Environmental and Social Impact Assessment Study for the proposed Geothermal Exploration Drilling for Sosian Energy Makongeni/Menengai Geothermal Project, Nakuru County, Kenya

8th November 2019

AUTHETICATION

I, **Prof. George Krhoda,** on behalf of Research on Environment and Development Planning Consultants Ltd. submit the following Final Draft Report, for the Proposed. To my knowledge all information contained in this report is accurate and a truthful representation of all findings as relating to the project.

Signed at NAIROBI on this **8th** day of **November** 2019

Position: **Managing Director**

Signature:……Date: **8th November 2019**

Research on Environment and Development Planning (REDPLAN) Consultants Ltd., a registered firm of experts by the National Environment Management Authority (License No.), confirms that the contents of this report are a true representation of the Environmental and Social Impact Assessment (ESIA) of the proposed Sosian Energy Makongeni/Menengai Geothermal Project, Nakuru County, Kenya.

Signed by the Firm of Experts:

Name: **Research on Environment and Development Planning (REDPLAN) Consultants Ltd.**

NEMA Registration No…**6111**

Signature:**……**Date: **8th November 2019**

SUBMISSION OF DOCUMENTATION

I, ...on behalf of Sosian Energy Company Ltd, receive this Environmental and Social Impact Assessment, Draft Report, for the Proposed Sosian Energy Makongeni/Menengai Geothermal Project, Nakuru County, Kenya

Signed at NAIROBI on this …….. day of …….2010.
Signature…… Designation: ……..

ABBREVIATIONS AND ACRONYMS

AfDB	African development Bank
AIC	African Inland Church
AUC	Africa Union Commission
CBOs	Community Based Organisations
CDM	Clean Development Mechanism
CDP	Community Development Programme
CEO	Chief Executive Officer
CERs	Certified Emissions Register
CFAs	Community Forest Associations
CFC	Chlorofluorocarbon
CITES	Convention on International Trade on Endangered Species
CLO	Community Liaison Officer
CSLO	Community Senior Liaison Officer
CSR	Corporate Social Responsibility
DFID	Department of International Development
DOSH	Director of Safety and Health
EA	Environmental Audit
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EMCA	Environment Management Coordination Act
EMAP	Environmental Monitoring and Audit Programme
EMP	Environmental Monitoring Plan
ESIA	Environmental and Social Impact Assessment
ESAMP	Environmental and Social Management Plan
ESRMP	Environmental Social Risk Monitoring Plan
EU	European Union
FAO	Food and Agricultural Organisation
FOMEC	Friends of Menengai Crater
HCFCGs	Hydrochlorofuorochlone Gases
GDC	Geothermal Development Company
GIS	Geographical Information System
GRMF	Geothermal Risk Mitigation Facility
GT	Gas Turbines
HIV/AIDs	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
ITF	International Trust Fund

KFS	Kenya Forest Service
KfW	*Kreditanstalt für Wiederaufbau*
KIA	Kenya Industrial Authority
KNES	Kenya National Electrification Strategy
KENTRACO	Kenya Electrification Transmission Company
KPLC	Kenya Power and Lighting Company
KWS	Kenya Wildlife Service
M&E	Monitoring and Evaluation
MFIs	Multilateral Financial Institutions
MSD	Medium Speed Diesel
MW	Mega Watt
MWESCO	Menengai West Stakeholders' Forum
NCGs	Non-Condensable Gases
NEPP	National Electricity and Petroleum Policy
NNE	North North East
NAWASCO	Nakuru Water Supply and Sewerage Services
NARUWASCO	Nakuru Rural Water Supply and Sanitation Services
NEMA	National Environment management Authority
MTP	Medium Term Plan
NGOs	Non-Governmental Organisations
NNW	North North West
ODS	Ozone Depleting Substances
OP	Operation Directive
OSHA	Office if Safety, Health and Accidents
PD	Public Disclosure
PPE	Personal Protective Equipment
PSV	Public Service Vehicle
RVCA	Rift Valley Catchment Area
SEP	Stakeholders' Engagement Plan
SREP	Scaling-up Renewable Energy Programme
SSE	South South East
S&H	Safety and Health
SPRCP	Spill Prevention Response Countermeasures Plan
TGH	Temperature Gradient Holes
TVA	Tectono-volcanic axes
WHO	World Health Organisation
WRUAs	Water Resources Users Association
UNCCD	United Nation Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UNESCO	United Nations Educational and Scientific Organisation

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EXECUTIVE SUMMARY

Introduction

Sosian Energy Limited (SEL), a renewable energy development company with interest in geothermal, wind, and solar energy production has been granted a Geothermal Resources License No. 8/2017 for exploration and development of the geothermal resources in the area. The license area covers about 9.8 km^2 in Makongeni/Menengai area, Nakuru County mainly consisting of large farms for which wheat cultivation, horticulture and dairy farming are the main agricultural activity.

Project activity

The present project activities considered during resource exploration phase are limited compared to the total development and operation of geothermal power. However it is a requirement by EMCA 2016 that environmental and social impacts be done to conform to national and international standards of execution. The activities will consist of the following:

- Preliminary survey;
- Drilling of Thermal Gradient Holes (TGH) (no. 3) to a depth of 200m using light truck-mounted rotary or diamond core rigs drilled without BOPE. for ground temp gradient to help site deep exploration wells
- Water wells (no 4) to provide water for drilling exploration wells
- Exploration drilling (no 3) to depth of about 2.7 km; expected to start in 2020

Objectives of ESIA

The objectives of ESIA are to:

a) Collect and analyse baseline information on the biophysical and socio-economic characteristics of the project area to reflect the current status.
b) Identify and assess compliance of project activities with relevant statutory and internal requirements. The key ones being:
c) National Legislative and Regulatory frameworks;
d) International Protocols and regulatory frameworks; and
e) Multilateral Financing Institutions (MFIs) more specifically KfW, AFD, World Bank, IFC, AfDB, AUC-GRMF, amongst others.
f) Describe and scope potential environmental, ecological and socio-economic impacts of drilling of exploration wells and development of the associated energy infrastructure.
g) Carry out public consultation and disclosure; develop and implement Stakeholder Engagement Plans (SEP) & Community Development Plan (CDP);
h) Identify measures for mitigating negative impacts of the project associated with drilling of Thermal Gradient Holes (TGH) and geothermal exploration wells.
i) Develop a detailed and up to date Environmental and Social Management Plan (ESMP) and mitigation plan including cost of mitigation measures for drilling operations; and
j) Establish mechanisms for Monitoring and Evaluation (M&E) of compliance, time frame and costs for implementing M&E.

Methodology

The general methodology for the present ESIA was a five-step process starting with identification of project activities and programme of action. This was followed by baseline data and information gathering and identification of environmental (physical and biological aspects) and social (human aspects) parameters and existing pressures. The stakeholders contributed to the discussion on environmental and social issues during stakeholders' consultation process. The third step involved identification and prediction of any potential positive and negative impacts that may result from project activities during its life cycle, based on the impact assessment criteria and rating scales. In the fourth step, the predicted impacts were evaluated using an objective significance ranking process. In the fifth step, the cumulative impacts was assessed the data from which has been used to develop the Environmental Management Plan (EMP) and Environmental Monitoring Action Plan (EMAP).

The ESIA was conducted in accordance with the national legal requirements and policy direction as stipulated by the Environmental Management and Coordination Act, 1999 revised 2016 and other pertinent legislations, regulations and standards governing the environmental quality, health and safety, protection of sensitive areas, land use control at the national and local levels and ecological and socio-economic issues. Additionally, the ESIA has considered in detail international standards and regulations relevant to geothermal development and these included:

- World Bank Environmental and Social Safeguard policies;
- KfW Development Bank Sustainability Guidelines/Standards 2014
- IFC Performance Standards, 2012
- IFC General Guideline on Environment, Health and Safety, 2007
- IFC Environment, Health and Safety for Geothermal Power Generation, 2007

Special emphasis was given to:

i. IFC Environmental and Social Performance Standards (PS) including:
   a) PS1: Social and Environmental Assessment and Management Systems
   b) PS2: Labor and Working Conditions and ILO Core Labour Standards
   c) PS3: Pollution Prevention and Abatement
   d) PS4: Community Health, Safety and Security
   e) PS5: Land Acquisition and Involuntary Resettlement
   f) PS6: Biodiversity Conservation and Sustainable Natural Resource Management
   g) PS7: Indigenous Peoples
   h) PS8: Cultural Heritage

ii. World Bank Group's Environmental and Health and Safety Guidelines including:
   a) General EHS Guidelines
   b) EHS Guidelines for Geothermal Power Generation
   c) World Bank Safeguard Policies

The ESIA Report gives a description of baseline information of the project area, legislative and regulatory frameworks for geothermal development, summary of positive and negative impacts of the proposed activities recognising the views of stakeholders in the area.

General conclusions

1) The project site is situated in private land, hence there will be no land acquisition nor resettlement required.
2) There are social groups in the vicinity of the geothermal power plant that have complained about the establishment of geothermal plant due to their previous encounters with other geothermal firms. This has led to distortion of facts and cynicism amongst the community. There will be need for awareness creation and information sharing amongst the community in order to gain acceptance of the geothermal plant in the area. Public participation is therefore crucial for the success of the investment.
3) The project site neither requires bush clearing nor land leveling. Instead the Sosian Energy Ltd. will reforest the unused property areas to mitigate global warming and provide sustainable timber stock for local market. The green areas could also become part of the recreation circuit, to which combined with Menengai Caldera, will offer a bouquet of adventure for visitors to the geothermal plant.
4) At the construction phase, use of heavy machinery may generate environmental and safety issues including need to widen the access road thus generating dust, excessive noise and vibrations, raising occupational and general public safety and health issues emanating from construction traffic, working at heights, exposure to heat during metal fabrication. These issues have been mitigated using current regulations governing construction and site management.

Recommendations

1) <u>On Solid Wastes management</u>

The management will use principles of Sustainable Waste Management Hierarchy as its foundation so that on-site efforts will concentrate on reuse, recycling, minimization of packaging material, reduction in size of waste material. Minimization of waste material centres on reducing packaging materials - use of large packaging such as bulk cement, barite or bentonite. The volume of the waste material will be reduced via on-site compaction. This will reduce the number of vehicle movements required for waste removal, as well as reducing the size of the landfill/dump site required. Landfilling, if approved by the County Government and NEMA, is a low-cost, low tech method that does not require wastes to be transported away from the project site, and, therefore, it is a very attractive option for the proponent. Once the pit locality is closed, the area will be graded to prevent accumulation of water, revegetated with native tree species.

2) <u>On Liquid waste materials</u>

The geothermal fluids which are geothermal brine and condensate from the cooling tower are injected back into geothermal reservoirs. The potential risk of groundwater pollution (mainly the deep aquifers) is minimal and if an accidental spill of geothermal brine occurs may affect only surface waters and so must be avoided by all measures. However, it will be possible to reinject 100% of brine once power plant is operational.

3) On Domestic and office waste

The company will establish offices and on-site camp accommodation for employees for which a on-site septic tank or soak pit will be established during drilling operation. The Contractor will ensure that the installed system meets national requirements and international industry standards. Office waste will be recycled or disposed of appropriately.

4) On induced seismicity and subsidence

Seismic events are generally of low magnitude of about 2 or less in the area (Hamilton et al, 1973). In the Menengai Caldera area, no significant recent seismic events have been recorded and there is no likelihood of a destructive magnitude Mc > 5 earthquakes occurring within the study area. A continuous seismic monitoring of the magma activities beneath the area has been recommended as a basis for an early warning system. Injection technology is available and employed at all geothermal sites that would minimize potential subsidence.

5) On land degradation and erosion hazard

Project activities such as road construction and well drilling will more or less move earth. This may expose the project site to soil erosion by wind and runoff. The project will minimize soil disturbance and instead carry out aforestation during all phases (exploration, development and operation) of the project, institute erosion control measures, where possible, and management of stormwater.

6) On vehicular movements and increased traffic

Vehicular movements and earth works during the road construction and drilling normally produce dust, increases toxic fumes. Procedures must be put in place to communicate EMS compliance to staff including contractors. The increase in vehicular and pedestrian movement increased the number of accidents.

7) Air quality and pollution control

Air quality may be disturbed by either dust from the vehicular use and construction site as well as pollution from emissions arising from drilling rigs and vehicular movements. Direct emission sources will include rig generators, vehicles and machinery while indirect emission are from fugitive emissions such as chemical leaks, and fabrication of materials. Dust is from road expansion and construction of new ones, vehicles and murrum road. During drilling boreholes and exploratory drilling of TGH and production wells dust and emissions from the rig may generate toxic fumes. Besides mitigation measures suggested, the proponent will ensure that there is extensive pre-planning to ensure that the required equipment, materials and personnel are available at the right location and at the correct time.

8) On Odour from hydrogen sulfide (H_2S)

Hydrogen sulphide (H_2S) can represent an odour nuisance at low concentrations but only toxic at concentrations above 0.002 ppm (Heath, 2002). Air emission from drilling is minor and mainly caused by fumes from diesel generator and dust from vehicular movement. During well testing, there might be insignificant amounts of CO_2, SO_2 and other gases discharged from the wells. The gases would eventually vent into the atmosphere under natural conditions although at much lower concentrations.

Re-injecting the geothermal fluids back into the reservoir diminishes the possible release of gases into the atmosphere. In low temperature utilization, CO_2 found in geothermal fluids could prove beneficial in direct use greenhouse applications as a growth stimulant. As a result of these environmental benefits, geothermal energy is a candidate for Clean Development Mechanism (CDM) of the Kyoto protocol, which would be an added incentive to the development of the resource.

9) On impacts on the economy

The geothermal power plant contributes to the generation of low cost electric energy which also contributes to the average annual growth in energy to the country and Nakuru County.

10) On population growth and housing demand

Residents of the surrounding areas to the geothermal power plant will arrive to seek for work at the plant. The total population of the municipality of Nakuru especially the small trading centres in the sub County of Menengai will likely increase. As a result there will be increased demand for housing, goods and services in the sub County. Other factors of migration to these areas include people travelling from inside of the county to settle in the areas around the geothermal power plant. Besides increased demand for services, there will be need for integration of new immigrants to the area to avoid and conflicts in future.

11) On youth employment

One fundamental request during the Stakeholders' consultation was challenge of youth unemployment. Recruitment of personnel required for the operation and maintenance of the geothermal equipment is primarily insular to the region.

12) On public health, safety and accidents

With increased single construction workers residing in the small trading centres, there will be potential spread of HIV/AIDs and other Sexually Transmitted Infections (STIs) There will be need for health awareness training and increased demand for health services. Road accidents may increase however the accidents should be mitigated through enforcement of speed limits and erection of bumps, humps and barriers to force drivers to slow down. Proper signage will also be erected along the accident prone sections.

13) On Fire risk and other hazards

Fire risk and other hazards will be common in areas such as the cooling towers, turbine and generator rooms, office premises, workshops, car parks and stores, most of which will be completed at the construction phase of geothermal development. For fire risk mitigation, a comprehesive fire response system will be installed including placement of fire hydrants at various places especially within the power station, office blocks, stores, workshops, and car parks.

14) On Noise Pollution

A standardised system of noise monitoring will ensure that equipment is adequately calibrated and levels are within occupational limits. For effective noise control, the main focus will be on control at source supplemented with control at pathway. Noise control measures will include distance from noise source; use of noise control techniques(using acoustic machine enclosures; selecting structures according to their noise isolation effect to envelop the building; using mufflers or silencers in intake and exhaust channels; using sound absorptive materials in walls and ceilings; using vibration isolators and flexible connections (e.g., helical steel springs and rubber elements); applying a carefully detailed design to prevent possible noise leakage through openings or to minimize pressure variations in piping); and modification of the plant configuration or use of noise barriers.

15) On aesthetic impacts

The existing farmland with livestock will significantly change and a significant deterioration shall be observed in the vegetation cover in case there are no interventions. The study recommends increase in vegetation cover in the area. Reforestation methods and increase in tree cover will mitigate some of these consequences.

16) Impact of bright lights

Appropriate lighting is used to ensure visual work can be done accurately, safely and in comfort; to increase timely production, and to enhance security and to promote the health and wellbeing of workers; to make the workplace an attractive and pleasant environment. There will adequate lighting during construction and generation of power. There will be lighting controlds to ensure that the public are shielded from the glares of light during the nights.

17) Tourism and recreation

Geothermal energy developments generally attract educational tourism worldwide (Goof, 2000) and the present project is included. Tourism will increase as a result of the geothermal power development in the area.

18) Enhanced Environmental Health and Safety

Sosian Energy Ltd will develop its own Environmental Health and Safety **(**EHS) policy with procedures for all likely injuries, alcohol drugs and weapons; adverse weather conditions; fire prevention; security issues, emergency preparedness in terms of drills with varying frequencies, e.g. monthly for fire and annually for incidents such as earthquakes according to International standards. The policy will include formations of safety committees and their operation; the use of all forms of PPE, fall protection in terms of ladders, working at elevated heights; environmental aspects such as incidents regarding steam, waste, uncontrolled air emissions, peak noise emissions etc.

A summary of impacts and mitigation measures of Sosian Energy Inc. Geothermal Development Project

Surface and groundwater management	• Ensure disposal of geothermal brine by either reinjection into wells or storage in protected ponds. • Ensure that all wells are cased to reduce contamination of shallow groundwater reservoirs; • Ensure effluent treatment, careful storage of waste water; • Use of geothermal fluids or recycle wastewater rather than freshwater for cooling purposes, • Case all wells with steel casing and cement to isolate fluid from environment and ground water resources; and • Carry out an EIA for establishing any dump site.
Water supply and Augmentation	• Use brine or steam condensate from the first well for drilling. • Drill water boreholes • Promote roof water catchments and reduce competition for water • Increase water harvesting by providing more water storage facilities within and outside the project area. .
Conservation of Fauna and Flora	• Ensure that direct reinjection method completely isolate any conditioning ponds from plants and animals; • Ensure proper cementing and pressure monitoring; Institute appropriate blowout preventers and related well control equipment until drilling operations are completed.
Air quality control	• Control dust, vehicular fumes, H_2S, and other thermal gases • Use of protective emergency gears such as eye goggles is recommended. • Provide appropriate warnings at work site. • Provide and clearly display emergency contacts. • Develop and implement detailed and site specific Emergency Response Plans. • Provision of adequate ventilation of occupied buildings to avoid accumulation of hydrogen sulphide gas. • Regularly maintain construction plant and machinery. • Sensitize construction workers on suppression of idling vehicles and machinery. • Install direct contact cooling tower where the H_2S is oxidized and trapped. • Establish closed-loop systems where possible so that gases removed from the well are not exposed to the atmosphere but are injected back into the ground to reduces air quality contamination;

	• Eliminate any enclosed area, where hydrogen sulfide will be resident whenever there is no wind; • Consider use of geothermal non-condensable gases as a soil amendment and fertilizer feedstock. • Train workers on the dangers of exposure to elevated H_2S levels; • Install H_2S monitors with alarm system including use of personal monitors by staff in potentially dangerous areas • Liaison strategy for communication with communities who may be affected by odour nuisance.
Agriculture Ecosystem	• Use hydrogen sulphide as a growth-stimulating, fertilizing effect on some plants where possible;
Soil degradation	• Prevent soil erosion during upgrading and construction of access road • Regularly water roads to avoid the impact of dust. • Establish maintenance responsibilities and ensure that road rehabilitation takes place.
Solid waste management	• Establish solid waste management for the site. • Waste Management Hierarchy as its foundation, i.e., Waste Reduction, Reuse, and Recycle. • Receptacles shall be provided for waste storage prior to collection. • Resource recovery will be encouraged once the project takes off so as to shrink waste stream and recover non-recyclables. • Refuse collection vehicles will be covered to prevent scatter by wind. • All persons involved in waste collection shall be in full protection attire.
Noise pollution and vibrations	• Keep machinery in high maintenance to reduce vehicular noise; • Generally localized, use of silencers/mufflers in masts, sound proofing • Communication with communities who may be affected by odour nuisance • Develop a tree nursery to provide free seedlings for replanting in the project site and to the neighbouring communities. • Prior to the commencement of works, require contractors to carry out a baseline noise survey for one week, on a 24-hour basis; • Equipment vendors will be required to guarantee optimized equipment design noise levels; • Acoustic attenuation devices should be installed on all ventilation outlet and high pressure gas or liquid should not

	be ventilated directly to the atmosphere, but through an attenuation chamber or device; • Vibrating equipment must be on vibration isolation mountings; • Develop a plan to monitor noise levels and respond to complaints and mitigate impacts. • A reforestation program that aims to reduce noise levels in critical areas of the geothermal field. • Silencers are used to reduce noise emissions to allowable levels.
Vehicular traffic congestion	• Movement of heavy construction traffic should be planned appropriately. • Expand road width, murrum to all weather, • Establish the speed limits; • Establish maintenance responsibilities and ensure that road rehabilitation takes place
Health and Safety/diseases	• Potential spread of HIV/AIDs and other sexually transmitted infections • Increase capacity of dispensary, expand existing hospital, and establish first aid and ambulance services. • Health and safety training, control speed on roads in market centres and schools' crossings
Fire hazards and fire outbreaks	• Put in place fire surveillance and early warning system to raise alarms during high fire hazard seasons. • Carry out fire drills regularly; • Provide First Aid kits.
Population/demography	• Establish a recreation and education centre
Housing/settlements	• Increased investment and business appetite for increased demand for goods and services in the community; • Incentive for increased educational programmes, awareness raising to locals.

CHAPTER 1: THE PROJECT BACKGROUND

1.1 Geographical Setting

Menengai is 10 km north of Nakuru, the fourth-biggest city in Kenya. Nakuru County is one of the 47 counties of the Republic of Kenya lying within the Great Rift Valley and covers an estimated area of 7,495.1 km². It is located between longitude 35 º 28` and 35º 36` East and latitude 0º 13 and 1º 10` south. The area known as Sosian Energy Makongeni/Menengai Geothermal Prospect covers the area due north and north-west of the Menengai Caldera. The prospect lies outside of the caldera wall and extends to the upper slopes of the Ol'rongai hills and is part of the Greater Menengai Geothermal area. The proprietor is the Sosian Energy Limited (SEL), a renewable energy development company with interest in geothermal, wind, and solar energy production. Ministry of Energy granted SEL a Geothermal Resources License No. 8/2017 for exploration and development of the geothermal resources in the area. SEL is desirous in developing the concession for 70 MWe out of the possible 140 MWe in line with the geothermal resources license. The license area covers about 9.8 km^2 mainly consisting of large farms for which wheat cultivation, horticulture and dairy farming are the main agricultural activity.

1.2 The Project Area

The prospect lies just outside of the Menengai caldera and within the area traversed by the NW trending tectono-volcanic axis (TVA) variously referred to as Molo TVA (Williams, et al, 1984). The Menengai volcano is located at the intra-continental crustal triple junction north of the Nakuru-Naivasha basin where the Nyanza rift joins the Kenya rift. Geothermal Development Company (GDC) has drilled geothermal wells in the Menengai caldera with a total power generation capacity of more than 130 MW of electric energy, which it intends to sell the steam to three independent power producers (IPPs) to build three geothermal power stations, each with capacity of 35 MW. The power stations are Menengai I Geothermal Power Station - owned by Orpower Twenty Two, Menengai II Geothermal Power Station owned by Quantum Power East Africa, and Menengai III Geothermal Power Station owned by Sosian Energy Ltd.

1.3 Project Development Objective

Geothermal, as a source of energy, is reliable; affordable; clean, sustainable, and the least cost source for Kenya. Kenya's total installed power capacity in 2018 stood at 2,997 MWe with a basket mix of 35.6% thermal, hydro (35.06%), geothermal (27%), wind (1.1%), and solar and biogas making up the rest. The project aims to contribute an additional 70 MW of electricity to the national grid. In this first phase, and Government policy on Green growth, the planned Sosian Energy plants will be developed in two stages of 35 MWe flash cycle power plant each. Once successfully implemented, the prospect will be evaluated for development of further 70 MWe to reach targeted maximum of 140 MWe. Each well has an estimated production of 5 to 30 MWe.

Figure 1.1: Drilling sites for GDC in the caldera floor

Source: Geothermal Development Company

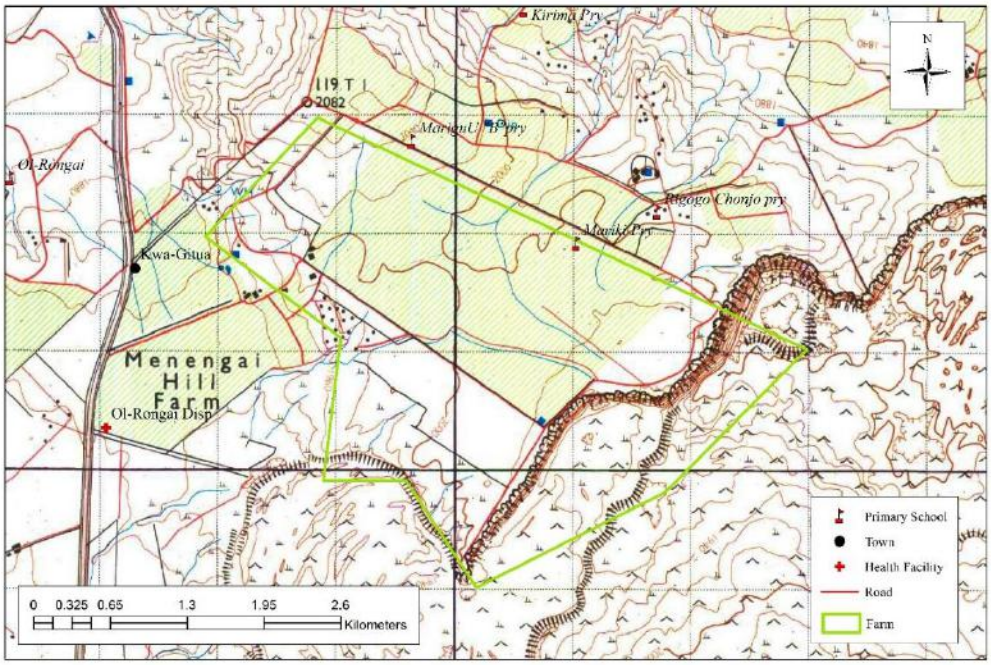


Figure 1.2: The Project site for Sosian Energy Makongeni/Menengai Geothermal Prospect

1.4 Justification of the Project:

Electricity is an enabler of the Big 4 Agenda and power production in Sosian Energy Makongeni/Menengai, Nakuru County will contribute to economic and social development in the region. Kenya has 5,000MWe to 10,000MWe that can be generated from geothermal sources clustered in three (3) regions namely the Central Rift (1,800MW), South Rift (2,450MW) and North Rift (3,450MW) (Ministry of Energy, 2017). Geothermal energy cannot be depleted, when managed

properly, and electricity generated from this project will not only firm and lead to reliable base load which will help to stabilize the voltage in the region but also reduce electricity tariff in the country because it is cheaper than the cost of electricity from oil based and other sources of energy. The environmental benefits of the project include reduced release of greenhouse gases that are responsible for climate change.

The security of energy supply especially electricity generation in Kenya seems to be threatened by the impact of climate change, chiefly by drought which negatively impacts hydropower and silt-laden rivers during floods. Inadequate electricity generation capacity and high power bills have been perennial problems in Kenya prompting the Government to explore various ways of tackling the deficit. A shift towards clean and renewable sources of energy such as geothermal power which is environmental friendly and more affordable to run will insulate the country against the effects of drought, which has been the major source of installed power. This is also in tandem with the power energy expansion plan up to 2030 that, according to report on Least Cost Power Development Plan (2017-2037), indicates that 26% of the total installed capacity will be obtained from geothermal, 19% from nuclear plants, 13% from coal plants and 9% from imports. Wind and hydro plants will provide 9% and 5% respectively while medium speed diesel (MSD) and gas turbines (GTs) - LNG plants will provide 9% and 11% of the total capacity respectively. This justifies the immediate need to increase geothermal capacity from the current 865MW to 5,530 MW (26%) in 2030 for which Sosian Energy hopes to contribute in narrowing the gap to meet the rising demand and move in tandem with economic growth projections.

1.5 Other alternative solutions

In comparing the contribution of other sources of energy, geothermal energy source is the least contributor to carbon dioxide, CO_2E that causes global warming and climate change. Burning natural gas for electricity releases between 0.6 and 2 pounds of carbon dioxide equivalent per kilowatt-hour (CO_2E/kWh); coal emits between 1.4 and 3.6 pounds of CO_2E/kWh. Wind, on the other hand, is responsible for only 0.02 to 0.04 pounds of CO_2E/kWh on a life-cycle basis; solar 0.07 to 0.2; geothermal 1 to 0.2; and hydroelectric between 0.1 and 0.5 (IPPCC, 2011).Other alternative solutions have been considered and rejected for the reasons summarized in Table 1.1. The supply for electricity is currently about 85% of the total demand. Working towards reducing the power gap, through investments in hydro-plants, geothermal, wind and solar sources among other initiatives, the government anticipates growth in demand and plans to provide diversification of energy sources. Not constructing the geothermal power plant would inhibit social and economic benefits accruing from improved electric power supply from clean and cheap sources such as geothermal, solar and wind to bringing down the cost of power to below 10 US cents from the current average cost of 17.92 US cents per kilowatt hour per unit for domestic households. No option alternative is therefore appropriate. The energy plan is expected to expand with geothermal power contributing significant proportion. Sosian Energy would be well positioned to play a critical role in achieving the national target.

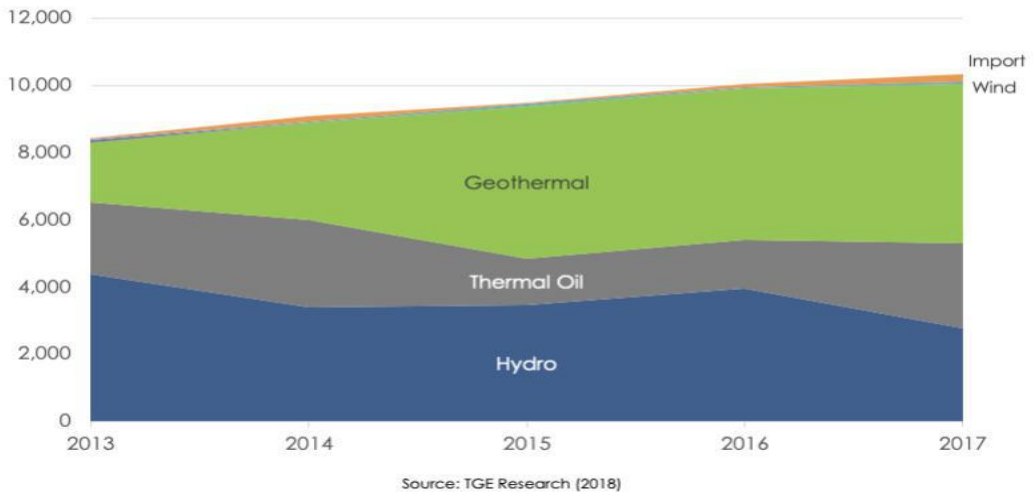


Figure 1.3: Growth of geothermal energy development in Kenya, 2013-2017

Source: Think Energy. 2018. Geothermal Energy in Europe and the Rest of the World Geotermikonference På Christiansborg Alexander Richter | Thinkgeoenergy 19 February 2018. See also Table 4.3 - Electric Power Generation Sources and Energy Generated, Government of Kenya, Energy Policy, 2018.

Geothermal generation accounted for the highest production of the total electricity produced in 2017 with a share of 45.9%.

Table 1.1 Project Alternatives and Reasons for Rejection Alternative

No.	Type of source/ Installed Capacity (MW)	Challenges and issues
1.	Hydropower 816 (36.0%)	• Construction of new hydropower projects are capital intensive. • Vulnerable to large variations in rainfall and climate change. • Potential negative environmental and social impacts. • Limited potential for scale-up.
2.	Thermal sources (Diesel engines). 697.5 (31.2%)	• High operation costs. • Highly dependent on international oil price fluctuations. • Negative environmental and social impacts.
3.	Coal	• Local coal deposits have been reported in Kitui County and Mwingi sub county. Expected to generate 981.0 (13.6% by 2030). • For now, Kenya will have to rely on imported coal which poses a number of challenges such as shipping and port handling logistics. • Potential negative environmental and social impacts. • Limited potential for scale-up.
4.	Wind. (25.1 MW, 1.1%) 350 MWe	• Progress at Lake Turkana (310MW), Kipeto (100 MW), Isiolo (100 MW), Meru (60 MW), Ngong (51 MW) and the Baharini Electra Wind Farm project in Lamu (90 MW) • Expected to increase to 861.6 MW (11.9% in 2030). • Low availability factor (<35%); intermittent supply

5.	Solar power	• The 40MW at Garissa. • Expected to generate 782.35 MW (10.8% in 2030) • Low availability factor, intermittent supply
6.	Nuclear – not in production until 2037)	• Nuclear generating units are characterized by high capital investment and long lead times. • Fraught with many barriers, risks and challenges - political, environmental and social as well as technological.
7.	Power imports from neighbouring countries	• National security. • Limited potential for scale-up (the capacity of the Kenya Ethiopia interconnection line will be limited to 2,000 MW) (Kazimierczuk, 2019). • High tariff • Intermittency during periods of adverse weather in source countries
8.	Geothermal 865 MW 26% of installed capacity (2019) and 47% of power consumed	• Not affected by drought and climatic variability; • Highest availability (capacity factor) at over 95 %; is green energy with no adverse effects on the environment; • Indigenous and readily available cf. thermal energy that relies on imported fuel. • Lowest cost for Kenya (LCPDP, 2011) • It is a baseload power -very reliable source power • Its cheap power it lower tariff • There is a lot of savings on foreign forex on dollar
	Co-generation 26 (1.26%)	Presently limited in scope and will have insignificant contribution.

Sources: Sutter *et al*, 2013: Least Cost Power Development Plan 2017-2037

The strategic plan of the government is to make geothermal sources the base load owing to its abundance (more than 10,000MW) and availability (>95%), reliability, least emissions, savings on foreign exchange and available technology already successful in Kenya. Unlike wind and solar energy, which are more dependent upon weather fluctuations and climate changes, geothermal resources are available 24 hours a day, 7 days a week. In order to meet Kenya's 2030 demand, a total of 5,530 MW of geothermal power or 26% of total capacity is planned. Other uses of geothermal resource is in direct use applications including crop dehydration (maize, onions, wheat, etc.), Greenhouse use, milk and pyrethrum processing in the predominantly agricultural region in Nakuru County and balneo-therapy for the tourism industry.

Table 1.2: List of specialist in the ESIA Study

No.	Name	Specialisation	Qualifications
1.	Prof. George Krhoda	Geomorphologist/Hydrologic Modelling, EIA Expert	B.Ed (Hons), M.A, PhD
2.	Dr. Dalmas Omiah	Anthropologist/Socialogist/Gender Expert	B.A, M.A, PhD
3.	Dr. Shadrack Kithia	Hydrologist	B.Sc, MSc, PhD
4.	Mr. Ammon Omiti Ojwang	Geology, Geophysics/Geothermal Resources	B.Sc, MSc.
5.	Ms. Valerie Akinyi Krhoda	Legal Expert	LLB, Diploma Certificate (Project Management)
6.	Ronnie Midigo	Sociologist	B.A, M.A., PhD

CHAPTER 2: PROJECT ACTIVITIES

2.1 Project Components

The project activities relate to Exploration Drilling for Sosian Energy Makongeni/Menengai Geothermal Project, Nakuru County, Kenya. The project cycle for the geothermal project comprises four phases and nine steps. The phases are resource detailed exploration, resource development, and steam gathering system and power plant installation phases. The exploration phase comprises of three development steps, namely, review of existing data, detailed surface exploration and exploration .drilling. The second phase is the resource assessment comprising of two steps, appraisal drilling and feasibility study. The third phase is the construction phase which comprises of two steps, namely, production drilling and construction of the steam gathering pipe network, power plant and transmission line construction. This road map up to power plant commissioning is important for goal setting and for fund raising for the project.

2.1.1 Detailed Surface Exploration

Sosian Energy Limited (SEL) has undertaken detailed surface exploration in the resource area to firm up information and data gathered previously from Geotermica Italiana, KenGen and GDC studies. The recent studies by SEL has determined existence of a geothermal system that should be confirmed by exploration drilling. Thermal gradient holes are required to further derisk the project prior to deep exploration drilling.

The resource development stages shall entail the following activities:

- Development of the necessary infrastructure such as access road, service roads and water supply.
- Resourcing for drilling equipment, drilling for steam and testing of wells.
- Appraisal and feasibility study for power production.

2.2 Project activity plan for resource development

The Exploration drilling for Sosian Energy Makongeni/Menengai Geothermal Project, Nakuru County will consist of the following activities:

a) Preliminary survey;
b) Drilling of Thermal Gradient Holes (TGH) (no. 3) to a depth of 200m using light truck-mounted rotary or diamond core rigs drilled without BOPE. for ground temp gradient to help site deep exploration wells
c) Water wells (no 4) to provide water for drilling exploration wells
d) Exploration drilling (no 3) to depth of about 2.7 km; expected to start in 2020

In order to achieve these activities, expansion of access-roads where necessary, and other service roads within the project site and construction of labour lines for workers, offices and stores will be necessary

2.2.1 Preliminary survey

There has been preliminary survey to determine issues such as access and land ownership, environmental scoping and field programme to collect information and data for the present ESIA. Consideration has been made on need to improve on existing access roads to allow equipment and crew to reach and work at the project site. The site preparation activities and access road may require murruming in areas of soft clay, reinforcing culverts and bridges to accommodate long and heavy trucks, turning curves widened and the steep slopes avoided and minimal or no removal of vegetation and topsoil disturbance. The proposed service roads within the project site will be surveyed prior to commencement of the work to ensure that options for the least possible disturbance to soil are factored into the access road construction.

2.2.2 Exploratory TGH Drilling

The TGH holes will be drilled up to a depth of 200m. Sosian Energy Ltd will procure from professional drilling firms of good international repute and the crew that will abide by Labour Law and Occupational Safety and Health requirements of Kenya and as laid in this ESMP. Day-to-day drilling activities will be managed at the drilling location by drilling supervisors working on shifts based on site. Both solid and liquid wastes from the drilling exercise that cannot be handled/disposed of onsite shall be transferred, as necessary, to a specifically designated site for appropriate disposal. Appropriate medical and transport facilities for staff will be on site, however in the event that a medical emergency requires immediate evacuation of personnel, medevac procedure will be in place.

2.2.3 Drilling for water supply

The drilling operation for water supply will be conducted to a depth of 150 to 200m. The number of employees will be less than 10 at the beginning and for a period of 3 days. Borehole drilling will be carried out at a diameter of not less than 0.254 m. using a rotary type machine. The drilling rig should be able to drill to a depth of at least 200 m. at the specified diameter. The rig and the drilling method adopted must be suitable for drilling through both unconsolidated material, and hard, compact volcanic rocks. The rotary drilling technique offers very high penetration rates in all types of materials, rig mobilisation and demobilisation are rapid, minimal casings are required during drilling exercise and reliable yield estimates can easily be made during drilling.

Foam or polymer are used to provide hydrostatic pressure to prevent formation fluids from entering into the well bore, keeping the drill bit cool and clean during drilling, carrying out drill cuttings, and suspending the drill cuttings while drilling is paused and when the drilling assembly is brought in and out of the hole.

The borehole will be cased and screened with high class casings and screens in order to avoid collapsing and sediment intake. Screen slots should be a maximum of 1.5 mm in size. The minimum open area of the screens should be 5%. The use of a gravel pack is recommended within the aquifer zone, because the aquifer could contain sands or silts, which are finer than the screen slot size. A 0.254m. diameter borehole screened at 0.203m will leave an annular space of approximately 0.0254 which is sufficient to allow the insertion of fine, quartzitic gravel. The grain size of the gravel pack

should be within the range of 2 to 5 mm, and granules should be rounded to well-rounded. Over 95% should be siliceous. Gravel pack should be washed down with copious volumes of water to avoid bridging. The bore hole water quality will be sent to a laboratory to determine its quality before use.

If little or no water is detected in the well, the well will be plugged and abandoned. Once the wells have been plugged (with cement) the casing will be cut below the ground level and a steel plate welded to the top of the casing. The top-hole section will be back-filled and a place marker installed on the surface indicating the position of the abandoned well.

2.2.4 Exploratory drilling

The exploratory well will be drilled to 2.7km depth and will require a drilling pad. During drilling operations, blowout prevention equipment shall be tested according to international standards. For an average well of 2 km depth, a drilling time of about 60 days (24 hour operation) is considered usual. Sosian Energy plans to drill 3 exploratory wells. The drilling program requires careful mobilisation of a range of supplies of rig, casing, drill rods, drilling chemicals, drilling mud etc. and any well completion should be followed by well testing and perhaps tracer testing to assess both production and subsurface conditions. Before drilling, a well pad, which is a large flat areas prepared so that the drilling rig can operate on a stable platform, will be prepared. The earth around the well pad will be levelled, compacted and stabilised before the drilling rig is brought to site in a number of pieces and assembled. The camp will be located adjacent to the rig providing storage of equipment, accommodation, kitchen facilities, domestic and sewage processing, etc. The casing of exploratory wells is similar to production well, and these are discussed below.

2.2.5 Drilling for productive wells

Initially, two or three well pads for both the production wells and the reinjection wells may be constructed. Several wells can be drilled from a single pad. Each well pad will have a 'sump', which is a kind of pond that acts as a collection point for water and mud used during drilling, as well as any geothermal water from the wells. Water and mud is required by the drilling process for clearing soil and rock as the hole gets deeper and to prevent the geothermal fluid flowing up the well. The sump may also hold fluids produced from the well during well testing, which is in the first few days after the well is drilled. The sump will be fenced off to avoid any wildlife accidentally falling in to it. The unused part of the well pad can be revegetated, and the sump is usually filled in or fenced when it is no longer needed.

All casing strings reaching the surface shall be cemented at a sufficient depth to provide adequate anchorage and support for the casing and any blowout prevention equipment required thereon. The several casing strings in order of installation are (a) surface; (b) intermediate; (c) anchor; (d) production strings. The following casing will be set and cemented at appropriate depths dependent upon geologic and engineering factors including the apparent geothermal gradients, depths and pressures of the various rock formations to be penetrated and all other pertinent information about the area.

The Surface Casing is set at a minimum depth of 30 m. before drilling into shallow formation suspected or known to contain geothermal resources, non-condensable gases, or other mineral resources or upon encountering such formations. The casing is mainly used to isolate the shallow

loose formation below. Before drilling below this string, a blowout prevention equipment will be installed for safety purposes. Drilling will be expected to be implemented according to "The African Union Coe of Practice for Geothermal Drilling" published by the African Union's Regional Geothermal Coordination Unit (https://www.bgr.bund.de/EN/Themen/Zusammenarbeit/TechnZusammenarb/Downloads/2029_CodeofPractice_en.pdf?__blob=publicationFile&v=3). The surface casing will be followed by intermediate casing as shown in Table 2.1 below.

Table 2.1: Outline of drilling activities of Exploration Drilling for Sosian Energy Makongeni/Menengai Geothermal Project

Type of casing	Depth (m.)	Cementation	Purpose
Surface Casing	minimum 30 m. to 60 m	Cemented with a high temperature resistant admix sufficient to fill the annular space back to the surface. Use high temperature resistant admix	contain geothermal resources, non-condensable gases, or other mineral resources
Intermediate Casing	below the surface casing	overlying formation fluids from the geothermal resources zone and to prevent the movement of fluids into possible fresh water zones	pressure zones, uncased fresh water aquifers, caveins, washouts, lost circulation zones, rapidly increasing thermal gradients or other drilling hazards
Anchor Casing	Depth equivalent to or in excess of 10% of the proposed total depth of the bore provided. not less than 250 m. nor more than 400 m.		
Production Casing	top of or through the potential producing zone and shall be set before completing the bore for production	Cemented back to the surface or, if lapped, to the top of the lap. A temperature or cement bond log must be kept in case there might be an inquiry	Run to the surface or lapped into the next larger casing string. liner overlap shall be a minimum of 30 m

Source: Hole, 2008.

2.2.7 Safety equipment and procedures

In order to ensure that all wells are under control at all times, Sosian Energy shall utilize trained and competent personnel, and utilize properly maintained equipment and materials. As discussed earlier, blowout preventers and related bore control equipment shall be installed, tested immediately thereafter and maintained ready for use until drilling operations are completed.

The target resource is expected to be around 500 m. to 3000m. The wells are cased to isolate fresh underground water to prevent contamination, maintain the hole integrity by preventing caving in to enable drilling further below, minimize lost circulation into shallow permeable zone, cover weak zones that are incompetent to control kick-imposed pressure (prevent blowouts), provide a means for attaching and anchoring BOP and wellheads and thereby contain resultant pressures, and provide safe conduit for the reservoir fluids to the surface, and to prevent cooling of the reservoir fluids by shallow cooler fluids and well collapse.

2.2.4 Casing operation

Casing or lining of the well is undertaken to ensure the integrity of the wellbore throughout the drilling and production operation stages. Casing consists of a stacked series of metal pipes installed into the new well in order to strengthen the walls of the well hole to prevent hole collapse, to prevent fluids and gases from seeping out of the well as it is brought to the surface, and to prevent other fluids or gases from entering the rock formations through which the well was drilled. A well casing extends from the surface to the bottom of the well and consists typically of a steel pipe. Casing with a diameter slightly smaller than that of the well hole is inserted into the well, and wet cement slurry is pumped between the casing and the sides of the well. Casing is installed as the well is progressively drilled deeper. The top interval of the well, extending from the surface to a depth below the lowermost drinking water zone, is the first to be completed, being cemented from the surface to below the drinking water zone. Next, a smaller diameter hole is drilled to a lower depth, and then that segment is completed. This process may be repeated several times until the final drilling depth is reached.

2.2.5 Well logging

Logging is a process that deals with performing tests during or after the drilling process to allow geologists and drill operators to:

a) Monitor drilling process progress in order to gain a clearer picture of subsurface formations;
b) Identify specific rock layers, in particular those that represent target zones for further exploration;
c) Ensure that the correct drilling equipment, materials, and supplies (such as drilling muds), are being used; and
d) Ensure that drilling is not continued if unfavorable surface or subsurface conditions develop.

2.2.6 TGH and Exploratory well completion

When drill cuttings and drilling mud reach the surface during drilling, they are separated by means of Solids Control Equipment (SCE), whose function is to recover useful mud, so that it can be re-circulated into the hole. All wells not in use or demonstrated to be potentially useful shall be promptly

plugged in the following manner— (a) cement used to plug any geothermal resources bore, except that cement or concrete used for surface plugging, shall be placed in the hole by pumping through drill pipe or tubing, and in the cement shall consist of a high temperature resistant admix;

2.2.7 Well suspension or abandonment

In uncased portions of wells, cement plugs shall be placed to protect all subsurface mineral resources including fresh water aquifers; and plugs shall extend a minimum of 30 m. below, if possible, and 30 m. above such aforementioned zones. Cement plugs shall be placed in a manner necessary to isolate formations and to protect the fluids in such formations from interzonal migration or contamination— where there is an open hole (uncased and open into the casing string above) a cement plug shall be placed in the deepest casing string by either (a) or (b) below. In the event that lost circulation conditions exist or are anticipated, or if the well has been drilled with air or other gaseous substance, the plug shall be placed in accordance with (c) below; a cement plug shall be placed across the shoe extending a minimum of 30 m. above and 30 m. below; or (iv) a cement retainer with effective back pressure control set approximately 30 m. above the casing shoe with at least 61 m. of cement below the retainer and 30 m. above; (v) a permanent bridge plug set at the casing shoe and capped with a minimum of 61 m. of cement.

2.2.8 Power generation

The government is focused on developing the geothermal potential in the country with a 10-year geothermal exploration plan that will involve sinking several wells in the Rift Valley. Numerous geothermal exploration activities are underway in 10 other blocks within the Rift Valley region. The Sosian Geothermal project will benefit the ongoing Last Mile Connectivity Project across the country especially to public facilities such as schools, trading, administrative and health centers and water points. Power generation will support services to medical and emergency response facilities, and '*jua kali*' operations such as welding, painting and machining in the rural areas.

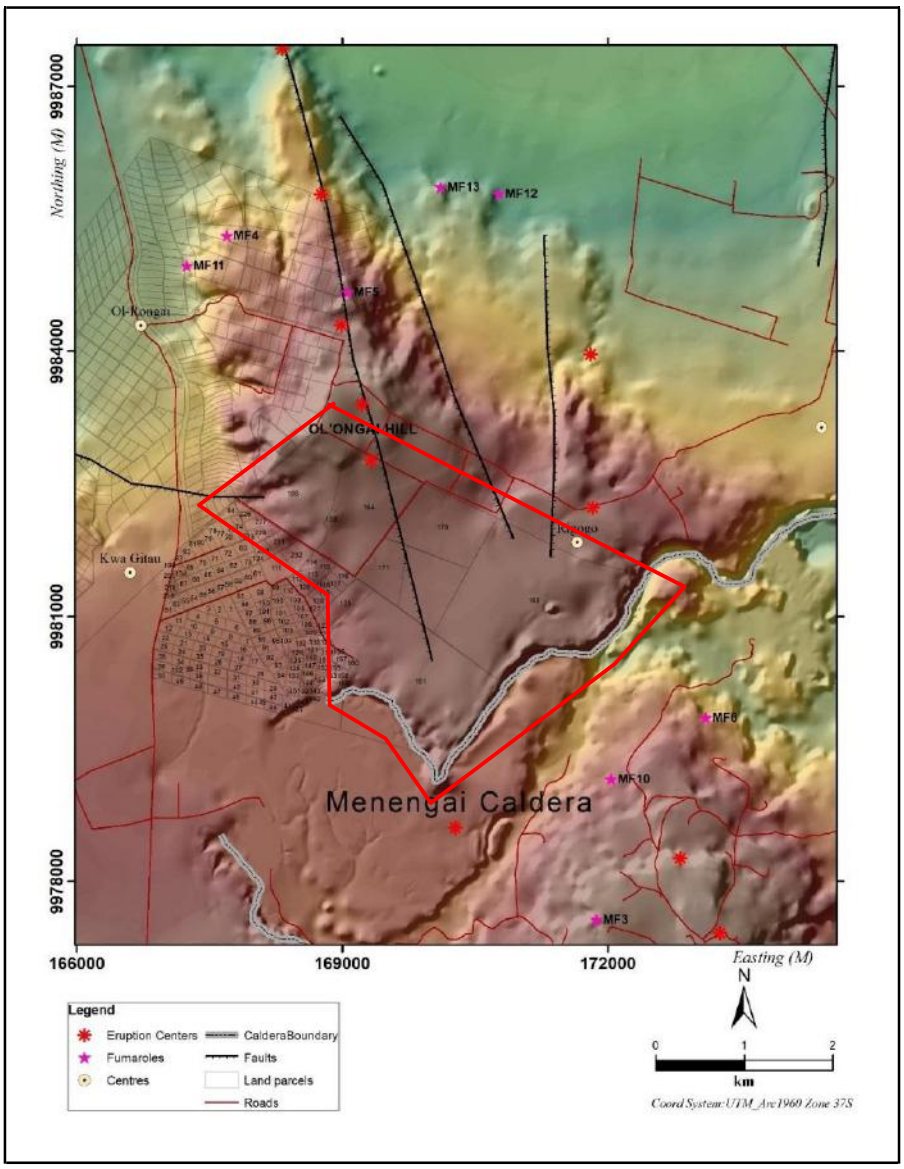


Figure 2.1: Location of the Sosian- Makongeni -Menengai-Geothermal Project

2.8 Appropriate Technology

The environmental quality during power generation is greatly improved by the technology adopted. Depending on the type of reservoir and its characteristics, three main types of technologies are adopted. The most commonly found geothermal resources contain reservoir fluids with a mixture of hot liquid (water) and vapour (mostly steam). The first one is the Flash Steam Power Plant which currently operates at KenGen's Olkaria geothermal fields. In a flash-steam plant, hot, liquid water from deep in the earth with temperatures above 240°C, is under pressure and thus kept from boiling. As this hot water moves from deeper in the earth to shallower levels, it quickly losses pressure, boils and "flashes" to steam. The steam is separated from the liquid in a surface vessel (steam separator) and piped to a turbine to generate electricity and the remaining hot water may be flashed again twice

(double flash plant) or three times (triple flash) at progressively lower pressures and temperatures, to obtain more steam. The turbine powers a generator (Figure 2.2)

The cooled brine and the condensate are sent back down into the reservoir through injection wells. Combined-cycle flash steam plants use the heat from the separated geothermal brine in binary plants to produce additional power before re-injection.

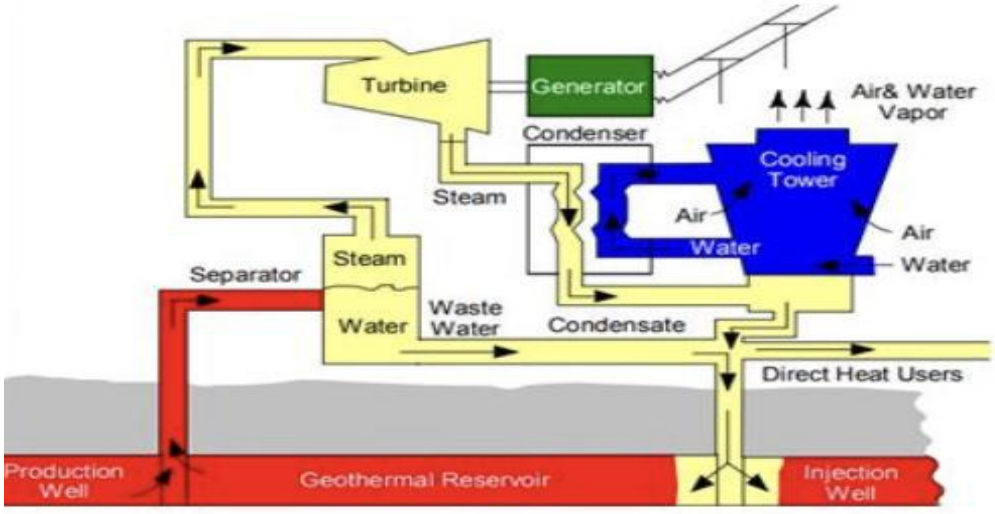


Figure 2.2: Flash Steam Power Plant Diagrams and Single Flash Steam Power Plant Schematic (from: Geo-Heat Center and U.S. Energy Department)

The second type of technology is the Binary Power Plant. Operating at Orpower4 (an Independent Power Producer) in Olkaria, the binary power plant is used where the geothermal fluid is either hot water, steam, or a mixture of the two varying in temperature as low as 73°C to 180°C or higher, heats another liquid with a lower boiling point such as isopentane or isobutane (known as the "working fluid"), that boils at a lower temperature than water. The two liquids are kept completely separate through the use of a heat exchanger used to transfer heat energy from the geothermal water to the working fluid. When heated, the working fluid vaporizes into gas and (like steam) the force of the expanding gas turns the turbines that power the generators. Because binary cycle plants are a closed loop system and virtually nothing is discharged to the atmosphere, binary cycle plants are the most environmentally benign technology currently in use. The amount of Non Condensable Gases that may be released into the atmosphere is determined by the nature of the reservoir and the type of technology. For instance, binary plants emit virtually no gases because it's closed loop system using heat exchange method. Dry steam and flashed steam plants emit water vapor containing these gases. The lower-temperature geothermal brine leaving the heat exchanger is re-injected back into the reservoir in a closed loop, diminishing the possibility of release of gases into the atmosphere thus promoting sustainable resource exploitation.

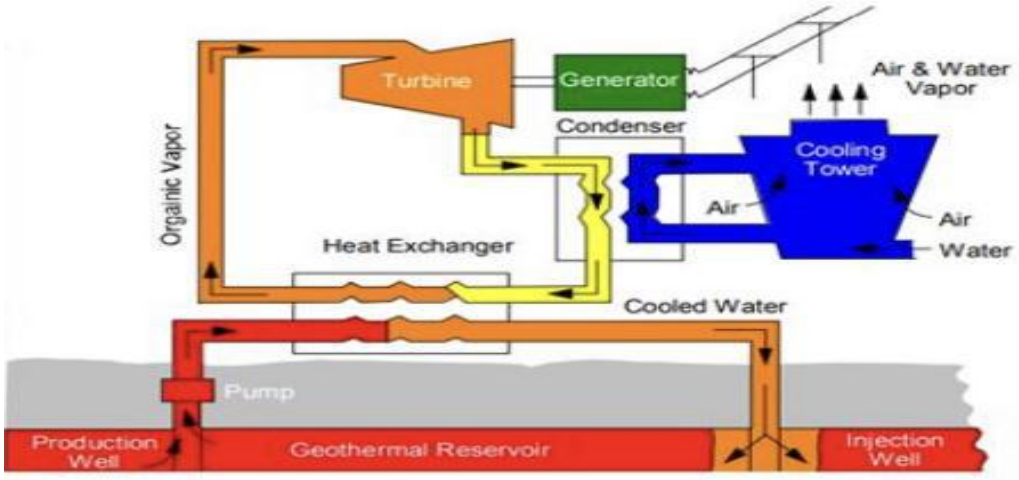


Figure 2.3: Binary Power Plant Schematic and Power Plant Diagrams
Source: Geo-Heat Center and U.S. Energy Department

The third type, dry steam plants directly utilize dry steam that is piped from production wells to the plant and then to the turbine. In dry steam plants, the condensate is re-injected into the reservoir or used for cooling.

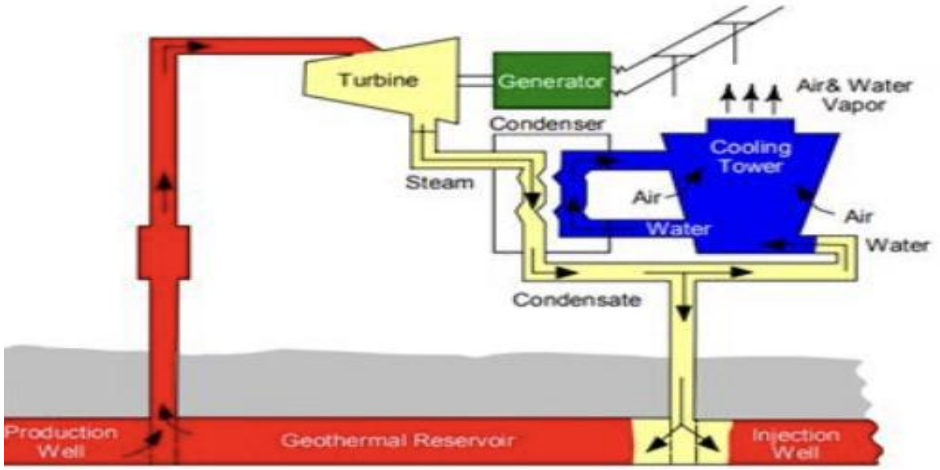


Figure 2.4: – Dry Steam Power Plant Diagram and Power Plant Schematic
Source: Geo-Heat Center and U.S. Energy Department)

2.8.1 Geothermal Energy Direct Uses

Direct use of geothermal resources cannot be neglected because the heated facilities and industries have the potential to revive the economy through the creation of local jobs, increased tourism, and enhanced community involvement. The direct use of geothermal resources is the use of the heat energy or the fluid from geothermal resources without intervening medium as opposed to its conversion to other forms of energy such as electrical energy schematically shown in Figure 2.5. Most direct use applications can be applied for geothermal fluids in the low to moderate temperature range 20 – 120°C. Geothermal heat is used directly, without involving a power plant or a heat pump, for a variety of applications such as space heating and cooling, food preparation, hot spring bathing and

spas (balneology), agriculture, aquaculture, greenhouses, industrial processes and lumber drying offer attractive and innovative opportunities for entrepreneurs and local businesses. The Government of Kenya, in its recent Energy Policy 2018, reiterated interest in expanding direct geothermal energy use. Geothermal energy is also used to heat buildings through district heating systems. Hot water near the earth's surface is piped directly into buildings for heat.

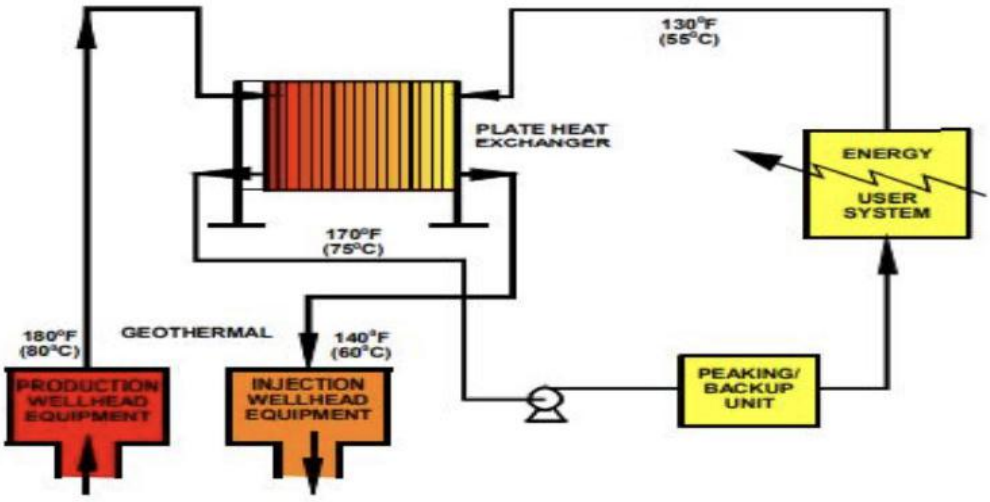


Figure 2.5*:* Typical Direct Use Geothermal Heating System Configuration and direct use of geothermal heat in 2010 among the IEA-GIA countries (GWh/a)

2.9 Institutional Framework for Electricity Sector Institutions

2.9.1 Accessibility

Kenya, with an estimated nominal GDP of $75 billion in 2017, Kenya's energy sector has improved both in performance and growth. Per-capita energy consumption is 178 kWh (2017e) compared to 126 kWh in Nigeria, although the latter has a per-capita GDP nearly 3 times higher. The number of connections, havie more than doubled from 32% to 73% of households in 5 years with the goal of attaining universal access by the year 2020. Over 70% of Kenya's electricity is generated from renewable / clean energy sources. Of these, geothermal remains the most significant source as the country focuses on increasing geothermal capacity and weaning off thermal sources. Unlike other renewable sources, geothermal is baseload stable power and is reliable and widely available.

2.9.2 Ministry of Energy (MOE)

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 mobilisation of financial resources. The MOE is responsible for national policy formulation of which the policy on Feed-in-Tariffs (FIT) is currently assisting increased access and for creating a framework to allow growth, investment and efficient operations in the sector. The MOE also grants and revokes generation and distribution geothermal licenses upon the recommendation of ERC.

2.9.3 Energy and Petroleum Regulatory Authority (EPRA)

The EPRA is responsible for regulation of the energy sector. The Energy Act of 2019 established EPRA as an independent energy regulatory authority with responsibility for economic and technical regulation of electric power, renewable energy, and downstream petroleum sub-sectors, including tariff setting and review, licensing, enforcement, dispute settlement and approval of power purchase and network service contracts.

2.9.4 Kenya Electricity Transmission Company (KETRACO)

The aging transmission and distribution networks largely contribute to approximately 16% system loss of the power generated. To address this, KETRACO is in the process of constructing ~4,500 km new lines, more than doubling the transmission network and introducing Kenya's first high-voltage 400 kV and 500 kV DC lines as well as 3 major regional interconnectors to Ethiopia, Uganda, and Tanzania. Beyond these lines that are under construction, KETRACO is planning a further ~4,200 km of lines to expand and strengthen the grid. In addition, Kenya Power is building in redundancies, reducing losses and adding in smart technologies to help strengthen the grid.

Kenya is also keen to begin selling surplus power to her neighboring countries and has jointly embarked on an interconnection program to connect Kenya to Uganda and Rwanda on one side, and Ethiopia and Tanzania. Kenya signed an agreement to sell 30MW to Rwanda beginning fall 2015 and plans to increase this as more power is added to the grid. Kenya has also signed an agreement with Zambia to sell power in 2017.

2.9.5 Kenya Power and Lighting (KPLC)

Formerly Kenya Power and Lighting Company (KPLC), it is the wholesale buyer of electricity and is obligated to purchase electricity from all power generators – including KenGen and Independent Power Producers (IPPs) -- based on negotiated Power Purchase Agreements (PPA). KPLC is responsible for onward transmission of purchased electricity and is the sole distributor of electricity from the national grid to consumers in Kenya. It operates Kenya's interconnected grid, as well as several off-grid stations in the northern regions of the country. As the single off-taker in the country, KPLC negotiates Power Purchase Agreements (PPAs) with generation providers and distributes to consumers. KPLC is listed on the Nairobi Stock Exchange, is 49.9% owned by private shareholders, with the remainder owned by the Government of Kenya. Most impressively, KPLC has nearly doubled access in Kenya over the last 5 years, from 26% of households in 2013 to 73% in 2017, meeting best-in-class benchmarks globally.

2.9.6 Kenya Electricity Generating Company (KenGen)

KenGen manages all public power generation facilities and is the main generator of electricity in Kenya which it sells on a wholesale basis to KPLC. KenGen, which produces approximately 70% of the Kenya's electricity, has a current installed capacity of 1,632MW. KenGen is responsible for developing new public sector generation facilities to meet increased demand. KenGen is listed on the Nairobi Stock Exchange, is 30% owned by private sector shareholders and 70% owned by the Government of Kenya.

2.9.7 Geothermal Development Company (GDC)

GDC is 100% owned by the Government of Kenya. GDC has the mandate to undertake the high-risk exploration and development of geothermal fields, including exploration, appraisal and production drilling, and the management of proven steam fields. GDC is also responsible for entering into Steam Sales Agreements with investors in the electricity sector, including KenGen and IPPs, in order that these entities can develop electricity generation capacity, with energy sourced from geothermal wells.

2.8.9 Rural Electrification Authority

Founded in 2006, REA's mandate has been to accelerate the pace of rural electrification across all 47 counties. Since its inception, REA has helped move rural electrification from 4% to 32% of rural households, largely through its efforts to connect ~60,000 public facilities (mostly primary schools) around the country and all household consumers within 600 meters of those facilities. In 2007, the government established REA to spearhead electrification projects in rural areas. Currently, rural connectivity stands at 32%, up from 4% at REA's inception. The REA coordinates the implementation of rural electrification projects with the help of KPLC, which acts as a contractor on their behalf. The program aims to connect load centers such as schools, trading centers, health centers and public institutions to the grid. The goal is to provide electricity to 40% of the rural population by 2020. REA is focused on connecting major town centers, schools and hospitals to the grid as well as looking at off-grid solutions such as diesel fired plants. However, REA is now issuing tenders to convert these plants to hybrid solar PV plants. Together, REA and KP have 4 major objectives to develop distribution and access in Kenya:

- Reach near-universal access by 2020 by adding 1 million new customers to the grid each year. The plan is to achieve this largely through the Last Mile Connectivity Program supported by the World Bank.
- Build a stronger and more flexible grid by building in redundancies, reducing losses, and adding in smart technologies.
- Increase the number of PPAs signed with power generators through the Scaling Up Renewable Energy Program (SREP).

CHAPTER 3: ESIA STUDY OBJECTIVES AND METHODOLOGY

3.1 Objectives of ESIA

There is statutory requirement for ESIA study to be undertaken for Exploration drilling for geothermal development. Sosian Energy Geothermal project's planned activities include (a) drilling of three (3) thermal gradient wells to 200m depths and develop EMMP and monitor project activities; (b) drilling of three deep geothermal exploration wells; (c) compensation plans for the acquisition of additional land if required; and (d) undertake stakeholder management and community consultations. It is rather too early to discuss the operational and decommissioning phases because the selection of the variety of technology available to the developer have not been made. The drilling of boreholes for water supply has not been included in this report because the latter goes to Water Resources Authority and Regional Office of NEMA in Nakuru.

The objectives of ESIA are to:

k) Collect and analyse baseline information on the biophysical and socio-economic characteristics of the project area to reflect the current status.
l) Identify and assess compliance of project activities with relevant statutory and internal requirements. The key ones being:
m) National Legislative and Regulatory frameworks;
n) International Protocols and regulatory frameworks; and
o) Multilateral Financing Institutions (MFIs) more specifically KfW, AFD, World Bank, IFC, AfDB, AUC-GRMF, amongst others.
p) Describe and scope potential environmental, ecological and socio-economic impacts of drilling of exploration wells and development of the associated energy infrastructure.
q) Carry out public consultation and disclosure; develop and implement Stakeholder Engagement Plans (SEP) & Community Development Plan (CDP);
r) Identify measures for mitigating negative impacts of the project associated with drilling of Thermal Gradient Holes (TGH) and geothermal exploration wells.
s) Develop a detailed and up to date Environmental and Social Management Plan (ESMP) and mitigation plan including cost of mitigation measures for drilling operations; and
t) Establish mechanisms for Monitoring and Evaluation (M&E) of compliance, time frame and costs for implementing M&E.

3.2 The Mandate of NEMA and EIA/EA Regulations 2003

The National Environment Management Authority (NEMA) is the institution that has been established under the Environmental Management and Coordination Act (EMCA) of 1999, revised 2016 in order to deal with matters pertaining to the environment, with the object and purpose of exercising general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of government in the implementation of all policies relating to the environment and development in Kenya (EMCA 2016). Some of its mandates that are relevant to ESIAs are to:

a) Co-ordinate the various environmental management activities being undertaken by the lead agencies and promote the integration of environmental considerations into development policies, plans, programmes and projects with a view to ensuring the proper management and rational utilisation of environmental resources on a sustainable yield basis for the improvement of the quality of human life in Kenya;
b) Carry out surveys and collect information which will assist in the proper management and conservation of the environment;
c) Undertake and co-ordinate research, investigation and surveys in the field of environment and collect, collate and disseminate information about the findings of such research investigation or survey;
d) Identify projects and programmes or types of projects and programmes, plans and policies for which environmental audit or environmental monitoring must be conducted under the Act (Second Schedule, S8);
e) Monitor and assess activities, including activities being carried out by relevant lead agencies in order to ensure that the environment is not degraded by such activities, environmental management objectives are adhered to and adequate early warning on impending environmental emergencies is given;
f) Undertake, in co-operation with relevant lead agencies, programmes intended to enhance environmental education and public awareness about the need for sound environmental management as well as for enlisting public support and encouraging the effort made by other entities in that regard;
g) Publish and disseminate manuals, codes or guidelines relating to environmental management and prevention or abatement of environmental degradation;
h) Render advice and technical support, where possible, to entities engaged in natural resources management and environmental protection so as to enable them carry out their responsibility satisfactorily.

The Legal Notice 101 of June 13th 2003, Environment (Impact Assessment and Audit) Regulations as provided for under section 147 of the EMCA (1999) provides the framework for undertaking EIAs and EAs in Kenya by NEMA licensed Lead Experts and Firm of Experts. An EIA or EA Study in Kenya is to be undertaken by a Kenyan duly licensed by the NEMA. The EIA/EA Regulations also provide information to project proponents on the requirements of either an EIA or EA as required by the EMCA. This ESIA Study has been undertaken in accordance with the requirements of the above legislation.

3.3 Scope of ESIA Study

a) Concise description of the project, its geographic, ecological, general layout including maps at appropriate scale where necessary.
b) Carry out baseline data collection on the environmental and socio-economic characteristics of the existing situation in the Sosian Energy Makongeni/Menengai Geothermal Prospect. This description involves;
    a. Physical environment (topography, geology climate and meteorology, air quality, hydrology etc.,

b. Biological environment (fauna and flora types and diversity, endangered species, sensitive habitats, etc.
c. Social and cultural environment, including present and projected, where appropriate (i.e., population, land use, planned development activities, community structure, employment and labour market, sources and distribution of income, cultural properties).

c) Identification and description of the pertinent laws, regulations and standards governing the environmental quality, health and safety, protection of sensitive areas, land use control at the national and local levels and ecological and socio-economic issues. The key ones beings:
d) KfW Development Bank Sustainability Guidelines/Standards April 2016;
e) IFC Performance Standards 2012
f) IFC General Guideline on Environment, Health and Safety 2007
g) IFC Environment, Health and Safety for Geothermal Power Generation 2007
h) Analysis and description of all, both positive and negative, significant environmental, ecological and social impacts brought about by the project.
i) Analysis and description of all occupational health and safety concerns brought about by the operations of the drilling, making recommendations on corrective and remedial measures to be implemented under the Environmental and Social Risk Management Plan (ESRMP).
j) Environmental and Social Risk Management Plan (ESRMP): A monitoring plan with specific description, and technical details, of monitoring measures, including the parameters to be measured, methods to be used, sampling locations, frequency of measurements, and definition of thresholds that will signal the need for corrective actions as well as deliver monitoring and reporting procedures.

3.4 Purpose of Scoping and bounding of impacts of project facilities and activities

Key Informants Interviews for senior officials from Sosian Energy Inc, government and NGOs was conducted on the 5th and 6th April, 2019 in order to get an appreciation of the project area, discuss aspects of the project and of the environment, and the data that will be gathered. The result of the reconnaissance is to assist in designing transect analysis for sampling purposes.

The expected activities that would be undertaken during implementation of Thermal Gradient Holes (TGH) to 200m depths and exploration drilling wells to 2.7km depths would involve, but not limited to, the following:

- Civil works for construction of access roads, drill sites, drilling of water boreholes, preparation of well pads, drilling and testing of the geothermal wells;
- Exploration of water for drilling;
- Geothermal steam for generation of electricity;
- Geothermal wastewater;
- Solid waste products from the processes including worn out machine parts, used lubrication oil, oil contaminated rags and other solid waste;
- Civil works and drilling debris;

- Emission of gases out of the fuel combustion process (CO_2, CO, SO_2 and NO_2), hydrogen sulphide (H_2S) and other non-condensable gases (NCGs) arising from drilling such as CO_2 and CH_4. NCGs.

Figure 3.1: Exploratory drilling

These activities may alter the air quality due to gaseous emissions and dusts, water quality due to effluents, thermal pollution that triggered earth's energy budget, underground water, potential land subsidence due to underground fluid withdrawal, noise and social- economic disruptions. Additionally the installation of pipelines and ancillary structures may affect plant and animal life and impact on landscape aesthetics. ESIA is a comprehensive analytical tool designed to evaluate environmental impacts that may have significant, diverse, and irreversible impacts on the natural environment and on humans dependent on the environment. ESIA therefore considers each of these effects, determines their level of impacts and establish mitigation measures wherever necessary.

The Consulting Team visited the Nakuru County to meet key stakeholders and specifically the project site and carried out a scooping mission. The purpose of the scoping exercise was to:

a) identify potential stakeholders with an interest in the project and inform them of the project and the ESIA process,
b) determine the spatial and temporal extent of the boundaries for the project as well as the key issues to be addressed in the environmental and social assessment,
c) focus the study on key and relevant issues for quick decision making, and
d) Identify areas of likely impact and environmental issues that may require further monitoring in the subsequent environmental audits.

The next steps is the Power Plant Development and Operations and includes:

- Financing arrangements;
- Power Plant Construction & Operations.
- Substation & Transmission Line.

CHAPTER 4: ESIA APPROACH AND METHODOLOGY

4.1 Scope and approach of the study

The assessment process is a systematic approach to the evaluation of the proposed Sosian Geothermal Project updates in the context of the natural, regulatory and socio-economic environments in which development is proposed. The approach to this exercise follows the requirements under the EMCA 2015, the EIA Regulations as stipulated under the Gazette Notice No. 56 of 13th June 2003, and the World Bank Safeguard Policies, KfW Development Bank on Sustainability Guidelines/Standards April 2016; IFC Performance Standards 2012, General Guideline on Environment, Health and Safety 2007, and Environment, Health and Safety for Geothermal Power Generation 2007. It involved largely an understanding of the project background, the preliminary designs and the implementation plan as well as commissioning regarding compliance to statutory requirements. In addition, baseline information was obtained through physical investigation of the project site, public consultations with members of the community in the project area, survey, photography, and discussions with the project proponents.

All the potential impacts arising from the project design have been identified, and either standard, recognised industry practice mitigation measures or impact-specific, feasible and cost-effective mitigation measures have been applied. Any potential impacts that remain after the application of mitigation measures are referred to as residual impacts. All residual environmental and social impacts, wherever any was identified, are assigned a level of impact of low, medium, high or beneficial, following the methodology adopted in the present study.

4.2 Stakeholders Engagement

Effective stakeholder engagement during the project's lifespan aims to facilitate the development of a "social licence" to operate due to mutual trust, respect and transparent communication between Sosian Energy and its stakeholders. The engagement will facilitate cost cutting, risk management, enhancement of the company's reputation, and avoidance of conflicts and improvement of company policies to better reflect emerging issues. Additionally it aids the identification, monitoring and reporting on impacts as well as management of stakeholder expectations during the project's life.

The Stakeholder Engagement Principles that underpin Sosian Energy's interactions with stakeholders will include the following:

a) **Commitment -** the need to understand, engage and identify with the community will be recognized and acted upon early in the process;
b) **Integrity** - engagement will be conducted in a manner that fosters mutual respect and trust;
c) **Respect -** the rights, cultural beliefs, values and interests of stakeholders and neighboring communities will be recognized;
d) **Transparency -** community concerns will be responded to in a timely, open and effective manner;
e) **Inclusiveness -** broad participation will be encouraged and supported by appropriate participation opportunities; and

f) **Trust -** there will be open and meaningful dialogue that respects and upholds the community's beliefs, values and opinions.

4.3 Objectives of the Stakeholder Engagement

The Stakeholders' Engagement Plan (SEP) seeks to define a technically and culturally appropriate approach to consultation and disclosure. The goal of SEP is to improve and facilitate decision making and create an atmosphere of understanding that actively involves project-affected people and other stakeholders in a timely manner, providing them sufficient opportunity to voice their opinions and concerns so as to influence project decisions. The SEP will also be a useful tool for managing communications between management and project stakeholders.

The key objectives of the stakeholders' engagement are to:

a) provide guidance for stakeholder engagement such that it meets the standards of International Best Practice;
b) identify key stakeholders that are affected, and/or able to influence the project and its activities;
c) identify the most effective methods and structures through which to disseminate project information, and to ensure regular, accessible, transparent and appropriate consultation;
d) guide Sosian Energy to build mutually respectful, beneficial and lasting relationships with stakeholders;
e) develop a stakeholder's engagement process that provides stakeholders with an opportunity to influence project planning and design;
f) establish formal grievance/resolution mechanisms;
g) define roles and responsibilities for the implementation of the SEP; and
h) define reporting and monitoring measures to ensure the effectiveness of the SEP and periodical reviews of the SEP based on findings.

4.4 Field Survey

The overall purpose of field survey was to gather data of the existing bio-physical and socio-economic conditions in the project area, address key environmental aspects that have been identified through the scoping process and those raised through public consultation processes. The two-tier survey was conducted for Key Informers (KI) of the county and, secondly and more specifically in the sub county where the project is located. The field survey adopted various techniques of baseline data collection on the existing environmental conditions.

The first round consultations and meetings with all parties concerned commenced on the 22st to 24thMay 2019. After these dates, the consultants tended to consult various groups on a need to kanow basis. The Consultants administered questionnaires during these consultation meetings. The participants were selected from various categories including:

- Local members of the public that are likely to be impacted by the project;
- County and national government officials including Department of Lands, Energy, Environment, Trade and Industry, Kenya Wildlife Service, Kenya Forest Service, etc.)

- Representatives of the political class,, faith leaders, human rights groups, and development organizations; and
- Representatives of the scientific community.

Table 4.1: Stakeholders' Engagement Activities

No.	Date	Time	Stakeholders' Group	Place
1	22.05.2019	9.00-12.30	County and National Government Officials	Offices
2.		14.30-15.30	KWS, KFS, NEMA, Water Resources Authority, GDC, Sosian Energy representatives.	Individual offices
3.	23.05.2019	9.00-12.30	Community Representatives	Donnies Hotel, Nakuru
5.	24.05.2019	8.00-18.00	Community Survey and Focus Group Discussions	Transect data collection

The consultants used checklists for assessing possible environmental impacts during both construction, operational and decommissioning phases of the project. Focus group discussions (FGDs) was used to complement the questionnaire study. The FGD study targeted groups and sections of public where group dynamics can help procure better data than other methods of data collection. The main point is that discussions have a tendency to bring out insights and understandings in ways which simple questionnaire items may not be able to tap. Also, FGDs can tap emotional and unconscious motivations not amenable to methods such as questionnaires and interviews.

Some administrative, social, economic, cultural and health issues were captured through interviews with key informants such as Sub County administration officers, opinion leaders, community elders, chiefs, teachers, health workers and spiritual leaders, among others.

4.5 Data analysis

Bio-physical and socio-economic data and expert information from key informants forms the baseline information for the area and were analysed and verified through triangulation. Information on potential impacts, both negative and positive, were analysed for the periods during drilling of TGH, well drilling and construction, operation and decommissioning of the power plant and prediction and evaluation of environmental, ecological and social impacts, both negative/positive; significant/non-significant impacts, temporary/permanent impacts, short, medium, long-term and cumulative impacts and occupational health and safety concerns have been considered. The analysis include evaluation of mitigation measures as well as residual impacts. The significance of a potential project impact is evaluated by considering the magnitude of the impact in combination with the sensitivity/vulnerability/importance of the impacted resource or receptor. The assignment of a significance rating enables decision-makers and stakeholders to understand how much weight should be given to the issue in their process. In the case of beneficial impacts, the significance is assigned as positive or beneficial.

Plate 4.1: Stakeholders' Meeting convened at the Church Compound

Plate 4.2: Senior officials following the discussion at the stakeholders' meeting

Plate 4.3: A Study Team member presenting at the stakeholders' meeting

4.6 Impact Identification, Impact Significance and Mitigation Measures

Various methods and techniques of data analysis have been employed in the present study. Thematic maps that identified features as population settlement, infrastructure, soil composition, natural vegetation areas, water resources and land use pattern. Exploratory data analysis was done using tables and graphs to present and visualize data. Spatial data analyzes were done using Geographic Information Systems (GIS) which also supported GIS map production.

In order to evaluate the significance of predicted impacts, a set of criteria adopted from the NEMA Regulations, World Bank and Equator Principles Criteria of World Health Standards are applied: emissions-based criteria which comprise standards for air and water quality, and noise; and environmental quality based criteria, which comprise significance criteria for valued ecosystem components or similar attributes. Because of paucity of data, reference points to evaluate impact significance were:

- Environmental standards established by EMCA 2015 in Kenya and at international level (including the World Bank Group);
- Level of public concern; and
- Scientific and professional evidence for loss/disruption of valued resource stocks and ecological functions; negative impact on social values, quality of life and livelihood; and foreclosure of land and resource use opportunities.

Environmental standards, objectives and targets used to evaluate impact significance are prescribed in law and regulations such as limits on waste/emission discharges and/or concentrations; ambient air and water quality standards; environmental objectives and targets contained in policy and strategy; and

approved or statutory plans that protect areas, allocate, zone, or regulate the use of land and natural resources.

The criteria used to evaluate whether or not adverse impacts are significant:

- Environmental loss and deterioration;
- Social impacts resulting directly or indirectly from environmental change;
- Non-conformity with environmental standards, objectives and guidelines;
- Likelihood and acceptability of risk;
- Reductions in species diversity;
- Depletion or fragmentation on plant and animal habitat;
- Loss of threatened, rare or endangered species;
- Impairment of ecological integrity, resilience or health e.g. disruption of food chains; decline in species population; alterations in predator prey relationships.
- Threats to human health and safety e.g. from release of persistent and/or toxic chemicals;
- Decline in commercially valuable or locally important species or resources e.g. fish, forests and farmland;
- Loss of areas or environmental components that have cultural, recreational or aesthetic value;
- Displacement of people8;
- Disruption of communities by influx of a workforce, e.g. during project construction;
- Pressures on services, transportation, and infrastructure.

GIS was used to produce overlays that identify, predict, assign relative significance to, and communicate impacts in a given geographical reference frame. The data presentation has been done in the form of suitable maps, matrices and in dedicated annexes. Checklists of environmental impact indicators were designed to stimulate the impact assessors to think broadly about possible consequences of contemplated project actions. These checklists were completed during the familiarisation tour in the project area. Assessors were asked to consider any other factors that were not on the checklist in order to avoid ignoring some important environmental and social aspects if they were not on the checklist. The checklist is attached as Annex 3.The assessors employed matrices to relate a list of project actions and a list of impact indicators as a way of identifying cause-and-effect relationships while Flow Diagrams (Figure 4.1) have been used to show connections between a particular development action and the potential resulting environmental or social impact. By linking development action and potential impacts, impacts analysts were able to identify action-effect-impact relationships and hence visualize the connection between action and impact.

Figure 4.1 below demonstrates the entire ESIA process. Each of these factors was used to support decisions on significance, geographical coverage and short term/long term impacts of any of the elements. The environmental and social impacts were categorised as short term (ST) implying that the impacts were limited to a short duration or to a specific phase of the project. The long term (LT) meant that the impact would persist beyond any single phase while reversible (R) impact is one in which there will be management control and reverse of the impact if it occurs. An Irreversible Impact (IR) is one that will not be controlled but the impact may be managed or mitigated. Local (L) impact

is one that is limited in geographical scale while Wide (W) or widespread impact is one that covers a large geographical area. Additionally the team considered Significant Impact (SI) as one that would impact under unusual conditions while Normal (N) represents those that are not significant.

The focus of environmental mitigation is to eliminate, offset, or reduce the resulting adverse environmental impacts of a project to the acceptable levels. In addition, there are strong indications that may be borrowed from analogous development and decisions that have been made in Olkaria and other similar situations. While it is true that the Sosian geothermal power development is similar to other geothermal developments in Olkaria, Menengai, and Eburru, the present assessment has introduced objective tools for decision making. The objectives of mitigation are to:

- Find better alternatives and ways of doing things;
- Enhance the environmental and social benefits of a proposal;
- Avoid, minimize or remedy adverse impacts; and
- Ensure that residual adverse impacts are kept within acceptable levels.

It is important that these mitigation measures are implemented and monitored in an orderly manner. This involves Environmental Management Plan (EMP) the objectives of which are to:

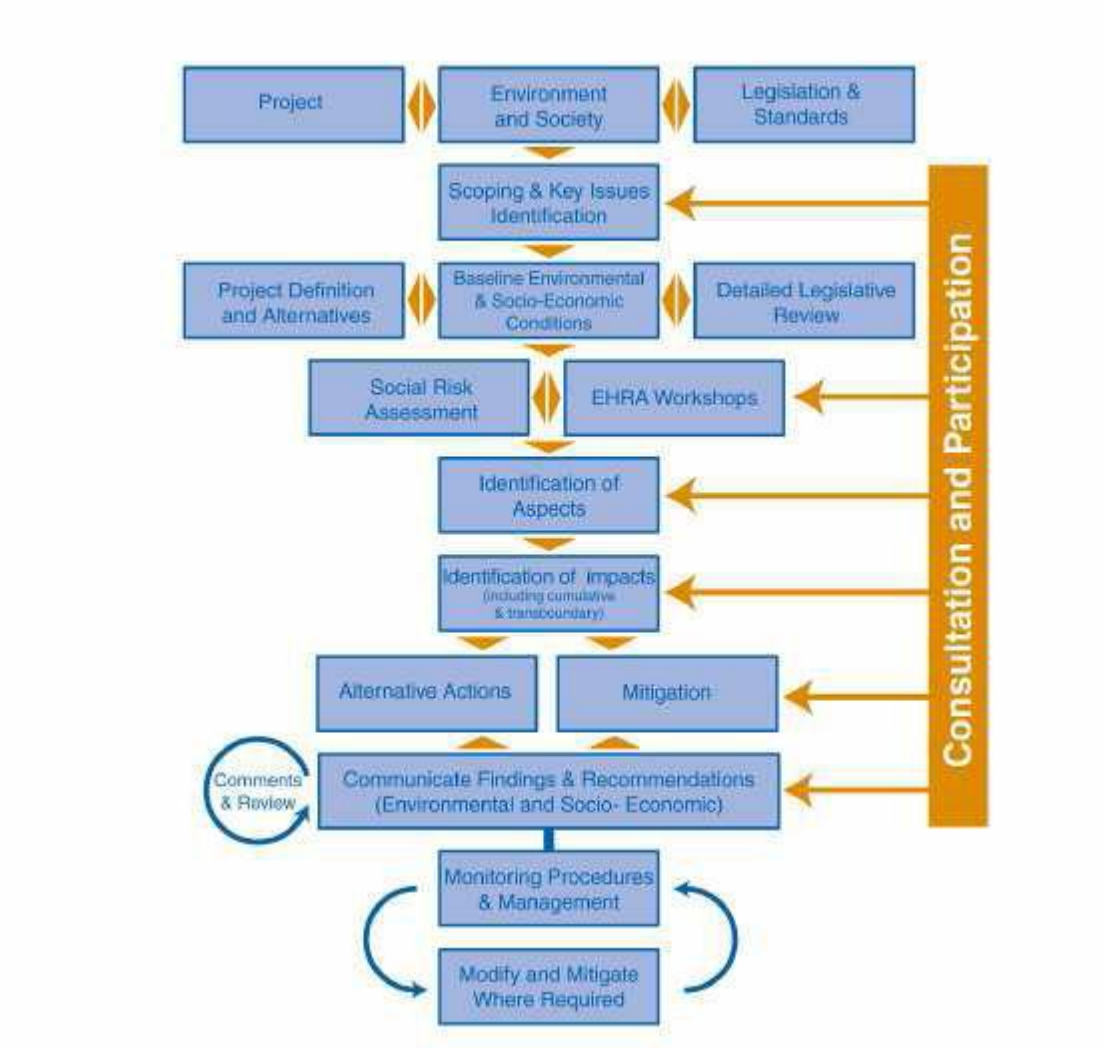
- Ensure that mitigation measures are implemented;
- Establish systems and procedures for implementation;
- Monitor the effectiveness of mitigation measures; and
- Take any necessary action when unforeseen impacts occur.

Elements of mitigation are organized into a hierarchy of actions:

- Avoid adverse impacts as far as possible by use of preventive measures;
- Minimize or reduce adverse impacts to 'as low as practicable' levels; and
- Remedy or compensate for adverse residual impacts, which are unavoidable and cannot be reduced further.

By applying a flow diagram, it is much easier to clearly visualize the sequence of events, for example soil and land degradation resulting from road construction. It is possible to attach significance on potential environmental impact. Assessors based all impact predictions on conceptual models of how the universe functions as well as experiences from similar projects undertaken elsewhere. Scientific methods were used to obtain useful predictions, particularly for impacts of the proposed project on the bio-geophysical aspects. For example, given the dominant wind direction within the project area together with topography, it is possible to estimate direction of most of the air pollution and possible receptors of air pollution. Assessors also used ranking scales to indicate whether there will be degradation, no change, or enhancement of environmental quality.

Figure 4.1: ESIA Process



Source: Environmental and Social Impact Assessment Methodology, November 2002

4.7 Scoping

The Terms of Reference provide the first impression of what was considered to be the most important considerations during scooping. The impacts that may have significant effect on the social and physical environments. Besides familiarizing with the project site, this time was also spent in consulting with key national and County government officials as well as NGOs, CBOS leaderships.

Table 4.2: Expected environmental and Social Impacts for the Study Area

No	ESIA	Issues considered	Rationale	Spatial Scope	Limitations of Methodology and Consequences for the Study Outcomes
1.	Project Design, Technologies, scale and extent	Project components, equipment and machinery used; Personnel and facilities required, management of fluid and solid wastes; Occupational and public health and safety. Supplies; decommissioning	Project components equipment/ machinery used, and facilities will have a number of environmental impacts related to construction, operations and decommissioning. Identification and prioritisation of factors requiring mitigation Personnel and public safety during operations need to be ensured.	Proposed drilling site; access roads selected camp site, storage, repair and waste disposal and facilities.	None
2.	Legislative and regulatory framework	Legislation and regulations applicable to geothermal project design, implementation, affected parties, and environment protection.	Ensure that all applicable laws are followed during project execution Be conversant with the authorizations required for the regulatory approval of the project; some legislation, regulations and guidelines embedded mitigations relevant to the proposed exploratory oil and gas well drilling	National legislation and regulations and authorities responsible International best practices in geothermal industry; Sosian's EHS, CSR and Code of Conduct.	None

3.	Geographical aspects and boundaries	Description of the project area, identification of key features.	Determination of the context within which the work is to be done. Assessment of the scale and extent of the work.	Project area	none
4.	Administrative set-up	Key administrative units and their roles in the project area.	Establishment of jurisdictions; Identification of key administrative contacts; Role in emergency situations (e.g. security threats) and response.	Project area	None
5.	Communication and Transport	Road infrastructure; telecommunications network.	Identification of areas difficult to access. Information on types of equipment/machinery that will be required for the project. Assist in development of contingency/emergency plans.	Project area	none
6.	Governmental, Non-Governmental and Community Based Organisations	Activities and projects carried out in the area.	Identification of potential local partners particularly with respect to CSR.	Project area	none
7.	Physiography and Geology	Assessment of susceptibility to erosion, landslides, earthquakes, subsidence and floods. Active surface processes.	Establishment of baseline conditions; Identification of potentially difficult areas to work in – terrain and accessibility by vehicles. Identification of areas requiring extra safety	Project area	Samples collected are representative of entire project site

			precautions, hazard /accident prone areas. Establishment of baseline conditions Identification of potentially difficult areas to work in – terrain and accessibility by vehicles.		
8.	Soils	Soil condition, areas subject to wind and water erosion, soil texture and drainage characteristics; soil chemical quality. Assessment of rehabilitation potential	Establishment of baseline conditions Ease of accessibility by vehicles Identification of hazard prone areas (e.g. ponding/flooding). Drilling rig and campsite construction considerations Disposal of domestic effluents, drilling mud and drill cuts Identification and prioritisation of factors requiring mitigation.	Project area	Some areas were not accessible due to flooding and ponding after the rains
9.	Climate	Temperature, winds, and precipitation	Establishment of baseline conditions. Information useful for project elements such as cooling of temperature sensitive equipment and installations. Personnel safety from adverse weather and related conditions e.g. flooding.	Access roads Selected camp sites and rig facilities.	Limited data available for trend analysis
10.	Surface and Ground water resources	Ground and surface water sources, Current and planned	Establishment of baseline conditions	Selected camp site and exploratory	Inaccessibility of some areas due to

		water use, Changes in quantity, identification of project components that can affect water demand,	Potentially high demand for water by project group in a water scarce region Planned water uses that affect water quantity may be blamed on the project proponent Identification and prioritisation of factors requiring mitigation	well drilling site and facilities	flooding and ponding
11.	Air quality	Ambient air quality, generation of dust, smoke, odorous fumes, and other toxic gaseous emissions. Identification of project components that can lower air quality	Establishment of baseline conditions. Assessment of project impacts on air quality. Identification and prioritisation of factors requiring mitigation.	Access roads Selected camp sites and rig facilities	Assumed to be good and varies mainly due to variations in wind speeds (natural particulate loading).
12.	Habitats, Flora and Fauna	Vegetation cover and classes, habitat conditions, floral and faunal communities, threatened or endangered faunal and floral communities., environmentally sensitive localities, wildlife corridors, pastoral areas. Assessment of ecosystem state	Establishment of baseline conditions Physical disturbance of terrestrial environment during operations such as pit excavations, campsite construction and drilling rig operation Determination of pre-project endanger communities Assessment of areas requiring special precautions Avoidance of human-human and human-wildlife	Project area and the surrounding locality.	Old data, but the agricultural ecosystem structures are resilient to the effects of land degradation

			conflicts. .Identification and prioritisation of factors requiring mitigation.		
13.	Land Resources	Land use and designation. Existing activities in the area. Currently known and exploited mineral resources Resource inventory	The land resources are critical resources supporting livelihoods in the area. Consideration of competing resources	Project area and surrounding communities.	none
14.	Visual Aesthetics	Aesthetic or high scenic value.	Establishment of baseline conditions. Assessment of project impacts such as vegetation clearance along cut lines and at campsites	Proposed drilling site Access roads Selected camp site and rig facilities	None
15.	Noise and Vibrations	Ambient noise and vibration levels in the area. Potential sources of noise and vibrations produced by project operations. Noise impacts on terrestrial fauna.	Establishment of baseline conditions Noise and vibrations impacts on the project workforce and the neighbouring public Impacts on nearby structures and facilities.	Proposed drilling sites, Access roads, selected camp and rig facilities.	Lack of studies on noise and vibration impacts on fauna
16.	Solid and Liquid Wastes	Disposal of sewage or domestic wastes; Damage to the environment through accidental spills of oil, fuel, cargo, waste or sewage	Establishment of baseline conditions Campsites will require to install waste discharge systems	Campsites, working areas	None
17.	Social Characteristics	Level of services available, social	Quality of life baseline. Ability to absorb change	Project area	Language barrier in some places

		support information, identification of key community needs.			Unwillingness to adopt new social practices
18.	Economic Setting	Area targeted for growth, labour and employment.	Quality of life baseline; Development level baseline; Willingness to adopt new economic activities	Project area	Unwillingness by the locals to adopt new economic opportunities
19.	Health Setting	Status of health facilities, access to health services, occupational health and safety hazards. Hazards due to the use, storage, disposal or transportation of flammable, explosive, or toxic substances. Emission of electromagnetic or other radiation which may adversely affect electronic equipment or human health. Traffic hazards	Determination of the available health facilities in the area. Availability of officials in the available health facilities Emergency preparedness.	Project area and the surrounding environment	Inaccessibility of some areas
20.	Security and Public Safety	Public risks. Crime. Conflicts over resources; Fires	Need to enhance security in the project area Emergency preparedness	Project area and surroundings	Some areas are considered as high risk areas in terms of security (inter-tribe conflicts

21.	Public Consultations	Awareness creation on the project, environmental pressures in the area; expert and indigenous knowledge of the area.	Involvement of all stakeholders Information gathering on environmental issues and concerns in the project area Acceptability of the project	Project area and the surrounding environment	Language barrier
22.	Corporate Social Responsibility	Community prioritisation of areas/projects for possible CSR assistance	These were stated during the public consultations	Project area and the surrounding environment	High and sometimes unrealistic expectations
23.	Mitigation Measures	Mitigation hierarchy	Avoiding or reducing at source Abating on-site Abating off-site Repair or remedy Compensate for loss or damage	Proposed drilling site Access roads Selected camp sites and facilities	
24.	Environmental Management Plan	Effective mitigations specified for the topics addressed, costs, responsibility management relevant legislation and regulations, and decommissioning	Least possible interference with the environment Compliance with principles, policies and legislation relating to conservation of environment Decommissioning of campsite	Proposed drilling site Access roads Selected camp site and rig facilities Proposed drilling site Access roads Selected camp site and rig facilities	None
25.	Environmental Monitoring Plan	Parameters to be monitored Personnel required Training needs	Ease of monitoring Effectiveness of monitoring method Cost of monitoring Frequency	Proposed drilling site Access roads Selected camp sites and rig facilities	None

CHAPTER 5: POLICY AND LEGISLATIVE FRAMEWORK

5.1 Guiding Principles of ESIA

The basis of the present ESIA is a thorough scientific knowledge base on geothermal development, public participation in the process, access to information by all stakeholders, and transparent process with the goal of delivering clear decision making and effective compliance and enforcement.

5.2 National Legislative and Regulatory framework

5.2.1 Constitution of Kenya 2010

The right to a clean and healthy environment has been given recognition by the Constitution 2010 (Republic of Kenya, 2010). The state is constitutionally obligated to ensure sustainable exploitation and utilization of natural resources and to ensure the equitable sharing of accruing benefits. The Fourth Schedule of the Constitution 2010 delineates the functions of the national and county governments of which a total of 14 functions have been devolved to the counties. The main devolved functions include county planning and development; agriculture; county health services; control of air pollution, noise pollution, other public nuisances and outdoor advertising; cultural activities, public entertainment and public amenities; county roads and transport; animal control and welfare; trade development and regulation; pre-primary education and village polytechnics; specific national government policies on natural resources and environmental conservation; county public works and services; firefighting services and disaster management; and, control of drugs and pornography, many of which are central to the proposed ESIA.

Besides these functions, the Constitution emphasises the importance of participatory development and capacities developed at the county and community level. Article 174(c) provides that the object of devolution is to: "enhance the participation of people in the exercise of the powers of the State and in making decisions affecting them." Article 184(1) (c) further requires that mechanisms "for participation by residents" be included in national legislation to urban areas and cities governance and management. The stakeholders' engagement under the present study intends to fulfil such a requirement.

5.2.2 Kenya Vision 2030 and the Big 4 Agenda

The long-term development strategy of the country is captured in Vision 2030. This vision aims at enabling Kenya attain the status of a middle income county with an annual GDP growth of 10% under its economic pillar. The social pillar endeavors to bring about equitable social development in a clean environment. Adequate and reliable energy supply is the cornerstone of both economic and social development.

The Big 4 Agenda includes ensuring food security, affordable housing, manufacturing and affordable healthcare and prioritises public investments towards their realisation in the current budget and aligned to the MTP III of the Vision 2030. Manufacturing as well as affordable housing will put tremendous pressure on power demand. The projects puts into focus the transformative development blueprint that is a strong enabling platform for accelerated development and increased and reliable sources of

energy. Sosian Energy through the development of the geothermal power generation play a pivotal role in the realization of the Big 4 Agenda.

5.2.3 Scaling-Up Renewable Energy Program (SREP) Investment Plan for Kenya

The objective of the Scaling-Up Renewable Energy Program in Low Income Countries (SREP) is to demonstrate, through pilot operations the economic, social and environmental viability of low-carbon development pathway to increasing energy access using renewable energy. The proposed project aims at fulfilling the SREP goal in mitigating climate change, a development path that the Kenya government has taken up very seriously.

5.2.4 National Energy and Petroleum Policy 2015

The National Energy and Petroleum Policy (NEPP) proceeded from the earlier Session Paper No. 4 of 2004 (The Energy Policy) because of new challenges such as Climate change, the Constitution of Kenya 2010 and the Vision 2030. It had concrete substance, detail and procedures required to do EIA under sections 58 to 69 of the Act. Regulation 16 provides that an EIA has to take into account environmental, social, cultural, economic, and legal considerations.

5.2.5 National Energy Policy, October 2018

It became necessary to review the energy sector policyin view of Kenya Vision 2030 and the developments thereon and promulgation of the Constitution on 27th August, 2010 and the Government‘s commitments to the Big Four Agenda. The policy, *inter alia* aims to prioritise and promote development of indigenous primary and secondary energy resources of which geothermal remains the central and most abundant indigenous resources. Chapter 3 provides for renewable energy including electricity generation from geothermal and hydro resources while Chapter 6 covers land, environment, health and safety regarding energy development. Geothermal power generation involves drawing fluids at high temperature that carry a mixture of gases and other liquids which may negatively impact on the environment. To mitigate these, policy submits that the current geothermal plants are equipped with emission control systems to reduce the exhaust. In addition, the practice of re-injecting the fluids into the earth for disposal and stimulation of reservoir also help to reduce environmental risk besides other mitigation measures that include extraction of products for industrial use.

5.2.6 Geothermal Resources Act No. 12 of 1982

The Act revised in 2012 has the main objective to control the exploitation and use of geothermal resources and vest the resources in the Government. The license confers upon the licensee the right to explore, drill, extract and use and do all those things that are reasonably necessary for conducting all those operations. The Minister may also declare a license forfeited by a licensee by notice due to the following reasons: 1) if the licensee wholly ceases work on or under the land for a continuous period of six months; 2) if the licensee commits a breach or is in default of any provision of the Act or regulations made thereunder or of any terms and conditions of the license.

5.2.7 Geothermal Resources Regulations, 1990

The Geothermal Resources Regulations of 1990 is a subsidiary legislation to the Geothermal Resources Act No. 12 of 1982. According to clause 3 of these Regulations, any person who is to be issued with a license to develop a geothermal resource for commercial exploitation is required to submit to the Energy Minister the following:

- Proposals for the prevention of pollution, the treatment of wastes, the safeguarding of natural resources, the progressive reclamation and rehabilitation of lands disturbed by prospecting or production operations and for the minimization of the effect of such operations on adjoining or neighbouring lands; and
- A statement of any significant adverse effect which the carrying out of production operations would be likely to have on the environment and proposals for controlling or eliminating that effect.

The requirement of the above regulation implies that prior to the enactment of EMCA, 1999 all geothermal resource project developers were required to assess the potential impacts associated with geothermal resource development and put in place adequate measures to promote environmentally sustainable development. The only shortcoming with this requirement was failure to incorporate stakeholder participation in the process of identification of environmental and social risks as is currently stressed by EMCA, 1999. Regulation 6 prohibits the use of a geothermal resource license to give rights over or enter upon a burial ground, church, public roads, national park or reserve. Regulation 9 directs that licensee shall give the Minister thirty days' notice of any proposed geophysical survey and drilling. Regulation 10 directs for the supervision of a competent representative of the licensee during the drilling of all bore holes who shall also maintain a driller's log for each bore hole. Regulation 13 provides that all geothermal operation must be conducted in a workman-like manner and must prevent the unnecessary waste of or damage to geothermal resources, protect the quality of surface waters, air, and other natural resources including wildlife, protect the quality of cultural resources among other provisions

5.2.8 Energy Act 2019

The Energy Act, 2019 repealed sections of the Energy Act, 2006, the Kenya Nuclear Electricity Board Order No. 131 of 2012 and is read together with the Geothermal Resources Act, 1982 and regulations 1990 and therefore consolidates regulations relating to energy development in Kenya. The Energy Act 2019 has put all renewable and geothermal energy resources vested in the national government. However the Act provides for National and County Government functions in relation to energy, to provide for the establishment, powers and functions of the energy sector entities; promotion of renewable energy; exploration, recovery and commercial utilization of geothermal energy; regulation of midstream and downstream petroleum and coal activities; regulation, production, supply and use of electricity and other energy forms; and for connected purposes In Art. 81, a license issued under section 80 shall, subject to this Act and other relevant laws, confer upon the licensee the right:

a) to enter upon the land being the subject of the license to sink a well and to extract geothermal resources and to do all such things as are reasonably necessary for the conduct of those operations;

b) in so far as it may be necessary for and in connection with the operations referred to in paragraph (a) to drill and construct all necessary wells; erect, construct and maintain houses and buildings for his own use and for use by his employees; erect, construct and maintain plant, machinery, buildings and other erections as may be necessary; utilize the geothermal resources; subject to the law governing water resources, to reclaim and utilize any water; and construct and maintain roads and other means of communication and conveniences;
c) to take and use or apply the geothermal resources for any purpose specified in the license.

Art. 93 2(h). preventing or abating nuisances in or near wells and industries using geothermal resources; (i) prescribing safety precautions; (j) prescribing drilling machinery, materials, and casing to be used in making of wells and to be available to cope with any emergency in connection with any well, and prohibiting the use of other classes of materials thereof; (m) providing for wells to be made with due diligence and by safe and satisfactory methods; (n) generally regulating the drilling of wells.

Regarding the amount of the royalty charged on licensees, this ranges between 1% to 2.5% to be paid during the first 10 years of production and between 2% and 5% for the following years. The division of the royalty will be 5% to the local communities 20% to the county government and the remaining 75% will be taken by the national government. The responsible cabinet secretary in charge of energy is permitted to vary or waive the amount of the royalty in the interest of promoting investment and development of the resource.

5.2.9 Kenya National Electrification Strategy (KNES) 2019.

The Kenya National Electrification Strategy 2019 is an ambitious roadmap to reaching more than 11.8 million households costing US $5.2 billion during the plan period. Following the Medium-Term Plan (2018-22) of Vision 2030 (the Big 4 Agenda) both centered on four pillars- universal healthcare, affordable housing, food security, and manufacturing; and all four dependent on the provision of adequate, affordable, and reliable electricity, geothermal energy is critical in the planned strategy. Currently providing more than 40% of electricity generated Sosian Energy will contribute by providing low-cost renewable energy resource.

5.2.10 Kenya National Climate Change Response Strategy

This policy paper is a comprehensive response to climate change which poses a threat to Kenya‘s socioeconomic development and specifically to hydro power production. The Strategy identifies mitigations efforts to combat climate change, chief of which is the Green Energy Development Programme. Geothermal energy has a prominent role in the Government of Kenya’s climate change mitigation plans for expanding electricity-generating capacity and reaching the goals of Vision 2030. The proposed Sosian Geothermal development is part of the fulfillment of this strategy.

5.2.11 Wildlife Conservation and Management Act, 2013 (No. 47 of 2013).

This act has a purpose to consolidate and amend the law relating to the protection, conservation and management of wildlife in Kenya. The Act makes every attempt to ensure the security of animal or vegetable life in a National Park or in a National Reserve or in a local sanctuary or for preserving the habitat and ecology thereof, to prohibit, restrict or regulate any particular acts in any area adjacent to

the Park, National Reserve or local sanctuary and to specify the acts which are prohibited or restricted or regulated and the extent or manner of the restriction or regulation. The Act affects geothermal generation within the National Parks, wildlife corridors including flight paths of birds, and the transmission lines traversing these parks. So far, Sosian Geothermal development is to be undertaken in private land.

5.2.12 Devolution Act 2011

The Act establishes all County Governments in Kenya including the Nakuru County Government. Public participation is enshrined in the Constitution and in the Devolution Act 2011. The present stakeholders' engagement have been done under this tenet to ensure that development is beneficial to both the local people and also embraces national interests.

5.2.13 County Governments Act No. 17 of 2012.

The Act provides for the regulation required to implement the provisions relating to devolved government and to give effect to Chapter 11 of the Constitution, to provide for county government powers, functions and responsibilities to deliver services and for connected purposes. The statute vests the power of spatial and environmental planning on the county. Additionally, rural electrification is a shared function between the County and National levels of Government. This presents an opportunity for collaboration with the counties to enhance electrical connectivity. Section 6 (3) of the County Government Act 2012 provides that, a national state organ, such as Rural Electrification Authority, can co-operate with a county government in delivery of services.

5.2.14 Forests Act, 2005

An Act of Parliament that provides for the establishment, development and sustainable management, including conservation and rational utilisation of forest resources for the socio-economic development of the country. The Act created the Kenya Forest Service whose roles among others is to manage all State forests; manage all provisional forests in consultation with the forest owners; and protect forests in Kenya in accordance with the provisions of this Act. Any activities within a forest area which are not included in a management plan shall only be undertaken with the consent of the Board granted in accordance with this section. The Act is not applicable to the present project in view that Sosian Energy may endeavour to support afforestation by the adjoin community.

5.2.15 Way Leaves Act, Cap 292

This Act of Parliament in section 3 gives the government or his agent power carry out survey for any sewer, drain, pipeline or power line into, though, over or under any lands whatsoever, but may not in so doing interfere with any existing building

5.2.16 Land Act2012 No. 6 of 2012

The Land Act provides for matters relating to public, private and community land.

5.2.17 Public Health Act, 2017

Revised after the Constitution 2010 to establish a unified health system, to coordinate the inter-relationship between the national government and county government health systems, to provide for

regulation of health care service and health care service providers, health products and health technologies and for connected purposes. One of the key aims relating to the present project is protect, respect, promote and fulfill the health rights of all persons in Kenya (All the local community neighbouring the project site) to the progressive realization of their right to the highest attainable standard of health, Article 10 of the Act imposes a duty to all levels of government to keep all records and prevention of environmental risks. The Act is relevant to geothermal operations in matters mainly concerning general health and safety of dwellings for human habitation, welfare of employees, and sanitation among other general public health concerns that may arise in the course of construction and operational phases.

5.2.18 Factories Act (CAP 514)

Section 5(1) (c) (vii) defines, in part, power stations as factories, which automatically includes geothermal installations. It states, in part… (vii) "Any premises in which persons are regularly employed in connection with generating, transformation or transmission of electrical energy or motive power of any kind for supply by way of trade, or for supply for the purposes of any industrial or commercial undertaking or any public building or public institution or for supply to streets or other public purposes". Provisions of the Act include among others the health, safety, and welfare of those in factory premises. The Labour Commissioner is responsible for the administration of the Act through gazetted and certified inspectors and officers. In connection with health, the Act requires that every factory should be kept clean always, have proper drainage, and have sufficient sanitary conveniences for the employees, unless otherwise stated by the Minister. To ensure safety, the Act requires that all machines and corrosive and poisonous fluids that may cause danger or risk to anyone within the factory be properly fenced off and fences maintained.

Machines including lifts and hoists should also be properly maintained, enclosed where necessary and be in proper working conditions always. Any maintenance shall be done by persons as per the specifications given in the Act. Prohibited areas should strictly remain so and instructions clearly given and administered. The Act also requires that all machines that may cause injury are to be operated by well-trained operators who are well informed of likely dangers and properly supervised. All working gear (fixed or movable) should be of good construction material, adequate strength, free from patent defects (should be tested before use when new), shall be properly maintained and inspected regularly by a person approved by the chief inspector by a certificate in writing. On issues concerning fire, the Act requires conditions that may cause fires be prevented by storing highly inflammable substances in fire resisting stores, that the factory has easily accessible, adequate and well maintained means of extinguishing fires and adequate suitably located means of escape. It also requires that all the necessary conditions laid down be met. Any contravention of the Act is an offence liable to penalties or fines stated in the Act.

5.2.19 Occupational Safety and Health Act, 2007 revised 2010

It is an Act of Parliament that provides for the safety, health and welfare of workers and all persons lawfully present at workplaces and for the establishment of the National Council for Occupational Safety and Health that inspects and enforces the Act. The Act is the most important one and applies

to all workplaces where any person is at work, whether temporarily or permanently. The purpose of the Act is to secure the safety, health and welfare of persons at work; and protect persons other than persons at work against risks to safety and health arising out of, or in connection with, the activities of persons at work. Geothermal development activities are labour intensive, hence the need to guarantee the safety of the workers and all persons lawfully present at workplaces.

Part II of the Act provides the General Duties that the Occupier must comply with respect to health and safety in the workplace. Such duties include undertaking S&H risk assessments, S&H audits, notification of accidents, injuries and dangerous occurrences, etc. many of which shall be applicable to the proposed project. Part III of the Act provides the Administrative framework for supervision of the Act.

Part IV deals with the enforcement provisions that the Director of Occupational Safety and Health Services (DOSHS) has been provided with under the Act. It discusses the instances when Improvement and Prohibition Notices can be issued as well as the powers of OSH officers. This part of the Act will be mandatory for the Occupier to comply with and will be enforced by the managers of the proposed project.

Part V of the Act requires all workplaces to be registered with the DOSHS. This part will be applicable for the proposed project as the Occupier will have to apply for registration of their project with the DOSHS on completion of the construction phase and before the operational phase of the project. Part VI of the Act gives the requirements for occupational health provisions which include cleanliness, ventilation, overcrowding, etc. Some sections of this part of the Act apply to the Occupier and critical during all phases of the project.

Part VII of the Act contains provisions for the safe operation of machinery and includes all prime movers and transmission equipment. Additionally this part includes the safe operation of cranes, chains, ropes, lifting tackles, pressure vessels and their statutory examination by DOSHS Approved Persons. This part of the Act will apply to the Occupier during the construction and operational phases respectively of the project.

Part VIII of the Act contains provisions for general safety of a workplace especially fire safety. This part of the Act will apply to the proposed project during the design, construction and operational phases respectively of the project. Part IX of the Act deals with Chemical Safety as this will be applicable to the proposed project for the company will receive, store, handle and distribute materials such as petroleum fuels, lubricants, etc. The Occupier will be required to have MSDS sheets for all hazardous materials handled in the workplace including labeling of all receptacles containing such hazardous materials. Part X of the Act deals with the General Welfare conditions that must be present during the operational phase of the project. Such conditions include first aid facilities, supply of drinking water, accommodation for clothing, ergonomics, etc.

Part XI of the Act contains Special Provisions on the management of health, safety and welfare. These include work permit systems, PPE requirements and medical surveillance. Many sections of this part of the Act will be applicable to the proposed project during the construction and operational phase.

Part XII of the Act deals with Special Applications such as platforms erected over water and workplaces where steam boilers or hoists and lifts are used. This part of the Act will not be applicable to the proposed project. Part XIII of the Act stipulates the various fines and penalties associated with noncompliance of the Act, including those fines and penalties that are important for the Occupier to read and understand the penalties for non-compliance with S&H provisions.

Part XIV of the Act is the last section of the Act and contains miscellaneous provisions which are not covered elsewhere in the Act. Some sections under this part of the Act will be apply to the proposed project and it is in the interest of the Occupier to read, understand and ensure compliance with it. Some of the important subsidiary legislation which operationalizes the Act and is applicable to the proposed project is described below.

5.2.20 Subsidiary legislation under OSHA

5.2.20.1 The Safety and Health Committee Rules 2004, Legal Notice no. 31

These rules came into effect on April 28th, 2004 and require that an Occupier establishes a Safety and Health (S&H) Committee if there are a minimum of 20 persons employed in the work place. The size of the S&H Committee depends on the number of workers employed at the place of work, and for this project will be appointed from various departments and cadres of workers. For the Proponent and Contractor, the OSHA 2007 and the S&H Committee Rules 2004 are important as they require compliance with the following measures:

- Posting of an Abstract of the Factories and Other Places of Work Act in key sections of each area of the factory or other workplace;
- Provision of first aid boxes in accordance with Legal Notice No. 160 of 1977;
- Ensuring that there are an appropriate number of certified first aiders trained by an approved institutions and that the certification of these first aiders is current;
- Provision of a General Register for recording amongst other things all incidents, accidents and occupational injuries;
- Appointment of a S&H Committee made up of an equal number of members from management and workers based on the total number of employees in the workplace;
- Training of the S&H Committee in accordance with these rules;
- Appointment of a S&H management representative for the Proponent;

The administrative structure of the S&H Committee is stipulated in the regulations and include a minimum of quarterly meeting, take and circulating minutes as well as key action and send a copy of the minutes to the DOSHS provincial office whenever required. Appropriate recordkeeping including maintenance of all current certificates related to inspection of critical equipment such as cranes, air compressors, lifts, and other machinery. Such inspections need to be undertaken by an approved person registered by the Director of the DOSHS.

5.2.20.2 Medical Examination Rules 2005, Legal Notice no. 24

These rules provide for Occupiers to mandatorily undertake pre-employment, periodic and termination medical evaluations of workers whose occupations are stipulated in the Second Schedule of the Act and the First Schedule of the above Regulation. Workers that fall under the above two schedules are required to undergo medical evaluations by a registered medical health practitioner duly registered by the DOSHS.

It will be incumbent on the main Contractor to ensure that Material Safety Data Sheets (MSDSs) for chemicals used in the construction phase are studied for toxicological and epidemiological information. If any of these products present negative impacts to human health, the workers exposed to the chemicals will be required to undergo medical examinations in accordance with the above Rules.

5.2.20.3: Noise Prevention and Control Rules 2005

These rules were promulgated on March 10th 2005 for occupational noise exposures and apply to workplaces in Kenya. The regulation is applicable to the project as there will be noise potentially generated by construction equipment that may exceed the permissible noise levels given below. The rules may be applicable to the Proponent during the operational phase of the project. The rules set the permissible level for occupational noise in any workplace (which includes construction sites) as follows:

- 90 dB(A) over an 8-hour TWA period over 24-hours; and
- 140 dB(A) peak sound level at any given time.

Additionally the rules set permissible limits for community noise levels emanating from a workplace as follows:

- 50 dB(A) during the day; and
- 45 dB(A) at night.

If noise levels exceed the above permissible levels, the Occupier is required to develop, rollout and implement a written hearing conservation program which should include the following sections as a minimum:

- Undertaking a Noise Level Survey;
- Education and training of persons affected by excessive noise;
- Engineering noise control methods;
- Hearing protection requirements;
- Posting of notices in noisy areas;
- Audiometric testing methods and frequencies for those exposed to high noises;and
- Annual program review.

The Proponent is to ensure that any equipment brought to a site in Kenya for use shall be designed or have built-in noise reduction devices that do not exceed 90 dB(A). The Proponent shall request the supplier of the machine or equipment for its noise characteristics. There is also a requirement for a Proponent to medically examine those employees that may be exposed to continuous noise levels of

85 dB(A) as indicated in Regulation 16. If found unfit, the occupational hearing loss to the worker will be compensated as an occupational disease.

It is expected that during the construction phase of the project, there may be plant and equipment that exceeds the threshold levels of noise stipulated under the Rules. It will therefore be incumbent on the main contractor and their subcontractors to ensure that their equipment is serviced properly and/or use equipment that complies with the threshold noise values given above. Alternatively the main contractor will be required to develop, rollout and implement a written hearing conservation program during the construction phase.

5.2.20.4 Fire Risk Reduction Rules, 2007

These rules were promulgated by the Minister for Labor on April 16th 2007 and apply to all workplaces. A number of sections of the rules apply to the proposed project as enumerated below. Regulation 5 requires Proponents to ensure that fire resistant materials are used for construction of new buildings. A number of minimum specifications of materials are provided in the regulation. Regulation 6 requires that all flammable materials to be stored in appropriately designed receptacles. Regulation 7 requires that all flammable storage tanks or flammable liquid containers be labeled with the words "Highly Flammable" in English or Kiswahili. It is therefore practical for the Proponent to use a system similar to the Hazardous Material Identification System (HMIS) of labeling their product containers. The regulation requires a Proponent to consult the product's MSDS for appropriate labeling requirements. Regulation 8(3) requires a Proponent to have a spill prevention, response and countermeasures plan (SPRCP). This may be important if there will be chemicals stored at the construction site.

Regulation 16 requires Proponents to ensure that electrical equipment is installed in accordance with the respective hazardous area classification system. It is also a requirement that all electrical equipment is inspected 6-monthly by a competent person and the Proponent is required to keep records of such inspections. Regulation 17 requires Proponents to clearly delineate fire escape exits. The regulation provides for the minimum standards to be applied in marking out all fire escape exits. This section may not apply to the proposed project.

Regulations 20 – 23 require Proponents to have trained firefighting teams within their premises. The above regulations provide for the minimum number of fire team members based on the total number of employees that may be present at any given time within the Proponent's premises. Each of the fire team members must undergo a training course in fire-fighting to be provided by a DOSHS approved institution. The DOSHS may develop a curriculum for this training including the minimum number of contact hours required.

Regulation 22 provides a description of the functions of a fire-fighting team. Regulation 23 requires Proponents to mandatorily undertake fire drills at least once a year.

Regulations 24, 26 and 27 refer to the communication system to be employed by Proponents for alerting staff. All premises must have properly marked assembly points and suitable means of alerting workers about a fire. Regulation 27 specifically requires Proponents to display "No Smoking" signs wherever flammable vapors may be present.

Regulation 28 requires Proponents to install fire detection systems in their premises (offices, workshops, etc.). Such systems must be connected to audible and visual flashing devices and the system must be maintained regularly to ensure its integrity at all times.

Regulations 29 – 31 refer to the installation and maintenance of firefighting systems in workplaces. Fire extinguishers are to be mounted at least 60cm above ground while a fire hose reel must be located within a radius of 30m of a fire hazard. The firefighting system shall be maintained annually by a competent person and records maintained by the Proponent. Fire extinguishers shall be hydrostatically tested once every 5 years. Any fire extinguisher that does not pass a hydrostatic test or is damaged mechanically shall be put out of service. Regulation 31 provides the types of firefighting appliances required for different flammable and combustible materials and the minimum distances between firefighting appliances that must be maintained.

Regulation 32 requires Proponents to color code all their pipelines according to the product being conveyed by them. All fire water pipes will be colored in red. Additionally this regulation provides for the color coding to be adopted for fire extinguishers.

Regulation 33 requires Proponents to have adequate fire water storage capacity. As a minimum this regulation requires Proponents to have at least 10m3 of dedicated fire water storage capacity.

Regulation 34 requires Proponents to develop, rollout and implement a comprehensive written Fire Safety Policy. This policy should contain a Fire Safety Policy Statement signed by the CEO, a Fire Safety Policy Manual and a brief summary of the Fire Safety Policy of the company. Regulation 35 requires a Proponent to notify the nearest OSH area office of a fire incident within 24 hours of its occurrence and a written report sent to the Director of DOSHS within 7 days.

Regulation 36 requires Proponents to undertake annual fire safety audits by a DOSHS registered fire safety auditor and submit a report to the DOSHS within 14 days. The definition of a fire safety audit includes a fire risk assessment. The cost of undertaking fire safety risk assessments and fire safety audits shall be borne by the Proponent.

5.2.20.5: Hazardous Substances Rules, 2007

These rules were promulgated by the Minister of Labor on April 16th 2007 and may apply to the proposed project if it is expected to handle chemicals that can potentially expose employees to hazardous substances.

The Rules state that the Proponent shall ensure that where chemicals come into contact with employees, the exposure limits set out in the First Schedule of the Regulations are not exceeded. Where employees may be exposed to two or more chemicals in the workplace the Proponent shall work out the combined exposure using the narrative given in the Second Schedule of the Regulations. The Minister of Labor is empowered to change the exposure limits given in the First Schedule of the Regulations. It is the responsibility of the Proponent to ensure that all employees exposed to chemicals in the workplace are protected adequately from exposure to hazardous substances that may be present using the hierarchy of hazard control methods. Such methods include elimination of the chemicals, substitution of the chemicals with less hazardous ones, engineering controls, administrative controls,

use of PPE and emergency response planning. If engineering controls are applied, the Proponent will undertake the maintenance and testing of the engineering controls once every 24 months using a DOSHS approved Engineering Controls Examiner who will submit his report to the Director DOSHS within 30 days.

Regulation 12 – 15 requires Proponents to have a chemical safety program developed and implemented at their workplace if chemicals will be stored and handled. The Proponent is required to maintain an inventory of all MSDSs for the chemicals stored and handled in their workplace. As a minimum, the MSDS shall comply with the format indicated in the Third Schedule of the Regulations and will be disclosed fully to the employees handling the chemical. All unused, obsolete or expired chemicals must be disposed of in an environmentally sound manner. All containers containing chemicals must be labeled appropriately as indicated in the MSDS for that chemical. Training of employees on the hazards associated with handling chemicals safely in the workplace will be provided at the Proponent's cost.

Regulation 16 requires the Proponent to monitor chemical exposure levels in the workplace annually by engaging a DOSHS registered Air Quality Monitor. The cost of the exposure monitoring survey will be borne by the Proponent. The Air Quality Monitor shall submit a report to the DOSHS Director within 30 days. Regulation 19 requires Proponents that use hazardous chemicals in the workplace to subject those employees to medical examinations in accordance with the requirements of Legal Notice 24: The Factories and Other Places of Work (Medical Examination)

5.2.17 Employment Act 2007

An Act of Parliament that declares and defines fundamental rights of employees, to provide basic conditions of employment of employees, to regulate employment of children and provide for matters connected with the foregoing. It was amended (Amendment) Bill, 2019.

5.2. 21 Use of Poisonous Substances Act, Cap 247

Section 3 of the Act casts a duty of all employers of protecting their employees against the risk of poisoning by poisonous substances.

5.3 Environmental Management and Coordination

5.3.1 Environmental Management and Coordination (Amendment) Act, No. 5 of 2015

This is an act of parliament to amend EMCA, 1999 which is the legal framework for managing the environment in Kenya. Clause 43 of the act amends section 58 of EMCA, 1999 by providing that the proponent of any project specified under the second schedule shall undertake a full EIA study and submit the EIA report to NEMA prior to being issued with any license by the Authority. The second schedule to this act provides a list of projects that are supposed to undergo EIA study. Among these projects are:

a) electricity generation stations;
b) electrical transmission lines;
c) electrical sub-stations; and
d) Pumped-storage schemes.

Section 42 of the act provides that all policies, plans and programmes (PPPs) for implementation shall be subject to SEA.

5.3.2 Environmental (Impact Assessment and Audit) Regulations, 2003

This is a subsidiary legislation to EMCA, 1999 that governs administration of the EIA procedure. According to clause 11, an EIA study shall be carried out in accordance to the terms of reference developed during scoping exercise by a project proponent and approved by NEMA. Clause 13 provides that an EIA study shall be carried out by a lead expert registered and licensed to operate by NEMA. Pursuant to clause 16, an EIA study shall take into environmental, social, cultural, economic and legal consideration and shall:

a) Identify the anticipated environmental impacts of the project and scale of the impact;
b) Identify and analyse alternatives to the proposed project;
c) Propose mitigation measures to be taken during and after the implementation of the project and
d) Develop an environmental management plan with mechanisms to monitoring and evaluating the compliance and environmental performance which shall include the cost of mitigation measure and the time frame of implementing them.

Clause 17 requires the project proponent to seek the views of the persons who may be affected by proposed projects when carrying out EIA studies. Clause 42 requires lead agencies, in consultation with NEMA, to subject all proposals for public policies, plans and programmes to SEA in order to determine which ones are the most environmental friendly and cost effective when implemented individually or in combination with others.

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

In Legal Notice No. 120, Water Quality Licensing Guidance Pack 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 regulations are applicable to the project and must be adhered to at all phases of development.

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

The aim of the Waste Management Regulations is to protect human health and the environment. Currently, different types of waste are dumped haphazardly posing serious environmental and health concerns. Regulation no. 4 casts a duty on the waste generator to ensure proper waste collection, segregation and disposal in accordance with the regulations. Regulation 5 requires the waste generator to adopt clean production methods so as to conserve energy and reduce emissions or waste that is arising from his activities. The waste generator has a duty to segregate hazardous and non-hazardous waste under regulation 6. Regulation 14 creates a general obligation of pollution mitigations in all industrial undertaking by installing anti-pollution equipment for the treatment of waste emanating therein. NEMA licenses transporters, incinerators, landfills, composers, recyclers and transfer stations.

Facilities to be licensed include local authorities, transporters and handlers of various types of waste. Strict adherence ti the licensing requirements will be ensured in the SHMP.

5.3.5 Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations 2009

Regulation 3 prohibits the making or causing to be made of any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. Regulation 4 prohibits the making or causing to be made of excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others. It is necessary to monitor noise levels continuously.

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

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

Rules 13 and 14 of the regulations define the permissible noise levels for construction sites and are reproduced below.

Table 5.1: permissible noise levels for construction sites

Facility	Permissible noise level permitted (Leq) in dB(A)	
	day	Night
Health facilities, educational institutions, homes for the disabled, etc.	60	35
Residential	60	35
Areas other than those in (i) and (ii) above	75	65

Time frame: Day: 6.01 am – 8:00 pm (Leq, 14 hours); Night: 8:01 pm – 6:00 am (Leq, 10 hours)

Rules 5 and 6 of the regulations define noise levels for various types of activities that generate noise. The First Schedule to the regulations defines permissible noise levels to be complied with during the operational phase of a project and is reproduced below.

Table 5.2: Permissible noise levels during operations

Zone		Permissible noise level permitted (Leq) in dB(A)			
		Day	Night	Day	Night
A.	Silent Zone	40	35	30	25
B.	Places of Worship	40	35	30	25
C.	Residential: Indoor Outdoor	 45 50	35	35 40	25
D.	Mixed residential (with some commercial and 2545places of entertainment)	55	35	50	25
E.	Commercial	60	35	55	25

Time frame: Day: 6.01 am – 8:00 pm (Leq, 14 hours); Night: 8:01 pm – 6:00 am (Leq, 10 hours)

The regulation further stipulates that a permit will be required during the construction and operational phase of a project if there will be equipment that will produce noise during these two phases. The main contractor shall apply for a noise permit from the NEMA during the construction phase of the project. The fourth schedule of the regulations contains details of the application for a noise license while the fifth schedule provides a description of the noise permit that the NEMA will grant the main contractor.

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

a) produces any loud and unusual sound; and
b) Exceeds 84 dB(A) when accelerating.
c) No person shall at any time sound the horn or other warning device of a vehicle except when necessary to prevent an accident or an incident.
d) The provisions of the Traffic Rules shall apply to this Regulation. Any person carrying out construction and drilling work shall ensure that the vibration levels do not exceed 0.5 centimetres per second beyond any source property boundary or 30 metres from any moving source.

5.3.6 National Guidelines for Strategic Environmental Assessment in Kenya

These guidelines were developed by NEMA in 2012 and are anchored on the Environmental (Impact Assessment and Audit) Regulations, 2003 which requires lead agencies to subject all public policies, plans and programmes to SEA (NEMA, 2012). However, the scope has been expanded to include both public and private organizations. SEA helps to streamline and strengthen project-specific EIAs.

Table 5.3: Permits and Licenses

Legislation Permit	Licenses Required
National Environmental Management and Coordination Act (EMCA) of 1999	License for drilling; Emission licenses; Effluent discharge and Waste disposal; and License to generate hazardous waste.
Energy Act, 2006	Generation, importation and exportation, transmission or distribution of electric energy; Enhancement of energy efficiency and conservation Supply of electric energy to consumers
Geothermal Resources Act of 1982	Established the Geothermal Resources Authority. . Regulates access to and exploitation of geothermal resources for power generation.
Electric Power Act 1997	Facilitate and regulate the generation, transmission, transformation, distribution, supply and use of electric energy for lighting and other purposes, and for purposes connected therewith.
Water Act no. 43, 2016	Establishes management, distribution and supply of water and water rights through a permit system. WRA licenses water abstraction from rivers and groundwater. Water Resources User Associations (WRUAs) is established to manage and conserve water at the lowest level. Water Works Development Agencies licenses water service providers, i.e. for supplying a company estate.
Wildlife (Conservation and Management) Act of 1976	Manages wildlife, subsequently, through an Amendment to the Act in 1989, establishes the Kenya Wildlife Service (KWS). Licence for operating in KWS managed areas, in parks and national reserves.
Building Code Act 1997	Usually enforced by Ministry of Public Works and Housing and entrenched in the bylaws in the Local Authorities Outlines safety measures for construction of buildings
Radiation Protection Act 1985 ·	Provides for the protection of the public and workers from the dangers arising from the use of devices or material capable of producing ionizing radiation. License for owning, purchasing, acquiring, importing, manufacturing, selling or dealing in, or storing, using, disposing of or exporting any kind of irradiating device or radioactive material or any other source of ionizing radiation
Trade License Act, Cap 497 of 2006	Provides for registration, regulating and trade licensing and enforcement of business practices.
Penal Code, Cap 63, 1930, Part XVII	One of the oldest statutes on air quality management, i.e. On "offences Against Health and Convenience" in Sections 191-193 strictly prohibiting releasing of foul air which affects the health of other persons.

Standards Act, Cap 496	Established the Kenya Bureau of Standards Regulates standardization practice by determining quality of goods and services through certification.
Building Codes of 1968	Controls standards and codes of construction materials
Work Injury and Benefits Act of 2007	Provide for compensation to employees for work related injuries and diseases contracted in the course of their employment and for connected purposes. Every employer must register with the Director
Occupational Health and Safety Act of 2007	Workplace health and safety standards _ Inspects and registers of workplaces
Public Health Act, Cap 242	Licenses for eating places such as restaurants and kiosks
Food, Drugs, and Chemical Substances Act, Cap 254 (rev. 1992)	Prohibition against sale of unwholesome, poisonous or adulterated food
Use of Poisonous Substances Act, Cap 247 (rev. 198)	License for disposal/storage of poisonous substances
Physical Planning Act, Cap 286	Development application Development permission for geothermal drilling
Traffic Act, Cap 403	License for driving or operating a vehicle
Transport Licensing Board Act, Cap 404	License for public service vehicles (PSVs)
Scrap Metal Act 1972 rev.	Provides for the control and regulation of dealing in scrap metal, and for other purposes connected therewith License for removal and sale of scrap metal

5.4 International Legislative and regulatory framework

5.4.1 United Nations Framework Convention on Climate Change (UNFCCC) of 1992 and its Kyoto Protocol (1997)

This convention sets objective criteria of establishing greenhouse gas concentrations in the atmosphere at a level intended to prevent human-induced interference with the global climate. The Kyoto Protocol, drawn up in 1997, provides a voluntary arrangement in which the developed nations agreed to limit their greenhouse gas emissions relative to the levels of the 1990. UNFCCC requirements regarding accreditation to Clean Development Mechanism (CDM) of the Kyoto Protocol must be made to secure certified emissions reductions (CERs) available through the CDM. CDM allows projects in developing countries to generate emission credits if they result in emission levels lower than would otherwise be the case; these credits can be marketed and eventually counted against a developed country's emission obligation. The IEA provides analysis on the effectiveness of the different emissions trading scheme options, both at international and domestic level. The Kenyan

administration attaches high priority to CDM, which is seen as an instrument for mobilizing investments in the country and advancing the development of new industrial projects.

The Kyoto Protocol, requires signatories to the UNFCC to reduce their greenhouses gases emissions to below 5% of their 1990 levels. National CDM guidelines exist and Kenya already has substantial number of projects in the pipeline, including some that have already been approved by the NEMA. While NEMA is responsible for regulating and supervising CDM in Kenya, climate protection investments are promoted by the new Kenya Investment Authority (KIA).

5.4.2 Convention on Biological Diversity of 1994

The project is located in a Conservation Area and shall be governed by the Convention on Biological Diversity of 1994. The objective of the Convention is the conservation of biodiversity, its sustainable use and fair and equitable sharing of benefits arising out of the use of the utilization of genetic resources.

5.4.3 African Convention on the Conservation of Nature and Natural Resources of 1968

This convention aims at undertaking and adopting the measures necessary to ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interests of the people. Kenya has moved ahead of many states in realizing the objectives of the treaty.

5.4.4 Convention concerning the protection of the world cultural and natural heritage

Kenya is a member of the World Heritage Committee which consists of representatives from 21 States. Parties to the Convention concerning the protection of the world cultural and natural heritage are elected by the General Assembly of States Parties to the Convention. World Heritage Convention is an international Treaty for the preservation of sites of global significance created in 1927 by United Nations Educational, Scientific and Cultural Organization (UNESCO).

5.4.5 Convention of Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) of 1971

This convention is applicable to the present study so far as decision may be made regarding the water supply requirement from Lake Nakuru and its environs which is a Ramsar site. The project site is far from any of the known Ramsar sites.

5.4.6 Convention on the International Trade in Endangered Species (CITES) of Wild Fauna and Flora, 1990

This is a 1990 treaty that regulates the wildlife trade and protects forests as habitat for endangered species. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival and it accords varying degrees of protection to many species of animals and plants. There are no endangered species in the project site.

5.4.7 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) of 1979

The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) of 1979 aims at conserving terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme (UNEP), concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include over 100 Parties from Africa, Central and South America, Asia, Europe and Oceania. The Convention was signed in 1979 in Bonn (hence the name) and came into force in 1983.

5.4.8 U.N. Convention to Combat Desertification (UNCCD), 1992

The U.N. Convention to Combat Desertification (UNCCD), 1992, was enacted in those countries experiencing serious drought and/or desertification, particularly in Africa. The aim of this convection is to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements. The Convention is based on the principles of participation, partnership and decentralization - the backbone of Good Governance and Sustainable Development. National Action Programmes (NAPs) are one of the key instruments in the implementation of the Convention.

Desertification is a very important area of concern for Kenya and especially in the project area because it is in ASALs region. Studies in 1997 showed that 64% of Kenya's land area was potentially subject to moderate desertification and about 23% was vulnerable to a range of severe to very severe desertification. In the northern rangelands, 12.3% suffered from severe land degradation, 52% to moderate land degradation, and 33% faced slight vulnerability to degradation. The latter study identified degradation in ASALs as a potential precursor to widespread desertification (KLA n.d.). In the early 2000s, approximately 30% of Kenya was affected by very severe to severe land degradation (UNEP 2002) and an estimated 12 million people, or a third of the Kenya's population, depended directly on land that is being degraded (Bai and others 2008). The droughts of 1970-2000 accelerated soil degradation and reduced per-capita food production (GoK 2002). 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.

5.4.9 Convention on the Ban of the Import into Africa and the Control of Trans boundary Movements and Management of Hazardous Wastes (Bamako Convention)

Convention on the Ban of the Import into Africa and the Control of Trans boundary Movements and Management of Hazardous Wastes (Bamako Convention) is a treaty of African nations prohibiting the import of any hazardous (including radioactive) waste. The Convention was negotiated by twelve nations of the Organization of African Unity at Bamako, Mali in January, 1991, and came into force in 1998.

Impetus for the Bamako Convention arose from the failure of the Basel Convention to prohibit trade of hazardous waste to less developed countries (LDCs), and from the realization that many developed nations were exporting toxic wastes to Africa. It is based on the precautionary principle that states that have preventive regulatory actions in regards to environmental protection should be accepted even in the absence of a conclusive scientific proof that a given substance or activity harms the environment.

5.4.10 International Convention on Substances that Deplete the Ozone Layer (Vienna Convention) of 1985

International Convention on Substances that Deplete the Ozone Layer of 1985 and its Montreal Protocol of 1987 also called the Vienna Convention was concluded in March 1985. It encourages intergovernmental cooperation on research, systematic observation of the ozone layer, monitoring of CFC production, and exchange of information. The Montreal Protocol, adopted in 1987, was intended to allow the revision of phase out schedules on the basis of periodic scientific and technological assessments.

5.4.11 Convention on the Protection of the Ozone Layer

In March 1985 the intergovernmental negotiations for an international agreement to phase out ozone depleting substances. The ozone layer sits in the lower region of the stratosphere from about 20-30 kilometers above the surface of the earth. The thickness of the ozone layer is about 3 to 5 mm, but it pretty much fluctuates depending on the season and geography. chlorofluorocarbons (CFC) managed to reach the stratosphere and depleted the ozone via a profound series of chemical reactions. Carbon tetrachloride, hydrochlorofluorocarbons (HCFCs) and methyl chloroform, chlorine or bromine are key gases known as Ozone-Depleting Substances (ODS). Geothermal energy offers an excellent mitigation for greenhouse gas emissions from use of petroleum products and hence climate change.

5.5 Purpose of the World Bank and Other Partners' Safeguard Policies on Environmental and Social Management (OP 4.01)

5.5.1 World Bank's Operational Directive OD 4.00[1]

The directive requires a fully-fledged Environmental Impact Assessment (EIA) to be undertaken for any power development project. This EIA study is also based on World Bank Operational Policies (OPs) covering environmental and social management safeguards. Reference has been made to the World Bank Safeguard Policies, the World Bank Group Environmental, Health, and Safety (EHS) Guidelines namely the EHS Guidelines and the World Bank Environmental Assessment Source Book Volume II, which provides the relevant sectorial guidelines including the Banks Operation Policies/Bank Procedures. The objective of the World Bank's environmental and social safeguard policies is to prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for bank and borrower staff in the identification,

[1] The World Bank (per OP 4.01) requires Borrowers to reference the EHSGs as the benchmark for "pollution prevention and abatement measures and emission levels that are normally acceptable to the Bank." The World Bank, ADB and AfDB all reference the EHSGs in their respective operational requirements with respect to pollution prevention and abatement. Accordingly, issues that are within the scope of the EHSGs are not detailed in this comparison

preparation, and implementation of programs and projects. Operational policies have often provided a platform for the participation of stakeholders in project design and have been an important instrument for building ownership among local populations (World Bank, 1999-2006).

The World Bank Environmental Assessment Sourcebook (Volumes I, II, and III) provides practical guidance for designing environmentally sustainable bank-assisted projects. The sourcebook collates various bank policies, procedures and guidelines into a single source. Additionally, the Bank's Pollution Prevention and Abatement Handbook 1998 describe pollution prevention and abatement measures, as well as emission levels that are acceptable to the Bank. These standards have been considered in decision making in the present study.

5.5.2 International Policy on Involuntary Resettlement/Relocation and Compensation of People World Bank WB OP/BP 4.12

Resettlement due to infrastructure development is not a new phenomenon in Kenya but the Government has no Policy Document or Act that aims at ensuring that persons, who suffer displacement and resettlement arising from such development activities, are compensated adequately for their losses at replacement costs. The World Bank's Operational Policy 4.12, (OP) has been designed to mitigate against impoverishment risks associated with involuntary resettlement and the restoration or improvement of income-earning capacity of the Project Affected Persons (PAP). The government of Kenya has developed Resettlement Policy Framework (RPF) according to project demands. The policy requires full public participation in resettlement planning and implementation and describes the conditions that borrowers are obliged to meet in operations involving involuntary resettlement.

The principle policy of resettlement/relocation is to ensure that development projects sponsored by the Bank do not cause undue disturbance to livelihoods of those who depend on the project or its associated resources. There is therefore a need to develop a Resettlement Action Plan (RAP) for the project that shall propose a procedure that will be followed to ensure that the livelihood of those affected by the project is restored as much as possible. First, geothermal drilling site, site offices and construction of other amenities will be on a portion of the land owned by Sosian Energy Ltd. Secondly, some sections of the access road on private land may require widening and these will be discussed based on Wayleaves Act Cap 292. Thirdly, rehabilitation of the road will require borrow materials that may be identified on other entities' land. Fourth, the school, church and homesteads currently located too close to potential drilling sites may require relocation to new sites. There will be no need for a resettlement plan because it is not anticipated in the present project.

5.5.3 World Bank Operational Policy -Environmental Assessment

The World Bank environmental assessment process is similar to NEMA's under EMCA 1999 and both provide insights to ascertain the applicability of other safeguard policies to specific projects be they World Bank projects or not. These are especially typical for policies on natural habitats, pest management, and physical cultural resources that are typically considered within the EA process. The policy describes an environmental assessment (EA) process for the proposed project, detailing the breadth, depth, and type of analysis of the EA process dependent on the nature, scale, and potential

environmental impact of the proposed project. The policy favors preventive measures over mitigatory or compensatory measures, whenever feasible.

The operational principles of the policy are reproduced here for the sake of clarity:

- Evaluate adequacy of existing legal and institution frameworks, including applicable international environmental agreements. This policy aims to ensure that projects contravening the agreements are not financed.
- Stakeholder consultation before and during project implementation
- Engage service of independent experts to undertake the environmental assessment.
- Provide measures to link the environmental process and findings with studies of economics, financial, institutional, social and technical analysis of the proposed project.
- Develop programmes for strengthening of institutional capacity in environmental management.

Most of the requirements of this safeguard policy have been responded to in this report, by evaluating the impact of the project, its alternatives, existing legislative framework and, conducting public consultations and by proposing mitigation measures for the potential impacts identified.

5.5.4 World Bank Operational Policy 4.04-Natural Habitats

This operational policy requires that the study use a precautionary approach to natural resource management, to ensure environmental sustainability. The policy requires conservation of critical habitat during project development. To ensure conservation and project sustainability the policy requires that the project alternative be sought when working in fragile environment areas and key stakeholders are engaged in project design, implementation, monitoring and evaluation including mitigation planning.

The requirements of this policy were observed as much as possible during the EIA study. The consulting team engaged several stakeholders during project impact so as to incorporate their concerns and views in the EMP. This policy is not triggered by the proposed project as the project area does not directly fall within conserved and/or protected natural habitats.

5.5.5 World Bank Operational Policy 4.36-Forests

This operational policy provides measures for protection of forests through impact evaluation and conservation of forest during project development. This policy ensures that the health and quality of forest and right and welfare of people and their level of dependence upon the forest is fully protected. This policy is not triggered by the proposed project as the project area does not directly fall within conserved and/or protected forest. Restoration activities that enhances biodiversity and forest ecosystem such as afforestation and protection of indigenous trees should also be observed.

5.5.6 World Bank Operational Policy on Physical Cultural Resources

This policy guides in preserving physical cultural resources and helps reduce chances of their destruction or damage. The policy considers Physical Cultural Resources (PCR) to be resources of archeological, paleontological, historical, architectural, and religious (including circumcision sites), aesthetic or other cultural significance.

5.5.7 World Bank Operational Policy 4.10-Indigenous People

This policy requires projects to be designed and implemented in a way that fosters full respect for Indigenous Peoples' (IPs) dignity, human rights and cultural uniqueness. It has explicit requirement for "free, prior, and informed consent" under specified circumstances and ensures that the IPs receive culturally compatible social and economic benefits and do not suffer adverse effects during the development process.

5.5.8 World Bank Operational Policy BP 17.50- Public Disclosure

This BP encourages Public Disclosure (PD) or Involvement as a means of improving the planning and implementation process of projects. This procedure gives governmental agencies responsibility of monitoring and managing the environmental and social impacts of development projects, particularly those impacting on natural resources and local communities. The policy provides information that ensures that effective PD is carried out by project proponents and their representatives. The BP requires that public involvement be integrated with resettlement, compensation and indigenous peoples' studies. Monitoring and grievances address mechanism should also be incorporated in the project plan.

The proposed project incorporated public participation and stakeholder consultations as part of the ESIA studies, in order to collect the views of the local communities and their leaders for incorporation into the project mitigation plan. The consultation was successful and the community members gave a number of views that have been considered for enhancing their livelihoods as well as in the mitigation plan.

5.8 IFC Performance Standards (PS) on Environmental and Social Sustainability 2012

Performance Standards on Environmental and Social Sustainability became effective on January 1, 2012 and focuses on 1: Assessment and Management of Environmental and Social Risks and Impacts, 2: Labor and Working Conditions, 3: Resource Efficiency and Pollution Prevention, 4: Community Health, Safety, and Security, 5: Land Acquisition and Involuntary Resettlement, 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources 7: Indigenous Peoples 8: Cultural Heritage.

5.9 IFC Environmental, Health and Safety General Guidelines, 2007

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These General EHS Guidelines are designed to be used together with the relevant Industry Sector EHS Guidelines which provide guidance to users on EHS issues in specific industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. The General EHS Guidelines, that includes climate change mitigation measures, are organized as follows as environmental, energy conservation, wastewater and ambient water quality, water conservation, general facility design and operation, communication and training, occupational and community health & safety.

5.10 PS1: Social and Environmental Assessment and Management Systems

The purpose of this directive is to assist companies to integrate plans and standards into their core operations—so they can anticipate environmental and social risks posed by their business activities and avoid, minimize, and compensate for such impacts as necessary. The main objectives are:

a) To identify and assess social and environment impacts, both adverse and beneficial, in the project's area of influence,
b) To avoid, or where avoidance is not possible, minimize, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment,
c) To ensure that affected communities are appropriately engaged on issues that could potentially affect them, and
d) To promote improved social and environment performance of companies through the effective use of management systems

The Management System will incorporate the following elements:

a) Social and Environmental Assessment;
b) management program; (iii) organizational capacity;
c) training;
d) community engagement;
e) monitoring; and
f) Reporting.

PS2: Labor and Working Conditions and ILO Core Labour Standards to take into account the promotion of decent working conditions when carrying out their investment operations.

Table 5.4: Overview of labour provisions

Area of Labour issues	Requirements applicable to IFC clients
General issues	Sosian Energy shall adopt national human resource (HR) policy and "document and communicate to their employees" information on their employment and working conditions
Freedom of Association	Compliance with national law. Where national law prohibits unions: alternative mechanisms for grievance and protection of working conditions must be put in place. Clients may not, under any circumstances, discourage workers from, or discriminate against workers for, organizing or bargaining collectively
Non discrimination	Compliance with national law if it prohibits discrimination. No discrimination, regarding recruitment although affirmative action may be practiced, compensation, working conditions, termination of employment training and retirement regarding gender, colour, religion, etc.
Child labour	No child labour that is exploitative or harmful to the child's education, health or development Minimum age: follows applicable national law, no employment of children under 18 in "dangerous work"

Forced labour	No use of work or services "not voluntarily performed" "under threat of force or penalty"
Working conditions	Follow the collective agreement where the client is party to such an agreement Where no collective agreement covers wages, hours of work, overtime arrangements and compensation, sick leave, maternity leave or annual leave, national law will be respected
OSH	Client must take steps to minimize, as far as possible, the risks of occupational injury and disease The client must: identify risks, take preventive measures, provide training to workers, document occupational accidents and diseases
Retrenchment	In the event of mass lay-offs, a retrenchment plan is required to mitigate effects of retrenchment in consultation with workers and in a non-discriminatory manner
Grievance mechanism	Possibility for workers to raise concerns with the management in a transparent and expeditious manner
Non-employee workers	Covers contract workers performing core functions for the client for a "substantial duration" All labour provisions apply, except those on HR policy, retrenchment and supply chains
Supplies chains	Client must "inquire about and address child labour and forced labour in its supply chain"

Source: IFC: 2006.

Sosian Energy will establish a professional HR department and act according to the law. Grievance mechanisms will be established. Similar regulations have been adopted by the African Development Bank, Asian Development Bank, amongst many other Development Financial Institutions (DFIs).

PS3: Pollution Prevention and Abatement

PS3 addresses issues around "green "development in terms of resources inputs, pollution prevention and management of waste. Sosian Energy recognizes that there will be hazardous waste as well other benign form of wastes, and each need to be managed prudently.

PS4: Community Health, Safety and Security

PS4 addresses issue arounf health and safety of the community living in the surrounding villages. The local community aired their complaints in the Stakeholders' Engagement that have been addressed in the ESIA, ESMP and in Grievance management.

PS5: Land Acquisition and Involuntary Resettlement

The present project site is adequate for the intended development. There has been no consideration of land acquisition or resettlement plan.

PS6: Biodiversity Conservation and Sustainable Natural Resource Management

PS 6 addresses the issues regarding Protection and Conservation of Biodiversity, Management of Ecosystem Services, Sustainable Management of Living Natural Resources, and Supply chain. Although the project is on private farmland, the ESIA has addressed issues raised by the adjacent

farmers in the region. The discussion relates to water scarcity, air pollution and vibrations, issues that require technical solutions.

PS7: Indigenous Peoples

The community is composed of different ethnic groups and there are no indigenous people. The Stakeholders' Consultation is intended to cultivate "Informed Participation" centered on mitigation measures and benefit sharing.

PS8: Cultural Heritage

The project site is in a mixed cultural background comprising of Kalenjin, Kikuyu, Luo, Kisii, and Maasai.

IFC Environment, Health and Safety for Geothermal Power Generation 2007

5.11 Overseas Private Investment Corporation-Environmental Guidance Renewable Energy – Geothermal Projects January 31, 2012

These guidelines presents the evaluation features most significant to geothermal projects and reflect the information contained in the IFC's Environmental, Health and Safety Guidelines for Geothermal Power Generation, IFC's General Environmental, Health and Safety Guidelines, IFC's Performance Standards and other relevant standards and guidelines. These features include:

- Presence of critical or sensitive habitat on or adjacent to the site.
- Socio-cultural issues. Community issues.
- Air emissions.
- Impacts from well drilling and other operations.
- Impacts related to the construction of ancillary facilities including access roads and power transmission lines.
- Cumulative effects.

The guidelines provides standards and benchmarks for decision making in all environmental matters regarding geothermal power development.

5.12 KfW Development Bank Sustainability Guidelines/Standards 2014

Sustainability Guidelines of KfW Development Bank of April 2014 reiterates the need for environmental and social impact assessments (ESIA) and climate change assessments to anticipate and appraise any foreseeable impact a project may have on the environment, the climate and/or on social factors (including human rights), and to identify and prevent any negative impact, or limit it to a tolerable level and (provided that the negative impact is inevitable but still tolerable) introduce compensation measures. ESIA identifies, monitors and manage any residual risks. The objective of the climate change assessment is also to recognise climate change impacts that may impair the achievement of objectives in due time so that, if applicable, required adaptation measures can be taken into consideration in the project conception. Apart from assessing individual projects, ESIAs and climate change assessments are designed to demonstrate to partner countries the need to appraise projects and explore opportunities to make them environmentally, climate and socially compatible;

they are also intended to raise awareness of development approaches that are ecologically and socially sustainable. As management tool to steer and shape projects over their entire life cycle, it provides guidance regarding ESIA process.

5.13 KfW Development Bank Sustainability Guideline Assessment of Environmental, Social, and Climate Performance: Principles and Process April 2016

KfW Development Bank, has financed measures in numerous areas to protect the environment and the climate and to support social development. Central to its activities are the principles of environmental and social compatibility as well as sustainability. KfW Development Bank pursues in particular the following principles for its FC measures that are financed:

- to avoid, reduce or limit environmental pollution and environmental damage including climate-damaging emissions and pollution;
- to preserve and protect biodiversity and tropical rainforests and to sustainably manage natural resources;
- to consider probable and foreseeable impacts of climate change including utilising the potential to adapt to climate change. In this context climate change is understood as climate variability and long-term climate change;
- to avoid adverse impacts upon the living conditions of communities, in particular indigenous people and other vulnerable groups, as well as to ensure the rights, living conditions and values of indigenous people;
- to avoid and minimise 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;
- to ensure and support health protection at work and the occupational health and safety of people working within the framework of a FC measure;
- to condemn forced labour and child labour, ban discrimination in respect of employment as well as occupation and support the freedom of association and the right to collective bargaining;
- to protect and preserve cultural heritage;
- to support the executing agency in the management and monitoring of possible adverse environmental, social and climate impacts as well as risks within the framework of the implement FC measure.

5.14 Equator Principles

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. Within the IFC, the Sosian Energy Power Project is a category B project – which implies a project with potentially limited adverse environmental or social impacts that are few in number, generally site specific, largely reversible, and readily addressed through mitigation measures.

Compliance with the Equator Principles (EP) is a requirement of many commercial banks for new project financing with total capital costs of US$10 million or more. These principles are:

a) Review and categorization based on International Finance Corporation (IFC) criteria
b) Social and Environmental Assessment
c) Applicable Social and Environmental standards
d) Action Plan and Management System
e) Consultation and Disclosure
f) Grievance Mechanism
g) Independent Review
h) Covenants requiring compliance
i) Independent Monitoring and Reporting
j) Public Reporting Process and Experience

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.

5.15 African Union Commission - Geothermal Risk Mitigation Facility (AUC-GRMF)

Geothermal power development has several challenges. The challenges are associated with upstream investment in determination of resource thus requiring exploration drilling to confirm the resource potential, high project costs needed to mobilize resources, hiring of technical expertise, and high project risks which requires facilitation of Partial Risk Guarantees. The African Union Commission (AUC), the German Federal Ministry for Economic Cooperation and Development (BMZ), the EU-Africa Infrastructure Trust Fund (EU ITF) and the UK Department for International Development (DFID) in 2012 set up Geothermal Risk Mitigation Facility (GRMF) to fund a portion of the upfront cost as well as bear a portion of the risk involved in geothermal exploration and the drilling of reservoir confirmation wells. The GRMF has two primary elements to provide:

- Grants of up to 80% of eligible expenses for surface exploration that leads to the siting of wells for reservoir confirmation drilling. Eligible expenses include conducting various geological, geochemical and geophysical surveys and the interpretation of data from such surveys.
- Grants of up to 40% of eligible expenses related to the drilling and testing of up to two reservoir confirmation wells. If upon completion of such drilling, the grant recipient commits to taking the project forward, a continuation premium of 30% to cover the drilling of additional production or injection wells, reservoir engineering studies, development of a project financing package, engineering studies required for generation facility design etc.
- Grant applicants with further assistance related to the establishment of infrastructure required in order to carry out exploration or drilling activities. 20% covered by GRMF grant.

CHAPTER 6: ASSESSMENT OF THE BIO-PHYSICAL AND SOCIO-ECONOMIC ENVIRONMENTS

6.1 Bio-physical Environment

6.1.1 Topography

The main topographic features in Nakuru County are the Mau Escarpment covering the Western part of the county, the Rift Valley floor, Eburru Volcano, Longonot, Menengai Caldera, elaborate drainage and relief system and the various inland lakes on the floor of the Rift Valley where nearly all the permanent rivers and streams in the county drain into (Figure 6.1). The current rolling topography influences rainfall distribution, temperature and winds system. The Menengai volcano rises to an elevation of 2278 m above mean sea level. The caldera creates a micro-climate as compared to the shoulders of the caldera.

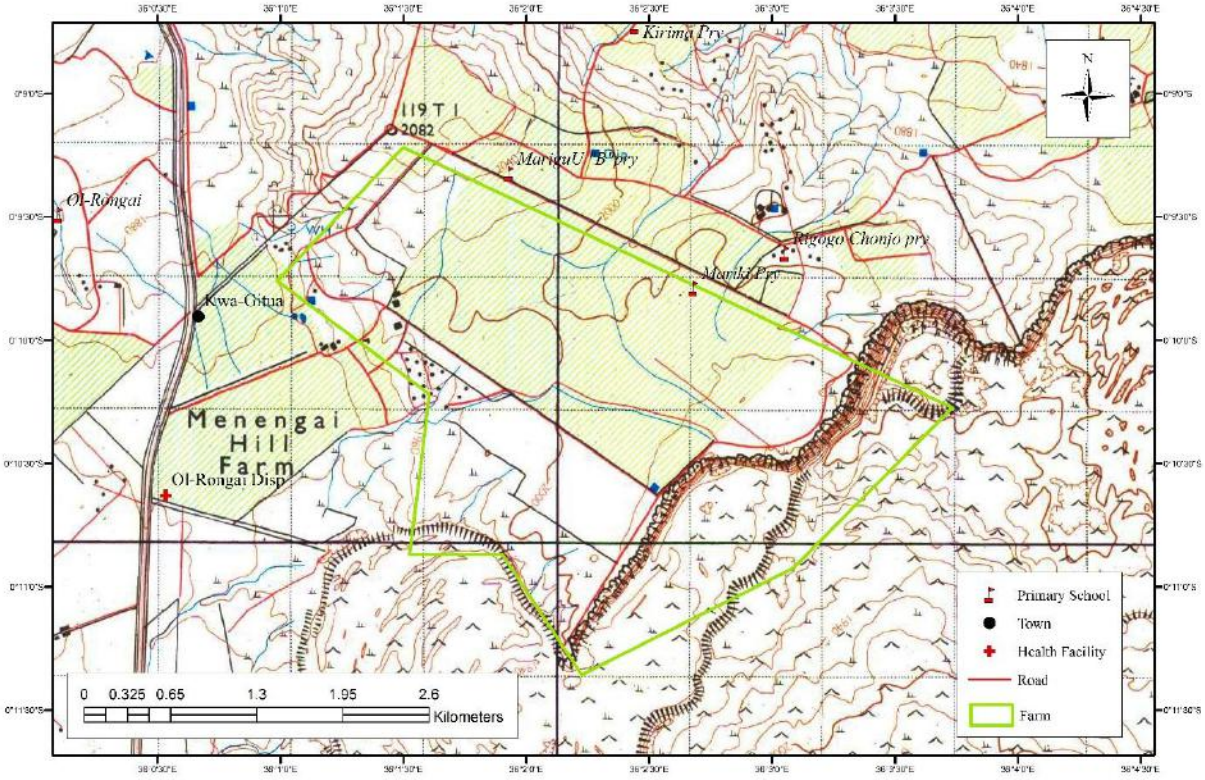


Figure 6.1: Physical characteristics of the project area

6.1.2 General Geology

Menengai Caldera is a massive shield volcano located within the East African Rift System (EARS) that extends for 3500 km N-S, from the southern end of the Red Sea through to the Indian Ocean off Mozambique and about 200-250 km wide. Its formation began 35 million years ago by rifting of the then single African tectonic plate into two major plates – the Somalia and the Nubia Plate. The volcano formed about 200,000 years ago and the prominent 12 x 8 km caldera formed about 8000 years ago.

The caldera floor is covered with numerous post caldera lava flows. This pulse of activity was preceded by transient uplift and subsidence at a second source, associated with the magma flow through the complex underground plumbing system. However Menengai caldera does not show any sign of activity presently and forms a major resources for geothermal energy development (Figure 6.2, Montegrossi, et al, 2015, Simiyu, 2012, Wambugu, 2009). At Menengai, two rift floor tectono-volcanic axes (TVA), Molo and Solai, are important in controlling the geothermal system. There is an approximately North-South line of vents outside and to the south of the Menengai caldera. The original rifting dropped approximately 1200 m. and second one about 900 m. The latter minor faulting in very complex grid patterns dropped the Rift valley a further approximately 300 m. during the upper outside the area of interest in the Nakuru Basin and west of Lake Nakuru respectively.

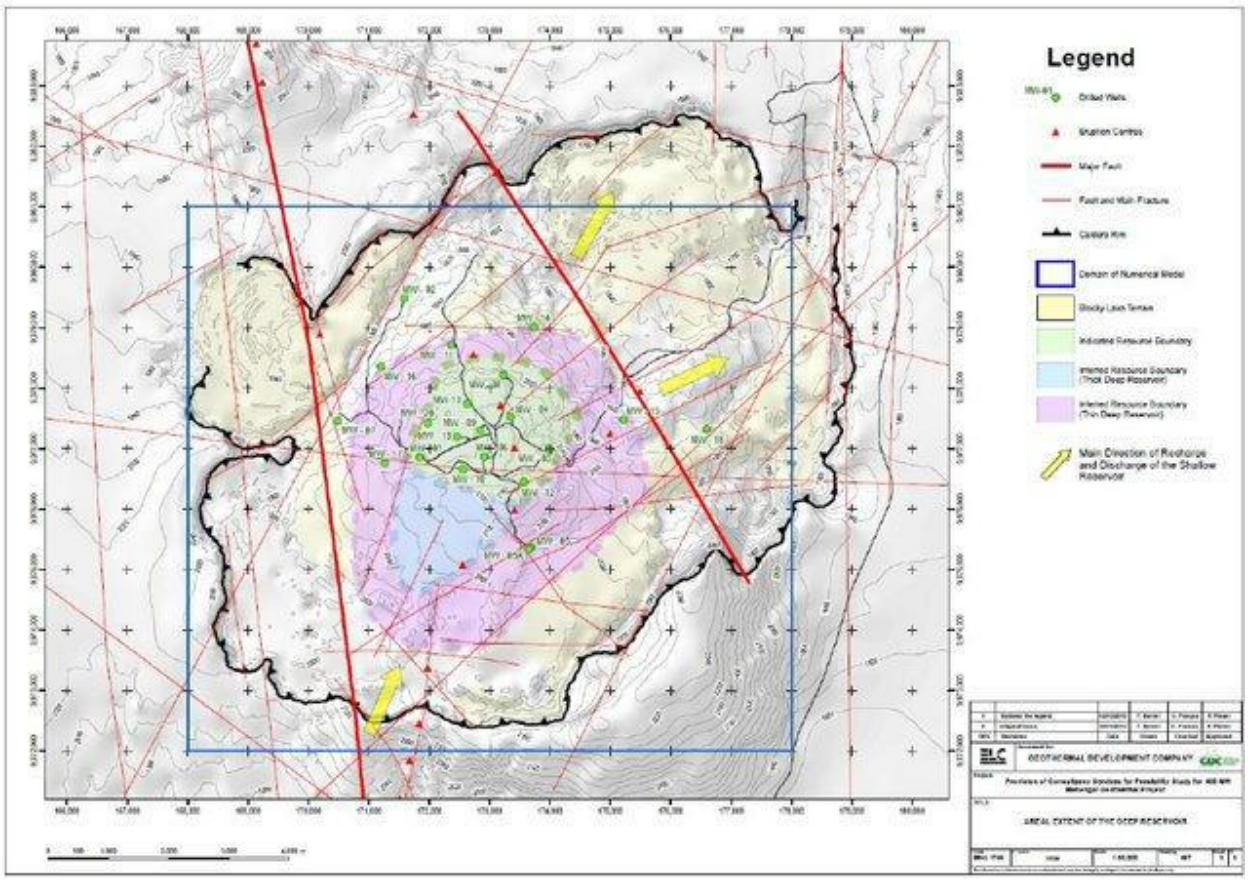


Figure 6.2: General geology of the Sosian-Makongeni-Menengai Highlands geothermal prospect area

The caldera formed as a result of cauldron subsidence, occasioned by sudden lowering of pressure resultant due to rapid release of gas and further collapse and engulfment of volcano super- structure. Later volcanic flows during the recent times (up to 2000 years ago) resulted in the formation of the caldera.

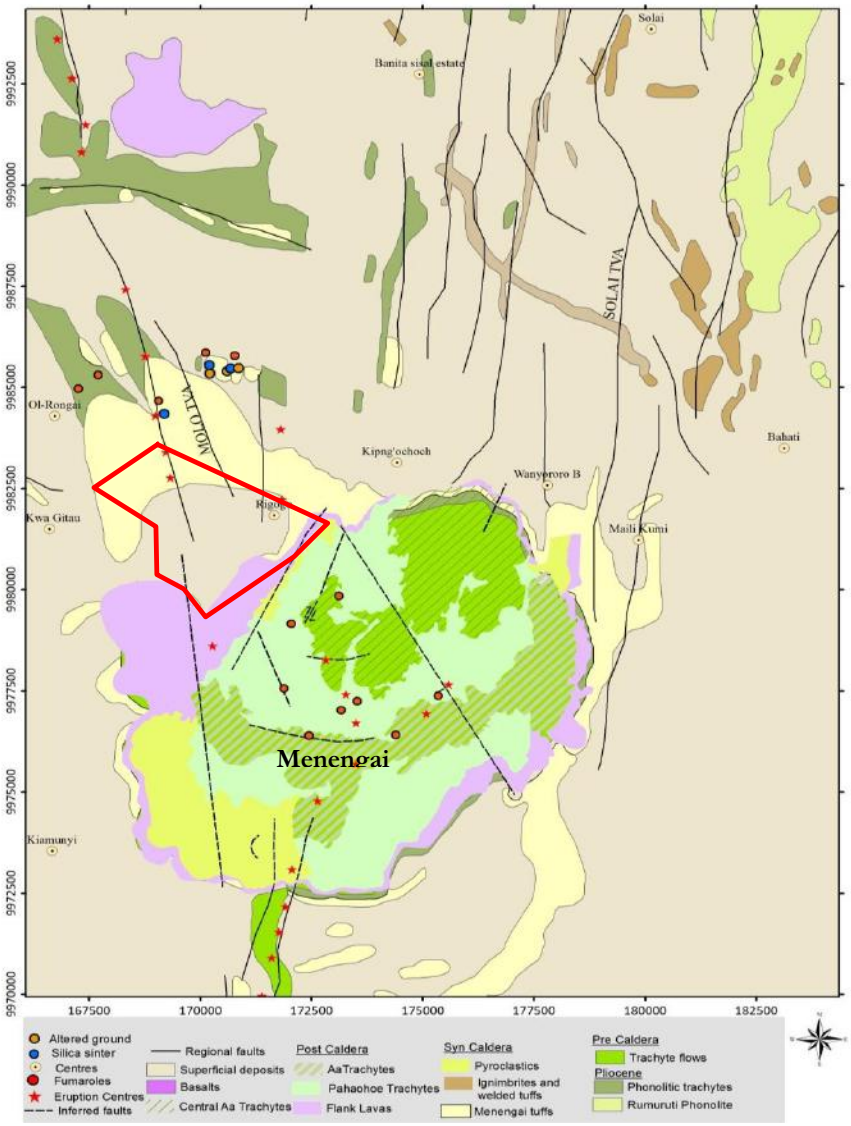


Figure 6.3: Geology of the project area

Upper Menengai lavas, which fill the caldera and are represented by trachyte lava flows and scoria cones (Leat P T, 1984). Trachyte lavas completely cover the floor of the caldera, concealing the rocks of the older volcano. The last eruptions are believed to have continued up to the last few hundred years (McCall, 1957, p. 66).

Plate 6.1: Venting along open extensional fracture

Many fumaroles are found randomly distributed in the caldera. Fumarole steam in the area has low contents of CO_2, H_2S, H_2, CH_4, and N_2. Gas geothermometry based on H_2S and CO_2 indicates that the reservoir temperatures are greater than 250ºC (Simiyu, 2008). Well MW-12 within the Caldera actually did encounter hot magma at ~3 km depth. Menengai is a trachytic caldera volcano composed almost entirely of compositionally zoned and strongly peralkaline, silica-oversaturated trachytes (Macdonald, et al, 2006). No mafic or intermediate lavas have been identified. The volcano has had a complex geochemical evolution, resulting from the interplay of magma mixing, crystal fractionation and various liquid state differentiation processes.

6.1.3 Rainfall and temperature

The climate of Nakuru County is strongly influenced by the altitude and physical features. . Climate is strongly influenced by seasonal migration of Inter Tropical Convergence Zone, (ITCZ) and the coinciding precipitation pattern. Rainfall associated with the transition of the ITCZ follows the highland sun in March and September with a lag of three to four weeks (Nicholson, 2000). The climate ranges from cold and humid to arid and semi-arid typical of the Rift Valley floor. Therefore the basin receives most of its precipitation during the long rains in April to May and the short rains in November. The project area is in zone III that receives rainfall of between 950 mm and 1500 mm per annum and has an altitude of between 900-1800m above sea level. Between the driest and wettest months, the difference in precipitation is 110 mm. The variation in annual temperature is about 2.0 °C. (Kenya Meteorological Department, 2000).

Table 6.1: Mean Monthly Temperature (0C) and Rainfall (mm) for Nakuru

	J	F	M	A	M	J	J	A	S	O	N	D
Avg. T (°C)	17.7	18.3	18.8	18.4	17.8	17	16.8	16.8	16.9	17.2	17.1	17.2
Min. T (°C)	8.3	8.8	9.6	10.5	10.2	8.9	9.3	9	8.2	8.7	9.3	8.6
Max. T (°C)	27.2	27.9	28	26.4	25.5	25.2	24.4	24.7	25.7	25.7	24.9	25.9
Rainfall (mm)	23	33	62	133	119	77	91	101	71	64	78	43

Figure 6.4: Monthly Means Temperatures for Nakuru

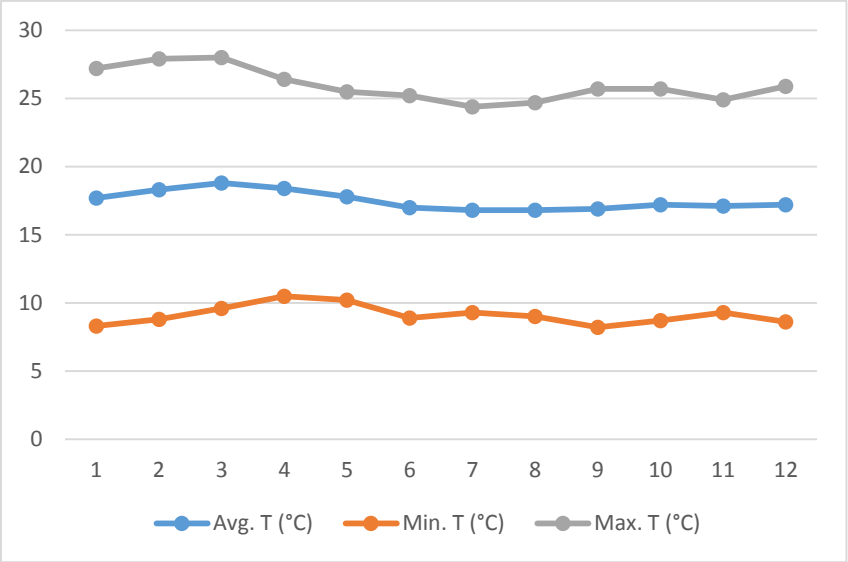


Table 6.2: Mean monthly rainfall for Rongai (9035073)

	J	F	M	A	M	J	J	A	S	O	N	D
Avg. T (°C)	18	18.2	18.5	18.5	17.9	17.1	16.6	16.7	17.1	17.4	17.4	17.5
Min. T (°C)	9	9.2	9.7	10.8	10.4	9.3	9.3	9.1	8.7	9.2	9.7	9.2
Max. T (°C)	27	27.3	27.3	26.3	25.5	25	24	24.3	25.5	25.7	25.1	25.9
Rainfall (mm)	28	42	69	145	120	73	115	108	69	64	86	52

Mean annual rainfall for Rongai (9035073) is 937mm. at an altitude of 1874m.There is a difference of 117 mm of precipitation between the driest and wettest months. The variation in annual temperature is around 1.9 °C. Similarly, rainfall recorded for the last 35 years at Menengai caldera, Madrugada Farm -LR 6886/6, co-ordinate 36.0226° E, 0.2535° S indicate that the annual rainfall ranges from 500-1500mm per annum with an annual mean rainfall of 923 mm. The long-rains occur in April to June while the short-rains in October/November. December to March is usually the dry season with strong winds in the caldera. The temperatures range from 25°C-30°C.

Figure 6.5: Mean Rainfall for Stations around Menengai

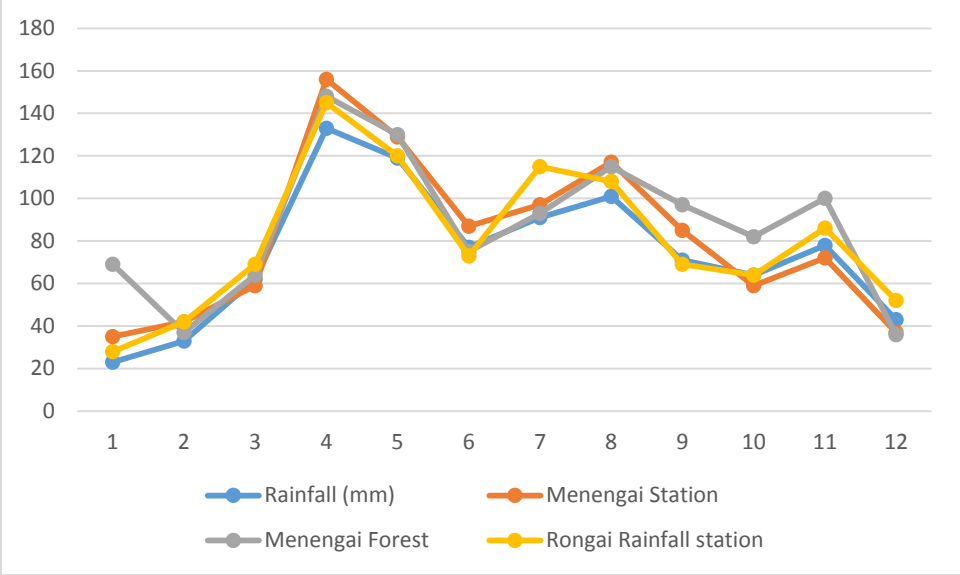


Table 6.3: Mean monthly rainfall for Menengai (9035267) and Menengai Forest Station (9036252)

Station	J	F	M	A	M	J	J	A	S	O	N	D
Menengai Station	35	42	59	156	129	87	97	117	85	59	72	37
Menengai Forest	69	37	64	148	130	75	93	115	97	82	100	36

6.1.4 Winds system

The winds system is very important for dispersal of both dust from civil works and from hydrothermal gasses discharged from the wells. Key environmental factors that are influenced by wind velocity and direction are proximity, morphology and prevailing wind directions are considered in determining the impact of air quality on humans and environment.

The hourly average wind vector (speed and direction) were measured at 10 m. above the ground represent the dispersal phenomenon associated with winds in the area. The direction of wind in is predominantly from SSE and NNW. The predominant average hourly wind direction in Nakuru varies throughout the year. The winds are dependent on local topography, tree cover, and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. The average hourly wind speed in Nakuru experiences mild seasonal variation over the course of the year. The windier part of the year lasts for 7.5 months, from October 4 to May 20, with average wind speeds of more than 10.2km per hour. The hourly average wind direction in Nakuru throughout October is predominantly from the east, with a peak proportion of 91% on October 31. The hourly average wind direction in Nakuru throughout October is predominantly from the east, with a peak proportion of 91% on October 31. The windiest day of the year is March 7, with an average hourly wind speed of 12.3km per hour. The calmer time of year lasts for 4.5 months, from May 20 to October 4. The calmest day of the year is July 25, with an average hourly wind speed of 8.2km per hour.

Table 6.4: Average monthly wind speed

J	F	M	A	M	J	J	A	S	O	N	D
0	2	3	4	5		6	7	8	9	10	11

The percentage of hours in which the mean wind direction is from each of the four cardinal wind directions, excluding hours in which the mean wind speed is less than 1.6km/hr. The lightly tinted areas at the boundaries are the percentage of hours spent in the implied intermediate directions (northeast, southeast, southwest, and northwest).

Table 6.5: Monthly temperature and precipitation in Nakuru

	Temperature			**Precipitation**
Months	**Normal** °C	**Warmest** °C	**Coldest** °C	**Normal mm**
January	18.0	25.5	10.5	4
February	18.8	26.7	10.9	4
March	19.4	26.8	12.1	8
April	19.2	25.0	13.4	15
May	17.8	23.5	12.1	13
June	16.3	22.5	10.0	5
July	15.6	22.0	9.2	3
August	15.9	22.7	9.1	4
September	17.3	25.0	9.7	4
October	18.5	25.7	11.3	7
November	18.4	24.0	12.7	14
December	18.1	24.4	11.7	9

Table 6.6: Weather patterns in Nakuru

Time	**Forecast**	**Temp. ^{0}C**	**Precipitation** mm	**Wind**
08:00–12:00	Partly cloudy.	17	0	Light breeze, 3.2km/s from southeast
12:00–18:00	Light rain.	22	0.7 mm	Light breeze, 3.2km/s from east
18:00–00:00	Cloudy.	20	0	Gentle breeze, 6.4km/s from southeast

Thursday 13/06/2019

Time	Cloud cover	Temp. ^{0}C	Precipitation mm	Wind
00:00–06:00	Partly cloudy.	16	0	Light breeze, 3.2km/s from south
06:00–12:00	Partly cloudy.	14	0	Light air, 1.6km/s from south-southeast
12:00–18:00	Partly cloudy.	23	0	Light breeze, 3.2km/s from east
18:00–00:00	Cloudy.	21	0	Light breeze, 4.8km/s from southeast

Friday 14/06/2019

Time	Cloud cover	Temp. ^{0}C	Precipitation mm	Wind
00:00–06:00	Partly cloudy.	17	0	Light breeze, 3.2km/s from south
06:00–12:00	Fair.	14	0	Light air, 1.6km/s from south-southeast
12:00–18:00	Light rain showers.	23	0.7	Light breeze, 3.2km/s from east
15:00–21:00	Rain showers.	22	1.2	Light breeze, 4.8/s from southeast

15/06/2019

6.1.5 Water Resources

The Menengai Caldera (2280 m asl) is located to the north of the lake. Lake Elementaita, a high-pH soda lake rich in blue-green algae and host of hot spring activity, is situated 13 km to the SE and separated by a low topographic divide. At greater depth, the regional flow is assumed to be northwards towards the low-lying area of Lake Bogoria. This flow pattern is affected by the presence of the major N–S trending rift faults that act as barriers to lateral flow, resulting in deeper and longer flow paths. The fault network of the rift floor tends to align with the regional flow path that follows the rift axis. The productivity of the shallow aquifers (<200 m bgl—below ground level) is variable.

At the moment water supply coverage in Nakuru County is at 66% meaning that 34% is either uncovered or lacking water services. Hence, there is an immediate need to boost water supply in the county. Still many of the county residents cover a distance of six kilometers to get to the nearest water point, while others still continue to take between 1 – 4 minutes to fetch drinking water. Nakuru County is endowed with other natural water resources which include: rivers, shallow wells, springs, dams, pans and boreholes spread all over the county. Some of the major rivers are: Malewa, Njoro, Molo and Igwamiti. In the project area, the main river of concern is the crater river and its tributary Kandutura stream with measured discharges of 0.068m^3/s and 0.005m^3/s respectively. This amount of water is low for drilling purposes hence the need to explore the option of borehole water.

Geothermal drilling requires a lot of water during the initial drilling phase for the exploration stage. The wells are estimated to reach a depth of about 200m. At this stage, water for drilling will be from three to four boreholes within the project area. The drilling of these boreholes is necessary due to lack of surface water resources within or near the project site. This water will also be used for road maintenance during the movement of the heavy drilling machinery to the site area. This will reduce the dust particles and pollution of the surrounding areas.

Table 6.7: Borehole Depth and Yield in Litres per Minutes [PO1]

Borehole number	Depth	Expected production discharge (litres per hour)	Yield in lpm
Kengen BH5	35	40,000	400
Kengen BH3	110	15,000	65

The prevailing geological and climatological conditions in the Nakuru area favour groundwater occurrence in three geologic formations; namely; lacustrine sediments, weathered and /or fractured zones in the volcanic rocks, and sediments interbedded between volcanic rocks.

The regional groundwater system in the area is locally recharged by infiltration of rainwater through the permeable volcanic soils, whose percolation into the deep lying aquifers is facilitated by the open fault and fissure zones acting as groundwater conduits. However, ample recharge takes place along the high lying areas of Bahati Forest and Kiplombe Hill located to the east and west of the of Nakuru area, respectively. Maximum mean annual rainfall in these recharge areas is approximately 1200 millimetres.

Groundwater occurrence is greatly determined by the geological conditions and tectonics. Structural features such as faults often optimize storage, transmissivity and recharge significantly occurring in areas adjoining surface drainage system as seen in streams disappearing beneath land surface as typified by River Ngosur. Shallow groundwater table, low rainfall and moderately low values of recharge characterize the low lying areas.

The extent of groundwater availability for recharge of geothermal systems depends primarily on hydrogeological factors such as recharge, transmissivity and storage. Features assessed include borehole depth, strike water level (i.e. the depth of the unit in which water was encountered) and static water level. Strike water level information indicates that the depths at which water was encountered ranges between a few meters to 240 m below the surface. About 50% of the boreholes had strike water levels at depth greater than 100 m, with the deepest levels recorded towards the western and northwestern part of project area particularly in Kabarak, Njoro and Rongai.

In the Menengai caldera – North, groundwater elevations adjacent to the Menengai caldera are high, indicating significant groundwater flow towards Olobanita area. Groundwater elevations vary between 1901-1623 m. indicating significant flow in a northwest direction. Confining pressures are generally low, hence the aquifer encountered in this area may result from permeable horizons within the Menengai volcanic deposits, rather than the Bahati tuffs. In the Rongai area, groundwater level

conditions in this area are not clearly understood because boreholes drilled in this area are either dry or produce steam. The groundwater elevations range between 1919-1739 m. above mean sea level: this indicates a flow in NNE direction towards Mogotio and Lomolo area. The confining pressures are low indicating unconfined conditions.

In the Lomolo-Mogotio area, groundwater elevation in this area is low ranging between 1425-1417metres; this indicates groundwater inflow from other areas. This receives inflow from: Rongai to the southwest, Olobanita to the southeast, Solai to the west and Kiplombe to the east. In the northen part towards Chemogoch area, the flow occurs in a northwest direction. From the groundwater results, it can be postulated that the groundwater of Lomolo-Mogotio area escapes through the fault systems forming a part of the flow towards Lake Baringo. The confining pressures are high indicating confined conditions resulting in high yields for the boreholes in the area. The Rongai regional aquifer system is composed of weathered volcanic rocks, fractured volcanic rocks, fractured and weathered volcanic rocks, and old land surfaces. This system is recharged locally and from the south in the areas of Njoro.

The characteristics of the aquifer are:

- Groundwater in this zone is confined.
- Average depth of boreholes is 225 m. bgl.
- Average depth to groundwater is 159 m. bgl.
- Average water rest level is 166 m. bgl.
- Average tested yield is 5.0 m^3 /hr.
- Average specific capacity is 4.4m^2/day hence indicating that this area is of low groundwater potential.

Boreholes in Mereroni area near the municipal boundary of Nakuru have high yields and are used by the Municipality of Nakuru for water supply. Nakuru area, though an area of internal surface drainage, obtains its main recharge of ground water not from the rain that falls within it, but from the rain that waters its high flanks, the Bahati Forest and the Mau. The principal processes that control the groundwater quality variations are the influence of silicate rocks weathering and anthropogenic contribution which is also significant. Most of these ions surpass local and international recommended limits and areas with lofty values have been defined.

Sewerage system has been developed in limited areas in Rift Valley Catchment Area (RVCA) and current sewerage coverage ratio is only 4%. There are four small-scale wastewater treatment plants in Nakuru, Naivasha, and Molo, with a total treatment capacity of about 18,393m^3/day. Around 69% of the population use on-site treatment facilities such as septic tanks, etc. The on-site treatment facilities include unimproved ones, but the ratio of the unimproved facilities is not known. Around 27% of the population does not have any treatment facilities and resort to unsanitary waste disposal. The implication of this is that groundwater is susceptible to human pollution and that care should be taken to avoid any groundwater contamination. The project proponent will try to provide sanitation facilities near the intake points or drilling points.

The project area has few surface water resources. From Menengai Caldera the drainage from the southern rim of the crater flows southwards into Lake Nakuru while the drainage from the northern rim of the crater flows mainly northwards. The topography in project area is rolling plains, covered by savannah vegetation cover that support various species of livestock. The permanent rivers in the area are Crater and Olbanita streams in the eastern parts. The N-S, NE-SW, and NW-SW trending fault/fracture systems provide underground channels resulting to stream water disappearing underground at some places.

Within the project area, groundwater flows to the north towards Olbanita area at elevations ranging between 1901m to 1623 m a.m.s.l and towards the northwest. The hydrogeological system comprises of high yielding boreholes mainly hosted in fractured fresh lavas; moderately high yield boreholes hosted in lacustrine beds; reworked volcanoclastic as well as in fractured lavas (Lagat et al, 2010).

6.1.6 Soils

The soil classification process follows the FAO-UNESCO legend that accommodates the world's soils in order to overcome gaps in national classification systems and to provide a common basis for soil correlation. The soils are vitric Andesols developed on young or recent volcanic ash and are well drained, moderately to deep, dark to reddish brown to dark brown, clay loam to clays.. The soils are easily eroded and that has been the cause of decline of productivity.

Plate 6.2: Soil along the banks of a road

Towards the crater rim, the soils are shallow to moderately deep, gravelly to stony and sometimes strongly calcareous.

6.1.7 Air quality

Topography, rainfall, winds and temperature determines air movements in the project area. Other factors are mainly engineering including stack heights, density of buildings, amongst many others. The project area is dominated by winds from the SSE and NNW. Long term air quality impacts are therefore expected to be most significant to the NNW and SSE.

The project will result in air pollution from dust from construction site and roads and also from Non Condensable Gaseous (NCG) emissions, exhaust smoke from generators, compressors and vehicles. The most important NCG is hydrogen sulphide gas due to its unpleasant odour and toxicological effects. H_2S ground level concentrations are expected to be below 1.0 ppm during drilling, which is far below the WHO threshold human exposure limit value of 10 ppm. The risk of Hydrogen Sulphide gas will be managed through a monitoring network of monitoring stations determined through air dispersion modelling, taking into account the location of emissions sources and areas of community use and habitation. The monitoring system will be used for early detection and warning. Emergency planning involving community and employees will be established. These mitigation measures will form part of the ESMP.

6.2 Biological/Ecological environment

6.2.1 Flora

The project area runs along the rim of the caldera, elevated from 1900–2300 m. above sea level. There is also a geothermal exploration project by the Geothermal Development Company (GDC) inside the Menengai Caldera floor. The rest of the area is covered by farmlands.

6.2.2 Fauna

There are no biodiversity on the project site. The movements of theses wildlife will be monitored to ensure that they do not get into protected waste dumps and thus endanger their lives. In addition, the fauna will constitute fair monitoring indicators for environmental viability. No wildlife migratory corridors have been established in the project area. There are no recorded archaeological sites and no surface artefacts were seen on the proposed development site.

6.3: Socio-Economic Characteristics of the Project Area

6.3.1 Administrative structure

The project site is in Menengai West Ward, Rongai Constituency in Nakuru County and among the eleven constituencies in Nakuru County. The ward area is 118.70 km^2 and comprises of Mercy Njeri, Olive-inn, Kamungei, Mangu, and Menengai sub–locations.

6.3.2 Population Distribution

Rongai sub county has a population of 163,864 (82,665 males and 81,199 females) with a population density of 255.2km^2 (NBS, 2009). Each household has 4.2 persons. From the socioeconomic survey undertaken in the project area, persons between the ages of 30-34 have the largest proportion of 11.0%. When taken together, as large as 29.4% of the sample are below the age of 15 years. The productive segment of the population (20 – 55yrs) is about 52.1% while old people (> 55 years)

accounted for 8.4%. Majority of households surveyed were male- headed (81.7%) whereas 18.3% of the households are female headed. Rongai constituency is cosmopolitan and has several minority communities including Luo, Kisii, Luhya, Turkana, Kamba, who work in sisal farms while others are self-employed and a few work in the national and county governments. The Kalenjin and the Kikuyu, however form the dominant communities and are large land owners in the constituency.

Table 6.8: Locations and wards

Location	**Population***
Boror	13,753
Kampi ya Moto	23,436
Lenginet	21,770
Maji Tamu	13,881
Makongeni	19,746
Ngata	17,910
Rongai	19,546
Solai	35,949
Waseges	29,722
Total	**x**

Source: 1999 census

6.3.3 Land use

Agriculture is mainly practiced in the region; current crops include: wheat, maize, alfalfa, beans and potatoes. Conversion of agricultural land for power generation, decline in local food production may cause food prices to increase. However will good communication and proximity to Nakuru Town, these shortages are likely to be short-lived. Business in and around trading centres will definitely grow. Menengai Crater Bee Keepers are a community based organization started in 2008 and was registered in 22nd July 2011. It is located in Menengai forest, Nakuru County. Since its formation and registration, it has been operational with the support from community development trust fund through Menengai Community Forest Association. The organization has 11 women, 8 men, and 2 youth totaling to 21 members. The organization's main activities have been establishment of an apiary, wax processing and eventual honey extraction and packaging. Operational area/ where the activities are carried out are within Menengai forest where the apiary is located. To date the organization has acquired 20 longstroth bee hives of which 10 have been colonized. However, despite receiving support from the community forest association (CFA), the organization face a challenge in acquiring more bee hives, semi processing units and packaging materials among other requirements. Main objectives and mandates:

a) To improve community livelihood through establishment of income generating activities;
b) To support the community forest association in forest protection and conservation;
c) Capacity building

The group has a chairperson, vice chairperson, secretary, vice secretary, coordinator and treasurer Menengai crater bee keeper's group is composed of: The chairperson who chairs all the meetings, vice chairperson, secretary, vice secretary, treasurer, coordinator and 15 members. Menengai crater bee keeper's has been operational since 2008.

The main activities are bee keeping and forest protections/ conservation. To date achievements' include establishing of apiary, honey processing, wax 6 production, packaging and selling. So the Menengai bee keeper's produces 200kg of processed honey annually. The Menengai crater bee keeper's organization through the Menengai Community Forest Association (CFA) is working in conjunction with the Kenya Forest Service (KFS) and Ministry of agriculture and livestock development department

The effect of the project above ground will occupy a relatively confined area and the disturbance will be minor. Current land use is mainly farming and livestock keeping. In Rongai sub-county subsistence employs about 70.1%, both subsistence and non-subsistence 16.7%, and food crops 48.5%. Rongai are predominantly agricultural sub county with maize and wheat crops being the predominant crops grown and cattle rearing for milk production, especially in areas neighbouring the project area.

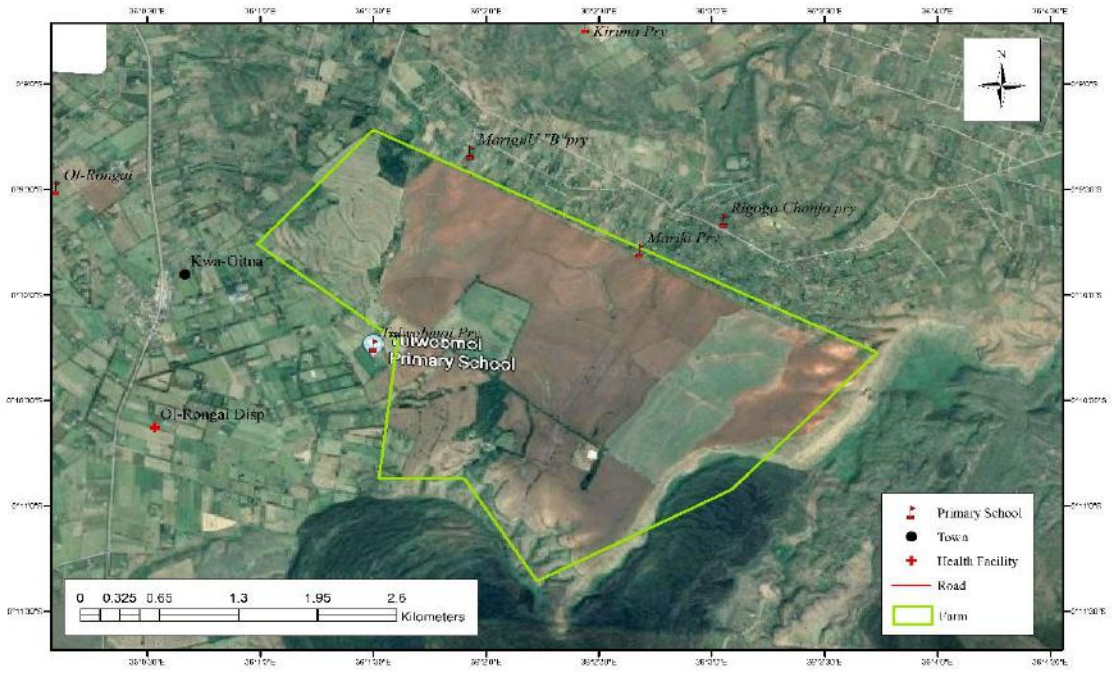


Figure 6.6: Land use and farm sizes

The main agricultural activities (both commercial and subsistence scale) of the project area are livestock keeping and crop farming. In the areas surrounding Menengai Caldera and parts of the intra-caldera, the main cash crops are wheat, sisal and coffee while the main food crops are maize, beans and potatoes. In the Kiamunyi, Mashiaro, Menengai farm, Valley farm and Kampi ya Moto areas, large-scale wheat, maize and dairy farming are predominant. In the eastern side of the caldera rim,

subsistence farming of maize, beans, potatoes and horticultural crops (tomatoes) is dominant. Large-scale sisal and coffee farming and livestock keeping characterize the Ol banita and Solai areas.
Livestock keeping is also practiced within the caldera particularly in accessible areas located to the west. The project will argue that gained experience proofs that geothermal power stations become educational/visitor centers with attracting every year thousands of visitors and therefore the geothermal installations can support the tourist industry.

Plate 6.3: Farmstead within the area outside of the project site.

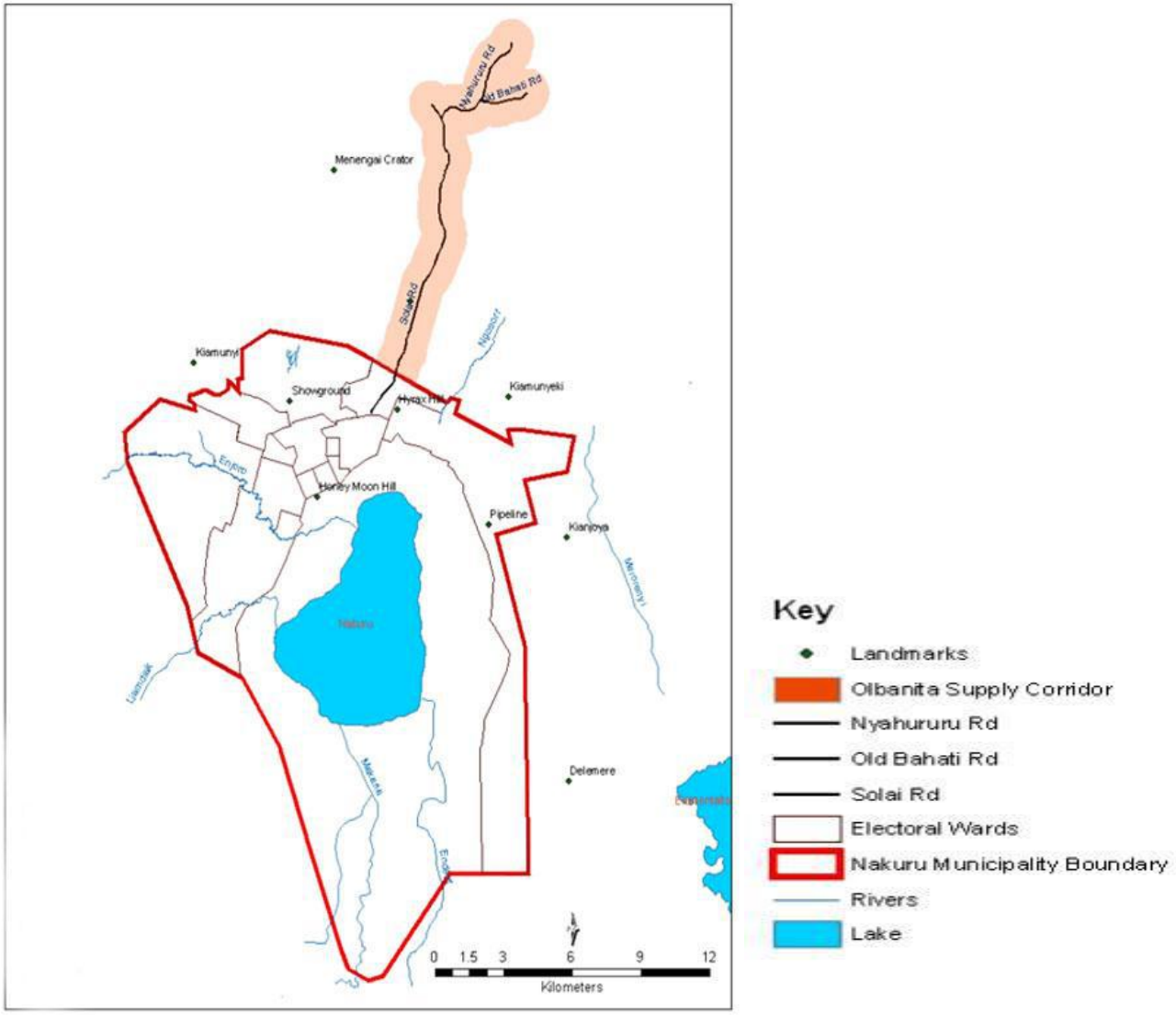
6.3.4 Water supply

The local population obtain water supply from Nakuru Water and Sewerage Services (NAWASCO) Ltd flow from river, treated within the project area for further distribution. This water is inadequate since part is distributed along the pipeline without treatment.

Plate 6.4: Water treatment plant managed by NAWASCO

The main water sources are Kabatini (8 boreholes), Nairobi Road (3 boreholes), Baharini (5 boreholes), Olbanita (8 boreholes), Mareroni (river intake), Malewa (river intake), and NARUWASCO (bulk water). At the moment water supply coverage in Nakuru County is at 66%. Hence, there is an immediate need to boost water supply in the county. Still many of the county residents cover a distance of six kilometers to get to the nearest water point, while others till continue to take between 1 – 4 minutes to fetch drinking water. Besides the water bodies mentioned earlier, Nakuru County is endowed with other natural water resources which include: rivers, shallow wells, springs, dams, pans and boreholes spread all over the county. Some of the major rivers are Malewa, Njoro, Molo and Igwamiti.

Figure 6.7: Nakuru Water and Sewerage Services Company



6.3.5 Transport Network

The project site is connected by a tarmac road from Nakuru town via Kiamunyu and Rongai. The project site is connected by a murrum road that goes to Kwa Gitau, splitting about 5 km. The murrum road from the branch from Kwa Gitau to project site is narrow and the edge of the paved surface is eroded hence requiring support to comfortably be used by heavy trucks.

During construction and drilling, the heavy trucks will transport machinery to the project site. The enhanced transportation load on the road network during exploratory drilling, development, operations and during decommissioning of the plant are heavy construction equipment, delivery trucks, heavy plant haulage trucks, and fuel delivery trucks delivering materials to the project site. Unskilled construction workers will also be brought in on a daily basis from the trading centres and Nakuru town. Water supply, however, is available on site.

Plate 6.5: Typical road section leading to the project site

Plate 6.6: Current road to the project site requiring murram

The road network will be graded and drainage improved to reduce soil erosion (Plates 6.9 and 6.10) and improved to allow fast as safe travel during project implementation.

Plate 6.7: Current road to the project site being undermined by poor drainage

These movements may generate dust, damage the road leading to the project site, increase vehicular noise levels, cause traffic congestion and increase the number of potential road accidents, increase exhaust emissions that may affect human and plant health in the area.

6.3.6 Employment and labour market

One of the requests during stakeholders' consultation was the issue of jobs for the youth. The company will determine and discuss full details of employment opportunities in consultation with stakeholders. However employment of unskilled labour required during construction of the geothermal power generation infrastructure such as roads, water supply and construction of the plant will be sourced from the local community as determined during such phases of implementation. Skilled labour is generally specialized and must require prior training or on the job-training and such skills will also be determined during phases of the power generation.

6.3.7 Education Facilities

The education facilities in the area include Kiamunyu Secondary School, AIC Lubwomoi Secondary School and primary schools include Kirima School (more than 3.0 km), Marigu Primary school (1.5km), Kwa Gitau Primary schools, Rigogo and Kipng'ochoch schools and AIC Tulwobmoi secondary school.

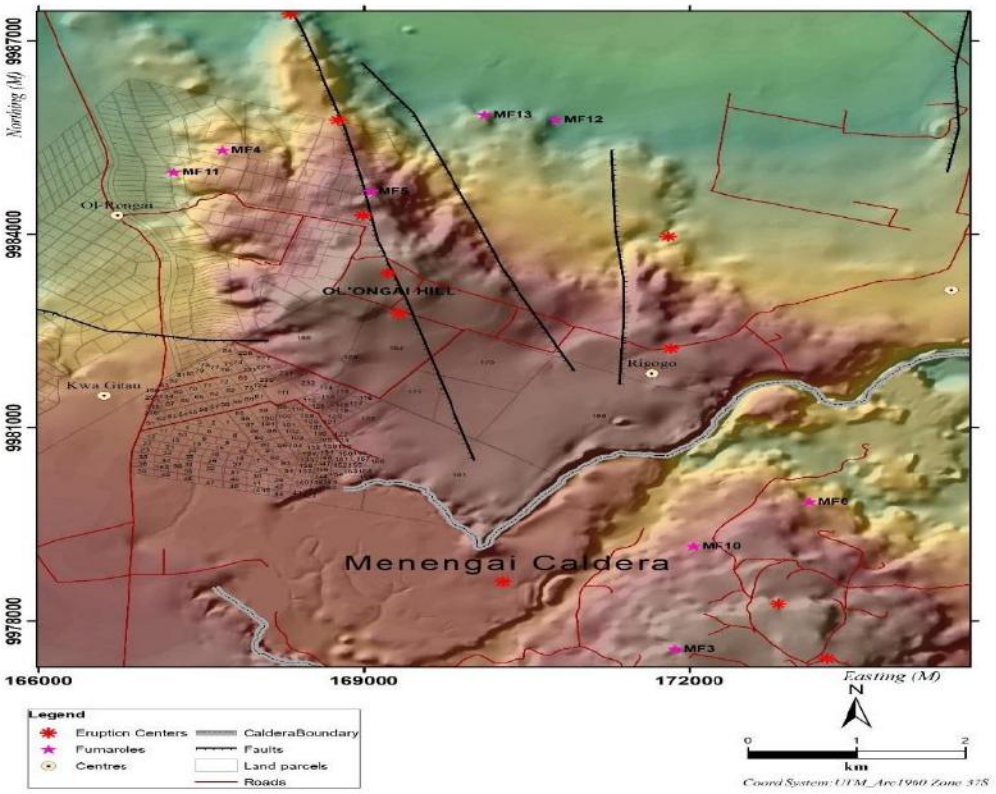


Figure 6.8: Land parcels within the project surrounding

The land use of the area around and within the prospect. The prospect boundary is shown by the red polygon. AIC Tulwobmoi secondary school is located within the fence perimeter of the project site.

Plate 6.8: AIC Tulwobmoi secondary school is located within the fence perimeter of the project site.

6.3.8 Cultural Artifacts

Hidden from view on the southern side of the Menengai caldera are caves sacred to Christians. One of the biggest caves can (allegedly!) accommodate up to 1,000 people. (Suleiman Mbatiah/Nation Media). Within the present site, there are no cultural sites which have been identified.

The main churches in the area are AIC Kiamunyu, Catholic Church and Gospel Community Church.

Plate 6.9: AIC Tulwobmoi Church shares the fence perimeter with the project site.

CHAPTER 7: CONSULTATION AND PUBLIC PARTICIPATION

7.1 Public participation

Stakeholder engagement was planned and designed to start early in the project and consult with a wide variety of stakeholders. A consultative participatory approach was adopted in which the stakeholders were introduced to the project and the project site, the environmental issues that are being addressed by ESIA and one-on-one discussions with key stakeholders was done.

Geothermal is considered the least cost power option with estimated potential of 10,000 MW spread in more than sixteen prospects within the rift valley of Kenya. The Sosian Makongeni-Menengai geothermal prospect is part of the larger Menengai geothermal resource area which has been identified as a suitable candidate for renewable energy capacity addition for the country. Under the Strategic Plan 2013-2017, for the Ministry of Energy, geothermal is listed as a priority renewable energy resource for supply of cost-effective power to the country.

The discussion was based on the different phases of the implementation, as follows:

- The feasibility study phase.
- The construction phase.
- The operations phase.
- The decommissioning phase.

The Feasibility Study phase has taken about four years and includes completed geophysical investigation, gas reservoir and environmental impact assessment. Since the Government of Kenya has realized that without the accelerated development of the least cost geothermal resources, which is abundant in the Kenya Rift, Kenya cannot attain self-sufficiency in power generation. The Government further recognizes the role of the private sector in the electricity subsector and has therefore opened up opportunities for the active participation of the private sector in providing funding, services, equipment and materials. In this respect, Sosian Energy Ltd is involved in various power generation enterprises in Kenya.

7.2 Benefits of Stakeholder Engagement

Effective stakeholder engagement during the projects lifespan will facilitate the development of a "social license" to operate due to mutual trust, respect and transparent communication between Sosian Energy and its stakeholders. It is expected to this engagement will facilitate cost cutting, risk management, enhancement of the company's reputation, avoidance of conflicts and improvement of company policies to better reflect emerging issues. Additionally it will aid the identification, monitoring and reporting on impacts as well as management of stakeholder expectations.

7.3 Stakeholder Engagement Principles

The Stakeholder Engagement Principles that will underpin Sosian Energy's interactions with stakeholders will include the following;

a. **Commitment -** the need to understand, engage and identify with the community will be recognized and acted upon early in the process;
b. **Integrity** - engagement will be conducted in a manner that fosters mutual respect and trust;
c. **Respect -** the rights, cultural beliefs, values and interests of stakeholders and neighboring communities will be recognized;
d. **Transparency -** community concerns will be responded to in a timely, open and effective manner;
e. **Inclusiveness -** broad participation will be encouraged and supported by appropriate participation opportunities; and
f. **Trust -** there will be open and meaningful dialogue that respects and upholds the community's beliefs, values and opinions.

7.4 Objectives of the Stakeholder Engagement Plan (SEP)

The SEP seeks to define a technically and culturally appropriate approach to consultation and disclosure. The goal of this SEP is to improve and facilitate decision making and create an atmosphere of understanding that actively involves project-affected people and other stakeholders in a timely manner, providing them sufficient opportunity to voice their opinions and concerns so as to influence project decisions. The SEP will also be a useful tool for managing communications between DPM and its stakeholders.

The key objectives of the SEP are to:

i. provide guidance for stakeholder engagement such that it meets the standards of International Best Practice;
ii. identify key stakeholders that are affected, and/or able to influence the project and its activities;
iii. identify the most effective methods and structures through which to disseminate project information, and to ensure regular, accessible, transparent and appropriate consultation;
iv. guide Sosian Energy to build mutually respectful, beneficial and lasting relationships with stakeholders;
v. develop a stakeholder's engagement process that provides stakeholders with an opportunity to influence project planning and design;
vi. establish formal grievance/resolution mechanisms;
vii. define roles and responsibilities for the implementation of the SEP; and
viii. define reporting and monitoring measures to ensure the effectiveness of the SEP and periodical reviews of the SEP based on findings.

7.5 Stakeholder Engagement Considerations

The following considerations will be made when engaging the stakeholders[2]:

Time and resources: Developing and building trust-based relationships with stakeholders takes time and resources. Sosian Energy will endeavor to implement a broad engagement strategy so that no willing stakeholder is excluded from the process of engagement. Some stakeholders will need to be educated about the concept of engagement itself, as well as on the complex issues requiring specialised and technical knowledge.

Raised expectations: Stakeholders can have unrealistically high expectations of benefits that may accrue to them from a project. Sosian Energy will therefore seek to manage these expectation by clearly communicating from the outset the project scope, establishing a clear understanding of their roles and responsibilities. Where possible opportunities to develop relationships with stakeholders and potential project partners who can assist with implementing corporate social responsibility projects will be pursued.

Stakeholder participation: Cultural norms and values can prevent stakeholders from freely participating in meetings. To mitigate conflicting demands within the community, and to facilitate identification of key stakeholders representative of common interests, Sosian Energy will employ local community liaison officers who are sensitive to local power dynamics to develop an awareness of the local context and implement structures to support and foster effective stakeholder engagement.

Consultation fatigue: Stakeholders can easily tire of the consultation processes especially when promises are unfulfilled, and their opinions and concerns are not taken into consideration. Often stakeholders feel their lives are not improving as a result of a project and this can lead to consultation meetings being used as an area to voice complaints and grievances about the lack of development. To mitigate this, Sosian Energy will undertake coordinated stakeholder engagement during the implementation process, and ensure this public consultation process is used to manage expectations, challenge misconceptions, disseminate accurate project information, and gather stakeholder opinions.

The remaining chapters of this report detail further how Sosian Energy will overcome these considerations of stakeholder engagement and attain the overarching goal of free, prior and informed consultation during project implementation.

7.6 National legislative framework and regulations for stakeholders' consultation

Chapter Five of the Constitution of Kenya 2010 recognizes the rights of citizens to participate in governance including consenting on a wide range of natural resource decisions affecting them directly. The constitution identifies 'participation of the people' among its national values and principles of governance. These principles and values include good governance, integrity, transparency and accountability and sustainable development, Article 10 (2).

[2] Schoonover, H., Grêt-Regamey, A., Metzger, M., Ruiz-Frau, A., Santos-Reis, M., Scholte, S., & Nicholas, K. (2019). Creating space, aligning motivations, and building trust: a practical framework for stakeholder engagement based on experience in 12 ecosystem services case studies. *Ecology and Society*, *24*(1).

Guidance from the Land laws including the Kenya Land Act 2012, the Land Registration Act 2012 and the National Land Commission Act 2012 were useful in answering any questions in relation to land rights that the community raised. The County Government Act 2012 is the best legislative barometer as to the participation benchmark provided under the new constitution. Part 8 of the Act on Citizen Participation states that 'Citizens have a right to petition a county government to conduct local referenda in relation to planning and investment decisions affecting the county as long as 25 percent of the local registered voters'.

The ESIA was developed as guided by the National Environmental Management Act 2016 (NEMA) and subsidiary legislation including regulation 101 among others. The requirement for public meetings was surpassed and consultations were also done to include distribution of the reports to lead agencies and local county government within the legal assumption that they are accessible to indigenous communities' representatives. The explanation of these county government powers also helped the community to know that they also have a local system through which they can petition should they feel the need.

Stakeholder engagement as the basis for building strong, constructive and responsive relationships, essential for the successful management of a project's environmental and social impacts, should be an on-going process. It should involve in varying degrees, the following elements: stakeholder analysis and planning; disclosure and dissemination of project information; consultation and participation; grievance mechanism; and on-going reporting to local communities.

7.7 International Regulatory requirements for stakeholders' Consultation and grievance mechanism

Sosian Energy Ltd will be seeking partners form the following organisation and therefore wishes to ensure that the SEP is in line with international practice. The key institutions being KfW Development Bank Sustainability Guidelines/Standards 2014, IFC Performance Standards 2012, IFC General Guideline on Environment, Health and Safety 2007, and IFC Environment, Health and Safety for Geothermal Power Generation 2007.

International Finance Corporation (IFC) Performance Standards (2012), PS 1 Assessment and Management of Environmental and Social Risks and Impacts; PS 2 Labor and Working Conditions; PS 5 Land Acquisition and Involuntary Resettlement; PS 6) 6 Biodiversity Conservation and Sustainable Natural Resources Management; International Finance Corporation (IFC) Policy on Social and Environmental Sustainability 7) IFC Stakeholder Engagement: A good Practice Handbook for Companies doing Business in Emerging Markets (2007) 8) IFC Policy on Disclosure of Information

Equator Principle 5: Stakeholder Engagement: requires clients to demonstrate effective Stakeholder Engagement as an ongoing process in a structured and culturally appropriate manner with Affected Communities and, where relevant, Other Stakeholders. 12) The International Bill of Human Rights and IFC Sustainability Framework

Sosian Energy will develop policy and procedures to develop Corporate Social Responsibility programs for external parties. This guideline shall also emphasise the importance of community participation and public consultation in developing and implementing CSR programs.

7.8 Stakeholder Analysis

A stakeholder analysis has been undertaken to determine the likely relationship between stakeholders and the Project, with an aim of identifying the appropriate consultation methods for each stakeholder group during the life of the project. The project identified the following stakeholder groups based on the International Principles of Social Impact Assessment Handbook (2003)[3] which defines stakeholders as "persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively." Each of these groups is discussed in greater detail in the subsequent sections. Proposed engagement methods are listed in Table 4 below. The stakeholders who may have a possibility to influence and make decisions on implementation of the project and/or may have an interest in the Project are shown in Table 3.

Table 7.1: Sosian Energy Stakeholders

Stakeholder Group	Stakeholders
National Government	County Commissioners – Nakuru County Assistant County Commissioner – Rongai Sub-county Chiefs and Assistant Chiefs, Village Elders, WRA, NEMA, KWS, KFS, NAWASCO
County Government	Office of the Governor,-Nakuru County Rongai Sub-county Administrator County Chief Officers in Charge of: Ministry of Energy; Ministry of Environment, Water and Natural Resources; Ministry of Gender and Social Services, Ministry of Agriculture; Gender, Lands, Agriculture and Fisheries, Nakuru Water and Sewerage Co. Ltd.
Lead Agencies	GDC, Kengen, Kenya Electricity Transmission Company (KENTRACO),
	Kenya Power-Rongai Sub_County
Project Affected Communities	Rigogo, Tulwobmoi, Ol Rongai
	Maringo

[3] Vanclay, F. (2003). International principles for social impact assessment. *Impact assessment and project appraisal*, *21*(1), 5-12.

Plate 7.1: A section of Opinion leaders' workshop at Donnies Hotel, Nakuru

7.9.2 Government Officials

The Government of Kenya consists of both the national and county structures. The principal government departments that have been consulted have a primary function of either protecting the health of the citizens through health services, water supply and sanitation, water resources and environmental management and biodiversity management.

- Ministry of Energy and Petroleum
- Ministry of Health;
- Ministry of Water and Sanitation
- Ministry of Roads, Housing and Public Works
- County Government of Nakuru
- Ministry of Tourism and Antiquities
- Ministry of Youth, Sports and Gender
- National Environmental Management Authority (NEMA)
- Water Resources Authority
- Kenya Wildlife Service
- Kenya Forest Service
- Kenya Power Generating Company
- KENTRACO

Plate 7.2: A section of Opinion leaders' workshop at Donnies Hotel, Nakuru

The institutions are responsible for policy direction and regulatory functions.

7.9.3 Communities around the Project site

There are no communities that inhabit the project area since it is situated in private land. The primary areas of influence of the project are neighbouring communities who live in Maringo and Rigogo villages. Solai ward has an area of 235.8 km^2 and a population of 21,315 (2013). The residents of Rigogo and Maringo Villages include Community Based Organisations, Youth and unemployed, Woman groups, Local academic institutions, and Local traders and businesses. Because of their proximity to the proposed project area, there were engaged as those that may be affected or benefit by the project.

Some of the information elicited during such interviews included:

- Cultural practices;
- Religion and belief systems;
- Social amenities and infrastructure;
- Health facilities available within the project area;
- Common diseases;
- Community health concerns relating to the project;
- Views on employment of locals in the project, and;
- Security issues.

Plate 7.3: Senior Officers and Community Opinion Leaders workshop

7.9.4 Friends of Menengai Crater

Friends of Menengai Crater (FOMEC) is a non-government organisation working to promote sustainable development based on sound conservation principles in the Menengai Caldera which forms the northern part of Lake Nakuru Catchment Basin with offices in Nakuru town.. The FOMEC's core business is to promote environmental and community development activities that include Environmental Education, Environmental Conservation, Environmental Monitoring and Environmental planning in the Caldera. The thrust of their activities is to enhance the integration of environmental dimensions of poverty reduction into the local development planning and implementation. Since inception in 2007, FOMEC has grown from strength to strength. FOMEC currently has 300 individual members and 18 corporate members.

Since the inception of the Menengai Geothermal Drilling Project, FOMEC has built close collaboration with the Geothermal Development Company (GDC), and are a formally recognized watchdog of the environmental impacts resulting from the Menengai Geothermal Drilling activities. FOMEC and GDC have an undertaking to carry out monthly environmental audits of the geothermal drilling activities to ensure quick mitigation measures are put in place. FOMEC has from time to time been contracted to carry out the NEMA annual Environmental and Social Audits. Other collaborative activities include participation in workshops and conferences, marking World Environment Days, the Menengai Half Marathon and as a member of the Menengai Geothermal Development Committee, contribute towards fast-tracking the Menengai project. Menengai is going to be Africa's largest geothermal project and will not only change the energy equitation in the country completely, but will also improve the local community lives and livelihoods.

7.9.5 Menengai West Stakeholders Forum (MWESFO)

MWESFO was represented by 6 members at the stakeholders' workshop.

7.9.6 Vulnerable Groups

The vulnerable groups within the Project area of interest can be grouped into categories of elderly, youth, women, unemployed, cultural minority group and those people with disabilities. Representation will be encouraged at consultation meetings and implementation of this plan.

7.9.7 Educational Institutions

The project area is served by three primary schools at Kwa Gitau, Rigogo and Kipngo'choch and Tulwobmoi Secondary School.

Plate 7.4: Entrance to Tulibwomoi Secondary School

7.9.8 Stakeholders involved in project implementation

This group includes investors, contractors and employees, within the project and the surrounding enterprises including tourism. For example, M/s. Atebuje Holdings Ltd. that have vast experience in baseline survey, feasibility studies and environmental management would be supportive whenever a monitoring team is established. Centres such as Mercy Njeri (12,000 people), Ol Rongai (15,000 people), Kwa Gitau, a trading centre with surrounding population of 7,000 people, Kipng'ochoch and Tulwobmoi would benefit considerably from increased business during the implementation of the project. It needs to be clarified that other interactions such trading, procurement of goods, etc. will be subject to national laws and regulations and must comply with company policies and procedures as part of core business activities.

The overarching engagement objectives, the specific objectives of engagement during this baseline phase were to:

a) Introduce the project and ESIA process to key stakeholders
b) Identify potential impacts and issues that will be covered in subsequent phases
c) Further identify stakeholders related to the Project
d) Identify and gain access to relevant data for the baseline
e) To gather stakeholder opinions on the proposed project and ensure that these opinions are fed into the assessment process
f) To gather stakeholder feedback on the development of management and mitigation measures of potential impacts, particularly where stakeholders have a potential role to play in these measures.

Engagement activities included interviews with stakeholder representatives (informal leaders) and key information organizations (communities, authorities, NGOs) using one-on-one meetings, workshops and smaller focus group meetings. Table 4 provides a list of different methods of sharing information used.

Table 7.2: Techniques for Engagement

Method	Activities
One-on-one interviews	Solicit views and opinions Enable stakeholders to speak freely and confidentially about controversial and sensitive issues Build personal relations with stakeholders Recording of interviews
Formal meetings	Present project information to a group of stakeholders Allow the group of stakeholders to provide their views and opinions Build impersonal relations with high level stakeholders Facilitate meetings using Power Point presentations Record discussions, comments/questions raised and responses
Public meetings	Present project information to a large stakeholder, and in particular communities Allow the group of stakeholders to provide their views and opinions Build relationships with local communities Facilitate meetings using Power Point models, project presentations, documents Record discussions, comments/questions raised and responses
Focus group meetings	Allow a smaller group of between 8 and 15 people to provide their views and opinions of targeted baseline information Build relationships with local communities Use a focus group interview guideline to facilitate discussions Record responses
Surveys	Gather opinions and views from individual stakeholders Gather baseline data Record data Develop a baseline database for monitoring impacts

7.9 Key Issues of past Engagement Activities

7.10 Stakeholder Engagement Activities

7.10.1 Organisation and schedule of activities

Stakeholder activities were conducted are as presented in table 1 below. The first consultation process between 3rd April and 30th May 2019 involved majorly government officials and other regulatory organisations and Sosian Energy Ltd employees.

Table 7.3: Stakeholder Engagement Activities

Date	Time	Consultation
03/04	0900-1800	Geothermal Development Company Water Resources Authority National Environmental Management Authority
22/05	0900-1800	National Government Officials
23/05	0900-1800	County Government Officials
24/05/19	0800-1800	Community Survey and Focus Group Discussions
30/05	0900-1600	Sosian Energy representatives
13/06	0900-1500	Community representatives
20/06	0900-1400	Community Members

During the first engagement was primarily on gathering information and opinions regarding stakeholders' understanding of the project and the manner in which they would prefer to be engaged during the project cycle.

It is important to note that from the onset Sosian Energy Ltd adopted and implemented a community integration plan to demonstrate how the local communities would be involved and benefit from job opportunities and other indirect socio-economic benefits (e.g. employment, accommodation services) and in line with the Mining Act no.12, 2016 and conform to the requirements of the Labour laws (The Employment Act, Labour Institutions Act, Labour Relations Act, Occupational Safety and Health Act (OSHA), and Work Injury Benefits Act (WIBA). The regulation requires the obligatory employment of local communities within development projects and this will include engineers, technicians, labourers, etc. and specifies requirements for training and procurement according to the law. In addition, the plan will follow international best practices (Environmental & Social Policies) which includes requirements for supply chain management. The Plan will also demonstrate providing priorities to local communities starting at the village level, county level, and finally at the national level.

Plate 7.5: A participant addressing the Stakeholders' meeting at Tulibwomoi Secondary school grounds

Based on findings of the stakeholder engagement, a summary of the social topics introduced by stakeholders are presented Table 5 below.

Table 7.3: Key Stakeholder Engagements

Stakeholder Group	Engagement modality	Stakeholders
Community leaders	Formal Meetings	Church leaders, Government officials, Community Based Organizations, NGOs, Government Parastatals
Community Members	Community Public Forums	Local Administrative leaders Political Leaders Members of CBOs, NGOs School representatives Representatives of the vulnerable groups General Community members
Government Organizations	Official Meeting	WRA KWS

The community integration plan will include managing expectations so that local communities are realistic about opportunities from the Project; include a local hiring plan to identify the number of skilled and unskilled job opportunities targeted to the local community throughout the construction and operation phases (provided they have the required skills and expertise needed to meet the development standards), water and health services that Sosian Energy may partner with the community, ensure timely and continuous communication and dissemination of information with the local community members to alleviate potential sense of social marginalization and improve their

understanding and perception of the benefits associated with development, and consider allocating funds for social responsibility programs to be implemented for the local communities. During these sessions, the stakeholders raised the following concerns shown in Table 7.6.

Table 7.4: Community Concerns

Issue	**Sub issue as perceived by potentially affected Population**	**Questions/comments from stakeholders**
Employment	Lack of job opportunities in the area	People in the area are in need of employment opportunities.
Geothermal power project impacts	The environmental quality is described as "good" at present.	There is a good understanding of potential environmental impacts of proposed project.
Water quality	Limited water supply Pollution of ground water	Community understand this adversity and would appreciate intervention to mitigate the same
Air quality	Dust and gaseous emissions	The air quality is excellent but there is a feeling that if the project goes ahead this may be affected.
Noise	Geothermal power operations are is 'noisy'	The stakeholders are unaware that magnitude of disturbance that might emanate from the use of heavy machinery and this is dependent on technology to be used.
Pollution	The project will use toxic substances that impact on human health and bee population	People have fears that toxic substances will be used that will effect environmental quality
Road safety	Community routes to be affected by heavy machinery Potential communication disturbance during construction period	What safety measures will be put in place? The road is used by school children
Blasting	Impacting structure of dwellings	Adequacy of the construction of the houses to withstand the vibrations from blasting
Compulsory acquisition of private land	Fear of displacement	Need for re-assurance on the zero-impact of The project will not require any community land or acquire any.

CHAPTER 8: ENVIROMENTAL AND SOCIAL IMPACT ASSESSMENT

8.1 Background

The consultants carried out a scoping exercise in which stakeholders and government officials raised issues (problems and expectations) with the consulting team. However these issues were clarified during the stakeholders' consulting in which a summary of issues, in the order of number of times raised in the questionnaires, and discussed as follows:

a) Anticipated problems associated with the project

- Displacement of people within the project area
- Air pollution from NCGs and dust during road construction
- Noise pollution
- Water scarcity
- Environmental degradation - soil pollution,
- Seismic activities and vibrations
- Outbreak of diseases such as STDs and diseases,
- Increased mushrooming of new urban centres/markets leading to improved businesses and income levels
- Discharge of waste waters into the environment may affect groundwater

b) Community expectations from the project

- Economic development of the area
- Improved infrastructures such as roads and social amenities like schools and hospitals
- Provision of employment opportunities
- Increased water supply for both domestic and livestock supply
- Compensation and resettlement of displaced peoples
- Enhanced business opportunities
- Building capacity of the community to monitor problems associated with the project.

8.2 The Five-Step Process

The general methodology for the present impact assessment was a five-step process starting with identification of project activities that may interact with the environment that has been discussed in Chapter 3. This was followed by identification of environmental (physical and biological aspects) and social (human aspects) parameters and existing pressures from the environmental baseline study. The stakeholders contributed immensely to the discussion on environmental and social issues during stakeholders' consultation process. The third step involved identification and prediction of any potential positive and negative impact that may result from project activities during its life cycle, based on the impact assessment criteria and rating scales outlined below. In the fourth step, the predicted impacts were evaluated using an objective significance ranking process. In the fifth step, the cumulative impacts was assessed the data from which will be used to develop the Environmental Management Plan.

The present geothermal development involves six phases, namely:

a) Exploration drilling of Thermal Gradient Holes[i] (TGH) for reservoir modeling

b) Drilling of boreholes and construction of storage tanks for water supply;
c) Drilling of production wells;
d) Development of geothermal power production and transmission;
e) Operations; and
f) Decommissioning of the plant.

8.3 Impact assessment during different phases of project implementation

8.2.1 Project site preparation

The local environmental impacts of geothermal power development can sometimes be significant, especially with regards to bush clearing and land leveling. The project site neither requires bush clearing nor land leveling. Instead the company will reforest the unused property areas to mitigate global warming and provide sustainable timber stock for local market. The green areas could also become part of the recreation circuit, to which combined with Menengai Caldera, will offer a bouquet of adventure for visitors to the geothermal plant.

8.2.2 Construction and operation phases.

At the construction phase, common environmental impacts associated with use of construction machinery, environmental and safety issues including widening of the road, are generation of construction dust, occupational and general public safety and health hazards emanating from construction traffic, working at heights, exposure to heat during metal fabrication, and elevated H_2S during power generation, connection of steam pipelines with the plant and excessive noise and vibrations.

The current impact categories, many of which were raised by stakeholders, have been examined in detail, and these include concerns revolving around:

- Land acquisition and compensation for affected parcels,
- Seismicity, landslides and other geological risks,
- Air quality issues including management of gas emissions including Non Condensable Gases (NCGs);
- Pressure on existing water resources.
- Effects on tourism
- Safety, health and risks of residents and workers;
- Traffic congestion;
- Location of schools, health and religious facilities;
- Opportunities for casual/ unskilled/skilled jobs,
- Disposal of solid and liquid waste;
- Potential spread of HIV/AIDs and other sexually transmitted infections;
- Impacts on soil compaction, soil pollution, and soil erosion and increased sedimentation in rivers;
- Visual and landscape impacts; and

During operations, however, the role of technology used to convert the resource to electricity (direct steam, flash, or binary) and the type of cooling technology adopted (water-cooled and air-cooled) become extremely important. The design, implementation, and monitoring features of the project will integrate the concerns, priorities, and perspectives raised by stakeholders. Table 7.3 below explains using a matrix for the various impact categories during the phases of geothermal development.

8.2.4 Solid Wastes Disposal

The management will use principles of Waste Management Hierarchy as its foundation on reuse, recycling, minimization of packaging material, reduction in size of waste material and finally reduction of time spent on location via optimization of drilling efforts. Minimization of waste material centres on reducing packaging materials - use of large packaging such as bulk cement, barite or bentonite. The volume of the waste material will be reduced via on-site compaction. This will reduce the number of vehicle movements required for waste removal, as well as reducing the size of the landfill/dump site required. Wherever possible, use of water will be minimized and recycled.

Landfilling, if approved by the County Government and NEMA, is a low-cost, low tech method that does not require wastes to be transported away from the project site, and, therefore, it is a very attractive option for the proponent. Once the pit locality is closed, the area will be graded to prevent accumulation of water. The sites will then be re-vegetated with native tree species. With respect to non-hazardous solid waste, there will be available an open dump near the geothermal power plant.

Management will use burning as a last resort because burning discharges GHGs to the atmosphere causing global warming. In case there will be burning, proper strategies to ensure that burning does not cause nuisance and that burning will take place during daytime. Wastes which cannot be handled at the drilling site will be removed to a designated offsite and suitably disposed of for reuse/recycling/municipal disposal. Sosian's management will establish a laboratory to ensure that any toxic material according to NEMA and World Bank standards in Table 7.3 is not discharged into open spaces or water bodies.

Table 8.1: Effluent discharge standards criteria for NEMA and World Bank

Pollutant or Effluent parameter	Maximum allowable limits	
	NEMA discharge standard (mg/l)	World Bank/ IFC standard (mg/l)
Ammonia	100	10
Biological oxygen demand (BOD)	30	50
Chemical oxygen demand (COD)	50	250
Chromium (VI)	0.05	0.1
Chromium (Total)	2	0.5
Iron	1.0	0.5
pH	6.5-8.5	6-9
Oil & grease	Nil	10
Hydrogen sulphide	15ppm	
Total residual chlorine	0.10	0.2
Total suspended solids (TSS)	30	50
Total Dissolved Solids	1200	
Temperature	$\pm 3^0$C above ambient temperature of receptor	$\pm 3^0$C above ambient temperature of receptor
Zinc	0.5	2.0
Boron	1.0	-
Sulphate	0.1	1.0
Fluoride	1.5	20
Arsenic	0.02	0.1
Cadmium	0.01	0.1

Sources: NEMA Environmental Management and Coordination Act (Water Quality) Regulations, 2006 and World Bank Pollution Prevention and Abatement Handbook, 1998

8.2.5 Liquid waste materials

The geothermal fluids are geothermal brine and condensate from the cooling tower are injected back into geothermal reservoirs. The liquid waste shall not be released into any surface waterways. The potential risk of groundwater pollution (mainly the deep aquifers), if an accidental spill of geothermal brine occurs must be avoided by all measures because technology provides, however up to 95% reinjection of the spent geothermal fluid and about 60% brine reinjection for the plant (Tole, pp.12).

8.2.6 Domestic and office waste

The company will establish offices and on-site camp accommodation for employees for which a sewage disposal system will be established on site during drilling operation. Since the exploration process is a temporary activity, the sewage will be diverted to a septic tank or soak pit for onward

transportation to a treatment plant. There will be clear separation of grey and black water which allows for proper disposal mechanisms to be put into place. The Contractor will ensure that the installed system meets national requirements and international industry standards. Office waste will be recycled or disposed of appropriately.

8.2.7. Induced seismicity and subsidence

Seismic events are generally of low magnitude of about 2 or less in the area (Hamilton et al, 1973). In the Menengai Caldera area, no significant recent seismic events have been recorded and there is no likelihood of a destructive magnitude Mc > 5 earthquakes occurring within the study area. Away from the project site, earthquake events in Uganda and Northern Tanzania are larger and deeper (Simiyu, 2012). Low-magnitude events "micro- earthquakes" typically cannot be detected by humans. These events are often monitored by geothermal companies. A continuous monitoring of the magma activities beneath the area by seismic methods and gas chemistry constitute the basis for an early warning system.

During operation, subsidence and induced seismicity are possible effects as is change in geothermal surface activity. Subsidence may be linked to geothermal reservoir pressure decline. However injection technology is available and employed at all geothermal sites that would minimize potential subsidence.

8.2.8 Land degradation and erosion hazard

Project activities such as road construction, well drilling, and power plant construction, laying of steam pipes, and construction of power transmission lines will more or less move earth. This may expose the project site to soil erosion by wind and runoff. The project will minimize vegetation clearance and instead carry out aforestation during all phases (exploration, development and operation) of the project, institute erosion control measures, where possible, and management of stormwater.

8.2.9 Vehicular movements and increased traffic

Vehicular movements and earth works during the construction and development of power plants, steam fields and transmission lines normally produce dust. This increases the particulate matter in the air which may lead to toxic inflammation of the lungs (Harrison and Yin, 2000). Procedures must be put in place to communicate EMS compliance to stakeholders including contractors.

The impact associated with the development constituted an increase in labour and service transport vehicles to and from the site. The increase in vehicular and pedestrian movement increased the number of accidents. To avoid the above impacts:

- The traffic should abide by the speed limits and by laws of the area.
- Movement of heavy construction traffic should be planned appropriately.
- Prevention of soil erosion during upgrading and use of access road and regular watering should be carried out to avoid the impact of dust.
- Establish maintenance responsibilities and ensure that road rehabilitation takes place as soon as possible (Ogola, 2004).

8.2.10 Air quality and pollution

Air quality may be disturbed by either dust from the vehicular use and construction site as well as pollution from emissions arising from both direct and indirect sources. Direct emission sources will include rig generators, vehicles and machinery while indirect emission are from fugitive emissions such as chemical leaks, increased vehicle traffic, and manufacturing. Dust is from road expansion and construction of new ones, vehicles and murrum road. During drilling boreholes and exploratory drilling of TGH and production wells dust and emissions from the rig may generate toxic fumes. The principal atmospheric emissions from the sources will include carbon dioxide (CO_2), methane (CH_4), oxides of nitrogen (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO) and volatile organic compounds (VOCs). CO_2 and CH_4 are two of the principal greenhouse gases (GHGs). To minimise unnecessary emission generation, the proponent will ensure that there is extensive pre-planning to ensure that the required equipment, materials and personnel are available at the right location and at the correct time.

Most notably hydrogen sulfide (H_2S) due to its characteristic odor of rotten eggs at very low concentrations, it is heavier than air, flammable, colourless and toxic. Hydrogen sulfide (H_2S) can represent an odour nuisance at low concentrations but it is toxic at concentrations above 0.002 ppm (Heath, 2002). Air emission from drilling is minor and mainly caused by fumes from diesel generator and dust from vehicular movement.

Although emissions of CO_2, SO_2 and NOx are lower for geothermal energy than for conventional fossil fuels, there are still important gaseous emissions associated with well testing and production that require mitigation. These gaseous pollutants include traces of ammonia, hydrogen, nitrogen, methane, radon and the volatile species of boron, arsenic and mercury, though generally in very low concentrations and can affect only the local environment. During well testing, the hot steam released may have temporary impact on nearby plants and air quality with respect to emission of H_2S and silica from carry-over. The growth of geothermal energy will have a large net positive effect on the environment in comparison with other fossil fuels in accordance with the Kyoto resolutions on global climate change. During production, geothermal power plants emit insignificant amounts of CO_2, SO_2 and absolutely no nitrogen oxides in comparison to thermal plants. These small quantities from geothermal plants are not emitted during power production as a result of combustion but are natural constituents of a geothermal reservoir. The gases would eventually vent into the atmosphere under natural conditions although at much lower rates (Goff, 2000). According to survey done by IGA, CO_2 composition in sampled geothermal power projects in the world range from 4 g/kWh to 740 g/kWh with the weighted average being 122 g/kWh. The estimates from the data collected gives an of average CO_2 content in the NCG at 90.46% (Table 8.6). A comparison of CO_2 emission data for fossil fueled power plants and geothermal power plants based on the weighted average above is shown on table 8.6 below:

Table 8.2: Comparison of CO_2 Emission by Power Source

Power source@ 35% efficiency	CO_2 Emissions (g/kWh
Geothermal	122/kWh (weighted average)
Coal	915/kWh
Fuel oil	760/kWh
Natural Gas combined cycle @ 60% efficiency	315/kWh

Source: International Geothermal Association (IGA), 2002

The nature of the reservoir and the type of technology determines the amount of Non Condensable Gases that may be released into the atmosphere. Other factors notwithstanding, dry steam and flashed steam plants emit water vapor containing these gases. However, the process of reinjecting the geothermal fluids back into the reservoir diminishes the possible release of gases into the atmosphere. In low temperature utilization, CO_2 found in geothermal fluids could prove beneficial in direct use greenhouse applications as a growth stimulant. Studies have shown that increase in CO_2 from normal level of 300ppm to approximately 1000ppm can raise crop yields by up to 15% (Dunstall and Graeber, 2004). As a result of these environmental benefits, geothermal energy is a candidates for Clean Development Mechanism (CDM) of the Kyoto protocol, which would be an added incentive to the development of the resource.

Hydrogen sulphide (H_2S) is a colorless gas that is harmless in small quantities, but is often regarded as an "annoyance" due to its distinctive "rotten-egg" smell. However hydrogen sulfide can be lethal in high doses. The consultants will determine the environmental protection program that ensures a standard practice of chemical composition of less than 3% geothermal steam, 96% carbon dioxide, 3.5% hydrogen sulfide and other inert gases. Table 7.7 shows the recommended threshold limits values, according to the Occupational Safety and Health Administration (OSHA), and the physiological effects on human health.

Table 8.3: Threshold limit values for H_2S and possible effects on human health

No.	Limit range (ppm)	Physiological effects	Long term exposure	Mitigation measures
1.	0.13 Odour threshold.	Odour is unpleasant and causes sore eyes.		
2.	Normal 4.6	Strong intense odour, but tolerable.	Prolonged exposure may destroy the sense of smell.	
3.	Normal 10-20	Causes painful eye, nose and throat irritation, headaches, fatigue, irritability, insomnia, gastrointestinal disturbance, loss of appetite, dizziness.	Prolonged exposure may cause bronchitis and pneumonia	Eye goggles recommended
4.	Prolonged exposure discouraged. 50	May cause muscle fatigue, inflammation and dryness of nose, throat and bronchial. May cause muscle fatigue, inflammation and dryness of nose, throat and bronchial.	Long-term exposure can cause lung disease. Eye goggles and minimal exposure recommended. Use self-contained breathing apparatus.	
5.	100-150	Loss of smell, stinging pain in eyes and throat. Fatal after 8 to 48 hours of continuous exposure	Evacuation	
6.	200-250	Nervous system depression (headache, dizziness and nausea are symptoms). Prolonged exposure may cause fluid accumulation in the lungs. Fatal after 4 to 8 hours of continuous exposure.	Evacuation	
7.	250-600	Pulmonary oedema (lungs fill with fluid, foaming in mouth, chemical damage to lungs)		
8.	300	May cause muscle cramps, low blood pressure and unconsciousness after 20 minutes	Evacuation	
9.	300 to 500	May be fatal after 1 to 4 hours of continuous exposure.	Evacuation	
10.	500	Paralyzes the respiratory system and overcomes victim almost instantaneously. Death after exposure of 30 to 60 minutes.	Evacuation	
11.	700	Paralysis of the nervous system.	Evacuation	
12.	1000	Immediately fatal.	Evacuation	

Source: Occupational Health and Safety, USA.
https://ohsonline.com/articles/2007/10/human-health-effects-from-exposure-to-lowlevel-concentrations-of-hydrogen-sulfide.aspx

H_2S emissions may reach a dispersion over a wide radius of the geothermal plant but this will be mitigated using direct contact condensers and in the cooling tower where the H_2S is oxidized and trapped. Closed-loop systems where gases removed from the well are not exposed to the atmosphere but are injected back into the ground after giving up their heat, so air emissions are minimal reduces air quality contamination considerably. H_2S emissions may reach a dispersion over a wide radius of the geothermal plant but this will be mitigated using direct contact condensers and in the cooling tower where the H_2S is oxidized and trapped. Closed-loop systems where gases removed from the well are not exposed to the atmosphere but are injected back into the ground after giving up their heat, so air emissions are minimal reduces air quality contamination considerably.

Table 8.4. Effects of CO_2 on human health

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

Source: Kubo et al, 1999

Several levels of impacts have been studied before. Sub-acute intoxication refers to the effects of continuous exposure to mid-level concentrations of hydrogen sulphide in the range 100 - 600 ppm. At these concentrations irritation of the mucous membranes of the eyes and the respiratory tract occur. Chronic intoxication is defined as the effects of intermittent exposure to low or intermediate concentrations (50-100 ppm) of hydrogen sulphide. These are characterized by 'lingering' largely subjective manifestations of illness.

Taking example from Olkaria geothermal power station, non-condensable gases contain about 5% hydrogen sulphide and 95% carbon dioxide. These gases are at higher temperature than ambient air when ejected into the atmosphere. Hot non-condensable fumes are lighter than normal air, and this helps the gases to mix rapidly with ambient air. Therefore hydrogen sulphide emitted from the gas ejectors does not preferentially settle out from the plume any more than other gases in air. The only time hydrogen sulphide settles down more preferentially than other gases in the air, is in enclosed area, where there is no wind (Tole, 2000, pp. 51). The two most commonly used vent gas hydrogen sulfide abatement systems are the Stretford and LO-CAT. Both systems convert over 99.9 percent of the hydrogen sulfide from geothermal non-condensable gases to elemental sulfur, which can then be used as a soil amendment and fertilizer feedstock. The cost to transport and sell the sulfur as a soil amendment is about equal to the revenue gained from the transaction.

The following mitigation measures may be adopted in order to minimise the contamination of ambient air:

- The non-condensable gases including H_2S should be discharged through cooling towers in order to strip off the soluble gaseous emissions including hydrogen sulphide;

- Monitoring systems can be installed within and outside the plant and the H_2S concentrations in the air should be closely monitored which will support the mitigation process.
- There are various Wet gas Sulfuric Acid process, LO-CAT, THIOPAQ and FeCl hybrid processes for the hydrogen sulphide removal from the non-condensable gas mixture.
- Training of all workers on the dangers exposure to elevated H_2S levels;
- Installation of H_2S monitors with alarm system including use of personal monitors by staff in potentially dangerous areas
- Liaison strategy for communication with communities who may be affected by odour nuisance.

8.2.11 Surface and groundwater quality

The geothermal fluid is located several kilometers beneath the surface and has no connection with groundwater sources. The water at the depth (2.0 km or more) is so salty, "brine", that it is not fit for human consumption. The potential impact on the water environment are eliminated by management and disposal of geothermal brine by either reinjection into wells or storage in protected ponds. Contamination of shallow groundwater reservoirs can as a result of failure of well casing failure. The abstraction of geothermal waters can cause ground instability and subsidence and lowering the water table (Heath, 2002). The pollution impacts on the water environment will be mitigated through effluent treatment, careful storage of waste water and its reinjection into deep wells and through careful monitoring of the condition of holding ponds and well casing. Additionally there will be pressure on existing water resources.

Use of geothermal fluids rather than freshwater for cooling purposes clearly will reduce the overall water footprints. For this reason geothermal plants have no fluid disposal problems as it can all be reinjected back to replenish the reservoir. Production and injection wells are lined with steel casing and cement to isolate fluid from environment and ground water resources. Continuous sonic logging measurements done on casing and cement ensure that no leakage occurs. The recycling of wastewater for extending the life of geothermal reservoir helps conserve water too. Sanitary wastewater is transported to a wastewater treatment plant in the geothermal field. The magnitude of the effect on water is less than 10% of the existing resource in the region, it is considered that this action is regional, because the water used is obtained from outside the geothermal plant. The technology for harnessing and utilizing geothermal energy has carefully been developed to minimize possible ground water pollution.

8.2.12 Fauna and Flora Impacts

The geothermal activities mostly affect vegetation by gaseous emissions, physical removal of vegetation to pave way for roads, drilling pads, and buildings and hot or cold geothermal brine flowing on the surface. At various concentrations, hydrogen sulphide is known to have acute or sub-acute intoxication effects on different species of fauna such as cats, dogs, rats, guinea pigs, and goats. The concentrations at which the effects occur vary from one species to another. Concentrations of 0.006ppm is known to be unsafe to aquatic animals. Disposal of geothermal water on the surface can cause high metal concentrations in soils and vegetation. In Olkaria I for instance, the wastewater is

stored in conditioning ponds before it is reinjected. Direct reinjection is the best method or completely isolate the conditioning ponds from plants and animals. There is no removal of vegetation for drill sites, roads, steam pipe lines and powerhouse, or site rehabilitation because the project site in a farmland. Well blowout shall be prevented through proper cementing and pressure monitoring. Blowout preventers and related well control equipment are normally used with a reliable supply maintained until drilling operations are completed.

8.2.13 Agriculture Ecosystem

At low concentrations hydrogen sulphide has a growth-stimulating, fertilizing effect on some plants. However at high concentrations, hydrogen sulphide causes leaf lesions, defoliation, and stunted growth with young plants being more susceptible than old plants. It is expected that there will be no damage to crops in spite of the site being an agricultural area. Additionally the evaporation ponds will be fenced off to keep away any migratory animals that may be encouraged if there are water shortage in the area.

8.2.14 Soil salinization

Soil pollution or soil salinization is the effect produced by the vapor emanating of geothermal plants with a high concentration of sodium, potassium and lithium. These and emissions of hydrogen sulfide and carbon dioxide, and precipitated compounds that are naturally in the atmosphere, falling to the ground and increasing salinization problem that naturally exists. Mineral recovery will be investigated in order to reduce any processes of soil salinization.

8.2.15 Climate Change

The geothermal power development project is a clean energy project that will help with mitigate climate change. The project will result in significant displacement of CO_2 emissions during the 30 to 35 years of operation. The project will develop a tree nursery to provide free seedlings for replanting in the project site and to the neighbouring communities. The project will be screened through the Africa Development Bank's Climate Safeguard System, the project has been classified in Category 2 which requires a review of its climate change risks and adaptation measures.

Practical risk management and adaptation options shall be integrated into the project design and implementation plans. Although geothermal plant still discharges CO_2 and methane gases to the atmosphere, the discharge is approximately 0.045 kg. of carbon dioxide equivalent per kilowatt-hour compared to natural gas generated electricity are between 0.27kg and 0.9kg. of carbon dioxide equivalent per kilowatt-hour and estimates for coal-generated electricity are 0.63 kg. and 1.62 kg of carbon dioxide equivalent per kilowatt-hour (IPCC, 2011), geothermal energy is still the most environment friendly source of electricity.. The ambient temperature conditions will be monitored to ensure that there are no micro-climatic impacts caused by the power generation.

Table 8.5: Matrix showing various impact categories during the phases of geothermal development

Impact category	Preliminary Exploration	Borehole Drilling 3 in no.	TGH Drilling	Production wells	Power production/Transmission	Operation	Decommissioning
Land acquisition N/A	-	-	-	-	-	-	-
Flora/ Fauna N/A	Levelling land for roads, site construction, Traffic to project site	Dust and traffic on feeder roads;	Dust and noise on roads/construction site, traffic on feeder roads;	Dust and noise on roads/construction site, Well pads (50x80m) constructed; traffic on feeder roads;	Noise on roads/construction site, traffic on feeder roads;	Noise on roads/construction site, traffic on feeder roads;	Dust and noise on roads/construction site, traffic on feeder roads; land reclamation.
Vehicular traffic	Increased traffic by wide vehicles	Dust and noise. Machinery small.	Dust and noise. Medium machinery used	Dust, noise and air pollutants, esp CNGs , HS2	Noise and CNGs	Noise and CNGs	Noise
Induced seismicity, subsidence and other geological hazards	Subsidence and induced seismicity are possible effects as is change in geothermal surface activity.	Limited and or absent	Limited and or absent	Limited and or absent	Limited and or absent	Limited and or absent	Limited and or absent

	Subsidence linked to geothermal reservoir pressure decline.						
Air quality	Dust and traffic on feeder roads;	Dust and traffic on feeder roads;	Dust and traffic on feeder roads; H_2S, CO;	Noise; air pollutants, esp H_2S, CO;	Noise; air pollutants, esp H2S, CO;	air pollutants, esp H_2S, CO;	Dust and traffic on feeder roads;
Noise pollution and vibrations	Noise on roads/constr uction site,	Noise on roads/constr uction site,	noise on roads/constr uction site,	Noise on roads/constr uction site.	Noise on roads/construction site.	Noise or power generators	Clearing, rehabilitation of site; traffic on feeder roads;
Solid waste disposal	Limited, few employees	Limited, few employees	Limited, few employees	Limited, recyclable materials	Recyclable materials	Recyclable materials	Recyclable materials
Water pollution and waste disposal	Water demand for dust control;	Water demand for drilling.	Demand increased	Demand increased.	Demand increased	Demand increased	Limited demand
Recreation, culture and aesthetics	Limited	Limited		Sports and recreation activities			Limited.
Health and Safety/diseases	Expand dispensaries and hospitals.	Emergency services improved.	Emergency services improved	Emergency services improved	Emergency services improved	Emergency services improved	Emergency services improved

Infrastructure and traffic congestion	Increased, road widened to 6.5m.	Increased, road built to 6.5m	Increased, road built to 6.5m	Traffic marshal, speed control	Traffic marshal, speed control	Traffic marshal, speed control	Traffic marshal, speed control
Population/demography	Increased population	Increased population	Increased population	Increased population	Increased population	Increased population	Population decrease.
Housing/settlements	More demand for housing	demand for housing	demand for housing	demand for housing	demand for housing	demand for housing	Out-migration.
Visibility and Emergency management	Dust, road construction, affecting domestic animals and humans.	Dust, road construction, affecting domestic animals and humans.					
Gender and Youth	Employment for youth.	Employment for youth.	Employment for youth.	Employment for youth. Employment for youth.		Employment for youth.	

Table 8.6: Matrix showing significance of predicted impacts

Impact category	Predicted Impacts	Positive/ Negative	Duration (short, medium, long term)	Reversibility (Reversible/ Irreversible)	Significance (High, Medium, Low)	Comments (explain criteria)
Flora/ Fauna	None	+ve	Short	Reversible	Low	Not applicable at the moment. All agricultural land.-
Vehicular traffic	Heavy, increased vehicles causing dust and fumes	-ve	Short term	Reversible	Low	Water to reduce dust, traffic regulations, Traffic marshal
Induced seismicity, subsidence and other geological hazards	N/A	N/A	N/A	N/A	N/A	None
Air quality	Air pollution from dust, vehicular fumes, H2S, and other thermal gases. Direct contact condensers and in the cooling tower where the H_2S is oxidized and trapped.	-ve	short	Reversible	High	Control dust, vehicular fumes, H2S, and other thermal gases
Noise pollution	Earth moving equipment (related to road, well pad, and sump pit construction), vehicle traffic, seismic surveys, blasting, and drill rig operations. Decibels ranging from 80 to 115dB	Noise pollution and vibrations	Short/Long		low	Generally localized, use of silencers/mufflers in masts, sound proofing.
Solid waste disposal	Generated by employees, spent construction materials	-ve	Short term	Reversible	Low	Establish solid waste management for the site.

Water pollution and waste disposal	Discharge from geothermal wells, oil waste from machinery, from labour lines	-ve	Short term	Reversible	Low	Linings of the boreholes, geothermal wells, organize a secure dump site.
Recreation, culture and aesthetics	Create recreation centre by tree planting, organizing grass areas	+ve	Long term	Reversible	High	Recreation and education centre
Health and Safety/diseases	Increase in accidents, increase in population, new diseases to the area.	-ve	Short term	Reversible	High	Increase capacity of dispensary, expand existing hospital, and establish first aid and ambulance services.
Infrastructure and traffic congestion	Increased traffic, heavy vehicles	-ve	Short term	Reversible	Low	Expand road width, murrum to all weather,
Population/demography/ Housing/settlements	Influx of people during construction, more men compared to women, vehicular traffic, limited housing.	-ve	Short term	Reversible	Low	Investment and business appetite, educational programmes, awareness raising to locals.
Visibility and emergency management	Obtrusive rigs and machinery	-ve	Long term	Irreversible	High	Health and safety training, control speed on roads in market centres and schools' crossings
Gender and Youth	Influx of young people more men compared to women	-ve/+ve	Long term	Reversible	Low	Establish community centres, organize sports and recreation activities.

Table 8.7: Summary of proposed environmental and social mitigation measures

Project Phase	Predicted impact and source of impact	Mitigation/enhancement measures
Drilling of boreholes and construction of storage tanks for water supply	▪ Vehicular traffic- increase in accidents, increase in population, ▪ Health and safety- new diseases to the area. ▪ Air pollution from dust, vehicular fumes ▪ Noise pollution from vehicle traffic, seismic surveys, blasting.	▪ Traffic to abide by the speed limits. ▪ Movement of heavy construction traffic should be planned appropriately. ▪ Prevention of soil erosion during upgrading and use of access road ▪ Regular watering should be carried out to avoid the impact of dust. ▪ Establish maintenance responsibilities and ensure that road rehabilitation takes place as soon as possible
Exploration drilling of Thermal Gradient Holes	▪ Vehicular traffic - Increase in accidents, increase in population, new diseases to the area. ▪ Air pollution from dust, vehicular fumes ▪ Noise pollution from vehicle traffic, seismic surveys, blasting ▪ High demand for water supply	▪ The traffic should abide by the speed limits and by laws of the area. ▪ Movement of heavy construction traffic should be planned appropriately. ▪ Prevention of soil erosion during upgrading and use of access road and regular watering should be carried out to avoid the impact of dust. ▪ Establish maintenance responsibilities and ensure that road rehabilitation takes place as soon as possible ▪ Drill boreholes for water supply
Drilling of production wells	▪ Solid and liquid waste management- oil waste from machinery, from labour lines ▪ Groundwater pollution from geothermal fluids	▪ Production and injection wells are lined with steel casing and cement to isolate fluid from environment and ground water resources. ▪ Keep machinery in high maintenance to reduce vehicular fumes;

		▪ Recycling of wastewater extends the life of geothermal reservoir; conserve water
Development of geothermal power production and transmission	▪ Visibility and emergency management, Obtrusive rigs and machinery ▪ Influx of young people more men compared to women ▪ Influx of young people more men compared to women ▪ Potential spread of HIV/AIDs and other sexually transmitted infections	▪ Direct contact condensers and in the cooling tower where the H_2S is oxidized and trapped. ▪ Use of binary technology that emits virtually no gases because it is a closed loop system using heat exchange method ▪ Hydrogen sulphide removal ▪ Installation of H_2S monitors with alarm system including use of personal monitors by staff in potentially dangerous areas ▪ Waste Management Hierarchy as its foundation, i.e., Waste Reduction, Reuse, and Recycle. ▪ Liaison strategy for communication with communities who may be affected by odour nuisance
Plant Operations	▪ Water pollution and waste disposal Discharge from geothermal wells, oil waste from machinery, from labour lines ▪ Soil pollution or soil salinization due to high metal concentrations in soils and vegetation.	▪ Closed-loop systems where gases removed from the well are injected back into the ground; air emissions are minimal; ▪ use of binary technology that emits virtually no gases because it is a closed loop system using heat exchange method ▪ reduces air quality contamination considerably ▪ Direct contact condensers and in the cooling tower where the H_2S is oxidized and trapped.

		▪ Installation of H_2S monitors with alarm system including use of personal monitors by staff in potentially dangerous areas ▪ Communication with communities who may be affected by odour nuisance ▪ Develop a tree nursery to provide free seedlings for replanting in the project site and to the neighbouring communities. ▪ Minerals recovery
Decommissioning of the plant	▪ Vehicular traffic ▪ Closure of all facilities and wells; ▪ Removal of above ground components and gravel from well pads , access roads (if not maintained for other uses), and other ancillary facility sites; ▪ Recontouring the surface; and revegetation	▪ Traffic to abide by the speed limits. ▪ Movement of heavy construction traffic should be planned appropriately. ▪ Prevention of soil erosion during upgrading and use of access road ▪ Regular watering should be carried out to avoid the impact of dust. ▪ Establish maintenance responsibilities and ensure that road rehabilitation takes place as soon as possible ▪ Waste Management Hierarchy as its foundation, i.e., Waste Reduction, Reuse, and Recycle.

8.2.16 Induced seismicity, subsidence and other geological hazards

Injection or extraction of fluid induces changes in reservoir pressure and temperature which perturbs in-situ stress conditions. This may be sufficient to trigger seismicity through a range of mechanisms. In many cases, the maximum magnitude of the induced events appears limited by the geometry of the volume e of the stimulated reservoir. This leads to the conclusion that monitoring the spatial growth of seismicity in real time can help constrain the risk of inducing large damaging earthquakes on nearby faults. There are very few reports of induced seismicity in geothermal power production.

8.3 Sociological-Cultural and Economic Impacts

8.3.1 Impacts on the economy

The geothermal power plant contributes to the generation of electric energy which also contributes to the average annual growth in energy in Nakuru. The construction of new wells in the geothermal power plant will produce additional power. The study shall consider all aspects with the human environment, including social issues affecting individuals and communities, along with the cultural aspects, including conservation of cultural heritage and human development, such as water supply, loss of housing, employment, immigration, migration and changes in the landscape.

8.3.2 Population Growth and Housing

Residents of the surrounding areas to the geothermal power plant will arrive to seek for work at the plant. The total population of the municipality of Nakuru especially the small trading centres in the sub County of Menengai will likely increase. As a result there will be increased demand for housing, goods and services in the sub County. Other factors of migration to these areas include people travelling from inside of the county to settle in the areas around the geothermal power plant. Besides increased demand for services, there will be need for integration of new immigrants to the area to avoid and conflicts in future.

The closest ethnic group to the geothermal power plant are those who visit the "crater" as part of their religious pilgrimage. There may be newcomers with different cultures to the area. The closest ethnic group to the geothermal power plant are those who visit the crater as part of their religious pilgrimage. There may be newcomers with different cultures to the area.

8.3.3 Youth Employment

One fundamental request during the Stakeholders' consultation was youth unemployment. The plant near the population works mainly in services and trade a portion of the population in industry and construction in agriculture, livestock and power. Recruitment of personnel required for the operation and maintenance of the geothermal power plant is primarily insular to the region. However, there are some nonresident contracted staff who come to inhabit temporarily or permanently in nearby towns.

There will be increased demand for services in the neighboring trading centres and towns to the geothermal power plant. Currently electricity services covers 96 % of households with piped water 64.1 %, with sewage service 56.9 %. Before the station boosts power generation in the area, there may

be overloads to the system. The geothermal power plant will contribute to the electrical service at the regional and national level, promoting the quality of life of the inhabitants of the region so they will have an efficient and sufficient service.

Other social services including schools, churches and water supply may be overwhelmed by new influx of workers in the area. There is a Kenya Electricity Transmission Company (KETRACO) electricity transmission line of 15 km 132 kV between Menengai and Soilo Substation that will evacuate the produced electricity from the power plant.

8.3.4 Public Health, safety and accidents

About 71 % of the area near the geothermal plant has medical services, of which 85% are entitled to social insurance. There will be potential spread of HIV/AIDs and other Sexually Transmitted Infections (STIs) as the number of male construction workers' camp in the project area. There will be need to recognize the increased demand for health services as well as health impacts of prolonged passive exposure to hydrogen sulfide. It is anticipated that there will be increased motor vehicle traffic during exploration, construction and operation of the power plant. Road accidents therefore may increase however the accidents should be mitigated through enforcement of speed limits and erection of bumps, humps and barriers to force drivers to slow down. Proper signage will also be erected.

Fire risk will be an important risk in areas such as the cooling towers, turbine and generator rooms, office premises, workshops, car parks and stores, most of which will be completed at the construction phase of geothermal development. Dead organic matter may also pose a fire risk especially during the dry seasons. For fire risk mitigation, a comprehesive fire response system will be installed including placement of fire hydrants at various places especially within the power station, office blocks, stores, workshops, and car parks.

8.3.5 Noise pollution and vibrations

The drilling rig will produce low-frequency noise. Noise will also be produced by rig power generators and support machinery such as motor vehicles, backhoes and cranes. The Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations, 2009 sets out maximum permissible noise levels in the First schedule of the Regulation for various zones The results of noise level assessment as shown in the tables below indicates that noise levels fall within the recommended standards of WHO and occupational exposure limits and community noise of 85 and 50 dB(A) respectively. The levels also complied with the maximum allowable limits of World Bank of 55dB (A) for residential and educational facilities and 70dB (A) for commercial and industrial premises during day time and night time (0700.200) and 2200-0700hrs respectively (Wamalwa and Kiama, 2016).

Table 8.8: Noise emission levels at the residential areas

dB(A)	AIC.T.P	MARIGO.B	RIGOGO.J	KIPN
Mean	43	43	43	43
Median	43	43	43	43
Max	47	48	45	47
Min	36	38	38	37
Mode	44	42	45	40
WHO TVL	45-50	45-50 45-50	45-50	45-50
WB Limits	55	55	55	55

WB- World Bank; WHO- World Health Organization; AIC.T.P- African Inland church, Tulimoi Primary; KIPN- Kipng'ochoch Centre.

World Bank maximum permissible noise level for industrial/commercial and residential/ institutional and educational area are 70 and 55 dB (A) respectively. WHO maximum permissible noise in work places assuming 8-hr, 5 day week and residential areas are 85, and 45-50 dB(A) respectively.

Table 8.9: Noise emission levels at Pump house, Laydown, Campsite, MW12 and MW13

Site	Pump house	Laydown,	Campsite	MW12	MW13
Mean	70	68	70	70	70
Median	38	40	52	37	58
Max	44	58	65	69	68
Min	54	59	66	68	68
Mode	54	57	65	66	67
WHO TVL	85	85	85	85	85
WB Limits	70	70	70	70	70

Evaluation of noise emission impacts from the activities require examination of mode and maximum levels recommended at a given site. Their evaluation over a long period is relevant especially when assessing the impact of noise on human health. The mode and maximum noise emission levels in the project's environs is shown in tables 8.11 and 8.12 respectively. Readings from all monitoring sites, the highest emission was 68 dB (A) and 69 dB (A) respectively. Noise emissions on mode at AIC Tulimoi Primary, Marigo B, Rigogo junction and Kipng'ochoch center were all within the permissible limits of World Bank and WHO thresh value limits for residential of 45dB(A), 50dB(A) respectively

The cumulative impact of noise is therefore dependent on the number of wells under testing that takes about 60 days and therefore has a temporary impact on the surrounding (Ogola, 2004). Construction noise is mainly generated by bulldozers, graders, trucks and cranes for the duration of power plant construction (KPLC & Sinclair Knight Merz, 1992). Noise during operation is from cooling towers, gas ejectors and powerhouse. To mitigate noise levels, use of silencers and earmuffs to workers is enforced. Indicative noise level is described on table 3.

In geothermal work, the noisiest activity is the testing of wells, where levels in excess of 100 dB(A) are recorded during vertical discharge test but this is usually for a short period. The power station and cooling towers are also high noise environments, with noise levels of above 70 dB(A). During major maintenance of the geothermal power plant, noise is generated by sediment ablation for pipe cleaning, the operation of the plant and electrical substation.

Noise is usually generated during earthwork construction, air drilling and well testing operations. The levels usually go beyond the ambient noise levels and, therefore, protective gear is recommended. The OSHA permissible daily exposure limits are shown in Table 8.12, above which protective gear is recommended. A standardised system of noise monitoring will ensure that equipment is adequately calibrated and levels are within occupational limits. Typical noise levels (in an approximate order of intensity) are shown in Table 8.13 below.

Table 8.10: Estimates of noise levels at different geothermal activities

No.	**Activity**	**Noise levels**
1.	Air drilling	120 dBa (85 dBa with suitable muffling
2.	Discharging wells after drilling	up to 120 dBa (85 dBa with suitable muffling)
3.	Well testing	70-110 dBa if silencers used

Source:

Table 8.11: NEMA Ambient Noise Levels Criteria

Receptor	Maximum allowable noise in decibels		
		Day time	Night time
A	Silent Zone	40	35
B	Places of worship	40	35
C	Residential : Indoor Outdoor	 45 50	 35 35
D	Mixed residential (with some commercial and places of entertainment)	55	35
E	Commercial	60	35

Source: NEMA Environmental Management and Coordination Act (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009.

Table 8.12: World Bank Ambient Noise Levels Criteria

Receptor	**Maximum allowable log equivalents(hourly measurements), in dB(A)**	
	World Bank	
	Day time	**Night time**
Residential, institutional, and educational	55	45
Industrial and commercial	70	70

Source: World Bank Pollution Prevention and Abatement Handbook, 1998.

For effective noise control, the main focus will be focused on control at source supplemented with control at pathway. Noise control measures will include distance from noise source; use of noise control techniques(using acoustic machine enclosures; selecting structures according to their noise isolation effect to envelop the building; using mufflers or silencers in intake and exhaust channels; using sound absorptive materials in walls and ceilings; using vibration isolators and flexible connections (e.g., helical steel springs and rubber elements); applying a carefully detailed design to prevent possible noise leakage through openings or to minimize pressure variations in piping); and modification of the plant configuration or use of noise barriers.

Noise impact modelling results indicate that with all the three power plants operating simultaneously the overall maximum increase in noise level over the baseline will be less than 3 dBA at around 1.72 km from the boundary of operations. As expected the noise impact would be most notable at night when baseline noise levels are lower and assessment criteria more stringent. Since the closest Noise Sensitive Receiver (NSRs) are situated at least 3 km away from these sites it unlikely a change in day or night time noise levels will be detected at these locations. The relatively small impact area is the combined result of the baseline noise levels (already in exceedance of assessment criteria), the design specifications of the facilities (i.e. galvanized steel sheet cladding of building that contains major noise sources), and the absence of permanent NSRs within 2 km radius from site. To minimize noise generation, it is recommended that:

- Prior to the commencement of works, contractors will be required to carry out a baseline noise survey for one week, on a 24-hour basis, to establish the background noise levels;
- Equipment vendors will be required to guarantee optimized equipment design noise levels;
- Acoustic attenuation devices should be installed on all ventilation outlet and high pressure gas or liquid should not be ventilated directly to the atmosphere, but through an attenuation chamber or device;
- Vibrating equipment must be on vibration isolation mountings;
- Develop a plan to monitor noise levels and respond to complaints and mitigate impacts.
- The generation of noise is a local problem. Several measures are generally taken:
- A reforestation program that aims to reduce noise levels in critical areas of the geothermal field.
- Silencers are used to reduce noise emissions to allowable levels.

8.3.5 Aesthetic Impacts

The existing farmland with livestock will significantly change and a significant deterioration shall be observed in the vegetation cover in case there are no interventions. Recommendations will be made in order to increase vegetation cover in the area. The power station, piping, and access roads may offer a visual intrusion into the natural landscape, and alter its appearance permanently. Reforestation methods and increase in tree cover will mitigate some of these consequences.

8.3.6 Impact of bright lights

Appropriate lighting is used to ensure visual work can be done accurately, safely and in comfort; to increase timely production, and to enhance security and to promote the health and wellbeing of workers; to make the workplace an attractive and pleasant environment. There will adequate lighting during construction and generation of power. There will be lighting controlds to ensure that the public are shielded from the glares of light during the nights.

8.3.7 Educational facilities

The study will investigate the location of the educational facilities in the project area. The project will promote environmental education campaigns and dissemination of the operation of the geothermal field. The low level of income and education of the population of the nearby suburbs to the geothermal power plant, limit the efficiency of energy saving programs. The standard ambient noise levels have been adopted to relocate educational institutions and any homesteads within the proposed drilling site.

8.3.8 Tourism and recreation

Educational tourism will increase as a result of the geothermal power development in the area. Recycling materials so that companies or individuals can take advantage of them. Hydrogen sulfide is now routinely abated at geothermal power plants, resulting in the conversion of over 99.9 percent of the hydrogen sulfide from geothermal non-condensable gases into elemental sulfur, which can then be used as a non-hazardous soil amendment and fertilizer feedstock (Kagel, et al, 2003). There are social groups in the vicinity of the geo-thermal power plant that have complained about the establishment of geothermal plant before. There will be need for awareness creation and information sharing amongst the community in order to gain acceptance of the geothermal plant in the area. Public participation is therefore crucial for the success of the investment.

8.3.9 Enhanced Environmental Health and Safety

Sosian Energy Ltd will develop its own Environmental Health and Safety **(**EHS) policy with procedures for all likely injuries, alcohol drugs and weapons; adverse weather conditions; fire prevention; security issues, emergency preparedness in terms of drills with varying frequencies, e.g. monthly for fire and annually for incidents such as earthquakes according to International standards. The policy will include formations of safety committees and their operation; the use of all forms of PPE, fall protection in terms of ladders, working at elevated heights; environmental aspects such as incidents regarding steam, waste, uncontrolled air emissions, peak noise emissions etc.

CHAPTER 9: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

9.1 Introduction

The Sosian geothermal project has all its social, environmental and safety concerns addressed in well-developed EMP. The EMP activities broadly seek to address social issues, staff and community safety, waste management, surface and groundwater quality, air quality, and rehabilitation and social afforestation program. Implementation of this ESMP is executed by well trained and competent Environmental Scientists Community Liaison Officers and Safety officers. The ESMP is instituted through regularly environmental monitoring programs as discussed in subsequent sections.

An environmental monitoring plan has been designed and included in the ESIA report. The purpose of monitoring is to identify and mitigate changes in the environment brought about by geothermal project development. This takes place during exploration, drilling, construction and operation. The monitoring plan has all the identified possible impacts, their mitigation and the persons responsible for implementation. A cost plan has been attached to all mitigation measures and possible alternatives analyzed. Participatory approach is encouraged in monitoring social issues (World Bank, 1994). Table 8.1 highlights the key environmental and social issues that are monitored during geothermal development.

Table 9.1 Social and environmental monitoring parameters for Sosian geothermal energy development

Social Monitoring Parameters	Environmental Monitoring Parameters
Soil pollution	• Collection of annual soil samples; Soil and vegetation chemical concentration
Public health and safety	• Water quality assessment and chemical concentration
Water use and consumption	• Ecosystem (plants & animals both aquatic and terrestrial)
Community complaints	• Noise level • Air pollution and deposit chemistry Air pollution and deposit chemistry • Soil erosion and control • Geo-hazard monitoring • Seismic monitoring • Water and gas chemistry • Ground water chemistry and levels
Employment and income	• Percent of local employees
Traffic volume	• Periodically monitor traffic census
Business and services	• Support the local traders' association
Demographic changes	• Periodic demographic and socio-economic surveys
Education	• School enrolment and facilities • Support Parents-Teachers Associations.

9.2: Meteorological Monitoring

Meteorological parameters monitoring is one of the key environmental activities in the Menenngai Highland project area. The monitoring aids in quantifying the effects of its operations in terms of weather and emission dispersion levels at the project site and its environs. This can only be achieved by real time meteorological data collection, analysis, and interpretation and reporting. Sosian Energy will install two (2) Automatic Weather station (AWS) within the project site. (Plate 9.1)) The station will collect data, on an hourly basis, of key parameters such as wind speed, wind direction, total rainfall, relative humidity, barometric pressure, air temperature and solar radiation.

Plate 9.1: An automatic weather station

Source: www.shutterstcok.com

9.3 Air Quality Characterization and H_2S Monitoring

Air emission from geothermal plants are significantly less than from conventional fuel sources, particularly for condensable gases. Air quality in Menengai highland is characterized in terms of H_2S, CO, CO_2, CH4, SO_2, Cl_2, O_2 and noncombustible gases (LEL) concentrations that shall be monitored on daily basis at specified time at designated monitoring points within the project site and its environs by use of gas detectors. The analysis of the gases shall be compared with existing national Occupational Safety and Health Act (OSHA) standards and other International standards such as World Health Organisation (WHO) and World Bank (WB) for health and safety purposes. Of greatest concern among the stakeholders during consultation is Hydrogen sulfide (H_2S) due to its distinctive smell and potential toxicity if in high doses. The effect of H_2S is however now effectively abated due to improved geothermal power generation technologies such as steam scrubbing/extraction and venting through cooling towers hence it is dissolved in the cooling water. Modelling of H_2S require real-time data and even with this, the results are quite unpredictable (Mariela, et al, 2015).

9.4 Solid Waste Management

The waste generated from Sosian Energy Ltd from Menengai Highland geothermal project mostly comes from rig operations and drillers' camp. The solid waste consists of plastic containers, cartons, scrap metals and other food/domestic refuse (paper, food remains) generated from the drillers camp and staff canteen. Best waste management practices have been adopted in dealing with all kinds of waste generated. Dustbins and refuse bags will be provided for solid waste collection (Plate 2).Waste is segregated at the source (Plate 3). A temporary waste collection site will be developed for proper and safe disposal of recyclable waste while food/biodegradable waste will composite for use at company's tree nursery as composite soil for raising tree seedlings towards maintenance of Sosian's grounds.

9.5 Rehabilitation of project site

This is carried out in an effort to restore the project biophysical environment after project operations. The rehabilitation program involves putting back to near original state of sites that have been disturbed by civil works activities (Plate 4) such as murram/laterite burrow pit or quarries.

9.6 Support for Social Afforestation

Social afforestation is a program specially designed by project environmental management team to reach out to the project surrounding communities. The program targets to support youth and women groups to raise tree seedlings and promote environmental conservation initiative. An average of two hundred thousand tree seedlings are donated and planted (Plate 7) every year, this is done in collaboration with local communities organized groups tree nurseries who get paid by Sosian to raise the tree seedlings.. Ultimately the planted trees will help conserve the water towers which supply drilling water to Sosian for instant the Aberdares complex.

9.7 Noise Level Assessment

Noise monitoring is carried out on a weekly basis during drilling. Noise levels over the monitoring period will be evaluated and checked against the acceptable World Bank/WHO limits and NEMA Maximum Permissible Noise Level Limits for Construction Sites. The Certified sound level meters will be used for data collection. In areas where noise levels are high especially for wells under discharge and testing and where noise gives rise to difficulties in verbal or sound communication, signs will be posted clearly and prominently marked "DANGER, HEARING PROTECTION MUST BE WORN" in compliance with The Factories and Other Places of Work (Noise Prevention and Control) Rules 2005 and suitable hearing protection (Ear Mufflers and Ear Plugs) will be provided to the affected workers and visitors as stipulated in the same Rules.

9.8 Water, soil and vegetation quality monitoring

Waste products from the drilling process will include brine and drilling fluid. Constituents of the brine may contain chemical constituents that may surpass the wastewater quality criteria for surface disposal in any environment as recommended by Environmental management and coordination (water quality) regulations of 2006. Wastewater reinjection has been adopted as this method of disposal of wastewater

eliminates flow of surface waters and the subsequent development of the deep gullies in this area. It also ensures that soil, water resources, humans and animals in and beyond the project site are not exposed to the wastewater. Means of containing wastewater from drilling has been developed so that they are not released directly to the ground and on to vegetation.

9.9 Stakeholder and Local Community Engagement

Sosian has on a continuous basis engaged its key stakeholders and the local community in the Menengai Highlands project area. This has been achieved through stakeholder and public meetings for community and stakeholder participation, to ensure they fully understand the project and are incorporated in its day to day implementations. In such meetings the corporate activities and future plans for the project are highlighted to ensure they are all on board.

9.10 Environmental Management Systems

Sosian will plan to work towards achieving ISO 14001 (Environmental management system) certification. This system will facilitate management of the current environmental monitoring programs in a comprehensive, systematic, planned and documented manner.

Table 9.2: Responsibilities for monitoring plan

Monitoring Parameter	Environmental Monitoring Parameter	Responsible Institution	Time frame	Estimated cost (US$/year)
Meteorological stations within the site and environment	Rainfall, Temperature, wind, humidity, evaporation	Sosian Energy Schools Hospital	Daily	2,000
Air quality	H_2S, CO, CO_2, CH4, SO_2, Cl_2	Sosian Energy	2xDaily	3,500
Solid waste management	Garbage collection, Liquid discharges, sump, etc	Sosian Energy		2,800
Site rehabilitation and afforestation to encourage educational tourism	Tree nurseries	Sosian Energy, Schools, Community groups, etrc.		1,800
Noise and vibrations		Sosian Energy		1,980
Water, soil and crop health	Water samples, soil samples	Sosian Energy	X2/year	
Stakeholders" and Community Engagement			Annual event	1,000
Environmental Management Systems		Sosian Energy		

9.11 Summary and Conclusions

The Environmental and Social Management Plan (ESMP) will improve mitigation of potential impacts continuously with regular reviews taking care of new or non-anticipated impacts. The full implementation will ensure that TGH and Exploratory drilling project in Menengai Highlands proceeds with full mitigation of all potential environmental and socioeconomic impacts as predicted in the ESIA study report ensuring environmental, social and economic sustainability of Makongeni/Menengai Geothermal Project.

CHAPTER 10: DECOMMISSIONING AND SITE RECLAMATION IMPACTS

10.1 General Decommissioning Activities

Potential environmental impacts from decommissioning and site reclamation activities are generally similar to those during the construction phase, but of shorter duration than those during the operations and maintenance phase. The process involves retirement of generation, decommissioning (removal of equipment and materials, demolition of building), Remediation (clean up contamination to support new use), and redevelopment (repurpose new site or develop for a new power generation technology).

Geothermal facilities are removed after their useful life, expected to be between 25 and 35 years, in a process called decommissioning. Following decommissioning, the site would be restored (reclaimed) to approximate its original condition or to some standard that results in stable environmental conditions. Typical activities during the decommissioning/reclamation phase include closure of all facilities and wells; removal of above ground components and gravel from well pads , access roads (if not maintained for other uses), and other ancillary facility sites; recontouring the surface; and revegetation . Impacts would be similar to those addressed for the construction phase; however, many of these impacts would be reduced by implementing good industry practices. Restoration during this phase would also ensure that impacts beyond the life of the geothermal energy development are avoided or minimized. Potential impacts from these activities are presented below, by the type of affected resource.

10.2 Removal and site clean-up

Well casing and disposal of waste according to laid-down guidelines on waste management and disposal. The well is plugged with mechanical and/or cement plugs, which effectively seal the wellbore. The wellhead equipment is then removed and the drilling rig is stripped down for transportation. As far as abandoning the well site, this will entail removing of all foreign material such as hard core, plastic liner, piping and fencing, and thereafter the land will be re-instated to its "as-found" state (revegetated).

10.3 Noise Control

Sources of noise during decommissioning would be similar to those during construction and would be generated primarily by construction equipment and vehicular traffic. Near residential areas, noise levels could exceed the NEMA guideline but would be intermittent and extend for only a limited time. All works will be done during the day time only.

10.4 Air Quality Control

Emissions generated by activities during the decommissioning and reclamation phase will include vehicle emissions, diesel emissions from large construction equipment and generators , and dust from many sources such as land clearing, structure removal, cement mixing, backfilling, dumping, reclamation of disturbed areas (grading, seeding, planting), and truck and equipment traffic. Best practices in construction industry will be applied and NEMA standards followed.

10.5 Social and Cultural practices

Decommissioning activities would have impact social and cultural practices because resources would have been removed from the locality, or resources would have been disturbed or shifted during previous phase activities. The access roads will be left in place, affording access to services. Visual impacts of the geothermal development would be mitigated if the area is restored to its pre-development condition.

10.6 Land and ecosystems

Impacts to ecological resources from decommissioning and reclamation activities would be similar in nature to the impacts that would occur during construction and drilling, but at a reduced magnitude. There will be a temporary increase in noise and visual disturbance associated with the dismantling and removal of project facilities and reclamation. Removal of sump pits would also eliminate a potential source of concern to wildlife species. Following site reclamation, the ecological resources at the project site could eventually return to pre-project conditions depending on the end use selected for the project site. Changed grass and forest areas may have been attributed to conservation for educational purposes, but these may be retained.

Impacts to soils would be similar to those occurring during the construction phase. Dismantling and removing roads, well pads, the geothermal power plant, and structures related to the power plant (e.g., the pipeline system and transmission lines) would occur during this phase. These activities would cause topographic changes. Soil compaction due to decommissioning activities. Any contaminated soils (e.g., in sump pits) will need to be removed, bio-remediated, or treated in some other manner.

10.7 Hazardous materials and waste management

Substantial amounts of solid and industrial waste will be generated during the dismantling of geothermal structures and facilities. Much of the solid material can be recycled and sold as scrap or used for other projects; the remaining nonhazardous waste would be sent to designated disposal facilities. Industrial wastes (oils, hydraulic fluids, coolants, solvents, and cleaning agents) would be treated similarly to wastes during the previous phases (e.g., put in containers, characterized and labeled, possibly stored briefly, and transported by a licensed hauler to an appropriate permitted off-site disposal facility). Impacts could result if wastes were not properly handled and were released to the environment.

10.8 Health and Safety

Potential human health and safety impacts during decommissioning and reclamation would be similar to those during the exploration and drilling and construction phases; and relate to earthmoving, use of large equipment, dismantling of industrial components (power plant, substation , and pipeline systems), and transportation of overweight and oversized materials. Improperly closed sites can be a safety hazard.

10.9 Land Use

Land use impacts resulting from drilling and construction could be largely reversed by decommissioning, depending on the end use selected for the project site. Since this land is privately owned, feasibility study will be suggested.

10.11 Socioeconomic of the community

Direct impacts would include loss of old jobs and creation of new ones for workers during decommissioning and reclamation activities and the associated income and taxes paid. Indirect impacts are those impacts that would occur as a result of the new economic development and would include things such as new jobs at businesses that support the workforce or that provide project materials, and associated income and taxes. There may be adverse effect to property values as a result of decommissioning. However site reclamation could result in economic values of residential properties adjacent to the geothermal development becoming equivalent to similarly developed residential areas that were not affected by industrial activities. There may be loss of royalty and tax revenue that likely will adversely impact the local and county economies.

10.12 Road use and traffic

Short-term increases in the use of local traffic will occur during decommissioning and reclamation. Overweight and oversized loads could cause temporary disruptions to local traffic.

10.13 Visual resources

Decommissioning activities would have only temporary and minor visual effects, resulting from the presence of workers, vehicles, and construction equipment (including lighting for safety); and from vegetation damage, dust generation, scarring of the terrain, and altering landforms or contours as structures are dismantled and removed.

10.13 Water resources management

The decommissioning and reclamation phase will involve ground-disturbing activities (related to dismantling facility structures and recontouring the surface) that could lead to an increase in soil erosion and surface runoff. Impacts to surface water would be limited but temporary and could be reduced by implementing best management practices based on storm water pollution prevention requirements and other industry guidelines.

Activities during this phase also include plugging and capping of production and injection wells . Improper abandonment could allow wells to serve as pathways for geothermal fluids to migrate to other aquifers , affecting both the geothermal resource and the quality of the affected aquifers. Proper well closure and capping would reduce the risk of these impacts.

Water would be also be used to control dust from road traffic and for consumptive use by workers. Depending on availability, it may be trucked in from off-site or obtained from local groundwater wells or nearby municipal supplies.

Upon completion of decommissioning, water consumption associated with the facility operations would end and disturbed areas would be contoured and revegetated to minimize the long-term potential for soil erosion and water quality related impacts. Consequent clean-up activities will be done in accordance with the agreement signed between the government and the proposer. The removal exercise shall be carried out with skill and diligence to avoid spill of hazardous substances and damage to the environment. If evaluation and testing shows that the reservoir is capable of commercial exploitation, the well will be temporarily abandoned with a completion string and wellhead in place, allowing later reentry ready to be linked into the production and export facilities at a future point in time.

To ensure transparency and availability of information regarding the Project, Sosian Energy will implement the following actions:

- Prepare website information concerning construction activities and programme. Any possible inconveniences will be included.
- A newsletter will be prepared and distributed in the local authority offices. The newsletter will include important information about the Project, any possible inconveniences to residents and traffic during construction. It will also provide contact information for Sosian Energy as well as a summary of the Grievance Mechanism.
- Attendance at key community events.
- Community and staff notice boards updated with Project developments and possible disturbance or inconveniences to local population.
- Project office and visitor information points set up for people to address grievances as well as to gain important insight into the Project as a whole.

In order to improve safety issues, signage and safety awareness programs will be implemented around the Project area and access roads to ensure security of workers and surrounding communities

CHAPTER 11: ENVIRONMENTAL MONITORING AND AUDIT PROGRAMME (EMAP)

11.1 Background of EMAP

Monitoring will be initiated before development starts so that the baseline that was done with ESIA may be improved. During exploration, construction and operation/utilization stages of geothermal projects, monitoring provides feedback on the actual environmental impacts or changes in natural conditions and the results can be used to improve the implementation of mitigating measures. Official monitoring enables Sosian Energy Ltd to assess the management of geothermal systems under development. A comprehensive Environmental Monitoring and Audit Programme (EMAP) will be implemented to check effectiveness of the mitigation measures as proposed and environmental compliance with relevant statutory requirements. Monitoring will be participatory with stakeholders' empowerment, based on the known science, best industry practice, embracing full disclosure and prompt action taken in case of adverse report.

The proposed key EMAP requirements include:-

a) Noise monitoring at designated monitoring stations during construction phase
b) Dust monitoring at designated monitoring stations during construction phase
c) Water quality monitoring during the course of construction works at river crossings to monitor any variation in water quality from the baseline conditions and identify any exceedance of Water Quality Objectives at sensitive receivers as stipulated by the Water Resources Regulations 2003.
d) Regular site inspections at the works areas as part of the EMAP procedures to ensure the recommended mitigation measures are properly implemented.
e) Sosian Energy will carry out environmental Audits as required by NEMA and through periodic monitoring will know areas in which the project affected community.

11.2 Monitoring Schedule

11.2.1 Noise Pollution

Monitoring is a continuous undertaking to be done during construction and operation phases. Actions to be taken will include;

- Monitor if noise levels at sensitive receptors during day and night comply to those stipulated in the First & Second Schedules;
- Respond to any complaints arising in relation to noise.
- Conducting regular site audits to ensure that noise control measures are properly implemented.

11.2.2 Air Quality Standards

Emissions and air quality monitoring programs provide information that can be used to assess the effectiveness of emissions management strategies. The air quality monitoring program will consider the following elements:

- Monitoring of weather elements including rainfall, humidity, temperature, evaporation and wind speed and direction;

- Monitoring parameters: - The monitoring parameters selected H_2S, CO_2, NOx and air particulates reflecting the pollutants of health and environmental concerns identified in the project processes.
- Baseline calculations: Baseline air quality monitoring at and in the project vicinity and key component sites should be undertaken before the project commences in order to assess background levels of ambient air quality conditions The differentiate between existing ambient conditions and project-related impacts will be interrogated and lessons learnt recorded for action.
- Monitoring type and frequency: - Data on emissions and ambient air quality generated through the monitoring program should be representative of the emissions discharged by the project over time.
- Monitoring locations: - Ambient air quality monitoring may consist of off-site or fence line monitoring either by Sosian Energy Company Ltd periodic reviews by the competent government agency, or by collaboration between both and stakeholders' representatives.
- Sampling and analysis methods: - Monitoring programs should apply NEMA/Government Chemist and or international standards for sample collection and analysis, such as those published by the International Organization for Standardization.

11.2.3 Water Resources Management

For the purposes of managing project impacts, surface water quality objectives include protection of dissolved oxygen levels in the waters, the turbidity and pH levels among other parameters. These parameters will be monitored on a regular basis and reports shared by shareholders and stakeholders. Compliance with the NEMA and International regulations providing for sound water resources management and climate footprints will be monitored through the respective agencies.

11.2.4 Waste Generation and impacts

The following monitoring procedures are proposed for the construction and operation phases of the Project:

- Inspect waste storage areas (dump sites, in case of any) on a weekly basis to make sure that wastes are being stored properly
- Maintain a waste register for all hazardous wastes and operation wastes.
- Review register monthly to identify any dramatic changes in waste generation patterns and possible opportunities for waste minimization.

11.2.5 Land and biodiversity

Sosian Energy will monitor the impacts of fauna strike and mortality during construction and operation and soil samples, a photographic record of agricultural ecosystems will be prepared by the contractor prior to construction commencing. This baseline will be used to detect any impact of gas emissions on crops and biodiversity in general, conduct monthly audits of the proposed management plans during construction period and recommend adaptive management on farms adjacent to the

project site; and on completion of the construction works, monthly visual inspections by a competent officer for a period of 2 years.

11.2.6 Environmental, Health and Safety Impacts

Sosian Energy will formulate and ensure proper adherence by the operator to the O&M manual. Regularly audits of community health records and the health clinics and fire safety drills carried out periodically.

11.2.7 Impact on the local economy

The Company will monitor the local jobs market, changes in population of the locality and culture, and increase in tourism. Employment data, interviews and occasional polls, increase in businesses at the three major trading areas (Kwa Gitau, will be done. Tourism may follow seasonal patterns that will become clear with time.

11.2.8 Changing cultural practices

The Company will be involved in improving educational and religious facilities and also involve in cultural fairs as part of CSR with the community.

11.2.9 Maintaining positive public opinion with the local community

Sosian will carry out polls and interviews to find the company's areas of community involvement through its public relations office. The use of digital platforms will be advisable.

11.2.10 Performance Criteria at the power station

The development of Service Charter and O&M manual with clearly spelt out standard operating procedures will ensure consistent maintenance practices by the Company in all its operations.

CHAPTER 12: STAKEHOLDER ENGAGEMENT PLAN

12.1 Information Disclosure

Information disclosure in a manner that is understandable and continuous is the main criteria for successful stakeholder engagement for the proposed development. This is because timely and accurate information is integral to meaningful engagement of all stakeholders including the affected communities.

12.2 Communication Methods

The principal communication channels will include community forums and use of notice boards.

12.2.1 Community Forums

In order to ensure effective consultation with community members during construction and operation of the Project, Sosian Energy will establish a Community Consultation Forum comprising elected community representatives, and aimed at disseminating project information to community members. The company will request communities to democratically elect representatives to voluntarily sit on the Forum, which meets quarterly. Representatives will be responsible for onward dissemination of project information to community members, and Sosian Energy will be responsible for taking minutes and attendance registers at Forum meetings.

The composition of the Forum might include the following Committee members:

a) Community members from the communities within the Projects area of interest;
b) Representatives from the Local Administrative units;
c) CBOs and NGOs; and
d) Sosian Energy Company Community Relations Department.

In summary, the Consultation Forum comprises a membership of persons that will be elected every six months. Committee members will be required to hold meetings with their communities, and provide Sosian Energy with copies of the attendance registers and minutes of these meetings.

For the Forum to be effective, it will be important for elected forum members to participate in training workshops to develop a Constitution and build capacity amongst forum committee members to effectively participate in meetings.

The venue for forum meetings should rotate amongst communities using a pre-agreed schedule determined at an inaugural meeting held at a location to be determined by Sosian Energy. Each community will then have a turn to hold a forum meetings.

12.2.2 Notice boards

Notice boards are an effective mechanism to inform forum members, and the community at large about project activities. Selecting the best location for the notice boards will be done in consultation with community members. These notice boards will be regularly updated with Project information

and activities, employment opportunities and impact management measures in case there is any. Noticeboards will also include a grievance/suggestion box.

12.3 Management of the SEP

Sosian Energy will engage the community throughout the life of the project. The Company will use designated information centres Stakeholder engagement is an on-going process throughout the project life cycle and there are three phases relevant to the Makongeni/Menengai Geothermal Project. The SEP is a living document that will be refined and modified throughout the life of the Project. While maintaining the focus and scope the SEP may be updated in order to meet the requirements of the project.

12.3.1 Establishment of Community Liaison Team

A trained community liaison team will take responsibility and lead all aspects of the stakeholder engagement. The proposed staffing complement is detailed in Chapter 6.

12.3.2 Establishment of an Information Centre

This centre will provide the public access to leaflets, information materials and the chance to view a model of the proposed mine layout. It will allow the public to meet and communicate personally with company representatives, to obtain information on on-going projects, ask questions on topics of interest as well as to lodge complaints or concerns.

12.4 ESIA Disclosure & Consultation Phase

This second phase of engagement will focus on disclosing and consulting on the draft results of the ESIA process. Within the overarching ESIA engagement objectives, the specific objectives for the draft ESIA phase of engagement will be to:

i. Provide feedback to the stakeholders on the draft impact assessment and associated management/mitigation measures (disclosure); and,
ii. Gather stakeholder input on the initial impact assessment and identified mitigation and enhancement measures (consultation).

It is planned that this phase of engagement will take place in (early August 2019) prior to the finalisation of the ESIA Package Report in (Mid-August 2019). During this engagement phase, disclosure and consultation activities will be designed along the following general principles:

i. Consultation events and opportunities will be widely and proactively publicised, especially among project affected parties, at least 2-3 weeks prior to any meeting;
ii. The non-technical summary will be accessible prior to any event to ensure that people are informed of the assessment content and conclusions in advance of the meeting;
iii. The location and timing of any meeting will be designed to maximise accessibility to project affected stakeholders;
iv. Information presented will be clear and non-technical, and will be presented in the local language understood by those in the communities;
v. Facilitation will be provided to ensure that stakeholders are able to raise their concerns; and
vi. Issues raised will be answered at the meeting or actively followed up.

Anyone wishing to comment on the draft ESIA will have an opportunity to do so during the 60-day disclosure period. Feedback forms (Appendix 2) will accompany all the disclosure documentation. Comments will either be placed in a confidential comment box in the Information centre or alternatively mails for provision of electronic feedback will be provided as well.

12.5 Resources and Responsibilities

Sosian Energy will have the overall responsibility for stakeholder consultation and involvement. The proposed staffing complement from the ESIA Management framework is presented in Figure 1 below.

12.5.1 Staff

The staffing for the stakeholder engagement will comprise the Community Liaison Officer and the Project Management Team

12.5.2 Community Liaison Unit

The head of the Community Liaison office is the Community Liaison Senior Officer (CLSO). CLSO will report to the Operations Manager with duties including but are not limited to:

a) Management of the Community Liaison Unit;
b) Management of all Community Liaison related tasks in the Information Centre;
c) Development of a Community Development Plan based on mitigations proposed in ESIA Package;
d) Implement community engagement strategy and oversee all community liaison related matters;
e) Management of the grievance mechanism set up for the project-affected areas;
f) Oversight of implementation and monitoring of Community Development Plan;
g) Establishment of a monitoring and evaluation plan and other 'tools' established such as the grievance register, commitment register and consultation register;
h) Provision of reports to Senior Management for onward submittal to the internal CSR monitoring.

12.5.3 Community Liaison Officer (CLO)

Reporting to the Community Liaison Senior Officer, duties will involve but are not limited to:

a) Performance of community engagement. Incorporated in this, Coordinate the Company's response to all issues related to the grievance mechanism set up by the Company;
b) Provision of liaison between Community Development Programme measures and implementing partners (e.g., NGOs);
c) Management of emerging community matters;
d) Monitoring and evaluation to track progress of implementation of mitigation measures and assess if progress and performance of mitigation actions being undertaken by the Company to ensure objectives are met.
e) Liaison with the appropriate company personnel to ensure that grievances are tracked, reported and responded to accordingly as necessary.

12.6 Stakeholder Engagement Tools and Materials

12.6.1 Grievance mechanism

This is a Complaint and Grievance Procedure that provides a mechanism for communities and affected parties to raise complaints and grievances and allow the project to respond to and resolve the issues in an appropriate manner. A register has been developed to record all grievances reported to the CLOs.

12.6.2 Commitment Register

This register is in use to record any public commitments made by the Project or public concerns raised about the Project that require action. This register is in addition to the stakeholder register.

12.6.3 Engagement Notes Format

To ensure that an accurate and detailed record of information and views are gathered at every stakeholder meeting, a consultation meeting note will be written up. Prior to all consultations, responsibility shall be appointed to one member of the project team to take detailed notes and write up these notes immediately after the consultation using the Consultation Note format.

12.7 Monitoring, Evaluation and Reporting

Monitoring of the stakeholder engagement process allows the efficacy of the process to be evaluated. Specifically, by identifying key performance indicators that reflect the objectives of the SEP and the specific actions and timings, it is possible to both monitor and evaluate the process undertaken.

Two distinct but related monitoring activities in terms of timing will be implemented:

- During the engagement activities: short-term monitoring to allow for adjustments/improvements to be made during engagement; and
- Following completion of all engagement activities: review of outputs at the end of engagement to evaluate the effectiveness of the SEP as implemented.

A series of key performance indicators for each stakeholder engagement stage have been developed. The Table below shows the indicators, and performance against the indicators will show successful completion of engagement tasks.

Table 12.1: Key Performance Indicators by Project phase

Project Phase	Activity	Indicator
Planning for construction ESIA Implementation	Share updates on project activities	Bill Boards displayed in allocated locations by time specified; Affected community stakeholders, with at least 30% women, have received and understand the ESIA information disclosed and attended the public meetings; Communities provided feedback; No complaints about non-receipt of materials received.
?	Confirmation that tasks are defined as specific individual or grouped environmental and social clauses in contract bid documents.	Contract Manager to draw on ESIA/SEP for bidding documents
?	Confirmation that environmental management criteria are included as part of the contractor selection process, including their experience preparing and implementing ESMPs, etc.	Contract Manager to draw on ESIA/SEP for Contractor selection process
	A safeguards advisor located and retained as an advisor by the PMU, providing assistance with ESMP implementation, contractor briefing on habitat protection, contractor ESMP supervision (including observations during construction), and participation in community consultation	PMU safeguard strengthening
	Compliance monitoring checklists prepared and being used by the contractor and safeguards consultant and due diligence notes, completed as defined in the ESMP, and making the notes available in an easily accessible file for the contractor, Technical Coordinator, PMU Project Manager and others to use.	ESIA/SEP to guide management and monitoring processes

The engagement activities conducted; levels of stakeholder involvement; the issues discussed and outcomes; and the extent to which stakeholder issues, priorities and concerns are reflected in the ESIA Report, particularly with respect to mitigation and monitoring strategies contained in the Environmental Management Plan.

Sosian Energy will maintain a database and activity file detailing all public consultation, disclosure information and grievances collected throughout the project, which will be available for public review on request.

Stakeholder engagement will be periodically evaluated by senior management of Sosian Energy, assisted by the CLSO/Community Liaison Senior Officer. The following indicators will be used for evaluation:

a) Level of understanding of the project stakeholders;
b) Annual grievances received and how they have been addressed; and,
c) Level of involvement of affected people in committees and joint activities and in the project itself.

In order to measure these indicators, the following data will be used:

a) Issues and management responses linked to minutes of meetings;
b) Monthly reports;
c) Feedback from primary stakeholder groups (through interviews with sample of affected people);
d) Commitment and concerns register and Grievance register.

Adherence to the following characteristics/commitments/activities will assist in achieving successful engagement:

- Sufficient resources to undertake the engagement;
- Inclusivity (inclusion of key groups) of interactions with stakeholders;
- Promotion of stakeholder involvement;
- Clearly defined approaches; and
- Transparency in all activities.

12.8 Grievance Management and Comment Response

12.8. 1 Objective

A concern or complaint raised by an individual or group affected by Sosian Energy exploration, construction or operational activities can result from either real or perceived impacts of a company's operations, and may be filed in the same manner and handled with the same procedure.

The objective of grievance management will be to:

a) provide stakeholders with a clear process for providing comment and raising grievances;
b) allow stakeholders the opportunity to raise comments/concerns anonymously through using the community suggestion boxes to communicate;
c) structure and manage the handling of comments, responses and grievances, and allow monitoring of effectiveness of the mechanism; and
d) ensure that comments, responses and grievances are handled in a fair and transparent manner, in line with Sosian Energy's internal policies, international best practice and lender expectations.

CHAPTER 13: CONCLUSION AND RECOMMENDATIONS

13.1 Expansion in geothermal resource harnessing in line with the national energy policy

The current electricity demand is over 1,600 MW while the effective installed capacity is 1,429 MW. The peak load is about 2,500MW in 2018 and projected to grow to 2,600-3600 MW by 2020 compared to a demand of eventually 5,000 MW. Electricity access is low despite the ambitious target to increase electricity connectivity from the current 15% to at least 65% by the year 2022. Under ideal circumstances, the country has the potential to generate more than 10,000 megawatts of geothermal energy. This is due the fact Kenya has a long-term development strategy, Vision 2030, whose aim is to drive the country into a globally competitive and prosperous low-carbon economy with high quality of life.

Nearly 15% of Kenyans still lack access to modern energy services, which impedes development efforts. The government has set an ambitious goal of universal access by 2020. Kenya has pushed hard to harness its geothermal capabilities. The rise of Kenya's geothermal industry. It ranks eighth in the world in geothermal energy production. It generated 45 MW of power with geothermal energy in 1985 and now generates about 865 MW; nearly 600 MW of that production has come online since 2014. The expansion to existing geothermal operations offers the least cost, environmentally clean source of energy (green) and highest potential to the country.

13.2 Adequacy of project land

The current project site is sufficient to host the geothermal power plant without any additional land. In case there will be any need that can be sourced on a willing seller-willing buyer status.

13.3 Resource potential ascertained

Launched over 50 years ago, geothermal energy has emerged as a significant electric power resource for Kenya. Assessments of geothermal hotspots indicate an estimated potential of 7,000–10,000 megawatts (MW) in the Kenyan Rift Valley and perhaps locally elsewhere in the country. Geothermal energy is an indigenous, environmentally attractive and proven energy resource. Direct uses of geothermal energy include eco-tourism (hot baths and spas), small-scale liquid and dry milk processing (pasteurisation, etc.) and agriculture (greenhouses, crop drying). Indirect uses of geothermal energy arise mainly through electricity production.

Unlike hydroelectric power, geothermal energy is immune to the adverse effects of climate change. This enhances its value as base load electricity. Geothermal energy does not have the adverse environmental effects unlike coal, diesel or gas-fired generation. Through geothermal electricity generation valuable CO_2 credits can be earned through CDM thus reducing overall cost while protecting Kenya's environment.

13.4 Entire resource area situated in private land

The geothermal prospecting license License No. 8/2017 covering a concession area Makongeni/Menengai north and north-west of the Menengai Caldera of about 9.8km^2 in Nakuru County is in private land.

13.5 Less overall activity impact

Although geothermal development generally have a host of negative impacts on people and the environment, the project has few negative impacts than any other project site considered in the recent review. The negative impacts such as emissions, dust and noise can be mitigated on the basis of scientific experience and improved technology.

13.6 Less labour force

The shift of work force will ensure that that are no large settlements of labour lines on the project site. The aim is to ensure that the area is made conducive for educational tours and tourism.

13.7 Less investment in infrastructural development in-terms of communication and labour camps

Most materials used to road improvement will be obtained locally avoiding long haulage of borrow materials outside the site.

13.8 Reduction of CO_2 emissions

Geothermal plants are environmentally friendly and mitigate against CO_2 that is responsible for global warming and climate change.

13.9 Management Commitment

Sosian Energy Ltd will formulate these Guidelines as a commitment to good international industry practice:

a) Environmental, Health and Safety Policy", which is communicated to every employee joining the Company, is implemented by managers and supervisors, at all levels, and is available to the public.
b) Safety Manual for Plant Operation and Maintenance, which is available to Plant Operators.
c) A designated Health and Safety Officer and a Health and Safety Committee.
d) A designated Environmental Officer who has gone for training and updating of skills
e) Full implementation of the current Environmental Management on a continuous basis including monitoring and taking appropriate corrective action.
f) The Environmental Health and Safety Committee members undergo training to upgrade skills to a level that they can train other workers on fire, health and safety issues.
g) First Aid kits and fire extinguishers should be placed at strategic places around the plant for rapid response to emergencies.

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APPENDICES

Appendix 1: Terms of Reference

TERMS OF REFERENCE

About Sosian Energy Limited

Sosian Energy Limited (SEL) was granted a Geothermal Resources License No. 8/2017 by the Ministry of Energy for exploration and development of the geothermal resources in the area north of Menengai caldera in the area also known as "Sosian Energy Makongeni/Menengai Geothermal Prospect". Sosian Energy Limited is a renewable energy development company with interest in geothermal, wind, and solar energy production. Sosian Energy Limited is desirous in developing the concession for 70 MWe out of the possible 140 MWe in line with the geothermal resources license. The geothermal resource license requires the developer to explore and develop the prospect for up to 140 MWe. The project development will start with detailed technical review of the available information then followed up with identification of gaps for infill studies that would lead to start of drilling of deep exploration wells by 2021. The concession measures about 10km^2.

Sosian Energy Makongeni/Menengai Geothermal Prospect

The area known as Sosian Energy Makongeni/Menengai Geothermal Prospect covers the area due north and north-west of the Menengai Caldera. The prospect lies outside of the caldera wall and extends to the upper slopes of the Ol'rongai hills and is part of the Greater Menengai Geothermal area (Figure 2).

The prospect lies just outside of the Menengai caldera and within the area traversed by the NW trending tectono-volcanic axis which has also been variously referred to as Molo TVA (Figure 2). The license area covers the area of large farms for which wheat cultivation and dairy farming are the main agricultural activity.

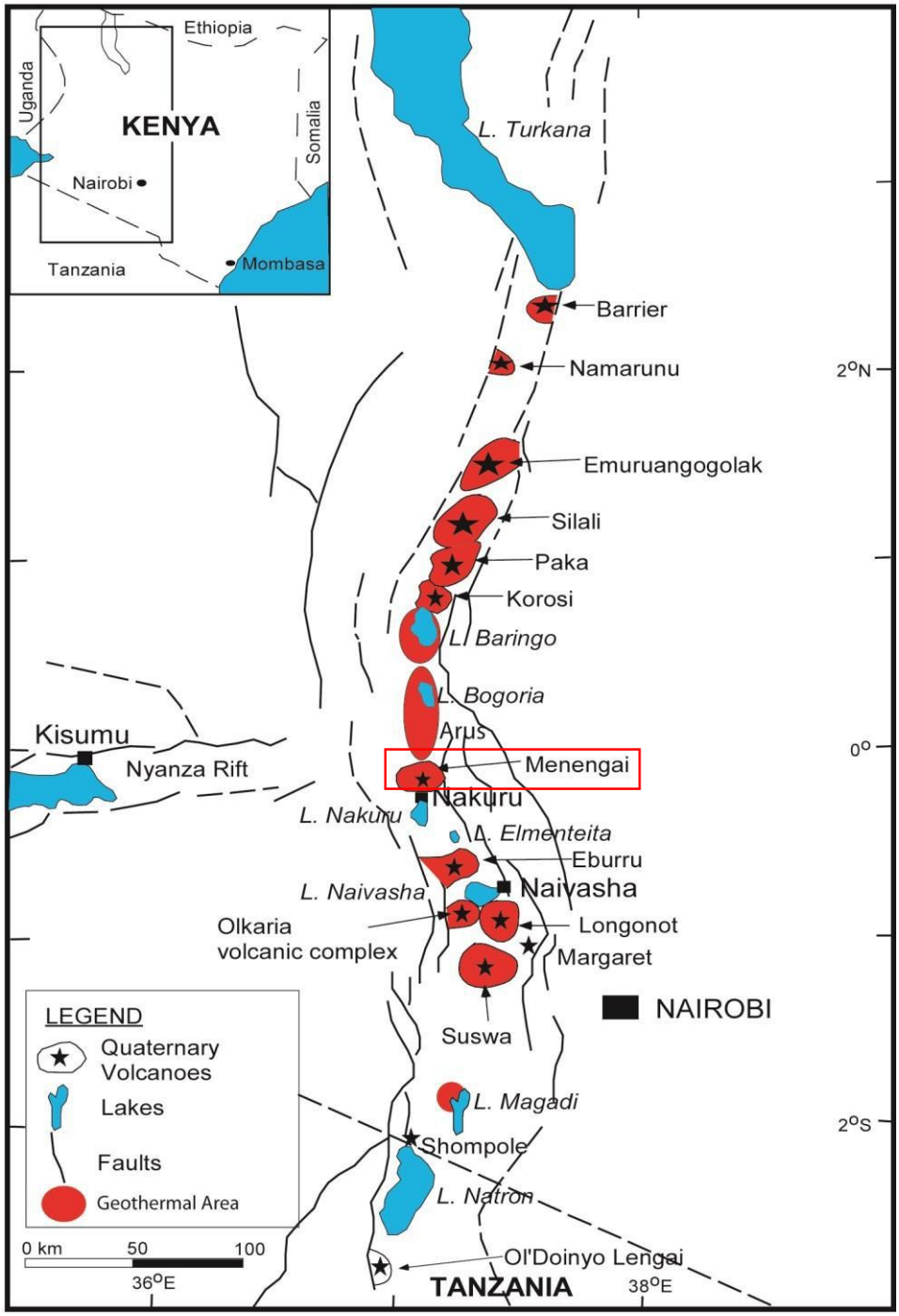
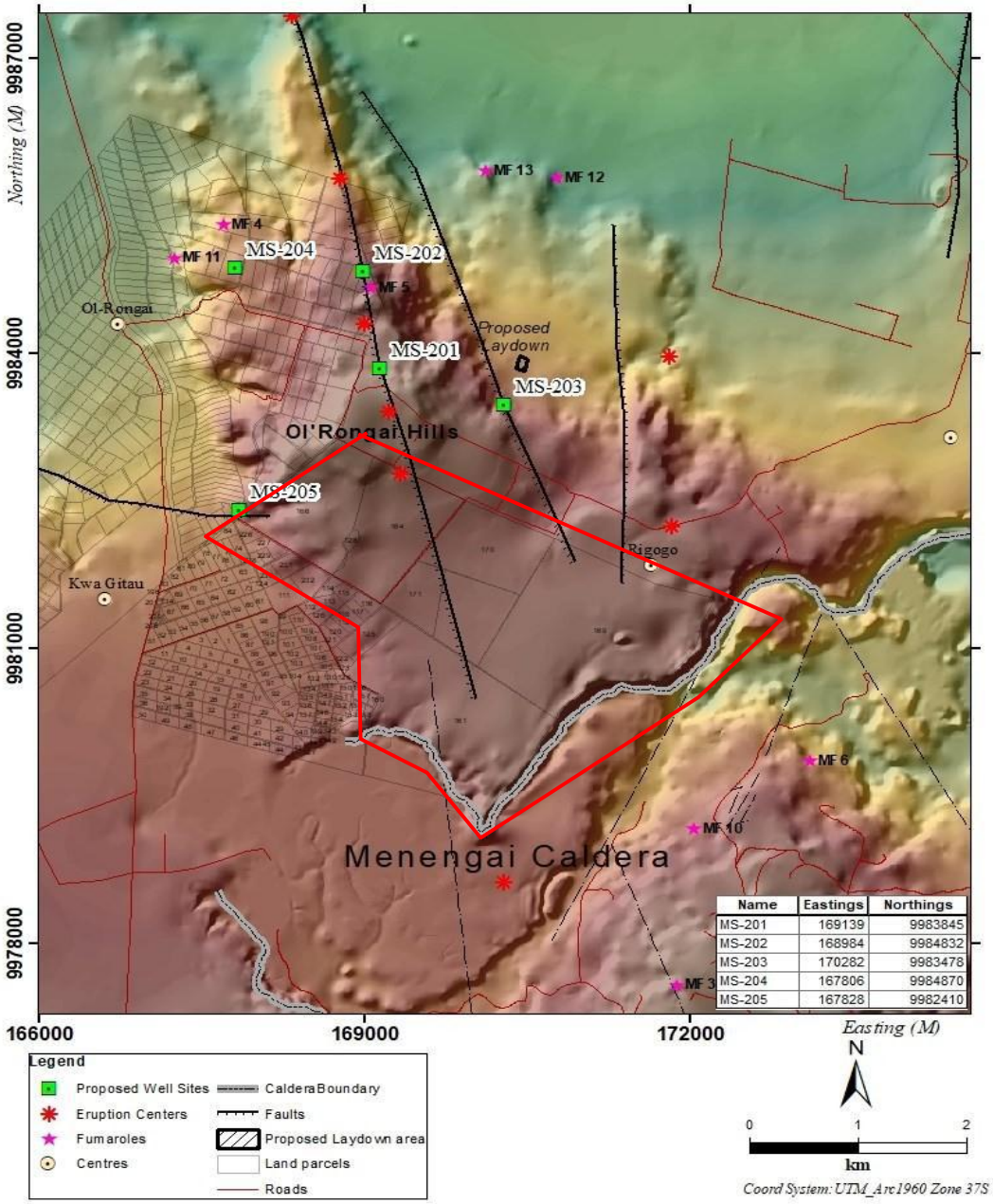


Figure 1: Map showing the location of Greater Menengai Geothermal area.

Figure 2: Map showing land use of the area around and within the prospect. The prospect boundary is shown by the red polygon.



2. ESIA Study Objectives and EMP for TGH and exploration drilling

The objectives of ESIA scoping are to:

1. Carry out baseline information on the biophysical and social characteristics of the project areas to reflect the current status.

2. Identify and assess compliance of project activities with relevant statutory and internal requirements. The key ones being:

a) National Legislative and Regulatory framework
b) International Legislative and regulatory framework
c) Multilateral Financing institutions (KfW, AFD, World Bank, IFC, AfDB, AUC-GRMF, etc.).

3. Describe and scope potential environmental, ecological and social impacts of drilling of exploration wells and associated infrastructure.

4. Carry out public consultation & disclosure; develop and implement stakeholder engagement plans (SEP) & Community Development Plans**5.** Identify measures for mitigating negative impacts of the project associated with drilling of geothermal exploration wells and thermal gradient holes (TGH).

6. Developing Land Acquisition & Compensation Plan (LACP), for drilling sites if required.

7. Develop a detailed and up to date Environmental and social Management Plan and mitigation plan including cost of mitigation measures for exploration drilling.

8. Establish mechanisms for monitoring and evaluating compliance and time frame for implementing such measures.

3. Scope of ESIA Study

1. Concise description of the project, its geographic, ecological, general layout including maps at appropriate scale where necessary.

2. Carry out Baseline data collection on the environmental and social characteristics of the existing situation in the Sosian Energy Makongeni/Menengai Geothermal Prospect. This description involves; 1) Physical environment (topography, geology climate and meteorology, air quality, hydrology etc.,

2) Biological environment (i.e., fauna & flora types and diversity, endangered species, sensitive habitats etc.3) Social and cultural environment, including present and projected, where appropriate (i.e., population, land use, planned development activities, community structure, employment and labour market, sources and distribution of income, cultural properties.

3. Identification and description of the pertinent regulations and standards governing the environmental quality, health and safety, protection of sensitive areas, land use control at the national and local levels and ecological and socio-economic issues. The key ones beings:

- KfW Development Bank Sustainability Guidelines/Standards 2014
- IFC Performance Standards 2012
  • IFC General Guideline on Environment, Health and Safety 2007
- IFC Environment, Health and Safety for Geothermal Power Generation 2007

4. Analysis and description of all, both positive and negative, significant environmental, ecological and social impacts brought about by the project.

5. Analysis and description of all occupational health and safety concerns brought about by the operations of the drilling. Recommendations shall be made on corrective and remedial measures to be implemented under the Environmental and Social Risk Management Plan.

6. Environmental and Social Risk Management Plan: A monitoring plan with specific description, and technical details, of monitoring measures, including the parameters to be measured, methods to be used, sampling locations, frequency of measurements, and definition of thresholds that will signal the need for corrective actions as well as deliver monitoring and reporting procedures.

3.1 Task Assignment

The consultant is expected to undertake investigations on conservation of natural resources, social aspects, economic activities, historical and anthropological heritages, public consultations and disclosures. The proposed geothermal wells drilling and associated infrastructural development plan will be provided to give a guideline of the facilities to be studied. The scope of services to be undertaken by the consultant shall include the following:

3.1.1 Task 1: Detailed Desktop Review

The consultant is to review all existing documentation, and previous ESIA reports related to geothermal wells drilling and power plants. They shall further undertake a detailed study of the proposed geothermal wells drilling at the Sosian Energy Makongeni/Menengai geothermal prospect. The consultant shall then concisely describe the project location including its geographical, ecological and the general layout of associated infrastructure including maps at appropriate scale where necessary.

3.1.2 Task 2: Description of the Baseline Environment

The Consultant is required to collect, collate and present baseline information on the environmental characteristics of the proposed project site. This description should involve but not limited to:

- Physical environment (topography, land cover, geology, climate and meteorology, air quality, hydrology, etc.
- Biological environment (i.e. flora and fauna types and diversity, endangered species, sensitive habitats etc.)
- Social and cultural environment, including present and projected. Where appropriate i.e. population, land use, planned development activities, community social structure, employment and labour market, sources and distribution of income, cultural/religious sites and properties, vulnerable groups and indigenous populations etc.).
- Economic activities i.e. agriculture, livestock, small scale industries etc.

3.1.3 Task 3: Legislative and Regulatory Framework

The Consultant shall identify and describe the pertinent regulations and standards -both local and international, governing the environmental quality, health and safety, protection of sensitive areas, land use control at the national and local levels and ecological and socioeconomic issues. Thereafter, the Consultant shall identify the project activities that should comply with the identified regulations.

Special emphasis should be given to:

i. IFC Environmental and Social Performance Standards (PS) including:

i) PS1: Social and Environmental Assessment and Management Systems
j) PS2: Labor and Working Conditions and ILO Core Labour Standards
k) PS3: Pollution Prevention and Abatement
l) PS4: Community Health, Safety and Security
m) PS5: Land Acquisition and Involuntary Resettlement
n) PS6: Biodiversity Conservation and Sustainable Natural Resource Management
o) PS7: Indigenous Peoples
p) PS8: Cultural Heritage

ii. World Bank Group's Environmental and Health and Safety Guidelines including:

d) General EHS Guidelines
e) EHS Guidelines for Geothermal Power Generation
f) World Bank Safeguard Policies

3.1.4 Task 4: Scoping of Impacts of Project Facilities and Activities

From the detailed field study, the Consultant shall analyze and describe all significant changes brought about by each facility/activity. These would encompass environmental, ecological and social impacts, both positive and negative, as result of each facility/activity intervention that are likely to bring about changes in the baseline environmental and social conditions discussed in Task 2. The Consultant will make a prioritization of all concerns identified and differentiate between short, medium, long-term and cumulative impacts during construction, operation and decommissioning. The Consultant shall also identify both temporary and permanent impacts. A detailed outline and discussion of specific conditions that might affect the environment which are unique to the type of facility and/or operation being audited should be provided.

3.1.5 Task 5: Occupational Health and Safety Concerns

The Consultant shall analyze and describe all occupational health and safety concerns brought about by activities during the phases of the project. The Consultant shall make recommendations on corrective and remedial measures to be implemented under the environmental management plan.

3.1.6 Task 6: Environmental and Social Management Plan for drilling of TGH

The Consultant shall develop a comprehensive environmental management plan. The plan should recommend a set of mitigation, monitoring and institutional measures to eliminate, minimize or reduce to acceptable levels of adverse environmental impacts and/or maximize socio –economic benefits. The Consultant should provide cost outlays for the proposed mitigation measures as well as their institutional and financial support, time frame and responsibility. This shall be provided for all phases of the project.

3.1.7 Task 7: Development of Land Acquisition & Compensation Plans (LACP) and Resettlement Action Plan (RAP)

The consultant shall undertake a socio-economic survey of the communities surrounding the proposed project.

- Conduct a census of the affected persons and identification of vulnerable groups and indigenous populations.
- Develop an eligibility criteria and establishment of a cut-off date for LACP.
- Evaluate and prepare an inventory of the affected properties.
- Evaluate all other socio-economic costs.
- Conduct public consultations/awareness creation of the relevant stakeholders, taking into consideration the gender concerns and vulnerable groups.
- Identification of alternative sites, to the affected land parcels.
- Develop adequate livelihood restoration mechanisms.
- Prepare the LACP implementation costs.
- Preparation of an implementation schedule.
- Develop a monitoring and evaluation methodology.
- Consider the relevant legal provisions for land acquisition and resettlement during preparation of an appropriate Land Acquisition & Compensation Plans (LACP) and resettlement action plan.
- Prepare and submit a detailed Land Acquisition & Compensation Plans (LACP) and
- Resettlement Action Plan (RAP).
- Develop a conflic resolution mechanism.

3.1.8 Task 8: Development of Monitoring Plan

The Consultant is required to give a specific description, and technical details, of monitoring measures for both ESMP and RAP, including the parameters to be measured, methods to be used, sampling locations, frequency of measurements, definition of thresholds that will signal the need for corrective actions as well as deliver a monitoring and reporting procedure. The consultant should provide a time frame and implementation mechanism, staffing requirements, training and cost outlays.

3.1.9 Task 9: Comparison

The consultant shall undertake a comparison of all the project alternatives including location, technology etc.

3.1.10 Task l0: Study Reports

The output will be an Environmental and Social Impact Assessment report for thermal gradient wells and full exploration wells and a Resettlement Action Plan (RAP)/ Land Acquisition & Compensation Plans (LACP) prepared in accordance with the regulatory provisions. The report shall be in English Language and has to be clear and concise. The reports should be in a format

acceptable to local competent authorities, international environmental standards and development partners. The consultant shall present the reports to the National Environment Management Authority (NEMA) for approval in the required number of copies.

3.1.11Task 11: ESIA Update Report Presentation and Peer Review

The consultant is required to present the draft report which may be subject to a peer review. In the event that any rectification is to be made on the report, the consultant will bear any applicable costs.

3.1.12 Task 12: Approval

The Consultant shall present the report prepared under Task 10 for approval by the relevant authorities. The Consultant shall be responsible for making any modifications that the authorities may demand before approval of the report.

3.1.13 Task 13. Counterpart Staff

The client will not provide counterpart part for this assignment.

4.0 DETAILED STUDY DESCRIPTION

This being a category one project, the consultants will conduct a comprehensive Environmental and Social Impact Assessment (ESIA) exercise. In addition the Consultant shall prepare a separate Environmental and Social Management Plan for the TGH and exploration wells (ESMP) and a Land Acquisition & Compensation Plans (LACP) in accordance with National and Multinational Donor Environmental and Social Assessment Procedures and policies on Involuntary Resettlement. The Consultant will be responsible for gathering, reviewing and analyzing all necessary data and information. Where these are insufficient, the Consultant shall make all practical efforts to produce the missing information/data including professional estimates and predictions based on the most likely conditions at the project area, reliable information and data from similar situations and conditions, etc.

The Consultant shall characterize the extent and quality of available data and describe the key-data gaps, the uncertainties associated with estimates, predictions, and data used from similar situations. The methods proposed for accommodating these gaps and uncertainties in a subsequent ESIA should be well stated and presented by the consultant. When estimated values are used in place of data, the consultant will be required to provide the uncertainty limits associated with these values and perform an appropriate sensitivity analysis.

The work will also include thorough consultations and meetings with all parties concerned (affected population or their representatives; county and national authorities; representatives of the scientific community; NGOs; etc,); in strict accordance with the requirements of the government of Kenya and multinational donor policies and procedures.

The consultant will be responsible to review and update the following tasks:

Main Tasks

The consultant will provide an inception report that will include a detailed work plan:

- Examine all aspects of the Project and produce an inception report which will review the tasks to be carried out and agree with the client on any modifications and additions that may be required.
- Prepare a detailed work plan indicating schedules and inputs required to complete the tasks. During this inception period the consultant will carry out a scoping exercise that will provide the basis for the final report and detailed work plan.
- Prepare a public consultation and disclosure plan.

4.1 Detailed Tasks

4.1.1 Provide Description of the Proposed Project

The consultant will provide a brief description of the Project including maps (at appropriate scales) where necessary.

4.1.2 Public Consultation Process

The consultant will:

- Identify all affected people (e.g. people affected by construction activities and during operation) and will facilitate dissemination of information to relevant authorities and Interested and Affected Parties (IAPs) concerning the proposed project NGOs and government departments and agencies that may have a stake in the Project and its effects should be consulted.
- Prepare a Stakeholder Consultation Plan, providing an opportunity for the relevant authorities and IAPs to raise issues and concerns pertaining to the proposed geothermal wells drilling and allow the identification of the additional alternatives and recommendations. Describe a schedule for public consultation with these different groups, including number and timing of public input. Methods to be employed e.g. media announcements, questionnaires, one on one meetings, public steering committees should also be captured. Public consultation should occur, at least, during the inception and collection of baseline information, and at the draft report stage. An annex of ESIA should summarize the Public consultation process and the results of the consultation process.
- Gather more detailed information through which the study team could anticipate issues not raised by the IAPs that will be addressed by the Environmental Social Impact Assessment report.
- Focus the study on relevant issues and recommend specific investigations, such that the resulting ESIA is useful to decision makers and it addresses the concerns of IAPs.

4.1.3 Legal and Administrative Framework

- Describe the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, land use control etc., at international and national levels.
- Describe the current administrative arrangements for environmental regulation, enforcement and management in Kenya.
- Provide a general assessment of the government agencies involved in environmental and social management issues, to ensure that the EMP will be effectively implemented.

4.1.4 Description of the Environment/Project Setting

- Physical environment: geology, topography, soils, climate and meteorology; ground water and surface hydrology • Biological environment: flora; fauna; rare or endangered significant natural sites, etc.; species of commercial importance, and species with potential to become nuisances, vectors or dangerous
- Socio-cultural environment: (include both present and projected where appropriate); population affected (numbers and subsistence systems), land use where appropriate and property (including houses, crops/plants and other properties etc.); planned development activities; public health; cultural characteristics (including cultural property and heritage); and gender differentiation.
- Economic activities: livelihood; employment; gender composition. Some examples of the specific activities are: based on field surveys; identification of any species of special concern, namely species with conservation status or endemic to the area including birds; commentary on conservation status of specific species; compilation of a broad scale vegetation or habitat map of the area indicating the extent to which the proposed project can affect each vegetation or habitat type; description of current land use and compilation of a broad land use map.

4.1.5 ESIA Scoping Methodology

As a chapter of the ESIA report, the consultant will describe the methods used for conducting the ESIA (scoping and bounding, impact analysis and public consultation process, etc.). The consultant will include a public participation plan to include stakeholder identification process, stakeholders identified, stages within the ESIA process where stakeholders have participated, and the different levels of participation used. Identification of impacts will include the identification of the important environmental components, and selection criteria used for identifying the significant impacts (positive and negative) whenever possible. Significant levels may be determined through the application of a scoring system if the consultant feels that such an approach is warranted. The consultant will employ environmental economic analysis where applicable, particularly to justify significant impacts to be mitigated.

4.1.6 Potential Impacts of the Proposed Project

Using the collected baseline data and the system or monitoring and evaluation, the consultant will take a systematic approach to identification, mitigation and evaluation of all impacts and will identify potential changes which the proposed project may cause.

These would include, but not be limited to, changes in the following:

- Physical environment
- Biological environment.
- Socio-cultural environment.
- Economic activities.
- Employment opportunities.
- Safety issues, including (i) measures to assure safety of local residents in relation to geothermal development activities (ii) ensure that the safety and health concerns of permanent, temporary and migrant workers are addressed and (iii) an HIV, AIDS program for workers and affected communities.
- Construction phase impacts.
- Waste management for the entire project, including the work camps and construction sites.
- Traffic density, safety and dust control.
- Land acquisition and resettlement as per national and international guidelines.

The Consultant will analyze:

- Positive and negative impacts.
- Direct and indirect impacts, short term and long term.
- Impacts that are avoidable/unavoidable; reversible/irreversible.
- Pre-construction actions to avoid or minimize negative impacts.
- Construction and operational phase impacts.
- Cumulative impacts occurring as a consequence of other activities in the project area: existing activities, projects under construction or planned activities within a reasonable time frame.
- Impacts in critical and non-critical habitats.
- Identify the potential risk of the spread of HIV/AIDS and other sexually transmitted diseases during the construction period, and prepare a detailed plan for awareness and prevention including resource implications.

Wherever possible, the consultant will describe impacts quantitatively. In terms of environmental costs and benefits, and assign economic values when feasible. Impact analysis should be divided between construction and operation impacts.

4.1.7 Environmental and Social Management Plan

An Environmental and Social Management Plan (ESMP) for TGH that addresses the following aspects should be prepared:

• Activities and impacts: Predicted adverse environmental and social impacts (and any uncertainties about their effects) for which mitigation is necessary should be identified and summarized. Effective measures to prevent or reduce significant negative impacts to acceptable levels during (i) construction and (ii) operation.

Estimate the impacts and costs of those measures. Estimate the costs of any residual impacts. Another area of impacts that could contribute substantially are the cumulative effects of construction and operational phases of the Project. Most of these, if not all, can be avoided by following a set of best practices that the consultant will prepare.

- Description of implementation and monitoring program: Prepare a detailed arrangement (responsibilities) for implementing and for monitoring implementation of mitigation measures and the impacts of the project during construction and operation and maintenance. This will include a description of monitoring methodology, specific operations and features to be monitored, monitoring reporting relationships, and arrangements to ensure that monitoring is effective and leads to modifications where required to ensure minimal impact on the environment. Include in the plan an estimate of costs and description of other inputs such as training and institutional strengthening to ensure effective monitoring. An indication of what performance indicators to be used is to be provided.
- Institutional strengthening and training: Identification of institutional needs to implement environmental recommendations:

4.1.8 Land Acquisition & Compensation Plans (LACP)

The Consultant shall develop a LACP based on a door-to-door survey ("resettlement survey") for all expropriation operations and displacements of houses and businesses needed for the selected option.

The objective of the LACP is to ensure that the population to be expropriated or temporarily displaced by the project is formally consulted and adequately compensated and treated. Resettlement will not be envisaged at this stage of the project. Displaced and expropriated persons should be consulted and compensated for the losses at full replacement costs prior to the actual move. Secondly, they should be assisted in the move and supported during the transition period when their land is not available for their use. Thirdly, assistance should be provided in their efforts to improve on their former living standards or at the very least maintain them.In general, a LACP would include the following sections:

i. Executive Summary

This should include the statement of objectives, legal framework and main recommendations.

ii. Description of the Project

A general description and identification of the project area.

iii. Potential impacts

Should include identification of:

- The project component or activities that give rise to LACP
- The zone of impact of such activities.
- The alternatives considered to avoid or minimize resettlement; and
- The mechanisms established to minimize resettlement to the extent possible, during project implementation.

iv. Main objectives of the LACP program

Socio-economic survey

Findings of socio-economic studies to be conducted in the early stages of project preparation and with the involvement of potentially displaced people, including:

i. The results of a census survey covering:

a) The current occupants of the affected area to establish a basis for the design of the LACP program and to exclude subsequent inflows of people for eligibility for compensation and resettlement assistance.
b) Standard characteristics of displaced households.
c) The magnitude of the expected loss - total or partial – of assets, and the extent of displacement, physical or economic.
d) Information on vulnerable groups or persons, for whom special provisions may have to be made.
e) Provisions to update information on the displaced peoples livelihoods and standards of living at regular intervals.

ii. Other studies describing the following:

a) Land tenure and transfer systems, including an inventory of common property natural resources from which people derive their livelihoods and sustenance, non-title-based infrastructure systems, and any issues raised by different tenure systems in the project area.
b) The patterns of social interaction in the affected communities, including social networks and social support systems, and how they will be affected by the project.
c) Public infrastructure and social services that will be affected.
d) Social and cultural characteristics of displaced communities including a description of formal and informal institutions that may be relevant to the consultation strategy and to designing and implementing the LACP.

iii. Legal

a)) Land Acquisition & Compensation Plan (LACP)/Resettlement Action Plan
b) m) Executive Summary of Environmental and Social Impact Assessment Report
c) Final Report

6.0 TERMS OF ENGAGEMENT

i) The Consultant will be engaged for a one term contract. However, duration of site supervision will depend on the activities on site.
ii) The consultant will attend a kickoff/scoping meeting for the purpose of clarification and discussion of tasks and key business issues.
iii) The consultant will provide costing indicating task, resource person/expert, rate/day, duration in man-days, labour, etc.
iv) The consultant will provide his own accommodation and transport.

v) The consultant will provide a detailed work plan prior to beginning works which will be mutually agreed with the Client.
vi) Client will provide all drawings and designs of the proposed development.

7.0 Consultant's Skill and Experience

The firms submitting proposals should demonstrate that they can mobilize and deploy necessary skills necessary to undertake the tasks set out in this Terms of Reference. Each individual on the team must be personally available to do the work as and when required. The Lead Consultant will be held accountable, in terms of services and technical assistance or the contract, for ensuring project deliverables and for the professional conduct and integrity of the team.

Consultants will be selected upon demonstration of the technical evaluation criteria stipulated in clause 2.7.1

8.0 Time Schedule

The consultant should develop a project implementation timeline aligned to the scope of work indicating the detailed activities and assignment of key staff using the guideline below:

9.0 Clients Inputs

a. Office & Stationery

The Consultant is made aware that the provision of the following facilities/services will be its responsibility:

i) The provision of accommodation and equipment
ii) The provision of all vehicles and transport arrangements
Medical arrangements
iii) Ensuring of security of its staff during the field study
iv) Other support services as may be necessary
v) Insurance

b. Sosian Energy Limited Staff

Sosian Energy Limited will assign a Community Liaison staff to coordinate access and meetings as may be required by the consultant during the duration of the assignment including management of the SEP and implementation of the committee activities.

10.0 IMPROVEMENT OF TOR

The Consultant may offer suggestions and improvements in the Terms of Reference, which it considers would result in better implementation of the project. Such proposals if accepted will form part of the Terms of Reference of the proposals submitted by the consultant. The effect on time and cost estimates given under the above clauses.

Appendix II: Questionnaire

Household Number ……..
PART 1: EXISTING CONDITIONS
SECTION A:
DEMOGRAPHIC DATA
1. Name …….. 2. Age ……..
3. Sex ……..
4. Level of education …… 5. Number of wives ……..
6. Number of children ……...
SECTION B: LAND USE SYSTEM
1. When did you come here? …….
2. Type and number of animals kept Type Number …….. …….. …….. …….. …….. …….. …….. …….. ……..
3. Where do you get your water? ……. ……..
4. Do you practice farming? Yes ……. No …….
If yes, where? ……

SECTION C: ECONOMIC ACTIVITIES
1. What income generating activities are you involved in? …….. ……..
2. What is your total monthly income? ……
SECTION D: SOCIO-CULTURAL ACTIVITIES
1. What socio-cultural activities are you involved in? ……
2. What schools do your children go to? ……
3. Which hospitals do you go to? ……
4. Where do you your shopping? ……
PART 2: SOCIO-ECONOMIC IMPACT
1. How will drilling and construction affect your life? ……. …….
2. How will the expanding road network impact on your life?
……..
……..
3. How will the proposed project affect your livelihood in terms of
a. Water availability and quality …… ……
b. Livestock numbers and forage ……. …….
c. Health issues ……
d. Social interactions ……
e. Where they live and for how long ……...
f. Access to hospitals and schools ……
g. Job opportunities/employment ……
h. The number of children and wives ……
i. Income levels …….
j. General living standards …….

PART 3: MITIGATION

1. What do you recommend as solutions to the above problem (s) ……..
2. Who do you think should be involved in solving the above problems and to what extent? ……

Appendix III: Interview Schedule

1. Name of the organization ……..

2. Type of business ……

3. In your opinion, what the probable environmental and social economic impacts of the project on
a. The surrounding community and environment
…….
…….
…….
b. Your operations?
…….
…….
4. What are the solutions you propose and why?
……

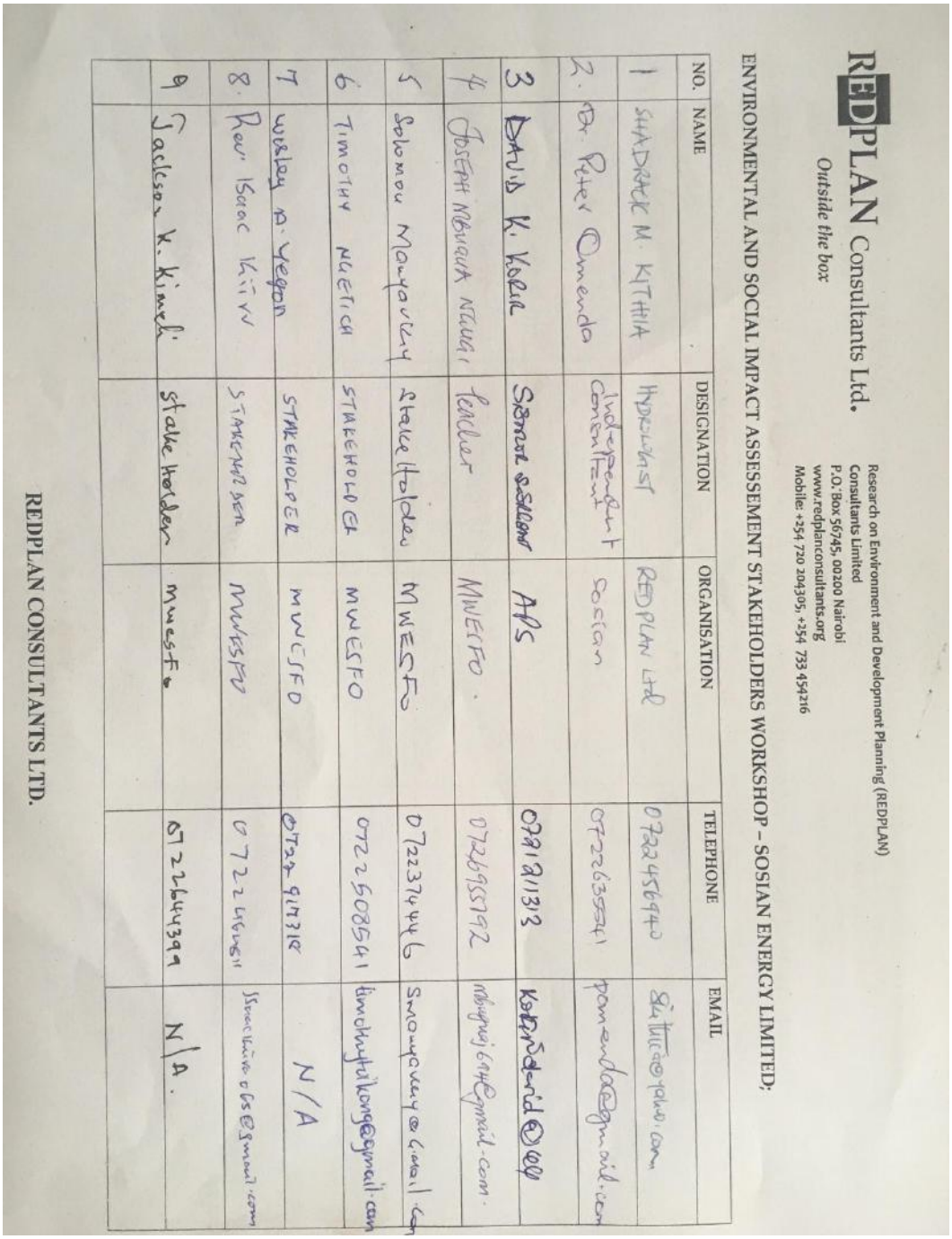
…….

[i] TGH indicate a potential geothermal resource over a large enough thermal anomaly to justify further drilling.

Appendix IV: Consultation with Senior Official

1. Dr. Peter Omunda – **Sosian Energy Consultant**
2. Dr. John Langat – **Regional Manager North Rift**
3. Dr. G. Watangula – **GDC**
4. Deputy Senior Warden – **KWS**
5. Mr. Nguruse, Regional Manager – **WRA**
6. Mr. A. Siasi – **County Director of Environmental**
7. Mr. Robert Mungai Nganga – **Resident of Menengai**
8. Moses Rotich – **Lead Engineer Sosian Energy**

Appendix V: List of Senior Officials



REDPLAN Consultants Ltd.
Outside the box

Research on Environment and Development Planning (REDPLAN)
Consultants Limited
P.O. Box 56745, 00200 Nairobi
www.redplanconsultants.org
Mobile: +254 720 204305, +254 733 454216

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSEMENT STAKEHOLDERS WORKSHOP – SOSIAN ENERGY LIMITED;

NO.	NAME	DESIGNATION	ORGANISATION	TELEPHONE	EMAIL
1	SHADRACK M. KITHIA	HYDROLOGIST	REDPLAN LTD	0722456940	Shkithia@yahoo.com
2.	Dr. Peter Omenda	Environment Consultant	Sosian	0722635541	pomenda@gmail.com
3	DAVID K. KORIR	Senior warden	KFS	0721211313	korirdavid@kfs.org
4	JOSEPH NDUNGU NJUGI	Teacher	MWESFO.	0726955792	ndungujoseph694@gmail.com
5	Solomon Manyanchy	Private Holder	MWESFO	0722374446	Smanyanchy@gmail.com
6	TIMOTHY NGETICH	STAKEHOLDER	MWESFO	0722508541	timchuyttikong@gmail.com
7	Wesley M. Yegon	STAKEHOLDER	MWESFO	0722 911218	N/A
8.	Rev. Isaac Kiiru	STAKEHOLDER	MWESFO	0722 [illegible]	[illegible]
9	Jackson K. Kimeli	stake holder	mwesfo	0722644396	N/A.

REDPLAN CONSULTANTS LTD.

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www.redplanconsultants.org
Mobile: +254 720 204305, +254 733 454216

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSEMENT STAKEHOLDERS WORKSHOP – SOSIAN ENERGY LIMITED;

NO.	NAME	DESIGNATION	ORGANISATION	TELEPHONE	EMAIL
1	Michael Langat	a farm.		0710546105.	
2	Ezekiel Komen	a farmer		0726003715	
3	Luka Tuikong		Tuluobmoi Comm.	0722347874	tuikongluka@gmail
4	Gabriel K. Gikonyo	Resident	Rigogo community	0721989080	None.
5	JAMES KITHOME	Resident ~~OL-RONGAI~~	OL-RONGAI	0703915513	Jmusyimiss@gmail
6	Mueni Joyce	Resident	OL-Rongai	0729886825	

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSEMENT STAKEHOLDERS WORKSHOP – SOSIAN ENERGY LIMITED;

NO.	NAME	DESIGNATION	ORGANISATION	TELEPHONE	EMAIL
	Ronnie Midigo	Consultant	REDPLAN	0721585729	ronniemidigo@gmail.com
	Dalmas Omia	"	"	0724234868	dalmas.ochieng@gmail.com
	Joseph K Koskei	RESIDENT		0715 723702	
	PATRICK MBUA	"		0723844217	—
	KANDIE DAVID	RESIDENT		0726587588	—
	ALEXANDER KENDA	RESIDENT		0722894252	

REDPLAN CONSULTANTS LTD.

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSEMENT STAKEHOLDERS WORKSHOP – SOSIAN ENERGY LIMITED

NO.	NAME	DESIGNATION	ORGANIZATION	TELEPHONE	EMAIL
1	SAMUEL GOR	RTM ~~WRA~~	WRA	0733991531	samuelgor360@gmail
2	FRANCIS ORIYO	ENV. Scientist	GDC	0722 941284	foriyo@gdc.co.ke
3.	Dr. Peter Omenda	Consultant	Sosian	0722635541	pomenda@gmail.com
4	Alice C Bett	Research scientist	Kws	0720144836	bettc@kws.go.ke

REDPLAN CONSULTANTS LTD.

Appendix VI: Minutes of the public meetings

MINUTES OF PUBLIC MEETING FOR THE PROPOSED SOSIAN ENERGY MAKONGENI/MENENGAI GEOTHERMAL PROJECT HELD AT DONNIES HOTEL ON 12TH JUNE, 2019

AGENDA

1. Opening Prayer
2. Introduction
3. Location and site of the project
4. Scooping Report
5. Presentation of the implementation time table
6. Discussion
7. Summary
8. Concluding Prayer

Present- Consultants

1. Prof. George Krhoda – Lead Consultanst
2. Dr. Dismas Ochieng – Sociologist/Anthropologist
3. Mr. Ammon Ojwang – Geophysicist
4. Ms. Valerie Akinyi – Lawyer
5. Dr. Shadrack M. Kithia – Hydrologist
6. Dr. Ronnie Midigo – Health Sociologist

Sosian Energy

Dr. Peter Omenda – Sosian Geothermal Consultants

Eng. Moses Korir – Project Engineer

Minute 1/12/2019: Preliminaries

The meeting started with a word of Prayer

Introductions: Prof. Krhoda started by welcoming participants and introduced the Consulting Team. He then invited Mr. Moses Korir, the Project Engineer to introduce the Company representatives.

Prof. Krhoda proceeded to present the purpose of the meeting.

a) Inform and create awareness on the project
b) To share project background
c) To seek community stakeholder support, goodwill and ownership.
d) Exchange knowledge, data and information on the project.

The participants self-introduced themselves and the respective organisations that they come from. Prof. Krhoda urged all participants to be free to share since the meeting is an open sharing forum. At this point Prof. Krhoda invited Sosian Engineer and Consultants to brief participants on the project details.

Min. 2/12/2019: The Company, location and site of the project

Engineer Korir welcomed the participants once again and proceeded to elaborate on the company details, how the company has been involved in other energy projects and now would like to invest in geothermal power generation. He added that Sosian Energy Limited (SEL) was granted a Geothermal Resources License No. 8/2017 by the Ministry of Energy for exploration and development of the geothermal resources in the area north of Menengai caldera in the area.. The project is on a private land of about 9.8km2. Sosian Energy Limited is a renewable energy development company with interest in geothermal, wind, and solar energy production.

Dr. Omenda proceeded to share the details of geothermal occurrence in the Rift Valley region and the great potential it has to produce clean energy and as a result lift the standard of living of the local people, the County and the country in general. Geothermal Prospect covers the area due north and north-west of the Menengai Caldera, The prospect lies outside of the caldera wall and extends to the upper slopes of the Ol'rongai hills and is part of the Greater Menengai Geothermal area. The expected power generation according to the concession is for 70 MWe out of the possible 140 MWe in line with the geothermal resources license, but further investigations will need to be carried out before the company can determine exactly the amount of possible power production there. He explained further that geothermal power is a fairly clean sources of electricity compared to other sources and to other various uses.

Min.3/12/2019: Scooping Report

Prof. Krhoda shared preliminary information collected form the documents regarding pernitent issues surrounding geothermal power development and experiences from the current installations and the expertise in the country. He added that participants should help the consultants to capture their views and opinions and if any views should come out after this meeting they should be addressed to the Consultants who shared their phone numbers and address.

He then invited Mr. Ammon, Dr. Ojwang, Dr. Kithis to take participants alond sone of the challenges and known solutions.

Min. 3/12/2019: Community Representatives' Concerns

The participants raised some issues perceived to be potentially harmful and social-related challenges with the Consulting Team and Sosian Engineer. Questions and answer or comments.

Some community members had had some workshops and meeting regarding geothermal development in the area and had taken tours to Ol Karia before. There is good understanding of potential environmental impacts of proposed project. The participants raised the following issues on question and answer format:

1. **Question:** Will there be compulsory acquisition of land from the community and will the community be compensated?

Response: The project does not envisage displacement from land at the moment, neither is it possible through compulsory acquisition. The community will needed an assurance that the project will not require take their private land or acquire any.

2. **Question:** Previously, the community was promised employment especially for the youth. This has not been forthcoming, now in its fourth year. What is the guarantee that there will be employment for the youth?

   Respnse: People in the area are in need of employment opportunities and the company will ensure that non-skilled labour is sources from the locality. However there are skilled jobs that must be competitively be sources from a wider catchment, even nationally. The company sought consultqnts from Italy because these are very specialized jobs..

3. **Question:** Geothermal development has several environmental and health hazards such as pollution, air quality, noise, dust, and many others, impacting structure of dwellings, roads, and water pollution. People have fears that toxic substances that will effect environmental quality may be used. What measures will Sosian take to deal with such hazards?

   Response: Adequacy of the construction of the houses, vibrations from blasting will be managed, road construction will be done with much care and only during the day, road safety for children and the community in general will be controlled according the NTSA requirements. The project will ensure that any substances that may impact on human and animal health is managed, controlled and restricted as required by law.

4. **Question:** Geothermal power operations are is 'noisy' and we have had some experience in the past.

   Response: The stakeholders are unaware that magnitude of disturbance that might emanate from the use of heavy machinery and this is dependent on technology to be used.

5. **Question:** There is a feeling that if the project goes ahead the air quality may be affected. Dust and gaseous emissions will also common.

   Response: Currently there are methods of controlling gaseous emission through re-injection of fluids beck into the hole. Additionally it is known that hydrogen sulphide may be dangerous in high proportions. Working with government regulators and international collaboration, Sosian will ensure that the lives of Kenyans are not endangered**.**

6. **Question:** There has been danger of geothermal fluids escaping into groundwater and affecting water quality. We also know that geothermal drilling uses a lot of water thus threatening the water quantity. Recognising that there is shortage or limited water supply within the sub county, how will Sosian Company augment its water demand?

   Response: Pollution of ground water is limited because all the geothermal holes are tightly cased to remove any chance of geothermal fluid mingling with groundwater. It will be recommended that Sosian company finds their own source of water to avoid competing with the community over limited resources, and after use of these sources for drilling, they can be handed over to the community for their use

7. **Question:** How will the company deal with the wildlife corridor to avoid human-wildlife conflicts in the area?
   Response: We are not aware of any wildlife corridor because the project site in its entirety is within the farmland. The basis of the allegation may have been for the geothermal project within the caldera itself. Further investigation will be done to find the truth about the matter.

Min.4/17/2019: Schedule of implementation

The Consultants provided a schedule for the project implementation with a caveat that there will be further investigation to proven adequacy of the source.

Min.4/12/2019: Schedule of implementation

The Consultants provided a schedule for the project implementation with a caveat that there will be further investigation to proven adequacy of the source.

Min. 5/12/2019: Way Forward

Prof. Krhoda said the following:

1. Government Department have been requested to support private investments, especially in power generation since there is power shortage to meet the Big 4 Agenda;
2. Currently there is no need for acquisition of any additional land;
3. Social marketing of this project will be taken seriously;
4. Experts should be broadly involved and community representatives to ensure project ownership and sustainability.
5. All stakeholders including political leaders should be involved as this is their project and the benefits will first be towards the local community according to the Mining Act.
6. There will be equitable benefit sharing.

The meeting closed with a word of prayer from one of the participants.

Appendix VII: Minutes of the public meetings

MINUTES OF PUBLIC MEETING FOR THE PROPOSED SOSIAN ENERGY MAKONGENI/MENENGAI GEOTHERMAL PROJECT HELD AT A.IC. TULOBMOI SECONDARY SCHOOL ON 21ST JUNE, 2019

AGENDA

1. Opening Prayer
2. Introduction
3. Location and site of the project
4. Scooping Report
5. Presentation of the implementation time table
6. Discussion
7. Summary
8. Closing Prayer

Present- Consultants

7. Prof. George Krhoda – Lead Consultanst
8. Dr. Dismas Ochieng – Sociologist/Anthropologist
9. Mr. Ammon Ojwang – Geophysicist
10. Ms. Valerie Akinyi – Lawyer
11. Dr. Shadrack M. Kithia – Hydrologist
12. Dr. Ronnie Midigo – Health Sociologist

Sosian Energy

Dr. Peter Omenda – Sosian Geothermal Consultants

Eng. Moses Korir – Project Engineer

Minute 1/27/2019: Preliminaries

The meeting started with a word of Prayer

Introductions: Prof. Krhoda started by welcoming participants and introduced the Consulting Team. He then invited Mr. Moses Korir, the Project Engineer to introduce the Company representatives.

Prof. Krhoda proceeded to present the purpose of the meeting.

e) Inform and create awareness on the project
f) To share project background
g) To seek community stakeholder support, goodwill and ownership.
h) Exchange knowledge, data and information on the project.

The participants self-introduced themselves and the respective organisations that they come from. Prof. Krhoda urged all participants to be free to share since the meeting is an open sharing forum. At this point Prof. Krhoda invited Sosian Engineer and Consultants to brief participants on the project details.

Min. 2/27/2019: The Company, location and site of the project

Engineer Korir welcomed the participants once again and proceeded to elaborate on the company details, how the company has been involved in other energy projects and now would like to invest in geothermal power generation. He added that Sosian Energy Limited (SEL) was granted a Geothermal Resources License No. 8/2017 by the Ministry of Energy for exploration and development of the geothermal resources in the area north of Menengai caldera in the area.. The project is on a private land of about 9.8km2. Sosian Energy Limited is a renewable energy development company with interest in geothermal, wind, and solar energy production.

Dr. Omenda proceeded to share the details of geothermal occurrence in the Rift Valley region and the great potential it has to produce clean energy and as a result lift the standard of living of the local people, the County and the country in general. Geothermal Prospect covers the area due north and north-west of the Menengai Caldera,. The prospect lies outside of the caldera wall and extends to the upper slopes of the Ol'rongai hills and is part of the Greater Menengai Geothermal area. The expected power generation according to the concession is for 70 MWe out of the possible 140 MWe in line with the geothermal resources license, but further investigations will need to be carried out before the company can determine exactly the amount of possible power production there. He explained further that geothermal power is a fairly clean sources of electricity compared to other sources and to other various uses.

Min.3/17/2019: Scooping Report

Prof. Krhoda shared preliminary information collected form the documents regarding pernitent issues surrounding geothermal power development and experiences from the current installations and the expertise in the country. He added that participants should help the consultants to capture their views and opinions and if any views should come out after this meeting they should be addressed to the Consultants who shared their phone numbers and address.

He then invited Mr. Ammon, Dr. Ojwang, Dr. Kithis to take participants alond sone of the challenges and known solutions.

Min. 3/27/2019: Participants' Concerns

The community raised some issues perceived to be potentially harmful and social-related challenges with the Consulting Team and Sosian Engineer. Questions and answer or comments.

Geothermal power project impacts

The environmental quality is described as "good" at present. There is a good understanding of potential environmental impacts of proposed project.

1. **Land**

Mr. Mbugua had told us of a story that the village of Rikongo in the sub county was settled in 1983/84 and they were later moved by the government without compensation to date. The community therefore felt that there would be displacement from their land through compulsory acquisition of private land as was done before. They needed an assurance that the project will not require take their private land or acquire any.

2. **Employment**

The participants has lamented because of lack of job opportunities for the youth in the area. People in the area are in need of employment opportunities. A detailed discussion ensued where it was agreed that Sosian will endeavor to prioritise the youth for unskilled jobs. However the company must be seen to carry out legal labour relations against all forms of discrimination.

3. **Impacting structure of dwellings**

Adequacy of the construction of the houses to withstand the vibrations from blasting. Blasting may weaken their houses and fail. Presently there is lack of evidence. However the consultants will investigate the allegation during complete ESIA.

4. **Road safety**

Participants felt that community roads will be affected by heavy machinery and heavy traffic. Potential transport disturbance during construction period is likely but safety measures will be put in place since the road is used by school children.

5. **Pollution**

The project will use toxic substances that impact on human health and the population. People have fears that toxic substances will be used that will effect environmental quality. The basis was on a brief by a "one" community consultants that quoted from various reports.

6. **Noise**

Geothermal power operations are is 'noisy'. The stakeholders are unaware that magnitude of disturbance that might emanate from the use of heavy machinery and this is dependent on technology to be used.

7. **Air quality**

The air quality is excellent but there is a feeling that if the project goes ahead this may be affected. Dust and gaseous emissions.

8. **Water quality and quantity**

There is limited water supply within the sub county. Pollution of ground water. Community understand this adversity and would appreciate intervention to mitigate the same.

Min.4/17/2019: Schedule of implementation

The Consultants provided a schedule for the project implementation with a caveat that there will be further investigation to proven adequacy of the source. Exploratory drilling will start in 2020 and the first powe plant will be commissioned in 2024/2025.

Min. 5/17/2019: Way Forward

Prof. Krhoda said the following:

a) Participants are aware of most of the environmental challenges in geothermal power development and have had experience and interaction with other geothermal companies;
b) Government Department have been requested to support private investments, especially in power generation since there is power shortage to meet the Big 4 Agenda;
c) Currently there is no need for acquisition of any additional land;
d) Social marketing of this project will be undertaken seriously;
e) Experts should be broadly involved and community representatives to ensure project ownership and sustainability.
f) All stakeholders including political leaders should be involved as this is their project and the benefits will first be towards the local community according to the Mining Act.
g) There will be equitable benefit sharing.

The meeting closed with a word of prayer from one of the participants.

Appendix VIII: NEMA Certificates

FORM 7 (r.15(2))

nema
mazingira yetu | uhai wetu | wajibu wetu

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY(NEMA)
THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

ENVIRONMENTAL IMPACT ASSESSMENT/AUDIT (EIA/EA) PRACTICING LICENSE

License No : NEMA/EIA/ERPL/11086
Application Reference No: NEMA/EIA/EL/14925

M/S **Research on Environment and Development Planning (REDPLAN) Consultants ...** (individual or firm) of address

P.O. Box 56745-00200, Nairobi

is licensed to practice in the

capacity of a (Lead Expert/Associate Expert/Firm of Experts) **Firm of Experts**
registration number **6111**

in accordance with the provision of the Environmental Management and Coordination Act Cap 387.

Issued Date: **8/6/2019** Expiry Date: **12/31/2019**

Signature.....

(Seal)
Director General
The National Environment Management Authority

P.T.O.

ISO 9001: 2008 Certified

FORM 7 (r.15(2))

nema
mazingira yetu | uhai wetu | wajibu wetu

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY(NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

ENVIRONMENTAL IMPACT ASSESSMENT/AUDIT (EIA/EA) PRACTICING LICENSE

License No : NEMA/EIA/ERPL/11085

Application Reference No: NEMA/EIA/EL/14923

M/S **Prof. George Krhoda**
(individual or firm) of address

P.O. Box 56745- 00200, Nairobi

is licensed to practice in the

capacity of a (Lead Expert/Associate Expert/Firm of Experts) **Lead Expert**
registration number **1485**

in accordance with the provision of the Environmental Management and Coordination Act Cap 387.

Issued Date: **8/6/2019**

Expiry Date: **12/31/2019**

Signature…..

(Seal)
Director General
The National Environment Management Authority

P.T.O.

ISO 9001: 2008 Certified