ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY FOR THE PROPOSED 140 MW OLKARIA II EXTENSION GEOTHERMAL POWER PLANT PROJECT

Final ESIA Report

August 2024

CERTIFICATION

ESIA EXPERT
I, **Prof. Jacob K. Kibwage** submit this Environmental and Social Impact Assessment study report for the proposed **140 MW Olkaria II Extension Geothermal Power Plant Project** located in Hell's Gate National Park, Naivasha Sub- County, Nakuru County. To the best of my knowledge, all information contained in this ESIA study report is an accurate and truthful representation of all findings related to the proposed project as per the project information provided by the proponent. *Signed in Nairobi on this ……………………day of ……………………, **2024.*** *Signature: …………………………………* *Designation*: ***ESIA Lead Expert, NEMA Reg. 0126***

PROJECT PROPONENT
I, **……………………………………………………………** on behalf of Kenya Electricity Generating Company Plc, submit this Environmental and Social Impact Assessment study report for the proposed **140 MW Olkaria II Extension Geothermal Power Plant Project** located in Hell's Gate National Park, Naivasha Sub- County, Nakuru County. To the best of my knowledge, all information contained in this ESIA study report is an accurate and truthful representation of all findings related to the proposed project. *Signed in Nairobi on this ……………………day of ……………………, **2024.*** *Signature: ………………………………………………..* *Designation*: **……………………………………………**

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ACRONYMS & ABBREVIATIONS

AAHSTO	Association of State Highway and Transportation Officials
ACA	Athi Catchment Area
ACC	Assistant County Commissioner
ACGIH	American Conference of Governmental Industrial Hygienists
AERMAP	American Meteorological Society/Environmental Protection Agency Regulatory Model Terrain Pre-processor
AERMET	American Meteorological Society/Environmental Protection Agency Regulatory Model Meteorological Processor
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
ALARP	As Low as Reasonably Practicable
AOI	Area of Influence
ATSDR	Agency for Toxic Substances and Disease Registry
AQ	Air Quality
AQG	Air Quality Guideline
AQRs	Air Quality Receptors
AQS	Air Quality Standards
B&L	B&L Engineering Services Limited
BEIs	Biological Exposure Indices
BOD	Biological Oxygen Demand
CBD	Convention on Biological Diversity
CBO	Community-Based Organization
CCTV	Closed-Circuit Television
CDCF	Community Development Carbon Fund
CDM	Clean Development Mechanism
CEC	County Environment Committees
CEDAW	Convention on the Elimination of all forms of Discrimination against Women
CERs	Certified Emission Reductions
CFCs	Chlorofluorocarbons
CH	Critical Habitat

CIDP	County Integrated Development Plan
CITES	Convention on International Trade in Endangered Species
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CPP	Consultation and Public Consultation
CR	Critically Endangered
CRC	Convention on the Rights of the Child
CRVWWDA	Central Rift Valley Water Works Development Agency
CS	Central Separator
CSR	Corporate Social Responsibility
DC	Direct Current
DCS	Distributed Controlled System
DHHS	Department of Health and Human Services
DOSHS	Directorate of Occupational Safety and Health Services
DN	Diameter Nominal
EAAA	Ecologically Appropriate Area of Analysis
EBA	Endemic Bird Area
EDG	Emergency Diesel Generator
EDL	Effluent Discharge License
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
EMF	Electric and Magnetic Fields
EN	Endangered
ENNCA	Ewaso Ng'iro North Catchment Area
EOO	Extent of Occurrence
EP	Equator Principles
EPA	Environmental Protection Agency
EPC	Engineering, Procurement, and Construction
EPRA	Energy and Petroleum Regulatory Authority

ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMMP	Environmental and Social Management and Monitoring Plan
ESS	Environmental and Social Standards
FCRS	Fluid Collection and Reinjection System
FEC	Fuel Energy Charge
FL	Frontline
FPIC	Free Prior Informed Consultation
FRP	Fiberglass Reinforced Polyester pipe
FY	Financial Year
GBV	Gender Based Violence
GCHM	Grievance and Complaints Handling Mechanism
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GEF	Grid Emission Factor
GHG	Greenhouse Gas
GIIP	Good International Industry Practice
GIS	Geographic Information System
GLCs	Ground Level Concentrations
GN	Guidance Note
GOGA	Greater Olkaria Geothermal Area
GoK	Government of Kenya
GPP	Geothermal Power Plant
GPS	Global Positioning System
GRM	Grievance Redress Mechanism
GSI	Geotechnical Site Investigations
GSUTs	Generator Step-up Transformers
GTC	Geothermal Training Centre
GWh	Gigawatt hours
GZ	Ground Zero
H_2S	Hydrogen Sulphide

HGNP	Hell's Gate National Park
HH	Household
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
HPDs	Hearing Protection devices
HSSE	Health, Safety, Security, and Environment
HTLS	High Temperature Low Sag
HUZ	High Use Zone
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
HVDC	High-Voltage Direct Current
IARC	International Agency for Research on Cancer
IBA	Important Bird Area
ICSC	International Chemical Safety Cards
ICT	Information and Communication Technology
IDF	Intensity Duration Frequency
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IFMIS	Integrated Financial Management Information System
IGA	International Geothermal Association
ILO	International Labour Organization
IPP	Independent Power Producer
IPPD	Integrated Payroll and Personnel Database
ISA	International Society of Automation
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
KCAA	Kenya Civil Aviation Authority
KENGEN	Kenya Electricity Generating Company Plc
KESHP	Kenya Environmental Sanitation and Hygiene Policy
KERRA	Kenya Rural Roads Authority
KETRACO	Kenya Electricity Transmission Company
KFS	Kenya Forest Service

KfW	Kreditanstalt für Wiederaufbau development bank
KMEG	Kwa Muhia Environmental Conservation Group
KMFRI	Kenya Marine and Fisheries Research Institute
KPI	Key Performance Indicator
KPLC	Kenya Power and Lighting Company
KWS	Kenya Wildlife Service
LAIFOMS	Local Authority Integrated Financial Operations Management System
LANAWRUA	Lake Naivasha Water Resources User Association
LC	Least Concern
LCA	Life Cycle Analysis
LCPDP	Least Cost Power Development Plan
LEL	Lower Explosive Limit
LMP	Labour Management Plan
LOAEL	Lowest Observed Adverse Effect Level
LN	Legal Notice
LNB	Lake Naivasha Basin
LNGG	Lake Naivasha Growers Group
LNRA	Lake Naivasha Riparian Association
LRVPs	Liquid Ring Vacuum Pumps
LUZ	Low Use Zone
LVNCA	Lake Victoria North Catchment Area
LVSCA	Lake Victoria South Catchment Area
masl	Metres Above Sea Level
MCR	Maximum Continuous Rating
MDAs	Ministries, Departments and Agencies
MEAs	Multilateral Environmental Agreements
MoEP	Ministry of Energy and Petroleum
MOU	Memorandum of Understanding
MRL	Minimal Risk Level
MSDS	Material Safety Data Sheet
NAIVAWASCO	Naivasha Water and Sanitation Company

NARUWASCO	Nakuru Rural Water and Sanitation Company Limited
NAWASSCO	Nakuru Water and Sanitation Services Company Limited
NBSAP	National Biodiversity Strategy and Action Plan
NCA	National Construction Authority
NCCRS	National Climate Change Response Strategy
NCG	Non-Condensable Gas
NDOC	National Disaster Operation Centre
NECC	National Environment Complaints Committee
NEMA	National Environment Management Authority
NET	National Environment Tribunal
NFPA	National Fire Protection Association
NGEC	National Gender and Equality
NGOs	Non-Governmental Organizations
NIOSH	National Institute for Occupational Safety and Health
NLC	National Lands Commission
NMK	National Museum of Kenya
NO_2	Nitrogen Dioxide
NOAEL	No Observed Adverse Effect Level
NPGD	National Policy on Gender and Development
NPSHa	Net Positive Suction Head available
NT	Near Threatened
O_3	Ozone
ODF	Open Defecation Free
OHS	Occupational Health and Safety
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
OPGW	Optical Ground Wire
OSHA	Occupational Safety and Health Act
OW	Olkaria Well
PAD	People Abled Differently
PAHs	Polycyclic Aromatic Hydrocarbons

PC	Process Contribution
PEC	Predicted Environmental Concentration
PELs	Permissible Exposure Limits
PIIM	Project Induced in-Migration
$PM_{2.5}$	Particulate Matter that are 2.5 micrometres and smaller
PM_{10}	Particulate Matter that are 10 micrometres and smaller
PPE	Personal Protective Equipment
PSVs	Public Service Vehicles
RAP	Resettlement Action Plan
RfC	Reference Concentration
RoD	Record of Decision
RoW	Right of Way
RTU	Remote Terminal Unit
RVCA	Rift Valley Catchment Area
SAGS	Steam field Above Ground System
SCADA	Supervisory Control and Data Acquisition
SCC	Stakeholders Coordination Committee
SCMP	Sub Catchment Management Plan
SCMS	Substation Control and Monitoring System
SDGs	Sustainable Development Goals
SEA	Sexual Exploitation and Abuse
SEP	Stakeholder Engagement Plan
SGR	Standard Gauge Railway
SiO_2	Silicon Dioxide
SO_2	Sulphur Dioxide
STIs	Sexually Transmitted Infections
T_c	Time of concentration
TCA	Tana Catchment Area
TDS	Total Dissolved Solids
TLV	Threshold Limit Value
TOR	Terms of Reference

TSP	Total Suspended Particles
TVOCs	Total Volatile Organic Compounds
UNCCD	United Nations Convention to Combat Desertification
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UTM	Universal Transverse Mercator
VTMP	Vehicle and Traffic Management Plan
VU	Vulnerable
WB	World Bank
WHO	World Health Organization
WHRC	Waste Heat Recovery Cycle
WIBA	Work Injury Benefits Act
WMP	Waste Management Plan
WRA	Water Resources Authority
WRTI	Wildlife Research and Training Institute
WRUAs	Water Resources User Associations
WWF	World Wildlife Fund

LIST OF UNITS

°C	Degree Celsius
dB (A)	A-weighted decibel
GW	Giga Watt
GWh	Giga Watt hour
Km^2	Kilometre Squared
kV	Kilovolt
kW	Kilowatt
Hz	Hertz
$\mu g/m^3$	micrograms per cubic meter
µS/cm	Micro-siemens per centimetre
mg/l	milligrams per litre
mgO_2/l	Milligrams of oxygen per litre
mgPt/l	Milligrams of Platinum per litre (Colour)
mm	Millimetres
MPN/100mL	Most probable number per 100 millilitres
MVA	Megavolt-amperes
MW	Mega Watt
MWe	Mega Watt Electrical
t/h	Tonne per hour

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EXECUTIVE SUMMARY

Introduction

The Environmental and Social Impact Assessment (ESIA) for the Olkaria II Extension Geothermal Power Plant was conducted to ensure compliance with various environmental and social standards, including Kenya's Environmental Management and Coordination Act (EMCA) Cap 387, the Environmental (Impact Assessment and Audit) Regulations 2003, World Bank Environmental and Social Standards (ESS), JICA's Environmental and Social Considerations, and KfW Development Bank guidelines. The assessment employed a comprehensive methodology encompassing environmental screening, scoping, desktop studies, household surveys, site visits, impact analysis, stakeholder consultation, GIS technologies, and environmental sampling and laboratory analysis. This report is structured into sections detailing the project description, impact assessment methodology, baseline analysis, legal framework, public consultation, alternatives analysis, potential impacts, mitigation measures, cumulative impacts, climate change risk assessment, grievance redress mechanism, and Environmental and Social Management Plans (ESMP), Environmental and Social Management and Monitoring Plan (ESMMP), Conclusion, Recommendations, References and Annexes.

Project Background

Kenya Electricity Generating Company Plc (KenGen), herein referred to as the 'proponent', is a public limited liability company, registered under the Companies Act of the laws of Kenya.

KenGen commenced exploration of the Olkaria geothermal area in the early 1950s which identified a geothermal potential zone of about 204 km^2, currently known as the Greater Olkaria. Currently, Kenya has a combined geothermal installed capacity of 988 MW. The country's geothermal installed capacity is generated by KenGen (799 MW) and Independent Power Producers (IPPs) such as: OrPower 4Inc (150 MW); Sosian Energy (35 MW); and Oserian Development (4 MW).

Studies estimate that there is still considerable geothermal potential in Olkaria geothermal area, hence KenGen plans to install additional geothermal generation capacity by upgrading, rehabilitating and developing new power plants in the region. As part of the company's strategy and in line with the national electricity master plans, KenGen intends to develop Olkaria II Extension Geothermal Power Plant, in the Northeast Olkaria field.

The estimated equivalent gross output of the proposed Olkaria II Extension Geothermal Power Plant is 146*Mwe*, with a net output of 140*Mwe*, after accounting for auxiliary power consumption and step-up transformers' losses. Completion of KenGen's top priority power plant projects will bring their total installed geothermal capacity in the Greater Olkaria area close to 1,100*Mwe*.

Project Location

The proposed project site is located approximately 6km south of Lake Naivasha in Kenya's Rift Valley, adjacent to the existing Olkaria II Geothermal Power Plant, on GPS coordinates

0°51'41.24"S, 36°17'50.83"E (elevation of 2000m ASL), within Hell's Gate National Park, in a piece of land leased from Kenya Wildlife Service (KWS), in Naivasha Sub-County, Nakuru County.

Project Justification

Kenya is experiencing a significant increase in electricity demand, driven by economic growth and population expansion. This has resulted in an upward trend in energy demand with peak demand increasing from 1,107 MW in FY 2010/11 to 2,149 MW in FY 2022/23. A new peak of 2,149MW was recorded on 14th December 2022.

To meet this demand, the government has prioritized the development of geothermal energy, given the substantial geothermal potential in the Rift Valley. Studies have consistently shown that Kenya has an estimated geothermal potential of 10,000 MW, mainly located in the Rift Valley, while hydro has an estimated potential of between 3,000 to 6,000 MW.

The Olkaria II Extension project aims to contribute an additional 140 MW to the national grid, supporting sustainable energy development and reducing reliance on fossil fuels.

Project Site Ownership

The proposed project site is within KenGen land set aside for geothermal development. KenGen entered into a sublease agreement with KWS for 1064.36 hectares of land (reference No. 12881/6) that was subdivided from land parcel No 12881/5/1. KenGen pays annual rent to KWS under the terms of the lease.

Proposed Project and Associated Activities

The project involves the construction and operation of a geothermal power plant with mechanical, electrical, control, monitoring systems, and associated civil, structural, and architectural works. The project activities are divided into three main phases:

- **Construction Phase:** Includes site preparation, drilling of geothermal wells, construction of power plant infrastructure, and installation of equipment.
- **Operation Phase:** Involves the production of geothermal energy, regular maintenance of equipment, and monitoring of environmental and social impacts.
- **Decommissioning Phase:** Entails the safe closure and dismantling of the plant and rehabilitation of the site.

Baseline Environmental and Social Analysis

The proposed project site is located approximately 6km south of Lake Naivasha in Kenya's Rift Valley, adjacent to the existing Olkaria II Geothermal Power Plant, on GPS coordinates -0.861456°, 36.297453° (elevation of 2000m ASL), within Hell's Gate National Park, in a piece of land leased from Kenya Wildlife Service (KWS), in Naivasha Sub-County, Nakuru County.

Naivasha Sub-County has twenty (20) wards, namely: Kongoni, Maiella, Kipkonyo, Moindabi, Ndabibi, Longonot, Munyu, Kijabe, Satellite, Mirera, Olkaria, Gatamaiyu, Karati, Maraigushu, Lake-View, Tarambete, Kinamba, Mununga, Kabati, and Sokoni. The proposed site area will be within Olkaria Ward.

According to the latest population and housing census conducted in 2019, the population size of Naivasha Sub-County was 355,383 (179,222 Male, 176,132 Female and 29 Intersex), with a population density of 181 persons per Km^2, covering a land area of 1,958 Km^2.

Some of the key environmental survey findings included:

- The proposed 140MW Olkaria II Extension Geothermal Power Plant will not lead to human displacement of community settlements as the power plant's footprint will be on KenGen's land (which was leased by KWS) set aside for geothermal development. Additionally, the proposed power plant will use already existing power evacuation systems i.e. power generated at Olkaria II Extension Geothermal Power Plant will be evacuated into the adjacent Olkaria II power plant's substation and thereafter into the national grid through the existing: Olkaria II to Suswa; Olkaria II to Olkaria I-AU; and Olkaria II-Lessos-Kibos transmission lines.
- The project site has three construction/ material laydown yards mainly used for storage of drilling bits and non-toxic drilling chemicals (caustic soda, drilling mud and drilling detergent);
- Polucon Services (Kenya) Limited, a NEMA-licensed laboratory, was contracted to undertake soil sampling and analysis. The results showed that the soils at the site were not contaminated, i.e. all parameters of Organic, Polychlorinated Biphenyls (PCBs), and Heavy metal elements in the samples, were below the Dutch Standards for Soils and Sediments.
- There is no endemic vegetation present on the site. The site is dominated by shrubs and common grasses.
- The project site is not a sensitive area (not used as a habitat for endangered species or used as a designated breeding ground for fauna).
- There are no rivers within the project site. Water samples from the storm water drainage channel adjacent to the proposed site, which drains water from Olkaria II Power Station, were collected and taken to the Water Resources Authority (WRA) laboratory for analysis. The results showed that all parameters analysed were within the NEMA thresholds for effluent discharge into the environment except for pH which was at 8.8, slightly above the required EMCA maximum limit of 8.5.s.

Air Quality

The findings of the ambient air quality measurement survey conducted during the ESIA study indicated that the baseline conditions within and surrounding the project area were within the acceptable levels stipulated by the Environmental Management and Coordination (Air Quality) Regulations, 2014.except for the Geothermal Spa and KWS Staff Quarters near Olkaria gate, which where Sulphur Oxide levels exceeded the allowable limits.

An air dispersion modelling study was conducted using the US EPA AERMOD model. In all instances, the maximum concentrations at the identified sensitive receptors were below the relevant standards and guideline values. A Comparison of the maximum ground level prediction with the appropriate ambient Air Quality Standards (AQS) indicated that the operation of the proposed power plant will not result in an exceedance of the limit values. The maximum predicted impacts were estimated at sensitive receptors located at about 8km radius from the emission sources. At these locations, the impacts were predicted to be below the daily limit values specified in the Environmental Management and Coordination (Air Quality) Regulations, 2014.

The highest predicted cumulative daily and annual H_2S impact at a receptor was 120.0 μg/m^3 and 11 μg/m^3, at the Geothermal Spa, as compared with the EMCA daily limit of 150 μg/m^3. The annual averaging period for H_2S is not regulated in Kenya. The predicted cumulative daily H_2S impact at the other monitored receptors included: 105 μg/m^3 at the KWS Staff Quarters near Olkaria gate; 90 μg/m^3 at Olomaiyiana Baptist Church; 56 μg/m^3 at Narasha Primary School; and 55 μg/m^3 at Geothermal Training Centre. The most impacted receptor, Geothermal Spa, falls within KenGen's property areas and can be considered as occupational exposure.

Although the ambient air quality measurement (28.3 μg/m^3) and air dispersion modelling results (105 μg/m^3) showed that the H_2S levels at the KWS staff quarters near Olkaria gate were below the EMCA ambient air quality limits and also well below the concentration (3,000 μg/m^3) known to cause health effects to human beings, according to the World Health Organization's (WHO) air quality guidelines, this study recommends that the KWS staff quarters at the Olkaria gate be relocated. They are currently located approximately 800 metres from the proposed project site and 400 metres South-West of the OW-739 well cluster, where wells designated for reinjection of brine are located. This implies that exposure to H_2S levels is expected to increase in future around the Olkaria gate.

Community studies near geothermal and volcanic sources indicate that respiratory impacts of H_2S are not limited to high exposures only; low levels also increase the risks of respiratory symptoms, respiratory disease and mortality as shown by other scientific studies examining communities near geothermal and volcanic H_2S sources including: Reykjavik (Iceland); Rotorua (New Zealand); the Azores (Portugal); and Mt. Amiata (Italy). Geothermal emissions and hazards have been reviewed by Bustaffa et al. (2020) and Hansell and Oppenheimer (2004). Portions of these communities experienced chronic exposure to H_2S, estimated to be between 0.02 and 1.0 ppm; Nuvolone et al. (2019) found a lower range of 0.0003 to 0.0224 ppm.

On the other hand, while Sulphur dioxide may also not be of major concern, it can cause respiratory problems such as bronchitis, and can irritate your nose, throat and lungs. It may also cause coughing, wheezing, phlegm and asthma attacks. The effects are worse when one is exercising near the source. Sulphur dioxide has also been linked to cardiovascular diseases.

From a health point of view, conclusion can be made that the area around the KWS staff quarters at the Olkaria Gate is safe for residence of the KWS rangers, based on the results obtained from the predicted cumulative daily H_2S concentration of 105 μg/m^3. However, this predicted cumulative level of H_2S was exactly equivalent to the concentration levels given by the WHO's air quality guidelines for Particulate Matter, Ozone, Nitrogen dioxide and Sulphur dioxide, which provide the 'Odour Threshold' level at 105 μg/m³ (Reference: EPA/600/R-14/039). This therefore implies that with the implementation of the proposed Olkaria II Extension Project, the KWS rangers residing in the six (6) houses near the Olkaria gate, will likely experience more nuisance due to the characteristic rotten egg smell of H_2S. Although, there is no documented link between odour and health effects, odourant compounds can affect human health through several mechanisms (e.g. Schiffman et al. 2005; Woodall et al. 2005; Wing et al. 2008). Odour emissions, odour perception, and odour nuisance present quality of life issues that can cause individuals to modify certain physical and social activities (e.g. outdoor physical activity), which can then lead to other health-related issues. Odour perception is often associated with odour nuisance and complaints, and sometimes with psychological responses, e.g. headache, nausea, and loss of sleep.

The consultant undertook consultations with the Hell's Gate National Park Warden and the KWS Rangers residing in the quarters near Olkaria Gate, and what came out clearly was that, even without the proposed project, the rotten egg smell of H_2S was a nuisance to them especially since they worked and resided in the same area, meaning they experienced the odour effect on a 24-hour basis. They therefore preferred that KenGen assist in the relocation of the staff quarters and reconstruct them near the staff quarters located adjacent to KWS Elsa Gate (-0.852469°, 36.369134°), which is approximately 15km and/or a twenty minutes' drive from the Olkaria Gate. This way, the KWS rangers would be transported from their staff quarters/Elsa Gate to the Olkaria gate during the start of the shift and back to their staff quarters at the end of their shift hours, on a daily basis.

They preferred this location due to the following reasons: the location is at the KWS Headquarters- residential area for Hell's Gate National Park staff; there is land available for construction which belongs to KWS, therefore there will be no need for acquisition of land; and the area around Elsa Gate is zoned as a Tourism zone (i.e. there are no geothermal power plants in the area), as compared to Olkaria and Narasha Gates, which are at an area zoned for Geothermal Resource/ Industrial Development. Hence there will be no exposure to any effects of H_2S or noise at the Elsa gate.

By relocating the staff quarters to the area near Elsa gate, H_2S exposure to the KWS rangers will be reduced from a time-weighted average of 24-hours to a maximum of 8-hours during the ranger's shift hours. This therefore reinforces the recommendation to relocate the six (6) KWS staff quarters.

To efficiently and effectively implement the measures set out for mitigating the negative social impacts associated with exposure to H_2S during the operation phase of the project (inclusive of the relocation of the KWS rangers' houses located near the Olkaria gate), a total of thirty million Kenya Shillings (Kshs. 30,000,000) will need to be set aside as indicated in the detailed Environmental and Social Management Plan (ESMP) provided as part of this project's ESIA Study Report.

Noise

As part of the ESIA Study, a noise assessment was carried out. Predictive noise mapping was performed for the proposed geothermal power plant operation with the use of inverse square law to determine the sound attenuation over a distance. The results indicated that the noise levels were below the IFC ambient noise limits for residential, institutional and educational areas, which is 55 dB(A) during the daytime for all the sensitive receptors except for the KWS staff Quarters near the Olkaria Gate and Olomaiyiana Baptist church, which recorded noise levels of 66.2 dB(A) and 57.2 dB(A) respectively. The results obtained from the predictive noise mapping analysis for the other monitored receptors were as follows: 53.0 dB(A) at the Geothermal Training Centre and 50.2 dB(A) at Narasha Primary School. For the Kenyan limits, provided by the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009, for residential, institutional and educational areas, which is 50 dB(A) during daytime and 35 dB(A) during the night-time, noise levels were exceeded at all the receptors.

The maximum predicted noise level was at the Geothermal Spa facility with noise level of 72.1 dB(A) which is below the noise level limit of 90 dB(A), provided by the Factories and Other Places of Work (Noise Prevention and Control) Rules of 2005 and falls within the KenGen property areas and was considered as occupational exposure.

For the residential areas, the Kenyan ambient noise limit of 35 dB(A) during night-time was exceeded at all the sensitive receptors. This is mainly due to the available data obtained from one monitoring point with an average noise level of 57.1 dB(A) that is already in exceedance of the Kenyan ambient noise limit for residential areas.

Ambient vibration measurement and modelling of the cumulative impact of vibration was not undertaken during the study, as vibration was not considered as a major issue associated with the proposed project and the Olkaria Geothermal Field in general. This is because there will be no blasting during the construction phase of this project and vibrations experienced during this phase will only be intermittently experienced when excavation and construction equipment are being used. Additionally, during the operation phase, the impact of vibrations caused by underground pipelines as condensate is pumped to the reinjection wells will be insignificant, as the Olkaria Geothermal Field is dominated with Volcanic Ash soils, which are known to absorb such vibrations, due to their low density and lack of cohesiveness nature.

Biodiversity of the proposed site area

a) Flora

The flora present within the proposed project area is almost similar to that of Hell's Gate National Park (HGNP) in general, as it is dominated by the shrubland community mostly comprising of *Tarchonanthus camophratus*, locally referred to as "leleshwa". Common grasses in the shrubland community of the project site include; *Cymbopogon Nardus*, *Setaria Sphacelata*, *Themeda triandra*, *Eragrostis cilianensis*, *Hyparrhenia hirta*, *Cynodon dactylon*, *Pennisetum clandestinum*, and *Digitaria abyssinica* among other grasses.

b) Fauna

Similarly, the fauna present within the proposed project area is almost similar to that of Hell's Gate National Park in general. It is important to note that the site is not a sensitive area used as a habitat for endangered species or used as a designated breeding ground for fauna. Herbivores may late at night or early in the morning, graze/browse outside the periphery of the proposed site but not within the project's footprint.

The wild animals that have been spotted outside the project's footprint grazing/browsing include the zebra (*Equus burchelli*), Hartebeest (*Alcelaphus buselaphus*), gazelle (*Gazella thomsonii* and *Gazella grantii*), Impala (*Aecpyceros melampus*), dik-dik (*Rhyncotragus kirkii*), giraffe (*Giraffa cemelopardalis*) and buffalo (*Syncerus caffer*) among other herbivores.

Invasive plants

One of the main problems in the South Rift Region is invasive plant species, which leads to the decline of healthy rangelands. Castor plants, Datura, Sodom apple and Leleshwa among others are some of the invasive plants in the project area. For castor accidental ingestion of its by-products can cause poisoning in animals and humans, characterized by digestive signs resulting from the presence of a toxalbumin called ricin. Seed toxicity varies among animal species; in horses, the lethal dose of seeds is 0.1 g/kg of body weight (Montão *et al*., 2018).

In goats, *Datura stramonium* ingestion is accompanied by tachypnoea, tremors, drowsiness, recumbency, and altered locomotion while in cattle excitability, tremors, rumen atony, nervousness, bloat, tenesmus, and anorexia are some of the clinical signs with death occasionally reported (Stegelmeier & Davis, 2023). *Solanum incanum* on the other hand is toxic to livestock and considered to be a major threat to grazing. It is also found in savanna grasslands where it might impact native herbivores. Leleshwa (*Tarchonanthus camphoratus*) though not poisonous, is not palatable to many of African herbivores and invades the grassland turning them into shrublands. However, in the Olkaria field, it plays a vital role in providing shade to animals and holding the fragile soil together thus combating soil erosion.

Socio-Economic Analysis

The ESIA Consultant, assisted by the six (6) field assistants, carried out Socio-economic surveys using digital questionnaires in the project area. The main aim of the activity was to collect data to feed on the baseline data as well as identify socio-economic impacts associated with the proposed project. This activity took place from 11th to 13th October 2023. A total of two hundred and twenty-six (226) respondents were interviewed as shown in the table below.

Table 0-1: Socioeconomic survey respondents

Villages	Respondents
Kambi Turkana and RAPLand	47 (20.8%)
Olomayiana Kubwa	33 (14.6%)

Kamere, DCK, Oldonyo, Sher, Rift, Oserian, Majengo, Kasarani and Kwa Muhia	57(25.2%)
Narasha, Olomunyak, Olmara, and Nkampani	47(20.8%)
Iseneto (Ilkituma, Oloserian, Oloiriwua, Olorropil, Olosing'ate, Oloshaiki & Kitet)	42(18.6%)
Total	**226**

The results of the survey indicated that:

- 35.84% of the respondents were aged between 20-30 years.
- Majority of the respondents (98.67%) were Christians.
- The dominant ethnic community (69.91%) is Maasai.
- The respondents' education levels attained are as follows: secondary (81%), primary (49%), college (33%), and university (7%).
- Majority of the respondents (63.27%) are livestock farmers.
- Majority of the population rears Sheep (36%), goats 33% and cows 22%.
- 8.41% of households reported to have members suffering from various disabilities with 55% affected with physical impairment; The major sources of income for the households surveyed were livestock keeping at 54%.
- The majority of household heads (56.19%) earn below Ksh10,000 in a month.
- 'Boda-boda'/ motorcycle is the most common mode of transport amongst the respondents.
- 98.67% of the respondents reported the mobile phone as their primary mode of communication.
- Whilst there were a variety of illnesses such as diarrhoea, headache, asthma and blood pressure, malaria and flu were the most prevalent.
- The majority of the respondents mentioned drought and very high temperatures as the main notable shifts in weather patterns in the area.
- 78% of the respondents used piped water, mostly provided by KenGen.
- 55.75% of the households were connected to the National power grid.

The majority of the households use charcoal and firewood from nearby bushes for cooking energy.

Policy Legal and Institutional Framework

This study provides an outline of policies, multilateral environmental agreements and national legislation relevant to the proposed project. The study also provides an institutional framework indicating the Government of Kenya institutions with relevant mandates and functions to influence the implementation of the proposed project.

World Bank Environmental and Social Standards (WB ESS) triggered.

The table below presents the WB ESS triggered by the proposed project.

Table 0-2: WB ESS triggered by the proposed project

Environmental and Social Standards	Triggered
ESS1: Assessment and Management of Environmental and Social Risks and Impacts	Yes
ESS2: Labour and Working Conditions	Yes
ESS3: Resource Efficiency and Pollution Prevention and Management	Yes
ESS4: Community Health and Safety	Yes
ESS5: Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement	No
ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Yes
ESS7: Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	No
ESS8: Cultural Heritage	No
ESS9: Financial Intermediaries	No
ESS10: Stakeholder Engagement and Information Disclosure	Yes

Consultation and Public Participation

Consultation and Public Participation (CPP) and Disclosure process is a policy requirement by the Government of Kenya which is enshrined in the Constitution of Kenya and a mandatory procedure as stipulated by the Environmental (Impact Assessment and Audit) Regulations, 2003 (Part III, section 17) and EMCA (Cap 387) Part VI, on Integrated Environmental Impact Assessment.

To ensure effective stakeholders' consultation and public participation, stakeholder mapping was conducted, and a database was created consisting of interested parties. Assessment tools were prepared for effective and systematic interviews by the ESIA Consultant assisted by a team of technical field assistants.

Various methods and instruments were identified and used for effective and efficient public consultation and participation. They include:

i. Public Consultative Meetings.
ii. Administration of Public Participation Questionnaires.
iii. Key Informant Consultation.
iv. Household Socioeconomic Survey.
v. Key Stakeholders' Meeting.

Public Meetings

Consultative meetings were continuously held during the ESIA Study exercise to deliberate on the positive impacts, negative impacts and mitigation measures for the proposed Geothermal Power Plant and associated facilities, as well as capturing issues raised by the local community. The five (5) public meetings were held on various dates in October 2023, with the local community members, Nyumba-Kumi elders, village elders, Chiefs, Assistant Chiefs, County officials, and institutions/organizations' representatives in attendance.

Table 0-3: Public meetings attendance breakdown

Date & Time	Location	Sub-Location	Targeted Villages	Venue	Attendance				
					Male		Female		Total
					No.	(%)	No.	(%)	
Wednesday 11th October 2023 9:00 a.m.	Olkaria	Olkaria	Kambi Turkana and RAPLand	RAPLand Social Hall, RAPLand	43	67%	21	33%	64
Wednesday 11th October 2023 2:30 p.m.	Olkaria	Kamere	Kamere, DCK, Oldonyo, Sher, Rift, Oserian, Majengo, Kasarani & Kwa Muhia	Elsamere Conservation Centre, Kamere	63	64%	35	36%	98
Thursday 12th October 2023 9:00 a.m.	Olkaria	Olkaria	Narasha, Olomunyak, Olmara & Nkampani	Narasha Baptist Church, Narasha	68	60%	45	40%	113
Thursday 12th October 2023 2:00 p.m.	Olkaria	Olkaria	Olomayiana Kubwa	"Kwa Ground", Olomayiana Kubwa	60	53%	54	47%	114
Friday 13th October 2023 9:00 a.m.	Enosoopukia	Nkoirienito	Iseneto (Ilkituma, Oloserian, Oloiriwua, Olorropil, Olosing'ate, Oloshaiki and Kitet)	Oloiriwua Baptist Church, Oloiriwua	105	65%	56	35%	161
TOTAL					**339**	**62%**	**211**	**38%**	**550**

ESIA Questionnaires

A total of One hundred and twenty (120) ESIA questionnaires were administered during the consultative public participation exercise. Those respondents who filled the questionnaires comprised 85 (71%) Males and 35 (29%) Females as shown in the table below.

Table 0-4: Summary of questionnaires filled by respondents

SN.	Date	Sub location/ Villages	Venue	Respondents		
				Male	Female	Total
1.	Wednesday, 11th October 2023	Kambi Turkana and RAPLand	RAPLand Social Hall	19 (68%)	9 (32%)	28
2.	Wednesday, 11th October 2023	Kamere, DCK, Oldonyo, Sher, Rift, Oserian,	KenGen Social Hall	23 (82%)	5 (18%)	28

		Majengo, Kasarani & Kwa muhia				
3.	Thursday, 12th October 2023	Narasha, Olomunyak, Olmara& Nkampani	Narasha Baptist Church	27 (87%)	4 (13%)	31
4.	Thursday, 12th October 2023	Olomaiyiana Kubwa	'Kwa ground' – Olomayiana Kubwa village	7 (39%)	11 (61%)	18
5.	Friday, 13th October, 2023	Iseneto (Ilkituma, Oloserian, Oloiriwua, Olorropil, Oloshaiki, Kitet and Olosing'ate)	Oloiriwua Baptist Church	9 (60%)	6 (40%)	15
TOTAL				**85 (62%)**	**35 (29%)**	**120**

Key Stakeholder Consultations

Key Informants were consulted to provide information on the Environmental and Social concerns associated with the proposed Geothermal Power Plant and associated facilities. The interviews were held in the months of September and October 2023, with relevant National Government, County and Sub-County heads of various Agencies and Departments.

Key Stakeholders Meeting

Additionally, a key stakeholders' meeting was convened on 30th November 2023 in Naivasha town at Astorian Grand Hotel, with a total of fifty-eight (58) attendees, comprising 37 (64%) Males and 21 (36%) Females as shown in the table below. This was carried out so as to engage the stakeholders more comprehensively depending on their interest in the proposed project. It also focused on those who have access to people and/or key resources needed for the ESIA exercise.

The meeting was held to: add more input to the ESIA analysis findings; fill information gaps identified during the ESIA study; better understand the proposed project area context; get views from lead agencies regarding the proposed project; and assist in prioritizing challenges that need to be addressed.

Table 0-5: Key stakeholders' meeting attendance breakdown

Date & Time	Venue	Targeted Group	Attendance				
			Male		Female		Total
			No.	(%)	No.	(%)	
Thursday 30th November, 2023 9:00 a.m.	Astorian Grand Hotel	Key Stakeholders from Nakuru and Nairobi Counties	37	64	21	36	**58**

The attendees mostly included representatives from: various Government departments and parastatals; Non-Governmental Organizations, Community-based Organizations, Private entities and higher learning institutions, among others.

Socio-Economic Survey

As earlier mentioned, the Socio-economic survey was carried out from 11th to 13th October 2023, using digital questionnaires in the project area of influence. The main aim of the survey was to help the ESIA parties (Proponent, Consultant and Regulatory Authority) understand the social and economic characteristics of the community found within the proposed project area of influence for informed decision making. The data obtained can as well be considered to have been obtained from a representative sample of the community for conclusions on the findings hence applicability as part of the baseline information for this study.

The socio-economic survey targeted populations that would be directly or indirectly affected by the project in Olkaria and Maiella locations in Nakuru County and Enosoopukia Location in Narok County. The table below presents a summary of Key issues raised by stakeholders during the Consultation and Public Participation (CPP) process:

Table 0-6: Summary of Issues/Concerns raised by all stakeholders consulted

S/N	Key Issue & Background	Response
1.	Sharing of employment opportunities among local communities Concerns over the discrimination of locals during recruitment in past KenGen projects were expressed. There was an expectation that locals should be given priority in recruitment and other business opportunities during the implementation of the proposed project. Stakeholders requested KenGen to consider women and People Abled Differently (PAD) during recruitment.	▪ The proponent clarified that recruitment for permanent employment positions at KenGen is done through KenGen's online recruitment portal and is handled from the head office in Nairobi. For casual jobs currently available at Olkaria projects, the proponent stated that they employed workers from the nearby villages. The Stakeholder Coordination Committee (SCC) is given the mandate of apportioning the available employment positions to the various villages. ▪ The ESIA consultant stated that a Labour Management Plan would be developed as part of the ESIA Study to guide the proponent on local recruitment. The community was encouraged to also take advantage of indirect benefits from the Olkaria projects. Women were encouraged to register companies and be in groups that could take up community projects like tree nurseries that could later be sold to KenGen and other companies. This could also enable the community to secure tenders for supplies of materials and equipment etc.

S/N	Key Issue & Background	Response
2.	Stakeholder Coordination Committee (SCC) Stakeholders were concerned that the current representatives to the SCC had been nominated by KenGen and not by the community. Additionally, concerns were related to the lack of adequate representation for youth, PAD, women representation & some ethnic groups in the SCC.	▪ The proponent clarified that initially, the community nominated representatives to the committee. However, this resulted in unscrupulous individuals being nominated to the committee. To address this concern, KenGen vetted and nominated the village representatives to the current SCC for Olkaria projects. Stakeholders were urged to give the current SCC a chance to complete their 3-year term.
3.	Corporate Social Responsibility (CSR) The community requested KenGen to expand its CSR initiatives in the villages. Proposed CSR projects included, ▪ Support to schools ▪ Support to vulnerable groups ▪ Scholarships ▪ Road improvement ▪ Health facilities ▪ Water & electricity connection.	▪ The proponent noted that they dedicate a percentage of their profits to CSR activities. Thus, the increase in the number of projects means more profits and an increase in the amount of money dedicated to CSR activities within the community. ▪ The project's corporate social responsibility will capture the community's concerns on scholarships, dispensaries, classrooms, market etc. based on the profits the company will make from the project.
4.	Benefits from commercialization of Certified Emission Reduction (CER). The community requested KenGen to dedicate a larger percentage of the proceeds from the commercialization of CERs to support the local community.	▪ The proponent pointed out that the community will benefit from the sale of carbon credits as a percentage of those profits will be directed into community projects as part of CSR.
5.	Public Participation & Consultation Stakeholders requested access to the final ESIA Report and Consultation Meeting Minutes.	▪ The ESIA Consultant noted that the ESIA Report and consultation minutes would be made public and available for download from the NEMA website.
6.	Invasive Species/ Castor Plant The low-lying villages in the Iseneto area (Ilkituma, Oloserian, Oloiriwua, Olorropil, Oloshaiki, Kitet and Olosing'ate), normally experience storm water from the higher areas of Olkaria and the Hells Gate National Park. In these villages, castor plant (locally called Embaleki.) was observed growing along the storm water channels. This resulted to the villagers falsely associating the occurrence of the plant to stormwater from Olkaria area. The stakeholders claimed that	▪ The proponent noted that casuals would be assigned to cut down the plants. ▪ The ESIA Consultant noted that the castor plant (*Ricinus communis*) has been classified as an invasive plant by the Global Invasive Species Database. Further, it was noted that the study would include recommendations to prevent/mitigate the introduction of invasive species in the area.

S/N	Key Issue & Background	Response
	their livestock either die or experience miscarriages, due to eating the toxic seeds of the castor plant.	
7.	Brine Water The communities were concerned that the brine overflow during heavy rains had resulted in the contamination of natural springs in the surrounding area which the community depended on for livestock and crop watering.	▪ The ESIA consultant stated that a high percentage of brine water resulting from the separation process will be reinjected into the steam field. Reinjection piping will be installed to convey the brine and condensate from the separators to the designated reinjection wells. ▪ The ESIA Consultant recommended additional studies to ascertain the impacts of brine on people, animals and vegetation.
8.	Noise Pollution Stakeholders were concerned that noise from wells and other facilities had the potential of disrupting the community.	▪ The ESIA consultant noted that the proposed project would use the most advanced technology which will result in low noise emissions.
9.	Air Pollution Concerns were raised regarding the potential health impacts of H_2S emissions on workers, the community, and the environment.	▪ The proponent committed to having monitoring stations in the surrounding villages. ▪ The ESIA Consultant urged the proponent to involve the local community when monitoring H_2S to allay fears related to H_2S exposure. The Consultant added that the proposed project would use advanced technology which emits minimal amounts of H_2S.
10.	Soil Erosion& Flooding Stakeholders raised concerns that additional development in the Olkaria area would exacerbate soil erosion and flooding in the lower areas.	▪ The proponent stated that they were working with KWS to put in place sufficient storm water management measures in Olkaria.
11.	Biodiversity Stakeholders were concerned that the proposed project infrastructure could disrupt existing wildlife corridors, resulting in human-wildlife conflicts as animals sought for alternative habitats.	▪ The ESIA Consultant stated that the project should balance between technology development and nature preservations. He further stated that a Biodiversity Assessment exercise will be undertaken as part of the ESIA Study.
12.	Waste Generation Concerns were raised regarding the straining of the existing waste management infrastructure. It was noted that activities associated with the implementation of the project as well as the population increase in the area, would lead to increased waste generation. KenGen was urged to adopt	▪ The ESIA Consultant urged the proponent to adopt the Circular economy approach in waste management. ▪ KenGen was urged to adopt recycling measures next to the site to ensure waste is effectively and efficiently managed at a lower cost.

S/N	Key Issue & Background	Response
	recycling measures next to the site to ensure waste is effectively and efficiently managed at a lower cost.	
13.	Impact on Water Stakeholders were concerned that the project activities could potentially impact both the quality and quantity of water, especially in Lake Naivasha.	▪ The ESIA Consultant stated that the proposed power plant is designed to have a closed loop system for the cooling tower and the condenser units thus conserving water. ▪ The project has been designed to eliminate the possibility of waste water from draining into the lake.

Analysis of Alternatives

The project alternatives were considered for the aspects listed below:

- Site Analysis
- Forms of Energy for development
- No Action alternative
- 'With Project' alternative
- Technologies for Geothermal Power Plants
- Handling discharge water.

Potential Environmental and Social Impacts and Mitigations Measures

The proposed project has associated socio-economic benefits and negative environmental impacts. The socio-economic benefits include.

Positive Impacts

a) **Creation of Employment Opportunities:** The project will create direct and indirect employment opportunities. Direct employment opportunities will include workers employed in the geothermal plant whereas indirect opportunities include labour force employed in supporting business such as transportation.

b) **Contribution of the Project to Green-house Gas (GHG) Emissions Reduction:** The annual CO_2 emissions from the 140*MWe* net power geothermal electricity are calculated using Kenya's GEF (0.2262 tCO2e/MWh), resulting in approximately 277,411.68 metric tons of CO_2 equivalent annually. This assumes continuous full-capacity operation, which may not be the case in practice. KenGen estimates that the GHG emissions reduction from the Olkaria-II Extension project is approximately 150,000 tCO2e annually, considering a 92% availability rate.).

c) **Increased power supply to the national grid:** The objective of the proposed project is to construct a 146*MWe* gross power output geothermal power plant, with associated infrastructure**.** This will then be connected to the national grid towards meeting the ever-increasing demand for electric power in the country.

d) **Corporate social responsibility (CSR):** It is worth noting that currently, as part of KenGen's Corporate Social Responsibility program, the company implements community development and socially uplifting projects such as repair of roads, water supply, school upgrading, education scholarships, developing school infrastructure and social afforestation.

KenGen is anticipated to identify needful areas neighbouring the project area/Olkaria Geothermal development area and participate in more CSR activities. The consultant recommends that the proponent assists those living in areas experiencing unavailability of water, inadequate/dilapidated infrastructure for both primary & secondary education and health infrastructure, as part of CSRs where possible, subject to the availability of funds. These CSR projects may include but not be limited to: Construction of elevated water tanks for the community; Increasing the amount of water supplied; Construction of school dining hall(s); Construction of social hall(s); Provision of community buses; Improvement/upgrading of more road networks serving the community; Construction of health facilities; Construction of trading centres; Rehabilitation centres for the youth who have reformed from drug abuse; Construction of public sanitary facilities; Provision of more education scholarships; and Construction of more classes for the community schools.

The proponent should however align the CSRs with the respective County and Sub-County Governments' initiatives, to avert duplication of development efforts.

e) **Potential for Carbon Market:** Geothermal power stations are eligible for Clean Development Mechanism (CDM) as outlined in the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), because they release lower greenhouse gases than thermal power plants.

f) **Rehabilitation and restoration of the site to its original status:** During the decommissioning of the project, the area will be rehabilitated close to its original status prior to development by re-vegetating the areas that were occupied by the geothermal power plant and its associated infrastructure.

g) **Discovery of recyclable materials:** Recyclable materials and reusable items will be sorted and collected before disposal of generated waste material**.**

Summary of the Environmental and Social Management Plan (ESMP)

The table below shows the proposed mitigation measures for anticipated impacts of major and/or critical significance.

Table 0-7: Proposed mitigation measures for environmental and social impacts

Key Impacts	Mitigation Measures
Negative Environmental Impacts during the Construction Phase	
Air Emission and Dust	▪ Maintenance and service of construction machinery and equipment in accordance with the manufacturer's specifications; ▪ Train and sensitize workers on dust minimization techniques and management of air pollution from vehicles and machinery; ▪ Avoid removal of vegetation until such a time when clearance is required and ensure exposed surfaces shall be re-vegetated or stabilized as soon as practically possible; ▪ Frequent watering of exposed lose surfaces and piles of soil; ▪ Incorporate dust/fumes arrestors in the batching plant e.g. use of dust nets; ▪ Conduct regular air quality monitoring at the site and nearby settlements;

Key Impacts	Mitigation Measures
	▪ Temporary suspension of material handling activities during high wind events.
Noise Pollution	▪ Regular monitoring and measurement of noise levels at the site; ▪ Install proper noise barriers to reduce noise exposure to close sensitive receptors and/or the nearest villages; ▪ Limit operation for specific loud pieces of equipment or operations to daytime; ▪ Encourage the adoption of low-noise technology and practice for machines during construction.
Surface and Subsurface Contamination	▪ Ensure all chemicals and fuels are stored in designated storage areas; ▪ Ensure all chemical and fuel storage sites are banded and with impermeable surface; ▪ Proper maintenance and regular servicing of vehicles to ensure no leakages from the vehicles; ▪ Develop and implement a spills prevention and emergency response plan for the site; ▪ Training of workers on spills response to minimize the risk of chemical spills.
Surface Water Pollution	▪ Banding the working area to avoid surface flows and storms into water courses; ▪ Minimizing vegetation clearance; ▪ Compaction or regular watering of loose surfaces; ▪ Avoid grey water runoff or uncontrolled discharges from the site/working areas; ▪ Water containing pollutants shall be discharged into a conservancy tank for pre-treatment.
Solid and liquid Waste Generation	▪ Develop and implement a Waste Management Plan; ▪ Ensure all oily water discharges flow through an oil–water separator or a grease trap before discharge; ▪ Introduce portable toilets in construction sites, road work areas and workers' camps; ▪ Ensure hazardous and toxic waste will be removed from the site by a licensed hazardous waste transporter and disposed of in a licensed facility.
Impact on Flora	▪ Ensure selective clearing of vegetation for future re-growth and regeneration to ensure minimal disruption of wild fauna's natural movement, territoriality, and other ecological processes; ▪ Clearly delineate areas for land preparation/other activities in the field to prevent loss of vegetation outside of designated works areas. ▪ Revegetation of areas outside the project footprint that are affected by construction activities. ▪ Inspections and decontamination of vehicles and equipment upon mobilization to limit the potential for carrying seeds of non-native/ invasive plant species.
Impact on Fauna	▪ Monitor birds and wildlife abundance, distribution and movement; ▪ Erect bumps in wildlife crossing areas along the roads leading to the site; ▪ Discourage unnecessary hooting; ▪ Maintenance of roads within the park as routes for tourists' activities and wildlife management; ▪ Ensure proper design of pipes along animal migration corridors;

Key Impacts	Mitigation Measures
	▪ Fit high voltage transmission lines with wire markers and flappers to alert birds on flight; ▪ Shelter high heat points and emission vents within the project area; ▪ Incident records accidents and other human-wildlife conflicts should be monitored and followed by appropriate corrective measures.
Negative Social Impacts during the Construction Phase	
Impacts on Community Health	▪ Regular watering of loose surfaces and covering of loose materials; ▪ Avoid offloading and application of loose construction materials during windy hours; ▪ Introduce speed limits on roads and ensure compliance to minimize accidents in the busy environment; ▪ Monitor community health regarding respiratory illness in collaboration with the local health centres for informed preventive care strategies; ▪ Engage the community when noisy construction activities are set to take place.
Traffic Congestion	▪ Establish and implement a Vehicle and Traffic Management Plan (VTMP) in consultation with relevant government agencies; ▪ Public consultation on the implementation plan of equipment and material mobilization; ▪ Construction staging and idling vehicles should be away from sensitive receptors to the extent feasible; ▪ Safety inductions for vehicle drivers and construction contractors;
Impacts on Labour Rights and Working Conditions	▪ Develop and implement a Labour Management Plan (LMP) with a commitment to providing appropriate working conditions and terms of employment in accordance with relevant national and international laws and standards; ▪ Ensure the LMP will establish, maintain and improve the Worker-Management relationship to promote fair treatment, gender equality, non-discrimination and equal opportunity for workers, and enable a grievance mechanism for workers; ▪ Ensure all contractors and suppliers comply fully with the laws and regulations of the government of Kenya and the LMP.
Occupation Health and Safety	▪ Provide and enforce all ranges of required PPEs for workers and visitors; ▪ Establish a comprehensive Occupational, Safety and Health Policy and emergency response plan. ▪ Ensure compliance with all standards and legally required health and safety regulations; ▪ Include standard best practice health and safety provisions in the construction contract. ▪ Establish and enforce a strict code of conduct for all project drivers including outside suppliers delivering materials. ▪ Provision of fire-fighting equipment available at the worker's camp; ▪ Install appropriate safety signage for all work sites;
HIV / AIDs and Sexually Transmitted Infections (STIs)	▪ Sensitize workers and the local communities on HIV/AIDs and STIs in conjunction with the Public Health Office; ▪ Provision of condoms to the construction workers, project team and the public.

Key Impacts	Mitigation Measures
	▪ Formation of peer groups from among the project staff to ensure continuity in training and awareness raising; ▪ The contractor has to ensure that staff are made aware of the risks of contracting or spreading sexually transmitted diseases;
Negative Environmental Impacts during the Operation Phase	
Surface Water contamination	▪ Minimize risk of brine and condensate discharge through implementation of reinjection system to respective reinjection wells; ▪ Monitor the chemical composition of brine and condensate routinely; ▪ Develop a brine management plan to minimize the risk of brine discharges; ▪ Provision of adequately sized concrete lined reinjection settling ponds; ▪ Keep the reinjection settling ponds empty, as frequently as possible; ▪ Installation of sump pumps at the reinjection settling ponds, to increase the rate of injection of excess geothermal fluid into reinjection wells as well as a portable pump to be used at plant start-up; ▪ Regular maintenance of wellheads and geothermal fluid pipelines, including corrosion control and inspection; pressure monitoring; and use of blowout prevention equipment such as shutoff valves.
Noise and Vibration	▪ Provision of appropriate PPEs to the workers, including Hearing Protection devices (HPDs), especially to staff and visitors in the vicinity of the vent station (rock muffler) and cooling towers; ▪ Sensitization and education of workers and visitors on the need to use PPE provided; ▪ Daily noise level monitoring to be conducted; ▪ Conduct health surveillance of workers which shall include audiometric tests for the power plant operators at least once a year; ▪ Provide at strategic positions signages in identified noise hazardous areas; ▪ Develop and implement a noise management plan.
Impact on Air Quality and Odour	▪ Educate workers on the dangers of exposure to H_2S; ▪ Use of abatement systems to remove H_2S emissions from Non-Condensable Gases (NCGs); ▪ An air quality monitoring plan should be adopted to ensure the lowest possible impacts; ▪ Installation of automatic H2S data logging monitors in the vicinity of the vent station, (integrated with the H2S alarm system of the power plant) including use of personal H2S detectors by staff near or within potentially dangerous areas, such as the vent station (rock muffler) and cooling tower; ▪ The community Liaison office to have a strategy for communication with those who may be affected by odour nuisance and the office to also ensure that they share air quality monitoring results for transparency and to allay any community health fears.
Increased Waste Generation	▪ Develop and implement a Waste Management Plan that includes appropriate collection, handling, treatment, and disposal of waste; ▪ Encourage the reuse of green waste locally for composting/firewood or landscaping purposes; ▪ Manage regular disposal schedules to remove waste from the site where necessary; ▪ Implement portable toilets in construction sites, road work areas and workers' camps to treat wastewater discharge as per Project design;

Key Impacts	Mitigation Measures
	▪ Provide temporary hazardous waste storage; ▪ Ensure hazardous and toxic waste will be removed from site by a licensed hazardous waste transporter and disposed of in a licensed facility.
Impacts on Flora	▪ Monitor invasive plant species at the project area and uproot unwanted germinating plants; ▪ Brine flows and ponds should be located close to the source. Distant flow should be transmitted through closed pipes; ▪ Rehabilitate disturbed areas neighbouring the plant, along roads, and abandoned campsites by planting indigenous plant species; ▪ Exotic plant species should not be introduced into this area.
Impacts on Wildlife	▪ Fencing around work areas to prevent animal entry and minimize light/disturbance impacts during the night time; ▪ Installation of safety barriers such as fences to avoid wildlife contact with hot pipelines, should temperatures exceed safe levels; ▪ Training of crews, during operation, on the appropriate response to Wildlife encounters; ▪ Minimize risk of brine/condensate discharge through implementation of reinjection system and provision of adequately sized concrete-lined storage ponds / system shut down in case of reinjection failure; ▪ Ensure steam pipes at known animal migration corridors are elevated or buried under the ground surface; ▪ Maintain Incident records for incidents concerning Wildlife; ▪ Park rules should be enforced within the park.
Negative Social Impacts during the Operation Phase	
Exposure to H_2S	▪ Regular monitoring of H_2S along the steam pipeline serving the power plant, cooling towers and nearby villages; ▪ Conduct routine maintenance and inspections of well equipment to identify and repair potential leaks; ▪ Establish a H_2S detection system for warnings when levels approach or exceed safe limits; ▪ Regularly maintain and calibrate monitoring equipment to ensure accuracy and reliability; ▪ Relocate and reconstruct the 6 KWS rangers' houses located near the Olkaria gate to minimize H_2S exposure; ▪ Development and Implementation of a H_2S emergency preparedness, prevention and response plan.
Fire Outbreak	▪ Develop an implementable fire policy and ensure compliance with fire safety rules under OSHA 2007; ▪ Employees are to be taken through regular trainings and fire drills for the operation and maintenance of the power plant and its associated infrastructure; ▪ Periodic maintenance to ensure that, there are no overloaded electrical systems, no incorrectly installed wiring, no live naked wires and fuel store areas are continuously monitored. ▪ Install high-performance combustible fixed gas detectors along with electro optical flame detection.

Key Impacts	Mitigation Measures
Occupational Safety and Health Impacts	▪ Establish and implement an Occupational Safety and Health Plan. ▪ Develop procedures and permit requirements for working in confined spaces and hot works within the plant; ▪ Installation of gas monitoring and detection systems; ▪ Development of a contingency plan for gas releases; ▪ Use of personal protective equipment (PPE) as appropriate, including insulated gloves and shoes; ▪ Installation of silencers on equipment in the steam processing facility; ▪ Establish procedures for working at heights: ▪ Establish proper lifting and loading procedures; ▪ Training workers in the use of the available information (such as International Chemical Safety Cards – ICSC, Materials Safety Data Sheets – MSDS, or equivalent) and safe work practices.
Negative Environmental Impacts during the Decommissioning Phase	
Generation of Solid Waste	▪ Consider the possible use of equipment and material in their current form to minimize generation of waste; ▪ Demolition waste can be recycled or reused; ▪ Development and application of a circular economy and an integrated solid waste management plan/ strategy in managing solid waste materials i.e., through a hierarchy of options.
Impacts related to air and noise pollution	▪ All machine operators and workers are to be provided with appropriate PPEs. ▪ Mobilize the ideal amount of equipment for the demolition works; ▪ Ensure that the equipment mobilized are serviceable; ▪ All the vehicles and machinery should be operated in compliance with relevant vehicle emission standards and manufacturer's specification to minimize noise pollution; ▪ Ensuring a scheduled time for major repairs and making use of noise barriers during that time; ▪ Turn-off equipment and vehicles that are not in use.
Negative Social Impacts during the Decommissioning Phase	
Losing work and business opportunities	▪ Before closing the power plant, the proponent should provide counselling and specialized skills to the workforce especially the Locals to enable them to remain productive to sustain their livelihood;
Occupation, Safety and Health concerns	▪ Prepare an Occupational Safety and Health Plan (OSH) for decommissioning purposes; ▪ Take steps to prevent accidents, injuries, and disease in the course of work; ▪ Ensure all contractors and sub-contractors working on the site or in the immediate vicinity of the Project activities comply with the Project's OSH policies; ▪ Provide OSH orientation training/induction to all employees for awareness of basic hazards, site-specific hazards, safe working practices and emergency procedures; ▪ Provide workers with readily available information about the chemical composition of fluids or chemicals they may come in contact with and an explanation of potential implications for human health and safety.

Summary of ESMP Costs

Below is the summary of estimated costs for the following 3 phases of the project cycle: -

- ***Construction Phase (2 Years)***
- ***Operation Phase/ cost per Annum***
- ***Decommissioning Phase***

Table 0-8: Summary of Environmental and Social Management Plan (ESMP) Costs

SN	Total ESMP Costs	Estimated Total Cost (Kshs)	Estimated Total Cost (USD)
1	Construction Phase (2 Years)	81,750,000	545,000.00
2	Operation Phase/ cost per Annum	59,650,000	397,667.00
3	Decommissioning Phase	10,500,000	70,000.00

1USD = Kshs. 150 (November 2023)

Conclusion and Recommendations

The Proposed Project is environmentally sound and has the potential to benefit the local community and the whole nation at large through additional clean energy to the national grid.

The ESIA has identified several issues pertaining to the proposed project. The issues/impacts have been assessed and described in detail for an adequate. The ESIA findings indicated that direct impacts will be moderate and limited to the immediate surroundings of the project site. The Environmental and Social Management Plan (ESMP) identified mandatory prevention and mitigation measures. The ESMP should be implemented as a prerequisite for a positive Record of Decision (RoD) by the appropriate authorities.

Given the nature and location of the project development activities, the conclusion is that the potential impacts associated with the proposed development are of a nature and extent that can be reduced, limited and eliminated by the application of the proposed appropriate mitigation measures hence the proposed project shall be successfully implemented with adherence to the recommendations made in a bid to realize its numerous benefits.

Recommendations

In reference to the foregoing, the following key recommendations are made in relation to the proposed project:

i. The proponent to ensure that any new wells to be drilled in relation to this project in the future shall be subjected to an Environmental and Social Impact Assessment;
ii. All project construction activities should be restricted within the designated project site area;
iii. The proponent shall adhere to the project's Stakeholder Engagement Plan (SEP) during all phases of the project; and
iv. The proponent shall implement the Grievance Redress Mechanism in place for the proposed project.

1 INTRODUCTION

This section presents the project background, proponent terms of reference, the objectives of the proposed project and the identity of the Proponent.

1.1 Background Information

Kenya Electricity Generating Company PLC (KenGen), herein referred to as the 'proponent', 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 the 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 power generating company in Kenya. The Company has a total installed capacity of 1, 904 MW comprising of Hydropower (825.69 MW), Geothermal (799 MW), Thermal (253.5 MW) and Wind (25.5 MW). As part of the Company's strategy and in line with the national electricity master plans, KenGen intends to develop Olkaria II Extension Geothermal Power Plant in Olkaria field.

KenGen commenced exploration of the Olkaria geothermal area in the early 1950s which identified a geothermal potential zone of about 204 km^2, currently known as the Greater Olkaria. The 204 km^2 extension of the Greater Olkaria geothermal zone was divided into seven sectors for the sake of rationalizing the development efforts: Olkaria East, Olkaria West, Olkaria Northwest, Olkaria Northeast, Olkaria Central, Olkaria Domes and Olkaria Southwest. Kenya has a combined geothermal installed capacity of 988 MW and is currently position seven in the world. The country's geothermal installed capacity is generated by KenGen (799 MW) and Independent Power Producers (IPPs) such as: OrPower 4Inc (150 MW); Sosian Energy (35 MW); and Oserian Development (4 MW).

As part of the company's strategy and in line with the national electricity master plans, KenGen intends to develop Olkaria II Extension Geothermal Power Plant (GPP) in Olkaria field. The estimated equivalent gross output of the proposed Olkaria II Extension is 146*Mwe*, with a net output of 140*Mwe*, after accounting for auxiliary power consumption and step-up transformers' losses. The proposed site for Olkaria II Extension was selected and site investigations done during the previous feasibility study carried out in 2017.

1.2 Purpose of Scoping

The ESIA Expert undertook scoping to evaluate the key issues which the ESIA will focus on, including what has been achieved so far in accordance with the Terms of Reference and ESIA Process, while ensuring that indirect and secondary effects are not overlooked and at the same time eliminating irrelevant impacts.

In accordance with the second schedule of the Environmental Management and Coordination Act (EMCA) Cap 387, the project falls under the 'Power and Infrastructure Projects' category which is classified as a 'High-Risk' project. This is because of the ecological sensitivity of the project area of influence and associated cumulative impacts.

Part VI, sections 58 and 59 of EMCA, Cap 387, provides that the proponent shall: before any financing, commencing, proceeding with, carrying out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the second schedule to this Act, submit a study report to the National Environment Management Authority, (NEMA), in the prescribed form, giving the prescribed information and which shall be accompanied by the prescribed fee. Further in section 58 (5), the Act states that the Environmental Impact Assessment (EIA) studies and reports required under the Act shall be conducted or prepared respectively by individual experts or a firm of experts authorized on that behalf by the Authority.

The specific objectives for the scoping were:

- To identify key issues of concern.
- To focus on key issues during the ESIA study.
- To facilitate focused specialist studies.
- To determine the assessment methods to be used.
- To identify all affected persons.
- To provide an opportunity for consultation and public participation.
- To facilitate the identification of alternatives.
- To facilitate early agreement on contentious issues.
- To save time and money.

1.3 Terms of Reference

The Terms of Reference (TOR) as drawn by the Client provides an outline of the tasks that the Environmental and Social Impact Assessment (ESIA) Expert was expected to undertake towards the preparation of a comprehensive ESIA Study report. Whereas the ESIA report is purposed to obtain an ESIA License from NEMA, the report shall also be utilized by the client as a guide towards sound environmental, socio-economic, safety and health management throughout the project life-cycle. The tasks outlined in the Client's TOR included:

i. Preparation of terms of reference for the studies and get approval of these terms of reference by NEMA;
ii. Prepare scoping reports for the projects;
iii. 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;
iv. Analysis of different alternatives to the project available for project siting on the basis of environmental and social considerations besides the economics;
v. Description of the preliminary design of the project;
vi. Evaluate 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;
vii. Undertake site baseline studies on environmental, social and economic aspects;
viii. Carry out air dispersion and noise modelling for the proposed project site and existing plants and determine the sensitive receptors in the neighbourhood of the project sites and make necessary recommendations;
ix. Description of the activities that shall be undertaken during the project's construction, operation and decommissioning phases;

x. Identification of the potential environmental impacts of the projects and the mitigation measures to be taken on flora and fauna during and after implementation and decommissioning of the projects;
xi. Carry out comprehensive environmental risk assessment for the sites;
xii. Assessment of project sites environmental restrictions;
xiii. Waste management: identification of the materials to be used, products and by-products, including waste to be generated by the projects and the methods of their disposal during construction, operation and decommissioning;
xiv. Carrying out assessment of noise pollution during construction, operation and decommissioning of the projects;
xv. Carrying out assessment of water pollution, if applicable, during construction, operation and decommissioning of the projects;
xvi. Carrying out assessment of air pollution during construction, operation and decommissioning of the projects;
xvii. Assessment/determination of land requirements and land agreements for the projects;
xviii. 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;
xix. 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 sites;
xx. Determine the employment and economic opportunities that will arise during projects implementation;
xxi. Develop plans to ensure the health and safety of the workers and neighbouring communities are taken care of;
xxii. Develop action plans for the prevention and management of possible accidents during the projects cycle;
xxiii. Carry out preliminary analysis of contribution of the projects to Green House Gas (GHG) emissions reduction:
xxiv. Integration of climate change vulnerability assessment, relevant adaptation, and mitigation actions into the ESIA studies;
xxv. 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;
xxvi. Developing an Environmental & Social Management and Monitoring Plan (ESMP) for the project detailing measures for addressing potential negative environmental and social impacts of the project. In addition, the ESMP should clearly identify institutional roles, responsibilities and costs in addressing the mitigation measures that will be proposed in the ESIA;
xxvii. Assessment of energy conservation measures during construction, operation, and decommissioning of the plant.

1.4 Parties Involved

There are different parties involved in the proposed project. These include:

i. **KenGen**: The Proponent
ii. **Government of Kenya**: Ministry of Energy and Petroleum (MoEP)

iii. **International Development Partners**: These include The World Bank (WB), Japan International Cooperation Agency (JICA) and KfW (Kreditanstalt für Wiederaufbau) Development Bank.
iv. **ELC Electroconsult S.p.A.**: The consulting Firm undertaking the current feasibility study.

1.5 Objectives of the project

KenGen, as the leading renewable energy producer in Kenya and in line with its strategy and the national electricity master plans, intends to develop the Olkaria II Extension Geothermal Power Plant to increase its output to feed into the national grid. The proposed project's gross output capacity is *146Mwe*, with a net output of 140*MWe*.

Development of the project will increase the total installed Geothermal Capacity in Kenya to approximately 1,128MW (1.128GW).

2 PROJECT DESCRIPTION

2.1 Project Context

Kenya Electricity Generating Company PLC (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 commenced exploration of the Olkaria geothermal area in the early 1950s which identified a geothermal potential zone of about 204 km^2, currently known as the Greater Olkaria. The 204 km^2 extension of the Greater Olkaria geothermal zone was divided into seven sectors for the sake of rationalizing the development efforts: Olkaria East, Olkaria West, Olkaria Northwest, Olkaria Northeast, Olkaria Central, Olkaria Domes and Olkaria Southwest. Kenya has a combined Geothermal installed capacity of 988 MW and is currently position seven in the world. The company has developed various power plants in the Olkaria area as indicated in Table 2-1 below, with a total installed capacity of 799*Mwe*.

Table 2-1: KenGen Geothermal Installed Capacity

Plant	**Installed Capacity (MWe)**	**Year of Commissioning**
Olkaria I	45	1985
Olkaria II	70	2003
Olkaria II 3rd Unit	35	2010
Eburru	2.4	2012
Olkaria I Units 4 & 5	150.5	2014
Olkaria IV	149.8	2014
Olkaria Well heads	88.5	2015
Olkaria V	172.33	2019
Olkaria I Unit 6	86	2022
Total	**799 *MWe***	

The Olkaria West geothermal field hosts the Olkaria-III power plant where a 150 *MWe* binary technology plant owned and operated by an Independent Power Producer (IPP), Orpower-4 Inc., which is wholly owned by Ormat International. In the Olkaria Northwest sector, a horticultural 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.

Studies estimate that there is still considerable geothermal potential in Olkaria hence KenGen plans to install additional generation capacity, with the plants listed in Table 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 1,077*Mwe*.

Table 2-2: KenGen Geothermal Projects Pipeline

No	Project Name	Capacity (MWe)
1	Olkaria I Rehabilitation	18
2	Olkaria IV & IAU Uprating	40
3	Olkaria II Extension Project	140
4	Olkaria VII	80.3
	Total	**278.3 MWe**

The Olkaria II Extension Project will be the main project of focus in this ESIA Study Report.

2.2 Project Location

The Olkaria II Extension project site is located adjacent to the existing Olkaria II Geothermal Power Plant, 6 km to the south of Lake Naivasha, in Naivasha Sub-County, Nakuru County (Figure 2-1). Additionally, the site is within Hell's Gate National Park, and some of its neighbours include: Kedong/Akira Ranches to the East and South, Oserian Estate to the North and Kongoni Farm and OrPower 4Inc to the West. Other existing power plants in the area include: Olkaria I, Olkaria I-AU, Olkaria III (owned by OrPower), Olkaria IV and Olkaria V.

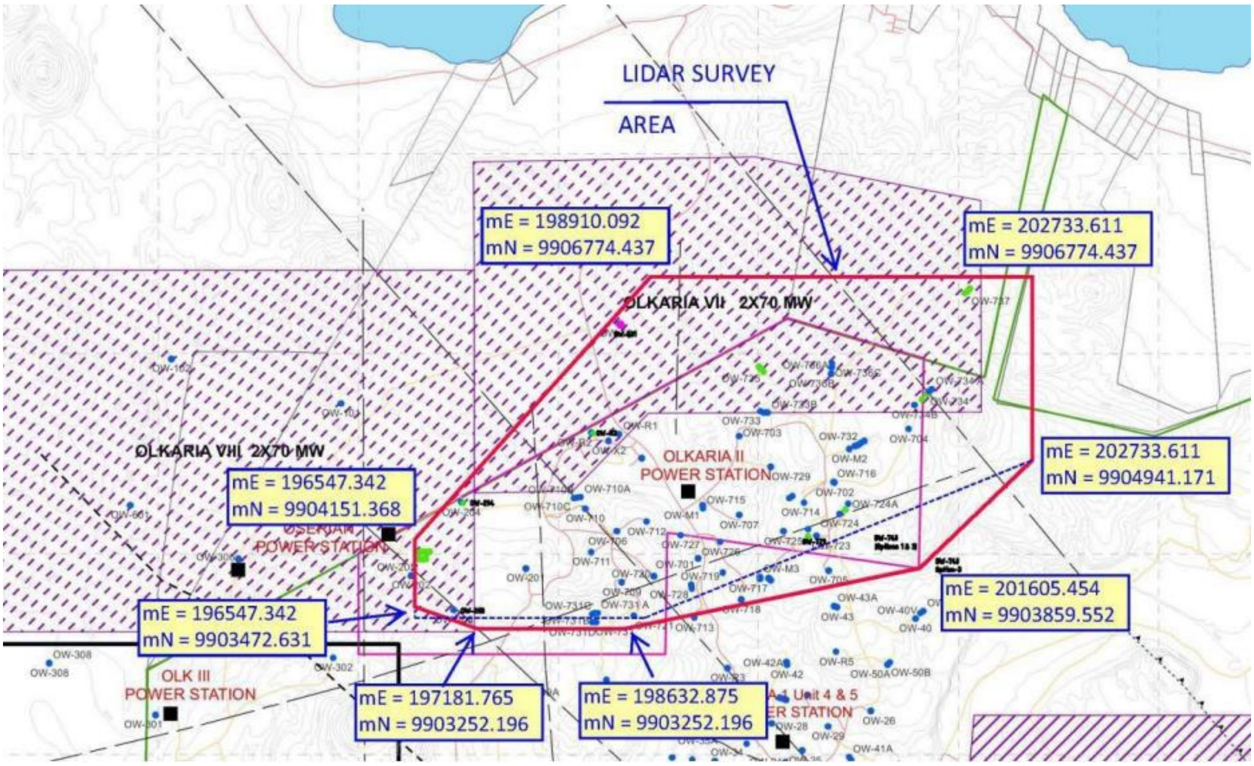


Figure 2-1: Olkaria II Extension Project Site

2.3 Project Justification

Energy is an essential factor for economic growth and social development. The growth of energy demand is often driven by factors such as: growing population, urbanization, intensive electrification programs, and the continued expansion of the manufacturing, agricultural, and other sectors that drive Gross Domestic Product (GDP) growth.

Kenya continues to record an upward trend in demand with peak demand increasing from 1,107 MW in FY 2010/11 to 2,149 MW in FY 2022/23. A new peak of 2,149MW was recorded on 14th December 2022. The total electrical energy generated grew by 5.03% from 12,652.74GWh in the 2021/2022 financial year to 13,289.63GWh in the 2022/2023 period. Geothermal energy generated increased by 21.84 % from 4,953.15 GWh to 6,035.00 GWh. The increase is attributed to additional geothermal capacity from Olkaria 1 Unit 6 and the Sosian geothermal plants. At a growth rate of 6.0%, the electricity demand will increase to 17,612.3 GWh, while the system peak demand will increase to 2,888.1 MW by 2027.

According to Energy and Petroleum Regulatory Authority, Kenya's power generation mix (GWh) comprised 44.6% of Geothermal, 22.5% of Hydro, 14.3% of Wind, 8.9% of Thermal, 6.2% of Imports, 3.5% of Solar and 0.0% of Biomass (EPRA, 2024). The government is focused on increasing the share of renewable energy in the generation mix towards a green economy and has prioritized the development of geothermal, wind and solar energy plants as well as solar-fed mini-grids for rural electrification.

Studies have consistently shown that Kenya has an estimated geothermal potential of 10,000 MW, mainly located in the Rift Valley, while hydro has an estimated potential of between 3,000 to 6,000 MW. Geothermal therefore has larger potential capacity for power generation compared to hydro power plants and it is in line with this that the proponent has identified the immediate need to increase the geothermal generating capacity, to meet the rising energy demand in accordance with the goals set under the country's medium-term and long-term development plans. The proponent has vast experience in drilling, development, operation and maintenance of Geothermal Power Plants, hence continued investment in Geothermal power plants creates synergy in utilizing already available skills.

The proponent holds a concession agreement with the Ministry of Energy and Petroleum (MoEP) for specific areas within the Greater Olkaria area giving it the right to develop the Olkaria steam fields and use the steam produced therefrom to generate electrical power. KenGen has already undertaken considerable investment of more than USD 127 Million in production and reinjection wells development, therefore the proposed 140MW Olkaria II Extension GPP will utilize the already existing production and reinjection wells. In view of this, it makes sense to utilize the available resources by construction of the power plant.

In the Least Cost Power Development Plan (LCPDP) 2022-2041, it is stated that "Kenya is not only looking to scale up its renewable energy sources and overcome challenges such as intermittency issues through the deployment of storage and hybrid projects but also to focus on geothermal power opportunities, in order to scale-down fossil fuel power plants hence improve affordability by end users".

Development of Geothermal Power will greatly support the desire to keep electricity tariffs low (6.5 US cents) and therefore spur economic growth and provide a good climate for direct foreign investments, which will create jobs and support the economy. Additionally, more geothermal energy will lead to lower values of Fuel Energy Charge (FEC). The charge enables recovery of the cost of fuel used in electricity generation which varies with monthly outputs from thermal power plants and fluctuations in fuel prices, computed at respective contracted specific fuel consumption rates for the plants.

The proposed 140 MW Olkaria II Extension Geothermal Power Plant is one of the energy sector's priority projects, which is envisioned to be people-centered and transformative and is likely to reduce the cost of living, create jobs and lead to inclusive growth. This project among others has been prioritized for early implementation. The proponent has indicated that the commercial operation date for the power plant is the year; 2026.

Arising from the above observations, it's therefore justified to develop Olkaria II Extension Geothermal Power Plant by 2026, three years earlier than the planned time of 2029 in the LCPDP.

2.4 Project Site Ownership

The proposed project site is within KenGen land set aside for geothermal development. KenGen entered into a sublease agreement with KWS for 1064.36 hectares of land (reference No. 12881/6) that was subdivided from land parcel No 12881/5/1. KenGen pays annual rent to KWS under the terms of the lease.

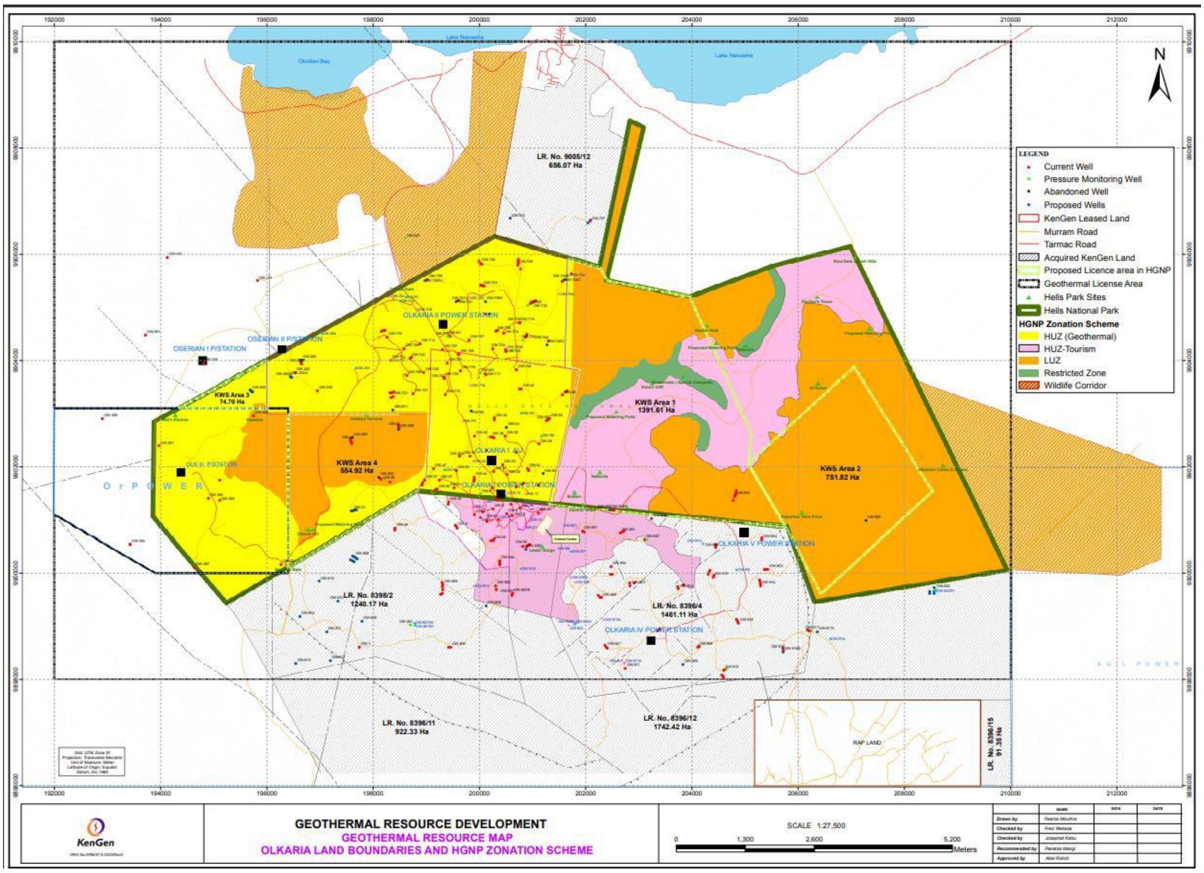


Figure 2-2: Hell's Gate National Park Zoning

(*Source: KenGen and KWS*) **LUZ = Low Use Zone *HUZ = High Use Zone*

2.5 Proposed Project and Associated Activities

2.5.1 Power Plant Process

The option selected for the Olkaria II Extension is a single flash condensing steam plant, with a wet cooling system, within a 2 X 70 MW net output framework.

Steam condensing turbines paired with wet cooling systems hold a dominant position in geothermal power production, and their prevalence can be attributed to their operational efficiency and adaptability to diverse geothermal reservoir conditions. In this configuration, steam from geothermal sources drives the turbine and is then directed to be condensed using a cooling system. Interestingly, the condensed geothermal steam itself is often utilized as the cooling water supply for the cooling tower, creating a synergistic and efficient loop. Wet cooling leverages water's high heat capacity to efficiently condense the steam, ensuring a substantial enthalpy drop across the turbine, which translates to higher power outputs. Given these advantages, steam condensing turbines with wet cooling have become a gold standard in the geothermal industry, encapsulating both reliability and efficiency in power generation.

With the given resource and considering a 20% steam margin, 146*MWe* of gross power, corresponding to 140*MWe* net power may be produced comfortably for Olkaria-II extension using a single flash with a wet cooling system. A breakdown of the design specifications selected for the power plant has been provided in Table 2-3 below.

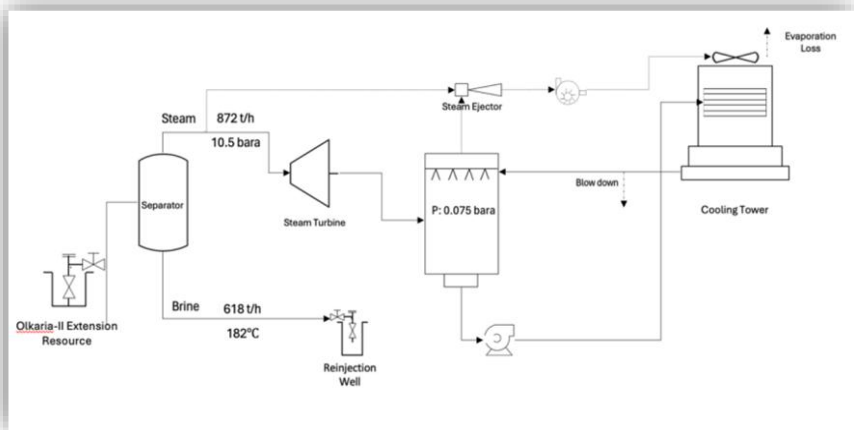


Figure 2-3: Schematic of a single flash cycle with a wet cooling system

Table 2-3: Summary of the design specifications for Olkaria II Extension GPP

COMPONENT	SPECIFICATION
Generation technology	Single flash cycle condensing steam turbine
Design steam flowrate	891.6 tonnes/hour
Total brine flowrate	693.7 tonnes/hour
Steam pressure	9 bara
Cooling system	Wet cooling tower
Turbine size	73.0 *MWe* - 2 turbines
Parasitic loads	6.0 *MWe*
Gross Output	146.0 *MWe*
Net Output	140.0 *MWe*

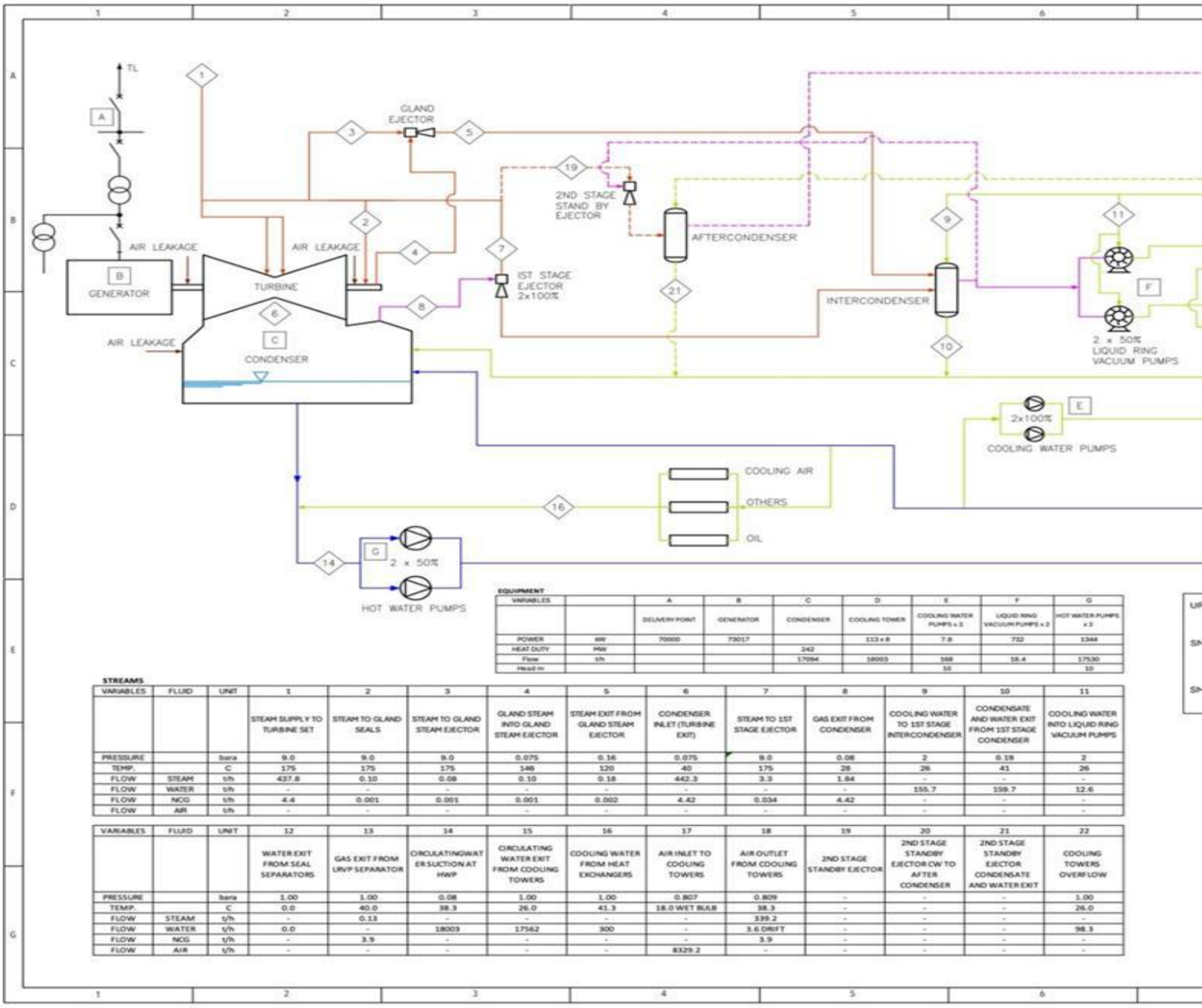
Reinjection rate	56.8%
Electrical capacity at load factor of 0.94	1,152 GWh/year

The systems will be incorporated into a 2 X 70 MW net capacity configuration, as it offers a harmonious blend of efficiency and simplicity, facilitating ease of maintenance and reliability. It ensures that while the plant enjoys the advantages of scale, it avoids the complexities and potential drawbacks associated with larger single-unit capacities or a more segmented multiple-unit approach. The 2 x 70 MW net output configuration also dovetails with industry trends toward larger unit capacities, as demonstrated by recent builds in the region, which favour operational stability and grid reliability. It provides the plant with sufficient flexibility to meet the grid's demand patterns without the need for excessive cycling, which could jeopardize the integrity and performance of the geothermal wells and the overall system.

The main equipment of the system includes the turbine, generator, condenser, cooling tower, hot water pumps, and the gas extraction system. A single turbine has a gross power of 73 MW and the delivered power to the grid is 70 MW net after accounting for auxiliary power consumption and step-up transformer's losses (Figure 2-4). The turbines are designed as condensing, single cylinder, double flow units, which are directly coupled to generators without gear reducers and capable of handling saturated geothermal steam inclusive of non-condensable gases. Notable features include integrated lubrication and hydraulic systems, steam strainers, and control valves for efficient operation. A key element is the turbine control system that adapts to load changes, essential for isolated operations.

The design focuses on durability, with provisions against erosion and corrosion, aiming for a 30-year operational lifespan while complying with the IEC EN-60045-1 standard. Additionally, the turbines are equipped with sophisticated lubrication, governing, and safety systems, ensuring reliable and safe performance under variable conditions. This design philosophy ensures that the turbines meet the specific needs of geothermal power generation, combining robust construction with advanced technology for optimal efficiency and reliability.

In the Olkaria geothermal field, where the non-condensable gas (NCG) content in steam is approximately 1% by weight, an efficient gas extraction system has been designed using a hybrid approach of steam ejectors and liquid ring vacuum pumps (LRVPs). This setup includes a backup steam ejector to ensure continuous operation even if the LRVPs fail. The system is designed to restore condenser pressure to operational levels within five minutes in any operational scenario. Compliant with Heat Exchange Institute Standards and constructed from durable materials like 316L stainless steel, the system features advanced monitoring and safety measures, such as vibration monitoring for pumps and operational modes like Runback Operation and Hot Standby. This ensures both reliability and compliance with environmental standards, making it a robust solution for maintaining the efficiency and operational integrity of the geothermal power plant.



EQUIPMENT

VARIABLES		A	B	C	D	E	F	G
		DELIVERY POINT	GENERATOR	CONDENSER	COOLING TOWER	COOLING WATER PUMPS x 2	LIQUID RING VACUUM PUMPS x 2	HOT WATER PUMPS x 2
POWER	kW	70000	73017		113 x 8	7.8	732	1344
HEAT DUTY	MW			242				
Flow	t/h			17094	18003	168	18.4	17530
Head m						10		10

STREAMS

VARIABLES	FLUID	UNIT	1	2	3	4	5	6	7	8	9	10	11
			STEAM SUPPLY TO TURBINE SET	STEAM TO GLAND SEALS	STEAM TO GLAND STEAM EJECTOR	GLAND STEAM INTO GLAND STEAM EJECTOR	STEAM EXIT FROM GLAND STEAM EJECTOR	CONDENSER INLET (TURBINE EXIT)	STEAM TO 1ST STAGE EJECTOR	GAS EXIT FROM CONDENSER	COOLING WATER TO 1ST STAGE INTERCONDENSER	CONDENSATE AND WATER EXIT FROM 1ST STAGE CONDENSER	COOLING WATER INTO LIQUID RING VACUUM PUMPS
PRESSURE		bara	9.0	9.0	9.0	0.075	0.16	0.075	9.0	0.08	2	0.19	2
TEMP.		C	175	175	175	146	120	40	175	28	26	41	26
FLOW	STEAM	t/h	437.8	0.10	0.08	0.10	0.18	442.3	3.3	1.84	-	-	-
FLOW	WATER	t/h	-	-	-	-	-	-	-	-	155.7	159.7	12.6
FLOW	NCG	t/h	4.4	0.001	0.001	0.001	0.002	4.42	0.034	4.42	-	-	-
FLOW	AIR	t/h	-	-	-	-	-	-	-	-	-	-	-

VARIABLES	FLUID	UNIT	12	13	14	15	16	17	18	19	20	21	22
			WATER EXIT FROM SEAL SEPARATORS	GAS EXIT FROM LRVP SEPARATOR	CIRCULATINGWATER SUCTION AT HWP	CIRCULATING WATER EXIT FROM COOLING TOWERS	COOLING WATER FROM HEAT EXCHANGERS	AIR INLET TO COOLING TOWERS	AIR OUTLET FROM COOLING TOWERS	2ND STAGE STANDBY EJECTOR	2ND STAGE STANDBY EJECTOR CW TO AFTER CONDENSER	2ND STAGE STANDBY EJECTOR CONDENSATE AND WATER EXIT	COOLING TOWERS OVERFLOW
PRESSURE		bara	1.00	1.00	0.08	1.00	1.00	0.807	0.809	-	-	-	1.00
TEMP.		C	0.0	40.0	38.3	26.0	41.3	18.0 WET BULB	38.3	-	-	-	26.0
FLOW	STEAM	t/h	-	0.13	-	-	-	-	339.2	-	-	-	-
FLOW	WATER	t/h	0.0	-	18003	17562	300	-	3.6 DRIFT	-	-	-	98.3
FLOW	NCG	t/h	-	3.9	-	-	-	-	3.9	-	-	-	-
FLOW	AIR	t/h	-	-	-	-	-	8329.2	-	-	-	-	-

Figure 2-4: Heat and Mass Balance for Olkaria II Extension Power Plant

2.5.2 Site Layout and General Description

The proposed plant layout will aim for efficient arrangement, environmental cautiousness and cost-effective construction. Key elements of the layout include:

- *Power House*: Positioned as the central point, it houses two main steam turbo-generators and auxiliary systems. Its single-floor, compact design optimizes the use of space and reduces construction costs.
- *Auxiliary Buildings and Equipment*: These are strategically placed around the power house, including the cooling towers and the switchyard, to ensure operational efficiency and accessibility.
- *Cooling Towers*: Located considering the prevailing wind direction to avoid moisture blowdown affecting the power plant area.
- *Equipment and Facilities*: The design includes a comprehensive setup for both mechanical and electrical processes, ensuring all necessary systems like steam condensers, gas extraction, and cooling systems are integrated. Notably they are the two hybrid non-condensable gas extraction systems and splash packing type cooling towers.
- *Control and Monitoring Systems*: Advanced systems for supervising, controlling, and data acquisition are planned to enhance the operational reliability and efficiency of the power plant.

The power plant's layout will be based on the following main guidelines:

i. The powerhouse shall be the centre of gravity for the arrangement of the remaining auxiliary buildings and areas, in particular cooling towers, control building, and switchyard;
ii. The selected area of the power house shall allow the realization of the building foundation without involving high engineering costs;
iii. The cooling tower's location is chosen taking into consideration the prevailing wind direction in the area, avoiding moisture blowdown in the power plant area;
iv. The power house is a single-floor, compact design building housing the two main steam turbo-generators. Auxiliary systems, emergency diesel generator and gas extraction system are located outside of the building;
v. The turbo-generators axis is orthogonal to the axis of the power house building. This arrangement has the advantage of reducing the overall length of the building and the distance between the centrelines of the turbo-generators, allowing a more economical structural design of the building;
vi. A dismantling area (loading bay) is foreseen, in a suitable location between the two units. The extraction water pumps are placed beside the turbo-generators, in a position suitable for using the power house crane for dismantling and maintenance purposes;
vii. The emergency diesel unit and the auxiliary equipment are placed at ground floor on the left side of power house.
viii. The non-condensable gas extraction system located outside the power house;
ix. The steam piping shall be arranged on pipe racks. The connections with the unit auxiliary transformers and the main transformers are consistent with the requirement of rationality, accessibility, and optimization of available space.

Facilities related to the mechanical processes of the power plant:

- Two (2) condensing steam turbines with control valves, stop valves, by-pass valves, governing system, oil control and lubrication systems, moisture separation and drains, gland steam condensing system, turning gear, over-speed detection, vibration monitoring, safety and protection systems;
- Two (2) main steam receiving systems complete with steam header/separator and mist eliminator, including accessories, supports, drainage, heat insulation, venting and valves;
- Two (2) direct contact type steam condensers with internal features for steam condensing, condensate cooling and non-condensable gas cooling and extraction;
- Two (2) non-condensable gas (NCG) hybrid extraction system consisting each one of two (2) 100% duty first stage main steam driven ejectors with a single inter-condenser, two (2) second stage 50% duty liquid ring vacuum pumps and separators plus one (1) 100% duty main steam driven ejector and after condenser as back-up to the liquid ring vacuum pumps;
- Four (4) single stage centrifugal vertical or mixed flow type hot water pumps with 50 per cent flow capacity each, for condensate and hot water extraction from the condenser to the cooling tower;
- One (1) chemical dosing system, one line for the main water-cooling circuits, and one line for the excess water re-injection circuit, one common caustic soda tank (capacity for two units);
- Two (2) mechanically induced draught, cross flow, splash packing type cooling towers;
- Two (2) auxiliary cooling water systems comprising each one: two (2) 100% duty pumps, two (2) 100% duty filters, all piping, fitting and accessories;
- All piping, valves, jointing materials and connections for coupling the above listed systems and any other equipment supplied;
- Supporting steel works, platforms, handrails, access walkways, grating covers and stairways as required for an easy access to all equipment;
- Thermal and acoustic insulation as required for all equipment;
- Special tools and appliances including devices, gauges, lifting jacks and tackles hoists etc. as required for an easy maintenance of all equipment.

Facilities related to the electrical systems of the power plant:

- Two (2) generators with auxiliaries and an excitation system;
- Two (2) step-up transformers;
- Two (2) MV/MV unit auxiliary transformers with a neutral earthing resistor;
- Two (2) MV/LV unit auxiliary transformers;
- One (1) MV/LV station auxiliary transformer;
- Medium voltage service system consisting of: two (2) unit auxiliary switchboards one (1) station service switchboard and automatic load transfer and change-over device;
- Low voltage service system consisting of: two (2) 400 V unit auxiliary switchboards, one station service 400 V switchboard, automatic load transfer and change over device, and local control panels;
- One (1) DC system;
- One (1) uninterruptible power system (UPS);
- Lightning protection;
- Lighting/socket and earthing system;

- 220 kV Switchyard;
- Cables and cabling system;
- Electrical Protection System for Generator/Step-up transformer;
- Electrical Protection System for HV bays;
- Emergency Diesel Generator;
- Station electrical services;
- Protection relay, synchronizing and metering systems.

Facilities for control and monitoring system for: Fluid Collection and Reinjection System (FCRS); power plant; and switchyard:

- One (1) Distributed Control System with the function of supervision, control and data acquisition of the power plant, the FCRS and the 220-kV switchyard;
- Emergency Shut Down Systems for the FCRS;
- Substation control and monitoring system (SCMS);
- Instrumentation.

Facilities for power plant services:

- One (1) water reservoir system;
- One (1) sludge removal system, comprising ponds, pumps and piping to the brines re-injection pipe of the FCRS;
- One (1) water treatment system
- One (1) raw water supply system;
- One (1) domestic water supply system;
- One (1) condensate collection and reinjection system;
- One (1) water treatment and distribution system;
- One (1) fire-fighting and monitoring system;
- One (1) gas monitoring system;
- One (1) power house overhead crane;
- Telecommunication and telephone system
- Workshop and relevant equipment and mobile plants;
- Store;
- Chemical laboratory and relevant equipment;
- Corrosion control system.
- One (1) compressed air system with two air compressors, two air coolers, two air storage tanks and one air dryer plus service air and instrumentation air distribution networks.
- Ventilation and air conditioning system, including heat evacuation system in the turbine hall and electrical room; forced ventilation in the battery room, store room, and sanitary rooms; natural ventilation louvres in other areas and air conditioning system in the control room and in the relay room;
- Closed circuit television (CCTV);

Civil, Structural and Architectural works shall include but not be limited to:

- Land clearing;
- Additional geotechnical investigations;
- Excavation and backfilling including hauling and cut slope protection;
- Plant internal roads and parking including kerb, drainage and culvert;
- Service roads along all the pipelines including kerb, drainage and culvert;

- Civil, structural and architectural works related to Plant (FCRS & Power Plant) Process;
- Foundation, structural and architectural works including excavations dewatering, preparation, form works, reinforced steel. Embedded steel, and finishing's for;
  - Power house
  - Cooling towers (basin and structure)
  - Ponds, thermal ponds, pits and basins (for FCRS and power plant)
  - Power transformers
  - Switchyard
  - Water reservoir tanks
  - Pipe supports and pipe trenches
  - Silencers and rock-muffler
  - Mist eliminators
  - Production and reinjection clusters
- Cable trenches and ducts;
- Pipe racks;
- Embedded steel, building superstructures, roofs, walls, stairs, doors;
- Windows and finishing for all buildings;
- Civil, structural and architectural works related to Plant (FCRS & Power Plant) Services;
- Foundation, structural and architectural works, including excavations, dewatering, preparation, formworks, reinforced steel, embedded steel, buildings super-structures, roofs, walls, doors, windows and finishing for;
  - Control building
  - Workshop and store
  - Sheltered areas
  - Car shelter
  - Guardhouses
  - Service buildings at production and reinjection clusters
  - Pumping stations
- Miscellaneous works;
  - Fencing and gates for the switchyard area
  - Switchyard road, gravelling and fencing
  - River water intake works and pumping station
  - Sludge disposal area
  - Landscaping, revegetation and site clearing
  - Furniture for all buildings

The required yard for the construction of the powerhouse, switchyard and ancillary structures is approximately 340 x 260 m, considering that the arrangement of the plant facilities is similar to the one of Olkaria II with the position of the powerhouse and cooling tower basins parallel to the road, and the switchyard in-between the powerhouse and road.

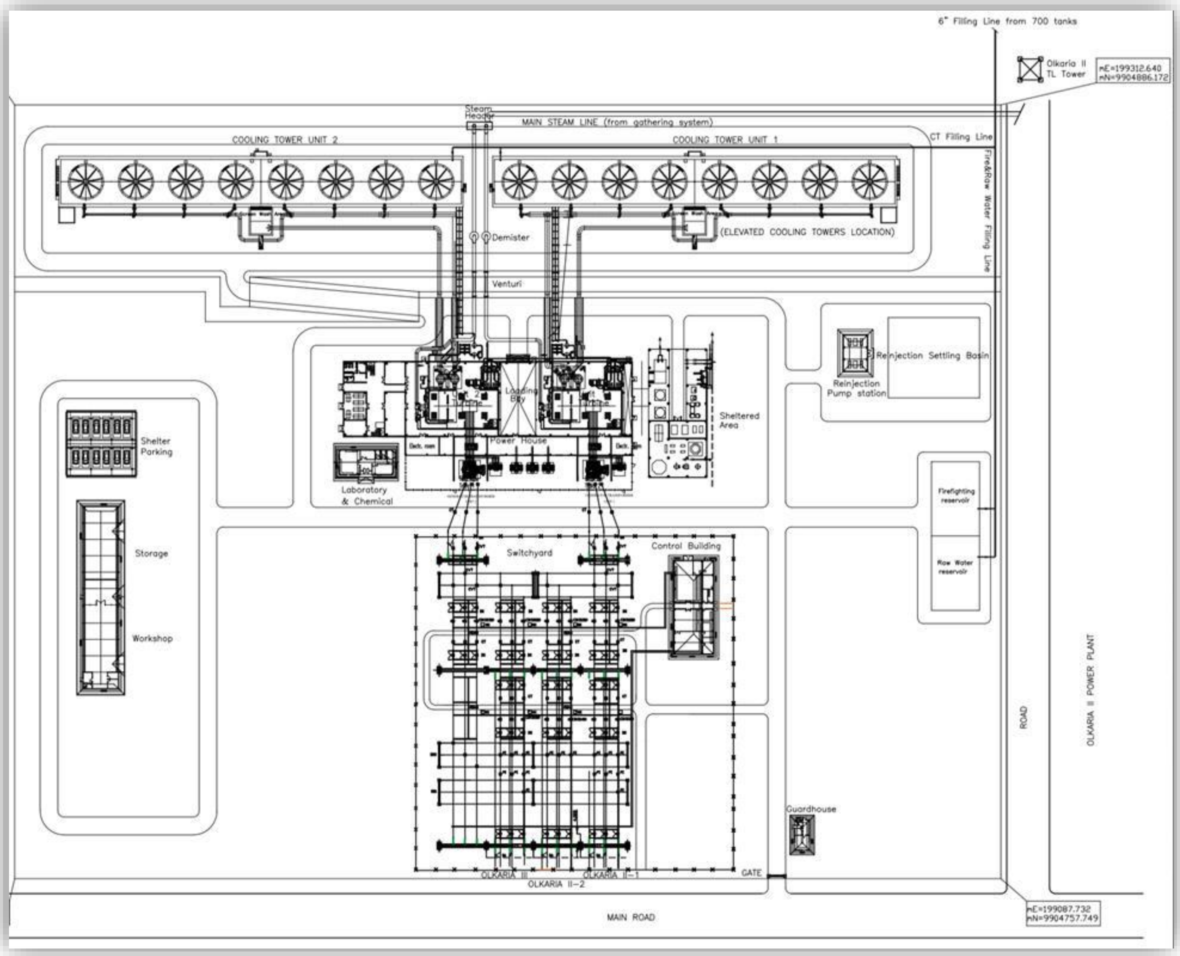


Figure 2-5: Layout of the power plant: powerhouse and ancillary buildings

2.5.3 Civil and Structural Works

2.5.3.1 Powerhouse

The powerhouse structure will consist of steel portal frames, reinforced concrete floors and foundations. Exterior cladding will mostly be profiled steel or aluminium sheeting. The turbine-generator units will be installed on concrete pedestals separated from the powerhouse structure and floors by joints, to limit the transmission of operation-sourced vibrations to the building structure. Control and electrical rooms, housing the boards of the plant supervising and monitoring system and equipment for transmission of electricity from the generation plant to the switchyard, will be located near the turbine-generator hall.

The main transformers will be located outdoors and adjacent to the electrical rooms, in individual bays with firefighting walls on three sides to protect the powerhouse building from any transformer explosion. Building services (lighting, air conditioning, etc.) will be designed to suit the ambient climate conditions.

Based on the geotechnical results and considering the remarkable loads and vibrations of the turbine-generators, the foundations of the power house shall be designed on piling (bored piles).

2.5.3.2 Cooling Towers

The cooling system for the steam turbines will be conventional forced-draft wet cooling towers. The water retaining basin of cooling towers will be a reinforced concrete structure on piling. To meet the requirements of the mechanical process, the operating water level in the cooling tower basin will be set about 3 m to 4 m above the powerhouse floor level.

The supporting structures for forced draft cooling towers will be bolted pultruded FRP (fiberglass) members. Because of their lightweight wind loadings, rather than seismic loadings control, the design of the towers will be lateral load resisting systems.

Concrete within each cooling tower and basin will be protected from the external effects of Hydrogen Sulphide, steam, anaerobic bacteria and water with a pH of between 2 to 4, by using a durable surface coating and/or membrane.

2.5.3.3 Switchyard

The required civil works for the construction of the switchyard will include the excavations and fills for yard preparation, the foundations of electrical equipment, earth mesh, cable ducts, drainage system and fencing. A small control building of reinforced concrete structure will also be constructed.

2.5.3.4 Ancillary Buildings and Structures

A typical geothermal power plant requires some ancillary buildings and structures, which mainly include:

- Workshop and storehouse;
- Make-up water reservoir;
- Wastewater treatment facility;
- Steel structures for gas extraction system, pipe racks, etc.;
- Guard house; and
- Fire pump house.

In addition, a building for the accommodation of operation and maintenance personnel can be considered either within the area of the power station or in another suitable location not far from the power plant facilities.

2.5.3.5 Access Road Network

The civil works will include the construction of access roads inside the plant yard, which will be designed to withstand transportation of heavy equipment, as stipulated by the American Association of State Highway and Transportation Officials (AAHSTO) and national standards. Some civil works are required also for the rehabilitation/upgrading of the access roads to the FCRS clusters. Most of these routes are already existing while only the last road stretches to the well pads need to be constructed. Some repairs and/or improvements of the existing roads shall be performed to ensure safe transit of construction equipment. The main design criteria of access roads are indicated in the table below.

Table 2-4: Design criteria of access roads

Road	Carriageway Width (m)	Lanes	Shoulder width (m)	Maximum Slope (%)	Cross Slope of Lanes (%)	Minimum Curve Radius (m)	Maximum Super-elevation (%)	Surface
Internal roads	6	2	1	8	2.5	-	4	Asphalt
Switchyard roads	5	1	1	-	2.5	-	4	Asphalt
Roads to FCRS clusters	6	2	1.5	10	2.5	25	4	Asphalt

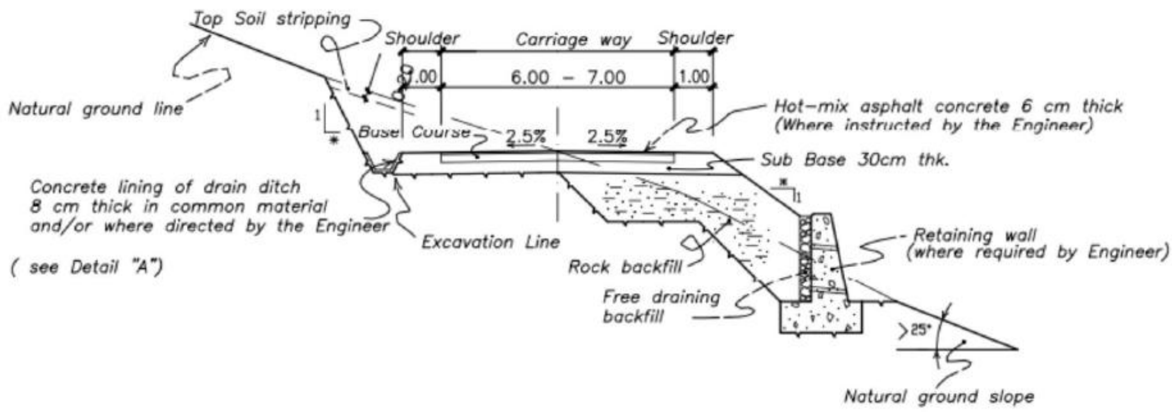


Figure 2-6: Road section (half embankment)

Road construction will require excavation, compaction of subgrade, placement of sub-base and base layers and application of bituminous wearing course. The subgrade will be prepared to specific level and density, and the stone base shall meet minimum requirements defined by the standards. A few road crossings along the pipe routes and pipe culverts under roads are envisaged.

Road construction activities will involve large earth moving machinery and consumption of large volumes of fuel and lubricants. Besides vegetation clearance and soil disturbance, the process will also generate dust, and it will be necessary to use a lot of water for sprinkling to minimize the impacts of dust.

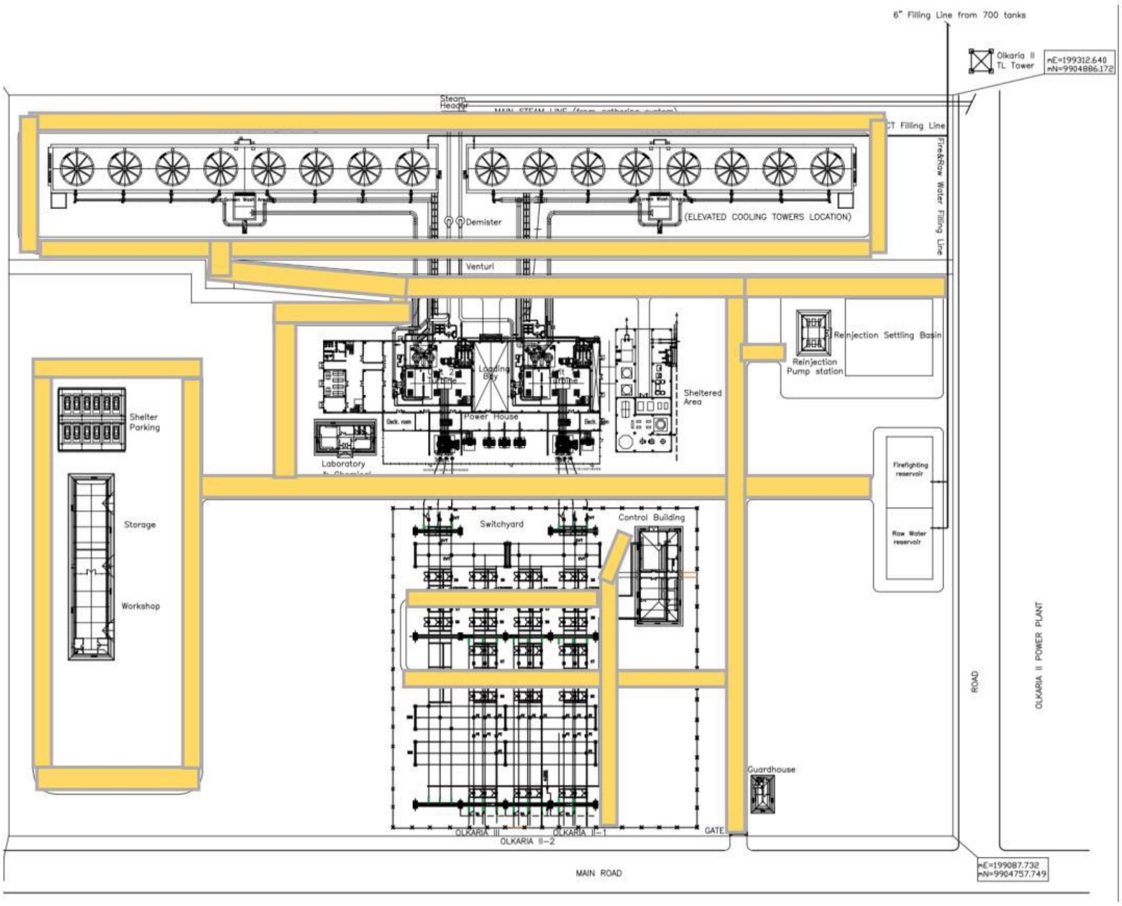


Figure 2-7: Layout of the power plant with internal roads

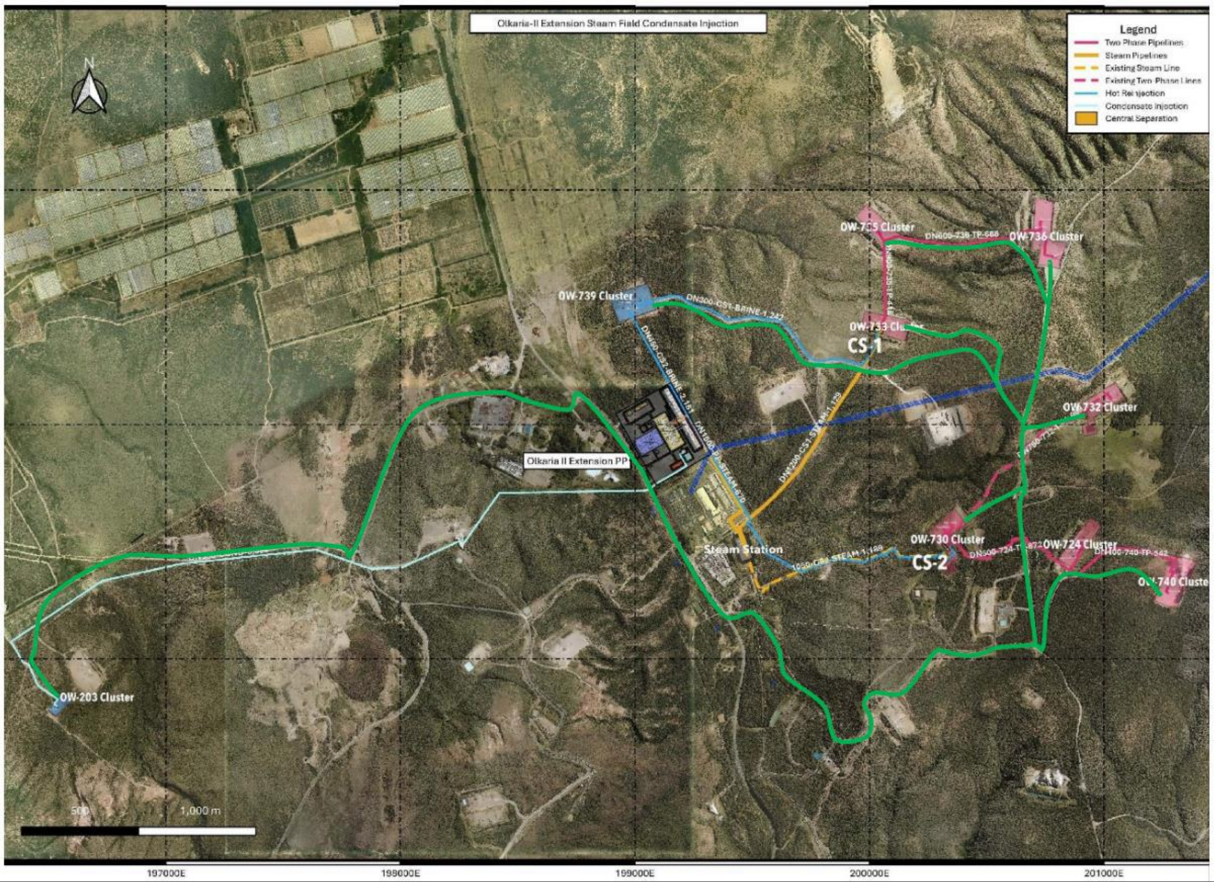


Figure 2-8: Access roads to the FCRS clusters

2.5.4 Plant Facilities and Systems

2.5.4.1 Steam Turbine and Auxiliaries

The steam turbines will be condensing type machines directly coupled to the generator without the use of a gear reducer. The two fundamental types of steam turbines are the impulse turbine and the reaction turbine. Both turbine types have provided satisfactory service for many decades and neither turbine type is fundamentally better than the other. The turbine shall be a single cylinder, double flow unit, full arc admission, directly coupled to a generator, self-contained regarding lubrication and hydraulic systems, arranged to operate with saturated geothermal steam containing 0.3% to 0.7% by weight of non-condensable gas.

The main steam-flow passes through screens, stop valves and control valves, before being admitted to the steam turbine. The screens trap solid particles that could damage the steam turbine. The main steam lines to the steam turbine have also pressure and temperature measuring devices as well as the hydraulically operated turbine stop and control valves.

During warm up and cooling of the turbine a turning gear with an electrical motor drive makes the shaft turn at low speed. Interlocks are provided to prevent running the motor without sufficient pressure in the lube oil system and engaging the turning gear while the turbine is running. The turning gear is automatically disengaged and the motor is switched off when the turbine speed exceeds a set value. The system includes all the necessary facilities to operate.

A particular feature of the plant design is a turbine control system which allows the turbine generator to reduce output to the auxiliary power consumption only, in the event of a loss of transmission capability (island operation). Impulse or reaction or a combination of both may be considered, following the standard of the selected manufacturer.

The efficiency of an impulse turbine is slightly less than the reaction turbine or impulse reaction turbine, but impulse turbines have the advantage of fewer stages that are wide in the axial direction and reduce the effects of blade scaling. Higher steam velocities in impulse steam turbines increase the risk of blade vibration and erosion causes greater friction loss. Intervals between major overhauls are longer for impulse turbines, primarily due to the heavier construction of the stationary blade diaphragms.

The efficiency of reaction turbines is higher than of impulse turbines, but maintaining high efficiency is more dependent on the condition of the seals. More care is needed in starting the turbine and this type is less able to respond to quick changes in operating conditions. Reaction turbines require a larger number of expansions resulting in more stages, which are narrow in the axial direction. Steam velocity is about 50% lower than that of impulse stages and causes much less erosion from water and solid particles.

Thrust on the rotor from steam expansion in the moving blades of reaction turbines must be compensated by a balance drum or double-flow casing design. Rotor thrust in impulse turbines is theoretically zero but can become large if blades become heavily fouled. The smaller rotor diameter of impulse turbines with wider spaces between blade stages allows easier application of specialized anti corrosion coatings. The wider spaces between blade stages also allow more efficient inter-stage moisture removal.

The turbine will be conceived for 30 years of operating life and shall conform to the IEC EN-60045-1 standard.

2.5.4.2 Condensing System

A direct-contact type condenser shall be employed in the project. Cooling water is sprayed directly into the condenser, mixing with, and condensing the incoming exhaust steam. The hot water is then cooled in a cooling tower. More steam condensate is produced within the condensers that is lost through evaporation or drift from the cooling towers and the excess condensate would be reinjected.

2.5.4.3 Non-Condensate Gases (NCG) Extraction System

The Non-Condensable Gases (NCG) extraction system is an equipment system designed to evacuate non-condensable gases (NCG) from the steam exhausted by the turbine. The system efficiently extracts the gas accumulating in the upper section of the condenser, providing a recompression and a separation from the steam, before being released into the atmosphere.

The non-condensable gases that are present in geothermal steam, and which accumulate in the condenser, must be pumped out from the condenser separately using gas removal equipment, to maintain condenser vacuum and heat exchange process effectiveness. The expansion process in a steam turbine is degraded if there is an increase in condenser pressure due to non-condensable gas accumulation. The non-condensable gases are generally disposed of by mixing them with the cooling tower discharge air plume. The appropriate equipment to be used for gas removal is dependent on the proportion of non-condensable gases present in the steam.

The actual technology provides three types of gas extraction equipment for the geothermal power plant:

i. Steam ejectors;
ii. Liquid ring vacuum pumps;
iii. Centrifugal compressor.

2.5.4.4 Circulating Water System

The exhaust outlet steam from the turbine goes into a direct-contact condenser, located below the turbine. Cooling water will be distributed within the condenser to condense the steam. Hot Well Pumps in the configuration of 2x50% capacity will send the water to the cooling tower for cooling down. After being collected in the basin, the cooling water returns to the condenser by the suction created by the condenser vacuum and by the head gap. These pumps are of vertical centrifugal design to accommodate the low Net Positive Suction Head Available (NPSHa).

A recirculation circuit allows discharging directly into the condenser in case of unavailability of the cooling tower (e.g. during testing and commissioning). Flow into the condenser will be controlled by a three-position valve, pre-set for three positions (i) two-pump operation, (ii) one-pump operation and (iii) fully closed). The water level is automatically controlled in the condenser by level controllers which operate butterfly valves on the discharge of each hot water pump. Condenser flooding is avoided in two ways: 1) at a very high level, the level device will send the trip signal, by closing the condenser three-position valve at the condenser inlet and 2) at high-high level by opening the vacuum breaker.

Some of the auxiliary systems that will need cold water to operate include:

- NCG extraction system;
- Gas cooler section of the condenser;
- Turbine lube oil system, generator air cooling system and other systems

2.5.4.5 Cooling Towers

2.5.4.5.1 Drift Eliminators

The evaporative heat exchanger surface shall be of the splash type, with bars organized in grid panels. The nozzles shall ensure suitable impingement of the water. The spacing of the grids shall be ensured by suitable hangers and guides. The grids shall be easily removable and replaceable, allowing easy access for inspection and maintenance.

Multi-pass drift eliminators will be provided. They shall effectively restrict the water loss from the tower to a maximum of 0.001 per cent of the circulated water quantity and to a maximum precipitation rate of 0.12 mm/h, without a significant increase in the air flow pressure drop or fan power demand. They shall be easily removed from inside the tower for cleaning.

Drift eliminators may be of either herringbone or honeycomb design and shall be manufactured from PVC or Polypropylene and shall be fire retarding and corrosion and ultraviolet resisting.

The drift eliminators and support structures shall be specifically designed to be completely self-draining and to shed water back to the cold-water basin. The design shall also ensure that the entrainment of water droplets into the air stream cannot occur.

2.5.4.5.2 Hot Water Distribution System

Hot water will be distributed to the fill in each cell via a system of headers, laterals, branch arms, and nozzles installed in the region above the fill and beneath the drift eliminators.

The design of the water distribution system will allow for 90% of the plan area of the cell to receive a water flow within 5% of the average flow. The water flow to no portion of the plan area will deviate by more than 10% from the average.

Nozzles will be heavy duty and not prone to breakage of components. The joint between branch arms and nozzles will be threaded so nozzles can be easily removed for cleaning of the branch arms. A means of cleanout will be provided at the ends of all headers and branch arms. As an alternative a distribution system using covered trays may be provided.

The risers and main distribution pipe work will be manufactured from FRP and provided with adequate support.

Secondary distribution pipe work may be manufactured from FRP or PVC. Risers external to the cooling tower will have a colour pigment added to the FRP. Pipe work in each cell will be identical and branch piping provided with flanges so that sections are interchangeable and can be removed for maintenance. For ease of removal, no branch pipe section will be longer than 3 metres.

Lockable flow regulator valves will be provided to equalize the water flow between individual tower cells.

2.5.4.5.3 Fan and Drive Assembly

Each cell will be provided with a fan and a drive assembly consisting of a gearbox, drive shaft and electric motor.

2.5.4.5.4 Access and Safety

One end wall of each tower will be equipped with a stairway rising from the level of the cold-water basin curb to the fan deck. A fire escape ladder with two landings will be provided at the other end. Lighting will be provided on the stairway, ladder, fan deck and around the tower.

Each cell will have a lift-off access hatch in the fan deck floor and a ladder leading down to a landing at the drift eliminator level. Each landing will have a lift-off hatch for entry to the top of the fill and distribution level. All access doors will open easily from inside the tower with door frames designed to avoid warping.

Fan cylinders manufactured from FRP will have easily removable external hatches of sufficient size to allow removal of all mechanical equipment and components. A removable access catwalk and platform will be provided to allow periodic monitoring and inspection of the fan assembly to be safely undertaken. The fan deck will be capable of supporting fan components such as the driving motor and gearbox during overhaul.

Maintenance facilities and necessary equipment will be provided to allow the fan, gearbox and motor to be removed and lowered to ground level. The equipment provided by the EPC Contractor may either be:

a) Mobile crane with sufficient reach to the centre of each fan stack;
b) Travelling overhead crane installed permanently on the fan deck.

Fire protection for the tower will be provided through the provision of manual fire hydrant points and hoses at appropriate locations around the tower at ground level. The cooling tower shall be equipped with fire protection, controlled by detectors and capable of spreading water from the top of the deck.

2.5.4.5.5 Intake Screens

Double-row intake bar screens will be provided with supporting steelwork and electric hoist lifting equipment. Suction facilities will be provided to remove trash accumulating upstream and downstream of either the upstream or downstream screens, comprising but not limited to:

a) 300 mm wide clearance between screen and concrete;
b) Underwater camera with light connected to 14" IPS LCD min 400nit colour monitor;
c) Suction pipes supported on metal frame and trolley to clean upstream screen surface, cavity between screens and basin floor immediately in front of screens;
d) Pump, valves, strainer and hoses.

Screen aperture will be optimized to minimize screen cleaning frequency while avoiding blocking of condenser spray nozzles. The design of the intake structure will include baffles and suction equipment to avoid dead bugs floating in the tower basin being sucked in through the bar screens. The screens and associated cleaning equipment will be manufactured from 316L stainless steel. A hose and hose point will be provided adjacent to the screen area to provide for wash water and allow manual cleaning of removed screens. A level transmitter will be provided upstream of the screens and differential pressure alarms provided across the screens.

2.5.4.6 Drain and Condensate Collection System

A centralized reinforced concrete plant drain sump will be provided and located next to the turbine hall building to receive all plant drains on the site including scrubber and vent station drains and allow dewatering of equipment including cooling tower basins and condenser.

The plant drain sump will preferably drain by gravity pipeline to the Drain and Condensate Collection Sump. A configuration of 2x100% duty pumps drains the condensate into the Cooling Tower Sump. The sump pumps, if provided will be fitted with low and high-level switches and alarms.

Water collected in the Cooling Tower Sump is pumped through a system of submersible 3x50% duty pumps to the OW-203 Cluster with the DN350 condensate pipeline. Cooling Tower Sump also collects the overflow coming from the two cooling towers.

The pumps of Cooling Tower Sump in configuration of 3x50% duty guarantee the maximum availability of the plant and allow to decrease the energy consumption when only one unit is in operation.

All platforms, ladders, supports and other hardware installed in the drain sump will be either FRP or stainless steel.

2.5.4.7 Transformers

The plant shall be provided with step-up transformers to deliver the generator output at 220 kV to the KenGen transmission grid. Similarly, auxiliary transformers are required to reduce the generator voltage down to the required voltages for plant auxiliary loads.

2.5.4.7.1 Generator step-up transformer

The generator transformer power output (MVA) will be determined such that the unit can deliver the generator rated power continuously at any voltage tapping with a frequency within ± 2% rated and a load power factor of 0.85 without exceeding the specified temperature rise under site conditions. The transformer cooling will be capable of continuous operation at its rate load with one cooling fan out of service.

The main transformers and the auxiliary transformers shall be connected to the generator by means of an isolated bus duct. The 220-kV interconnection with the switchyard will be made using transformer outdoor bushings connected to a high-level slack span anchored to a gantry straddling the transformer bay 28. The High Voltage (HV) windings of the transformer shall be protected with surge arresters mounted as closely as possible to the transformer HV terminals.

2.5.4.7.2 Unit transformer

The unit transformer will step-down the generator voltage 11 kV to the medium voltage of rating 6.6 kV, suitable for distribution to MV motors. It will be oil-type and can either have Oil Natural Air Natural (ONAN) or ONAN/Oil Natural Air Forced (ONAF) cooling. The 4 MVA capacity of the transformer is based on the estimation of the ratings of plant auxiliaries. The voltage impedance will be in the range 6%–8%. The off-load tap changer will provide at least 5 tapping steps at 2.5% per step to achieve voltage range of ±5% of rated primary voltage

2.5.4.7.3 Auxiliary and Service Transformers

The auxiliary transformers will reduce further the selected medium voltage 6.6 kV to low voltage 400 VAC for station and unit loads. Auxiliary transformers will be the outdoor type with ONAN cooling. The 2 MVA capacity of the transformer is based on the estimation of the ratings of plant auxiliaries. The off-load tap changer will provide at least 5 tapping steps at 2.5% per step to achieve a voltage range of ±5% of the rated primary voltage.

2.5.4.8 Switchyard

The Switchyard "circuit breaker and a third" switching configuration is proposed to be adjacent to the power plant, with two diameters arranged North – South in general, with busbars running East – West, in parallel to the alignment of the two generator step-up transformers (GSUTs).

Connection of each GSUT HV terminal is made at high level. The power station end is anchored to the power station wall and the switchyard end is supported by gantries, which also support strung flexibles at the same high level, making up the high-level connections of the diameter. The connection allows for a maintenance access road to be built between the power station and the switchyard, with sufficient clearance to allow easy access for recovery of a transformer.

The switchyard control building shall be constructed using masonry or other durable permanent materials, according to the Kenya Electricity Transmission Company Limited (KETRACO) standards, and will house: Protection and Control facilities; telecommunication equipment and SCADA RTU; Auxiliary 400 V AC supply and Auxiliary DC supply equipment switchgear; distribution Boards and other ancillary equipment; and facilities associated with switchyard and grid, functions so as to be operationally independent from the power station. Duplicate Auxiliary 110 V DC Battery Bank and Chargers will be provided, for protection and control for the 220 kV Switchyard. Duplicate Auxiliary 48 V DC Battery Bank and Chargers will be provided for the Telecommunication and SCADA systems. The Switchyard Control Building shall be designed to consider enough space for the accommodation of equipment related to the possible future switchyard extension up to four 220 kV Diameters.

The following primary equipment will be provided at Olkaria II Extension Substation:

a) 245 kV Circuit Breakers; 7x three phase sets with single pole mechanism;
b) 245 kV Free Standing Current Transformers for Protection & Measurements; 7 x Three Phase Sets;
c) 245 kV Free Standing Current Transformers for Energy Metering; 2 x Three Phase Sets;
d) 245 kV Capacitor Voltage Transformers; 5 x Three Phase sets for protection and control and Energy metering;
e) 245 kV Capacitor Voltage Transformers; 7 x Single phase;
f) 245 kV Line motorized Circuit Disconnectors complete with Earth Switches: 5 x three phase sets;
g) 245 kV motorized Busbar Disconnectors 14 x Three phase sets; and
h) 245 kV Surge Arresters 3 x Three phase sets.

All switchgear will be supplied in a complete package, including stands and support structures. All necessary civil works for installation will be undertaken as part of the project.

2.5.4.9 Balance of Equipment and Mechanical Plant

The mechanical balance of the power plant will provide the main plant and equipment requirements as follows;

i. **Auxiliary cooling water system** – comprising 2 x 100% (one operation & one stand-by) duty pumps and ancillary equipment to supply cooling water to the GRS, lube oil coolers, generator air coolers and air compressors.
ii. **Condensate reinjection system** – comprising 2 x 100% (one operation & one stand-by) duty pumps and ancillary equipment to pump excess condensate from the cooling tower basin to the reinjection wells.
iii. **Chemical dosing system** – comprising of a caustic soda storage and injection system to control the pH in the circulating water and the reinjected condensate. A system will also be required to inject biocides into the circulating water to minimize organic growth in the cooling tower.
iv. **Instrument and utility air system** – comprising 2 x 100% (one operation & one stand-by) duty air compressors, air receivers and ancillary plant to supply instrument air to plant utility air for the workshop and general service areas.
v. **Firefighting system** – comprising 2 x 100% (one operation & one stand-by) duty fire pumps and ancillary equipment to supply firewater to outdoor hydrants and sprinkler systems around lube oil systems, oil filled transformers and diesel fuel tank. The pumping station is normally fed by a dedicated part of the raw water reservoir, but it can be fed also by the cooling towers basin in emergency.
vi. **Turbine hall crane** – sized to lift the heaviest component during plant erection and maintenance.
vii. **Emergency diesel generator system** – capable of meeting the starting and operational demands for essential services required to maintain the generating unit and the steam field in a safe condition and ready to be re-started once start-up power is re-established.
viii. **Raw water and domestic water system** – comprising pumping system, storage, treatment, and distribution system.
ix. **Central Air Conditioning and ventilation system** – to provide filtered and H_2S free air at positive pressure to electrical, instrument and control rooms.

2.5.5 Power Plant Services

2.5.5.1 Water Treatment and Distribution System

A chemical treatment system will be provided to maintain satisfactory water chemistry in the circulating water system and the complete condensate reinjection line. Design of the cooling water systems will rely on appropriate materials, protective coating of wetted surfaces and control of biological activity. The design of the chemical treatment systems and selection of chemicals will avoid the requirement for direct blowdown of the cooling tower basin.

The chemical treatment system will minimize the amount of dosing required and will rely on:

a) Control of dissolved H_2S in the circulating water by appropriate design of condenser and gas cooler;
b) Choice of appropriate materials;
c) Protective coating of wetted surfaces;
d) Control of biological activity.

The condensate reinjection system will be provided with pH control to ensure that condensate reaching the injection well(s) has a nominal pH of 7.0.

The chemical treatment area will include a bunded area for the bulk chemical tanks (plus mixing/day tanks), stacking chemical containers, and drums. Provision to access the bunded area with hand truck and forklift will be provided. Stairs, ramps and platforms will be provided for convenient access to move drums and for the operator to visually inspect the inside of tanks, drums and day tanks.

The chemical treatment area will be covered to enable operation and monitoring of the plant in all weather conditions. Floors in the chemical treatment area will be suitably treated to protect the concrete from the effects of spillage. Emergency shower and eyewash facilities will be provided within immediate access to all areas where operations and maintenance personnel may be exposed to chemicals.

The chemical dosing system will be supplied with a local operator panel to start, stop and indicate the operation of the chemical dosing pumps. The entire system will be remotely monitored from the Distributed Controlled System (DCS).

2.5.5.2 Compressed Air System

The system supplies service air for many uses and instrument air for the actuation of the control equipment of both units. The instrument air will be dried, oil-free and H2S purified. The system consists of 2x100% air compressors, one air compressed tank in the compressing station. The compressors operate alternatively, sending the air to the air compressed tank. The exit line from each receiver tank splits in two lines: one for the instrument air and one for the service air.

The capacity of the instrument air receiver(s) will be sufficient to supply the total instrument air requirements during normal operation if supply from all compressors becomes unavailable, for a period of at least one hour with subsequent safe shutdown of both generating units. The capacity of air receivers installed near the vent valves will be sufficient to allow three complete cycles of stroking all vent valves.

All instrument air will pass through 2x100% activated carbon and/or potassium permanganate filters for H_2S removal. Instrument air will pass through automatic regenerating, adsorption type dryers. Air supply from the dryers and after filters will meet the International Society of Automation (ISA) requirements for instrument air quality and will have a moisture dew point not greater than -40°C. Two air dryers, each of 100% instrument air capacity will be provided.

2.5.5.3 Fire Fighting and Fire Detection System

The purpose of the fire protection system is to detect, annunciate and suppress fire automatically and/or manually. The fire protection system will meet/exceed the guidelines provided by the National Fire Protection Association (NFPA)-850.

The fire protection system will include a hydrant and sprinkler fire protection system, fire alarm system, portable fire extinguishers, piping & valves and fittings. The alarm annunciator panel will be positioned such that it will be readily viewed from outside the main entrance to the control annex building and will be duplicated in the Control Room.

The fire protection system will include inert gas protection of electrical, relay and control rooms using Inergen or other clean agents like 3M Novec 1230 or FM-200.

The firewater system will include outdoor fire hydrants as well as a combination of dry-pipe, pre-action, and deluge sprinkler systems which will be utilized on the main and auxiliary transformers, the steam turbine lube oil skids, lube oil storage tanks and emergency diesel generator fuel storage tank. Fire pumps including the jockey pump will normally draw water from the fire water storage tank through a suction isolation valve and strainers with pumps located in a dedicated fire pump house close to the cooling towers.

The carbon dioxide fire protection system protects the electrical and control rooms in the powerhouse. The turbine lubricating oil tanks will be protected by a spray system. Portable dry chemical extinguishers will be provided in the control room, chemical laboratory, staff room and other necessary locations.

Heat and smoke detectors are installed in the indoor oil tank and electrical rooms. Those in the indoor oil tanks will be at constant temperature, explosion proof type, and those in the electrical rooms will activate on either rate of rise or fixed temperature.

2.5.5.4 Turbine Hall Crane

An overhead gantry crane with dual hoists will be provided, sized and arranged to allow for the removal and reinstallation of all items in the turbine generator building for overhaul and maintenance. Sufficient overhead clearance will be provided for all major equipment during the movements of large items to and from the unloading bay.

2.5.5.5 Emergency Diesel Generator (EDG)

The emergency diesel generator (EDG) will meet the starting and operational demands for services, including essential battery charging, turning gear, lube oil pumping, air compressors ventilation and air-conditioning plant, lighting, anti-condensation heaters, and any other services required to permit the generating units to be maintained in a safe condition and ready to be re-started with a minimum of delay once start-up power is re-established.

The EDG will be supplied completely with its own cooling and heat rejection system, comprising a water-cooling circuit for oil, engine jacket, generator and, if required, charge air cooling. Heat rejection will be via a radiator to be supplied with the engine. The radiator will be generously sized and include a 20% fouling margin. It will be installed inside the powerhouse, but close to an outside wall to ensure an adequate flow of fresh air for cooling and engine aspiration and ready access to the outdoor diesel fuel storage tank.

2.5.5.6 Service Water System
A service water system with a minimum capacity of 5 m^3/day will be installed to provide "clean water". Water treatment equipment will be provided to treat raw water that complies with water quality criteria. The service water will be supplied throughout the Plant, such as to utility stations, safety shower/eye wash showers, toilets and hot and cold water to the control and electrical annex, and any other specified users of service water.

2.5.5.7 Air Conditioning and Ventilation
Temperature control for the turbine hall will be achieved by drawing ventilation air through low-level louvres and exhausting at a high level with roof-mounted vents. The maximum temperature in the turbine hall will not exceed 35°C.

The battery room will be provided with an exhaust system activated by detector to relieve gases in the event of battery explosion. The room will normally be pressurized with two air changes per hour fresh air and high-level vent.

Electrical, switchgear and control room spaces will be provided with air conditioning to control temperature, humidity and H2S. Temperatures will not exceed 23 °C and relative humidity levels will remain below 65%. For equipment integrity H_2S levels will be a maximum of 0.1 ppm.

A proprietary programmable control system will be installed to stably and automatically control all Heating, Ventilation and Air Conditioning (HVAC) plants. The control system will interface with the fire alarm panel to instigate shut down of ventilation and air conditioning plant under fire conditions. The HVAC control system will be connected to the DCS to indicate alarms, trip, control room temperature and humidity.

Ventilation will be provided in the battery rooms, toilets, kitchen(s), store, workshop, offices and other general spaces within the powerhouse annex. Battery room, toilets and kitchen areas will be maintained at negative pressure.

2.5.5.8 Closed-Circuit Television (CCTV)
The plant supply will be provided with Closed Circuit Television (CCTV) for covering all the area of the project, namely: powerhouse building, power plant internal roads, switchyard, FCRS. The System will include: Outdoor and Indoor Cameras; MPEG4 Encoder; (NAS)/RAID 4 tb Backup Device; Workstation with monitors; NVR/Camera/Database Server; and LAN cables, switches and accessories.

2.5.5.9 Workshop Equipment
The workshop equipment will be sufficient to carry out the emergency maintenance and repair of the Plant without utilizing the need of sophisticated equipment and highly specialized tradesmen. All machines and equipment will be rated to operate on 400 V, 3 phases, 50 Hz, AC supply complete with all controls and starters and a comprehensive set of spares.

All necessary guards to afford protection from electrical apparatus and moving parts of machinery will be provided. All machines and equipment will be fully installed, connected, commissioned and ready for use with adequate tool storage cabinets and stands. The necessary containers will be provided for mixing cutting fluid (suds) and the collection of waste material swarf and chippings.

2.5.5.10 Electronic and Instrument Test Room and Equipment

A dedicated electronic and instrument test room will be provided. Specialised electronics and instrument equipment will include: soldering irons with solder; tweezers; dead weight testers; test pressure gauges; pneumatic calibrators; multi range test rig; vacuum pump; temperature baths; thermometers; hand tachometer; machine analysis kit; oscilloscope; wave generator; dc precision potential meter; digital volt meter; multi testers; power supply units; rheostats; variac; stop watch; digital timer; ultrasonic cleaning unit.

2.5.5.11 Chemical Laboratory Equipment

The power plant will be provided with a fully equipped laboratory to perform water analysis; condensate analysis; oil analysis and general environmental analysis. The following equipment will be present in the laboratory: atomic absorption spectrophotometer; ultra violet spectrophotometer; flame photometer; precision balance; top loading balance; furnace; ovens; pH meter with specific ion analyser; magnetic hotplates stirrers; fume cupboard; water bath; distillation plant; set of titration equipment; set of filtration equipment; glassware; heating pads; precision mercury thermometers; digital thermometers; reagents; filter paper, indicator strips, consumables; laboratory computer; laser printer; personal gas detectors; H_2S gas detection equipment; safety equipment; and first aid equipment.

2.5.6 Geothermal Fluid Collection and Reinjection System

20 production wells will be utilized to feed the gross 146 *MWe* Olkaria II Extension GPP. The steam-field is classified into north and south clusters.

2.5.6.1 North cluster steam-field arrangement

The North cluster includes well pads OW-736, OW-735, and OW-733, and no pipelines exist in this section. The central separator station CS-1 is proposed to be in Cluster 733, which shall manage the fluid separation of Clusters 736, 735, and 733. There shall be two two-phase lines; one from OW-735 to OW-733 and one from OW-736 to OW-733. The two-phase line from OW-735 carries around 313 t/h fluid with an enthalpy of 2347 kJ/kg, while the two-phase line from OW-736 carries around 253.4 t/h fluid with an enthalpy of 2247 kJ/kg. With the inclusion of fluid produced in OW-733 around 208.4 t/h with an enthalpy of 2025 kJ/kg, the total two-phase fluid that shall be separated in the central separation station (CS-1) in OW-733 cluster amounts to around 775 t/h.

The separation in CS-1 in Cluster OW-733 takes place at a pressure of around 10.1 bara which results in 568.3 t/h steam production to be utilized in the power plant, and 206.9 t/h brine to be reinjected. The steam line from CS-1 extends southwest towards the power plant steam header, passing behind Cluster OW-741. This steam line has a diameter of DN1200, spans 924 meters to the power plant steam header. The total pressure drop in this line is estimated to be around half bar which should result in a pressure value of 9.5 bara in the steam header.

The brine from CS-1 is directly conveyed to the reinjection Cluster OW-739, which can accommodate all the brine from OW-733, OW-735 and OW-736 by gravity. The route for the brine line follows a downward slope as shown in the figure below, ensuring stable flow and maintaining a constant liquid phase without flashing. This reinjection line is planned to be DN300 in diameter and extends 1,212 meters).

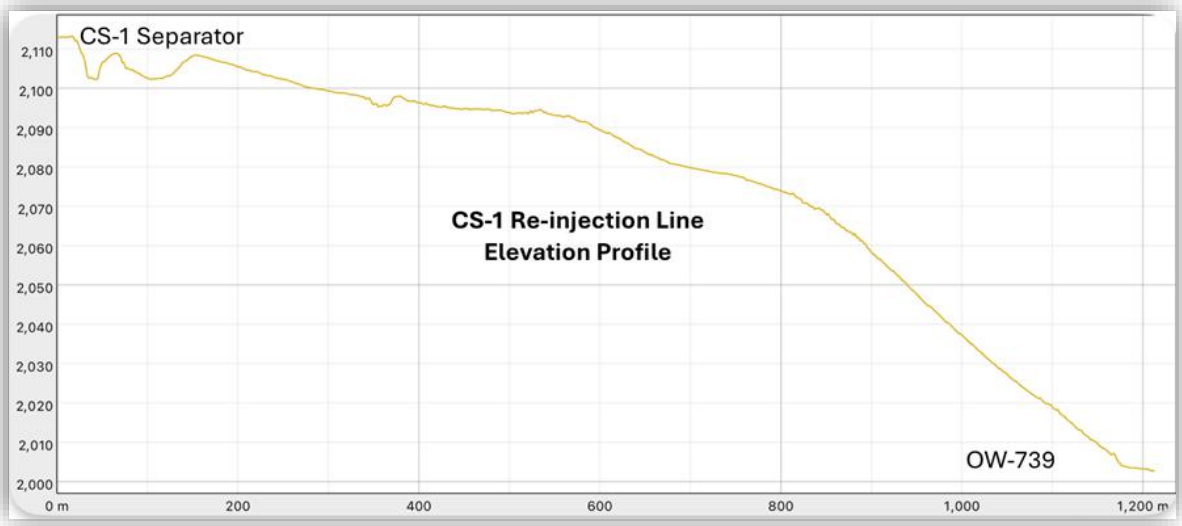


Figure 2-9: CS-1 to OW-739 Reinjection Line Elevation Profile

2.5.6.2 South cluster steam-field arrangement

The Southern cluster comprises of well pads OW-732, OW-740, OW-724, and OW-730. Well pads OW-732, OW-724, and OW-730 are interconnected using the existing infrastructure. A two-phase line with a diameter of DN750 extends from OW-732 to the separators at OW-730 (SN-3) carrying around 333 t/h fluid with an enthalpy of 1500 kJ/kg, while another two-phase line with a diameter of DN400 extends from OW-724 carrying around 208 t/h fluid with an enthalpy of 1679 kJ/kg to the separator station at OW-730.

This current infrastructure, including the separator station at OW-730, does not require any modifications and is suitable for use in the Olkaria-II extension project. The existing separators (SN-3) are appropriately sized to meet the project’s requirements.

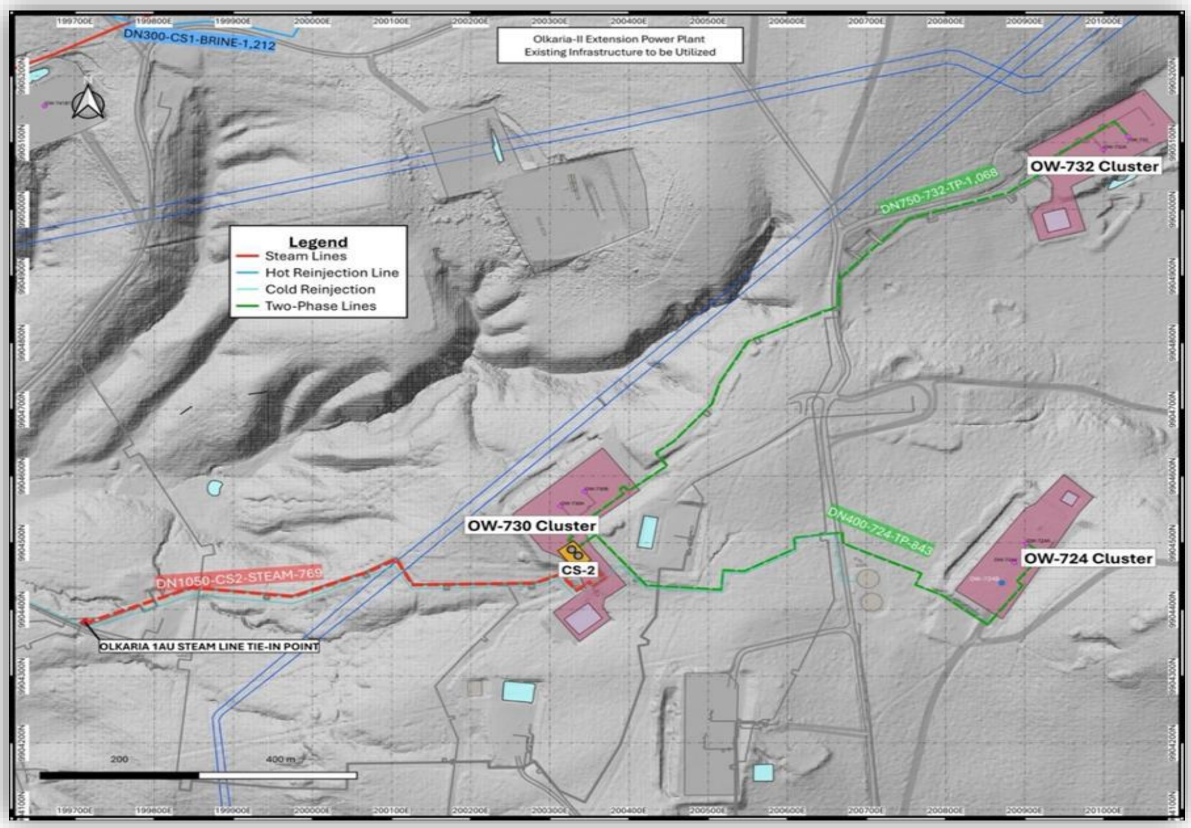


Figure 2-10: Existing Infrastructure to be utilized in the south cluster

To ensure evenly distributed reinjection and meet the preference for reinjecting into OW-724B, it is recommended to establish a dedicated well pad separation station at OW-740. This setup would facilitate gravity-driven reinjection of all fluid from OW-740 into OW-724B. However, due to the proximity of OW-724B to existing production wells, there is a risk of thermal breakthrough. To mitigate this risk, a bypass reinjection line should be installed to redirect the reinjection from OW-724B to the discharge point of the CS-2 (SN-3) separator, allowing reinjection to bypass OW-724B if necessary. Additionally, a valve should be installed on this bypass line before its connection to the CS-2 discharge, enabling throttling and pressure equalization between the bypass and reinjection lines when required.

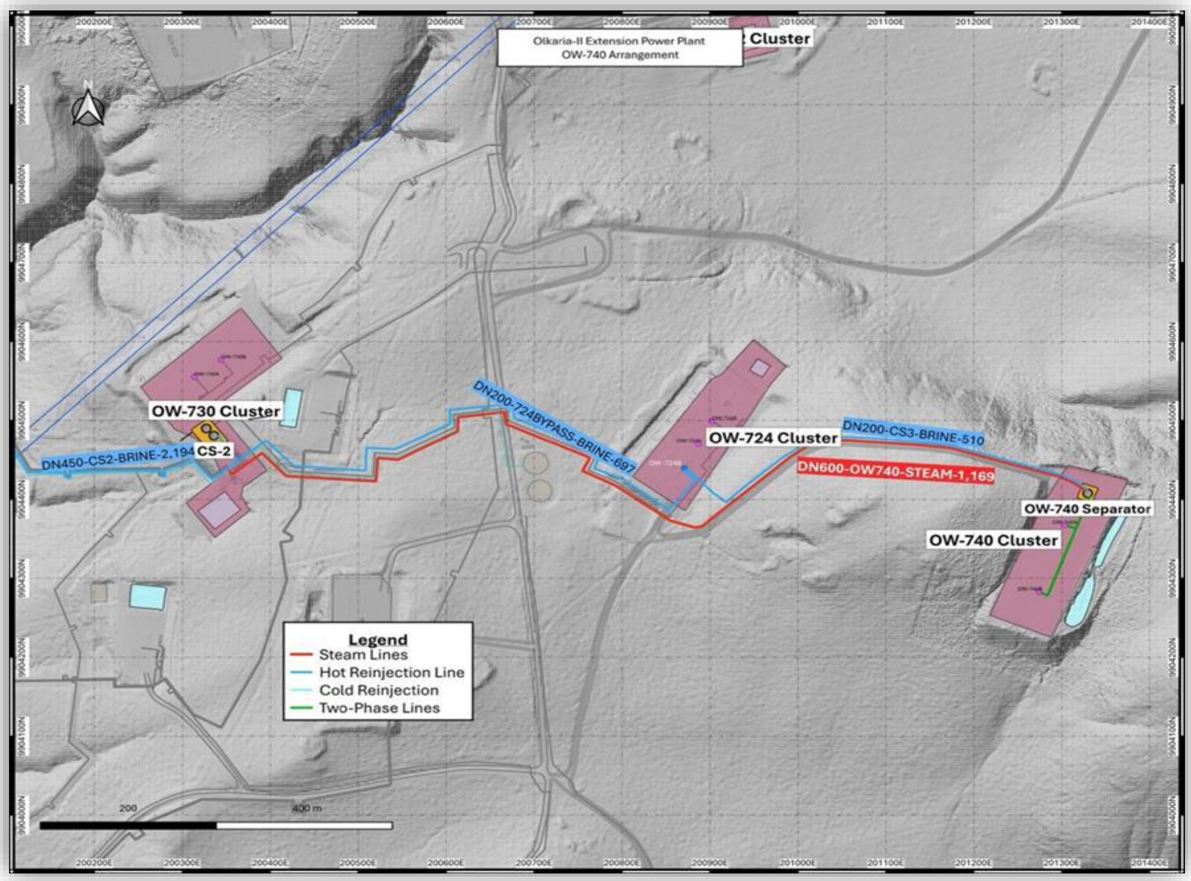


Figure 2-11: OW-740 arrangement and reinjection to OW-724B

The steam line from the OW-740 separator will carry approximately 153 t/h of steam, including the anticipated production from wells OW-740 and OW-740C to be drilled in a separate project. This line will extend to the CS-2 (SN-3) separation station, where it will merge with the existing steam line at the separator discharge. The existing DN1050 steam line will handle around 499 t/h of steam and continue westward to the Olkaria 1AU tie-in point before turning northwest towards the Olkaria-II extension power plant, as shown in Figure 2-12.

A valve will be installed at the divergence towards Olkaria 1AU to allow for isolation while maintaining the ability to direct steam to this unit when necessary. The new DN1050 steam line, to be installed from the Olkaria 1AU tie-in point to the power plant steam header, is approximately 887 meters long. Including the existing line, the total steam line length from CS-2 (formerly SN-3) to the power plant header is about 1,656 meters. The expected pressure drop along this line should not exceed 1 bar.

The brine line from CS-2 (SN-3), carries around 370 t/h brine until OW-739 cluster by gravity. There is sufficient hydraulic head in CS-2 in relation to OW-739 cluster which should realize the reinjection with ease. The profile of the reinjection line can be seen Figure 2-13.

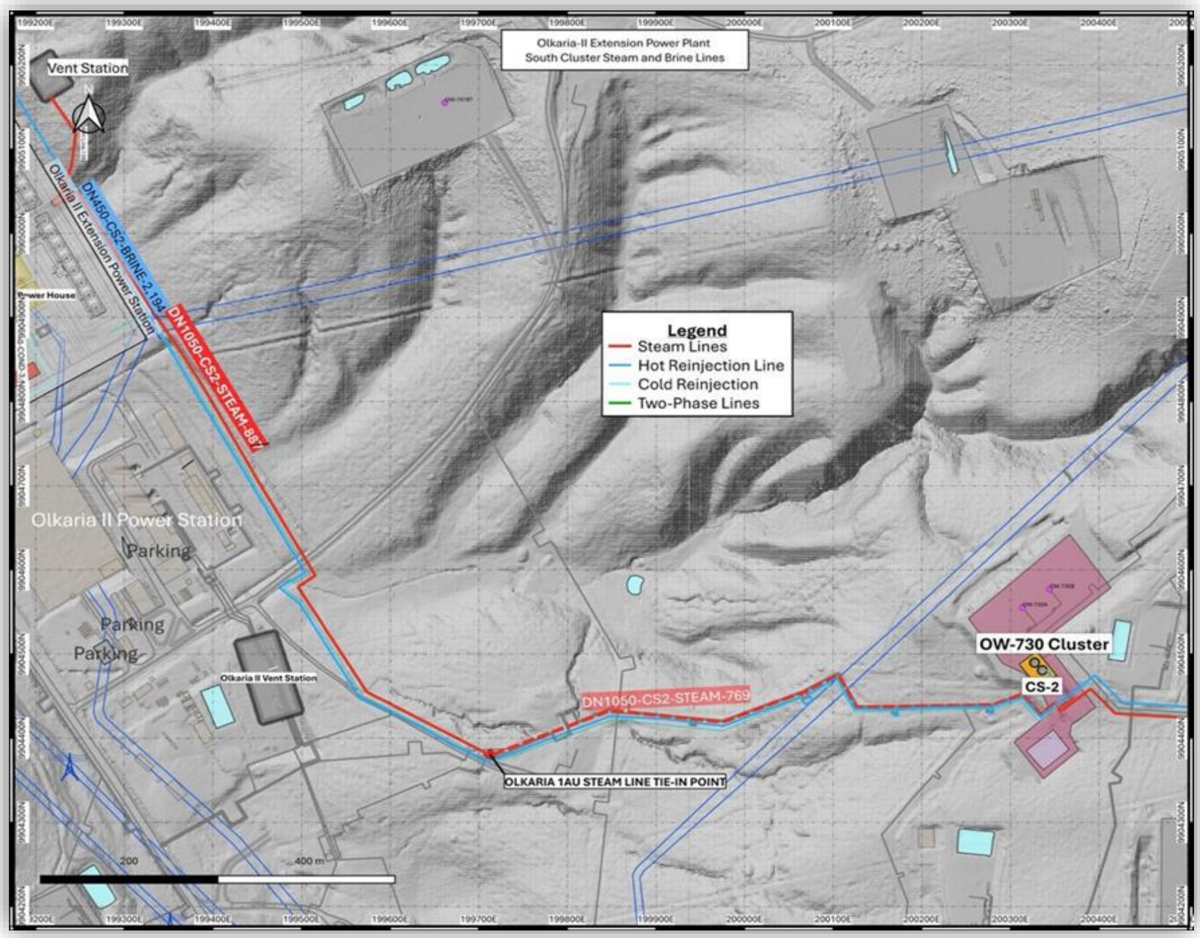


Figure 2-12: South cluster steam and reinjection lines

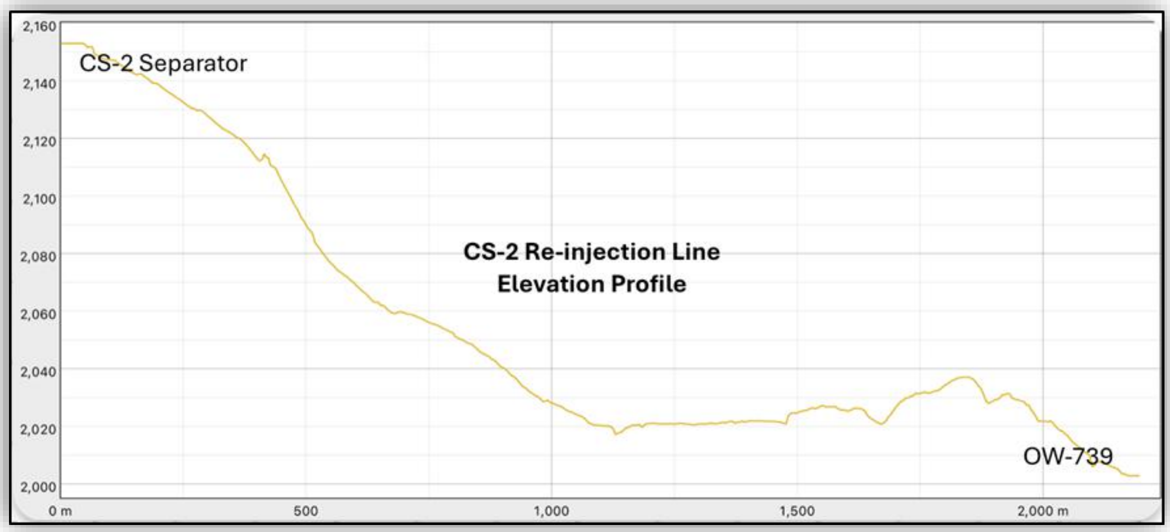


Figure 2-13: CS-2 to OW-739 Reinjection Line Elevation Profile

2.5.6.3 Vent Station for Olkaria II Extension

The venting station for the Olkaria-II Extension is planned to be northeast of the power plant, about 60-70 meters away from the cooling towers (Figure 2-15). Placing it at this distance helps prevent long-term corrosion from H_2S. The flow from the venting station will be minimized through proper operation and the correct selection of wellhead flow-adjusting valves. These wellhead valves will be designed for precise flow adjustment, ensuring minimal to no venting during normal operations. As a result, noise and H_2S emissions will be limited to stoppages and trip conditions. Having minimal venting would also help preserve the reservoir conditions in the long run.

2.5.6.4 Summary of steam field arrangement

A total of 891.6 t/h steam is required for Olkaria-II extension project to produce 146 MW gross power at 9 bara turbine inlet pressure. This leaves around 10% steam buffer in the field. If drillings of OW-740 and OW-740C will be successful, the total steam amount would be around 1,067 t/h which corresponds to 174.8 MW Gross power considering a SMC Gross value of 6.11 t/MWh. The overall steam field summary, including all the wells to be utilized in Olkaria-II Extension project, is shown in the table below.

Table 2-5: Steam field summary table

SOUTH CLUSTER	WHP (bara)	Flow Rate (t/h)	Brine Flow Rate (t/h)	Separator	Reinjection wells	Injection Capacity at 10 bara WHP
OW-724A	13.4	153	93	CS-2 (former SN-3)	OW-739	299
OW-724V	13.4	55	24		OW-739A	425
OW-730A	12.5	90	20		OW-739R1	436
OW-730B	12.5	86	27		OW-203	354
OW-732	13.0	177	123			
OW-732A	13.0	156	94			
OW-740A	13.7	59	7	OW-740 Well pad Separator		
OW-740B	13.7	82	64			
OW-740[1]	13.7	68	27			
OW-740C[1]	13.7	68	27			
TOTAL BRINE FROM SEPARATOR CS-2:			**381**			
TOTAL BRINE FROM SEPARATOR 740:			**125**		**OW-724B**	**310**
NORTH CLUSTER	**WHP (bara)**	**Flow Rate (t/h)**	**Brine Flow Rate**	**Separator**	**Reinjection wells**	**Injection Capacity at 10 bara WHP**
OW-733	12.2	41	16	CS-1	OW-739	299
OW-733A	12.2	107	39		OW-739A	425
OW-733B	12.2	68	28		OW-739R1	436
OW-735	13.4	122	34		OW-203	354
OW-735A	13.4	85	16			

OW-735B	13.4	107	21			
OW-736	13.7	48	6			
OW-736A	13.7	96	37			
OW-736B	13.7	28	11			
OW-736C	13.7	151	93			
OW-736D	13.7	78	13			
OW-741B	-	-				
TOTAL BRINE FROM SEPARATOR CS-1:			**314**			
BRINE GRAND TOTAL:			**820**	**TOTAL INJECTION CAPACITY:**		**1823**

Note 1: These wells are yet to be drilled, their production values were guessed estimates based on the existing wells

The overall arrangement of the steam field is shown in Figure 2-14 below.

The total brine to be reinjected is approximately 820 tons per hour. The combined capacity of the allocated reinjection wells at the OW-739 cluster and well OW-724B is about 1,823 tons per hour, which is nearly double the reinjection needs for the Olkaria-II Extension.

The Olkaria-II extension is expected to inject 206 tons per hour of condensate into well OW-203, which has double the needed capacity. Due to the uneven terrain, pumps are necessary for the injection process. The condensate line to OW-203 is approximately 3,598 meters long with a DN350 diameter.

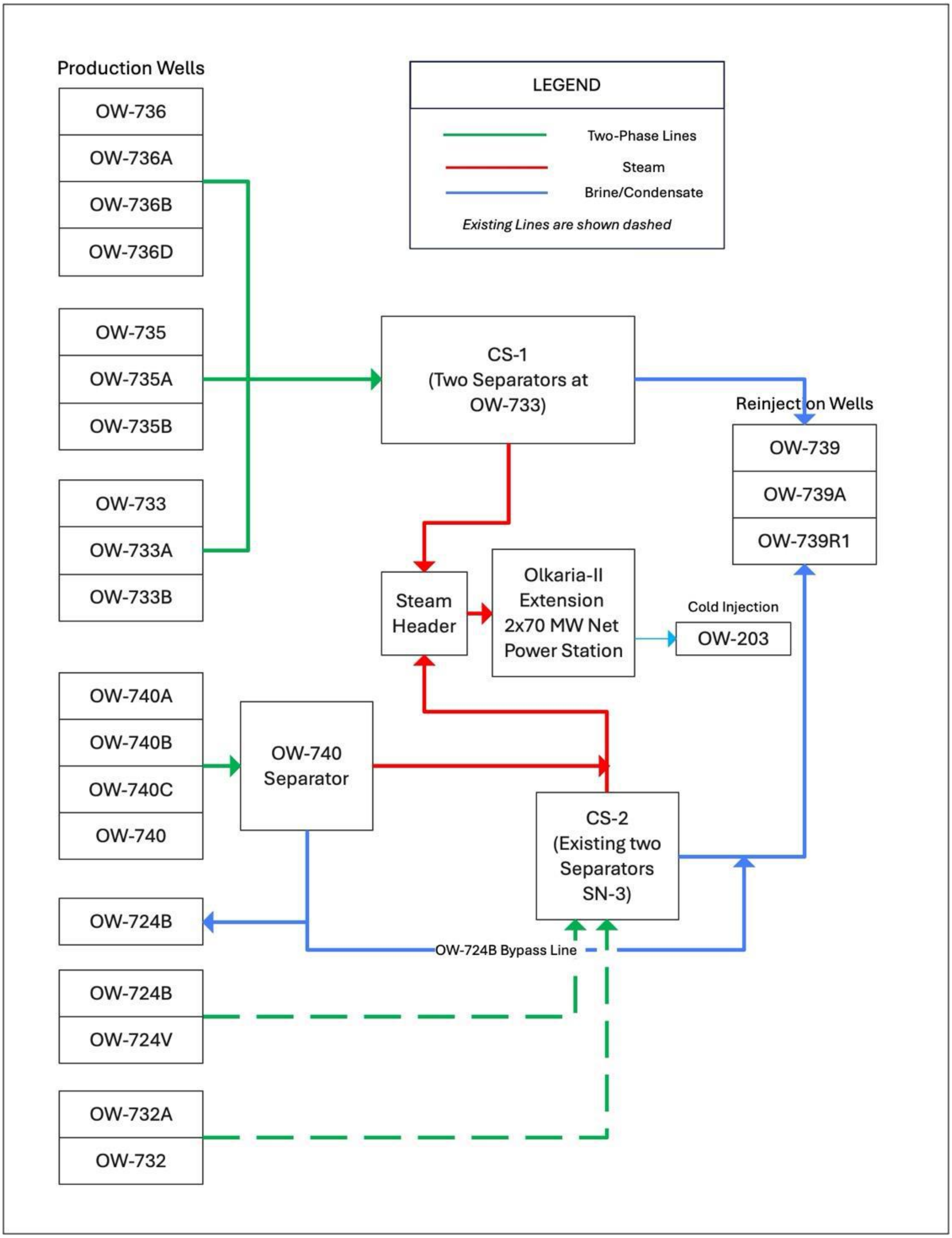


Figure 2-14: Overall steam field arrangement

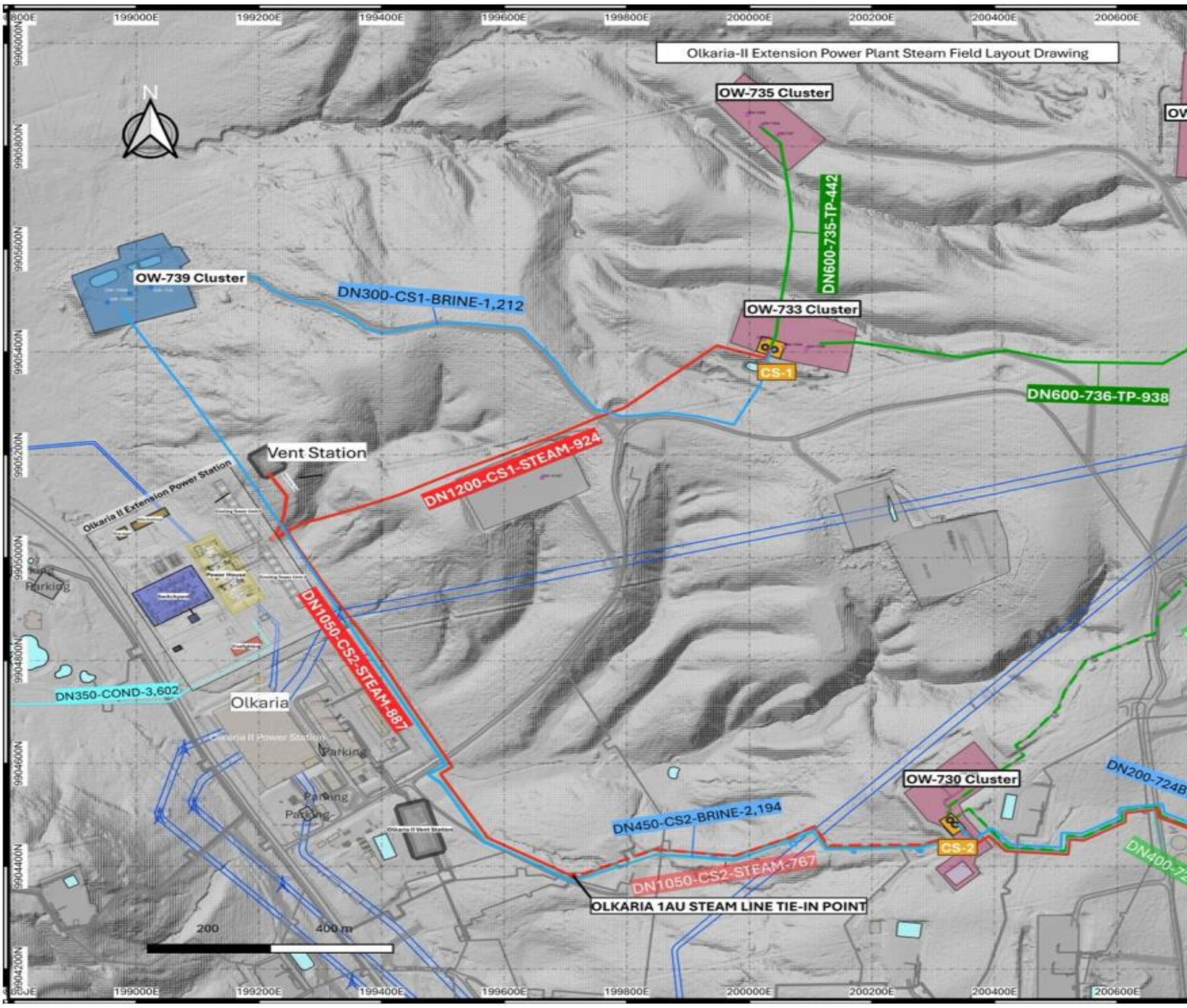
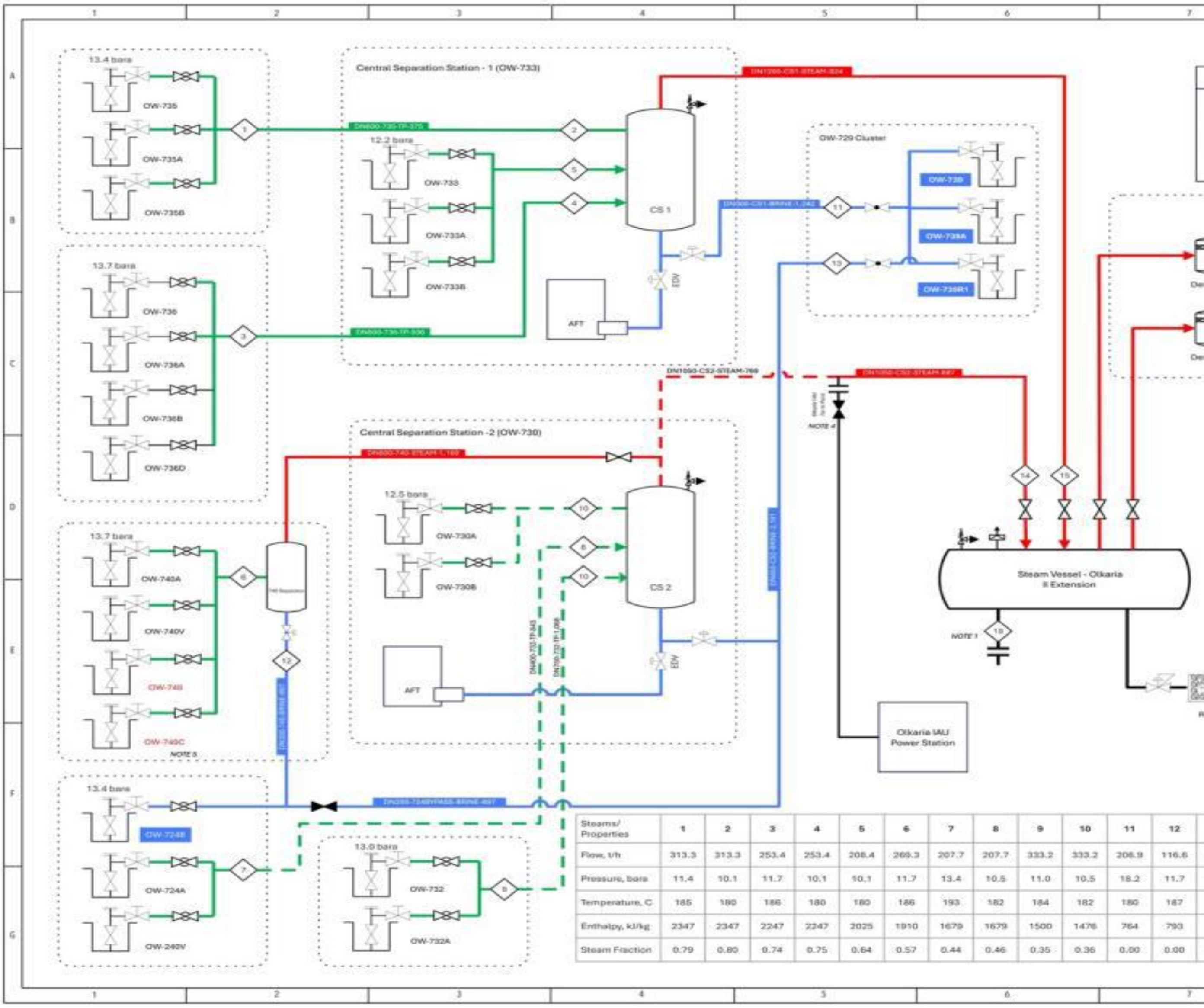


Figure 2-15: FCRS Layout Drawing



Steams/ Properties	1	2	3	4	5	6	7	8	9	10	11	12
Flow, t/h	313.3	313.3	253.4	253.4	208.4	269.3	207.7	207.7	333.2	333.2	206.9	116.6
Pressure, bara	11.4	10.1	11.7	10.1	10.1	11.7	13.4	10.5	11.0	10.5	18.2	11.7
Temperature, C	185	180	186	180	180	186	193	182	184	182	180	187
Enthalpy, kJ/kg	2347	2347	2247	2247	2025	1910	1679	1679	1500	1476	764	793
Steam Fraction	0.79	0.80	0.74	0.75	0.64	0.57	0.44	0.46	0.35	0.36	0.00	0.00

Figure 2-16: FCRS process flow diagram

2.5.7 Grid Connection

Currently, there are eight power plants within Olkaria with total combined effective capacity of 842.3 *MWe* as illustrated in the table below:

Table 2-6: Current Installed Capacity of Olkaria Geothermal Power Plants

S/N	Power Plant Name	Capacity (*MWe*)
1.	Olkaria I	0 (Under rehabilitation)
2.	Olkaria I AU	223.3
3.	Olkaria II	101
4.	Olkaria III	150
5.	Olkaria IV	140
6.	Olkaria V	158
7.	Well head 914	42.50
8.	Well head 37	27.50
Total		**842.3**

There are currently three 220 kV double circuit transmission lines that evacuate the power generated at Olkaria to Suswa for onward transmission to load centres in Kiambu, Nairobi, Athi River and the Coast region. One 220 kV double circuit line with a rated capacity of 610 MVA, evacuates generation from Olkaria V, Olkaria IV and Well head 914 power plants, totalling 340.5 MW to Suswa substation. The other two, 220 kV double circuit lines with a combined rated capacity of 1220 MVA, connect the other power plants (Olkaria Central) with combined generation capacity of 548.6 MW to Suswa Substation. There are a further three transmission lines; 220 kV Double Circuit line and 2x132 kV Lines that evacuate power from Olkaria Central to Western Kenya, Central and North Rift regions and to Narok.

In addition to Olkaria Geothermal Power connected to the Suswa substation, Lake Turkana Wind Power Plant with installed capacity of 310 MW is also connected to Suswa substation via a 438 km 400 kV double circuit line that is currently operated at 220 kV. Further 500 kV High-Voltage Direct Current (HVDC) Bipole Link from Ethiopia with capacity to deliver 2000 MW is also terminated at Suswa 400 kV substation via a 500 kV DC-400 kV AC converter station. Currently, Kenya imports up to 200 MW from Ethiopia through this Link.

2.5.7.1 Power Evacuation System

Olkaria II Extension 140 MW Geothermal Power Plant will be located adjacent to Olkaria II Substation. 220 kV Olkaria II Extension substation will be built in a breaker and a third configuration, comprising two diameters, one of which will be partially built. Generated power from Olkaria II Extension Power Plant will be evacuated to the Grid via a 220 kV Double Circuit line, approximately 0.5 km long built in single canary conductor, from Olkaria II Extension Substation to the existing Olkaria II Substation. The spare 220 kV bay at Olkaria II Substation will be developed, while 220 kV Suswa Double Circuit line will be transferred to diameter 3 to allow termination of the 220 kV Double circuit line from Olkaria II Extension in Diameter 4 at Olkaria II Substation. This solution has minimal environmental and social impact and requires minimum CapEx. The line will be equipped with an optical ground wire (OPGW), to allow integration of Olkaria II Extension Power Plant and substation, to the existing telecommunication system and SCADA.

220 kV Olkaria III Line currently terminated at Olkaria II Substation, and which passes through the area where 140 MW Olkaria II Extension Geothermal Power Plant will be built, will be re-routed and terminated at Olkaria II Extension Substation.

System studies showed that the selected transmission line for evacuation of power from Olkaria II Extension Geothermal Power Plant to the Grid had adequate capacity. Load flow studies indicated that no transmission line would be overloaded due to connection of Olkaria II Extension GPP to the Grid at Olkaria II Substation. Under N-1 contingency conditions for transmission lines within Olkaria area, the highest loaded line would be 220 kV Olkaria II Extension-Olkaria II Substation Circuit 2 at 95.08% of line circuit capacity, for outage on 220 kV Olkaria II Extension – Olkaria II Circuit 1. All other transmission line outages around Olkaria resulted in power flows well within the line(s) rated capacity.

It was however observed that outage on 220 kV Suswa-Nairobi North Line 1 causes overload on 220 kV Suswa-Nairobi North Line 2 of 370 MW, i.e. 125% of line rated capacity. This was however within the emergency loading capability of the line, allowing system operators at National Control Centre to carry out remedial measures to manage the loading on the line.

Kenya Electricity Transmission Company (KETRACO) indicated that construction of 400 kV Gilgil-Thika-Malaa-Konza Line would be commissioned in 2028, instead of 2026 as per transmission expansion plans in LCPDP 2022 - 2041. Under this scenario, fault one 220 kV Suswa-Nairobi North circuit, could cause the remaining circuit to trip on overload. Consequently, load flow on 400 kV Suswa-Isinya Line could rise from 456.6 MW to 650.5 MW per circuit. The system performance was satisfactory following the N-2 contingency, with system bus voltages within statutory grid code requirements of ±10% for 220 kV and 132 kV nominal voltages and ±5% for 400 kV nominal voltage.

To Further Mitigate this challenge, KETRACO planned to replace the conductors on the two transmission circuits between Suswa and Nairobi-North with High Temperature Low Sag (HTLS) conductors that permit the high loading on the line and/or install phase shifting transformers at Suswa substation to force more power flow onto the Suswa-Isinya-Athi River-Nairobi transmission corridor, thereby reducing power flow on Suswa-Nairobi North double circuit line. In line with the LCPDP 2022 - 2041 transmission development plans, the corrective measure is to be implemented by KETRACO by 2026.

Following integration of Olkaria II Extension 140 MW GPP, system voltages at various buses were observed to be all within statutory limits during both system peak load and minimum load periods. The increase in short circuit currents because of connection of Olkaria II Extension 140 MW GPP to the power grid for faults at various system Buses will be minimal and there will be no violations on rated short circuit capacity for existing circuit breakers in neighbouring and remote substations.

The power system exhibited satisfactory performance under transient conditions, including: three phase short circuit faults, close and remote to the Olkaria II Extension 140 MW power plant; loss of load at Nairobi North substation; and trip on 86.3 MW Unit No. 6 at Olkaria 1AU power plant.

2.5.7.2 Olkaria II Extension – Olkaria II Transmission Line

The 220-kV double circuit transmission line will be strung from the diameter 1 gantries in Olkaria II Extension substation switchyard across the road to the terminal transmission tower. The line will then be routed along the road in the direction of Olkaria II Substation for a distance of approximately 300 m. From the terminal tower across the road, the circuits will be strung and connected on Olkaria II substation gantries on diameter 4 and then terminated to the respective bay terminal equipment within diameter 4. Prior to termination of this line, 220 kV Suswa Circuits 1 and 2 will be relocated to two bays in diameter 3 to free one bay in diameter 4 for connection of Olkaria II Extension circuit 2. The selected route allows connection of the transmission line from Olkaria II Extension substation to Olkaria II substation without crossing other Transmission lines and without use of the 220 kV underground cables, thereby easing operation and maintenance activities.

2.5.7.3 Switchyard Extension and Modification

The Transmission Line for evacuation of generation from Olkaria II Extension Power Plant will be connected to the power grid at Olkaria II Substation and terminated onto Diameter 4 at Olkaria II Substation. To achieve this, the following Extension and Modification works are required to be carried out at Olkaria II Substation:

i. Olkaria III Line currently terminating at Olkaria II substation will be re-routed before it crosses the main road and finally terminated at Olkaria II Extension substation. This will provide adequate space for construction of the power plant, cooling towers and the substation.
ii. New Line primary terminal equipment, including Line Disconnector plus Earth Switch, Capacitor Voltage Transformers and Surge Arresters will be installed on Diameter 4 below the gantry on the side of 220 kV Busbars and facing the main road to allow the use of S440 – S430 bay from the direction of the main road.
iii. The spare bay in diameter 3 will be completed by construction of the foundations and installation of Circuit Breaker S310 and associated Disconnectors and Current Transformers as well as installation of primary line terminal equipment for S310-S320 bay comprising Line Disconnector plus Earth Switch, Capacitor Voltage Transformers and Surge Arresters.
iv. New Main 1 & Main 2 Protection and control panels for the New Transmission Line Bay S320-S310 will be installed in the control building. The space currently occupied by the old Olkaria III protection panels will be used. Protection and control Relay for the new circuit breaker S310 will also be mounted in the control building.
v. Existing Hydrogen Sulphide (H_2S) protection schemes will be extended to the control boxes of the new primary and to the new Marshalling Boxes in the switchyard and to the new protection and control panels in the control building. The H_2S protection plant will be refurbished and upgraded to ensure the protection of all equipment in the switchyard and in the control building.
vi. Design of the existing 220 kV Busbar protection schemes for Olkaria II that has not been commissioned will be reviewed and the scheme shall be fully implemented and commissioned to ensure fast and selective protection scheme for the two busbars. This can be achieved by arranging an outage for one bus bar at a time.
vii. To Replace Old Protection Panels for 220 kV Olkaria III line and install two new Protection Main 1 and Main 2 panels for New S310-S320 Line Bay. The requirements for Transmission Line protection.
viii. Finally, 220 kV Suswa circuit 1 will be transferred to S320-S310 Bay and 220 kV Suswa circuit 2 will be transferred to S330-S340 Bay all in diameter 3. This can be achieved with a day's shutdown to transfer one circuit.

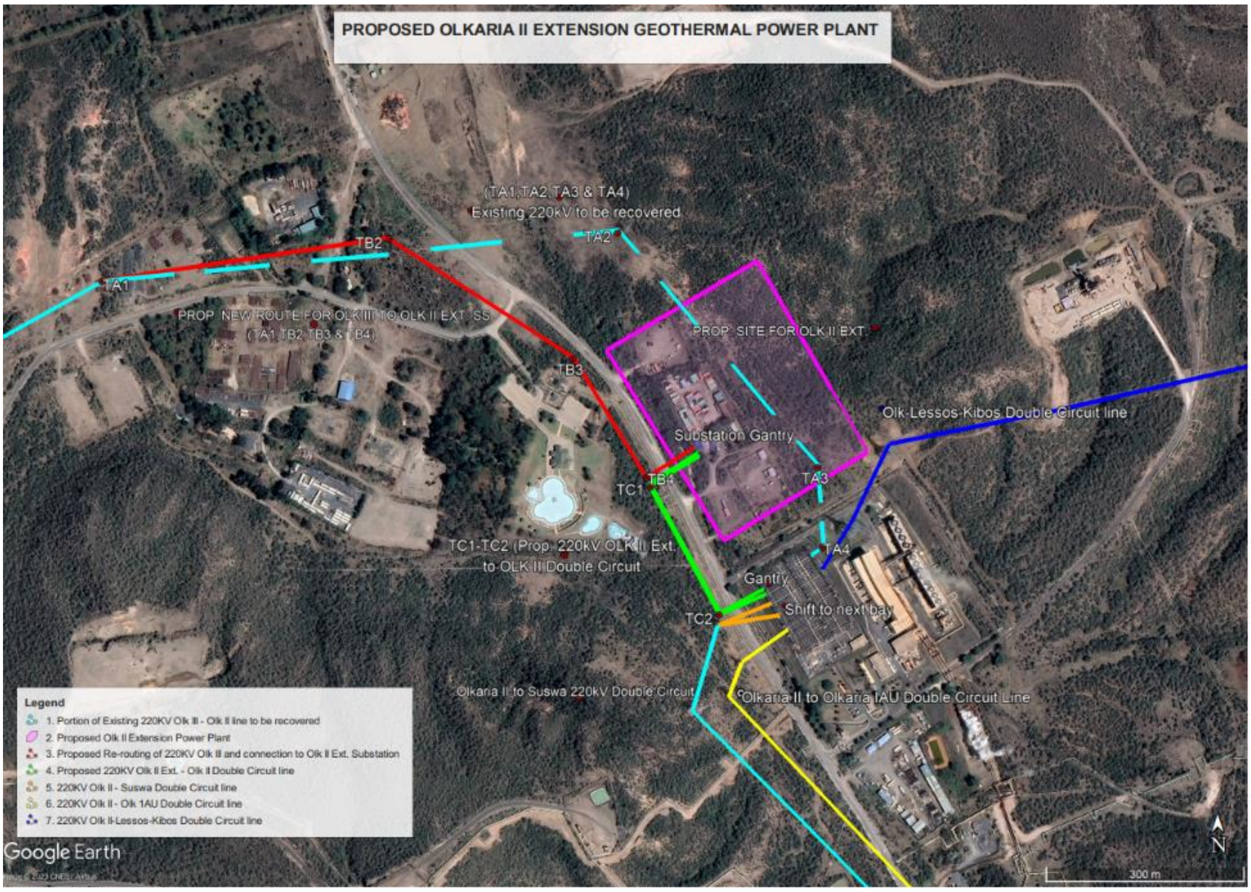


Figure 2-17: Proposed Olkaria II Extension power evacuation layout

The arrangement of the power station and the substation is similar to that of Olkaria II, where the power plant and cooling towers are located above the substation. The switchyard for Olkaria II Extension Substation is in a breaker and a third configuration which is the configuration used in other 220 kV substations around Olkaria and other transmission substations on the Kenyan power grid

This configuration provides good security for the power plant and for the power grid, while allowing for easy extension of the switchyard in future. This arrangement of power plant and substation is convenient for termination of 220 kV Olkaria II Extension – Olkaria II double circuit transmission line in both substations. Re-routing and termination of 220 kV Olkaria III line from Olkaria II substation to Olkaria II Extension substation will be easily achieved. This arrangement and relocation of 220 kV Suswa 1 and 2 Circuits at Olkaria II Substation to Diameter 3 allow routing and termination of the transmission lines without transmission line crossing or the need to use 220 kV underground cables, thereby easing operation and maintenance of the facilities. Further, use of the already existing transmission lines will ensure that the proposed project will not lead to displacement of community settlements.

2.5.8 Drainage System

The powerhouse, cooling towers, auxiliary buildings and switchyard areas shall be protected against possible flash floods due to exceptional meteorological events by constructing an effective drainage system. Flash floods are also experienced in arid and semi-arid areas similar to the Olkaria region, which is perennially impacted by flash floods, according to the Kenya Meteorological Department (refer to publication "Extreme Weather Events in Kenya between 2011 and 2020). In April 2012 a rainfall of 274.3 mm was recorded against a monthly average of 120.2 mm, which was 228% of the rainfall normally received.

Considering that soils in Olkaria site are sensitive to erosion, it is mandatory to design an efficient drainage system of the plant area so as to ensure a suitable discharge of rainwater and prevent any erosion phenomena. A preliminary design was developed at the feasibility study level to define the main drainage works of the power plant.

Rainwater flowing from the hill on the north-eastern side shall be collected by an external drainage system, conveyed into the plant perimetral drainage channels and finally discharged into a channel on the north-western side of the plant yard. The internal drainage system, comprising drain ditches and trenches catching the rainwater inside the plant yard, will also convey the discharges into the perimetral channel. The catchment areas surrounding the proposed site have been defined from the topographic map below.

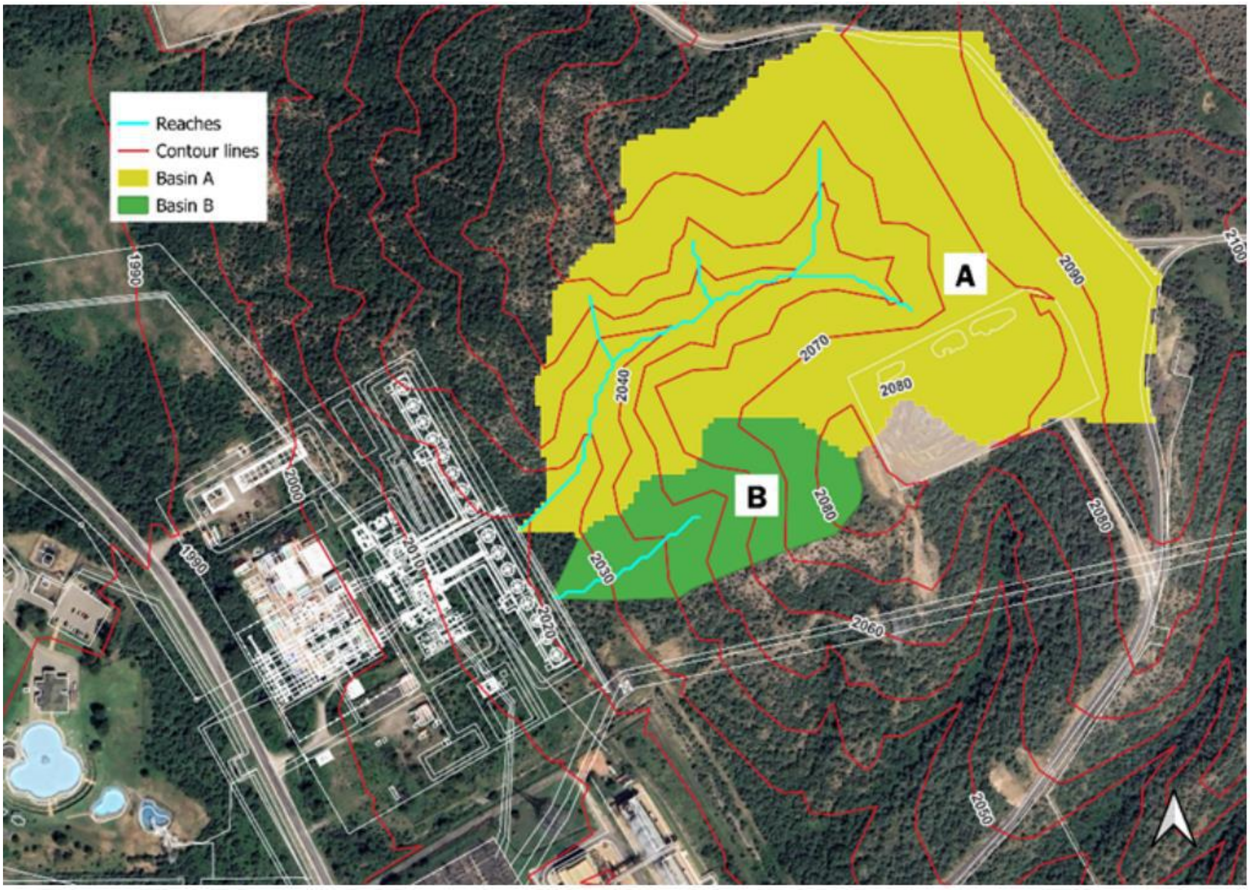


Figure 2-18: Catchment basins at Olkaria II Extension site

It is preliminarily assumed that the power plant yard will be at elevation 2,000 m.a.s.l. while the cooling towers level will be 5 m higher. The rainfall data used for the design were taken from the Intensity Duration Frequency Curve (IDF). The drainage system was designed for exceptional events, i.e. considering a peak discharge with a design return period of 100 years and a time of concentration (t_c) of 10 minutes.

The calculation of the drainage system has been developed by using the software Opflow (Politecnico of Milan) assuming steady flow condition. Different types of ditches are used for collecting and discharging rainfall water, according to the expected flow to be evacuated. The scheme of drains for sub-basins is shown in the figure below.

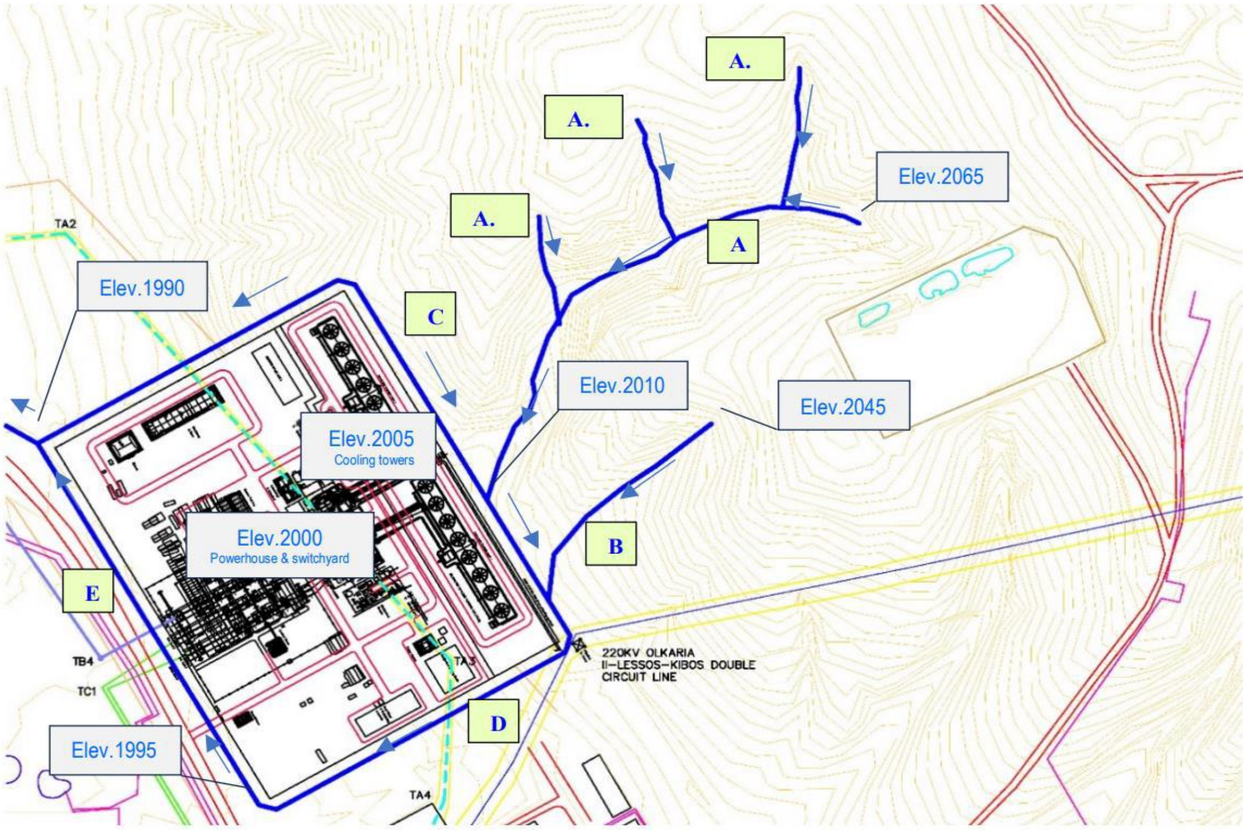


Figure 2-19: Scheme of drains for Olkaria II Extension power plant

The drainage channels will be concrete-lined and will be of trapezoidal type cross-sections. The drainages inside the power plant yard will be conveyed into the E channel located in the southern-western side. The total runoff of the drainage system is estimated at 1.9 m^3/s considering a runoff coefficient of 0.8. The drainage channels A, B, and D will be stepped to dissipate energy and reduce velocity as shown in the figure below. The slope for the stepped channels is assumed as 0.3%.

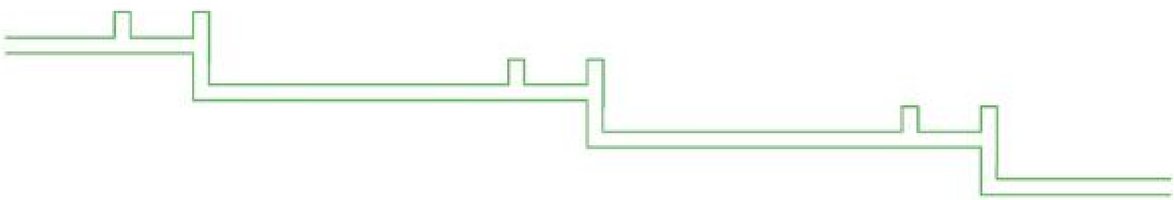


Figure 2-20: Longitudinal section of the stepped drainage channel

The maximum computed velocity in the drainage channels will be 5.84 m/s, which is an acceptable value. These is a significant issue with siltation at the proposed site. The drainage facilities that will be designed during the construction stage will aim at mitigating siltation. Regular maintenance shall also be planned to prevent siltation in drainage works.

2.5.9 Water Supply

Over the life cycle of a geothermal power plant, from construction to operation, considerable amount of water is consumed during Plant operations. Water consumption refers to the water that is withdrawn from a resource such as river, lake or non-geothermal aquifer that is not returned to that resource.

The main source of water near Olkaria geothermal field is Lake Naivasha, approximately 6 km far from the proposed plant location. Currently there is a raw water supply system which provides the geothermal plants in Olkaria field with the service water. The system comprises a pumping station at lake Naivasha at elevation 1,900 m.a.s.l., a main pipeline with tee offs to 3 tank locations (300, 700 and 900 series tanks) and the pipelines conveying water from tanks to the plants.

The 2 tanks of 700 series at elevation 2,185 m.a.s.l, each having a storage capacity of 4,200 m3 , supply water to the existing Olkaria II plant. The water is transferred from the 700 series tanks to a fire tank of 1,600 m3 capacity, by a 4" diameter pipe and then to the powerhouse by 2 pipes of 8" diameter. A 6" bypass ensures also a direct connection from the 10" diameter tee off pipe to one of the 8" diameter pipes. It is deemed that the same source of water used for feeding the existing Olkaria II power plant can also be used for the service water of the Olkaria II Extension Power Plant, by enhancing the existing water supply system and installing the necessary new piping lines. A schematic drawing of the water supply system of the existing Olkaria II power plant, including the proposed system for Olkaria II Extension power plant is shown in the figure below.

An 8" line is extended from 700 tanks, following the existing pipeline route until Olkaria II and diverging to Olkaria II Extension's cooling tower basin and to the tanks for fire-fighting water and raw (sanitary) water. The line sizing aims at achieving the filling of a single cooling tower basin in 48 hours.

The raw water is needed for the following uses:

i. Refilling of the cooling water basin;
ii. Fire-fighting system; and
iii. Sanitary system

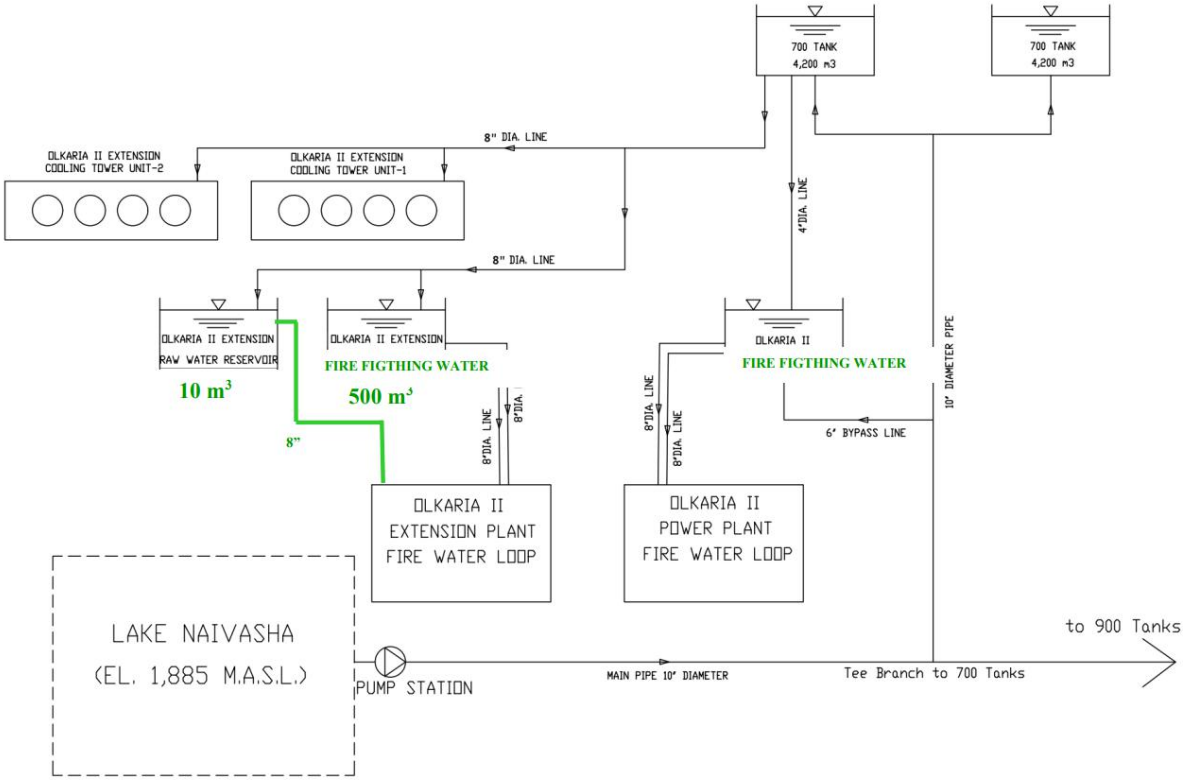


Figure 2-21: Schematic of the water supply system for the existing Olkaria II GPP and Olkaria II Extension GPP

The refilling of the closed circuit of the cooling water basin is an emergency procedure to restore the functional operation of the plant. The amount of water for the basin of Olkaria II extension plant is 3,600 m^3.

The fire-fighting system is designed considering the worst scenario, which is usually due to fire accident of the step-up transformers. The amount of water required by the system was computed according to the guidelines of the National Fire Protection Association (NFPA) standard. It is preliminarily estimated that 400 m^3 of water is needed for the fire-fighting system of the 85 MVA transformers.

The amount of water for sanitary systems was estimated as 4 m^3/day considering the requirement for 40 people working in the plant, assuming 100 litres/day as per capita water requirement.

Hence steel tanks of 500 m^3 and an independent smaller one of 10 m^3 shall be constructed for storage of fire-fighting and raw (sanitary) water. To reduce water demand, the proponent reuses brine for drilling and the power plant will be designed to have a closed loop system for the cooling tower and the condenser units.

2.5.10 Workforce

The construction workforce at its peak will number about 200 persons. Some of the workers will be settled at the site and others in the vicinity of the project site. Besides accommodation and catering, they will require other amenities such as health facilities, recreation and potable water.

The proponent may use pre-fabricated container-like housing units for accommodation, offices and other amenities. These shall be connected to diesel driven generator sets for stop gap electricity production, potable water supply and a centralized wastewater management system. Fire Safety will be a priority and the camp site will be assessed for fire safety by the relevant authorities and adequate measure taken to ensure it complies with applicable standards before people are allowed to move in. Setting up of the camp site may lead to environmental impacts such as: vegetation clearance; noise pollution; and gaseous emissions, from the diesel generators for electricity supply and waste generation.

The expected operational workforce could number between 10-30 persons who will live locally in Naivasha.

2.5.11 Energy Systems

Construction activities at the proposed geothermal power plant site will use temporary power sourced from the local substation. Any construction activities in remote locations will be powered using diesel generators.

2.6 Wells allocated to the proposed project

The proposed Olkaria II Extension GPP will utilize twenty (20) production wells, five (5) brine reinjection wells and two (2) condensate reinjection wells. An Environmental and Social Impact Assessment (ESIA) was previously undertaken by KenGen, for the "drilling of eighty (80) geothermal steam production wells for expansion of electricity power production" and an EIA License of the same was issued by NEMA (see ***Annex 8***).

The existing wells allocated to this project were covered in the EIA License of the 80 wells. However, it is recommended that a separate ESIA should be carried out for the make-up wells that will need to be drilled at different stages of the project in the future, during the powerplant's 25-year or 30-year exploitation period, as identified in sections 2.6.2.2 and 2.6.3 of this report.

2.6.1 Production Wells

The list of production wells allocated to this project, with their coordinates is given in the table below. Well OW-740 has not yet been drilled completely but will be completed, together with drilling of new well OW-740C as part of a separate project and not part of the proposed project, whereas well OW-741B cannot sustain any flow. Based on this, only **eighteen (18) production wells** are currently available for the proposed project.

Table 2-7: List of production wells allocated to Olkaria II Extension project

S/N	Well	Steam output (t/h @11 bar)	Northing (m)	Easting (m)
1.	OW-724A	94.0	9904499.079	200902.212
2.	OW-724V	36.2	9904470.53	200886.68
3.	OW-730A	74.5	9904555.061	200313.485
4.	OW-730B	83.8	9904576.874	200344.068
5.	OW- 732	95.4	9905109.082	201030.337
6.	OW-732A	70.0	9905089.61	200999.04
7.	OW- 733	25.6	9905116.14	200151.44

S/N	Well	Steam output (t/h @11 bar)	Northing (m)	Easting (m)
8.	OW-733A	73.8	99051025.97	200121.15
9.	OW-733B	22.8	9905105.83	200188.46
10.	OW- 735	93.2	9905820.961	200046.471
11.	OW-735A	65.5	9905840.613	200020.68
12.	OW-735B	87.6	9905861.45	199996.88
13.	OW- 736	50.0	9905798.918	200726.94
14.	OW-736A	58.2	9905834.212	200733.69
15.	OW-736B	19.8	9905866.902	200732.999
16.	OW-736D	65.2	9905717.784	200779.196
17.	OW- 740	-	9904031.65	201391.40
18.	OW-740A	56.8	9904367.224	201303.542
19.	OW-740B	22.8	9903983.74	201376.45
20.	OW-741B	-	9904838.34	199730.43
Total		**1,095.2**		
Average		**60.8**		

2.6.2 Reinjection Wells

The proponent expressed a clear preference for greater resource conservation for future geothermal projects in the field, despite the incremental tariff impact (~1 US¢/kWh) due to the costs associated with the construction and operation of the reinjection system (K&M, 2018). The reinjection of separated brine and recovered steam condensate was then considered as an option also for the Olkaria II Extension project.

Production data review suggests that for a net power of 140 *MWe*, the separated brine could be in the order of 590t/h, while the steam could be in the order of 890 t/h. Assuming the evaluated condensate recovery of 23%, the condensate rate to be reinjected would amount to about 205t/h. The fraction of fluid to be reinjected would then amount to about 53.6% of the total fluid produced. Thus, even with full reinjection of separated brine and condensate, the liquid water reinjected back into the reservoir would be less than 54% of that discharged. This would occur with most of the production wells already discharging at high enthalpy with boiling in the reservoir. Thus, it is believed that fluid reinjection is an important factor in sustaining the reservoir P and the long-term availability of fluid to withdraw the heat from the crossed high temperature formations over the power plant life.

Table 2-8: Summary of reinjection wells available and planned for Olkaria II Extension

Well	Injection capacity (t/h)	Planned Use
OW-203	350	Condensate
OW-20#	290	Condensate

OW-703	250	Hot brine
OW-724 B	310	Hot brine
OW-739	330	Hot brine
OW-739A	460	Hot brine
OW-739R1	490	Hot brine

2.6.2.1 Brine Reinjection Wells

The three (3) wells at pad 739 have been considered for continuous brine reinjection. Well OW-724B was not considered in the FCRS design but it could be considered as a further option to sustain the reservoir exploitation in the SE boundary of NE well field. Well OW-703 already used for discontinuous hot reinjection could be considered as a reinjection well for the new FCRS.

Table 2-9: List of brine reinjection wells allocated to Olkaria II Extension project

Well	Northing (m)	Easting (m)	Elevation (masl)	Well Type
OW-703	9905176.00	199810.00	2088.65	Vertical
OW-724B	9904439.80	200870.90	2182.30	Directional
OW-739	9905526.23	199023.99	2001.73	Vertical
OW-739A	9905513.61	198989.36	1999.73	Directional
OW-739R1	9905496.31	198952.88	1996.82	Vertical

2.6.2.2 Condensate Reinjection Wells

The table below lists the dedicated primary and back-up condensate reinjection wells. All plant condensates are to be pumped to dedicated condensate reinjection wells located at higher elevations than the power station and at a considerable distance from it.

Table 2-10: Nominated condensate reinjection well for Olkaria II Extension project

Fluid Source	Flow (Max) (t/h)	Reinjection well	Injection capacity (t/h)	Remarks
Plant condensate from Power Station	958	OW-203	354	**2 back-up wells are to be drilled** near OW-203/OW-204, as part of a separate project, not the proposed project.
		OW-204	594	
		2 back up wells TBA	>594	

The proponent confirmed the use of OW-203 while that of OW-204 was not confirmed for reinjection of Olkaria II Extension condensate. OW-203 with a stated capacity of 354 t/h is in principle able to dispose of the entire condensate rate estimated at some 205 t/h, but as no data about well OW-203 was available, no checks of actual well injection capabilities could be made. The proponent confirmed that one additional well was to be considered for the condensate reinjection, located to the WSW of the power plant close to well OW-203. This is highly suggested to ensure that back-up capability to reinject the condensate is available during plant operation.

2.6.3 Make-up Wells

No specific data about make-up wells was delivered for this study, therefore reference was made to the Feasibility Study undertaken by K&M (2018), who concluded that future draw-down from the project was expected to be like the draw-down experienced in Olkaria I and Olkaria II. In addition, if the project would have employed full re-injection, the draw-down was expected to have a lower negative impact on the affected resource. At the time of the study, additional make-up wells required for both the new and existing power plants were not explicitly quantified. The predicted decline for various field sectors as given by Mannvit et al. (2017) were reported by K&M (2018) as follows:

i. Olkaria I: 0.5% / year;
ii. Olkaria I AU 4, 5 and 6: 1.5% / year;
iii. Olkaria II: 1.5% / year;
iv. Olkaria IV and V: 1.5% / year;
v. Olkaria VI: 2.5% / year (because of the great uncertainty involved).

The purpose of make-up wells is to maintain a stable steam supply to the power plant in response to the natural production decline rate during long term reservoir exploitation. The present available power potential is preliminarily estimated at 152.8 MW or 109% of the power plant capacity, which corresponds for 18 wells to an average well potential of 8.49 MW. According to KenGen planning, additional wells OW-740 and OW-740C will be drilled and tested in time for the power plant start-up. For these wells, a lower average potential of 6.5 MW is estimated, considering the results of previous wells drilled on the same pad.

It is therefore considered that 17 wells, out of the 20 initially available, will be feeding the power plant at start-up. The 18th, 19th and 20th wells will start producing once the net power potential falls below 98% of target potential of 140 MW. For the evaluation number of make-up wells using the decline curve approach, an average well potential of make-up wells of 8.49 MW was considered. This initial average well potential is reduced for the decline occurred at the time of well activation.

A new make-up well will be activated once the total net power potential falls below 98% of target potential of 140 MW. The plant load factor is conservatively assumed as 100%.

For the base case scenario, after 30 years of exploitation, the number of active production wells will be 26, allowing for some power decline below the target power in the last one year and half. 6 make-up wells are to be connected from year 8.0 to year 24.8, which is about 1 well every 2.8 years. For a 25-year exploitation period, the number of production wells would be 25, as shown in Table 2-11 below.

Table 2-11: Number of wells to be available at plant start up and during plant operation for the base case scenario

Production time (y)	Start-up production wells	Start-up brine reinjection wells	Start-up condensate reinjection wells	Make-up wells	Non-commercial make-up wells	Total number of wells
25	20 (17 Active)	5	2	5	2	34
30	20 (17 Active)	5	2	6	3	36

2.7 Expected Project Waste and By-products

This section presents major expected wastes and by-products from the proposed project.

2.7.1 Liquid waste

In high-temperature liquid-dominated geothermal fields such as Olkaria, the volume of wastewater can be large. The waste fluid is disposed of by primarily reinjecting into the resource underground. Surface disposal causes more environmental problems than reinjection.

Environmental problems are not only caused by the volumes involved, but also by the relatively high temperatures and toxicity of the waste fluid. The chemistry of the fluid discharge is largely dependent on the geochemistry of the reservoir and the operating conditions used for power generation. Most high-temperature geothermal bore waters include high concentrations of the following toxic chemicals.

- Boron
- Silica
- Sodium
- Potassium
- Magnesium
- Calcium
- Fluoride
- Chloride
- Sulphate
- Carbon dioxide
- Hydrogen sulphide

Lubricants and possible spills from petroleum products during drilling (if required) can add to chemical pollution.

Most of the chemicals are present as solutes and remain in solution from the point of discharge but may settle at the bottom of sediments in evaporation ponds where they may accumulate to high concentrations. Chemicals which remain in solution may be taken up by aquatic vegetation and other organisms and may move further up the food chain into birds and animals residing near the project area if not properly disposed of. Any release of wastewater into cooling ponds or waterways may result in shallow groundwater supplies becoming contaminated and unfit for human use.

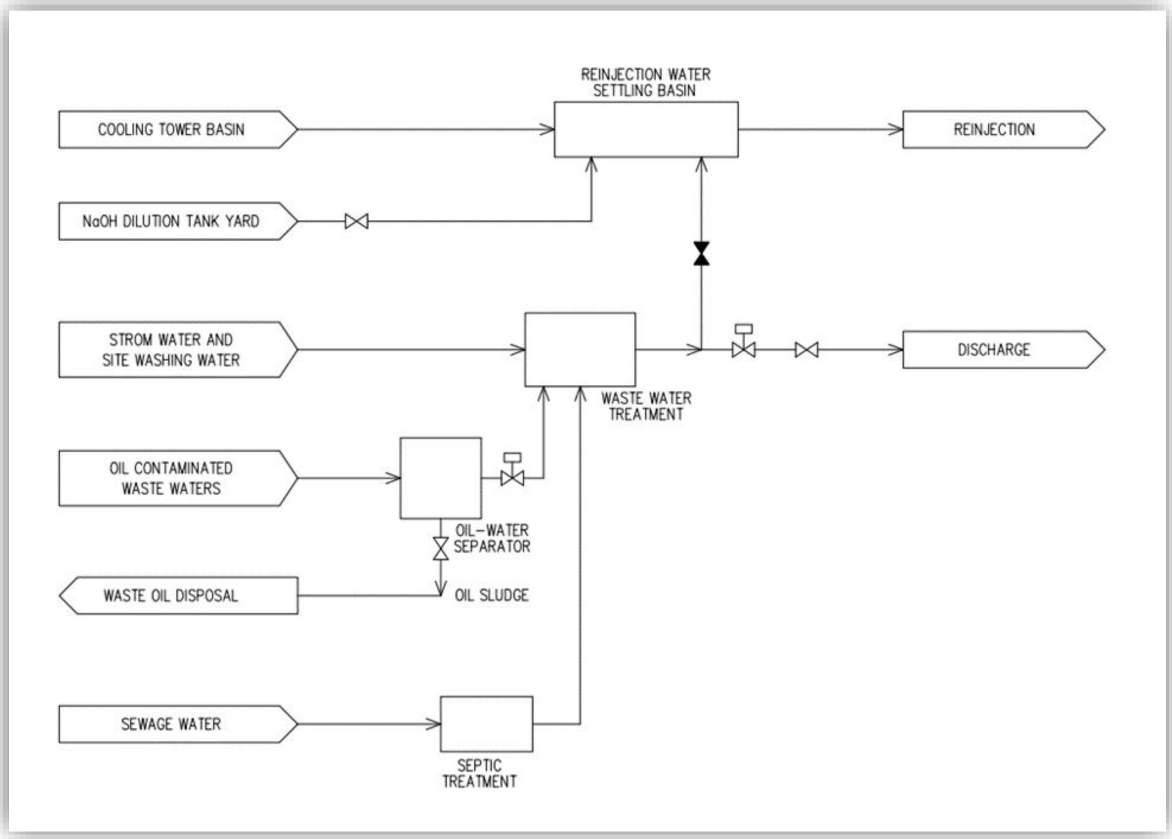


Figure 2-22: Wastewater management schematic flow diagram

2.7.2 Gaseous Wastes

Gas discharges from high-temperature geothermal fields such as the Olkaria II Extension site may result in the release of Non-Condensable Gases (NCG) and fine solid particles into the atmosphere. In vapor-dominated fields in which all waste fluids are reinjected, non-condensable gases in steam will be the most important discharges from an environmental perspective.

The emissions are mainly from the gas exhausters of the power station, often discharged through a cooling tower. Gas and particulates discharged during drilling (if required), cleanouts and testing, and from line valves and waste bore water degassing, are usually insignificant. Gas concentrations and compositions cover a wide range, but the predominant gases are carbon dioxide (CO_2) and hydrogen sulphide (H_2S). Carbon dioxide (CO_2) gas is most prevalent in fields in which the reservoir contains sedimentary rocks, particularly those with limestones.

2.7.3 Solid Waste

Geothermal development produces significant amounts of solid waste, including Scrap Metal, Plastics, and chemical components like sulphur, silica, drilling muds and sludge, which contain heavy metals that are classified as hazardous and must be disposed of safely. Sulphur, silica, and carbonate precipitates are typically collected from cooling towers, air scrubber systems, turbines, and steam separators. This sludge may be classified as hazardous depending on the concentration and potential for leaching of silica compounds, chlorides, arsenic, mercury, vanadium, nickel, and other heavy metals. Other solid waste includes by-products of drilling such as drilling muds and other chemicals, cement and construction debris. While these wastes are not considered hazardous, presence of asbestos in insulation material may constitute hazardous wastes.

2.8 Estimated Project Cost

The proposed project is estimated to cost United States Dollars Four Hundred and thirty-seven million, fifty seven thousand, eight hundred and forty ($ 437,057,840). While considering an average exchange rate of 1$ = Kshs. 130 (CBK Exchange rates August 2024), this estimated project cost translates to **Kenya Shillings Fifty-six billion, eight hundred and seventeen million, five hundred and nineteen thousand, two hundred (Kshs. 56,817,519,200)**.

This project falls under the ‘Power and Infrastructure’ class of “High Risk Projects” category, according to Legal Notice No. 31 of 2019, on amendment of the second schedule of EMCA, 1999. Due to the classification of this project in the above-mentioned category, section 48 of the Environmental (Impact Assessment and Audit) Regulations, 2003, read with Gazette Notice No. 13211 of 2013, provides that projects under this category are subject to an EIA license fee of 0.1% of the total project cost, with a minimum of Kshs. 10,000. However, the National Environment Management Authority (NEMA) has set a maximum EIA License fees cap of Five Million Kenya shillings, for all high-risk projects, that have estimated project costs of more than Kenya Shillings Five Billion (Kshs. 5,000,000,000).

Considering that the proposed project’s estimated cost is above the Kenya Shillings Five Billion threshold, its EIA license fees will be capped. Therefore, the EIA license fee payable to NEMA for the proposed 140 MW Olkaria II Extension Geothermal Power Plant will be **Kenya Shillings Five Million (Kshs. 5,000,000)**.

3 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT METHODOLOGY

This section describes the approach the ESIA Expert applied to execute specified tasks in accordance with the TOR. The ESIA Expert employed the most effective and efficient methodology to undertake this assignment based on the scope, the specified tasks and the objectives. The methodology aimed at promoting public participation in the process and observed timeliness to ensure completion within the set study period. The ESIA methodology also aimed at addressing the World Bank Environmental and Social Standards (ESS), JICA's Environmental and Social Considerations and KfW Development Bank Sustainable development guidelines applicable to the proposed project. The ESIA was carried out in accordance with EMCA Cap 387 and the Environmental (Impact Assessment and Audit) Regulations, 2003 and their respective sub-regulations and recent amendments.

3.1 Analysis of Project Alternatives

A comprehensive comparison of project alternatives was undertaken. This comparison assessed different alternatives based on:

i. Their effectiveness in achieving the project objectives as well as potential trade-offs;
ii. Their potential environmental and social impacts;
iii. The feasibility of mitigating these impacts;
iv. Operational requirements and their suitability under local conditions;
v. Their institutional, training, and monitoring requirements;
vi. Their estimated cost-effectiveness; and
vii. Their conformity to existing policies, plans, laws and regulations

Some of the alternatives considered were based on the following aspects:

i. Location;
ii. Energy demand;
iii. Sources of electricity generation;
iv. Technologies and processes for Geothermal Power Plants;
v. Transmission route;
vi. Non-Action Alternative.

After the analysis, the ESIA Expert recommended the preferred alternatives to the Proponent.

3.2 Environmental and Socioeconomic conditions of the Project Area

Baseline information is provided in Chapter 4 of this report. The collection of baseline data was designed to satisfy information requirements and focused on relevant aspects that are likely to be affected by the proposed project.

Baseline information compiled included:

i. Physical environment:
- Climate (Rainfall, Temperature, Humidity);
- Geology and Topography;
- Water Resources (River and Lake).

ii. Biological features:

- Ecologically Sensitive Areas;
- Flora and Fauna.

iii. **Socio- economic characteristics:**

- Population dynamics (Households; Age distribution; Ethnicity to identify indigenous, vulnerable and marginalized groups; Community governance structures) etc.;
- Livelihood;
- Employment;
- Land use practices.

3.3 Baseline Methodology

The methodology for collection of Baseline information included;

a) **Environmental Characteristics:** The following approaches were applied to obtain physical environmental data:
   - Field Observations;
   - Literature review on meteorology data, energy sector documents, and other relevant documentation;
   - Ecological and Biodiversity studies;
   - Sampling (Water quality, soil sampling, air dispersion and noise modelling).

b) **Socio-Economic Data:** The following approaches were applied to obtain Socio-economic data:
   - Literature review;
   - Field Survey;
   - Public participation and consultation meetings;
   - One-on-one Interviews;
   - Key stakeholders consultative meeting.

3.4 Literature Review (Desktop Studies)

The purpose of literature review was to gather existing information from secondary sources for the purpose of the study. Such information included relevant data for baseline information, legal requirements and past environmental monitoring reports.

The following sources of secondary data were reviewed:

- Relevant policies and legal instruments;
- Nakuru County Integrated Development Plan, 2018-2022;
- Nakuru county socio-economic reports;
- Olkaria Geothermal PPP Project Feasibility Study Report, 2018;
- Kenya Population and Housing Census Report, 2019;
- Past ESIA and Environmental Audit Reports.

3.5 Site Characteristics Analysis

The ESIA Consultant carried out site visits throughout the study period. Several field visits to the site and the area of influence were undertaken as necessary and for different purposes as discussed below. The following tools were utilized during the site visits:

i. Screening Checklist (***Annex 1***)
ii. Scoping Checklist (***Annex 2***)

Plate 3-1: The ESIA Team at the proposed project site

3.5.1 Air Quality Assessment

Assessment of air quality was done using the following approaches:

3.5.1.1 Field Surveys

Air Quality Samples were collected using the AQM-09 air quality monitoring system for Henan Oceanus. The AQM-09 air quality monitoring system is equipped with high-quality sensors to detect pollutant gases (CO, SO_2, NO_2, H_2S, etc.) Particulate matter ($PM_{2.5}$ and PM_{10}).

Carbon monoxide (CO), Nitrogen dioxide (NO_2) and Sulphur dioxide (SO_2) concentrations were measured using the AQM-09 air quality monitoring system fitted with gas specific electrochemical sensors. The concentration of gases was continuously measured with averaged concentrations logged at one-minute intervals. The resolution for the instrument is 0.1 ppm (Parts per Million) for CO, 1 ppb (Parts per billion) for NO_2 and SO_2.

Sampling of Total Volatile Organic Compound Concentrations was measured using the AQM -09-air quality monitoring system fitted with Photoionization detectors (PID). The sample gas was exposed to an ultraviolet light from a lamp, which ionizes the sample to be detected by the instrument and reported as a concentration. The concentration of gases was continuously measured with averaged concentrations logged at one-minute intervals.

3.5.1.2 Model-Based Survey

AERMOD software for atmospheric dispersion modelling was used to predict the H_2S concentrations in the vicinity of the proposed Olkaria II Extension Geothermal Power Plant. AERMOD is a comprehensive multi-level air dispersion modelling system that simulates essential atmospheric physical processes and provides refined concentration estimates over a wide range of meteorological conditions and modelling scenarios (US EPA, 2004). The model assumes the pollutant concentration distribution to be Gaussian in both vertical and horizontal directions. In this distribution, the pollutant concentration profile assumes that maximum concentrations are encountered in the centre of the plume, with concentrations decreasing towards the edge following the shape of a bell curve. AERMOD comprises two pre-processors AERMET and AERMAP.

The AERMET pre-processor combines meteorological data (e.g., wind speed and direction, temperature and cloud cover) with surface characteristics (e.g., albedo, surface roughness and Bowen ratio). Terrain influences are accounted for in the AERMAP pre-processor. Other variables, such as emission source parameters (stack height and diameter, exit temperatures and velocities, and pollutants emission rates) and the receptors that define the modelling domain were obtained as inputs by the model. Ground concentrations of pollutants (PC) were calculated for each specified averaging period over the full modelling period at each receptor in the modelling domain. Maximum modelled ground level concentrations (GLCs) were then graphically mapped as contours across the grid or as discrete points at each sensitive receptor, and they represent the 'worst-case' meteorological conditions for atmospheric emissions.

The AERMOD dispersion model was used in the estimation of upwind and downwind ground level concentrations of Sulphur Dioxide, Carbon Dioxide, Oxides of Nitrogen (NOx), and Respirable Particulate Matters; the main pollutants of concern for the industry category. The AERMOD modelling methodology is shown schematically in the Figure below.

The latest version of the software was used comprising three parts: AERMOD Meteorological Pre-processor (AERMET version 10.2.0), AERMOD Terrain Pre-processor (AERMAP version 10.2.0) and AERMOD (version 10.2.0**)**. The AERMET processes the hourly surface data and upper air data to output SFC and PFL files that are used in AERMOD. The AERMAP was used to process the terrain data in conjunction with a layout of receptors and sources for AERMOD control files. In this work, the commercial interface ISC-AERMOD View (Version 10.2.0) (Lakes Environmental Software) was used in modelling the dispersion of the pollutants. Dispersion modelling was undertaken to determine the highest hourly, highest daily and annual average ground level concentrations.

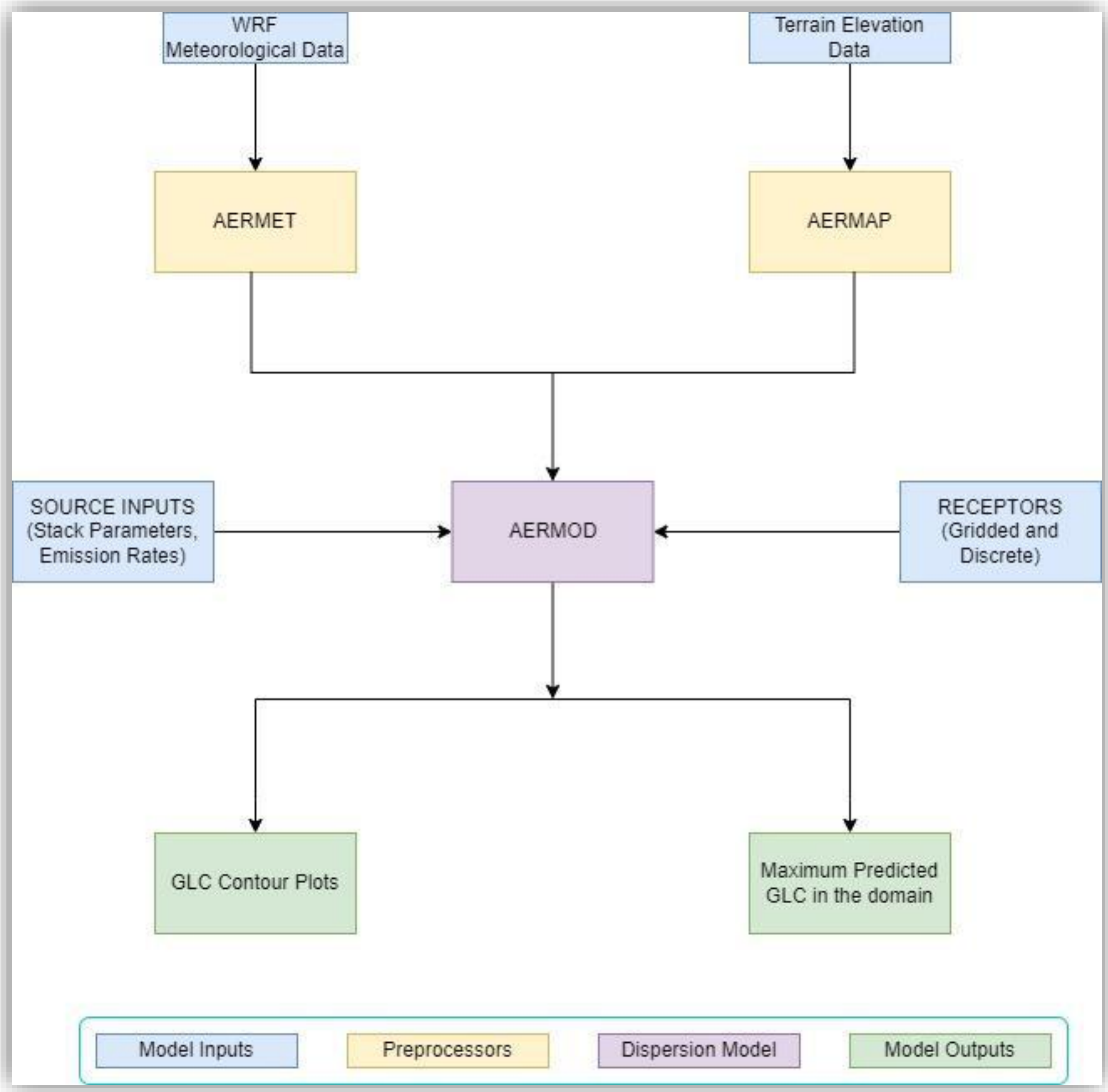


Figure 3-1: Modelling methodology schematic diagram

Maximum modelled ground level concentrations (GLCs) were graphically as contours across the grid at each receptor in the modelling domain. The averaging periods were selected to facilitate comparisons of the simulated ground level concentrations to the ambient air quality criteria set out in the Kenyan Environmental Management and Coordination (Air Quality) Regulations, 2014.

3.5.2 Ambient Noise Assessment

Assessment of Noise pollution was based on the following methodologies:

3.5.2.1 Baseline Noise Conditions

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 the power plants (Olkaria I AU unit 6, Olkaria I unit 4& 5, Olkaria I unit 1,2,3, Olkaria II, Olkaria IV and Olkaria V) for the period 2018 – October 2023 was used to assess the background noise levels for the environment and human health purposes.

3.5.2.2 Noise Mapping Approach

To determine an estimate of a sound pressure level at a distance the inverse square law can be used. In terms of the propagation and attenuation of sound, the inverse square law is a principle in physics whereby a point source emits a sound wave uniformly in all directions (essentially spherically), where the intensity of the sound wave energy at any given point away from the source is diminished as a function of the total surface area of the sphere coincident with that point.

To determine the sound attenuation over a distance using the inverse square law, an idealization needs to be made in which there are no reflective surfaces or barriers between the source and the location at which the sound level is being determined.

According to the inverse square law, it can be shown that for each doubling of distance from a point source, the sound pressure level decreases by approximately 6 dB. Examples of point sources could include valves, small pumps, and motors.

3.5.3 Surface Water Survey

Surface water survey was conducted for two main purposes. One, to establish a water quality baseline within the water courses near the proposed project, and the other, to collect descriptive data on each of these water courses.

There are no rivers within the project site. However, effluent from Olkaria II was noted to flow through the existing storm water channels.

Water samples were collected on the 15th of September 2023, from the storm water flow which also carries effluent from the Olkaria II powerplant. The samples were delivered to the Water Resources Authority (WRA) lab for analysis and the results have been annexed to this report as ***Annex 17.*** The data is analysed under section 4.2.4.2 of this ESIA Report.

3.5.4 Household Socioeconomic Surveys

Socio-economic baseline data was collected using a digital household questionnaire. As a data collection tool, the digital questionnaire enabled faster and more accurate collection, collation and analysis of data. Field assistants were recruited and trained on the administration of the digital household questionnaires using phones and tablets. A sample socioeconomic Questionnaire is annexed to this report under ***Annex 12.***

3.6 Evaluation of the Policy, Legislative Regulatory and Institutional Framework

Chapter 5 of this report (Policy, Legal and Institutional Framework) represents the evaluation of the pertinent International, National and County policies, legislation, and regulations applicable to the proposed project.

The Consultant identified the pertinent policy, regulations, and standards - both local and international- governing the environmental quality, health and safety, protection of sensitive areas, protection of endangered species, land use control at the national and local levels and ecological and socioeconomic issues. The examination of the legislation included the relevant international conventions to which the Kenyan government is a signatory. The consultant assessed the relevant government agencies involved in environmental and social management issues, to ensure that the ESMP will be effectively implemented. The consultant described how the identified legislations and policies constrain or support the project designs and implementation.

The consultant also identified international guidelines including, JICA Guidelines, World Bank/IFC Environmental and Social Standards (ESS) and the KfW Development Bank: Sustainability Guidelines which are relevant to the proposed project.

3.7 Environmental and Social Impacts Analysis Methods

3.7.1 Impact Prediction and Evaluation

The definition of impacts was an objective exercise; it predicted the potential for the project and its associated activities to change the existing environmental values as a consequence of its implementation. The cornerstone of impact prediction was the project description, which defined all the elements of the project and associated activities. Often, given the timing of the need for ESIA, a detailed design of the project and project elements may not be available, if that is the case, it is necessary to provide as much definition as possible as to the parameters that will be employed in a detailed design.

As suggested in Table 3-1 below, the prediction and evaluation of impacts, was an iterative process, involving the project design team in the optimization of project design to mitigate against the potential impacts of the project. In the case of environmental impacts, this may be something such as alteration of footprints in the alignments to avoid loss of ecosystems, and in the case of social elements it could include aspects of timing, use of local resources or other aspects of interaction with the community that may enhance potential benefits or reduce potential negative effects.

The impact assessment process did not only consider planned project components under normal conditions but also included consideration of the interaction of the project with unplanned or abnormal conditions that may exist through the life cycle of the proposed project. These unplanned interactions may be project-derived, such as accidents, spills or changes necessitated by external circumstances, or they may be related to abnormal or extreme environmental conditions that could occur through the lifecycle of the project, such as extreme storms or seismic events.

3.7.2 The Definition of Impacts

Environmental and social impacts can be both positive and negative, it may even be possible through mitigation strategies to turn potentially adverse impacts into positive outcomes, hence the cyclic nature of the development of impacts and mitigation strategies, in which the potential for these improvements can be explored. The table below describes the terminologies that are used throughout the ESIA study report to define and describe impacts.

Table 3-1: Definition of impacts

Term	Definition
Impact Severity and Impact Magnitude	
Severity	The severity of an impact is a function of a range of considerations including impact magnitude, impact duration, impact extent, and legal and guideline compliance.

Magnitude	Estimates the size of the impact (e.g., the size of the area damaged or impacted the % of a resource that is lost or affected etc.), which influences the level of severity.
Impact Nature	
Negative Impact	An impact that is considered to represent an adverse change from the baseline or introduces a new undesirable factor.
Positive Impact	An impact that is considered to represent an improvement on the baseline, or introduces a new desirable factor.
Neutral Impact	An Impact that is considered to represent neither an improvement nor deterioration in baseline conditions.
Impact Duration	
Temporary	Impacts are predicted to be of short duration and intermittent/occasional in nature.
Transient	Impacts that are predicted to last only for a limited period (e.g., during construction) but will cease on completion of the activity, or as a result of mitigation/reinstatement measures and natural recovery.
Long term	Impacts that will continue over an extended period (e.g., operational noise) but cease when the Project stops operating. These will include impacts that may be intermittent or repeated rather than continuous if they occur over an extended time period.
Permanent	Impacts that occur once for development of the Project and cause a permanent change in the affected receptor or resource (e.g., the destruction of a cultural artefact or loss of a sensitive habitat) that endures substantially beyond the Project lifetime.
Impact Extent	
Local	Impacts are on a local scale (e.g., restricted to the vicinity of the plant).
Regional	Impacts are on a broader scale (effects extend well beyond the immediate vicinity of the facilities and affect the greater Nakuru and Narok Counties).
Extensive	Countrywide.

The ESIA process must define both the potential for a proposed project to have an impact environmentally or socially, but also what the net outcome of that impact will be after mitigation measures are applied. The ESIA study not only describes the direct impacts of the project itself, but also the way in which the project will interact with other influences that may derive a social or environmental impact. Thus, there are several different types of impacts that need to be considered as described in the table below.

Table 3-2: Impact types

Impact Type	Definition
Direct Impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment (e.g., between occupation of a plot of land and the habitats which are lost).

Secondary Impact	Impacts that follow on from the primary interactions between the project and its environment as a result of subsequent interactions within the environment (e.g., loss of part of a habitat affects the viability of a species population over a wider area).
Indirect Impact	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (e.g., presence of project promotes service industries in the region).
Cumulative Impact	Impacts that act together with other impacts or the impacts from non-project related activities affect the same environmental resource or receptor.
Residual Impact	Impacts that remain after mitigation measures have been designed into the intended activity.

3.7.3 Evaluation of Impacts

In evaluating the significance or importance of impacts, several factors were taken into consideration. These included an assessment of projects' components and their effect on the existing environment, as measured by its baseline and the potentially affected sensitive receptors. The impact was then assessed based on its potential severity, sensitivity, and likelihood of unplanned events. The steps involved in the evaluation of impacts and level of impact are shown in the figure below:

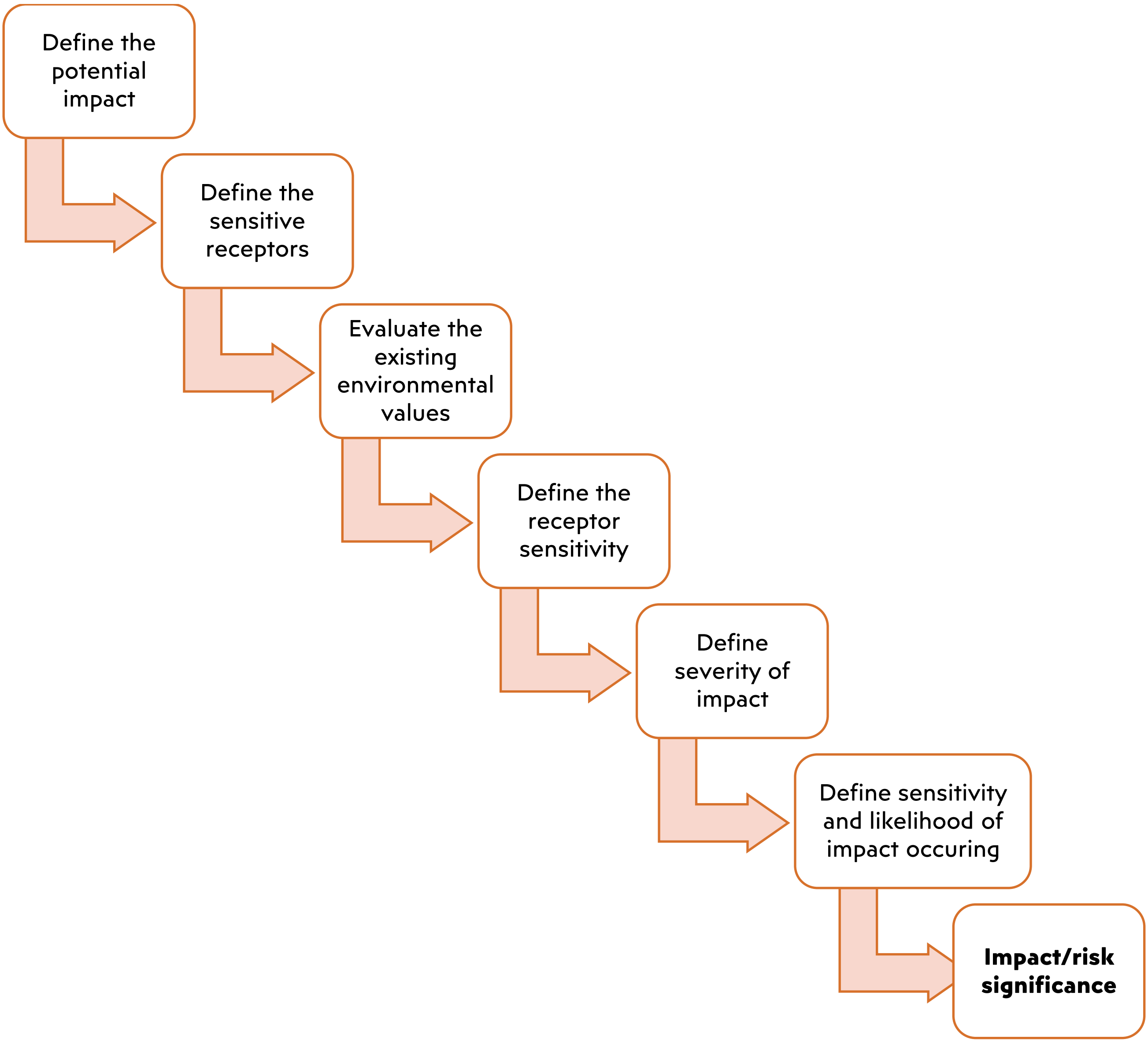


Figure 3-2: Steps involved in the evaluation of impacts and level

3.7.4 Impact Criteria

The evaluation of the impact was determined with impact severity, nature and sensitivity of the receiving environment and likelihood of occurrence.

- Impact severity: the severity of an impact is a function of a range of considerations including impact magnitude, impact duration, impact extent, and legal and guideline compliance.
- Nature and sensitivity of the receiving environment: the characteristics of the environmental or social receptor will be taken into consideration with respect to its vulnerability or sensitivity to an impact,
- Likelihood of occurrence: how likely or probable is it that this impact will occur.

a) Impact severity

The criteria described above were used to determine impact severity and are further defined as follows:

- **Impact magnitude:** the magnitude of the change that is induced, such as the percentage of resources that might be lost, the predicted change in the level of a pollutant, or a quantitative measure of losses or benefits to the community.
- **Impact duration**: time period over which the impact is expected to last.
- **Impact extent**: the geographical extent of environmental change, or the degree to which social impact may reach into the immediate, surrounding, or even general community.
- **Regulations, standards and guidelines:** the status of the impact in relation to regulations or prevailing legislation, comparison of the predicted outcome with recognized standards and guidelines relevant to the project, its location and context.

Wherever possible, the severity of an impact should be described in quantitative terms, based on numerical values, compared to regulatory limits, project standards or guidelines, or the number of people that have the potential to be impacted. However, in some instances. it is necessary to take a more qualitative approach in the definition of some outcomes, either because quantitative estimates are simply not possible, or because numerical evaluations are just not relevant (this is particularly true of some of the social elements, such as community perception).

Definitions of impact severity levels are as follows:

- **High**: a major alteration of the existing environment that is likely to be irreversible or will result in the loss of that environmental value for a period of time.
- **Medium**: an alteration to the existing environment that will modify its current status but will not stop its role in the environment or is easily reversed.
- **Low**: an alteration to the existing environment but few sensitive receptors or a change that will be transient.
- **Slight**: measurable but no effective change to the current environmental value.

b) Nature and sensitivity of the receiving environment

The criteria under which the nature and sensitivity of the receiving environment is assessed can be described as:

Table 3-3: Impact sensitivity assessment criteria

Criteria	Details
Abundance	▪ Rarity: is the impacted receptor a rare occurrence of that environmental state, or social parameter (such as an endangered species or habitat); ▪ Size or extent: necessary to define the amount of loss that may apply to the impact on a particular environmental or social element.
Adaptability	▪ Resilience: what is the ability of the particular environmental or social element to withstand the change (for instance social/health impacts may have different outcomes for a very old or very young members of the community);

	▪ Ability to recover: what is the potential to recover from the impact, how complete will recovery be and how long will it take.
State	▪ Degree of disturbance: is the state of the environmental or social element in its natural condition, or has it been disturbed by other activities in the past; ▪ Uniqueness: is the particular environmental condition a unique situation, or is it a fairly common occurrence, what is the potential to replicate the situation by way of offset or compensation. ▪ Establishment: how well-established is this particular environmental/social condition, is its future tenuous or is it likely to persist.
Value	▪ Implicit value: how important is it to retain particular environmental/social condition, in the context. ▪ Its interrelationship with the broader environment. Will the loss of this particular environmental/social condition lead to further breakdown of the existing environment? ▪ Recognised value: has the environmental condition been recognised in some formal sense, such as a declaration of a conservation area or National Park.

c) Likelihood of Occurrence

For unplanned events or extreme situations, the likelihood that the particular environmental condition will exist can be ascribed a qualitative probability, as per the categories defined in the table below:

Table 3-4: Likelihood categories

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions, i.e., the event is heard of and associated with the industry.
Possible/Likely	The event is likely to occur at some time during normal operating conditions, i.e., an incident has occurred in the industry before.
High Likelihood/Inevitable	The event will occur during normal operating conditions (is inevitable), or the event will happen several times per year at a location.

The likelihood is estimated based on experience and available evidence that such an outcome has previously occurred. Impacts resulting from routine or planned events (normal operations) are classified as having a high likelihood of occurrence.

3.7.5 Evaluation of Significance

To ascribe significance to the impacts of this ESIA, the terminologies that have been adopted are described in the table below:

Table 3-5: Terminology for impact significance

Significance	Definition
Positive Impact	An impact that is considered to represent an improvement on the baseline or introduces a new desirable factor.
Negligible Impact	Magnitude of change is comparable to natural variation.
Minor Impact	Detectable but is not significant - should be further mitigated if possible but is an acceptable risk.
Moderate Impact	Significant, amenable to mitigation, should be further mitigated if possible borderline acceptability.
Major Impact	Significant; amenable to mitigation; must be mitigated - not acceptable.
Critical Impact	Intolerable; not amenable to mitigation; alternatives must be identified – Project Stopper.

Definitions of impact significance are as follows:

- **Critical**: high significant changes of the existing environment that is likely to be irreversible.
- **Major**: a major alteration of the existing environment that will result in the loss of that environmental value for a period of time.
- **Moderate**: an alteration to the existing environment that will modify its current status but will not stop its role in the environment or is easily reversed.
- **Minor**: an alteration to the existing environment but few sensitive receptors or a change that will be transient.
- **Negligible**: measurable but no effective change to the current environmental value.
- **Positive**: in the case that a positive impact is identified, no magnitude or sensitivity is assessed. It is considered sufficient to indicate that the project is expected to result in a positive impact, without identifying the significance of the impact that is likely to occur.

It must be noted that critical impacts are not acceptable for planned operations and can only be tolerated in the instance of unplanned or incidental events, and only then when the likelihood of occurrence has been reduced through project planning to at least low or unlikely.

a) Evaluation of impacts from the planned project activities

The significance of each impact was determined by comparing the impact severity against the sensitivity of the receptor in the impact significance matrix provided in the table below:

Table 3-6: Environmental impact significance matrix

		Sensitivity of Receptor		
		Low	**Medium**	**High**
Impact Severity	**Slight**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Critical

Impacts assessed as '*Negligible*' will require no additional management or mitigation, either because: the magnitude of the impact is sufficiently small for the receptor; or the sensitivity is sufficiently low, and adequate controls have been included in the project design. Negligible impacts are therefore deemed to be insignificant, and do not require any further remedial action.

Impacts that are evaluated to be '*Minor, Moderate or Major*', will require the implementation of further management or mitigation measures. '*Moderate to Major*' impacts are therefore considered to be significant. For potentially major impacts the objective of mitigation is to reduce the residual risk to a moderate level.

In the development of mitigation measures to reduce moderate impact, the emphasis is on demonstrating that the impact has been reduced to a level that is As Low as Reasonably Practicable (ALARP). It will not always be practical to reduce the moderate impact of minor ones in consideration of the cost effectiveness of the project.

Impacts evaluated as 'Critical' can't be managed or mitigated and therefore demand the selection of alternatives to eliminate the potential sources. They cannot be contemplated as part of the normal operation of the project and can only be considered if the project design has taken every possible step to reduce the probability of occurrence to as low as possible.

b) Evaluation of Community and Social Impacts

For the assessment of social impacts, the same approach has been undertaken as for the environmental impacts; however, the terminologies have been altered slightly to consider community interpretation. So rather than referring to potential impacts of having a graded scale of significance (any social issue is of major significance to some or many parties), the term urgency is used to indicate the prioritization process that is necessary in dealing with community and social issues.

The level of impact significance (or urgency) for various social concerns are evaluated as per the table below:

Table 3-7: Social impact significance matrix

		Sensitivity of Receptor		
		Low	**Medium**	**High**
Impact Severity	**Slight**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Critical

The significance of social impacts on various social concerns is defined in the table below:

Table 3-8: Terminology for Social Impact Significance

Impact Significance	Definition
Positive Impact	▪ An outcome that will derive an economic benefit to the community. ▪ The provision of community amenities that have previously been unavailable. ▪ An outcome that can be expected to improve community health.
Negligible Impact	▪ Will challenge the perceptions and may cause unease that will need to be clarified amongst an insignificant number of people within the community.
Minor Impact	▪ Likely to impact few individuals and will impair current lifestyles or customs. ▪ Will challenge the perceptions and may cause unease that will need to be clarified amongst some groups within the community, scale at local level, and of a short duration. ▪ Will change daily function or remove resources for small number of family or household.
Moderate Impact	▪ Likely to impact some groups of people and will impair current lifestyles or customs. ▪ Will challenge the perceptions and may cause unease that will need to be clarified amongst a large proportion of the community, larger scale to district level at longer duration. ▪ Will change daily function or remove resources for a number of family or household. ▪ That there may be health impacts on sensitive groups in the community that can be avoided.

Major Impact	▪ Likely to impact a large number of people, over a majority of the area of influence, and will impair current lifestyles or customs. ▪ Will change daily function or remove resources for larger community groups over a regional or national area. ▪ That any member of the community will be injured or suffer health impacts if an impact were to occur. ▪ That any member of the community may be in harm's way due to a project activity.

3.7.6 Impact Mitigation

The assessment process was intended to identify impacts and benefits associated with project activities and ways of dealing with them during the planning and design stage of the project. The ultimate goal of the assessment process was to reduce the negative impacts and enhance the benefits or positive impact of any intended activity. Planned mitigation measures were described, and additional measures or controls were recommended where impacts were still considered to be unacceptable.

In deciding appropriate mitigation strategies there is a hierarchy of responses, as indicated in the Figure below:

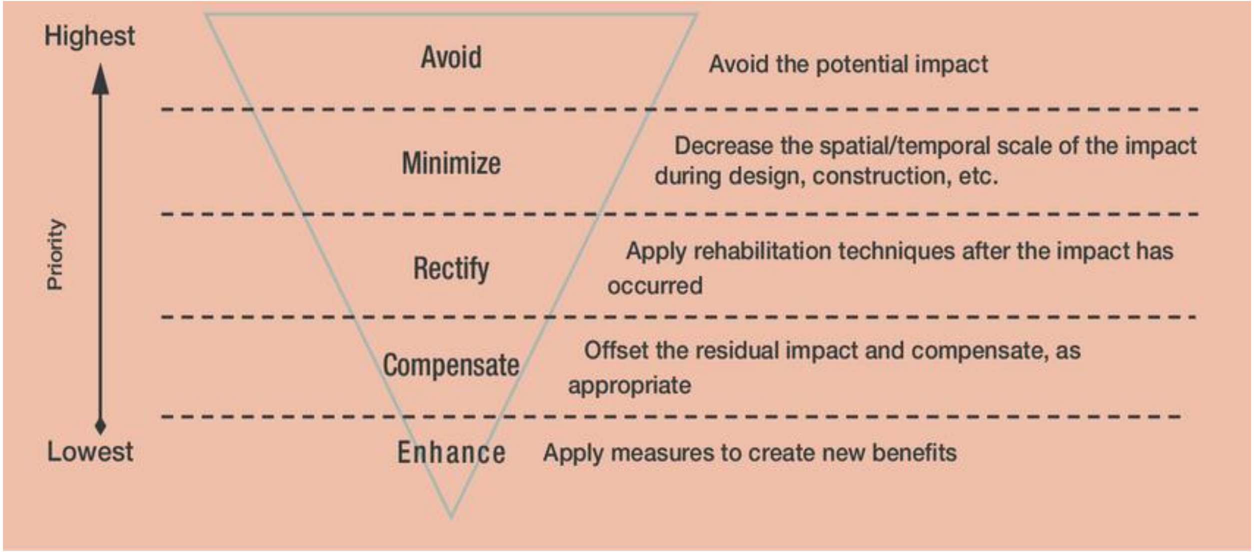


Figure 3-3: Impact mitigation hierarchy

Mitigation hierarchy

It is the nature of the industry that some impacts are just not reversible, but the positive outcomes of the project outweigh the residual impact, hence the need for the ESIA process to develop the best possible outcomes from the implementation of a project.

There is also the possibility of unplanned events and extreme and unusual environmental conditions that may lead to major or even critical impacts. It is incumbent on the project proponent to reduce the probability of such events to as low as reasonably practical, and even after this, it is a necessary part of the mitigation process to define a response should the event occur. There is again a hierarchy of responses to such occurrences:

- **Control:** this is a response to deal with potential negative impacts at the time and an emergency may be occurring, it can include such things as bushfire fighting capacity, or even stop work plans for extreme weather events;
- **Recovery**: in the event that an emergency situation has occurred it is important to identify how project proponents will respond to the potentially negative impacts such recovery plans could include response plans for containing or neutralizing spills, or compensation packages for affected parties.

Many mitigation or control measures will require a degree of management to ensure their success in reducing potential impacts to the residual level (mitigated impact significance). Generally, the implementation of mitigation measures aims to reduce the severity of impacts. However, in some cases where the degree of magnitude and extent of the project activities that influence the level of severity cannot be reduced, mitigation measures are proposed to manage sensitivity of the receiving environment and community. These are as proposed in some of the social impacts' management. Most of these residual (mitigated) outcomes still require a degree of monitoring throughout the project's implementation, to ensure that the mitigation management process is effective.

The mitigation measures (both social and environmental) that have been proposed in this ESIA have been considered in their application to the future of the proposed project. In as much as possible, the project seeks to establish environmental and social mitigation strategies that are robust and will continue to be applied as the project progresses. It is these management and monitoring efforts that form the environment and social management plan (ESMP), which is part of this ESIA report.

3.8 Environmental Risk Assessment for the site

Risk is simply defined as undesirable occurrence that would result in environmental, social, safety and health impacts. The proposed project is rated as a high-risk project. This implies that if the risks associated with the project were to occur, there would be consequent significant or irreversible impacts and effects to the environmental or social receptors. In view of this, the consultant undertook a comprehensive risk assessment focusing on major identified impacts.

Understanding the significance of risks is important for prioritizing the need for mitigation measures. For evaluating significance, it is important to consider the likelihood that a given risk event is expected to occur and the magnitude of the expected impacts (consequence). The latter refers to the extent to which a risky event might negatively affect environmental or social receptors. This included consideration of the following criteria:

- sensitivity of the receptor;
- severity of impacts;
- expected duration and scale; and
- whether or not the impact is reversible.

Assessing the significance of risks takes into consideration whether there are known, acceptable and readily available good practices to address those impacts and whether the executing entities and/or main stakeholders have experience applying such measures.

3.9 Development of Waste Management Plan

The ESIA Expert identified the materials to be used, products and by-products including waste to be generated during project construction, operation and decommissioning activities. The Expert developed a Waste Management Plan (WMP) included as part of the Environment Health and Safety (EHS) Action Plan ***(Annex 20)*** providing guidelines on waste storage, handling, treatment and disposal.

3.10 Assessment of Land Requirements and Land Agreements for the Project

The expert determined that KenGen entered into a sublease agreement with KWS for 1064.36 hectares of land (reference No. 12881/6) that was subdivided from land parcel No LR.105419/1. KenGen pays an annual rent to KWS and has been utilizing the land for a while.

3.11 Stakeholder Consultation and Information Disclosure

The ESIA consultant undertook public and stakeholder consultations as described in accordance with the Environmental (Impact Assessment and Audit), Regulations, 2003. The stakeholder and public consultations were gender inclusive, transparent, and conducted in consideration of socially acceptable means in relation to the project area. To that effect, the ESIA Consultant prepared a Stakeholder Engagement Plan (SEP) ***(Annex 19)***. The SEP provides procedures for mapping and analysis of the stakeholders and qualification of stakeholders for consultation. The SEP also provides tools and instruments to be used for stakeholder consultation including their appropriateness. The SEP provides stakeholder engagement procedures for this ESIA Study and also in the future during the operation of the power plant. In addition, the SEP also provides monitoring and evaluation process for determination of the level of realization of its objectives and to inform its review.

3.12 Occupational Safety and Health

The ESIA Expert has developed an Environment Health and Safety (EHS) Action Plan ***(Annex 20)*** for the following safety and health aspects;

i. Workers and Public Safety during construction, operation and decommissioning of the project.
ii. Prevention and management of possible accidents during construction, operation and decommissioning of the project.

These plans may form part of the Mitigation measures and be incorporated in the Environmental and Social Management and Monitoring Plan (ESMMP).

3.13 Analysis of Contribution of the project to Greenhouse Gas (GHG) Emission Reduction

The consultant carried out a preliminary analysis of the contributions of the project to GHGs emissions reduction. This was based on the assessment of the project Life Cycle and associated operations which will not only involve measuring GHG emission factors at the commissioning of the power plant, but also a continued analysis of GHG emissions over time. According to the Life Cycle Analysis (LCA) approach, emissions were assessed for the Plant Cycle and Fuel Cycle separately. The Plant Cycle GHG emissions include emissions related to the construction of the power plant and surface installations, drilling and completion of wells (if required), the production of the materials needed for these installations, and the eventual decommissioning of the facilities, normalized over the lifetime of the project. The Fuel Cycle emissions refer to the release of geothermal Greenhouse Gas (GHG) during the energy conversion process. The Fuel Cycle emissions are sometimes referred to as operational emissions or fugitive emissions.

3.14 Preparation of the Environmental and Social Management and Monitoring Plan (ESMMP)

The ESMMP is the main output of the ESIA process which is a strategy for managing risks and mitigating impacts. The identification of mitigation measures was done in consultation with affected groups and interested stakeholders and was guided by the mitigation hierarchy. The mitigation hierarchy implies that all reasonable attempts must first be made to avoid negative social or environmental impacts. If avoidance is not possible without challenging the conservation objective of the project, measures should be taken to minimize the impacts to acceptable levels and address remaining residual impacts with adequate and fair compensation measures. The risk management strategy is documented in an Environmental and Social Management and Monitoring Plan (ESMMP) that describes:

- Summary of Potential Impacts;
- Associated Risks;
- The mitigation measures developed during the ESIA;
- An implementation schedule;
- Required resources and estimated cost;
- Responsible actors for the implementation of ESMMP Actions; and
- Monitoring Procedures.

The technical and operational feasibility, cultural adequacy and sustainability of proposed measures have been demonstrated as well as requirements for capacity building and institutional strengthening, where relevant. The ESMMP has indicated how the measures designed to avoid impacts will be monitored for effectiveness.

The ESMMP details the measures to be taken during the implementation, operation and decommissioning of the proposed project to eliminate or offset adverse environmental and social impacts, or to reduce them to acceptable levels and also the actions needed to implement these measures.

The ESMMP covers the whole project life cycle. Elements in the ESMMP include the following:

- Construction Phase;
- Operation Phase; and
- Decommissioning Phase

The ESMMP may be revised to incorporate:

- Emerging issues that were not foreseen during the ESIA Study;
- Views raised as a result of public consultation during implementation of the ESMMP;
- Omissions identified and Lessons learnt during monitoring of the project and ESMMP implementation.

The consultant will provide a template for recording the above findings that would trigger a review of the ESMMP for consideration.

3.15 Climate Change Vulnerability Assessment

The ESIA expert assessed the influence of the proposed project on climate change, the impacts of climate change and vulnerability within and around the proposed project area of influence and highlighted the possible adaptation and mitigation actions. The focus was on flora and fauna, population, biodiversity and water resources.

The approach methodology involved:

a) Stakeholder Engagement and consultation with local communities, NGOs, and other stakeholders in the initial stages to understand specific climate-related concerns.
b) Data & Baseline Establishment: Climate data involved the review of historical and projected climate data for Naivasha (temperature, precipitation, sea-level rise, etc.). Vulnerability assessment baselines were determined by observation and feedback from stakeholders on which parts of the environment and society are most vulnerable to climate change.
c) With regards to climate change impact assessment, both direct and indirect impacts were determined by both literature review and stakeholders view on how climate change may directly or indirectly affect the project, and how the project may exacerbate or mitigate local vulnerabilities. Use of existing modelling & scenarios Analysis was done to ascertain the effect of climate change scenarios and understand how they might interact with the project.

The above findings and observations were integrated into the ESIA report by combining the climate change impact and vulnerability assessment findings with the findings of the ESIA. Assessment of synergies and trade-offs was carried out to understand how the project might have co-Benefits for climate adaptation, or how it might inadvertently increase vulnerabilities.

With regards to **climate change mitigation** and based on project activities, measures have been proposed on how to reduce the project's greenhouse gas emissions. Similarly, different adaptation strategies have been proposed to ensure the project is climate proofed and the ecosystem/communities are resilient to future climate change (e.g., designing infrastructure to cope with floods, drought or erratic rainfall).

Monitoring and Management: A system for climate monitoring has been proposed to monitor climate parameters and their changes over time. Based on monitoring results, the project strategies have been adjusted to address unforeseen climate change impacts. Regular updates and engagements with local communities and other stakeholders about the findings and changes made in response to climate change have been recommended. Additionally, regular reviews have been recommended to assess the latest climate change data to ensure that the project can withstand the challenges of climate change and contribute positively to the resilience of both the environment and society.

3.16 Assessment of Energy Conservation Measures for the Project Cycle

The Consultant carried out this assessment mainly by evaluating the energy needs across the project life cycle, possible sources of the required energy, possible measures and appropriate technologies to lower or minimize energy consumption. The consultant also relied much on the understanding of the design of the power plant and proposed applicable technologies.

4 BASELINE ENVIRONMENTAL AND SOCIAL ANALYSIS

This section examines the baseline environmental and socio-cultural characteristics of the proposed project site and its surroundings. The analysis will focus on the immediate context of the proposed project site and aspects that relate to the identified impacts in order to be relevant to decisions about project design, operation, or mitigation measures.

The qualitative and quantitative descriptions presented in the chapter are based on:

i. Desktop studies and literature review;
ii. Site visits;
iii. Technical meetings with relevant authorities and organizations;
iv. Public Consultation Meetings;
v. Biophysical baseline surveys including laboratory analysis;
vi. Information obtained during detailed socio-economic surveys;
vii. Modelling and Simulations.

4.1 Proposed Project Site

The proposed project site is located approximately 6km south of Lake Naivasha in Kenya's Rift Valley, adjacent to the existing Olkaria II Geothermal Power Plant, on GPS coordinates -0.861456°, 36.297453° (elevation of 2000m ASL), in Hell's Gate National Park, in a piece of land leased from KWS, in Naivasha Sub- County, Nakuru County.

Naivasha Sub-County has twenty (20) wards, namely: Kongoni, Maiella, Kipkonyo, Moindabi, Ndabibi, Longonot, Munyu, Kijabe, Satellite, Mirera, Olkaria, Gatamaiyu, Karati, Maraigushu, Lake-View, Tarambete, Kinamba, Mununga, Kabati, and Sokoni. The proposed site area is within Olkaria Ward.

A large portion of the proposed project area has no vegetation, but is instead used as yards for storage and material laydown. The yard located in the Eastern section of the area was used by 'GEG KE Ltd Kenya' as a storage area and a camp site for workers during the construction of Well Heads and other geothermal rehabilitation activities. However, the yard has not been actively used for quite some time. The yard located in the Middle section of the area belongs to Mitsubishi and is currently being used for material lay down and storage of equipment (Drilling Detergents/ Non-toxic Chemicals, Pipes, Drilling Casings, Rig equipment and some non-toxic waste). Adjacent to the Mitsubishi yard, is Fichtner's project execution office. The yard and the office will need to be decommissioned to give way for the proposed project. The Western section or lower part of the project area is used by KenGen's steam-field department for storing their equipment.

Plate 4-1: Existing storage facility and waste material

Plate 4-2: Proposed Site and Existing Vegetation

4.2 Physiographic Environment Analysis

4.2.1 Topography

The area and its environs are situated at the floor of the Great Rift Valley, bounded by the Mau Escarpment (3080 metres above sea level) and the Eburru Volcanic pile to the West and North West, Lake Naivasha (1883 masl) to the North, Mount Longonot to the South East, Kinangop Plateau and Nyandarua (Aberdare) Range to the North East and East, and Mount Suswa to the South (GIBB Africa Ltd, 2009).

The topography of the Olkaria geothermal field is characterized by a wide range of features associated with volcanic activity such as: craters; remnants of pre-existing craters; fault scarps; fissures; and steam jets., and various small hills with several small trees and bushes. Elevations of the geothermal facilities range from 2220 masl at Well pad OW 740 on the east of the geothermal field, to 1890 masl at reinjection Well pad OW 807 in the south (K&M Advisors, 2018).

The proposed site has a gentle east to west slope across the site (2327 - 1990 masl), relatively close to the main access road (Olkaria Route) into the Olkaria geothermal field.

The figure below shows the locations of the lava field and dome areas on either side of Ol Njorowa Gorge as well as the distribution of field lab thermal cameras, seismic sensors, and the meteorological station.

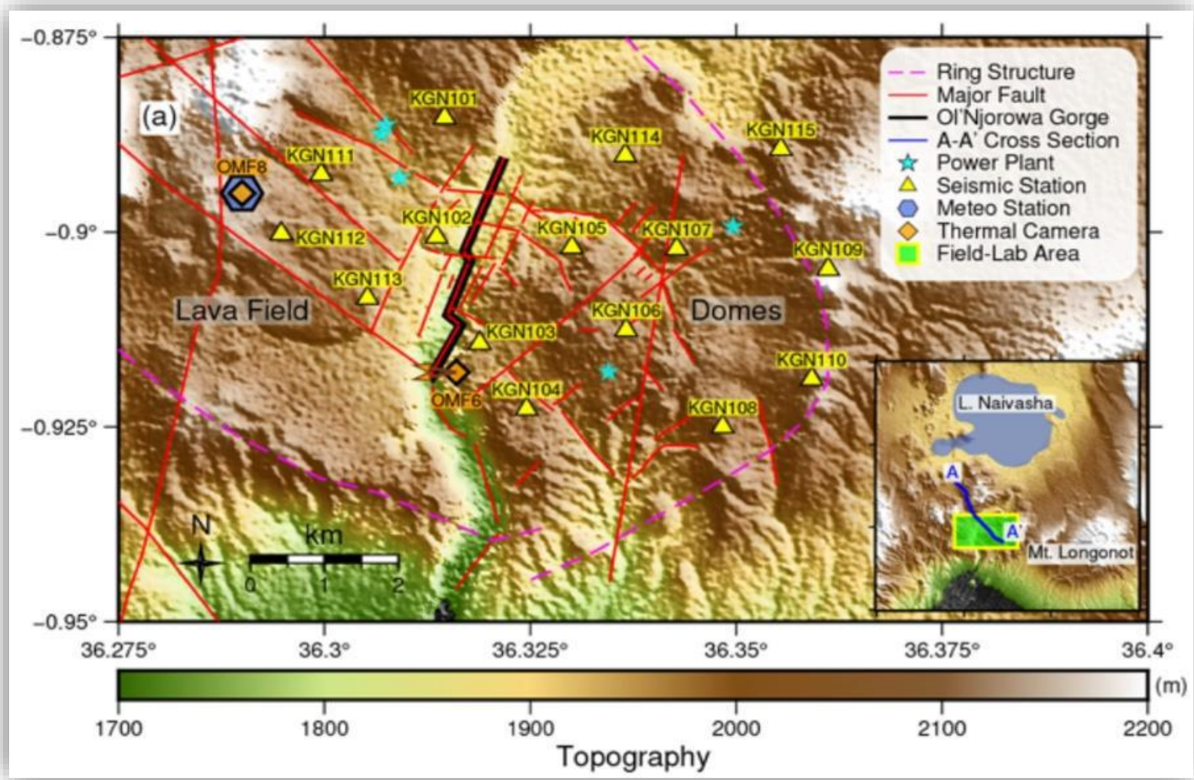


Figure 4-1: Topography of the area

4.2.2 Climatic conditions

The Olkaria area and other surrounding areas around Lake Naivasha are classified as semi-arid areas. The monthly distribution of rainfall borrows largely from the national bimodal pattern of rainfall distribution with long rains in March, April and May while the short rains are received in October and November. Rainfall in the project area and its environs is generally low, recording an average of 634mm annually. Evaporation exceeds precipitation almost throughout the year as it ranges from approximately 1,700mm per year in areas around the lake to approximately 1,000mm per year on higher ground, with variations from year to year. The mean monthly maximum temperatures in the area range from 24.6 to 28.3°C.

4.2.3 Geology and Soils

4.2.3.1 Geology

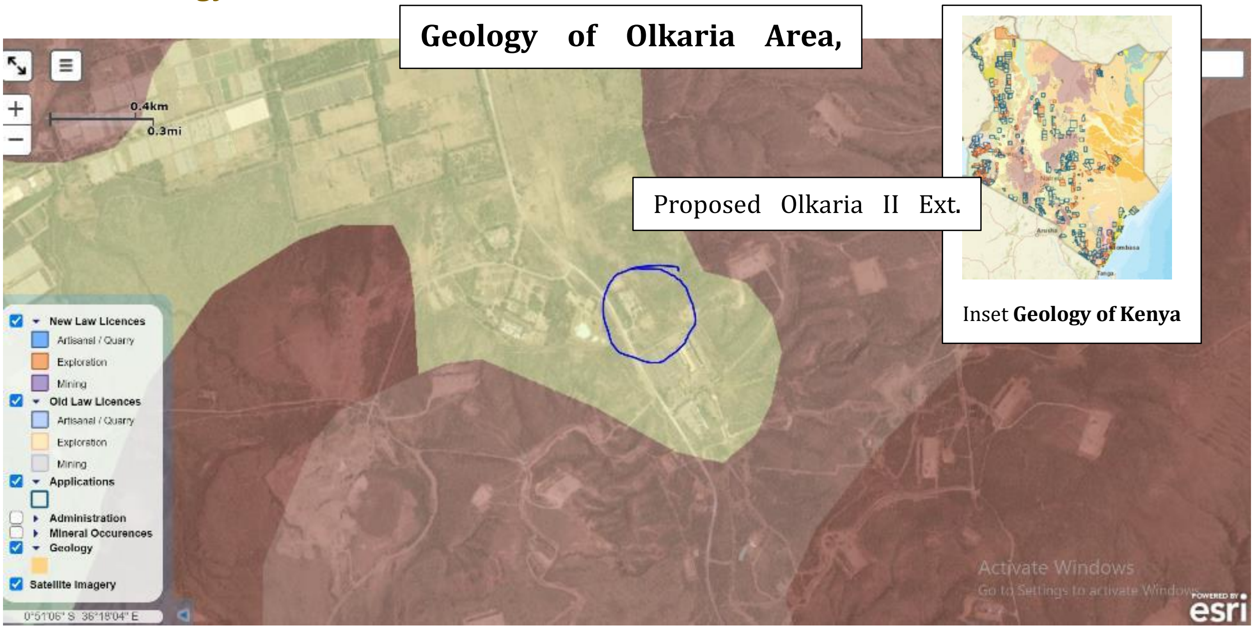


Figure 4-2: Geology of Olkaria area

The Olkaria II Extension geothermal power plant is proposed to be sited in the same geological structure as the Olkaria II Power station as shown in the map above but north of Olkaria I.

Olkaria is characterized by numerous quaternary volcanic centres, including a ring of volcanic domes on the east and south sides of the field area, which may represent a caldera boundary. Rhyolitic lavas and pyroclastic rocks dominate the surface geology. Beneath this is a series of basalts, trachytes and pyroclastic units above the Proterozoic basement rock, which is composed of gneiss, schists and other metamorphic rocks belonging to the Mozambiquian group.

The proposed project site is in a volcanic zone characterized by rhyolite lava in green. The system has a clay cap of hydrothermally altered rocks that overlie the top of the reservoir and keep the hot fluids contained.

The temperature distributions at 0 masl suggest the likely location of heat sources (up the flow of deep hot fluids) for the Greater Olkaria Geothermal Area (GOGA). Additionally, it suggests the permeability structure and the possible lateral connections. Although it is difficult to define the position of heat sources, at least two-deep up flow zones can be identified on the eastern side of the Olol Butot fault, one located in the NEPF and other comprising the EPF and the Domes. The analysis of the fluid geochemistry also suggests these two up flow zones.

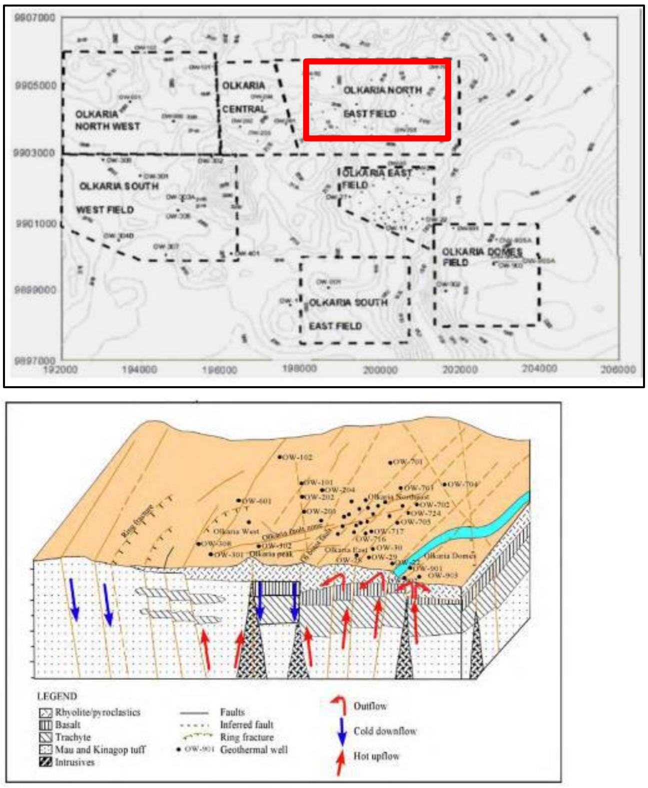


Figure 4-3: Volcanic activity

Volcanic units are cut by numerous faults, some of which can be mapped on the evidence of aligned features such as hot ground, extrusion centres and craters. Notable among these are the Olol Butot and the Olkaria Faults. While the dominant fault direction is N-S, parallel to the rift trend, other faults have been inferred that trend NNW (such as the Gorge Farm Fault and the Suswa Lineament).

4.2.3.2 Geochemistry

Fumaroles are widespread over the greater field area, often associated with structures (faults or fractures and volcanic centres) visible at the surface and represent discharge from the shallow two-phase part(s) of the system(s). The Domes area lacks fumarolic activity, probably due to a thick pile of impermeable pyroclastic rocks, which acts as a seal.

Given the complexity of the geology and existence of fault lines, care needs to be taken to develop heavy structures where the protazoaic basement rock is confirmed through geotechnical studies, away from Faultline or outflow or wells.

4.2.3.3 Soils

The soils in the project area are formed from quaternary to recent volcanic eruptions during which lava flows have been overlaid by airborne ash, pumice and dust, often in well-defined layers. These layers are poorly consolidated although there has been some redistribution of the original material under the action of rainfall and runoff. Little weathering has taken place due to the relatively recent origin and semi-arid climate. The soil is of Volcanic Ash type and its texture is that of a sandy loam or loamy sand. The soils are non-cohesive. Clay content is around 5%, silt is in the region of 15 - 30% and sand is around 65 - 80%. The soils in the area are apparently loose and it is anticipated that there would be increased erosion on the various sites where construction activities may involve vegetation clearance and soil loosening. Such sites include areas around the power plant, well-pads and along road shoulders (K&M Advisors, 2018).

Soil map Overlayed on Project Site and Pipeline Routes.

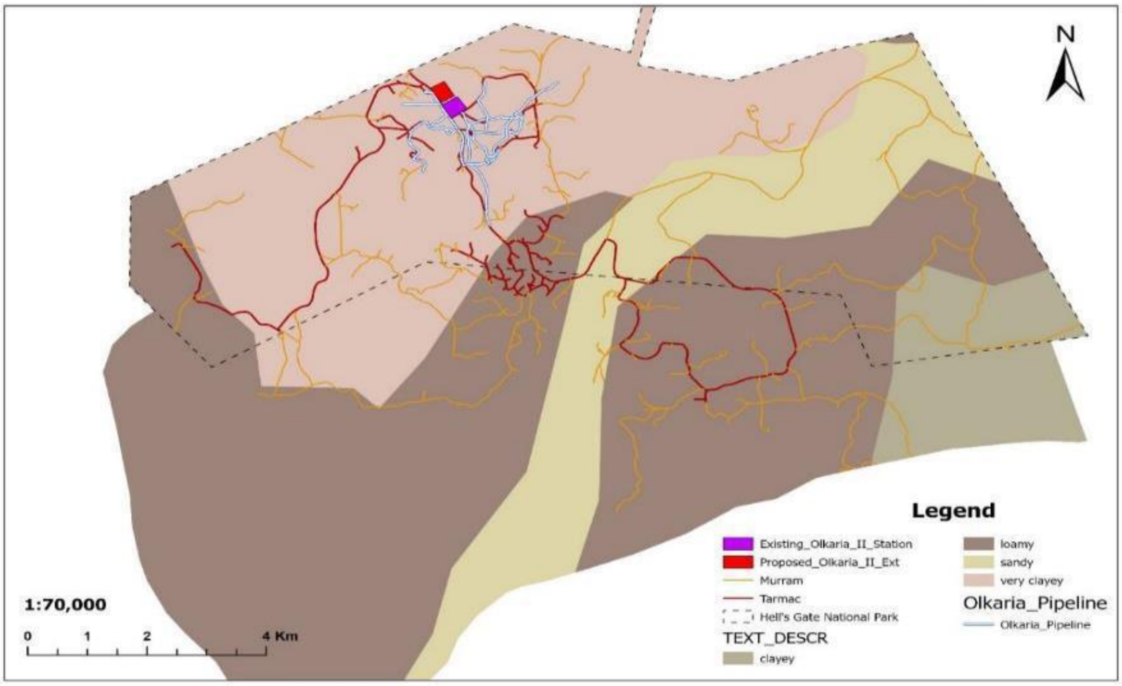


Figure 4-4: Soils in the project area

The consultant appointed Polucon Services (Kenya) Limited, a NEMA licensed laboratory, to undertake soil sampling and analysis. On 30th October 2023, four (4) composite soil samples were collected from the project site as shown in the figure below and taken to the lab under optimal conditions.

Figure 4-5: Soil sampling sites

The results showed that the soils at the site had not been contaminated, i.e. all parameters of Organic, Polychlorinated Biphenyls (PCBs), and Heavy metal elements in the samples, were within the Dutch Standards for Soils and Sediments. This is as presented in the tables below.

Table 4-1: Composite sample 1 test results

TEST REPORT NO: R202316014120-01				
SAMPLE	SOIL			
SAMPLE REFERENCE	S202316014120			
PLACE SAMPLED	Proposed site for Olkaria II Extension Geothermal Power Plant			
ANALYSIS STARTED	31st October 2023			
SAMPLING METHOD	POL/FTS/002			
MARKS	Composite Sample 1			
TEST	**METHOD**	**RESULTS**	**UNITS**	**DUTCH STANDARDS FOR**

				SOILS AND SEDIMENTS
BTEX				
Benzene	PQA/LIM/002	<0.01	mg/kg	1.1 Max
Toluene	PQA/LIM/002	<0.01	mg/kg	32.0 Max
Ethyl Benzene	PQA/LIM/002	<0.01	mg/kg	110.0 Max
Xylene	PQA/LIM/002	<0.01	mg/kg	17.0 Max
PCBs				
Polychlorinated Biphenyls (PCBs)	ISO 13876	<0.01	mg/kg	1.0 Max
HEAVY METALS				
Lead as Pb	EPA 3050B	<0.01	mg/kg	530 Max
Cadmium as Cd	EPA 3050B	<0.01	mg/kg	13 Max
Mercury as Hg	EPA 3050B	<0.001	mg/kg	-

Table 4-2: Composite sample 2 test results

TEST REPORT NO: R202316014121-01				
SAMPLE	SOIL			
SAMPLE REFERENCE	S202316014121			
PLACE SAMPLED	Proposed site for Olkaria II Extension Geothermal Power Plant			
ANALYSIS STARTED	31st October 2023			
SAMPLING METHOD	POL/FTS/002			
MARKS	Composite Sample 2			
TEST	**METHOD**	**RESULTS**	**UNITS**	**DUTCH STANDARDS FOR SOILS AND SEDIMENTS**
BTEX				
Benzene	PQA/LIM/002	<0.01	mg/kg	1.1 Max
Toluene	PQA/LIM/002	<0.01	mg/kg	32.0 Max
Ethyl Benzene	PQA/LIM/002	<0.01	mg/kg	110.0 Max

Xylene	PQA/LIM/002	0.01	mg/kg	17.0 Max
PCBs				
Polychlorinated Biphenyls (PCBs)	ISO 13876	<0.01	mg/kg	1.0 Max
HEAVY METALS				
Lead as Pb	EPA 3050B	0.06	mg/kg	530 Max
Cadmium as Cd	EPA 3050B	0.02	mg/kg	13 Max
Mercury as Hg	EPA 3050B	<0.001	mg/kg	-

Table 4-3: Composite sample 3 test results

TEST REPORT NO: R202316014122-01				
SAMPLE	SOIL			
SAMPLE REFERENCE	S202316014122			
PLACE SAMPLED	Proposed site for Olkaria II Extension Geothermal Power Plant			
ANALYSIS STARTED	31st October 2023			
SAMPLING METHOD	POL/FTS/002			
MARKS	Composite Sample 3			
TEST	**METHOD**	**RESULTS**	**UNITS**	**DUTCH STANDARDS FOR SOILS AND SEDIMENTS**
BTEX				
Benzene	PQA/LIM/002	0.01	mg/kg	1.1 Max
Toluene	PQA/LIM/002	<0.01	mg/kg	32.0 Max
Ethyl Benzene	PQA/LIM/002	<0.01	mg/kg	110.0 Max
Xylene	PQA/LIM/002	<0.01	mg/kg	17.0 Max
PCBs				
Polychlorinated Biphenyls (PCBs)	ISO 13876	<0.01	mg/kg	1.0 Max
HEAVY METALS				
Lead as Pb	EPA 3050B	0.02	mg/kg	530 Max
Cadmium as Cd	EPA 3050B	0.04	mg/kg	13 Max

Mercury as Hg	EPA 3050B	<0.001	mg/kg	-

Table 4-4: Composite sample 4 test results

TEST REPORT NO: R202316014123-01				
SAMPLE	SOIL			
SAMPLE REFERENCE	S202316014123			
PLACE SAMPLED	Proposed site for Olkaria II Extension Geothermal Power Plant			
ANALYSIS STARTED	31st October 2023			
SAMPLING METHOD	POL/FTS/002			
MARKS	Composite Sample 4			
TEST	**METHOD**	**RESULTS**	**UNITS**	**DUTCH STANDARDS FOR SOILS AND SEDIMENTS**
BTEX				
Benzene	PQA/LIM/002	0.01	mg/kg	1.1 Max
Toluene	PQA/LIM/002	<0.01	mg/kg	32.0 Max
Ethyl Benzene	PQA/LIM/002	<0.01	mg/kg	110.0 Max
Xylene	PQA/LIM/002	0.01	mg/kg	17.0 Max
PCBs				
Polychlorinated Biphenyls (PCBs)	ISO 13876	<0.01	mg/kg	1.0 Max
HEAVY METALS				
Lead as Pb	EPA 3050B	0.08	mg/kg	530 Max
Cadmium as Cd	EPA 3050B	<0.01	mg/kg	13 Max
Mercury as Hg	EPA 3050B	<0.001	mg/kg	-

4.2.4 Hydrology and Water Resources

4.2.4.1 County Water Status

The main sources of water for Nakuru County are surface water and groundwater. Surface water is mainly sourced from permanent and seasonal rivers, dams and water pans. The major rivers are: Malewa; Molo; Igwamiti; and Njoro. Underground water is sourced from boreholes, springs and shallow wells. The county is supplied with water by various schemes. These include; public water companies, community water supply schemes and private water vendors.

The Nakuru County Department of 'Water, Energy, Environment, Natural Resources and Climate Change' estimates that 63% of the population in the County have access to improved treated water which is either piped, rainwater, borehole, protected well or protected spring. 49.5% of Households access piped water, although the highest percentage is among the urban dwellers.

The County water resource management and regulatory services are offered by the Water Resource Authority (WRA) and the Central Rift Valley Water Works Development Agency (CRVWWDA) respectively. Further, there are three County owned water service providers namely: Naivasha Water and Sanitation Company (NAIVAWASCO); Nakuru Water and Sanitation Services Company Limited (NAWASSCO); and Nakuru Rural Water and Sanitation Company Limited (NARUWASCO). Additionally, other water supply schemes are managed by the community through their elected representatives (County Government of Nakuru, 2018).

4.2.4.2 Site Hydrology and Hydrogeology

The general water flow from the proposed site and wells allocated to the proposed project is from about 2,200m above sea level, northwards towards Lake Naivasha at 1883m above sea level. The water flows from Olkaria II and well pads - OW 732, OW 736 and OW 740 - towards Olkaria II Extension, then finally drains to Lake Naivasha as shown in the figure below. To mitigate against water flow, proper drainage needs to be established to allow free water flow from high to low areas.

Additionally, the flow accumulation from the locations of Olkaria I, I-AU, III, IV and V power plants (approximately 2,000 m.a.s.l), is southwards towards the Iseneto village in Suswa Ward, Narok East Sub-County, Narok County (approximately 1,630 m.a.s.l), as shown in the figure below. The rivulets are potential areas for flooding, hence should be avoided due to flush floods common in Hell's Gate and Olkaria environment.

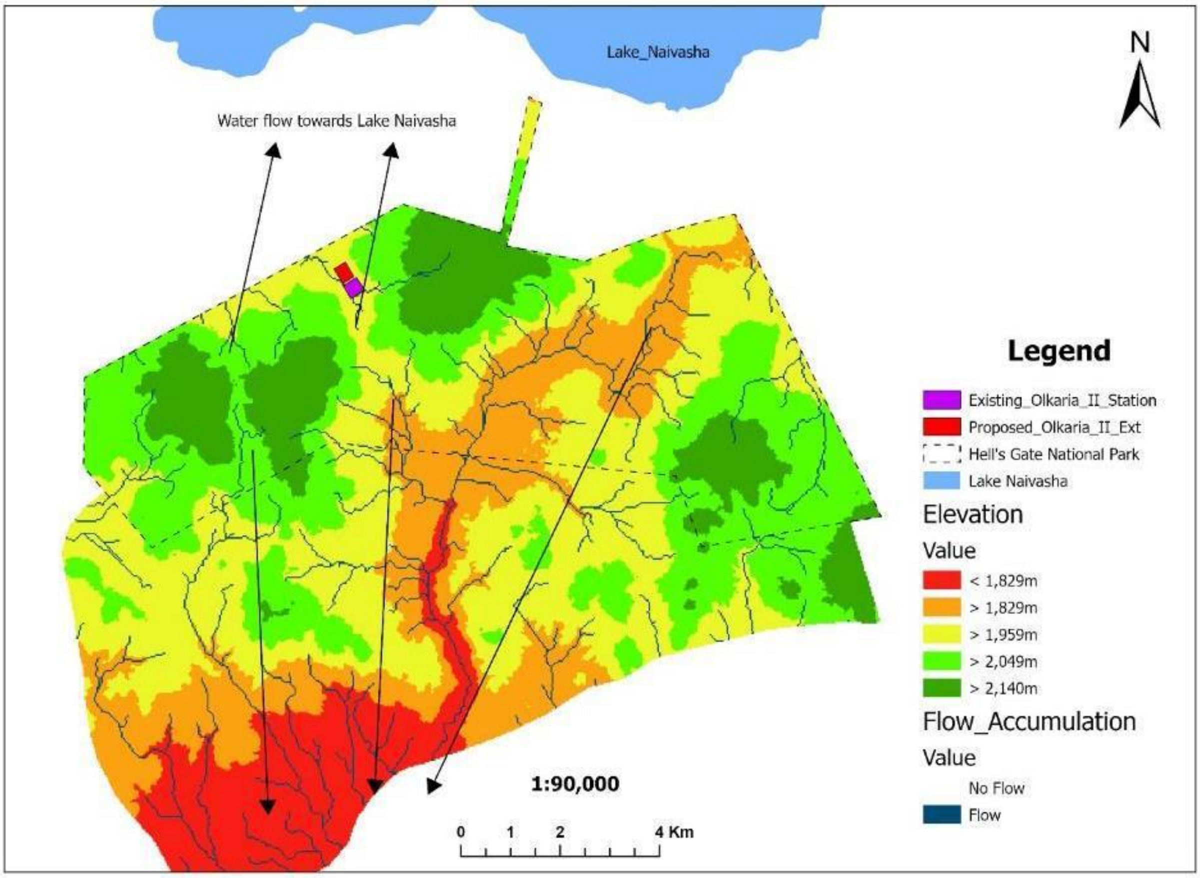


Figure 4-6: Project area hydrology

The geothermal field is located in an arid area, where annual potential evapotranspiration exceeds annual precipitation. It has been postulated that groundwater recharge is predominantly from the Mau plateau to the west, with probably some contribution from Lake Naivasha (Arusei, 2000). Discharges at the surface are in the form of fumaroles, as well as hot and cold springs.

Groundwater is recharged laterally from the high rift flanks and axially along the floor southwards. The rift planks, the grid faulting and the tectono-volcanic axis along the rift floor control the hydrogeology and the rift valley. The grid faulting acts as a channel for ground water or they provide barriers to lateral flow. Thus, faulting causes the groundwater to flow from escarpments to the centre and then follow longer flow paths reaching greater depths and aligning their flow to Lake Naivasha. The water table is deeper towards the south (Lagat, 2003). Though the rocks, particularly lacustrine sediments are very porous (Thompson and Dodson, 1963), the water table is deep between 100-266 m. The region is water scarce and the available water could be saline when found (Randel and Johnson, 1991).

There are no rivers within the project site. Effluent from Olkaria II power plant was noted to flow through the existing storm water channel that is adjacent to the proposed site, along the main road. Water samples were collected in September 2023, from the storm water flow which also carries effluent from Olkaria II powerplant and delivered to the Water Resources Authority (WRA) lab for analysis. As shown in the table below, all parameters analysed were within the NEMA thresholds for effluent discharge into the environment except for pH and colour, which were at 8.8 and 45 mgPt/l respectively. The high levels observed for colour could be attributed to sediments present in the drainage channel, due to stormwater from unpaved surfaces flowing into the channel and instances of water erosion.

Table 4-5: Effluent analysis results

S/N	Parameters	Unit	Results	Effluent Discharge Standards	
				Environment (NEMA 2006)	Public Sewers (NEMA 2006)
1.	pH	pH Scale	8.8	6.5-8.5	6-9
2.	Colour	mgPt/l	45	15	40
3.	Total Phosphorous	mg/l	0.1	2 guideline values	N/A
4.	Temperature	°C	21.3	± 3 ambient temp.	20-35
5.	Chemical Oxygen Demand (COD)	mgO_2/l	27	50	1000
6.	Biological Oxygen Demand (BOD) (20°)	mgO_2/l	3	30	500
7.	Oil & Grease	mg/l	ND	Nil	5 or 10
8.	Total Suspended Solids	mg/l	ND	30	250
9.	E. coli	MPN/100mL	ND	Nil	N/A
10.	Copper	mg/l	ND	1.0	1.0
11.	Cadmium	mg/l	ND	0.01	0.5
12.	Zinc	mg/l	ND	0.5	5.0
13.	Chromium (Total)	mg/l	ND	2	2
14.	Total Coliform	MPN/100mL	ND	30	N/A

**ND = Not Determined*

4.2.4.3 Lake Naivasha Basin

There are six (6) catchment areas in the country as shown in the figure below. They include: Rift Valley Catchment Area (RVCA); Ewaso Ng'iro North Catchment Area (ENNCA); Tana Catchment Area (TCA); Lake Victoria North Catchment Area (LVNCA); Lake Victoria South Catchment Area (LVSCA); and Athi Catchment Area (ACA). The Water Resources Authority (WRA) has several offices across the country, covering the 5 major water towers (Mt. Kenya, Mt. Elgon, Mau Complex, Aberdare and Cherangani Hills) and is in charge of managing the twenty-six (26) Sub-Basin Areas spread across the country (*Source: Water Resources Authority, WRA*).

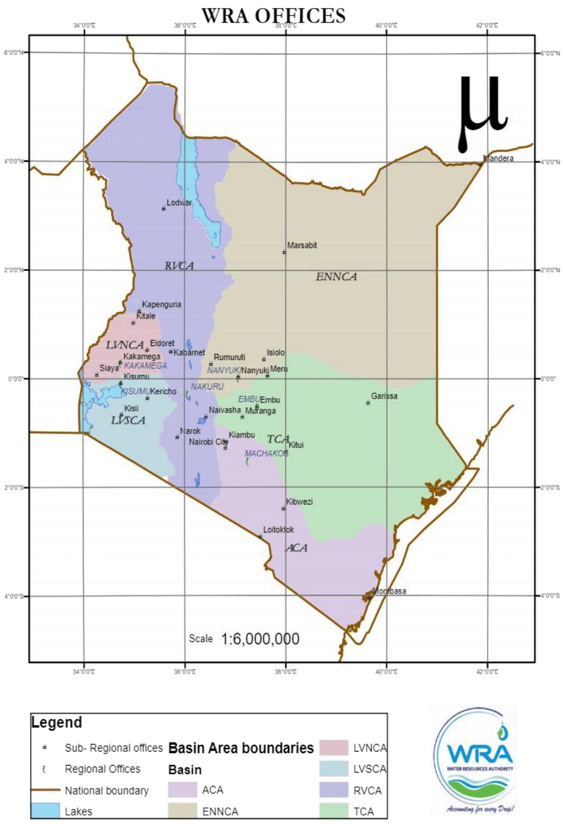


Figure 4-7: Map of catchment areas in Kenya

The proposed site is located in the lower region of the Lake Naivasha Basin (LNB) which is within the eastern side of the Rift Valley Catchment Area (RVCA). LNB encompasses about 3,400 km^2 and extends towards Mau Escarpment to the West (3048 m.a.s.l.), Aberdares to the East (4000 m.a.s.l.) and Eburru Hill to the North-East (2800 m.a.s.l.). It extends from the lacustrine beds, rift valley floor, rift plateau and rift escarpments. The basin hosts Lake Naivasha, which is a Ramsar Site and an Important Bird Area (IBA).

The proposed site for Olkaria II Extension lies approximately 6km South of Lake Naivasha (139 Km^2). The wetland associated with the lake is a suitable habitat for a wide range of aquatic flora and fauna and is one of the Ramsar sites in Kenya (Declared in 1995). The lake is a unique freshwater lake that lies on the floor of the Eastern Rift Valley at a mean altitude of 1883 masl. Lake Naivasha is the largest water mass in the area and comprises other two lakes: Lake Oloidien; and Lake Sonanchi/Crater Lake.

The Lake Naivasha Basin has several Water Resource Users Associations (WRUAs) that are mandated with: Resolving conflicts arising from water use; Developing a Sub Catchment Management Plan (SCMP); Monitoring water resource availability, quality and use; Protection and conservation of the catchment and the resource; Ensuring compliance with the Water Act 2016; and Exchanging information and ideas on water resource use. As shown in Figure 4-8 below, Lake Naivasha Basin has twelve (12) WRUAs which include: Karati Longonot WRUA; Kianjogu WRUA; Lake Naivasha WRUA (LANAWRUA); Lower Gilgil WRUA; Lower Malewa WRUA; Mariba WRUA; Middle Malewa WRUA; Mkungi Kitiri WRUA; Upper Gilgil WRUA; Upper Malewa WRUA; Upper Turasha WRUA; and Wanjohi WRUA.

As cited by Barasa (2018), two perennial rivers, Malewa and Gilgil, drain their waters into Lake Naivasha. They share discharge at 80% and 20%, respectively. River Karati, an ephemeral river, drains east of the Lake, and flows for approximately two months in a year. There is little runoff from the south of the lake. Flows from Mau Hills and Eburru, which are to the West and North West, infiltrate the ground before reaching the Lake.

Often, the Lake experiences fluctuation in levels. The Lake has no surface outlet and its water level follows the long cycles of wet and dry periods with an amplitude of about 12 m over the last century. According to Harper et al (1990), the lake's level fluctuations have not been found to show any direct relationship with local rainfall, except during periods of exceptionally high rainfall when the level rises.

Figure 4-8: Lake Naivasha Basin WRUAS
(*Source: Water Resources Authority, WRA*)

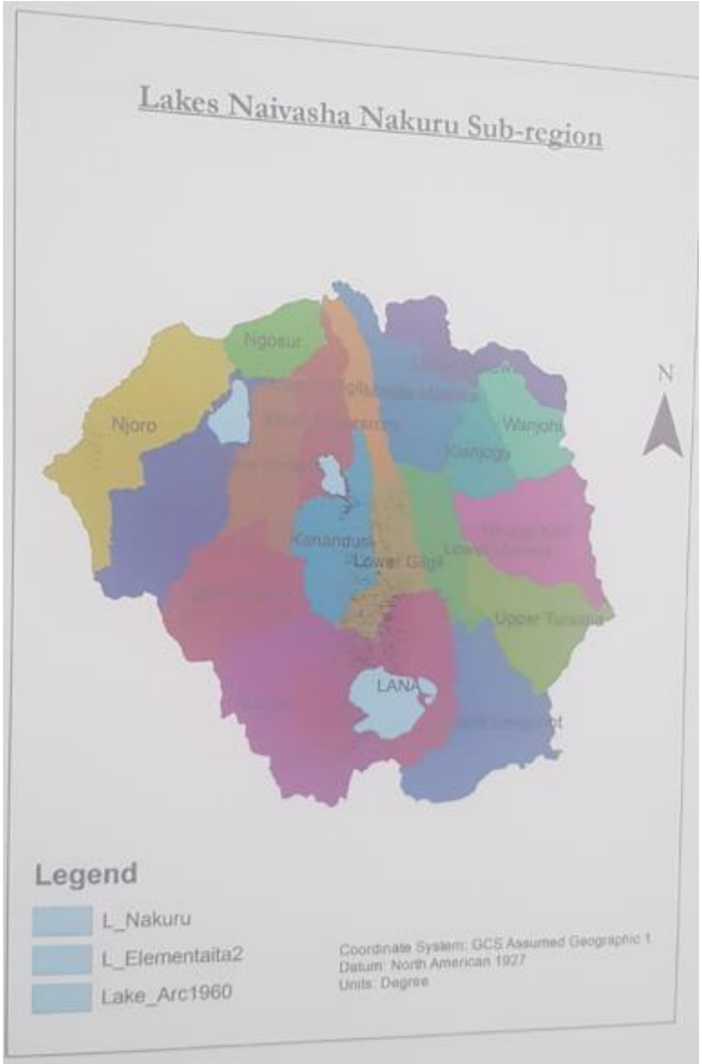


Figure 4-9: Map of Lake Naivasha-Nakuru Sub-region
(*Source: Water Resources Authority, WRA*)

4.2.4.4 Lake Naivasha Water Levels

The lake levels trend from July 2021 to July 2023 indicated a steady decline in water levels. The average lake level reading taken for the month of July, 2023 was 1889.224 masl. Levels were above the set level of 1885.3 masl by WRA for lake water abstraction up to the permit amount.

The two year and long-term lake level variations are as shown in the graphical figures below.

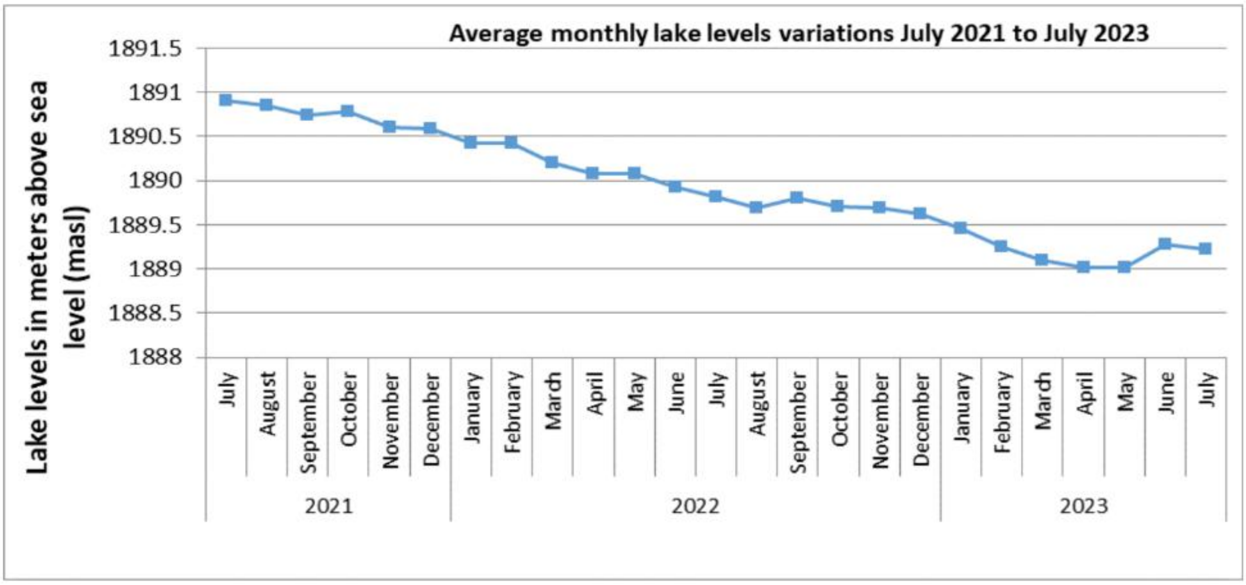


Figure 4-10: Lake Naivasha Water Level Variations from July 2021 to July 2023

(Source: KenGen, 2023)

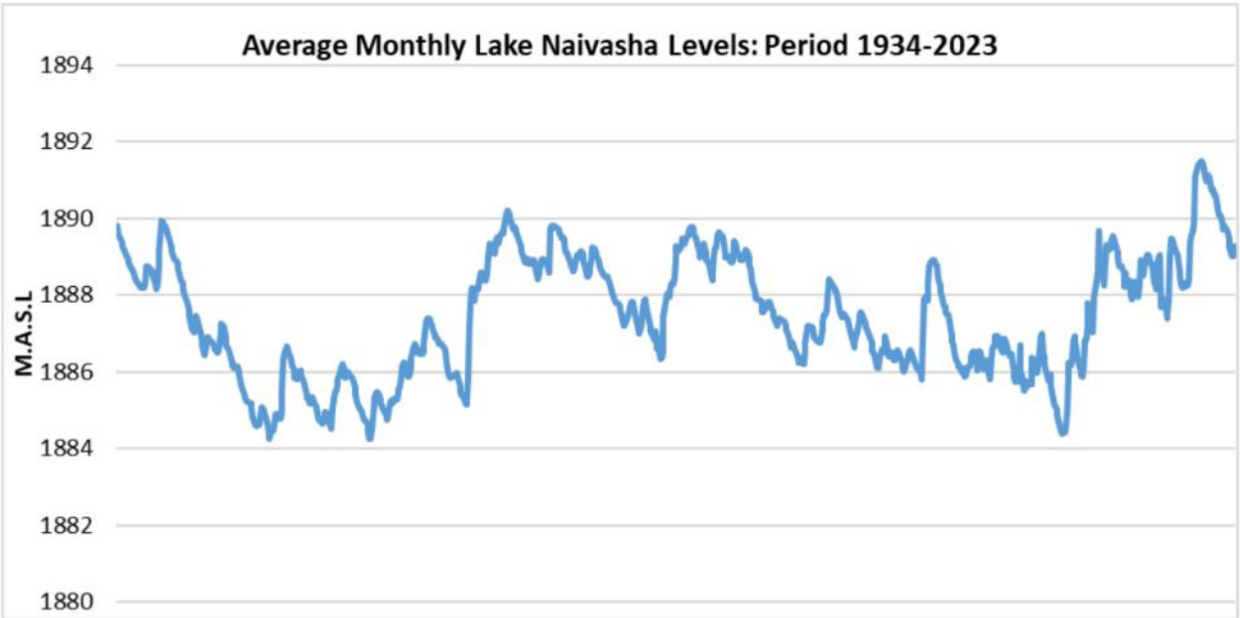


Figure 4-11: Lake Naivasha water level variations since January1934 to July 2023

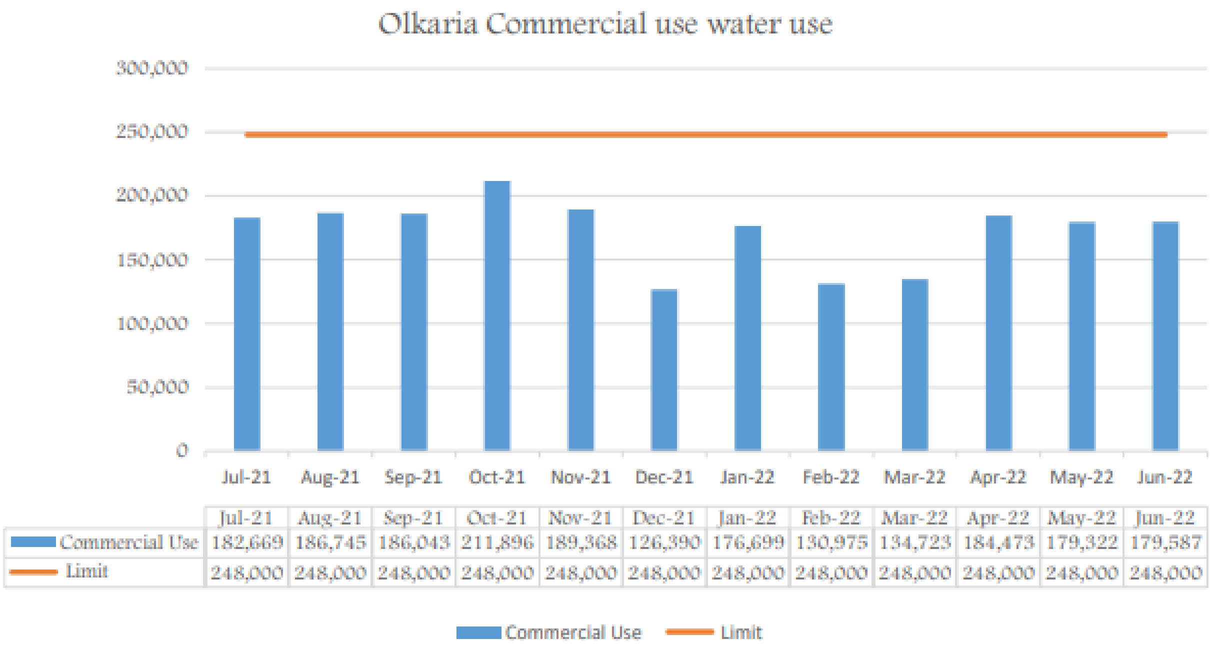
(Source: KenGen, 2023)

4.2.4.5 Water Abstraction from Lake Naivasha

From review of documents available at the Water Resources Authority (WRA)-Naivasha Office, it was noted that KenGen has an active Surface Water Abstraction Permits to abstract water from Lake Naivasha at a rate of: 795.40 m^3/day to meet housing/domestic uses at Olkaria; 8,000 m^3/day to meet industrial/commercial uses at Olkaria; and 2,600 m^3/day to meet public and industry/commercial uses at Eburru, - for the period between 2023 to 2028.

During the financial year 2021/22, the water abstracted for domestic and commercial use was below the permitted abstraction limits. The maximum permitted abstraction for

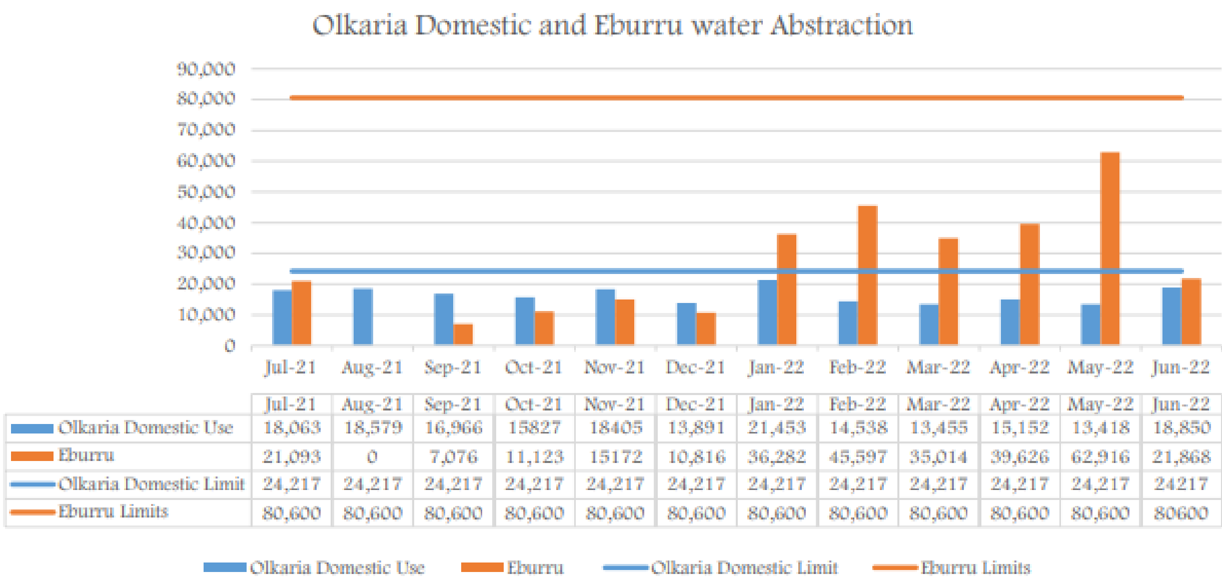
Olkaria, Eburru commercial activities and domestic use were 248,000M^3, 80,600M^3 and 24,217M^3, respectively. Additionally, the company re-used a total of 1,236,179m^3 of brine as a measure to conserve Lake Naivasha.



	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22
Commercial Use	182,669	186,745	186,043	211,896	189,368	126,390	176,699	130,975	134,723	184,473	179,322	179,587
Limit	248,000	248,000	248,000	248,000	248,000	248,000	248,000	248,000	248,000	248,000	248,000	248,000

Figure 4-12: Water abstracted for commercial use at Olkaria (June 2021 to June 2022)

(Source: KenGen, 2022)



	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22
Olkaria Domestic Use	18,063	18,579	16,966	15827	18405	13,891	21,453	14,538	13,455	15,152	13,418	18,850
Eburru	21,093	0	7,076	11,123	15172	10,816	36,282	45,597	35,014	39,626	62,916	21,868
Olkaria Domestic Limit	24,217	24,217	24,217	24,217	24,217	24,217	24,217	24,217	24,217	24,217	24,217	24217
Eburru Limits	80,600	80,600	80,600	80,600	80,600	80,600	80,600	80,600	80,600	80,600	80,600	80600

Figure 4-13: Water abstracted for domestic use in Olkaria & Eburru (June 2021 – June 2022)

(Source: KenGen, 2022)

For the period between January to October 2022, the quantity of water abstracted for both commercial and domestic uses was below the allowable permitted limits as shown

In the month of July, 2023, the water abstracted from Lake Naivasha for domestic and commercial uses is shown in the table and figure below.

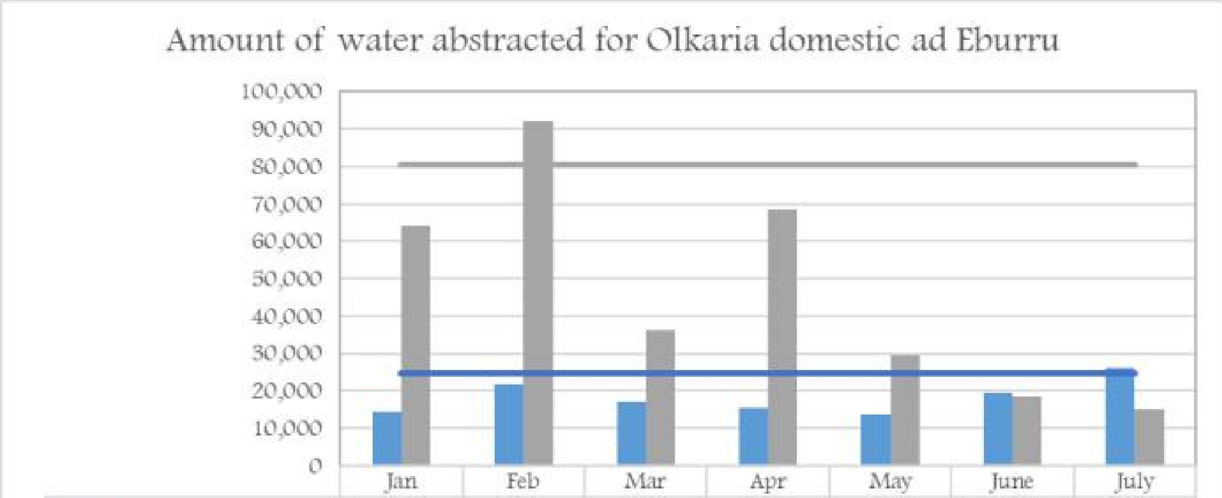
Table 4-6: Amount of water abstracted from lake Naivasha in July 2023

Abstraction Point	**Water Use**	**Amount abstracted (m^3)**	**WRA permitted levels (m^3/month)**	**Remarks**
Olkaria Housing pumping station	Olkaria domestic use	26,068	24,676	The amount of water abstracted was within the WRA permitted limits
Olkaria High-lift pumping station	Olkaria commercial operations	153,918	248,000	
Eburru pumping Station	Eburru operations & domestic use	15,179	80,600	
Total water abstracted		**195,165m_3**	**352,817m^3**	

(Source: KenGen, 2023)

The amount of water abstracted for domestic uses at Olkaria, commercial uses at Olkaria and Eburru operations and domestic uses in the month of July 2023 were 26,068m^3, 153,918m^3 and 15,179m^3, respectively. The water abstracted was within Water Resources Authority (WRA) permitted levels of 24,217m^3, 248,000m^3 and 80,600m^3 respectively. No brine was pumped following the shutting down of Olkaria I power plant for rehabilitation.

Figure 4-14: Water abstracted for commercial uses at Olkaria in July 2023
(Source: KenGen, 2023)



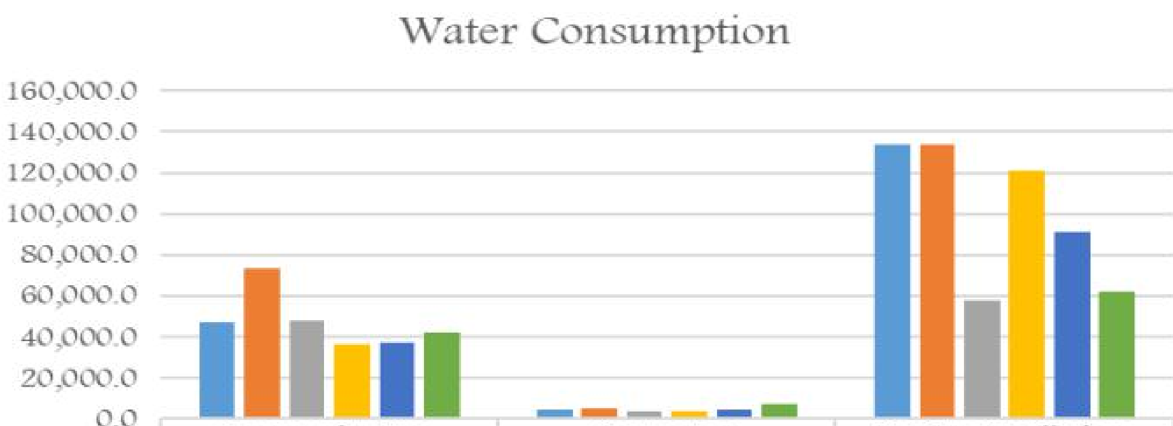
	Jan	Feb	Mar	Apr	May	June	July
Olkaria Domestic Use	14,454	21,678	17,143	15,219	13,796	19,424	26,068
Eburru	64,189	92,202	36,269	68,606	29,446	18,277	15179
Olkaria Domestic Limit	24,676	24,676	24,676	24,676	24,676	24,676	24,676
Eburru Limits	80,600	80,600	80,600	80,600	80,600	80600	80600

Figure 4-15: Water abstraction for domestic use in Olkaria and Eburru in July 2023

(Source: KenGen, 2023)

4.2.4.5.1 Water Consumption

KenGen supplies water to the community as part of CSR. Communities that benefit include; OW-801 Community (Olomaiyiana Kubwa), Inkorionito, Iseneto, Narasha, Eburru community and RAP Land. The company also supplies the contractors with raw water namely OR power 4 Inc., Sinopec, Geothermal Training Centre and H-YOUNG Olkaria II.



	Community Uses	Contractors	KenGen Installations
Jan	47,143.0	4,011.7	134,276.3
Feb	73,026.0	4,510.0	133,607.0
Mar	47,871.0	3,438.6	57,729.4
Apr	35,938.0	3,064.0	120,900.0
May	36,688.0	3,839.0	90,835.0
June	42,052.0	6,937.0	61,855.0

Figure 4-16: Water consumption by community, contractors and KenGen Installations

(Source: KenGen, 2023)

4.2.4.6 Lake Naivasha Water Quality

In Kenya's Eastern Rift Valley, Lake Naivasha is a freshwater body situated roughly 100 kilometres north of Nairobi, with a maximum depth of 8 meters. Oserian bay is one of the lake sites that borders Oserian flower farm and button hills sanctuary of animals. Table 4-7 and graphs thereunder displays the water quality parameters and nutrients of Oserian bay in the last 10 years (2012-2022), as recorded by the Kenya Marine and Fisheries Research Institute (KMFRI).

Oserian bay's water quality characteristics recorded pH values ranging 6.72 in 2021 to 8.40 in 2017, dissolved oxygen ranged between 6.08mg/l in 2017 to 10.50mg/l in 2022 and temperatures from 20.20˚C in 2015 to 25.05˚C in 2022. Secchi disk ranged between 11.10cm in 2015 to 84.70cm in 2016, total dissolved solids ranged from 0.10 mg/L in 2014 to 0.89 mg/L in 2018, salinity 0.08 ppt in 2020 to 0.12ppt in 2019, depth 3.36 metres in 2012 to 6.68 metres in 2020, nitrates 0.05mg/l in 2014 to 4.95 mg/l in 2021, phosphates 0.02mg/l in 2013 to 0.36mg/l in 2018 and conductivity 105.00(2013)-281.73(2016) µS/cm.

Table 4-7: Lake Naivasha Water Quality data from 2012 to 2022

Year	Temperature ^0C	Dissolved O_2 (mg/L)	pH	Secchi depth (cm)	TDS (mg/L)	Salinity (ppt)	Depth (m)	Nitrates (mg/L)	Phosphates (mg/L)	Conductivity (µS/cm)
2012	22.90	8.72	8.04	61.07	0.11	-	3.36	-	-	206.67
2014	20.20	-	7.36	55.04	0.10	-	5.80	0.05	0.02	105.00
2015	22.20	7.06	8.11	11.10	0.12	-	3.96	-	-	250.00
2016	22.16	8.30	7.95	84.70	0.89	-	5.20	0.15	0.08	224.14
2017	22.85	6.08	8.40	50.95	0.13	0.10	3.82	0.43	0.17	281.73
2018	21.76	7.99	7.86	38.43	0.16	0.11	3.86	0.87	0.36	228.71
2019	22.65	9.27	8.19	62.50	0.16	0.12	4.88	-	-	243.60
2020	22.71	8.11	7.80	64.30	0.10	0.08	6.68	1.18	0.22	161.70
2021	21.61	6.57	6.72	65.75	0.15	0.11	5.34	4.95	0.27	224.60
2022	25.05	10.50	-	63.00	0.14	0.12	6.07	1.69	0.15	-

(*Source: KMFRI*) *TDS – Total Dissolved Solids, Data trends of all the water quality data show that parameters have been relatively constant over the years. There is a notable difference in the 2015 and 2016 parameters which can be attributed to conservation measures by different stakeholders. One parameter that fluctuated most was the Secchi disk transparency while Ph was the most stable. There has been less transparency due to a combination of increased algal blooms brought on by rising eutrophication and the disappearance of macrophytes in the lake (Njiru, Waithaka & Aloo, 2017).

Ground seepage is the main reason behind the freshness of Oserian Bay and the entire lake despite the non-existence of a visible outlet (Ndung'u ,2014). The main causes of variations in Oserian bay's water level are subsurface seepage, rainfall, evaporation, and the quantity of water used. Studies have indicated that horticulture farms' usage of water for irrigation is linked to an 80% drop in water levels (Njiru, Waithaka & Aloo, 2017). On comparing the results of the data against water quality standards provided by NEMA, it was found that the pH and nitrates concentrations of Oserian Bay met the threshold standards for domestic water sources.

4.2.4.6.1 Temperature

The values of temperature varied across the period under review (Figure 4-17). The lowest values (20.2 °C) were recorded in 2014, and the highest (25.1 °C) in 2022. The rest of the period had relatively low temperatures ranging between 22.2 °C and 22.9 °C. Over the study period, the mean temperature (±SE) at Oserian Bay was 22.4 ± 0.4 °C. The general variations of temperature value could be attributed to the phenomena of lake level fluctuations. High volumes of water take longer to warm due to precipitation (Omondi *et al*., 2022).

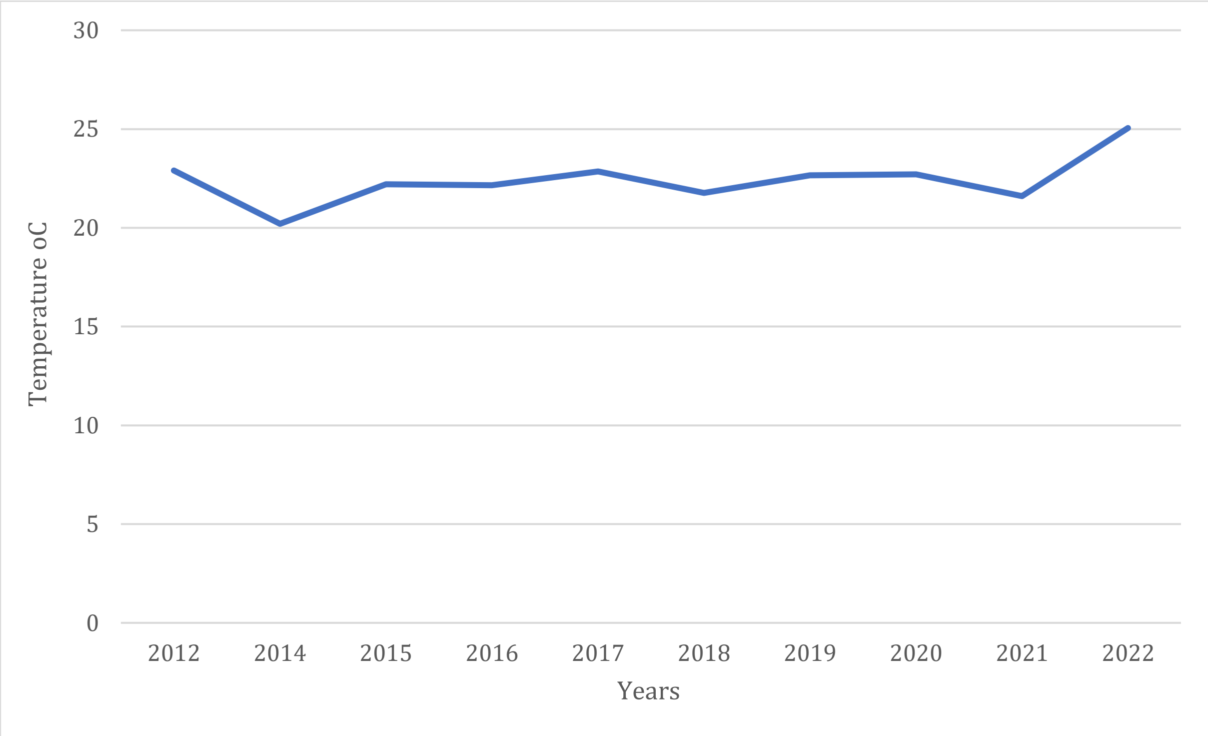


Figure 4-17: Temperature (°C) trends of water at Oserian Bay

4.2.4.6.2 Dissolved Oxygen

The levels of dissolved oxygen varied throughout the study period (Figure 4-18). The lowest values (6.08mg/L) were recorded in 2017, while the highest values(10.5mg/L) were recorded in 2022. Over the study period, the mean dissolved oxygen (±SE) at Oserian Bay was 8.1 ± 0.5mg/L. In 2017, there were significant fish kills in Lake Naivasha that could be attributed to the low dissolved oxygen in that year. Fish suffocation induced by night-time oxygen deprivation is a common cause of sudden fish deaths in bodies of water

Occasional fish kills are linked to natural factors such as changes in climatic conditions, which can lead to deoxygenation of the water, illnesses, stress, toxic algae, thermal shock, and salt shock, among others (Njiru *et al*., 2015).

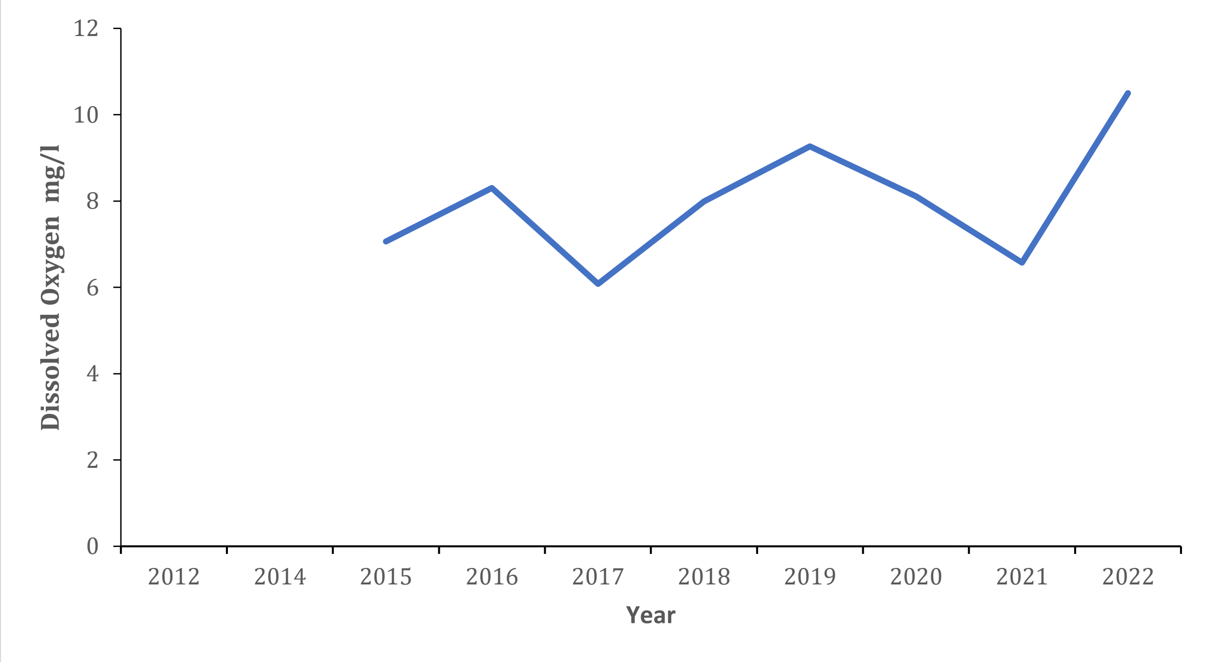


Figure 4-18: Dissolved Oxygen(mg/L)

4.2.4.6.3 pH

The levels of pH were relatively constant throughout the study period (Figure 4-19). The lowest values (6.72) were recorded in 2021, while the highest values (8.4) were recorded in 2017. The rest of the period had relatively constant pH values between 7.3 and 8.2. Over the study period, the median pH (±SE) at Oserian Bay was 8.0 ± 0.2. This is in line with NEMA standards for drinking water 6.5-8.5.

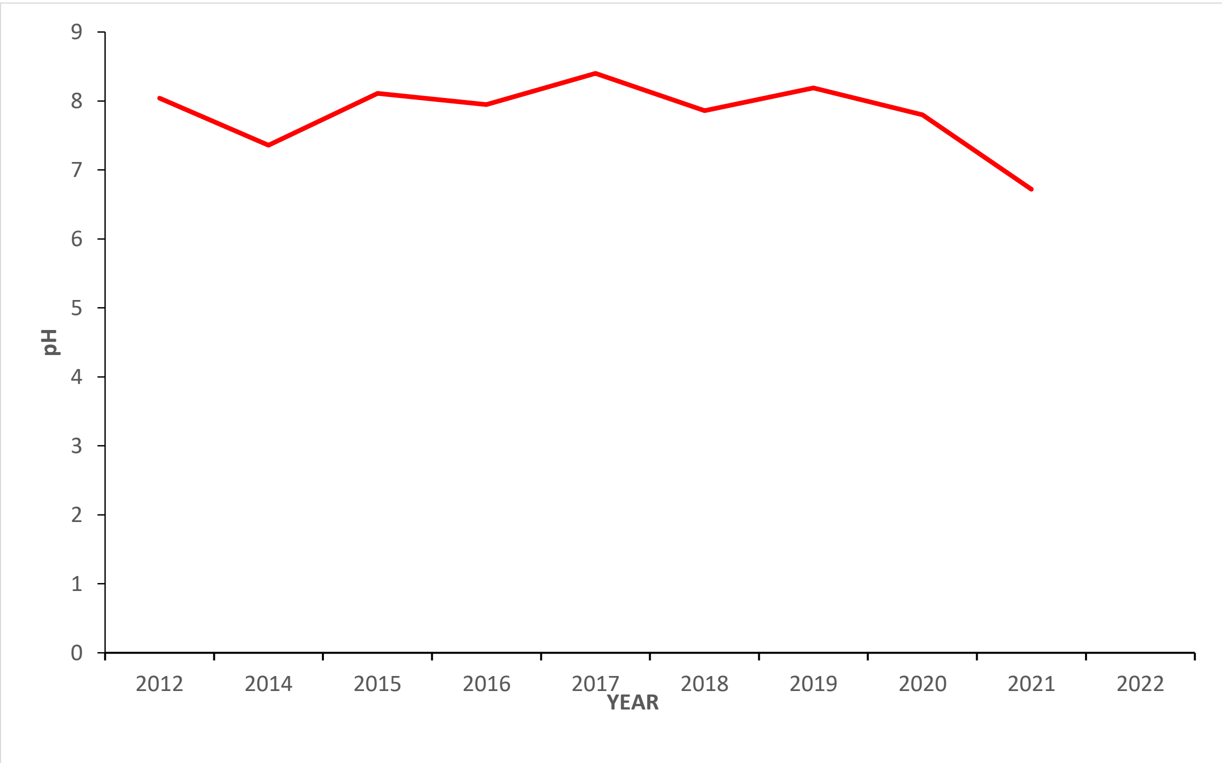


Figure 4-19: pH trends in Oserian Bay

4.2.4.6.4 Secchi Depth

The values of Secchi depth varied throughout the study period (Figure 4-20). The lowest values (11.1cm) were recorded in 2015 while the highest values(84.7cm) were recorded in 2016. The rest of the period had values of such depth ranging between 38.43 cm and 65.8. Over the study period, the mean secchi depth (±SE) at Oserian Bay was 55.7 ± 6.2. The main reason for the variations in Secchi depth could be attributed to the water turbidity, lower transparency could be caused by algal growth. The lake water levels are also known to affect the dynamism of turbidity since a decline in water levels leads to an increase in turbidity (Ndung'u ,2014).

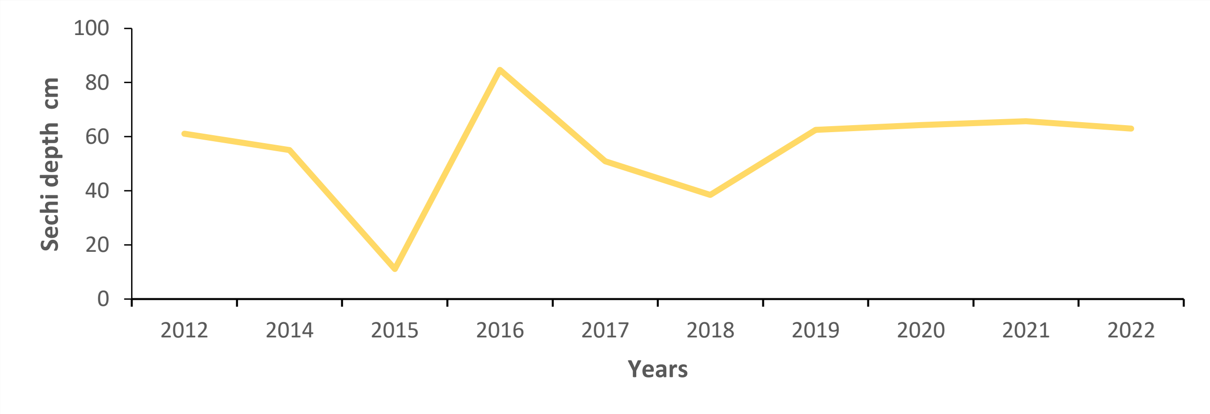


Figure 4-20: Secchi Depth (cm) trends of Oserian Bay

4.2.4.6.5 Total Dissolved Solids

The values of TDS varied across the period under review (Figure 4-21). The lowest values (0.1 mg/L) were recorded in 2020 and 2014, and the highest (0.89 mg/L) in 2016. The rest of the period had relatively low values of TDS, ranging between 0.11 and 0.16 mg/L. Over the study period, the mean TDS (±SE) at Oserian Bay was 0.2 ± 0.1 mg/L. The general variations of TDS values could be attributed to anthropogenic sources.

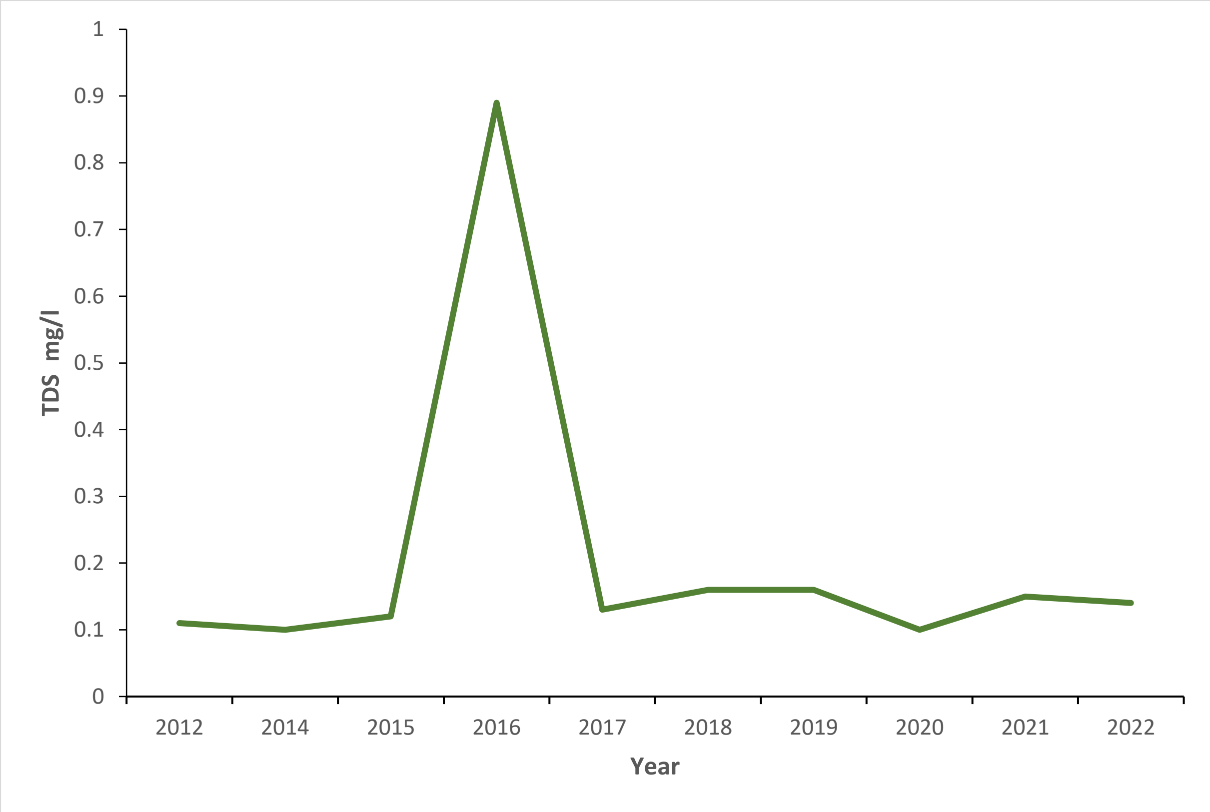


Figure 4-21: TDS (mg/L) trends in Oserian Bay

4.2.4.6.6 Salinity

The values of salinity were relatively constant across the period under review (Figure 4-22). The lowest values (0.08ppt) were recorded in 2020 and 2022, and the highest value (0.12ppt) in 2019. The rest of the period had relatively constant salinity values ranging between 0.10 and 0.12 ppt. Over the study period, the mean salinity (±SE) at Oserian Bay was 0.1 ± 0.0. The general variations of salinity values could be attributed to precipitation levels in the region. Also, the proximity of Oserian bay to Lake Oloidien has an impact on its salinity levels. There is higher salinity and species richness in Oserian Bay compared to other parts of lake Naivasha due to its proximity to Lake Oloiden (Carolyne et al., 2022).

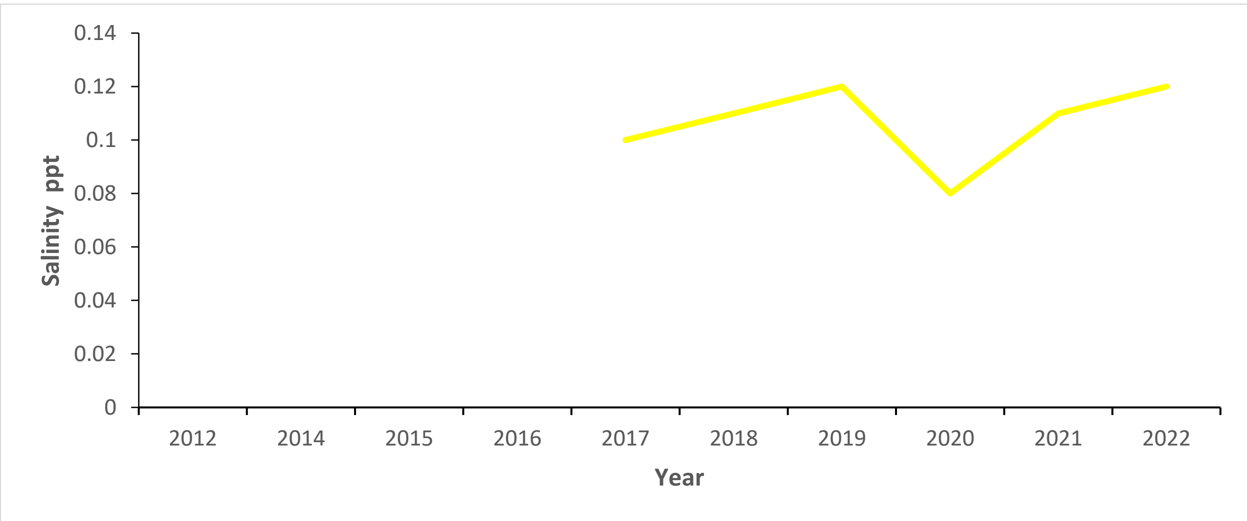


Figure 4-22: Salinity(ppt) trends in Oserian Bay

4.2.4.6.7 Depth

The values of depth varied across the period under review (Figure 4-23). The lowest values (3.4 m) were recorded in 2012 and the highest (6.7m) in 2020. The rest of the period had depth values ranging between 3.8m and 6.0m. Over the study period, the mean depth (±SE) at Oserian Bay was 4.9 ± 0.4 m. The general fluctuations in Oserian Bay's water level could be due to sedimentation and increased water abstraction. A study by Morara *et al.,* (2022) also suggests that water level fluctuations in Lake Naivasha could be due to extended dry and wet seasons and excessive water abstraction from the lake and its catchment basin from crop irrigation and other human uses.

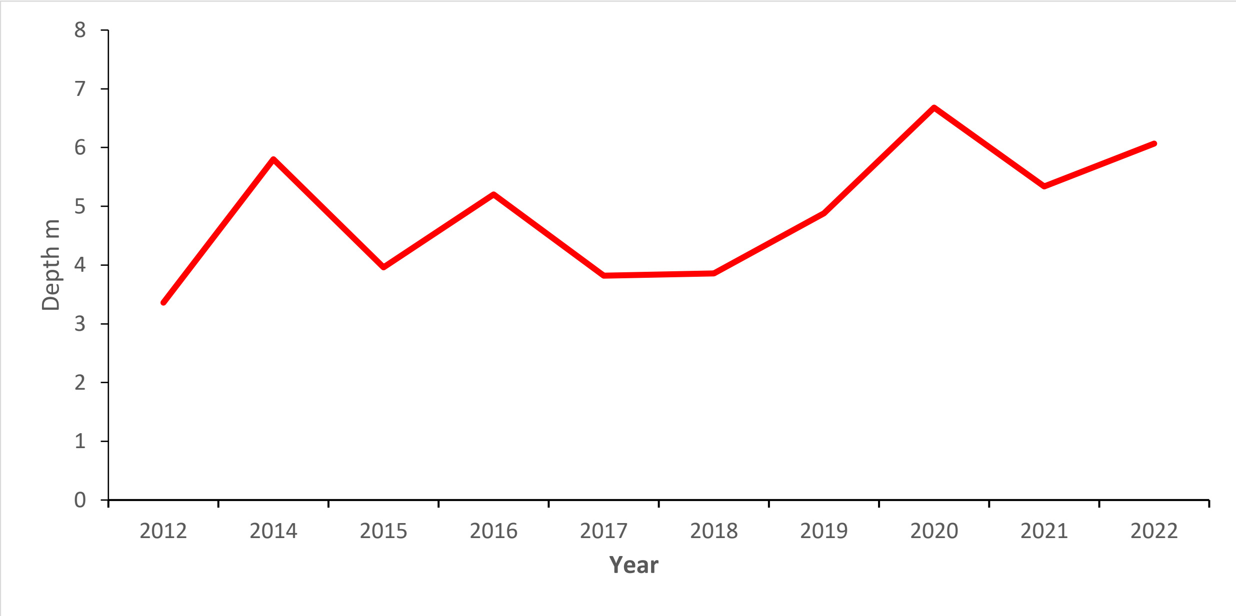


Figure 4-23: Depth(m) trends in Oserian Bay

4.2.4.6.8 Nitrates

The values of temperature varied across the period under review (Figure 4-24). The lowest values (0.05 mg/l) were recorded in 2014 and the highest (4.9 mg/l) in 2022. However, some of the data was not available. Over the study period, the mean nitrates values (±SE) at Oserian Bay were 1.3 ± 0.6 mg/l. The general variations of nitrate value could be attributed to anthropogenic activities.

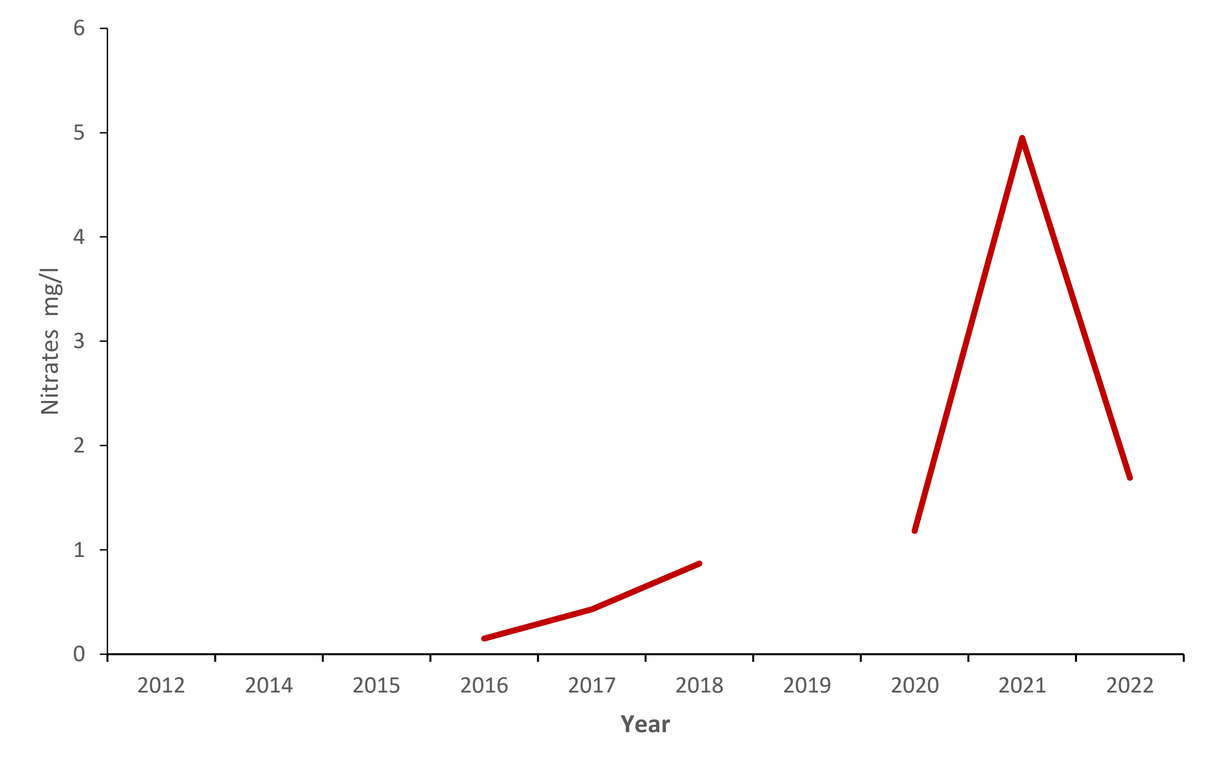


Figure 4-24: Nitrates (mg/l) trends in Oserian Bay

4.2.4.6.9 Phosphates

The values of phosphates varied across the period under review (Figure 4-25). The lowest values (0.02mg/l) were recorded in 2014, and the highest value (0.36mg/l) in 2018. The rest of the period values of phosphates ranged between 0.08 and 0.27 mg/l. Over the study period, the mean phosphates level (±SE) at Oserian Bay was 0.2 ± 0.0mg/l. The general variations of phosphate values could be attributed to the runoff from fertilizers. Onyango *et al.*, (2023) suggest that the agricultural intensification in L. Naivasha is contributing to the nutrient enrichment and eutrophication in the lake.

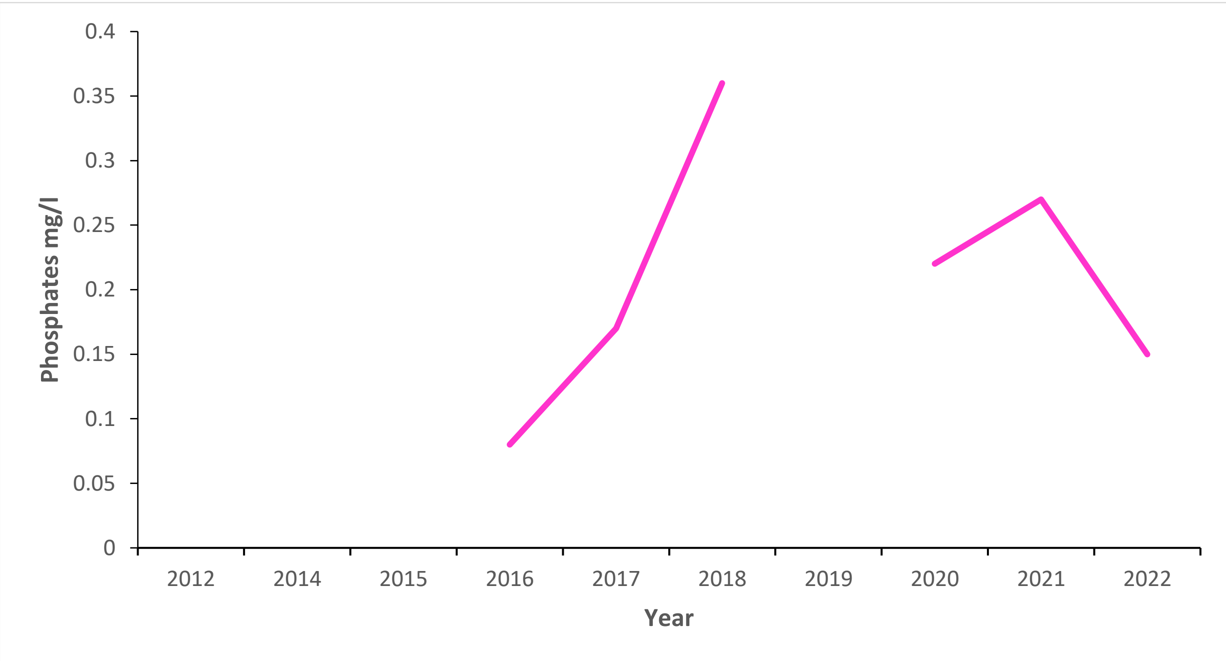


Figure 4-25: Phosphates(mg/l) trends in Oserian Bay

4.2.4.6.10 Conductivity

The values of conductivity varied across the period under review (Figure 4-26). The lowest values (105.0 µS/cm) were recorded in 2014, and the highest value (281.3µS/cm) in 2017. The rest of the period values of conductivity ranged between 161.7 and 228.7 µS/cm. Over the study period, the mean conductivity level (±SE) at Oserian Bay was 213.9 ± 17.4 µS/cm. The general variations of conductivity values could be attributed to the connection between Oserian Bay and Lake Oloidien through underground seepage.

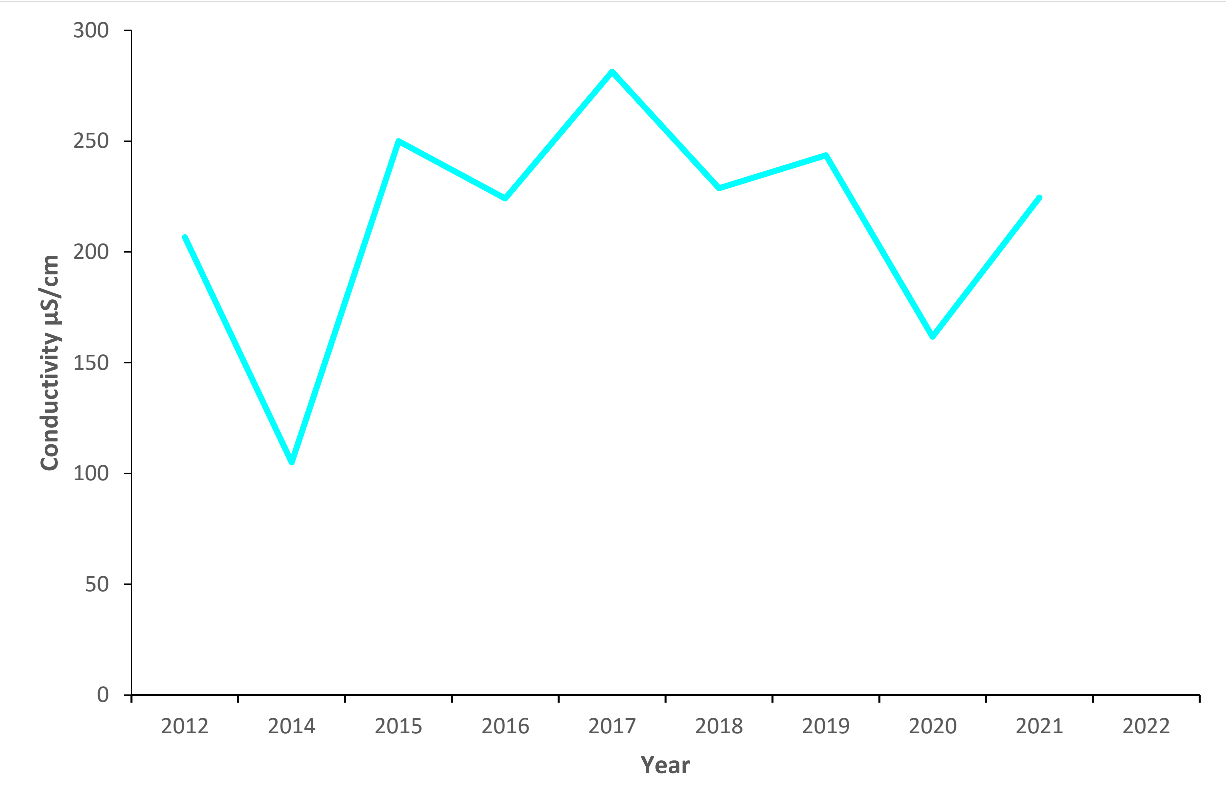


Figure 4-26: Conductivity (µS/cm) trends in Oserian Bay

4.2.5 Baseline GHG Emissions

The GHG emissions that would occur in the absence of the geothermal project are normally calculated. This typically involves assessing the energy mix in the grid and determining how much CO_2 is emitted per unit of electricity generated (e.g., kg CO_2/MWh). In Kenya, diesel oil is taken as the base fuel that geothermal energy would displace, hence the baseline emission factor of 0.865 metric tons of CO_2 per MWh.

- **Geothermal Plant's Electricity Generation**: This involves determining how much electricity the geothermal plant produces over a specific period. This is influenced by the plant's efficiency. An efficient geothermal plant will generate more electricity from the same heat source than a less efficient one.
- **Factor in Plant's Own Emissions**: Geothermal plants have been known to have their own emissions, mainly in the form of trace gases like CO_2, hydrogen sulphide, and methane (Zarrouk & Moon, 2014). These GHG emissions of the geothermal plant are subtracted from the calculated displaced emissions to get the net emission reduction.

- **Resulting Emission Reductions**: The difference between the displaced emissions and the plant's own emissions gives the total GHG emission reductions attributed to the geothermal project.

The crux of the matter is that the more efficient a geothermal plant is, the more electricity it produces from a given heat source, leading to greater displacement of fossil fuel-based energy and thus more significant emission reductions. The actual methodology for these calculations can vary based on several factors but mostly guidelines set by the certifying body for instance most of the Certified Emission Reductions (CERs) issued to KenGen from already operating geothermal plants are from the Clean Development Mechanism (CDM) under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC).

4.2.6 Air Quality

Air quality assessment was done within the proposed project site and the project area of influence. The assessment was based on Air quality standards as provided in the Environmental Management and Coordination (Air Quality) Regulations, 2014. Although bordering commercial, settlement and grazing areas, the project site can be classified as an industrial area. These regulations under the property boundary states that No person, operator, or owner of any facility shall cause or allow fugitive emissions to cause the ambient air quality at its property boundary to exceed the limits prescribed under the First Schedule. It further states that, no person, owner, or operator of a facility shall cause or allow the emission of air pollutants over the limits stipulated under the Third Schedule.

The third schedule further specifies the emissions limits for controlled and non-controlled facilities. The proposed power plant will use steam and will be required to monitor Carbon Dioxide (CO_2), Hydrogen Sulphide (H_2S), Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NOx) as these would be the most significant air pollutants emitted by the facility.

Table 4-8: EMCA Ambient Air Quality Limits

Pollutant	TWA (hrs.)	Industrial area (µg/m3)
Suspended Particulate Matter (SPM)	24	500
Particulate Matter (PM10)	24	150
Particulate Matter (PM2.5)	24	75
Sulphur Dioxide (SO2)	24	125
Nitrogen Dioxide (NO2)	24	80
Carbon Monoxide (CO)/Carbon Dioxide (CO2)	8	5.0
Ozone	1	200
Total VOCs	24	600
Non-Methane Hydrocarbons	Instant peak	0.7

The World Health Organization (WHO) has published the Ambient Air Quality Guidelines (AQG) and the guideline values are as presented in the table below. The limits are broadly similar to EU Limit Values and are not mandatory. They have been set at a level that protects human health for all members of the public.

Table 4-9: WHO Ambient Air Quality Limits

Pollutants	Averaging Period	Interim Target 1($\mu g/m^3$)	Guideline Value in ($\mu g/m^3$)
PM_{10}	Annual	35	15
	24-hour[a]	75	45
$PM_{2.5}$	Annual	70	5
	24-hour	150	15
Sulphur dioxide	1-hour	40	500
	24-hour	125	40
Nitrogen Dioxide	Annual	40	10
	24-hour	120	25
Carbon Monoxide (CO)	24-hour	7 mg/m^3	4 mg/m^3

Source: WHO Air Quality Guidelines, 2021

The Ambient Air Quality (AAQ) measurements were done continuously for a period of 30 minutes at each monitoring point. The average value for each pollutant is reported as shown in Table 4-10 and Table 4-11.

Table 4-10: Results for TVOCs, $PM_{2.5}$ and PM_{10}

Description	TVOCs	PM 2.5	PM 10
Location	**Average ($\mu g/m^3$)**	**Average ($\mu g/m^3$)**	**Average ($\mu g/m^3$)**
KWS Staff Quarters near the Olkaria gate	154.1	2.63	7.94
Geothermal SPA	325.1	2.96	5.24
Olomaiyiana Baptist Church	58.4	12.70	33.36
Narasha Primary School	271.3	3.38	8.23
Geothermal Training Centre	178.7	8.20	13.43
EMCA Air Quality Limits	**600 $\mu g/m^3$**	**75 $\mu g/m^3$**	**150 $\mu g/m^3$**

Table 4-11: Results for H_2S, SO_2 and NO_2

Description	**H_2S**	**SO_X**	**NO_X**
Location	**Average (µg/m³)**	**Average (µg/m³)**	**Average (µg/m³)**
KWS Staff Quarters near the Olkaria gate	28.30	136.65	2.79
Geothermal SPA	147.8	137.41	2.87
Olomaiyiana Baptist Church	66.4	80.50	37.24
Narasha Primary School	110.7	1.70	58.70
Geothermal Training Centre	58.1	0.85	4.04
EMCA Limits	**150 µg/m³**	**125 µg/m³**	**150 µg/m³**

The findings of the ambient air quality measurement survey indicated that the baseline conditions within and surrounding the project area were within the acceptable levels stipulated by the Environmental Management and Coordination (Air Quality) Regulations, 2014. However, as for Hydrogen Sulphide, areas such as Geothermal Spa and Narasha Primary School were a bit elevated at 147.8 µg/m³ and 110.7 µg/m³, as compared to the EMCA limit of 150 µg/m³. The findings of H_2S at the other receptors that were monitored included: 66.4 µg/m³ at Olomaiyiana Baptist Church; 58.1 µg/m³ at the Geothermal Training Centre and 28.3 µg/m³ at the KWS Staff Quarters near the Olkaria gate.

Additionally, measurements for Sulphur Oxides at the receptors were within the EMCA guidelines, except for the Geothermal Spa and KWS Staff Quarters near Olkaria gate, which exceeded the allowable limits at 137.41 µg/m³ and 136.65 µg/m³ respectively, against the EMCA limits of 125 µg/m³. While Sulphur dioxide may not be of major concern, it can cause respiratory problems such as bronchitis, and can irritate your nose, throat and lungs. It may also cause coughing, wheezing, phlegm and asthma attacks. The effects are worse when one is exercising near the source. Sulphur dioxide has also been linked to cardiovascular diseases. The high levels of Sulphur dioxide concentration observed at the Geothermal Spa and KWS Staff Quarters near Olkaria Gate, can be attributed to increased traffic activities rather than due to the operations of Geothermal Resource Development. Vehicles used by visitors/tourists, KWS and/or KenGen staff members, are the likely contributors of elevated levels of Sulphur Dioxide at the Olkaria Gate and Geothermal Spa, especially during the day, when they visit or carry out their day-to-day operations at these two locations. The drivers of the cars/trucks used by the above-mentioned groups occasionally leave their engines running while parked, waiting to be processed/served. Studies have shown that idle car engines that are left running release more exhaust fumes (including Sulphur dioxide), into the air than when the vehicle would be moving. Finally, measurements for Nitrogen Oxides, Total Volatile

Organic Compounds (TVOCs), $PM_{2.5}$ and PM_{10}, at all receptors were within the EMCA ambient air quality limits.

Hydrogen Sulphide

Hydrogen Sulphide is heavier than air and H_2S is both an irritant and an asphyxiate gas due to this property. According to the WHO, levels up to 20 ppm generally have no effects on healthy people except for asthmatic people where the exposure level must be 2 ppm maximum. Concentrations above 20ppm can cause irritation of the eyes and respiratory tract, above 50-100 ppm can cause neurotoxic effects while 500-1,000 ppm are of immediate life danger (WHO 2005). World Health Organization gives a value for smell to become a nuisance at 7 ($\mu g/m^3$) and above, at a 30-minute average.

The Kenyan Environmental Management and Coordination (Air Quality) Regulations, 2014 sets the 24-hr ambient air quality value of **150 $\mu g/m^3$** for industrial areas/zones. Currently, there are no set limits for residential and controlled areas.

The Kenyan occupational exposure standards provide threshold limits for hazardous chemical substances under the Factories and Other Places of Work (Hazardous Substances) Rules, 2007. The occupational exposure limits for H_2S are set at **10 ppm (14 mg/m^3)** and **15 ppm (21 mg/m^3)** for both **8-hour** average (TWA) and short-term (STEL) **15**-minute average periods, respectively.

Table 4-12: Kenyan Ambient Air Quality Tolerance Limits

Pollutant	Averaging Period	EMCA (Air quality) Regulation, 2014 Limits ($\mu g/m^3$)
Hydrogen Sulphide (H_2S)	24 hours	150
	1 year	NR

Table 4-13: Heath Effects and approximate corresponding H_2S Concentration, WHO

Health Effect	H_2S Concentration		Reference
No Observed Adverse Effect Level	0.0014 µL/L	0.0021 mg/m^3	EPA/600/R-14/039
Odour threshold	0.007 µL/L	0.0105 mg/m^3	EPA/600/R-14/039
Bronchial constriction in asthmatic individuals	2 µL/L	3 mg/m^3	EPA/600/R-14/039
Eye irritation	4 – 21 µL/L	6 – 31.5 mg/m^3	EPA/600/R-14/039
Fatigue, loss of appetite, headache, irritability, poor memory, dizziness	20 µL/L	30 mg/m^3	EPA/600/R-14/039

Olfactory paralysis	>100 µL/L	>150 mg/m^3	EPA/600/R-14/039
Respiratory distress	>400 µL/L	>600 mg/m^3	EPA/600/R-14/039
Death (likely a result of respiratory failure/arrest)	>500 µL/L	>750 mg/m^3	EPA/600/R-14/039

Source: WHO Guidelines, 2005

Table 4-14: Examples of United States and Regional H_2S Gas Standards, Guidelines and Screening

Standards, Guidelines and Screening Level Description	**H_2S Concentration**		**Form**	**Reference**
California Ambient Air Quality Standard	0.03 µL/L	0.045 mg/m^3	1-hour average	EPA/600/R-14/039
Maine Ambient Air Guidelines	0.03 µL/L	0.045 mg/m^3	30-minute average	EPA/600/R-14/039
	0.001 µL/L	0.0015 mg/m^3	1-year average	
Minnesota Ambient Air Quality Standards (applies to property boundary, primary standards)	0.05 µL/L	0.075 mg/m^3	30-minute average not to be exceeded > 2 times per year	EPA/600/R-14/039
	0.03 µL/L	0.045 mg/m^3	30-minute average not to be exceeded > 2 times in any 5 consecutive days	
Montana Ambient Air Quality Standards (17.8.214)	0.05 µL/L	0.075 mg/m^3	1-hour average not to be exceeded > once per year	EPA/600/R-14/039
New Mexico (20.2.3.110)	0.01 µL/L	0.015 mg/m^3	1-hour average	EPA/600/R-14/039
New York Ambient Air Quality Standards (257-10.3)	0.01 µL/L	0.015 mg/m^3	1 hour	EPA/600/R-14/039
Pennsylvania Ambient Air Quality Standards	0.005 µL/L	0.0075 mg/m^3	24 hours	EPA/600/R-14/039
	0.1 µL/L	0.15 mg/m^3	1 hour	
	0.0015 µL/L	0.00225 mg/m^3	Residential Air	EPA/600/R-14/039

U.S. EPA Region 9 Regional Screening Levels (Also used by U.S. EPA Region 3 and 6[1])	0.0063 µL/L	0.00945 mg/m³	Industrial Air	

A summary of the potential health effects of H_2S, from the New Zealand Ambient Air Quality Guidelines, is presented in Table 4-15. As indicated in the table, the levels at which the health effects of H_2S become a concern are well above the level at which it is considered to be a nuisance odour. In general, emissions from most geothermal power plants are at a level, which could produce nuisance odour effects, but are well below levels for adverse health effects.

Table 4-15: Potential Health Effects of H_2S

Concentration (µg/m³)	Effect
0.2-2.0	Odour threshold - detectable by 50% of people. Considered to have a smell of "rotten eggs" at 3 to 4 times this concentration
7.0	Nuisance odour level (not considered applicable to geothermal areas)
15,000	Eye irritation
70,000	Permanent eye damage
225,000	Paralysis of olfactory perception (odour can no longer be detected)
400,000	Risk of pulmonary oedema
750,000	Over-stimulates the central nervous system, causing rapid breathing, cessation of breathing, convulsions, and unconsciousness
1,400,000	Lethal

Source: New Zealand Ministry for the Environment

4.2.6.1 Background Air Quality

The ambient air quality monitoring data from KENGEN's environmental laboratories for Olkaria Power Plants and Olomayiana areas for the period between 2018 to 2023 was used to assess the background air quality levels for environmental and human health purposes. The concentrations of the Hydrogen Sulphide (H_2S) values are summarized in Table 4-16 and Table 4-17 below.

Plate 4-3: Ambient air sampling during the October 2023 campaign

The air quality monitoring data shows increasing trends of ambient levels of Hydrogen Sulphide for the five years (2018-2023), with the first two years representing mainly the construction period of Olkaria V power plant 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 4-16: Summary of background air quality levels (2018-2023)

Pollutant/Location	Air Quality Level (µg/m³)							Kenya AQ Criteria
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**Max**	**(µg/m³)**
H_2S /Within the Power Plants	11	139	167	112	279	418	**418**	**13,939**
H_2S/KWS Olkaria Gate	21	NR	NR	NR	NR	NR	**21**	**150**

NR: Not Reported

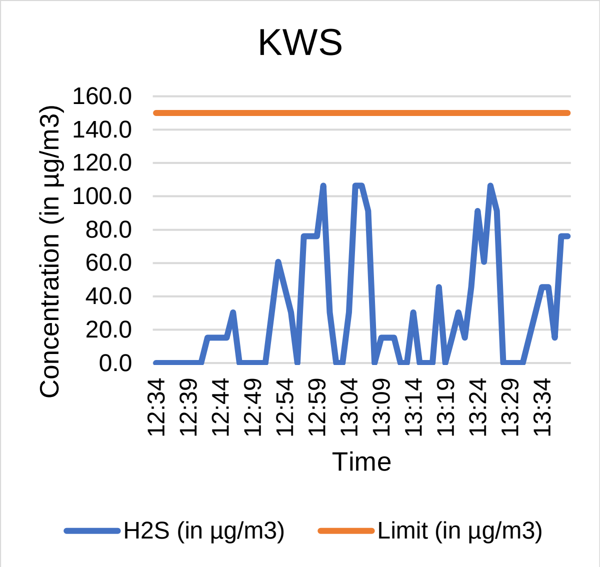
Table 4-17: Actual ambient air quality measurement data October 2023

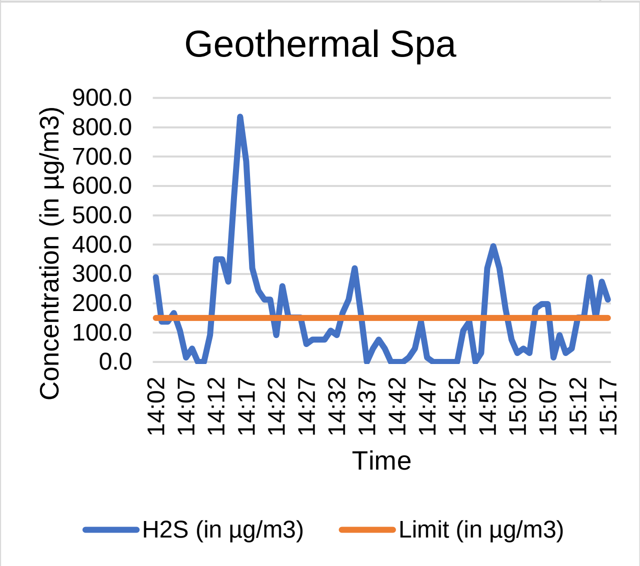
Location	UTM Coordinates		Air Quality Level (µg/m³)	Kenya AQ Criteria (µg/m³)
	X	**Y**	**2023**	

KWS Staff Quarters near Olkaria Gate	198618.54	9905146.06	28.3	**150**
Geothermal Spa	198932.47	9904579.10	147.8	**150**
Olomaiyiana Baptist Church	200051.26	9898827.95	66.4	**150**
Narasha Primary School	196141.36	9898206.02	110.7	**150**
Geothermal training Centre	201570.96	9908830.98	58.1	**150**

NR: Not Reported

Figure 4-27: Ambient air quality monitoring points (October 2023) campaign


KWS
Concentration (in µg/m3)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
12:34
12:39
12:44
12:49
12:54
12:59
13:04
13:09
13:14
13:19
13:24
13:29
13:34
Time
H2S (in µg/m3)
Limit (in µg/m3)


Geothermal Spa
Concentration (in µg/m3)
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
14:02
14:07
14:12
14:17
14:22
14:27
14:32
14:37
14:42
14:47
14:52
14:57
15:02
15:07
15:12
15:17
Time
H2S (in µg/m3)
Limit (in µg/m3)

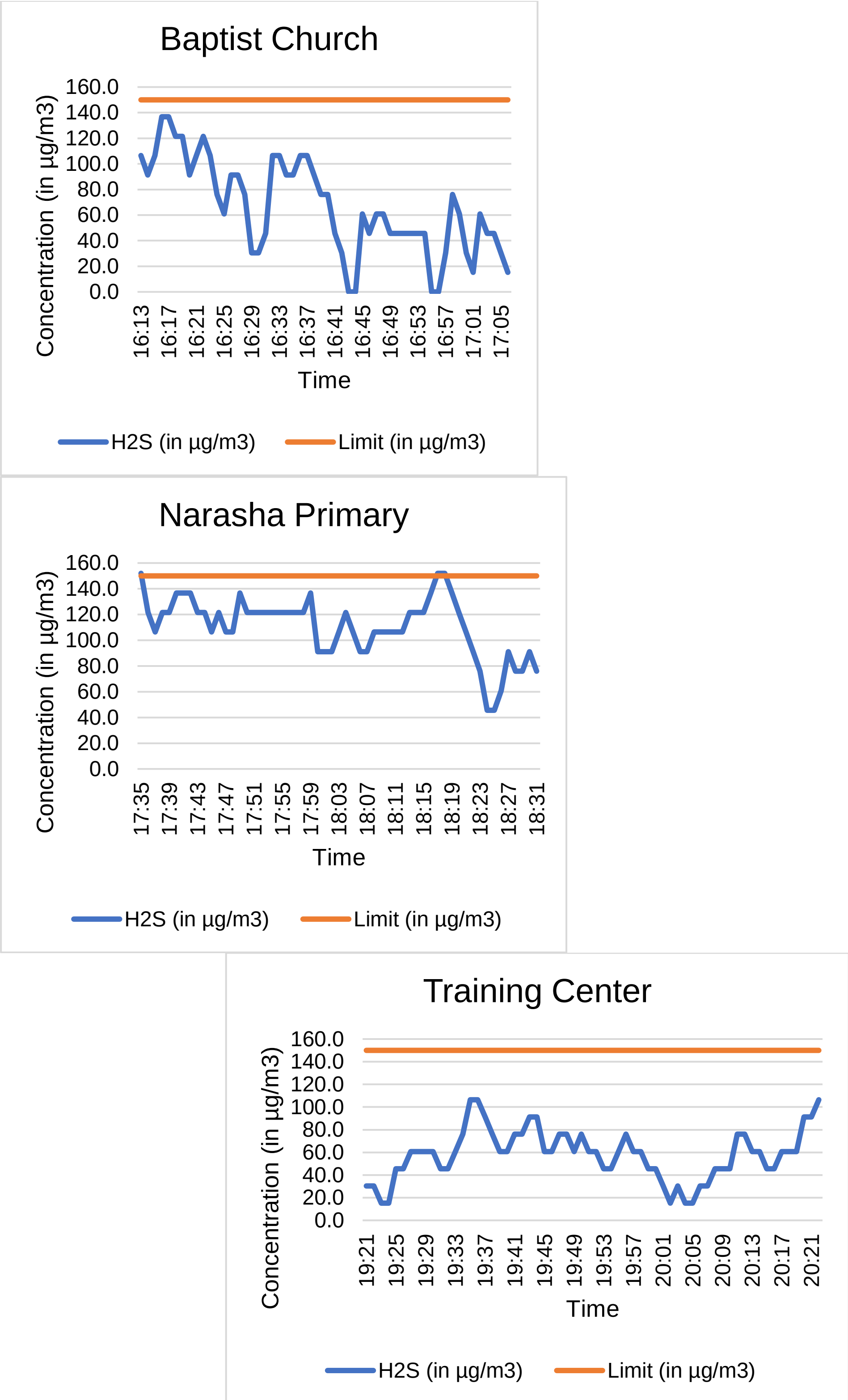


Figure 4-28: Graphical Presentation of measured H_2S Results

4.2.6.2 Air Dispersion Modelling

AERMOD software for atmospheric dispersion modelling was used to predict the H_2S concentrations in the vicinity of the proposed Olkaria II Extension Geothermal Power Plant. AERMOD is a comprehensive multi-level air dispersion modelling system that simulates essential atmospheric physical processes and provides refined concentration estimates over a wide range of meteorological conditions and modelling scenarios (US

EPA, 2004). The model assumes the pollutant concentration distribution to be Gaussian in both vertical and horizontal directions. In this distribution, the pollutant concentration profile assumes that maximum concentrations are encountered in the centre of the plume, with concentrations decreasing towards the edge following the shape of a bell curve. AERMOD comprises two pre-processors AERMET and AERMAP.

4.2.6.3 Maximum Air Quality Impacts

The results are provided in tabular form as discrete values simulated at the boundaries' locations. The isopleths were used selectively to present areas of significance to the assessment criteria. Ground level concentration isopleths depict interpolated values from the concentrations simulated by AERMOD 10.2.0 for each of the receptor grid points specified. The areas of maximum concentration are depicted in the table below in comparison to the Kenyan Air quality Standards. The areas of maximum concentrations were mainly near the existing power plant and wells.

It should be noted that the modelling results represent the maximum predicted proposed plant contribution for H_2S during the entire four-year modelling period, the values are therefore conservative.

Table 4-18: Maximum predicted PCs of air pollutants for the existing plants and other sources

Pollutant	**Average Period**	**Maximum PC (µg/m³)**	**Kenya Air Quality Limit (µg/m³)**	**PC as % of the Limit**
H_2S	1-hour	8442	**NR**	**-**
	8-hour	2269	**13,939**	**16**
	24-hour	911	**150**	**607**
	Annual	150	**NR**	**-**

***NR** – Not Regulated*

The table below shows the results for all source groups at the sensitive receptors to determine the impact on the community.

Table 4-19: H_2S Levels at different sensitive receptors

Averaging Time	**H_2S (µg/m³)**			
	1 hour	**8 hours**	**24 hours**	**Annual**
Air Quality Standards	**NR**	**13,939**	**150**	**50**
KWS Staff Quarters near the Olkaria gate	600	200	100	10
Geothermal Spa	900	200	100	10

Olomayiana Baptist Church	165	200	80	10
Narasha Primary School	500	100	50	8
Geothermal Training Centre	165	100	60	10

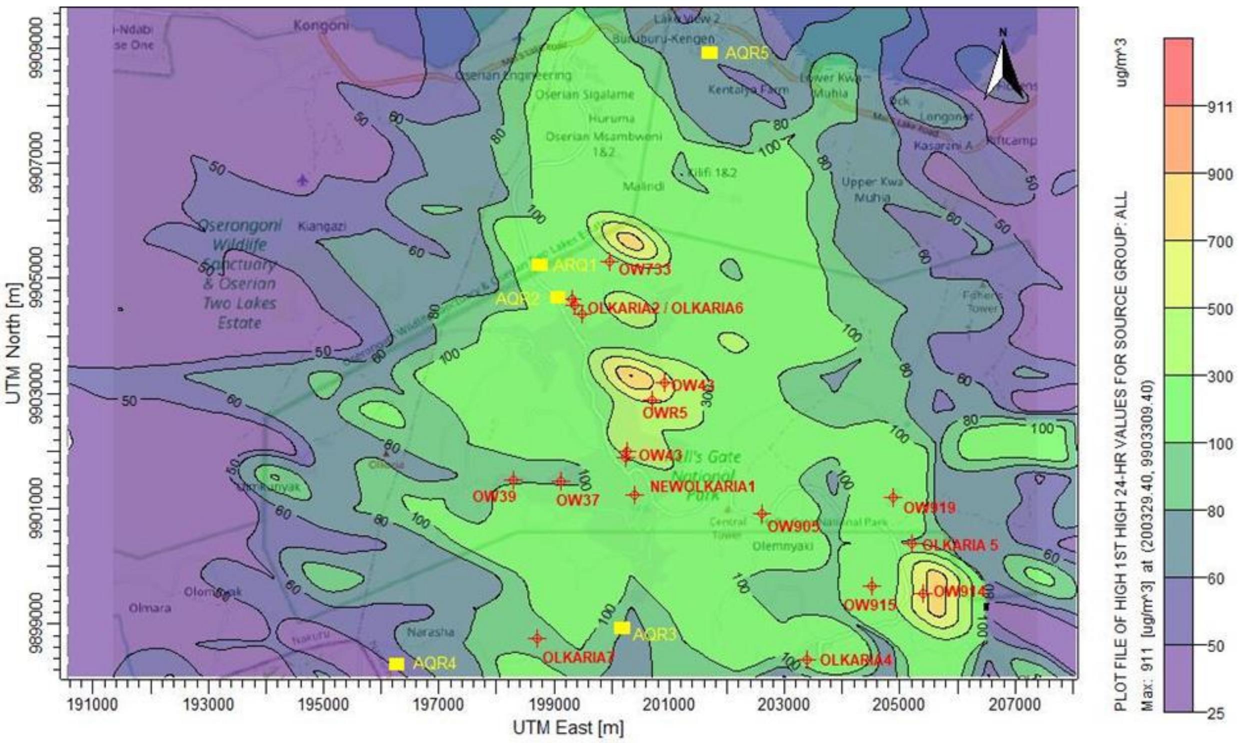


Figure 4-29: Maximum ground level 24-hr H_2S concentrations

4.2.6.4 Maximum Air Quality Impacts Scenario with the Proposed Extension

The results in the table below show the maximum predicted modelled concentrations for the proposed plant, modelled with the case of site expansion. The highest average H_2S concentration was recorded around the well areas.

Table 4-20: Maximum air quality impact for the scenario with the proposed extension

Pollutant	**Average Period**	**Maximum PC (µg/m³)**	**Kenya Air Quality Limit (µg/m³)**	**PC as % of the Limit**
H_2S	1-hour	1431	**NR**	**-**
	8-hour	462.4	**13,939**	**3.34**
	24-hour	274.0	**150**	**182.7**
	Annual	21.60	**NR**	**-**

NR – Not Regulated

Table 4-21: Simulated air emissions results at the receptors depicting the case for Olkaria II Extension.

Averaging Time	H_2S (µg/m³)			
	1 hour	8 hours	24 hours	Annual
Air Quality Standards	**NR**	**13,939**	**150**	**NR**
KWS Staff Quarters near the Olkaria gate	80	20	5	0.6
Geothermal Spa	100	60	20	2.0
Olomaiyiana Baptist Church	30	20	10	1.0
Narasha Primary School	30	10	6	0.2
Geothermal Training Centre	30	10	5	0

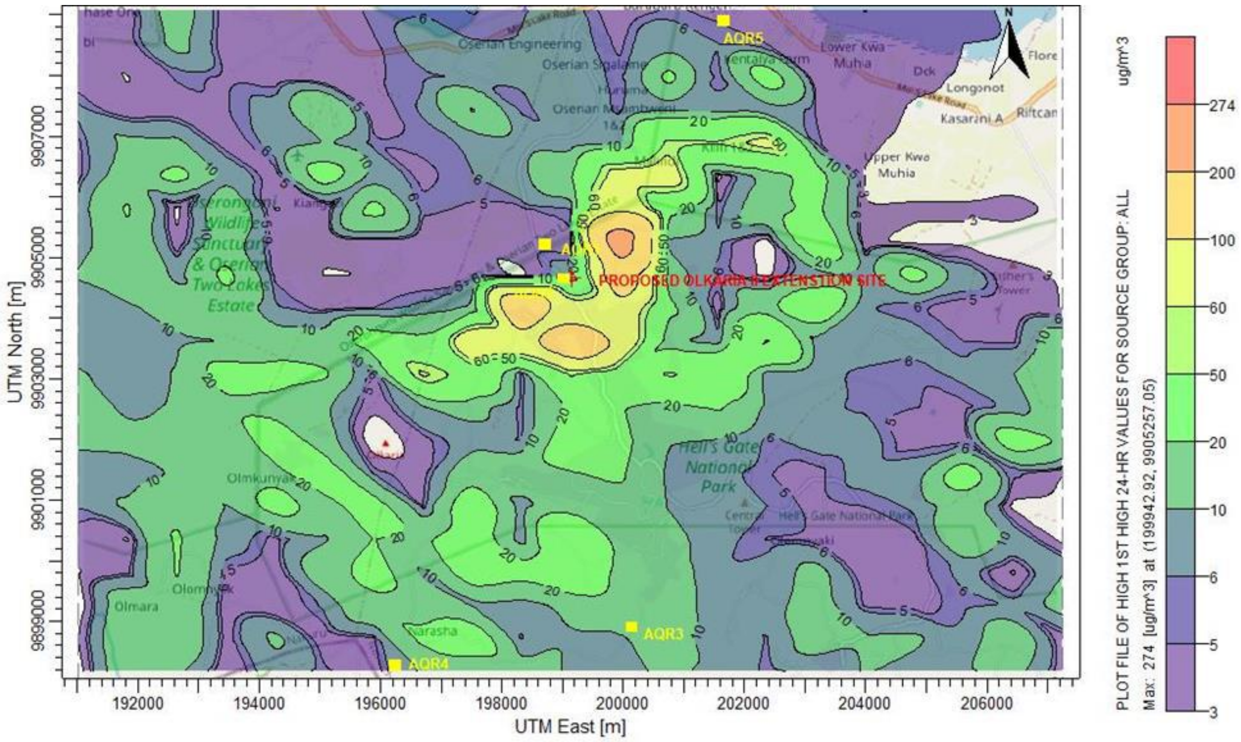


Figure 4-30: Maximum ground level 24-hr H_2S concentrations for Olkaria II Extension case

4.2.6.5 Cumulative Impacts – Predicted Environmental Contribution

The cumulative results were calculated as:

Process Contribution (PC) + Background Contribution

The results in Table 4-22 show the maximum predicted modelled concentrations as well as background levels.

Table 4-22: Cumulative impact of the proposed expansion using measured H_2S (October 2023 campaign)

Air Quality Sensitive Receptors	Average Period	Maximum PC (µg/m³)	Background (µg/m³)	Maximum PEC (µg/m³)	Kenya Air Quality Limit (µg/m³)	PEC as % of the Limit
KWS Staff Quarters near the Olkaria gate	1- hour	80	ND	80	**NR**	**-**
	8- hour	20	ND	20	**13,939**	**0.14**
	24-hour	5.0	28.3	33.2	**150**	**22.2**
	Annual	0.6	ND	0.6	**NR**	**-**
Geothermal Spa	1- hour	100	ND	100	**NR**	**-**
	8- hour	60	ND	60	**13,939**	**0.43**
	24-hour	20	147.8	167.8	**150**	**111.7**
	Annual	1.0	ND	1.0	**NR**	**-**
Olomayiana Kubwa Baptist Church	1- hour	30	ND	30	**NR**	**-**
	8- hour	20	ND	20	**13,939**	**0.14**
	24-hour	10	66.4	76.4	**150**	**70.9**
	Annual	1.0	ND	1.0	**NR**	**-**
Narasha Primary School	1- hour	30	ND	30	**NR**	**-**
	8- hour	10	ND	10	**13,939**	**0.01**
	24-hour	6	110.7	116.7	**150**	**77.8**
	Annual	0.2	ND	0.2	**NR**	**-**
Geothermal Training Centre	1- hour	30	ND	30	**NR**	**-**
	8- hour	10	ND	10	**13,939**	**0.01**
	24-hour	5	58.1	63.1	**150**	**42.1**
	Annual	0	ND	0	**NR**	**-**

NR – Not Regulated, ND - No Data

The results in Table 4-23 show the maximum predicted modelled concentrations as well as simulated background levels.

Table 4-23: Cumulative impact of the proposed Olkaria II Extension using simulated background data

Air Quality Sensitive Receptors	Average Period	Maximum PC (µg/m³)	Background (µg/m³)	Maximum PEC (µg/m³)	Kenya Air Quality Limit (µg/m³)	PEC as % of the Limit
KWS Staff Quarters near Olkaria Gate	1- hour	80	600	680	**NR**	**-**
	8- hour	20	200	220	**13,939**	**1.57**
	24-hour	5	100	105	**150**	**70.0**
	Annual	0.6	10	10.6	**NR**	**-**
Geothermal Spa	1- hour	100	900	1000	**NR**	**-**
	8- hour	60	200	260	**13,939**	**1.87**
	24-hour	20	100	120	**150**	**80.0**
	Annual	1.0	10	11	**NR**	**-**
Olomayiana Kubwa Baptist Church	1- hour	30	165	195	**NR**	**-**
	8- hour	20	200	220	**13,939**	**1.57**
	24-hour	10	80	90	**150**	**60.0**
	Annual	1.0	10	11	**NR**	**-**
Narasha Primary School	1- hour	30	500	530	**NR**	**-**
	8- hour	10	100	110	**13,939**	**0.79**
	24-hour	6	50	56	**150**	**37.3**
	Annual	0.2	8	8.2	**NR**	**-**
Geothermal Training Centre	1- hour	30	165	195	**NR**	**-**
	8- hour	10	100	110	**13,939**	**0.79**
	24-hour	5	50	55	**150**	**36.7**
	Annual	0	10	10	**NR**	**-**

NR – Not Regulated

It is noted that the simulated and measured background air quality data for the existing emission sources did not differ significantly. However, measured baseline air quality data has been used in assessing the impact of the proposed power plant, as measured data is considered more accurate.

4.2.6.6 Discussion of Results

In all instances, the maximum concentrations at the identified sensitive receptors were below the permissible 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 an exceedance of the limit values. The maximum predicted impacts are estimated at sensitive receptors located at about 8km 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 cumulative daily and annual H_2S impact at a receptor was 120.0 μg/m^3 and 11 μg/m^3, at the Geothermal Spa, as compared with the EMCA daily limit of 150 μg/m^3. Annual averaging period for H_2S is not regulated in Kenya. The predicted cumulative daily H_2S impact at the other monitored receptors included: 105 μg/m^3 at the KWS Staff Quarters near Olkaria Gate; 90 μg/m^3 at Olomaiyiana Baptist Church; 56 μg/m^3 at Narasha Primary School; and 55 μg/m^3 at Geothermal Training Centre. The most impacted receptor, Geothermal Spa, falls within KenGen's property areas and can be considered as occupational exposure.

4.2.6.7 Conclusions and Recommendations

The air quality modelling considered short and long-term pollutant concentration emanating from the operation of the proposed Olkaria II Extension 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 stipulated under the Factories and Other Places of Work (Hazardous Substances) Rules 2007, and meets the standards of the Environmental Management and Coordination (Air Quality) Regulations, 2014.

The maximum impact of the emissions was 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 indicated that the emissions from the facility had 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.

The maximum predicted short (24-hr) and long-term (annual) mean H_2S contribution from the proposed power plant at the identified sensitive receptors was at the Geothermal Spa recreational area, at 120.0 μg/m^3 and 11.0 μg/m^3, respectively.

Based on the modelled results, the proposed Olkaria II Extension power plant will comply with the National & International air quality criteria. However, should the model input parameters change in the detailed engineering phase, a model re-run would be required to ensure 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 operations and upset conditions. The proponent should also consider installing continuous (real-time) air quality monitoring networks at locations of areas of maximum impact and sensitive receptors.

4.2.7 Noise

As part of the ESIA Study, a noise assessment was carried out. The main purpose of the assessment was to focus on evaluating the level of noise contribution from the proposed project to the nearby sensitive receptors with national and international standards. The assessment was based on the standards as provided in: The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009; and the Factories and Other-Places of Work (Noise Prevention and Control) Rules, 2005 for residential and occupational permissible noise levels.

The assessment included a study of the legal requirements pertaining to noise impacts, a study of the physical environment of the area surrounding the project and the analysis of existing noise levels in the area. The impact assessment focused on the estimation of noise emissions and impacts associated with the operational phase of the plant.

Predictive noise mapping was performed for the proposed geothermal power plant operation with the use of inverse square law to determine the sound attenuation over a distance. The method specializes in computer simulations of noise pollution dispersion. Estimates of the cumulative noise levels from the study were derived from the noise emissions from all the major noise generating components and activities of the proposed project.

4.2.7.1 Noise Receptors of Interest

A set of noise receptors of interest were identified near the proposed project site as indicated in the figure below. The locations considered as receptors, were selected to assess the potential impact due to the proposed project emissions on protected areas. Geothermal Spa was identified as a relevant receptor due to high population trends within the area. Also considered, were also sensitive locations for human health such as places of worship, residential and educational areas, which were identified from an aerial photograph of the site and reconnaissance. The sensitive receptors are indicated in the figure below.

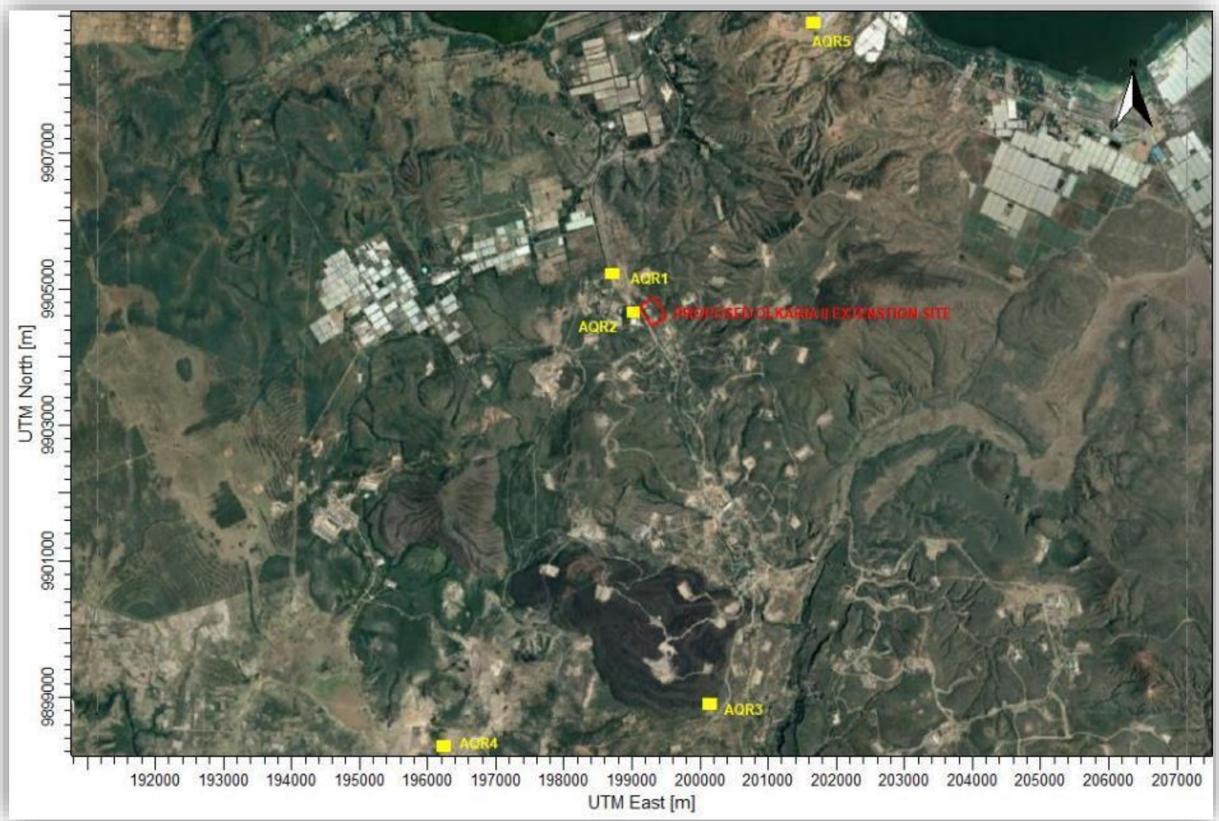


Figure 4-31: Location of the Noise Receptors of Interest

Table 4-24: UTM Coordinates of Noise Receptors

Air Quality Receptors (AQRs)	UTM Coordinates		Distance (km)
	X (m)	Y (m)	
1. KWS Staff Quarters near the Olkaria gate	198618.54	9905146.06	0.83
2. Geothermal Spa	198932.47	9904579.10	0.30
3. Olomaiyiana Baptist Church	200051.26	9898827.95	5.90
4. Narasha Primary School	196141.36	9898206.02	7.12
5. Geothermal training Centre	201570.96	9908830.98	4.94

4.2.7.2 Baseline Noise Conditions

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.

Figure 4-32: Location of Noise Monitoring Measurements

The noise monitoring data at the power plants (Olkaria I AU unit 6, Olkaria I unit 4 & 5, Olkaria I unit 1,2,3, Olkaria II, Olkaria IV and Olkaria V) for the period between 2019 – 2023, was used to assess the background noise levels for the environment and human health purposes. The noise levels are summarized in the table below. The highest recorded noise level data was used for calculating the ambient noise impact, hence considered conservative.

Table 4-25: Summary of Ambient Noise Level data (2019-2023)

Location	**Noise Level d(BA)**						**Kenya Noise Criteria (dBA)**
	2019	**2020**	**2021**	**2022**	**2023**	**Mean**	
Olkaria 1AU 6	71.2	81.6	85.6	86.5	88.1	**92.1**	
Olkaria 1 unit 4 & 5	102.8	103.8	100.8	98.3	103.9	**109.4**	
Olkaria 1 unit 1,2 & 3	104.2	101.1	99.8	103.2	NR	**107.1**	**90**
Olkaria 2	99.6	95.1	98.3	98.8	111.5	**112.3**	
Olkaria 4	100.6	94.5	99.9	100.2	104.6	**108.0**	
Olkaria 5	NR	97.6	91.6	94.0	98.1	**102.1**	
Olomaiyiana	47.4	55.6	41.1	42.8	47.7	**57.1**	**50**

NR – Not Reported

The noise monitoring data was mainly from the current KenGen Power generation facilities (occupational), ambient noise at a sensitive receptor represented by data from Olomaiyiana community monitoring point.

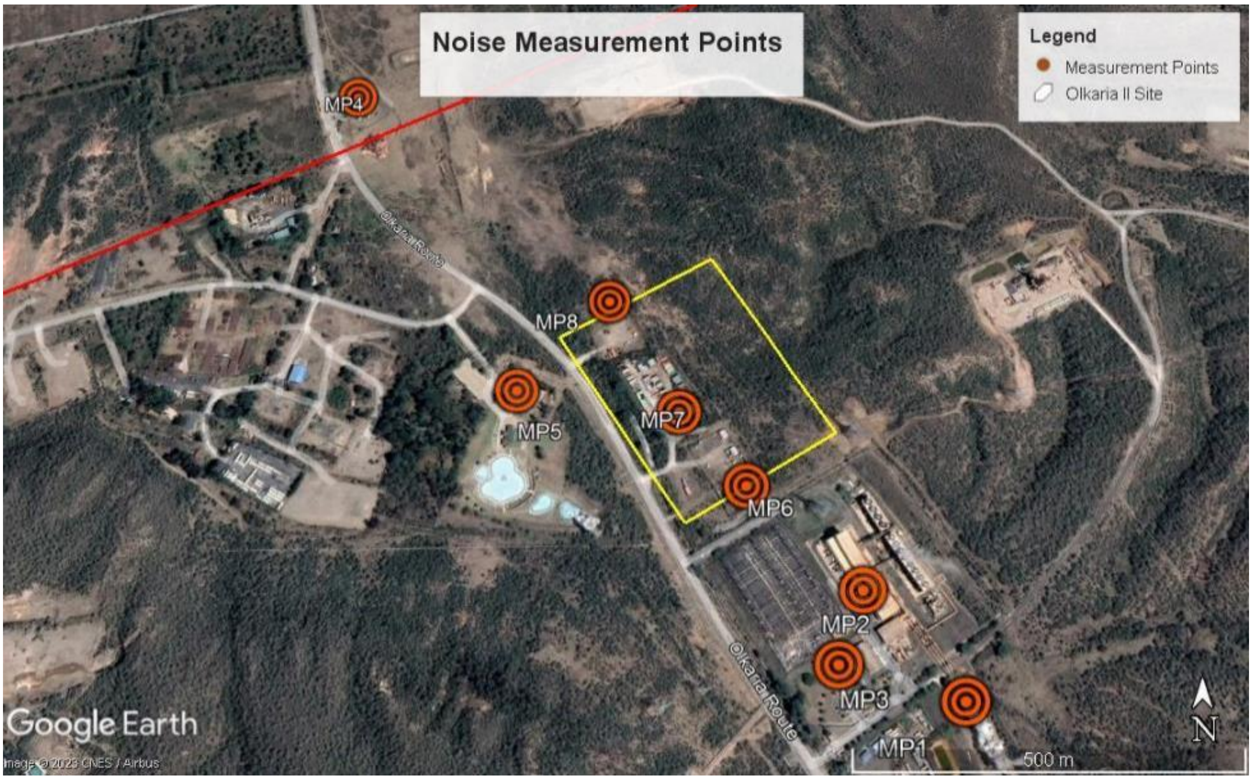


Figure 4-33: Noise measuring sites

Table 4-26: Summary of Measured Ambient Noise Level data 2023

Location	Coordinates	Measured Noise Level d(BA)	Sound Level Limits
MP1 - Near Olkaria II Ventilation Station	-0.86585,36.30050	72.6	90
MP2 - Olkaria II Office Area	-0.86454, 36.29943	70.8	90
MP3 - Olkaria II Canteen Area	-0.86543, 36.29906	62	90
MP4 - KWS Olkaria Gate and Wardens residence area	-0.85698, 36.29251	56	50
MP5 - Geothermal SPA	-0.86187, 36.29512	58	90
MP6 - Outside Olkaria II Substation	-0.86320, 36.29808	60	90
MP7 - Near Mitsubishi Yard	-0.86218, 36.29725	59	90
MP8 - Lower Section of the Proposed Site	-0.86082, 36.29622	54	90

The average occupational noise levels were in compliance with the Kenyan Factories and Other Places of Work (Noise Prevention and Control) Rules 2005 limits of 90 d(BA). However, the data from MP4 - KWS Olkaria gate and Wardens residence area indicated that the noise level exceeded the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 - noise criteria of 50 dB(A) for residential areas. The World Bank/IFC stipulates guideline levels of 55 dB(A) and 45 dB(A) for both day and night schedules, respectively.

4.2.7.3 Noise Modelling

The table below shows the cumulated noise impact following the noise modelling exercise. The detailed results are contained in ***Annex 15*** of this ESIA Report. With respect to Olkaria II, the maximum cumulative noise levels at the five sensitive receptors were as follows:

- 66.2 dB(A) at the KWS Staff Quarters near Olkaria gate, located at about 0.83Km from the proposed power plant;
- 72.1 dB(A) at Geothermal Spa located at about 0.30Km from the proposed power plant;
- 57.2 dB(A) at Olomaiyiana Baptist Church located at about 5.90Km from the proposed power plant;
- 50.2 dB(A) at Narasha Primary School located at about 7.12Km from the proposed power plant;
- 53.0 dB(A) at the Geothermal training Centre located about 4.94km from the proposed development.

It should be noted that data from Olomaiyiana was used in the assessment of the cumulative impact of noise in other indicated receptors due to the unavailability of background data from these locations. It is therefore recommended that actual baseline data be obtained for accurate estimation of the present ambient noise levels.

Table 4-27: Summary of the cumulative results

No.	Receiver name	Distance from the site (km)	Limit		Level	
			Day	Night	Day	Night
			dB(A)		dB(A)	
1	KWS Staff Quarters near the Olkaria gate	0.83	50	35	66.2	66.2
2	Geothermal Spa	0.30	90	35	72.1	72.1
3	Olomaiyiana Baptist Church	5.90	50	35	57.2	57.2
4	Narasha Primary School	7.12	50	35	50.2	50.2

5	Geothermal training Centre	4.94	50	35	53.0	53.0

The noise levels were below the IFC ambient noise limits for residential, institutional and educational areas, which is 55 dB (A) during daytime for all the sensitive receptors except KWS staff Quarters near Olkaria Gate and Olomaiyiana Baptist church. However, for the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 – the limits for residential, institutional and educational areas, which is 50 dB (A) during daytime and 35 dB (A) during the night-time, were exceeded at all the receptors. The assessment showed that the Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005 - occupational exposure limits were met at all the monitoring locations.

The maximum predicted noise level was at Geothermal Spa facility with noise level of 72.1 dB(A) which was below the noise level limit of 90 dB (A) and falls within the KenGen property areas and is considered occupational exposure.

For the residential areas, the Kenyan ambient noise limit of 35 dB (A) was exceeded at all the sensitive receptors. This was mainly due to the available data obtained from one monitoring point with an average noise level of 57.1 dB(A) that was already in exceedance of the Kenyan ambient noise limit for residential areas. It is recommended that a noise management plan be put in place during construction and operational phases of the project.

4.2.7.4 Vibration

Ambient vibration measurement and modelling of the cumulative impact of vibrations was not undertaken during the study, as vibration was not considered as a major issue associated with the proposed project and the Olkaria Geothermal Field in general. This is because there will be no blasting during the construction phase of this project and vibrations experienced during this phase will only be intermittently experienced when excavation and construction equipment are being used. Additionally, during the operation phase, the impact of vibrations caused by underground pipelines as condensate is pumped to the reinjection wells will be insignificant, as the Olkaria Geothermal Field is dominated with Volcanic Ash soils, which are known to absorb such vibrations, due to their low density and lack of cohesiveness nature.

4.3 Biological Environment

Hell's Gate National Park is home to 304 species of plants belonging to 35 groups. The natural vegetation on the cliff top is mostly composed of open grassland with *Cynodon dactylon* and *Digitaria scalarum* dominating, but *Festuca Pilgeri* (tussock grass) predominates. *Tarchonanthus comphoratus* and *Acacia drepanolobium* are the predominant shrubs, seldom growing taller than 4 metres (Rop, 2021).

The main tree species are *Cussonia spicata*, *Schefflera abyssinica*, *Acacia xanthophloea*, and *Euphorbia magnicapsular*. According to John (2018) , there are twenty three (23) species of mammals namely: *Syncerus caffer* (Buffalo), *Equus quagga* (Common Zebra), *Rendunca renduna* (Chanler's Mountain Reedbuck), *Gazella grantii* (Grant Gazelle), *Gazella thomsonii* (Thompson's Gazelle), *Giraffa cemelopardalis* (Maasai Giraffe), *Alcephalus buselaphus* coki (Coke's Hartebeest), Taurotraqus oryx (Eland), *Apyceros melampus* (Impala), *Phacochoerus aethiopicus* (Warthog), *Kobus defassa* (Dafassa

Waterbuck), *Oreotragus* (Klipspringer), *Rhaphicerus campestris* (Steinbok), *Rhynchotragus kirkii* (Kirk's Dik Dik), *Finisciurus sp*. (Squirrel), *Tachyorectes plendens* (Mole Rat), *Crocuta* (Spotted Hyena), *Panthera pardus* (Leopard), *Papio anubis* (Olive Baboon), *Heterophyrax brucei* (Rock Hyrax), *Orycteropus afer* (Aardvark), *Erinaceus albiventris* (Hedgehog), *Lepus microtis* (African Hare) and *Pedetes capensis* (Spring Hare). Harper (1991) cited in Camiña (2019) studied Hell's Gate National Park and mentioned that there are 144 species of birds. The cliffs and gorges found in the park are important breeding areas for vultures and swifts.

4.3.1 The Hells Gate National Park Habitat

Hell's Gate National Park habitat can be characterized as follows:

i. **Geothermal Fields**: the park is known for its geothermal features, and geothermal fields may extend beyond the park boundaries. Proper management of geothermal activities is crucial to prevent negative impacts on the park's ecosystems.
ii. **Escarpments and Highlands**: The Park is situated within the Great Rift Valley, and the surrounding areas may include escarpments and highland regions. These areas can impact the flow of water, as well as serve as habitats for different plant and animal species.
iii. **Riparian Zones**: The park is intersected by several rivers, and the riparian zones along these water bodies are crucial for various species. The quality of these zones can be influenced by land use practices upstream and downstream.
iv. **Lake Naivasha**: Hell's Gate National Park is located close to Lake Naivasha, a freshwater lake. The lake and its wetlands provide a habitat for waterfowl, hippos, and fish. The lake's ecosystem is interconnected with the terrestrial ecosystems of the park.
v. **Rangelands and Pastoral Area**s: Some areas adjacent to the park may be used for pastoralism. Sustainable grazing practices and coexistence with wildlife are essential considerations in these areas.
vi. **Human Settlements**: Villages and small towns are often found near the boundaries of the park. The proximity of human settlements can impact wildlife migration routes and may lead to conflicts, especially with large herbivores.
vii. **Agricultural Lands**: Surrounding areas may include agricultural lands where local communities engage in farming activities. The interface between agricultural areas and the park can lead to human-wildlife conflict as animals may venture into farmlands.
viii. **Conservancies and Wildlife Corridors**: Conservation areas and wildlife corridors outside the park may facilitate the movement of wildlife between different ecosystems. These areas play a role in maintaining genetic diversity and supporting seasonal migrations.

4.3.2 Mammals and Birdlife in the area

African buffalo, zebra, eland, hartebeest, Thomson's gazelle and baboons are common. The park is also home to klipspringer antelope and Chandler's mountain reedbuck.

Out of 1100, bird species studied in Kenya only 144 bird species have been recorded at Hell's Gate National Parks (Harper, 1991). Out of 144 species only 8 species are considered globally threatened which are *Gyps rueppelli, Gyps africanus, Necrosyrtes monachus, Neophron percnopterus, Sagittarius serpentarius, Ardeotis kori, Gypaetus barbatus* and *Terathopius ecaudatus* while *Prionops poliolophus* are in near threatened state. Specific species; *Gypaetus barbatus meridionalis* feeds on bone marrow and inhabit rocky vertical cliffs, however, they were last recorded in 1991.

Hells Gate National Park is part of the Serengeti Endemic Bird Area (EBA) which is characterized by acacia scrub, grassland with open acacia woodland. In Tanzania, the EBA extends southwards of Serengeti National Park to the south of Lake Eyasi Basin including Wembere steppe. In Kenya EBA, it continues northwards to Lakes Nakuru and Naivasha. The restricted range species in this EBA include Grey-breasted Spurfowl (*Francolinus rufopictus*), Fischer's Lovebird (*Agopornis fischeri*), Usambiro Barbet (*Trachyphonus usambiro*), Grey-crested Helmet-shrike (Prionops poliolophus), Karamoja Apalis (*Apalis karamojae*) and Rufous-tailed Weaver (*Histurgops ruficauda*). Of these, only two species have been recorded in Kenya, *Prionops poliolophus* and *Apalis karamojae*, where they both range northwards up the Rift Valley to sites around Lake Naivasha. *Prionops poliolophus* has been recorded at Hell's Gate National Park (BirdLife International, 1998).

4.3.3 Vegetation of the greater project area

The area has unique vegetation with about 550 different plant species in several habitats.

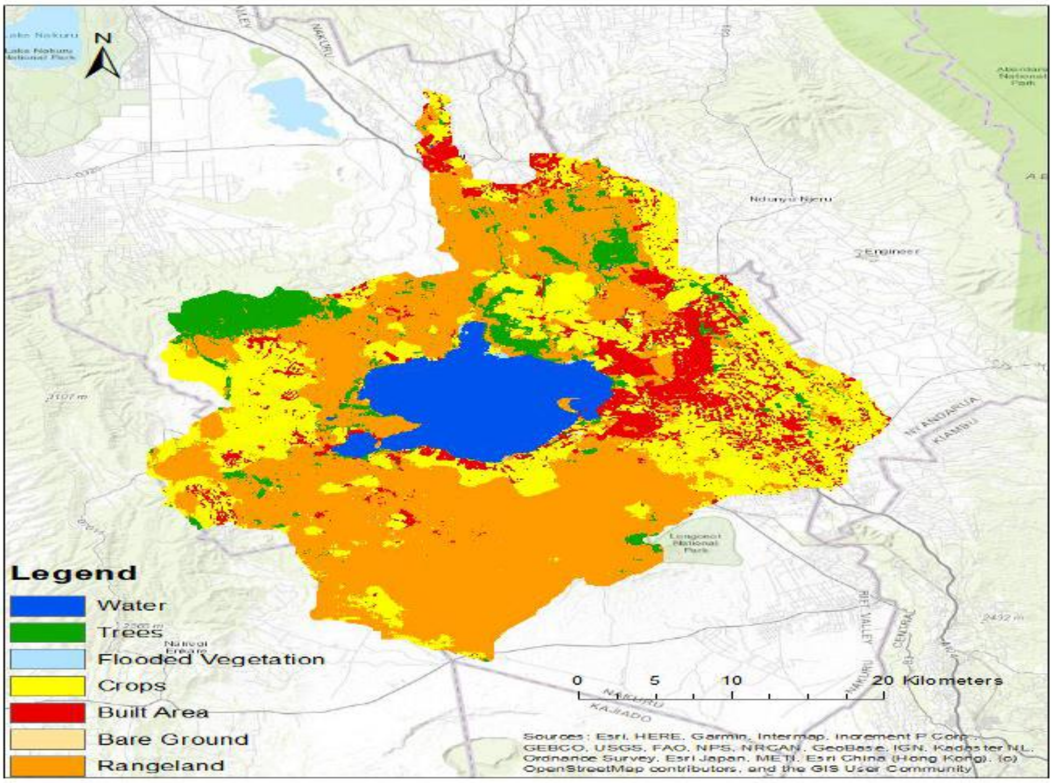


Figure 4-34: Land Use and Land Cover Map of the project's Ecologically Appropriate Area of Analysis (EAAA)

Source: Karra et al. (2021).

The rangelands are mostly open grasslands and shrubs with few to no trees.

4.3.3.1 Acacia Forest

The Acacia trees occur along the lake shores where enough water is available. There are thirty species of birds which only live in these forests, for example tropical boubou and three species of flycatcher. The Acacia Forest is also the home to buffalo, leopard, vervet and colobus monkeys.

4.3.3.2 Acacia Savannah
This is the second largest habitat in the projects area especially near the lakes, occurring where the acacia forest cannot grow due to lack of adequate water and regular burning of the grass, which prevent acacia saplings from developing. Species such as jackal, impala and giraffe are found in this habitat. There are also many bird species including weaver, dove, ground hornbill, Augur buzzard and Martial eagle.

4.3.3.3 Open Grassland
This area comprises alkaline and plain grassland communities. Alkaline grassland communities are mainly found on highly alkaline soils that are frequently water logged. The species composition here is dominated by *Cyperus Laevigatus, Sporobolus spicatus, Pluchea bequaertii* and *Typha* species, all in various associations.

4.3.3.4 Wooded Grassland
These are areas of scattered trees on grasslands.

4.3.3.5 Forests
There are two types of forest habitats in the project area:

a) Euphorbia forest- This was the largest surviving example of Euphorbia Forest in East Africa. However, the forest has recently been destroyed by factors which are still being investigated. These plants, also known as “Candelabra Trees”, grow up to 15 metres high and are not good for either building or charcoal burning, but Black rhinos and baboons utilize them as food and shelter.

b) Virgin Olea forest- This is commonly known as “Olive Forest” and is confined to the Southwest of the Lake Nakuru. The dominant trees species here are *Olea Africana* and *Teclea simiplicifolia.* The forest is a small remnant of a larger forest which extended to the higher slopes of the Mau escarpment.

Table 4-28: Woody and Herbaceous vegetation in the Habitats of the project area

Woody vegetation (Shrubs and trees)	Herbaceous vegetation (Forbs and grasses)
Acacia xanthophoea	*Helitropium longiflorum*
Acacia tortilis	*Urochloa panicoides*
Acacia Elatoir	*Cyperus kilimandascus*
Acacia Horrida	*Solunum incanum*
Acacia nubica	*Cynodon spp*
Acacia reficiens	*Brachiaria leersoides*
Acvacia Senegal	*Indigofera spp*
Acacia zanzibarica	*Molugo naudicaulis*
Acacia tortilis	*Amaranthus spp*
Boscia angustifolia	*Sedera hersuta*
Commiphora Africana	*Tragus berteronianus*

Cordia africana	*Berleria ancathoides*
Euphorbia spp	*Commelina bengalensis*
Grewia tenax	*Ipomea spp*
Maerua spp	*Cormicapus spp*
Phyllanthus somalensis	
Prosopis juliflora	
Salvadora persica	
Solanum coagulans	
Solanum incanum	

4.3.4 Invasive plants

Invasive plant species can pose a significant threat to native ecosystems by outcompeting indigenous plants, altering habitat structure, and disrupting ecological processes. Conservation efforts often involve monitoring, early detection, and the implementation of control or eradication measures for invasive species.

One of the main problems in the South Rift Region is invasive plant species, which lead to the decline of healthy rangelands. Castor plants, Datura, Sodom apple and Leleshwa among others are some of the invasive plants in the project area. For castor, accidental ingestion of its by-products can cause poisoning in animals and humans, characterized by digestive signs resulting from the presence of a toxalbumin called ricin. Seed toxicity varies among animal species; in horses, the lethal dose of seeds is 0.1 g/kg of body weight (Montão *et al*., 2018).

In goats, *Datura stramonium* ingestion is accompanied by tachypnoea, tremors, drowsiness, recumbency, and altered locomotion while in cattle excitability, tremors, rumen atony, nervousness, bloat, tenesmus, and anorexia are some of the clinical signs with death occasionally reported (Stegelmeier & Davis, 2023). *Solanum incanum* on the other hand is toxic to livestock and considered to be a major threat to grazing. It is also found in savanna grasslands where it might impact native herbivores. Leleshwa (*Tarchonanthus camphoratus*) though not poisonous, is not palatable to many of African herbivores and invades the grassland turning them into shrublands. However, in the Olkaria field, it plays a vital role in providing shade to animals and holding the fragile soil together thus combating soil erosion.

Castor plant (*Ricinus communis*)

Thorn apple *(Datura stramonium*)

Sodom apple (*Solanum incanum*)

Leleshwa (*Tarchonanthus camphoratus)*

Plate 4-4: Invasive species in the project site

Measures should be put in place to ensure the appropriate disposal of invasive tree species that will be removed during site preparation. In addition, appropriate measures should be established to control the introduction of other invasive species during the construction period especially through transport vehicles and construction materials sourced from areas with such species.

4.3.5 Critical habitats of the Hell's Gate National Park

According to Zimmerman, Peres, Malcolm & Turner (2001), Kenya is ranked number 13 globally among the richest countries in avifauna because 1100 species are listed. There are 41 species considered globally threatened, 5 critically endangered, 15 endangered, 18 vulnerable, and 3 with deficient data. In addition, there are nine breeding endemic birds in Kenya.

Critical Habitat Assessments are typically conducted to evaluate and identify areas crucial for the survival of species or ecosystems. These assessments are essential for informed conservation and management decisions. Hell's Gate National Park is known for its unique landscapes, geothermal features, and diverse wildlife. When discussing critical and natural habitats in the context of Hell's Gate National Park, it's essential to consider the various ecosystems, flora, and fauna that contribute to the park's ecological significance. There are a couple of critical habitats that include;

Gorges and Cliffs that characterize the park, as well as batholiths such as the Fischer's and Central Towers. These rocky formations serve as critical habitats for bird species, including raptors and cliff-nesting birds. Harper (1991) cited in John (2018) mentioned that 144 species of birds have been recorded within this park in which cliffs provide suitable breeding grounds for *Falcon biarmicus* (Lanner Falcon) and *Gyps rueppelli* (Rüppell's Griffon Vulture). Rüppell's vultures are Critically endangered as per the IUCN red list category. There has been a trend of declining population and distribution of birds over the last twelve years at the national park and the surrounding habitats. Some species of vultures such as *Neophron percnopterus* (Egyptian Vulture) and *Gypaetus barbatus* (Lammergeier or Bearded Vulture), that used to breed at the park are currently locally extinct. Further, Hells Gate National Park is in close proximity to Lake Naivasha Important Bird Area (IBA) which has a threatened status (Bennun & Njoroge, 1999). Within this ecosystem, disturbances due to increases in air temperature, noise, H_2S, habitat loss and fragmentation caused by geothermal power generation are significant (John (2018). These environmental changes and threats within the ecosystem of Hell's Gate National Park have not been studied thoroughly, consequently, there is no empirical evidence to ascertain the impacts on birds' and other animals' populations.

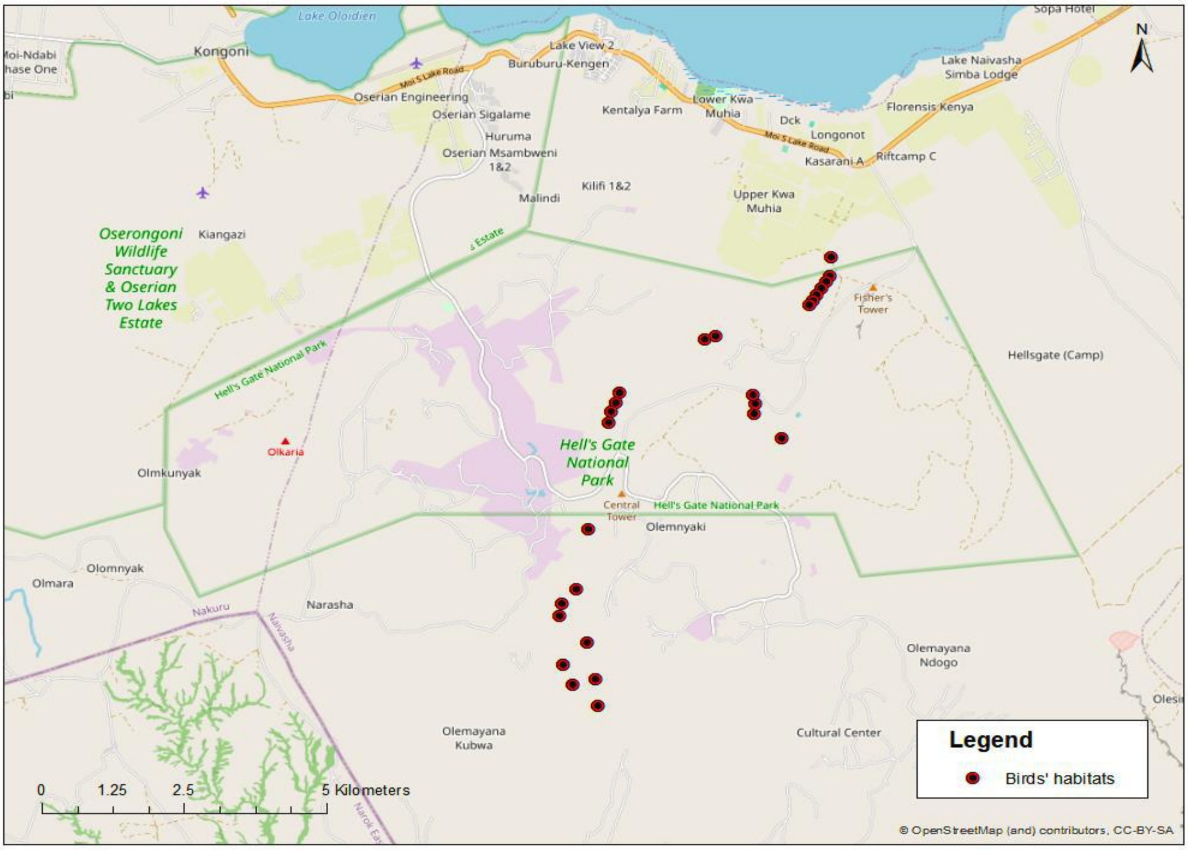


Figure 4-35: Birds' habitats including Fisher's and Central towers within the area

Extensive grasslands and savannah within the park provide crucial habitat for herbivores such as zebras, gazelles and buffalos. These areas also support predators like leopards and hyenas. Wooded areas, including acacia forests, are important for various bird species, small mammals, and insects. The trees provide nesting sites, shade, and food resources for a range of wildlife (John, 2018; Gichure *et al*., 2023).

The park is traversed by several seasonal and permanent rivers. Riparian zones along these water bodies are critical habitats for aquatic life, amphibians, and provide a water source for a variety of animals. Hell's Gate is renowned for its geothermal activity, including hot springs and geysers. The unique conditions created by geothermal features support specialized microorganisms and plant species adapted to these environments. While not within the park boundaries, nearby Lake Naivasha is an essential habitat for numerous bird species, including waterfowl and migratory birds. The lake is also home to hippos and diverse fish species (Becht, Odada & Higgins, 2006).

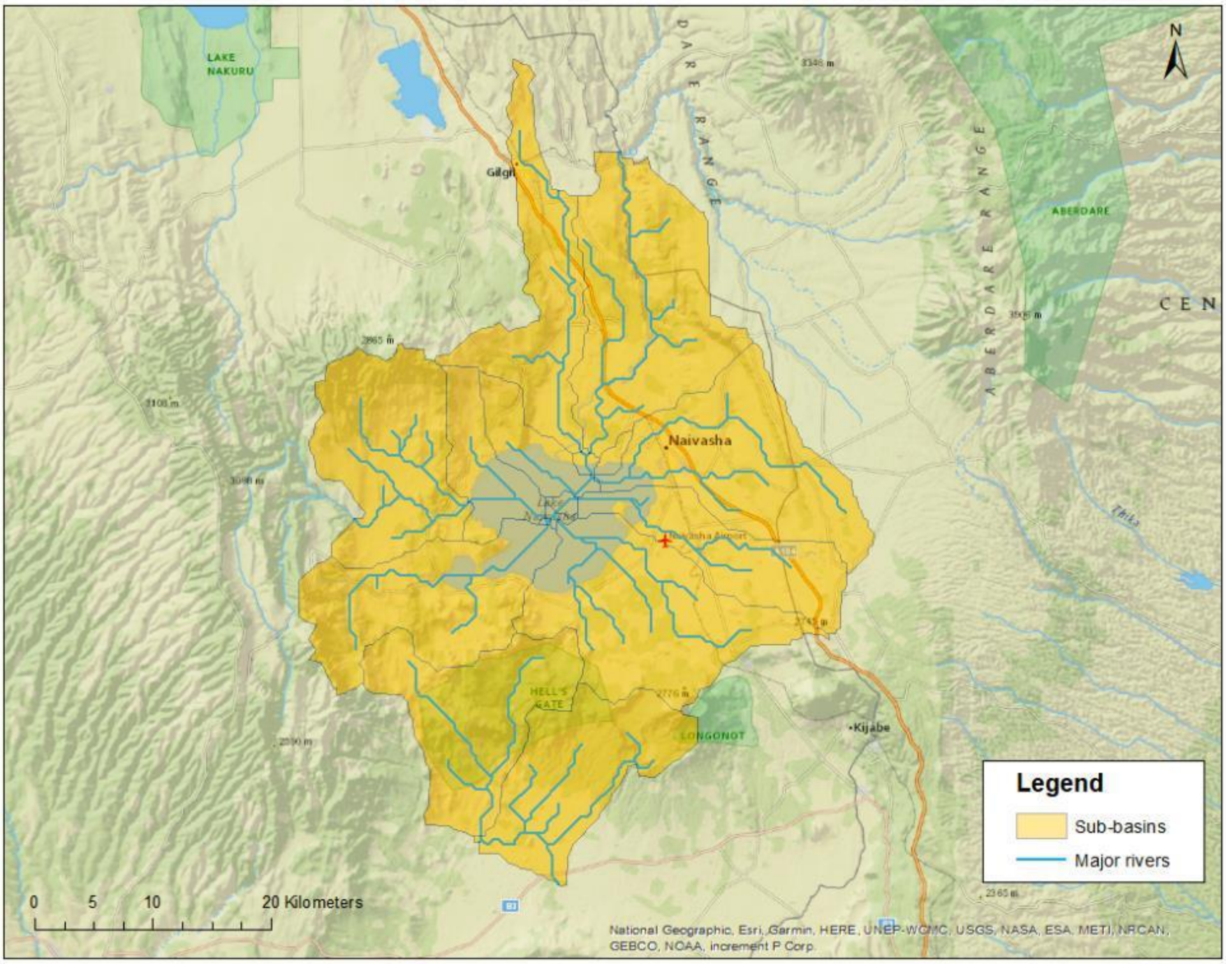


Figure 4-36: Hydrological features of the project's Ecologically Appropriate Area of Analysis (EAAA)

4.3.6 Important Plants Species and their Benefits to the Community

There are a variety of plant species in the hells gate national park that are beneficial to the community. Certain plant species may have cultural significance to local communities, playing a role in rituals, ceremonies, or traditional practices. The diverse plant life in the park contributes to its overall biodiversity, making it an attractive destination for ecotourism. This, in turn, can bring economic benefits to local communities through tourism-related activities.

Acacia trees are common in the savannah and grassland areas. They provide shade, act as windbreakers, and are a valuable food source for herbivores. *Commiphora africana* (African Myrrh) is a species often found in the park's dry woodlands. It is used in traditional medicine for various purposes. *Euclea divinorum* is a shrub found in the park. Its fruits are consumed by both humans and wildlife, and it also has medicinal uses. Various species of Aloe are present, some of which may have medicinal properties with antioxidant and antibacterial properties. Local communities may use these plants for various health remedies. Plants can support local livelihoods through activities such as traditional crafts, herbal medicine, and sustainable harvesting of non-timber forest products. *Aloe Vera* is one plant among others with benefits that include reducing dental plaque, accelerating wound healing, preventing wrinkles, and managing blood sugar (Akaberi *et al*., 2016). Various grass species provide food for herbivores like zebras and buffalos, forming the basis of the food chain. Sedges contribute to the diversity of vegetation and may be important for stabilizing soil in wetland areas.

4.3.7 Critical Habitat (CH) Qualifying Species and Species of Concern

Following the assessment of the habitats and biodiversity found in the Ecologically Appropriate Area of Analysis (EAAA), expert consultation, stakeholders' interviews, and literature review, our study revealed the following potential CH qualifying species and species of concern.

Table 4-29: Potentially CH Qualifying species

Common name	Scientific name	Conservation status
Mammals		
Chanler's mountain reedbuck	*Rendunca renduna*	LC but of special concern
Grant gazelle	*Gazella grantii*	LC
Thompson's gazelle	*Gazella thomson*	LC
Maasai giraffe	*Giraffa cemelopardalis*	EN
Coke's hartebeest	*Alcelaphus buselaphus cokii)*	LC
Eland	*Taurotragus oryx*	LC
Warthog	*Phacochoerus aethiopicus*	LC
Dafassa waterbuck	*Kobus defassa*	LC
Klipspringer	*Oreotragus*	LC
Steinbok	*Rhaphicerus campestris*	LC
Kirk's dik	*Rhynchotragus kirkii*	LC
Spotted hyena	*Crocuta*	LC
Leopard	*Panthera pardus*	VU but of special concern
Olive baboon	*Papio anubis*	LC
Rock hyrax	*Heterophyrax brucei*	LC
Aardvark	*Orycteropus afer*	LC
Hedgehog	*Erinaceus albiventris*	LC
African hare	*Lepus microtis*	LC

Common name	Scientific name	Conservation status
Spring hare	*Pedetes capensis*	LC
Mountain reedbuck	*Redunca fulvorufula*	EN
Birds		
Lanner falcon	*Falcon biarmicus*	LC
Rüppell's vulture	*Gyps rueppellii*	CR
Egyptian vulture	*Neophron percnopterus*	EN
Bearded vulture	*Gypaetus barbatus*	NT
Hooded vulture	*Necrosyrtes monachus*	CR
Bateleur	*Terathopius ecaudatus*	EN
Secretary bird	*Sagittarius serpentarius*	EN
Kori bustard	*Ardeotis kori*	NT
Gray-crested helmet shrike	*Prionops poliolophus*	NT
Fish		
Blue-spotted tilapia	*Tilapia zillii*	LC but of special concern
Eurasian carp	*Cyprinus carpio*	VU and of special concern
Nile tilapia	*Oreochromis niloticus*	LC but of special concern
African sharptooth catfish	*Clarias gariepinus*	LC but of special concern
Straight fin barb	*Barbus paludinosus*	LC but of special concern
Large-mouthed bass	*Micropterus salmoides*	LC but of special concern
Mosquito fish (The guppy)	*Poecilia reticulata*	LC but of special concern
North American rainbow trout	*Oncorhynchus mykiss*	LC but of special concern
Sardine like	*B. amphigramma*	LC but of special concern
Small-toothed carp	*Aplocheilichthys antinorii*	LC but of special concern
Tilapia	*Oreochromis leucostictus*	LC but of special concern
Tilapia	*Tilapia zillii*	LC but of special concern
Blue-spotted tilapia	*Tilapia zillii*	LC but of special concern
Eurasian carp	*Cyprinus carpio*	**VU**
Nile tilapia	*Oreochromis niloticus*	LC but of special concern
African sharptooth catfish	*Clarias gariepinus*	LC but of special concern

Common name	Scientific name	Conservation status
Plants		
Whistling thorn	*Acacia drepanolobium*	LC but of special concern
Leleshwa	*Tarchonanthus camophratus*	LC but of special concern

Key: CR-Critically Endangered, LC – Least concern, NT- Near threatened, EN – Endangered, Vu - Vulnerable

Following the potential for CH determination, the biodiversity features that qualify for CH, were analysed guided by the IFC standard 6 and Guidance Note 6, for CH disaggregation and through expert knowledge. The Extent of Occurrence (EOO) of the species was mapped out within the EAAAs and information on population dynamics were incorporated to check if they met the CH-qualifying criteria. Our study revealed the following potential CH qualifying species and species of concern.

The Rüppell's vulture is listed as critically endangered by the IUCN with a decreasing population trend. Bird *et al*. (2020) states that they have undergone rapid population decline over a period of three generations (approx. 95.3%). The declines are attributed to habitat loss and conversion to agro-pastoral systems, declines in wild ungulate populations, hunting for trade, persecution, electrocution and collision with powerlines and poisoning. Although Hell's Gate National Park (HGNP) is generally within the critically endangered Rüppell's Vulture's EOO, the vulture's breeding and nesting grounds are not within the proposed site for Olkaria II Extension Geothermal Power Plant.

These vultures are known to occur throughout the year at their breeding/nesting grounds (IUCN, 2023; Virani *et al*. 2012), such as the cliff of HGNP (see 'extant resident'; Figure 4-37), located approximately 4.5 Km South East of the site (-0.870056°, 36.338362°), in an area that is categorized as a 'Restricted Zone' by the Kenya Wildlife Service (KWS), where activities in this zone are restricted to research only and visitors' activities are tightly regulated and managed by the KWS.

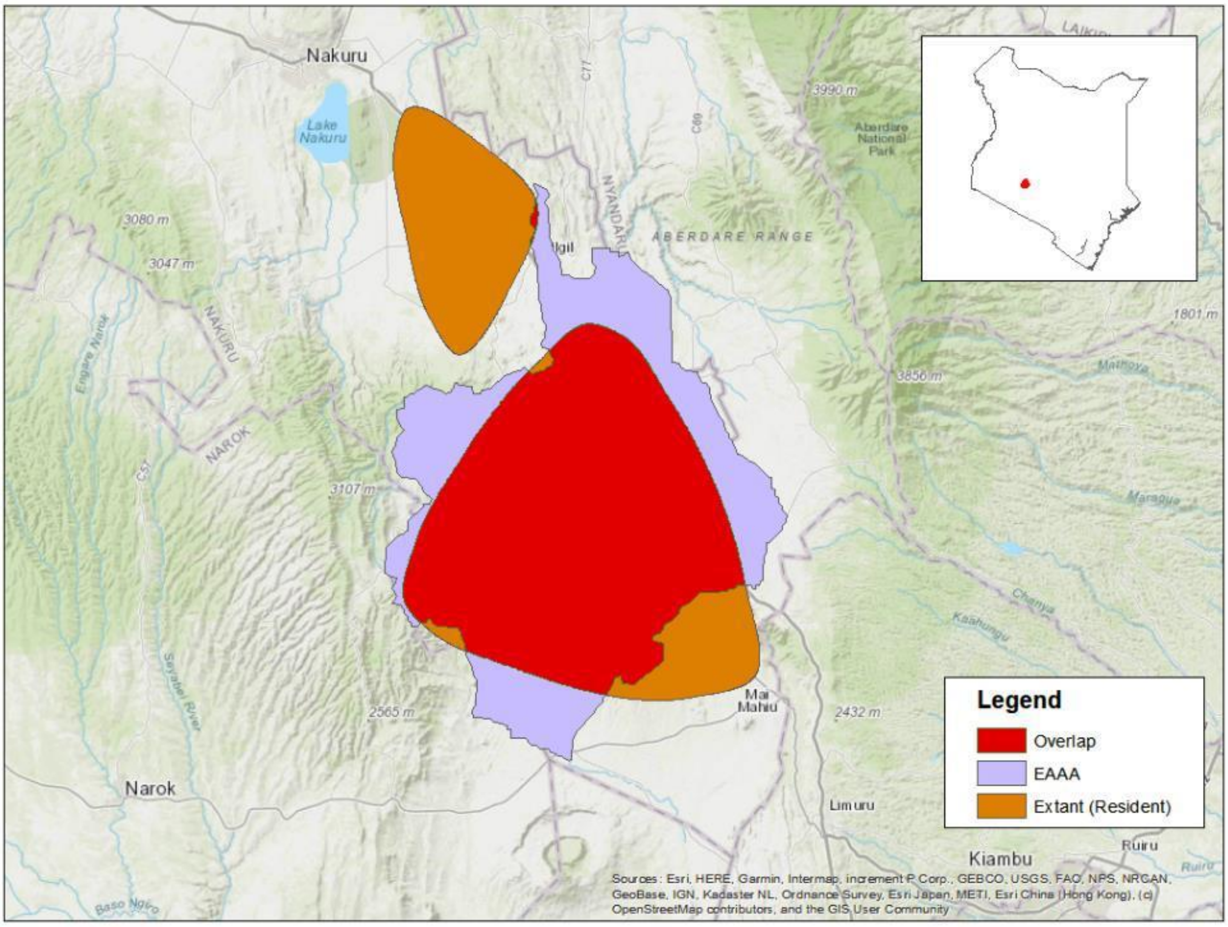


Figure 4-37: Rüppell's Vulture EOO and the study's EAAA. The red section represents the overlap

The CR Rüppell's vulture does not trigger Critical Habitat as it intersects only 0.0082% of the global extant resident area. In addition, even though the intersected areas harbour breeding locations, they are considered of less magnitude than Kwenia (probably the most important breeding location in Kenya) and cliffs at Mount Ololokwe in northern Kenya that support larger numbers of Rüppell's Vultures (Virani *et al*. 2012).

The Hooded vulture (*Necrosyrtes monachus*) is listed as Critically Endangered by IUCN with their population currently decreasing at an alarming rate (>80%). Consequently, local extirpations are reported including in our project's EAAA (Figure 4-38). The decline is owed to habitat loss and degradation, hunting for food, indiscriminate poisoning, trade for traditional medicine, persecution and electrocution (IUCN, 2023).

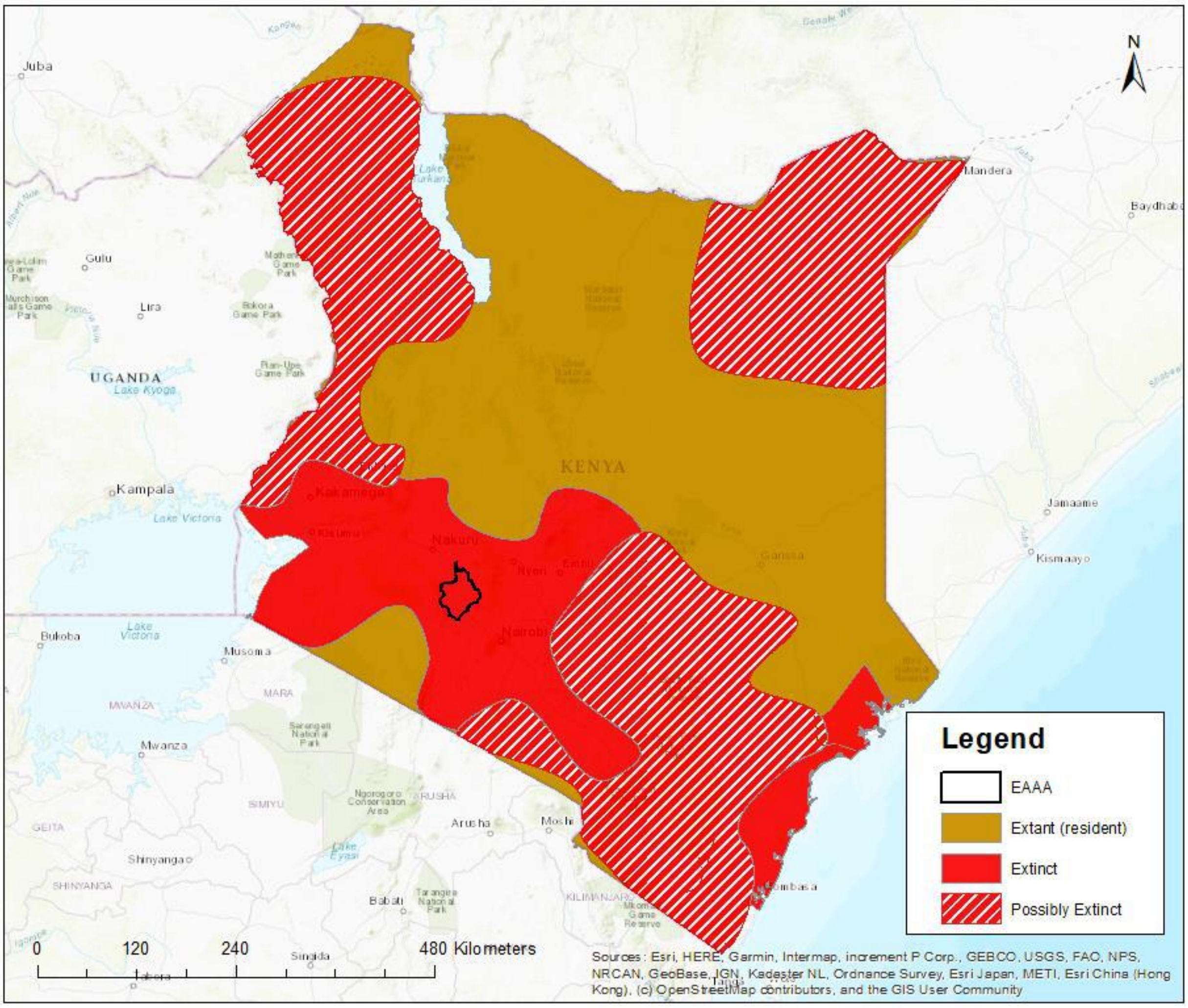


Figure 4-38: The hooded vulture's EOO in Kenya. Note that it is extinct within our project's EAAA

The Masai Giraffe (*Giraffa camelopardalis ssp. Tippelskirchi*) is listed as Endangered with a decreasing population trend. Habitat loss and Illegal hunting are the major causes of the decline. They are widely distributed in Tanzania and Kenya with the largest populations in Kenya occurring in Tsavo National Park, Kajiado, Tana River, Laikipia and the Mara ranches (East, 1999). In Kenya, majority of their population occur outside protected areas contrary to Tanzania.

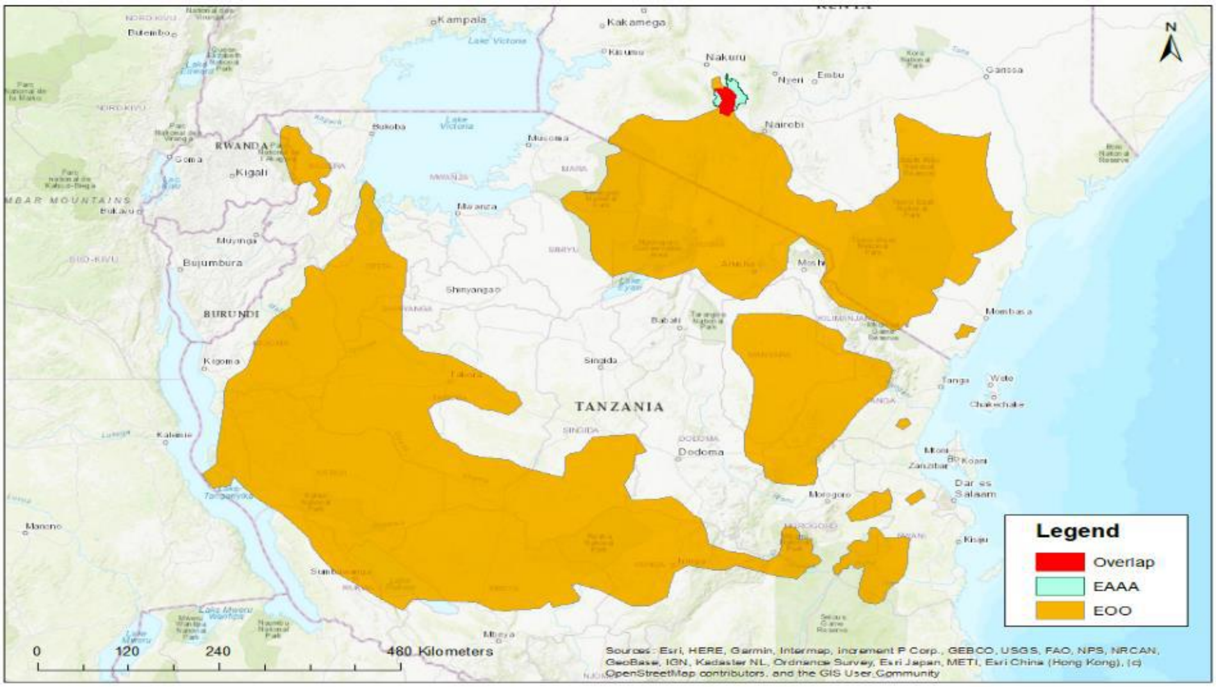


Figure 4-39: The Masai giraffe's EOO

The project's EAAA intersects 0.198% of the Masai giraffes EOO. This is below the required threshold for Endangered species to trigger Critical habitat.

The Egyptian Vulture (*Neophron percnopterus*) is listed as Endangered. This listing comes in the backdrop of recent rapid population decline in India and long-term declines in other parts of its range (Angelov *et al.*, 2020). This makes it the first vulture listed as such in Africa. East Africa has the largest breeding population of this species including Northern Kenya where pairs are most frequently sighted around livestock enclosures in Marsabit, North Horr, Loylengalani, Laisamis and the Chalbi Desert, often with Hooded Vultures (D. Ogada unpubl. data). There are historical records of breeding in HGNP before there rapid decline. The population decline in Kenya is believed to be majorly due to poisoning. HGNP and its environs including this project's EAAA fall within this species' migratory route (Arkumarev, McGrady & Angelov, 2019). The project's EAAA intersects 0.0034% of its EOO (Figure 4-40) falling below the threshold required to trigger critical Habitat under criterion 3.

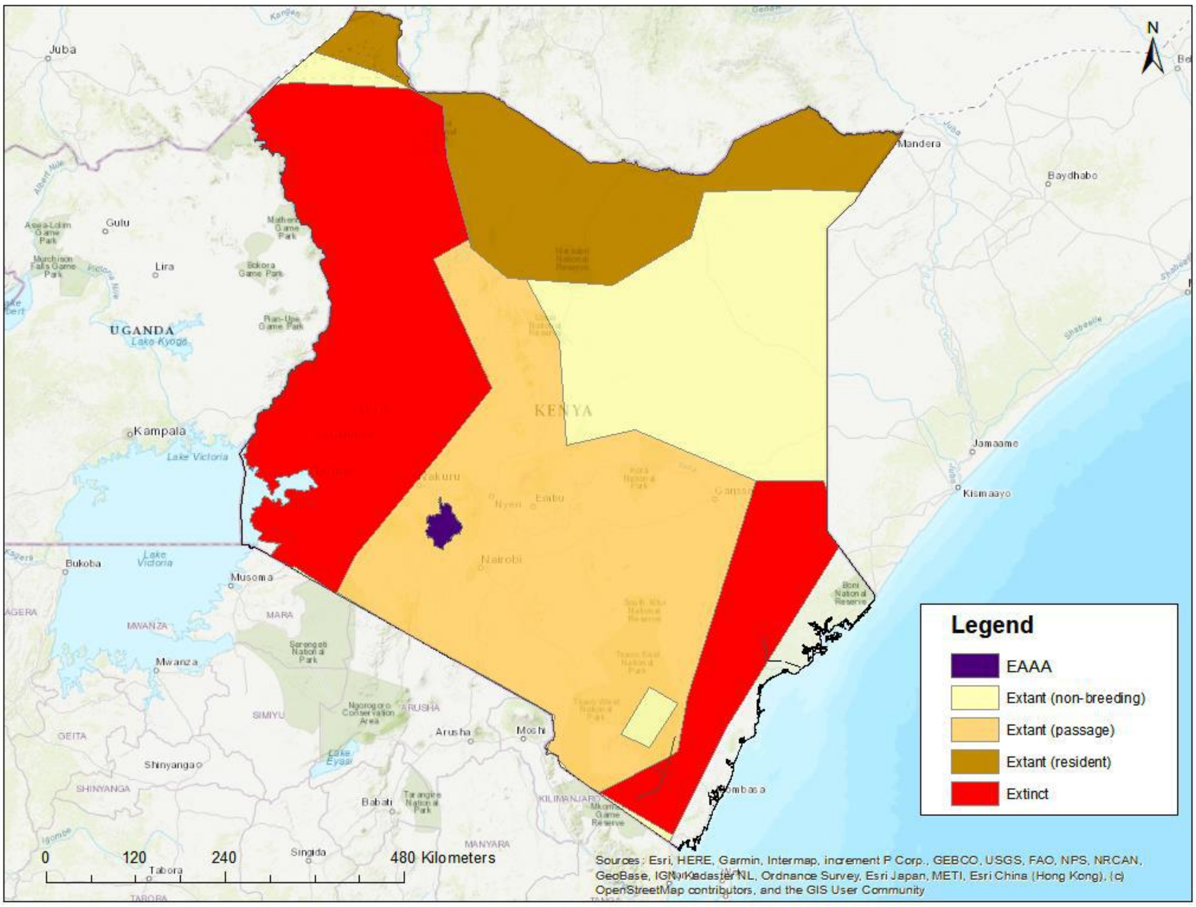


Figure 4-40: The Egyptian vulture's EOO in Kenya. Our project's EAAA wholly overlaps with its EOO

The Egyptian vulture occurs within the project's EAAA for relatively short periods during the year while migrating between breeding and non-breeding regions of its EOO.

Bateleur (*Terathopius ecaudatus*) is listed as Endangered by IUCN having experienced rapid population declines (between 50-79%) within the last three generations and with a current decreasing population trend. The declines are due to poisoning, pesticides and nest disturbance (IUCN, 2023). This species' EOO wholly covers the projects EAAA, with the overlap covering 0.0073% and falling short of the Critical Habitat threshold.

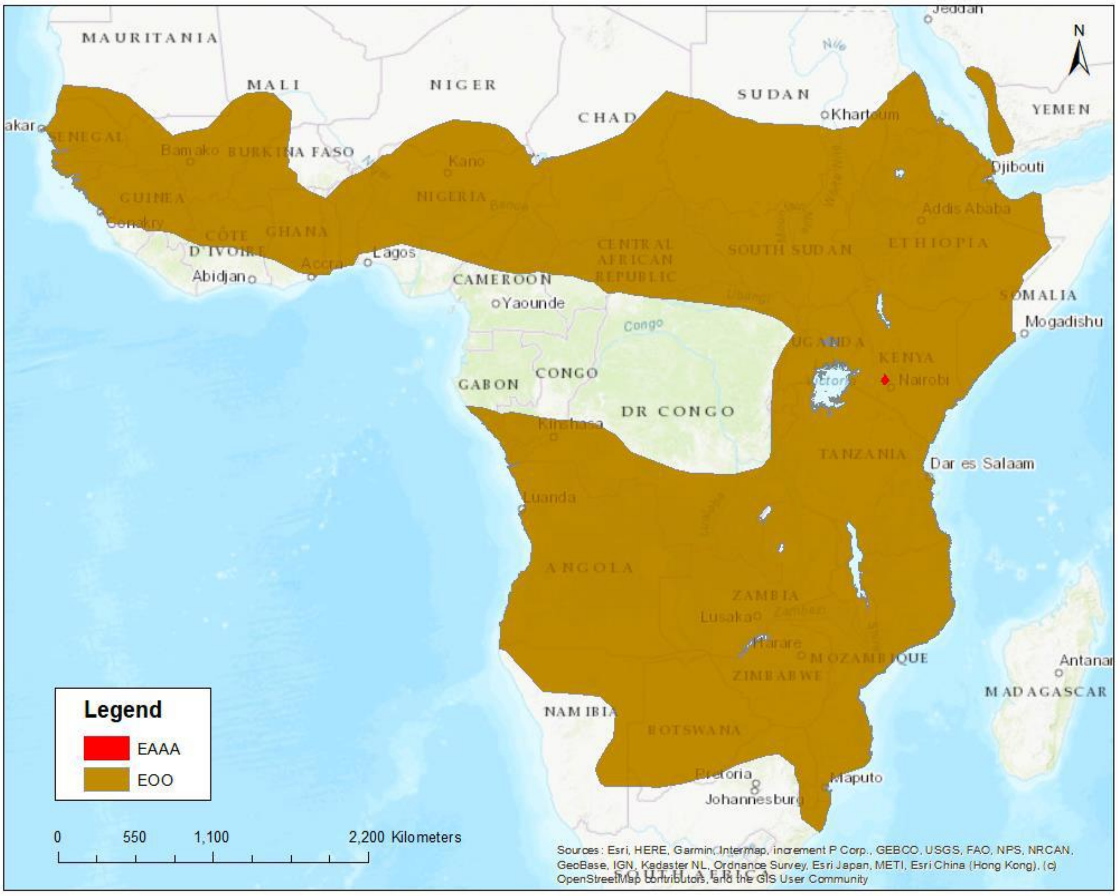


Figure 4-41: Bateleur's EOO that encompasses the whole of Kenya including the project's EAAA

The Secretary bird (*Sagittarius serpentarius*) is listed as an Endangered bird species by the IUCN with an estimated 6700-67000 mature individuals. The declining population is associated with habitat degradation, hunting, disturbance and capture for trade. In Kenya, attempts to breed were observed to be disturbed by long droughts and unfavourable weather conditions while their suitable habitat (open landscapes, ranging from open plains and grasslands, to lightly wooded savanna), is being converted to other land uses, particularly for commercial purposes (Hofmeyr Symes, & Underhill, 2014). The project's EAAA intersect 0.0074% falling below the threshold to trigger Critical Habitat.

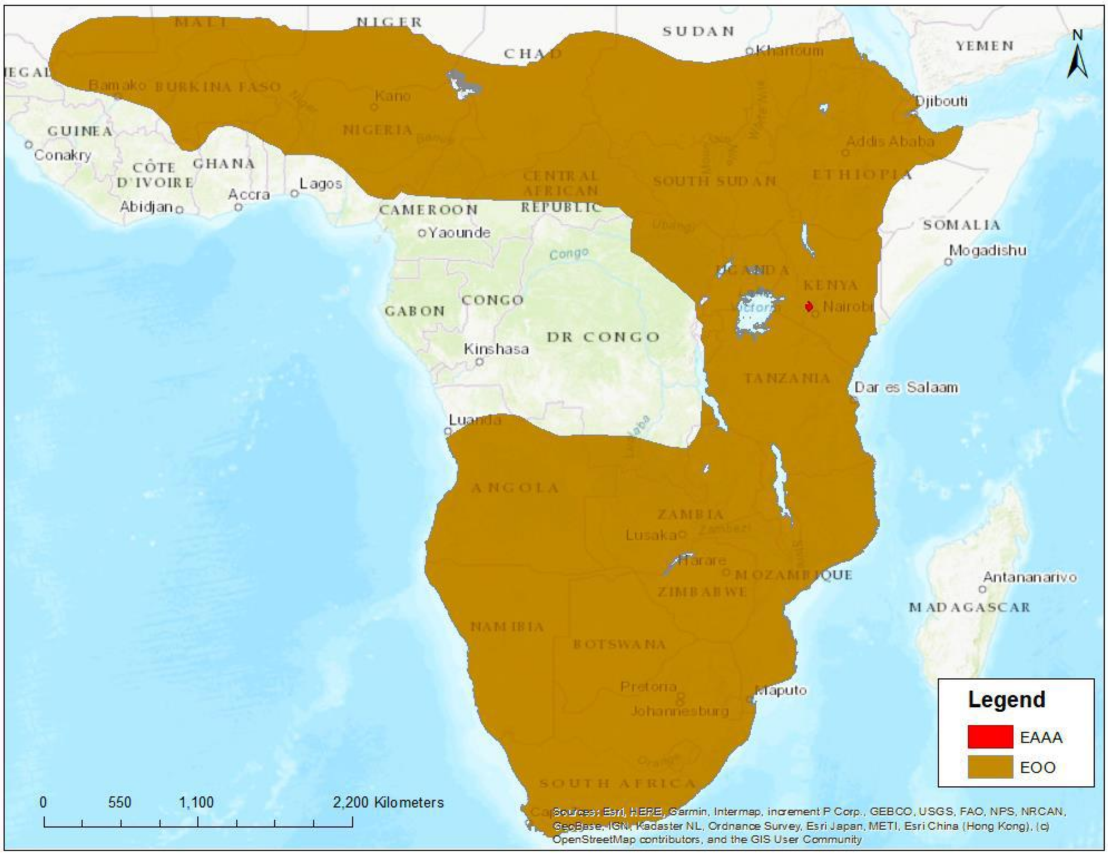


Figure 4-42: The Secretary bird' EOO

Hells Gate National Park was once the home of the Bearded Vulture (*Gypaetus barbatus*) and these birds were regionally endemic since they are only found in one more country, Ethiopia. The bird has however not been sighted in the park for the last decade but of concern to the management regarding species diversity is local extinction of the bird and failure to establish a viable population after a trial reintroduction few years ago.

The mountain reedbuck (*Redunca fulvorufula*) is a species of special concern in Hells Gate National Park since it is rarely found in the rest of the ecosystem save for the parks.

The Lake Naivasha fishery is constituted by three introduced species, *Sarotherodon leucostictus*, *Tilapia zillii* and *Micropterus salmoides*. No indigenous species are currently found in the lake. There are varying reasons for the introductions but most of them are seen through the lenses of fisheries management. Provision of sports fishery, supplemental to stocks, to fill empty niches, control weeds, and disease vectors and even create a commercial fishery are some of the reasons why fish species are introduced into new ecosystems.

Some of the problems facing the two lakes are intensive non-selective fishing, catchment degradation, industrial and agricultural pollution, the introduction of exotic species and an uneven patchwork of governmental laws (reviewed by Ogello *et al*., 2013). Ogello *et al* (2013) upheld Hardin's argument that the freedom of the commoners has caused resource overuse in Lake Victoria leading to poverty and therefore recommend access limitation as a way of encouraging wise use of the lakes' resources. The aquatic community of Lake Naivasha lacks a significant number of endemic species due to frequent fluctuations in water levels, leading to the complete drying of the lake on multiple occasions within human memory. One example is the 'small-toothed carp' or 'black *lampeye' Aplocheilichthys antinorii* (Vinc.), which was declared extinct in 1964 after no specimens were found for several years.

A notable shift occurred in the fish population of Lake Naivasha, transitioning from the long-term dominance of tilapia species Oreochromis leucostictus and Tilapia zillii (Cichlidae) to carp (Cyprinus carpio, Cyprinidae). This change resulted from the accidental introduction of carp during the 1999 'El-Niño' rains, which swept them downstream from an upstream dam where they had been introduced by the Kenya Fisheries Department a few years earlier. Since 2004, carp have overwhelmingly dominated fish catches, representing over 95% of the annual yield in some years. Fish catches have been on the rise since 2009, following a year of unusually low water levels.

Commercially important fish species in Lake Naivasha include blue-spotted tilapia, carp, and large-mouthed bass. Other tilapia species like *Tilapia zillii* and *Oreochromis niloticus* were introduced to promote tilapia catches. *Barbus paludinosus* (*B. amphigramma*, Cyprinidae), a small pelagic native sardine-like fish, is ecologically important but not extensively fished. It colonized the lake in the late 1980s, becoming a breeding fish in the 1990s. Although effective in consuming zooplankton, its impact on the lake ecosystem has not been studied.

The large-mouthed bass (*Micropterus salmoides*, Centrarchidae), introduced from North America in 1929 as a sport fish, persists in moderate numbers along the rocky edges of the lake. *Clarias gariepinus* (Clariidae), a catfish, appeared in the lake in the last five years, likely washed down from established fish ponds in the basin. The mosquito fish *Poecilia reticulata* (Poeciliidae), originally from South America and introduced in the 1960s for insect pest control, is present in low numbers. The North American rainbow trout *Oncorhynchus mykiss* (Salmonidae) is common in rivers but rarely found in the lake.

The Hells Gate National Park has two plant species which are of concern to conservation, *Acacia drepanolobium* (Whistling thorn). This is the most abundant acacia species and forms an important source of food for the giraffes. It is armed with long, sharp thorns, which are swollen at the base to form a round chamber. These chambers are often inhabited by small ants that hollow out the swelling and derive nourishment from the tree's secretions. In return the ants provide protection from leaf-eating herbivores. It is the wind whistling past the openings of the swellings that gives the tree its name. It has a very hard wood and is used for fencing around Masai Bomas.

Tarchonanthus camophratus (Leleshwa). This species though not very important as a food item, is important in that it provides cover and habitat for other fauna components. Its camphor wood and the camphor oil which the bush produces help protect the plant against insect attack and fungal diseases. It is traditionally used for fencing and the leaves are used by the Maasai as a deodorant. The "leleshwa" is disappearing in most of the Rift Valley due to human cultivation and hence the need for its proper conservation.

4.3.8 Vegetation loss in Hell's Gate National Park

Hell's Gate National Park is a unique protected area with stunning landscapes, and diverse wildlife. While the park is relatively well-preserved, there are several factors contributing to vegetation loss in certain areas. Some potential causes include: Expansion of agricultural activities, leading to the clearing of land. This has led to encroachment resulting in the loss of natural vegetation in and around the park. Uncontrolled grazing by livestock, particularly in areas adjacent to the park, has put pressure on vegetation.

Overgrazing is leading to the depletion of plant species and negatively impacting the ecosystem.

The spread of invasive endemic plant species (leleshwa) is outcompeting other native vegetation, leading to a decline in biodiversity. This is altering the composition of plant communities and affecting the overall health of the ecosystem. However, in the Olkaria field, it plays a vital role in providing shade to animals and holding the fragile soil together thus combating soil erosion.

There have been cases of human-induced wildfires especially in Longonot leading to significant vegetation loss. Changes in climate patterns, such as shifts in precipitation and temperature, has impacted vegetation. Prolonged droughts, for example, stress plant communities and make them more susceptible to diseases and pests.

While Hell's Gate is known for its geothermal features, intense geothermal activity in specific areas is potentially impacting vegetation. Direct exposure to geothermal fluids, heat, or toxic gases may limit the growth of certain plant species. The current expansion of geothermal activities characterized by the extensive pipeline networks in Hell's Gate National Park is fragmenting and reducing the habitat range accessible to wildlife by over 60%. This has resulted to over-utilization and consequently degradation of the remaining sections of the park.

High tourist visitation and their associated activities has led to trampling of vegetation, soil erosion, and other forms of habitat disturbance. The recently launched safari rally is heavily impacting on vegetation as well as wildlife animals. Sustainable tourism practices are essential to minimize these impacts.

The construction of roads, buildings, and other infrastructure within or near the park has resulted in habitat fragmentation and vegetation loss disrupting wildlife corridors and impacting the park's overall ecological balance.

Addressing these challenges requires a holistic approach that involves community engagement, sustainable land management practices, conservation initiatives, and effective policies and regulations. It's essential to balance human needs with the preservation of biodiversity to ensure the long-term health of Hell's Gate National Park.

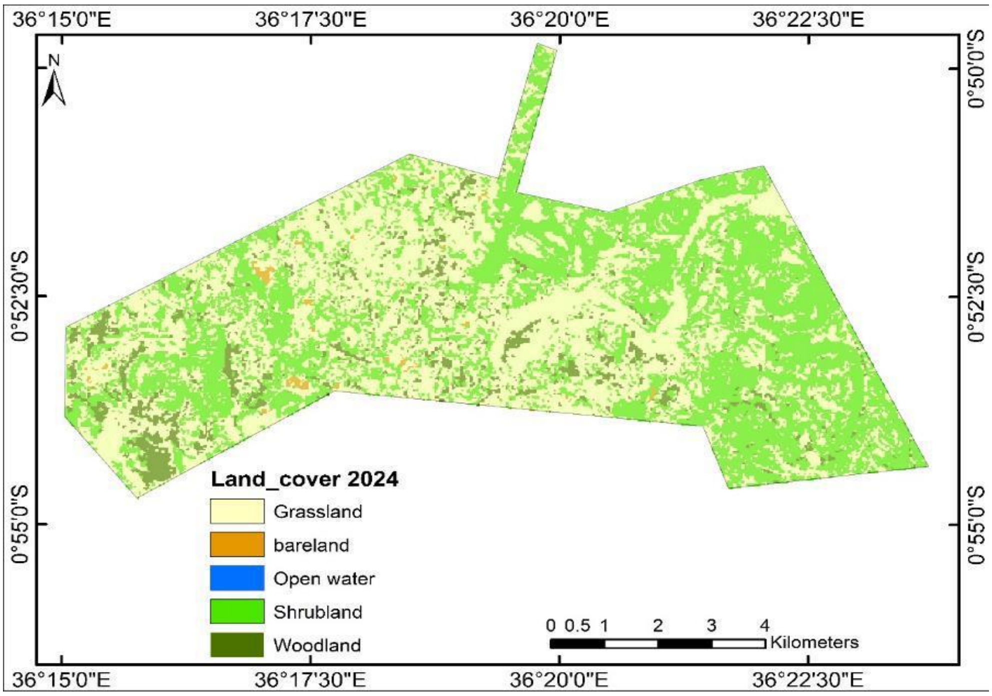


Figure 4-43: Vegetation Cover in Hell's Gate National Park

A detailed biodiversity assessment report has been provided as an annex (***Annex 16***) to this ESIA Report.

4.3.9 Biodiversity of the proposed site

4.3.9.1 Flora

The flora present within the proposed project area is almost similar to that of Hell's Gate National Park in general, as it is also dominated by the shrubland community mostly comprising of *Tarchonanthus camophratus*, locally referred to as "leleshwa". Common grasses in the shrubland community of the project site include *Cymbopogon nardus*, *Setaria sphacelata*, *Themeda triandra*, *Eragrostis cilianensis*, *Hyparrhenia hirta*, *Cynodon dactylon*, *Pennisetum clandestinum*, and *Digitaria abyssinica* among other grasses.

It is important to note that a portion of the proposed project area has no vegetation, but is instead used as yards for storage and material laydown. The yards have been in existence for the past 20 years and have been used for storage of: non-toxic drilling chemicals (caustic soda, drilling mud, and drilling detergent) and tools (drilling bits). The yard located in the **Eastern section** of the area was used by 'GEG KE Ltd Kenya' as a storage area and a camp site for workers during the construction of Well Heads and other geothermal rehabilitation activities. However, the yard has not been actively used for quite some time. The yard located in the **Middle section** of the area belongs to Mitsubishi, and is currently being used for material lay down and storage of equipment (Drilling detergents/non-toxic chemicals, Pipes, Drilling Casings, Rig equipment and some non-toxic waste). Adjacent to the Mitsubishi yard, is Fichtner's project execution office. The yard and the office will need to be decommissioned to give way for the proposed project. The **Western section** or lower part of the project area is used by KenGen's steam-field department for storing their equipment.

Figure 4-44: Illustration of the current vegetation at the proposed site

Most of the vegetation clearing will be inevitable at the Northern Section of the proposed site area. Additionally, vegetation clearing will also be associated with installation of new and maintenance of existing steam-field pipelines, construction and maintenance of the central separators, maintenance of the ventilation station area and at the Olkaria IAU Steam Line Tie-In Point (as shown in Figure 4-45). This may lead to disturbance of the ecosystem that provides feeding grounds for fauna within the area.

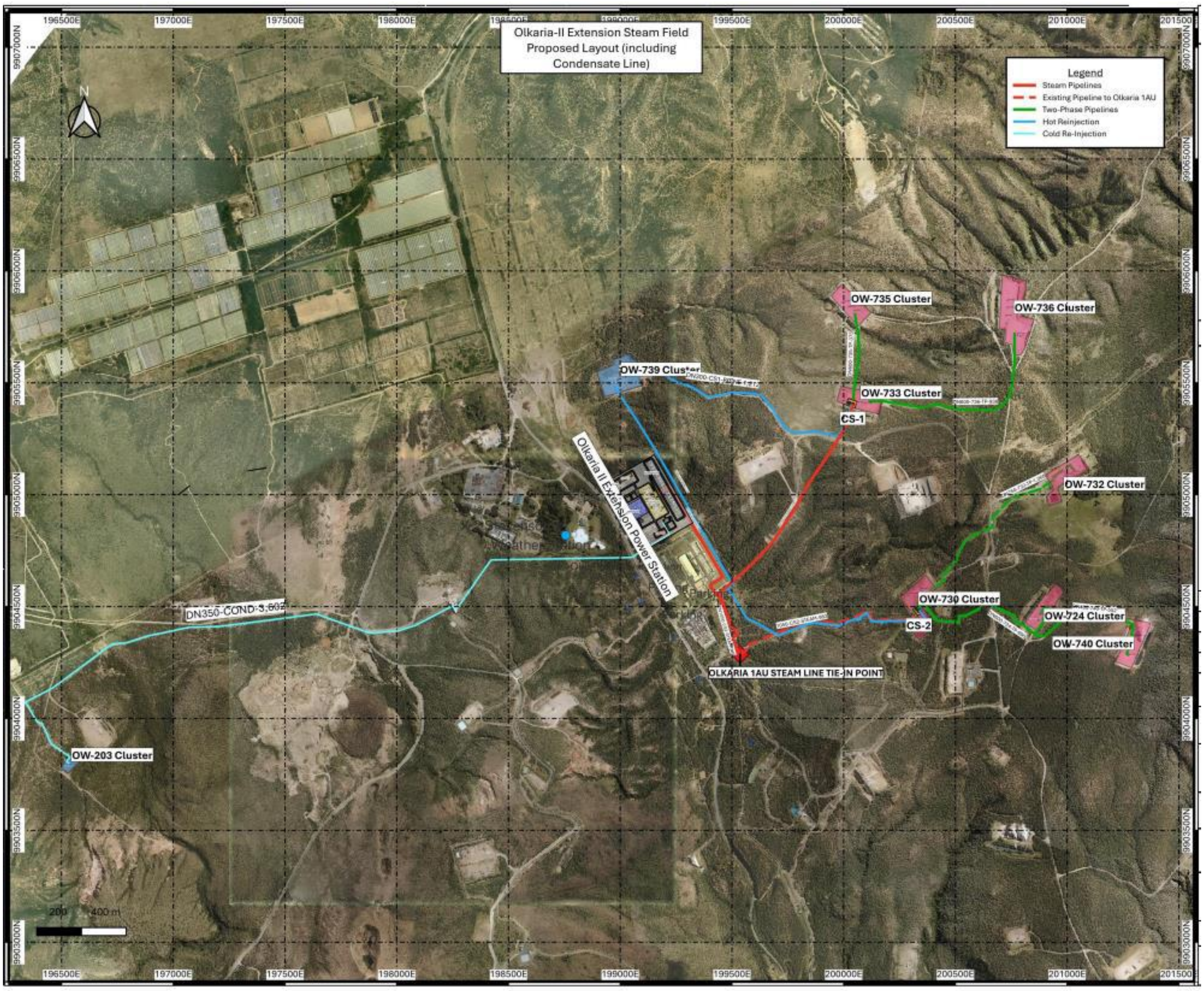


Figure 4-45: Steam and Condensate Field Layout

4.3.9.2 Fauna

Similarly, the fauna present within the proposed project area is almost similar to that of Hell's Gate National Park in general. It is important to note that the site is not a sensitive area used as a habitat for endangered species or used as a designated breeding ground for fauna. Herbivores may late at night or early in the morning, graze/browse outside the periphery of the proposed site but not within the project's footprint.

The wild animals that have been spotted outside the project's footprint grazing/browsing include the zebra (*Equus burchelli*), Hartebeest (*Alcelaphus buselaphus*), gazelle (*Gazella thomsonii* and *Gazella grantii*), Impala (*Aecpyceros melampus*), dik-dik (*Rhyncotragus kirkii*), giraffe (*Giraffa cemelopardalis*) and buffalo (*Syncerus caffer*) among other herbivores.

4.4 Social Environment

4.4.1 Administrative and Political Units

Nakuru County is divided into eleven administrative Sub-Counties namely, Nakuru East, Nakuru West, Naivasha, Molo, Njoro, Kuresoi North, Kuresoi South, Rongai, Bahati, Subukia and Gilgil. The project site lies within Naivasha subcounty.

The County is divided into 11 Constituencies namely, Nakuru Town East, Nakuru Town West, Bahati, Subukia, Rongai, Njoro, Molo, Kuresoi South, Kuresoi North, Gilgil and Naivasha. The Total number of the County's electoral wards is 55.

4.4.2 Infrastructure Development

Kenya's Vision 2030 has identified infrastructure as an enabler and foundation for socio-economic transformation. The County's infrastructure facilities include road network, rail network, airstrips, ICT, housing among others.

4.4.2.1 Road and Rail Network

The entire road network in the County is approximately 1,2491.7km: out of which paved roads are 993.7 Km; gravel surface roads are 4500Km and 6998Km of earth surface roads. 55 percent of the roads are estimated to be of fair condition. A meter gauge railway line length 192 Km traverses the county connecting the major urban areas of the county. About 120km of the Standard Gauge Railway (SGR) phase 2A from Nairobi to Naivasha passes through the county. Kenya Railways has been renovating the meter gauge that is expected to revamp rail transport for both passengers and cargo.

4.4.2.2 Airport and Airstrips

Currently, the County does not have an existing airport. However, there are plans for expansion of the airstrip at Lanet Military Base for commercial services. This will improve economic integration with the rest of the nation and open international market for products within the County including direct export of horticulture and floriculture.

4.4.2.3 Information and Communication Technology (ICT)

The rapid uptake of ICT has seen a significant rise in investment of ICT infrastructure across the County. An estimated 82.5 percent of households in Nakuru County own a mobile phone whereas the mobile network coverage in the County is at 91 per cent. Access to internet is at 16.3%, access to television at 56.6 % and radio access is at 90.8 %. (KIHBS 2015-16).

The County Government has taken strides towards adoption of ICT. Various ICT platforms in the County include; Integrated Financial Management Information System (IFMIS), Integrated Payroll and Personnel Database (IPPD), Local Authority Integrated Financial operations Management System (LAIFOMs) and ZIZI. With the support of the Presidential Digital Communication Unit the County has provided free internet service through WIFI hotspots popularly known as '*Bilawaya'* thus promoting access to internet services.

There are several post offices across the County. However, the post office is facing fierce competition from other courier service providers as well as services provided by Public Service Vehicles (PSVs).

4.4.3 Tourism

The main tourist attractions in Nakuru County include: Lake Nakuru National Park, Hell's Gate National Park and Mt. Longonot National Park. Other tourist sites include; Menengai Crater, Subukia Shrine, Lord Egerton Castle, Lake Naivasha, Lake Elementaita, Hyrax Hill prehistoric site, Ol-doinyo Eburru volcano and Mau Forest. Private wildlife conservancies that attract tourists in the county include; Marura, Oserian and Kedong in the Naivasha sub-County and Kigio and Soysambu in Gilgil sub-County. The main tourist activities include; bird watching, cycling, hiking, rock climbing, picnics, excursions and game drives.

Tourism is an important activity around Lake Naivasha, as well as in the project area. Presently, several tourist facilities including the geothermal spa, hotels and lodges have been developed to cater for the growing industry. With spectacular scenery, the presence of charismatic wildlife and avifauna, a fine climate, tranquil surroundings and easy access, the 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 presence of Olkaria Geothermal Power Stations.

For those nine (9) years, Hell's Gate National Park (HGNP), which houses Olkaria Geothermal Power Plants and the proposed power plant, experienced fluctuations in the number of visitors touring the Park. Between 2014 and 2019, the total number of visitors in HGNP gradually increased, with a slight decline observed in the year 2019 and 2020.

During the COVID-19 pandemic in the year 2020, the total number of tourists, both domestic and foreign who visited the park drastically dropped. This drop was attributed to the restrictions in movement and interactions among people, that had been put both locally and worldwide, to control the spread of the virus.

It is noteworthy that the number of visitors has been on an upward trend since 2021, which is attributed to the decline in COVID-19 cases which allowed people to embark on excursions and other tourism-related activities within the park. In the year 2022, visitations by the citizens increased to levels that were higher not only than those observed in the year 2019 (before the COVID-19 pandemic), but also increased to 10-year record-highs. Although the visitations by the residents and non-residents are also increasing during the period, they are yet to reach levels that were observed before the COVID-19 pandemic.

This is as illustrated in Figure 4-46 and Figure 4-47.

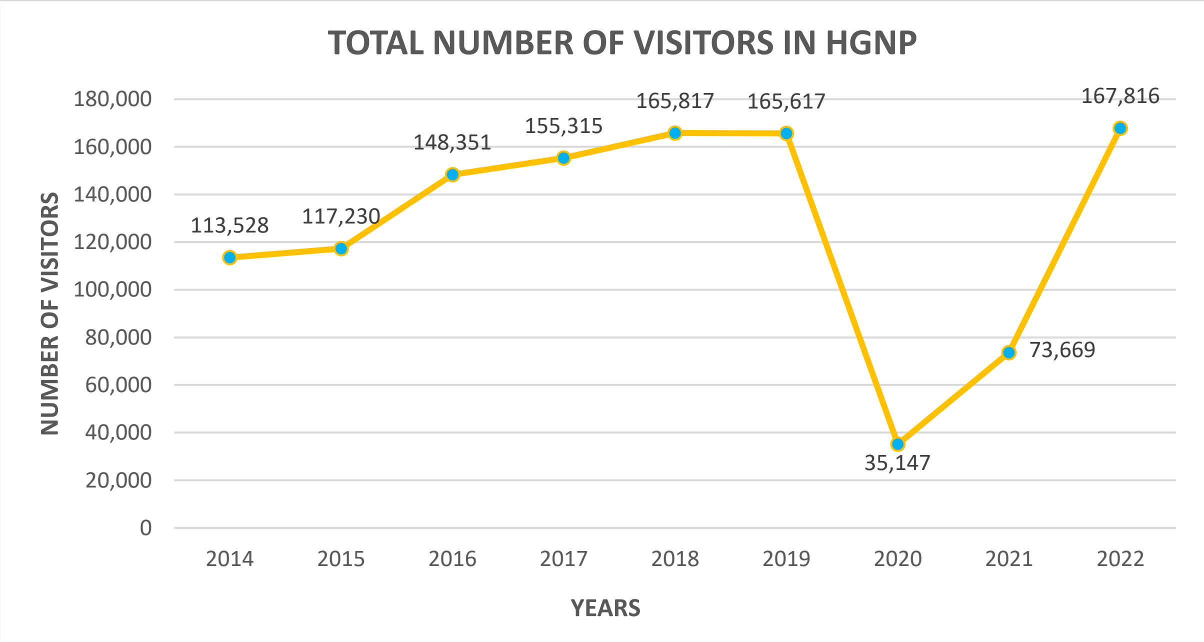


Figure 4-46: Total number of visitors in HGNP between 2014 to 2022

(*Source: KWS, 2018; KWS, 2023*)

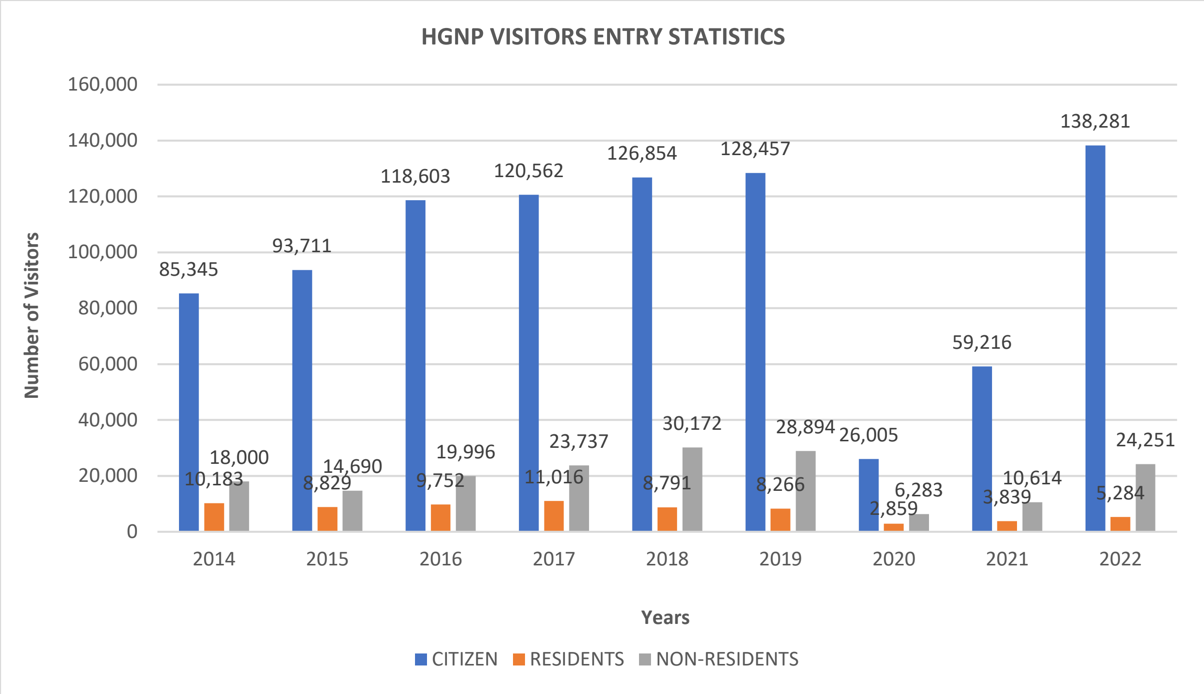


Figure 4-47: HGNP Visitors Entry Statistics

(*Source: KWS, 2018; KWS, 2023*)

4.4.4 Socio-Economic Survey

Socio-economic surveys were carried out from 11th to 13th October, 2023 using digital questionnaires in the project area of influence. The main aim of the survey was to help the ESIA parties (Proponent, Consultant and Regulatory Authority) understand the social and economic characteristics of the community found within the proposed project area of influence for informed decision making. The data obtained can as well be considered to have been obtained from a representative sample of the community for conclusions on the findings hence applicability as part of the baseline information for this study.

The socio-economic survey targeted populations that would be directly or indirectly affected by the project in Olkaria and Maiella locations in Nakuru County and Enosoopukia Location in Narok County. All these Locations are made up of villages as illustrated in the table below.

A total of two hundred and twenty-six (226) respondents were interviewed. This sample size was sufficient to ensure a representative and reliable analysis of the ESIA objectives taking into account the specific characteristics of the people living around the project area. Out of the 226 respondents interviewed, 47 were from Kambi Turkana and RAPLand, 33 from Olomayiana Kubwa, 57 from villages around Kamere, 47 from Narasha and villages in Maiella, and 42 from villages in Iseneto.

Table 4-30: Analysis of respondents

County	Location	Sublocation	Villages	Respondents
Nakuru	Olkaria	Olkaria	Kambi Turkana and RAPLand	47 (20.8%)

			Olomayiana Kubwa	33 (14.6%)
		Kamere	Kamere, DCK, Oldonyo, Sher, Rift, Oserian, Majengo, Kasarani and Kwa Muhia	57(25.2%)
	Olkaria and Kamere	Olkaria and Maiella	Narasha, Olomunyak, Olmara, and Nkampani	47(20.8%)
Narok	Enosoop ukia	Narok East	Iseneto (Ilkituma, Oloserian, Oloiriwua, Olorropil, Kitet, Olosing'ate, Oloshaiki and Kitet)	42(18.6%)
Grand Total				**226(100%)**

4.4.4.1 Household Composition

Most respondents (35.8%) were between 20-30 years as indicated in the figure below:

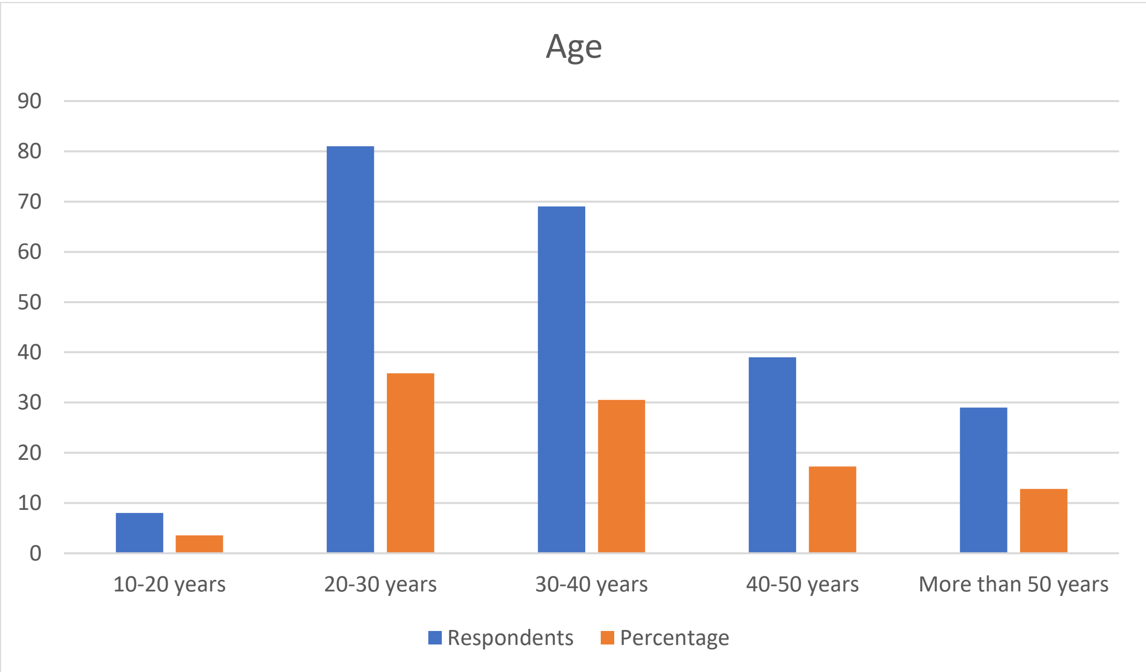


Figure 4-48: Respondents' age

The data depicts a scenario where the youth claim the largest percentage of the respondents. Several respondents (12.8%) were above the age of fifty, most of whom were elders in the community.

4.4.4.2 Religion

Majority of the respondents (98.7%) were Christians as presented in the table below. This was evidenced from the field visits as there were several churches in every village. A small portion of the respondents were Muslims, pagans, and other religious denominations.

Table 4-31: Respondents' religion

Religion	Respondents	Percentage (%)
Christian	222	98.7%
Islam	2	0.9%
Other	1	0.4%
Non-Religious	1	0.4%
Grand Total	**226**	**100%**

4.4.4.3 Marital Status

Among the 226 respondents, 84% were married, 14.2% were single, and 0.9% were separated while the other 0.9 % were widowed as presented in the figure below.

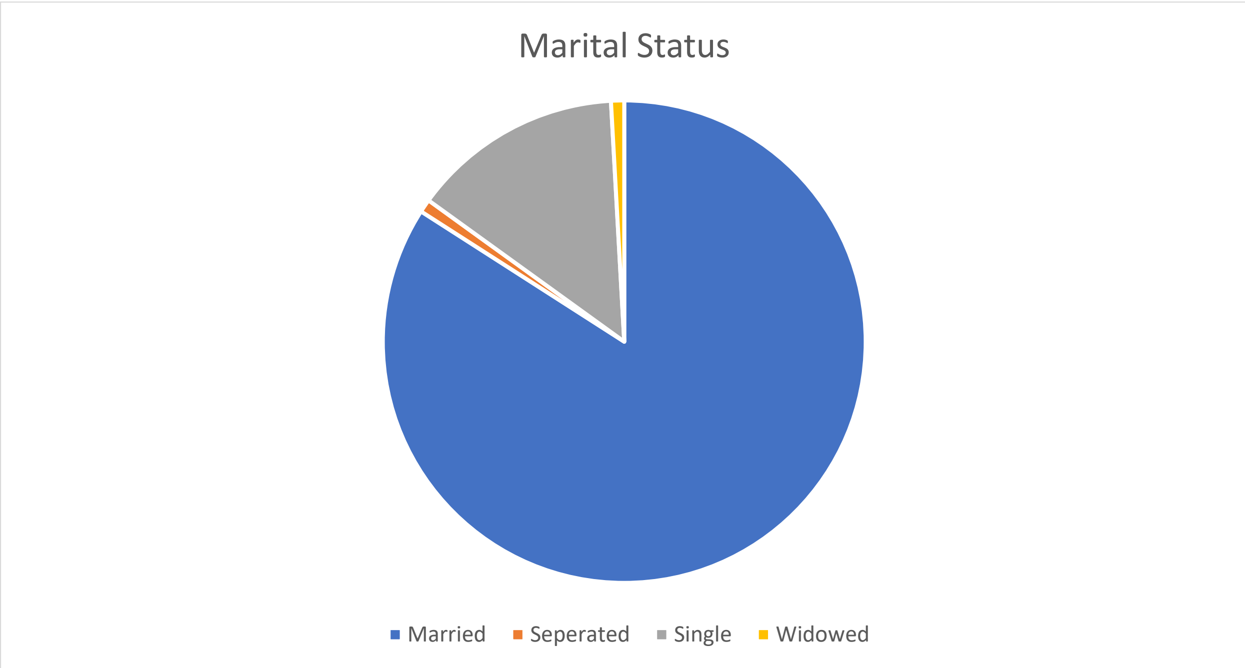


Figure 4-49: Respondent's marital status

4.4.4.4 Ethnic Distribution

The respondents interviewed were ethnically distributed as shown in the table below. The surrounding area has inhabitants from many of the tribes in Kenya. This is due to the influx of people in search of employment opportunities owing to the industries and farms in the area and those conducting supporting businesses such as in the service industry such as hotels. Majority of the neighbours to the project (69.9%) are from the Maasai community, many of whom lived in their ancestral land before being resettled.

Table 4-32: Ethnic distribution

Ethnic Group	Respondents	Percentage (%)
Kalenjin	3	1.3%
Kamba	2	0.9%
Kikuyu	21	9.3%
Kisii	8	3.5%
Luhya	16	7.1%
Luo	11	4.9%
Maasai	158	69.9%
Other	7	3.1%
Abasuba	1	0.4%
Borana	1	0.4%
Embu	1	0.4%
Meru	1	0.4%
Turkana	3	1.3%
Grand Total	**226**	**100%**

The project shall implement targeted interventions to ensure individuals from the neighbouring communities are adequately and effectively engaged and equally enabled to access project benefits and opportunities.

4.4.4.5 Education

The respondents' education levels attained are as follows: secondary (81), primary (49), college (33), and university (7). As presented in the figure below, 56 respondents had no formal education.

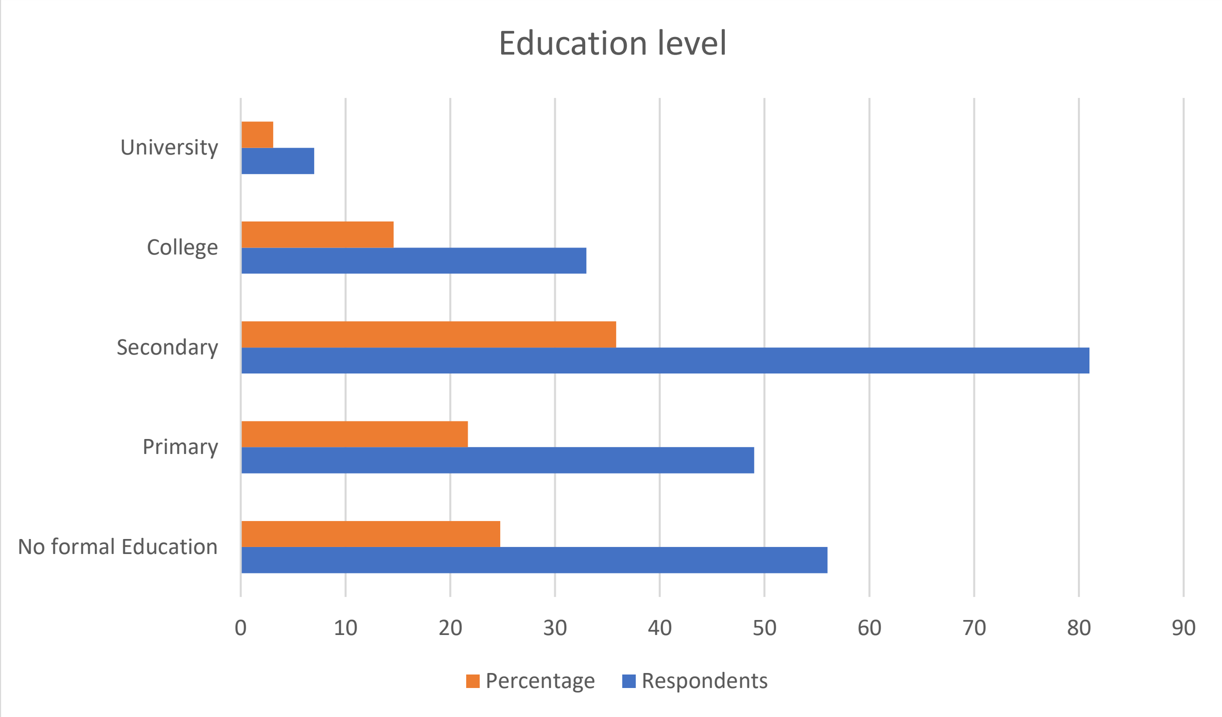


Figure 4-50: Respondents' education level

Majority of the inhabitants in the area have studied only at the ordinary levels and a few more up to the advanced levels. The area is highly lacking in tertiary level who are degree, master's and PhD holders. This explains the huge deficiency in professionals in various fields of study in the area.

4.4.4.6 Housing

Majority of the people (49.56%) in the survey lived in permanent houses which were made of stone. This is in line with the Nakuru CIDP (2018-2022) which denotes that the main wall material is stone. Some of the Maasai being the dominant group, still held onto their traditional houses making up 22.5% of the respondents. Some have however migrated to temporary houses made of iron sheets and semi-permanent made of iron sheets and mud plastered walls as shown in the table below.

Table 4-33: Respondents' housing

Type of House	Respondents	Percentage (%)
Permanent	112	49.6%
Semi-Permanent	44	19.5%
Temporary	19	8.4%
Traditional	51	22.6%
Grand Total	**226**	**100%**

Most people in the area (85%) live more than 5km from the proposed site as presented in the table below. This is because of resettlement that was carried out during the development of the existing Olkaria Geothermal Power Plants.

Table 4-34: Respondents' household distance from the site

Distance to Site	Respondents	Percentage (%)
More Than 5	191	85%
4-5km	6	3%
3-4km	16	7%
2-3km	7	3%
1-2km	6	3%
Grand Total	**226**	**100%**

As presented in the table below, most of the inhabitants (53%) have lived around the Olkaria area for 20 years or more.

Table 4-35: Respondents' years of residence

Years	Respondents	Percentage (%)
0-5 Years	19	8%
5-10 Years	50	22%
10-15 Years	21	9%
15-20 Years	17	8%
More Than 20 Years	119	53%
Grand Total	**226**	**100%**

4.4.4.7 Household Size and Gender Distribution

The data depicts a scenario of a youthful group (33%) of people aged above eighteen (18) years and thirty-five (35) years living around the Olkaria geothermal site as the dominant group. It was also clear that there are many households (48%) with children who are below the age of eighteen years. People who are between the youthful age and sixty years old were at 16% and a few people past the age of seventy making up 3%. From the respondents, there were no people between the ages of sixty (60) to sixty-nine (69) years as shown in the table below.

Table 4-36: Household age distribution

Age Group	Count of Respondents(N=226)	%(N=226)	Total HH Size	Percentage (%)

0-18 Years	3	1%	758	48%
19-35 Years	135	59%	520	33%
36-59 years	76	34%	255	16%
60yrs – 69yrs	8	4%	0	0%
70 and Above Years	4	2%	50	3%
Total HH Size			1,583	100%

In examining the demographic profile, particular attention was directed towards gender dynamics as they play a significant role in shaping community structures. From the data collected on household size, a total of 763 of the household members were male and 820 were female with 204 respondents out of the total respondents having their household headed by males and only 21 headed by a female. Only one respondent had a household head below 18 years as shown in the table below.

Table 4-37: Household Heads

Current Household Head	Respondents	Percentage (%)
Female Household Head	21	9.3%
Household Head Is Less Than 18 Years	1	0.4%
Male Household Head	204	90.3%
Grand Total	**226**	**100%**

The above data is influenced by the communities' longstanding patriarchal structures that assign leadership roles to men.

4.4.4.8 Land Ownership

It was established that the majority of the respondents (41.2%) lived on communal land as shown in the figure below. This number included those who were resettled to pave way for past Olkaria geothermal projects. 23% were found to live in privately-owned land while 21.2%had rented due to their engagements such as service providers or temporary and permanent employment.

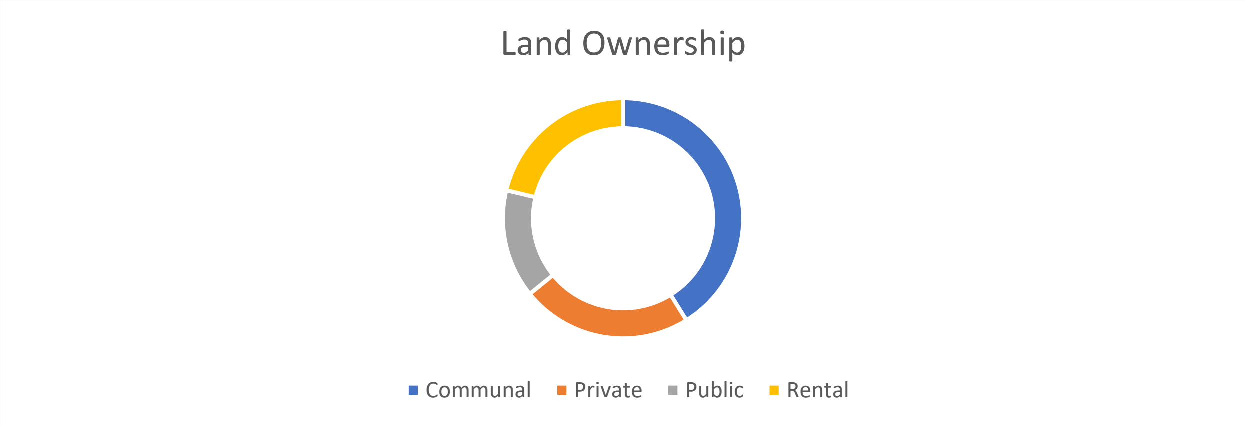


Figure 4-51: Respondents land ownership status

With land being owned communally, the majority of the dwellers (48%) owned less than ten acres of land in the area as shown in the table below.

Table 4-38: Communal land ownership sizes

Estimated Communal Size	Respondents	Percentage (%)
Less Than 10 Acres	45	48%
10-20 Acres	14	15%
20-30 Acres	8	9%
30-40 Acres	13	14%
40-50 Acres	1	1%
More Than 50 Acres	12	13%
Grand Total	**93**	**100%**

50% of the private land owners lived in under ten acres of land as shown in the table below. There are however a few outliers with twenty or more acres of land with the majority being those in their communal land.

Table 4-39: Private land ownership sizes

Estimated Private Size	Respondents	Percentage (%)
Less Than 10 Acres	26	50%
10-20 Acres	10	19%
20-30 Acres	3	6%
30-40 Acres	11	21%
More Than 50 Acres	2	4%
Grand Total	**52**	**100%**

4.4.4.9 Source of Livelihood

Majority (63.3%) were livestock farmers. This is due to the high prevalence of the Maasai community who are pastoralists. Another group of about 26.1% engaged in businesses such as hairdressing, hotel industry, crop farming, and chicken rearing among others, as presented in the table below.

Table 4-40: Respondents' source of livelihood

Activities	Total (N=226)	Percentage (%) (N=226)
Livestock Farming	143	63.3%
Hotel	3	1.3%
Business/Industry	59	26.1%
Any Other (Explain)	48	21.2%
Animal Husbandry Keeping	19	8.4%

4.4.4.9.1 Farm Animals

The livestock practices provided a fascinating insight into the predominant pastoralist lifestyle of the communities. While the majority (65%) of the respondents engaged in keeping cows, the numerical count revealed a higher (36%) presence of sheep than cows (22%) in the overall animal population. This can be due to the fact that sheep have to adjust to changing weather patterns. Other animals kept are as illustrated in the table below. These animals are synonymous with the large representation of the Maasai community. However, some people kept hens and dogs though in small numbers. There are also some animals such as ducks and turkeys though in small numbers.

Table 4-41: Farm animals kept by respondents.

Animal	Respondents(N=226)	%(N=226)	Total Animals	Percentage (%)
Cows	146	65%	3,487	22%
Goats	138	61%	5,169	33%
Sheep	143	63%	5,676	36%
Donkeys	63	28%	191	1%
Hens	95	42%	1,091	7%
	Grand Total		**15,614**	**100%**

4.4.4.10 Economic Conditions

4.4.4.10.1 Occupation

The major sources of income for the households surveyed were livestock farming at 39% owing to the large group of herders and livestock farmers in the area. There were however about 15% who were in employment, 20% in private business and 19% in crop farming. There were a few who practiced fishing (1%) and self-employment income generating activities as shown in the table below.

Table 4-42: Households' income types

Income Type	Respondents	Percentage (%)
Crop Farming	62	19%
Livestock Farming	122	39%
Private Business	64	20%
Employment	49	15%
Boda-boda Operation	12	3%
Fishing	3	1%
Other	11	3%

4.4.4.10.2 Household Income

As presented in the table below, the majority of household heads earned below sh10,000 in a month standing at 56.2%. They were followed from afar by 27.4% of people who earned about Ksh10,000-Ksh20,000 in a month. The data also depicts a large section of the population that lives under the poverty line. In 2022 World Bank updated the global poverty line from $1.90 to $2.15 per day.

Table 4-43: Average monthly income

Average Monthly Income (Kenya Shillings)	Respondents	Percentage (%)
0-10,000	127	56.2%
10,001-20,000	62	27.4%
20,001-30,000	18	8.0%
30,001-40,000	4	1.8%
40,001-50,000	4	1.8%
50,001-100,000	7	3.1%
Over 100,000	4	1.8%
Grand Total	**226**	**100%**

4.4.4.11 Health

For the past one year preceding this survey, 191 out of the 226 respondents had a member of their household sick. Whilst there were a variety of illnesses such as diarrhoea, headache, asthma and blood pressure, it was malaria and flu that were the most prevalent as shown in the table below.

Table 4-44: Types of illnesses

Illness	Respondents	Percentage (%)
Malaria	77	22%
Diarrhoea	7	2%
Stomach Ache	8	2%
Vomiting	6	2%
Upper Respiratory Infection	18	5%
Lower Respiratory Infection	4	1%
Flu	156	45%
Asthma	3	1%
Eye Problem	12	3%
Backache	4	1%
Blood Pressure	5	2%
Fracture	2	1%
Pregnancy Related	2	1%
Typhoid	3	1%
Others	38	11%

Majority (62%) of the households visited public health facilities while 39% had sourced health services from private health facilities. A few others also visited chemists depending on the severity of the illness.

62.8% of the respondents reported that the health facilities were more than 5km from their homes. Some however had access to dispensaries that were less than 5km from their households.

4.4.4.12 Water and Sanitation

70% out of the total respondents said they used piped water, 14% relied on borehole water, 3% on rainwater,1% relied on river/stream water and 1% relied on wells as shown in the table below. The respondents combined the use of these sources of water with other sources of water.

Table 4-45: Water sources for the respondents

Water Source	Respondents	Percentage (%)
Piped Water	176	70%
Shallow Well	2	1%
Rainwater	8	3%
River/Stream	3	1%
Borehole	34	14%
Other	28	11%

Most of the respondents don't pay or buy water since KenGen had connected the water for them and those that didn't have piped water were brought to by a water boozer as evidenced during the field visits.

On issues of toilet facilities that households have, 90% of the respondents confirmed having pit latrines in their homes. This is consistent with data from Nakuru CIDP (2018-2022) which indicates that they dispose of human waste through pit latrines which is at 76.9% while 10% reported that they used flash systems.

4.4.4.13 Source of Energy

The respondents who had access to electricity connection were 55.8% of the total with the rest having no connection at all.

Table 4-46: Status of household electricity connection

Connected to Electricity?	Respondents	Percentage (%)
No	100	44.3%
Yes	126	55.8%
Grand Total	**226**	**100.00%**

The respondents utilized a combination of different sources of cooking energy, with majority of the households using charcoal and firewood from the nearby bush to support their cooking activities. A very small number used kerosene probably due to proximity to a fuel station. Some made use of gas as their main source of cooking as illustrated in the table below.

Table 4-47: Cooking energy sources

Cooking Energy Source	Respondents	Percentage (%))
Electricity	2	0.5%

Gas	103	26%
Kerosene	3	1%
Charcoal	137	35%
Firewood	143	37%
Other	2	0.5%

Most households relied on electricity and solar energy as the main source of lighting as indicated in the figure below.

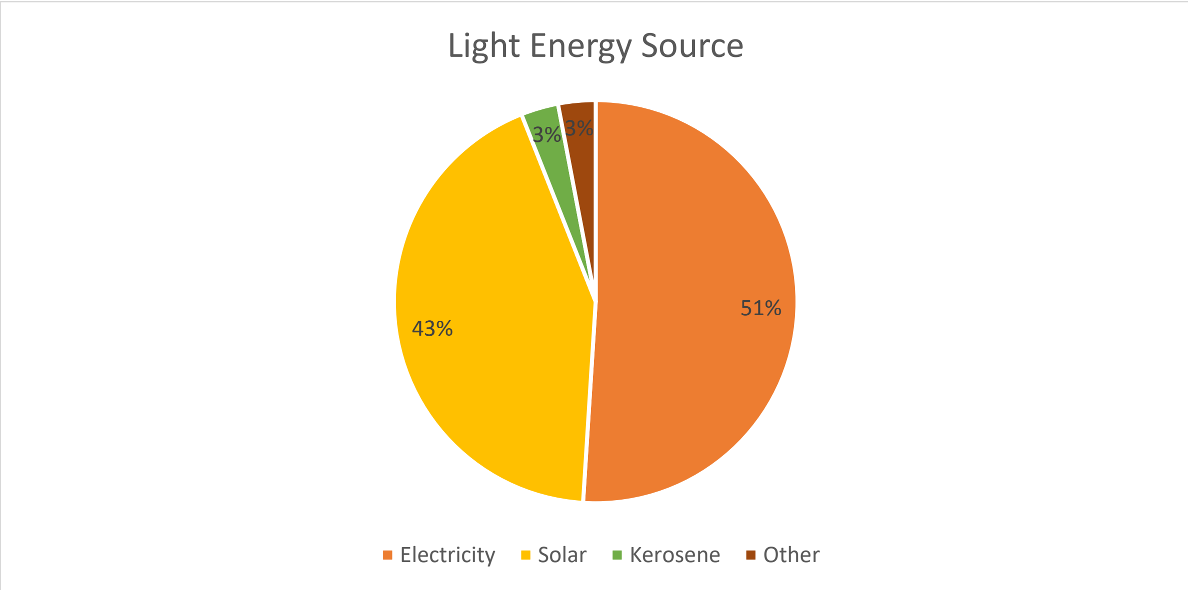


Figure 4-52: Lighting energy sources

4.4.4.14 Waste Disposal

The data also shows there's no system or particular standard for the waste disposal. As a result, the majority of the population dispose their waste through burning and some through digging pits and burying or through dumping in the dump sites for those with close access to one as shown in the table below.

Table 4-48: Waste disposal methods

Waste Disposal	Respondents	Percentage (%)
Private Service Provider	40	14%
Dump Site	93	33%
Bin	86	31%
By the Roadside	4	1%

Outside the Structure	31	12%
Other	26	9%

4.4.4.15 Means of Communication and Transport

The use of *boda-boda*/motorcycle is the most common mode of transport amongst the respondents. Out of the 226, 101 respondents used a motorcycle/*boda-boda* and 25 private cars. The other 55 responded as being on foot as well as using public and private transport when moving for long distances. The primary mode of communication used by 98.7% of respondents was mobile phone.

4.4.4.16 Vulnerable Groups

4.4.4.16.1 Elderly Persons

From the data collected, only 30 households were confirmed to be living with elderly individuals above 70 years. From the 30 households, 21 elders had registered with INUA Jamii, and the rest had not registered because some didn't see a need, others had their source of income and only a small percentage didn't know where to register.

14 of the respondents who lived with elderly individuals confirmed that they received financial support from the government initiative as shown in the figure below.

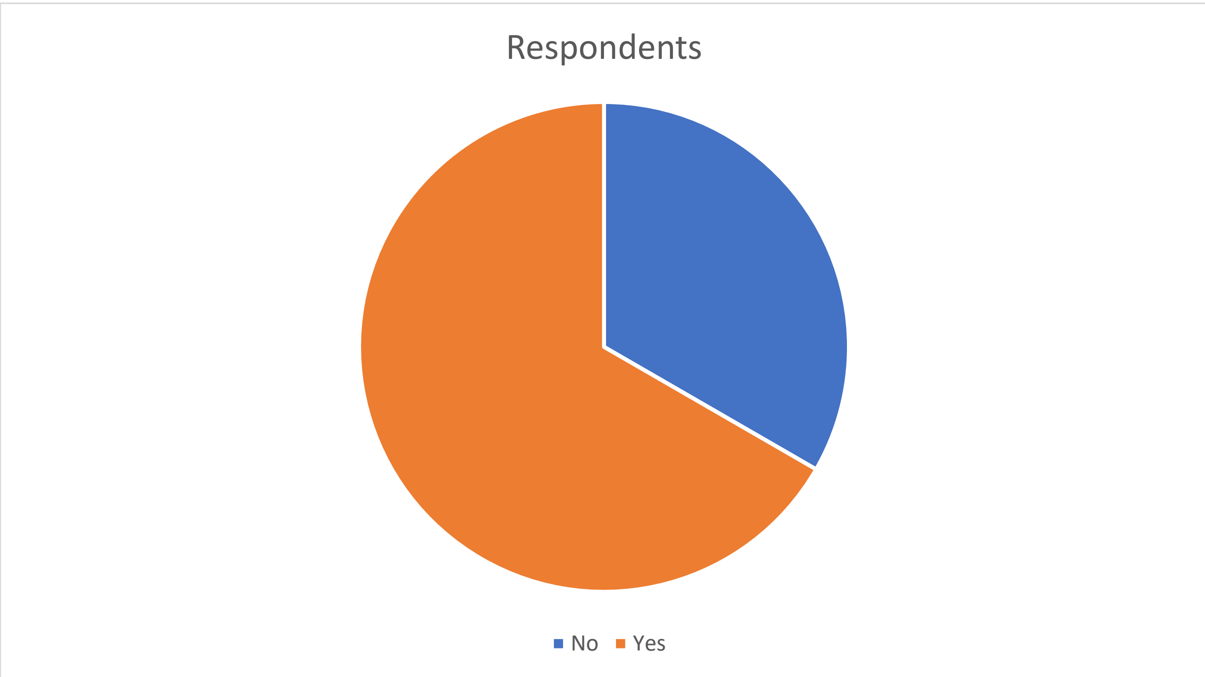


Figure 4-53: Status of Inua Jamii cash transfer for the elderly

4.4.4.16.2 People Abled Differently

Of the household respondents, 91.6% had no member suffering from disability with 8.4% having members suffering from various disabilities such as being dumb, deaf or visually impaired, with the biggest population of the sample size (55%) being physically impaired as shown in the table below.

Table 4-49: Types of disabilities

Disability Type	Respondents	Percentage (%)
Deaf	1	5%
Dumb	3	15%
Mental	1	5%
Others	2	1%
Physical	11	55%
Visual	2	10%
Grand Total	**20**	**100%**

4.4.4.17 Climate Issues

Majority of the respondents mentioned drought and very high temperatures as the most experienced weather patterns in the area. Though rare, flash floods were also experienced in times of very heavy rainfall that would sometimes be accompanied by high wind speeds.

The extreme drought and high temperatures persisted for a very long time leading to detrimental effects on the respondents and their families and village at large.

On assistance received due to persistent drought in the area, 71% of the respondents lamented on lack of help in such times of need while 22% mentioned they had received help from the government. It was also noteworthy that the civil society played a role in helping during such occurrences through activities such as supply of relief food.

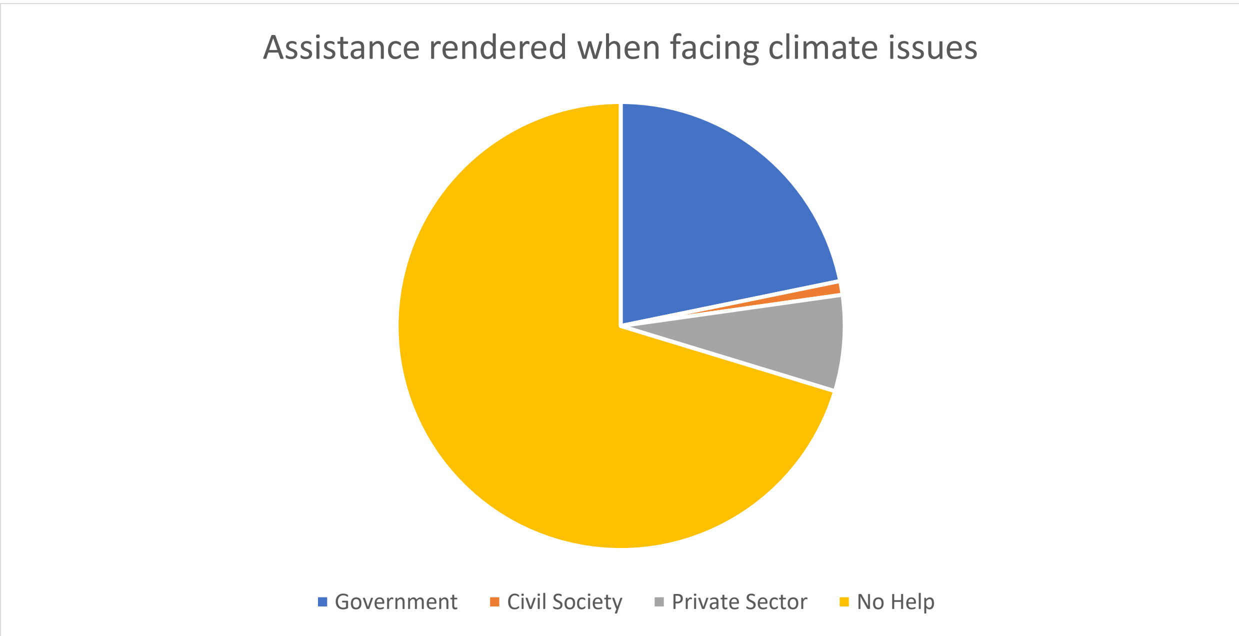


Figure 4-54: Assistance rendered during adverse climatic events

With the majority being herders, they moved animals in search of better pasture while others sought for casual labour in nearby farms. As shown in the table below, those who practiced crop farming, were able to change agricultural practices to cope with the harsh weather.

Table 4-50: Coping mechanisms against adverse climatic events.

Coping Mechanisms	Respondents	Percentage (%)
Changing agriculture practices	19	7%
Moving animals to another area	132	50%
Charcoal burning	1	0.5%
Moving to town	4	2%
Casual labourers in nearby farms	29	11%
Climb to higher grounds	8	3%
Avoid flooded areas	10	4%
Soil erosion control	1	0.5%
Any other	58	22%

4.4.4.18 Natural Resources

With Lake Naivasha just nearby, majority (46%) of the respondents depended on the natural resource for various activities such as fishing and boat riding. Others made use of the nearby thickets for charcoal burning (20%) as well as quarries for sand harvesting (8%).

Table 4-51: Natural resources available to respondents

Natural Resources	Respondents	Percentage (%)
Quarries	19	8%
Water Body	111	46%
Forestry	49	20%
Fisheries	38	16%
Other	25	10%

5 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

5.1 Introduction

Laws governing environmental protection and conservation in the Republic of Kenya are derived from constitutional statutes and ratified international conventions. These laws regulate the establishment and operation of development projects such as the proposed Olkaria II Extension Geothermal Power Plant project. The associated activities in this project may negatively impact the environment, human health and socioeconomic well-being of the people who interact with such projects.

This chapter includes a summary of the policies, laws, regulations and institutional setup relevant to environmental and social management in Kenya and pertinent to this project. A review of the most pertinent regulations and standards governing health and safety has been included. In addition, analysis of international good practice (World Bank/IFC Environmental and Social Standards, JICA Environmental and Social Considerations and Multilateral Environmental Agreements (MEAs) and their applicability to the proposed project were reviewed and presented to guide the proponent.

5.2 International Conventions and Agreements

Kenya has ratified various conventions and treaties and may also have signed different agreements relevant to the proposed project. Some of these international instruments may also have been domesticated in the country using regulations. The ESIA expert referred to the most relevant instruments to verify how the proposed project design, implementation and operation processes are in line with the requirements of the international instruments. These instruments are as discussed in Table 5-1.

5.3 Policy Framework

The Consultant analysed relevant policies and provided relevant provisions to guide the implementation of the proposed project. Table 5-2 shows a discussion on the policies identified.

5.4 Legal Framework

Kenya has a wealth of laws and regulations that guide environmental management and conservation in the country. Most of these laws are sector specific and cover a wide range of environmental, social, safety and health management aspects for sustainable development. The legislations relevant to this project were identified and are as described and summarized in Table 5-3.

5.5 County Government of Nakuru Laws

The proposed project is located within the jurisdiction of the County Government of Nakuru. The County Government has a mandate to develop County Laws to facilitate the execution of the devolved units' functions. The relevant County Government laws applicable to this project are presented in Table 5-4.

Table 5-1: International conventions and agreements

No.	Convention	Objective/Summary	Relevance to Project/Compliance
1.	The Rio Declaration on Environment and Development (1992)	The declaration outlines the principles intended to guide the world countries to achieve sustainable development	The project should contribute to sustainable development through protection of the environment, and the facilitation and encouragement of public awareness and participation by making information available.
2.	Convention on Biological Diversity (CBD), 1993	To ensure the conservation of biological diversity; the sustainable use of its components and the fair and equitable sharing of the benefits	The provisions of this convention will be considered in the conservation of various species of plants, animals and the variety of ecosystems in the project area.
3.	Convention on the conservation of Migratory Species of Wild Animals (Bonn Convention)1983	To conserve migratory species of wild animals (terrestrial or marine) given that migratory species are an international resource	This convention has been domesticated in the Wildlife (Management and Conservation) Act (2013) hence its provisions will be implemented in the proposed project
4.	Convention on International Trade in Endangered Species (CITES),1975	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 lead agency for CITES in Kenya is KWS. The proponent will ensure that through the guidance of KWS, habitats of endangered species are not interfered with and no unauthorized trade of endangered species is carried out.

No.	Convention	Objective/Summary	Relevance to Project/Compliance
5.	United Nations Framework Convention on Climate Change (UNFCCC), 1994	To stabilize greenhouse gas concentrations at a level that allows ecosystems to adapt naturally to climate change so that food production is not threatened, while enabling economic development to proceed in a sustainable manner.	The proponent will ensure that the contractor puts in place measures to reduce GHG emissions during the construction phase of the proposed Olkaria II Extension Geothermal Power Plant project.
6.	The Paris Agreement, 2015	Provides the framework to address climate change for a safer and sustainable future. It has an objective of preventing a global temperature increase above 1.5 degrees Celsius relative to pre-industrial levels by reduction of Greenhouse gas emissions.	The proponent will ensure measures set out in the ESMP are fully implemented to ensure that adverse impacts of GHG emissions are mitigated.
7.	United Nations Convention to Combat Desertification (UNCCD),1996	To combat desertification and mitigate the effects of drought to achieve sustainable development.	The proponent will engage in activities geared towards mitigating drought through conserving forest cover, developing tree programmes with relevant ministries/local communities, encouraging clean energy use and water conservation
8.	African Convention on the conservation of Nature and Natural Resources, 1968	To facilitate sustainable use of renewable & non-renewable resources, particularly the soil, water, flora and fauna.	The proponent will promote the planting of indigenous trees, to try to restore a balance within the ecosystem.
9.	Vienna Convention for the protection of the Ozone Layer, 1964	This Convention encourages intergovernmental cooperation on research, systematic observation of the ozone layer, monitoring of Chlorofluorocarbons (CFCs) production, and the exchange of information on the effects of human activities on the ozone layer	The proponent will ensure measures set out in the ESMP are fully implemented to ensure that adverse impacts of GHG emissions are mitigated.

No.	Convention	Objective/Summary	Relevance to Project/Compliance
		and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer.	
10.	Ramsar Convention on Wetlands of International Importance, 1975	The purpose of the convention is to stop the loss of wetlands and to promote their conservation and wise use as a means to achieving sustainable development. Article 1 of the Ramsar Convention defines a wetland as ".... areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"	The proponent will ensure that the contractor will put in place necessary measures to prevent potential for contaminating Lake Naivasha which is designated as a Ramsar Site.
11.	Convention concerning the Protection of the World Cultural and Natural Heritage, 1972	To safeguard and ensure respect for the world's Intangible Cultural Heritage, including raising awareness of the importance of intangible heritage and encouraging international cooperation and assistance.	The proponent will ensure due diligence is practiced where historical property is encountered during construction of the proposed project and other related activities.
12.	Convention on the Elimination of all forms of Discrimination against Women (CEDAW),1979	It places explicit obligations on states to protect women and girls from sexual exploitation and abuse.	The proposed project will ensure tenets of human right and protection of women and girls from sexual exploitation and abuse are embroiled in the development and are adhered to during all phases of the project.
13.	Convention on the Rights of the Child (CRC), 1990	The Convention acknowledges children as individuals with rights and responsibilities according to their age and development (rather than the property of their parents or as victims), as well as members of a family and community. Underlying the Convention are four main principles: non-discrimination, the best interests of	The proponent will not allow any underage persons to employed to work on the proposed project, in any phase of the project.

No.	Convention	Objective/Summary	Relevance to Project/Compliance
		the child, the right to life, survival and development and the right to participation. CRC reaffirms children's basic human rights to health, shelter and education.	
14.	International Labour Organization (ILO),	It is built on the constitutional principle that universal and lasting peace can be established only if it is based upon social justice. It has generated such hallmarks of industrial society as the eight-hour working day, maternity protection, child-labour laws, and a range of policies which promote workplace safety and peaceful industrial relations. Key ILO Conventions include: -**Equal Remuneration Convention (1951) (No. 100)** - Calls for equal pay and benefits for men and women for work of equal value -**Discrimination (Employment and Occupation) Convention (1958) (No. 111)** - Calls for a national policy to eliminate discrimination in access to employment, training, and working conditions, on grounds of race, cooler, sex, religion, political opinion, national extraction or social origin, and to promote equality of opportunity and treatment -**Minimum Age Convention (1973) (No. 138)** - Aims at the abolition of child labour, stipulating that the minimum age for admission to employment shall not be less than the age of completion of compulsory schooling -**Worst Forms of Child Labour Convention (1999) (No. 182)** - Calls for immediate and effective measures to secure the prohibition and elimination of the worst forms of child labour which include slavery and similar practices, forced recruitment for use in armed conflict, use in prostitution and pornography, any	Kenya has been a signatory to ILO since 1963 and all labour conditions in the country are expected to abide by the ILO provisions, through compliance to the country's Employment Act, Children's Act, Persons with Disabilities Act, Sexual Offences Act and National Gender and Equality Act.

No.	Convention	Objective/Summary	Relevance to Project/Compliance
		illicit activity, as well as work which is likely to harm the health, safety, and morals of children	
15.	Sustainable Development Goals (SDGs) 2015	Goal Number 7 (Affordable and Clean Energy) recognizes that Energy is central to nearly every major challenge and opportunity the world faces today. Focusing on universal access to energy, increased energy efficiency and the increased use of renewable energy through new economic and job opportunities is crucial to creating more sustainable and inclusive communities and resilience to environmental issues like climate change.	The proposed Geothermal Power Plant will contribute to affordable and clean energy, and in the process contribute to other SDGs which include but not limited to; Gender equity, decent work and economic growth etc.

Table 5-2: Policy framework

No.	Policies, Plans and Strategies	Influence/Mandate	Relevance to Project/Compliance
1.	Constitution of Kenya, 2010	Article 42 under the Bill of Rights of the Constitution of Kenya, 2010 provides inter alia that every citizen has a right to a clean and healthy environment. Chapter 5 of the Constitution provides for the sustainable management of land and the environment in Kenya. Specifically, Part 2, Articles 69 – 72 deals with environmental and natural resources management in Kenya and the proposed project will be conducted in accordance with these articles. Article 69(1)(f) of the Constitution requires the State to develop systems for environmental impact assessment. The State already has a system for environmental impact assessment in the form of the Environment Management and Coordination Act, Cap, 387 and its subsidiary legislations.	The project's management is expected to protect the Environment in all phases of the project's cycle by fully implementing the measures set out in the Environmental and Social Management and Monitoring Plan (ESMMP) of this report.
2	Kenya Vision 2030	It aims at transforming Kenya into a globally competitive, newly industrialized, middle income and prosperous country. The growth objectives require a sustainable annual economic growth rate of more than 10% supported by industry, agriculture and services.	The proposed project aims to increase the total installed geothermal capacity, to enhance electricity service provision in Kenya
3	Least Cost Power Development Plan (LCPDP) (2022-2041)	It is the third update of the long-term plan compiled since the completion of the 2015-2035 Power Generation and Transmission Master Plan in 2015. The primary objective of the plan is to derive a long-term power generation and transmission expansion plan that considers the growing demand, new developments, and policies in the planning period at least cost	As part of the proponent's strategy and in line with the national electricity master plans, the proponent intends to develop the proposed project with an estimated equivalent gross output of 146 *MWe*.

4	Kenya National Biodiversity Strategy and Action Plan (NBSAP) of 2019-2030	It sets the time required to realize the action, performance and verifiable indicators and allocates responsibilities for implementation to different institutions that include Government Ministries, Departments and Agencies (MDAs), County Governments, Private sector, Research and Academic Institutions, NGOs and CBOs. Its vision is to ensure that by 2030, Kenya will have a highly valued, conserved and sustainably utilized biodiversity contributing to socio-economic wellbeing of the people of Kenya.	The proponent will adhere to the mitigation measures set out in the Environmental and Social Management Plan as provided in this report, to ensure conformity with the provisions of this strategy.
5	National Water Policy, 2021	The overall goal of the policy is to guide the achievement of sustainable management, development, and use of water resources in the country. The overall objective of the policy is to provide a framework that is dynamic, innovative, and effective for re-engineering the water sector. It aims to accelerate the delivery of water supply services through progressive realization of the human right to water towards universal access and strengthen sustainable water resource management in the country.	The proponent will ensure adequate protection of water resources for population access.
6	National Sustainable Waste Management Policy of 2021	The goal of the policy is to: protect public health and the environment and drive job and wealth creation by creating an enabling environment for sustainable, integrated waste management and the minimization of waste generation, to contribute to a circular economy. The policy highlights interventions in the application of the waste hierarchy and circular economy model for managing waste in Kenya as well as the enabling framework to support its implementation and realization of a zero-waste economy.	The proponent shall comply to this policy through frequent awareness creation to the staff and workers of the project throughout its lifecycle; and contracting a waste management company that is licensed by NEMA to handle all waste that will be generated from the site and its allocated infrastructure.
7	Sessional Paper No.1 of 2020 on Wildlife Policy	It seeks to conserve wildlife resources in national parks, national reserves and national sanctuaries in an effective and equitable manner, ensure maintenance and enhancement of	The proposed project and its subcomponents are within Hell's Gate National Park. The proponent will be in

		ecological integrity of wildlife and their habitats through the integration of private and community lands into protected area systems and to harness the contribution of wildlife resources into the national economy and enhance the benefits to all.	continuous consultations with KWS and the local community, to ensure that the construction, operation and maintenance of the project does not interfere with existing wildlife.
8	National Policy on Gender and Development (NPGD) 2019	The overall objective of the Gender and Development Policy is to facilitate the mainstreaming of the needs and concerns of men and women in all areas of the development process in the country. The construction sector plays a key role in socio-economic development.	The proponent will ensure gender concerns are mainstreamed into the planning and implementation of the project to ensure that the needs and interests of each gender are addressed.
9.	National Energy Policy, 2018	The overall objective of the energy policy is to ensure affordable, sustainable, adequate, competitive, secure and reliable supply of energy at the least cost geared to meet national and county needs while protecting and conserving the environment.	The project will encourage the generation of electricity from renewable resources and will promote the construction and maintenance of necessary transmission infrastructure. Environmental, Social, Health and Safety considerations will be factored into the development.
10.	Sessional Paper No. 1 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 proposed project will be consistent with the provisions of this Policy to avoid conflicts with the community.
11.	Kenya Environmental Sanitation and Hygiene Policy (KESHP) 2016-2030	It aims to increase the proportion of the population with access to improved sanitation to 100% by 2030 and ensure a clean and healthy environment for all in Kenya.	The proponent and the contractor will seek to comply with the provision of this policy to achieve 100% Open Defecation Free (ODF) in the project area during the construction period.
12.	Sessional Paper No. 10 of 2014 on the	It recognizes the various vulnerable ecosystems and proposes various policy measures not only to mainstream sound environmental management practices in all sectors of	The proposed project and its sub-components are located in Hell's Gate National Park, which will create the need

	National Environment Policy	society throughout the country but also recommends strong institutional and governance measures to support achievement of desired objectives and goals.	for sustainable management of natural resources.
13	National Policy on Older Persons and Ageing, 2014	The policy, among other issues, emphasizes on social protection in old age through either non-contributory benefits focused on reducing poverty and vulnerability, or contributory benefits aimed at maintaining the income of individuals.	The aged will be involved during all phases of the project's life cycle
14	Kenya AIDS Strategic Framework (II) (2020/21-2024/25)	It provides guidance for implementing an evidence-based HIV response. It outlines priority interventions and emphasises on the need to create an enabling system to maximize on the impact of interventions. Its vision is to maintain a Kenya free of HIV infections, stigma and AIDS-related deaths. It seeks to provide comprehensive HIV prevention, treatment, care and support towards Universal Health Coverage for all people in Kenya.	Due to the large of number of workers who will be involved in the proposed project and the associated social issues with projects of such as scale, HIV/AIDS has been considered as one of the proposed impacts, hence adequate mitigation measures are proposed to that effect.
15.	Forest Policy, 2014	The overall goal of this Policy is sustainable development, management, utilization and conservation of forest resources and equitable sharing of accrued benefits for the present and future generations of the people of Kenya. The policy seeks to promote investment in commercial tree growing, forest industry and trade, enhance management of forest resources for conservation of soil, water biodiversity and environmental stability	The proponent will ensure all forest resources are managed sustainably to yield social, economic and ecological goods and services for the current generation without compromising similar rights of future generations.
16.	Kenya Health Policy of 2014-2030	It gives directions to ensure significant improvement in overall status of health in Kenya in line with the Constitution of Kenya 2010, the country's long-term development agenda, Vision 2030 and global commitments. It focuses on: ensuring equity; people centeredness and a participatory approach; efficiency: a multi-sectoral approach; and social accountability in the delivery of	The proposed Project is expected to employ both skilled and unskilled workers some who might come from the marginalized groups within the project area. The rights and fundamental freedoms of these workers will be protected in compliance with the requirements of this policy.

		healthcare services. It also embraces the principles of protection of the rights and fundamental freedoms of specific groups of persons, including the right to health of children, persons with disabilities, youth, minorities, the marginalized and older members of the society, in accordance with the Constitution.	
17.	National Climate Change Response Strategy (NCCRS), 2010	Its main focus is ensuring adaptation and mitigation measures are integrated into all government planning, budgeting and development objectives. The vision of the NCCRS is for a prosperous and climate change resilient Kenya, whereas the Mission of the Strategy is to strengthen nationwide focused actions by ensuring commitment and engagement of all stakeholders towards adapting to and mitigating against climate change.	The proponent will ensure that the infrastructure design of the proposed project is climate-proof over its lifespan. This includes carrying out geotechnical site investigations (GSIs) to determine appropriate sites for infrastructure development; factoring a maintenance component into all infrastructural development funds; and designing infrastructure that can withstand the prevailing climatic conditions.

Table 5-3: Legal and Regulatory Framework

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
1.	Environmental Management and Coordination Act (EMCA) Cap 387	It is the principal law in Kenya that governs the management, use and regulation of environmental resources including natural capital. Section 58 of the Act makes it a mandatory requirement for an EIA study to be carried out prior to implementing projects specified in the (amended) Second Schedule (L.N No. 31 of 2019) of the Act. Such projects have the potential of causing significant impacts on the environment. Similarly, section 68 of the same Act requires operators of existing projects or undertakings to carry out Environmental Audits (EA) in order to determine the level of conformity with statements made during the EIA study	The project falls under "High-Risk Projects" category of the 2nd schedule, as Power and Infrastructure projects specifically: *"(b) geothermal development; and (e) high voltage electrical transmission lines";* for which an EIA study is mandatory. In compliance, the ESIA study report will be submitted to NEMA so as to obtain an EIA License prior to the implementation of the proposed project.
Regulations under EMCA Cap 387			
2.	Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing)	These Regulations apply to conservation of biodiversity which includes Conservation of threatened species, Inventory and monitoring of Biological Diversity and protection of environmentally significant areas, access to genetic resources, benefit sharing and offences & penalties.	These regulations apply to the proposed project based on the biological diversity around Hell's Gate National Park and the RoW for the proposed Transmission Line, hence integration of biodiversity concerns into development planning will be very important. The proponent will continuously consult KWS, implement the mitigation measures set out in this report and will obtain an ESIA License prior to commencement of the project, since it may have an adverse impact on the ecosystem.

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
	Regulations, 2016		
3.	Environmental Management and Coordination (Air Quality) Regulations, 2014	The regulation prohibits emissions of air pollutants exceeding permissible levels from controlled areas, stationary sources, mobile sources, occupational exposure, material handling, demolition areas, waste incineration, open burning of hazardous waste, or from cross-border. The regulation also requires that all emissions should be licensed. Hydrogen Sulphide is listed as one of the priority air pollutants to be monitored with a stipulated threshold of $150 \mu g/m^3$	The emissions generated from construction activities have the potential of polluting the immediate atmospheric environment. Vegetation clearing, earthworks and bulk delivery of construction material, if unmanaged may result in generation of dust. In addition, H_2S will be the main emission of concern during operation. The proponent will comply to the mitigation measures proposed in this ESIA report and will continue to conduct ambient air quality analysis of: the proposed and existing geothermal power plants; and infrastructure.
4.	Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009	These regulations provide that, no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. Section 15 of the regulations states that any person intending to carry out construction, demolition, mining or quarrying work shall, during the Environmental Impact Assessment studies shall: ✓ identify natural resources, land uses or activities which may be affected by noise or excessive vibrations from the construction, demolition, mining or quarrying;	The proponent will implement the measures set out in the ESMP of this report and will conduct regular Noise level monitoring within the proposed geothermal power plant to check for compliance and any required corrective actions.

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
		✓ determine the measures which are needed in the plans and specifications to minimize or eliminate adverse construction, demolition, mining or quarrying noise or vibration impacts; and incorporate the needed abatement measures in the plans and specifications.	
5.	Environmental Management and Coordination (Controlled Substances) Regulations, 2007	These regulations stipulate that controlled substances must be clearly labelled with among other words, "Controlled Substance-Not ozone friendly'') to indicate that the substance or product is harmful to the ozone layer. Advertisement of such substances must carry the words, "Warning: Contains chemical materials or substances that deplete or have the potential to deplete the ozone layer. The regulation makes it mandatory for industries, and other stake holders in ODS trade, to obtain a license to import these substances. The ozone-friendly refrigerants, oil lubricants, and other ozone-friendly alternative chemicals to CFCs shall be the only ones that shall be licensed for importation for use in equipment.	The project is likely to involve the use of coolants/refrigerants in the operation phase therefore it is imperative that the proponent ensures that the appropriate ones are adopted. The proponent will also undertake Free Prior Informed Consultation (FPIC).
6.	Environmental Management and Coordination (Water Quality) Regulations, 2006	It provides guidelines to Filling in Application Form for Effluent Discharge License, Monitoring Guide for Discharge into the Environment, Fees Chargeable under the Water Quality Regulations. Regulation 4 stipulates that everyone has a duty to refrain from any act which directly or indirectly causes, or may cause immediate or subsequent water pollution.	The proponent will undertake frequent effluent discharge quality and quantity monitoring through sampling. Additionally, the proponent will apply for an Effluent discharge license (EDL).

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
7.	Environmental Management and Coordination (Waste Management) Regulations, 2006	The aim of the Waste Management Regulations is to protect human health and the environment. These Regulations outline requirements for handling, storing, transporting, and treatment / disposal of all waste categories (Hazardous wastes; Pesticides and Toxic Substances; Biomedical wastes; radioactive substances).	The Proponent shall observe the guidelines as set out in the ESMP of this report as well as the recommendations provided for mitigation /minimization /avoidance of adverse impacts arising from the Project activities. Additionally, the proponent will contract a NEMA Licensed waste handler to collect, transport and dispose waste generated.
8.	Environmental (Impact Assessment and Audit) Regulations, 2003 and (Amendment) Regulations, 2019 (L.N No. 32 of 2019)	Environmental Impact Assessment and Environmental Audits under EMCA Cap 387 is guided by these regulations. It provides that major development projects are required to be subject to an EIA process and the resultant EIA report is to be submitted to NEMA for approval and issuance of an EIA license, after demonstrating that the possible negative impacts of a project will be effectively mitigated.	This ESIA report complies to these regulations by covering environmental and social issues, project details, impacts, policy and legislative frameworks, mitigation measures for impacts, management plans and procedures. The proponent is committed to fully implement the ESMP laid out in this report and other conditions laid out by NEMA. The proponent will also undertake Annual Environmental Audits of the project during the operation phase of the project.
Occupational Safety and Health			
9.	Occupational Safety and Health Act (OSHA), 2007	It applies to all workplaces where any person is at work, whether temporarily or permanently. The purpose of the act is to secure the safety, health and welfare of persons at work and protect persons other than the workers against risks to safety and health arising out of, or regarding, the activities of the facility.	The OSHA 2007 Abstract shall be posted at site and the proponent shall publicize the company's OSH Policy. Annual Environmental, Health and Safety Audit will be undertaken and reports submitted to NEMA and health and safety committees will be established. Additionally, there will be provision of

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
		Section (3) provides that every occupier shall carry out appropriate risk assessments in relation to the safety and health of persons employed and, on the basis of these results, adopt preventive and protective measures.	PPEs, access to clean water and sanitation and insurance covers. The proponent will also be required to: i. Report any <u>non-fatal accident</u> **within 7 days** to the area's Occupational Safety and Health Officer. ii. Report any <u>fatal accident</u> to the area Occupational Safety and Health Officer **within 24 hours.**
Regulations under OSHA, 2007			
10.	Factories and Other Places of Work (Hazardous Substances) Rules, 2007 (L.N No. 60)	The rules provide for safety measures to be adhered to when handling hazardous substances at work places. They include: Occupational exposure limits; Control measures; Maintenance of Material Safety Data Sheet; Provision and use of personal protective equipment; Sound disposal of hazardous materials; Provision of training and information to employees; Air monitoring and measurement; Medical examination; and Duties of employees	The proponent and contractor will comply by: Maintaining at the point of use Material Safety Data Sheets (MSDS) for the various materials in use; carrying out regular monitoring of the levels of H_2S emissions; providing suitable PPEs to employees; and Documenting safe working procedures on the use, handling and storage of hazardous materials
11.	Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007 (L.N No. 59)	The rules provide for fire safety measures with specific focus on the following critical requirements: Safe handling and storage of flammable substances; Provision of fire escape exits; Formation of firefighting team; Fire safety training; Conducting fire drills; Installation, maintenance, inspection and testing of fire equipment; Documentation of a fire safety policy; and Annual fire safety audits.	The proponent and contractor will ensure that: staff are trained on fire-fighting; there is provision of fire protection systems (portable fire extinguishers, hose reels, sprinklers hydrants, smoke detectors, fire alarm and fire water tank): and fire audits are regularly undertaken.
12	Factories and Other Places	These Rules provide for the conducting of medical examination on various occupations including work	The proponent shall ensure that all employees undergo a pre-employment and periodic medical

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
	of Work (Medical Examination) Rules, 2005 (L.N No. 24)	involving exposure to noise. There should be Pre-employment and annual repeat examinations within two weeks where abnormal examination results are noted. Examinations are to involve clinical examinations, biological monitoring and other necessary tests depending on the type of exposure.	testing within the course of the project activities to survey on their health.
13	Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005 (L.N No. 25)	According to section 5 of the rules, where noise in a workplace exceeds the continuous equivalent of 85 A-weighted decibels (dB (A)) the occupier must develop and implement an effective noise control and hearing conservation programme which must be in writing and should address: Noise measurement; Education & training; Engineering noise control; Hearing protection; Posting of notices in noisy areas; and Annual programme review Additionally, section 13 provides that where the noise level is above 90 dB (A), the employer shall: Post a sign at the entrance to and in every room or conspicuous place, clearly and prominent marked "DANGER HEARING PROTECTION MUST BE WORN"; Supply hearing protection to all persons required to enter such an area; and Ensure that all workers and any other person entering this area wear hearing protectors	The proponent will implement the measures set out in the ESMP of this report to mitigate against any negative impacts associated with noise emission.
14.	Factories and Other Places of Work (Safety and Health	These Rules make several provisions in support of formation of Safety and Health Committees at all factories and other workplaces which regularly employ twenty or more employees. These committees are tasked with the	The proposed project will employ more than 20 workers during all phases of the project and therefore the proponent will comply with the requirements of this regulation by: establishing a Safety and Health Committee in a manner provided

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
	Committees) Rules, 2004 (L.N No. 31)	responsibility of overseeing OSH implementation and performing safety audits.	by the rules and ensuring the committee meets at least four times in every year (interval of three (3) months).
15.	Factories (Building Operations and Works of Engineering Construction) Rules, 1984	Section 48 (1) prohibits any timber or material with projecting nails to be placed or be allowed to remain in any place at a site where they are a source of danger to persons employed. Section 55 (C) provides that properly maintained scaffolds or; where appropriate, ladders or other means of support which shall be sufficient and suitable for the purpose shall be provided, placed and kept in position for use where work cannot be safely done on or from the ground or from part of a building or other permanent structure.	The proponent and contractor will ensure that the relevant provisions of these rules and provisions of OSHA 2007 are adhered to throughout the construction and operation phases of the Geothermal Power plant and assigned infrastructure.
16.	Occupational Safety and Health (Electric Power) (Special) Rules, 1979 (L.N No. 340)	These Rules apply to the generation, transformation, conversion, switching, controlling, regulating, distribution and use of electrical energy in any factory and in any premises, place, process, operation or work.	The proponent will ensure that only authorized personnel shall undertake any work where technical knowledge or experience is required in order to adequately avoid danger, and no person shall work alone in any case. Additionally, the proponent will ensure that the substation(s) will be constructed in a way that no person other than the authorized persons can obtain access and shall have efficient means of ventilation and kept dry.
17.	Factories (First-Aid) Rules, 1977 (L.N No. 160)	These rules stipulate that there shall be provision of well-maintained and readily available and accessible first aid boxes or cupboards. Section 7 of the rules provide that no person shall be placed in charge of a first aid box or cupboard unless he or she has received adequate training in the application of	The proponent will adhere to the provisions of section 2 (c) and 5 of these rules. Additionally, the proponent will ensure the first aid boxes/cupboards are plainly and clearly marked on the outside with the words “FIRST AID” and contact information of the First Aider on-duty.

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
		first-aid to the injured persons and holds a certificate of competence issued by: The St. John Ambulance of the St. John Council of Kenya; or The Kenya Red Cross Society; or such other body or society as may be approved from time to time, by the Labour Commissioner. The certificate of competence must be renewed annually.	
Other Relevant Legislation			
18.	Climate Change Act, 2016 and amendment Act of 2023	The Act provides a regulatory framework for an enhanced response to climate change; to provide for mechanism and measures to achieve low carbon climate development, and for connected purposes. The Act is applied in all sectors of the economy by the national and county governments to: Mainstream climate change responses into development planning, decision making and implementation; and mainstream the principle of sustainable development into the planning for and decision making on climate change response.	The aim of the project is to explore and generate geothermal energy, which is considered environmentally friendly. However, the vehicles and machines that will be used may contribute to additional GHG emissions. To avoid this, the proponent will implement the measures set out in the ESMP of this report.
19.	Sustainable Waste Management Act, 2022	The objectives of the Act are but not limited to: promotion of sustainable waste management; promotion of effective delivery of waste services; improvement of the health of all Kenyans by ensuring a clean and healthy environment; reduction of air, land, fresh water and marine pollution; and the creation of an enabling environment for employment in the green economy in waste management, recycling and recovery.	The project will have an efficient water treatment plant and domestic sewage disposal facilities. There will be frequent creation of awareness on sustainable waste management, to the staff and workers of the project, throughout its phases. Additionally, there will be enhanced waste mapping, segregation, collection, transportation and disposal of waste.
20.	Children Act, 2022	Section 18 (1) of the Act provides that no person is allowed to subject a child to child-labour, domestic servitude, economic exploitation or any work or employment which	The proponent and contractor will ensure that during construction and operation of the

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
		is hazardous, interferes with the child's education or is likely to be harmful to the child's health or physical, mental, moral or social development.	Geothermal Power Plant, no persons under the age of 18 years will be employed. Additionally, employees will be required to provide National Identification Cards at the point of employment
21.	Energy Act, 2019	It aims to consolidate the laws relating to energy, to provide for National and County Government functions in relation to energy, promotion of renewable energy; exploration, recovery and commercial utilization of geothermal energy; regulation, production, supply and use of electricity and other energy forms. Article 178 of the act gives provisions for installation of energy infrastructure along roads, and railways, government property, including forests, National parks, reserves and heritage sites, for the purpose of the production, conveyance and supply of energy.	The proponent will ensure necessary permits and licenses are obtained from EPRA
22.	Physical and Land Use Planning Act, 2019	Section 57 (1) provides that no person shall carry out development within a county without a development permission granted by the respective county executive committee member. Additionally, Section 58 (4) of the Act states that "Where an applicant is not the registered owner of the land for which development permission is being sought, that applicant shall obtain the written consent of the registered owner of that land and the applicant shall provide that written consent to the respective county executive committee member at the time of applying for development permission"	The proponent has actively engaged KWS and obtained a Letter of consent seeking to carry out development of the proposed project. Additionally, the proponent engaged all relevant county departments during the ESIA process and development of the stakeholder engagement plan

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
23.	Forest Conservation and Management Act, 2016	The act provides for the establishment, development and sustainable management, including conservation and rational utilization of forest resources for the socio-economic development of the country. It recognizes the importance of forests for the benefits of soil and ground water regulation, agriculture and their role in absorbing greenhouse gases. The Act has four priority areas related to the management of forests, including; 1) reducing pressure to clear forests for agriculture and other uses 2) promoting the sustainable utilization of forests 3) improving governance in the forest sector and 4) the enhancement of carbon stocks and reforestation of degraded lands.	The proponent will be in continuous consultations with KFS and will ensure that disruption of the environment in any forested areas is minimized and mitigation measures set out in the ESMP of this report are well implemented.
24.	Water Act, 2016	Section 143 provides that no person, without authority, will throw, convey, cause or permit to be thrown or conveyed, any rubbish, dirt, refuse, effluent, trade waste or other offensive matter or thing into or near to any water resource in such manner as to cause, or be likely to cause, pollution of the water resource.	The proponent shall ensure shall ensure the implementation of appropriate measures, so as to prevent potential contamination of both surface and underground water sources.
25.	Protection of traditional Knowledge and Cultural Expressions Act, 2016	It mandates the National Government to: promote and conserve traditional knowledge and cultural expressions of communities in Kenya; protect traditional knowledge and cultural expressions from misuse and misappropriation; and facilitate access to information and the sharing of information and data relating to traditional knowledge and cultural expressions. Section 18 (1) of the Act provides that a person shall not, in any way, misappropriate, misuse, abuse, unfairly,	The proponent will ensure that Free Prior Informed Consultation with the local community will be undertaken.

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
		inequitably or unlawfully access and exploit traditional knowledge and cultural expressions.	
26.	Wildlife Conservation and Management Act, 2013	The Act provides that the holder of a permit or license shall use the land in accordance with the requirements for sustainable use of land. Section 30 of the Act prohibits any activity which is likely to have adverse effects on the environment, including the seepage of toxic waste into streams, rivers, lakes and wetlands.	The proponent has leased the land dedicated for the proposed project from KWS and necessary licenses have been obtained. The proponent will comply by fully implementing the measures set out in the ESMP to mitigate any adverse impacts to wildlife.
27.	Civil Aviation Act, 2013 and (Amendment) Act 2016	Section 46 (1a) provides that a person shall not wilfully or negligently imperil the safety of an aircraft or any person on board, whether by interference with any member of the crew of the aircraft or by tampering with the aircraft or its equipment, or by disorderly conduct or by any other means. Further in section 56 of the Act, the Cabinet Secretary may, where he considers it to be necessary in the interests of the safety of air navigation, by order published in the Gazette, prohibit the erection within a declared area of any building or structure above a height specified in the order	The proponent will obtain a permit for the construction of the cooling towers, transmission line and substation from the Kenya Civil Aviation Authority.
28.	Land Act, 2012 and Land Laws (Amendment) Act, 2016	It is t intended to give effect to Article 68 of the Constitution, to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land-based resources, and for connected purposes. Part VIII of the Act provides compulsory conditions and guidelines for acquiring land.	The land on which the proposed project will be undertaken is owned by a state agency (KWS). The proponent has a MOU with KWS, allowing KenGen to explore, exploit and generate electricity from the site which is within Hell's Gate National Park.
29.	County Government	It vests responsibility upon the County Governments in planning of development projects within their areas of	The County Government of Nakuru will be actively involved as a Key Stakeholder in all phases of the

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
	Act, 2012 and (Amendment) (No. 2) Act, 2020	jurisdiction, be it projects of importance to the county government or those of national importance. Section 113 of the Act makes public participation in County planning processes compulsory.	project. Additionally, relevant county licenses will be obtained from the relevant county departmental offices.
30.	Environment and Land Court Act, 2011	The court has jurisdiction to hear any dispute relating to environment and land. The Court has original and appellate jurisdiction to hear and determine all disputes in accordance with Article 162(2)(b) of the Constitution and with the provisions of the Act or any other written law relating to environment and land. The court is also empowered to hear cases relating to public, private and community land and contracts, choices in action or other instruments granting any enforceable interests in land.	Any land or/and environmental cases arising from the project will be handled in accordance with the provisions of this Act.
31.	National Construction Authority Act, 2011	The Act establishes the National Construction Authority (NCA), which is established to oversee the construction industry and coordinate its development. The authority is mandated to: promote and stimulate the development, improvement and expansion of the construction industry; advise and make recommendations to the Cabinet Secretary on matters affecting or connected with the construction industry; undertake or commission research into any matter relating to the construction industry; and prescribe the qualifications or other attributes required for registration as a contractor under this Act, among other duties.	The proponent will demonstrate compliance by ensuring all local and foreign contractors are registered under the Authority and have appropriate licenses and permits for operating
32.	The National Gender and	Its main objective is to provide precedence for the prevention of discrimination on the basis of sex in the	The proponent shall ensure equal job opportunities for all gender throughout the project's cycle and will

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
	Equality (NGEC) Act, 2011	national development process in order to improve social, legal/civic, economic, and cultural conditions of women, men, girls and boys in Kenya. The Act lays out a priority that each project will develop integrated gender equality strategies at the initiative level in priority areas.	implement some of the requirements of the Act that have been captured in the ESMP.
33.	Work Injury Benefits Act (WIBA), 2007	Provides guideline for compensating employees on work-related injuries and diseases contracted in the course of employment. It requires provision of compulsory insurance for all employees.	The construction operations and activities may pose safety and health risks to construction workers. The proponent will abide to the provisions of WIBA when handling injuries reported in the cause of implementation of the proposed project. Workers contracted during the different phases of the project will be provided with insurance covers to ensure that they are compensated in case they are injured while working. The proponent will apply registration of the site as a workplace and will send a notification to DOSHs two weeks prior to commencement of construction
34.	Employment Act, 2007 and (Amendment) Act, 2022	The Act applies to all employees employed by any employer under a contract of service and covers the following elements: Protection of wages; Rights and duties in employment; Termination and dismissal; Protection of children; Insolvency of the employer; Employment records; Employment management; Foreign Contracts of Service; and Dispute settlement procedures (between employer and employees). The Act provides for prohibition against forced labour, discrimination in employment and sexual harassment.	The proponent and contractor will ensure that employees are of the right age, have entitlement to leave, and are protected from any discrimination and sexual harassment among others.

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
35.	Kenya Roads Act, 2007	Section 49 of the act requires written permission to be obtained from for construction or erection of any structures or other thing on, over, and below roads the surface of a road reserve.	The proponent will obtain written permission to construct bitumen grade access roads and Transmission Lines over roads, from the Kenya Rural Roads Authority (KERRA)
36.	HIV and AIDS Prevention and Control Act, 2006	Section 7 provides that the Government shall ensure the provision of basic information and instruction on HIV and AIDS prevention and control to employees of all Government Ministries, Departments, authorities and other agencies; and employees of private and informal sectors	The proponent and contractor will promote educational and informational campaigns and organize for Voluntary Counselling and Testing of workers during the construction phase. Additionally, the proponent will ensure there is no discrimination of workers on the basis of their HIV status
37.	Sexual Offences Act, 2006	The act protects people and employees from any unwanted sexual attention or advances by staff members. This act ensures the safety of women, children, and men from any sexual offences, including rape, defilement, and indecent acts. The sexual offense act, 2006 supports the Kenya Employment Act of 2007 that a worker should not be harassed sexually to receive preferential treatment at the workplace or detrimental treatment on present or future employment.	The proponent will ensure that there is ample working environment in all workplaces in the project and matters related to Gender-Based-Violence at the workplace are managed appropriately.
38.	Persons with Disabilities Act, 2003	The Act guarantees that: No person shall deny a person with a disability access to opportunities for suitable employment; a qualified employee with a disability shall be subject to the same terms and conditions of employment and the same compensation, privileges, benefits, fringe benefits, incentives or allowances as qualified able-bodied employees; and an employee with a	During construction period, the proponent and contractor will offer employment opportunities to both skilled and non-skilled persons.

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
		disability shall be entitled to exemption from tax on all income accruing from his employment.	
39.	Building Code, 2000	The main objectives of the Building code are to: Promote order and safety in construction works and the health and safety of persons in or about construction works; Set standards for building materials, products, elements, systems, and services; Set standards for the operations and works at construction sites; and Provide for the safety and security of building users and occupants	The proponent will obtain certificate of completion for buildings (campsites geothermal power plant and its offices, and substation and its offices). Additionally, the proponent will obtain county approvals of building plans.
40.	Geothermal Resources Regulation, 1990	Section 13 of the regulation provides that all geothermal operations shall be conducted in a workmanlike manner and should: prevent the unnecessary waste of or damage to geothermal or other energy and mineral resources; protect the quality of surface waters, air, and other natural resources, including wildlife, soil, vegetation and natural history; protect the quality of cultural resources, including archaeological, historical, scenic and recreational resources; and prevent injury t life and damage to property.	The proponent undertook a comprehensive feasibility study in 2017 and another recent feasibility study, which evaluated; the site selected for construction of drilling sites, roads, sumps, steam transmission lines and other construction attendant to geothermal operations; the stability and suitability of earth conditions
41.	Geothermal Resources Act, 1982	The act provides that no person shall sink a bore, tap or take and use or apply geothermal resources for any purpose unless he is first granted an authority or license. Section 7 of the Act provides that the cabinet secretary may on application being made to him in respect of any land, grant a license (to be known as a “geothermal resources license”) over part or the whole of a geothermal resources area under such terms and conditions as he may determine.	The proponent is in possession of a geothermal resource license for the entire Olkaria Geothermal field. Additionally, the proponent will adequately implement the ESMP set out in this report, so as to ensure safety of workers, the local community, visitors and animals, throughout the life cycle of the proposed project.

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
42.	Standards Act Cap 496	The Act establishes the Kenya Bureau of Standards whose functions include but are not limited to: promoting standardization in industry and commerce; making arrangements or providing facilities for the testing and calibration of precision instruments, gauges and scientific apparatus; making arrangements or providing facilities for the examination and testing of commodities and any material or substance from or with which and the manner in which they may be manufactured; and providing for the testing of locally manufactured and imported commodities with a view to determining whether such commodities comply with the provisions of this Act or any other law dealing with standards of quality or description.	The proponent will ensure that all materials used during construction are those that meet the standards of the Kenya Bureau of Standards, and standardization & marks requirements will be adhered to.
43.	Way Leaves Act Cap 292	The Act gives powers to the Government, any person in service of the government and any contractor executing any work for the government, to carry any sewer, drain or pipeline into, through, over or under any lands whatsoever but may not in so doing interfere with any existing building	The proponent will issue a notice, at least one month before carrying out intended work (laying of sewer, drain or pipeline) over or under any private land.
44.	Public Health Act Cap 242	Section 115 of this act prohibits causing nuisance or other conditions liable to be injurious or dangerous to health. Section 118 provides a list of nuisances that includes any noxious matter, or wastewater, flowing or discharged from any premises, wherever situated, into any public street, or into the gutter or side channel of any watercourse, irrigation channel or bed thereof not approved for the reception of such discharge.	The proponent will ensure that adverse impacts of air and water pollution will be mitigated through measures set out in the ESMP of this report.

No.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
45.	National Museums and Heritage Act Cap 216	The Act provides for the preservation and protection of historical monuments and objects of archaeological, paleontological, ethnographical and traditional interest. It prohibits any person from carrying out activities on or in relation to any object declared to be preserved or protected. The Act equally spells out the procedures and requirements to declare and inspect newly discovered sites that may have archaeological, paleontological, ethnographical, historical and traditional significance for purposes of protection.	The proponent will ensure due diligence is practiced where historical property is encountered during construction of the proposed project and other related activities.
46.	Penal Code Act CAP 63	Section 191 of the Penal Code makes it an offence for any person or institution that voluntarily corrupts, or foils water for public springs or reservoirs rendering it less fit for its ordinary use. Similarly, section 192 prohibits making the atmosphere in any place noxious to health of persons/institution in dwellings or business premises in the neighbourhood or those passing along a public way.	The contractor and proponent will ensure strict adherence to the ESMP throughout the project cycle in order to mitigate any possible negative impact associated with dust, noise, and effluent discharge.

Table 5-4: Nakuru County Government Laws

N0.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
1.	**Nakuru County Climate Change Act, 2021**	The objective of the Act is to enhance climate resilience through development, management, implementation, regulation and monitoring of adaptation & mitigation measures and actions	The proponent has complied to this Act by carrying out a preliminary analysis of contribution of the project to Green House Gas (GHG) emissions reduction and integrating climate change

N0.	Laws and Regulations	Influence/Mandate	Relevance to Project/Compliance
			vulnerability assessment and relevant adaptation & mitigation actions into the ESIA studies. Additionally, the proponent will continue to perform its statutory functions in a manner that contributes to the implementation of the County Climate Change Action Plan.
2.	**Nakuru County Waste Management Act, 2020**	The objective of this Act is to facilitate fulfilment and realization of Article 42 on right to a clean and healthy environment and Article 43 on health and sanitation, and implementation of section 2 (g) of the Fourth Schedule to Constitution of Kenya on refuse removal, refuse dumps and waste disposal	The proponent shall ensure that relevant licenses are obtained from the county department of "Water, Energy, Environment, Natural Resources and Climate Change. Additionally, the proponent will contract a waste handler that has been licensed by the county Department and/or NEMA, to collect, transport and dispose waste in areas designated for disposal.
3.	**Nakuru County Public Participation Act, 2016**	Section 9 of the Act provides that a public participation notice shall be published at least twenty-one (21) days before the meeting in the County Gazette or the media in terms of this Act or shall be displayed at the sub-county, ward or village offices, provided that notice of a shorter period may be given in an emergency situation that calls for public participation or consultation. The notice shall indicate the time, date and venue of the meeting and shall be in the official languages but shall have regard to language preferences and usage of the area.	The proponent ensured and will continue to undertake stakeholder engagements as provided by the provisions of this Act.

5.6 International Policies, Guidelines and Best Practices

5.6.1 IFC General Guidelines for EHS

The General Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). They define acceptable pollution prevention and abatement measures and emission levels in World Bank financed projects. These General EHS Guidelines have been designed to be used together with the 'Guidelines for Electric Power Transmission and Distribution' which provide specific guidance to users on EHS issues in power transmission sector. The applicability of the EHS Guidelines has been tailored to the hazards and risks established during the environmental assessment. The applicability of specific technical recommendations has also been based on the professional opinion of qualified and experienced Environment, Social, Health and Safety experts.

Where the Kenyan regulations differ from the levels and measures presented in the EHS Guidelines, the proposed project has adopted whichever is more stringent. The general EHS guidelines adopted in this ESIA study can be summarized as follows;

i. **Environmental:** Effective management of the environmental, health, and safety (EHS) issues entails the inclusion of EHS considerations in an organized, hierarchical approach. This section has provided guidance on Environmental issues in the construction of the proposed 140 MW Olkaria II Extension Geothermal Power Plant, that includes: Air Emissions and Ambient Air Quality; Energy Conservation; Wastewater and Ambient Water Quality; Water Conservation; hazardous Materials Management; Waste Management; Noise; Contaminated Land; and Occupational Health and Safety.

ii. **Occupational Health and Safety:** Employers and supervisors are obliged to implement all reasonable precautions to protect the health and safety of workers. This section has provided guidance and examples of reasonable precautions to implement in managing principal risks to occupational health and safety in accordance with the IFC Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution. The measures will apply to construction, operation, and decommissioning activities. This guideline has provided guidance on issues related to: General Facility Design and Operation; Communication and Training; Physical Hazards; Chemical Hazards; Biological Hazards; Radiological Hazards; Personal Protective Equipment (PPE); Special Hazard Environments; and Monitoring

iii. **Community Health and Safety:** This section complements the guidance provided in the preceding environmental and occupational health and safety sections, specifically addressing some aspects of project activities as may be applicable on a project basis. Community Health and Safety issues may arise at any stage of a project life cycle and can have an impact beyond the life of the project. They include; water quality and availability, structural safety of project infrastructure, life and fire safety, traffic safety, transport of hazardous materials, disease prevention, emergency preparedness and response.

iv. **Construction and Decommissioning:** These guidelines provide additional guidance on prevention and control of Environment, Occupational Health & Safety and Community Health & Safety impacts that may occur during the development of the proposed project and at the of its' lifecycle.

5.6.2 IFC EHS Guidelines for Geothermal Power Generation

The guidelines provide environmental, health and safety issues that may occur during geothermal exploration, construction and generation. It also provides Good international industry practice on managing the associated impacts such as; effluent, air emission, solid waste and well blowouts and pipeline failure, water consumption and extraction, heat, noise, geothermal gases, confined spaces and infrastructure safety.

Environmental, health and safety performance and monitoring indicators for effluent and emissions are also provided in the guidelines to be used to measure performance and make corrections where performance is not satisfactory as briefly discussed below:

i. **Effluent Monitoring Guidelines:** The guidelines recognize that spent geothermal fluids are typically re-injected to the host rock formation, resulting in minor effluent volumes involving reject waters. However, if spent geothermal fluids are not re-injected, effluents should meet site-specific discharge levels for surface water as discussed in the General EHS Guidelines.
ii. **Emissions Monitoring Guidelines:** Although geothermal energy projects do not normally generate significant point source emissions during construction and operations, hydrogen Sulphide emissions, or other types of emissions, should not result in ambient concentrations above nationally established air quality standards or, in their absence, internationally recognized guidelines.
iii. **Occupational Health and Safety Guidelines:** Occupational Health and Safety performance should be evaluated against internationally published exposure guidelines. Examples of these include: the Threshold Limit Value (TLV) occupational exposure guidelines and Biological Exposure Indices (BEIs) published by American Conference of Governmental Industrial Hygienists (ACGIH), the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Safety and Health (NIOSH), Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA), Indicative Occupational Exposure Limit Values, published by European Union member states, or other similar sources.

5.6.3 IFC EHS Guidelines for Electric Power Transmission and Distribution

The EHS Guidelines for Electric Power Transmission and Distribution include information relevant to power transmission between a generation facility and a substation located within an electricity grid, and power distribution from a substation to consumers in residential, commercial, and industrial areas.

5.6.4 World Bank/IFC Environmental and Social Standards (ESS)

The proposed project will trigger relevant World Bank/IFC Environmental and Social Standards (ESS) outlined in Table 5-5;

Table 5-5: World Bank/IFC Environmental and Social Standards

No.	Environmental and Social Standards	Expectation	Triggered	Remarks
1.	**Assessment and Management of Environmental and Social Risks and Impacts**	Development of an environmental and social management system (ESMS) that will help integrate plans and standards so as to anticipate environmental and social risks posed by geothermal activities and avoid, minimize, and compensate for such impacts as necessary. A good management system provides for consultation with stakeholders and a means for complaints from workers and local communities to be addressed.	Yes	The proponent has complied to the provisions of this ESS by carrying out this ESIA study by establishing and maintaining a process for identifying the environmental and social risks and impacts of the project; developing an ESMP that defines roles, responsibilities, and authority. Additionally, an Environmental and Social Monitoring Plan has been developed so as to monitor and measure the effectiveness of the management plan, as well as compliance with any related legal, contractual obligations and regulatory requirements.
2.	**Labour and Working Conditions**	Fair treatment of workers, ensuring safe and healthy working conditions, avoidance of the use of child or forced labour, and identify associated risks in their primary project supply chain.	Yes	The proponent will enforce the requirements of this standard throughout the lifecycle of the project.
3.	**Resource Efficiency and Pollution Prevention and Management**	Implementation of technically and financially feasible and cost-effective measures for improving efficiency in its consumption of energy, water, as well as other resources and material inputs, with a focus on areas that are considered core business activities.	Yes	The proponent will ensure there is careful handling of any hazardous substances throughout the project's phases. Additionally, there will be frequent monitoring of H_2S levels within the proposed site.

No.	Environmental and Social Standards	Expectation	Triggered	Remarks
		Avoiding the release of pollutants or, when avoidance is not feasible, minimize and/or control the intensity and mass flow of their release.		
4.	**Community Health and Safety,**	Identify and evaluate the risks and impacts to the health and safety of the affected communities during the project's life cycle and propose mitigation measures that are commensurate with their nature and magnitude.	Yes	The proponent will implement the measures set out in the ESMP to ensure that the risks are avoided rather than being minimized.
5.	**Land Acquisition, Restrictions on Land use and Involuntary Resettlement**	Avoidance of involuntary resettlement wherever possible and minimize its impact on those displaced through mitigation measures such as fair compensation and improvements to and living conditions. Active community engagement throughout the process is essential.	No	KenGen entered into a sublease agreement with KWS for 1064.36 hectares of land (reference No. 12881/6) that was subdivided from land parcel LR. No. 105419/1 and KenGen pays annual rent. The power plant's footprint will be on this portion of land, which was set aside for geothermal resource development, therefore there will be no land acquisition. Additionally, the proposed project will not lead to human displacement of community settlements as it will utilize the already existing power transmission lines. Power generated at Olkaria II Extension GPP will be evacuated into the adjacent Olkaria II GPP substation and thereafter to the national grid through the existing: Olkaria II to Suswa; Olkaria II to Olkaria

No.	Environmental and Social Standards	Expectation	Triggered	Remarks
				I-AU; and Olkaria II-Lessos-Kibos transmission lines.
6.	**Biodiversity Conservation and Sustainable Management of Living Natural Resources**	Protecting and conserving biodiversity, maintaining ecosystem services, and managing living natural resources adequately which are fundamental to sustainable development. The risks and impacts identification process as set out in Performance Standard 1 should consider direct and indirect project-related impacts on biodiversity and ecosystem services and identify any significant residual impacts. This process should consider relevant threats to biodiversity and ecosystem services, especially focusing on habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution.	Yes	There shall be clearing of the land and access road reserve during the construction phase and therefore interacting with animal habitats and potentially some protected plant species. The assessment will focus on minimizing impacts on Birds, Wild animals, reptiles and destruction of habitats.
7.	**Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities**	Minimize negative impacts, foster respect for human rights, dignity and culture of indigenous populations, and promote development benefits in culturally appropriate ways. Informed	No	The Constitution of Kenya, 2010, defines marginalized group as pastoral persons and communities, whether they are in nomadic or a settled community that, because of its relative geographic isolation, has experienced only marginal participation in the integrated social

No.	Environmental and Social Standards	Expectation	Triggered	Remarks
		consultation and participation with project affected persons throughout the project process are a core requirement and may include Free, Prior and Informed Consent under certain circumstances.		and economic life of Kenya as a whole. The proposed project is in a region highly populated by the Maasai community. This is a Pastoralist community considered marginalized due to their limitation on land access and has also made a decision to maintain and conserve its culture. Other than ensuring comprehensive consultation of the community, the assessment focused on how to create beneficial opportunities for the community, respect their human rights & culture and ensuring that environmental and social impacts associated with the proposed project are minimized or controlled not to interfere with the livelihood of the community.
10	**Stakeholder Engagement and Information Disclosure**	Requires engagement with stakeholders though-out the project life cycle, commencing such engagements as early as possible in the project development process and in a timeframe that enables meaningful consultations with stakeholders on project design.	Yes	Stakeholder Engagement and Information Disclosure is guaranteed under the Kenyan laws. The main objective of the public participation is to disseminate and inform the local stakeholders about the project with special reference to its key components, present the information collected in the Environmental and Social Impact Assessment (ESIA) report which will be submitted to the National Environment Management Authority (NEMA).

5.6.5 JICA Guidelines for Environmental and Social Considerations, 2022

The objectives of JICA Guidelines are to encourage project proponents to have appropriate environmental and social considerations, as well as to ensure JICA's proper implementation of support for and review of environmental and social considerations. The Guidelines outline JICA's responsibilities and procedures, along with its requirements for project proponents, in order to achieve these objectives. In doing so, JICA endeavours to ensure transparency, predictability, and accountability in supporting and reviewing environmental and social considerations.

Requirements for the proponent include:

i. Incorporate the output of environmental and social considerations studies into project planning and decision-making processes.

ii. When JICA provides support for and reviews environmental and social considerations, JICA requests project proponents to fulfil the requirements described in Appendix 1. In addition, JICA requests them to cover items presented in Appendix 2 when preparing the environmental assessment reports required for Category A projects.

Below is the process of Environmental and Social Considerations as per JICA Guidelines:

1. **Information Disclosure:** JICA actively encourages project proponents to disclose and present information about environmental and social considerations of their projects to local stakeholders, well in advance. JICA discloses information on its website in Japanese, English, official language(s) and/or language(s) widely used in the host countries. It also provides the relevant reports for public reading at the JICA library and at related overseas offices.
2. **Categorization:** JICA classifies projects into four categories, based on the extent of environmental and social impacts, considering the project's characteristics, scale, site condition etc. They include:
    - <u>Category A</u> – projects that are likely to have significant adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to assess, or projects with a wide range of impacts or irreversible impacts. It includes projects in sensitive sectors, projects with characteristics that are likely to cause adverse impacts, and projects located in or near sensitive areas (as listed in Appendix 3 of the guidelines).
    - <u>Category B</u> - Proposed projects are classified as Category B if the potential adverse impacts on the environment and society are less than those of Category A projects. Generally, these are site-specific, with few irreversible impacts, and can be addressed by general mitigation measures in most cases.
    - <u>Category C</u> - Proposed projects are classified as Category C if these are likely to have minimal or little adverse impacts on the environment and society.
    - <u>Category F1</u> - Proposed projects are classified as Category FI if these satisfy all of the following conditions: JICA's funding of projects is provided to a financial intermediary or executing agency; the financial intermediary or executing agency substantially undertakes the selection and appraisal of sub-projects under the projects, only after JICA's approval of the funding, so that the sub-projects cannot be specified prior to JICA's approval for the funding (or prior to JICA's appraisal of the project); and those sub-projects are expected to have potential impacts on the environment and society.

The Olkaria II Extension Geothermal Power plant falls under Category A of these guidelines, as the project falls under: Sensitive Sectors ("4: Thermal power, including geothermal power"); Sensitive characteristics ("2: Largescale groundwater pumping"); and Sensitive Areas ("1: National Parks).

3. **Impacts to be Assessed:** The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, wastes, accidents, water use, climate change, biodiversity, and ecosystem services, including trans-boundary or global scale impacts. These also include environmental and social impacts such as: involuntary resettlement, migration of population, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as peoples in poverty and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritages, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. Items to be addressed in a specific project are narrowed down to relevant items through the scoping process.
   In addition to the direct and immediate impacts of projects, the derivative, secondary, and cumulative impacts as well as impacts associated with indivisible projects are also to be examined and assessed, so far as it is rational. The impacts through a project life cycle are also considered.
4. **Consultation with Local Stakeholders:** In principle, project proponents take the initiative to consult with local stakeholders through means that induce broad public participation to a reasonable extent, in accordance with Appendix 5 of the JICA Guidelines. This is for realizing the environmental and social considerations that is most suitable to local situations, and for reaching an appropriate consensus.
   In the case of Category, A projects, JICA encourages project proponents to consult with local stakeholders about their development needs, potential adverse impacts on the environment and society, and the analysis of alternatives at an early stage of the project.
5. **Considerations for Social Environment and Human Rights:** JICA gives special attention to the human rights of vulnerable social groups, including women, children, elderly people, people in poverty, indigenous peoples, persons with disabilities, refugees, internally displaced persons, and minorities.
6. **Laws, Regulations and Standards of Reference:** JICA confirms that project proponents comply with the laws or standards related to the environment and society established by the host country governments, including local governments. Additionally, the environmental and social considerations of a project should not deviate significantly from the World Bank's environmental and social policies.
7. **Advice of the Advisory Committee for Environmental and Social Considerations:** For Category A projects and necessary projects among Category B projects, the Advisory Committee for Environmental and Social Considerations gives advice on environmental and social considerations for the preparatory surveys.

For Category A projects; Project proponents must submit environmental assessment reports (using the format given in Appendix 2 of the guidelines). For projects that result in large-scale involuntary resettlement, a Resettlement Action Plan (RAP) also must be submitted. For projects that require the measures for indigenous people, an Indigenous Peoples Plan must be submitted as well.

As earlier mentioned, the proposed 140MW Olkaria II Extension Geothermal Power Plant will not lead to human displacement of community settlements as it will use already existing power evacuation systems. Power generated at Olkaria II Extension GPP will be evacuated into the adjacent Olkaria II GPP substation and thereafter into the national grid through the existing: Olkaria II to Suswa; Olkaria II to Olkaria I-AU; and Olkaria II-Lessos-Kibos transmission lines.

5.6.6 KfW Development Bank: Sustainability Guidelines

KfW Development Bank finances investments and related advisory services in developing and emerging countries on behalf of the German Federal Government, which are implemented by local partners as the executing agency. The priority areas of KfW's activities in developing countries include social development, environmental and climate protection, adaptation to climate change, and the conservation of natural resources. Its work also encompasses FC-measures which make a crucial contribution to implementing international agreements on environmental and climate protection, and on the conservation of natural resources such as the United Nations Framework Convention on Climate Change (UNFCC), the Convention on Biological Diversity (UNCBD) and the Convention to Combat Desertification (UNCCD). For FC-measures where the primary objective is not environmental, climate or resource protection, KfW Development Bank seeks to nevertheless incorporate climate and/or environmental outcomes or adaptation to climate change into the scope of the FC-measure.

In line with the overall objective of promoting sustainability and avoiding adverse environmental, social and climate impacts and risks, KfW Development Bank aligns its Financial Cooperation measures with the following principles:

a) to avoid, reduce or limit environmental pollution and environmental damage including climate-damaging emissions and pollution;
b) to preserve and protect biodiversity and tropical rainforests and to sustainably manage natural resources;
c) to consider probable and foreseeable impacts of climate change including utilizing the potential to adapt to climate change.
d) to avoid adverse impacts on the living conditions of communities, in particular indigenous peoples and other vulnerable groups, as well as to ensure the rights, living conditions and values of indigenous peoples;
e) to avoid and minimize involuntary resettlement and forced eviction of people and their living space as well as to mitigate adverse social and economic impacts through changes in land use by reinstating the previous living conditions of the affected population;
f) to ensure and support occupational health and safety as well as health protection in the workplace;
g) condemn forced labour and child labour, ban discrimination in respect of employment and occupation avoid all forms of discrimination;
h) to avoid negatively influencing existing conflict dynamics;
i) to protect and preserve cultural heritage;
j) to support the executing agency in the management and monitoring of possible adverse environmental, social and climate impacts and risks associated with the implementation of the financed project.

This guideline has the following objectives:

- to define a common binding framework to incorporate environmental, social and climate standards into the planning, appraisal, implementation, and monitoring of FC-measures;
- to enhance transparency, predictability and accountability in the decision-making processes of the internal environmental and social due diligence (ESDD) and climate mainstreaming.

The foundation of the assessment of environmental and social impacts of a FC-measure is its compliance with relevant national law and legal requirements as well as the assessment requirements of KFW Development Bank. The KfW Development Bank assessment standards are the Environmental and Social Standards of the World Bank Group (i.e., for public agencies, the Environmental and Social Standards (ESS) as well as relevant Operational Policies of the World Bank and the IFC Performance Standards (PS)). For cooperation with the private sector, General and sector-specific Environmental, Health and Safety (EHS) Guidelines as well as the Core Labour Standards of the International Labour Organization (ILO). Within the framework of donor harmonization (Paris Declaration), KFW Development Bank can also use comparable standards of other development banks.

All FC-measures are classified into one of the following four categories "A" (high risk), "B+" (substantial risk), "B" (moderate risk) or "C" (low risk), according to the relevance of their potentially adverse environmental and social impacts and risks.

- FC-measures are classified as **Category A** if it risks having diverse significant adverse impacts and risks on the environment or the social conditions of the affected population. Such impacts and risks may derive from the complex nature of the FC-measure, its scale (large to very large), the sensitivity of the location(s) of the FC-measure or from the potential impacts and risks being irreversible or unprecedented. Such impacts and risks may affect a larger area that is beyond the site of the facility under construction, the facility itself as well as any associated facilities or just the FC-measure area in a narrower sense.
  It is mandatory to analyse and appraise any adverse environmental and social effects as part of an independent Environmental and Social Impact Assessment (ESIA) study including an Environmental and Social Management Plan (ESMP). The ESMP should describe all measures that need to be taken to avoid, mitigate, offset, and monitor any adverse impacts and risks that have been identified by the ESIA. It should also assign responsibilities for implementing such measures and list the costs involved.
- A FC-measure is classified as **Category B** if it potentially risks having adverse impacts and risks on the environment or the social conditions of those concerned, However, the impacts and risks tend to be less significant than those of Category A FC-measures and can usually be mitigated through standard, best available mitigation approaches. The potential impacts and risks of Category B FC-measures are limited to a local area, are in most cases reversible and easier to mitigate through appropriate measures.
- If it is expected that a Category B FC-measure has single significantly adverse environmental and social impacts or risks (**Category B+**), an ESIA and an ESMP as well as an ESMS adapted to these impacts and risks are required, as described under Category A.

- FC-measures will be classified as **Category C** if they are expected to have no or only minor adverse environmental and social impacts or risks, and if the implementation and operation of the FC-measure does not require any particular protection, compensation or monitoring measures.

The Olkaria II Extension Geothermal Power plant falls under Category A of these guidelines.

5.6.7 Equator Principles, 2020

Equator Principles (EP) were adopted by International Finance Corporation (IFC) as a part of performance standards, General EHS Guidelines of 2007 and EHS Guidelines or Geothermal Generation of 2007. As provided by Principe 1 of Equator Principles, this project was categorized as a 'Category A' project, as it has the potential for significant adverse environmental and social risks and/or impacts that are diverse, irreversible or unprecedented.

The EP relates to good practice with specified applicable social and environmental performance and generally requires compliance with the Performance standards and guidelines of the IFC dependent upon the economic status of the country.

5.6.8 Analysis of the project's compliance with the standards set by the Word Bank, JICA, and KfW

Table 5-6: Analysis of Compliance with World Bank, JICA and KfW standards

No.	Environmental and Social Standards/ Guideline	Comment
World Bank Environmental and Social Standards (ESS)		
1.	**Assessment and Management of Environmental and Social Risks and Impacts**	The ESIA Study assessed environmental and social impacts and risks and provided mitigation measures in the ESMP. KenGen is expected to ensure the implementation of the ESMP to manage
2.	**Labour and Working Conditions**	A Labour management plan has been developed under *Annex 21* for use in managing labour and working conditions
3.	**Resource Efficiency and Pollution Prevention and Management**	The ESIA Report includes technically and financially feasible and cost-effective measures for ensuring efficiency in the consumption of energy and water. The ESIA report outlines measures aimed at avoiding the release of pollutants to the environment These measures form part of the ESMP.

No.	Environmental and Social Standards/ Guideline	Comment
4.	**Community Health and Safety,**	The ESIA Study has identified and evaluated the risks and impacts to the health and safety of the neighbouring communities during the project's life cycle and proposed mitigation measures that are commensurate with their nature and magnitude.
5.	**Biodiversity Conservation and Sustainable Management of Living Natural Resources**	As part of the ESIA Study, a Biodiversity assessment was undertaken aimed at protecting and conserving biodiversity, maintaining ecosystem services, and managing living natural resources adequately which are fundamental to sustainable development.
6.	**Stakeholder Engagement and Information Disclosure**	A stakeholder Engagement Plan was prepared to guarantee engagement with stakeholders though-out the project life cycle. KenGen disclosed and presented information about environmental and social considerations of the project to local stakeholders, well in advance through various consultation sessions including one-on-one meetings and public forums
JICA Guidelines		
1.	**Information Disclosure**	KenGen disclosed and presented information about environmental and social considerations of the project to local stakeholders, well in advance through various consultation sessions including one-on-one meetings and public forums
2.	**Assessment of impacts**	The ESIA Study assessed environmental and social impacts and risks and provided mitigation measures in the ESMP. KenGen is expected to ensure the implementation of the ESMP to manage
3.	**Consultation with Local Stakeholders**	A stakeholder Engagement Plan was prepared to guarantee engagement with stakeholders though-out the project life cycle.

No.	Environmental and Social Standards/ Guideline	Comment
		Stakeholders were consulted to express their opinions regarding their development needs, potential adverse impacts on the environment and society, and the analysis of alternatives. This was undertaken at an early stage of the project
4.	**Considerations for Social Environment and Human Rights**	JICA gives special attention to the human rights of vulnerable social groups, including women, children, elderly people, people in poverty, indigenous peoples, persons with disabilities, refugees, internally displaced persons, and minorities.
5.	**Laws, Regulations and Standards of Reference**	The ESIA report contains a policy, legal and institutional framework relevant to the proposed project which the proponent shall comply with.
KfW Development Bank assessment standards		
1.	The KfW Development Bank assessment standards are the Environmental and Social Standards of the World Bank Group (i.e., for public agencies, the Environmental and Social Standards (ESS)	
Equator Principles		
1.	The Equator Principles are the Environmental and Social Standards of the World Bank Group (i.e., for public agencies, the Environmental and Social Standards (ESS)	

5.7 Institutional Framework

Environmental management in Kenya takes a sectoral approach. This implies that there are different government of Kenya Ministries, Departments and Agencies who have legally mandated functions either regulatory or management that would require consideration during the proposed project life cycle. The relevant institutions are outlined in Table 5-7.

Table 5-7: Institutional Framework

No.	Institutions/Departments	Influence/Mandate	Relevance to Project/Compliance
1.	Ministry of Environment, Climate Change and Forestry	It is responsible for policies and programmes aimed at improving, maintaining, protecting, conserving, and managing the Country's natural resources (water, forestry, wildlife and environment).	The proposed project is expected to align with the policies and programs of this Ministry notably the requirements of EMCA Cap 387, and its implementing regulatory Authority-NEMA, all of which are enshrined within this Ministry.
2.	National Environment Management Authority (NEMA)	It exercises general supervision and co-ordination over all matters relating to the environment and is the principal instrument of the Government, that implements all policies relating to the environment.	The Authority will review this ESIA report for the proposed project, visit the project sites to verify information provided in the report and issue an ESIA license if it considers that all the issues relevant to proposed projects have been identified and mitigation measures to manage them have been proposed.
3.	National Environment Tribunal (NET)	It is a statutory body that resolves conflicts between NEMA and any of their clients regarding the environment. Any aggrieved party whether the Authority or a party client to the Authority in writing can launch an appeal against any decision made by the Authority (NEMA), or if the authority is aggrieved by failure of a party to execute an order or a decision.	The tribunal will come in handy if the project's implementation parties are aggrieved by NEMA's decision or license conditions.
4.	National Environment Complaints Committee (NECC)	It Investigates any allegations or complaints against any person or the authority in relation to the condition of the environment in Kenya and on its own motion, any suspected case of environmental degradation and to make a report	This committee will act as a safeguard for members of the public who feel aggrieved by actions taken under the proposed project and can exercise their constitutional rights to launch a

No.	Institutions/Departments	Influence/Mandate	Relevance to Project/Compliance
		of its findings together with its recommendations thereon to the Cabinet Secretary	complaint should they have exhausted all other grievance redress mechanisms available to them.
5.	Ministry of Energy and Petroleum (MoEP)	It is responsible for formulation and articulation of energy policies through which it provides an enabling environment for all stakeholders. Its tasks include national energy planning, training of manpower and mobilization of financial resources. It also grants and revokes generation and distribution of geothermal energy licenses.	MOEP will be the coordinating ministry for the project.
6.	Energy and Petroleum Regulatory Authority (EPRA)	It was established with responsibility for economic and technical regulation of electric power, renewable energy, and downstream petroleum sub-sectors. Its functions also include tariff setting, review, licensing, enforcement, dispute settlement and approval of power purchase and network service contracts.	EPRA will be the coordinating agency for the proposed project.
7.	Energy and Petroleum Tribunal	The tribunal has jurisdiction to hear and determine all matters referred to it, relating to the energy and petroleum sector. Section 36 (4) of the Energy Act gives the tribunal appellate jurisdiction over the decisions of EPRA and any licensing authority and in exercise of its functions may refer any matter back to EPRA or any licensing authority for re-consideration	The tribunal will come in handy if the project's implementation parties are aggrieved by ERA's and any other licensing authority's decision or license conditions.
8.	Kenya Electricity Transmission Company (KETRACO)	It was established to be responsible for the development, maintenance and operation of the national transmission grid network. It is also	It is responsible for development of power evacuation transmission lines for the power generated from the proposed

No.	Institutions/Departments	Influence/Mandate	Relevance to Project/Compliance
		responsible for facilitating regional power trade through its transmission network.	geothermal power plant and its connection to the existing national grid.
9.	Kenya Wildlife Service (KWS)	KWS undertakes conservation and management of wildlife resources across all protected area systems in collaboration with stakeholders. Its main objective is to conserve and manage national parks, wildlife conservation areas, and sanctuaries under its jurisdiction.	KWS will be actively involved as a Key Stakeholder in all phases of the project as land dedicated to the project has been leased to the proponent by KWS through an MOU. Additionally, KWS will be key on wildlife management within the proposed site and RoW for the transmission line.
10.	Kenya Forest Service (KFS)	KFS is mandated to provide for the development and sustainable management, including conservation and rational utilization of all forest resources for the socioeconomic development of the country and for connected purposes.	KFS will play a critical role in providing information on any forest land that will be traversed by the proposed power evacuation transmission lines.
11.	Directorate of Occupational Safety and Health Services (DOSHS)	It is one of the departments within the Ministry of Labour and Social Protection, whose primary objective is to ensure the safety, health and welfare of all workers in all workplaces.	The proponent must have the proposed power plant and existing power plants registered as a work place with the Nakuru county office and also submit regular audit and any incidence reports report to the agency.
12.	Water Resources Authority (WRA)	It is responsible for the regulation of water resources issues such as water allocation, source protection and conservation, water quality management and pollution control and international waters. Its roles and responsibilities include but not limited to: Planning, management, protection and conservation of water resources; Regulation of conservation and abstraction	WRA will provide the necessary water extraction permits required for the project.

No.	Institutions/Departments	Influence/Mandate	Relevance to Project/Compliance
		structures; and Catchment's and water quality management	
13.	County Government of Nakuru	Nakuru County as the project host county will have various inputs in the project implementation in line with constitutional functions of county governments.	The county government of Nakuru is expected to actively be engaged in coordinating various project related activities such as environmental conservation and consultative public participation. This will be achieved through the county's department of 'Water, Energy, Environment, Natural Resources and Climate Change'. Additionally, the proponent will adhere to the provisions of relevant Nakuru County Legislations
14.	County Environment Committees (CEC)	The functions of these committees are to: be responsible for the proper management of the environment; and develop a county strategic environmental action plan every five (5) years	Since the proposed project is of national importance, the review of the report will be done at a National level for issuance of EIA license. However, it is also notable that the EIA study report should also be reviewed at Nakuru County level to create awareness and obtain local institutional ownership.
15.	State department of Lands and Physical planning	Its main objective is to facilitate the improvement of the livelihood of Kenyans through efficient land administration, equitable access, secure tenure and sustainable management of land resource. Its responsible for; lands policy management, physical planning, land transactions, land adjudication, settlement matters, land	The proposed project is expected to align with the policies and programs of this Ministry notably the requirements of Lands Act, Land Registration Act, Land Acquisition Act, Environment & Land Court Act, and its implementing

No.	Institutions/Departments	Influence/Mandate	Relevance to Project/Compliance
		registration, as well as land and property valuation services.	regulatory Authority-NLC, all which are enshrined within this Ministry.
16.	National Museums of Kenya (NMK)	The functions of NMK include: serving as the national repository for things of scientific, cultural, technological and human interest; serving as places where research and dissemination of knowledge in all fields of scientific, cultural, technological and human interest may be undertaken; identify, protect, conserve and transmit the cultural and natural heritage of Kenya; and promote cultural resources in the context of social and economic development	NMK will be a key institution to be engaged if the proposed project finds any important cultural heritage sites and/or archaeological sites. The NM Chance Finds Procedure will be followed and the proponent will seek a Letter of No Objection from NMK.
17.	Kenya Civil Aviation Authority (KCAA)	It is responsible for regulating the aviation industry in Kenya and for providing air navigation services in the Kenya flight region.	Erecting transmission line towers requires a permit from the Kenya Civil Aviation Authority hence the proponent will be required to obtain permits and clearance from KCAA.

6 CONSULTATION AND PUBLIC PARTICIPATION

The Consultation and Public Participation (CPP) and; disclosures process, is a policy requirement by the Government of Kenya which is enshrined in the Constitution of Kenya and a mandatory procedure as stipulated by the Environmental (Impact Assessment and Audit) Regulations, 2003 (Part III, section 17) and EMCA (Cap 387) Part VI, on Integrated Environmental Impact Assessment.

The process enables stakeholders including beneficiaries and members of the public to contribute to the overall project planning and design, by making recommendations and raising concerns on proposed projects before they are implemented. In addition, the process creates a sense of responsibility, commitment, and local ownership for smooth implementation.

This chapter describes the process of the public participation and consultation that was adopted in order to identify the key issues of the proposed Geothermal Power Plant and associated facilities. Views and concerns from the local residents, local leaders, and surrounding institutions, who in one way or another would be affected or have interest in the proposed transmission line and associated facilities, were sought through one-on-one interviews, key stakeholder and public meetings.

6.1 Objectives of the Consultation and Public participation

The key objectives of the consultation and public participation process for the proposed Geothermal Power Plant and associated facilities was to:

a. **Inform:** Promote stakeholder understanding of issues about the project with special reference to its key components and description, problems, alternatives, opportunities and solutions through balanced and objective information sharing;
b. **Consult:** To obtain feedback and acknowledge concerns and aspirations of stakeholders and interested parties on analysis, alternatives, and decisions regarding the project;
c. **Engage:** Work directly with stakeholders to ensure that their concerns and aspirations are understood and considered in the ESIA report and to assure them that their concerns / aspirations would be directly reflected in the developed alternatives; and that feedback will be provided on how their input influenced the final decision.
d. **Empower:** Make stakeholders partners in each aspect of the decision, including development of alternatives and identification of preferred solution to ensure ownership of subprojects at grassroots level.

In addition, the process enabled the establishment of a communication channel among the stakeholders, the consultant, the project proponent and the Government. The consultation and public participation also offered a platform for concerns of the stakeholders to be known to the decision-making parties at an early phase of project development. Further, to ensure that all stakeholders are meaningfully engaged and consulted throughout the project cycle, a Stakeholder Engagement Plan (SEP) was prepared and has been provided as an annex (***Annex 19***) to this report.

6.2 Methodology in Consultation and Public Participation

In order to ensure effective stakeholders' consultation and public participation, stakeholders' mapping was conducted, and a database created consisting of interested parties. Assessment tools were prepared for effective and systematic interviews by the ESIA Consultant assisted by a team of technical field assistants.

Various methods and instruments were identified and used for effective and efficient public consultation and participation. They include:

i. Public Consultative Meetings;
ii. Administration of Public Participation Questionnaires;
iii. Key Informant Consultation;
iv. Household Socioeconomic Survey;
v. Key Stakeholders' Meeting.

The key stakeholder consultations and interviews were conducted on 14th-15th September, 5th October, between 11th to 13th October 2023 and on 30th November 2023, within and around the proposed project location, to steer mutual understanding of public concerns and also incorporate key stakeholders' opinions into this report.

6.2.1 Public Consultative Meetings

As stipulated by: Article 10 and Article 69 of the Constitution of Kenya; and Part VI Section 58 of EMCA Cap 387, public participation is an important exercise in the national values and principles of governance, that will promote the achievement of the fundamental principles of sustainable development.

To obtain the views of the public, the consultant organized a total of five (5) public consultation meetings, which were held at RAPLand, Kamere, Narasha, Olomayiana Kubwa (Nakuru County/Naivasha Sub-County) and Iseneto (Narok County/Narok East Sub-County), as shown in Figure 6-1 and Table 6-1 below. Courtesy calls were made to the respective local administration leaders (Chiefs and Assistant chiefs) to advice on the most suitable venues for holding public meetings. The selection of the public meeting venues was also done in consultation with the village elders and '*Nyumba-Kumi*' representatives (The venues' selection was based on ease of site accessibility, population, and venues that were known for holding public meetings in the respective project areas).

Public meeting notices were then prepared in line with the agreed venues and delivered to the respective chiefs, assistant chiefs, village elders, local community members, organizations and/or institutions, seven (7) days prior to the commencement of the public meetings. These notices were also displayed and announced at public and strategic places including Chief's offices, Assistant Chief's offices, trading centres, places of worship and water collection points.

The public meetings were held to engage a wider audience in information sharing and discussion. The meetings increased awareness of the proposed Geothermal Power Plant and associated facilities. Participants were provided a chance to voice their concerns, issues and ideas. These meetings also created avenues for exploring alternative strategies and building consensus. This contributed to giving the proposed Geothermal Power Plant and associated facilities, a social license to operate in Naivasha Sub-County.

Consultative meetings were continuously held during the ESIA Study exercise to deliberate on the positive impacts, negative impacts and mitigation measures for the proposed Geothermal Power Plant and associated facilities, as well as capturing issues raised by the local community. Five (5) public meetings were held on various dates in October 2023, with the local community members, *Nyumba-Kumi* elders, village elders, Chiefs, Assistant Chiefs, County Officials, and institutions/organizations' representatives in attendance.

Five hundred and fifty (550) people were engaged during the public meetings that were held, to ensure a comprehensive public participation exercise. Those in attendance comprised of 339 (62%) Males and 211 (38%) Females.

Out of the targeted villages, villages within Enosoopukia location, Nkoirienito sub-location which include Iseneto (Ilkituma, Oloserian, Oloiriwua, Olorropil, Olosing'ate, Oloshaiki and Kitet villages), had the highest representation in terms of attendance and participation in the meetings with a total of 161 community members attending the public meeting which was held at Oloiriwua Baptist Church. Out of the 161 attendees, 105 were males while 56 were females which represented 65% and 35% respectively of the those in attendance.

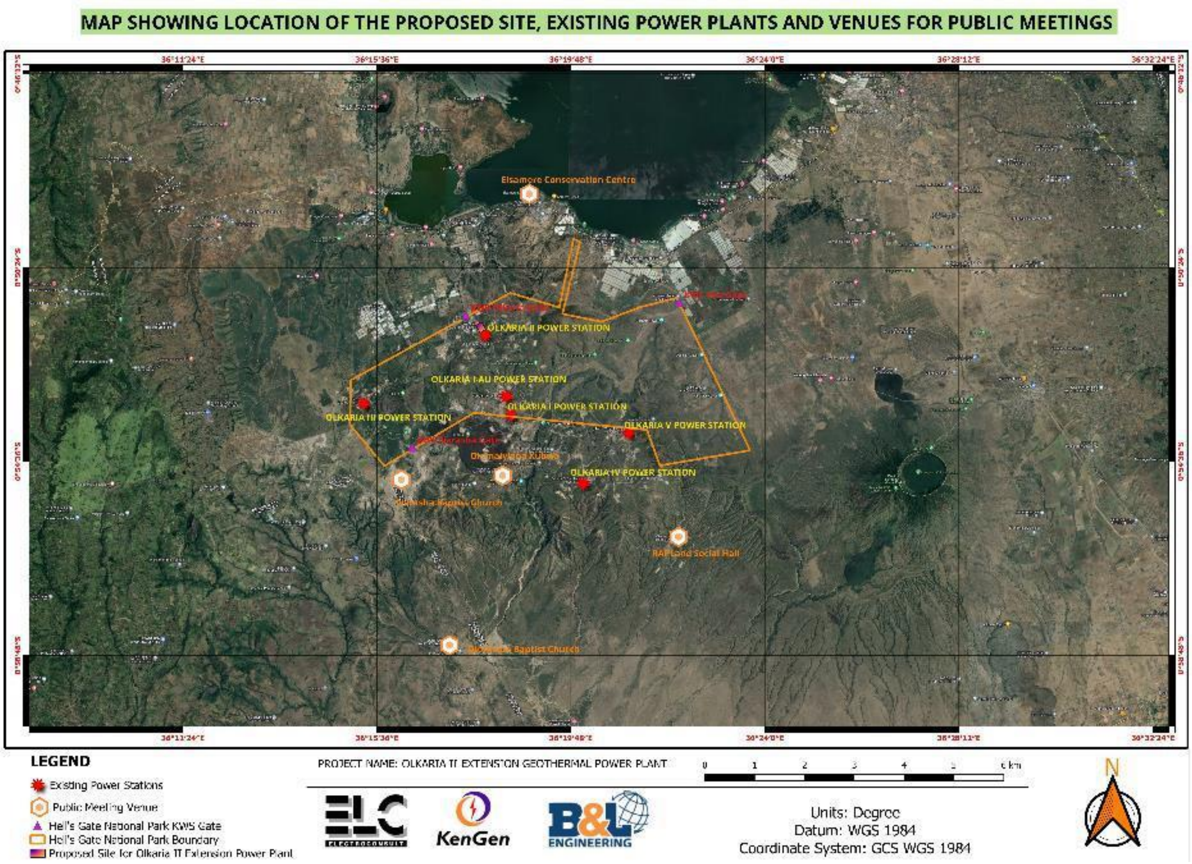


Figure 6-1: Map showing location of Public Meetings Venues

(*Source: ESIA Team GIS*)

Table 6-1: Table showing attendance breakdown of Public Participation meetings

Date & Time	Location	Sub-Location	Targeted Villages	Venue	Attendance				
					Male		Female		Total
					No.	(%)	No.	(%)	
Wednesday 11th October 2023 9:00 a.m.	Olkaria	Olkaria	Kambi Turkana and RAPLand	RAPLand Social Hall, RAPLand	43	67%	21	33%	64

Wednesday 11th October 2023 2:30 p.m.	Olkaria	Kamere	Kamere, DCK, Oldonyo, Sher, Rift, Oserian, Majengo, Kasarani & Kwa Muhia	Elsamere Conservation Centre, Kamere	63	64%	35	36%	98
Thursday 12th October 2023 9:00 a.m.	Olkaria	Olkaria	Narasha, Olomunyak, Olmara & Nkampani	Narasha Baptist Church, Narasha	68	60%	45	40%	113
Thursday 12th October 2023 2:00 p.m.	Olkaria	Olkaria	Olomayiana Kubwa	"Kwa Ground", Olomayiana Kubwa	60	53%	54	47%	114
Friday 13th October 2023 9:00 a.m.	Enosoopukia	Nkoirienito	Iseneto (Ilkituma, Oloserian, Oloiriwua, Olorropil, Olosing'ate, Oloshaiki and Kitet)	Oloiriwua Baptist Church, Oloiriwua	105	65%	56	35%	161
TOTAL					**339**	**62%**	**211**	**38%**	**550**

(*Source: ESIA Team Field Survey*)

Table 6-2: Approximate distances between the participants'' area of residence and the proposed site

S/N	Targeted Villages	Distance to the Proposed Site	Number of Participants
1.	Kamere, DCK, Oldonyo, Sher, Rift, Oserian, Majengo, Kasarani & Kwa Muhia	Between 1- 5 Km (Approximately: 5 Km)	98
2.	Olomayiana Kubwa	Between 5-10 Km (Approximately: 6 Km)	114
3.	Narasha, Olomunyak, Olmara & Nkampani	Between 5-10 Km (Approximately: 7 Km)	113
4.	Kambi Turkana and RAPLand	Over 10 Km (Approximately: 11 Km)	64
5.	Iseneto (Ilkituma, Oloserian, Oloiriwua, Olorropil, Olosing'ate, Oloshaiki and Kitet)	Over 10 Km (Approximately: 13 Km)	161

In all the meetings held, the following project information was shared:

i. The name of the project (Olkaria II Extension Geothermal Power Plant);
ii. Estimated equivalent gross output of the power plant (146 *MWe*);
iii. The boundary/location of the proposed project in relation to other existing power plants in Olkaria;

iv. Facilities that will be associated with the proposed Geothermal Power Plant;
v. Purpose of the ESIA;
vi. Purpose of the public community meetings;
vii. Role and contribution of the community in the assessment;
viii. Importance/benefits of the proposed project to the community;
ix. Impacts of the proposed project and their mitigation measures;
x. Public rights and entitlements e.g. right to accept or reject the project.

Recorded minutes with participants' attendance sheets for the meetings held have been provided under ***Annex 9*** and ***10*** of this report.

Plate 6-1:Public Meeting held in RAPLand on 11/10/2023
(*Source: ESIA Team Field Survey*)

Plate 6-2: Public Meeting held in Kamere on 11/10/2023
(*Source: ESIA Team Field Survey*)

Plate 6-3: Public Meeting held in Narasha on 12/10/2023
(*Source: ESIA Team Field Survey*)

Plate 6-4: Public Meeting held in Olomaiyiana Kubwa on 12/10/2023
(*Source: ESIA Team Field Survey*)

Plate 6-5: Public Meeting held in Iseneto on 13/10/2023
(*Source: ESIA Team Field Survey*)

6.2.2 Public Participation Questionnaires

Questionnaires were administered to members of the public to identify the positive and negative impacts and proposals on mitigation measures towards the negative impacts.

The public consultation was carried out on diverse dates in the month of October 2023. A total of One hundred and twenty (120) questionnaires were administered. 85 (71%) of the Respondents were Males while 35 (29%) were Females. Refer to Table 6-3 for a detailed breakdown.

Plate 6-6: An interview/questionnaire administration session with some of the locals
(Source: ESIA Team Field Survey)

Table 6-3: Summary of ESIA public participation questionnaires administered

DATE	TARGETED VILLAGES	VENUE	QUESTIONNAIRES ADMINISTERED TO PARTICIPANTS					
			SERIAL GROUP	Male		Female		Total
				No.	(%)	No.	(%)	

11/10/2023	Kambi Turkana and RAPLand	RAPLand Social Hall, RAPLand	1-28	19	68%	9	32%	28
11/10/2023	Kamere, DCK, Oldonyo, Sher, Rift, Oserian, Majengo, Kasarani & Kwa Muhia	Elsamere Conservation Centre, Kamere	29-56	23	82%	5	18%	28
12/10/2023	Narasha, Olomunyak, Olmara & Nkampani	Narasha Baptist Church, Narasha	57-87	27	87%	4	13%	31
12/10/2023	Olomayiana Kubwa	"Kwa Ground", Olomayiana Kubwa	88-105	7	39%	11	61%	18
13/10/2023	Iseneto (Ilkituma, Oloserian, Oloiriwua, Olorropil, Olosing'ate, Oloshaiki and Kitet)	Oloiriwua Baptist Church, Oloiriwua	106-120	9	60%	6	40%	15
TOTAL				**85**	**71%**	**35**	**29%**	**120**

(Source: ESIA Team Field Survey)

6.2.3 Key Informant Consultation

Key Informants were consulted to provide information on the Environmental and Social concerns associated with the proposed Geothermal Power Plant and associated facilities. The interviews were held on 14th-15th September and 5th October 2023, with relevant National Government, County and Sub-County heads of various Agencies and Departments at their respective offices. The Key Informants were drawn from the following:

a) Local Administration: The Chief's, Assistant Chiefs and Village elders of Olkaria, Maiella and Enosoopukia Locations;
b) Naivasha Sub-County, Assistant County Commissioner 1 (ACC 1);
c) National Government - Social Development Department, Naivasha;
d) Naivasha Sub-County - Social Development Department;
e) Naivasha Sub-County - Land Adjudication and Settlement Department;
f) Naivasha Sub-County - Physical Planning Department;
g) Directorate of Occupational Safety and Health Services (DOSHS), Naivasha office;
h) Water Resources Authority (WRA), Naivasha Office;
i) Wildlife Research and Training Institute (WRTI);
j) Kenya Wildlife Service (KWS);
k) Kenya Marine and Fisheries Research Institute (KMFRI)
l) Ngati Farmers' Cooperative Society.

Plate 6-7: Consultative meeting with Chiefs, Assistant Chiefs and Village Elders (Source: ESIA Team Field Survey)

6.2.4 Key Stakeholders' Meeting

The key stakeholders' meeting was convened on 30th November 2023 in Naivasha town at Astorian Grand Hotel, with a total of fifty-eight (58) attendees, comprising of 37 (64%) Males and 21 (36%) Females, as shown in Table 6-4.

This was carried out in order to engage the stakeholders in a more comprehensive manner depending on their interest in the proposed project. The meeting was held to:

- Add more input to the ESIA analysis findings;
- Fill information gaps identified during the ESIA study;
- Better understand the proposed project area context;
- Get views from lead agencies regarding the proposed project; and
- Assist in prioritizing challenges that need to be addressed.

Table 6-4: Key stakeholder meeting attendance breakdown

Date & Time	Venue	Targeted Group	Attendance				
			Male		Female		Total
			No.	(%)	No.	(%)	
Thursday 30th November 2023	Astorian Grand Hotel	Key Stakeholders from Nakuru and Nairobi Counties	37	64	21	36	**58**

9:00 a.m.							

The attendees mostly included representatives from: various Government departments and parastatals; Non-Governmental Organizations, Community Based Organizations, Private entities, Institutions of higher learning, among others as indicated in Table 6-5 below.

Table 6-5: Categorization of Key Stakeholders in attendance

S/N	Category	Stakeholder
1.	**County Administration**	Nakuru County Commissioner/Assistant County Commissioner/Chief Olkaria
2.	**Government Agencies**	National Environmental Management Authority (NEMA)
		Kenya Wildlife Services (KWS) – Hell's Gate National Park and Mt. Longonot National Park Wardens
		Directorate of Occupational Safety and Health Services (DOSH)
		Wildlife Research and Training Institute (WRTI)
		Water Resources Authority (WRA)
		Energy and Petroleum Regulatory Authority (EPRA)
		Kenya Electricity Transmission Company Limited (KETRACO)
		Kenya Marine and Fisheries Research Institute (KMFRI)
		Geothermal Development Company (GDC)
		Naivasha Water and Sanitation Company (NAIVAWASCO)
3.	**Sub County Departmental Offices**	County Government of Nakuru, Department of Environment, Naivasha Sub-County
		County Government of Nakuru, Department of Roads and Transport, Naivasha Sub-County

S/N	Category	Stakeholder
		County Government of Nakuru, Department of Physical Planning, Naivasha Sub-County
4.	**Political Leadership**	Olkaria Member of County Assembly (MCA)
5.	**Non-Governmental Organization**	WWF – Kenya
6.	**Private Institutions**	Akiira Geothermal Ltd
		OrPower 4 Inc.
		Kedong Ranch Ltd
		Elsamere Conservancy Centre
		Lake Naivasha Riparian Association (LNRA)
7.	**Community Based Organizations**	Lake Naivasha Water Resources User Association (LANAWRUA)
		Lake Naivasha Growers Group (LNGG)
		Kwa Muhia Environmental Conservation Group (KMEG)

Plate 6-8: KenGen representative addressing some of the concerns raised

Plate 6-9: Olkaria MCA raising concerns during the key stakeholders meeting

Plate 6-10: The ESIA Consultant making a presentation on the proposed project

Plate 6-11: Climate Change Expert addressing concerns raised by the Key Stakeholders

6.2.5 Socio-Economic Survey

Socio-economic survey was carried out from 11th to 13th October 2023 using digital questionnaires in the project area of influence. The main aim of the survey was to help the ESIA parties (Proponent, Consultant and Regulatory Authority) understand the social and economic characteristics of the community found within the proposed project area of influence for informed decision making. The data obtained can as well be considered to have been obtained from a representative sample of the community for conclusions on the findings hence applicability as part of the baseline information for this study.

The socio-economic survey targeted populations that would be directly or indirectly affected by the project in Olkaria and Maiella locations in Nakuru County and Enosoopukia Location in Narok County. All these Locations are made up of villages as illustrated in Table 6-1.

A total of two hundred and twenty-six (226) respondents were interviewed. This sample size was sufficient to ensure a representative and reliable analysis of the ESIA objectives taking into account the specific characteristics of the people living around the project area. Out of the 226 respondents interviewed, 47 were from Kambi Turkana and RAPLand, 33 from Olomayiana Kubwa, 57 from villages around Kamere, 47 from Narasha and villages in Maiella, and 42 from villages in Iseneto.

6.3 Summary of issues raised during stakeholder consultations

The section below presents a summary of Key issues raised by stakeholders during the Consultation and Public Participation (CPP) process.

6.3.1 Sharing of employment opportunities among local communities

The Olkaria area has seen an influx of people in search of employment opportunities owing to the industries and farms in the area. This, coupled with the low tertiary level education among the Maasai, has resulted in the notion that it is only non-locals who benefit from technical job opportunities, with the locals only benefiting from majorly casual employment.

Concerns over the discrimination of locals during recruitment in past KenGen projects were expressed. There is an expectation that locals should be given priority in the recruitment and other business opportunities during the implementation of the proposed project. Stakeholders requested KenGen to consider women and People Abled Differently (PAD) during recruitment.

The proponent clarified that recruitment for permanent employment positions at KenGen is done through KenGen's recruitment portal and is handled from the head office in Nairobi. For casual jobs currently available at Olkaria projects, the proponent stated that they employ workers from the nearby villages. The Stakeholder Coordination Committee (SCC) is given the mandate of apportioning the available employment positions to the various villages.

The ESIA consultant stated that a Labour Management Plan will be developed as part of the ESIA Study to guide the proponent on local recruitment. The community was encouraged to also take advantage of indirect benefits from the Olkaria projects. Women were encouraged to register companies and be in groups that can take up community projects like tree nurseries that can later be sold to KenGen and other companies. This can also enable the community to secure tenders for supplies of materials and equipment, among others.

6.3.2 Stakeholder Coordination Committee (SCC)

A major aspect of KenGen's work with communities in recent years revolve around the various Stakeholder Coordination Committees (SCC) that have been formed for a select number of projects. The function of the SCCs is to ensure representation of the various interest groups in the project, including the local community as well as other stakeholder groups, in all aspects of a project. SCCs have been instrumental in minimizing conflicts between the community and KenGen, and when necessary, serve as a forum for resolving conflicts that may arise.

The SCCs are also critical in the discussion and negotiation around project benefits, especially employment and economic opportunities, and accrued project benefits. Generally, there are three sub-committees for each SCC: (i)Environment, Health, and Safety; (ii)Employment; and (iii) Economic Opportunities.

Stakeholders were concerned that the current representatives to the SCC had been nominated by KenGen and not by the community. Additionally, concerns were related to the lack of adequate representation for youth, PAD, women & some ethnic groups in the SCC.

The proponent clarified that initially, the community nominated representatives to the committee. However, this resulted in unscrupulous individuals being nominated to the committee. To address this concern, KenGen vetted and nominated the village representatives to the current SCC for Olkaria projects. Stakeholders were urged to give the current SCC a chance to complete their 3-year term.

6.3.3 Community Benefits and Support

6.3.3.1 Corporate social responsibility (CSR)

The project area also lacks sufficient social infrastructure such as roads, schools, water, and health facilities. Through its CSR initiatives, KenGen has supported the community in addressing the social infrastructure development gap. As a result, there is a presumption from the community that KenGen is responsible for the development of social infrastructure. The community requested KenGen to expand its CSR initiatives in the villages. Proposed CSR projects included;

- Support to schools
- Support to vulnerable groups
- Scholarships
- Road improvement
- Health facilities
- Water & electricity connection.

The proponent noted that they dedicate a percentage of their profits to CSR activities. Thus, the increase in the number of projects means more profits and an increase in the amount of money dedicated to CSR activities within the community.

In addition, the project's corporate social responsibility will capture the community's concerns on scholarships, dispensaries, classrooms, market etc. based on the profits the company will make from the project.

6.3.3.2 Benefits from commercialization of Certified Emission Reduction (CER).

As provided for in article 12 of the Kyoto Protocol, Kenya Electricity Generating Company (KenGen) developed and registered six renewable energy projects in the Clean Development Mechanism (CDM) to support climate Change mitigation and the resultant Certified Emission Reduction (CER). The registered projects have a potential to reduce 1.5 million CO_2e annually and have so far been issued with **5,057,253 CERs** (gross). KenGen commercialized some of the issued CERs with partners. Of the issued CERs, KenGen still has **4,578,148** available CERs for commercialization.

KenGen, voluntarily dedicates 10% of the income from commercialization of CERs to support neighbouring communities in a program themed Community Benefit Program. So far, KenGen has invested more than **USD. 360,000** to support communities in the area of education infrastructure, water and sanitation and mobility. The following projects have been undertaken around the Olkaria area:

i. Construction and equipping of three classrooms in Oloirowua Primary School;
ii. Excavation of Olosing'ate water pan;
iii. Construction and equipping of three classrooms in Nkaampani Primary;
iv. Construction and extension of a 10km Maiella waterline.

The community requested KenGen to dedicate a larger percentage of the proceeds from the commercialization of CERs to support the local community.

The proponent pointed out that the community would benefit from the sale of carbon credits, as a percentage of the profits made would be directed into community projects as part of CSR.

6.3.4 Public Participation & Consultation

As part of ESIA Studies for previous KenGen projects in the Olkaria area, stakeholders had participated in numerous consultation forums where they expressed concerns and suggested various measures in relation to the projects. However, the stakeholders casted doubt in the consultations as their concerns and suggestions were rarely factored during the project development.

Thus, the stakeholders opined that consultation meeting minutes will be necessary to hold the proponent accountable during the proposed project implementation. Stakeholders requested access to the final ESIA Report and Consultation Meeting Minutes.

The ESIA Consultant assured the community that the ESIA Report and consultation minutes would be made public and would be available for download from the NEMA website.

6.3.5 Invasive Species/ Castor Plant

The low-lying villages in Iseneto area (Ilkituma, Oloserian, Oloiriwua, Olorropil, Oloshaiki, Kitet and Olosing'ate), normally experience storm water from the higher areas of Olkaria and the Hells Gate National Park. In these villages, castor plant (locally called *Embaleki*.) was observed growing along the storm water channels. This has resulted in the villagers falsely associating the occurrence of the plant to the storm water from the Olkaria area. The stakeholders claimed that their livestock either die or experience miscarriages, due to eating the toxic seeds of the castor plant.

The proponent noted that casuals will be assigned to cut down the plants.

The ESIA Consultant noted that castor plant *(Ricinus communis)* has been classified as an invasive plant by the Global Invasive Species Database. The plant normally grows in disturbed areas, and they grow rapidly, shading out native seeds and seedlings and producing monospecific stands in areas with previously healthy native vegetation. This plant is also common in abandoned fields, drainages, ditches, and along roadsides and railroad tracks. The castor plant was observed growing in the Olkaria area. The consultant noted that the ESIA study will include recommendations to prevent the introduction of invasive species in the area.

6.3.6 Brine Water

The communities were concerned that the brine overflow during heavy rains had resulted in the contamination of natural springs in the surrounding area which the community depends on for livestock and crop watering. The community claimed brine-contaminated water had caused death and poor health of livestock in the area.

The consultant established that the Ministry of Livestock, KenGen and Iseneto Community had undertaken a participatory research on the impacts of geothermal exploration on livestock keeping in Iseneto area. The research was undertaken between December 2015 and August 2016 following allegations from the Iseneto community that brine was affecting their livestock. The research findings attributed the animal deaths to varying factors namely: - pneumonia, lack of enough feed and worms' infestation. The research recommended that as a way forward and in the spirit of cordial relationship with the local communities, KenGen together with the Ministry of Livestock sponsor a vaccination and deworming program, in a bid to create awareness of good livestock practices. The report also recommended community capacity building on good animal husbandry.

The ESIA Consultant stated that for the proposed project, geothermal brine resulting from the separation process will be reinjected into the steam field. Reinjection piping will be installed to convey the brine and condensate from the separators to the designated reinjection wells. The ESIA Consultant recommended additional studies to ascertain impacts of brine on people, animals and vegetation.

6.3.7 Air Pollution
Significant pollutants likely to be emitted from the proposed powerplant include: Carbon Dioxide (CO_2), Hydrogen Sulphide (H_2S), Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NO_x).

The Key pollutant of concern is Hydrogen Sulphide (H_2S), which at different concentrations is associated with; (i)Nuisance "rotten eggs" odour, (ii)Eye irritation, (iii)Permanent eye damage, (iv)Paralysis of olfactory perception, (v)Risk of pulmonary oedema, (vi)Over-stimulates the central nervous system, causing rapid breathin*g, cessation of breathing, convulsions, and unconsciousness, (vii)Death*.

Concerns were raised regarding the potential health impacts of H_2S emissions on workers, the community, and the environment. The community urged KenGen to involve the SCC in H_2S monitoring to allay fears related to H_2S exposure.

The proponent committed to having monitoring stations in the surrounding villages. The ESIA Consultant urged the proponent to involve the local community when monitoring H_2S. The Consultant added that the proposed project will use advanced technology which emits minimal amounts of H_2S.

6.3.8 Soil Erosion& Flooding
The topography of the Olkaria geothermal field is characterized by a wide range of features associated with volcanic activity such as: craters; remnants of pre-existing craters; fault scarps; fissures; and steam jets., and various small hills with several small trees and bushes.

The participants were concerned that clearance of existing vegetation and compaction of soil at the site would result in increased soil erosion and flooding in the low-lying villages, especially around Iseneto area (Ilkituma, Oloserian, Oloiriwua, Olorropil, Oloshaiki, Kitet and Olosing'ate). Stakeholders raised concerns that additional development in the Olkaria area will exacerbate the soil erosion and flooding in the lower areas.

The proponent stated that they were working with KWS to put in place sufficient storm water management measures in Olkaria.

6.3.9 Noise Pollution
Potential noise sources from the proposed project include:

a) *Construction noise from construction activities*;
b) *Noise during plant commissioning* – The Power Plant and Steam field Above Ground System (SAGS) will be required to undergo a "steam blow" to clean out the pipe work;
c) *Normal operational noise* will be from: steam ejectors, control valves, steam turbine (attenuated by the turbine hall building enclosures), cooling tower induced draft fans, well testing, emergency diesel generator, pumps, and other large pieces of equipment.
d) *Abnormal operation noise* will be from: (i) Venting out the plant during start up and shutdown, (ii) Steam venting can also occur from pressure safety valves or rupture disks that may occur during plant upset conditions.
e) *Decommissioning activities*.

Stakeholders were concerned that noise from wells and other facilities would disrupt the community.

The ESIA Consultant informed the stakeholders that the proposed project would use the most advanced technology which would result in low noise emissions.

6.3.10 Biodiversity

Direct exposure to geothermal fluids, heat, or toxic gases may limit the growth of certain plant species. The current expansion of geothermal activities characterized by the extensive pipeline networks in Hell's Gate National Park is fragmenting and reducing the habitat range accessible to wildlife.

The construction of roads, buildings, and other infrastructure within or near the park has resulted in habitat fragmentation and vegetation loss disrupting wildlife corridors and impacting the park's overall ecological balance.

Stakeholders were concerned that the proposed project infrastructure could disrupt existing wildlife corridors, resulting in human-wildlife conflicts as animals seek alternative habitats. Further, important ecological sites such as nesting sites for critically endangered vultures exist within the Hells Gate Ecosystem could be affected. The proponent was urged to implement measures to address the potential impacts of alien species. The community urged KenGen to revive the community tree nurseries to encourage tree planting in the area. KenGen was advised to partner with the Kenya Forest Service (KFS) and Kenya Wildlife Service (KWS) to ensure tree planting initiatives are beneficial for the Hells Gate National Park ecosystem

The ESIA Consultant stated that the project should balance between technology development and nature preservations. He further stated that a Biodiversity Assessment exercise will be undertake as part of the ESIA Study.

6.3.11 Waste Generation

Concerns were raised regarding the straining of the existing waste management infrastructure. It was noted that activities associated with the implementation of the project as well as population increase in the area, would lead to increased waste generation. KenGen was urged to adopt recycling measures next to the site to ensure waste is effectively and efficiently managed at a lower cost.

The ESIA Consultant urged the proponent to adopt the Circular economy approach in waste management.

6.3.12 Impact on Water

The surface rainwater from the Olkaria area drains into Lake Naivasha and part of it to Lake Magadi sub-basin. The project site is located approximately 6 km south of Lake Naivasha. Stakeholders were concerned that project activities could potentially impact both the quality and quantity of water, especially in Lake Naivasha.

The ESIA Consultant stated that the proposed power plant is designed to have a closed loop system for the cooling tower and the condenser units thus conserving water. Additionally, brine and condensate will be reinjected. The project design has been designed to eliminate the possibility of wastewater from draining into the lake as detailed below:

a. **Condensate -** Excess condensate will be discharged from the cooling tower and will be reinjected into the steam field. Reinjection piping will be installed to convey the condensate from the cooling tower to the designated reinjection wells.

b. **Brine -** Geothermal brine resulting from the separation process will be reinjected into the steam field. Reinjection piping will be installed to convey the brine from the separation plant to the designated reinjection wells.

c. **Waste Water -** All wastewater from the powerhouse and workshop that may contain grease, oil or chemicals will pass through grease traps and/or oil separators prior to discharge to local water ways.

d. **Cooling Tower Sludge -** Occasionally the cooling tower will require cleaning due to a build-up of solids collecting in the basin of the cooling tower. In this operation the cooling tower sludge will be pumped out of the tower basin to a sludge drying pit. After the sludge has turned into mud cake by natural drying to mud, it will be disposed of in a local landfill.

e. **Sewage -** Sewage from the staff facilities (control room, offices and workshop) will be treated on site by use of a septic tank system. This method of sewage disposal is common practice with a negligible environmental impact.

7 ANALYSIS OF ALTERNATIVES

Project alternatives were considered for the aspects listed below:

- Site Analysis.
- Energy forms.
- No Action alternative
- With Project alternative.
- Technologies for Geothermal Power Plants.
- Technologies for handling discharge water.

7.1 Alternative Site Analysis

The proposed project site is in Olkaria geothermal field, adjacent (North North-West) to the existing Olkaria II Geothermal Power Plant within the borders of the Hells Gate National Park. The region has proved to have adequate geothermal resources through various research and development studies and accomplished drillings by KenGen and other private companies as well. The current proposed project site was selected after the conclusion of the previous feasibility study, carried out by K&M Advisors in the year 2017.

It is important to note that at the time (2017), the original proposed site location was about 1.4 km further north from the current position, however as the study was ongoing, it was deemed necessary to relocate the proposed site to the current location due to the following factors related to the new area (current project location):

a) The section of land within which the site is located is owned by KenGen through a long-term lease agreement with KWS;
b) The original proposed project site was owned by Oserian Flower Farm; however, they were not interested in selling that piece of land. KenGen was concerned that it would be difficult to obtain ESIA clearance unless it was able to acquire the affected parcel as well;
c) The site is far from Oserian Flower Farm, hence the farm will be exposed to minimal harmful impacts associated with Geothermal Power Plants (Plume emissions and noise). Additionally, the area of land directly opposite the site is also under long term lease by KenGen, and therefore gives sufficient radius for plume emission and noise from the proposed power plant.
d) KenGen already had an ESIA License for Geothermal Exploration for the area;
e) The site is close to the existing Olkaria II Geothermal Power Plant; making it possible for the two plants to share relevant infrastructure such as Sub-station and Transmission hence minimizing cost and project footprint.
f) The site is currently occupied by workshops/yards and would therefore not lead to extended disturbance of biodiversity;
g) The site would allow the proposed power plant to make use of already existing transmission lines, leading to no human displacement of community settlements or disturbance to wildlife.
h) The proposed site is strategically located near existing production and reinjection wells which would also be utilized/shared by the proposed geothermal power plant.

i) The site is mainly on a flat terrain, gently sloping at the North-North-East side (East to West slope), thus bulk earthworks will not be excessive.
j) The site is relatively close to the main access road into the Olkaria Geothermal Field, which is also tarmacked.
k) The selected site location is neither ecologically sensitive nor is it rich in biodiversity.

7.2 Alternative Forms of Energy for development

The project proposes to use geothermal form of energy. Below is a comparison of the different forms of energy development available in Kenya and their suitability for the Olkaria site.

Table 7-1: Alternative forms of energy

Technology	Advantage	Disadvantage
Geothermal Power	▪ Renewable energy source ▪ Need a relatively small area of land. ▪ Utilizing resources of the area	▪ Possible ecological impacts ▪ Emissions: air and water ▪ Ideal for the Olkaria site with the implementation of the ESMP
Thermal	▪ Relatively high level of plant efficiency	▪ Small scale, ▪ Uses fossil fuel and therefore not clean energy. ▪ Produces GHG emissions that cause climate change and global warming. ▪ Very expensive since Kenya imports fossil fuel ▪ Not ideal for the Olkaria site
Wind Power	▪ Renewable energy source	▪ Requires constant blowing of wind throughout the year ▪ Not as efficient as geothermal ▪ Requires huge amount of land ▪ Not ideal for the Olkaria field.
Solar Power	▪ Renewable energy source	▪ Will require about 200 acres to produce net power of 140*MWe* ▪ Large areas required ▪ Energy production only during sunlight hours / not a base load power ▪ More expensive to install ▪ Not as efficient as geothermal
Hydro	▪ Renewable energy source	▪ Requires huge amount of flowing water ▪ Not ideal for Olkaria field where there it is more drought prone and without huge rivers

7.3 No Action Alternative

The no-action alternative is often defined by the baseline information and is crucial in the assessment of impact because other alternatives are weighed with reference to it. This alternative would mean that the project does not proceed.

According to the latest biannual report (2023/2024) posted by the Energy and Petroleum Regulatory Authority (EPRA), the country's installed capacity is as presented in the table below. With an installed capacity of approximately 943.7 MW, geothermal accounts for 27.04% of the total installed capacity in the country.

Table 7-2: Kenya's installed capacity as at 31st December 2023

Technology	Total Installed Capacity (MW)	% Total Installed
Hydro	872.4	25.00%
Geothermal	943.7	27.04%
Thermal	629.7	18.05%
Wind	436.1	12.50%
Solar	410.4	11.76%
Bioenergy	113.8	3.26%
Imports	200	-
WHRC	83.5	2.39%
Total	**3,689.5**	**100.00%**

(*Source: EPRA, 2024*)

Due to over reliance on hydropower in the past, the country has paid a high price for heavy reliance on a single source of power. In 1999 and 2002, severe droughts nearly brought the Kenyan economy to a standstill after the hydropower dams dried out leaving power rationing in its wake. This experience has underscored the need to diversify the power sources in Kenya.

The "No Action Alternative" will therefore involve several losses both to the proponent, the community and the Country as a whole. Without implementation of the project, the following shortcomings are expected:

- The government will be unable to timely develop the energy resources required to spur Vision 2030;
- Reduced business opportunities due to lack of infrastructure in the proposed project area;
- Reduced interaction both at local, national and international levels by the community, hence education and general awareness is a major loser;
- No employment opportunities will be created for the local community neighbouring the project area and for Kenyans in general who would have worked in the proposed project area;
- Increased urban poverty and crime in Kenya;
- Discouragement for investors; and
- Lack of development, research and innovation in the Country.

7.4 'With Project' Alternative

The security of energy supply especially electricity generation in Kenya seems to be threatened by climate change induced phenomena, chief among them, drought which negatively impacts other sources of power generation, notably hydro. Inadequate electricity generation capacity and high-power bills have been perennial problems in Kenya prompting the Government to explore various ways of tackling the glitches.

A shift to alternative sources of energy such as geothermal power which is environmentally friendly and more affordable to run compared to other sources of energy like fossil fuel will insulate the country against the effects of drought, which often interferes with hydroelectric power which historically has been the major source of installed power.

7.5 Alternative Technologies for Geothermal Power Plant

The Olkaria II Geothermal field is characterized by high enthalpy, boasting a significant steam reserve. This makes it possible to implement almost any power plant cycle configuration. Given this broad spectrum of options, the most viable options in terms of power production and field sustainability will be identified under this section.

The selection of a geothermal power cycle necessitates a comprehensive evaluation based on a multitude of factors. Environmental and Social Safeguards, Cost-effectiveness, energy conversion efficiency, and operation and maintenance requirements must be assessed, alongside the historical performance and dependability of the technology.

The suitability of each power cycle in relation to the specific geothermal resource characteristics is important, ensuring compatibility and optimization of the energy extraction process. Ultimately, the chosen power cycle should emerge as the most feasible option, balancing environmental, economic, technical, and sustainable criteria, while promising a reliable and efficient conversion of geothermal energy into electricity.

7.5.1 Thermal Cycle Options

Geothermal power plants can be divided into two main groups, steam cycles and binary cycles. Typically, the steam cycles are used at higher well enthalpies and binary cycles for lower enthalpies. The steam cycles allow the fluid to boil, and then the steam is separated from the brine and expanded in a turbine. Usually, the brine is rejected to the environment or re-injected. The brine can be flashed again at a lower pressure if a double flash system is used.

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

7.5.1.1 Binary-Cycle

Binary cycle power plants represent a significant advancement in the field of geothermal energy exploitation. Unlike conventional geothermal plants, which directly utilize steam or hot water from the Earth's crust to turn turbines, binary cycle plants operate on a closed-loop system. In these plants, the geothermally heated fluid is used to heat a secondary fluid with a lower boiling point, typically an organic compound like isobutane or pentane. As this secondary fluid vaporizes, it turns a turbine, which then drives a generator to produce electricity.

Table 7-3: Advantages and Disadvantages of Binary Cycle

Advantages	Disadvantages
1. **Operates efficiently at lower temperature reservoirs**, ranging from 100°C to 200°C. 2. The system is closed loop, therefore **there's minimal environmental impact, with almost no emissions** apart from the release of non-condensable gases in the case of geothermal steam being utilized.	1. The binary cycle system is inherently **more complex** due to the integration of two separate fluid loops. This can lead to **higher initial capital costs** for installation and potential **challenges during operations**. 2. A binary plant might produce **less electricity** than a single flash unit, leading to a **wider efficiency gap**

3. **Provides 99.3% reinjection rate**, eliminating evaporative losses and environmental and social impacts.	**between the potential and actual energy** converted to electricity. 3. With **more moving parts** and the inclusion of a secondary working fluid, there may be **increased maintenance needs** over time. The heat exchangers can be **susceptible to fouling or scaling**, which can degrade their performance. 4. The use of hydrocarbons like isobutane or pentane in binary plants presents **additional health, safety, security, and environmental (HSSE) concerns**. These organic fluids can be flammable and pose a **risk of explosion or fire** if there's a leak and they come into contact with ignition sources. 5. Often **require significant cooling**, especially in locations where ambient temperatures are high. This can **necessitate the use of large cooling towers or ponds, increasing the plant's water consumption and footprint**.

Output of the System: Using the flow rate values projected by the project's Feasibility Study Engineers and a reinjection temperature of 80°C, it is estimated that the production from a pure binary cycle for Olkaria-II Extension resource would be around **113 *MWe*** net power. Bearing this in mind a pure binary cycle is quite below the 140 *MWe* net power that the resource has a potential to produce.

Therefore, this option is **not viable** for the proposed power plant.

7.5.1.2 Condensing Steam Cycle

Geothermal Steam Cycle Power plants are similar to other steam turbine thermal power stations. Heat from a fuel source (in geothermal case, the earth's crust) is used to heat water or another working fluid. They use water at temperatures greater than 150°C that is separated and piped, then condensed steam is cooled at the cooling tower and the excess condensate re- injected.

Flash steam cycle plants are the most common type of geothermal power generation plants in operation today, which use water at temperatures greater than 182°C that is pumped under high pressure to the generation equipment at the surface. The working steam is then used to turn a turbine into a generator, thereby producing electricity. The fluid is then cooled and returned to the heat source.

7.5.1.2.1 Back Pressure Turbine

What differentiates back pressure turbines from condensing turbines is the exhaust pressure. While condensing turbines discharge steam at a pressure lower than atmospheric, causing it to condense, back-pressure turbines release steam at pressures above atmospheric. This steam can then be utilized for other processes, like district heating, or be re-injected into the ground.

Table 7-4: Advantages and Disadvantages of Back Pressure Turbine

Advantages	Disadvantages
1. **More cost-effective** in scenarios where there's a **demand for both electricity and heat**. 2. **Simpler in design** compared to condensing turbines, leading to potentially **reduced maintenance costs** and **increased reliability**. 3. Have **relatively fast construction time**, allowing for a quicker transition from drilling to electricity production. 4. Has **reduced upfront investment** due to the simplicity of its design and cost-effectiveness.	1. **Less efficient than condensing turbines** for power generation alone, as they **don't take full advantage of the steam's enthalpy drop**. However, when co-generation is considered (using the steam for both electricity and heat), the overall efficiency can be much higher. 2. **Has 0% reinjection rate**,

Output of the System: With a back-pressure turbine, a power value of **86.3 *MWe*** Gross is produced with a 20% steam margin. Given the presence of already drilled wells in the field, the effectiveness of back pressure turbines for standalone power production may be debatable, particularly since they offer lower power yields than other options. Yet, the true value of these turbines emerges when the residual steam is utilized for supplementary functions, like integrating them with a binary cycle system.

Therefore, this option is **not viable** for the proposed power plant.

7.5.1.2.2 Condensing Turbine with Wet Cooling

Steam condensing turbines paired with wet cooling systems hold a dominant position in geothermal power production, and their prevalence can be attributed to their operational efficiency and adaptability to diverse geothermal reservoir conditions. In this configuration, steam from geothermal sources drives the turbine and is then directed to be condensed using a cooling system. Interestingly, the condensed geothermal steam itself is often utilized as the cooling water supply for the cooling tower, creating a synergistic and efficient closed-loop system.

Table 7-5: Advantages and Disadvantages of Condensing Turbine with Wet Cooling

Advantages	Disadvantages
1. **Leverages water's high heat capacity** to efficiently condense the steam, ensuring a substantial enthalpy drop across the turbine, which **translates to higher power outputs**. 2. The **maturity of these systems** means that they come with a proven track record, making them **safe** and **sound investments** for stakeholders.	1. It is estimated that **only about 25-30%** of produced steam **would be reinjected**.

This **reduces technological ri**sks, offering a **more predictable return on investment**. 3. Wet cooling systems are reliable, with a **proven track record**, **reduce technological risks** and offers **predictable investment returns**. 4. **Facilitates reinjection of about 55-60%** of the extracted fluid being reinjected, thus reduces evaporative losses and environmental and social impacts.	

Output of the System: With the given resource and considering a 20% steam margin, **146 *MWe*** of gross power, corresponding to **140 MWe** net power may be produced comfortably for Olkaria-II extension using a single flash with a wet cooling system.

Therefore, this option is **VIABLE** for the proposed power plant.

7.5.1.2.3 Condensing Turbine with Dry Cooling

Dry cooling systems primarily use air to cool and condense the steam, instead of water. This means they consume considerably less water than wet cooling systems, making them suitable for areas with water scarcity.

Table 7-6: Advantages and Disadvantages of Condensing Turbine with Dry Cooling

Advantages	Disadvantages
1. **Provides 99.3% reinjection rate**, eliminating evaporative losses and environmental and social impacts.	1. Tends to be **less efficient** than their wet cooling counterparts, especially **in warmer climates.** 2. Those equipped with fans typically incur **higher initial capital costs.** It is further compounded by **increased operating expenses**, driven primarily by the energy consumption of the fans. 3. From a spatial perspective, dry cooling systems often **demand a larger footprint**, therefore generally **occupying more space** than wet cooling alternative. 4. Its fans being highly susceptible to temperature fluctuations, tend to experience **power reductions as ambient temperatures rise**. Consequently, the **discrepancy in cumulative power production is anticipated to be larger**

Output of the System: By implementing a dry cooling system for Olkaria-II resource while maintaining a 20% steam margin, a total of **144.1 *MWe*** gross power was obtained, corresponding to **132.3 *MWe*** net power. This is almost 8 MW lower than what was produced using a wet cooling system.

Therefore, this option is **not viable** for the proposed power plant.

7.5.1.2.4 Bottoming Units

The “bottoming unit" is basically a back-pressure turbine and a binary cycle connected in series. In this setup, after the geothermal steam has passed through the back-pressure turbine and performed work, the residual heat in the steam or brine (which might otherwise be wasted) is used to heat a secondary fluid in the binary cycle. The secondary fluid, with a lower boiling point than water, gets vaporized and drives a secondary turbine, thus generating additional electricity. Essentially, by combining these two systems in series, the overall efficiency of the power plant is enhanced by making the most out of the available thermal energy.

Table 7-7: Advantages and Disadvantages of Bottoming Units

Advantages	Disadvantages
1. **Provides 99.3% reinjection rate,** eliminating evaporative losses and environmental and social impacts	1. It comes with **complexity of operation**. 2. Has a **higher requirement of land** due to the extensive use of air coolers, 3. Has significantly **higher cost implications** due to additional turbines, heat exchangers, feed pumps and air coolers.

Output of the System: With the given resource and considering a 20% steam margin, **137 MWe** net power may be produced. If the brine is also added to the system, this power may exceed 140 *MWe* net. However, this is not recommended because it would create a serious scaling risk not only in the heat exchangers but also in the reinjection lines.

Therefore, this option is **not viable** for the proposed power plant.

7.5.1.3 Summary on thermal cycle options

The binary cycle, bottoming units, and dry-cooled condensing turbines are appealing due to their 100% reinjection rate, eliminating evaporative losses found in wet cooling towers. Despite this, wet cooling towers remain a superior choice for the Olkaria-II extension project, particularly due to their higher efficiency. They utilize the geothermal fluid for cooling, offering cost-effectiveness and reliability. Additionally, established field experience strongly supports the preference for conventional wet-cooled condensing cycles in this context.

7.5.2 Cooling System Options

In general, thermal power plants use dry, wet or hybrid cooling towers. The choice of a type of cooling tower among these three options depends essentially on the characteristics of the site where they are installed and especially the costs generated (both capital and operating costs). Two systems generate most of the operating costs: the water pumping circuit and the air extraction circuit. The technology of the three types of cooling towers differs from one model to another.

7.5.2.1 Dry Cooling Tower

In a dry cooling tower simple tubes provide heat transfer between water inside the tubes and air in a cross-flow configuration ensures the cooling of this water.

Table 7-8: Advantages and Disadvantages of Dry Cooling Tower

Advantages	Disadvantages
1. Has **zero water loss**	1. Has the **highest energy consumption** 2. Requires the **most space/area of land**.

This option is **not favourable.**

7.5.2.2 Wet Cooling Tower

In a wet cooling tower, the contact is direct between water and air within a fill pack. Wet cooling towers can be cross-flow or counter-flow referring to the direction of air and water flows, whereas they can be splash-type or film-type referring to the construction of the fill pack.

7.5.2.2.1 Film Fill

Film fill produces a more efficient heat transfer as it generates a bigger surface area, this results in a smaller land footprint of the cooling tower and a slightly lower cost. However, film fills generally have shorter lifespan due to increased wear and tear and require more frequent maintenance, in particular in geothermal plants where Sulphur mud is prone to deposit and should be periodically removed.

7.5.2.2.2 Splash Fill

A splash fill is ideal to operate a cooling tower which requires the recirculation of low-quality water which has a high level of solid material in it.

Table 7-9: Advantages and Disadvantages of Wet Cooling Tower

Advantages	Disadvantages
1. The favourable heat exchange performance offers the advantage of having a **more compact geometry** than the dry cooling tower which requires a large exchange surface. 2. Has **lower energy consumption** than the dry cooling towers. 3. Has **lower capital cost** implications. 4. Has **lower maintenance requirements**. 5. Has overall **simplicity** and **reliability**. 6. Requires **reduced land footprint**. 7. Has **lower resource consumption.** 8. Avoids issues such as colloidal sulphur deposits, fouling, and clogging that film-type fill might encounter.	1. Has **higher energy consumption than the hybrid cooling towers**.

The Wet Cooling Tower option with Splash Fill was deemed as **FAVORABLE.**

7.5.2.3 Hybrid Cooling Tower

In a hybrid cooling tower, the flow as in dry cooling towers is taken, to which is added a water spraying system as used in wet cooling towers. The cooling effect is even better than for the wet cooling towers.

Table 7-10: Advantages and Disadvantages of Hybrid Cooling Tower

Advantages	Disadvantages
1. Require **less space than the <u>dry cooling tower</u>**. 2. It Has the **lowest energy consumption**.	1. Require **more space than the <u>wet cooling tower</u>.** 2. Has **increased complexity**. 3. Has a **higher capital cost implication**.

This option is **not favourable.**

7.5.3 Unit Size Options

Geothermal steam turbines for the Olkaria II Extension Geothermal Power Plant would be available in three possible unit sizes: 140 MW net power for a single unit installation, 70 MW net power when two units are installed, and 47 MW net power when three units are installed, being such figures referred to the net power dispatched by each unit to the grid.

With reference to the operation costs and plant complexity, it was considered that, once the technology is chosen, a small plant unit would require all the systems and components of a big unit. Therefore, it is reasonable to envisage that splitting the power plant further should result in an increase of maintenance costs as a result of an increased number of components. A configuration with fewer units results in a simpler infrastructure concerning control systems and monitoring, hence it is also reasonable to envisage that the number of people necessary to run the power plant would slightly increase by increasing the number of units although they are installed in the same area.

7.5.3.1 Single 140 MW Net Power Unit

Even though the cost of the electromechanical equipment in a single 140 MW net power unit would be 80% of the cost for the 2 x 70 MW net power units option, it would not be recommendable to install such a big unit both considering on one side the necessary availability and flexibility of the system, and the other side. the limited number of reputable and experienced manufacturers for such size of a geothermal unit.

This option is **not favourable.**

7.5.3.2 2 x 70 MW Net Power Units

It is estimated that the land footprint requirement of the 2 x 70 MW net power units option (inclusive of powerhouse building, ancillary buildings, cooling towers and switchyard) would be in the range of 34,300 m^2.

Additionally, this configuration ensures that there is a balance in the plant's requirements, reliability, efficiency, simplicity and load flexibility offered by the grid, ease of maintenance, reduced environmental impacts and the capital costs of the project with the operational cost required for the life of the power plant.

This is therefore the most **FAVORABLE** option.

7.5.3.3 3 x 47 MW Net Power Units

The cost of electro-mechanical components for a 47 MW net power unit is estimated to be 80% of the cost of a 70 MW net power unit's equipment. Therefore, splitting the 140 MW net power plant into three units would result in a 20% higher cost than having two units.

The land footprint requirement for the 3 x 47 MW net power units option would be in the range of 53,900 m^2, i.e. 57% more than that required by the 2 x 70 MW net power units option. Additionally, the infrastructure expansion for the third unit's connection could pose significant challenges in Olkaria II Switchyard due to the added electrical equipment and area of land considerations.

This option is **not favourable.**

7.5.4 Conclusion on Power Plant Technology Selection

The proponent’s concerns regarding the sustainability of the geothermal field were fully acknowledged, and the appeal of a 100% reinjection strategy from a conservation standpoint was understood. However, it must be recognized that complete reinjection is not a prerequisite for the achievement of sustainability, provided that the system is managed properly. The measures for mitigating potential impacts associated with brine water and condensate have been provided in section 8.3.1 and the ESMP of this ESIA study report. The maintenance of equilibrium between environmental stewardship and operational efficiency is considered paramount.

Furthermore, the reinjection rate associated with wet cooling towers is not only practical but also adequate for sustaining long-term geothermal well discharge, as indicated by the successful operation of existing plants within the Olkaria Geothermal Field.

Therefore, with all factors considered—environmental and social; technical viability; cost implications; historical data; and operational stability—the recommendation to adopt a **Single Flash Wet Cooling System** within a **2 x 70 MW net power framework** stands as the most strategic and prudent direction for the Olkaria II Extension Geothermal Power Plant (ELC & KenGen, 2024).

7.6 Handling of Discharge Water

Alternatives considered for the handling of discharge water and mud are:

- Reinjection
- Discharge to brine collection ponds and infiltration.

7.6.1 Reinjection

By monitoring and using reinjection along with extraction from the geothermal resource, a certain degree of sustainability will be reached:

- Fluid extracted from the resource will be reinjected back;
- Heat energy left in the fluid will also returned to the reservoir;
- Reinjection can damp down subsidence by reducing pressure drop which can accompany extraction from the reservoir;
- Discharge of geothermal fluid to other natural and physical resources will be reduced;

- Natural flow to geothermal features will be sustained;
- Risk of hydrothermal eruptions will be reduced;

Brine reinjection is **recommended** for the proposed Olkaria II Extension power plant. The proponent should however ensure that there is an appropriate reinjection regime, which is vital for good reservoir management, to ensure there are no adverse effects of reinjection such as: induced seismicity; fault lubrication; ground inflation; increased flow from geothermal springs; and increased subsurface outflow to surface water. Additionally, the reinjected fluid may need to remain above a certain temperature or pH to prevent the deposition of minerals that lead to clogging of pipes and reducing subsurface permeability.

7.6.2 Brine collection ponds

Brine collection ponds are used for collecting brine from tested wells and the power station. The fate of effluent water or brine collected in a pond would be evaporation and infiltration into the soil and bedrock. The pond also acts to delimit the area affected by the discharge. The ponds are, however, vulnerable to overflowing especially during the rainy season where brine could mix with stormwater resulting in the release of the brine into the environment. Due to past occurrences, the community around the project expressed fears that brine could affect plants and animals if not well managed. The sole use of brine collection ponds without any form of reinjection is not a recommended alternative.

8 POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATIONS MEASURES

The proposed project has associated socio-economic benefits accruable at different stages as well as potential negative environmental and social impacts. These benefits and impacts are discussed in details in this section for Construction, Operation and Decommissioning phases of the proposed project. Sufficient mitigation measures are proposed for each negative impact. Additionally, the raw and mitigated significance are presented for each impact.

8.1 Negative Environmental Impacts during the Construction

8.1.1 Air Emissions and Dust

The construction of geothermal power plants results to release of air pollutants in the form of gases and dust. Gases arise from fuel-powered machinery and vehicles while dust results from clearing of vegetation and loose materials. These emissions may be stationary (on-site) or mobile (transport-related).

Exhaust emissions such as CO, NO_x, SO_2, PM_{10}, and $PM_{2.5}$ would be generated from the combustion of diesel fuel. In addition, fugitive dust emissions in the form of PM_{10} and $PM_{2.5}$ would result from vehicle traffic and other earth-moving activities associated with the construction over unpaved areas including during handling of loose construction materials.

Mitigation:

- All construction machinery shall be maintained and serviced in accordance with the manufacturer's specifications;
- Workers shall be trained/sensitized on dust minimization techniques and management of air pollution from vehicles and machinery;
- The removal of vegetation shall be avoided until such time as clearance is required and exposed surfaces shall be re-vegetated or stabilized as soon as practically possible;
- Unless inevitable, vehicles shall avoid earth roads susceptible to fugitive dust until dust management routines are done;
- Incorporate dust/fumes arrestors in the batching plant e.g. use of dust nets;
- Provision of appropriate protective personal equipment including respirators and aprons;
- ensure regular servicing of machinery to meet the relevant emission standards.
- Ensure the use of clean fuels in vehicles and other construction Machinery;
- Switching off the engines of all vehicles and machinery on site when not in use;
- Schedule of vehicle movement and number of vehicles in transit at any given time to limit emissions generation;
- Plant and equipment to be used in the project to comply with recognized performance and design standards;
- Conduct regular air quality monitoring at the site and nearby settlements;
- Vehicle selection strategy to consider the impact on total emissions;
- Schedule of vehicle movement and number of vehicles in transit at any given time to limit emissions generation;
- Plant and equipment to be used in the project to comply with recognized performance design standards;
- Minimize the amount of excavated material on site;

- For manageable stockpile volumes, geotextiles can be used to cover soil heaps to prevent erosion and dust generation by wind;
- Restrict heights from which materials are dropped, as far as practicable, to minimize the fugitive dust arising from unloading/loading;
- Frequent watering of loose surfaces and piles of soil to avoid dust shedding;
- Temporary suspension of material handling activities during high wind events;
- Consideration of the location of stockpiles for temporary storage areas with respect to the location of sensitive receptors and prevailing wind;
- Avoiding double handling of materials wherever reasonably practicable;
- Field supervisors to have responsibility to monitor conditions and adjust the frequency of watering;
- Sealing/re-vegetation of completed earthworks as soon as reasonably practicable after completion.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Medium	Low	Minor

8.1.2 Noise Pollution

Construction activities will inevitably release noise to locations in close proximity to the site. Noise levels generated by construction works will have the potential to impact sensitive receptors. Noise levels at a receptor depends on several factors such as the number and type of equipment and machinery used, the distance between the noise sensitive receptor and the construction site and the level of attenuation likely due to ground absorption, air absorption and barrier effects.

Vibration was not considered as a major issue associated with the proposed project as there will be no blasting during the construction phase. Vibrations that will be experienced during this phase will be intermittently experienced, when excavation and construction equipment are being used.

Mitigation:

- Regular monitoring and measurement of noise levels at the site;
- Install proper noise barrier wall to reduce noise exposure to close to sensitive receivers and/or the nearest villages;
- Limit operation for specific loud pieces of equipment or operations to day-time;
- Limit exposure of workers handling noisy and vibrating equipment;
- Construction activities should be limited to daylight hours although scheduling may require overnight operations on specific occasions;
- Require contractors to prepare and implement a Vehicle and Traffic Management Plan (VTMP);
- Encourage the adoption of low-noise technology and practice for machines during construction;
- Develop and implement a noise management plan.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Medium	Low	Minor

8.1.3 Increased Soil Erosion and Sedimentation

The project site is covered with kikuyu grass, shrubs, and a few acacia trees. These will be cleared during site preparation for construction. This may result to increased soil erosion and sedimentation of nearby water courses caused by surface runoff and through storm drains. Additionally, during construction, earthworks and truck movements on unpaved surfaces are bound to result in significant amounts of loose soil materials which are prone to erosion. Loose surfaces and materials at the construction site and access roads are also prone to wind erosion.

Mitigation:

- Minimize project footprint by limiting clearing of vegetation to construction areas only;
- Develop top-soil management plan;
- Site clearing or disturbance of the natural vegetation will be planned and approved as part of the project management process;
- Among the areas that require immediate restoration, the Contractor will allow minimal vegetation clearing and disturbance on the slopes to avoid difficulties during restoration;
- No grey water runoff or uncontrolled discharges from the site/working areas (including wash-down areas) to adjacent watercourses and/or water bodies shall be permitted;
- Water containing pollutants such as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from the site;
- Runoff loaded with sediment and other suspended materials from the site/working areas should be prevented from discharging to adjacent watercourses and/or water bodies must be prevented;
- Prepare a restoration scheme to guide re vegetation of areas cleared during construction comprising of indigenous species and to be rid of any invasive species;
- Banding the site to control run-off loaded with sediment and other suspended materials from the site from watercourses;
- Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas (including groundwater) are not polluted.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Low	Negligible

8.1.4 Surface and Subsurface Contamination

Surface and subsurface contamination would result from accidental chemical and fuel spills and leaks. Chemical and petroleum products are normally found and used in equipment and maintenance areas, fuel storage areas, refuelling stations and vehicle/equipment wash down areas. The spill of these pollutants or improper storage may result in direct contamination of soils, which may require immediate response and clean-up operations.

Mitigation:

- Ensure all chemicals and fuels are stored in designated storage areas;
- Ensure all chemical and fuel storage sites are banded and with impermeable surface;
- Develop and implement a spills prevention and emergency response plan for the site including containment, clean-up and reporting procedures.;
- Storage areas to be located away from surface waters;
- Proper maintenance and regular servicing of vehicles to ensure no leakages from the vehicles;
- Training of workers on spills response to minimize the risk of chemical spills.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Low	Negligible

8.1.5 Surface Water pollution

Surface water pollution may arise from different contaminants carried away from the site during construction into water bodies and especially during rainy seasons. These contaminants include chemicals, soil sediments, fuel spillages and other loose construction materials such as cement and paints. Soil sediments will arise mainly from enhanced soil erosion due to vegetation clearing and are likely to cause increased sedimentation in the low-lying areas especially during rainfall. The surface rainwater from the Olkaria area drains into Lake Naivasha and part of it to the Lake Magadi sub-basin. This has the potential to adversely impact baseline water quality. The severity is considered medium as the project site is located approximately 6km away from the lake.

Mitigation:

- Banding the working area to avoid surface flows and storms into water courses;
- Compaction or regular watering of loose surfaces;
- Ensure no grey water runoff or uncontrolled discharges from the site/working areas (including wash-down areas) to adjacent watercourses and/or water bodies shall be permitted;
- Water containing pollutants such as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from site;
- The Contractor shall instruct their staff and sub-contractors that they must use toilet provided and not the bush or watercourses;
- Delineate the areas that will be cleared before any land clearing or earthmoving activity begins to limit the area of disturbance. If possible, conduct the clearing by phases to minimize area of disturbance and sediment generation at any given time;

- Use of interim control mechanisms such as sheeting to stabilize batters and slopes prior to permanent stabilization.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Low	Minor	Low	Low	Negligible

8.1.6 Solid and Liquid Waste Generation

Construction activities will lead to the generation of different waste streams. Some wastes are as discussed in section 2.7 of this report. The different waste categories will include;

i. Green Waste: This will arise from cleared vegetation and bushes
ii. Excavated material
iii. Waste oil: From onsite repair of Vehicles and machinery
iv. Domestic Waste: Food remains from Workers camps
v. Office waste: From the site office
vi. Hazardous waste: From chemicals used in construction including their packaging materials
vii. Domestic Liquid waste: From kitchen, Bathrooms and washrooms
viii. Waste water from geothermal plants (Brine)

Table 8-1: Waste categories and mitigation measures during construction

Waste Category	Mitigation measures
Green Waste from Land Clearing and Preparation	▪ Encourage reuse of green waste locally for composting/fire wood or landscaping purposes; ▪ Manage regular disposal schedules to remove waste from the site where necessary; ▪ Minimize clearing of vegetation to project site only.
Domestic Solid Waste	▪ Provide waste storage bins; ▪ Encourage segregation of waste at the source; ▪ Maximize reuse and recycling as appropriate; ▪ Ensure regular collection of waste by NEMA Licenced waste transporter; ▪ Limit number of staffs housed within the site.
Domestic Liquid Waste	▪ Install a Bio-digester; ▪ Discharges from kitchen and washroom facilities into the septic tank are to be directed through oil-water separators or grease traps, and appropriate disposal methods as required; ▪ Implement portable toilets in construction sites, road work areas and workers' camps to treat wastewater discharge as per Project design; Portable toilets shall be

	used with a septic tank which functions as an effluent removal system.
Hazardous Waste	▪ Provide a Waste Management Plan that provides appropriate measures for the segregation of different waste streams, collection, handling, storage, treatment and disposal methods; ▪ Provide temporary hazardous waste storage; ▪ Hazardous and toxic waste should be removed from the site by a licensed hazardous waste transporter and disposed of in a licensed facility.
Operational Liquid Waste (Brine)	▪ Regular monitoring of chemical content in brine; ▪ Deep re-injection below lake level into purpose drilled or unused production wells.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Moderate	Moderate	Low	Medium	Minor

8.1.7 Impact on Flora

A large portion of the proposed powerplant site has no vegetation but is instead used as yards for storage and material laydown. Most of the vegetation clearing will be associated with Steam field piping and associated separation, scrubbing and venting systems. This may lead to disturbance of the ecosystem that provides feeding grounds for fauna within the area.

The proposed project will involve the establishment of steam pipelines, including two-phase pipeline, condensate injection pipeline and brine injection pipeline in addition to the powerplant. Given the proposed site area and buffer size of 7.5 m on both side of the pipelines, the area of land that will be cleared of the cover will be approximately 66.26 ha. The steam pipeline will involve clearing an area of 2.71 ha of land cover of which grassland will be 0.59 ha and shrubland 2.12 ha. The two-phase pipeline will involve clearing 1.23 ha of land of which 1.14 ha of grassland and 0.08 ha of shrubland will be affected. The condensate Injection pipe will require clearing of 0.17 ha of land affecting 0.08 ha of grassland and 0.08 ha of shrubland. The brine injection pipeline will involve clearing of 57.83 ha of land cover affecting 43.37 ha of grassland, 12.85 ha of shrubland and 1.61 ha of woodland. The powerplant will sit on approximately 9.10 ha of land and will involve clearing of approximately 3.60 ha of grassland and 0.72 ha of shrubland. The percentage of the individual land cover types that will be affected include Grassland (1.38%), Shrubland (0.52%) and Woodland (0.36%).

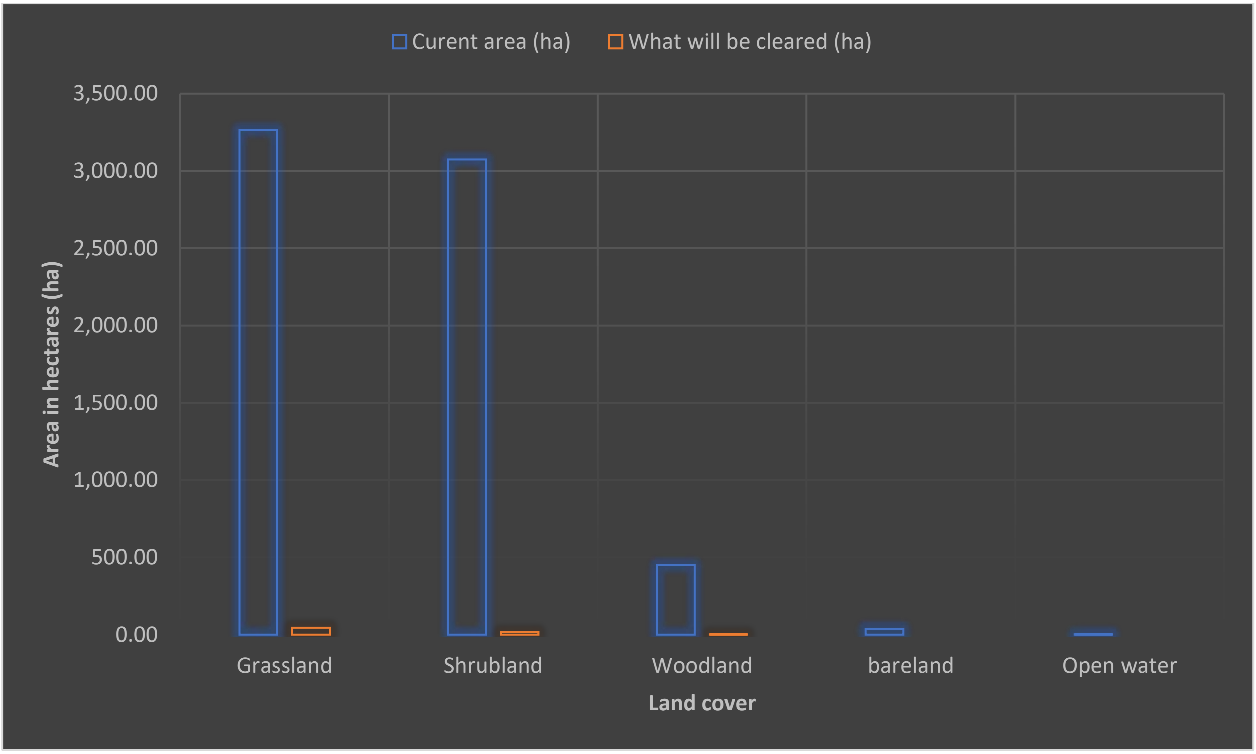


Figure 8-1: Land cover that will be affected by the proposed project

Mitigation:

- Ensure there is selective clearing of the vegetation for future re-growth and regeneration. This will ensure minimal disruption of wild fauna's natural movement, territoriality, and other ecological processes;
- Delineate areas for land preparation/other activities in the field to prevent loss of vegetation outside of designated works areas.
- Ensure washing of vehicles is done away from the site to ensure that seeds from exotic and invasive species are not introduced through vehicles during construction;
- Revegetation of areas outside the project footprint that are affected by construction activities. Indigenous plant species should be used. If planting takes place during the dry season, the planted areas should be watered regularly until properly established;
- Inspections and decontamination of vehicles and equipment upon mobilization to limit the potential for carrying seeds of non-native/ invasive plant species.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Low	Minor	Low	Low	Negligible

8.1.8 Impact on Fauna

There was no observed permanent habitation of the site by wildlife. There are potential impacts on different form of wildlife such as mammals, Birds, Reptiles and Insects. Direct impacts on wildlife may occur inside the construction's boundaries if wildlife enters into the construction site and pose risks to individuals within and across the site boundary.

Mitigation to appropriately handle wildlife entry into construction sites will reduce risks to both animals and the construction crews. Other direct impacts to wildlife particularly less-mobile animals (herpetofauna) may also occur inside the construction boundaries.

Sources of indirect impacts on fauna also include noise from the construction activities, general increase in human activity, and evening light pollution, which have the potential to stress or disorientate wildlife close to the project area. Mitigation activities that reduce noise and evening pollution will minimize these impacts.

The specific Impacts are discussed below;

Impacts on (Macrofauna) Mammals

It was observed that wild animals like Giraffes, Zebras and Buffalos pass outside the periphery of the proposed site. Construction work activities may stress and disorientate the herbivores making them look for other grazing areas. Increased traffic during construction will also push wild animals from the area and may also result to the knock-down of wild animals.

Impacts on Avifauna (Birds)

There are different birds found within the park and the site area is not isolated from them. In view of this, construction works may impact these birds. For example, dust from loose surfaces, roads and loose materials settling on perching and nesting sites may push some birds that fly over the site.

Impacts on Herpetofauna (Reptiles)

Presence of reptiles cannot be ruled out from the site especially on the rocky grounds as they may be impacted by construction works. Clearing of vegetation may lead to excessive run off leading to washing out breeding burrows of reptiles. Site clearing may result to movement and relocation of surface materials such as rocks, which form habitat features used by cold blooded reptiles for sun basking. Present Reptiles will also be affected or scared away by noise and vibrations.

Impacts on Invertebrates

Vegetation clearing may lead to increased run off, washing away important invertebrate groups. Impacts on Insects will have cumulative effects on ecosystem functions and processes such as pollination hence slowing down vegetation regeneration.

Mitigation:

- Revegetation of cleared grounds as appropriate;
- Monitor birds and wildlife abundance, distribution and movement;
- Erect bumps on wildlife crossing areas along the roads.
- Discourage unnecessary hooting.
- Restrict and regulate access for earthmoving machines;
- Incident records accidents and other human-wildlife conflicts should be monitored and followed by appropriate corrective measures.
- Enforce Park rules within the park;
- Fit high voltage transmission lines with wire markers and flappers to alert birds on flight;
- Ensure regular watering of loose surfaces to avoid dust emissions;

- Shelter high heat points and emission vents within the project area;
- Liaise with KWS to ensure all Reptiles and their eggs discovered during construction works are hiding under rocks and sheltered terrains such as Pythons and House snakes are captured and safely release them in suitable habitats.
- Ensure steam pipes at known animal migration corridors are elevated or buried under the ground surface. Modify pipe loop designs to minimize hindrance to wildlife movement as well as scaring them away. Other design options like pipe burying, wider loops or concave ones should be explored for habitat suitability and to ensure big game can still move along their routine corridors and routes.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Medium	Minor

8.1.9 Sustainability and Climate Change Impacts

The construction of the project will be a net generator of greenhouse gas. Construction vehicles and equipment will generate greenhouse gases due to the burning of fossil fuels and clearing of vegetation which will result in the loss of sequestering capacity for carbon dioxide.

Mitigation:

- Ensure use of clean fuels in vehicles and machinery;
- Use generators with low emissions;
- Switch off engines for vehicles and machinery when not in use;
- Conduct regular maintenance and service of vehicles and equipment used for construction works to minimize emissions;
- Revegetate all areas safe from any development works at the site with local vegetation to increase local sequestering capacity for greenhouse gases.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low	Low	Negligible	Low	Low	Negligible

8.2 Positive Environmental Impacts during Operation

8.2.1 Contribution of the Project to Greenhouse Gas (GHG) Emissions Reduction:

Geothermal power plants are known to emit approximately 99% less carbon dioxide (a green-house gas) than fossil fuel power plants of similar size, according to many research studies (Zarrouk & Moon, 2014). As a result, initiatives to mitigate climate change have direct influence on the economic viability of geothermal projects, potentially making them more attractive compared to fossil fuel-based alternatives.

The estimated equivalent net output for Olkaria II Extension is 140*MWe*. To determine how much GHG in carbon dioxide (CO_2) equivalent would be displaced by 140*MWe* of geothermal power replacing fossil fuel, in this case diesel oil, the first step is to determine how much diesel is used in our power generation energy mix.

According to EPRA (2024), Kenya's energy generational mix (GWh) predominantly consists of 44% of geothermal, 23% of hydro, 14% of wind, and 4% of solar accounting for roughly 85% of green energy the remaining 15% being thermal, that is imported diesel and biomass. This means that the amount of diesel used is minimal, therefore the Grid Emission Factor (GEF) that corresponds to this amount of diesel needs to be used. The GEF measures the amount of carbon emissions per unit of electricity generated.

To calculate the annual CO_2 emissions from the net 140*MWe* geothermal electricity, we use Kenya's GEF which has been accepted by the United Nations Framework Convention on Climate Change (UNFCCC). In this case the available GEF for Kenya was given as 0.2262 tCO_2e/MWh (UNFCCC, 2020).

First, determine the total energy produced in a year:

- Energy in a year = Capacity X Hours in a year
- Energy in a year = 140MW X 24hours/day X365days/year
- Energy in a year = 1,226,400MWh

Now, calculate the annual emissions:

- Annual Emissions = Energy in a year X Grid Emission Factor
- Annual Emissions = 1,226,400MWh X 0.2262 tCO2e/MWh
- Annual Emissions = 277,411.68 tCO_2e

Therefore, if the 140MW net power geothermal plant operates at full capacity (24/7) for an entire year, it would produce approximately 277,411.68 metric tons of CO_2 equivalent annually based on the given grid emission factor. The calculation assumes the plant runs at full capacity non-stop, which might not be the case in real-world scenarios due to maintenance, fluctuations in demand, and other factors.

8.3 Negative Environmental Impacts during Operation

8.3.1 Surface Water Contamination

During the operation phase, limited amounts of brine and condensate will be generated. Steam, gases and geothermal fluid are released through the separators. If released to the environment, geothermal fluids could cause crop damage and impact on water quality making it unfit for domestic, municipal, commercial/ industrial, or horticultural uses. Brine may have deleterious effects on plants due to its chemical composition and the fact that it is usually at high temperature. The chemical concentration of brine has the potential to harm plants and wild animals; thus, the disposal mechanism should allow reduced chances of harmful contact.

For this proposed project, there will be approximately 56.8% reinjection of geothermal fluid generated, whereas the remaining percentage of fluid generated will either evaporate during the cooling process or may be reused. However, there are instances where geothermal fluids may be released into the environment due to: accidental leakage/spillage of hot brine as it is piped from the separators to reinjection wells; or accidental overtopping of the reinjection settling basin, especially during failure of the reinjection system or during the rainy season when excess rainwater leads to overflow of the reinjection basin, containing condensate that was awaiting reinjection. Pipeline ruptures may also result in the surface and subsurface release of geothermal fluids i.e. condensate and/or brine water with high temperatures and pH levels, which contain trace elements such as: Fluorine (F), Chlorine (Cl), Sulphate (SO_4), Chromium (Cr), Calcium (Ca), Boron (B), Manganese (Mn), Iron (Fe), Copper (Cu), Zinc (Zn), Arsenic (As), Cadmium (Cd), Mercury (Hg), Lead (Pb), etc.

Discharge of geothermal fluid to rivers can lead to increase in the concentrations of these minerals and of heat load to the river. This has long-term and short-term adverse effects on water quality and the riverine ecosystem, affecting uses such as contact recreation, crop irrigation, stock watering, provision of household water, and harvesting of fish, shellfish and edible aquatic plants. Aquatic plants that proliferate in the new environment may have to be removed to ensure that the water body remains navigable. These weeds may be so contaminated with heavy metals, particularly arsenic, that they must be disposed of in special contaminated waste repositories. The discharge of hot brine creates a plume of heat that may extend some way down the river, creating a heat barrier for migratory fish including as eels, trout and salmon and therefore disrupting their life cycle and the fisheries that depend on them (Luketina, 2022). It is however important to note that there are no rivers within or close to the proposed site for Olkaria II Extension Power Plant.

Where there are lakes within or nearby, such as the proposed project which is located approximately 6km south of Lake Naivasha, the geothermal fluids can contaminate lake sediments with heavy metals, reducing potential uses of the water body. As documented by Kim (2010), arsenic has a very complex chemistry and occurs in several forms with different toxicity and solubility. A seasonal increase in lake water temperature can lead to a sudden release of a particularly toxic form of arsenic into the water column, with the potential to result in mass fish kills. Studies have shown that the major contaminant causing fish kills is Mercury (Hg), with Arsenic (As) being the secondary causative factor.

From the flow direction and accumulation assessment illustrated in section 4.2.4.2 of this report, it was observed that cumulative flows from the proposed project area, Olkaria II and well pads located upslope of the proposed site, head northwards towards Lake Naivasha, a fresh water lake that is a suitable habitat for a wide range of aquatic flora and fauna, and is one of the Ramsar sites in Kenya. Therefore, accidental flows of brine or condensate from this area will ultimately flow towards the lake and pose significant aforementioned threats to the Lake Naivasha ecosystem, especially if the quality of trace elements such as Mercury, Arsenic and Lead, in the spilled brine and/or condensate, are above the levels provided under the Environmental Management and Coordination (Water Quality) Regulations 2006, and WHO drinking water quality guidelines.

Mitigation:

- Minimize risk of brine and condensate discharge through implementation of reinjection system to respective reinjection wells;
- System shut down in case of reinjection failure or well blow-out;
- Provision of adequately sized concrete lined reinjection settling ponds/basins;
- Keep the reinjection settling ponds/basins empty, as frequently as possible;
- Installation of sump pumps at the reinjection settling ponds/basins, to increase the rate of injection of excess geothermal fluid into reinjection wells as well as a portable pump to be used at plant start-up;

- Regulate flow from production wells during failure of the reinjection system i.e. when kickback of the system is experienced;
- Brine and condensate flows and ponds/basins should be located close to the source;
- Distant flow should be piped to prevent animal or vegetation contact;
- Monitor the chemical composition of brine and condensate routinely;
- Develop a brine management plan to minimize the risk of brine discharges;
- In the event of emergency discharge of brine or condensate to surface waters, treatment should be undertaken prior to discharge of effluent to comply with effluent standards;
- Monitor well levels and pressure to identify leaks early and repair casing or decommission the wells to avoid further contamination;
- Detailed analysis of aquifer structure and existing groundwater use in the development area;
- Sludge/precipitates to be stored in banded areas;
- Regular maintenance of wellheads and geothermal fluid pipelines, including corrosion control and inspection; pressure monitoring; and use of blowout prevention equipment such as shutoff valves;
- Design of emergency response for well blowout and pipeline rupture, including measures for containment of geothermal fluid spills;
- ESIA to be conducted before drilling of any additional make up well(s).

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium	Likely	Moderate	Low	Unlikely	Negligible

8.3.2 Noise and Vibration

Noise-generation during operations will mainly result from:

i. Well heads and drain ports;
ii. Venting stations (rock muffler);
iii. Cooling towers;
iv. Turbines and Generators;
v. Vertical discharge wells.
vi. Drilling of make-up wells

The new vent station is expected to maintain noise levels equivalent to or below those of the existing vent station at Olkaria II Geothermal Power Plant.

Additionally, due to the low density and lack of cohesiveness associated with Volcanic Ash soils present in the project site and general Olkaria Geothermal area (as indicated in section 4.2.3.3), the impact of vibration caused by underground pipelines as condensate is pumped to the reinjection wells was considered to be insignificant, as the properties of volcanic ash soils are known to absorb such vibrations.

Mitigation:

- Provision of appropriate PPEs to the workers, including Hearing Protection devices (HPDs), especially to staff and visitors in the vicinity of the vent station (rock muffler) and cooling towers;
- Sensitization and education of workers and visitors on the need to use PPEs provided;

- Daily noise level monitoring to be conducted;
- Conduct health surveillance of workers which shall include audiometric test for the power plant operators at least once in a year;
- Provide at strategic positions signages in identified noise hazardous areas;
- Ensure ruptured ejectors in the power plant are reinstated as soon as possible;
- Design of atmospheric separators for production testing to be optimized for noise abatement;
- Apply modern technology with minimal noise levels especially from the cooling towers;
- Vertical discharge well testing to be conducted at times advised and agreed to by nearby communities;
- Develop an effective grievance mechanism to record and respond to noise complaints;
- Installation of vibration dampers where feasible;
- Develop and implement a noise management plan;
- ESIA to be conducted before drilling of any additional make up well(s).

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	High	Major	Medium	Medium	Moderate

8.3.3 Impact on Air Quality and Odour

Geothermal power plant emissions are negligible compared to those of fossil fuel combustion-based power plants. Hydrogen Sulphide (H_2S), Mercury and Carbon dioxide (CO_2) are the main potential air pollutants associated with geothermal power generation employing flash or dry steam technologies. Carbon dioxide is present in the steam although its emission is considered negligible compared to fossil fuel combustion sources. Vapor-dominated geothermal systems tend to produce more carbon dioxide than liquid-dominated systems, but for all types of systems, CO_2 discharge generally decreases during development.

Emissions may occur during well drilling, well flow testing activities, and via the open contact condenser /cooling tower systems unless pumped out of the condenser and re-injected into the reservoir along with reject geothermal fluids. Well-field and plant-site vent stations can also be potential sources of H_2S emissions, primarily during upset operating conditions when venting is required. H_2S gas produces an odour effect/ 'rotten eggs' smell.

It is crucial to note that emissions at the vent station occur sporadically and intermittently, especially during instances of partial or total load rejection and in case of system trip. The software used for simulating pollutant dispersion assumes steady-state conditions, which cannot truthfully reflect the occasional nature of emissions at the vent station.

In reference to the overall emissions from the power plant, it should be noted that whenever geothermal steam flow is partially or fully vented to the vent station, the corresponding quantity of H_2S shall be deducted from the emissions produced by the cooling tower.

During normal operations of the GPP, zero discharge from the vent station will be targeted, by maintaining steady flow from the wells and choosing precision valves at the wellheads which can realize fine adjustment of the flow rate.

Mitigation:

- Situate automatic H_2S sensors around the power plant;
- Ensure cooling towers are sited properly;
- Put up monitoring stations for precipitation chemistry;
- Monitor changes in geothermal development technology for adoption where necessary;
- Educate workers on the dangers of exposure to H_2S;
- Use of abatement systems to remove H_2S emissions from Non-Condensable Gases (NCGs);
- An air quality monitoring plan should be adopted to ensure the lowest possible impacts;
- Continuous monitoring of H_2S within the plant's boundary and other active sites within Olkaria;
- Installation of automatic H_2S data logging detectors in the vicinity of the vent station, (integrated with the H_2S alarm system of the power plant) including use of personal H_2S detectors by staff near or within potentially dangerous areas, such as the vent station (rock muffler) and cooling towers;
- The community Liaison office to have a strategy for communication with those who may be affected by odour nuisance and the office to also ensure that they share air quality monitoring results for transparency and to allay any community health fears.
- ESIA to be conducted before drilling of any additional make-up well(s).

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	High	Major	Medium	Medium	Moderate

8.3.4 Increased Waste Generation

Geothermal technologies do not produce a substantial amount of solid waste. Sulphur, silica, and carbonate precipitates are typically collected from cooling towers, air scrubber systems, turbines, and steam separators. This sludge may be classified as hazardous depending on the concentration and potential for leaching of silica compounds, chlorides, arsenic, mercury, vanadium, nickel, and other heavy metals.

Other wastes that will be generated include:

i. Sewage wastes;
ii. Domestic and food wastes;
iii. Hazardous Waste: This will arise mainly from plant maintenance operations: contaminated plant and machinery; contaminated PPEs; contaminated spill

response equipment; contaminated rags; batteries; and waste electrical and electronic components.

Improper waste management (including improper handling, inadequate storage, and lack of redundancy measures for containment) can release pollutants into the environment which may impact local ecology, surface and groundwater quality, baseline soil quality, and human health through various pathways (ground and surface water, surface run-off, dust or dispersion through air, and direct ingestion or inhalation). Waste management should be the responsibility of All individuals within the power plant.

Table 8-2: Waste categories and mitigation measures during operation

Waste Category	Mitigation measures
Domestic Solid Waste	▪ Preparation and implementation of a Waste Management Plan that includes suitable disposal bins, maximizes reuse and recycling, appropriate collection and storage facilities, and involves appropriate disposal methods as required. In addition, the Project needs to provide temporary storage for domestic solid waste and coordinate with NEMA approved waste handlers in terms of transporting waste to the nearest landfill location.
Domestic Liquid Waste	▪ Provide a Waste Management Plan that includes collecting black and grey waters to a septic tank, providing an oil separator at the base camp outlet prior to discharge to public sewerage system, and appropriate disposal methods as required; ▪ Discharges from kitchen and washroom facilities into the septic tank are to be directed through grease traps, and appropriate disposal methods as required; ▪ Implement portable toilets in construction sites, road work areas and workers' camp to treat wastewater discharge as per Project design; and ▪ Portable toilets shall be used with septic tank which has a similar function as effluent removal system.
Hazardous Waste	▪ Provide a Waste Management Plan that includes appropriate segregation of different waste streams, collection, handling storage and disposal methods as required. ▪ Provide temporary hazardous waste storage ▪ Hazardous and toxic waste will be removed from site by licensed hazardous waste transporter and disposed in a licensed facility. ▪ Prepare a Spill Response Plan.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Moderate	Moderate	Low	Medium	Minor

8.3.5 Impacts to Vegetation from Well Heads and Drain Ports

Adverse effects on the exposed plants may occur near well heads and drain ports due to over-spray during discharges. Salinity can potentially cause plant damage including drying of leaf tissues, which occurs first at the tip of older leaves and progresses along the margins as severity increases, resulting in abnormal defoliation. The severity is considered medium. No known species of flora located in the project site are protected species, therefore sensitivity is considered low. Impacts to vegetation are assessed as minor.

Mitigation:

- If feasible, apply cover on the potentially exposed plants;
- Spraying of clean water on plants might be applied as an alternative in case the application of cover is not feasible.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Moderate	Moderate	Low	Medium	Minor

8.3.6 Impacts on Flora

Operations of the geothermal plant may impact on the vegetation in the area in different ways. For example, brine water can affect plants, dust may affect plants' growth, loss of insects will hinder pollination and there is the probability of introduction of invasive species especially through vehicles.

Mitigation

- Monitor invasive plant species at the project area and uproot unwanted germinating plants;
- Brine flows and ponds should be located close to the source. Distant flow should be transmitted through closed pipes
- Rehabilitate disturbed areas neighbouring the plant, along roads, abandoned campsites etc., by planting native plant species – this should be done as soon as practicable to avoid colonization by invasive and opportunistic pioneer species;
- Exotic plants species should not be introduced into this area.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Low	Minor	Low	Low	Negligible

8.3.7 Impacts to Wildlife

Noise and H_2S from the power plant, general increases in human activity, and evening light disturbances have the potential to stress or disorientate wildlife and lead to them leaving the area. Additionally, poorly managed brine and effluent could be accessed by wild animals for drinking, which might be injurious to their health. Further, pipelines could lead to habitat fragmentation and disruption of wildlife routes.

Mitigation:

- Fencing around work areas to prevent animal entry and minimize light/disturbance impacts during the night time. Application of unidirectional light is an alternative if the fencing is not feasible;
- Installation of safety barriers such as fences to avoid wildlife contact with hot pipelines, should temperatures exceed safe levels;
- Training for crews, during operation, on the appropriate response to wildlife encounters;
- Prohibit workers and local community from hunting and poaching of wildlife;
- Provide banner informing prohibitions of hunting and poaching of wildlife and training for base camp occupants on the appropriate response to wildlife encounters that may occur and instruction to occupants to refrain from harassing wildlife;
- Minimize risk of brine / condensate discharge through implementation of reinjection system and provision of adequately sized concrete lined settling ponds / system shut down in case of reinjection failure;
- In the event of emergency discharge of brine/condensate to surface waters, treatment should be undertaken prior to discharge of effluent to comply with effluent standard;
- Ensure steam pipes at known animal migration corridors are elevated or buried under the ground surface. Modify pipe loop designs to minimize hindrance to wildlife movement as well as scaring them away. Other design options like pipe burying, wider loops or concave ones should be explored for habitat suitability and to ensure big game can still move along their routine corridors and routes;
- Brine ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact;
- Maintain Incident records (of poaching, accidents and other human wildlife conflicts etc.) for monitoring and taking of corrective measures;
- Roads feeding into the park area should be maintained as routes for tourist's activities and wildlife management;
- Access for earthmoving machines should be regulated;
- Park rules should be enforced within the park; and
- Regulate traffic flow and discourage vehicular disturbances such as hooting accordingly.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Medium	Minor

8.3.8 Ground Subsidence and Seismic Risks

In geothermal development, the withdrawal rate of geothermal fluids may surpass the natural rate of replenishment. This leads to pressure drop in the reservoir which can promote land subsidence. Subsidence is greater in liquid-dominated fields because of the geological characteristics typically associated with each type of field. Ground subsidence can affect the stability of pipelines, drains, and well casings. It can also cause the formation of ponds and cracks in the ground and, if the site is close to a populated area, it can lead to instability of buildings. Flooding may occur if the subsidence occurs on land adjacent to a water body. The presence of numerous fault lines may lead to increased seismic risks (GIBB International Ltd, 2019).

Subsidence, induced seismicity may cause the cracking of relatively impermeable subsurface layers that form a barrier between fresh or geothermal surface water and underlying strata. If such a barrier, known as an aquitard, is cracked, then the surface water may drain away, causing the streams, springs, lakes and pools to dry up. The empty pools can no longer be used for tourism, bathing and other cultural activities, and its ecosystems are rendered extinct.

Mitigation:

- Continuous monitoring of seismic activity in Olkaria and its surrounding;
- Increase the number of the re-injection wells within, to allow increased reinjection of brine and condensate which will promote stability and distribution of mass within the reservoir (This was also recommended by the findings of the Feasibility Study carried out in 2023-2024, which concluded that it would promote a higher fraction of condensate and a more distributed saturated brine reinjection.);
- Formulation of a community risk management plan that incorporates trigger levels and a communication strategy. The plan should incorporate IPP's in the area (such as OrPower 4Inc., Akiira and Oserian), other relevant government agencies, National Disaster Operation Centre (NDOC).

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium	Likely	Moderate	Low	Unlikely	Negligible

8.4 Positive Environmental Impacts during Decommissioning

8.4.1 Reduced negative environmental impacts of operation.

At the operation phase of the project many negative environmental impacts will arise. Such impacts include; air pollution, noise pollution, impacts to wildlife etc. All these impacts will subsequently be eliminated when the project is decommissioned.

8.4.2 Rehabilitation and restoration of the site to its original status

During the decommissioning of the project, the area will be rehabilitated close to its original status prior to development by re-vegetating the areas that were occupied by the geothermal power plant and its associated infrastructure.

8.4.3 Discovery of recyclable materials

Recyclable materials and reusable items will be sorted and collected before disposal of generated waste material. For example, steel that will be obtained after decommissioning can be sold as scrap to scrap metal handlers.

8.5 Negative Environmental Impacts during Decommissioning

The following negative environmental impacts are associated with decommissioning of the power plant.

8.5.1 Generation of Solid Waste

Decommissioning of the structures and equipment including machinery will result in the generation of solid waste in different forms including hazardous material. The waste will mainly comprise of concrete rubble, steel and disused pipes and fittings;

Mitigation:

- Consider possible use of equipment and materials in their current form to minimize generation of waste;
- Demolition waste can be recycled or reused to ensure that materials that would have otherwise been disposed of as waste, are diverted for productive uses; Development and application of a circular economy and an integrated solid waste management plan/ strategy in managing solid waste materials i.e., through a hierarchy of options: 1. Source reduction 2. Reuse 3. Recycling 4. Combustion 5. Sanitary land filling.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium	Likely	Moderate	Low	Likely	Minor

8.5.2 Dust and Exhaust Emissions

Dust will arise from excavation works aimed at exposing buried power plant infrastructure. The use of heavy machinery and equipment will lead to exhaust emissions.

Mitigation:

- Use of PPEs such as dust masks by demolition crew.
- Mobilize the ideal amount of equipment for the demolition works.
- Ensure that the equipment mobilized are serviceable.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium	Likely	Moderate	Low	Likely	Minor

8.5.3 Noise and Vibration from Structure Demolition

Heavy equipment that will be mobilized will lead to the emission of noise and vibrations.

Mitigation:

- All the vehicles and machinery should be operated in compliance with relevant vehicle emission standards and manufacturer's specification to minimize noise pollution.
- Ensuring a scheduled time for major repairs and making use of noise barriers during that time.
- Turn-off equipment and vehicles that are not in use.
- All machine operators and workers to be provided with appropriate PPEs.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium	Likely (Medium)	Moderate	Low	Likely (Medium)	Minor

9 POTENTIAL SOCIAL IMPACTS AND MITIGATION MEASURES

All phases of the project have the potential to influence the socio-economic status of the local community either positively or negatively. While the Project may adversely affect the local community, there are also socio-economic benefits. These socio-economic benefits and negative social impacts are discussed in detail hereunder.

9.1 Positive Social Impacts during Construction

9.1.1 Employment and Business Opportunities

Engagement with the community during the ESIA baseline study identified a high interest in working for the Project. Local youth have a high expectation that the project will prioritize them when recruiting workers. There will be a positive effect on the local economy from hiring local workers for construction activities. This will lead to development of additional skills for those who will be employed in especially in construction works. Additionally, there will be transfer of skills from the more qualified personnel to the local unskilled workers who will be working in the construction activities.

Whereas the ability of the local community to provide the quality and quantity of service required might be limited, the socio-economic impacts on business opportunities are assessed to be positive. The increased number of immigrants to the area for work will expand the market for local traders, especially if a large number of workers will not be housed at the site camp. The indirect effects from the Project activities and the presence of non-local workers would be expected to generate more business and entrepreneurship in the accommodation, food and entertainment sectors, and provide a multiplier effect on the local economy.

In addition, the Project construction materials including quarry materials, transportation, hardware, and other general materials supply, should to the extent possible be sourced from the local markets or sources. . These are opportunities to benefit the local community either directly or indirectly.

Enhancement:

There is need for implementation of a number of measures to enhance the project's socio-economic benefits. Such measures include;

- KenGen should develop a Local Content strategy indicating approaches for ensuring local community opportunities;
- Train locals on required skills and preparation of tender documents;
- Prioritizing local workers in accordance with the Project qualifications;
- Coordination with village leaders for the local recruitment process.
- Transparency on recruitment process to avoid conflicts between community members;
- Prioritize incorporation of traditional/indigenous knowledge in project designing and implementation which can only be obtained from the local community;
- Ensuring wages for the local workers are in accordance with applicable regulations;

- Providing opportunities for local business in the procurement of goods and services to support the Project activities, including non-formal or indirect services e.g., transportation services/car rental, food catering and homestays for workers.

9.1.2 Improved Local and National Economy

Through the provision of employment to the locals, income from their salaries and wages will improve the economy of the trading centres. The Engineering, Procurement, and Construction (EPC) contractor is expected to purchase some of the materials from the local market and as such, contribute positively to the local and national economy. The workers will need basic amenities such as food, shelter, and clothing during the construction period. They will also need recreation for time off. All these goods and services will be sourced from providers within the area.

At the national level, indirect economic gains will be realized too. This will mainly be through outsourcing goods and services from other areas of the nation. Such goods and services may include but not be limited to: cement; sand ballast; reinforcement steel; personal protective equipment; transportation of materials; warehousing; and logistics. All income generated including acquisition of statutory approvals and permits will result to revenue for the National or County governments through taxes, fees and levies.

Enhancement:

- Ensure all materials available locally or within Kenya are procured from within the Country and avoid importation of such materials;
- Obtain all relevant approvals, permits and licenses from respective National and County Government Offices.

9.1.3 Training and Capacity Building

It is anticipated that the proposed project will lead to training and capacity building of the locals, the employees, the project contractor/sub-contractors and KenGen's staff seconded to the project. The locals will benefit from on-job trainings including livelihood restoration trainings such as entrepreneurial training for existing small businesses. Additionally, locals will be made aware of the impacts of HIV/AIDs, Gender Based Violence (GBV), Sexual Exploitation and Abuse (SEA), Sexual Harassment (SH) etc., and their management protocols; project plans Stakeholder Engagement Plan (SEP), Grievance Redress Mechanism (GRM) etc., among others.

Employees are likely to benefit from health and safety related trainings such as health and safety awareness (use of the available information such as Material Safety Data Sheets (MSDSs), safe work practices including fall protection program that includes training in climbing techniques and use of fall protection measures and appropriate use of Personal Protective Equipment (PPE), fire safety trainings, first aid, emergency evacuation, and trainings regarding code of conduct for the workforce.

9.1.4 Improved Infrastructure and Social Services

Successful development of the Proposed project may trigger KenGen interest to undertake Socially Uplifting Projects as part of its wider CSR policy. Such activities may include the repair of roads, and especially of the access roads to be used during the construction process. The projected increase in population and subsequent revenue growth will necessitate development of social amenities such as improved water supply and sewerage services, development of social halls within established town centres and improvement of standards and number of medical facilities.

9.2 Negative Social Impacts during Construction

9.2.1 Project Induced in-Migration (PIIM)

Project induced in-migration (PIIM) involves temporary or permanent movement of people into the area considered as the Project Area of Influence (AOI), in anticipation of, or in response to, the real or perceived socio-economic opportunities and benefits associated with development and implementation of the project. A number of social risks typically arise due to influx migration including:

i. Social conflict between immigrants and Host community in economic competition. The conflict may worsen due to the Local community's low education level and lack of skills required for construction works. There is a perception that previously, non-locals have benefitted from past geothermal power plants developments in the Olkaria area;
ii. Pressure on Public and social amenities like schools, health facilities, play grounds etc. Increase population leads to increased generation of liquid and solid wastes and if not well managed will lead to rise in communicable diseases;
iii. Increase in traffic, potential road accidents, and crime as the Project AOI is relatively undeveloped with low existing traffic flow;
iv. Increased burden on and competition for public service provisions, including heightened pressure on accommodation and rent although there are a number of accommodations for tourism purposes already existing;
v. Possible appreciation or hike in prices of land, housing, goods and services triggered by the availability of disposable income among the immigrant workforce.

Mitigation:

- Prioritize Local community workforce to the extent possible including possible training to enhance absorption of local workforce;
- Manage labour influx in accordance with the World Bank (WB) 'Guidance Note on Managing the Risks of Adverse Impacts on Communities from Temporary Project Induced Labour Influx' and the analysis of labour Influx Management;
- Ensure continued community engagement in accordance with the Proposed Project SEP;
- PIIM risk reduction planning, which involves effective and ongoing engagement with the local community to optimize employment and business opportunities for locals, while consulting the community regarding predicted PIIM, which includes disclosure of the potential benefits and risks associated with these changes;
- Community empowerment programs including trainings on employability skills to increase their capacity to absorb benefits not only from the Project but also other potential economic opportunities to improve their livelihoods.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Low	Minor	Low	Low	Negligible

9.2.2 Noise Pollution: Disturbance to Tourists at the Geothermal Spa

Project construction activities especially those associated with emission of noise may disturb tourists seeking peace and tranquillity at the Geothermal spa, located approximately 200 metres away from the project site.

Mitigation:

- Proper environmental management to reduce noise should be in place during the land preparation and construction;
- Provide informative signage to alert tourists of the imminent noise;
- Implement the Stakeholder Engagement Plan and Grievance Redress Mechanism.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Medium	Minor

9.2.3 Impacts on Community Health

Dust during construction will arise from excavation activities, wind-blown dust from loose services such as access roads, open and bare grounds surfaces and the use of loose materials and piling of loose excavated materials. Dust increases due to blowing of wind. The increase in vehicular mobilization for delivery of materials and equipment result in elevated noise levels. The derivative impacts of decreased air quality and increased noise will potentially create a disturbance to the health of the community residing near the project site, and also the workers.

Mitigation:

- Frequent watering of loose surfaces and covering of loose materials;
- Avoid offloading and application of loose construction materials during windy hours;
- Introduce speed limits on roads and ensure compliance to minimize accidents in the busy environment;
- Monitor community health in regard to respiratory illness in collaboration with the local health centres for informed preventive care strategies;
- In addition, to aligning with World Bank expectations, the Project is expected to establish a grievance mechanism that is accessible for all community groups to report dust/emissions/noise issues. Should any complaint be received, the Project will undertake an immediate investigation as part of the grievance resolution procedure.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Medium	Low	Minor

9.2.4 Traffic Congestion

Equipment and material for civil works will be delivered to the project site via The Moi South Lake Road and the local road network. Traffic disruption is expected to occur on road bends and hills due to heavy vehicles slowly driving on the roadways. It is anticipated that many of these vehicles will cause traffic congestion on the local roads and interchanges.

Mitigation:

- Establish and implement a Vehicle and Traffic Management Plan (VTMP) in consultation with relevant government agencies;
- Public consultation on implementation plan of equipment and material mobilization;
- Contractor/Sub-contractors to strategically place temporary traffic cones/barricades and direction delineators to maintain one through lane in each direction during peak hours;
- Construction staging and idling vehicles should be away from sensitive receptors to the extent feasible;
- Installation of safety signs and barricades;
- Safety inductions for vehicle drivers and construction contractors; and
- Strict enforcement of applicable speed limit through the villages.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Medium	Minor

9.2.5 Visual Impact (Landscape character impact)

Over the years, geothermal power stations have become tourist attractions. For example, between the months of May and June 2023, there was an increase of approximately 3,180 visitors on educational trips who visited Olkaria power stations, Additionally, there was increase of 703 visitors, who visited the Geothermal Spa within the same period (KenGen, 2023). Many people may enjoy the sight of geothermal steam pipes snaking geometrically across the park, steam emanating from already existing geothermal power plants, and geothermal cooling towers poking up above the landscape. They may see these as an elegant and pleasing reminder of the power inherent in the earth and the scientific and technological genius that allows it to be harnessed, displacing the use of non-renewable fossil fuels. However, not everyone may feel that way.

The proposed location is surrounded by other power plants such as Olkaria II, thus severity is considered low. One of the main causes of visual impact during construction is the hoarding of the site, machinery and equipment involved.

Mitigation:

- Limit vegetation clearing to construction areas only.
- Preparation of a landscape planting plan for the entire project area. Planting plan to be comprised of indigenous species and to be rid of any invasive species.

- Keep design for pipeline and project components, colour and structure material compatible with the natural settings, where possible and practicable.
- Store excavation material away from residences and the existing roads.
- Limitation of earthworks to construction areas only.
- Clean and tidy temporary waste storage areas.
- Provide proper waste disposal.
- Construction site management to ensure that heavy equipment remains in designated areas.
- Lighting of temporary working areas and site compounds during periods of darkness to be minimized where possible.
- Ensure site rehabilitation to be conducted refer to the baseline condition and previous land use of the affected area.
- Ensure all steam pipes camouflage with immediate environment.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low	Medium	Minor	Low	Low	Negligible

9.2.6 Impacts on Social Fabric and Community Perception

The Maasai are the main local community ethnic group. The implementation of the project will influence community perceptions both positively and negatively for a variety of reasons which were expressed during the stakeholder engagement meetings. Most participants cited job creation as their main reason for supporting the project. Others were concerned with the release of H_2S and poor disposal of brine from the project.

The project activities may result in adverse impacts on the environment and agricultural activities which may trigger social tension and discord if not managed properly. Further, the PIIM (both from migrant workers and non-locals seeking opportunities from the project) may introduce different cultural practices, religion(s), pressures and social behaviours to the community. Some concerns were recorded during the baseline consultation associated with the non-local workers recruited by past KenGen projects which makes the community perceive KenGen and its Contractors as being discriminative against the locals. The concerns of the community should be taken into consideration during project planning and development of a social management plan.

Mitigation:

- Implementation of the prepared Stakeholder Engagement Plan (SEP) which includes ongoing stakeholder engagement and consultation not only at the macro/regional level with the government, but also at local level with the cultural groups and the local community;
- Disclosure of information regarding jobs and business opportunities widely to the local community within the Project AOI, along with information about the Project activities, as part of the SEP;
- Undertake a comprehensive induction/training to all workers concerning local culture and customs, and encourage workers' appreciation toward these cultures, as part of the Project Code of Conduct;

- Adopt and disclose a community GRM to provide the community with the opportunity to formally lodge complaints related to the Project workforce behaviour or other social-related issues;
- Build the capacity of the Stakeholder Coordination Committees (SCC) and allow the community to nominate their representatives to the SCC;
- The contractor should ensure that at minimum, at least 30% of all skilled and unskilled manpower engaged are from the local community;
- The contractor should ensure that all employment requirements from the local community, are channelled through KenGen's Community Liaison Office;
- The community Liaison office to ensure there is coordination with village leaders for the local recruitment process;
- Ensure there is transparency in the recruitment process to avoid conflicts between community members;
- Ensuring wages for the local workers are in accordance with applicable regulations.
- Contractor to organize and ensure that there is provision of meals and drinking water to casual workers in a timely and clean manner;
- Providing opportunities for local business in the procurement of goods and services to support the Project activities, including non-formal or indirect services e.g., transportation services/car rental, food catering and homestays for workers;
- Sensitize the local community on KenGen's CSR program and clearly communicate the role of the Government in infrastructure development.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Low	Negligible

9.2.7 Impacts on Labour Rights and Working Conditions

The pursuit of economic growth through employment creation and income generation should be accompanied by the protection of the fundamental rights of workers. The potential impacts on violation of labour rights and working conditions from the Project activities, including gender inequality and unequal opportunity, are Minor.

There is a likelihood that the violation of worker's rights may occur to workers under the sub-contractors, informal/casual/non-skilled labour, and local workers.

Mitigation

- Develop and implement a Labour Management Plan (LMP) with commitment to provide appropriate working conditions and terms of employment in accordance with relevant national and international laws and standards. Working conditions and terms of employment include aspects such as wages and benefits; hours of work; overtime arrangements and overtime compensation; breaks; rest days; and leave for illness, maternity, vacation or holiday;
- The LMP will establish, maintain and improve the Worker-Management relationship to promote fair treatment, gender equality, non-discrimination and equal opportunity for workers, and enable a grievance mechanism for workers;

- Ensure all contractors and suppliers comply fully with the laws and regulations of the government of Kenya and the LMP.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium	Likely (Medium)	Moderate	Low	Likely (Medium)	Minor

9.2.8 Occupation Health and Safety Risks

The project will result in exposure to risks for the project workforce through the Project construction activities that could potentially lead to accidents causing injuries and fatalities. Issues can also result from the use of heavy equipment, dangerous materials and other construction-related activities. In addition, consideration should be given to potential fires caused by equipment sparks, welding, or cigarettes. Further health and safety issues may arise from temporary noise disturbances during the construction phase.

Mitigation:

- Provide and enforce all ranges of required PPEs for workers and visitors;
- Establish a comprehensive Safety and Health Policy in compliance with KenGen's Occupation Safety and Health Policies;
- Implement the specified H&S programme throughout the construction period;
- Ensure compliance with all standards and legally required health and safety regulations;
- Establish an emergency response procedure and display on all work areas;
- Provision of medical facilities for staff;
- Include standard best practice health and safety provisions in the construction contract. The provisions should include insurance to enable the contractor to pay for any and all treatments required by workers including those of all sub-contractors, together with any subsequent lifelong disability payments;
- Establish and enforce a strict code of conduct for all project drivers including outside suppliers delivering materials. The code should focus on safety, especially speed, and loading, especially banning all carriage of staff, workers and passengers except in seats;
- Provision of a standard first aid kit at the site office at all times;
- Training of first aiders;
- Obtain WIBA cover for employees;
- Provision of fire-fighting equipment available at the worker's camp;
- Install appropriate safety signage for all work sites;
- Registration of the work place;
- Carry out accident and incidents investigations and implement corrective actions;
- Maintain an accident register;
- Ensure regular and routine Staff and visitor induction;
- Provision of sanitary facilities for employees;
- Provision of wholesome drinking water for employees;
- Train workers on Occupational Safety and Health and Construction safety;
- Develop & publicize an emergency response plan;

- Carry out OSH Risk Assessment;
- Carry out Fire Safety Audit;
- Ensure all Lifting Plant Equipment are examined by an authorized plant examiner;
- Report any non-fatal accident **within 7 days** to the area Occupational Safety and Health Officer;
- Any fatal accident is to be reported to the area Occupational Safety and Health Officer **within 24 hours.**

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium	Likely (Medium)	Moderate	Low	Likely (Medium)	Minor

9.2.9 HIV/AIDs and Sexually Transmitted Infections (STIs)

During construction, the project will bring in a significant population of new people in the project area. The workforce will be housed within or outside the site. These workers will also not immigrate to the area with their families. As a result, chances for an increased rate of HIV/AIDs infection are high. This is because the traders, workers and business people will have money to spend and some may use it to attract resident from the project area in a bid to solicit for sex, thereby creating avenues for the spread of HIV/AIDS.

Mitigation:

- Where workers must be housed, select appropriate locations away from concentration of human settlements for construction camps;
- Sensitize workers and the local communities on HIV/AIDs and STIs in conjunction with the Public Health Office;
- Provision of condoms to the construction workers, project team and the public. This should be kept in places that are not locked and are accessible to the above persons;
- Where possible conduct regular sensitization campaigns and monitoring and evaluation of the modes used during the course of the project;
- Formation of peer groups from among the project staff to ensure continuity in training and awareness raising;
- The contractor has to ensure that staff are made aware of the risks of contracting or spreading sexually transmitted diseases;
- The contractor should ensure that the project workers are sensitized on the local culture.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium	Likely (Medium)	Moderate	Low	Likely (Medium)	Minor

9.3 Positive Social Impacts during Operation

9.3.1 Creation of Employment Opportunities

The project will create direct and indirect employment opportunities. Direct employment opportunities will include workers employed in the geothermal plant whereas indirect opportunities include labour force employed in supporting business such as transportation. These opportunities will enhance trade which will consequently lead to the development of new businesses, thus improving the local economy and reducing unemployment.

9.3.2 Potential for Carbon Market

Geothermal power stations are eligible for the Clean Development Mechanism (CDM) as outlined in the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), because they release lower greenhouse gases than thermal power plants. When the Olkaria II Extension Power Station will be included as a CDM project, community projects around the Greater Olkaria Geothermal Area (GOGA) will benefit from the revenue generated from CDM through financing of community projects.

For the case of Olkaria II 3rd unit power plant, the Community Development Carbon Fund (CDCF) was used to construct a 10km domestic water supply line in Maiella ward, class rooms at Oloiriwua and Nkaampani primary schools and digging of a community water pan at Olosing'ate. This implies that both the local community and KenGen will benefit as a result of CDM.

9.3.3 Increased power supply to the national grid

The key positive operation impact will be meeting the development objective. The objective of Olkaria II Extension Geothermal Power Plant project is to construct a 140*MWe* net output geothermal power plant with associated infrastructure. This will then be connected to the national grid towards meeting the ever-increasing demand for electric power in the country. The project will partly contribute to the realization of Vision 2030 through enhancing the country's energy security. Further, electricity generation via geothermal energy exploitation is regarded as environmentally-friendly and sustainable.

9.3.4 Corporate Social Responsibility (CSR)

It is worth noting that currently, as part of KenGen's Corporate Social Responsibility program, the company implements community development and socially-uplifting projects such as repair of roads, water supply, school upgrading, education scholarships, developing school infrastructure and social afforestation.

The proponent is anticipated to identify the needful areas in the project area/surrounding and participate in more CSR activities. The consultant recommends that the proponent assists those living in areas experiencing unavailability of water, inadequate/dilapidated infrastructure for both primary & secondary education and health infrastructure, as part of CSRs where possible, subject to availability of funds. These CSR projects may include but not be limited to:

i. Construction of elevated water tanks for the community;
ii. Increasing the amount of water supplied;
iii. Construction of school dining hall(s);
iv. Construction of social hall(s);
v. Provision of community buses;

vi. Improvement/upgrading of more road networks serving the community;
vii. Construction of health facilities;
viii. Construction of trading centres;
ix. Rehabilitation centres for the youth who have reformed from drug abuse;
x. Construction of public sanitary facilities;
xi. Provision of more education scholarships; and
xii. Construction of more classes for the community schools.

The proponent should however align the CSRs with the respective County and Sub-county Governments' initiatives to avert duplication of development efforts.

9.4 Negative Social Impacts during Operation

9.4.1 Exposure to H_2S

Inhalation is the most common route of exogenous Hydrogen Sulphide exposure. It is rapidly absorbed through the lungs in humans and can also be absorbed through the gastrointestinal tract. The distribution of inhaled H_2S is rapid and widespread and its storage in the body is limited by rapid metabolism and excretion. Hydrogen sulphide is metabolized through three path-ways: oxidation, methylation, and reactions with metalloproteins or disulphide-containing proteins. The major metabolic pathway for detoxification of hydrogen sulphide is oxidation in the liver, and the major oxidation product of sulphide is thiosulphate, which is then converted to sulphate and subsequently excreted in urine. It is also excreted unchanged in exhaled air, faeces and flatus.

Studies in humans suggest that the respiratory tract and nervous system are the most sensitive targets of hydrogen sulphide toxicity. Exposure to **low** concentrations of hydrogen sulphide may cause: irritation to the eyes, nose, or throat; headaches; poor memory; tiredness, balance problems; and loss of consciousness. It may also cause difficulty in breathing for some asthmatics. Respiratory distress or arrest has been observed in people exposed to very high concentrations of hydrogen sulphide. Exposure to **medium** concentrations of hydrogen sulphide may cause: more severe eye and respiratory irritation (including coughing, difficulty breathing, accumulation of fluid in the lungs), headache, dizziness, nausea, vomiting, staggering and excitability. Exposure to **high** concentrations may cause: shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma and death. Effects can occur within a few breaths, and possibly a single breath. In most cases, the person appears to regain consciousness without any other effects.

Single, short-term and medium-term inhalation exposures to hydrogen sulphide have also resulted in respiratory, olfactory, cardiovascular, neurological, hepatic, and developmental neurochemical effects and abnormal growth in developing cerebellar Purkinje cells in animals. Sufficient information is available to demonstrate that hydrogen sulphide is not likely to bioaccumulate or biomagnify in the food chain (ATSDR, 2003).

Long-term exposure to H_2S may have human health implications. H_2S exposure can involve, among other symptoms, cardiovascular and gastrointestinal disturbances. Respiratory symptoms may include shortness of breath, bronchitis, and pneumonia. Blood-related symptoms might include easy bruising, abnormal blood counts, anaemia, or clotting disorders. In some individuals, there may be permanent or long-term effects such as: eye irritation, headaches, fatigue, poor attention span, insomnia, poor memory, poor motor function, weight loss, and digestive disturbance. During the testing of wells, the potential occurrence of H_2S emissions would be because of the bursts of heated steam.

Hydrogen sulphide has not been shown to cause cancer in humans, and its possible ability to cause cancer in animals has not been studied thoroughly. The Department of Health and Human Services (DHHS) and the International Agency for Research on Cancer (IARC) have not classified hydrogen sulphide as to its carcinogenicity. The Environmental Protection Agency (EPA) has determined that data for hydrogen sulphide are inadequate for carcinogenic assessments.

There is very little information on possible health problems in children who have been exposed to hydrogen sulphide. Exposed children probably will experience effects similar to those experienced by exposed adults. It is not known whether hydrogen sulphide causes birth defects in people. Additionally, the results of studies in animals suggest that exposure to low concentrations of hydrogen sulphide during pregnancy does not cause birth defects (ASTDR, 2016).

An air dispersion modelling study was conducted using the US EPA AERMOD model. 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) indicated that the operation of the plant will not result in exceedance of the limit values. The maximum predicted impacts are estimated at sensitive receptors located at about 8km 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.

Although the ambient air quality measurement (28.3 μg/m^3) and air dispersion modelling results (105 μg/m^3) showed that the H_2S levels at the KWS staff quarters near Olkaria Gate were below the EMCA ambient air quality limits and also well below the concentration (3,000 μg/m^3) known to cause health effects to human beings, according to the World Health Organization's (WHO) air quality guidelines, this study recommends that the KWS staff quarters at the Olkaria gate be relocated. They are currently located approximately 800 metres from the proposed project site and 400 metres South-West of OW-739 Well Cluster where wells designated for reinjection of brine are located. This implies that exposure to H_2S levels are expected to increase in future around the Olkaria Gate.

Most of the guidelines and regulations on exposure to Hydrogen Sulphide are mainly for acute (short-term duration) with low-level long-term guidelines being very scanty. WHO guidelines for the protection of human health recommend the following tolerable values: 150 μg/m^3 average concentration over a period of 24 h; 100 μg/m^3 over a period of 14 days; and 20 μg/m^3 over a period of 90 days (WHO, 2000; WHO, 2003).

For intermediate exposure duration (15–365 days), the Agency for Toxic Substances and Disease Registry (ATSDR) set a Minimal Risk Level (MRL) of 0.02 ppm, with a 'no-observed-adverse-effect level' (NOAEL) of 30.5 ppm. For long-term, even lifetime, exposure duration, the Environmental Protection Agency (EPA) sets the reference concentration (RfC) of 0.0015ppm with a 'lowest-observed-adverse-effect level' (LOAEL) of 30ppm and a NOAEL of 10 ppm.

Community studies near geothermal and volcanic sources indicate that respiratory impacts of H_2S are not limited to high exposures only; low levels also increase the risks of respiratory symptoms, respiratory disease and mortality as shown by other scientific studies examining communities near geothermal and volcanic H_2S sources including: Reykjavik (Iceland); Rotorua (New Zealand); the Azores (Portugal); and Mt. Amiata

(Italy). Geothermal emissions and hazards have been reviewed by Bustaffa et al. (2020) and Hansell and Oppenheimer (2004). Portions of these communities experienced chronic exposure to H_2S, estimated to be between 0.02 and 1.0 ppm; Nuvolone et al. (2019) found a lower range of 0.0003 to 0.0224 ppm.

The low levels of Hydrogen Sulphide present in the atmosphere may undergo oxidation and lead to the formation of Sulphur Dioxide (SO_2). While Sulphur dioxide may not be of major concern, it can cause respiratory problems such as bronchitis, and can irritate your nose, throat and lungs. It may also cause coughing, wheezing, phlegm and asthma attacks. The effects are worse when one is exercising near the source. Sulphur dioxide has also been linked to cardiovascular diseases.

From a health point of view, conclusion can be made that the area around the KWS staff quarters at the Olkaria Gate is safe for residence of the KWS rangers, based on the results obtained from the predicted cumulative daily H_2S concentration of 105 $\mu g/m^3$. However, this predicted cumulative level of H_2S was exactly equivalent to the concentration levels given by the WHO's air quality guidelines for Particulate Matter, Ozone, Nitrogen dioxide and Sulphur dioxide, which provide the 'Odour Threshold' level at 105 $\mu g/m^3$ (Reference: EPA/600/R-14/039). This therefore implies that with the implementation of the proposed Olkaria II Extension Project, the KWS rangers residing in the six (6) houses near the Olkaria gate, will likely experience more nuisance due to the characteristic rotten egg smell of H_2S. Although there is no documented link of odour and health effects, odourant compounds can affect human health through several mechanisms (e.g. Schiffman et al. 2005; Woodall et al. 2005; Wing et al. 2008). Odour emissions, odour perception, and odour nuisance present quality of life issues that can cause individuals to modify certain physical and social activities (e.g. outdoor physical activity), which can then lead to other health-related issues. Odour perception is often associated with odour nuisance and complaints, and sometimes with psychological responses, e.g. headache, nausea, and loss of sleep.

The consultant undertook consultations with the Hell's Gate National Park Warden and the KWS Rangers residing in the quarters near Olkaria Gate, and what came out clearly was that, even without the proposed project, the rotten egg smell of H_2S was a nuisance to them especially since they worked and resided in the same area, meaning they experienced the odour effect on a 24-hour basis. They therefore preferred that KenGen assist in the relocation of the staff quarters and reconstruct them near the staff quarters located adjacent to KWS Elsa Gate (-0.852469°, 36.369134°), which is approximately 15Km and/or a twenty minutes' drive from the Olkaria Gate. This way, the KWS rangers would be transported from their staff quarters/Elsa Gate to the Olkaria gate during the start of the shift and back to their staff quarters at the end of their shift hours, on a daily basis.

Figure 9-1: Overview of the KWS Gates in Hell's Gate National Park

They preferred this location due to the following reasons: the location is at the KWS Headquarters- residential area for Hell's Gate National Park staff; there is land available for construction which belongs to KWS, therefore there will be no need for acquisition of land; and the area around Elsa Gate is zoned as a Tourism zone (i.e. there are no geothermal power plants in the area), as compared to Olkaria and Narasha Gates, which are at an area zoned for Geothermal Resource/ Industrial Development. Hence there will be no exposure to any effects of H_2S or noise at the Elsa gate.

By relocating the staff quarters to the area near Elsa Gate, H_2S exposure to the KWS rangers will be reduced from a time-weighted average of 24-hours to a maximum of 8-hours during the rangers' shift hours. This therefore reinforces the recommendation to relocate the six (6) KWS staff quarters.

Mitigation:

- Regular monitoring of H_2S along the steam pipeline serving the power plant, cooling towers and nearby villages;
- Conduct routine maintenance and inspections of well equipment to identify and repair potential leaks;
- Establish a H_2S detection system for warnings when levels approach or exceed safe limits;
- Regularly maintain and calibrate monitoring equipment to ensure accuracy and reliability;
- Relocate and reconstruct the 6 KWS rangers' houses located near the Olkaria gate to minimize H_2S exposure;

- Establish a health data collection program in collaboration with County Department of Health Services for monitoring and detection of health effects associated with H_2S exposure to workers and larger community;
- Development and Implementation of a H_2S emergency preparedness, prevention and response plan.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
High	Unlikely	Moderate	Low	Unlikely	Negligible

9.4.2 Impacts on Social Fabric and Community Perception

The implementation of the Project will influence community perceptions both positively and negatively for a variety of reasons which were expressed during stakeholder engagement meetings. Most participants cited job creation as their main reason for supporting the Project. Those who disagreed were mostly concerned that the Project would pose a risk to the community and livestock by emitting H_2S and poor disposal of brine. In general, the locals are a relatively traditional Maasai community who have been exposed to development projects in the Olkaria area.

Despite the predominantly positive attitudes towards the Project and the generally harmonious characteristic of the community, the Project activities may result in adverse impacts on the environment and agricultural activities which may trigger social tension and discord if not managed properly. Further, the PIIM (both from migrant workers and non-locals seeking opportunities from the Project) will introduce different cultural practices, religion/s, pressures and social behaviours to the community. Some concerns were recorded during the baseline consultation associated with the non-local workers recruited by past KenGen Projects which make the community perceive KenGen and its Contractors as being discriminative against the locals. The identified concern from the community must be taken into consideration during Project planning and development of a social management plan.

Mitigation:

- Implementation of the prepared Stakeholder Engagement Plan (SEP) which includes ongoing stakeholder engagement and consultation not only at macro/regional level with the government, but also at local level with the cultural groups and the local community;
- Disclosure of information regarding jobs and business opportunities widely to the local community within the Project AOI, along with information about the Project activities, as part of the SEP;
- Undertake a comprehensive induction/training to all workers concerning local culture and customs, and encourage workers appreciation toward these cultures, as part of the Project Code of Conduct;
- Adopt and disclose a community GRM to provide the community with the opportunity to formally lodge complaints related to the Project workforce behaviour or other social-related issues;

- Build the capacity of the Stakeholder Coordination Committees (SCC) and allow the community to nominate their representatives to the SCC;
- The community Liaison office to ensure there is coordination with village leaders for the local recruitment process;
- Ensure there is transparency in the recruitment process to avoid conflicts between community members;
- Ensuring wages for the local workers are in accordance with applicable regulations;
- Providing opportunities for local business in the procurement of goods and services to support the Project activities, including non-formal or indirect services e.g., transportation services/car rental, food catering and homestays for workers;
- Sensitize the local community on KenGen's CSR program and clearly communicate the role of the Government in infrastructure development;
- Set up a mobile H_2S monitoring station and a program for monitoring H_2S levels in the villages and involve the community in the monitoring program to build trust.
- Minimize risk of brine / condensate discharges through implementation of reinjection system and provision of adequately sized concrete lined storage ponds / system shut down in case of reinjection failure or well blow-out;
- Develop brine management plan to minimize risk of brine discharges.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Low	Negligible

9.4.3 Fire Outbreak

With the installation of the Geothermal Power Plant, related substations, transmission lines and associated control infrastructure, there is likely of a fire outbreak during operation due to human error, faulty equipment/equipment sparks, or welding. The risk of fire increases where methane or pentane gas is potentially present. Fire may not only be detrimental to the development and energy supply to the national grid, but also to the safety of operation staff and local community.

Mitigation:

- Develop an implementable fire policy and ensure compliance with fire safety rules under OSHA 2007.
- Employees to be taken through regular trainings and fire drills for the operation and maintenance of the power plant and its associated infrastructure.
- Periodic maintenance to ensure that, there are; - no overloaded electrical systems; no incorrectly installed wiring; no live naked wires; and fuel store areas are continuously monitored.
- Install high-performance combustible fixed gas detectors along with electro optical flame detection.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Medium	Minor

9.4.4 Occupational Health and Safety Impacts

The occupational safety and health hazards specific to the operation phase of the proposed Olkaria II Extension Geothermal Power Plant project primarily include: presence of geothermal gases, working in confined spaces, exposure to; heat noise and chemicals, live power lines; working at heights; electric and magnetic fields (EMF). Maintenance workers may be exposed to occupational hazards from contact with live power lines during operation and maintenance schedules and when working at elevation during repairs and maintenance of the towers. Occupational Health and Safety measures will be paramount for personnel operating near the vent station, due to the unpredictable nature of venting at the station.

These Occupational Safety and Health issues are discussed in detail below;

a) Geothermal gases

Occupational exposure to geothermal gases, mainly hydrogen sulphide gas and methane may occur during non-routine release of geothermal fluids (for example, pipeline failures) and maintenance work in confined spaces such as pipelines, turbines, and condensers. The significance of the hydrogen sulphide hazard may vary depending on the location and geological formation particular to the facility.

b) Confined spaces

Entry of workers into confined spaces has the potential for accidents, and may vary among geothermal facilities depending on design, on-site equipment, and presence of groundwater or geothermal fluids. Specific and unique areas for confined space entry may include the turbine, condenser, cooling water tower (during maintenance activities), monitoring equipment sheds (during sampling), and the well hole “cellar” (a subsurface depression created for drilling purposes).

c) Heat

Occupational exposure to heat may occur during operation and maintenance of pipes, wells, and related hot equipment. Non-routine exposures include potential blowout accidents during drilling (if required) as well as malfunctions of the steam containments and transport installations.

d) Noise

Noise sources in geothermal facilities are mainly related to well drilling (if required), steam flashing and venting. Other sources include equipment related to pumping facilities, turbines, and temporary pipe flushing activities. Temporary noise levels may exceed 100 dB (A) during certain drilling (if required) and steam venting activities.

e) Live power lines

Workers may be exposed to occupational hazards from contact with live power lines during operation and maintenance activities.

f) Working at height on structures and poles

Workers may be exposed to occupational hazards when working at elevation during operation and maintenance activities.

g) Electric and magnetic fields

Electric utility workers typically have a higher exposure to Electric Magnetic Fields (EMF) than the general public due to working in proximity to electric power lines.

h) Ergonomics, Repetitive Motion and Manual Handling

Injuries due to ergonomic factors, such as repetitive motion, overexertion, and manual handling or lifting, take prolonged and repeated exposures to develop, and typically require periods of weeks to months for recovery.

i) Exposure to chemicals

Occupational exposure to chemicals includes exposure to Polychlorinated Biphenyls (PCBs) in transformers and other electrical components.

Table 9-1: OSH risk categories and mitigation measures during the operation phase

OSH Risk Category	Mitigation Measure
Geothermal gases	▪ Installation of gas monitoring and detection systems. ▪ Development of a contingency plan for gas releases including all necessary aspects from evacuation to resumption of normal operations. ▪ Provision of adequate ventilation of occupied buildings to avoid accumulation of gases.
Confined spaces	▪ Ensure Permit-required confined spaces are provided with permanent safety measures for venting, monitoring, and rescue operations, to the extent possible. The area adjoining an access to a confined space should provide ample room for emergency and rescue operations. ▪ Before workers are required to enter a permit-required confined space, adequate and appropriate training in confined space hazard control, atmospheric testing, use of the necessary PPE, as well as the serviceability and integrity of the PPE should be verified. Further, adequate and appropriate rescue and / or recovery plans and equipment should be in place before the worker enters the confined space. ▪ Mechanical equipment in the space should be disconnected, de-energized, locked-out, and braced, as appropriate.

OSH Risk Category	Mitigation Measure
	▪ The atmosphere within the confined space should be tested to assure the oxygen content is adequate, and that the presence of any flammable gas or vapor does not exceed permissible levels of its respective Lower Explosive Limit (LEL).
Heat	▪ Reducing the time required for work in elevated temperature environments and ensuring access to drinking water for rehydration. ▪ Shielding surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc. ▪ Use of personal protective equipment (PPE) as appropriate, including insulated gloves and shoes.
Noise	▪ Use of rock mufflers, sound insulation, and barriers. ▪ Installation of silencers on equipment in the steam processing facility. ▪ Use of appropriate noise protection PPEs.
Live Power Lines	▪ Ensure only trained and certified workers are allowed to install, maintain, or repair or maintain power lines ▪ Workers should not approach an exposed energized or conductive part even if properly trained unless power is cut off. ▪ Specific training, safety measures, personal safety devices, and other precautions should be defined in a health and safety plan.
Working at height on structures and poles	▪ Implementation of a fall protection program that includes training in climbing techniques and use of fall protection measures; inspection, maintenance, and replacement of fall protection equipment; and rescue of fall-arrested workers, among others. ▪ Hoisting equipment should be properly rated and maintained and hoist operators properly trained. ▪ When operating power tools at height, workers should use a second (backup) safety strap.
Electric and Magnetic Fields	▪ Training of workers in the identification of occupational EMF levels and hazards. ▪ Establishment and identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, limiting access to properly trained workers.
Ergonomics, Repetitive Motion and Manual Handling	▪ Use of mechanical assists to eliminate or reduce exertions required to lift materials, hold tools and work objects, and requiring multi person lifts if weights exceed thresholds.

OSH Risk Category	Mitigation Measure
	▪ Implementing quality control and maintenance programs that reduce unnecessary forces and exertions. ▪ Selecting and designing tools that reduce force requirements and holding times, and improve postures. ▪ Incorporating rest and stretch breaks into work processes, and conducting job rotation.
Exposure to chemicals	▪ Training workers in the use of the available information (such as International Chemical Safety Cards – ICSC, Materials Safety Data Sheets – MSDS, or equivalent), safe work practices, and appropriate use of PPE. ▪ Implementation of engineering and administrative control measures to avoid or minimize the release of hazardous substances into the work environment, to keep the level of exposure below internationally established or recognized limits. ▪ Providing workers with a fact sheet or other readily available information about the chemical composition of liquid and gaseous phases with an explanation of potential implications for human health and safety.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Medium	Minor

9.4.5 Community Health and Safety Impacts

The community safety and health hazards specific to the operation phase of the proposed Olkaria II Extension geothermal power plant primarily include: exposure to Hydrogen Sulphide gas, infrastructure safety and impacts on water resources.

a) Hydrogen Sulphide (H_2S) gas and Steam Visual Hazard

In addition to the prevention and control of emissions and exposure to hydrogen sulphide gas described in the occupational health and safety sections above, the potential for exposures to members of the community should be carefully considered during the planning process and the necessary precautions implemented.

Additionally, some geothermal wells produce what is known as wet steam, which is a mixture of steam and water. Since dry steam is preferred for use in the power station because of its higher energy content and its greater chemical purity, in a wet steam system, the water is removed at the wellhead and discharged to the environment as separated geothermal water. Depending on the volume produced and its temperature, it may flash to steam, or be discharged to a holding pond or channel for use elsewhere or for later reinjection. In any case, there will be steam produced and if it is near a road, in cold misty atmospheric conditions, it may be sufficiently thick to momentarily block the vision on drivers travelling along the main road that is adjacent to the proposed site.

b) Infrastructure Safety

Communities may be exposed to physical hazards associated with the wells and related pipeline networks. Hazards may result from contact with hot components, equipment failure, or the presence of active and abandoned well infrastructure which may generate confined space or falling hazards.

c) Impacts on Water Resources

The extraction, reinjection, and discharge of geothermal fluids may affect the quality and quantity of surface and groundwater resources. Examples of specific impacts include the inadvertent introduction of geothermal fluids into shallower productive aquifers during extraction and reinjection activities or a reduction in the flow of hot thermal springs due to withdrawal activities.

Mitigation:

Table 9-2: Community Safety and Health risk and mitigation measures during operation phase

Community Safety and Health Risk	Mitigation Measure
Hydrogen Sulphide (H_2S) gas and Steam Visual Hazard	▪ Siting of potential significant emissions sources with consideration of hydrogen sulphide gas exposure to nearby communities (considering key environmental factors such as proximity, morphology and prevailing wind directions). ▪ Installation of hydrogen sulphide gas monitoring network. The number and location of monitoring stations should be determined through air dispersion modelling, taking into account the location of emissions sources and areas of community use and habitation. ▪ Continuous operation of the hydrogen sulphide gas monitoring systems to facilitate early detection and warning. ▪ Emergency planning involving community input to allow for effective response to monitoring system warnings. ▪ Ensure that there are no major fluid discharge points near the road.
Infrastructure Safety	▪ Placement of access deterrents, such as fences and warning signs, to prevent access and warn of existing hazards. ▪ Consideration of the feasibility of subsurface pipelines or heat shields to prevent public contact with hot geothermal pipelines.

	▪ Managing closure of infrastructure such as pipelines and access roads, including: cleaning, disassembly, and removal of equipment; analysis of soil quality with clean-up where warranted; re-vegetation of site and blockade; and reclamation of access roads where necessary. ▪ Managing closure of well heads including sealing the well with cement, removing the well head, and backfilling depression around the well head,
Impacts on Water Resources	▪ Completion of a hydrogeology and water balance assessment during the project planning stage to identify hydraulic interconnections between the geothermal extraction and reinjection points and any sources of potable water or surface water features. ▪ Avoiding negative impacts on surface water by introducing strict discharge criteria and appropriate means to bring water quality and temperature to acceptable standards. ▪ Isolation of steam producing sources from shallower hydrologic formations which may be used as sources of potable water through careful site selection and properly designed and installed well casing systems ▪ Elaboration of a comprehensive geological and hydrogeological model including overall geological, structural and tectonic architecture, reservoir size, boundaries, geotechnical and hydraulic host rock properties.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium	Medium	Moderate	Low	Medium	Minor

9.5 Positive Social Impacts during Decommissioning.

9.5.1 Creation of temporary Jobs

For demolition to take place properly and in good time, a source of labour will be required hence creation of employment opportunities.

9.5.2 Income from the sale of scrap metals

The steel that will be recovered after decommissioning can be sold as scrap to scrap metal handlers who may be from the local community.

9.6 Negative Social Impacts during Decommissioning.

9.6.1 Losing Work and Business Opportunities

Workforce termination in the decommission stage will reduce job opportunities at the study area and beyond.

Mitigation:

Before closing the power plant, KenGen should provide specialized skills to the workforce so that they can still work in the community even after retirement. With such an arrangement, workers will be able to sustain their lifestyle, as layoffs associated with the decommissioning of the power plant will not negatively impact the workforce.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium	Likely (Medium)	Moderate	Low	Likely (Medium)	Minor

9.6.2 Occupational Safety and Health Concerns

There will be OSH concerns for the workforce through the Project decommissioning activities that could potentially lead to accidents causing injuries and fatalities. OSH issues may also arise from use of heavy equipment and hazardous materials. In addition, consideration should be given to potential fires caused by equipment sparks, welding, or cigarettes. Further health and safety issues may arise from temporary noise disturbances during the decommission phase.

Mitigation:

- Prepare an Occupational Safety and Health Plan (OSH) for decommissioning purposes.
- Take steps to prevent accidents, injuries, and disease in the course of work;
- Ensure all contractors and sub-contractors working on the site or in the immediate vicinity of the Project activities comply with the Project's OSH policies;
- Provide OHS orientation training/induction to all employees for awareness of basic hazards, site-specific hazards, safe working practices, emergency procedures.
- Provide workers with readily available information about the chemical composition of fluids or chemicals they may come in contact with and an explanation of potential implications for human health and safety.

10 CUMULATIVE IMPACTS

The area of influence may encompass cumulative impacts resulting from the incremental impact on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.

For this assessment, cumulative impacts are defined as the incremental impact of the project after mitigation, considered in the context of other projects and activities in the area, from the perspective of the sensitive receptors identified during this impact assessment.

The proposed project represents a common activity near the site. Future major energy infrastructure projects are planned for this area. As such, there are many operational aspects which will interact cumulatively with other anthropogenic activities.

Current and future activities which have been considered in assessing cumulative impacts are:

i. Geothermal exploration in the Olkaria area;
ii. Farming activity in the area; and
iii. Tourism activity.

Table 10-1: Cumulative Impact Assessment

Environmental Element	Other Contributing Anthropogenic Activities	Nature of the Cumulative Impact	Potential Cumulative Significance
Land Cover and Spatial Planning	Geothermal exploration, Agricultural and tourism activities are expected to grow. The Olkaria area still has unexplored geothermal potential. With future projects, the area will see an increase in population.	These activities have the potential to increase land demands that may result in land uptake for geothermal and tourism purposes; however, land for geothermal exploration and development in this area has already been demarcated by the KWS and County government Therefore, geothermal expansion may not require additional land hence no major changes in land use are anticipated. However, increase in geothermal activities will lead to reduction in land available for grazing of livestock and wild animals.	Minor

Environmental Element	Other Contributing Anthropogenic Activities	Nature of the Cumulative Impact	Potential Cumulative Significance
Geology, Geomorphology and Soils	No known cumulative impacts	No known cumulative impacts	Nil
Surface Hydrology and Water Resources	Agricultural, commercial and domestic activities	Construction water use may be competing with other water demands during the dry season; this can be mitigated by the import of water from further afield. However, the Project will primarily use water from lake Naivasha Since the project won't involve well drilling, the project will consume insignificant amount of water compared to the current uses within the surrounding power plants and population. Further, the water levels in Lake Naivasha have been in an upward trend. Therefore, the cumulative significance is assessed as Negligible.	Minor
Waste Management	All other anthropogenic activities in the area	Waste management issues are associated with many aspects of domestic life. It is expected that the proposed project may put a strain on the existing waste disposal facility in Naivasha.	Minor
Ecosystem Services	No known cumulative contributor	No known cumulative contributors	Nil
Air Quality and Community Health	Past and future Geothermal development projects	The current and upcoming Geothermal development projects in Olkaria area have the potential to lead to a cumulatively high emission of	Moderate

Environmental Element	Other Contributing Anthropogenic Activities	Nature of the Cumulative Impact	Potential Cumulative Significance
		H_2S in the area. Though the current and upcoming projects have a significant improvement in technology, H_2S emissions should be a consideration in all future project studies. The requirement for a full ESIA and emission modelling for geothermal projects will ensure that emissions are well mitigated. An air dispersion modelling study for the proposed project was carried out. 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. The maximum predicted impacts are estimated at sensitive receptors located at about 8km 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.	
Flora and Fauna	Geothermal exploration and development	The environmental effects of geothermal development and power generation include the changes in land use associated	Moderate

Environmental Element	Other Contributing Anthropogenic Activities	Nature of the Cumulative Impact	Potential Cumulative Significance
		with exploration and plant construction, noise and visual intrusion, the discharge of water and emission gases, the release of foul odours, and soil subsidence, including obstruction of wildlife migratory corridors and dispersal routes.	
Noise Pollution	Operation of Geothermal power plants	With continued existence of old geothermal power plants and development of new plants, noise pollution from these plants will keep increasing unless there will be introduction of technology to address noise emission.	Major

Mitigation:

Based on project activities, as defined in sections 8 and 9, it is recommended that the proponent to undertake several additional measures to manage cumulative impacts, as follows:

- Apply engineering measures to minimize land requirements for geothermal activities;
- Formulate and implement a Waste Management Plan (WMP);
- Undertake annual/ regular Environmental audits and safety and health compliance audits;
- Monitoring of health implications and incidents among workers and local community exposed to H_2S;
- Implement biodiversity offset programs.

11 CLIMATE CHANGE RISK ASSESSMENT

11.1 Introduction

KenGen's climate change policy acknowledges the global challenge posed by climate change, which threatens the sustainability of business operations. The Policy aims to address these challenges through the implementation of effective mitigation and adaptation measures (KenGen, 2019). Key objectives of the KenGen Climate Change policy can be summarized as follows:

- Mainstreaming climate change initiatives in company policies, programs, and plans.
- Promoting Carbon Asset Development in the organization's projects.
- Instituting measures for climate change measurement and reporting.
- Establishing partnerships and stakeholder engagements regarding climate change initiatives.
- Enhancing climate change education and awareness among employees and stakeholders, highlighting Kenya's climate response efforts.
- Building resilience against climate change impacts by strengthening adaptive capacity and disaster risk reduction.

Although KenGen's mitigation strategies focus on reducing climate change impacts by promoting 'greenhouse gas' emissions reduction through green energy projects, which is the main purpose of the current Olkaria II Extension Geothermal Power Plant project. The policy emphasizes adaptation strategies, recognizing the need to manage the inevitable effects of climate change, irrespective of the success of mitigation efforts.

11.2 Rationale and Objectives of the Assignment

KenGen recognizes that some of its activities might contribute to climate change and is thus dedicated to pursuing low-carbon and climate-resilient development. Presently, KenGen's mitigation efforts have reduced the national carbon footprint by over 1 million tons of carbon dioxide equivalent. The proposed Olkaria II Extension Power Plant project should be viewed in this light.

The objective of the proposed project is one of KenGen's strategies to meet the increasing demand for green electricity, which is also in line with the national electricity master plans. The estimated equivalent gross output for Olkaria II Extension is 146 *MWe*.

This report responds to the consultant's TORs represented below:

1. Carry out preliminary analysis of contribution of the Olkaria II Extension project to Green-House Gas (GHG) emissions reduction.
2. Integration of climate change vulnerability assessment, relevant adaptation, and mitigation actions into the ESIA studies.
3. Climate risk assessment for the project site.

11.3 Analysis of Contribution of the Project to Green-House Gas (GHG) Emissions Reduction

Geothermal power plants are known to emit about up to 99% less carbon dioxide (a green-house gas) than fossil fuel power plants of similar size, according to many research studies (Zarrouk & Moon, 2014). As a result, initiatives to mitigate climate change have direct influence on the economic viability of geothermal projects, potentially making them more attractive compared to fossil fuel-based alternatives.

To determine how much GHG in carbon dioxide (CO_2) equivalent would be displaced by a net 140 *MWe* of geothermal power replacing fossil fuel, in this case diesel oil, the first step is to determine how much diesel is used in our power generational energy mix.

According to EPRA (2024), Kenya's energy generational mix (GWh) predominantly consists of 44% of geothermal, 23% of hydro, 14% of wind, and 4% of solar accounting for roughly 85% of green energy the remaining 15% being thermal, that is imported diesel and biomass. This means that the amount of diesel used is minimal, therefore the Grid Emission Factor (GEF) that corresponds to this amount of diesel needs to be used. The GEF measures the amount of carbon emissions per unit of electricity generated.

To calculate the annual CO_2 emissions from the net 140*MWe* geothermal electricity, we use Kenya's GEF that has been accepted by United Nations Framework Convention on Climate Change (UNFCCC). In this case the available GEF for Kenya was given as 0.2262 tCO2e/MWh (UNFCCC, 2020).

1. First, determine the total energy produced in a year:
   - Energy in a year= Capacity X Hours in a year
   - Energy in a year=140MW X 24hours/day X365days/year
   - Energy in a year=1,226,400MWh

2. Now, calculate the annual emissions:
   - Annual Emissions = Energy in a year X Grid Emission Factor
   - Annual Emissions = 1,226,400MWh X 0.2262 tCO2e/MWh
   - Annual Emissions = 277,411.68 tCO2e

Therefore, if the proposed GPP operates at full capacity, 24/7, for an entire year, it would produce approximately **277,411.68 metric tons of CO_2 equivalent annually** based on the given grid emission factor. The calculation assumes the plant runs at full capacity non-stop, which might not be the case in real-world scenarios due to maintenance, fluctuations in demand, and other factors.

However, during a discussion with the KenGen officer in charge of climate change and carbon markets, the estimation of GHG emissions reduction from the development of Olkaria II Extension will be approximately 150,000 tCO2e annually, for the 140*MWe* net output Geothermal Power Plant, based on a 92% availability (Joshua Were & James Metto, Pers-comm). The low figures could be explained by several factors including the discussion below.

According to (Zarrouk & Moon, 2014), geothermal power plants have lower conversion efficiency compared to conventional thermal power plants. However, there's inconsistency in literature regarding the calculation of this efficiency as several factors affect the conversion efficiency, hence also affecting the GHG emission reduction. These factors include:

- Power plant design (e.g., single or double flash, triple flash, dry steam, binary, hybrid).
- Size of the plant.
- Gas content.
- Dissolved minerals content.

- Parasitic load.
- Ambient conditions (temperature and pressure).

The final carbon dioxide emissions represented as certified emissions reduction (CERs) are normally adjusted for the above factors. Typically, the steps below are followed:

Baseline Emission Calculation: The GHG emissions that would occur in the absence of the geothermal project are normally calculated. This typically involves assessing the energy mix in the grid and determining how much CO_2 is emitted per unit of electricity generated (e.g., kg CO2/MWh). In Kenya case diesel oil is taken as the base fuel that geothermal energy would displace as shown above, hence the baseline emission factor of 0.865 metric tons of CO2 per MWh.

Geothermal Plant's Electricity Generation: This involves determining how much electricity the geothermal plant produces over a specific period. This is influenced by the plant's efficiency. An efficient geothermal plant will generate more electricity from the same heat source than a less efficient one.

Factor in Plant's Own Emissions: Geothermal plants have been known to have their own emissions, mainly in the form of trace gases like CO_2, hydrogen sulphide, and methane (Zarrouk & Moon, 2014) These GHG emissions of the geothermal plant are subtracted from the calculated displaced emissions to get the net emission reduction.

Resulting Emission Reductions: The difference between the displaced emissions and the plant's own emissions gives the total GHG emission reductions attributed to the geothermal project.

The crux of the matter is that the more efficient a geothermal plant is, the more electricity it produces from a given heat source, leading to greater displacement of fossil fuel-based energy and thus more significant emission reductions. The actual methodology for these calculations can vary based on several factors but mostly guidelines set by the certifying body for instance most of the CERs issued to KenGen from already operating geothermal plants is from the Clean Development Mechanism (CDM) under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC).

11.4 Integration of Climate Change Vulnerability, Adaptation and Mitigation Assessment into the ESIA Studies

Climate change can impact the construction of a geothermal plant in a number of ways, potentially influencing the viability, efficiency, and safety of such projects (Ciapala, Jurasz, & Janowski, 2021). The direct impacts of climate change include water availability, which is manifested through drought, floods and water temperature. Climate change can increase the frequency and severity of droughts, which can affect the availability of water resources necessary for geothermal plants. Changes in water temperatures can affect the efficiency of geothermal plants, which often use water for cooling purposes. Increased frequency of extreme precipitation events can lead to flooding, which might affect the construction timeline and the safety of the infrastructure. More frequent and severe storms can affect the infrastructure and safety protocols, necessitating robust and resilient construction strategies. Temperature changes have also an effect on ground temperatures can therefore affect the efficiency of geothermal energy extraction. For instance, increasing ambient temperatures can decrease the efficiency of cooling systems used in geothermal plants.

According to KenGen Sustainability department, Olkaria area has experienced intervals of depressed rains and heavy torrents. The depressed rains have not had any significant impact on the Geothermal project infrastructure. On the other hand, heavy torrents and deep percolation have the potential to affect the structural integrity of the power plants. For the community, this has led to cutting off of access roads and water lines. KenGen further avers that extended drought has been experienced in the recent past, this phenomenon has led to the death of livestock due to lack of pasture. Occurrence of heavy rains and deep percolation due to the nature of the soil have the potential to lead to structural defects that affected power plants, roads and water utilities (Joshua Were & James Metto, Pers-comm).

The indirect impacts of climate change include supply chain disruptions by disrupting transportation networks, affecting the supply chains and potentially increasing the cost and time required for construction. With regards to community and social considerations, climate change might necessitate the relocation of communities, potentially affecting the availability of sites for geothermal plants. According to KenGen, resources and facilities that need to be enhanced against climate change impact include roads, water lines and schools in order to enhance community resilience against climate change. KenGen states that the proposed project will have a positive impact on the health of the community through development of robust health awareness programs and support of the local facilities with medical supplies and infrastructure. The project will lead to increased disposable income for the community through employment hence can access better healthcare.

Mitigation Assessment

To effectively assess these potential climate change impacts, stakeholder engagement and consultation with local communities, NGOs, and other stakeholders including pastoralists and farmers, were carried out. There was consensus that KenGen tries to provide up-to-date prior information on weather situation (proper forecasting), livestock offtake programs before the onset of droughts and livestock insurance schemes. With regards to land use and planning, KenGen has stated that the land use has changed from being nomadic pastoralism to permanent residency with fewer livestock numbers. They further stated that there is no significant impact on land use as a result of implementation of geothermal project in reference to climate risk. The community can be involved during identification of potential sites of the projects to mitigate the negative impacts related to climate change e.g., increase water flow through drainage channels created during project implementation.

11.5 Climate Risk Assessment of the Proposed Site and Geothermal Plant

Determining the climate risk assessment for a Geothermal Power Plant involves understanding a variety of the short-term, medium and long-term potential impacts of climate change on the plant's operations. Initially, it is essential to gather comprehensive data on the plant's functions, from its location and well depth to its cooling systems. Key climate variables, such as precipitation changes or temperature fluctuations, which could affect the plant are then identified. The plant's vulnerability to these changes is analysed, considering factors like its reliance on freshwater cooling in areas prone to droughts. Once potential vulnerabilities are understood, the impacts on the plant, such as reduced efficiency or operational disruptions, are evaluated.

To address these risks, adaptation strategies, like diversifying water sources or modifying plant designs, are developed. It is crucial to incorporate these findings into the plant's management strategies, continuously monitor the evolving climate risks, and periodically revisit the assessment. Engaging with stakeholders, including local communities and governments, enriches the understanding and collaborative mitigation of risks. Proper documentation of the entire process aids in decision-making and ensures regulatory compliance.

According to KenGen, climate risks my lead to inability of the project to achieve contracted capacity and energy availability which may impact the organization reputation. The opportunities to enhance the project's reputation is by proactively addressing identified climate risks including provision for drainage, surface runoff, subsurface percolation (from rains and auxiliary water systems) due to excessive rainfall as well as mitigation of impacts of droughts through proactive reservoir management. KenGen has also stated that the occurrence of heavy rains and deep percolation due to the nature of the soil have the potential to lead to structural defects that affected power plants, roads and water utilities. Application of traditional geological technics to determine the best location for structures to avoid under-surface instability. Extended drought has been experienced in the recent past and this phenomenon has led to death of livestock due to lack of pasture.

12 ENVIRONMENTAL AND SOCIAL RISKS TO THE PROPOSED PROJECT

12.1 Climate Change Risks

As extensively described in Chapter 11 of this ESIA report, climate change can affect geothermal plant construction in various ways, impacting its viability, efficiency, and safety. Direct impacts include changes in water availability due to droughts, floods, and water temperature variations. These changes can affect the availability of water resources for geothermal plants and the efficiency of cooling systems. Extreme weather events like floods and storms can disrupt construction timelines and affect infrastructure safety. Temperature changes also influence ground temperatures, which can impact geothermal energy extraction efficiency. The Olkaria area has experienced depressed rains, heavy torrents, and droughts, which could potentially affect the structural integrity of the proposed Olkaria II Extension Power Plant.

Climate risks could affect the project's reputation and capacity, but proactive measures like drainage and reservoir management can mitigate these risks. Additionally, soil-erosion due to flooding may lead to structural defects, requiring geological techniques for optimal location planning. Droughts have previously impacted the area, affecting livestock due to pasture scarcity. KenGen, being the proponent of the proposed project, aims to enhance community resilience by improving infrastructure like roads, water lines, and schools. They also plan to implement health awareness programs and provide medical supplies, thereby improving the community's health and income through employment opportunities.

12.2 Land Subsidence

Microgravity monitoring measurement is one of the comprehensive geophysical surveys utilized in the Olkaria geothermal field as a component of the reservoir monitoring tool. The method is essential for mapping the redistribution and changes in subsurface fluid mass distribution associated with geothermal reservoir systems (Omollo & Nishijima, 2024). The change in the mass of geothermal fluid is determined by repeat measurement; hence, it is an effective method for monitoring the mass balance due to production and reinjection into a geothermal reservoir. The field activities involving production, reinjection, and shutting in of wells cause measurable gravity changes on the surface associated with monitoring results from mass changes and redistribution of geothermal fluid (Nishijima, et al., 2016).

Land subsidence has been reported in other parts of the World to be a problem in geothermal fields as a result of large mass production and a lack of good reservoir management, causing a decrease in pore pressure within the reservoir, which may result in the settlement of key infrastructure within the field. Subsidence can be notated over a long period of monitoring with an abnormally drastic increase in gravity change; hence, in cases where a notable subsidence takes place, a high change in gravity is observed. For ease of conformity, a decrease in gravity is considered a negative change or a net mass loss due to production and natural discharge, and an increase is considered a positive change or a net mass gain due to mass reinjection and natural recharge (Hunt, 2000).

In the study undertaken by Omollo and Nishijima (2024), on average, it was noted that from the year 2018 to 2021, there was continuous negative gravity change/decrease in microgravity at the North East side of the field where the proposed power plant will be located, whereas from 2021 to 2022, some sections of the North East Field stabilized and other sections experienced a further decrease in microgravity.

Most of the areas of low gravity change are associated with a high production rate and a possible inadequate replenishment of the system at the tapping depths of the reservoir. In a geothermal reservoir, variation in steam pressure may be consistent with variation in liquid pressure; the steam pressure may change as well as the liquid pressure. Thus, the mass depletion in the reservoir with minimal recharge results in a high steam fraction in the affected areas, reflected in the gravity change. In the Northeast and East fields, the trend seemed to form a continuous system that is observed as controlled by a nearly linear structure in the NE-SW direction.

The Omollo and Nishijima (2024) study was also consistent with Albino and Biggs (2021) study. From their research using the InSAR survey, for the period between 2015 to 2020 in the East Africa Rift System (EARS), it was observed that during this period, for the first time, Olkaria had undergone subsidence within an area of 114 km^2 at a rate of -2.5 ± 0.2 cm year, and within this period of microgravity monitoring, a noticeable negative gravity change was recorded in some sections of the field, especially in the sections of the Northeast and East fields. Therefore, it is important to note that sometimes the negative gravity values change in some areas within the field over the monitoring period and can also be attributed to loss of mass from the reservoir due to exploitation or subsidence.

The re-injection areas had shown a positive gravity change over the 2018-2022 monitoring period due to the effect of the increase in mass; hence, it is necessary to increase the number of the re-injection wells within to increase the stability and distribution of the mass within the reservoir. It is recommended that a biannual monitoring program be implemented to check on changes that may occur due to the high mass extraction from the reservoir for close observation and characterization of the reservoir (Omollo & Nishijima, 2024).

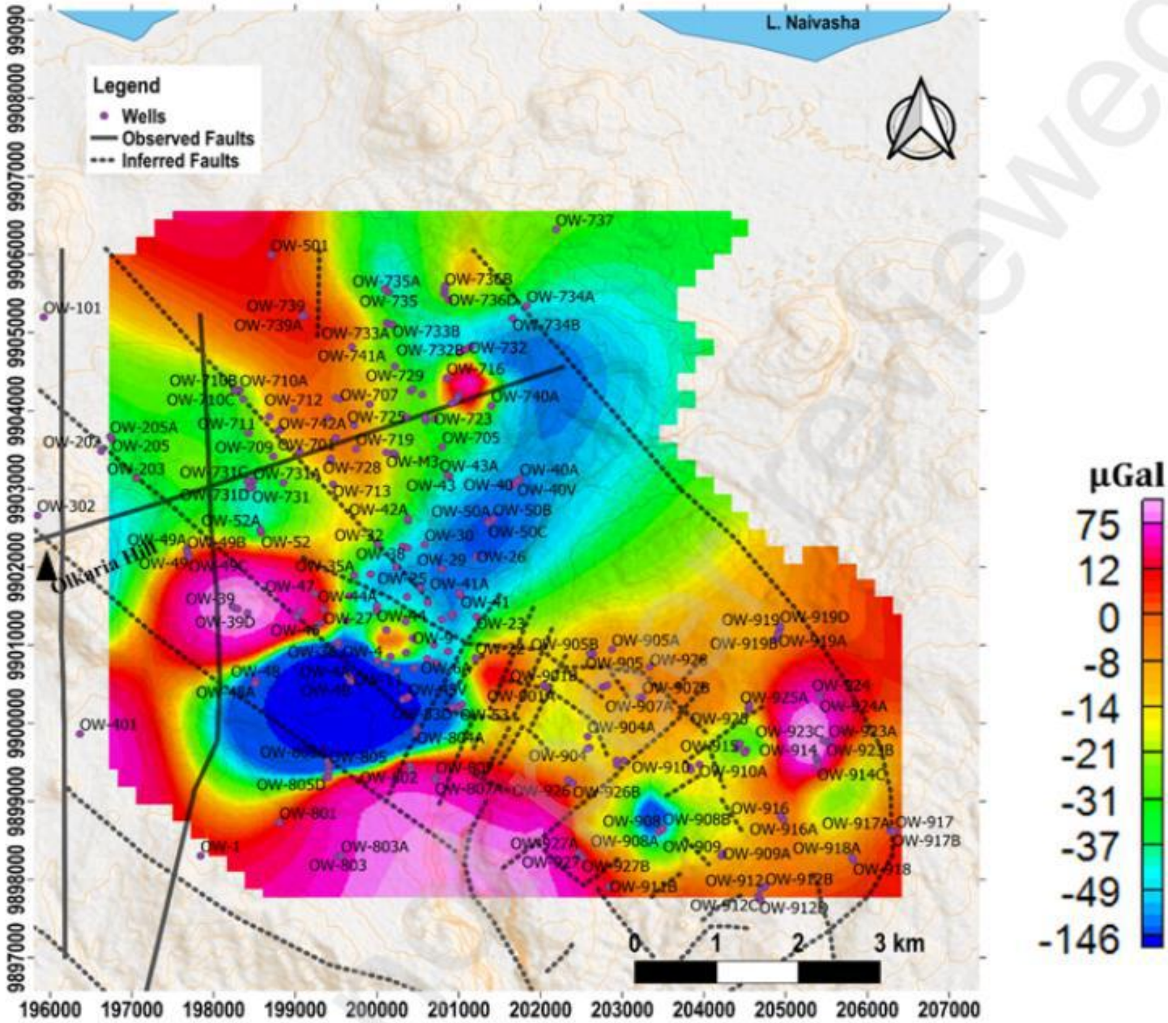


Figure 12-1: Micrograpity Time-Lapse Change within the Olkaria Geothermal field from 2018-2022

(Source: Omollo & Nishijima, 2024)

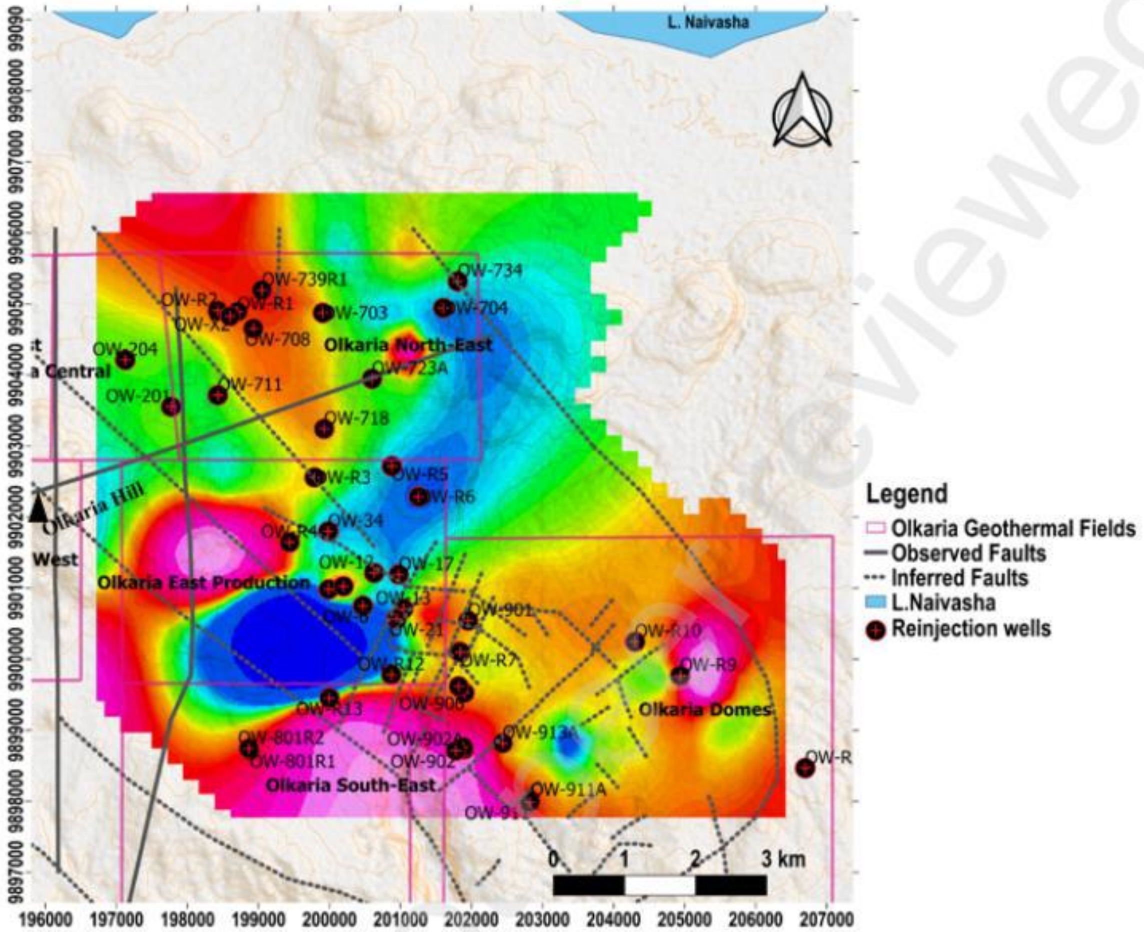


Figure 12-2: Microgravity Time-Lapse change within the Olkaria geothermal field shown together with the Reinjection Wells Distribution
(Source: Omollo & Nishijima, 2024)

12.3 Tremors and Micro-Seismicity

The rift is a seismically active zone and may experience tremors and earthquake hazards. For example, Ofwona (2000) cited study by Simiyu (1999), showed 2,515 events that were detected out of which about 2203 were located. The figure below shows the seismic cloud spread with time, which seemed to expand in the NE direction implying a major fluid flow in the SW direction. Abstraction of steam for geothermal development have been reported to lead to induced micro-seismicity in geothermal fields. However, reinjection of the fluids will minimize seismic hazard arising out of the project.

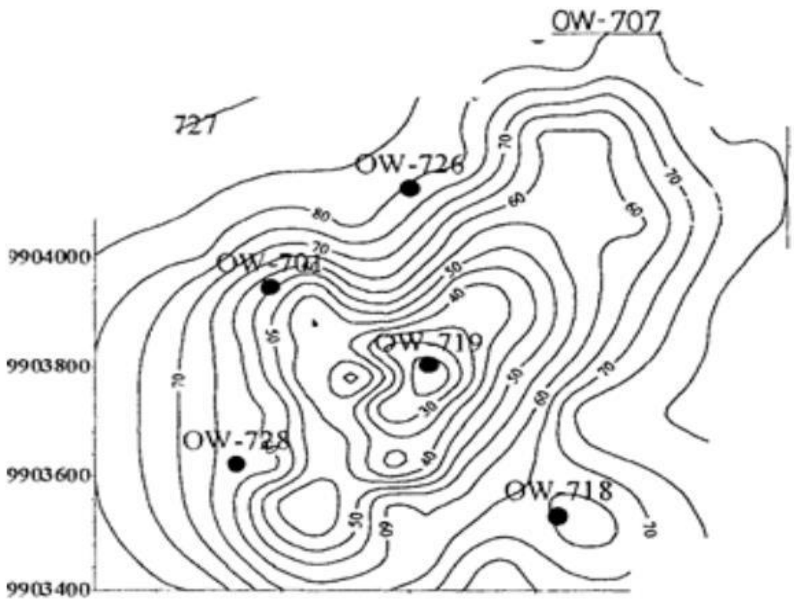


Figure 12-3: Contour Map of Micro-seismic Spread over Time
(Source: Ofwona, 2000)

12.4 Community Perception

During consultations with the local community, it was clear that the community had developed resentment towards KenGen despite the numerous community support and CSR initiatives by KenGen. The resentment centered around the following issues:

1. Perceived discrimination of the local community during recruitment exercises by KenGen and KenGen contractors
2. Expectations of infrastructure development in the community by KenGen including construction of roads, hospitals, electricity, housing, schools, and provision of water
3. Complaints regarding H_2S and brine releases from the powerplants to the community and perceived impacts on human and livestock health.

These negative perceptions may lead to social unacceptability of the Geothermal Power Plants in the Olkaria area hence affecting their sustainability including effects on project financing.

Mitigation:

- Build the capacity of the Stakeholder Coordination Committees (SCCs) and allow the community to nominate their representatives to the SCC.
- The contractor should ensure that at minimum, at least 30% of all skilled and unskilled manpower engaged are from the local community.
- The contractor should ensure that all employment requirements from the local community, are channelled through KenGen's Community Liaison Office.
- The community Liaison office to ensure there is coordination with village leaders for the local recruitment process.
- Ensure there is transparency in the recruitment process to avoid conflicts between community members.
- Ensuring wages for the local workers are within applicable regulations.
- Contractor to organize and ensure that there is provision of meals and drinking water to casual workers in a timely and clean manner.

- Providing opportunities for local businesses in the procurement of goods and services to support the project activities, including non-formal or indirect services e.g., transportation services/car rental, food catering and homestays for workers.
- Sensitize the local community on KenGen's CSR program and clearly communicate the role of the Government in infrastructure development.
- Set up a mobile H_2S monitoring station and a program for monitoring H_2S levels in the villages and involve the community in the monitoring program to build trust.
- Minimize risk of brine/condensate discharge through implementation of reinjection system and provision of adequately sized concrete-lined settling ponds / system shut down in case of reinjection failure or well blow-out.
- Develop a brine management plan to minimize the risk of brine discharges.

12.5 General risks associated with the geothermal exploration

The project's Feasibility Study team identified the following risks (situation and events) that are likely to occur during the Construction, Project Start-up and Operation phases of the proposed Olkaria II Extension Geothermal Power Plant project. Detailed descriptions of the risks and their mitigation measures have been comprehensively described and analysed in the ELC & KenGen (2024) report.

1. Vintage production data
2. Cyclic well discharge
3. Excessive boiling in the reservoir
4. Lack of an updated numerical model of NE well field
5. Lack of back-up condensate reinjection
6. Limited recharge from condensate reinjection well
7. Too concentrated reinjection of separated brine
8. Long-term brine reinjection capacity of well pad OW-739
9. Lack of steam rate at plant start-up
10. Lack of make-up wells simulation
11. Lack of monitoring of individual production well behaviour
12. Non representative sampling from two-phase lines
13. Unexpected field behaviour under exploitation
14. Failure of the plant to reach the planned plant output and/or the planned availability factor
15. Project Completion Delays
16. Project cost overruns
17. High cost of service
18. Abandonment of project by Project Company during construction
19. Delay in Drilling Plan (make-up wells)
20. Delay in substation/transmission interconnection
21. Delay in water supply infrastructure
22. Operating cost overruns for events within Project Company's control
23. KPLC fails to pay capacity, energy or any other payments on time
24. Non-availability or non-convertibility of foreign currency
25. Force Majeure (non-political events or "acts of God") such as natural disasters, fire, epidemics, or strikes)
26. Domestic political events such as war, riot, sabotage, radioactive contamination, lapses of consent, and changes in laws that affect the project.

13 GRIEVANCE REDRESS MECHANISM (GRM)

Grievance redress is a critical component of an effective ESMP and project implementation. The purpose of Grievance Redress Mechanism (GRM) is to provide a forum to the internal and external stakeholders to voice their concerns, queries, and issues with the project. Such a mechanism would provide the stakeholders with project personnel or channels through which their queries will be channelled and will ensure timely responses to each query. This will allow for trust to be built amongst the stakeholders and prevent the culmination of small issues into major community unrest. The GRM will be accessible and understandable for all stakeholders in the project and the entire project life cycle. The GRM will be communicated to all relevant stakeholders and will also be applicable to any contractor that will occupy and/or use land during the construction and operations phase.

As a requirement of the World Bank Environmental and Social Standards (ESS), the scope, scale and type of grievance mechanism required should be proportionate to the nature and scale of the potential risks and impacts of the project. The GRM may include:

a) Different ways in which users can submit their grievances, which may include submissions in person, by phone, text message, mail, e-mail or via a website;

b) A log where grievances are registered in writing and maintained as a database;

c) Publicly advertised procedures, setting out the length of time users can expect to wait for acknowledgement, response and resolution of their grievances;

d) Transparency about the grievance procedure, governing structure and decision makers;

e) An appeal process (including the national judiciary) to which unsatisfied grievances may be referred when resolution of grievance has not been achieved.

The grievance mechanism and resolution procedure sets out a step-by-step approach of receiving, acknowledging, registering, investigating and addressing complaints and grievances from all stakeholders affected and interested in the project.

The procedure is as shown in Figure 13-1 and Figure 13-2.

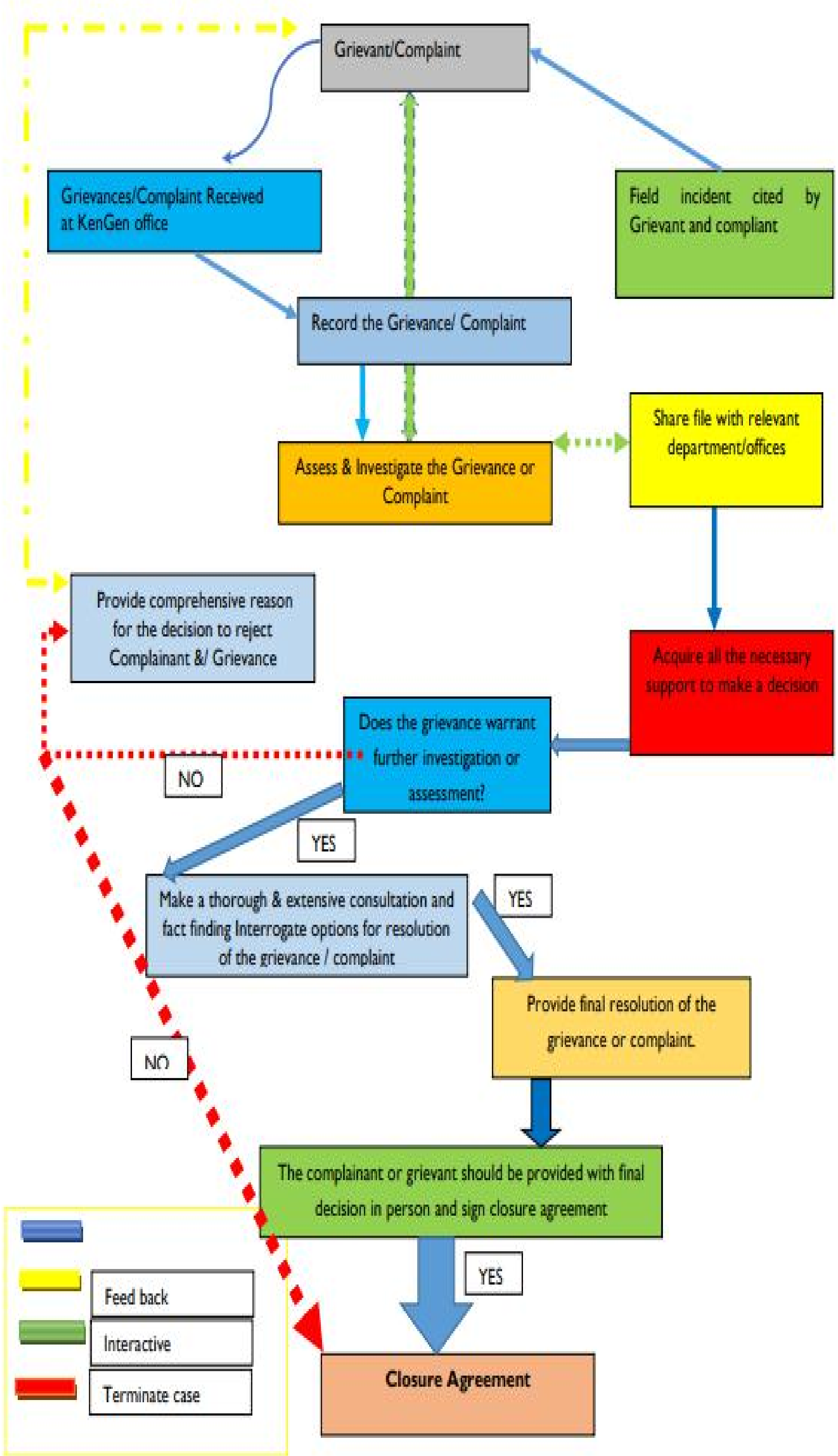


Figure 13-1: Grievance and Complaints Handling Mechanism

Complainant submits grievance

Level One	Step 1	KenGen's Community Liaison Officer (CLO) confirms receipt and records details of grievance in database.	Complainant is issued a copy of grievance form.		**Time period up to 2 weeks**
Level One	Step 2	CLO investigates and gathers additional information.	CLO proposes resolution strategy and validates with area manager.		
Level One	Step 3	CLO attempts to resolve grievance.	Data entry updated.		
	No	Grievance resolved	**Yes** Resolve/Close out grievance in database	Notify actions to complainant in writing.	Undertake timely follow-up with complainant to ensure satisfactory grievance redress.
Level Two	Step 4	CLO escalates grievance to Community Relations Manager, relevant departments and external parties as necessary.	Database entry updated		**Time period within one month**
Level Two	Step 5	Senior staff member attempts to resolve grievance.	Database entry updated		
	No	Grievance resolved	**Yes** Resolve/Close out grievance in database	Notify actions to complainant in writing.	Undertake timely follow-up with complainant to ensure satisfactory grievance redress.
Level Three	Step 6	Grievance escalated to Executive Committee community engagement subcommittee. Senior management attempts to resolve grievance.	Database entry updated.		**Time period within 3 months**
	No	Grievance resolved	**Yes** Resolve/Close out grievance in database.	Notify actions to complainant in writing.	Undertake timely follow-up with complainant to ensure satisfactory grievance redress.
Level Four	Step 7	If no resolution can be agreed, remind complainant of rights to initiate alternative dispute resolution, mediation, arbitration or litigation.	Involve legal Department.		

Figure 13-2: Grievance and Complaints Handling Timeline

13.1 Grievance and Complaints Handling Procedures

13.1.1 Receiving Complaints

Complaints and grievances can be made verbally, on a visit to any of the KenGen offices. It can be in written form and delivered by hand or mail or email or through a hotline or voice recording or written phone messages. The complaint or grievance may have a sender's name and address. All complaints will be valid and will be responded to, even if they are anonymous. Those complaints or grievances that are submitted anonymously shall be responded to via community bulletins, Chief's Barazas and other communication methods that KenGen may deem appropriate. All cases will thereafter be registered with the GRM office at KenGen headquarters in Nairobi.

Complaints that are similar in nature, facts and character shall be responded to uniformly as one complaint. In those cases, should meetings be required to resolve the complaint then such meetings shall be organized jointly with all similar complaints. In some cases, all complainants may choose representatives to attend such meetings.

Those cases that come from complainants that demand or request confidentiality, shall be processed and responded to in confidence.

13.1.1.1 Online Approach

An online platform shall be set up for receiving grievances as an easy option for those with ability to use online services like websites and SMS messaging systems. (A web-based form shall be developed for use as well as a phone-based application or SMS protocol). This will be useful for providing the geographical location of the incidents and limit movement of stakeholders to KenGen offices.

13.1.1.2 NGOs, CBOs and Other Related Approaches

This may include working with external and community organizations, NGOs, CBOs etc. to launch the community concerns.

13.1.1.3 Recording Complaints

All complaints and Grievances shall be recorded, filed and registered as a complaints or Grievance. Each matter shall have a case / record (File Number) unique only to that file and the complainant shall use that number for follow up or to give additional information. The current records will be a listing and narrative in a record book. Additionally, all records will be digitally stored and all communication with respect to a complaint or grievance shall quote the file number for follow up and monitoring purposes.

All complaints and grievances shall be acknowledged as having been received by KenGen within 10 days.

13.1.2 Case File Tracking

The digital files movement will be shared regularly with the Frontline offices to help them give more accurate feedback to the complainant. Feedback will be given as often as possible at least twice in a month.

13.1.3 Resolution of Grievances & Complaints

Grievances and Complaints resolution processes can be held up for months due to community based, cultural values or political interests and expediencies that drive a lack of agency to resolve. KenGen shall approach such situations prepared for such delays, but also be willing to provoke and agitate for a solution. The GCHM will allow for attempts to resolve the complaints or grievances at every point, from the frontlines all the way to the final arbiters – the Exco Grievance and Complaints Handling Mechanism (GCHM) Committee.

13.2 Grievance and Complaints Handling Mechanism (GCHM) Operation Committees

The following are the four steps to resolving grievances and complaints and creating an enabling environment to find solutions.

13.2.1 Ground Zero: Stakeholder Coordination Committee

Stakeholder Coordination Committees (SCCs) shall be utilized as a communication vehicle for community awareness about the lodging of complaints or grievances. They will explain clearly how complaints and grievances with respect to a project are processed and resolved. The SCCs will galvanize the community towards a better appreciation of the Environmental and Social Impact Assessment Report for this and subsequent projects and ensure that all matters relating to such impacts are appropriately communicated to members of impacted communities through their representatives.

The Ground Zero (GZ) GCHM team will be comprised of the Project Engineer, Resident Engineer, Environmental Officer and the Community Liaison Officer. A GCHM Communication Officer will be tasked with preparation and dissemination of project information through the most appropriate channels possible and to ensure that feedback from the community is recorded and responded to as required.

The responsibilities of the GZ-GCHM team include:

i. Management of Community Engagement during and after Environmental and Social Impact Assessment Study Report (ESIA) and public participation processes;

ii. Preparation and dissemination of briefs on the project particularly issues addressed by the ESIA report and KenGen's project team;

iii. Establishment and maintenance of the SCC engagement with the project and dealing with all initial public /community concerns;

iv. Receiving and processing all complaints and grievances under the GCHM; and

v. Preparing a GCHM Status Report at Ground Zero for the Regional Manager.

13.2.2 Step 1: Frontline GCHM Committee

The Frontline GCHM Committee (FL-GCHM Team) is the first step of handling a formal complaint or grievance. GZ Team generally deals with preventive measures, and pre-project community engagement and stakeholder coordination services. They may also answer questions and respond to situations arising from lack of information or misinformation.

The FL-GCHM Team comprises of personnel at the frontline office that handle community engagements and stakeholder relations. They may include the Community Liaison Officer, Environmental Officer, Social Safeguard Specialist and others closely working in areas that require community engagement.

The responsibilities of the FL-GCHM team include:

i. Managing the receipt and documentation of grievances or complaints;

ii. Acknowledging such receipts and documenting the grievances or complaints;
iii. Sharing records with relevant offices for their information and comment;
iv. Investigating (fact finding) the matter and attaching their evaluation report to the complaint record;
v. Rejecting complaints that are frivolous and lacking in merit;
vi. Reporting to the Regional GCHM Team of the rejected complaints.

The complainant has a right to resubmit the complaint under an appeal process that bypasses the Frontline CGHM and goes directly to the Regional Manager.

If a grievance or complaint after initial evaluation by the frontline office is determined to be valid before the GCHM, the file will go into investigation and further fact finding. The complainant will thereafter receive an acknowledgement letter and the process of dispute resolution will be established. The Frontline office shall make all necessary investigations and information gathering and shall also carry out an assessment including an interview with the complainant or grievant. A report shall be sent to the Regional GCHM Committee with a recommendation.

This step will take no more than 45 days.

13.2.3 Step 2: The Regional GCHM Committee

The Regional GCHM Committee (R-GCHM Team), comprising of five officials and chaired by the Regional Manager (or Geothermal Development Director for Geothermal area), shall evaluate the cases brought to its attention by the FL–GCHM Team and either confirm the recommendation made or revisit the matter.

The responsibilities of the R-GCHM team will include:

i. Carrying out further investigations and interviews;
ii. Holding discussions on the remedy sought, facilitated by an independent local mediator within the community or through the Stakeholder Coordination Committee;
iii. Undertake additional enquiries open to verify a grievance or complaint or seek new information;
iv. Holding meetings with the complainant or grievant until a solution is found and use available professionals at their disposal to elucidate and extrapolate matters before them; and
v. Seeking external assistance from other stakeholders in government agencies and county governments to enlighten the committee.

Complaints and grievances that have no merit or seem instigated for purposes other than to remedy a wrong committed by KenGen's action or inaction shall be expunged. The committee shall communicate the matter to the complainant explaining the reasons for the rejection.

The grievant or complainant has a right to appeal that decision to the Office of the Managing Director of KenGen. The committee may seek guidance from the Line Directors at the headquarters at any point as the matter before them may require.

This step will be completed within three months (90 days) of receiving a complaint and the successful cases will be sorted out and matters resolved within (45) days of reaching that decision.

13.2.4 Step 3: GCHM Exco Sub-Committee (KenGen's GCHM Apex Committee

The committee is chaired by the Director Corporate Regulatory Affairs, and it comprises of the Director of Geothermal Development, Director Operations, Director Human Resources and the Company Secretary and Legal Affairs office. This committee shall receive referrals from Regional GCHM Committees for concurrency as well as appeals from complainants who are dissatisfied about the outcome at the Regional GCHM Committee.

The Exco Committee will enrich and expound the decision, fine-tuning it for both consistency with the law and also ensuring that appropriate consideration of corporate goals have been made. The GCHM Exco Sub-Committee Team's effort is to enrich, enlighten and support resolution of conflicts and act as the final arbiter in dispute resolution. They shall be responsible for signing resolution memoranda between the grievant or complainant and KenGen.

The appeals brought to the Exco Sub-Committee team from the R-GCHM will be taken seriously and heard afresh, before a team that does not include anyone who was involved in the matter at the Regional GCHM. The rationale for the rejection of an appeal will be sound, justifiable and substantiated.

All matters brought before the GCHM Exco Sub-Committee will be dispensed within a maximum of 90 days from the date they are received (*Source: RTI International, 2021*).

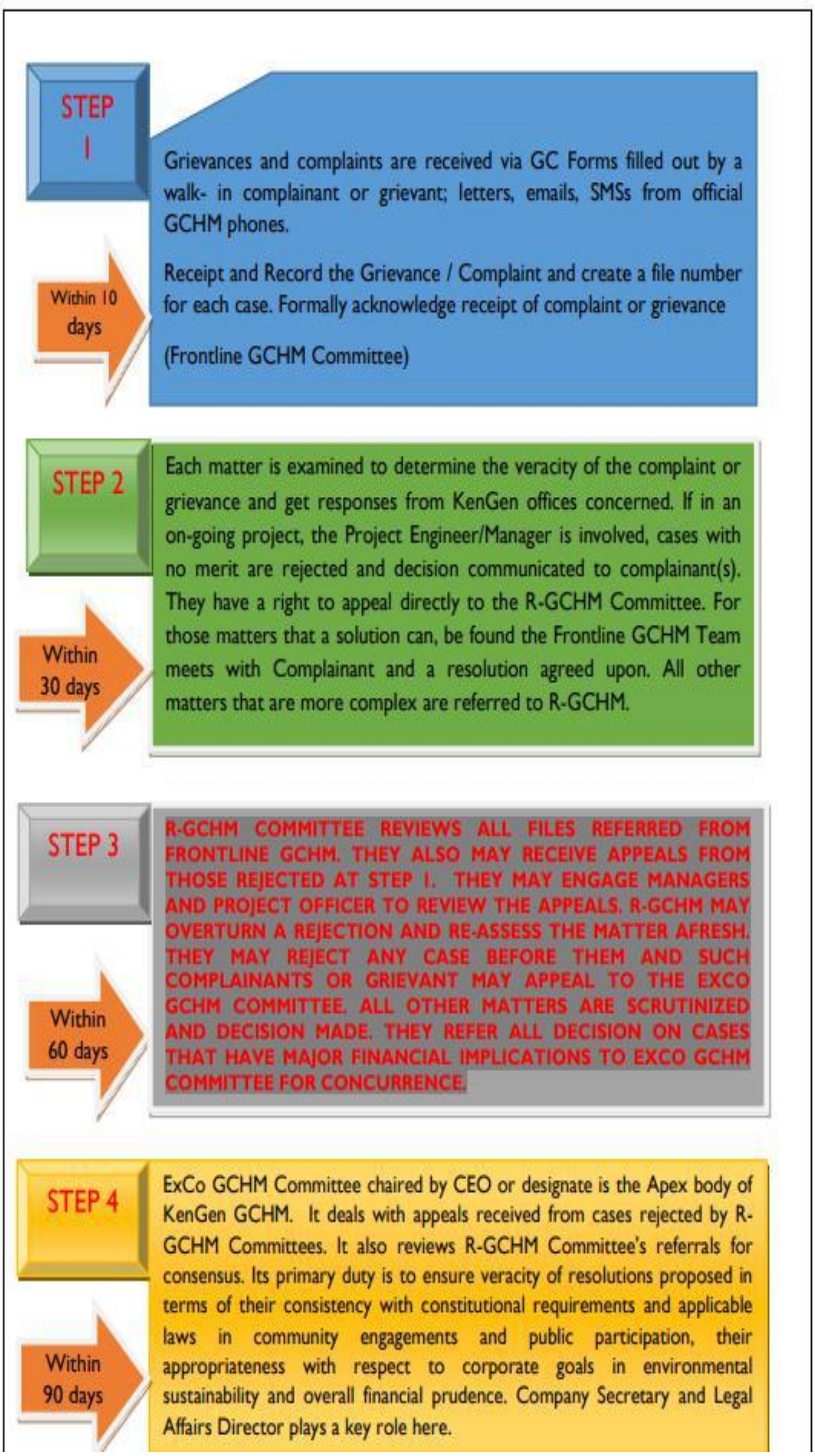


Figure 13-3: GCHM Committee Steps

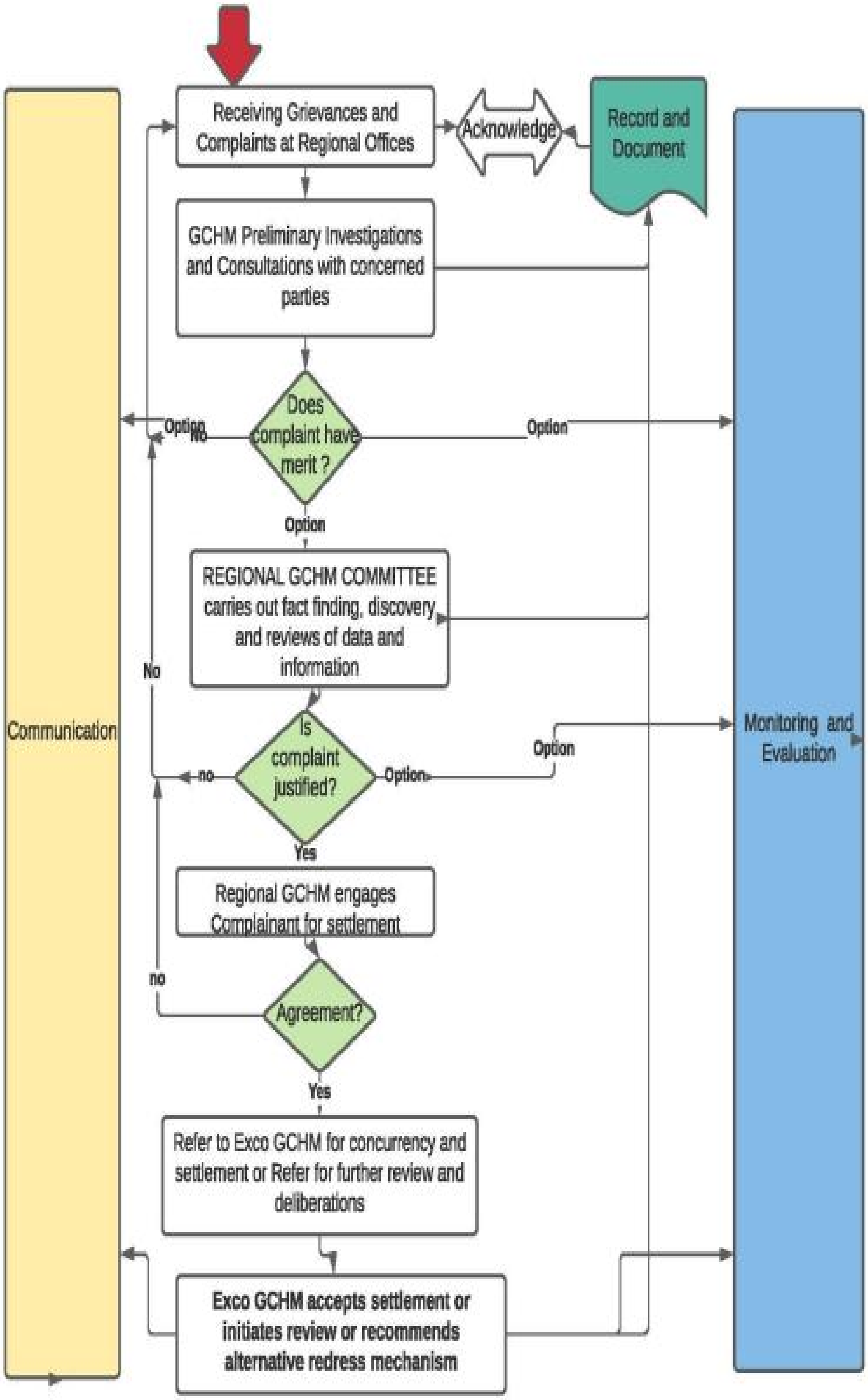


Figure 13-4: GCHM Interactive Process

(*Source: RTI International, 2021*).

14 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

14.1 Introduction

The proponent of the proposed project acknowledges that the proposed project activities will have some impacts on the biophysical environment, health and safety of its employees and members of the public, and the socio-economic wellbeing of the residents. Thus, the focus was on reducing the negative impacts and maximizing the positive impacts associated with the project activities through a continuous improvement programme. Environmental and Social Management Plans (ESMPs) for ***Construction, Operation and Decommissioning Phases***, have been developed to assist the proponent in mitigating and managing environmental and social impacts associated with the life cycle of the project. These have been illustrated in Table 14-1 to Table 14-3 below.

The ESMPs consist of the following sections:

- **Section A:** Negative Environmental Impacts during Construction Phase
- **Section B:** Negative Social Impacts during Construction Phase
- **Section C:** Negative Environmental Impacts during Operation Phase
- **Section D:** Negative Social Impacts during Operation Phase
- **Section E:** Negative Environmental Impacts during Decommissioning Phase
- **Section F:** Negative Social Impacts during Decommissioning Phase

It is noteworthy that key factors and processes may change through the life of the project and considerable provisions have been made for dynamism and flexibility of the ESMP. As such, the ESMP should be subjected to a regime of periodic review. The ESMP costs used are current market rates but these can be reviewed over time.

14.2 Environmental and Social Management Plan Implementation

Environmental and Social Impacts analysis of the project was carried out where several environmental and social impacts were identified and analysed. To minimize the effect of these impacts, mitigation measures have been proposed which will act as a guide for their management. This will enable the Proponent, Contractor and other stakeholders to minimize and mitigate the impacts of the project and enhance the surrounding communities to accept the project with minimal resistance if the impacts are successfully mitigated and managed.

14.3 Roles and Responsibilities

Each of the proposed mitigation measures has an outline of shared roles and responsibilities of various actors who will be involved in the respective management plan implementation. The responsibilities lie across the service providers/ contractors working closely with other government agencies.

14.4 Building Capacities on Environmental and Social Safeguards

The formulation of a comprehensive Environmental and Social Management Plan is a culmination of the ESIA process. To ensure the ESMP is fully implemented, the proponent and contractor are expected to mobilize human resources to build their existing capacities on Environmental and Social Safeguards to facilitate compliance of the project with the requirements of Kenya's environmental policies, laws and regulations and the international best practices. Project contracts should be reviewed by the Proponent's Safeguards Team directly or through a Safeguards consultant. Regarding the implementation of the social aspects of the ESMP, it is proposed that the Resident and

Supervising Engineers shall work closely with the Environmental and Social Safeguards Teams at KenGen to ensure high compliance with the proposed mitigation measures.

14.5 Construction Phase

The estimated period of construction for the proposed power plant is 2 years. Hence, the cost estimates for the construction phase are for 2 years.

Table 14-1: Environmental and Social Management Plan (ESMP) during Construction Phase

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
Section A: Negative Environmental Impacts during Construction Phase				
Air Emission and Dust	▪ All construction machinery shall be maintained and serviced in accordance with the manufacturer's specifications; ▪ Train and sensitize Workers on dust minimization techniques and management of air pollution from vehicles and machinery; ▪ Avoid removal of vegetation until such a time when clearance is required and exposed surfaces shall be re-vegetated or stabilized as soon as practically possible; ▪ Frequent watering of exposed surfaces and piles of soil to prevent airborne dust emissions; ▪ Unless inevitable, vehicles shall avoid earth roads susceptible to fugitive dust until dust management routines are done; ▪ Incorporate dust/fumes arrestors in the batching plant e.g. use of dust nets; ▪ Provision of appropriate protective personal equipment including respirators and aprons; ▪ Ensure regular servicing of machinery to meet the relevant emission standards; ▪ Ensure the use of clean fuels in vehicles and other construction Machinery; ▪ Switching off the engines of all vehicles and machinery on site when not in use;	Contractor	Continuous	7,500,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
	▪ Schedule of vehicle movement and number of vehicles in transit at any given time to limit emissions generation; ▪ Plant Machinery and equipment to be used in the project to comply with recognized performance and design standards; ▪ Conduct regular air quality monitoring at the site and nearby settlements; ▪ For manageable stockpile volumes, geotextiles can be used to cover soil heaps to prevent erosion and dust generation by wind; ▪ Consideration of the location of stockpiles for temporary storage areas with respect to the location of sensitive receptors and prevailing wind; ▪ Restrict heights from which materials are dropped, as far as practicable, to minimize the fugitive dust arising from unloading/loading; ▪ Temporary suspension of material handling activities during high wind events; ▪ Avoid double handling of material wherever reasonably practicable.			
Noise Pollution	▪ Regular monitoring and measurement of noise levels at the site; ▪ Install proper noise barrier wall to reduce noise exposure to close sensitive receivers and/or the nearest villages; ▪ Limit operation for specific loud pieces of equipment or operations to day-time; ▪ Limit exposure of workers handling noisy and vibrating equipment; ▪ Construction activities should be limited to daylight hours although scheduling may require overnight operations on specific occasions; ▪ Require contractors to prepare and implement a Vehicle and Traffic Management Plan (VTMP);	Contractor	Continuous	2,750,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
	▪ Encourage the adoption of low noise technology and practice for machines during construction; ▪ Develop and implement a noise management plan.			
Increased Soil Erosion and Sedimentation	▪ Minimize project footprint by limiting clearing of vegetation to construction areas only; ▪ Site clearing or disturbance of the natural vegetation will be planned and approved as part of the project management process; ▪ Among the areas that require immediate restoration, the Contractor will allow minimal vegetation clearing and disturbance on the slopes to avoid difficulties during restoration; ▪ No grey water runoff or uncontrolled discharges from the site/working areas (including wash-down areas) to adjacent watercourses and/or water bodies shall be permitted; ▪ Water containing pollutants such as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from the site; ▪ Runoff loaded with sediment and other suspended materials from the site/working areas should be prevented from discharging to adjacent watercourses and/or water bodies must be prevented; ▪ Preparation of a landscape planting plan for the entire project area comprising of indigenous species and to be rid of any invasive species; ▪ Banding the site to control run-off loaded with sediment and other suspended materials from the site from watercourses; ▪ Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas (including groundwater) are not polluted.	Contractor	Continuous	3,750,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
Surface and Subsurface Contamination	▪ Ensure all chemicals and fuels are stored in designated storage areas; ▪ Ensure all chemical and fuel storage sites are banded and with impermeable surface; ▪ Proper maintenance and regular servicing of vehicles to ensure no leakages from the vehicles; ▪ Develop and implement a spills prevention and emergency response plan for the site including containment, clean-up and reporting procedures; ▪ Training of workers on spill response to minimize the risk of chemical spills.	Contractor	Quarterly	1,500,000
Surface Water Pollution	▪ Banding the working area to avoid surface flows and storms into water courses; ▪ Minimizing vegetation clearance; ▪ Compaction or regular watering of loose surfaces; ▪ No grey water runoff or uncontrolled discharges from the site/working areas (including wash-down areas) to adjacent watercourses and/or water bodies shall be permitted; ▪ Water containing pollutants such as cement, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from the site; ▪ The Contractor shall instruct their staff and sub-contractors that they must use the toilet provided and not the bush or watercourses.	Contractor	Continuous	500,000
Solid and liquid Waste Generation	▪ Develop and implement a Waste Management Plan that includes appropriate procedures for collection, handling, storage and disposal; ▪ Limit the number of workers housed at the site to limit waste generation;	Contractor	Continuous	2,500,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
	▪ Ensure all oily water discharges flow through an oil–water separator or a grease trap before discharge; ▪ Introduce portable toilets in construction sites, road work areas and workers' camps; ▪ Ensure hazardous and toxic waste will be removed from the site by licensed hazardous waste transporter and disposed of in a licensed facility.			
Impact on Flora	▪ Ensure there is selective clearing of the vegetation for future re-growth and regeneration. This will ensure minimal disruption of wild fauna's natural movement, territoriality, and other ecological processes; ▪ Delineate areas for land preparation/other activities in the field to prevent loss of vegetation outside of designated works areas. ▪ Ensure washing of vehicles is done away from the site to ensure that seeds from exotic and invasive species are not introduced through vehicles during construction; ▪ Revegetation of areas outside the project footprint that are affected by construction activities. Indigenous plant species should be used. If planting takes place during the dry season, the planted areas should be watered regularly until properly established; ▪ Inspections and decontamination of vehicles and equipment upon mobilization to limit the potential for carrying seeds of non-native/ invasive plant species.	Contractor	Continuous	5,500,000
Impact on Fauna	▪ Revegetation of cleared grounds as appropriate; ▪ Monitor birds and wildlife abundance, distribution and movement; ▪ Erect bumps on wildlife crossing areas along the roads; ▪ Discourage unnecessary hooting;	Contractor	Quarterly	4,500,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
	▪ Brine ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact; ▪ Maintenance of roads within the park as routes for tourists' activities and wildlife management; ▪ Restrict and regulate access for earthmoving machines; ▪ Incident records accidents and other human-wildlife conflicts should be monitored and followed by appropriate corrective measures; ▪ Enforce Park rules within the park; ▪ Fit high voltage transmission lines with wire markers and flappers to alert birds on flight; ▪ Ensure regular watering of loose surfaces to avoid dust emissions; ▪ Shelter high heat points and emission vents within the project area; ▪ Liaise with KWS to ensure all Reptiles and their eggs discovered during construction works are hiding under rocks and sheltered terrains such as Pythons and House snakes are captured and safely release them in suitable habitats. ▪ Ensure steam pipes at known animal migration corridors are elevated or buried under the ground surface. Modify pipe loop designs to minimize hindrance to wildlife movement as well as scaring them away. Other design options like pipe burying, wider loops or concave ones should be explored for habitat suitability and to ensure big game can still move along their routine corridors and routes.			

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
Sustainability and Climate Change Impacts	▪ Use of low-emission vehicles for mobilization activities; ▪ Use generators with low emissions; ▪ Switch-off engines when not in use; ▪ Conduct regular maintenance of vehicles and equipment to minimize emissions; ▪ Disturbed areas that will no longer be developed can be revegetated with local vegetation to serve as a buffer for future activities and operation and to increase local sequestering capacity for greenhouse gases; ▪ Ensure regular monitoring of possible GHGs emissions.	Contractor	Continuous	4,000,000
Cumulative Impacts				
Cumulative Impacts	▪ Apply engineering measures to minimize land requirements for geothermal activities; ▪ Formulate and implement a Waste Management Plan (WMP); ▪ Undertake annual/ regular Environmental audits and safety and health compliance audits; ▪ Monitoring of health implications and incidents among workers and local community exposed to H_2S; ▪ Implement biodiversity offset programs.	KenGen		2,500,000
Sub-total for mitigating environmental impacts				**34,500,000**
Section B: Negative Social Impacts during Construction Phase				
Project Induced In - Migration (PIIM)	▪ Prioritize local community workforce to the extent possible including possible training to enhance absorption of local workforce; ▪ Manage labour influx in accordance with the World Bank (WB) 'Guidance Note on Managing the Risks of Adverse Impacts on Communities from Temporary Project Induced Labour Influx' and the analysis of labour Influx Management;	KenGen	Continuous	5,000,000

Key Impacts	**Mitigation Measures**	**Responsibility**	**Frequency**	**Cost Estimates (Kshs)**
	▪ Ensure continued community engagement in accordance with the Proposed Project SEP; ▪ PIIM risk reduction planning, which involves effective and ongoing engagement with the local community to optimize employment and business opportunities for locals, while consulting the community regarding predicted PIIM, which includes disclosure of the potential benefits and risks associated with these changes; ▪ Community empowerment programs including trainings on employability skills to increase their capacity to absorb benefits not only from the Project but also other potential economic opportunities to improve their livelihoods.			
Noise Pollution: Disturbance to Tourists at the Geothermal Spa	▪ Proper environmental management to reduce noise should be in place during the land preparation and construction; ▪ Provide informative signage to alert tourists of the imminent noise; ▪ Implement the Stakeholder Engagement Plan and Grievance Redress Mechanism.	Contractor	Continuous	500,000
Impacts on Community Health	▪ Regular watering of loose surfaces and covering of loose materials; ▪ Avoid offloading and application of loose construction materials during windy hours; ▪ Introduce speed limits on roads and ensure compliance so as to minimize accidents in the busy environment; ▪ Monitor community health in regard to respiratory illness in collaboration with the local health centres for informed preventive care strategies; ▪ Engage community when noisy construction activities are set to take place;	Contractor	Continuous	7,500,000

Key Impacts	**Mitigation Measures**	**Responsibility**	**Frequency**	**Cost Estimates (Kshs)**
	▪ Establish a grievance redress mechanism that is accessible for all community groups to report dust/emissions/noise issues. Should any complaint be received, the Project will undertake an immediate investigation as part of the grievance resolution procedure.			
Traffic Congestion	▪ Establish and implement a Vehicle and Traffic Management Plan (VTMP) in consultation with relevant government agencies; ▪ Public consultation on the implementation plan of equipment and material mobilization; ▪ Contractor/Sub-contractors to strategically place temporary traffic cones/barricades and direction delineators to maintain one through lane in each direction during peak hours; ▪ Construction staging and idling vehicles should be away from sensitive receptors to the extent feasible; ▪ Installation of safety signs and barricades; ▪ Safety inductions for vehicle drivers and construction contractors; ▪ Strict enforcement of applicable speed limit through the villages.	Contractor	One-Off	1,500,000
Visual Impact (Landscape Character Impact)	▪ Limit vegetation clearing to construction areas only; ▪ Preparation of a landscape planting plan for the entire project area. The planting plan is to be comprised of indigenous species and to be rid of any invasive species; ▪ Keep design for pipeline and project components, colour and structure material compatible with the natural settings, where possible and practicable; ▪ Limitation of earthworks to construction areas only; ▪ Store excavation material away from residences and the existing roads; ▪ Clean and tidy temporary waste storage areas; ▪ Ensure proper waste disposal;	Contractor	Continuous	750,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
	▪ Construction site management to ensure that heavy equipment remain in designated areas; ▪ Ensure timely rehabilitation of the site; ▪ Ensure all steam pipes camouflage with the immediate environment.			
Impacts on Social Fabric and Community Perception	▪ Implementation of the prepared Stakeholder Engagement Plan (SEP) which includes ongoing stakeholder engagement and consultation not only at the macro/regional level with the government, but also at the local level with the cultural groups and the local community; ▪ Disclosure of information regarding jobs and business opportunities widely to the local community within the Project AOI, along with information about the Project activities, as part of the SEP; ▪ Undertake a comprehensive induction/training to all workers concerning local culture and customs, and encourage workers' appreciation toward these cultures, as part of the Project Code of Conduct; ▪ Adopt and disclose a community GRM to provide the community with the opportunity to formally lodge complaints related to the Project workforce behaviour or other social-related issues; ▪ Build the capacity of the Stakeholder Coordination Committees (SCC) and allow the community to nominate their representatives to the SCC; ▪ The contractor should ensure that at minimum, at least 30% of all skilled and unskilled manpower engaged are from the local community;	KenGen	Quarterly	1,250,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
	▪ The contractor should ensure that all employment requirements from the local community, are channelled through KenGen's Community Liaison Office; ▪ The community Liaison office to ensure there is coordination with village leaders for the local recruitment process; ▪ Ensure there is transparency in the recruitment process to avoid conflicts between community members; ▪ Ensuring wages for the local workers are in accordance with applicable regulations. ▪ Contractor to organize and ensure that there is provision of meals and drinking water to casual workers in a timely and clean manner; ▪ Providing opportunities for local businesses in the procurement of goods and services to support the Project activities, including non-formal or indirect services e.g., transportation services/car rental, food catering and homestays for workers; ▪ Sensitize the local community on KenGen's CSR program and clearly communicate the role of the Government in infrastructure development.			
Impacts on Labour Rights and Working Conditions	▪ Develop and implement a Labour Management Plan (LMP) with a commitment to providing appropriate working conditions and terms of employment in accordance with relevant national and international laws and standards; ▪ Ensure the LMP will establish, maintain and improve the Worker-Management relationship to promote fair treatment, gender equality, non-discrimination and equal opportunity for workers, and enable a grievance mechanism for workers; ▪ Ensure all contractors and suppliers comply fully with the laws and regulations of the government of Kenya and the LMP.	KenGen	One-Off	750,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
Occupation Health and Safety Risks	▪ Provide and enforce all ranges of required PPEs for workers and visitors; ▪ Establish a comprehensive Safety and Health Policy in compliance with KenGen's Occupation Safety and Health Policies; ▪ Implement the specified H&S programme throughout the construction period; ▪ Ensure compliance with all standards and legally required health and safety regulations; ▪ Establish an emergency response procedure and display it on all work areas; ▪ Provision of medical facilities for staff; ▪ Include standard best practice health and safety provisions in the construction contract. The provisions should include insurance to enable the contractor to pay for any treatments required by workers including those of all sub-contractors, together with any subsequent lifelong disability payments; ▪ Establish and enforce a strict code of conduct for all project drivers including outside suppliers delivering materials. The code should focus on safety, especially speed, and loading, especially banning all carriage of staff, workers and passengers except in seats; ▪ Provision of a standard first aid kit at the site office at all times; ▪ Training of first aiders; ▪ Obtain WIBA cover for employees; ▪ Provision of fire-fighting equipment available at the worker's camp; ▪ Install appropriate safety signage for all work sites; ▪ Registration of the work place; ▪ Carry out accident and incident investigations and implement corrective actions;	Contractor	Continuous	25,000,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
	▪ Maintain an accident register; ▪ Ensure regular and routine Staff and visitor induction; ▪ Provision of sanitary facilities for employees; ▪ Provision of wholesome drinking water for employees; ▪ Train workers on Occupational Safety and Health and Construction safety; ▪ Develop & publicize an emergency response plan; ▪ Carry out OSH Risk Assessment; ▪ Carry out Fire Safety Audit; ▪ Ensure all Lifting Plant Equipment are examined by an authorized plant examiner; ▪ Report any non-fatal accident **within 7 days** to the area Occupational Safety and Health Officer; ▪ Any fatal accident is to be reported to the area Occupational Safety and Health Officer **within 24 hours**			
HIV / AIDs and Sexually Transmitted Infections	▪ Where workers must be housed, select appropriate locations away from the concentration of human settlements for construction camps; ▪ Sensitize workers and the local communities on HIV/AIDs and STIs in conjunction with the Public Health Office; ▪ Provision of condoms to the construction workers, project team and the public. This should be kept in places that are not locked and are accessible to the above persons; ▪ Where possible conduct regular sensitization campaigns and monitoring and evaluation of the modes used during course of the project; ▪ Formation of peer groups from among the project staff to ensure continuity in training and awareness raising;	Contractor	Continuous	5,000,000

Key Impacts	Mitigation Measures	Responsibility	Frequency	Cost Estimates (Kshs)
	▪ The contractor has to ensure that staff are made aware of the risks of contracting or spreading sexually transmitted diseases; ▪ The contractor should ensure that the project workers are sensitized on the local culture.			
Sub-total for mitigating social impacts				**47,250,000**
Total for Construction Phase				**81,750,000**

14.6 Operation Phase

The estimated period of operation for the proposed power plant is 30 years. The cost estimates below are per year.

Table 14-2: Environmental and Social Management Plan (ESMP) during Operation Phase

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
Section C: Negative Environmental Impacts during Operation Phase				
Surface Water Contamination	▪ Minimize risk of brine and condensate discharge through implementation of reinjection system to respective reinjection wells; ▪ System shut down in case of reinjection failure or well blow-out; ▪ Provision of adequately sized concrete lined reinjection settling ponds/basins; ▪ Keep the reinjection settling ponds/basins empty, as frequently as possible; ▪ Installation of sump pumps at the reinjection settling ponds/basins, to increase the rate of injection of excess geothermal fluid into reinjection wells as well as a portable pump to be used at plant start-up; ▪ Regulate flow from production wells during failure of the reinjection system i.e. when kickback of the system is experienced; ▪ Brine and condensate flows and ponds/basins should be located close to the source; ▪ Distant flow should be piped to prevent animal or vegetation contact; ▪ Monitor the chemical composition of brine and condensate routinely; ▪ Develop a brine management plan to minimize the risk of brine discharges;	KenGen	Continuous	1,200,000

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
	▪ In the event of emergency discharge of brine or condensate to surface waters, treatment should be undertaken prior to discharge of effluent to comply with effluent standards; ▪ Monitor well levels and pressure to identify leaks early and repair casing or decommission the wells to avoid further contamination; ▪ Detailed analysis of aquifer structure and existing groundwater use in the development area; ▪ Sludge/precipitates to be stored in banded areas; ▪ Regular maintenance of wellheads and geothermal fluid pipelines, including corrosion control and inspection; pressure monitoring; and use of blowout prevention equipment such as shutoff valves; ▪ Design of emergency response for well blowout and pipeline rupture, including measures for containment of geothermal fluid spills.			
Noise and Vibration	▪ Provision of appropriate PPEs to the workers, including Hearing Protection devices (HPDs), especially to staff and visitors in the vicinity of the vent station (rock muffler) and cooling towers; ▪ Sensitization and education of workers and visitors on the need to use PPE provided; ▪ Daily noise level monitoring to be conducted; ▪ Conduct health surveillance of workers which shall include audiometric test for the power plant operators at least once in a year; ▪ Provide at strategic positions signages in identified noise hazardous areas; ▪ Ensure ruptured ejectors in the power plant are reinstated as soon as possible;	KenGen	Continuous	750,000

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
	▪ Design of atmospheric separators for production testing to be optimized for noise abatement; ▪ Apply modern technology with minimal noise levels especially from the cooling towers; ▪ Vertical discharge well testing to be conducted at times advised and agreed to by nearby communities; ▪ Develop an effective grievance mechanism to record and respond to noise complaints; ▪ Installation of vibration dampers where feasible; ▪ Develop and implement a noise management plan; ▪ ESIA to be conducted before drilling of any additional make up well(s).			
Impact on Air Quality and Odour	▪ Situate automatic H_2S sensors around the power plant; ▪ Ensure cooling towers are sited properly; ▪ Put up monitoring stations for precipitation chemistry; ▪ Monitor changes in geothermal development technology for adoption where necessary; ▪ Educate workers on the dangers of exposure to H_2S; ▪ Use of abatement systems to remove H_2S emissions from Non-Condensable Gases (NCGs); ▪ An air quality monitoring plan should be adopted to ensure the lowest possible impacts; ▪ Continuous monitoring of H_2S within the plant's boundary and other active sites within Olkaria; ▪ Installation of automatic H_2S data logging detectors in the vicinity of the vent station, (integrated with the H_2S alarm system of the power plant) including use of personal H_2S detectors by staff near	KenGen	Continuous	2,500,000

Key Impacts	**Mitigation Measures**	**Responsibility**	**Monitoring Frequency**	**Cost Estimates /Year (Kshs)**
	or within potentially dangerous areas, such as the vent station (rock muffler) and cooling tower; ▪ The community Liaison office to have a strategy for communication with those who may be affected by odour nuisance and the office to also ensure that they share air quality monitoring results for transparency and to allay any community health fears. ▪ ESIA to be conducted before drilling of any additional make up well(s).			
Increased Waste Generation	▪ Develop and implement a Waste Management Plan that includes appropriate collection, handling, treatment, and disposal of waste; ▪ Encourage the reuse of green waste locally for composting/firewood or landscaping purposes; ▪ Manage regular disposal schedules to remove waste from the site where necessary; ▪ Discharges from kitchen and washroom facilities into the septic tank are to be directed through grease traps, and appropriate disposal methods as required; ▪ Implement portable toilets in construction sites, road work areas and workers' camps to treat wastewater discharge as per Project design; and ▪ Provide temporary hazardous waste storage; ▪ Hazardous and toxic waste will be removed from site by licensed hazardous waste transporter and disposed in a licensed facility.	KenGen	Continuous	3,600,000
Impacts to Vegetation from Well	▪ If feasible, apply cover on the potentially exposed plants; ▪ Spraying of clean water on plants might be applied as an alternative in case the application of cover is not feasible.	KenGen	Continuous	2,500,000

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
Heads and Drain Ports				
Impacts on Flora	▪ Monitor invasive plant species at the project area and uproot unwanted germinating plants; ▪ Brine flows and ponds should be located close to the source. Distant flow should be transmitted through closed pipes; ▪ Rehabilitate disturbed areas neighbouring the plant, along roads, and abandoned campsites by planting indigenous plant species – this should be done as soon as practicable to avoid colonization by invasive and opportunistic pioneer species; ▪ Exotic plants species should not be introduced into this area.	KenGen	Quarterly	600,000
Impacts to Wildlife	▪ Fencing around work areas to prevent animal entry and minimize light/disturbance impacts during the night time; ▪ Application of unidirectional light is an alternative if the fencing is not feasible; ▪ Installation of safety barriers such as fences to avoid wildlife contact with hot pipelines, should temperatures exceed safe levels; ▪ Training for crews, during operation, on the appropriate response to wildlife encounters; ▪ Prohibit workers and local community from hunting and poaching of wildlife; ▪ Provide banner informing prohibitions of hunting and poaching of wildlife and training for base camp occupants on the appropriate response to wildlife encounters that may occur and instruction to occupants to refrain from harassing wildlife; ▪ Minimize risk of brine / condensate discharge through implementation of reinjection system and provision of adequately	KenGen	Continuous	2,500,000

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
	sized concrete lined settling ponds / system shut down in case of reinjection failure; ▪ In the event of emergency discharge of brine/condensate to surface waters, treatment will be undertaken prior to discharge of effluent to comply with effluent standard; ▪ Ensure steam pipes at known animal migration corridors are elevated or buried under the ground surface. Modify pipe loop designs to minimize hindrance to wildlife movement as well as scaring them away. Other design options like pipe burying, wider loops or concave ones should be explored for habitat suitability and to ensure big game can still move along their routine corridors and routes; ▪ Brine ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact; ▪ Maintain Incident records (of poaching, accidents and other human wildlife conflicts etc.) for monitoring and taking of corrective measures; ▪ Roads feeding into the park area should be maintained as routes for tourist's activities and wildlife management; ▪ Access for earthmoving machines should be regulated; ▪ Park rules should be enforced within the park; and ▪ Regulate traffic flow and discourage vehicular disturbances, such as hooting, accordingly.			
Ground Subsidence and Seismic Risks	▪ Monitoring of seismic activity in Olkaria and its surrounding; ▪ Increase the number of the re-injection wells within, to allow increased reinjection of brine and condensate which will promote stability and distribution of mass within the reservoir;	KenGen	Continuous	1,000,000

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
	▪ Formulation of a community risk management plan that incorporates trigger levels and a communication strategy. The plan should incorporate IPP's in the area (such as OrPower 4Inc., Akiira and Oserian), other relevant government agencies including National Disaster Operation Centre (NDOC).			
Sub-total for mitigating environmental impacts				**14,650,000**
Section D: Negative Social Impacts during Operation Phase				
Exposure to H_2S	▪ Regular monitoring of H_2S along the steam pipeline serving the power plant, cooling towers and nearby villages; ▪ Conduct routine maintenance and inspections of well equipment to identify and repair potential leaks; ▪ Establish a H_2S detection system for warnings when levels approach or exceed safe limits; ▪ Regularly maintain and calibrate monitoring equipment to ensure accuracy and reliability; ▪ Relocate and reconstruct the 6 KWS rangers' houses located near the Olkaria gate to minimize H_2S exposure; ▪ Establish a health data collection program in collaboration with County Department of Health Services for monitoring and detection of health effects associated with H_2S exposure to workers and larger community; ▪ Development and Implementation of a H_2S emergency preparedness, prevention and response plan.	KenGen	Continuous	30,000,000
Impacts on Social Fabric and	▪ Implementation of the prepared Stakeholder Engagement Plan (SEP) which includes ongoing stakeholder engagement and consultation not only at the macro/regional level with the	KenGen	Continuous	5,500,000

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
Community Perception	government, but also at local level with the cultural groups and the local community; ▪ Disclosure of information regarding jobs and business opportunities widely to the local community within the Project AOI, along with information about the Project activities, as part of the SEP; ▪ Undertake a comprehensive induction/training to all workers concerning local culture and customs, and encourage workers appreciation toward these cultures, as part of the Project Code of Conduct; ▪ Adopt and disclose a community GRM to provide the community with the opportunity to formally lodge complaints related to the Project workforce behaviour or other social-related issues; ▪ Build the capacity of the Stakeholder Coordination Committees (SCC) and allow the community to nominate their representatives to the SCC; ▪ The community Liaison office to ensure there is coordination with village leaders for the local recruitment process; ▪ Ensure there is transparency in the recruitment process to avoid conflicts between community members; ▪ Ensuring wages for the local workers are in accordance with applicable regulations; ▪ Providing opportunities for local business in the procurement of goods and services to support the Project activities, including non-formal or indirect services e.g., transportation services/car rental, food catering and homestays for workers;			

Key Impacts	**Mitigation Measures**	**Responsibility**	**Monitoring Frequency**	**Cost Estimates /Year (Kshs)**
	▪ Sensitize the local community on KenGen's CSR program and clearly communicate the role of the Government in infrastructure development; ▪ Set up a mobile H_2S monitoring station and a program for monitoring H_2S levels in the villages and involve the community in the monitoring program to build trust. ▪ Minimize risk of brine / condensate discharges through implementation of reinjection system and provision of adequately sized concrete lined storage ponds / system shut down in case of reinjection failure or well blow-out; ▪ Develop brine management plan to minimize risk of brine discharges.			
Fire Outbreak	▪ Develop an implementable fire policy and ensure compliance with fire safety rules under OSHA 2007; ▪ Employees to be taken through regular trainings and fire drills for the operation and maintenance of the power plant and its associated infrastructure; ▪ Periodic maintenance to ensure that, there are no overloaded electrical systems, no incorrectly installed wiring, no live naked wires and fuel store areas are continuously monitored. ▪ Install high-performance combustible fixed gas detectors along with electro optical flame detection.	KenGen	Continuous	2,000,000
Occupational Safety and Health Impacts	▪ Installation of gas monitoring and detection systems. ▪ Development of a contingency plan for gas releases including all necessary aspects from evacuation to resumption of normal operations.	KenGen	Continuous	7,500,000

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
	▪ Provision of adequate ventilation of occupied buildings to avoid accumulation of gases. ▪ Ensure Permit-required confined spaces are provided with permanent safety measures for venting, monitoring, and rescue operations, to the extent possible. The area adjoining an access to a confined space should provide ample room for emergency and rescue operations. ▪ Before workers are required to enter a permit-required confined space, adequate and appropriate training in confined space hazard control, atmospheric testing, Further, adequate and appropriate rescue and / or recovery plans and equipment should be in place before the worker enters the confined space. ▪ The atmosphere within the confined space should be tested to assure the oxygen content is adequate, and that the presence of any flammable gas or vapor does not exceed permissible levels of its respective Lower Explosive Limit (LEL). ▪ Reducing the time required for work in elevated temperature environments and ensuring access to drinking water for rehydration. ▪ Shielding surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc. ▪ Use of necessary personal protective equipment (PPE) as appropriate, including insulated gloves, shoes, ear muffs, safety straps, ▪ Use of rock mufflers, sound insulation, and barriers. ▪ Installation of silencers on equipment in the steam processing facility.			

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
	▪ Ensure only trained and certified workers are allowed to install, maintain, or repair or maintain power lines. ▪ Workers should not approach an exposed energized or conductive part even if properly trained unless power is cut off. ▪ Specific training, safety measures, personal safety devices, and other precautions should be defined in a health and safety plan. ▪ Implementation of a fall protection program that includes training in climbing techniques and use of fall protection measures; inspection, maintenance, and replacement of fall protection equipment; and rescue of fall-arrested workers, among others. ▪ Hoisting equipment should be properly rated and maintained and hoist operators properly trained. ▪ Training of workers in the identification of occupational EMF levels and hazards. ▪ Establishment and identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, limiting access to properly trained workers. ▪ Use of mechanical assists to eliminate or reduce exertions required to lift materials, hold tools and work objects, and requiring multi person lifts if weights exceed thresholds. ▪ Implementing quality control and maintenance programs that reduce unnecessary forces and exertions. ▪ Selecting and designing tools that reduce force requirements and holding times, and improve postures.			

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates /Year (Kshs)
	▪ Incorporating rest and stretch breaks into work processes, and conducting job rotation. ▪ Providing workers with a fact sheet or other readily available information about the chemical composition of liquid and gaseous phases with an explanation of potential implications for human health and safety ▪ Training workers in the use of the available information (such as International Chemical Safety Cards – ICSC, Materials Safety Data Sheets – MSDS, or equivalent) and safe work practices. ▪ Proper signage and warnings should be placed at strategic places within the power plant to forewarn staff and visitors of potential hazards i.e. sources of Noise and H_2S emissions. ▪ Implementation of engineering and administrative control measures to avoid or minimize the release of hazardous substances into the work environment, to keep the level of exposure below internationally established or recognized limits.			
Sub-total for mitigating environmental impacts				**45,000,000**
Total for Operation Phase				**59,650,000**

14.7 Decommissioning Phase

The following costs are current once for decommissioning a similar plant. The estimated costs shall require review upwards due to increased inflation and change of other factors like technological developments over time.

Table 14-3: Environmental and Social Management Plan (ESMP) during decommissioning phase

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates (Kshs)
Section E: Negative Environmental Impacts during Decommissioning Phase				
Generation of Solid Waste	▪ Consider possible use of equipment and materials in their current form to minimize generation of waste; ▪ Demolition waste can be recycled or reused to ensure that materials that would have otherwise been disposed of as waste, are diverted for productive uses; ▪ Development and application of a circular economy and an integrated solid waste management plan/ strategy in managing solid waste materials i.e., through a hierarchy of options: 1. Source reduction 2. Reuse 3. Recycling 4. Combustion 5. Sanitary land filling.	Contractor	One off	2,500,000
Impacts related to air and noise pollution	▪ Use of PPEs such as dust masks by demolition crew. ▪ Mobilize the ideal amount of equipment for the demolition works. ▪ Ensure that the equipment mobilized are serviceable. ▪ All the vehicles and machinery should be operated in compliance with relevant vehicle emission standards and manufacturer's specification to minimize noise pollution. ▪ Ensuring a scheduled time for major repairs and making use of noise barriers during that time. ▪ Turn-off equipment and vehicles that are not in use. ▪ All machine operators and workers to be provided with appropriate PPEs.	Contractor	One off	5,000,000

Key Impacts	Mitigation Measures	Responsibility	Monitoring Frequency	Cost Estimates (Kshs)
Sub-total for mitigating environmental impacts				**7,500,000**
Section F: Negative Social Impacts during Decommissioning Phase				
Losing work and business opportunities	▪ Before closing the power plant, the proponent should provide counselling and specialized skills to the workforce especially the Locals to enable them to remain productive to sustain their livelihood;	KenGen	Continuous	1,500,000
Occupation, Safety and Health concerns	▪ Prepare an Occupational Safety and Health Plan (OSH) for decommissioning purposes; ▪ Take steps to prevent accidents, injuries, and disease in the course of work; ▪ Ensure all contractors and sub-contractors working on the site or in the immediate vicinity of the Project activities comply with the Project's OSH policies; ▪ Provide OHS orientation training/induction to all employees for awareness of basic hazards, site-specific hazards, safe working practices, emergency procedures; ▪ Provide workers with readily available information about the chemical composition of fluids or chemicals they may come in contact with and an explanation of potential implications for human health and safety.	Contractor		1,500,000
Sub-total for mitigating social impacts				**3,000,000**
Total for Decommissioning Phase				**10,500,000**

14.8 Summary of ESMP Costs

Below is the summary of estimated costs for the following 3 phases of the project cycle:-

- ***Construction Phase (2 Years)***
- ***Operation Phase/ cost per Annum***
- ***Decommissioning Phase***

Table 14-4: Summary of Environmental and Social Management Plan (ESMP) costs

SN	Total ESMP Costs	Estimated Total Cost (Kshs)	Estimated Total Cost (USD)
1	Construction Phase (2 Years)	81,750,000	545,000.00
2	Operation Phase/ cost per Annum	59,650,000	397,667.00
3	Decommissioning Phase	10,500,000	70,000.00

1USD = Kshs. 150 (November 2023)

Note: All site negative impacts shall be mitigated by the contractor while KenGen shall focus on all issues outside the site (especially social issues). Normal supervision of the project shall be done using KenGen environmental and social safeguards staff under their employment terms.

15 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (ESMMP)

15.1 Introduction

This section of the ESIA presents the Environmental and Social monitoring and follow-up programs that should be implemented to ensure general and specific mitigation measures during construction activities and their long-term success at the operation phase are adequately applied. The Monitoring programme in the table below was developed taking into cognizant the following: frequency of monitoring; personnel; recording; equipment; baseline information and data analysis and review. The environmental indicators to be monitored are described in the table below. The monitoring parameters will be revised as the project development proceeds to enable the incorporation of foreseen and unforeseen indicators. On environmental and social monitoring, the Proponent, and the contractor will have monitoring responsibilities.

15.2 Monitoring Standards

All indicators have been captured as parameters to be monitored in the Environment and Social Management and Monitoring Plan (ESMMP). Baseline information has been outlined in Chapter 4. The targets during monitoring will be the National Environment Management Authority (NEMA), World Health Organization (WHO) and any other International Environmental Standards applicable to the project.

Table 15-1

: Environmental and Social Management and Monitoring Plan

Component	Action	Standards / Targets	Location	Frequency	Responsibilities	Annual Cost (Kshs)	Supervision	Monitoring &Evaluation
Ambient Air Quality	Conduct regular visual inspection of construction sites and access roads.	Avoid significant degradation of baseline conditions associated with dust production, equipment and machinery idling, or generating abnormal amounts of exhaust fumes	1. KWS Staff Quarters at Olkaria Gate. (-0.856957°, 36.292625°) 2. KenGen Geothermal Spa. (-0.862305°, 36.295501°) 3. Olomaiyiana Baptist Church. (-0.914379°, 36.305352°) 4. Narasha Primary School (-0.918087°, 36.267166°) 5. Geothermal Training	Continuous during construction activities	Contractor	200,000	Site HSE representative	Proponent, Lenders & NEMA

Component	Action	Standards / Targets	Location	Frequency	Responsibilities	Annual Cost (Kshs)	Supervision	Monitoring &Evaluation
			Centre (GTC) site (-0.824016°, 36.318765°) 6. Project work sites					
H_2S Monitoring	Obtain a mobile H_2S monitoring equipment	Avoid exposure beyond the stipulated standard	1. KWS Staff Quarters at Olkaria Gate. (-0.856957°, 36.292625°) 2. KenGen Geothermal Spa (-0.862305°, 36.295501°) 3. Olomaiyiana Baptist Church (-0.914379°, 36.305352°) 4. Narasha Primary	Continuous during operation activities	KenGen	1,000,000 (one off)	KenGen HSE Department,	Lenders & NEMA

Component	Action	Standards / Targets	Location	Frequency	Responsibilities	Annual Cost (Kshs)	Supervision	Monitoring &Evaluation
			School (-0.918087°, 36.267166°) 5. Geothermal Training Centre (GTC) site (-0.824016°, 36.318765°) 6. The power plant and other nearby villages					
Ambient Noise	Inspect construction site and measure dB levels, at locations where noisy activities are realized close to sensitive receptors (houses,	Respect the noise levels set in the EIA License conditions	Project work sites and neighbouring property boundaries.	Continuous during construction activities	Contractor	200,000	Site HSE representative	Proponent, Lenders &NEMA

Component	Action	Standards / Targets	Location	Frequency	Responsibilities	Annual Cost (Kshs)	Supervision	Monitoring &Evaluation
	schools, etc.) and following reception of specific noise related grievances.							
Surface Water Flow	Inspect construction site and clean crossing and drainage structure when material or waste accumulations are observed.	Ensure adequate evacuation of stormwater from work site and that no water ponds or local flooding appear (refer to the	Project work sites and neighbouring property boundaries.	Continuous during construction activities	Contractor	100,000	Site HSE representative	Proponent, Lenders & NEMA
Flora	Conduct transect surveys across different habitats. Remote sensing using	Maintain Species richness and abundance. Preservation of vegetation cover and	Within project sites	Once, before start of construction.	Contractor	100,000	Site Engineer and Site HSE representative	Proponent, Lenders & NEMA

Component	Action	Standards / Targets	Location	Frequency	Responsibilities	Annual Cost (Kshs)	Supervision	Monitoring &Evaluation
	satellite imagery	composition. Prevent invasive species. Preservation of endemic and threatened species. Preservation of associated critical ecosystems						
Fauna	Use camera traps for mammals. Bird counts and point transects. Radio-tracking for	Ensure population size and distribution of key species, threatened species, endemic species,	Within project sites	Once, before start of construction	Contractor	No additional costs	Site Engineer and Site HSE representative	Proponent, Lenders & NEMA

Component	Action	Standards / Targets	Location	Frequency	Responsibilities	Annual Cost (Kshs)	Supervision	Monitoring &Evaluation
	selected species.	feral species, special concern species is not affected by the project						
Soil	Conduct annual soil monitoring	Ensure soil is not contaminated by chemicals	Within project sites	During operation of the project	KenGen	50,000	KenGen HSE Department,	Lenders & NEMA
Grievances	Develop, implement and operate a gender-sensitive grievance redress mechanism in compliance with IFC PS1 for general population potentially affected by	Respond to and close all grievances received.	Mainly from local areas surrounding the work site but all grievances must be considered.	Continuous during construction and operation activities.	KenGen	No additional costs	Site HSE representative	Proponent, Lenders & NEMA

Component	Action	Standards / Targets	Location	Frequency	Responsibilities	Annual Cost (Kshs)	Supervision	Monitoring &Evaluation
	construction activities, including reports of GBV.							
Mobility and Livelihoods	Evaluate the effectiveness of the Traffic Management Plan.	Working areas are clearly indicated; transport routes are optimized; diversion roads do not block access to health services; key economic activity locations (e.g., access to suppliers, business and major tourism locations, and	Entire working sites	Continuous during construction activities.	Contractor	200,000	Site HSE representative	Proponent, Lenders & NEMA

Component	Action	Standards / Targets	Location	Frequency	Responsibilities	Annual Cost (Kshs)	Supervision	Monitoring &Evaluation
		economic outlets) and sociocultural activity locations.						
Gender Relations	Ensure fair representation of both men and women in employment opportunities.	Aim at employing women who are often overlooked in as many of the construction work fields as possible.	Entire construction workforce and working sites	Continuous during pre-construction and construction activities.	Contractor	No additional costs	Contractor's Human Resource Agent	Lenders and Proponent's Human Resources Agents
	Ensure equal payment for male and female workers for equivalent jobs and qualifications.	100% pay parity	Entire construction workforce and working sites	Continuous during the entire project cycle	Contractor	No additional costs	Contractor's Human Resource Agent	Lenders and Proponent's Human Resources Agents
Worker Health and Safety	Provide all workers with Health and	100% of workers sensitized on Safety	Entire construction workforce	Continuous during construction activities.	Contractor	No additional costs	Site Engineer and Site HSE representative	Proponent, Lenders & NEMA

Component	Action	Standards / Targets	Location	Frequency	Responsibilities	Annual Cost (Kshs)	Supervision	Monitoring &Evaluation
	Safety sensitisation							
	Assess the proportion of work accidents duly reported.	100% assurance of safety techniques effectiveness and to aid in developing more solutions.	Entire construction workforce	Continuous during construction activities.	Contractor	No additional costs	Site Engineer and Site HSE representative	Proponent, Lenders & NEMA

The list of the environmental parameters and their measurable indicators will guide the proponent to access the effective level of the environmental monitoring plan and need to modify it for appropriate action.

16 CONCLUSION AND RECOMMENDATIONS

The Proposed Project is environmentally feasible and has the potential to benefit the local community and the whole nation at large through providing energy to the national grid.

The ESIA has identified several issues pertaining to the proposed project. The issues/impacts have been assessed and described in detail to gain an adequate understanding of possible environmental and social effects of the proposed project – from design to decommissioning, in order to formulate mitigation measures in response to negative aspects which have emerged. ESIA findings indicated that direct impacts will be moderate and limited to the immediate surroundings of the project site.

The Environmental and Social Management Plan (ESMP) identified mandatory prevention and mitigation measures. The ESMP should be implemented as a prerequisite for a positive Record of Decision (RoD) by the appropriate authorities. The Environmental and Social Management and Monitoring Plan (ESMMP) provides parameters to be monitored, responsibilities, frequency and associated budget. The consultant is recommending that the Project Implementing Agency assigns its technical team to undertake the monitoring of the mitigation measures for the project through its existence. This way the proponent will achieve sustainable project implementation at reduced cost for undertaking the monitoring. The figures given are an absolute maximum such implementation and monitoring could cost. However, regular internal monitoring shall be carried out by the project proponent.

Given the nature and location of the project development activities, the conclusion is that the potential impacts associated with the proposed development are of a nature and extent that can be reduced, limited and eliminated by the application of the proposed appropriate mitigation measures hence the proposed project shall be successfully implemented with adherence to the recommendations made in a bid to realize its numerous benefits.

Recommendations

In reference to the foregoing, the following key recommendations are made in relation to the proposed project:

i. The proponent to ensure that any new wells to be drilled in relation to this project in the future shall be subjected to an Environmental and Social Impact Assessments;
ii. All project construction activities should be restricted within the designated project sites;
iii. The proponent shall adhere to the project's Stakeholder Engagement Plan (SEP) during all phases of the project; and
iv. The proponent shall implement the Grievance Redress Mechanism in place for the proposed project.
v. All site negative impacts to be mitigated by the contractor while KenGen focus on all issues outside the site (especially social issues).

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18 ANNEXES

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