the area but they do not enjoy the services. They therefore requested for electricity supply be provided to them from Olkaria. The stakeholders were informed that the role of electricity supply and connection is done by Kenya Power and Lighting Company (KPLC). The increased power from the proposed project will help to meet the country's electricity demand, reduce power outages and boost economic development.

6.3.4 Stakeholder concerns

Air emissions

Several stakeholders raised concerns on the air emissions from the power plants. The complaints received from the stakeholders especially members of the local community are summarized below as follows:

- Complaints were raised on the hydrogen sulphide smell with claims that people develop breathing problems when they inhale the gas;
- Hydrogen sulphide enhanced rusting of iron sheet rooftops (**mabati**) and green houses' metallic flower structures with subsequent reduction of the lifespan of the green houses;
- Some stakeholders complained of increase in hydrogen sulphide levels and subsequent effects including vomiting, headaches and miscarriages. Some pregnant women, however, liked the smell of the gas; and
- Narasha and Eburru communities complained that growth of their crops is affected by the hydrogen sulphide plumes.

With regard to the effect of hydrogen sulphide emissions on crops, it is noted that a study conducted to investigate the effect of geothermal emissions from cooling towers and gas ejectors on flowers grown in the vicinity of KenGen Olkaria geothermal power plants and Oserian Development Company areas, showed that that hydrogen sulphide emissions did not have any effect on the growth of flowers (Kollikho and Kubo, 2001). Although hydrogen sulphide (H_2S), a major constituent of air emissions is toxic to humans at high concentrations, and may have long-term negative impacts at lower concentrations, the concentration (of hydrogen sulphide) prevalent among the receptors is much lower than the maximum allowable levels (150ug/l) recommended by NEMA and WHO. Air emission modelling for Olkaria VII project demonstrated that the normal operations of the proposed geothermal plant met the NEMA Ambient Air Quality Regulations and will not lead to any exceedances of Human Health Occupational Exposure Limits stipulated under Factories and other Places of Work (Hazardous Substances) NEMA Rules, 2007. Indeed, the highest predicted average daily H_2S concentration at a receptor was 20.0 µg/m³ which is below the Kenyan daily ambient air quality limit value of 150 µg/m³.

Stakeholders were informed that research is still on-going on impacts of hydrogen sulphide emissions and so far, the amount in the air has not been found to have any adverse effect on human health. They were further informed that the feasibility study is currently conducting further research on the issue and more information will be shared once the results are published.

Disposal of brine

Complaints had been lodged in relation to spillage of brine and resultant pollution of the environment and subsequent contamination of grazing fields and poisoning of wildlife and livestock. The stakeholders wanted to know the disposal methodology of the brine from the geothermal power plants and requested the brine lagoon to be fenced off. The stakeholders were assured that they do not need to worry about brine since it will be re-injected into the ground. Indeed, there are already seven (7) wells that have been drilled

and set aside for re-injection of produced brine. Furthermore, brine is a key resource for KenGen for the purpose of maintaining of well pressures and also for the purpose of compliance to legal requirements.

Degradation of Lake Naivasha catchment area

Lake Naivasha Riparian Owners Association (LNROA) and several other stakeholders were very concerned about the future of Lake Naivasha. As a source of fresh water for irrigation, the lake has always been a hub of socio-economic development in Naivasha Sub County. Recently (2009 – 2010), however, River Malewa water flow which provides 90% of Lake Naivasha discharge did not reach the lake for two months. The stakeholders were concerned about the current degradation of Lake Naivasha catchment which portends grave consequences on the future of the lake. Other environmental problems facing the lake were identified as follows:

- Due to the degradation of the catchment, Lake Naivasha is facing an acute siltation problem;
- Wastes from the Kihoto settlement (a relatively recent development on the riparian zone to the north of Lake Naivasha) contributes immensely to the pollution of lake water; and
- The land around the lake is flaunt with land grabbing issues with the people cultivating on the fringe zone as the lake water recedes with resultant effect on the lake water quality.

It is noted, however, KenGen is a member of Lake Naivasha Riparian Association and Water Users Association and plays a key role in influencing and implementing conservation efforts within Naivasha Basin.

Disturbance and loss of biodiversity

Many stakeholders were concerned that the proposed geothermal project is likely to interfere with the flora and fauna in the Hell's Gate National Park resulting in loss of habitat and biodiversity. In several consultative meetings, they engaged the Consultants on serious debate on modalities of sustainable exploitation of Olkaria geothermal resources without compromising wildlife conservation in Hell's Gate National Park. In some of the meetings, the stakeholders recalled three instances where geothermal project activities were detrimental to wildlife including:

- A case where geothermal well facility was the cause of mortality to one of the Lagemeyer vultures introduced in the Hell's Gate National Park in 1998;
- A giraffe was electrocuted near Olkaria 1 Additional Unit; and
- Another giraffe was entangled on the loop of steam pipelines and died a painful death near Narasha local community area.

The stakeholders further noted that the activities involved in the production of geothermal power are conducted in an ecologically sensitive area and hence the following concerns:

- Increased geothermal activities inside the National Park may push animals further away outside the park boundaries;
- There were concerns about littering in the park especially during project construction activities;
- Some stakeholders said the Olkaria area is environmentally stressed due to KenGen geothermal activities;
- Geothermal activities have increased the spread of invasive species in the protected area;
- Stakeholders wanted KenGen to put in place modalities of reducing loss of biodiversity during construction;
- Geothermal operations have a negative effect on the safety of the vultures and other birds of prey in the project area. Several stakeholders felt the vulture population in Hell's Gate National Park is diminishing; and
- Project construction activities are likely to increase dust, noise levels and hydrogen sulphide in the area.

With regard to the above concerns, it should be noted that KenGen is committed to the protection of habitat and biodiversity of the area of operation including the conservation of the Hell's Gate National Park. Before implementation, every project undergoes a detailed environmental and social impact assessment (ESIA) with inclusion of mitigation measures to reduce loss of habitat and biodiversity. Towards this endeavour, mitigation measures (including their costing) have been proposed for the protection of the habitat and the biodiversity of the project area including:

- Discourage any wanton destruction of vegetation and habitats beyond the designed project works;
- Restore lost biodiversity on the disturbed area through planting of appropriate trees and shrubs and protection of fauna species and their habitat;
- Eradication of alien plant species in the project area;
- Participation in monitoring and biodiversity investigations with other stakeholders including KWS and KMFRI;
- Increase surveillance and security in the Hell's Gate National Park during the construction stage, and
- Installation of loops along the steam pipeline system to facilitate movement of animals in the impacted area.

In addition, KenGen will undertake to conduct sustained monitoring of changes in biodiversity and changes in habitat of the project area during the process of project implementation.

Changes in land use

Concerns were raised on the change of land use especially at the Kedong Ranch, a facility established in 1974 for the rearing of livestock including cattle, goats, sheep, camels and horses. Recently subdivision of land in Kedong Ranch has commenced thus opening the way for other land uses in the area. With the subdivision of land and subsequent change in land use, animal dispersal from the Hell's Gate National Park to the Longonot National Park will cease with severe consequences on wildlife conservation.

Influx of project workers

Following the commencement of the projection activities especially during the project construction phase, there will be an influx of project workers in the project area. The following concerns were raised on the effect of increasing labour force:

- Increased poaching and snaring of animals and littering the Hell's Gate National Park environment;
- Increased noise levels emanating from Contractor's use of machinery;
- Construction activities have the potential to scare away the animals and interfere with feeding and breeding activities;
- Increased human population is likely to trigger problems of waste management;
- Over speeding of contractor's vehicles could cause fatal accidents inside the park and surroundings;
- Increase in cultural contamination;
- Increase in infectious diseases including sexually transmitted disease such as HIV/AIDS; and
- Increased demand for water, power supply and social services.

6.3.5 Other issues raised by the stakeholders

Other issues raised by the stakeholders touched on several attributes including relationship among KenGen, KWS and KETRACO, issues on transmission lines, noise levels, implementation of ESIA recommendations, soil erosion and siltation, subsidence, security, expansion of KenGen activities, environmental protection, scholarships and community expectations.

- **Relationships between KWS and KenGen -** Expressed concern on the state of relationship between KenGen and KWS - with friction developing on the ownership of resources in the project area between the two institutions, a situation likely to affect implementation time of projects;
- **Challenges in building transmission lines -** During the process of constructing power transmission lines in the project area, KETRACO faces many challenges from the Maasai

community, which harbour great expectations such as KenGen's cooperate social responsibility which KETRACO is not able to meet due to limited budget. A need was expressed to have a joint coordination mechanism between KenGen and KETRACO at operation level in order to remove constraints between the two institutions.

- **Increase in noise levels –** Stakeholders complained that noise pollution emanating from the proposed power plant and the contractor's use of machinery would create nuisance to the community and also scare away animals and interfere with their feeding and breeding activities.
- **Poor implementation of ESIA recommendations –** Some stakeholders felt that the social component in ESIA studies has been wanting and the implementation of project environmental and social management plans (ESMP) were not carried out as described in the Consultants' reports.
- **Soil erosion and siltation -** Activities associated with the construction and implementation of the proposed Olkaria VII project will increase soil erosion in the project area and siltation of water bodies in the area of operation;
- **Occurrence of subsidence -** The abstraction of steam is likely to affect stability of the Rift Valley floor including the occurrence of subsidence;
- **Security Issues -** Following the establishment of RAP Land settlement area, there has been increased volume of people crossing the park with subsequent compromise to the security of the protected area and KenGen geothermal installations.
- **Expansion of KenGen activities -** Continued expansion of KenGen geothermal activities is diminishing the habitat for wildlife population and increase wildlife/ human conflicts outside the park.
- **Environmental protection in community areas**

  Stakeholders raised concerns on the state of environment in their respective community areas. Others requested KenGen to restore all the areas that will be evacuated during the construction phase of the project. In addition, they requested to be supported with tree nurseries so that they can raise tree seedlings and plant trees to protect the environment and safeguard climate change challenges.

  The stakeholders were commended for their interest in environmental restoration and protection. They were further informed that KenGen has a tree nursery initiative which supports any community that would like to plant trees. This is in line with the call to plant 1.5 billion trees per year by the president. Stakeholders were asked to visit KenGen offices for more information on the tree nurseries.
- **The need for scholarships**

Many stakeholders raised questions on the availability of scholarships for their students. Others wanted to know if KenGen/project will support construction of schools in certain areas. The KenGen staff in attendance informed the stakeholders that the company provides scholarships to the bright and needy students from the local communities who meet KenGen's criteria.

- **Corporate social responsibility**

  Many stakeholders appreciated the benefits of the proposed Olkaria VII power plant and commended KenGen's role in generation of electricity and generous support to the communities through the Corporate Social Responsibility. The Maasai community have high demands from KenGen at Olkaria, but KenGen is limited in what it can legally provide to the community. The stakeholders requested several community projects from KenGen including water projects, sanitation, schools and tree planting.

  The stakeholders were informed of the KenGen Corporate Social Responsibility (CSR) programme. They were encouraged to write and send proposals to KenGen which has a committee that reviews and approves the proposals based on merit and availability of funds to support the approved projects.

- **Community expectations**

  Many members of the local communities have great expectations and perceive KenGen as an institution to provide job opportunities. There is therefore a need to raise awareness on KenGen's role in geothermal activities among the communities of the project area in order to increase their level of understanding and manage their expectations such as removing any misconceptions they may have on the Company's role and operations in regard to its support to the local community.

6.3.6 Stakeholders' recommendation

During the public participation meetings, the stakeholders proposed several recommendations on modalities of resolving environmental and social issues emanating from the implementation of the proposed Olkaria VII geothermal power plant project. Among the recommendations/ proposals, put forward, by the stakeholders include the consideration for KenGen to:

- Protect wildlife habitats and compensate for the loss of biodiversity by planting more plants including trees, shrubs and grasses as found appropriate;
- Join the conservation forums in Naivasha area and play an active role in resolving the prevailing conservation issues;

- When called upon collaborate / partner with other stakeholders in mobilizing resources to acquire and develop clear wildlife corridors between Hell's Gate and Longonot National Parks, between Eburru and Lake Naivasha and between Suswa and Oserian;
- Create synergies with other players and stakeholders around the Lake Naivasha for the purpose of holding a deep conversation on how to solve the current degradation process facing Lake Naivasha;
- Put in place practical mechanisms of dealing with noise and hydrogen sulphide pollution and disposal of brine;
- Incorporate other sources of energy in the production of electricity especially the hybridization of steam and solar energy;
- Explore other ways of utilizing the steam including production of drinking water;
- Start a programme to purposely educate, enlighten and increase awareness among the communities of the project area and environs on power production activities in Olkaria including the management of brine disposal, effect of noise and hydrogen sulphide and corporate social responsibility, among other issues;
- Many members of the local communities have great expectations and perceive KenGen as an institution to provide job opportunities. There is therefore a need to raise awareness on KenGen geothermal activities among the communities of the project area, in order to increase their level of understanding, manage their expectations and remove any misconceptions they may have on the Company's role and operations;
- Contribute in the conservation of Mau Forest ecosystem including Eburru area, where the production of geothermal energy is taking place;
- Work with other stakeholders including KWS and KFS in developing the ecotourism potential of Eburru area;
- Intensify the tree nursery activities including raising seedlings that are relevant for the rehabilitation of Olkaria environment; and
- Fence and secure all the brine lagoons and prevent both domestic and wild animals from drinking the brine.

6.4 Public Disclosure

Upon completion of preparation of the draft ESIA report, a national consultative disclosure meeting was held on 28th November, 2023 at the Astorian Grand Hotel in Naivasha town. The meeting brought together key players to express their views and concerns on the proposed project's ESIA report. Following the disclosure of the ESIA report, the participants discussed the contents of the ESIA report and contributed to

its finalization. A summary of the views and comments that emanated from disclosure meeting on the ESIA report are highlighted in Table 6.4-1 below as follows:

Table 6.4-1 Summary of the views and comments of the Stakeholders

Issues and comments	Responses
Brine Disposal • How is the brine discharged? Are the wells deep or can they contaminate existing aquifers?	• The brine wells are cased and the re-injection is very deep therefore there is no contact with the aquifers. Water samples from springs in the project area are regularly tested and there are no heavy metals found; all the elements are below WHO guidelines.
Water abstraction • The presentation did not cover the issue of water abstraction from Lake Naivasha and how to handle over abstraction of water from the lake. • WRA has up to date data on water abstraction and will share it to the team.	During the assessment, KenGen provided some data but we were not able to get data for all water abstractors.
Inclusivity • WRA needs to be included as part of collaborators of KenGen. • KWS should be included under monitoring of snares.	• Noted. At the corporate level, KenGen is a member of Lake Naivasha Riparian Owners Association.
Grievance Redress Mechanism (GRM) • Grievance redress mechanism (GRM) was not covered in the presentation	• GRM is covered in the report although it was not presented in the disclosure meeting.
Cumulative Impacts • The cumulative impact assessment is an important aspect	• KenGen conducted Strategic Environmental Assessment (SEA) which factored in the cumulative impacts.
Roads within the project area • Road drainage allows water to flow into the gullies which affects the downstream communities – there are no stop gap measures for this in the report. • Roads within the project area should have signs including speed limits.	• Noted. Necessary measures will be taken. • Noted. Necessary action will be taken.
Securing the wildlife corridor • The subdivision of Kedong ranch is likely to affect the wildlife corridor. KenGen and KWS should liaise to secure the wildlife corridor.	• KWS was requested to take the lead in securing wildlife corridor.
ESMP • Under implementation, brine disposal and soil erosion after construction is not covered in the plan.	• They are covered in the report.

6.5 Grievance Redress Mechanism

This section describes the procedures to be followed in handling complaints and grievances during project preparation, implementation and operation. Grievance redress mechanisms (GRM) provide a structured and transparent process for addressing and resolving complaints, concerns, or grievances raised by stakeholders. This mechanism ensures that people have a platform to express their grievances, seek redress, and receive fair treatment. The main objective of the GRM is to ensure that KenGen at both corporate and operational levels, is aware of and responds to stakeholder concerns. In addition, the GRM provides important management information such as identifying emerging stakeholder and community concerns and addressing them proactively through projects planning and operations. The GRM is designed to empower KenGen to successfully and effectively manage project grievances and complaints. The objectives of the grievance resolution mechanism will be:

- To create a mechanism through which affected people can communicate their dissatisfaction or grievances;
- To create a mechanism through which the project will be able to pick-up all the complaints;
- To create a mechanism through which the project will systematically, promptly and exhaustively respond to peoples' complaints; and
- To create avenues through which affected people and the project can come together in order to solve problems and handle emerging issues.

To achieve the above, KenGen will ensure it complies with measures outlined in the textbox below:

- Handles grievances in accordance with the GRM and site-specific grievance procedures, giving due consideration to confidentiality and legal requirements.
- Undertakes to assess each complaint and grievance objectively and to fully investigate all issues.
- Remedies impacts, address causes and takes all required actions.
- Monitors grievance resolution and keeps stakeholders informed of the progress and outcomes of the grievance remediation process.
- Trains and implements procedures which will ensure that all KenGen grievance management teams and its employees comply with the GRM.
- Follows established reporting requirements related to grievance management and ensures that all high severity complaints and grievances are given due priority.

- Ensures that KenGen legal department is properly informed and consulted on any grievances which have legal ramifications.
- Publishes the GRM process in KenGen's project sites using appropriate and easily accessible areas.

Given the low social impact of the project it is not very probable that people will become negatively impacted by the project. Any negative impact, however, needs to be mitigated promptly in order to avoid unnecessary tensions and conflicts. The strategy to be adopted will promote involvement of the lowest level authorities since they are easily accessible to the people. The strategy will also include a combination of the legal requirements and socially/customarily acceptable practices.

6.5.1 Key Grievance Management Principles and Guiding Standards

This GRM outlines the principles of grievance management and defines the organizational structure and processes required to implement a functional, effective and culturally appropriate grievance mechanism that is responsive to stakeholder needs. The GRM describes the steps in the grievance management process, recommends timeframes, describes key roles and responsibilities in grievance management by KenGen. The GRM recognizes that there may be different national regulatory and/or cultural requirements, specific types of community and public concerns as well as internal organizational arrangements. The key principles followed in implementing the KenGen GRM are summarized in the textbox below:

- **Appropriate to KenGen project scope**: The grievance management must be formalized in proportion to the level of potential risks and potential impacts on affected communities, stakeholders and workers posed by the proposed Olkaria VII project;
- **Culturally appropriate** to KenGen's project sites and reflecting the ways in which each community handles their concerns;
- **Accessible** to all members of the public, individual and institutional stakeholders at no cost, with no retribution and with possibility to access all available alternative grievance resolution remedies recognized by the project, national and international legal systems;
- **Clearly communicated** the KenGen GRM and associated grievance procedures will be communicated through appropriate and relevant channels in the project sites;
- **Transparent, fair** and with clear grievance resolution accountabilities.

6.5.2 Grievance Management Process

In order to ensure that complaints are received and addressed appropriately and in a timely manner, a grievance redress structure that is responsive, easy to understand and implement is necessary. The proposed approach accords the complainant a range of options to use with clear timelines on when to expect a response to issues. The process will be managed by a Grievance Manager who will ensure that all the complaints are logged by grievance coordinators and can be tracked to ensure compliance with the laid down procedures. The grievance process requires that in the proposed Olkaria VII project site, incoming grievances are recorded, tracked and managed by the respective Grievance Coordinators. The process allows an ongoing flow of information, enabling KenGen to understand and monitor the grievances impact over the course of project implementation. The GRM will work within the existing legal and cultural framework and should be incorporated to the existing GRM within KenGen.

7 POSITIVE IMPACTS OF THE PROPOSED PROJECT

In implementing the Olkaria VII geothermal Power project, KenGen is in line with the Low-Cost Power Development Plan (LCPDP), 2022 – 2041. The proposed project will have significant positive environment impacts when compared to other forms of power production including the thermal power production which involves the burning of fossil fuel. The major positive impacts of the project will include stabilization of electricity in Kenya, potential for carbon market, contribution to reduction of carbon emissions, promotion of economic growth in the country, contribution to the Government revenue, increased employment and increased business opportunities among other positive benefits.

7.1 Stabilization of Electricity

The development of Olkaria geothermal power plant will play an important role in the stabilization of power situation in the country. The project will add 80.3MWe into the national grid. This will be a relatively cheap power source since geothermal power is the least cost source of baseload energy for the Kenyan power system. Although hydro power development is also relatively cheap, there is a scarcity of suitable hydropower sites for exploitation in Kenya. Furthermore, hydro power is proving to be very unstable due to climate change and subsequent variability of the hydrological regime in the Tana River catchment. Failure to implement Olkaria VII geothermal power project as planned, will result in deficit of 65 to 100MWe in the years 2029, 2030 and 2031. This is likely to have far reaching implications in the country including a situation of power shortages, reliance on non-sustainable power sources and a slowdown on the country's development objectives.

7.2 Potential for Carbon Market

The proposed project has the potential to meet all the necessary requirements to become a carbon project under the Clean Development Mechanism (CDM). The proposed project will achieve CO_2 emission reduction by replacing electricity generated by fossil fuel fired power plant connected to the national grid. The annual value of CO_2 reduction for Olkaria VII geothermal power plant project has been estimated to be US$29,250,000 (WestJEC, 2024).

7.3 Promotion of Economic Growth

This project will play a significance role in stimulating economic growth in Kenya. The power input will contribute significantly to the Kenya's Rural Electrification Programme which has potential to promote spin-off effects on rural economy in Kenya. Today the energy situation in Kenya is unsatisfactory as evidenced by the frequent unplanned power outages, an important circumstance which slows down the

economic development in the country. Power produced by this project will to some extent alleviate the situation and contribute to the promotion of economic growth in Kenya.

7.4 Increased Employment Opportunities

The proposed Olkaria VII project will create job opportunities in the project area and beyond. Direct job opportunities will be available for high calibre professionals including engineers, information technology (IT) personnel, mechanics and consultants. It is, however, unlikely that the local community will benefit from this calibre of specialised job market. Of greater relevance to the local community will be job opportunities involving unskilled and semi-skilled labour force especially during the construction of the power plant and accessories, rehabilitation of the access roads and installation of the steam pipeline system and water supply, among other construction activities. Indirectly the project will create opportunities for self-employment in the project area especially during the rehabilitation of the roads and the construction of the geothermal power facility. Since the project will require local materials for the above project activities, the local community stand to benefit from their engagement in several activities including the making of ballast, collection of sand, mining of murram, cutting of building stones, making of concrete blocks and transportation of goods and building materials. Other employment opportunities in the project area will spring from spin-off activities including trade, accommodation, and supply of goods and services to both the skilled and unskilled labour.

7.5 Increased Contribution to Government Revenue

The project will contribute toward the boosting of Government revenue. The project proponent (KenGen) will pay corporation tax at 30% of net profit. The project will generate income to the Government through EIA license fee of 0.05% of the total cost of the project (to a minimum of KSh 10,000 and a maximum of KSh 1,000,000) fee to NEMA and through withholding income tax from remuneration paid to employees at graduated scale rates. Through engagement of employees, the project will generate revenue for the Government in the form of Pay as You Earn (PAYE). The project will pay Value Added Tax (VAT) at most of the items bought for the installation for the geothermal power project. In addition, the Government will benefit from other taxes including operating licenses.

8 NEGATIVE IMPACTS OF THE PROPOSED PROJECT

Although the proposed Olkaria geothermal power project will realize tremendous economic benefits and other positive impacts as outlined above, it will also have negative effects on the environment of the project area as discussed below.

8.1 Negative Impacts on Socio-economic Environment

The socio-economic negative impacts of the project will be triggered mainly by the increased population in the project area following the commencement of the implementation of the proposed geothermal power project. As the local community and other people from outside the project area respond to employment opportunities, the project area and the surrounding Naivasha area, will witness an increase of people. This influx of people is likely to lead to a number of negative socio-economic impacts including cultural contamination, increased incidences of diseases, increased insecurity and community conflicts, challenges of labour force management, increased accidents and occupational hazards, among other negative impacts.

8.1.1 Cultural contamination

The implementation of the proposed project will facilitate interaction of people of different cultures in the project area. Although the local community, the Maasai is a fairly a conservative society, influence from outsiders is likely to impact negatively on the local community cultural norms and practices. To some extent, there will be changes in community values, clothing, behaviour and other attributes. Based on experiences from other projects, the project workers from different cultures are likely to introduce unfavourable social behaviour including theft, increase in the consumption of alcohol and drugs, production of illegal brews and introduction commercial sex among other vices. This will promote cultural contamination in the project area leading to long-term erosion of the normal community morals, values and other modes of cultural way of life.

8.1.2 Increased poaching and exploitation of natural resources

As stated above, during the project's construction phase there will be high number of people in the project area. The increased number of workers are likely to make high demand on natural resources of the project area especially in KenGen land and the Hell's Gate National Park. This area is expected to experience increase in cases of poaching and snaring of animals for bush meat. In addition, the project workers are likely to exploit the area for fire wood, building material and charcoal.

8.1.3 Increased incidences of diseases

The influx of people in the project area and environs is likely to increase the incidences of diseases. The situation will be aggravated by the entry of commercial sex workers into the project area following the

commencement of project activities. There is therefore the risk of contracting sexually transmitted diseases (STD5) especially the dreaded Human Immuno-deficiency Virus / Acquired Immuno-deficiency Syndrome (HIV/AIDS) among the project workers and the local community.

8.1.4 Visual intrusion

The geothermal power plant construction activities, road rehabilitation activities, steam installation works and other project activities are likely to create disfigured landscapes in the project area including the sites of the quarries and borrow pits. In addition, there will be large spoils along the road, around the quarries and periphery of the borrow pits and other places along the steam pipe routes. The resultant disfigured landscapes and mounds of spoils are visually intrusive. In addition to the soil mounds, presence of machinery, equipment and materials on the project site will be visually intrusive.

8.1.5 Potential impact of labour force

Depending on the mode of human management on the project site, the project workers especially during project construction phase are likely to indulge in activities that are likely to cause negative impacts on the environment of the project area as discussed above. Furthermore, labour camps for project workers are usually fraught with sanitation and waste disposal problems that are likely to have negative impacts on the environment. Wastes generated by the construction workers including food remains and human wastes could attract animal pests and vermin including rats, crows, flies etc. to the construction sites with resultant implications on the spread of diseases. As a whole the establishment of labour camps in the project area will definitely present serious management challenges to the Contractor and Resident Engineer.

8.1.6 Increase in pollution from solid wastes and effluent discharge

It is expected that various solid and liquid waste streams will be generated from activities associated with the project construction and operation phases. It is envisaged that the major waste streams are likely to be:

- Domestic effluent; and
- Miscellaneous solid wastes.

The labour campsites are expected to produce considerable quantities of domestic effluents containing a wide range of substances which have high potential to pollute the environment if not properly disposed of. Solid wastes generated from the labour campsites will have diverse composition of material including paper, glassware, plastic material, food remains, metallic cans and other heterogeneous material. Solid wastes have potential to pollute the environment since they cause visual intrusion and form suitable breeding sites for flies and vermin which can transmit diseases to human beings in the project area.

8.1.7 Increased accidents and occupational hazards

Implementation of the project will definitely increase volume of human and motor traffic in the project area and surroundings. The increase in human and motor traffic will be aggravated by the transportation of construction materials and proposed geothermal power plant equipment required to install the power plant facility. This is likely to result in a higher risk of accidents occurring in the area of operation especially during the road rehabilitation, power plant construction and operation stages.

During the implementation of the project, several activities including vehicular transport, operation of heavy machineries and blasting of hard rock in quarries have potential for accidents risks both among the project workers and the local community. Factors that may exacerbate this situation include inadequate appropriate protection gear for project workers including the helmets, overalls, boots and gloves. Based on the nature of technology involved, construction, operation and maintenance activities associated with the geothermal power plant have potential occupational hazards with regard to work force engagement. The nature of occupational hazards will include:

- Machine/equipment injury risk;
- Occupational noise and vibration;
- Fire risk;
- Risk of exposure to electro-magnetic radiation;
- The risk of electrical shock; and
- Miscellaneous hazards.

8.1.8 Land acquisition and involuntary resettlement

The project area for the Olkaria VII geothermal power project is located in KenGen land, close to the southern boundary of Hell's Gate as shown in Map 1.4-4 Areas of Interest for Olkaria VII Plant Site. Through a rigorous selection criterion, Site No 1 was selected for the Construction of Olkaria VII power plant and accessories. Hence there will be no acquisition of land for the construction of Olkaria VII geothermal power plant. Since there are no local communities residing in the project site and the surrounding area, the project will not displace any human communities. The project does not have any project affected persons and there will be no relocation or involuntary resettlement of the project affected persons (PAPs).

8.2 Negative Impacts on Bio-physical Environment

Project activities during the construction and operation of the proposed geothermal power facility will cause negative effects on the bio-physical environment of the project area. Specifically, site preparation activities including the clearing and trampling of vegetation, excavation of soils and other geological formations,

levelling of landscape and general construction work will trigger direct negative impacts associated with loss of habitat, destruction of floral and faunal communities, soil erosion, dust pollution, siltation and other related negative impacts.

8.2.1 Increased soil erosion

Increased soil erosion is likely to occur in the project area during the road rehabilitation, operations of borrow pits and quarries, construction of the geothermal power facility including buildings and installation of accessories. The presence of loose earth (resulting from the above activities) could lead to acute and chronic soil erosion problems in the project area. The situation is aggravated by the friable nature of sediments in Naivasha area and the poor vegetation cover prevalent in the whole of the project area.

8.2.2 Increased siltation of aquatic habitats

Some of the excavated sediments from the project site and the construction spoils emanating from excess excavated material and construction debris are unlikely to impact negatively on the environment of the project area and the nearby lacustrine habitat associated with Lake Naivasha. However, depending on the siting of the quarries and borrow pits, some of the generated spoils and other excavated material could be washed into the shore of Lake Naivasha with subsequent increase siltation of the lake water. This occurrence will have some limited ecological implications on the aquatic habitat. The silt particles entering Lake Naivasha aquatic system through runoff and silt laden winds can increase water turbidity and reduce the lake water transparency. The suspended material will cut down light penetration thus reducing the photosynthetic capabilities of the primary producers including the phytoplankton, benthic algae, periphyton and other aquatic flora.

8.2.3 Ponding

Construction work and other project activities may lead to creation of stagnant water bodies in quarries, borrow pits and depressions created during the project construction phase. Although water collected in the depressions may be a respite for the pastoralist in this dry area, the resultant stagnant water bodies are likely to be suitable habitats for the breeding of mosquitoes and snails that are disease vectors for malaria and bilharzia respectively.

8.2.4 Dust pollution

Project construction activities have the potential to generate high levels of dust in the project area. The situation will be aggravated by the aridity and the scarce vegetation cover in the project area. Areas where high dust production is likely to take place include sections where road construction is taking place and the quarries and borrow pits sites. The crushing plants also have great potential to generate high quantities of

dust thus creating hostile environment and a health hazard to the workers and nearby communities and vegetation.

8.2.5 Air emissions

Project construction activities will contribute to air pollution through gaseous emissions. This will emanate mainly from exhaust pipes of vehicles and machinery used in construction activities. The composition of gases released to the environment will include carbon dioxide, water vapour, organic acids, ammonia and traces of carbon monoxide, nitrogen oxides and sulphur oxides among other substances.

During the operation phase, however, air emissions will mainly be in form of hydrogen sulphide released from the cooling towers of the geothermal plants. Simulation was done using AERMOD software to predict the impacts of air emissions on the surrounding environment. The isopleths were used selectively to present areas of significance to the assessment criteria. Ground level concentration isopleths depict interpolated values from the concentrations simulated by AERMOD 10.2.0 for each of the receptor grid points specified. The areas of maximum concentration are depicted on Table 8.2-1 below in comparison to the Kenyan Air quality Standards. The maximum contour maps of the maximum Process Contribution (PCs) of H_2S at each receptor in the modelling domain are provided in Annex 10. In all instances, the maximum concentrations at the identified sensitive receptors were below the relevant standards and guideline values. Comparison of the maximum ground level prediction with the appropriate Ambient Air Quality Standards (AQS) indicates that the operation of the plant does not result in exceedance of the limit values.

In general, the maximum predicted impacts are estimated at sensitive receptors located at about 2km radius from the emission sources. However, at these locations the impacts are predicted to be below the daily and annual limit values specified in the Air Quality Regulations, 2014. The highest predicted average daily H_2S concentration at a receptor is 20.0µg/m³ which is below the Kenyan daily ambient air quality limit value of 150µg/m³. The highest predicted annual average concentration is 1.00µg/m³. Although annual averaging period is not regulated for H_2S in Kenya, this predicted long concentration is considered low as compared to the international best practice e.g., United States and Regional H_2S Gas Standards, Guidelines that specifies long term limit value of 1.5µg/m³. The maximum impacted receptors are Wellhead OW37, Olkaria II Power Plant, and Olkaria IV Power plant which are fall within the KenGen property areas and are considered as occupational exposure.

Table 8.2-1: Maximum predicted PCs of air pollutants compared with Air Quality Limits

Pollutant	Average Period	Maximum PC ($\mu g/m^3$)	Kenya Air Quality Limit ($\mu g/m^3$)	PC as % of the Limit
H_2S	1-hour	1,407	**NR**	**-**
	8-hour	349	**13,939**	**2.5**
	24-hour	125	**150**	**83.3**
	Annual	15.5	**NR**	**-**

NR – Not Regulated

Table 8.2-2 below shows the results for all source groups at the sensitive receptors to determine the impact on human health.

Table 8.2-2: Simulated results at the receptors

	H_2S ($\mu g/m^3$)			
Averaging Time	**1 hour**	**8 hours**	**24 hours**	**Annual**
Air Quality Standards	**NR**	**13,939**	**150**	**50**
Olkaria I Power Plant	14	5	1	0
Olkaria RIG Workshop	14	3	1	0
Wellhead OW37	100	50	10	1.0
Olkaria 1AU Power Plant	0	0	0	0
Maasai Cultural Center	0	0	0	0
Nearest part of Ol Njorowa Gorge	14	10	3	0.3
Ol Mayiana Kubwa Baptist Church	0	0	0	0
Ranger's Post	0	0	0	0
Ol Mayiana Kubwa Community	14	10	3	0.3
Olkaria V Power Plant	14	10	1	0.3
Nearest cliff serving as a nesting and roosting habitat for vultures	100	30	10	0.8
Olkaria II Power plant	100	30	10	1.0
KenGen SPA Facility	30	7	1	0.3
Olkaria IV Power Plant	100	30	8	1.0

The results in Table 8.2-3 below show the maximum predicted modelled concentrations for the proposed plant, modelled with the case of site expansion.

Table 8.2-3: Maximum Impact Air Quality Impacts for Case II

Pollutant	Average Period	Maximum PC ($\mu g/m^3$)	Kenya Air Quality Limit ($\mu g/m^3$)	PC as % of the Limit
H_2S	1-hour	2,812	**NR**	**NR**
	8-hour	667	**13,939**	**4.8**
	24-hour	251	**150**	**167.3**
	Annual	31	**50**	**62.0**

NR – Not Regulated

Table 8.2-4: Simulated Results at the receptors depicting the case for expansion Case II).

				H_2S ($\mu g/m^3$)
Averaging Time	**1 hour**	**8 hours**	**24 hours**	**Annual**
Air Quality Standards	**NR**	**13,939**	**150**	**50**

Olkaria I Power Plant	28	10	3	0
Olkaria RIG Workshop	28	7	5	0
Well head OW37	500	100	20	3.0
Olkaria 1AU Power Plant	0	0	0	0
Maasai Cultural Center	0	0	0	0
Nearest part of Ol Njorowa Gorge	28	10	6	0.7
O1 Maiyana Kubwa Baptist Church	0	0	0	0
Ranger's Post	0	0	0	0
O1 Maiyana Kubwa Community	28	10	6	0.7
Olkaria V Power Plant	28	10	3	0.3
Cliff serving nesting and roosting habitat for vultures	100	60	20	1.0
Olkaria II Power plant	100	10	20	3.0
KenGen SPA Facility	28	60	3	0.5
Olkaria IV Power Plant	100	40	10	1.0

Cumulative Impacts – Predicted Environmental Contribution

The cumulative results are calculated as:

Process Contribution (PC) + Background Contribution

The results in Table 8.2-5 show the maximum predicted modelled concentrations as well as background levels.

Table 8.2-5: Cumulative impact for case with case 1

Air Quality Sensitive Receptors	Average Period	Maximum PC (µg/m^3)	Background (µg/m^3)	Maximum PEC (µg/m^3)	Kenya Air Quality Limit (µg/m^3)	PEC as % of the Limit
Maasai Cultural Center	1- hour	0	ND	0	**NR**	**-**
	8- hour	0	ND	0	**13,939**	**-**
	24-hour	0	ND	0	**150**	**-**
	Annual	0	ND	0	**NR**	**-**
Nearest part of Ol Njorowa Gorge	1- hour	14	ND	14	**NR**	**-**
	8- hour	10	ND	10	**13,939**	**0.07**
	24-hour	3.0	ND	3.0	**150**	**2.00**
	Annual	0.3	ND	0.3	**NR**	**-**
Ol Mayiana Kubwa Baptist Church	1- hour	0	ND	0	**NR**	**-**
	8- hour	0	ND	0	**13,939**	**0.00**
	24-hour	0	ND	0	**150**	**0.00**
	Annual	0	ND	0	**NR**	**-**
Ranger's Post	1- hour	0	ND	0	**NR**	**-**
	8- hour	0	ND	0	**13,939**	**0.00**
	24-hour	0	ND	0	**150**	**0.00**

	Annual	0	ND	0	**NR**	**-**
Ol Mayiana Kubwa Community	1- hour	14	ND	14	**NR**	**-**
	8- hour	10	ND	10	**13,939**	**0.07**
	24-hour	3.0	24	27.0	**150**	**18.0**
	Annual	0.3	ND	0.3	**NR**	**-**
Nearest cliff serving as a nesting and roosting habitat for vultures	1- hour	100	ND	100	**NR**	**-**
	8- hour	30	ND	30	**13,939**	**0.22**
	24-hour	10	ND	10	**150**	**6.67**
	Annual	0.8	ND	0.8	**NR**	**-**

NR – Not Regulated
ND- No Data

Table 8.2-6: Cumulative impact for the case II

Air Quality Sensitive Receptors	Average Period	Maximum PC (µg/m^3)	Background (µg/m^3)	Maximum PEC (µg/m^3)	Kenya Air Quality Limit (µg/m^3)	PEC as % of the Limit
Maasai Cultural Center	1- hour	0	ND	0	**NR**	**-**
	8- hour	0	ND	0	**13,939**	**-**
	24-hour	0	ND	0	**150**	**-**
	Annual	0	ND	0	**NR**	**-**
Nearest part of Ol Njorowa Gorge	1- hour	28	ND	28	**NR**	**-**
	8- hour	10	ND	10	**13,939**	**0.07**
	24-hour	6.0	ND	6.0	**150**	**4.00**
	Annual	0.7	ND	0.7	**NR**	**-**
Ol Mayiana Kubwa Baptist Church	1- hour	0	ND	0	**NR**	**-**
	8- hour	0	ND	0	**13,939**	**0.00**
	24-hour	0	ND	0	**150**	**0.00**
	Annual	0	ND	0	**NR**	**-**
Ranger's Post	1- hour	0	ND	0	**NR**	**-**
	8- hour	0	ND	0	**13,939**	**0.00**
	24-hour	0	ND	0	**150**	**0.00**
	Annual	0	ND	0	**NR**	**-**
Ol Mayiana Kubwa Community	1- hour	28	ND	28	**NR**	**-**
	8- hour	10	ND	10	**13,939**	**0.07**
	24-hour	6.0	24	30.0	**150**	**20.0**
	Annual	0.7	ND	0.7	**NR**	**-**
Nearest cliff serving as a nesting and roosting habitat for vultures	1- hour	100	ND	100	**NR**	**-**
	8- hour	60	ND	60	**13,939**	**0.43**
	24-hour	20	ND	20	**150**	**13.33**
	Annual	1.0	ND	1.0	**NR**	**-**

NR – Not Regulated
ND- No Data

It should be noted that several stakeholders also raised concerns on the perceived detrimental effect of hydrogen sulphide plumes. The gas was reported to have adverse effects on the health of pregnant women and caused breathing problems in some people. In addition, the acid rain emanating from the hydrogen sulphide destroyed crops, and enhanced corrosion of roof tops (**mabati**) of houses and steel structures of

green houses, among other negative effects. However, results from the above H_2S modelling do not corroborate the above claims.

8.2.6 Noise Impact

The noise monitoring data at Olkaria 1 unit 6 for the period 2019 – 14th April 2023 was used to assess the background noise levels for the environment and human health purposes. The main noise emitting sources are the Power House, the Cooling Towers, AU6 Central and DGs. The historical monitoring data shows that the Power House has the highest noise emissions with average noise levels of 86.5dB (A) during the three year monitoring period. The data from the Power House was used to represent unmitigated noise emissions scenario for conservative purposes while mitigated situation was represented with source noise of 60 dB (A) and 35dB (A) representing the Kenyan regulatory limits for diurnal and nocturnal schedules, respectively. The calculated noise level impacts for unmitigated scenarios are as indicated in Table 8.2-7 below, with Figure 8.2-1 and Figure 8.2-2 depicting the contours of the same cases for day and night schedules. The calculated figures show that the noise impact of the proposed facility will be low/negligible on the receptors that are far (about 2.8km and beyond). However, due to topography and the complex terrain the pattern does not follow like the case of the Rangers Post, which is at a lower elevation.

Table 8.2-7: Summary of the unmitigated results for both day and night schedules

No.	Receiver name	Distance from site (km)	Limit		Level	
			Day	Night	Day	Night
			dB(A)			dB(A)
1	Olkaria I Power Plant	0.5	90	35	19.4	19.4
2	Olkaria RIG Workshop	0.6	90	35	17.2	17.2
3	Wellhead OW37	0.6	90	35	20.7	20.7
4	Olkaria 1AU Power Plant	0.9	90	35	15.0	15.0
5	Maasai Cultural Center	1.6	50	35	7.8	7.8
6	Nearest part of Ol Njorowa Gorge	1.6	50	35	5.9	5.9
7	Ol Maiyana Kubwa Baptist Church	2.1	50	35	5.1	5.1
8	Ranger's Post	1.9	50	35	0	0
9	Ol Maiyana Kubwa Community	2.3	50	35	3.9	3.9
10	Olkaria V Power Plant	2.5	90	35	4.7	4.7
11	Nearest cliff serving as a nesting and roosting habitat for vultures	2.8	50	35	0	0
12	Olkaria II Power plant	3.5	90	35	0	0
13	KenGen SPA Facility	3.5	90	35	0	0
14	Olkaria IV Power Plant	4.3	90	35	0	0

Day: 6:00am to 6:30pm Night: 6:30pm to 6:00am

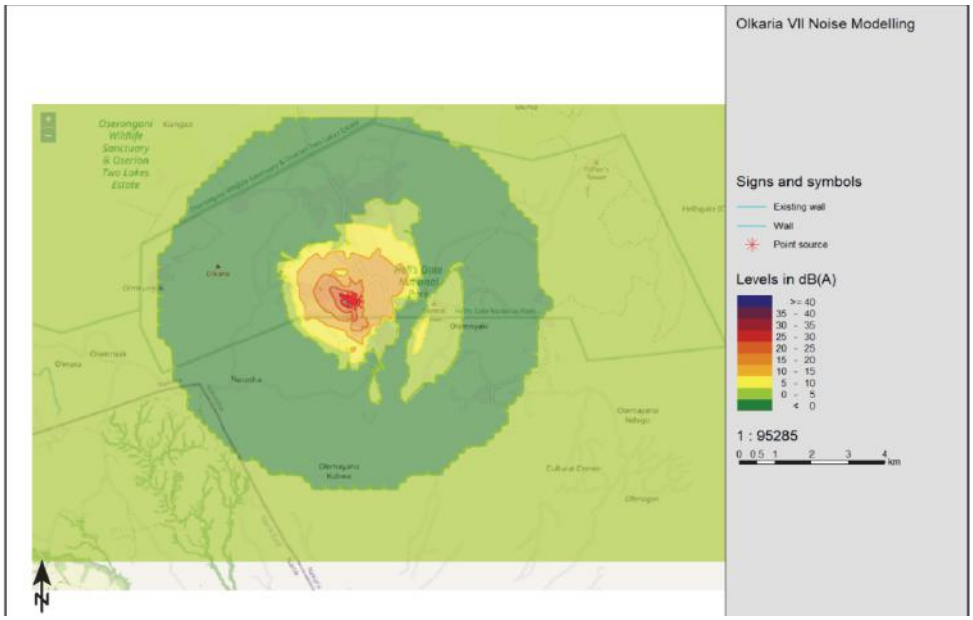


Figure 8.2-1 Diurnal Noise Contours

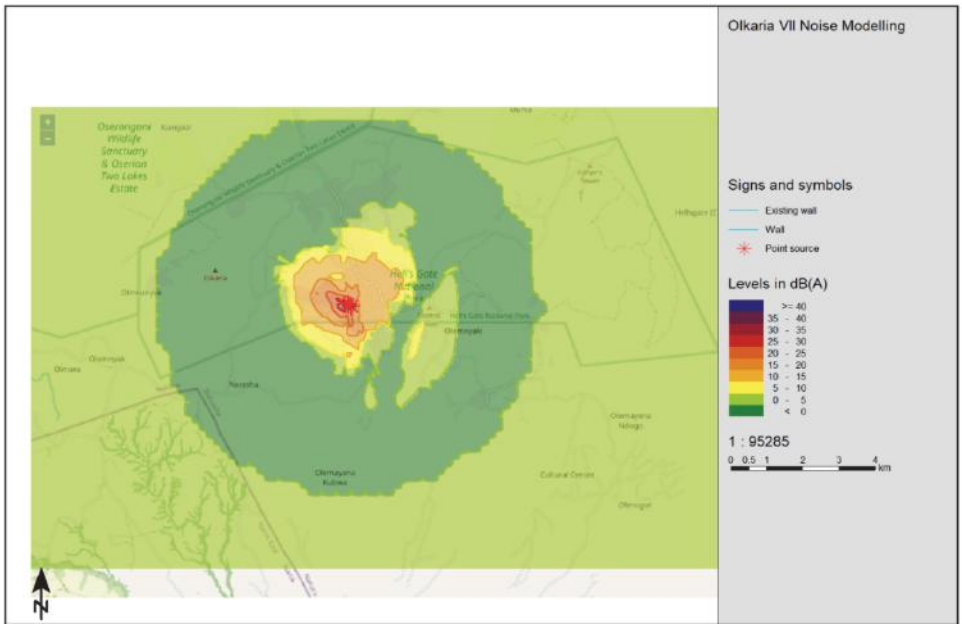


Figure 8.2-2 Nocturnal Noise Contours

8.2.7 Brine pollution

Although brine generated from the geothermal power plants is usually re-injected into the ground in designated re-injection wells, there has been cases of spillage of brine and resultant pollution of the environment. Most of these cases of brine spillage are associated with brine lagoons attached to the separators.

8.2.8 Loss of habitat

Habitat loss is mainly brought about by land taken for the construction of power plant and other project infrastructure including access roads, steam pipelines, transmission line and substation. The presence of power plant and other project facilities will indirectly affect local fauna by decreasing the area of habitat available for breeding, feeding, nesting, roosting and resting. Additionally, this may bring about the fragmentation of populations of terrestrial fauna and avifauna. However, due to the small area that will be occupied by the geothermal power facility, the loss of habitat may only present relatively low negative impacts.

8.2.9 Destruction of floral communities

As stated above, the vegetation of the project site has been very much disturbed by past human and project activities. Vegetation was destroyed during the construction of the road and installation of the steam pipe lines, water pipes and power transmission lines. During the field investigations, it was observed that many of the trees (*Acacia xanthophloea*) and shrubs (*Tarchonanthus camphoratus* and *Acacia drepanolobium*) were cut and used to construct a Maasai livestock kraal (**boma**) inside but to the to the south of the project site. Construction on the project site will disturb and destroy the remnants of the trees (*Acacia xanthophloea*) and shrubs (*Tarchonanthus caphoratus* and *Acacia drepanolobium*) and other plants on the site. However, the site is rather small (17 acres) and the area has been previously disturbed and hence negative impacts on the vegetation is rather low.

8.2.10 Impact on terrestrial fauna

As noted above, the project site has been very much disturbed by past human and project activities and the vegetation was destroyed during the construction of the road and installation of the steam pipe lines, water pipes and power transmission lines. Additionally, vegetation was cut in the process of building a temporary Maasai livestock kraal (**boma**) inside but to the to the south of the project site. During the field investigations, there was no wildlife observed on the project site. However, some domestic animals including Maasai cows, goats and sheep were observed grazing on the site. Since the project site does not have any wildlife populations (except a few members of insect community and other invertebrates), the development on the project site will not cause any significant impacts on the faunal community.

8.3 Health and Occupational Hazards as a Cross-cutting Issue

Health and occupational hazards associated with the proposed project are cross cutting issues which may occur in the project area due to a combination of several project processes including influx of workers, creation of ponding conditions, increased human and motor vehicle traffic and operations of the installed geothermal power plant facility as outlined below:

- Creation of stagnant water bodies in quarries, borrow pits and other depressions are likely to be suitable habitats for the breeding of mosquitoes and snails that are disease vectors for malaria and bilharzias respectively;
- The influx of people in the project is likely to increase the incidences of diseases including sexually transmitted diseases (STDs) especially the Human Immuno deficiency Virus / Acquired Immuno-deficiency Syndrome (HIV/AIDS) among the project workers and the local community;
- Following the commissioning of the geothermal power project and the subsequent increase in the volume of human and motor traffic in the project area, there is likely to be an increase in human and motor traffic resulting in a higher risk of accidents occurring in the area of operation including the Hell's Gate National Park;
- Several activities including driving, operation of heavy machineries and blasting of hard rock in quarries and operations in borrow pits are likely to result in increase in accidents risks both among the project workers and the local community. Occurrence of accidents is likely to be exacerbated by lack of or provision of inadequate working gear among project workers including the helmets, overalls, boots and gloves; and
- Occupational hazards are likely to occur due to the work force engagement in both day time and night-time activities. In this regard, workers will be exposed to machine/ equipment injury risk, occupational noise and vibration, fire risk, risk of exposure to electro-magnetic radiation, the risk of electrical shock and other miscellaneous hazards and risks.

8.4 Cumulative and Long-term Impacts

Cumulative impacts are impacts on the environment that result when the effects of implementing the project's activities are added to the effects of other past, present and reasonably foreseeable future actions. Cumulative impacts are important because impacts of individual projects may be minor when considered in isolation but quite significant when the projects are viewed collectively. As discussed earlier in the report, the Olkaria geothermal area is well endowed with potential extractable geothermal power. The prevailing suitable geothermal attributes in the project area have attracted the development of several KenGen geothermal power plants including Olkaria-IAU, Olkaria-II, Olkaria-IV, Olkaria-V and sixteen small geothermal wellhead plants, all adding up to close to 800 MWe of installed capacity. In addition, Olkaria-III power plant, owned and operated by an IPP (Ormat International) produces 150 MWe through binary cycle technology and a horticulture company, Oserian Development Company has installed two power plants for internal use, a 2 MWe Ormat binary-cycle power plant and a 2 MWe backpressure steam turbine.

The above situation where other geothermal development projects are established close to the project area, will lead to cumulative and long-term impacts in the project area, far beyond what has been predicted for the Olkaria VII geothermal power plant. In this case, the cumulative effect of the above geothermal power projects will enhance the negative impacts including loss habitats and biodiversity, increased pressure on natural resources, increased insecurity and unplanned settlements, visual intrusion and increased pollution, increase in incidences of HIV/AIDS and increased cultural contamination, among other negative impacts in the project area. It should also be noted that the Olkaria VII is designed for an operation life of 30 years. Hence the above negative impacts are both cumulative and long term.

8.5 Impacts of Project De-commissioning

The de-commissioning of the Olkaria VII after 30 years of operation will affect the environment of the project area although on a small scale. There will be wasted energy used to break down the various components of the power plant. In addition, de-commissioning activities will cause some minor negative impacts on the flora and fauna and physical environment of the project area. Following the de-commissioning of the project, buildings belonging to the project are likely to be acquired by the project proponent, KenGen. It is important to note, however, that the proposed power plant will be in the project area for a fairly long time. It is expected that after 30 years, the power plant may undergo rehabilitation and new components will replace the old ones.

8.6 Impacts Beyond National Boundaries

The proposed Olkaria VII geothermal power plant project is located in Naivasha Sub County of Nakuru County. This location is situated in the middle of the country (Kenya), more than 400km to Sudan, Ethiopia, Uganda or Tanzania, the nearest countries to the project area. The impacts of this project are not likely to adversely affect the environment beyond the national boundaries. However, it should be noted that some of the avifauna that visit Hell's Gate National Park and surroundings have migrated from other countries. There is therefore the potential that the proposed project may affect the over wintering birds and the migration of birds on passage to other countries. The siting of the proposed project, however, is unlikely to have any significant impact on the migrating birds.

8.7 Impact Evaluation and Significance

It should be noted that the impacts described above do not carry the same weight and some impacts have more serious implications than others. Having predicted both positive and negative changes that are likely to affect the various ecological, physical and social components of the environment, it is logical to evaluate their relative significance. However, the significance of the identified impacts as used in this report is a subjective matter. It is based on the professional judgment of the Consultant which in turn is based on the

accumulated knowledge and experience from other projects. The terms "significant positive and negative impacts" as used in this study are defined as follows:

- **Significant Positive Impact** - Highly positive impact with substantial benefits leading to improvement of living standards of communities in the project area and beyond; and
- **Significant Negative Impact** - Severe negative impacts leading to major socio-economic losses and systems disruption which requires major mitigation measures.

The magnitude of the positive and negative environmental impacts of the development of proposed geothermal power project are summarized below in Table 8.7-1. The interpretation of the impacts ranking is presented in Table 8.7-2. Based on the above ranking of the magnitude of impacts, stabilization of electricity sector, promotion of economic growth and potential for carbon market are the three major or significant positive impacts (+3) emanating from the development of the proposed geothermal power project. Medium positive impacts (+2) will be associated with increased employment, contribution to the Government revenue and promotion of business in the project area and surroundings.

There are no significant negative impacts (-3) identified in the proposed project. There are a few medium negative impacts (-2) including loss of habitat and destruction of flora and fauna that are associated with the proposed geothermal power project. Implementation of the proposed project is likely to cause a wide range of minor negative impacts (-1) including increased cultural contamination, noise levels and increased incidences of diseases, labour force management challenges and increased accident risks, among other minor impacts of the proposed project.

Table 8.7-1 Significance of the Main Environmental and Social Impacts

Nature of Impacts	Magnitude of Impacts	Remarks/Comments
Socio-economic Impacts		
Stabilization of electricity	+3	The introduction of 80.3 MWe in the national grid will alleviate power outages especially during the dry seasons and reduce heavy reliance on thermal power.
Potential for carbon market	+3	The proposed project has the potential to generate immense carbon credit value for the project proponent.
Promotion of economic growth	+3	This project will contribute to rural electrification, stimulate economic growth in Kenya and boost the growth of local and national economy.
Increased employment opportunities	+2	The local community will benefit from job opportunities for the semi-skilled and unskilled cadres who will form the bulk of the labour force
Increased contribution to Government revenue	+2	The project will contribute towards the boosting of Government revenue through corporation tax, EIA licence, PAYE and VAT among other taxes.
Cultural contamination	-1	The labour force in the project area, may introduce unfavourable social behavior leading to cultural contamination of the local community.
Increased poaching and exploitation of natural resources	-1	The increased number of workers is likely to make high demand on fuel wood resources of the project area.
Potential negative impacts of labour force	-1	The labour force is likely to indulge in harvesting of trees and charcoal making activities to the detriment of the environment of the project area.
Increased health and occupational hazards	-1	Increased involvement in the project's activities is likely to lead into increased occupational and health hazards
Increased accidents	-1	Over-speeding on the rehabilitated roads and increased project activities may lead to increase in accidents in the project area.
Increase in pollution from solid wastes and effluent discharge	-1	Solid and liquid waste streams will be generated from activities associated with the project construction and operation phases especially from labour campsites and staff houses.
Increased incidences of diseases	-1	Influx of workforce in the project area is likely to lead to increased incidences of HIV/AIDS and other sexually transmitted diseases.
Visual intrusion	-1	Visual intrusion will be prominent during construction phase when project activities will result in deep cuts and accumulation of spoils in several sites of the project area.
Physical Impacts		
Increase in noise levels	-1	Increase in noise levels will mainly occur during the use of heavy machinery along the roads and in borrow pits
Increase in dust	-1	Increase in dust pollution will mainly emanate from road construction activities and operations in quarries and borrow pits in the project area.

Increased ponding conditions	-1	Likely to occur in the borrow pits and other areas where the road activities create excavations leading to depressions.
Gaseous air emissions	-1	Level of gaseous emissions will depend on the state of technology and the level of servicing of the vehicles, machinery and diesel generators used in the road rehabilitation activities.
Increase in soil erosion and siltation	-1	Soil erosion will occur along the exposed road surface and other areas due to the effect of the runoff. The situation will be aggravated by the gradient of the terrain. -
Brine pollution	-1	Brine pollution emanates from the spillage of brine associated with brine lagoons attached to the separators.
Biological/Ecological Impacts		
Loss of habitat	-2	The loss of habitat will mainly occur in the areas cleared to give way to the power plant, transmission line and substation, installation of steam pipelines and water supply system.
Destruction of floral communities	-2	Destruction of floral communities will mainly occur in the areas cleared to give way to the power plant, transmission line and substation, installation of steam pipelines and water supply system.
Impacts on terrestrial fauna	-2	Negative impacts on terrestrial fauna occur in the areas cleared to give way to the power plant, transmission line and substation, installation of steam pipelines and water supply system.

Table 8.7-2. The Ranking of Magnitude of environmental impacts.

Magnitude of Impact	Nature of impact	Description	Ranking
Minor Impact	Minor Positive Impact	Slight benefits especially to local communities	+1
	Minor Negative Impact	Minor negative at local level	-1
Medium Impact	Medium Positive Impact	Benefits likely to positively change (improve) quality of life in the project area	+2
	Medium Negative Impact	Impacts likely to adversely affect the environment or quality of life in the project area if not mitigated	-2
Significant/ Major Impact	Highly Positive Impact	Substantial benefits leading to improvement of living standards of communities in the project area and beyond.	+3
	Major Negative Impact	Severe negative impacts leading to major socio-economic losses and systems disruption in the project area and beyond. Requires major mitigation measures.	-3

9 PROPOSED MITIGATION MEASURES

In order to alleviate negative impacts emanating from the implementation of the proposed Olkaria VII geothermal power plant project, promote sustainable development and maintain a healthy environment in the project area, the developer through the contractor, environmental manager or other relevant agents, will undertake to institute several measures to reduce or alleviate the negative impacts of the project as presented below.

9.1 Mitigation of Negative Social-economic Impacts

Measures proposed to reduce or alleviate negative impacts of the proposed project are presented below in the following sections:

9.1.1 Amelioration of socio-economic negative impacts

As stated above in Chapter 8-Project Negative Impacts, the commencement of project activities will attract an influx of project workers of various cultural backgrounds leading to long-term erosion of the normal community morals, values and other modes of cultural way of life. In order to avoid or ameliorate cultural contamination and other socio-economic impacts in the project area, the project proponent needs to raise awareness among the local community especially the members of Maasai community, on the influence of project workers and the dangers of cultural contamination.

9.1.2 Reduction of poaching and utilization of wood resources

As stated in the report, the increased population in the project area will increase poaching and make high demand on park resources including fire wood and charcoal. The project proponent in collaboration with KWS needs to put in place measures to discourage workers from entering the park, engaging in poaching activities and utilizing park resources such as fire wood. Alternatively, the Contractor needs to construct the labour camps far away from the protected area or utilize the urban centres of Kasarani, Karagita and Kamere to secure accommodation for the labour force.

9.1.3 Reduction of incidences of communicable diseases

With the influx of project workers in the project area, there will be subsequent entry of commercial sex workers into project area. To prevent the spread of HIV/AIDS in the project area, the Contractor/ Project proponent should organize and support education programmes to increase awareness and change public attitudes towards HIVIAIDS and other sexually transmitted diseases (STDs). In order to protect the project workers, there will be a need for the Contractor to supply the workers with STD prevention devices including the male and female condoms.

9.1.4 Reduction of visual intrusion

In order to reduce visual intrusion, all degraded areas resulting from the project construction activities need to be landscaped and suitable grass, shrubs and trees planted to blend with the environment. The presence of the power plant and its accessories including the steam pipeline system and other facilities in otherwise unspoilt natural environment is likely to be visually intrusive to some people. In addition, it has the potential to detract observers including tourists from the normal scenery. It is therefore necessary to paint the project components including the steam pipeline system with colours that blend with the environment especially shades of pale green, brown and grey in order to further reduce visual intrusion in the project area. It may, however, be noted that the steam power plant system is not an ordinary sight and being a novelty, could be appealing to a wide cross- section of local community, other Kenyans and even foreign visitors. Indeed, it could as well be a local attraction drawing many observers from beyond the project area.

9.1.5 Management of labour force

The labour force engaged in the construction of the project activities have potential to degrade the environment of the project area as discussed above in earlier sections of the report. The project management should therefore put in place mechanisms to deter the work force from engaging in wonton cutting of trees, charcoal burning, and other detrimental activities. Due to the close proximity of the project area to the Hell's Gate National Park, the Contractor/ Project proponent needs to raise awareness among the project workers on sensitivity and vulnerability of the project area and the need to desist from any destructive activity in the park and its surroundings. In addition, the Contractor should consider using pre-fabricated material (which can later be retrieved at the end of the project) in building the labour camps. This will deter the labour force from unnecessary cutting and trampling of vegetation and enhance the protection of the protected area.

In order to maintain a healthy environment for the labour force, the project management should put in place suitable measures to clean the environment associated with labour camps. This will include proper disposal of human waste. The Contractor should put in place mechanisms for the collection of all wastes generated (solid wastes, organic wastes, food remains, garbage etc.) in the labour camps, segregate the various wastes and arrange for subsequent disposal through either efficient incineration or disposal in a sanitary landfill.

9.1.6 Compliance with national and international labour laws and policies

The proposed project will comply with the Kenya laws that protect labour standards and the employment guidelines stipulated in the Labour Relations Act (2007) and the Employment Act (2007) as outlined below:

- **The Labour Relations Act (2007) -** An Act of Parliament to consolidate the law relating to trade unions and trade disputes, to provide for the registration, regulation, management and

democratization of trade unions and employers organizations or federations, to promote sound labour relations through the protection and promotion of freedom of association, encouragement of effective collective bargaining and promotion orderly and expeditious dispute settlement, conducive to social justice and economic development.

- **The Employment Act (2007)** - An Act of Parliament to declare and define the fundamental rights of employees, to provide basic conditions of employment of employees and to regulate employment of children. In this regard, the Contractor will comply with the legal conditions set to protect the rights of employees with special attention to gender equality and representation; all forms of discrimination, employee entitlement to normal leave, maternity leave and sick leave; sexual harassment; forced/compulsory and child labour and working hours.

In addition to compliance with the Kenya laws on labour and employment, the geothermal power project will also be in conformity with the International Finance Corporation (IFC) and other related institutions policies on labour especially forced labour and child labour. For example, IFC will not support projects that use forced labour or harmful child labour as defined below:

1. **IFC Policy on Child Labour** - Employment of children that is economically exploitive, or is likely to be hazardous to, or interfere with the child's education, or harmful to the child's health, or physical, mental, spiritual, moral and social development.
2. **IFC Policy on Forced Labour** - All work or service, not voluntarily performed, that is exacted from an individual under threat of force or penalty.

In addition, the project will comply with labour norms based on standards set by international conventions and the International Labour Organization (ILO).

9.1.7 Waste management

During the operation phase of the project, waste management will mainly involve disposal of solid wastes and human wastes. The project therefore needs to put in place procedures for the collection of solid material from the staff houses, offices and other areas of the geothermal power facility for subsequent disposal either through burning in an efficient incinerator or disposal in a landfill facility.

The main concern with regard waste management is the human waste. There will be a need to keep living quarters in the area of operation in a satisfactory degree of sanitation in order to prevent outbreak of diseases. The management of human waste in the project area should be done through use of suitable disposal systems including a combination of septic tanks and pit latrines as found appropriate. Septic tanks will be appropriate where there is excellent permeability of soils. In addition, there should be sufficient

water for WC flushing. Pit latrines are essentially appropriate for low-cost dwellings especially in the labour camps. The pit latrines should be deep, clean and without any offensive smell. They should also be free of fly and mosquito nuisance. This sanitation facility should consist of what is now referred to as a ventilated improved pit latrine (VIP) with good quality concrete floor slabs.

9.1.8 Indigenous Peoples Plan

The Masai community fits into the description of Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities category as described in the World Bank Environment and Social Framework (ESF). In the ESF, the Environment and Social Standard 7 (ESS7) on Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities ensures that the development process fosters full respect for the human rights, dignity, aspirations, identity, culture, and natural resource-based livelihoods of Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities. In addition, the ESS7 is also meant to avoid adverse impacts of projects on Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities, or when avoidance is not possible, to minimize, mitigate and/or compensate for such impacts. An IPP can therefore be developed if Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities are present in, or have collective attachment to the project area.

The proposed Olkaria VII geothermal power plant project is situated in KenGen land and there are no human settlements at the project site. Hence, an IPP will not be required for Olkaria VII Geothermal Power Plant project.

9.2 Action Plan for Occupational Health and Safety

During the construction, operation and decommissioning phases of the proposed project, the Project Proponent will adopt national and international Occupational Health and Safety (OHS) Guidelines for the proposed geothermal energy project in the prevention of accidents, containment of health hazards and management of security and fire outbreaks among other contingencies in the project area.

9.2.1 Prevention of accidents

Implementation of the project will definitely increase volume of human and motor traffic in the project area and surroundings. The increase in human and motor traffic will be aggravated by the transportation of construction materials and geothermal power plant accessories' parts and equipment required to install the power plant facility. Since accidents could result in loss of work time, different levels of disability and fatalities, the project proponent will put in place mechanisms to reduce the number of accidents among the project workers (whether directly employed or subcontracted) to a rate of zero as outlined below.

- The project developer should design and implement safety measures for the prevention of accidents. The project proponent will also develop emergency plans to contain accident risks associated with project activities including vehicular transport, operation of machinery, equipment and other related activities;
- Project workers need to be educated on the use of unfamiliar machinery, equipment and tools that may cause a danger to the users. In addition, the workers should be provided with safety instruction manuals and other essentials to contain accidents;
- Proper and appropriate road traffic signs, markings, and road furniture should be installed on the rehabilitated road sections; and
- Workers should be provided with protective clothing (nose and mouth masks, ear muffs, overalls, industrial boots and gloves) and helmets.

In addition to the above measures, the following precautions should be taken to minimize the impacts of accidental oil leakages and spills, if they ever occur during the course of project implementation and de-commissioning. Proposed precautions include:

- Establishment of an appropriate preparedness programme;
- Training of relevant personnel; and
- Provision of relevant spill mitigation equipment including adsorbent material, leakage plugging devices, foam cover spraying equipment and oil skimmers and water spraying equipment, among other measures to contain accidents.

9.2.2 Health issues

During the construction, operation and de-commissioning phases of the proposed project, attention must be focused on the health of workers in order to attain health conditions that will permit them to lead socially and economically productive lives. Proper disease control, disease prevention and treatment and methods of raising awareness must be employed among the project workers in order to minimize disease incidences and reduce morbidity. Of particular importance to the project workers are communicable diseases such as HIV/AIDS in the project area. AIDS (Acquired Immune-deficiency Syndrome) was first diagnosed in Kenya in 1984 and now has become a serious health and economic problem in the country. The project workers and the surrounding local community must be educated on the strategies of minimizing the risk of contracting HIV/AIDS including the use of male and female condoms.

In order to enhance health conditions in the project area, there is need for the project proponent and the Contractor to collaborate in the use of available medical facilities in order to provide health care to the permanent and casual project workers and the local community. In addition, the project developer should

provide a conducive working environment including integrity of workplace, adequate lavatory facilities, potable water supply, clean eating area, lighting, appropriate access, first aid among other facilities as recommended in the Public Health Act (2007), Occupational Safety and Health Act (2007) and Work Injury Benefits Act (2007).

The developer should put in place mechanisms for the provision of adequate health care for workers, safety of workers and compensation to employees for work related injuries and diseases contracted in the course of their employment, in accordance to the laws of Kenya and as stipulated in the Public Health Act (2007), Occupational Safety and Health Act (2007) and Work Injury Benefits Act (2007).

- **The Public Health Act (2007)** - An Act of Parliament to make provision for securing and maintaining health;
- **The Occupational Safety and Health Act (2007)** - An Act of Parliament to provide for the safety of workers, and all persons lawfully present at work places; and
- **The Work Injury Benefits Act (2007)** - An Act of Parliament to provide for compensation to employees for work related injuries and diseases contracted in the course of their employment.

9.2.3 Fire protection

All the buildings should be designed, constructed and operated in full compliance with local building codes and regulations and should be in conformity with internationally accepted life and safety standards. In addition, adequate measures should be taken against the potential fire hazards in the project area. They include installation of functional fire protection systems such as water based firefighting system with water hydrants strategically placed to cover the whole geothermal power plant premises. In addition, CO_2 based portable and fixed fire extinguishers need to be sited at strategic positions to cover the staff premises. The above fire protection systems should be backed by a reliable service provider to service the appliances at least on a quarterly basis.

9.2.4 Other measures to enhance occupational health and safety

Other measures to enhance occupational health and safety in the project area include:

- Provision of a fully equipped first aid kits in the project area during the project construction and operational phases;
- Provision of medical cover for all staff in order to enhance health standards at the geothermal power plant facility;
- The health staff, environmental managers, and other relevant workers should be well trained to act as Safety Officers after acquiring adequate knowledge and experience on first aid training and excellent knowledge of safety regulations;

- The Contractor should have Workmen's Compensation Cover for the workers;
- The project should conduct health and safety audits regularly for all the workers on an annual basis;
- Take measures against risks of electrical shock;
- Conduct environmental audits for the geothermal power plant facility in accordance to the requirements of NEMA;
- Put in place mechanisms aimed at acquiring ISO 14001 certification on environmental management and Occupational Health and Safety Standard Certification (OHSAS 18001) for the proposed power plant facility;
- Conduct training programmes covering several aspects of safety, customer care, defensive driving, first aid, HIV/AIDS, environmental awareness, swimming and life saving activities among other training aspects.

9.3 Mitigation of Impacts on Physical Environment

The main issues with regard to the mitigation of physical environment impacts include control of dust and gaseous emissions, reduction of ponding, soil erosion, siltation, noise abatement and air emissions, among other issues.

9.3.1 Control of dust and gaseous emissions

The dust particles and the chemical substances contained in gaseous emissions emanating from operating vehicles and heavy machinery may cause eye and throat irritations even at low levels. Respiratory illness, lung damage and other health hazards are likely to occur when the workers are exposed to high concentrations of the dust and gaseous emission pollutants and for a long time. To mitigate air quality impacts during the implementation of the access roads rehabilitation, power plant construction activities, and other projects works, emissions of dust, smoke and other substances should be limited through good practices. These include watering of access routes, deviations and other disturbed sites, use of dust extractors and covering of lorries and other vehicles transporting construction materials. Appropriate selection of machinery will also minimize pollution from the gaseous emissions. Workers involved in construction activities that generate dust and gaseous emissions should be provided with appropriate protective devices to cut down on dust and gaseous emissions inhaled. These will include masks, helmets and appropriate overalls.

9.3.2 Reduction of ponding conditions

The project activities including rehabilitation of access roads, construction of the power plant and other project activities may lead to creation of stagnant water bodies in quarries, borrow pits and other depressions

created during the construction works. Although water collected in the depressions may be a respite for the Maasai pastoralist community, the resultant stagnant water bodies are likely to be suitable habitats for the breeding of mosquitoes and snails that are disease vectors for malaria and bilharzias respectively. Measures should therefore be put in place to improve impeded drainage in the project area through landscaping and filling in the created depressions. The drainage of runoff in the project area should be adequately accommodated in the road design which should allow for bridges, culverts and drifts at appropriate locations. In addition, the road design should also provide side drains, and metre drains to direct the runoff away from the rehabilitated road.

9.3.3 Reduction of soil erosion and siltation

As stated above, activities associated with the implementation of this project may stimulate increased soil erosion in the project area. This will mainly emanate from the road rehabilitation activities, operations of borrow pits and quarries, construction of the geothermal power plant and other related activities. There is therefore, a need to carry out a serious programme to rehabilitate the degraded environment. A major environmental problem will emanate from the disposal of loose earth which is likely to be a source of silt in the run off especially during the rainy season. Immediate action should therefore be taken to address the issue of soil erosion and the potential for the siltation of aquatic systems. Consequently, the following measures need to be carried out:

- Silt traps to be installed to prevent sediments from entering aquatic systems;
- Proper terracing and landscaping of the affected area; and
- Planting of appropriate sediment binding grasses such as *Cynodon dactylon*, *Pennisetum clandestinun* and other suitable grasses on the exposed slopes and other surfaces.

9.3.4 Noise abatement

Relatively high noise levels in the project area will mainly emanate from the road rehabilitation activities and during the construction of the geothermal power plant facility. In addition, high levels of noise are likely to prevail in the project area due to use of motor vehicles and heavy machinery especially at the quarries, borrow pits and crusher plants. During the operation phase, noise will be produced by the power plant system. Noise control measures should be implemented if noise levels in the project area exceed 90 dBA for 8 hours. Protection at the individual level against the effect of noise should also be provided. Sound levels reaching the inner ear may be effectively attenuated by the use of hearing protective devices such as ear plugs and ear muffs particularly when noise levels exceed 85-90 dBA. In addition, regular audiograms should be conducted for employees as proof that sound control and hearing protection measures are effective in preventing hearing loss.

The project proponent should comply with IFC Environment, Health and Safety (EHS) Guidelines especially the Noise Limits for Various Working Environments. Under the above IFC Guidelines, no employee should be exposed to a noise level greater than 85dBA for a period of more than 8 hours per day without hearing protection. Other measures to abate noise levels include:

- Conduct proper maintenance of the power plant components and equipment in accordance with the manufacturer's specifications;
- Prohibit the movement of vehicles at dark; and
- Continue with the monitoring of noise at all noise receptors.

9.3.5 Air emissions from the power plant

Hydrogen sulphide (H_2S), a major constituent of air emissions is toxic to humans at high concentrations, and may have long-term negative impacts at lower concentrations. However, the concentration of hydrogen sulphide prevalent among the receptors is much lower than the maximum allowable levels (150ug/l) recommended by NEMA and WHO. Since many stakeholders have raised complaints about harmful effect of H_2S, the project proponent should raise awareness among the community in the project area with regard to hydrogen sulphide plumes emitted by the proposed power plant. There is also a need for continuous monitoring of the hydrogen sulphide. In addition, the project proponent should put in place a programme to assess the effects of low concentrations of hydrogen sulphide on the human community, fauna and flora of the project area.

9.3.6 Brine disposal

According to the steam production forecast, the brine production forecast in the geothermal power system was estimated to be 870 - 990 t/h for 25 years. The brine that is separated by each individual separator is separately re-injected via gravity into the following specifically designated hot brine reinjection wells - OW-807, OW-807A, OW-R12, and OW-R13. Although brine generated from the geothermal power plants is usually re-injected into the ground in designated re-injection wells, there has been cases of spillage of brine and resultant pollution of the environment. Most of these cases of brine spillage are associated with brine lagoons attached to the separators. The project proponent should put in place mechanisms of securing the brine associated with separator lagoons. The brine separators should be fenced off and no animals or unauthorized persons should gain entry into the fenced off area.

9.3.7 Disposal of steam condensate

The steam that condenses after passing through the turbines will be highly acidic due to the presence of carbon dioxide (CO_2) and hydrogen sulphide (H_2S). The steam condensate from Olkaria VII geothermal power plant will be disposed of by cold re-injection into the existing deep wells in the area of pad 801 as

stated above. In addition, all discharges from the steam traps will be channelled into a dedicated 4" diameter drain piping system running in parallel along the entire extent of the steam lines, that is, connecting from each separator to the power station and to be finally interconnected to end at the thermal pond located at Pad 53.

9.3.8 Disposal of Sanitary wastewater

The sanitary wastewater generated by the power plant was estimated at 6.025m^3/day. Sanitary wastewater will be collected and discharged into a septic tank of capacity of 7.5m^3 as onsite treatment method. Waste water including sludge accumulated in the septic tank will be removed by means of an exhauster service vehicle and disposed of to wastewater treatment plant at Naivasha Town, which is approximately 40km away from Olkaria.

9.3.9 Handling of process chemicals

Some of the process chemicals used in the treatment of raw water include biocides, soda ash, chlorine and alum. Others include oils, lubricants and detergents. All these substances should be stored and handled responsibly in accordance with the prescribed procedures, and material safety data sheets (MSDS). In addition, a response plan needs to be drawn up for addressing chemical spills.

9.3.10 Mitigating oil pollution

During the construction stage, sources of oil pollution emanate from vehicles and heavy machinery involved in construction activities. In addition, lubrication and transformer oils will be used during the power plant operation phase. A certain amount of sludge consisting of used lubricating oils will be generated from the condenser and cooling towers. During the construction and the operation stages, proper maintenance of the power plant and machinery and proper procedures of decanting, storing and handling of oil products will minimize risks of oil spills and oil pollution. Oil pollution can be minimized by installing oil interceptors in all the storm drains around the power plant site. The project proponent should draw a response plan to address any oil spill occurrences.

9.3.11 The use of construction material

The use of materials that are detrimental to the health of construction workers and to the persons working in the completed building where the deleterious materials have been used should be prohibited. The Contractor should not use following materials that may have negative environmental effects:

- Calcium silicate bricks or tiles;
- Asbestos in any form;
- Lead paint or any material containing lead;
- Any product containing cadmium;

- High alumina cement; and
- Any other substance regarded to be detrimental to human health.

9.3.12 Disposal of solid wastes

During the construction and operation stages, the project will generate solid wastes as follows:

- During construction, the project will produce solid wastes of various composition including building materials, concrete, paper, plastic, timber and scrap metal, among other solid wastes;
- Also, during the construction, the Contractor will demolish various facilities on completion of project works; and
- During the operation stage, silica which precipitates in the steam pipelines will be removed periodically.

The Contractor needs to exercise due diligence to minimize the amount of solid wastes produced and to ensure that debris is disposed of in an appropriate manner at a specified and approved dump or sanitary landfill. The Contractor will landscape all disturbed areas and ensure the project site is left in a clean and sightly condition on completion of project works.

9.4 Mitigation of Impacts on Biological Environment

Following the implementation of the project activities, there will be habitat loss which will be mainly brought about by land taken for the construction of power plant and other project infrastructure including access roads, steam pipelines, transmission line and substation. The presence of power plant and other project facilities are likely to affect local fauna by decreasing the area of habitat available for breeding, feeding, nesting, roosting and resting. The Contractor will, however, exercise due diligence to minimize the project impacted areas.

9.4.1 Restoration of floral community

As stated above the vegetation of the project site has been very much disturbed by past human and project activities. Vegetation was destroyed during the construction of the road and installation of the steam pipe lines, water pipes and power transmission lines. Many of the trees (*Acacia xanthophloea*) and shrubs (*Tarchonanthus camphoratus* and *Acacia drepanolobium*) were cut and used to construct a temporary Maasai herders' livestock kraal (**boma**) in the project site. Construction on the project site will disturb and destroy the remnants of the trees (*Acacia xanthophloea*) and shrubs (*Tarchonanthus caphoratus* and *Acacia drepanolobium*) and other plants on the site. Due to the previous disturbance and cutting of trees on the project site, the proposed project can only cause minor negative impacts on the floral community of the project area. In order to minimize the project negative impacts on the floral community, the project proponent needs to carry out the following:

- Clearing of vegetation should not be done indiscriminately but be limited to where the construction will take place;
- All the disturbed areas should be rehabilitated and re-vegetated with locally occurring trees, shrubs and grasses; and
- Measures should be taken to curb any spilling of brine and to follow the proper procedures in the deep re-injection of all brine and condensate discharges;

9.4.2 Protection of fauna

As noted above the project site has been very much disturbed by past human and project activities. During the field investigations, there was no wildlife observed on the project site. However, some domestic animals including Maasai cows, goats and sheep were observed grazing on the site. Since the project site does not have any wildlife populations (except a few members of insect community and other invertebrates), the development on the project site will not cause any significant impacts on the faunal community. Never the less, there is need to protect and rehabilitate the faunal habitat of the areas affected by the project activities and the project proponent needs to carry out the following:

- Cleared and disturbed project areas should be rehabilitated by re-planting indigenous vegetation following the completion of project works;
- Project construction activities should be kept to the minimum level to avoid excessive destruction and loss of habitat;
- The project proponent in collaboration with KWS should increase surveillance and control the entry of project workers to the park in order to prevent poaching of animals and other detrimental activities to the fauna and habitat;
- The project proponent should control the traffic by enforcing the speed limits and erection of bumps in order to reduce animal deaths from excessive vehicle speeds;
- The design and installation of drains and steam pipelines should be done appropriately so that they will not form barriers to the movement of animals;
- Loops should be installed in appropriate places along the steam pipelines to allow the passage of animals across the steam pipelines;
- Fences should be erected around the brine ponds in order to prevent wild animals from drinking the brine; and
- All the brine discharges and condensates should be discharged by deep re-injection.

10 PROPOSED ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Environmental and Social Management Plan (ESMP) should fully be integrated with the overall management of the proposed Olkaria VII geothermal power plant. Its effective planning and implementation will be the responsibility of the project proponent (KenGen). Its aim is to develop an efficient implementation instrument and support tool for sustainable environment management of the Olkaria project area and the immediate surroundings.

10.1 Objective of the Environmental and Social Management Plan

The main objective of the environmental and social management plan (ESMP) is to provide guidance on how to protect the environment during the project implementation and thereafter. The ESMP outlines the procedures for the implementation of the proposed mitigation measures and other procedures that will be undertaken to ensure environmental protection of the project area in compliance with environmental laws and regulations. The ESMP will be carried out during all the stages of the project implementation from pre-construction right through to decommissioning. In addition, it will involve all relevant stakeholders in the environmental management of the project.

10.2 Organizational - set up for the Implementation of the Management Plan

The project proponent will have executive responsibility for the implementation of the ESMP. The project proponent will, be assisted by a core of several experts including the Contractor, Resident Engineer and the Environmental and Social Officers on all aspects of decision making in the implementation of the ESMP. In addition to the above in-house team, other relevant stakeholders will have an important role to play in the environmental management. They include representatives of the National Environmental Management Authority (NEMA) as represented by the County Director of Environment (CDE) in Naivasha Sub County, Kenya Wildlife Service (KWS), the local administration including the Assistant County Commissioner (ACC), the Chief and Assistant Chief, Olkaria Location, relevant Government officers (Fisheries Officer, Livestock Officer, Cooperatives Officer), Member of Parliament (MP) for the Naivasha Constituency, Member of County Assembly (MCA), Olkaria, community representatives and opinion leaders, faith-based organizations (FBOs), NGOs, CBOs and other interested parties will also play their different roles in the implementation of the ESMP.

Details on the implementation of the environmental and social management plan (ESMP) including the cost estimates for the proposed ESMP are contained in Table 10.2-1. The implementation of the ESMP covers all stages of project implementation.

Table 10.2-1 Environmental and Social Management Plan for the Proposed Project

Item	Environmental Impact	Mitigation Measures	Responsibility for Implementation	Site of Implementation	Implementation Schedule	Responsibility for Monitoring	Monitoring Indicators	Estimated Costs (KSh)
1	Support for Community awareness, sensitization and education programmes. Impact of cultural contamination.	Raise awareness among the local community on potential impacts of interacting with the labour force.	KenGen Contractor/ Local Administration/ Community leaders	In the project area and along the towns and settlements around Lake Naivasha, at Narasha, Ol Maiyana Kubwa, Rap land, Kamere etc.	Before commencement and during the project implementation periods.	The Chief, Ministry of Culture, NEMA, KenGen (Resident Engineer, Environmental Manager/ Implementation consultant)	No. of meetings to raise awareness; Cases of anti-social behaviour reported; Cases of abuse of drugs and illicit alcohol reported, number of commercial sex workers reported	6,194,000
2	Negative impacts of labour force	Put in place mechanisms to deter the work force from engaging in poaching of wildlife and cutting of trees for fuel wood, charcoal burning and building material. Use pre-fabricated material (which can later be retrieved at the end of the project) in	Contractor Contractor	Hell's Gate National Park, Along the rehabilitated road, around borrow pits and in the vicinity of the geothermal power plant facility.	During the project implementation period.	Ministry of Labour, NEMA, KenGen (Resident Engineer, Environmental Manager/ Implementation consultant)	No. of complaints received; No. of structures built with pre-fabricated materials; No. of charcoal kilns on in the project area, number of trees cut; No of snares found; etc.	4,450,000

Item	Environmental Impact	Mitigation Measures	Responsibility for Implementation	Site of Implementation	Implementation Schedule	Responsibility for Monitoring	Monitoring Indicators	Estimated Costs (KSh)
		building the labour camps.						
3	Pollution from labour camps	Use suitable human waste disposal systems including a combination of septic tanks, solar and pit latrines as found appropriate Segregate solid wastes in the RE, Contractor and labour camp units and arrange for subsequent disposal through either efficient incineration or disposal in an approved dump or in a sanitary landfill.	Contractor Contractor	In the Resident Engineer/Contractor camps and labour camp units	During project construction and implementation stages	NEMA, KenGen (Resident Engineer, Environmental Manager/ implementation consultant) and Ministry of Health.	No. of WC, solar and pit latrines constructed; No. of solid waste receptacles installed; No. and type of incinerators installed; Approved sanitary landfill / dump facility identified and utilized.	7,000,000
4	Increase in accidents and occupational hazards	Design and implement safety measures and emergency plans to contain accident risks. Install appropriate road traffic signs, markings and road furniture on the rehabilitated road. Provide workers with protective clothing (nose and	KenGen/ Contractor	Along the roads to be rehabilitated, borrow pits, within the power plant facility and other sites of the project area where project activities will be taking place.	During construction and operation stages of the proposed project.	Ministry of Health, NEMA, KenGen (Resident Engineer, Environmental Manager/ Implementation consultant)	No of complaints from workers and local community; No. of traffic accidents; No. and type of protective clothing and gear provided to workers.	8,848,000

Item	Environmental Impact	Mitigation Measures	Responsibility for Implementation	Site of Implementation	Implementation Schedule	Responsibility for Monitoring	Monitoring Indicators	Estimated Costs (KSh)
		mouth masks, ear muffs, overalls, industrial boots and gloves) and helmets as applicable						
5	Increased incidences of communicable diseases such as STDS and HIV/AIDS	Raise awareness among the project workers and support mechanisms to prevent and control spread of communicable diseases among the project workers and local communities.	KenGen/ Contractor/ Local Authority/ Ministry of Health/ community leaders	Urban settlement in project area/ labour camps and residential areas of senior project workers and community areas of Kamere, Narasha, Ol Maiyana Kubwa RAP Land and other settlements around Lake Naivasha.	Before the commencement of the project and during the project construction stage and in the operation stage.	Ministry of Health, National AIDS Council, NEMA and KenGen (health personnel, Environmental Manager/ Implementation consultant)	Incidences of STDs among workers and local community; No. of cases treated; No. of condoms dispensed to workers and local community; No of meetings held to raise awareness on STDs and HIV/AIDS.	6,194,000
6	Visual intrusion	Rehabilitate all degraded areas through landscaping and subsequent planting of suitable grass, shrubs and trees to blend with the environment.	Contractor	Along the rehabilitated road, access roads, along the steam pipe lines, around borrow pit sites and other sites that have been affected by project activities.	After the completion of project construction activities.	NEMA, KWS, KenGen (Resident Engineer, Environmental Manager/ Implementation consultant)	No. of sites landscaped and terraced; No and type of trees and shrubs and amount of grass planted.	7,962,500

Item	Environmental Impact	Mitigation Measures	Responsibility for Implementation	Site of Implementation	Implementation Schedule	Responsibility for Monitoring	Monitoring Indicators	Estimated Costs (KSh)
		Paint the power plant and other project buildings and the steam pipe lines with appropriate colours						
7	Increase in noise levels	Use of protective hearing devices such as ear plugs and ear muffs among project workers when noise levels exceed 85-90 dBA. Selection of appropriate machinery and regular servicing of machinery and vehicles. Procure Type 1 noise monitoring equipment with data logger and 1/3 octave filter.	Contractor	In areas where project activities are taking place.	During construction and operation stages.	NEMA, Contractor, KenGen (Resident Engineer, Environmental Manager/ Implementation consultant)	No. of complaints from local residents; Noise levels recorded; No. and type of protective hearing devices dispensed to workers.	9,735,000
8	Increased ponding conditions	Improve impeded drainage through landscaping and filling in the created depressions.	Contractor	Along the access roads, around borrow pits and quarries and all the sites where project works have created depressions.	Immediately after construction stage.	NEMA, KenGen (Resident Engineer, Environmental Manager/ Implementation consultant)	No. of drains and depressions rehabilitated	9,735,000
9	Increased soil erosion and siltation	Where applicable install silt traps to reduce sediment	Contractor	In disturbed sites where there are cuts and fills in the	During construction	NEMA, KenGen (Resident	Number of silt traps; No. of sites	13,274,000

Item	Environmental Impact	Mitigation Measures	Responsibility for Implementation	Site of Implementation	Implementation Schedule	Responsibility for Monitoring	Monitoring Indicators	Estimated Costs (KSh)
		load directly entering riverine environments. Carry out terracing and landscaping of the disturbed sites as appropriate. Plant sediment binding grasses, shrubs and trees on the exposed slopes and other surfaces as appropriate.		vicinity of bridges and culverts, around borrow pits and exposed slopes.		Engineer, Environmental Manager/ Implementation consultant)	landscaped; Levels of turbidity recorded in the silt receiving waters/ areas.	
10	Increase in dust levels	Limit levels of dust through good practice such as watering of access routes, construction sites, deviations and other disturbed sites and cover lorries transporting construction materials. Provide workers with appropriate dust protective gear including masks and overalls.	Contractor	Along the access roads, at borrow pit sites and other sites where project works are taking place.	During construction stage and in other phases where dust levels are emitted	NEMA, KenGen (Resident Engineer, Environmental Manager/ Implementation consultant)	Complaints from local residents; number of water bowsers used; number and type of dust protective gear supplied to the labour force.	4,450,000
11	Increase in gaseous emissions	Reduce gaseous emissions by selection of appropriate machinery and	Contractor	Along the access roads, quarries and borrow pits and other sites where	During construction and operation stages.	NEMA, KenGen (Resident Engineer, Environmental	No. of complaints from local residents; Levels of	4.450,000

Item	Environmental Impact	Mitigation Measures	Responsibility for Implementation	Site of Implementation	Implementation Schedule	Responsibility for Monitoring	Monitoring Indicators	Estimated Costs (KSh)
		regular servicing of vehicles. Provide workers with appropriate protective gear including masks to cut down on gaseous emissions inhaled.		project works are taking place.		Manager/ implementation consultant)	nitrogen and sulphur oxides; Carbon monoxide; Occurrence of smog.	
12	Effect of Hydrogen sulphide plumes and noise levels.	Install CEMs for real time monitoring of H_2S. Procure and install weather station. Assess effects of low levels of H_2S on physical structures people, flora and fauna.	KenGen	In the power plant and the whole of project area	During the project operating stage	KenGen Environmental Manager	Levels of H_2S recorded; monitoring reports; Visits to the H_2S receptors	23,000,000
13	Disposal of brine	Ensure all brine produced is re-injected into designated re-injection wells. Fence off and secure all the brine ponds associated with separators	KenGen	Olkaria VII power plant and all brine ponds associated with separators	During the project operation stage	KenGen Environmental Officer	No of functional re-injection wells; No of brine ponds fenced off and secured.	As per maintenance cost.
14	Loss of habitat and biodiversity	Discourage any wanton destruction of vegetation and habitats beyond the designed project works.	Contractor	At the power plant site, along the access roads, along the route of the steam pipe lines and transmission line, in	During construction, operation and the implementation of other project activities.	KenGen (Resident Engineer, Environmental Manager/ Implementation	No. of tree nurseries established; seedlings planted in the disturbed	27,429,000

Item	Environmental Impact	Mitigation Measures	Responsibility for Implementation	Site of Implementation	Implementation Schedule	Responsibility for Monitoring	Monitoring Indicators	Estimated Costs (KSh)
		Restore lost biodiversity on the disturbed area through planting of appropriate trees, shrubs and grasses and protection of fauna species and their habitat. Eradication of alien plant species in the project area. Participation in monitoring and biodiversity investigations with other stakeholders including KWS and KMFRI Increase surveillance and security in the Hell's Gate National Park during the construction stage Support for local initiatives in environmental protection		quarries and borrow pits and other areas where biodiversity has been destroyed.		consultant), KWS, NEMA,	areas; No of disturbed sites rehabilitated; extent of eradication of alien species.	
Total cost for the implementation of the mitigation/ monitoring activities; the equivalent Kenya Shillings is based on US$1=KSh138.03								**KSh 132,721,500 (US$ 961,539)**

11 ENVIRONMENTAL AND SOCIAL MONITORING PLAN

Key attributes of monitoring covered in this chapter include the need for environmental monitoring, basic attributes of environmental monitoring, significance of environmental monitoring, monitoring arrangement and focus areas for monitoring.

11.1 The Need for Environmental Monitoring

Monitoring is envisioned as an important process in the protection of environment of the project area. It will reveal changes and trends brought about by the presence and operations of the installed Olkaria VII geothermal power plant facility. By using the information collected through monitoring, impact mitigation and benefit enhancement measures can be improved and projects works or operations will be modified or halted when necessary. Since it is an essential tool in respect to environmental management, the project proponent will therefore undertake to conduct sustained environmental and social monitoring of the project area during the life of the Olkaria VII geothermal power plant project. The environmental and social monitoring provides the basis for rational management decisions regarding impact control and mitigation.

11.2 Basic attributes of environmental monitoring

As stated above, environmental monitoring is envisioned as an important process in the proposed management plan. The project proponent or the appointed agents and other relevant parties will undertake to conduct sustained environmental and social monitoring of the project area putting into consideration the following:

- Monitor changes in the environmental conditions of the project area through collection and analysis of appropriate environmental and social data throughout the life of the project:
- Check the extent to which the mitigation and benefit enhancement measures have been adopted and their effectiveness in practice;
- Provide a mechanism whereby unforeseen or unexpected impacts during the ESIA study can now be identified and provide measures to mitigate the unexpected negative impacts;
- Prepare periodical reports and liaise with relevant bodies and authorities through an established forum in order to discuss and resolve issues arising from the monitoring process; and
- Prepare the annual Environmental Audit (EA) report to NEMA and implement any subsequent recommendations arising from the EA report.

11.3 Significance of environmental monitoring

The significance of monitoring stems from the fact that the inputs derived from the Environmental and Social Impact Assessment (ESIA) into the project design and planning, including mitigation measures

and environmental management plan are largely based on "predictions". It is therefore essential that the basis for the choices, options and decisions made in formulating or designing the project and other environmental and social safeguard measures are verified for adequacy and appropriateness during the monitoring process. Monitoring verifies the effectiveness of impact management, including the extent to which mitigation measures are successfully implemented. The results of environmental monitoring will determine the success and efficacy of the proposed mitigation measures in protecting the environment of the project area.

11.4 The Monitoring Arrangement

Environmental monitoring will commence following the securing of permit from NEMA and the recruitment of the project Contractor, the Resident Engineer and Environmental Manager (this officer could be recruited in-house from KenGen staff). Once the project is underway, the project proponent (as represented by the Environmental and Social Development Managers and the Resident Engineer) and representatives of NEMA, local administration, relevant Government officers, community leaders and other relevant stakeholders will regularly visit the project area to review and ascertain that the clauses and conditions set by NEMA for the protection of the environmental are adhered to by the Contractor. As part of regular project activity, monitoring will involve systematic collection of data through a series of repetitive measurements and observations. Monitoring reports prepared by Environmental Manager will be reviewed by NEMA to ensure that proposals contained in the Environmental and Social Management Plan (ESMP) as contained Table 10.2-1 Environmental and Social Management Plan for the proposed project are being carried out by the Contractor as required.

The project will also conduct periodic interviews with project beneficiaries and other stakeholders in order to assess their opinions with regard to the implementation of the project. Details on the responsibility for monitoring and monitoring indicators are presented in Table 10.2-1 Proposed Environmental and Social Management Plan. Finally, the Environmental and Social Development Manager will analyse the collected data and information collected and subsequently compile and formalize the monitoring report in accordance with the set guidelines and timeframes and submit it as the Annual Environmental Audit Report (EA) to NEMA.

11.5 Focus areas for monitoring

The project proponent will carry out monitoring on the environment of the project area and surroundings including Lake Naivasha and surroundings. Typical environmental variables to monitor include:

- Changes in biodiversity;
- Changes in habitat;
- Changes in water quality;
- Soil erosion and siltation;

- Noise levels;
- Air emissions;
- Local community dynamics
- Spread of communicable diseases
- Increase in social problems;
- Changes in resource use;
- Increase in charcoal burning activities;
- Increase in poaching;
- Dust and gaseous emissions;
- Increase in accidents; and
- Any other relevant changes in ecological, socio-economic and environmental attributes.

Specific environmental and social variables recommended for monitoring with regard to Olkaria VII geothermal power project are presented in Table 10.2-1 Environmental and Social Management Plan for the proposed project. The total cost for implementation of the mitigation/ monitoring activities for Olkaria VII project is estimated at KSh 132,721,500 equivalent to US$ 961,539 at an exchange rate of USD$=KSh138.03. This total is broken down to USD429,000 for mitigation measures during construction and USD532,539 after Commercial Operating Date (COD).

12 CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

The following conclusions are drawn with regard to the implementation of environmental and social impact assessment of the proposed Olkaria VII geothermal power plant:

1. The proposed project will realize significant positive impacts that include stabilization of electricity in Kenya, potential for carbon market, contribution to reduction of carbon emissions, promotion of economic growth in the country, contribution to the Government revenue, increased employment and increased business opportunities among other positive benefits.
2. Against the background of project positive impacts, there will be negative impacts associated with the project construction and operation activities including loss of habitat and biodiversity, disturbance and destruction of floral and faunal communities, soil erosion, increase in dust levels, visual intrusion, increase in health risks, increase in unplanned catering services, poor waste management and poaching, among other negative impacts.
3. The increase in number of people in the project area following the commissioning of the project will lead to a number of negative socio-economic impacts including cultural contamination, increased incidences of diseases, insecurity, challenges of labour force management and increased accidents and occupational hazards, among other negative socio-economic impacts.
4. The modelling of hydrogen sulphide emissions has demonstrated that the normal operations of the proposed geothermal plant would not lead to any exceedances of human health stipulated under Factories and other Places of Work (Hazardous Substances) Rules 2007, and meets the NEMA Ambient Air Quality Regulations.
5. With regard to the noise modelling assessment, the noise levels are below the IFC ambient noise limits for residential, institutional educational areas, which are 55 dB (A) during daytime. The assessment also indicate occupational exposure limits will be met at all the selected monitoring locations.
6. The study has proposed several measures to reduce negative impacts including amelioration of social negative impacts, noise abatement, waste management, reduction of visual intrusion, restoration of habitat and biodiversity, reduction of soil erosion and siltation, prevention of accidents and health hazards and provision of health care services.
7. Monitoring plan has also been developed for the proposed project. This is an important process in the protection of environment of the project area since it will reveal changes and trends

brought about by the presence and operations of the installed geothermal power project. In addition, it will ensure that environmental and social mitigation measures identified in the planning stage and incorporated in the project design are being implemented in a sustainable manner.

12.2 Recommendations

The Consultant has proposed the following recommendations that will enhance sustainable implementation of the proposed project and protect the environment of the project area:

1. The project proponent (KenGen) needs to support the implementation of environmental management (including mitigation plan and monitoring) in order to protect the environment of the project area from the negative impacts of project implementation.
2. Environmental monitoring should be conducted in the project area in order to detect changes and trends brought about by the presence and operations of the installed project facilities with emphasis on changes in habitat, flora and fauna and environmental attributes such as noise, air emissions and brine.
3. There is need to rehabilitate all areas affected by proposed power project through terracing, landscaping, grassing and planting of appropriate trees and shrubs in order to restore the lost biodiversity, curb soil erosion and enhance the aesthetic value of the power plant and surroundings.
4. Since many members of the local communities have great expectations and perceive KenGen as an institution to provide job opportunities, there is a need to raise awareness and educate the community on the Company's role in geothermal power production in order to increase their level of understanding and remove any misconceptions they may have on the Company's operations in the project area.
5. In order to prevent and control diseases among the project workers and local community, the Contractor needs to raise awareness on communicable diseases such as HIV/ AIDS and supply the project workers with STD prevention devices including the male and female condoms.
6. The simulated air emissions and noise assessment modelling results should be validated by way of actual measurements and monitoring at the predicted fall out areas. The noise monitoring should be done using Type 1 noise level meter with real-time data logging system and 1/3rd octave band filters.
7. Meteorological station should be installed at the new power station to obtain real-time accurate weather and climate data.
8. There is need to construct fence and secure all the brine lagoons in order to prevent both domestic and wild animals from drinking the toxic brine.

9. KenGen needs to intensify the Company's tree nursery activities including raising seedlings that are relevant for the rehabilitation of Olkaria environment.

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ANNEXES