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EAST AFRICA

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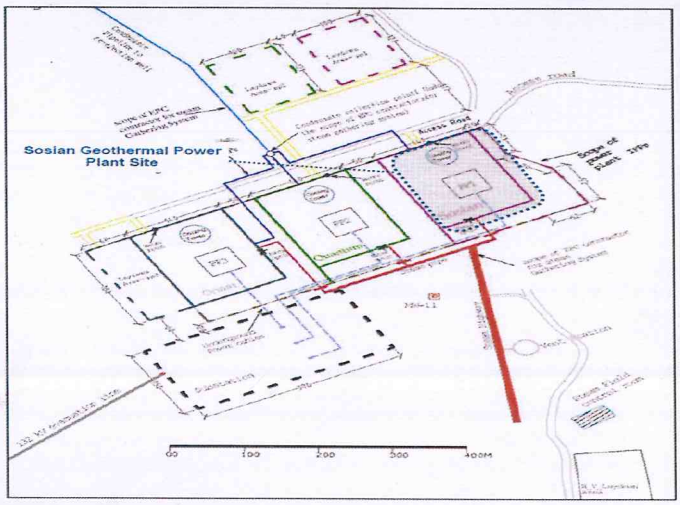
UPDATED ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT FOR THE DEVELOPMENT OF 1X35 MW GEOTHERMAL POWER PLANT IN MENENGAI



FINAL REPORT

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ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ADMS	Atmospheric Dispersion Modelling System
AfDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
ANSI	American National Standard Institute
AQSRs	Air Quality Sensitive Receptors
ARAP	Abbreviated Resettlement Plan
ASALs	Arid and Semiarid Lands
ASG	Atmospheric Studies Group
BOO	Build Own and Operate
CEDAW	Convention on the Elimination of all forms of Discrimination against Women
CFCs	Chlorofluorocarbons
CIA	Cumulative Impact Assessment
CITES	Convention on International Trade in Endangered Species
dB	Decibels
DCS	Distributed Control System
DOSH	Directorate of Occupational Safety and Health
EA	Environmental Audit
ECD	Early Childhood Development
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EMCA	Environmental Management and Coordination Act
EMP	Environmental Management Plan
ERC	Energy Regulatory Commission
ESIA	Environmental & Social Impact Assessment
FIs	Financial Intermediaries
FOMEC	Friends of Menengai Crater
GHGs	Green House Gases
GPS	Geographical Positioning System
H_2S	Hydrogen sulphide
HVAC	Heating, ventilation and Air Conditioning system
IFC	International Finance Corporation
ILO	International Labour Organization
IMCE	Inter ministerial Committee on Environment
IPP	Independent Power Producer
IUCN	International Union for Conservation of Nature
KEBS	Kenya Bureau of Standards
KETRACO	Kenya Electricity Transmission Company
KFS	Kenya Forest Service
KPLC	Kenya Power and Lighting Company (now Kenya Power)
KRA	Kenya Revenue Authority
KWS	Kenya Wildlife Service
LOAEL	Lowest observable adverse effect level
LPG	Liquefied petroleum gas
LRVPs	Liquid Ring Vacuum Pumps
LSA	Later Stone Age
MDBs	Multinational Development Banks
MDGs	Millennium Development Goals
MEAs	Multilateral Environmental Agreements
MoEP	Ministry of Energy and Petroleum
MSDS	Materials Safety Data Sheets
MW	Mega Watts
NACADA	National Authority for the Campaign Against Drug and Alcohol Abuse
NARUWASCO	Nakuru Rural Water and Sanitation Company
NAWASSCO	Nakuru Water Sanitation Services Company
NCGs	Non condensable Gases

NEMA	National Environment Management Authority
NET	National Environment Tribunal
NFPA	United States National Fire Protection Association
NSRs	Noise Sensitive Receptors
ODS	Ozone Depleting Substances
OSHA	Occupational Health and Safety Act
PAPs	Project Affected Persons
PES	Payment for Environmental Services
PISSA	Project Implementation and Steam Supply Agreement
PPA	Power Purchase Agreement
PPE	Personal Protective Equipment
ppm	Parts per million
QPEA	Quantum Power East Africa
RTI	Respiratory Tract Infections
RVWSB	Rift Valley Water Services Board
SACCOs	Savings and Credit Cooperative Societies
SEAs	Strategic Environmental Assessment
SERC	Standards and Enforcement Review Committee
TLV	Threshold Limit Value
TOR	Terms of Reference
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organization
USGS	United States Geological Survey
VECs	Valued Environmental and Social Components
WB	World Bank
WHO	World Health Organization
WIBA	Work Injury Benefits Act
WRMA	Water Resources Management Authority
WRUA	Water Resource Users Association

EXECUTIVE SUMMARY

E1 Project background and components

Quantum Power East Africa (QPEA) was awarded a tender by Geothermal Development Corporation (GDC) through competitive bidding to install 1x35MW Geothermal Modular Power Plant in Menengai Geothermal Field in Nakuru County for 25 years on a Build Own and Operate (BOO) basis. The purpose of the Power Plant Project is to increase the power generation capacity of Kenya to enhance socio- economic development and diversify sources of power supply by developing the country's huge geothermal potential. The project involves finance, design, procurement, supply, installation/construction, testing, commissioning, operation and maintenance of 35MW Geothermal Modular Power Plant. The justification for the site is the availability of Steam from the Geothermal Wells; the primary fuel for the project. The Project site is one of three 35 MW plants in the Menengai Geothermal field for which the GDC simultaneously granted identical build-own-operate geothermal concessions and allocated adjacent plant sites.

The project area is bounded by 36°01'E and 36°07'E and 0°09'S and 0°15'S. Administratively, the Menengai Geothermal field lies within Rongai and Nakuru North Sub Counties of Nakuru County. The geothermal power plant will be constructed within the caldera area which falls in Mercy Njeri sub location. Menengai crater forest reserve is a public land under the management of Kenya Forest Service. GDC has a memorandum of understanding with KFS on the development of geothermal resources within the reserve.

The power plant will be driven by steam owned by the GDC and supplied to the Power Plant under the terms in the Project Implementation and Steam Supply Agreement (PISSA) to generate a net electrical capacity of 35MW. The design of the Plant is based on a single-flash steam cycle with a condensing turbine. Nominal gross capacity will be 37.7 MW and Guaranteed Net Plant Output is 35 MW. The main plant system components include:

- Steam System: High pressure steam piping is carbon steel with 3 mm corrosion allowance, rock wool insulated with aluminium cladding. The design pressure and temperature of main steam system is 11 barg and 190°C;
- Steam metering and purity monitoring system: Steam flow rate at the boundary will be measured by the venturi flow meter consisting of single tube and double metering/differential pressure transmitter;
- A turbine generator unit with power output rating of 37.63 MW as measured at the generator terminal;
- Condenser and turbine drain system;
- Non Condensable Gas (NCG) extraction system through a 30m high steel stack;
- Main and Auxiliary cooling water circuit;
- Compressed air system: for air supplies to pneumatic operated valves;
- Electrical system: voltage levels in the system are 415V, 690V, 11kVand132kV, 50Hz; connected power is dimensioned to 50MVA at the main transformer with11kV at the MV side and 132kV at the HV side; and the Generator power output is 37.63MW electrical power.
- Earthing and Lightning protection;
- Transformers: Step Up transformer rated at 11/132 kV, 50 MVA; Station Service transformer rated at 11/0,69 kV, 4 MVA; and Auxiliary transformer rated at 690/415 V, 315 kVA
- Instrument and control system
- Process Control System for the total power plant based upon Distributed Control System (DCS), including the SCADA functionality with I/O, internal and external communication;
- Fire, Security and Detection System;
- Heating, ventilation and Air Conditioning (HVAC) system;

- H_2S safety system: for both human hazard detection system and equipment protection system

The construction process is scheduled to start seven days after the Effective date between GDC/KPLC and the QPEA GT Menengai Ltd in the mutually agreed PISSA/PPA and is estimated to take 2 years. Power generated will be supplied to Kenya Power Company (KPLC) under the terms in the Power Purchase Agreement (PPA). The power will be generated at 11kV and stepped up to 132kV and evacuated by transmission lines constructed by the Kenya Transmission Company (KETRACO).

GIBB Africa Ltd as a Firm of Experts Registered by NEMA was commissioned by QPEA GT Menengai Ltd, to undertake an ESIA Study update for the proposed 1x35 MW Modular Geothermal Power Plant so that the report would comply with Multinational Development Banks (MDBs) and the International Finance Corporation (IFC) performance standards, and equator principles among other international best practices. The ESIA Study was initially undertaken by the University of Eldoret on behalf of Geothermal Development Company Limited (GDC) for all the proposed 3x35 MW Modular Geothermal Power Plant. The initial ESIA study report was submitted to National Environment Management Authority (NEMA), application reference no. EIA/872 and approved in November 2012 vide NEMA license registration No. 0014205.

The update study was conducted through: desktop review of earlier reports and other related literature to identify gaps; baseline socio-economic survey; eight (8) public meetings with communities in the project area; interviews with key informants including various government agencies; and specialist impact assessment studies trough air quality modelling using Atmospheric Dispersion Modelling System version 4.2 (ADMS 4) and noise modelling using the Calculation of Sound Propagation by the Concawe method' (SANS 10357, 2004).

E2 Policy, legal and regulatory framework

The role of the environment in sustaining national heritage is recognized in the Constitution of Kenya, 2010 as a heritage of inter generational benefit. Section 69 of the constitution explains each and every citizen's obligations in respect of the environment. It obligates the state to sensure sustainable exploitation, utilisation, management and conservation of the environment and natural resources, and ensures the equitable sharing of the accruing benefits. The main legal and institutional framework for the management of environment and for matters connected therewith and incidental thereto for environmental management in Kenya is Environmental Management and Coordination Act (EMCA), 1999. EMCA has provided for the development of several subsidiary legislations and guidelines which govern environmental management and are relevant to the project implementation. These include;

- The Environmental (Impact Assessment and Audit) Regulations, 2003 Legal Notice No. 101;
- The Environmental Management and Coordination (Waste Management) Regulations, 2006 Legal Notice No. 121;
- The Environmental Management and Coordination (Water Quality) Regulations, 2006 Legal Notice No. 120;
- The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 Legal Notice No. 61;
- The Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulations, 2006 Legal Notice No. 160;
- The Environmental Management and Coordination (Fossil Fuel Emission Control) Regulations, 2006 Legal Notice No. 131;
- The Environmental Management and Coordination (Controlled Substances) Regulations, 2007 Legal Notice No. 73.

The new Constitution and EMCA therefore obligates the QPEA and its contractors to work in a clean environment and not to contravene the right of any person within its zone of influence, to this entitlement. National environment Management Authority is the lead EMCA enforcement

agency. The Occupational Safety and Health Act, 2007 provides for the safety, health and welfare of all workers and all persons lawfully present at workplaces and hence promote healthy environments and is enforced by Directorate of occupational safety and Health. Other relevant legislations with provisions cross-cutting the project's implementation and environmental, management have also been reviewed.
The project also triggers various international environment and social management safeguards which QPEA has to comply with. The key ones include:

- the World Bank Operational Policy (OP) 4.01: Environmental Assessment;
- the World Bank Operational Policy 4.04: Natural Habitats;
- the World Bank Operational Policy OP 17.50: Public Disclosure;
- IFC Environmental, Health and Safety General Guidelines;
- IFC Environmental, Health, and Safety Guidelines for Geothermal Power Generation;
- IFC Performance Standards on Environmental and Social Sustainability;
- IFC Cumulative Impact Assessment and Management Guidance for the Private Sector in Emerging Markets; and
- IFC Performance Standard 8: Cultural Heritage

Where the international environment and social management safeguards policies were more stringent than Kenyan guidelines, the latter applied.

E3 Existing Environment

The project area is classified into two main agro-climatic zones. The lowland areas of Mogotio and Kisanana in the north are located in semi-arid zone IV with an annual rainfall of 800 mm and mean temperatures of 30°C. Bahati and parts of Kampi ya Moto divisions with an altitude of between 1800 m and 2400 m above sea level and average rainfall of between 760 mm and 1270 mm per year fall within a dry sub-humid equatorial climatic zone.

As per the 2009 national housing and population census, Nakuru North and Rongai sub counties have a total population of 211,691 (103,316 males and 108,375 females) and 163,864 (82,665 males and 81,199 females) respectively. From the socioeconomic survey undertaken in the project area in this study, the productive segment of the population (20 – 55yrs) is about 52.1% while the elderly group (> 55 years) accounted for 8.4%. Majority of households surveyed were male- headed (81.7%) whereas 18.3% of the households are female headed. Nakuru North and Rongai are predominantly agricultural sub counties with maize and wheat crops being the predominant crops grown and cattle rearing for milk production, especially in areas neighbouring the project area.

Vegetation survey in the Menengai Caldera carried out at the initial ESIA study identified a total of 217 plant species consisting of herbs (132), shrubs (45) and trees (40). *Rhus natalensis*, *Dodonea sp.* and *Tarchonanthus comphoratus* are among the most dominant species. The caldera also contain some plant species that are believed to be rare and unique to this area such as *Artemisia afra, Protea gaguedi, Tetradenia riparia, Diplolophium africanum, Agauria salicifolia* and *Osyris lanceolata.* None of the identified species have been assessed for the IUCN red list (IUCN, 2014). However, *Osyris lanceolata* is listed in the sixth schedule of wildlife conservation and management Act of 2013 as endangered. Jimsonweed, *Datura stramonium* listed in the same schedule as an invasive species was also found in the caldera. At the rim of the caldera, mainly on the eastern and south eastern side, plantation forest (mainly of *Eucalyptus spp.*) under Kenya forest service exists.

There are few wild animal species in the project area. This is because large parts of the area outside the caldera are farmlands with no open grazing and dispersal areas. Representatives 9 mammalian species, 4 herpertofauna species and 40 species of aves were noted in the caldera. Of these species, the African Rock Python, *Python sebae* is classified as endangered and one bird, the Nyanza swift is protected under the Wildlife Conservation and Management Act of 2013. 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.

The caldera is not pristine and already various types of infrastructure are developed through the preceding geothermal exploration, drilling of steam production wells and a number of activities related activities are still ongoing. Pre-project noise levels were established to be already higher than legal thresholds provided in Environmental Management and coordination (Noise and Excessive Vibration Pollution) (Control) Regulations of 2006.

E4 Feedback from consultation

During the ESIA update study, consultations were held through: (1) eight (8) general public meetings at sub location levels within the project area; (2) key informant interviews with civil, government agencies and other institutions in the project area, from Nakuru North and Rongai sub counties, Nakuru County headquarters as well as regional agencies based in Nakuru; and (3) household surveys. A summary of expected benefits and expressed concerns are given below.

i. The Expected benefits

- The project will attract more investment into Nakuru County;
- It will create more employment and investment opportunities for people in Nakuru County;
- The increased power generation is expected to reduce common incidences of power outages which currently affects production capacity pf many establishments e.g. NAWSCO which runs numerous waters supply boreholes (constitute 90% production capacity) powered by electricity;
- Geothermal power plant's development will increase power available to the national grid and reduce cost of electricity;
- GDC has already experimental agricultural field for use of brine. These can be enhanced by participation of IPPs following the development of the power plants; and
- The project will lead to improved development of infrastructure which will improve marketing of agricultural produce.

ii. Expected negative impacts

- Local water service providers and water resources management authority have expressed concerns on increased borehole water temperatures with increased geothermal drilling activities in the project area;
- Potential destruction of scenic features characteristic of the Menengai landscape;
- Potential conflicts between locals and non-locals on employment;
- Environmental pollution from: dust, noise and odour;
- Interference with sacred caves at the rim of the caldera which are regularly patronized by various religious sect members;
- Increase pressure on waste management systems within the caldera which are already inadequate;
- Social problems including increased incidence of HIV/AIDS as experienced with Rongai flower farms in the area;
- Effects from Hydrogen sulphide (H_2S) gas to affect people, crops and may also cause acidic rain;
- The caldera area is naturally prone to wildfires (even in the absence of human interventions like charcoal burning); and
- Pollution from brine.

E5 Assessment of Project Impacts

The project will have both positive and negative impacts as summarised in the following sections:

i. Positive Impacts

During construction, the key positive impacts will be creation of employment opportunities for estimated 300 construction staff for a period of about two years; income generation activities to the local communities through sale of local construction materials and food by women; improvement in local economy from increased trade activities and potential diffusion and transfer of communication and knowledge from specialist construction staff to the local participants.

During operation phase, the most significant positive impact of the project will be the realization of its objective by injecting addition 35 MW of electric energy into the national grid. This will enhance the country's energy supply and security through a relatively more environmentally friendly energy generation process. Similarly, it is in line with enabling the energy sector make strides towards the policy directions envisaged in the Vision 2030.

Further, the operation phase is anticipated to: create 15 direct permanent job opportunities in the plant management and maintenance and numerous other indirect opportunities; generate income to the IPP and local power distributor; potentially attract Clean Development Mechanism funding; and enhance tourism activities within the Menengai caldera.

ii. Negative Impacts

The proposed project will be associated with a number of negative impacts both at construction and operation phases. At the construction phase, major impacts will be the common construction environmental and safety issues including: limited vegetation clearance within the plant area to be replaced by infrastructure; generation of construction dust, occupational and general public safety and health hazards emanating from construction traffic, working at heights, exposure to heat and elevated H_2S during connection of steam pipelines with the plant and excessive noise and vibrations; potential disturbance of encountered wildlife including the endangered and protected species noted within the caldera; and increased risks of wildfires within the caldera.

Other potential negative impacts include:

- Impact from materials quarry sites;
- Construction waste generation;
- Potential spread of HIV/AIDs and other Sexually Transmitted Infections;
- Impact on flora: spread of invasive *Datura stramonium*, exposure to escaping steam containing Non Condensable Gases (NCGs);
- Impacts on Soils
    - Soil erosion and increased sedimentation
    - Soil pollution
    - Soil compaction;
- Visual and landscape impacts; and
- Pressure of existing water Resources

Given absence of recorded archaeological sites or observed artefacts within the project site, no potential impacts on archaeological features are anticipated. However, a chance find procedure has been developed as a precautionary measure for use during construction excavation works.

During the operation phase, the major negative impact of the power plant will be associated with discharge of Non Condensable Gases (NCGs) into the atmosphere and noise generation from the steam turbine, generator and other associated plant equipment. NCGs constitute 3.3% to 4% of the geothermal steam from Menengai and hydrogen sulphide (H_2S) and carbon dioxide (CO_2) are the predominant NCGs. H_2S presents an unpleasant, typically "rotten eggs" odour at relatively low concentrations and is toxic in higher concentrations. CO_2 is not significant in terms of direct impact to human health in open environments but is a greenhouse gas. Specialist air quality (H_2S) and noise impact assessment study established the area is dominated by winds from the SSE and NNW. Any long term air quality and noise impacts are

therefore expected to be the most significant to the NNW and SSE of proposed operations. Several air quality sensitive receptors (AQSRs), mainly rural settlements and small rural centres, are situated within the vicinity of the proposed power plant.

The H_2S modelling results showed that the WHO daily guideline value of 150 µg/m³ is not exceeded at any of the AQSRs even with the highest probable NCGs concentration in the steam of 4% and with all the three power plants operating simultaneously. This indicates that no adverse public health impacts are anticipated with H_2S emissions from the plant's operation relative to WHO standards. On likely impacts on occupational health of power plant workers, the modeling results indicate that the anticipated levels are not likely to exceed the WHO Lowest Observable Adverse Effect Level (LOAEL) of 10 ppm. However, the WHO odour annoyance threshold of 0.005ppm will be exceeded at the nearby AQSRs causing odour annoyance. QPEA has incorporated two separate H_2S safety systems for the plant: the human hazard detection system consisting of one central unit with 4 ports and 4 fixed detectors for 1-500 ppm H_2S level; and equipment protection system designed for 1-1000 ppb H_2S detection.

To ensure the lowest possible impact on AQSRs and the environment it is recommended that an air quality management plan should be adopted. This includes:

- The mitigation of sources of emission;
- The management of associated air quality impacts; and
- Ambient air quality monitoring;
- Training of all workers on the dangers exposure to elevated H2S levels;
- Installation of H2S 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.

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 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. galvanised 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:

- equipment vendors must 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.

From the above impact modelling outcomes, no resettlement of community for safety reasons is envisaged in the project implementation process. Other negative operation impacts include:

- Accidental chemical spills;
- Operation wastes;
- Impacts on groundwater resources;
- Ground subsidence;
- Impact on Air Quality;
- Operation Noise impacts

E6 Conclusion and Recommendations

This ESIA Study update has been prepared to provide sufficient and relevant information on the proposed 1x35 MW geothermal power plant in Menengai by QPEA. The report responds to the environmental assessment requirements by NEMA and IFC safeguards.

Most of the anticipated adverse impacts associated with the project can be readily managed to acceptable levels with implementation of the recommended mitigation measures and ESMP developed in this report such that the overall benefits from the project will greatly outweigh the adverse impacts. No land take for the power plant or resettlement of community for safety reasons is envisaged in the project implementation process. Further, the requisite conditions for most of the mitigations have been incorporated by QPEA on project design documents reviewed by the consultant.

The project construction and operation activities are not expected to strain existing water supplies by NAWASCO. However, consultations with the regional office of Water Resources Management Authority and NAWASCO pointed out that since geothermal wells in the Menengai caldera were commissioned, the water temperature from the Ol Banita boreholes near the caldera have been recording increased temperatures. This has impacted on operation and maintenance cost of the bulk water service providers and complaints from water consumers. It is notable that underground water is the main water supply to the locals and the nearby Nakuru town. This study recommends that GDC, NAWASCO and the water resources management authority should undertake joint studies to investigate possibility of thermal contamination of underground water aquifers within the area with geothermal steam production and institute appropriate mitigations where necessary.

Public consultations revealed that the local communities have high socioeconomic interests and a lot of expectations with the geothermal power development activities going on within the Menengai caldera. It is recommended that QPEA develop and implement a community liaison strategy with proper communication and feedback mechanism; and a clear and transparent employment policy for the local communities.

In general, the proposed project will result in appreciable benefits to the country power production and create opportunities for both social and economic development. The project is already licensed by NEMA and QPEA has received a no objection letter from the National Museums of Kenya (NMK).

It is recommended that the proposed project be implemented in compliance with all the relevant legislation and planning requirements of Kenya at all times. In line with this, the proponent QPEA and the contractor (s) must take the legislative framework reviewed in this report into consideration, during and after the implementation of the project, as will be appropriate.

Further, the following are recommended:

- QPEA management should establish an Environment, Safety and Health department with suitably qualified staff in the field of environment, social and occupational safety and health management. The department will work in liaison with GDC, QPEA contractors and relevant government lead agencies to ensure sound environmental and social performance;
- Ensure implementation of NMK chance find procedure during construction phase;
- In liaison with GDC Ensure that community expectations are managed through well structured community liaison plan;
- Ensure compliance with NEMA approval conditions throughout the project phases; and
- Ensure statutory annual environmental and occupational safety and health audits are carried out annually throughout the project implementation and operation periods.

1 INTRODUCTION

1.1 Background

This document is an updated Environmental and Social Impact Assessment Study Report for the proposed 1x35 MW Geothermal Power Plant in Menengai commissioned by Quantum Power East Africa (QPEA). The project is expected to generate an additional 35MW of electricity to be connected to the national grid. It involves finance, design, procurement, supply, installation/construction, testing, commissioning, operation and maintenance of 35MW Geothermal Modular Power Plant. The justification for the site is the availability of Steam from the Geothermal Wells; the primary fuel for the project.

QPEA is one of the three Independent Power Producers (IPPs) each awarded a tender by Geothermal Development Corporation (GDC) through competitive bidding to install a 1x35MW Geothermal Modular power Plant in Menengai Geothermal Field in Nakuru County for 25 years on a Build Own and Operate (BOO) basis. The purpose of the Power Plant Project is to increase the power generation capacity of Kenya to enhance socio- economic development and diversify sources of power supply by developing the country's huge geothermal potential.

GDC is a wholly government owned limited liability company and is mandated to undertake integrated development of geothermal resources through initial exploration, drilling, resource assessment and promotion of direct utilization.

QPEA GT Menengai Limited is a locally registered and incorporated company operating in Kenya as a developer, owner and operator of the Geothermal Power Plant. This company is in turn owned by Quantum Power East Africa Ltd (QPEA) being a registered holding company located in Mauritius.

The power plant will be driven by steam owned by the GDC and supplied to the Power Plant under the terms in the Project Implementation and Steam Supply Agreement (PISSA) to generate a net electrical capacity of 35MW.Power generated will be supplied to Kenya Power Company (KPLC) under the terms in the Power Purchase Agreement (PPA) for commercial and industrial activities countrywide thus contributing job creation, increase productivity, electricity connection rates and improve the quality of life. Other direct project beneficiaries include people living around the project site who will benefit from employment during project implementation and operation, contractors and consultants will supply goods and services. The power is generated at 11kV and stepped up to 132kV and evacuated to lines constructed by the Kenya Transmission Company (KETRACO) who are responsible for high voltage transmission infrastructure in the country. KPLC will operate and maintain the transmission line.

1.2 Project Location and Site

The Project is located in the Menengai Geothermal Field on the outskirts of the Nakuru town in Nakuru County, Kenya about 180 km North-west of Nairobi. Administratively, the project area lies within Nakuru North and Rongai sub counties of Nakuru County. Access is through the Kunste-Bahati road off A104.

The Project site is one of three 35 MW plants in the Menengai Geothermal field for which the GDC simultaneously granted identical build-own-operate geothermal concessions and allocated adjacent plant sites. The project area is bounded by 36°01'E and 36°07'E and 0°09'S and 0°15'S

Figure 1-1 and Figure 1-2 below illustrate the location of Menengai Geothermal Field in Kenya and project site respectively.

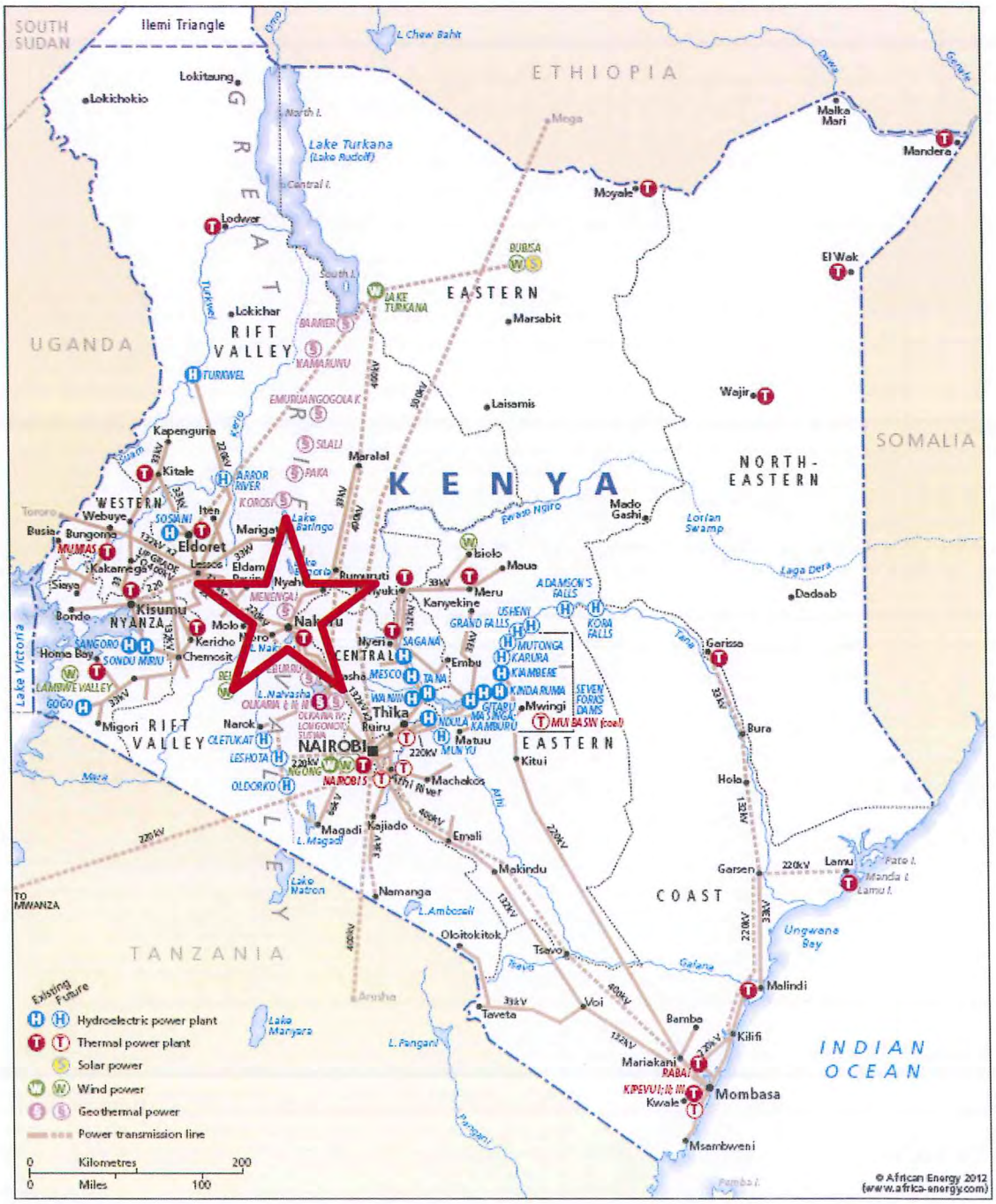


Figure 1-1: Location of the Menengai Geothermal Field in Kenya

Source:

The power plant boundaries is defined by the following coordinates

Site boundary	Eastings (m)	Northings (m)
A	171988	9978612
B	172427	9978851
C	172531	9978660
D	172094	9978421

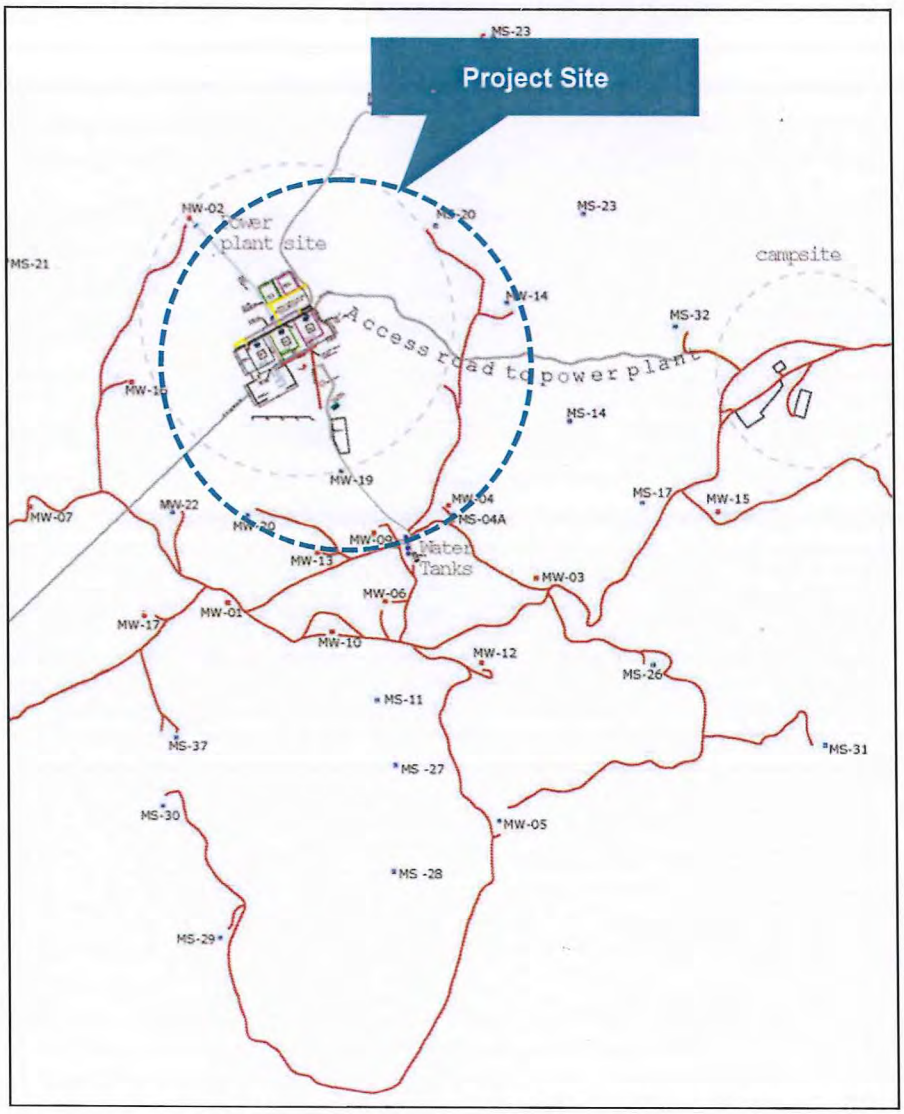


Figure 1-2: Project site in the Menengai Geothermal Field

1.3 Electricity Supply Status in Kenya

Kenya has an installed capacity of 1,429 MW. Whilst about 57% is hydro power, about 32% is thermal and the rest comprises geothermal and emergency thermal power. Solar PV and Wind power play a minor role contributing less than 1%. However, hydropower has ranged from 38-76% of the generation mix due to poor rainfall. Thermal energy sources have been used to make up for these shortfalls, varying between 16-33% of the mix

Current electricity demand is 1,191 MW and is projected to grow to about 2,500 MW by 2015 and 15,000 MW by 2030. To meet this demand, Kenya's installed capacity should increase gradually to 19,200 MW by 2030.

1.4 Project Justification

Energy is considered an essential ingredient for economic growth and social development in Kenya and anywhere in the world. The growth of energy demand is often driven by several factors namely, population growth, economic growth, urbanization, rural energization programmes, increasing penetration of energy intensive appliances and industrialization.

While Kenya is experiencing significant growth in energy demand, energy supply appears to have stagnated or dwindled. The security of energy supply especially electricity generation in Kenya seems to be threatened by climate change induced phenomenon, chief among them, drought. Inadequate electricity generation capacity and high power bills have been perennial problems in Kenya prompting the Government to explore various ways of tackling the glitches. A shift to alternative sources of energy such as geothermal power which is environmental friendly and more affordable to run compared to other sources of energy like fossil fuel will insulate the country against the effects of drought, which often interferes with hydroelectric power which historical has been the major source of installed power. The proposed geothermal power plants in Menengai will minimize climate drawbacks facing hydroelectric power generation and reducing the component of our energy mix that is dependent on the price of fossil fuels. It will create a reliable and stable renewable source of energy which will ensure sustainability of the Kenyan economy.

The Energy situation in Kenya dictates that there is need to develop the electricity generation capacity in the country for faster economic growth. According to Vision 2030, it is estimated that the national power requirements in the next 17 years will reach 15000MW, which is about ten times the current 1700MW power generation capacity. This justifies the immediate need to more than double the power generation to 5000MWe in the next 5 years to meet the rising demand and move in tandem with economic growth projections.

1.5 Need for update of ESIA prepared by GDC

ESIA Study was initially undertaken by the University of Eldoret on behalf of Geothermal Development Company Limited (GDC) for its proposed 3x35 MW Modular Geothermal Power Plant. The initial ESIA study was submitted to National Environment Management Authority (NEMA), application reference no. EIA/872 and approved in 2012 vide NEMA license registration No. 0014205. A copy of the licence has been annexed in Appendix VI.

QPEA is applying for funding from the international lenders to fund the proposed development. One of the prerequisites to funding is compliance with specific lender's environmental and social safeguards. Preliminary review and gap analysis of the original ESIA study report, NEMA license and ESMP established the need for additional inputs in order for the report to comply with MDBs and IFC requirements. GIBB Africa Ltd as a Firm of Experts Registered by NEMA was commissioned by QPEA GT Menengai Ltd, to update an ESIA Study.

1.5.1 Objectives of the ESIA update

The overall objective of Environmental and Social Impact Assessment (ESIA) update is to ensure that the report fulfils the requirements of the international lenders by undertaking the following tasks:

- Task 1: Review of existing documentation;
- Task 2: Identify gaps that can hinder the international lenders approval of the reports in Task (1) above; and
- Task 3: Prepare a report based on Task 1 and 2 above.

The specific objectives of the study were to:

1. Verify the compliance of the existing project ESIA report and ESMP and with the following policies and guidelines;
   - African Development Bank's environmental and social policies and guidelines;
   - World Bank's Operational Policies;
   - International Finance Corporation's Performance Standards including Environmental, Health, and Safety Guidelines for Geothermal Power Generation
   - Equator Principles.
   - International Labour Organisation (ILO) Core Labour Conventions Terms and Conditions of Employment both as at 14th September, 2013
2. Re-organisation of the ESIA Report to meet the MDBs and IFIs reporting requirements;
3. Confirmation of the Project Description and the technologies to be used at the power
4. stations;
5. Sustainability of water resources in consideration of the boreholes at Menengai and water supply from Nakuru Water and Sewerage Company (NAWASCO);
6. Adequacy of the baseline socio-economic survey done within and outside the project
7. boundaries
8. Adequacy of the Public Participation and Disclosure;
9. Aligning of the air quality modelling to the location of proposed power plants and preparation of a management plan;
10. Conduct of a Resettlement Action Plan Study as recommended in the ESIA license issued by NEMA;
11. Seismisity of the area and the related hazard management plan;
12. Socio-economic survey of the direct impact area of the power plant;
13. Identification of direct and indirect socio-economic impact zones;
14. Abbreviated Resettlement Action Plan (ARAP) arising from project impacts on community health and safety;
15. Public consultations and participation in the project area;
16. Update the environmental and social impacts of the associated with the construction, operation and decommissioning of the Project.
17. Noise modelling;
18. Re-evaluation of impacts and determination of mitigation measures; and
19. Update of the ESMP based on the study findings.

1.5.2 Target Group for the ESIA Report

This Environmental and Social Impact Assessment Study Report has been prepared for use by different stakeholders to be involved in the project. The report contains useful information on policies and procedures to be adhered to, implementation modalities, analysis of potential environmental and social impacts and suggested mitigation measures at various stages of the project activities. The information will be useful in planning, implementation, management and maintenance of the plant.

In this regard, the report will be useful to the following stakeholders:

- Multinational Development Banks;
- The Lead Agencies;
- The NEMA monitoring and compliance section;
- Funding agencies and donors;
- Planners and engineers to be involved in preparation of designs and plans for project;
- Contractors engaged in the construction works for the project;
- The potential project affected persons (PAPS) living within the project area; and
- Beneficiaries of the project both at local and regional level.

1.6 Methodology

This ESIA Report has been prepared in accordance with the Environmental (Impact Assessment and Audit) Regulation, 2003. It is also guided by the IFC's EHS General Guidelines, IFC's EHS Guidelines for Geothermal Projects and Equator Principles III.

The study methodology comprised the following activities:

- Preliminary meetings;
- Data collection and document review;
- Site inspection and discussions with site personnel;
- Air and Noise Dispersion Modelling;
- Ecological Assessment;
- Baseline Socio-Economic Studies;
- Community Resources Mapping;
- Meetings with stakeholders;
- Public Consultation;
- Data Analysis;
- Reporting.

The ESIA Report has confined itself to the construction of the 1x35MW modular geothermal power stations and associated infrastructure.

1.6.1 Preliminary meetings

An initial meeting was held with the Client representative at GIBB's offices on 21 October 2014 to brief him on the ESIA study work program and the various activities to be undertaken as part of the study as well as request for project information such as the project design. Another meeting was also held with GDC Environment and Community liaison department representatives on 22 October 2014 at the GDC Nakuru main office where the consultant briefed them on the work program and the various tasks to be undertaken by the ESIA team.

1.6.2 Desktop study

This entailed desktop review of project related literature in order to gain background information of the project. Some of the reports reviewed include:

- ESIA Study Report prepared by the University of Eldoret;
- Water Quality Assessment Report;
- GDC Environmental Monitoring Reports;
- Noise Assessment Reports;
- NEMA EIA License for the project;
- Project Design Report;
- Air Quality impact Assessment Report for the proposed Menengai Geothermal Power plant In Kenya;
- Noise impact Assessment Report for the proposed Menengai Geothermal Power plant In Kenya;
- National Census Report 2009; and
- Available reports on the project area on geology, soils, hydrology etc.

1.6.3 Field visit

A visit to the project area was undertaken from 20 October 2014 and 19 November 2014 to undertake a top-up exercise for the Environmental and Social Impact Assessment of 1x35 MW Geothermal Power Plant in Menengai. Specialized studies undertaken during this visit include: Baseline socio-economic survey and public and stakeholder consultations.

1.6.4 Methodology for specialised studies

(a) Air Quality Assessment

An air quality impact assessment was conducted by an independent consultant, Airshed Planning Professionals, for the operational phase activities planned for the proposed Menengai geothermal power plant. The main objective was to quantify the extent to which ambient pollutant levels will increase as a result of the project.

(i) Approach to assessment

The air quality impact assessment included a study of the receiving environment and the quantification and assessment of the impact of the proposed Menengai geothermal power plant on human health and the environment. The receiving environment was described in terms of local atmospheric dispersion potential, the location of potential Air Quality Sensitive Receptors (AQSRs) in relation to proposed activities as well as pre-development ambient pollutant levels. A comprehensive atmospheric emissions inventory was compiled for the operational phase of the project. Pollutants quantified included only hydrogen sulphide (H_2S).

(ii) Meteorological data

An understanding of the atmospheric dispersion potential of the area is essential to an air quality impact assessment. Physical environmental parameters that influence the dispersion of pollutants in the atmosphere include terrain and meteorology. Existing pre-development ambient air quality in the study area was also considered.

Readily available terrain data was obtained from the Atmospheric Studies Group (ASG) via the United States Geological Survey (USGS) web site at (ASG, 2011). In the absence of on-site meteorological data (that is required for atmospheric dispersion modelling), use was made of simulated data for a period between 2011 and 2013. The MM5 (short for Fifth-Generation Penn State/NCAR Mesoscale Model) is a regional mesoscale model used for creating weather forecasts and climate projections. It is a community model maintained by Penn State University and the National Centre for Atmospheric Research.

(iii) Dispersion modelling

Estimated emissions along with information on the receiving environment were used as input to an atmospheric dispersion model which simulated ground level pollutant concentrations. The assessment was done for the operational phase of the project only.

In the simulation of ambient air pollutant concentrations use was made of the Atmospheric Dispersion Modelling System version 4.2 (ADMS 4) developed by the Cambridge Environmental Research Consultants (CERC). This model simulates a wide range of buoyant and passive releases to the atmosphere either individually or in combination.

Model inputs summary

Parameter	Comments
Dispersion Model Selection	Version 4.2 of ADMS
Meteorological Requirements	hourly MM5 surface and profile data for the period 2011 to 2013
Source Data Requirements	The ADMS model is able to model point, jet, area, line and volume sources. Stack and cooling tower fans were modelled as point sources.

Parameter	Comments
Modelling Domain	The dispersion of pollutants expected to arise from proposed activities was modelled for an area covering 15 km (east-west) by 10 km (north-south). The area was divided into a grid matrix with a resolution of 200 m, with the geothermal power plants located centrally. The nearest town and farmsteads were included as AQSR. ADMS calculates ground-level (1.5 m above ground level) concentrations at each grid and discrete receptor point. Topography was included in dispersion simulations.
Results presentation	Dispersion modelling was undertaken to determine highest hourly, 8 hourly, highest daily and annual average ground level concentrations. Averaging periods were selected to facilitate the comparison of simulated pollutant concentrations to relevant ambient air quality, inhalation health criteria and odour thresholds. Results are provided in tabular form as discrete values simulated at specific AQSR receptor locations. Selective use is also made of isopleths to present areas of exceedance of assessment criteria. It should be noted that ambient air quality criteria apply to areas where the Occupational Health and Safety regulations do not apply, thus outside the property or lease area. Ambient air quality criteria are therefore not occupational health indicators but applicable to areas where the general public has access i.e. off-site.

(iv) Determining risks of the project on the receiving environment

The simulated ground level pollutant concentrations were screened against internationally accepted reference inhalation concentrations. In the evaluation air emissions and ambient air quality impacts reference was made to:

- Screening levels for non-criteria pollutants published by various internationally recognised organisations;
- Odour thresholds and;
- Occupational limits.

Health risk screening was done through the comparison of simulated non-criteria pollutant concentrations (H_2S) to inhalation screening levels. Potential for odour impacts was done through the comparison of simulated non-criteria pollutant concentrations (H_2S) to odour thresholds. Occupational limits were used to assess the occupational impact.

(v) Assumptions, Exclusions and Limitations

- The quantification of sources of emission was restricted to proposed operations at the geothermal power plants;
- Project information required to calculate emissions for proposed operations were provided by Quantum. Where necessary, assumptions were made based on the specialist's experience. Assumptions had to be made on the other two independent power producers (IPPs) located on either side of the proposed Quantum plant as details on their emissions were not available;
- Routine emissions were estimated and simulated;
- In the absence of on-site surface meteorological data, use was made of modelled MM5 data for an on-site location;
- A minimum of 1 year, and typically 3 to 5 years of meteorological data are generally recommended for use in atmospheric dispersion modelling for air quality impact assessment purposes. 3 years of meteorological data (2011 to 2013) were used in the atmospheric dispersion modelling; and
- The impact assessment was limited to H_2S during the operational phase.

(b) Noise Modelling

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

Baseline acoustic environment was described in terms of the location of Noise Sensitive Receptors (NSRs) in relation to the proposed power plant, the ability of the environment to attenuate noise over distances and existing or pre-development noise levels.

Sound power levels for main power plant equipment were determined from supplier specifications and theoretical calculations. The effective sound power level of the turbine hall was also estimated by taking into account the building size, sound absorption by cladding and floor as well as transmission losses through the galvanised steel sheet cladding.

The propagation of noise from proposed activities was calculated according *to 'The Calculation of Sound Propagation by the Concawe method'* (SANS 10357, 2004). The Concawe method makes use of the International Organisation for Standardization's (ISO) air absorption parameters and equations for noise attenuation as well as the factors for barriers and ground effects. In addition to the ISO method, the Concawe method facilitates the calculation of sound propagation under a variety of meteorological conditions. Meteorological data obtained from the MM5 data set as used in the air quality impact assessment were applied.

The noise source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (Concawe). Noise levels were calculated over an area of 5 km east-west by 5 km north-south at intervals of 50m.

Noise impacts were calculated in terms of:

- Total day- and night time noise levels as a result of:
  - The proposed QPEA plant in addition to the baseline; and
  - The QPEA, Ormat and Sosian geothermal power plants in addition to the baseline.
- The effective increase ambient day and night-time noise levels over the baseline as a result of:
  - The proposed QPEA plant; and
  - The QPEA, Ormat and Sosian geothermal power plants.

The impacts were assessed according to guidelines published by NEMA in the Environmental Management and Coordination (Noise and excessive vibration pollution)(control) regulations of 2009 and IFC. To assess annoyance at nearby places of residence, reference was made to guidelines published in SANS 10103 (2008).

(c) Ecological Survey

This top-up study has relied on baseline ecological survey data established from the initial study by the University of Eldoret. The data was collected through the following approaches.

(i) Vegetation

Vegetation sampling was carried out on and around the six determined sites. Visual observation and recording of all spermatophytes encountered. Plant scientific names, family names, growth forms, natural habitat and their status whether indigenous or

exotic were also noted and recorded. Selected plants images were also collected and the sites geo-referenced.

(ii) Avifauna

Birds investigation was based on line transect, which was designed at every site by use of binoculars. Bird species were identified and recorded. Also bird calls or songs or any other songs were incorporated in birds identification exercise. During observations, only birds visible within a range radius of 25 m from transects were recorded.

(iii) Mammals

For Mammals, the survey used was standard line transect methods that are practiced widely in animal census (Burnharm *et al* 1980). Each site held one transect of 500 m in length and tracks, dung, footprint and other signs associated to certain species of mammals observed within the transect were recorded.

(iv) Herpertofauna

Field search were conducted in the study area where and at time when the reptiles were known to be active or detectable. The search for reptiles was centred on the ground and on trees. Active and barrowing reptiles encountered were recorded. Any other evidence or signs of presence of particular vertebrate were noted.

(d) Baseline Socio-Economic Studies

The following approaches were used

(i) Approach 1: Household Survey

The structured household interviews were carried out among the target population based on formatted questions. The survey grasped mainly quantitative information buy some open-ended questions (qualitative information) was useful for the study.

(ii) Study Design

A sampling frame and sample size was drawn from the households in the vicinity of the project site. The sample was based on stratified sample drawn from households neighbouring the project area. The sampling rate was between 10% and 25% of the households depending on the statistical significance within the ea of the strata identified.

(iii) Recruitment of Enumerators

To ensure gender balance and reduce biasness on information gathering, female and male enumerators were recruited and trained to carry out the exercise. The objective of training the enumerators was to create awareness on the importance of the survey, provide training on interviewing techniques and build common understanding on the study tools as well as create team work.

The interviewer's guide and household questionnaires were discussed during the training and followed by pre-testing in the field.

(iv) Conducting the Survey

Door-to-door consultations were conducted by the enumerators with household heads or a responsible adult in the absence of the household head. Special considerations were given for child headed household holds if encountered. A supervisor was assigned the responsibility of quality assurance of the completed questionnaires on a

daily basis. Quality assurance was undertaken to ensure compliance with the interview guidelines and completeness of the questionnaire.

(v) Data Analysis and Presentations

The analysis of quantitative data was done using PASW (Predictive Analytics Software) formally known as Statistical Packages for Social Sciences (SPSS). Data is presented in form of prose, tables, matrices, pie charts and graphs.

(e) Approach 2: Interview with Key Informants

Semi-structured interviews were conducted with local national and county government leaders and heads of line ministries in the project area of influence. Discussions focused on existing socio-economic situation in the project area. The meetings provided an opportunity to introduce the project to the community leaders and identify key informers.

(f) Approach 3: Public Meetings

Public meetings were organized in the project area at the Sub location level with assistance from the local administration and conducted in compliance with MDBs and IFIs procedures. Qualitative data captured in the course of the discussions was used for triangulation of the output from other primary data sources throughout the study.

(g) Public Consultation and Disclosure

Public participation was done through one-on-one interviews and public meetings in tandem with the baseline socio-economic studies. Disclosure of study findings will also be done through public meeting (workshop) prior to completion of the ESIA Study Report.

1.7 ESIA Update study team

The ESIA team comprised the following:

Maurice Namiinda	Project Director;
George Owuor	Team leader/Lead EIA Expert;
Anastasia Ngatti	Sociologist/Public Consultation Expert;
Aggrey Kwadha	Lead EIA expert
Paul Mwangi	Occupational Health and Safety Expert; and
Alfrick Murunga	Assistant Environmentalist
Airshed Planning Professionals	Air quality and Noise Modelling experts

1.8 Structure of the report

This report has been prepared under the following chapters:

Executive summary: This chapter presents a summary of the significant findings and recommended actions, with an emphasis on expected impacts.

Chapter 1: **Introduction:** This chapter gives description of the project background, location, purpose, objectives, reporting requirements, study methodology and the structure of the report.

Chapter 2: **Policy**, **Legal and regulatory framework**: This chapter outlines the overview of legislative framework, regulatory, international guidelines and conventions relevant to this project.

Chapter 3: **Description of the project environment:** This chapter gives description of the environmental setting of proposed project and surrounding areas, e.g., climate, soils, geology, vegetation, fauna, land use, human populations, socio-economics, cultural heritage.

Chapter 4: **Project description:** This chapter gives a description of the project details and design and implementation strategies.

Chapter 5: **Project alternatives:** This chapter gives an analysis of project alternatives including the no-project option.

Chapter 6: **Public and stakeholder consultation:**' This chapter gives description of the objectives, methods used and summary of results of the public consultation activities undertaken during the project report stage.

Chapter 7: **Impacts assessment and mitigation measures:** This chapter presents the analysis of beneficial and adverse impacts of the project on the biophysical and human (social, cultural and economic) environments. The analysis covers anticipated impacts during the construction, operation phases and decommissioning phases and also describes the enhancement and mitigation measures proposed to enhance benefits or prevent, minimize, mitigate or compensate for adverse impacts as well as the estimated cost of mitigation.

Chapter 8**:** **Environmental and Social Management Plan:** This chapter gives in details summary of procedures and plans to ensure that the mitigation measures and monitoring requirements approved during the environmental compliance review will actually be carried out in subsequent stages of the project.

Chapter 9: **Conclusions and Recommendations:** This chapter summarises the consultant's conclusion and recommendations form the assessment.

2 POLICY LEGAL AND REGULATORY FRAMEWORK

2.1 Background

Regulation 18 (1) (b) of the Environmental (Impact Assessment and Audit) Regulations 2003 require an environmental assessment study report to, among others; include a concise description of national environmental legislative and regulatory framework. This chapter presents a review of the current local policy, legal and regulatory framework as well as MDBs and IFC guidelines applicable to environmental management of the proposed geothermal power project. Where the international environment and social management safeguards policies were more stringent than Kenyan guidelines, the latter applied in the analysis of impacts.

2.2 Policy framework

2.2.1 National Environment Policy, 2013

The National Environmental Policy gives the framework to guide the country's efforts in addressing the ever-growing environmental issues and challenges such as:

- Environmental governance;
- Loss of biodiversity;
- Valuation of environmental and natural resources;
- Rehabilitation and restoration of environmentally degraded areas;
- Urbanisation, waste management and pollution;
- Climate change, energy, security and disaster management;
- Public participation, environmental education and awareness;
- Data and information;
- Poverty;
- Chemicals Management.

The objectives of this Policy are to:

- Provide a framework for an integrated approach to planning and sustainable management of Kenya's environment and natural resources;
- Strengthen the legal and institutional framework for good governance, effective coordination and management of the environment and natural resources;
- Ensure sustainable management of the environment and natural resources, such as unique terrestrial and aquatic ecosystems, for national economic growth and improved livelihoods;
- Promote and support research and capacity development as well as use of innovative environmental management tools such as incentives, disincentives, total economic valuation, indicators of sustainable development, Strategic Environmental Assessments (SEAs), Environmental Impact Assessments (EIAs), Environmental Audits (EA) and Payment for Environmental Services (PES);
- Promote and enhance cooperation, collaboration, synergy, partnerships and participation in the protection, conservation, sustainable management of the environment and natural resources;
- Ensure inclusion of cross-cutting and emerging issues such as poverty reduction, gender, disability, HIV&AIDS and other diseases in the management of the environment and natural resources;
- Promote domestication, coordination and maximisation of benefit from Strategic Multilateral Environmental Agreements (MEAs).

The Policy discusses in depth the following key environmental topics:

- Management of ecosystems and sustainable use of natural resources;
- Environmental stewardship;
- Environmental quality and health;
- Research, education and monitoring;
- Environmental governance.

Relevance

ESIA is one of the environmental management tools identified and supported by the policy.

2.2.2 Draft National Energy and Petroleum Policy

Chapter 3 of the Energy Policy discusses renewable energy available in Kenya such as geothermal, hydro, biomass, bio fuels, biogas, solar, wind, municipal waste and biomass co-generation.

On geothermal energy, the policy outlines the policies and strategies to be implemented by the government under different implementation plans. It also highlights the challenge experienced by the sector:

- Relatively long lead time of between 5-7 years from conception to production of electricity;
- Geothermal projects typically progress through stages of reconnaissance, surface exploration, feasibility study, exploratory drilling, appraisal drilling, production drilling, steam field development and power plant construction stages which normally involve high upfront investment costs;
- High resource development risks;
- Inadequate geothermal expertise and expensive external technology;
- Remote location, siting restrictions and long distances to existing load centres necessitating heavy investment in transmission and other support infrastructure;
- Competing and conflicting interests in use of land and natural energy resources by various sectors of the economy; and
- Relocation and resettlement of affected persons during geothermal development.

Chapter 6 on Land, Environment, Health and Safety, the policy discusses policies and strategies and implementation Plan for the following issues related to the energy sector in Kenya:

1 Land and Socio-Economic Issues;
2 Environment, Health and Safety;
3 Climate Change Mitigation;
4 Renewable Energy EHS Concerns
5 Conservation of Catchment Areas;
6 Disaster Prevention and Management.

Relevance

This ESIA study addresses some of the concerns on geothermal energy as underscored in the policy including the management of associated gases and liquids which may contribute to global warming, acid rain, noxious smells and ground water pollution if released on the surface.

2.2.3 Kenya Vision 2030

Vision 2030 aspires to transform Kenya into a newly industrialized middle-income country by 2030. It identifies energy and electricity as a key element of Kenya's sustained economic growth and transformation. According to the vision, the country aims at enhancing and diversifying national power generation and supply by identifying new generation and supply

sources through exploitation of geothermal power, coal, renewable energy sources, and connecting Kenya to energy-surplus countries in the region.

The vision for the environmental sector is "people living in a clean, secure and sustainable environment". The vision is inspired by the principle of sustainable development and by the need for equity in access to the benefits of a clean environment. The vision focuses on four strategic thrust:

- Conservation;
- Pollution and waste management;
- ASALs and high risk disaster zones; and
- Environmental planning and governance.

Relevance

Geothermal energy has been identified as one of the sources of energy that would substantially address the prevailing energy deficit. The proposed development is thus in line with sector specific objectives in vision 2030. This ESIA study report is one of the tools geared toward ensuring the project is undertaken in a sustainable manner with proper management of any resultant wastes.

2.2.4 The Kenya National Climate Change Response Strategy

Kenya has developed a national Climate change response strategy in response to challenges and opportunities posed by climate change. The vision of the Strategy is for a prosperous and climate change resilient Kenya. The mission is to strengthen and focus nationwide actions towards climate change adaptation and GHG emission mitigation.

In order to cushion key sectors against the impacts of climate change, the Strategy has identified sectoral adaptation and mitigation needs. To counter potential threats to the energy sector Kenya needs to, and should implement the following measures:

- Accelerate the development of geothermal energy;
- Accelerate the development of green energy including wind, solar and renewable biomass;
- Energy Efficiency.

2.2.5 National Land Policy, 2009

The National Land Policy in Chapter 3 under section 3.4, Environmental Management Principles, provides for the policy actions for addressing the environmental problems such as the degradation of natural resources, soil erosion, and pollution of air, water and land.

The policy advocates for environmental assessment and audit as a land management tool to ensure environmental impact assessments and audits are carried out on all land developments that may degrade the environment and take appropriate actions to correct the situation. Public participation has also been indicated as key in the monitoring and protection of the environment.

Section 3.4.3.3 advocates for the Implementation of the polluter pays principle which ensures that polluters meet the cost of cleaning up the pollution they cause, and encourage use of cleaner production technologies.

In section 131 (d) the government undertakes to provide mechanisms for resolving grievances arising from human/wildlife conflicts for sustainable management of land based natural resources.

Relevance

The proposed works shall implement the ESMP from this environmental assessment to ensure that all the rivers and streams within the project area are not polluted by the subsequent activities during construction and operational phases.

2.2.6 GDC Health, Safety and Environment Policy, 2011

GDC has developed an elaborate health, safety and environment policy geared towards ensuring safety and environmental protection in all its working environment. In its health and safety policy statement, GDC undertakes as follows:

"GDC shall conduct all its activities taking foremost account of health and safety of its employees, contractor and local community while paying proper regard to the environment".

The policy in clause 2 stipulates responsibilities of various players involved in GDC activities including GDC itself, GDC employees; and any procured contractors.

Of relevance to QPEA is clause 2.1 which requires all contractors engaged by GDC to:

- Abide by its policy and be responsible for management of their employees through training, mentoring etc.;
- Perform all work in a manner to prevent HSE incidents;
- Ensure training and proper tools/equipment;
- Notify GDC immediately of any health, safety or environmental (HSE) incidents, even if no injury occurs;
- Provide GDC with a written report on incidents within 24 hours;
- Undertake Proactive HSE efforts;
- Contractor shall hold a pre-job or pre-task HSE meeting on-site in which the specific hazards pertaining to the job are discussed prior to beginning all work; and
- Contractor shall have their own written drug, alcohol and firearms policy in effect.

QPEA shall review the current GDC policy and ensure full compliance in the power plant construction and operation activities undertaken by itself and on its behalf by any sub contractors.

2.2.7 GDC Environment Policy, 2012

GDC also has an Environment policy in place whose goal is to provide a framework for addressing environmental issues and ensuring that all GDC's project are implemented in line with relevant laws, regulations and conventions so as to realize sustainable development.

The policy scope covers all GDC projects and programs in its operation areas. The policy commits GDC to internationally acceptable business standards that are ethical, healthy and environmentally acceptable/friendly and in conformity with all relevant laws, regulations and convention that are in force.

One of the main objectives of the policy is to mainstream environmental management in GDC strategic plan, performance contracts and annual activity plans. The key institutions responsible for the policy implementation include:

- The GDC Board of directors;
- CEO and Managing director and the management;
- The environmental department; and
- All GDC company employees to be responsible.

The policy among others provides for specific environmental management requirements including:

- Air quality monitoring and meteorology;

- Waste management;
- Water, effluent, soils and flora quality;
- Regulatory compliance/permits; and
- Environmental awareness.

QPEA shall review the current GDC Environmental Policy and in liaison with the established departments, ensure full compliance in the power plant construction and operation activities undertaken by itself and on its behalf by any sub contractors.

2.2.8 Millennium Development Goals (MDGs)

Adopted by world leaders in the year 2000 and set to be achieved by 2015, the Millennium Development Goals (MDGs) provide concrete, numerical benchmarks for tackling extreme poverty in its many dimensions. The MDGs also provide a framework for the entire international community to work together towards a common end making sure that human development reaches everyone, everywhere. If these goals are achieved, world poverty will be cut by half, tens of millions of lives will be saved, and billions more people will have the opportunity to benefit from the global economy.

Goal 7 of the MDGs is on ensuring Environmental Sustainability. It highlights on the following issues that need to be addressed:

- Protection of forest ecosystems;
- Need for reduction in Green House Gases;
- Reduce overexploitation of marine resources;
- Promoting Non extinction of some animal species;
- Improve access and quality of water especially to the poor; and
- Try and face out the sprawling of urban slums.

Relevance

The proposed power project will contribute to reduction of green house gases emissions from energy generation process while this ESIA study has been done for the proposed project to ensure that it reflects Environmental Sustainability especially during the time of construction and implementation.

2.3 Legal Framework

2.3.1 The Constitution of Kenya, 2010

The role of the environment in sustaining our heritage is recognized in the Constitution of Kenya, 2010 as a heritage of inter generational benefit. Chapter 5 on Land and Environment is more particular on this. Part 2 of the chapter defines environment and natural resources, obligations in respect of the environment, enforcement of environmental rights, agreements relating to natural resources and legislation relating to the environment.

Section 69 explains each and every citizen's obligations in respect of the environment in subsection (1). it states the following:

The State shall:

- Ensure sustainable exploitation, utilisation, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;
- Work to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya;

- Protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources of the communities;
- Encourage public participation in the management, protection and conservation of the environment;
- Protect genetic resources and biological diversity;
- Establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
- Eliminate processes and activities that are likely to endanger the environment; and
- Utilise the environment and natural resources for the benefit of the people of Kenya.

Subsection (2) states:

Every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources.

Relevance

The constitution of Kenya provides for sound environmental management and sustainability and therefore this study provides one of the tools through which this can be achieved within the development.

2.3.2 Environment Management and Coordination Act (No. 8 of 1999)

Part II of the Act vests on every person a right to a healthy environment and a responsibility to safeguard it. The Act therefore makes it mandatory for QPEA to work in a clean environment and protect people living close to the project.

Part V Section 44 includes protection of hill tops, hill sides, mountain areas and forests; Menengai area basically lies in a caldera. QPEA will be required to institute measures for the sustainable use of caldera so as to prevent environmental degradation as required by the Act.

Section 51 and 54 deals with conservation of biological resources and protection of the environmental significant areas, the proposed development lies in a caldera ecosystem, which needs to be protected.

Section 56 deals with the protection of ozone layer and emissions of dangerous gases to the atmosphere, the geothermal processes will lead to emission of CO_2. CO and CH4 which are ozone layer depleting substances. QPEA will be required to abide by the allowable discharge limits to the atmosphere.

All the chapters 1 to 13 apply to the new project at one stage or the other and therefore QPEA is required to understand and use the Act in total.

Relevance

Under section 58 (1) *of Kenya Government's Environment Management Coordination Act (EMCA), Number 8 of 1999 and National Environmental Management Authority (NEMA) Regulations for Environmental Impact Assessment and Audit of June, 2003,* the proposed 1X30 MW Geothermal Power Plant Project in Menengai falls under the prescribed list of projects for which environmental impact assessment is mandatory, prior to implementation *(Second Schedule , page 174 of EMCA No.10 electrical infrastructure section (a) electrical generation stations).* The basis is that the proposed project constitutes several components of activities, which would result in considerable changes and significant effects to the environment including on land, water, atmospheric resources and biological diversity.

EMCA has provided for the development of several subsidiary legislations and guidelines that govern environmental management which are relevant to the proposed project as reviewed below.

(a) Environmental (Impact Assessment and Audit) Regulations 2003

The Environmental Impact Assessment and Audit Regulations state in Regulation 3 that *"the Regulations should apply to all policies, plans, programmes, projects and activities specified in Part III and V of the Regulations"* basically lists the guidelines of undertaking, submission and approval of the ESIA Report.

Regulation 26 (1) provides that a holder of an environmental impact assessment licence may, on payment of the prescribed fee, transfer the licence to another person only in respect of the project to which such licence was issued.

Relevance

The project has already been licensed by NEMA in accordance with these regulations. QPEA should thus arrange with GDC to have the existing licence transferred to QPEA as provided in these regulations.

(b) Environmental Management and Coordination (Waste Management) Regulations 2006

These Regulations apply to all categories of waste as provided in the Regulations. These include:

- Industrial wastes;
- Hazardous and toxic wastes;
- Pesticides and toxic substances;
- Biomedical wastes;
- Radio-active substances.

These Regulations outline requirements for handling, storing, transporting, and treatment / disposal of all waste categories as provided therein. Wastes contaminated with petroleum product are considered to be hazardous. QPEA will have to abide by these regulations in dealing with waste management especially the provisions of industrial, hazardous and toxic wastes which may be generated during their operations.

Relevance

The proposed geothermal power plant project, during construction and operation, will generate various types of wastes which will need to be disposed as per the guidelines in the regulations.

(c) Environmental Management and Coordination (Water Quality) Regulations 2006

These Regulations protect the quality of drinking water, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife and water used for any other purposes.

These Regulations outline:

- Quality standards for sources of domestic water;
- Quality monitoring for sources of domestic water;
- Standards for effluent discharge into the environment;
- Monitoring guide for discharge into the environment;
- Standards for effluent discharge into public sewers;
- Monitoring for discharge of treated effluent into the environment.

In fulfilling the requirements of the regulations QPEA will undertake monitoring of both domestic water and wastewater and ensure compliance with the acceptable discharge standards.

Relevance

During the construction and operation phases, the proposed project's water supplies will require compliance with the standards established under these regulations.

(d) Environmental Management and Coordination (Conservation of Biological Diversity) (BD) Regulations 2006

These Regulations apply to conservation of biodiversity which includes Conservation of threatened species, Inventory and monitoring of Biological Diversity and protection of environmentally significant areas, access to genetic resources, benefit sharing and offences and penalties. The Regulations mainly applies due to the location of the proposed project site with the Menengai caldera. Proper environmental management will be required to conserve the biological diversity within the area.

Relevance

A detailed assessment of the likely impacts of the power plants on biodiversity in the area has been conducted to ensure their sustainability.

(e) Environmental Management and Coordination (Fossil Fuel Emission Control) Regulations 2006

These Regulations apply to all internal combustion engine emission standards, emission inspections, the power of emission inspectors, fuel catalysts, licensing to treat fuel, cost of clearing pollution and partnerships to control fossil fuel emissions used by QPEA . The fossil fuels considered are petrol, diesel, fuel oils and kerosene.

These regulations will be applicable to equipment and machinery used by the contractor during plant construction and periodic maintenance.

(f) Environmental Management and Coordination (Controlled Substances) Regulations 2007

The Government of Kenya banned the importation of Chlorofluorocarbons (CFCs) with effect from 1 January 2009, to ensure that Kenya is compliant with the provisions of the Montreal Protocol on Substances that Deplete the Ozone Layer.

This regulation makes it mandatory for industries, and other stake holders in ODS trade, to obtain a license to import these substances. The ozone-friendly refrigerants, oil lubricants, and other ozone-friendly alternative chemicals to CFCs shall be the only ones that shall be licensed for importation for use in equipment. No license shall be issued to any person to import CFCs.

The customs officers, at the points of entry, shall use CFC identifiers to detect and intercept CFCs that may be imported illegally. Intercepted CFC shall be shipped back to the country of origin at the cost to be met by the importer.

(g) Environmental Management and Coordination, (Wetlands, Riverbanks, Lake Shores and Sea Shore Management) Regulations 2009

These regulations include management of wetlands, wetland resources, riverbanks, lakeshores, and seashores. The regulations will empower the District Environment Committee to co-ordinate, monitor, and advice on all aspects of wetland and water resource management within the district.

(h) Environmental Management and Coordination (Noise & Excessive Vibration Pollution) Control Regulation, 2009

These Regulations prohibit QPEA from making or causing any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. It also prohibits QPEA from excessive vibrations, which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment or excessive vibrations, which exceed 0.5 centimetres per second beyond any source property boundary or 30 metres from any moving source. Under the regulation QPEA will be required to undertake daily monitoring of the noise levels within the proposed geothermal station to maintain compliance.

Relevance

The Regulations also provide maximum permissible intrusive noise levels and maximum permissible noise levels for construction sites under the First and Second Schedule which QPEA will have to abide by.

2.3.3 Energy Act No. 12 of 2006

This Act consolidates regulations relating to energy in Kenya. Section 103 of the Act specifically makes provisions on renewable forms of energy including geothermal energy. The Minister is obligated to promote the use of renewable energy in Kenya (Section 103 (1)). The Minister is charged with formulating a national strategy for coordinating research in renewable energy. The Act expressly identifies geothermal energy as a form of renewable energy whose production should be fostered in the Country. The Energy Regulatory Commission must take into account the impact of the undertaking on the social, cultural or recreational life of the community when determining license generation applications under section 30 of the Act. Under this Act, the Ministry of Energy and Petroleum released The Energy (Electricity Licensing) Regulations, 2010 which describe the manner and form for applying for generation and transmission licences.

2.3.4 Geothermal Resources Act, 1982

The Geothermal Resources Act, 1982, establishes a series of steps which the geothermal developer must follow. The Minister (hereinafter the Cabinet Secretary) for Energy must first Authorize all resource exploitation; (2) a "geothermal resources license" must be obtained from the Cabinet Secretary to enable the developer to drill, extract, and utilize the resources, and (3) if electricity is to be produced the developer must obtain a license under the Electric Power Act, or if Commercial by-products are reclaimed; the geothermal resources license must include a lease consistent with the Mining Act.

The Geothermal resources Regulations, 1990, set forth a model license which establishes the basis for negotiating the arrangements for obtaining the rights to the Kenyan Geothermal resources license. The Model License establishes a schedule of payment for land rental and royalty for the sale of steam or electricity. It provides for the forfeiture of the license in the event of either unauthorized inactivity on the part of the developer or breach of the geothermal laws, regulations or licence.

The Model License mandates a reporting system and establishes an incentive system whereby the Minister of Energy undertakes to secure a number of investment incentives for the licensee.

The legal basis of Kenya's Geothermal Policy is stated in the Geothermal Resources Act of 1982. The Act was written to control the exploitation and use of geothermal resources, to vest the resources in the Government of Kenya, and to provide for connected purposes. The Act defines terms commonly used in the exploitation of the geothermal resources.

The regulatory aspect of the Geothermal Policy is provided for in the Geothermal Resources Regulations of 1990. These regulations stipulate the procedures to be followed by those who wish to explore, drill, extract and utilize geothermal resources and therefore wholly applies to QPEA from its definition, principle and operation.

(a) Provisions of Geothermal Resources Act

(i) Authority for Geothermal Resources

Ownership of all geothermal resources under any land is vested with the Government. The Cabinet Secretary for Energy is responsible for declaring any area a geothermal resources area. The Act prohibits any unauthorized use of the geothermal resources. In order to extract and use geothermal resources one has to be granted authority or license. Authority to search for geothermal resources is also granted by the Cabinet Secretary for Energy. The Cabinet Secretary may authorize any person (including a public officer) to make surveys, investigations, tests and measurements in search of geothermal resources. The written authority empowers a person to enter any land specified by the authority, drill any bore, make geological and geophysical surveys and generally do all things necessary in connection with the search for geothermal resources. When practicable, reasonable notice of intention to enter upon any land shall be to the owner of the land. Also, the authorized person should be ready to produce his notice of authority when required to do so by the owner or occupier of the land on which he intends to enter or has entered. The authority granted is subject to the condition that every bore drilled shall be kept under close supervision, maintained in safe condition and finally left in a condition of lasting safety.

The authority granted is not transferable and is valid for one year but it may be renewed on a yearly basis after expiration. The authority may be revoked if the person to whom it was granted has not complied with any requirement or condition of his authority or if the operations being carried out are detrimentally affecting other specified bores. It may also be revoked if it is in the public interest that the operations being carried out should cease.

(ii) Geothermal Resources License

The Geothermal Resources License may be granted over part or the whole of a geothermal resources area. The license application must be on the approved form and should be accompanied by the prescribed fees. The license granted will be for a term not exceeding thirty years or as the Cabinet Secretary for Energy may determine.

The license shall confer upon the licensee the right to enter upon the land being the subject of the license to drill and to extract geothermal resources and to do all such things as are necessary for the conduct of those operations. This means the right to drill and construct all necessary boreholes, erect the necessary infrastructure for operations, utilize the geothermal resources and subject to the Water Act, reclaim and utilize any water. The licensee also has the right to take and use or apply the geothermal resources for any purpose specified in the license.

Where any by-product obtained in the production of geothermal resources may be reclaimed for further use or sale and is a mineral within the meaning of the Mining Act, the license may be modified so as to allow for the inclusion of a mining lease to enable recovery of that by-product.

The license is renewed for a term not exceeding five years subject to such terms and conditions as the Cabinet Secretary for Energy may think fit. The licensee shall not transfer or assign his license or any part thereof the consent in writing of the Cabinet Secretary for Energy. The license may be declared forfeited if the licensee wholly ceases to work in the area of the license during a continuous six months period without the written consent of the Minister for Energy, or if he a breach or is in default of any provision of the Geothermal Resources Act. The forfeiture of a license shall not affect any liability already by the licensee.

(iii) Power of licensee in respect of generation of electricity

The holder of a licence under the Electric Power Act (Cap. 314) may for the purposes of generating, transmitting or supplying electrical power:

- Extract, take, use and apply geothermal resources on or under any land which is the subject of licence;
- Erect, construct, provide and use such works and appliances as may be necessary for the purpose of generating electricity, and in connection with the transmission, use, supply and sale of electricity.

(iv) Safety of persons

The Act places responsibility and liability to the licensee for for any loss, damage or injury to any person or property resulting from his works or operations, whether as a result of negligence or otherwise.

2.3.5 Geothermal Resources Regulations, 1990 (314A)

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 Cabinet Secretary 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. Any information given by the licensee to the Cabinet Secretary will be treated as confidential as per regulation 14.

2.3.6 Occupational Health and Safety Act, 2007

This is an Act of Parliament which provides for the safety, health and welfare of all workers and all persons lawfully present at workplaces and it also provides for the establishment of the National Council for Occupational Safety and Health and for connected purposes.

It applies to all workplaces where any person is at work, whether temporarily or permanently and therefore will apply to the project both during construction and operation phases.

The purpose of this Act is to:

- Secure the safety, health and welfare of persons at work; and
- Protect persons other than persons at work against safety and health arising out of, or in connection with the activities of persons at work.

The Occupational Health and Safety Act (OSHA) 2007 repealed the Factories and Other Places of Work Act. Anything done under the provisions of the Factories and Other Places of Work Act including subsidiary legislation issued before the commencement of the OSHA 2007 shall be deemed to have been done under the provisions of this Act.

The Factories and Other Places of Work Act had over the years passed several subsidiary rules and regulations for effective implementation of the Act. All shall, as long as it is not inconsistent with OSHA 2007 remain in force until repealed or revoked by subsidiary legislation under the provisions of OSHA 2007 and shall for all purposes be deemed to have been made under this Act.

These regulations include:

- The Factories (Cellulose Solutions) Rules 1957;

- The Factories (Wood Working Machinery) Rules 1959;
- The Factories (Dock) Rules 1962;
- The Factories (Eye Protection) Rules 1978;
- The Factories (Electric Power) (Special) Rules 1978;
- The Factories (Building Operations and Works of Engineering Construction) Rules 1984;
- The Factories and Other Places of Work (Health & Safety Committees) Rules 2004;
- The Factories and Other Places of Work (Medical Examination) Rules 2005;
- The Factories and Other Places of Work (Noise Prevention and Control) Rules 2005;
- The Factories and Other Places of Work (Fire Risk Reduction) Rules 2007;
- The Factories and Other Places of Work (Hazardous Substances) Rules 2007.

The scope of OSHA 2007 has been expanded to cover all workplaces including offices, schools, academic institutions and plantations. It establishes codes of practices to be approved and issued by the Director, Directorate of Occupational Health and Safety (DOHS) for practical guidance of the various provisions of the Act.

Other parameters within the Act relevant to the project include:

- Duties of employers, owners or occupiers of workplace;
- Establishment of safety and health committees;
- Annual safety and health audit of workplaces;
- Safety and Health obligations for persons who may come to premises for work and are not employees of that particular workplace;
- Reporting of any accident, dangerous occurrence or occupational poisoning caused in the workplace to the area Occupational Health and Safety Office. These incidents should be entered in the General Register. In case of a fatal accident information to the area Safety and Health Office should be within 24 hrs and a written notice to the same within 7 days;
- The duties of manufactures, designers, importers and suppliers to ensure that all articles and substances for use at workplace are safe and will not cause injury to health and the environment;
- Duties of self employed persons;
- Duties of employed persons;
- Prohibition of interference or misuse of any appliance, convenience or any other facility provided to secure Safety, Health and Welfare at work by any person (occupier, self employed person or employed);
- The administration of the Act is the responsibility of a Director and other appointed and gazetted officials (Occupational Health and Safety Officers);
- The registration of all workplaces by the Director DOHS forming the basis of his work statistics;
- Machinery safety to include:
    - Safe use of machinery, plant and equipment;
    - Prime makers and transmission machines;
    - The maintenance, construction of fencing safeguards;
    - The statutory requirements of various machines, plants and equipment (hoists and lifts, chains and ropes, cranes, steam receivers and containers, air receivers, cylinders for compressed liquefied and dissolved gases and refrigeration plants).
    -
- Chemical safety including:
    - Handling, transportation and disposal of chemicals and other hazardous substances;
    - Importance of Materials Safety Data Sheets (MSDS);
    - Labelling and marking of chemical substances;
    - Classification of hazardous chemicals and substances;

- Establishment and adoption of exposure limits on hazardous substances in a workplace;
- Control of air pollution, noise and vibrations;
- Redeployment on medical advice.
-

- Health, safety and welfare special provision including:

  - Permit to Work systems;
  - Work processes that are likely to harm persons below eighteen (18) years;
  - Supervision of apprentices and indentured learners;
  - Training and supervision of inexperienced workers;
  - Medical surveillance.

- Penalties, offences and legal proceedings including:

  - The upward adjustments of all fines imposed in the event of failure to comply with provisions of the Act;
  - The need to investigate and prosecute the real offender otherwise all those who fail to comply with any provisions of this Act that have been legally imposed on him/her shall be prosecuted;

- The establishment of the safety and Health fund and Safety and Health regulations and procedures thereof.

2.3.7 Work Injury Benefits Act (WIBA), 2007

It is an act of Parliament (No. 13 of 2007) to provide for compensation to workers for injuries suffered in the course of their employment.

It outlines the following:

- Employer's liability for compensation for death or incapacity resulting from accident;
- Compensation in fatal cases;
- Compensation in case of permanent partial incapacity;
- Compensation in case of temporary incapacity;
- Persons entitled to compensation and methods of calculating the earnings;
- No compensation shall be payable under this Act in respect of any incapacity or death resulting from a deliberate self-injury; and
- Notice of an accident, causing injury to a workman, of such a nature as would entitle him for compensation shall be given in the prescribed form to the director.

Relevance

During power plant construction and operation period, both the proponent and any appointed contractors will need to abide by all the provisions of WIBA.

2.3.8 The public Health Act (Cap. 242)

This is an Act of Parliament to make provision for securing and maintaining health. Section 115 of this act prohibits causing nuisance or other conditions liable to be injurious or dangerous to health. Section 118 provides a list of nuisances that includes any noxious matter, or wastewater, flowing or discharged from any premises, wherever situated, into any public street, or into the gutter or side channel of any watercourse, irrigation channel or bed thereof not approved for the reception of such discharge.

(a) The Public Health (Drainage and Latrine) Rules

Rule 85 provides that every owner or occupier of every workshop, workplace or other premises where persons are employed shall provide proper and sufficient latrines for

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

Relevance

The project construction and operation activities are bound to expose both workers and members of the general public to situations injurious to health. All activities of the project are thus expected to abide by this act to ensure a healthy environment.

2.3.9 Water Act 2002

Water in Kenya is a national resource, subject to any right of the user, legally acquired. The control and right to use water is exercised by the Minister administering the Act, and such use can only be acquired under the provisions of the Act. The Cabinet Secretary is also vested with the duty to promote investigations, conserve and properly use water throughout Kenya. Water permits may be acquired for a range of purposes, including the provision and employment of water for the development of power and other uses. The following are the regulations developed under Water Act 2002 relevant to the project:

(a) The Water Resources Management Rules (2007)

These Rules are described in Legal Notice Number 171 of the *Kenya Gazette Supplementary Number 52 of 2007*. They apply to all water resources and water bodies in Kenya, including all lakes, watercourses, streams and rivers, whether perennial or seasonal, aquifers, and shall include coastal channels leading to territorial waters.

The Water Resources Management Rules empower Water Resources Management Authority (WRMA) to impose management controls on land use falling under riparian land.

It also enables any person with a complaint related to any matter covered by these rules to the appropriate office in WRMA as per the Tenth Schedule which provides a format for report on complaints. WRMA is to reply to the complainant with "*copies to all other relevant parties within twenty one days of receiving the complaint, starting with what action is being taken, the position of the Authority on the matter and any recommendation to the complainant.*"

The rules also elaborate on the following:

- Mechanisms for appeal;
- Public notification;
- Public consultation;
- Orders on compliance;
- Protection of the integrity of the water resources monitoring network;
- Water Resource User Associations;
- Water Resource Database;
- Approval of activities listed in the fifth schedule of Water Act 2002;
- Authorisation and permitting;
- Wetlands;
- Allocation of water for irrigation;
- Prior right to water for storage;
- Dams;
- Groundwater development and its regulation;

- Control of water pollution and effluent discharge;
- Water works;
- Water use charges on permitted water use;
- Conservation of riparian land and catchment areas;
- Catchment management strategies;
- Protected areas and ground water conservation areas;
- Establishment and protection of reserve water;
- Miscellaneous provisions which include provisions on:
    - Qualifications to practise as a water resource professional;
    - Qualifications for a registered contractor;
    - Recognised water quality laboratories;
    - Emergency orders;
    - Penalties for offences;
    - Revocation of rules under Cap 372.

Part IX *: Conservation of Riparian and Catchment Areas* of the Rules, Section 116(5) states " *Unless otherwise determined by a water resources inspector, the riparian land adjacent to the ocean is defined as a minimum of two metres vertical height or thirty metres horizontal distance from the high watermark, whichever is less".*

Section 118 (1) of the Rules state " No person shall undertake the activities listed in the Sixth Schedule on riparian land unless authorised by the Authority in consultation with other relevant stakeholders".

Part IV: *Ground Water* of the Rules, Section 72 (4) state "*Where any borehole or well is intended to be equipped with a motorised pump, the application shall be accompanied by a hydrogeological assessment report in the prescribed form set out in the second schedule".*

Part IV, Section 73 states as follows:

"……

(1) For the regulation of ground water development, the authority will determine the allocation plan for a given aquifer or part thereof, the spacing of boreholes, or wells to be equipped with a motorised plant and will be guided by:

- *Existing borehole or well spacing;*
- *Individual aquifer characteristics, including water quality;*
- *Existing aquifer use;*
- *Existing bodies of surface water.*

(2) The allocation plan shall be available and accessible to the public during normal working hours from any of the Authority Offices.

……"

Part IV, Section 74 states as follows:

"……

(1) All new boreholes and wells to be equipped with motorised pumps shall be subject to test pumping.

(2) Continuous constant rate pumping test of not less than twenty four hours duration and recovery duration of not less than twenty hours or as otherwise stipulated by the Authority.

2.3.10 The Wildlife (Conservation and Management) Act, 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 in its sixth schedule list various animal and tree species that are nationally considered as critically endangered, vulnerable, nearly threatened and protected. It also lists in its seventh schedule, national invasive species for which control is required.

Section 48 restricts activities involving the above listed species without a permit from KWS. KWS can make recommendations to the responsible cabinet secretary, to prohibit carrying out of any activity which: is of a nature that may negatively impact on the survival of species listed in sixth schedule; or is specified in the notice or prohibit the carrying out of such activity without a permit issued by KWS.

Relevance

Any critically endangered, vulnerable, nearly threatened or protected species found within the project area will have to be managed in line with this Act.

The project is not located in a wildlife sensitive area. However, in the whole lifecycle of the project actions the Proponent will ensure as much as possible not to jeopardize the wellbeing of wildlife, (if any) which are one of Kenya's greatest heritage. Failure of which will attract the consequences enumerated in section 56 of the Act which include a fine not exceeding forty thousand shillings

2.3.11 Urban Areas and Cities Act No. 13 of 2011

This Act came into operation on the repeal of the Local Government Act (Cap. 265) as per section 1(2) *Subject to subsection (3), this Act became operational after the first elections held under the Constitution in 2014.*

According to section 27 and 28 of the Act, it empowers County Government to appoint a Manager to manage or prohibit all places of work that by reason of smoke, fumes, or chemical gases, dust smell, noise or vibration or other cause may be a source of danger, discomfort, or annoyance to the neighborhood, and to prescribe the conditions subject to which businesses, factories and workshops shall be carried on. The 1X30 MW Geothermal Power Station Project falls under the jurisdiction of County Government of Nakuru and is expected to abide by all the by-laws such as legislation governing control of pollutants and wastes, business permits and so forth.

2.3.12 The County Governments Act 2012

This statute vests the power of spatial and environmental planning on the County. Sections 114 specifically outline the procedures for planning nationally significant project such as the proposed project.

Relevance

The Proponent is required to involve the Nakuru County Government and the public (as undertaken in this study) and seek any relevant approvals from the County.

2.3.13 The Physical Planning Act Chapter 286

The Act *inter-alia*, governs the preparation and implementation of physical development plans in Kenya. Section 29 of the Act gives power to local authorities to determine development applications and grant all development permissions. The Nakuru County Government has to determine all physical development plans and the proponent will operate in full consultation with the respective council.

2.3.14 Forest Act, 2005

This Act provide for the establishment, development and sustainable management, including conservation and rational utilization of forest resources for the socio-economic development of the country.

The Act establishes the Kenya Forest Service with the following mandate:

- Formulate for approval of the Board, policies and guidelines regarding the management, conservation and utilization of all types of forest areas in the country;
- Manage all state forests;
- Manage all provisional forests in consultation with the forest owners;
- Protect forests in Kenya in accordance with the provisions of the Act;
- Promote capacity building in forest management;
- Collaborate with individuals and private and public research institutions in identifying research needs and applying research findings;
- Draw or assist in drawing up management plans for all indigenous and plantation state, local authority.

The Act requires community participation in forest conservation and management done through a registered community forest association under the Societies Act. The association thereafter can be granted forest user right under the management agreement with the Director of KFS.

Relevance

The land on which the proposed project will be undertaken is owned by Kenya Forest Services (KFS). KFS has plantation forestry within the project immediate neighbourhood and is also in the process of formulation a community forest association all which are managed in line with the forest Act.

2.3.15 Land Act, 2012

This is an Act of Parliament intended to give effect to Article 68 of the Constitution, to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land based resources, and for connected purposes. The Kenyan Constitution under the bill of rights provides protection of property rights under Article 40. It further provides for the acquisition of private property by government for public purposes or for public interest. Conditions and guidelines for acquiring are described in Part VIII of the Act. However the land on which the proposed project will be undertaken is owned by a state agency, Kenya Forest Services (KFS). The Proponent has an agreement (Appendix IX) with KFS allowing GDC to explore, exploit and generate electricity from geothermal resources.

2.3.16 Land and Environment Court Act, 2012

This is an Act of Parliament to give effect to Article 162(2) (b) of the Constitution; to establish a superior court to hear and determine disputes relating to the environment and the use and occupation of, and title to, land, and to make provision for its jurisdiction functions and powers, and for connected purposes. The principal objective of this Act is to enable the Court to facilitate the just, expeditious, proportionate and accessible resolution of disputes governed by this Act.

Section 13 (2) (b) of the Act outlines that in exercise of its jurisdiction under Article 162 (2) (b) of the Constitution, the Court shall have power to hear and determine disputes relating to environment and land, including disputes:

- Relating to environmental planning and protection, trade, climate issues, land use planning, title, tenure, boundaries, rates, rents, valuations, mining, minerals and other natural resources;
- Relating to compulsory acquisition of land;

- Relating to land administration and management;
- Relating to public, private and community land and contracts, chooses in action or other instruments granting any enforceable interests in land; and
- Any other dispute relating to environment and land.

Section 24 (2) also states that the Chief Justice shall make rules to regulate the practice and procedure, in tribunals and subordinate courts, for matters relating to land and environment.

Section 30 (1) states that all proceedings relating to the environment or to the use and occupation and title to land pending before any Court or local tribunal of competent jurisdiction shall continue to be heard and determined by the same court until the Environment and Land Court established under this Act comes into operation or as may be directed by the Chief Justice or the Chief Registrar.

Relevance

Any land or/and environmental cases arising from the project will be handled in accordance with the provisions of this act.

2.3.17 The Penal Code (Cap. 63)

Section 191 of the Penal Code makes it an offence for any person or institution that voluntarily corrupts, or foils water for public springs or reservoirs rendering it less fit for its ordinary use. Similarly, section 192 prohibits making the atmosphere in any place noxious to health of persons/institution in dwellings or business premises in the neighbourhood or those passing along a public way.

Relevance

The contractor and proponent will be required to ensure strict adherence to the Environmental Management Plan throughout the project cycle in order to mitigate any possible negative impact associated with dust, noise, and effluent discharge.

2.4 Administrative Framework

2.4.1 The National Environment Council

The National Environmental Council (the Council) is responsible for policy formulation and directions for the purposes of the Act. The Council also sets national goals and objectives, and determines policies and priorities for the protection of the environment.

2.4.2 The National Environment Tribunal

The Tribunal performs the following functions:

- To hear and determine appeals from NEMA's decisions and other actions relating to issuance, revocation or denial of Environmental Impact Assessment (EIA) licences or amount of money to be paid under the Act and imposition of restoration orders;
- To give direction to NEMA on any matter of complex nature referred to it by the Director General; and
- In accordance with the Forest Act No. 7 of 2005, NET is mandated to review decisions of the board under sections 33 and 63.

2.4.3 The National Environment Management Authority

The responsibility of the National Environmental Management Authority (NEMA) is to exercise 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.

In addition to NEMA, the Act provides for the establishment and enforcement of environmental quality standards to be set by a technical committee of NEMA known as the Standards and Enforcement Review Committee (SERC) which will govern the discharge limits to the environment by the proposed project.

(a) County Environmental Offices

NEMA has offices at county levels contributing to decentralised environmental management.

Relevance

The project is licensed by NEMA as required and the NEMA county officers will have overall supervision of environmental matters during both construction and operation.

2.4.4 Public Complaints Committee

The Act (EMCA 1999) established a Public Complaints Committee, which provides the administrative mechanism for addressing environmental harm. The Committee has the mandate to investigate complaints relating to environmental damage and degradation. Its members include representatives from the Law Society of Kenya, NGOs and the business community.

2.4.5 Ministry of Energy and Petroleum (MoEP)

It is responsible for formulation and articulation of energy policies through which it provides an enabling environment for all stakeholders. Its tasks include national energy planning, training of manpower and mobilisation of financial resources.

2.4.6 Energy Regulatory Commission (ERC)

It was established as an energy sector regulator under the Energy Act, 2006, with responsibility for economic and technical regulation of electric power, renewable energy, and downstream petroleum sub-sectors. Its functions also include tariff setting, review, licensing, enforcement, dispute settlement and approval of power purchase and network service contracts.

2.4.7 Energy Tribunal

This quasi-judicial body was established under section 108 of the Energy Act, 2006. It came into operation in July 2007 to primarily hear appeals against the decisions of ERC. It also has jurisdiction to hear and determine all matters referred to it relating to the energy sector.

2.4.8 Geothermal Development Company (GDC)

This is a 100% state-owned company established by the Government of Kenya as a Special Purpose Vehicle for the development of geothermal resources in Kenya.

GDC will supply/deliver steam to the plant based on parameters in the PISSA. GDC will also develop the Steam gathering facilities and condensate re-injection systems before the testing and commissioning of the plant.

2.4.9 Kenya Electricity Transmission Company (KETRACO)

This is a Government of Kenya wholly owned company established to be responsible for the development, maintenance and operation of the national transmission grid network. It is also responsible for facilitating regional power trade through its transmission network.

KETRACO will be responsible for development of power evacuation transmission line for the power generated from the plant and its connection to the existing national grid. In this respect, they will be responsible for a separate ESIA study for the transmission lines.

2.4.10 Independent Power Producers (IPPs)

IPPs are private companies which will be responsible for the construction and operation phases of the power plants and selling the generated electricity in bulk to KPLC.

2.4.11 Kenya Forest Service

Kenya Forest Service (KFS) is mandated to manage protected forests within the country and is also the owner of the land in which the project is located. Protection of the Menengai forest cover and general management of the area will require close collaboration between the proponents and KFS. GDC has a memorandum of understanding with KFS as annexed in Appendix IX in which they have agreed in the development of geothermal resources, management and conservation of forest resources.

2.4.12 Kenya Wildlife Service

Kenya Wildlife Service (KWS) is principal institution responsible for implementation of the Wildlife Management Act, 2013. KWS is responsible for protection of all wildlife within the Menengai forest and thus works jointly with KFS in the forest conservation management program.

2.4.13 Directorate of Occupational Safety and Health

Directorate of Occupational Safety and Health (DOSH) is a government agency responsible for enforcement of Occupational Safety and Health throughout the country for the protection of workers and the general public at all work places in line with OSHA, 2007.

The proponent must have its power plants registered as a work place with the Nakuru county office and also submit regular audit and any incidence reports report to the agency.

2.4.14 County Government of Nakuru

Nakuru County as the project host county will have various inputs in the project implementation in line with constitutional functions of county governments. The functions of the county government relevant to the proposed project, as outlined in the Fourth Schedule, Constitution of Kenya 2010 are as follows:

- Agriculture and husbandry;
- Provision of essential services such health services, county transport, education;
- Control pollution and disasters management;
- Monitor cultural activities, public entertainment and public amenities;
- County planning and development;
- County public works and services;
- Implementation of specific national government policies on natural resources and environmental conservation; and
- Encourage public participation in county governance and development

The county government of Nakuru is thus expected to actively be engaged in coordinating various project related activities as far as general environmental conservation and public participation are concerned. This will be better achieved through the county directorate of

environment under Ministry of Environment, Natural Resources, Energy and Water.

2.5 International Guidelines

2.5.1 World Bank Safeguard Policies

The following operational policies are triggered by the proposed geothermal power plant in Menengai:

(a) Operational Policy (OP) 4.01: Environmental Assessment

The objective of OP 4.01 is to ensure that Bank-financed projects are environmentally sound and sustainable, and that decision-making is improved through appropriate analysis of actions and of their likely environmental impacts. This policy is triggered if a project is likely to have potentially adverse environmental risks and impacts in its area of influence. The Bank classifies the proposed project into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts:

1. ***Category A***: A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" situation), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. For a Category A project, the borrower is responsible for preparing a report, normally an EIA (or a suitably comprehensive regional or sectoral EA);
2. ***Category B****: A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas--including wetlands, forests, grasslands, and other natural habitats--are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed more readily than for Category A projects. The scope of EA for a Category B project may vary from project to project, but it is narrower than that of Category A EA. Like Category A EA, it examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. The findings and results of Category B EA are described in the project documentation (Project Appraisal Document and Project Information Document).13*
3. ***Category C****: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project.*
4. ***Category FI****: A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts.*

OP 4.01 covers impacts on the natural environment (air, water and land); human health and safety; physical cultural resources, social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources) and transboundary and global environment concerns.

The proposed geothermal power plant in Menengai fall under Category A thus requires a full environmental and social impact assessment study.

(b) Operational Policy 4.04: Natural Habitats

This policy recognizes that the conservation of natural habitats is essential to safeguard their unique biodiversity and to maintain environmental services and products for human society and for long-term sustainable development. The Bank therefore supports the protection, management, and restoration of natural habitats in its project financing, as well as policy dialogue and economic and sector work. The Bank supports, and expects borrowers to apply, a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development. Natural habitats are land and water areas where most of the original native plant and animal species are still present. Natural habitats comprise many types of terrestrial, freshwater, coastal, and marine ecosystems. They include areas lightly modified by human activities, but retaining their ecological functions and most native species.

Specifically, the policy prohibits Bank support for projects which would lead to the significant loss or degradation of any Critical Natural Habitats, whose definition includes those natural habitats which are either:

- legally protected,
- officially proposed for protection, or
- Unprotected but of known high conservation value.

The proposed geothermal station has the potential to cause conversion (loss) or degradation of natural habitats within the Menengai caldera, directly (through construction) as well as indirectly (through human activities induced by the project).

(c) Operational Policy OP 17.50: Public Disclosure

The World Bank adopts this measure as the best way to improve project planning and implementation. This procedure cast a duty on governmental agencies to monitor and manage the environmental and social impacts of development projects, particularly those impacting on natural resources and local communities. Community resources may be widely defined to include geothermal energy though all natural resources are owned by the state local community peg ownership to them because they are found within their ancestral land. Based on this, the policy requires that the public be given sufficient information on the projects to enable them partake in informed effective decision making.

(d) World Bank policy OP 4.11 Physical Cultural Resources

OP 4.11 on Physical Cultural Resources, was revised on April 2013 to takes into account the recommendations in *Investment Lending Reform: Modernizing and Consolidating Operational Policies and Procedures*, Given that some cultural resources may not be known or visible, it is important that a project's potential impacts on cultural resources are considered at the earliest possible stages of project processing.

The assessment of impacts to cultural heritage has been based on identified aboveground features and known sites of archaeological interest, this is because, there is no archaeological cultural and settlement inventory covering the project area throughout the history of human occupation. However, as the policy requires, precaution is necessary in case of chance find.

Relevance

The contractor and QPEA will be required to follow chance find Procedures and engage a specialist from National Museums of Kenya (NMK) should any archeological site or artifact encountered during construction.

2.5.2 International Finance Corporation (IFC) Guidelines

(a) IFC Environmental, Health and Safety General Guidelines

The EHS general guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. The guideline will be tailored for the project specific impacts on the environment and human health. The guidelines provide issues and recommendation in the following areas:

- Environmental;
- Occupational health and safety;
- Community health and safety;
- Construction and decommissioning.

(b) IFC Environmental, Health, and Safety Guidelines for Geothermal Power Generation

The EHS Guidelines for Geothermal Power Generation are applicable to geothermal power generation activities such as exploration and reservoir evaluation, production field development, and power plant construction.

The guidelines provide environmental, health and safety issues that may occur during geothermal generation project such as;

- Effluent.
- Air emission.
- Solid waste.
- Well blowouts and pipeline failure.
- Water consumption and extraction.
- Heat.
- Noise.
- Geothermal gases.
- Confined spaces.
- Infrastructure safety.

Environmental, health and safety performance and monitoring indicators are also provided to be used to measure performance and make correction where performance is not satisfactory.

(c) IFC Performance Standards on Environmental and Social Sustainability

The Performance Standards are relevant to the project, providing guidance on how to identify risks and impacts, and help avoid, mitigate, and manage risks and impacts as a way of ensuring project sustainability, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities. In the case of its direct investments (including project and corporate finance provided through financial intermediaries), IFC requires project proponents to apply the Performance Standards to manage environmental and social risks and impacts so that development opportunities are enhanced.

Eight Performance Standards establish standards that the project proponent is to meet throughout the life of an investment by IFC:

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

(d) IFC Performance Standard 8: Cultural Heritage

This Performance Standard recognizes the importance of cultural heritage for current and future generations. In line with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities. In addition, the requirements of this Performance Standard on a project's use of cultural heritage are based in part on standards set by the Convention on Biological Diversity. The key objectives of the standards are:

1. To protect cultural heritage from the adverse impacts of project activities and support its preservation; and
2. To promote the equitable sharing of benefits from the use of cultural heritage.

Among the performance standard requirements, In addition to complying with applicable law on the protection of cultural heritage, including national law implementing the host country's obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage, the client is required to identify and protect cultural heritage by ensuring that internationally recognized practices for the protection, field-based study, and documentation of cultural heritage are implemented.

No archaeological sites have been recorded in the project area and no artefacts were seen on the proposed development site during a visit by archaeological specialist. However, since the project will entail excavation activities, a chance find procedure will be formulated for precautionary purposes. The proponent has obtained No-Objection letter from the NMK (see Appendix VII) in which a Chance Find Procedure has been recommended.

(e) IFC Cumulative Impact Assessment and Management Guidance for the Private Sector in Emerging Markets

The Guidelines are based on IFC's experience in applying its Performance Standards and are to be used in conjunction with the Performance Standards, their Guidance Notes, and the World Bank Group Environmental, Health, and Safety Guidelines, which contain basic requirements and good international practices to be followed when designing, developing, and/or implementing projects. It provides a practical guidance to companies investing in emerging markets to improve their understanding, assessment, and management of cumulative environmental and social impacts associated with their developments.

For private sector management of cumulative impacts, IFC considers good practice to be two pronged:

- effective application of and adherence to the mitigation hierarchy in environmental and social management of the specific contributions by the project to the expected cumulative impacts; and

- best efforts to engage in, enhance, and/or contribute to a multi stakeholder, collaborative approach to implementing management actions that are beyond the capacity of an individual project proponent.

Cumulative Impact Assessment (CIA) should focus the assessment and management strategies on Valued Environmental and Social Components (VECs) such as

- physical features, habitats, wildlife populations (e.g., biodiversity);
- ecosystem services;
- natural processes (e.g., water and nutrient cycles, microclimate);
- social conditions (e.g., health, economics), or
- cultural aspects (e.g., traditional spiritual ceremonies).

It should employ information from a variety of instruments including, regional and local environmental, social and resource studies, programs and/or planning documents; strategic, sectoral, and regional assessments; project impact assessments, cumulative impact assessments, and targeted studies on specific issues.

Project initiated CIA have six objectives:

1. Assess the potential impacts and risks of a proposed development over time, in the context of potential effects from other developments and natural environmental and social external drivers on a chosen VEC;
2. Verify that the proposed development's cumulative social and environmental impacts and risks will not exceed a threshold that could compromise the sustainability or viability of selected VECs;
3. Confirm that the proposed development's value and feasibility are not limited by cumulative social and environmental effects;
4. Support the development of governance structures for making decisions and managing cumulative impacts at the appropriate geographic scale (e.g., airshed, river catchment, town, regional landscape);
5. Ensure that the concerns of affected communities about the cumulative impacts of a proposed development are identified, documented, and addressed;
6. Manage potential reputation risks.

2.5.3 Equator Principles III

The Equator Principles apply globally and to all industry sectors. It applies to the four financial products described below when supporting a new Project:

1. Project Finance Advisory Services where total Project capital costs are US$10 million or more;
2. Project Finance with total Project capital costs of US$10 million or more;
3. Project-Related Corporate Loans Export (including Finance in the form of Buyer Credit) where all four of the following criteria are met;

    - The majority of the loan is related to a single Project over which the client has Effective Operational Control (either direct or indirect).
    - The total aggregate loan amount is at least US$100 million.
    - The EPFI's individual commitment (before syndication or sell down) is at least US$50 million.
    - The loan tenor is at least two years.

4. Under the Equator Principles, Project categorisation is commensurate with the nature, scale and stage of the Project, and with the level of environmental and social risks and impacts.

The categories are:

- **Category A** – Projects with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible or unprecedented;
- **Category B** – Projects with potential limited adverse environmental and social risks and/or impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and
- **Category C** – Projects with minimal or no adverse environmental and social risks and/or impacts.

For all Category A and Category B Projects, the Equator Principles Financial Institutions (EPFIs) will require the client to conduct an Assessment process to address, to the EPFI's satisfaction, the relevant environmental and social risks and impacts of the proposed Project (which may include the illustrative list of issues found in Exhibit II). The Assessment Documentation should propose measures to minimise, mitigate, and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed Project.

The EPFI will require that the Assessment process evaluates compliance with the applicable standards as follows:

- For Projects located in Non-Designated Countries, the Assessment process evaluates compliance with the then applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) (Exhibit III);
- For Projects located in Designated Countries, the Assessment process evaluates compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues. Host country laws meet the requirements of environmental and/or social assessments (Principle 2), management systems and plans (Principle 4), Stakeholder Engagement (Principle 5) and, grievance mechanisms (Principle 6).

2.5.4 African Development Bank Integrated Safeguard Systems, 2013

AfDB adopted Integrated Safeguard Systems (ISS) in 2013 which is the cornerstone of its strategy to promote growth that is socially inclusive and environmentally sustainable. The ISS promotes best practices and also encourages greater transparency and accountability. It provides a process for the people, especially the most vulnerable communities, to express their views by providing project-level grievance and redress mechanisms.

The safeguards aim to:

- Avoid adverse impacts of projects on the environment and affected people, while maximising potential development benefits to the extent possible;
- Minimize, mitigate, and/or compensate for adverse impacts on the environment and affected people when avoidance is not possible; and
- Help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

The Bank requires that borrowers/clients comply with these safeguards requirements during project preparation and implementation. The Integrated Safeguards Policy Statement sets out the basic tenets that guide and underpin the Bank's approach to environmental safeguards. The bank has adopted five operational safeguards as follows:

- Operational Safeguard 1: Environmental and social assessment;
- Operational Safeguard 2: Involuntary resettlement land acquisition, population displacement and compensation;
- Operational Safeguard 3: Biodiversity and ecosystem services;
- Operational Safeguard 4: Pollution prevention and control, hazardous materials and resource efficiency; and

- Operational Safeguard 5: Labor conditions, health and safety.

Operational Safeguard 1: Environmental and social assessment is the overarching governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements.

At the project identification phase, the screening exercise focuses on the environmental and social dimensions of a project to categorise it in one of four categories listed in Table 2-1.

Table 2-1: AfDB categories for Environmental Assessments

Category	Requirement
Category 1	Projects those are likely to cause significant/irreversible environmental and social impacts and require a full ESIA.
Category 2	Projects likely to cause less adverse environmental and social impacts than category 1. Likely impacts are few in number, site-specific, largely reversible, and readily minimized by applying appropriate management and mitigation measures or incorporating internationally recognized design criteria and standards.
Category 3	Projects with negligible adverse environmental and social risks, projects do not directly or indirectly affect the environment adversely and are unlikely to induce adverse social impacts. They do not require an environmental and social assessment.
Category 4	Projects involve investment of Bank's funds through Financial Intermediaries (FIs) in subprojects that may result in adverse environmental or social impacts. Specific requirements for this type of project include an assessment of FI capacities to handle environmental and social considerations.

The geothermal power plant project covers a small area. The impacts during operational phase have potential to be widespread and adverse on lives of the people, wildlife and plants within and in surrounding areas. This study is informed by the fact that geothermal power plants can have severe environmental and social impacts on major sensitive components of the environment, thus require full ESIA studies.

Under the ISS, the Borrower is responsible for integrating environmental and social considerations sponsored projects according to the Bank's requirements.

2.6 International Conventions

2.6.1 Vienna Convention for the Protection of the Ozone Layer

Intergovernmental negotiations for an international agreement to phase out ozone depleting substances concluded in March 1985 with the adoption of the Vienna Convention for the Protection of the Ozone Layer. This Convention encourages intergovernmental cooperation on research, systematic observation of the ozone layer, monitoring of CFC production, and the exchange of information.

The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in September 1987, and was intended to allow the revision of phase out schedules on the basis of periodic scientific and technological assessments. The Protocol was adjusted to accelerate the phase out schedules. It has since been amended to introduce other kinds of control measures and to add new controlled substances to the list.

2.6.2 Convention on Biological Diversity

The purpose of this convention is to ensure the conservation and sustainable use of biodiversity. Kenya signed the convention on 5th June 1992 and ratified the same on 26th July

1992. The National Environment Management Authority (NEMA) is the national focal point to this Convention on Biological Diversity. The provisions of this Convention have been integrated in many laws of Kenya.

2.6.3 African Convention on the Conservation of Nature and Natural Resources

This convention reaffirms the importance of natural resources both renewable and non renewable, particularly the soil, water, flora and fauna. The main objective is to facilitate sustainable use of the above resources. The convention was adopted in Algiers on 15th September, 1968 and came into force on 16th June 1969.

Relevance

Some indigenous trees exist within the project area whose conservation are important. The project shall encourage the planting of indigenous trees to try to restore a balance within the ecosystem.

2.6.4 The Ramsar Convention

Kenya ratified the convention in June 1990. The Ramsar Convention on Wetlands is primarily concerned with the conservation and Management of Wetlands. Parties to the convention are also required to promote wise use of wetlands in their territories and to take measures for the conservation by establishing nature reserves in wetlands, whether they are included in the Ramsar list or not.

The proposed project is expected to observe and adhere strictly to the Ramsar Convention's principles of wise use of wetlands in the project area. Wetlands are defined by the convention on Wetlands or the Ramsar Convention (1971) as: "Areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salty, including areas of marine water the depth of which at low tide does not exceed six meters"

In Kenya, as well as in east Africa, wetlands are defined as: " areas of land that are permanently, seasonal or occasionally water logged with fresh, saline, brackish or marine water, including both natural and manmade areas that support characteristic biota" the latter definition has the approval of the national wetland standing committee of Kenya's Inter ministerial Committee on Environment (IMCE). It is the refinement of Ramsar Convention's definition for the East Africa and does not exclude anything defined by the Ramsar Convention. This definition included swamps, marshes, bogs, soaks, shallow lakes, ox-bow lakes, river meanders and flood plains, as well as riverbanks, lakeshores where wetland plants grow. It also includes marine and inter-tidal wetlands such as deltas, estuaries, mudflats, mangroves, salt marshes, sea grass beds, shallow coral reefs and creeks.

2.6.5 Millennium Development Goals

Whilst there is no mention of energy in each of the eight Millennium Development Goals (MDGs), energy services is inevitably an essential input to achieving all the eight goals. This is due to the fact that in order to implement the goal accepted by the international community, to halve the proportion of people living below the poverty line, by 2015, access to affordable energy services is a prerequisite.

2.6.6 The 1992 UNFCCC

The UNFCCC is a "Rio Convention", one of three adopted at the "Rio Earth Summit" in 1992. Its sister Rio Conventions are the UN Convention on Biological Diversity and the Convention to Combat Desertification.

The primary purpose of the convention is to establish methods to minimize global warming and in particular the emission of the greenhouse gases. The UNFCCC was adopted on 9th May 1992 and came into force on 21st March 1994. The Convention has been ratified by 189

states. Kenya ratified the Convention on 30th August 1994. NEMA is the focal point for the Convention.

2.6.7 Convention on International Trade in Endangered Species

This Convention was adopted on 3rd March 1973 and came into force on 1st July 1975. The purpose of the Convention is to regulate the international trade in wild plants and animals that are at risk of extinction as a result of trade. The Convention seeks to control trade not only in live species but also in dead specimen and their derivatives. The Kenya Government ratified CITES on 13th December 1978. The lead agency for the CITES in Kenya is the Kenya Wildlife Service (KWS).

2.6.8 Kyoto Protocol to the UNFCCC

The Kyoto Protocol requires signatories to the United Nations Framework Convention on Climate Change to reduce their green house emissions levels to 5% below 1990 levels by the year 2012. The Protocol came into force on 16th February 2005, after it received the pre-requisite signatures. However, major countries like United States, China, India, and Australia are not signatories to the Protocol. NEMA is the national focal point for this Protocol.

2.6.9 Convention on the Rights of the Child

The Convention on the Rights of the Child (CRC), 1989 is the most comprehensive compilation of international legal standards for the protection of the human rights of children. The CRC is also the most widely ratified international human rights treaty, ratified by all countries in the world, with the exception of two. The Convention acknowledges children as individuals with rights and responsibilities according to their age and development (rather than the property of their parents or as victims), as well as members of a family and community. Underlying the Convention are four main principles: non-discrimination, the best interests of the child, the right to life, survival and development and the right to participation.

The CRC reaffirms children's basic human rights to health, shelter and education. Special emphasis is placed on safeguarding family unity and the reunification of families (Articles 8, 10, 20). Another fundamental right enumerated in the Convention is the child's right to education and the obligation of states to make primary education free and compulsory for all children (Articles 28, 29). Education has also been identified as an effective and essential form of protection for displaced children. For example, displaced children in school may be more protected from the risks of military recruitment, exploitation and abuse. Educational and recreational activities, like sports, can also help children recover from the trauma of conflict and displacement *(Internal Displacement Monitoring Centre, 2004).*

2.6.10 Convention on the Elimination of all forms of Discrimination against Women

The Convention on the Elimination of all forms of Discrimination against Women (CEDAW) places explicit obligations on states to protect women and girls from sexual exploitation and abuse.

Universal Declaration of Human Rights (Article 7), the UN Charter (Articles 1, 13, 55, and 76) and the International Covenant on Civil and Political Rights (Article 24) reaffirm the freedoms and rights of all children, including internally displaced children.

2.6.11 International Labour Organisation

Since 1919, the International Labour Organization (ILO) has developed and maintained a system of international labour standards aimed at promoting opportunities for women and men to obtain decent and productive work, in conditions of freedom, equity, security and dignity.

International labour standards are legal instruments drawn up by the ILO's constituents (governments, employers and workers) and set out basic principles and rights at work. They are either *conventions*, which are legally binding international treaties that may be ratified by

member states, or *recommendations*, which serve as non-binding guidelines. Some of the key provisions that must be observed under the standards include:

- Freedom of association of workers;
- Prevention of Forced labour;
- Prevention of Child labour; and
- Prevention of Discrimination

Kenya is a signatory to ILO since 1963 and all labour conditions in the country are expected to abide by the ILO standards and international best practices.

3 DESCRIPTION OF PROJECT ENVIRONMENT

3.1 Physical Environment

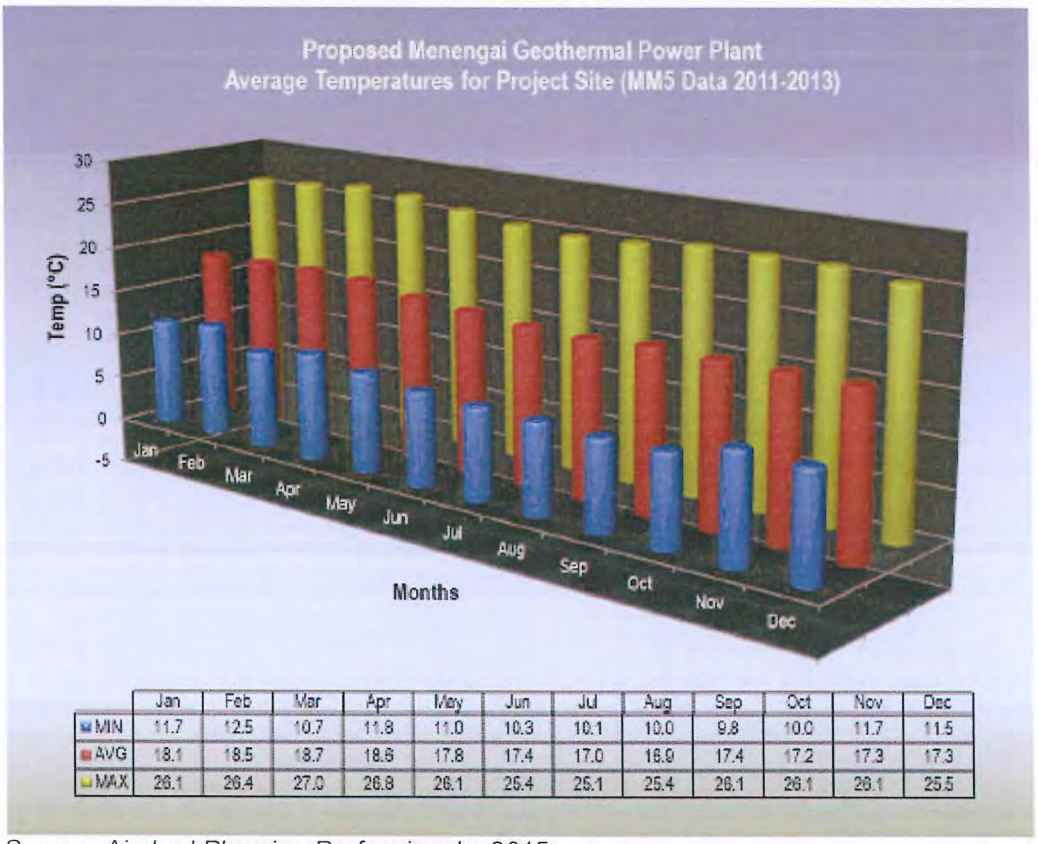
3.1.1 Climate

The project area is classified into two main agro-climatic zones. The lowland areas of Mogotio and Kisanana in the north are located in semi-arid zone IV with an annual rainfall of 800 mm and mean temperatures of 30°C. Njoro, Bahati and parts of Kampi ya Moto divisions with an altitude of between 1800 m and 2400 m above sea level and average rainfall of between 760 mm and 1270 mm per year fall within a dry sub-humid equatorial climatic zone.

(b) Temperature

In the general area, temperatures vary with topography and range from 9.4 to 29.3 °C.

Minimum, mean and maximum temperatures for the Project site for the period January 2011 – December 2013 are illustrated in Figure 3-1 below.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MIN	11.7	12.5	10.7	11.8	11.0	10.3	10.1	10.0	9.8	10.0	11.7	11.5
AVG	18.1	18.5	18.7	18.6	17.8	17.4	17.0	16.9	17.4	17.2	17.3	17.3
MAX	26.1	26.4	27.0	26.8	26.1	25.4	25.1	25.4	26.1	26.1	26.1	25.5

Source: Airshed Planning Professionals, 2015

Figure 3-1: Minimum, mean and maximum temperatures for the Project site

Annual average maximum, minimum and mean temperatures for the Project site are given as 27.0°C, 9.8°C and 17.7°C, respectively, based on the 2011 to 2013 modelled data. Average daily maximum temperatures range from 16.7°C in April to 18.5°C in July, with daily minima ranging from 20.8°C in April to 14.5°C in August.

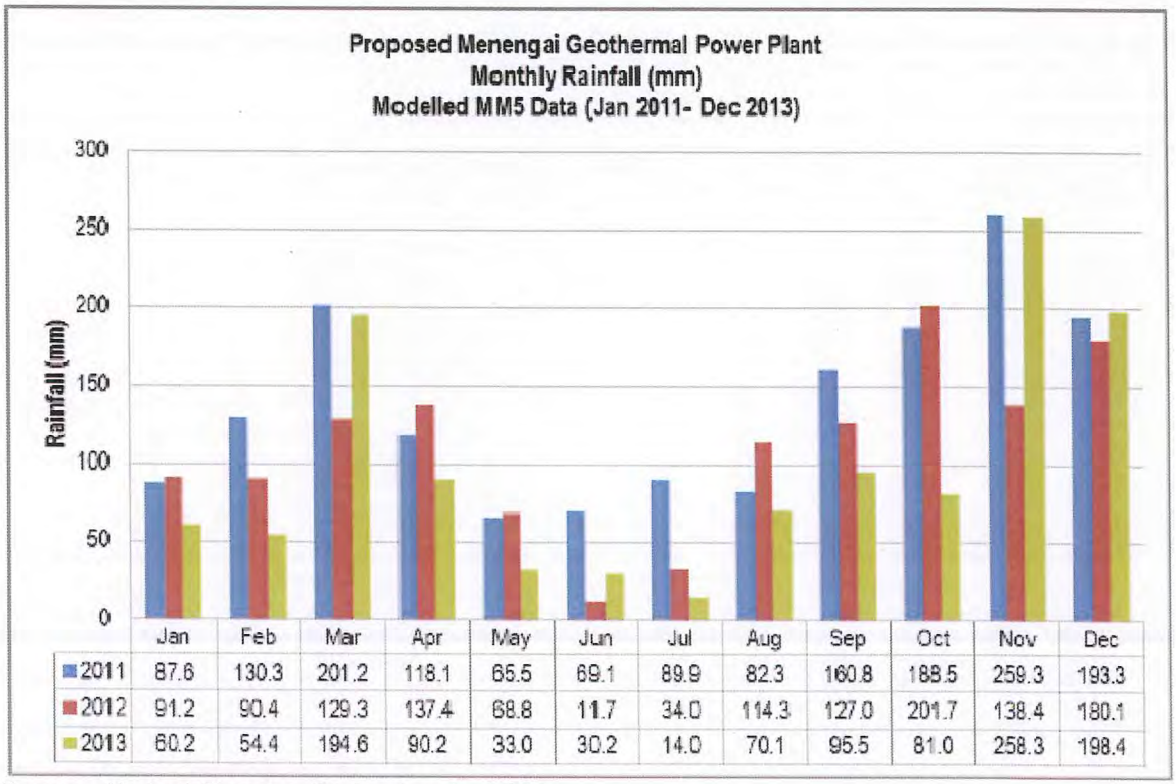
During the day, temperatures increase to reach maximum at around 12:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 06:00 i.e. just before sunrise.

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers.

(c) Rainfall

Around Nakuru area, mean annual rainfall is approximately 900 mm. The rainfall regimes are bimodal with the long rains occurring in March to July and the short rains in September to November.

Monthly rainfall for the Project site (January 2011 – December 2013) is given in Figure 3-2. Average total annual rainfall for this period is in the range of 1380 mm. The study area falls within a summer rainfall region, with over 65% of the annual rainfall occurring during the October to March period.



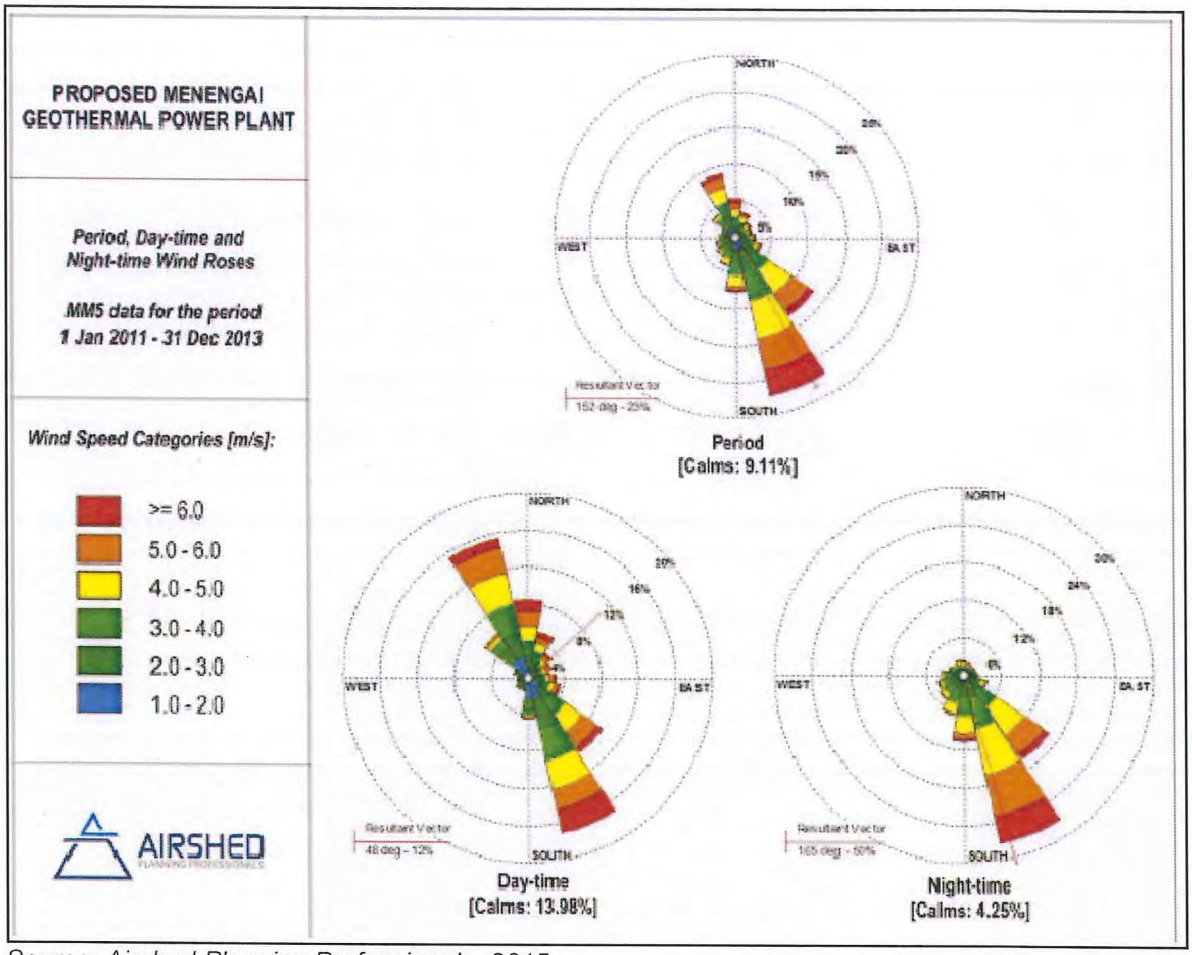
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	87.6	130.3	201.2	118.1	65.5	69.1	89.9	82.3	160.8	188.5	259.3	193.3
2012	91.2	90.4	129.3	137.4	68.8	11.7	34.0	114.3	127.0	201.7	138.4	180.1
2013	60.2	54.4	194.6	90.2	33.0	30.2	14.0	70.1	95.5	81.0	258.3	198.4

Source: Airshed Planning Professionals, 2015

Figure 3-2: Monthly rainfall for the Project site (January 2011 – December 2013)

(d) Surface wind field

Wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the red area, for example, representing winds in between 6 and 10 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.



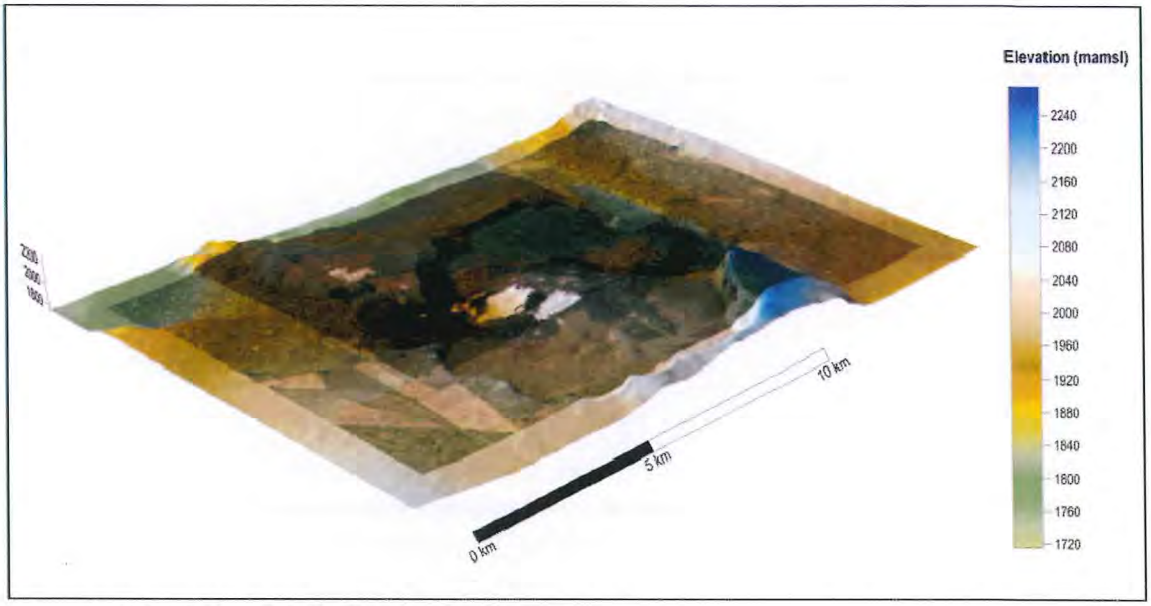
Source: Airshed Planning Professionals, 2015

Figure 3-3: Period, day- and night-time wind roses (MM5 Data, 2011 to 2013)

The period wind rose (Figure 3-3) depicts the predominance of south-south-easterly winds with wind speeds of greater than 5 m/s. The day-time wind rose shows an increase in winds from the north-westerly and northerly sector, whereas the night-time wind rose shows a decrease in the northerly and north-westerly winds and an increase in the south-easterly, south-south-easterly and southerly winds.

3.1.2 Topography

An analysis of topographical data indicated a slope of more than 1:10 from areas of operations to the nearest elevated point. The topography of the study area is shown in Figure 3-4 overleaf.



Source: Airshed Planning Professionals, 2015

Figure 3-4: Topography of study area

3.1.3 Geology and Soil

Menengai Caldera is characterized by two trachytic main rock series by age. The older one is that of Pliocene which is characterized by two successive strata. The earlier one is of Pliocene and is characterized by phonolitic trachytes. These appear to have formed during volcanic processes before the formation of the caldera as depicted by their outcrops on the walls of the caldera's ring-structure. Overlying the phonolitic trachytes is the successive stratum that comprises welded vitreous tuffs and ignimbrites. These extend briefly outwards from the ring-structure, except markedly longer extensions towards south east and north-west, with bias towards northwest direction (Figure 3-5). This implies a major direction of flow during the volcanic episode.

The younger rock series is recent (Quaternary) and is characterized by trachyte flows. Glassy flows are common among the recent series. This series cover almost all the caldera floor (Figure 3.1) and its occurrence depicts products of volcanic processes that accompanied or followed after the caldera-collapse.

Like in many other sections Eastern African Rift System, Menengai Caldera occurs within a normal-fault-system. Generally, the occurrence appears as an interruption of intense faulting and fracturing that runs north-south Kenya's rift valley. However at and around the caldera, the ring-structure of the fault created by formation of the caldera is conspicuous. Other associated faults are also observed in and around the caldera. Other noticeable structures are lava flow structures that are depicted by the rocks structures. These include ropy, bandy, blocky and glassy structures of rocks observed inside the caldera during this study. The lithological and structural geology play a part in the physiography of the project area.

The soils in the prospect area are volcanic soils of varying thickness. These occur together with superficial deposits. Due to the physiography of the caldera, patches of alluvial deposits are found in some basinal features within the caldera, and the lower areas from the base of the volcano outwards.

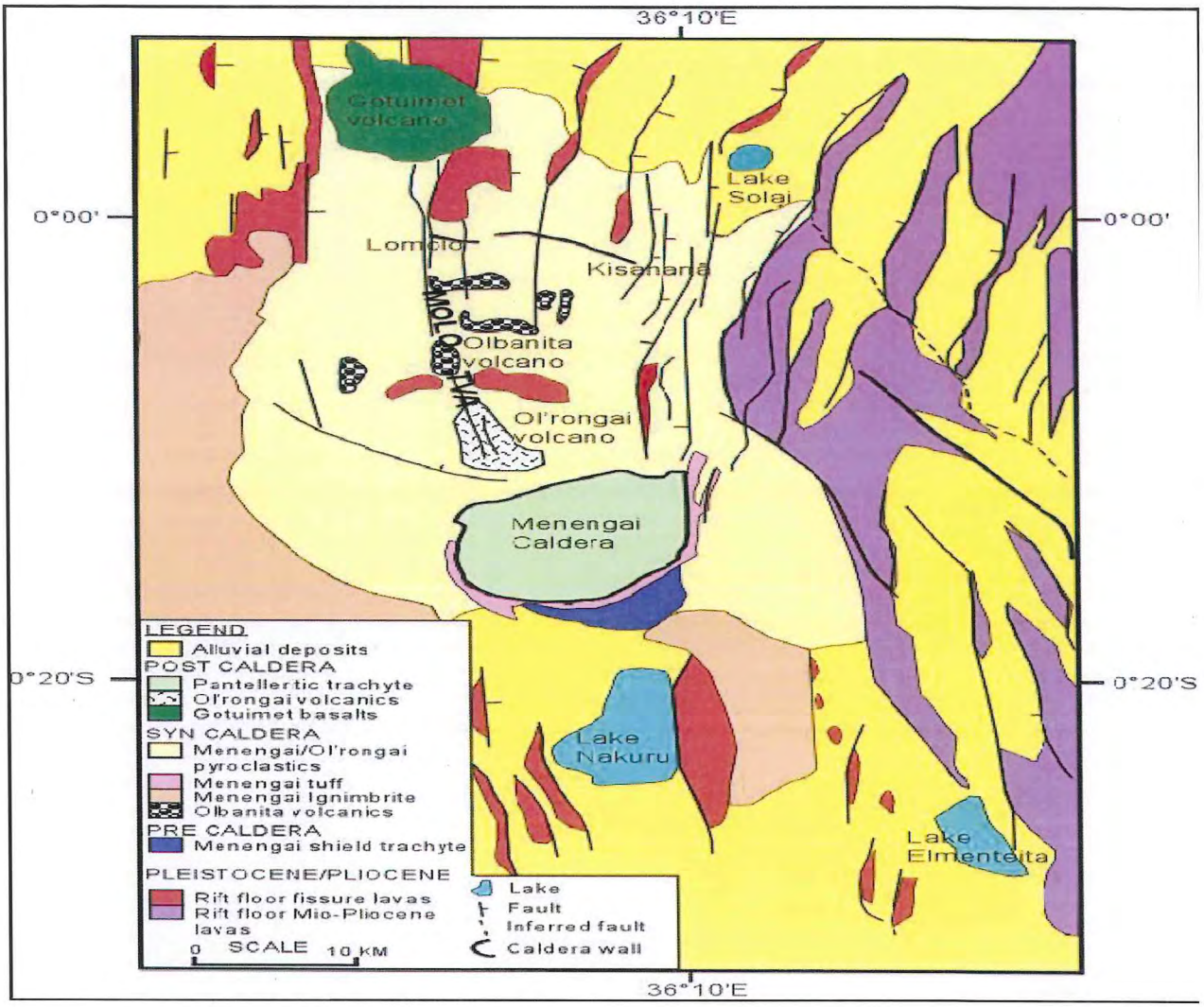


Figure 3-5: Geological Map of Menengai Caldera

Source: GDC

3.1.4 Hydrology and Hydrogeology

The Menengai area lies on the rift floor that gently slopes northwards. On the east, the Bahati and Marmanet scarps bound the eastern inner rift trough and are relatively higher and wetter grounds. To the west the rift floor slopes gently into a series of ridges connecting the Mau-Londiani-Kilombe hills. The surface drainage system is therefore largely internal from the east and the western scarps (Figure 3-6). On the rift floor, the drainage is mainly from Menengai Caldera northwards with the exception of the drainage from the southern rim or slopes of Menengai Caldera into Lake Nakuru. The permanent rivers in the area (but located outside the caldera) are Molo and Rongai in the NW area. The perennial rivers are the 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 interrupting the Olbanita stream at several places. Other surface water bodies include Lakes Nakuru and Solai, and the Olbanita swamp.

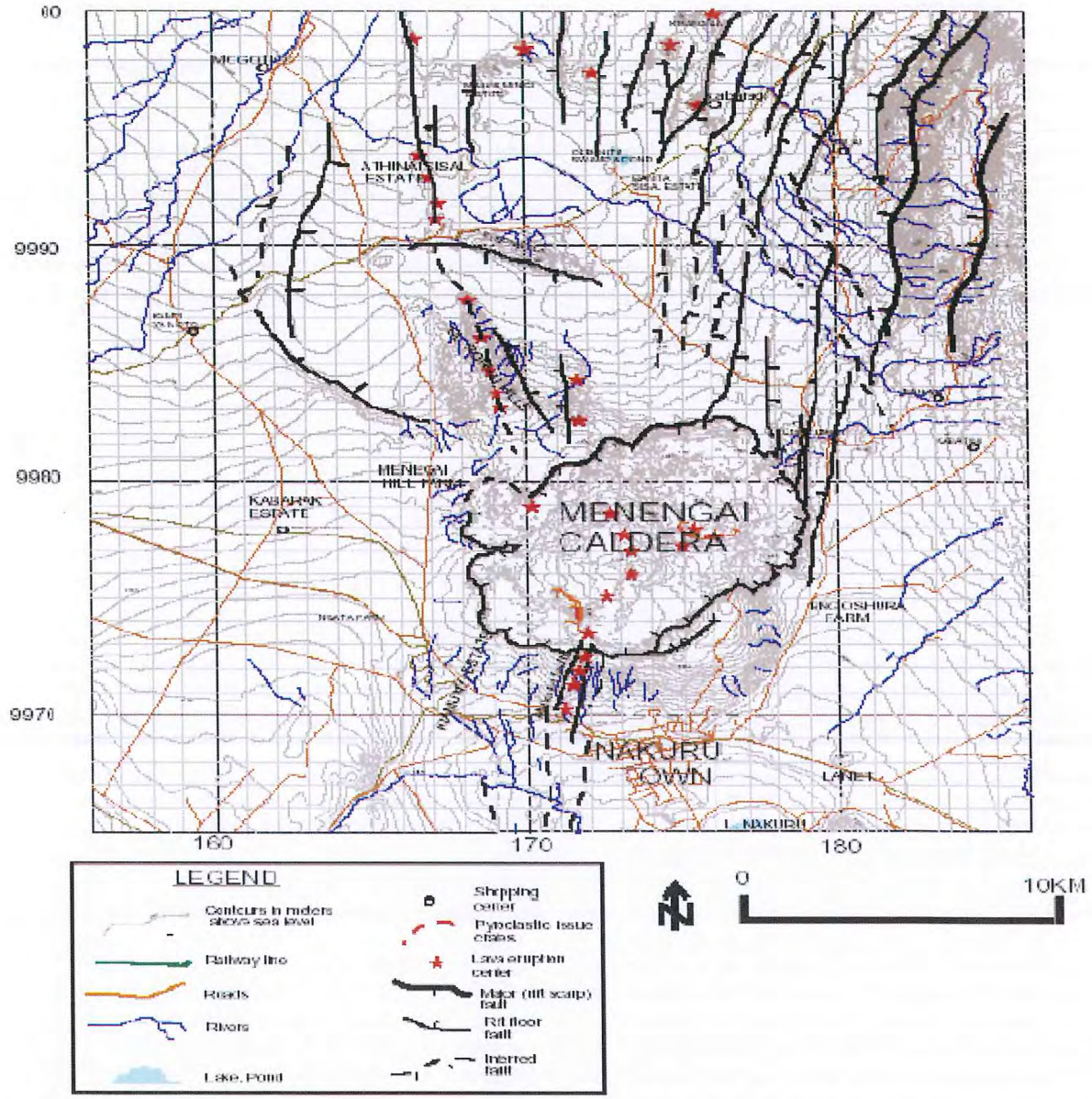


Figure 3-6: Map of Menengai Volcano illustrating surface drainage patterns and lava eruption centres

Source: GDC

Lake Nakuru represents the intersection of a piezometric surface and a topographic surface (see Figure 3-7). The ground water around Lake Nakuru and northwest of the lake is

controlled by a sedimentary formation comprising of lake sediments and reworked pyroclastics. The boreholes immediately to the north and northwest of the lake show lake water contamination indicating interconnection (Geotermica Italiana Srl, 1987). The same sedimentary formations are found in the boreholes located in the east of Menengai caldera implying connectivity with the N-S running Solai tectonic axis. There is one location inside the caldera on the eastern rim where a cold spring occurs at the foot of the caldera, further confirming that the southern part of the Solai tectonic axis is an important control for groundwater movement.

The Olbanita swamp is located in an area dominated by dry and thermally anomalous boreholes. The productive ones are characterized by very shallow, low-yield aquifers that get depleted fast since the deeper formations are impervious. These are perched water bodies adjacent to the swamp. The swamp owes its existence to impervious bedrocks that have been affected by hydrothermal alteration. The formations underlying the swamp are the ignimbrite beds that show marked hydrothermal alteration.

Majority of the boreholes in the prospect area were drilled to between 100-200 m depths. The relative yields may be matched with petro-physical property of the feeder formations expounded below.

1. *Very high yield boreholes (>20 m^3/h)*: Hosted in fractured, fresh lavas and talus. These are boreholes located on the eastern scarps and Bahati areas and are normally fed by channels along rift scarps faults.
2. *Moderate high yield boreholes (9-15 m^3/h)*: Aquifers include lacustrine beds, reworked volcanicalstics and fractured lavas in the rift floor. These are mainly found in boreholes around Lake Nakuru, Nakuru town, to the east and north east of Menengai caldera along the Solai TVA and around Kisanana.
3. *Poor yield Boreholes (<6 m^3/h)*: Aquifers are inter-bedding contacts between tuff and ignimbrite beds. These types of boreholes are found to the east of Menengai caldera, Kampi ya Moto and Rongai areas.
4. *Dry and thermally anomalous boreholes*: These include the completely dry boreholes and those that encountered perched water bodies and therefore dried up after the aquifer was depleted and those that produced low-pressure steam, hot water and CO_2. These are distributed along the Molo TVA that extends from the Menengai caldera northward through the Ol'rongai volcano, Lomolo, Goitumet volcano (See Figure 3-7).

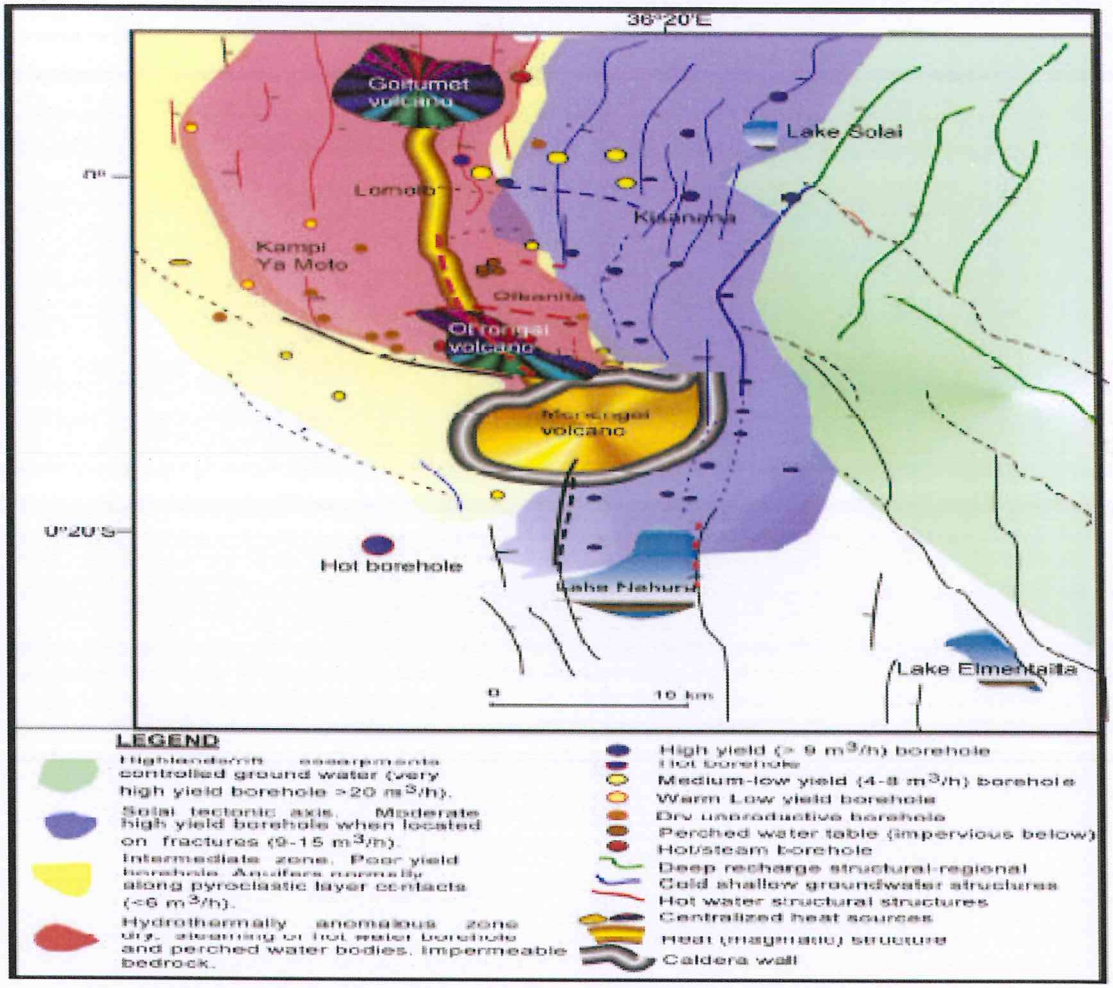


Figure 3-7: Hydrogeological regime of the Menengai and the surrounding

Source: GDC

The geology and soils of Menengai volcano partly control the surface run off pattern. Radiating away from the caldera are gullies and stream valleys along which run off water flows. The streams are seasonal and discharge into rivers at the floor of the rift valley. From the walls of the fault surrounding the caldera, streams drain into the caldera, some of which flow most times of the year. Some of the streams flow over structures within the caldera as illustrated in photo plate 3.1 below.

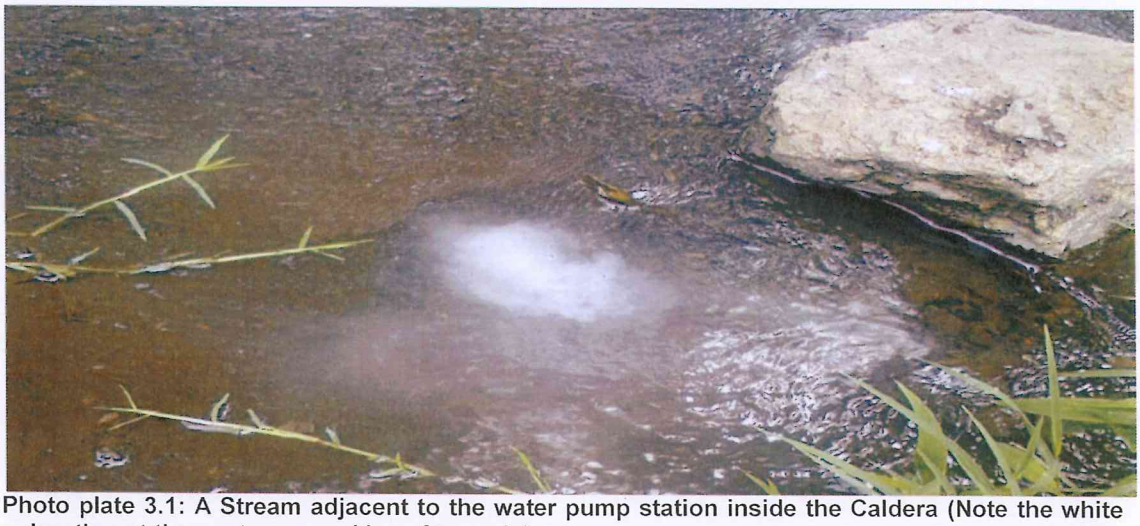


Photo plate 3.1: A Stream adjacent to the water pump station inside the Caldera (Note the white coloration at the centre caused by a fumarole)

The presence of boreholes in and outside the caldera is depictive of the hydrogeology of the project area. GDC has successfully drilled bore holes inside the caldera, while numerous other bore holes have been drilled in the wider Menengai area (Figure 3-8).

Geothermal wells with over 2km depth have been drilled in the caldera mainly in the central parts. This is indicative of occurrence of aquifers at different levels and with different water qualities. The structural geology and possible presence of porous volcanic rocks could be the main features that allow for ground water at the different levels and therefore different chemical composition depicted by the white colour geothermal spring at the bottom of the stream (See Plate 3.1 above).

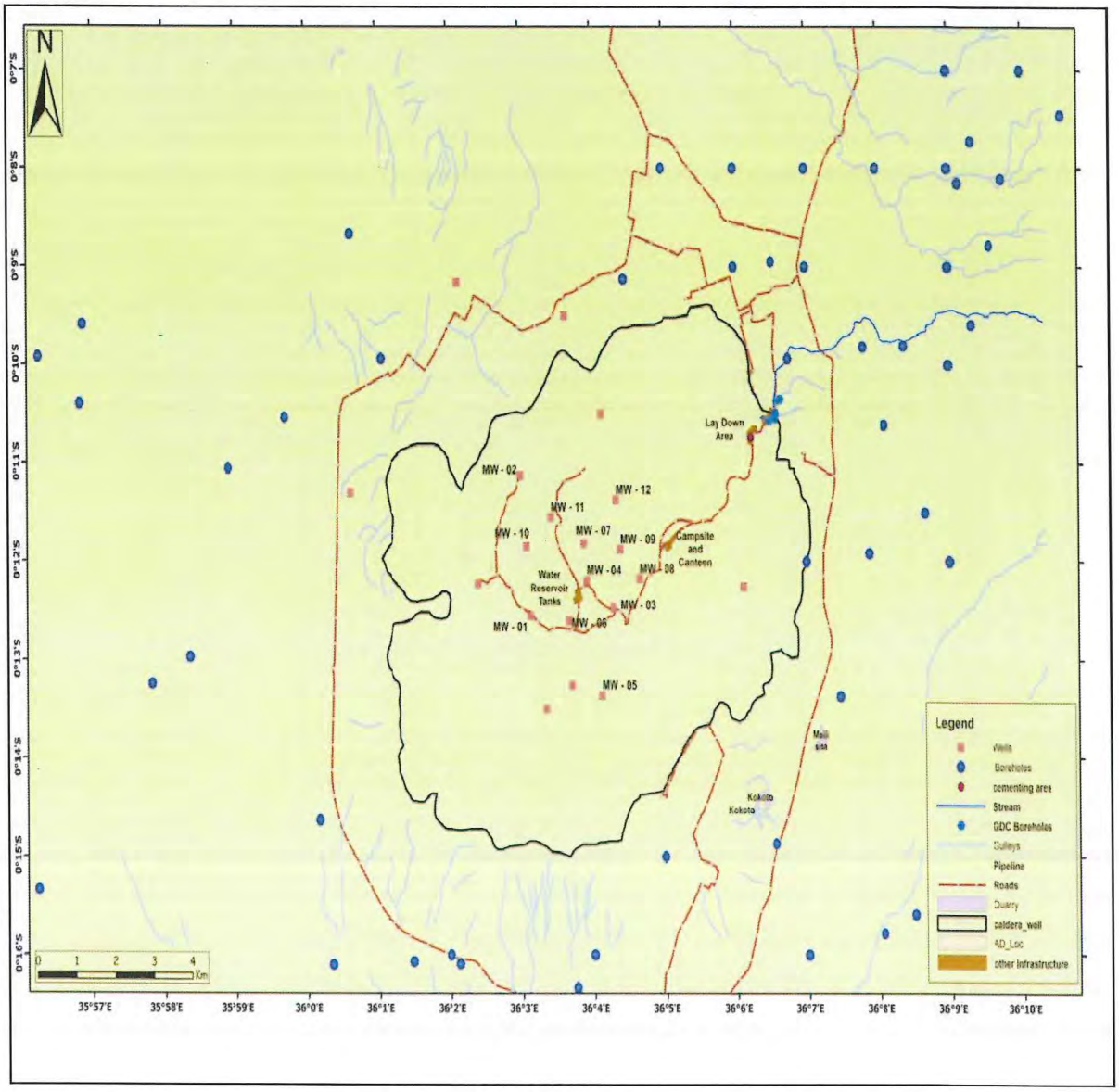


Figure 3-8: **Map Showing Surface and Ground Hydrology at the Menengai Volcano**

Source: GDC

3.1.5 Water and Effluent Quality

Laboratory analysis results of the quality of drilling water returns, geothermal brine and hot spring are presented in Table 3-1 and Table 3-2 below.

Table 3-1: Quality of the Stream Water, Hot Spring and MW-01 Geothermal Brine

Parameter	Stations			NEMA effluent standards
	Geothermal feature (Plate 3.1)	Stream at Pump Station Menengai	MW-01 Brine	
pH	7.63	7.31	9.24	6.5-8.5
Chlorides(ppm)	7.18	0.69	444.8	
Total dissolved solids (ppm)	690.00	354.00	190.90	1.0
Conductivity (µS/cm)	544.00	95.30	313.00	10
Fluorides (ppm)	1.20	0.72	2.76	10
Turbidity (NTU)	15.17	291.00	0.14	0.5
Silica(ppm)	ND	ND	17.90	1.0
Aluminium(ppm)	0.81	10.57	0.05	1.0
Iron(ppm)	0.12	6.34	0.37	250
Potassium(ppm)	8.24	5.74	392.00	1.5
Manganese(ppm)	0.02	0.22	NIL	0.01
Lead(ppm)	ND	ND	0.10	2.0
Zinc(ppm)	0.02	0.12	ND	0.01
Cadmium(ppm)	ND	ND	ND	0.01
Copper	ND	1.13	ND	
Boron	ND	ND	ND	

Source: GDC Monitoring Report

Table 3-2: Effluent Quality of Drilling Water Returns and MW1 Geothermal Brine

Parameter	Stations		NEMA effluent standards
	MW1 Drilling Water Returns	MW1 Brine	
pH	7.58	9.72	6.5-8.5
Conductivity (mS/cm)	1.13	15430	
Sulphur (S)	117.3		1.0
Iron (Fe)	0.66	ND	10
Manganese (Mn)	2.89	ND	10
Zinc (Zn)	0.03	0.2	0.5
Copper (Cu)	<0.01	ND	1.0
Boron (B)	0.43	ND	1.0
Chloride (Cl)	10.99	1.0	250
Florides (F)	10.95	193.71	1.5
Cadmium (Cd)	<0.01		0.01
Chromium (Cr)	<0.01	0.007	2.0
Lead (Pb)	0.02	ND	0.01
Selenium (Se)	<0.01		0.01

Source: GDC Monitoring Report

The brine is alkaline whereas chloride concentration is high (444.4 ppm) which is typical of chloride geothermal water. Silica was also higher than the NEMA recommended limits. Except for chlorides and conductivity, which varied significantly (subject to experimental errors), compared to the GDC monitoring data, the rest of the data obtained during the ESIA study, fairly matched with the GDC data.

Toxic heavy metals such as lead, cadmium, zinc and copper were below detection limits. With proper disposal, the dangers of accumulation of heavy metals in the environment is minimal and even non-existent considering that the brine is alkaline and therefore uptake by plants especially lead and cadmium from geothermal water is inhibited (Simiyu, 2004). The drilling water returns and brine effluent will be discharged in lined ponds and later re-injected, to safeguard ground water.

Wanyororo spring water and raw water from Nakuru Water Sanitation Services Company (NAWASSCO) before treatment have elevated fluoride concentrations (See Table 3-3). However, after treatment the fluoride levels reduced to below recommended safe limit (1.5 ppm). Thus water treatment is necessary in this area if fluoride associated effects have to be minimized.

Table 3-3: Quality of drinking water sources in Menengai project area

Parameters	NAWASSCO Treat Water	NAWASSCO Raw Water	Wanyororo Spring Water	KEBS Standards	W.H.O Standards
pH	8.91	8.87	1.4	6.5-8.5	8.5
Conductivity µS/cm	13.86	1030		2500	<1500
Chloride	1.0	50	4.93	250	<250
Fluoride	0.07	13.31	2.01	1.5	1.5
Sulphide	0.001	0.001	1.68	0.1	<84
Copper	ND	0.02	<0.01	1.0	<2.0
Zinc	0.72	0.23	<0.01	5.0	<3.0
Chromium	0.004	0.008	<0.01	0.05	<0.05
Boron	ND	ND	ND	<0.01	<0.3
Cadmium	ND	ND	ND	<0.01	<0.1
Lead	ND	ND	ND	0.01	<0.01
Nickel	ND	ND	ND	0.01	<0.02
Selenium	ND	ND	ND	<0.01	<0.02
Mercury	ND	ND	ND	<0.01	<0.01
Arsenic	ND	ND	ND	<0.01	<0.02

Source: GDC Monitoring Report

3.1.6 Air Quality

The proposed geothermal power plant is located in an area affected by natural sources of atmospheric emissions, including steam, carbon dioxide, and H_2S, via natural geothermal features such as vents and fumaroles and in some areas the smell of hydrogen sulfide is perceptible. It is notable that a number of geothermal production wells have already been drilled within the caldera by GDC while some new well drilling and testing, including construction of drilling infrastructure (well pads and access roads) are still ongoing. These activities already have implications on the project area air quality.

Potential atmospheric emissions from the Project are discussed in section 7; the only air pollutant considered to be of concern in the study is H_2S. Monitoring for H_2S levels in the ambient air from existing geothermal features (wells within the caldera) was conducted by the University of Eldoret in 2013. The results of this campaign are given in Table 3-4.

Table 3-4: Summary of pre-development ambient air quality sampling campaign results (Muse, 2013)

Period	Well	H_2S concentration ($\mu g/m^3$)	H_2S concentration (ppm)
Jan 2013	MW-1	1200	0.8
Jan 2013	MW-4	1800	1.2
Jan 2013	MW-3	900	0.6
Jan 2013	MW-9	9750	6.5
Feb 2013	MW 1	2100	1.4
Feb 2013	MW-4	2700	1.8
Feb 2013	MW-3	600	0.4
Feb 2013	MW-9	6750	4.5
March 2013	MW-1	2400	1.6
March 2013	MW-4	3300	2.2
March 2013	MW-3	2400	1.6
April 2013	MW-3	1800	1.2
April 2013	MW-9	2100	1.4
April 2013	MW-12	7200	4.8
May 2013	MW-12	8550	5.7
May 2013	MW-3	2700	1.8
June 2013	MW-1	3450	2.3
June 2013	MW-3	2100	1.4
June 2013	MW-4	3900	2.6
June 2013	MW-9	2550	1 7

Source: GDC Monitoring Report

The concentrations of H_2S were monitored and it was found that they were high at the weir box in the discharging wells while in the rest of the working areas the concentration levels were zero ppm. At most of these monitored wells, the odour threshold (0.00046 ppm-0.002 ppm or 0.76-3.21 µg/m3) is frequently exceeded, as well as the ACGIH TLV for hydrogen sulfide which is set at 1 ppm (1.5 mg/m^3) for an eight hour exposure.

3.1.7 Noise

The existing major sources of noise in the Menengai Caldera are generators supplying power to the rigs, discharging wells, electric motors, air compressors, mobile machinery, mud pumps, drilling operation, all of which operate around the clock. The environmental noise impact of geothermal drilling operations results from a combination of noise from all these sources.

Noise level monitoring and assessment in Menengai is carried out at least three times per week to establish both background and operational noise levels. This monitoring is carried out in compliance to the provisions of Environmental Management and Co-ordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009 regarding noise limits at the work place and also the Occupational Safety and Health and Act 2007. The noise level in the proposed project area was assessed using an Integrated Handheld Sound Level meter (Model Extech 407768). The results are summarized in Table 3-5 below.

Table 3-5: Average noise levels at various locations in Menengai taken over a period of 8 months (2012-2013)

Zones		Stations	Sound level limits dB(A)
		Coordinates	Day (Average)
A	Pump house	9980536.71N 177969.17E	58.6
B	Lay down	9980346.51N 177647.11E	61,6
C	Campsite	9978263.77N 175548.60E	67.7
D	MW-03	9976408.8N 174140.9E	72.1
E	Tank site	9976588.0N 173220.0E	58.0
G	MW-01	9976852.51N 173498.67E	64.1
H	MW-04	996900.05N 173565.68E	42.2
I	Mlima Punda	9975742.66N 173498.67E	64.9
J	Mw-06	99766243.5N 173119.6E	50.1
K	MW-07	9977586.30N 1705504.21E	44.4
	MW-08	9977809.9N 173458.92E	53.3
L	MW-09	9977299.73N 172879.32E	77.3
M	MW-10	9975815.38N 173729.9E	70.8
N	MW-11	9976592.79N 172433.511E	59.9
O	MW -12	9978707.31N 1723745.12E	60.4
P	MW- 13	9977192N 772464E	68.7
Q	MW - 14	9979004N 173744E	87.6
R	MW - 15	9977463N 175201E	76.7

Source: GDC Monitoring Report

Noise level at the discharging well was recorded at 91.5 dB, which is above the recommended ambient and occupational standards (45 and 85 dB) respectively. As one gets away from the well the noise decreases to a low of 43.5 dB at the pumping station (Pump not running at the time of study).

Noise levels during drilling operations are higher closer to the drilling rig under weather conditions that allow drilling noise to dominate the overall noise levels such as light winds from the drilling sites towards the neighbour, low cloud, temperature inversions etc.

Background noise is significantly low at night. Night-time measurements were all conducted outside the Menengai crater within community areas.

For estimating cumulative impacts within Menengai crater, the following conservative representative background noise levels were used in the noise modeling:

- 45.2 dBA (lowest median value)for the night; and
- 55.2 dBA for the day.

3.2 Biological Environment

A detailed ecological survey covering flora and fauna in both the disturbed and undisturbed areas of the caldera was carried out by the University of Eldoret. The idea behind this survey was mainly to determine biological baseline before implementation of the proposed project.

3.2.1 Flora

The survey identified a total of 217 plant species in the Menengai Caldera (See Appendix III). These species consist of herbs (132), shrubs (45) and trees (40). The *Rhus natalensis*, *Dodonea sp.* and *Tarchonanthus comphoratus* are among the most dominant species.

The Menengai Caldera also contain some plant species that are believed to be rare and unique to this area such as *Artemisia afra* (Photo plate 3.2), *Protea gaguedi, Tetradenia riparia, Diplolophium africanum, Agauria salicifolia* and *Osyris lanceolata.* Remnants of endangered tree species the East African sandalwood (*Osyris lanceolata*) was sighted in the Caldera (Photo plate 3.3). An online search of these species conservation status established that they have not been assessed for the IUCN red list (IUCN, 2014). However, *Osyris lanceolata* is of national conservation importance and is listed as endangered in the sixth schedule of wildlife conservation and management Act of 2013.

Photo plate 3.2: *Artemisia afra* - one of the rare and unique to the Menengai Caldera

Photo plate 3.3: *Osyris lanceolataone* (East African Sandalwood) - An endangered tree species found in the Caldera.

3.2.2 Fauna

There are few wild animal species in the project area as reported by FOMEC (2011). This is because large parts of the area are farmlands with no open grazing and dispersal areas. Animal species such as baboons (Photo plate 3.4), leopards, wild pigs and snakes are common within Menengai Caldera. Cases of Human - Wildlife conflicts mainly due to invasions of farms by baboons and monkeys have been reported. Other wild animals present include antelopes, dikdik, gazelles, ant bears, leopards, snakes (puff udder). No wildlife migratory corridors have been established in the project area.

(a) Mammals

The Caldera is home to 9 species of mammals (See Appendix 5). Hyraxes, rabbits and baboons were recorded. Evidence of some cats including jackals and leopards was also confirmed from faecal remains and paw-prints as shown on photo plate 3.5 below.

Photo plate 3.4: A baboon sported in one of the sites near the forest in Menengai Caldera

Photo plate 3.5: Leopard foot prints at Well 1

(b) Herpetofauna

Three reptile families (Agamidae, Boidae and Elapidae) were encountered in the project area (See Appendix 5). Four species from these families were recorded; namely: Red-headed Rock Agama, the Elmentaita Rock Agama, African Rock Python and Forest cobra.

The African Rock Python (*Python sebae*) is classified in the Wildlife Conservation and Management Act of 2013 as endangered.

(c) Avifauna

The Rift valley is a major fly way form migratory birds which include heavy birds as well as small ones. A total of 40 birds species were recorded at the Menengai crater (See Appendix V). Common bird species spotted in the caldera include malachite sunbird, doves, swifts, swallows and woodpeckers. Among them are rare species such as African black eagle (See photo plate 3.6 below) and the protected Nyanza swift.

Photo plate 3.6: The African black eagle flying in the project area

3.3 Socio-Economic Environment

3.3.1 Background

A household socio-economic survey aimed at assessing and establishing the current social, cultural and economic conditions of the persons living in the projects primary and secondary zones of impact was conducted between 20 October 2014 and 19 November 2014. The survey was conducted in a total of fourteen sub locations. Mercy Njeri sub location was the only one located in the primary zone of impact whereas the other 13 sub locations were within the secondary zone of impact. These sub locations include:

- Kabatini;
- Maili Sita;
- Teachers;
- Kiamaina;
- Maili Kumi;
- Wanyororo;
- Bahati;
- Ol Rongai;
- Kampi ya Moto;
- Menengai;
- Landi Mawe;
- Ndungiri; and
- Kirima.

The proposed geothermal power plant will be constructed within the caldera area which falls in Mercy Njeri sub location. This will be the primary zone of impact whereas the secondary zones of impact are the neighbouring settlement bordering the caldera. These sub locations are within Nakuru North and Rongai sub counties.

(a) Administrative boundaries

The Menengai Geothermal field lies within Rongai and Nakuru North Sub Counties of Nakuru County. It borders Subukia Sub County to the North, Bahati Sub County to the East and Nakuru West Sub County to the South. The project area of influence covers locations such as;

- Kabatini;
- Teachers;
- Kiamaina;
- Bahati;
- Ol Rongai;
- Kampi ya Moto;
- Menengai;
- Solai; and
- Kirima.

3.3.2 Population and Household Characteristics

The population figures for the two Sub counties as per the 2009 Kenya Population and Housing Census are presented in Table 3-6 below.

Table 3-6: Population figures for Sub Counties within the Project Area

Sub County	Male	Female	Total Population 2009	Projected Population-2015	Projected Population-2017
Nakuru North	103,316	108,375	211,691	262,074	278,558
Rongai	82,665	81,199	163,864	202,864	215,624

Source: 2009 Population and Housing Census

The 2015 and 2017 projections of population sizes are based on the Nakuru County population growth rate estimated at 3.05% per annum (Nakuru County Integrated Development Plan, 2013).

(a) Demographic characteristics

The demographic characteristics of the study area population are presented in Table 3-7. 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. The productive segment of the population (20 – 55yrs) is about 52.1% while old people (> 55 years) accounted for 8.4%. This indicates that the dependency ratio in the project area is relatively low, meaning that those not in working age do not have pressure on the working age group.

Table 3-7: Demographic characteristics of the study area

Age Distribution	Percentage Distribution		Grand Total
	Male	Female	
0-4	10.0	10.4	10.2
5-9	8.3	10.4	9.4
10-14	13.3	6.7	9.8
15-19	9.2	11.1	10.2
20-24	6.7	11.9	9.4
25-29	10.0	10.4	10.2
30-34	9.2	12.6	11.0
35-39	10.8	8.1	9.4
40-44	8.3	3.0	5.5
45-49	3.3	2.2	2.7
50-54	3.3	4.4	3.9
55-59	0.8	0.7	0.8
60-64	0.8	2.2	1.6
65-69	0.8	2.2	1.6
70-74	2.5	2.2	2.4
75-79	0.8	0.7	0.8
80-84	1.7	0.0	0.8
85-90	0.0	0.7	0.4
Grand Total	**100**	**100**	**100**

Source: Field Survey November 2014

The situation is presented in Figure 3-9 below.

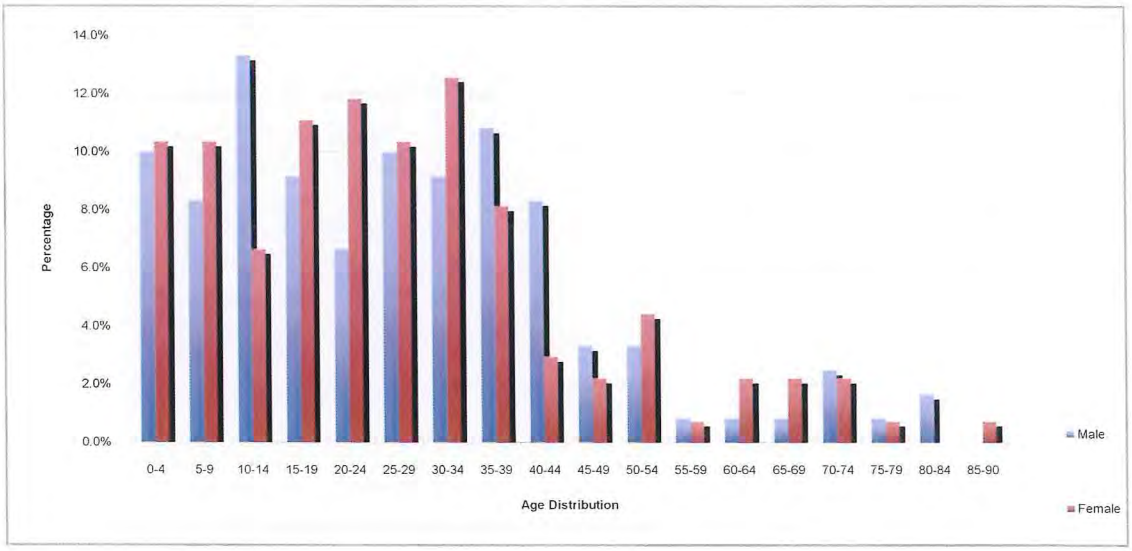


Figure 3-9: Demographic structure according to the Ages and Sex of the Population neighbouring the Study Area (Field Survey, November 2014)

(b) Household Headship

As presented in Table 3-8 below, majority of households surveyed are male-headed (81.7%) whereas 18.3% of the households are female-headed.

Table 3-8: Household headship of the study area

Sex	Distribution	Area		Total
		Project area (Caldera)	Project neighboring communities	
Male	Frequency	3	656	659
	% within Area	75	88.4	81.7
Female	Frequency	1	86	87
	% within Area	25	11.6	18.3

(c) Religion

A survey of the households in the primary project area revealed that all the inhabitants were Catholics. Within the project neighbouring communities the survey revealed two major religions professed by inhabitants of the area. These are Islam and Christianity. Muslims accounted for about 0.3% while Christians are over 94.4%. Only a small proportion (5%) had no religious affiliation. This distribution is shown in table 3.5 and illustrated in Figure 3-10 below.

Table 3-9: Religious affiliation in the project neighbouring communities

Area	Distribution	None	Catholic	Protestant	Muslim	Total
Secondary impact zone	Frequency	151	577	2108	8	2844
	Percent (%)	5.3	20.3	74.1	0.3	100.0

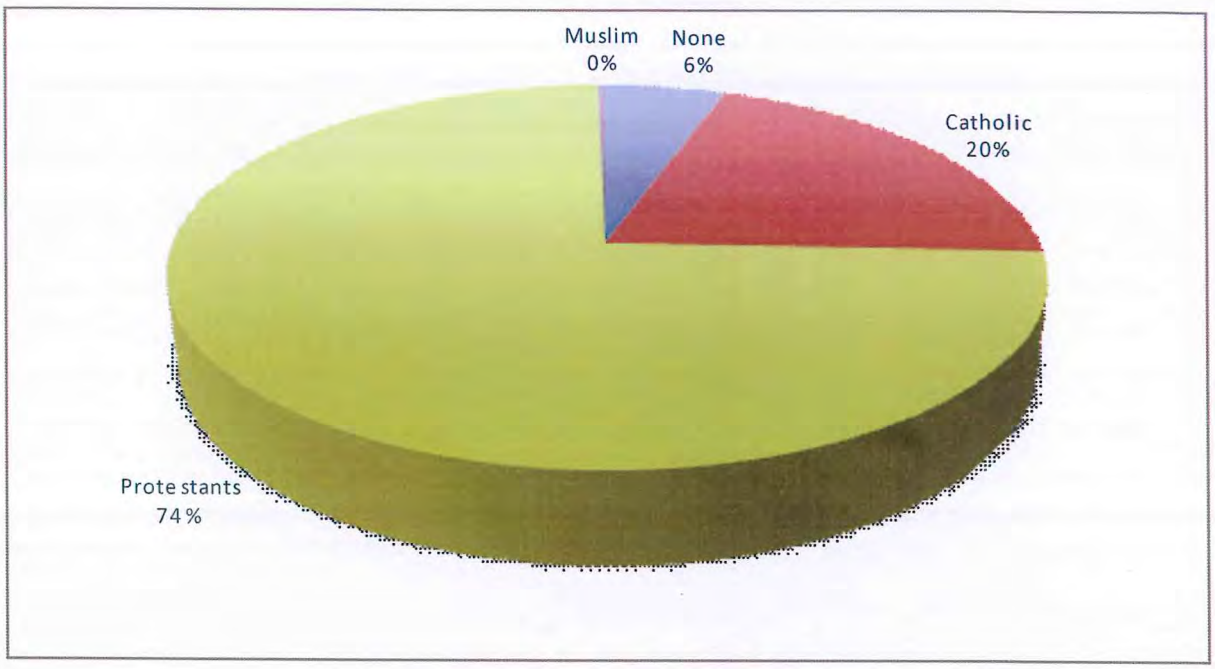


Figure 3-10: Proportion of religious groups of respondents neighboring the project area

(d) Education

Educational institutions are organised into zones. The zones in the area covered by the project are Bahati and Solai zones. The number of various institutions and enrolment by third term (as at November 2014) are as indicated below.

Table 3-10: Student enrolment in Education institutions in Nakuru North Sub County

Category	No.	Students			Teachers		
		M	F	Total	M	F	Total
Public ECD	24						
Private ECD	45						
Public Primary	20	7,469	7,363	14,832	117	276	393
Private Primary	45	1,538	1,899	3,437	109	112	221
Public Secondary	16						
Private Secondary	16						
Tertiary (Public Polytechnic)	1						

Source: Education office, Maili Sita

Teachers to pupil ratio from Table 3-10 is 1:38 in public primary schools and 1:16 in private primary schools

Table 3-11: Student enrolment within educational institutions in Rongai Sub County

Category	No.	Boys	Girls	Total
Public ECD	88	3,710	3,655	7,365
Private ECD	92	2,221	2,195	4,416
Public primary	73	16,055	15,376	31,431
Private Primary	42	3,091	2,912	6,003
Public secondary	34	4,963	4,549	9,516
Private secondary	16	1,963	2,097	4,060
Tertiary college	-	-	-	
University	1	Not available	Not available	
Total		32,007	30,784	62,791

Source: Education office Rongai Sub County

3.3.3 Housing conditions

Shelter is one of the basic human needs and good quality of life includes having comfortable housing. Good housing is one of the first steps in any meaningful attempt to tackle social problems. There is generally a strong relationship between household economic conditions and quality of housing and as such information on housing characteristics is critical to explaining associations between households' social and economic conditions. Housing as a shelter is one of the basic needs of a human being. In this survey, we assessed the quality of respondent's houses in terms of roofing, walls and floor.

Out of the four households present in the caldera, one had a thatched roof and the rest were roofed with corrugated iron sheet. All the four houses had mud walls and earth floors.

Table 3-12 below shows the roofing, wall and floor characteristics of houses sampled neighbouring the project area (secondary impact zone).

Table 3-12: Housing characteristics of neighbouring the project area

Roofing Characteristics						
Area	**Distribution**	**Thatched**	**Corrugated Iron Sheet**	**Tiles**	**Others**	**Total**
Neighboring communities	Frequency	14	714	4	2	734
	(%)	1.9	97.3	0.5	0.3	100.0
Walls characteristics						
Area	**Distribution**	**Mud**	**Stone**	**Bricks**	**Other**	**Total**
Neighbouring communities	Frequency	325	386	5	30	746
	(%)	43.6	51.7	0.7	4.0	100.0
Floor characteristics						
Area	**Distribution**	**Earth**	**Cement**	**Wooden**	**Others**	**Total**
Neighbouring communities	Frequency	362	376	1	6	745
	(%)	48.6	50.5	0.1	0.8	100.0

3.3.4 Access to water and sanitation

According to the survey, the main source of water for the households in the Caldera area is water vendors whereas for the communities neighbouring the project area are: rainwater, piped community water and water vendors. Rainwater accounts for over 62% whereas piped community water and water vendors account for 45% and 31% respectively. Other sources of water include shallow wells (0.8%), rivers (4.4%), piped water to homesteads (12.5%), boreholes (3.2%), water pans (2.4%) and springs (1.5%). The distribution is shown in the table below.

Table 3-13: Sources of water for households neighbouring the project area

Distribution	Springs	Boreholes	Shallow wells	Rainwater	Water pan	Piped Community	Piped homestead	River	Water vendors
Frequency	12	24	6	468	18	340	94	33	233
%	1.6	3.2	0.8	62.2	2.4	45.2	12.5	4.4	30.9

Time taken to fetch water from the different sources of water ranges from 30 minutes to more than an hour. Quantities of water by households and used per day is as illustrated in figure 3.7 below.

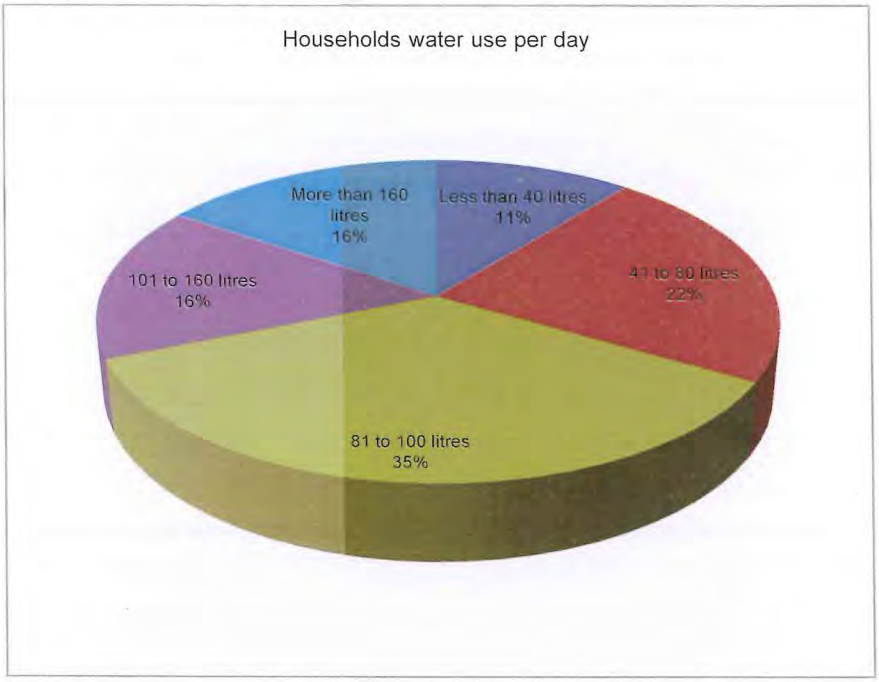


Figure 3-11: Household water consumption per day

(a) Water treatment

Within the project area, households treat water by boiling. Communities neighbouring the project area treat their water by boiling (40%), chlorination (9%) and water filtering (0.5%). Majority of the respondents did not treat their water (59%) whereas less than 1% did not know what is done with their water.

(b) Sanitation

Pit latrines are the only type of toilet used by households in the project area (caldera). Within the communities neighbouring the project area, majority of the households sampled use pit latrines (92%) and the rest use flush toilets (8%). None of the respondents went to the bush to defecate.

3.3.5 Health conditions

(a) Disease prevalence

According to the public health officer of Nakuru North Sub County, the most common prevalent diseases are as shown in Table 3-14 below.

Table 3-14: Common diseases affecting the population in Nakuru North Sub County

Diseases affecting persons under 5 year	Rank	Diseases affecting persons over 5 years	Rank
Disease of the respiratory system	1	Disease of the respiratory system	1
Diarrhoea	2	Disease of the skin	2
Disease of the skin	3	Dental diseases	3
Clinical malaria	4	Rheumatism: joint pains	4
Confirmed malaria	5	Clinical malaria	5
Pneumonia	6	Typhoid fever	6
Eye infection	7	Confirmed malaria	7
Mumps	8	Diarrhoea	8
Chicken pox	9	Urinary tract infections	9
Ear infection	10	Pneumonia	10

In Kampi ya Moto and Ngata divisions, Rongai Sub County, the most common diseases affecting the population are;

1. Upper Respiratory Tract Infections (RTI);
2. Diarrhoea;
3. Pneumonia;
4. Skin diseases;
5. Rheumatism: joint pains;
6. Typhoid;
7. Eye infection;
8. Malaria;
9. Hypertension;
10. Chicken pox.

HIV/AIDs prevalence in the two Sub Counties stands at 3.7% in Rongai and 3.2% in Nakuru North sub counties. Most vulnerable groups to HIV/AIDS include; commercial sex workers, employees of flower farms, sisal estates, widows and orphans and vulnerable children.

(b) Health institutions

Health institutions in the study area are categorised as either public or private. Public health institutions consisted of dispensaries, health centres and hospitals whereas private facilities are mainly private clinics and medicine stores.

Table 3-15: Health institutions in Nakuru North Sub County

Division	Public Facilities	Private
Kiamaina	4	8
Bahati	3	1
Dundori	3	5

In Rongai Sub County, the numbers of health institutions are:

- Health centres-5
- Dispensaries -14
- Others (private and FBO)-10

Doctor to patient ratio stands at 1:60,670 and 1:10,000 in Rongai and Nakuru North respectively which is higher than the WHO recommended ratio of 1:1,000.

3.3.6 Community problems

The community in the study area experience various social and environmental problems:

(a) Social problems

A number of social problems exist in the project study area as identified by the respondents:

- Insecurity;
- Water scarcity;
- Youth unemployment;
- Poor infrastructure (roads);
- Lack of health facilities.

(b) Environmental problems

Environmental problems experienced by the communities in the project area are mainly associated with geothermal exploration activities such as:

- Air pollution;
- Noise and vibrations;
- Dust;
- Bad odours.

3.3.7 Archaeological background

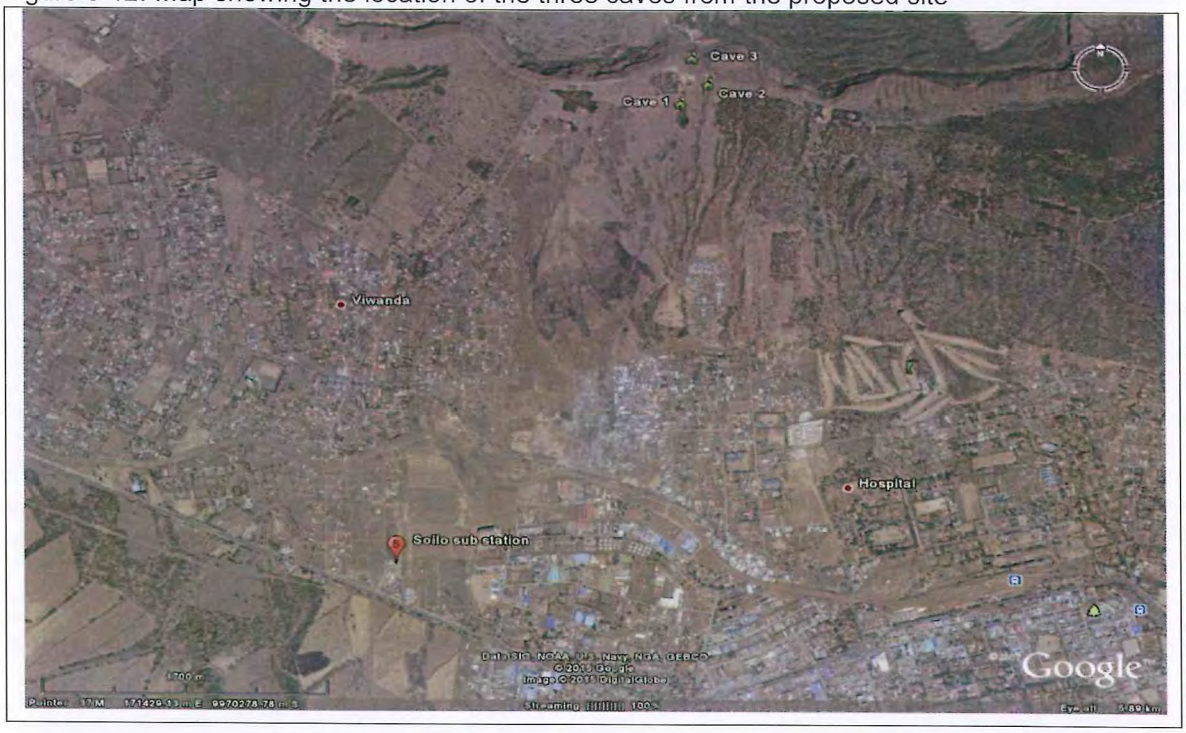
No previous archaeological surveys have been carried out in the crater, and therefore no archaeological sites are recorded. However, there are several sites recorded on the map covering this area, Sheet Number 119/1, Series Y731. The sites, named GqJi 1-6 all belong to the Later Stone Age (LSA) with artifacts such as pottery, stone bowls and stone tools recovered from them. The closest site to the crater, GqJi6 is located about 5 km from northern edge of the crater. The area south of Menengai crater covered by map Sheet number 119/3 also has LSA sites (GrJi 1-70) with artifacts similar to those mentioned above. This area is interesting because it contains many prehistoric human remains at sites such as Makalia, Bromheads and Nakuru burial sites. The high density of artifacts found in these sites is an indication of intense occupation over long periods of time. It is therefore likely that some form of evidence of human occupation may be present in parts of the crater.

A rapid field survey was conducted in the project area on the 11 February, 2015 by a specialist from National Museums of Kenya carried out to establish whether there are any archaeological sites, monuments or features within the area proposed for development. No archaeological objects or features were seen on the surface. There are no caves, rock art or fossils within the site. Neither are there objects of historical, cultural, artistic and religious value located on and around the proposed area of development. However, three caves were sited at the vicinity of the project proposed site as shown in the figure 3-12 with their respective coordinates in table 3-16. These caves are not used by any particular group but used by individuals. None of the obsidian is worked on and there is no evidence of human modification on any objects found here. There is however a slight possibility that human remains may be present, as they have been found in similar settings on Mt Suswa. These burials are usually marked with piles of loose stones commonly referred to as cairns.

Table 3-16: Coordinates of the Cave 1, 2 and 3

Way point	Eastings (m)	Northings (m)	Elevation(m)
Cave No. 1	171866	9972323	2082
Cave No. 2	172032	9972455	2142
Cave No. 3	171935	9972634	2118

Figure 3-12: Map showing the location of the three caves from the proposed site



3.3.8 Economic Characteristics

Nakuru North and Rongai are predominantly agricultural sub counties with maize and wheat crops being the predominant crops grown and cattle rearing for milk production, especially in areas neighbouring the project area.

There are several trading centres around the project area. These include:

- Ol Rongai;
- Kampi ya Moto;
- Kipng'ochoch;
- Wanyororo;
- Maili Kumi;
- Maili Tisa;
- Maili Saba;
- Maili Sita;
- Menengai.

(a) Employment status of persons living in the project area

The survey of the study area identified that 13.8% of the respondents interviewed were formally employed, 72.9% were informally employed and 13.3% were unemployed. The informally employed forms the largest proportion of the population since they are mainly semi-skilled and unskilled labour.

(b) Income sources

The primary source of income for the households in the project area is farming. In the neighbouring communities the primary source of income is farming followed by trading and salaried employees.

Table 3-17: Primary income sources

Area	Distribution	Farming	Trading	Salaried	Artisan	Other sources
Project Area (Menengai Geothermal Field)	Count	4	0	0	0	0
	% within Area	100	0	0	0	0
Neighboring communities	Count	656	219	202	102	102
	% within Area	51	17	16	8	8

(c) Income profiles

The monthly income of sampled households in the study area is shown in the Table 3-20 shows that more than three-quarter of the respondents (81.3%), earn less than Kes 20,000 per month. Some 8.2% of the surveyed population earn between Kes 20,000 and Kes 29,999. However, only 10.2% admitted that they earn between Kes 30,000 and Kes 99,999 monthly. Finally, 0.5%, which is a small proportion of the respondents, earn above Kes 100,000 monthly.

The income profile is not surprising because perhaps majority of those interviewed are subsistent farmers, casual labourers and small scale traders who earn a lower income and encompass the largest proportion of the population.

Table 3-18: Estimated Monthly income of the respondents in the Study Area

Income Distribution per month in KES	Count	%
Below 20,000	1,106	81.3
20,000-29,999	111	8.2
30,000-39,999	72	5.3
40,000-49,999	31	2.3
50,000-59,999	13	1.0
60,000-69,999	13	1.0
70,000-79,999	6	0.4
80,000-89,999	2	0.1
90,000-99,999	1	0.1
100,000-109,999	1	0.1
120,000-129,999	1	0.1
150,000-159,999	2	0.1
200,000-209,999	1	0.1
290,000-300,000	1	0.1
Grand Total	**1,361**	**100**

3.3.9 Land tenure and ownership

The land tenure systems in Kenya are categorized as private, community and public land. The Menengai crater is public land under the management of KFS.

Land ownership in the communities neighboring the project area as presented by the respondents, is 86.2% privately owned, 12.8% public land and 1% communally owned.

(a) Land use potential and agricultural activities

Land in the project study area is used for agriculture, residential and commercial purposes. Within the primary impact zone, residential and agriculture are the main land uses. Land use in the project neighbouring areas is as shown in the Table 3-19 below.

Table 3-19: Land uses in the project neighbouring areas

Distribution	Land use in the project study area				
	Residential	Cash crop farming	Subsistence farming	Commercial	Grazing/Pasture/ Fodder
Count	621	83	477	29	294
% within Area	41.3	5.5	31.7	1.9	19.5

3.3.10 Energy sources

The main source of energy for cooking is firewood (60.6%). This is followed by charcoal, which accounts for 32.8% as reflected in Table 3-20 below.

The main source of energy for lighting is kerosene (48.1%) that is used in kerosene lamps to light homes in both the primary and secondary impact zones of the project. 44.5% of the households sampled are connected to the national electricity grid and use electricity for lighting their homes. 0.1% of the respondents do not light their household whereas 2.1% and 2.4% use battery powered lamps and LPG lamps respectively.

Table 3-20: Energy sources for cooking and lighting

Sources of energy for cooking							
Area	Distribution	Firewood	Charcoal	Kerosene	Electric cooker	LPG	
Project Area	Count	4	0	0	0	0	
	% Within The Area	100	0	0	0	0	
Neighboring communities	Count	453	222	13	7	52	
	% Within The Area	60.6	29.7	1.7	0.9	7.0	
	Sources of energy for lighting						
Area	Distribution	Battery lamp	Kerosene lamp	LPG Lamp	None	Electricity	Other
Project Area	Count	0	4	0	0	0	0
	% within Area	0	100	0	0	0	0
Neighboring communities	Count	15	344	17	1	318	20
	% within Area	2.1	48.1	2.4	0.1	44.5	2.8

3.3.11 Roads access

Majority of the communities are located around the project area. As a result, they enjoy good road facilities such Nakuru-Bahati road and Nakuru-Kabarak road. Within the study area, communities are connected to each other by earth road, constructed and maintained by the various local government councils. Three settlements are linked by poor road network and thus largely inaccessible during the rainy season.

3.4 Existing infrastructure and activities

The project location is not pristine. Various types of infrastructure are already developed within the Menengai caldera through the preceding geothermal exploration, drilling of steam production wells and a number of activities related activities are still ongoing. These include:

- Access Roads: graded access roads to all established drilling pads' locations for all weather passage. These are currently used by various vehicular categories from light vans to heavy trucks. New one area also being opened up;
- Drilling pads and associated features required for the drilling rigs and facilities including:
  - Drilling rigs;
  - Storage areas (laydown areas) for drilling materials;
  - Parking for service vehicles;
  - Ponds or 'sumps' for settling of drilling fluids; and
  - Space for well testing equipment.
- Additional well pads under construction;
- Drilling camps (mainly for rig operating teams) with several containerised or portable cabin style buildings providing sleeping accommodation, kitchen and dining facilities, food and water storage, recreation room, showers, toilets and septic tanks to form a single accommodation unit;
- Power and water supplies: Existing camps and drilling pads are connected to grid power supplies and internal piped network of water lines, mainly running along the access roads. New connections were ongoing at the time of field visit.

Photo plates presenting the existing facilities and activities within the caldera are presented below.

Section of newly done access road and well pads within the caldera as observed from the Menengai view point

A close up view of newly done well pad

	
Some of the GDC drilling rigs within the caldera as observed from the view pint	*An existing discharge well under test. These are some of the activities contributing to the existing high noise and H_2S levels within the caldera.*

4 PROJECT DESCRIPTION

4.1 Project Design

QPEA shall supply the Power Plant and guarantee its performance, both based on functional specifications provided by GDC in the PISSA and KPLC in the PPA.

The design of the Plant is based on a single-flash steam cycle with a condensing turbine, a type of technology which is fully developed and well-proven in the geothermal power industry. Nominal gross capacity will be 37.7 MW and Guaranteed Net Plant Output 35 MW.

4.1.1 Project components

Below is a technical description of the major components of the Project

Table 4-1: Project components and descriptions

System	Description
General	• The power plant consists of a single production unit. • The power plant is primarily designed for base load operation. The plant is assumed to be started up and shut down only for the scheduled maintenance and an emergency case, which means the plant would be started up and shut down a few times per year • The power plant shall comply with the Kenyan Grid Code. • The initial start-up of equipment such as filling water, system warming, operating the vent/ drain/ isolation valves etc. require the manual operations by the multiple operators. Also, the roving operators shall execute the periodic surveillance, monitoring and local operation as required to assist the operator in the plant control room. • The power plant can be continuously operated from 40% to 110% of the rated gross output. At the overload condition (>100% load of the rated), the pressure increases accordingly (sliding pressure). The low load operation less than 40% load including the house operation, the operating hours shall be less than one (1) hour per such operation. If the power grid system does not recover within one hour, the plant is to be shut down. • Rated power output of the turbine generator unit is 37.63 MW as measured at the generator terminal • Turbine is double flow, upward exhaust and double inlet. The continuous operation speed range is from -5% to +3% of the rated speed 3,000 rpm. • Rated conditions turbine inlet pressure is 5.77bara, as measured at turbine strainer inlet. • Operating range is 2.8 to 6.36 bara at turbine inlet between which the plant will be able to continuously operate between 40% and 110% of rated output. • Generator is totally-enclosed, water to air cooled, global VPI and brushless excitation. • Generator rating is made with 0.8 (lag) power factors. Generator size is 51.9MVA. • Generator voltage is11kV • Design ambient wet-bulb temperature for the cooling tower is18°C. • Steam that condenses in the condenser will mix with cooling water and act as make-up water for cooling tower. No other make-up water is estimated to be required during normal operation, only for initial filling and after maintenance stops.

System	Description
Steam System	• High pressure steam piping is carbon steel with 3 mm corrosion allowance, ANSI150, rock wool insulated with aluminum cladding. The design pressure and temperature of main steam system is 11 barg and 190°C. • Main steam venting will be through pressure regulation in GDC steam supply system. • Emergency steam vent station will be fitted upstream of the droplet separator. The vent station will be of rock muffler type, consisting of emergency valves, with perforated outlet pipes under a rock filling in a concrete basin. • Turbine unit overpressure protection will be done via rupture disks located before the droplet separator. • Droplet separator is vertical, cylindrical and vane-element type. It is carbon steel with 3 mm corrosion allowance. It is designed to receive 2.0 wt% wet steam and leave it as 0.05 wt% wet steam. • The ejector motive steam piping is branched off from the main steam line. It is carbon steel with 3 mm corrosion allowance, ANSI 150, rock wool insulated with aluminum cladding. • The turbine gland seal steam supply piping is branched off at the downstream of the turbine steam strainer. It is carbon steel with 3 mm corrosion allowance, ANSI 150, rock wool insulated with aluminum cladding. • The turbine gland leakage steam piping is stainless steel 316L without corrosion allowance, ANSI 150. • Turbine wash pump piping is branched off from the hotwell pump discharge. The turbine washing pump suction piping is stainless steel 316L without corrosion allowance, ANSI 150 and turbine washing pump discharge piping is stainless steel 316L without corrosion allowance, ANSI 300.
Steam metering and purity monitoring system	• Steam flow rate at the boundary will be measured by the venturi flow meter consisting of single tube and double metering/differential pressure transmitter. • Steam flow rate at the downstream of droplet separator will be measured by vortex flow meter for reference. • Steam purity (SiO concentration, Cl- concentration, pH, and NCG weight percent in steam) at the downstream of droplet will be monitored by the steam purity monitor.
Condenser and turbine drain system	• Condenser is direct contact, spray type. Shell is clad of stainless steel 316L and carbon steel. Internal pipes, nozzles, internal ribs are stainless steel 316L. Exhaust duct and external ribs are carbon steel. • Steam pipe drain system piping and atmospheric flash vessel is stainless steel 316L without corrosion allowance,ANSI150
Gas extraction system	• NCGs will be dispersed through cooling towers; • Gas extraction system configuration is 50%x2sets Ejector, 25%x1set Ejector, 125% inter condenser and 50%x2 sets Vacuum pump and 25% x1set Liquid Ring Vacuum pump. • First stage steam jet ejector and Inter Condenser are stainless steel 316L
Main and Auxiliary cooling water circuit	• Cooling tower is fibreglass, counter flow; mechanical draft and low-clog film fill type. • Main cooling water piping is stainless steel 316L or FRP without corrosion allowance, ANSI150. • Auxiliary cooling water piping is stainless steel 316L or FRP without corrosion allowance,ANSI150 • Condensate reinjection piping is FRP without corrosion allowance,ANSI150 • Condensate reinjection pump required head is designed as 3.0 m (1.4barg at pump discharge, if condensate reinjection pump is required, gravitational flow to be determined). • Hot well pump is vertical centrifugal type, 100% x 1set. • Auxiliary cooling water pump is horizontal centrifugal type, 100% x2ses

System	Description
Compressed air system	• Compressed air system supplies air to pneumatic operated valves. • Air compressor is screw compressor, oil lubricated, and built-in water separator, air-cooled. • Backup compressor will also be supplied and installed into system. • Air tank is cylindrical vessel, freestanding. • Compressed system will have air filters for, general-purpose, dust protection and for high efficiency. • Compressed air system will have heatless freestanding hairdryers. • System is design for PN10. • Material is Stainless steel 316. • A general service air compressor will also provide for maintenance purposes.
Electrical system	• The voltage levels in the system are 415V,690V,11kVand132kV,50Hz • Connected power is dimensioned to 50MVA at the main transformer with11kV at the MV side and 132kV at the HV side. • The Generator power output is 37.63MW electrical power. • Distribution voltage and generator voltage is 11kV and all connected loads are specified for 415/240V including motors <3 kW or 690V for all motors, 3 kW or bigger. • In general the load factor/power factor of generator is assumed to be quoted at between 0.8 lagging and 0.9 leading. • The electrical system has built-in protection and connection to the DCS supervision including communication and HMI presentation • Prioritized loads are supplied via UPS systems • The DCS system shall be capable of storing at least 12 months historical data
Earthing and Lightning protection	• The plant will be protected via an earth system that is dimensioned to handle protective earth (PE), potential equalization within the power plant and lightning or the power plant and includes connection to the transmission grid system.
Lighting	• Indoor lighting, including emergency lighting, shall follow normal standard of lux, as specified. All areas in the building will have to be classified according to the type of room and usage of it. Based upon this classification the lighting will be dimensioned and specified. • Outdoor lighting will be arranged via pole lights for roads and walking areas, facade lights and entrance lights to light up the power plant for different purposes.
Transformers	• Transformers will be located outdoors. The HV/MV transformers to be oil cooled. ONAN natural cooling will be provided. • The LV transformer to be of dry type • All connection will be open(oil to air bushings) • Preliminary power requirements as stated in this document, will be confirmed when all loads and requirements are finalized and provided by actual Vendors: o Step Up transformer: 11/132 kV, 50 MVA o Station Service transformer: 11/0,69 kV, 4 MVA o Auxiliary transformer: 690/415 V, 315 kVA
Instrument and control system	• Distributed Control System (DCS); • Interface via fibre cable to the GDC steam control system and the KPLC transmission system; • Redundant I/O servers; • One engineering workstation and two operator workstations; • A redundant fiber ring connection between data collection and operator interface and between data collection and process control; and • Redundant control net connection between CPUs and I/O.
Process Control System	• Control system for the total power plant will be based upon Distributed Control System (DCS), including the SCADA functionality with I/O, internal and external communication. • The control system shall have backup redundancy, except for the I/O´s.

System	Description
	• All DCS equipment shall be power supplied by batteries (UPS). • All control equipment will be located in clean rooms, sensors, transmitters and other control equipment not located inside a clean room shall be protected separately from H_2S.
Standby power system	• Prioritized subsystems, objects and parts in the power plant is supplied via UPS for all critical loads in order to not lose control in case of a power shutdown situation appears in the transmission line. Critical loads and emergency conditions to be defined. • The UPS systems are designed in combination with a Standby Diesel Generator in order to optimize the efficiency and total cost of the system. o The UPS 220 VAC is sized to power DCS system, plant control & operation, prioritized servers, communication, security and emergency systems for at least 1 hour o TheUPS110VDCissizedtopowerelectricalcircuitprotection, communication, security and emergency systems for atleast 1 hour.
Stand by Diesel Generator	• The Stand by Diesel Generator shall be sized to power the UPS220VAC and UPS110VDC systems. • Start-up time is limited to max 1minute with the auto-start feature. • The storage tank system shall contain fuel for 24hours of operation. Refilling of the storage tank has to be organized.
Ducting	• The layout of the powerhouse includes ducting for all cables: MV, LV, control, indications, and lighting and communication. The ducting consists of ladders and conduits from the electrical rooms to all the objects in the power plant. • The layout of the power plant includes space for cable trays, ducting and conduits between buildings and all parts that are to be connected. (Lighting, entrances etc.) Outdoor located cable trays and ladders shall be protected by covered metal frames. • Connection to/from the 50MVA transformer to the HV yard goes via an underground cable and is terminated to the first advised connection point according to the specification from the HV yard owner (KETRACO).
Motors	• Smaller motors (<3 kW) will be supplied with 415V and bigger motor sizes supplied with 690V. • All motors are supplied via direct on-line start.
Fire, Security and Detection System	• Fire protection and alarm systems shall be installed in addition to portable and service water systems. • The fire water tank to be installed shall be designed to also serve the service water system • Project area to be secured, fenced and suitably lit. • H_2S detection systems at points to be identified during design. • Mobile H2S detection monitors for operations personnel during operation.
Water supply (Potable-, Fire- and Service-water)	• Water will be supplied to raw water storage tank which shall receive water from GDC water supply tanks. This tank, which is a paneled prefabricated steel tank, will also be used as a fire water tank. • The water storage tank on site will also contain the potable water required for normal plant use as well as the fire water storage capacity required under the NFPA. The tapping point for the potable water, which shall be pumped to the treatment plant, will be at such a high elevation so that it is not possible to draw from the fire water reserve. • Delivery water will also be capable of being delivered by bowser truck via a connection and lift pump. • Water for domestic use (potable water in the toilet and kitchen) will be drawn from the raw water storage tank and treated in a containerized treatment plant and get stored in a 2000 lit plastic water tank. • Main fire pump will supply 30l/s with 30m to outdoor Fire hydrant system as well as indoor sprinklers, firehoses. • A jockey pump will supply the fire water system with 0,6l/sat30m head.

System	Description
	• Potable water system will supply water to building via a 2x3l/s30m head pumps. • Potable water pumps are located in the pumping station open shade.
Waste water system	Two options will be considered during execution of the project: *Option-1*: The sewer and grey water from toilet and kitchen in the control room will be collected in to water tight septic tanks. This domestic sewer will be emptied from the septic tank periodically by a honey sucker and disposed a waste water treatment plant/ disposing area allocated by the local municipality (Nakuru water and Sewerage company). *Option 2:* The sewer and grey water will be drained into a bio digester type septic tank, which will have two compartments. While keeping the sludge behind the digested liquid will be drained into a French drain to soak in to the ground. This will avoid the need for a frequent emptying of the septic. We would rather de-sludge in a longer duration.
Storm water drainage	The project drainage system shall be designed for the following: • Since the surrounding area is an open veld, storm water will be allowed to flow on the ground as a sheet flow. • Where it crosses roads, a possibility of low water drift or buried pipe culvert could be used. • Storm water drainage design will be based on 20 year return period of flood. Any spillage of oil in the floors of the turbine hall will be washed and drained to the oil separator manhole, located just outside the turbine hall, where by the drainage after the oil is removed from it, will be released to the storm water drainage. The oil that is captured in the oil separator can be extracted by a recycler, should there be anyone locally. Should there be spillage in the lube oil pump and vessel holding pit next to the turbine, it needs to be pumped and stored in the oil storage sump outside the turbine hall, to be emptied by a honey sucker and transported in to a disposing site.
Heating, ventilation and Air Conditioning (HVAC) system	• Turbine hall will be supplied with fresh air through louvered windows. H2S cleaning is not required here • Air handling in clean rooms (control annex) will be supplied by four air handling unit, one for pre-cleaning and another for specific room air supply • H_2S air filtering will be done with Purafil cleaning mechanism or similar • Air in clean rooms is circulated and partly re-cleaned to maintain H_2S level at minimum for electrical equipment protection
Principle for fire protection system	• The fire prevention and protection is in accordance with recommendations from NFPA 850: Recommended practice for fire protection for electrical generating plants and high voltage direct converter stations, as well as from other NFPA and European standards.
H_2S safety system	• Two separate H_2S safety systems will be supplied, the human hazard detection system. • The human hazard detection system is designed for 1 ppm. The human hazard detection system will contain one central unit with 4 ports and 4 fixed detector for 1-500 ppm H_2S level. Fixed sensors will be located in potential H_2S hazard zones, such as low point, pit and near NCG extract systems and exhausts • The human hazard detection system includes 10 hand held sensor for personnel • The equipment protection system will be located in the electrical and control

System	Description
	rooms (clean rooms).The equipment protection system is design for 1-1000 ppb H_2S detection.
Buildings and Structures	• Power House with Plant equipment mounted on appropriate reinforced concrete foundation blocks separate from the foundations of other structures and buildings. • Workshop and storage for safe storage and controlled issue of equipment, materials and chemicals, serving as offices for engineering and maintenance personnel. • Administration building for Plant personnel and management. • Transformer yard/station with restricted access containing a GSU, auxiliary and service transformers mounted on reinforced concrete base slabs. • Air-tight control and electrical rooms, air conditioned to protect equipment and instruments from hydrogen sulphide (H_2S). • The buildings will be made of structural steel and cladded with galvanized (zinc coated) IBR steel sheets 0.58mm thick; and • The buildings which require walling will have brick walls.
Structures (trench) for underground cable to Switch yard	This will be a cut and cover trench. The trench will have sand bedding and a sand blanket cover, which will be overlain by the back fill of the excavated material. This trench will commence from the step up transformer and crosses the plant boundary fence and runs up to the tie in point of the KPLC switch yard. The length of this cable trench will be approximately 200m.
Structures for transformers	Both main step up and auxiliary transformers will be placed on a concrete bunded enclosure. It will be a slab with 500mm high bund wall sitting on the ground. The bunded enclosure will be filled with crushed stones. It will also have a 3m high wall fencing made of steel mesh on square hollow section posts.
Control annex structure (clean rooms)	The control annex structure will be a lean to structure to the turbine hall. It is made of a steel structure framing with brick wall in fill between the members. It will have galvanized IBR sheet roofing 0.58mm thick. The PLC room and electrical rooms will be clean rooms with air pressurization of 100Pa. This building consists of the LV room (5x13.5m), MV room (5x13.5m), Control room (8x13.5m), workshop and tools room (6x13.5m), other service rooms (6x13.5m).
Structures for water supply (tank and pumping station)	The raw water storage tank will be made of paneled modular steel, to be procured from prefabricated modular ranks supplier. It will be placed on the ground with dwarf wall foundation. The pumping station will be an open shade with structural steel frames, with galvanized IBR sheet roofing.
Support structures for steam and NCG systems	The non-condensable gas system support structure will be of structural steel, with platforms made of non-slip grating supplied by Mentis or equivalent. It will also have access stairs with steps, also made of non-slip grating supplied by Mentis or equivalent. The steam pipes will be supported on concrete plinths, which will have a structural steel support to variable heights depending on the head room requirement of the particular area.
Turbine generator foundation structure	The turbine generator foundation will be a large reinforced concrete block laid out as per suppliers/Fuji's drawing. It will have 30 to 50mm grouting between the base plate and the concrete block.

System	Description
Structures for cold end systems (Condenser/Hotwell pit, underground piping finish and cooling tower basin and sump structure)	The condenser/ hotwel pit will be a reinforced concrete slab base and wall, all situated below natural ground level. The cooling tower containment basin is also made of reinforced concrete base slab and wall, to be coated with epoxy based water proofing internally to prevent exposure to the hydrogen sulphide present in the cooling water.
Turbine hall building	This will be a made of structural framing with reinforced concrete foundations. It will be cladded with galvanized IBR roof sheeting both the roof and the side cladding. It will be fitted with a 30ton overhead crane. The turbine hall has a size of 18x30m.
Service building (Workshop)	This building is incorporated in to the control (annex building).
Road, walkways, fencing and site finish	All the roads will be gravel roads, to be made of selected excavated material layer works, to be finished with imported granular fill material. There will not be any walk ways except the 1m apron around the buildings, to be made of concrete. The construction of roads will be limited to only inside of the power plant site.
Noise allowance	The noise that will be emitted from the turbine generators will be 90 to 95dB (according to Fuji/supplier), the machines will not have noise attenuation facility, thus hearing protection will have to be worn at all times when in the turbine hall, as the noise levels are a health hazard. The control room noise level will be limited to a maximum of 65 to 70dB, while the electrical and other rooms will be limited to a maximum of 85dB.
Fencing and gate	The plant site is 140x180m in size and it will be fenced with galvanized steel mesh type fence, which has a maximum height of 2.5m above NGL. It will only have one access gate. A guard house will also be situated next to the gate. The size of the guard house will be 3.5x6.5m

The project site layout is presented in Figure 4-1.

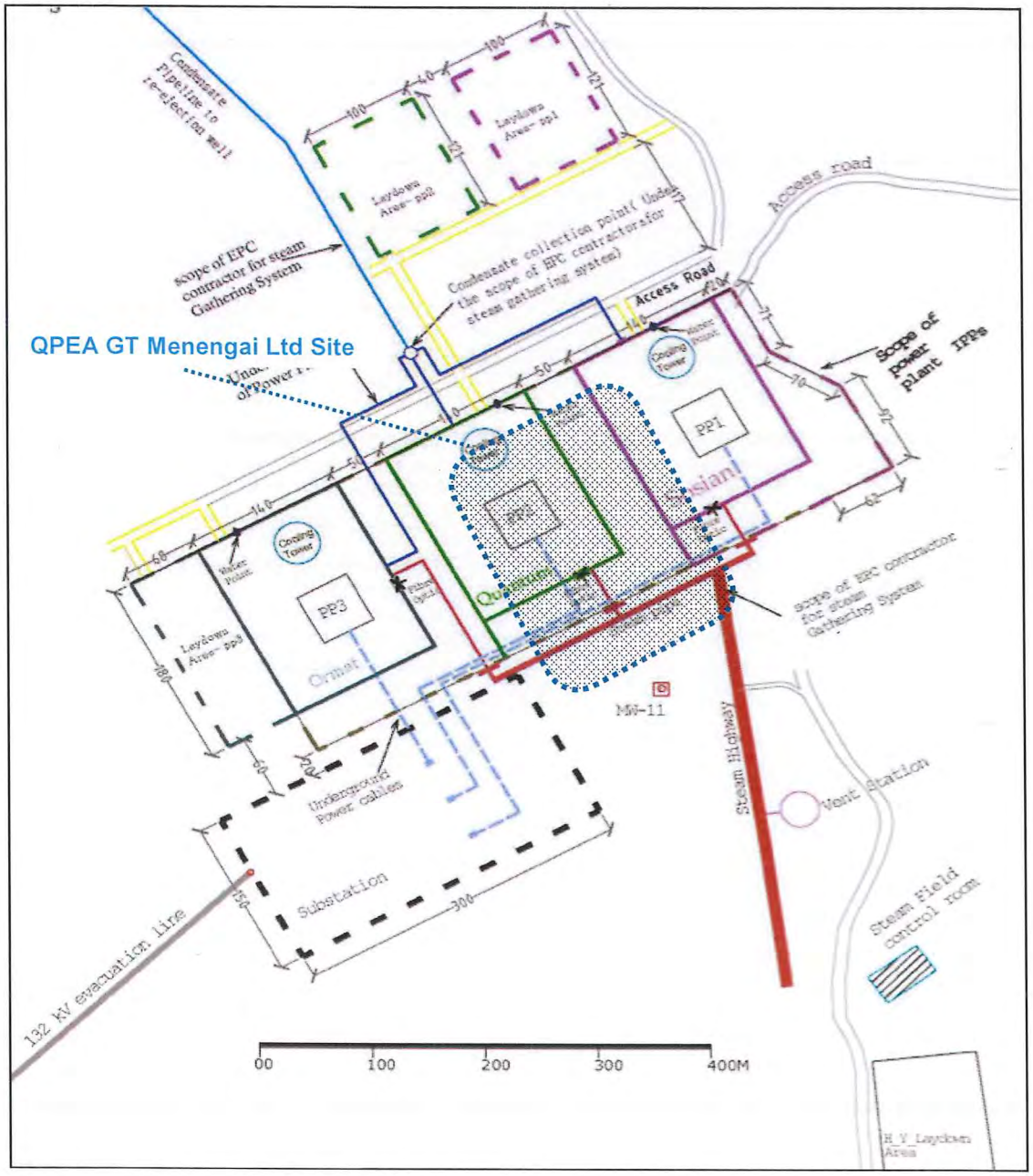


Figure 4-1: Project Site Layout

4.1.2 Steam supply

GDC will supply/deliver steam to the plant based on parameters in the PISSA. Currently a number of wells have been drilled, tested and a feasibility report provided in respect of the geothermal resource at the Menengai Geothermal project area. GDC will develop the Steam gathering facilities and condensate re-injection systems before the testing and commissioning of the plant.

4.1.3 Process description

GDC will deliver 98% dry saturated geothermal steam at 6 bars (absolute) through their steam gathering system to a steam turbine through a droplet separator, steam purity meter, main and backup meter, strainer, main stop valves, and control valves.

The saturated steam is expanded in the turbine, where some of the steam energy is transformed into mechanical energy in a shaft coupled with the electrical generator to produce 37 MW of gross electricity. 2 MW of the electrical output from the generator will be used within the Plant (parasitic/captive) and the balance of 35MW will be evacuated by KETRACO.

Steam exhaust from the turbine through its exhaust duct is cooled without mixing using cold water from the cooling tower basin in a direct contact main condenser. The goal is to condense this steam by extracting energy because it requires less work to pump an incompressible liquid than compressible gas or steam. An expansion joint and rapture discs will be installed between the turbine and the condenser to accommodate erection allowance and thermal expansion. The heat exchange is determined by the temperature difference usually at least 5°C; therefore, the maximum temperature of the cooling water must not exceed the condensation temperature in the condenser.

The Geothermal steam includes non-condensable gases (NCG) all the time. Based on the steam analysis supplied by GDC, the composition of the non-condensable gases is 3.3-4% of steam. Carbon dioxide is typically about 98% of the gas content and will be released to the atmosphere. Non condensable gases cause a problem in the condenser; while the steam is condensed and pumped out, the gases are kept on in gaseous form producing an increase in the pressure in the condenser. The solution to this problem is to compress the gases and suck them out of the condenser.

NCGs are cooled down in the main condenser to reduce the accompanying steam and are extracted by the gas removal system by the cooling tower fan stacks, exhaust stack and seal water discharge separator for dispersion into the atmosphere. The gas removal system consists of a 1st Stage steam ejectors (50%/50%/25%), an inter condenser (125%), a 2nd stage Liquid Ring Vacuum Pumps (LRVPs) (50%/50%/25%), and a Seal water discharge separator. After first stage compression, an inter condenser is installed to condense motive steam. The separator will be installed after the liquid ring vacuum pump to separate NCGs from the LRVP seal/working fluid. The motive steam for the ejectors is drawn from the main steam line. Drainage from the inter condenser and the LRVP separator is led into the main condenser. Some NCGs are then released to the atmosphere through the Seal water discharge separator.

In the extraction process, some amount of steam will always be included since the steam is mixed with other gases inside. Hence, the gas mixture is then assumed to be saturated with steam when it is sucked out from the condenser. In this case, air cooling in a forced flow/draught cooling tower is used to accommodate the heat load from the condensing steam.

A cooling tower is an evaporative heat transfer device in which atmospheric air cools warm water with direct contact between the water and the air, by evaporating part of the water. The mixture of cold water and condensate is sent to the top of the cooling tower and the GDC re-injection line by a circulating hot well water pump. In the cooling tower, the mixture is cooled down and sent back to the condenser by gravity and condenser vacuum from LRVPs.

Cold water from the cooling tower basin is used not only for the condenser cooler but also for the turbine oil cooler, generator air cooler, air compressor cooler, the inter condenser and the seal water discharge separator. The cooling tower is of the multi cell mechanically induced-draft wet, Fibreglass counter-flow type.

4.1.4 Power Evacuation

Currently the Project area is within 15 km from an existing 132kV double circuit Tororo – Lessos – Juja line and about 30km to the Lanet 132kV substation. A 33KV line has also been extended into the Project area.

KETRACO will develop a 15km 132kV double circuit transmission line from Menengai to an exiting Soilo sub station (which will be expanded) and a 132kV substation next to the project site. KETRACO conducted ESIA and ARAP studies for the new transmission line. The ESIA for the transmission line and the accompanying sub station has been approved by NEMA

through Licence No. NEMA/EIA/PSL/526 issued on 5 September 2014 while the ARAP implementation is underway. The transmission line has been aligned to minimize impacts on settlements and mainly passes through government land.

4.2 Project Inputs

4.2.1 Geothermal steam

Geothermal steam is the sole primary raw material in the project. This shall be supplied to the Power Plant from the production wells in the GDC Steam Gathering System for power generation and the resultant condensate will be pumped back into the reinjection wells.

About 8,000 kg of steam will be consumed to generate one (1) megawatt (MW) of electricity per hour. The measured composition by volume of the main steam flowing through each of the existing turbines is:

- Steam – 96.7%; and
- Non Condensable Gases (NCGs) Contents – 3.3%.

The composition of NCGs is provided in Table 4-2 below.

Table 4-2: Composition of non-condensable Gases (% by Volume) in Menengai Wells

NCG Contents (3.3% normal,4% max)	**% of NCG**
Carbon dioxide (CO2)	96.2%
Hydrogen Sulphide (H_2S)	3.0%
Hydrogen (H_2)	0.4%
Methane (CH4)	0.1%
Oxygen (O2)	0.3%
Total NCG flow	**100.00%**

4.2.2 Chemical dosing

Chemical dosing system shall be installed in the Power Plant for the cooling water circuit to prevent pH levels getting too low as well as prevent algae growth in cooling tower. These chemicals are biocides, dispersants, anti-sealants and pH control dosing chemicals. The chemical dosing system shall include its waste management system.

4.2.3 Water

Raw water supply is required for construction, fire water, and potable water for drinking and domestic and for plant maintenance.

Water will be supplied to the Project from GDC water supply tanks within the Menengai Geothermal project area into a water storage tank on site for potable water required for normal plant use as well as the fire water storage capacity required under the NFPA. Water will also be capable of being delivered by bowser truck incase water is not available from GDC.

It is estimated that 230 cubic metres of water will be required for fire fighting and an average of 30 litres per second as potable water. Currently, estimates for the amount of water that will be required at the construction phase of the project are not available.

4.2.4 Oil

The turbine generator oil system is required to:

- Supply lubrication oil for the bearings and mechanical seals of turbines and/or the generator;

- Supply the control and governor system with hydraulic oil.

Each turbine/generator island features necessary oil pumps, filters, coolers, tanks, control valve, relief valves and instrumentation. In the event of electrical supply cut out, emergency systems pump the oil round the system.

4.3 Project schedule and Phasing

The Project is to be commissioned within 17 months from the effective date of the PISSA as shown below.

Table 4-3: Project schedule

Milestones	Time (months)
PISSA Signature Date	1st November 2014
Target Effective Date	S + 6
Actual Effective Date	E
Construction Start Date	E + 7 days
First Commissioning Date	E + 15
Required Grid Available (T-Line and substation commissioned)	E + 15
Required Steam Available (GDC works commissioned)	E + 15
Full Commercial Operations date	E + 17
Exit and Site restoration	6 Months after Steam Supply Period.

Where "S" is the Signature date and "E" is the Effective date between GDC/KPLC and the QPEA GT Menengai Ltd in the mutually agreed PISSA/PPA.

5 PROJECT ALTERNATIVES

5.1 Alternative Forms of Energy for development

The project proposes to use geothermal form of energy. Below is the comparison of the different forms of energy development available in Kenya and their suitability for the Menengai site.

Table 5-1 Form of Energy

No.	Form Of Energy	Comparison
1	Geothermal	Ideal for Menengai as the resource is abundant
2	Hydro	It is affected by hydrology and not ideal for Menengai
3	Wind	Requires constant blowing of wind throughout the year. Not ideal for Menengai field.
4	Thermal	Uses fossil fuel and therefore not clean energy. Not ideal for the Menengai site

5.2 No Action Alternative

The no-action alternative is often defined by the baseline information and is crucial in the assessment of impact because other alternatives are weighed with reference to it. This alternative would mean that the project does not proceed.

According to the latest report posted by energy regulatory commission, the country's installed capacity of nominal and effective power generation is as presented in Table 5-2 below.

Table 5-2: Installed capacity of nominal and effective power generation in Kenya

Ownership	Source	Installed capacity as at 30 June 2013	
		Nominal (MW)	Effective (MW)
KenGen	Hydro	816	767
	Pero-termal-EPPs	120	120
	Petro-thermal	259	209
	Geothermal	158	153
	Wind	5.3	5.1
IPPs	Petro-thermal	272.6	273.1
	Geothermal	92.4	92.4
	Bagasse Cogeneration	26	21.5
	Small hydro	0.3	0.3
Rural electrification Programme	Petro-thermal	16	11.6
	Totals	**1765.60**	**1653.00**

Source; ERC annual report, 2012-2013

The largest power generator in the country is the Kenya Electricity Generating Company (KenGen) which accounted for 70% of the industry's effective generation capacity by 2012/13. Independent Power Producers (IPPs) accounted for 22% while Emergency Power Producers accounted for 7% in the same period. Isolated grid generation accounted for less than 1% under the Rural Electrification Programme (REP). The generation mix comprises of 46% hydro, 37% fossil fuels, 14% geothermal, 2% bagasse (cogeneration) and 0.3% wind.

It is notable that the national demand for electric power has continued to grow significantly from the year 2007/08 to 2012/13 at an average annual growth rate of 5.37%. This was driven by amalgamation of normal economic growth, increased connections courtesy of the Rural Electrification Programme as well as the flagship projects which are the major drivers of Vision 2030. The peak demand rose from 1,236MW in 2011/12 to 1,354MW in 2012/13 representing a record high of 9.55% for the past five years. The supply of electricity on the other hand had a 5.44% increase from 7,670GWh in 2011/12 to 8087GWh in 2012/13.

Due to over reliance in the hydropower over the last ten years the country has paid a high price over heavy reliance on single source of power. In 1999 and in 2002, severe droughts nearly brought the Kenyan economy to a standstill after the hydro power dams dried out leaving power rationing in its wake. This experience has underscored the need to diversify the power sources in Kenya.

The "No Action Alternative" will therefore involve several losses both to the proponent, the community and the Country as a whole. GDC, a 100% Government of Kenya owned company, is tasked with accelerating development of geothermal resources to support development of at least 10,000 MW by 2030 in line with Vision 2030. To this end, GDC has invested a lot in research and steam exploration with the ones in Menengai now ripe for development with agreement already signed between GDC and the IPPs.

Without implementation of the project, the following shortcomings are expected:

- The government will be unable to timely develop the energy resources required to spur Vision 2030;
- Reduced business opportunities due to lack of infrastructure in the proposed project area;
- Reduced interaction both at local, national and international levels by the community, hence education and general awareness is a major loser;
- No employment opportunities will be created for the local community in project area and for Kenyans in general who would have worked in the proposed project area;
- Increased urban poverty and crime in Kenya.
- Discouragement for investors;
- Development of infrastructural facilities (roads, electrical etc.) associated with the project in its host areas will not be undertaken;
- Lack of development, research and innovation in the Country; and
- Loss of money by government because money has been spent on exploration and well drilling phases.

The 'no action alternative' is therefore not feasible development option for this project.

5.3 Alternative sources of electricity generations

The summary of the key issues with the Power generation options available in Kenya is given in Table 5-3 below.

Table 5-3 Summary of the key issues associated with the different energy sources in Kenya

Fuel Type	Location	Positive	Negative	Availability
Geothermal power	Rift Valley	Sustainable Non-polluting Little environnemental impact.	It can only be economically developed in selected areas with particular volcanic features	Medium to long term solution – Available
Hydropower	Tana River Catchments Western Kenya Small micro schemes	Compact; a large amount of electrical power can be produced by a moderately sized station Sustainable	The building of dams is usually environmentally destructive. River valleys are often fertile and densely populated resettlement. The water released from a hydro-power station often comes from the bottom of a dam. Water is often released from a hydro-power dam at times that depends on power consumption not ecological needs.	Medium to long term solution – Available
Solar Power	Throughout Kenya	Sustainable It is a well proven technology; Well suited to providing power in home or single building applications.	The manufacturing process requires large amounts of energy; Does not produce much power when the sun isn't shining, and negligible power at night. An alternative power supply is needed for these periods. Electricity generated by solar panels is quite expensive.	Short term but limited solution - Available
Wind Power	Limited application	Sustainable Non-polluting A well proven technology	Does not produce power when the wind isn't blowing, so a back-up electrical supply is also needed If batteries provide the backup they have the disadvantage of being expensive and needing to be replaced every few years	Medium to long term solution
Liquid Fuel	Imported via Mombasa	Generators are very compact. Produces less CO2 than coal.	Not believed sustainable long term Produces carbon dioxide (CO2), The world's oil reserves are limited. Oil spills, cause severe pollution. Some oils contain high levels of sulphur.	Medium to long term solution
Coal	Prospects in Mombasa and Kitui	Relatively low cost compared to other fuel type options.	Not sustainable Produces more carbon dioxide (CO2) per Watt-hour of energy than any other generation method; Very large quantities of ash have to be disposed of some coal contains significant amounts of sulphur, one of the main causes of acid rain. Coal also	Long term solution

Fuel Type	Location	Positive	Negative	Availability
			contains small amounts of heavy metals.	
Gas	Tanzania	Relatively low cost fuel option when available generators are very compact Produces less CO2 than coal or oil Can be used in HFO plants with minor alterations.	Not available, needs to be imported from Tanzania need to build extensive pipeline not sustainable produces carbon dioxide. (CO2), natural gas reserves are limited.	Medium to long term solution
Electricity from Waste	Has to be near reliable sources of solid waste	Generate energy whilst reducing the volume of waste	Produces high levels of carbon dioxide and nitrogen dioxide Ash disposal and air pollution emissions Toxic materials include trace metals such as lead, cadmium and mercury, and trace organics, such as dioxins and furans.	Medium to long term solution
Conventional nuclear power	None	Compact a large amount of electrical power can be produced by a moderately sized station. Low fuel costs Small number of accidents; Normally does not produce any significant atmospheric Pollutants Quantity of waste produced is small	Expensive, especially in capital costs, maintenance costs, and due to the long lead time in planning and construction; There is a danger of radiation release. While there are few accidents the consequences of Some accidents may be catastrophic. Decommissioning a nuclear power station at the end of its useful life is very difficult and expensive. Safe long-term disposal of nuclear waste is difficult. The lead time in building a nuclear power station is around ten years A tempting target for terrorist attack.	Long term solution, 10 year lead time.

5.4 Advantages and Environmental benefits of Geothermal Energy

5.4.1 Advantages of Geothermal Energy

Geothermal energy has the following advantages:

- Geothermal energy is generally considered environmentally friendly and does not cause significant amounts of pollution;
- Geothermal reservoirs are naturally replenished and therefore renewable;
- Harnessing geothermal energy does not involve any fuels, which means less cost fluctuations and stable electricity prices;
- Excellent for meeting the base load energy demand (as opposed to other renewable energy forms such as wind and solar);
- It makes small footprint on land;
- Recent technological advancements (e.g. enhanced geothermal systems) have made more resources exploitable and lowered costs of energy; and
- There is massive potential of geothermal resource making it the ideal form of energy.

5.4.2 Environmental benefits

The use of geothermal energy as a source of power generation has a number of environmental benefits.

The project will directly contribute to economic growth by alleviating the persistent electricity interruptions that affect the productivity of the industrial, commercial and agricultural sections of the Kenyan economy. It will mitigate the effects of power shortages that hinder economic development in the short and long term, by providing base load power supply which is consistent with the least cost expansion plan. Moreover, it will supply the much needed back-up power for Kenya's hydroelectric dam system which is prone to water shortages and climatic uncertainty.

The project will use an indigenous energy resource for power generation. Therefore it will reduce exposure of the economy to fossil fuel price fluctuations and the associated exchange rate risk for fuel procurement. In addition it will benefit regional environment (especially air quality) since geothermal electricity production produces none of the conventional air pollutants associated with alternative fossil fuel generation options. It will also supply jobs to some local residents and be a source of local economic growth.

The global benefits of the project include avoided GHG emissions. In particular it provides for substantial carbon dioxide emission reductions in comparison to fossil fuel based generation of a similar capacity. Existing geothermal electric stations, that fall within the 50th percentile of all total life cycle emissions studies reviewed by the Intergovernmental Panel on Climate Change (IPCC), produce on average 45 kg of CO2 equivalent emissions per megawatt-hour of generated electricity (kg CO2eq/MW·h). For comparison, a coal-fired power plant emits 1,001 kg of CO2 per megawatt-hour when not coupled with carbon capture and storage (CCS).

5.5 Alternative technologies for Geothermal Power Plants

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

The steam cycles allow the fluid to boil, and then the steam is separated from the brine and expanded in a turbine. Usually the brine is rejected to the environment or re-injected. The

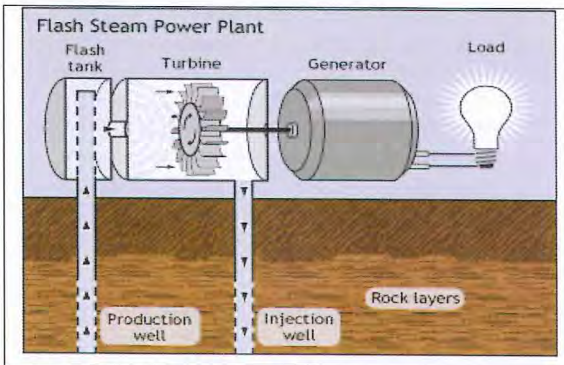
brine can be flashed again at a lower pressure if double flash system is used.

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

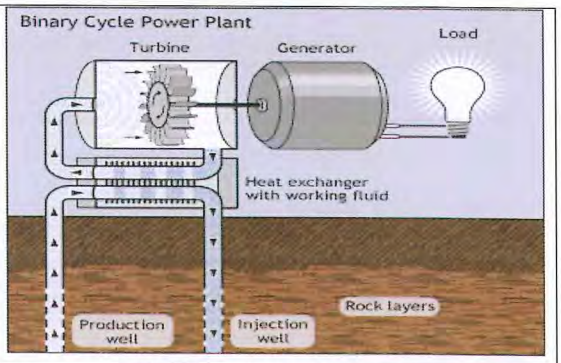
5.5.1 Steam Cycle Power Plants

Geothermal Steam Cycle Power plants are similar to other steam turbine thermal power stations. Heat from a fuel source (in geothermal case, the earth's core) is used to heat water or another working fluid. They use water at temperatures greater than 150^{0}C that is separated and piped, then condensed steam is cooled at the cooling tower and the excess condensate re-injected.

Flash steam cycle plants are the most common type of geothermal power generation plants in operation today, which use water at temperatures greater than 182°C (455 K; 360 °F) that is pumped under high pressure to the generation equipment at the surface. The working steam is then used to turn a turbine of a generator, thereby producing electricity. The fluid is then cooled and returned to the heat source.



Flash Steam Power Plant



Binary – Cycle Power Plants.

A single-flash steam cycle is proposed for Menengai geothermal power plant.

5.5.2 Binary-Cycle Power Plants

Most geothermal areas contain moderate-temperature water (below 400°F). Energy is extracted from these fluids in binary-cycle power plants. Hot geothermal fluid and a secondary (hence, "binary") fluid with a much lower boiling point than water pass through a heat exchanger. Heat from the geothermal fluid causes the secondary fluid to flash to vapor, which then drives the turbines. Because this is a closed-loop system, virtually nothing is emitted to the atmosphere. Moderate-temperature water is by far the more common geothermal resource, and most geothermal power plants in the future will be binary-cycle plants.

Binary cycle geothermal power generation plants differ from Dry Steam and Flash Steam systems in that the water or steam from the geothermal reservoir never comes in contact with the turbine/generator units.

The limitations of Binary Geothermal Power Plant include:

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

5.5.3 Recommendation for Menengai Power Plant Design

A single flash Steam Cycle is recommended for the Menengai power plant. The advantages of this system are:

- The risk of well enthalpy turning out to be different than planned because of well drilling and plant building being done simultaneously;
- The risk of well enthalpy changing when utilization of the reservoir starts;
- The second separator stage is usually at pressures below silica saturation limit. This calls for acid or inhibitor dosing and has potential to cause increased maintenance cost or operational problems.

6 PUBLIC AND STAKEHOLDER CONSULTATIONS AND DISCLOSURE

6.1 Introduction

Public consultation and disclosure is defined as the two-way communication between the project ESIA team and the targeted and affected groups. It is important in the environmental and social assessment study process as it promotes the feeling of ownership, cooperation, and accountability, and builds a good rapport with affected community.

Part III Section 17 of the Environmental (Impact Assessment and Audit) Regulations, 2003 requires that during the process of conducting an environmental impact assessment study, the project proponent seeks the views of persons who may be affected by the project. In seeking the views of the public, the project proponent will hold at least three public meetings with the affected parties and communities to explain the project and its effects, and to receive their oral or written comments.

6.1.1 Objectives of the consultation process

The overall goal of the consultations is to disseminate project information and to incorporate the views of the local community and other stakeholders in the identification of potential impacts, design of the mitigation measures and the management plan.

The specific objectives of the consultations are:

- Promote public understanding and acceptance of the project by minimising potential perceived environmental impacts through education and open discussion;
- Obtain feedback that can be used as constructive input into improving the project design and management;
- To unearth the perception of the communities around on the project on the impacts;
- To inform the community on the correct details of the project; and
- To determine ways of communicating with the community.

6.2 Stakeholder Analysis

Howlett and Nagu (1997) define stakeholders as 'all those people and institutions who have an interest in the successful design, implementation and sustainability of the project. This includes those positively and negatively affected by the project. Stakeholder participation involves processes whereby all those with a stake in the outcome of a project can actively participate in decisions on planning and management. They share information and knowledge, and may contribute to the project, so as to enhance the success of the project and hence ultimately their own interests.'

A stakeholder analysis will help the geothermal power plant project developers to identify:

- Interests of all stakeholders who may affect or be affected by the project;
- Potential conflicts or risks that could jeopardize the project;
- Opportunities and relationships that can be built on during implementation;
- Groups that should be encouraged to participate in different stages of the project;
- Appropriate strategies and approaches for stakeholder engagement;
- To unearth the perception of the communities around on the project on the impacts; and
- Ways to reduce negative impacts on vulnerable and disadvantaged groups.

Three essential steps were utilized in stakeholder analysis including:

- Identifying key stakeholders and their interests (positive or negative) in the project;
- Assessing influence, importance and level of impact upon each stakeholder;
- Identifying how best to engage stakeholders.

6.2.1 Stakeholder Identification

To enhance maximum participation and achieve a better output, the right stakeholders should be taken on board. This is done through stakeholder identification and involvement based on their needs, interests, relative power and potential impact on project outcome.

In this regard, two broad categories of stakeholders were identified. These include:

- *Primary stakeholders* – those who are the beneficiaries of a development intervention or those directly affected (positively or negatively).by the project;
- *Secondary stakeholder*- those who influence development or are indirectly affected by the project especially those stakeholders involved in resettlement planning and implementation. These include the implementing agency, relevant government departments, and local administration among others

The stakeholders identified and consulted during this update study, their affiliations and categorisation are presented in Table 6-1 below.

Table 6-1: Schedule of stakeholders consulted during the ESIA update study

No.	Name	Affiliation	Stakeholder category
1	Quantum Power East Africa GT Ltd	Project Proponent	Primary
2	Geothermal Development Company (GDC)	Special purpose vehilce to entre into steam sales agreements with investors in the energy sector	Primary
3	Settlements and communnities affected by both positive and negative impacts of the project	Project beneficiaries and persons advaersely affetced by the project's direct impacts	Primary
4	Director of Environment, Ministry of Environment, Natural Resources, Energy and Water	Host County Government	Secondary
5	Rift Valley Water Services Board (RVWSB)	Water Services Board	
6	Water Resources Management Authority (WRMA), Rift Valley Catchment Area	Water Regulatory Body	
7	Nakuru Water and Sanitation Services Company (NAWASCO)	Water Service Providers	
8	Olbanita Water Resource Users Association	Water Resource Users Association	
9	Kenya Forest Service-Mau Conservancy	Conservation agency	
10	Kenya Forest Service-Menengai Forest Station		
11	Kenya Wildlife Service, Nakuru office		
12	Directorate of Occupational Safety and Health- Nakuru County	National Government	
13	State Department of Agriculture, Nakuru North sub county		

14	State Department of Agriculture, Rongai sub county	National Government Line Ministries	
15	Department of Gender and Social Development officer, Nakuru North Sub county		
16	Department of Gender and Social Development officer, Rongai Sub county		
17	Youth Development Officer, Nakuru North sub county		
18	Public Health Officer, Nakuru North Sub county		
19	Public Health Officer, Rongai Sub county		
20	Ministry of Education, Nakuru North sub county		
21	Ministry of Education, Rongai sub county		
22	National museums of Kenya (NMK)		
23	Friends of Menengai Crater (FOMEC)	NGO	

6.2.2 Stakeholder Engagement

Avenues for stakeholder engagement include:

- Key informant interviews; and
- Public meetings

The feedbacks from these forms of engagements are described in the following sections.

6.3 Key Informants Interviews

Key informant interviews were held with various heads and representatives of line ministries and other government agencies at both the county and national governments in Nakuru County as well as active NGOs identified within the project area. These stakeholders were identified based on their needs, interests, relative power and potential impact on project outcome and absence of documented evidence of consultation in the earlier ESIA study. Even though some of the contacted agencies have regional coverage, the consultations focused on Nakuru North/Bahati and Rongai sub counties as the two sub counties directly affected by the project in Nakuru County.

The objectives of these meetings were to:

- Introduce the project to the agencies/administration and present current status of the project to those who already knew about it;
- Obtain more information about the project area toward updating the baseline information on the 2 target Sub Counties i.e. Rongai and Nakuru North; and
- Obtain views of the stakeholders on updating the project's ESIA report.

During the consultations, both open ended discussions and thematic questionnaires were deployed. Notes of the consultative meetings, signed attendance lists and filled questionnaires are attached in Appendix I. Summary of the issues arising are presented in Table 6-2 below.

Table 6-2: Summary of the issues rising from the stakeholders consultations

SN	Category of stakeholders	Issues and Concern	Positive Impacts and Suggestions	Response from the consultant team
1.	Department of Water, Nakuru North Sub County	• If the proposed plants get water supply from NAWASCO, there will be no problem. However, NARUWASCO has no adequate water and cannot even meets its current demands	• Any underground water for domestic use must be treated because of high fluoride contents	• Existing arrangement is such that GDC gets domestic supplies from NAWACO and the same is expected of the IPPs
2	Department of Gender and Social Development , Nakuru North Sub County	• Further land fragmentation in areas around the project area • Increased moral decadence due to increased levels of disposable income: more drinking, higher number of vulnerable children etc. • Destruction of scenic features characteristic of the Menengai landscape • Hostility and increased tension among youth of working age perceiving that jobs are benefiting non-locals • Environmental pollution: dust, noise and odor • Displacement of monkeys into settled areas • Adulteration of social norms occasioned by influx of non-residents working at the site; • Climate change: there is common belief that drilling geothermal wells is responsible for the heavy rains currently witnessed in the area	• Lobbying for zoning of the area so as to prevent fragmentation • Mobilization of individuals working at the site into self-help groups or investment oriented groups • Institute environmental protection measures • Consistent and meaningful involvement of local residents at all levels of the project	Environmental and social management plans has been formulated within the ESIA study report to manage the predicted impacts Air and noise modelling are being undertaken as part of the study to establish likely levels of pollution and affected areas for informed management interventions. From past monitoring by GDC, hydrogen sulphide levels have been found to be within limits acceptable by World Health Organization Geothermal power production contributes least to climate change in comparison with other means like thermal power productions
3	Public Health Office, Ministry of Health, Nakuru North and Subukia Sub Counties	Nil	• Community will get employment opportunities • Improved road network and cheap energy • Improved water supply and security due to power supply • Improved quality of education –reduction	Nil

SN	Category of stakeholders	Issues and Concern	Positive Impacts and Suggestions	Response from the consultant team
			of eye problems due to straining	
4	Nakuru County Government, Ministry of Environment, Natural Resources, Energy and Water-Director of Environment	• Initial ESIA report was not shared with the county government of Nakuru as one of the lead agencies for comments	• The Nakuru county government embraces the project • The county government will also help a lot in ensuring that the project implementation conforms to the approved ESMP • The project will attract more investment into Nakuru County • It will also create more employment and investment opportunities for people in Nakuru County.	• It was noted that the first report was done in 2012 when the county government was still not in place. The consultant agreed to share the report under update via mail.
5	Nakuru Water and Sanitation Services Company (NAWASCO)	• Necessary protections around the aquifer to prevent dissipation of high temperature –already high temperatures ($33^{o}C$ to $42^{o}C$) have been noted at NAWASCO boreholes. This has seen increased O&M cost on borehole pumps and motors • NAWASCO has already raised the issue of increased borehole water temperatures with GDC who promised to undertake studies and give feedback • Increased hydrogen sulfide levels into the natural environment which may change the surface water quality and which constitutes the groundwater recharge for aquifers used by NAWASCO	• The project is a good initiative that would enhance economic growth probably enabling lower energy cost in manufacturing/production sector • Expect reduced power outages which are currently frequent and affects NAWSCO production capacity. Boreholes (powered by electricity) constitute 90% production capacity • Geothermal drilling goes beyond the aquifers used by NAWASCO (250-300m) and due care is necessary if no leakage is to be experienced from the water supply boreholes • Adoption of appropriate construction technology and provision of adequate insulation materials around the entire depth of aquifers used by NAWASCO • Incorporate adequate safety measures to safeguard against accidental damages or in case of plant breakdown	• Part of the study includes air dispersal modelling to help predict likely future scenario of hydrogen sulphide pollution and inform formulation of appropriate mitigation measures. Further, air quality monitoring will be an ongoing process at and around the power plants • Follow ups will be done with GDC on the issue of increased borehole water temperatures.

SN	Category of stakeholders	Issues and Concern	Positive Impacts and Suggestions	Response from the consultant team
6	Rift Valley Water Services Board (RVWSB)	• There have been complaints of rising borehole water temperatures since GDC commissioned the geothermal wells in Menengai • Emissions from the plants may affect local communities • Fear of cross contamination of aquifers during brine re-injection • If casing is not properly done, there is a risk that the water in the aquifers will be drained into the fault lines or contaminated by the minerals in the steam	• Geothermal power plants development will add more power to the national grid and reduce cost of electricity • Most boreholes in the project area are pumped by electricity. Anticipated reduced power cost will lower their cost of operation • Properly designed and controlled drilling process to ensure no contamination of aquifers • Ensure that brine is pre-treated before reinjection or dispose of safely • Reinjection wells should be well encased to prevent any potential contamination of borehole aquifers	• Respondent informed that study includes air dispersal modelling to help predict likely future scenario of hydrogen sulphide pollution and inform formulation of appropriate mitigation measures. Further, air quality monitoring will be an ongoing process at and around the power plants
7	Water Resource Management Authority (WRMA), Rift Valley Catchment Area	• If the plants depend solely on the groundwater pumped from the area, there are possibilities of depleting or over abstracting from the aquifer. It will also affect water supplies to local communities • It will affect ground water recharge as surfaces get covered by concrete • Increased population in the area is likely to have pressure on the available water resources and other environmental resources	• Trends in underground water in the area have been steady. The area has a god groundwater potential and it has not been overexploited • The project will create jobs for the locals and also come with development of social amenities • Alongside the underground water supplies, alternative supply sources should be sought e.g. storage for rainwater harvesting or alternative surface water supplies • Destruction of environment should be minimal. There should be plans to restore the natural environment as it was before the project • Alternative sources of water should be developed to cater for the increased population. •	• Large volumes of water are usually required where cooling of plants is necessary. However, The proposed plants are not anticipated to require large amounts of water for cooling. Water requirements will be mainly to meet the domestic needs of workers at the plants.

SN	Category of stakeholders	Issues and Concern	Positive Impacts and Suggestions	Response from the consultant team
8	Directorate of Occupational Safety and Health, Nakuru County Office	Nil	• DOSH enforces Occupational Safety and Health Act (OSHA), 2007 • In case of mishaps/accidents, DOSH also enforces Workers Injury and Benefits Act (WIBA) • Conducts registration of work places, ensuring workers are safe, have well access to work and are trained and instructed on safety • GDC is registered with DOSH and is regarded as the occupier of the Menengai Power Plant site. It is an occupier's responsibility to ensure that any contractors adhere to its safety and health policy	Nil
9	Friends of Menengai Crater (FOMEC)	• GDC is raising seedlings for sale and own planting. This is killing the local groups engaged in similar activities. Instead, GDC should buy seedlings from local groups engaging in tree nursery business • There are sacred caves within the caldera which are regularly patronized by various religious sect members. These should be preserved • Power plant staff will add pressure on already existing bad waste management system within the caldera • Use of poor quality brine sump lining materials which break down • Erosion from accidental brine spillage • Uncontrolled leakages from existing GDC water pipelines. This has attracted livestock leading to increased soil erosion	• The development is positive for harnessing resources for clean power production • GDC has experimental agricultural field for use of brine. These should be enhanced with the development of the power plants • IPPs should know that pollution is a real issue in Menengai and proper waste management should be instituted • Exposed workers need adequate protection measures e.g. from noise, dust and smell • Recommend an environmental emergency management plan for any accidental brine spillage and associated erosion to ensure timely management • Recommend independent audit of the site activities and disclose findings to all stakeholders	A joint site visit with FOMEC representative was agreed and undertaken to enable the mapping of the sacred caves. Recommendations on environmental management and annual independent environmental audits will be considered in the final ESM developed for the updated report.

SN	Category of stakeholders	Issues and Concern	Positive Impacts and Suggestions	Response from the consultant team
		• Light pollution at the caldera will affect insects survival	• There is need to create awareness among the local communities especially on exposure to burst brine pipes and used brine sump linings	
10	Public Health Office, Ministry of Health, Rongai Sub County	Nil	• Creation of employment opportunities • Improvement of infrastructure e.g. road linkages to and from site • Improved power generation • Setting up of shopping centers	Nil
11	Department of Gender and Social Development , Rongai Sub County	• Youth in the area are underemployed and feel left out by GDC in favor of those from Nakuru North sub county • When the local community is hosting such development, what will they get in return?	• Local youth groups are not very strong and need to be empowered by the development stakeholders as it happened in Nakuru North sub county	A social survey is being undertaken as part of the study and any CSR by the developers will be informed by the findings from the survey and discussions with the locals
12	State Department of Agriculture, Rongai Sub County	• Labor used in the farms is mainly from young people. The project may reduce labor available to farmers and increase the labor cost • Erosion from trucks moving to and from the project site • Social issues: increased incidence of HIV/AIDS as experienced in Rongai flower farms • What kind of pollution is likely from the project? Pollution from acid rain is likely to impact crops while contamination of underground aquifer will impact people since most people in the area rely on borehole water	• Power plants workers will provide ready market for food (farm produce). Local farmers can benefit from increased capital for crop production • Increased power availability will increase crop production e.g. via irrigation • Developers should have a CSR activity for the community like tree planting, promoting 4K clubs and soil conservation activities	Potential pollution due to noise, dust and hydrogen sulphide gas as well as accidental spillage of brine. The current study also includes noise and air quality modelling to identify areas likely to be affected and inform formulation of appropriate mitigation measures
13	State Department of Agriculture, Nakuru North Sub County	• If hydrogen sulfide (H_2S) is not contained, it will affect crops and also contaminate soils by making it more acidic; • Quarries within the project area have been associated with structural issues	• Will bring development of infrastructure which will improve marketing of agricultural produce and even improve prices; • Employment opportunities created through the plants will reduce incidences	Nil

SN	Category of stakeholders	Issues and Concern	Positive Impacts and Suggestions	Response from the consultant team
		affecting houses and masonry tanks through development of cracks. E.g. the Kagoto quarry next to Kagoto primary school; and • Farmers in Menengai crater area (Kiamaina division) have already complained of acidic rain affecting their roofs and crops and that the rain water harvested from roof catchments is yellow and cannot be used	of unemployment and alcoholism in the area which even affect agriculture • The ministry hopes to have well-endowed stakeholders within the area including GDC which will boost agricultural activities as well • Proper management measures should be put in place to avoid soil and water pollution	
14	Department of Water, Rongai Sub County	• There is likely to be pressure on existing water supplies, which are mainly boreholes • Likelihood of environmental degradation if waste is not properly managed • Noise pollution from the plants' operations	• Community benefits from support to community water supplies • Increased power supply to the national grid will likely lower existing power interruptions • Eventual reduction in power cost will lead to improved living standards as the cost of living will come down • GDC and IPPs should monitor the impacts of their activities on water supply to the local community • There should be a link between the community and the developers to facilitate regular meetings with water users and service providers	Nil
15	Kenya Forest Service-Mau Conservancy	• There is a proposal to establish a model ecotourism site at the rim of the caldera. KFS is branding Menengai view point. It is not known whether any fumes emitted from the wells and power plants can affected the installations • The impacts of noise on wildlife should be addressed	• There are illegal activities within the forest including charcoal burning, illegal grazing and cutting of poles. We appeal to stakeholders having a MoU with KFS to complement activities undertaken through the Community Forest Association (CAF) to ensure that flora and fauna are not affected	• The study also involves air quality and noise modeling to show areas that may be exposed to dangerous levels of emissions and inform the need for any resettlement for safety reasons where necessary.

SN	Category of stakeholders	Issues and Concern	Positive Impacts and Suggestions	Response from the consultant team
16	Kenya Forest Service-Menengai Forest Station Manager	• The area is naturally prone to wildfires (even in the absence of human interventions like charcoal burning). This implies that even any indigenous vegetation survival is difficult due o the natural conditions: stony surfaces and low water retention capacity, making dry vegetation a good conduit for wildfires • Any transmission line must be cleared of vegetation. The existing vegetation is mainly shrubs and therefore limited clearance is expected only for pylon sites	• Electric fencing of all forest areas (both plantation and in the caldera) should be enforced together with conditions limiting entry and controlling grazing. The surrounding communities currently access the forest area from any point leading to overgrazing. Part of Menengai forest association will allow grazers to be identified • Participatory Forest Management Plan (PFMP) advocates for management of areas on sustainable yield basis and hence no adverse impacts are expected • Introduce fruit trees like *Psidium guajava*, to help contain monkeys and baboons and reduce existing human-wildlife conflicts with farmers. • Pollution related issues are expected to be managed by the expertise available at GDC	
17	Kenya Wildlife Service, Nakuru office	Nil	• The project area is not protected by KWS but known to be inhabited by small mammal like vervet monkeys and baboons. Leopard's presence cannot be ruled out due to their hunting behavior. • Detailed comments to be given only after site visit by KWS.	• GDC contacts were shared with the KWS officer to allow KWS make own arrangements for site visit
18	Education Officer, Bahati Zone in Nakuru North sub county	• Existing quarries in the area have caused problems in Kagoto primary school. When blasting, cracks have developed in the school buildings and even a fatal accident from blasted rocks involving a pupil in the school has been reported. There is a new Heshima secondary school with a storey building next to the Kagoto	• Ensure strict observation of labour laws to ensure that children remain in school with the help of local leaders	• The consultant however informed the respondent that in such projects, use of materials from NEMA licensed quarries is usually recommended and whenever the contractor has to establish a new quarry, a separate ESIA is usually undertaken

SN	Category of stakeholders	Issues and Concern	Positive Impacts and Suggestions	Response from the consultant team
		primary school. Due to fears on structural failure from cracks caused by blasting at the quarries, it has led to use of very stringent quality standard materials which are very costly. Further, the cost of maintaining the institutional buildings is his high. These are likely to increase if the project sources materials from these quarries; • The project might also lead to increased school dropout cases which is common in the area; • The project may reduce migration of locals to urban centers like Nakuru town and encourage spread of HIV/AIDS locally;		
19	Olbanita Water Resource Users Association	• Do not foresee any problem with the implementation of the proposed geothermal power plants since the resources used will be mainly underground-based. • Since the project is in our area, how will the local community and Olbanita WRUA benefit from it?	• GDC and partners should always invite Olbanita WRUA to any stakeholders meetings with the locals, especially on water resources management and all should register with the WRUA to promote management of water resources in the area; • GDC and partners should consider putting up a water storage tank for Olbanita WRUA to facilitate supplies	• The consultant informed the WRUA that the local community already enjoys some water supply from NAWASCO following arrangements made by GDC as a CSR. GDC has contributed through community water tanks which facilitate local water supplies.

6.4 Public Meetings

A total of eight (8) public meetings were organized in the sub locations neighbouring the project area in collaboration with local chiefs and assistant chiefs. The schedule of the meetings held is as shown in Table 6-3 below.

Table 6-3: Schedule of public meetings

Rongai Sub County				
No.	**Sub Location**	**Date**	**Time**	**Venue**
1.	Kampi ya Moto	Thursday, 30th October, 2014	10.55 AM	GDC Kabarak Farm
Nakuru North Sub county				
2.	Kirima	Monday, 3rd November, 2014	11.30 AM	Full Gospel Church
3.	Ndungiri	Monday, 3rd November, 2014	12.15 PM	Ndungiri Cattle Dip
4.	Ol Banita	Monday, 3rd November, 2014	3.05 PM	Full Gospel Church
5.	Wanyororo	Wednesday,5th November, 2014	11.30 AM	Wanyoro Trading Center
6.	Menengai	Thursday,6th November, 2014	11.40 AM	Menengai Trading Center
7.	Mwaki Mugi	Friday,7th November, 2014	11.12 AM	Kabatini Chief's Office
8.	Mutukania/Landi Mawe/Karonga	Tuesday,11th November,2014	11.30 AM	Rehema Church Ahero

6.4.1 Objectives of Public Consultation Meetings

Public consultative meetings were held in the eight sub locations, listed above within the project area. The objectives of these meetings were as follows:

- Awareness creation about the project to the community with respect to scope of the project; stakeholders of the project; development approach to be employed in the project; roles and responsibilities of the community and other stakeholders and role of GIBB Africa Ltd. in the project;
- Explaining to the community on the different activities the study team will be undertaking in the ESIA studies and further explaining the communities' role.
- Informing the community on the environmental and social impacts of the project will be addressed;
- Getting feedback from the communities on their views on the project and issues of concern.

Some photos of the participants during the various meetings are presented in the table overleaf.

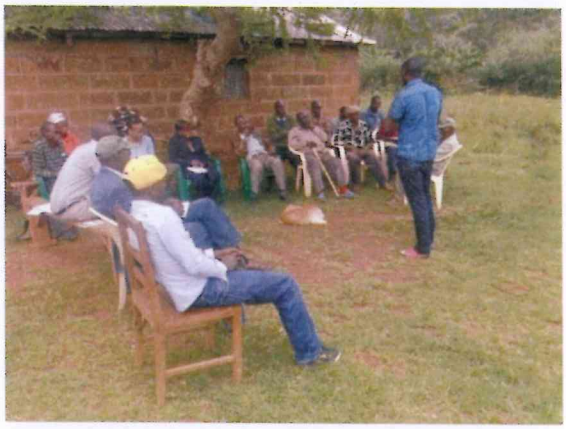


Photo 1: Public meeting in Ndugiri sub location at social centre grounds

Photo 2: participants at a meeting held in Ol Banita sub location at Ol banita Full Gospel Church

Photo 3: Stakeholder meeting in Mercy Njeri sub location at the Chief's compound

Photo 4: Stakeholder meeting Mercy Njeri sub location

Photo 5: Stakeholder meeting in Kirima sub location

Photo 6: Attendance at a public meeting in Wanyororo sub location

Photo 7: Attendance at a public Kiamaina sub location

Photo 8: A participant contributing during a meeting in Kiamaina sub location

6.5 Summary of Issues raised in Public Meetings

A total of eight public meetings were conducted at sub location levels during this update study. A summary of the issues raised by the consulted stakeholder community members during the public meetings are presented in table 6-3. Complete records of public meeting records are presented in Appendix II.

Table 6.3: Summary of comments from public meetings

SN	Sub Location	Issues and Concern	Response from the consultant team
1.	**Kampi Ya Moto**	• Clarification on the actual route of the power transmission lines and the likely impacts. • The water supply source for the power plant due to concern over the perennial water problem in the area. • Benefits from the project to the local community.	• The power transmission lines from the power plants to the substation were a different project undertaken separately by Kenya Electricity Transmission Company (KETRACO). • Water supply to the power plants will be provided by GDC from their boreholes located in the Caldera. The anticipated benefits to the local community are: • Employment opportunities for both skilled and unskilled labor; • Sourcing of building materials such as building stones from quarries around the project area.
		• As part of the IPP community social responsibility programme, attendants at the meeting asked that the following projects be given priority in respective order of water supply; Education; Development of a hospital (Kachwera); and Grading of access roads.	• Point noted and will be forward to the project proponent for consideration.
		• Education and awareness creation on the significant impacts associated with the power plant	• Some of the significant impacts identified by the consultant in relation to geothermal power generation included Noise; Air quality; and cheap renewable energy.
		• Relationship between Independent Power Producers and Geothermal Development Company.	• GDC is a government parastatal mandated with geothermal exploration in Kenya whereas the IPPs are private companies involved in power generation. The two have signed an agreement where the IPPs purchase steam from GDC for power generation.
		• Local community to be prioritized when employing skilled and unskilled labour during the construction and operation phases of the project. Unskilled labour should not be sought from outside the project area.	• The ESIA study report will recommend to the Contractors and Quantum to prioritize the local community when employing unskilled labour.
		• The consultant to arrange for meetings with neighbouring communities after completion of the ESIA study to educate them on the outcome of the study and how the community will be impacted by the project and mitigation measures put in place to avoid or minimize the impacts.	• A disclosure workshop will be organized in Nakuru after the approval of the ESIA study report where key stakeholders will be invited.

SN	Sub Location	Issues and Concern	Response from the consultant team
		• A nominated Senator present at the meeting informed the attendants that there is a new law (Natural Resources Sharing Bill) being debated in the Kenyan Senate which will ensure benefits from the exploitation of natural resources are shared with the local communities through a signed agreement.	• Point noted and acknowledged.
		• A local leader advised the community as a way forward to avoid being left behind was by the community members organizing themselves and setting up special committees to make follow up on the development in Menengai on technical, legal and socio-economic issues.	• Point noted and acknowledged.
		• The project size in comparison to Olkaria.	• Olkaria has several power plants with a higher capacity compared to the three to be constructed in Menengai.
		• Local community involvement prior to commencement of the project was welcomed as a right step.	• The public meeting was one of the avenues of involving the local community prior to commencement of the construction phase of the project.
		• The ESIA Study report should be disclosed at the local level for the community to enable discussion and debate by the project beneficiaries and affected persons.	• A disclosure workshop will be organized in Nakuru after the approval of the ESIA study report where key stakeholders will be invited.
2.	**Kirima**	• Employment opportunities for the youth and career choices for the youth in order to improve their chances of getting hired. • Increased incidences of human-wildlife conflict as animals invade private farm due to disturbances in the Caldera. • Geothermal development has restricted access to the caldera thus depriving the community benefits such as grazing grounds, firewood and poles for fencing.	• When hiring especially semi-skilled and unskilled labour, priority would be given to the project neighbouring community. Courses such as engineering and earth sciences would enhance their chances of getting a job in the geothermal sector. • Consultation to be done with KFS and KWS on suitable measure to be implemented to minimize incidences of human-wildlife conflict. • The ESIA stud report will recommend to relevant stakeholders not to restrict certain section of the caldera in order for the neighbouring communities to continue accessing goods from the caldera. • Brine has high levels of toxicants thus cannot be used for irrigation

SN	Sub Location	Issues and Concern	Response from the consultant team
		• Brine to be supplied to local community to be used for irrigation farming and if it could be used to cure skin infections.	farming but can be used to treat skin infections.
		• Follow up should be made by GDC to ensure success after providing tree seedlings.	• Communication to be done to GDC.
		• Clarification as to whether rusting of iron sheet roofs in the area was as a result of geothermal steam	• There have been complaints raised in Olkaria Naivasha about rusting of iron sheet roofing being caused by geothermal emission but there is no evidence to show that geothermal emissions was the cause. Further investigations will be required to clarify the cause.
		• Cold weather experienced in the area was affecting their potato crops thus they wanted to know if it is as a result of geothermal development activities impacting the weather around the area.	• Changes in climatic conditions were attributed to global warming and climate change phenomenon and geothermal air emissions.
		• Hiring for job opportunities in the project area is done through SACCO in Bahati which requires membership. Majority of the youth in the area do not have the funds to join the SACCO thus they are locked out. The SACCO itself discriminates when hiring favouring persons from where it is based.	• Job opportunities will be communicated through the area chief. Applicants will pass their credentials to the chief who will then pass them to the employer for review. SACCOs will not be involved in hiring.
		• When hiring unskilled workers, people from the neighbouring communities to be prioritized and not people from outside the project area.	• Priority will be given to the project neighbouring communities. Job opportunities for semi-skilled and unskilled labour will be communicated through the area chief and not SACCOs.
		• The community wanted to know if rain water harvested from rusting iron sheet roofing had health risk when consumed.	• Laboratory analysis of the water needs to be undertaken to verify if it has implications on human health.
3.	**Ndungiri**	• The expected environmental and social impacts from the project.	Expected environmental and social impacts from the project include: • Air emissions (H2S and CO2) and air quality; • Noise and disturbances; • Employment opportunities during the construction and operation phase of the project;
		• Initiation of afforestation program to improve ground cover.	• Consultation to be sought from GDC on the issue of issuance of tree seedlings.
		• Assistance sought from the client regarding the poor state of the access roads	• Client acknowledged the concern.

SN	Sub Location	Issues and Concern	Response from the consultant team
		• Direct benefits from the project to Ndungiri sub location	Direct benefits to people of Ndungiri Sub location from the project include: • Geothermal power plants can be a tourist draw when students, scientists, or interested individuals visit the site, thereby bringing business to the local community; • Geothermal development will bring significant economic advantages such as jobs and tax payments. Power generating companies will provide additional voluntary contributions to the neighbor communities
		• Reservations that steam released from the wells is affecting vegetation growth especially grass since it rains in the area but the land cover remains fallow.	• Steam released into the atmosphere from the wells in the Caldera does not affect vegetation. Further investigation is required to establish the cause.
		• Fear of acid rain corroding roofing as some cases have been reported in Naivasha.	• Complaints have been raised in Olkaria Naivasha on the rusting of iron sheet roofing on house being associated with the geothermal steam but this has not been proven.
		• Request to the Client to assist in constructing Ndungiri polytechnic administration block, ladies hostel and provide training machinery and equipment.	• The Client noted the requested.
		• Brine from the wells to be supplied to the community to be used for household and irrigation.	• Brine has high levels of toxicants which are harmful and therefore brine cannot be used for consumption, household use and irrigation of crops.
		• Bad odour from the Caldera affecting breathing especially at night.	• Hydrogen Sulphide present in geothermal steam is the cause of bad odour.
		• Creation of scholarships to aid needy student and hosting sports events in the area to promote local talent among the youth.	• The suggestion was noted.
		• GDC and KFS to assist in environmental education in the area and provision of tree seedlings to increase ground cover.	• GDC and KFS to be consulted and informed on the matter.
		• Disease affecting maize crop in the area is caused by geothermal steam from the Caldera	• The disease affecting maize crop in the area is a viral disease and not associated with geothermal steam or activities.
		• The area is experiencing erratic weather conditions and most people attribute it to the geothermal project and emissions released.	Erratic weather conditions are being experienced worldwide. This has been linked to global warming and climate change.

SN	Sub Location	Issues and Concern	Response from the consultant team
4.	**Ol Banita**	• The relationship between ground shaking and exploration drilling. • Clarification as to whether steam from wells resulted into rust on house roofing. • Will negative environmental impacts result into halting of the project? • Clarification as to whether work on the construction of the power plant had commenced. • Provision of social amenities by QPEA	• Nature of some geothermal exploration activities such as drilling of wells and release of geothermal steam from underground reservoir may result in ground shaking. • There have complaints in other areas such as Olkaria Naivaisha of Iron sheet roofing rusting due to H2S but there is no evidence to link H2S to rusting. • Mitigation measures in the ESIA study report will be implemented to eradicate and minimize negative impacts thus allowing the project implementation. • Construction works had not yet commenced. Work will commence on January 2015. • No social amenities will be provided by QPEA.
5.	**Wanyororo**	• Benefits from the project to the local community. • It was suggested that QPEA GT Menengai Ltd have a Memorandum of Understanding with the local community on employment of persons from the area so that in case the issues in the M.O.U are not fulfilled they can hold QPEA responsible • Long term effects from the project and mitigation measures.	Benefits to the local community will include: • Employment opportunities for skilled, semi-skilled and unskilled labour from the project area; • Sourcing construction materials such as sand and building stones from local suppliers; • Reliable power source; • Reduced cost of electricity. • Point was noted and acknowledged. Some of the long term impacts from the geothermal power plant are: • Air emissions (CO2 and H2S); • Noise; • Reduction in the cost of electricity. Mitigation measure will include: • Sitting and design changes; • Air quality monitoring; • Continuous noise measurement; • Building barriers around the power plant to contain noise.

SN	Sub Location	Issues and Concern	Response from the consultant team
		• Public disclosure of the ESIA study report to educate the local community on the impacts and mitigation measures. • The use of brine after power generation for irrigation in greenhouses • Prioritize employment of locals especially women and youth. Hiring should not to be undertaken through SACCOs as there is no equity when hiring. • On job trainings for non skilled labour to build their technical capacity and issuance of long term contract. • Commencement of construction of power plant. • A big portion of land in the Caldera belonged to Wanyororo yet the community had not been compensated for their private land. It was suggested that the community be part of any agreement between GDC and IPPs and given shareholding in the projects.	• Public disclosure workshop will be organized in Nakuru after the approval of the report where all stakeholders will be invited. Impacts and mitigation measures from the ESIA study report will be communicated. • Brine cannot be used for household use and irrigation because it contains high levels of pollutants. It can only be used to treat skin infections. • Priority will be given to persons from the project neighbouring communities when hiring semi-skilled and unskilled labour. Available vacancies will be advertised through the area Chief and not through SACCOs. • Qualified persons with job specific skills will be hired for the duration of the work • Construction of the power plant will commence in January 2015 and will last for a period of 15 to 17 months. • Where private land is acquired for geothermal energy development, land owners should be compensated.
6.	**Menengai**	• Benefits to the community from the project • Access to electricity from the project. • Menengai Sub location experiences severe water scarcity and depends mainly on rain water harvested during the rainy season. The community requested that in case the project proponent would consider doing something for them water project to be priority.	Benefits to the community from the project include: • Employment opportunities; • Geothermal power plants can be a tourist draw when students, scientists, or interested individuals visit the site, thereby bringing business to the local community. • Electricity from the project will be injected into the national grid and accessed by application to Kenya Power. • Point noted and will be forward to the project proponent for consideration.

SN	Sub Location	Issues and Concern	Response from the consultant team
		• Promises to Menengai Sub location community by GDC have not been realized. Project proponent urged to do something for the community. • A request was made to the project proponent to support entrepreneurs and community self help groups. • A consensus was reached that any employment presented to the community should be advertised through the area Chief.	• Point noted and will be forward to the project proponent for consideration. • Point noted and will be forward to the project proponent for consideration. • Point noted and will be forward to the project proponent for consideration.

7.	**Mwaki Mugi**	• Priority to be given to the youth as far job vacancies for the project is concerned.
		• Compensation for power transmission lines passing through private land.
		• Involvement of the County Government in the project.
		• Benefits from the project to the local community.
		• Inquiry as to whether grading has been done on the access to the Caldera through Mwaki Mugi y GDC and IPPs.
		• Assistance to be provided to the community to generate revenue and employment from the Menengai Crater through promotion of tourism.
		• Increased incidences of human-wildlife conflict ever since geothermal exploration started in Menengai.
		• Recommendation to GDC in the construction of an operation theatre and providing an ambulance to Bahati district hospital. They asked if they could be assisted in renovating and building a school administration block in one of the local schools as well as a police station to enhance security in the area.
		• Talent promotion through sports targeting local youth such as cross country athletic race to promote environmental conservation in
			• Job vacancies for the local youth would be considered during the construction and operation phases of the project.
			• Power transmission is a separate project undertaken by Kenya Electricity Transmission Company (KETRACO).
			• County Government involved during key project stakeholders consultations.
			Benefits to local community are:
			  • Employment opportunities for both skilled and unskilled labor;
			  • Sourcing of building materials such as building stones from quarries around the project area.
			• The designated access road through Wanyororo will be used by the IPPs.
			• Point noted and will be forward to the project proponent for consideration.
			• ESIA study report will recommend to the stakeholders involved measures to minimize human-wildlife conflict.
			• Point noted and will be forward to the project proponent for consideration.

SN	Sub Location	Issues and Concern	Response from the consultant team
		Menengai. • Tree seedlings for tree planting by the community around the project area to be provided to the local community by GDC in order to promote environmental conservation and water catchment. • Creation of a data bank of all qualified but unemployed person as well as a committee for handling the recruitment of locals in the event of available job opportunities. • Proposal that local business and companies be contracted to provide materials such building stones which are abundant in the area. • Involvement of the community throughout the project cycle in order to inform the community on the progress and challenges. • Measures of involving the community in conservation of environment in the Caldera since exploration activities were degrading the natural environment.	• Point noted and will be forward to the project proponent for consideration. • Consultation to be done with GDC on the tree planting programme. • Point noted and will be forward to the project proponent for consideration. • Point noted and will be forward to the project proponent for consideration. • The local community will be involved throughout the project life cycle updating them on progress and challenges. Public meetings and local administrative leaders would be used to pass information. • Consultation would be made with Kenya Forest Service on the issue.
8.	**Mutukania/ Landi Mawe/Karonga**	• Consultation and sensitization of the project neighbouring communities was important and commended the Consultant for undertaking it prior to commencement of the project. • Prioritization of youth for semi-skilled and skilled labour. • Request for assistance of community health workers with First Aid kits; rent for office space; identification of materials and stipend for members. • Sport evangelism to be initiated in collaboration with NACADA to curb alcoholism among the youth. • Benefits from the power plant project to the community. • The area experiences scarcity of water and a	• It is a requirement by law for community involvement prior to commencement of any project of such magnitude. • The Consultant in the ESIA report will recommend that people from the project area be prioritized when hiring semi-skilled and unskilled labour during construction of the power plants. • Point noted and will be forward to the project proponent for consideration. • Point noted and will be forward to the project proponent for consideration. Benefits from the geothermal power plant project include: • Creation of employment opportunities during the construction and operation phases of the project; • Electricity cost reduction making it affordable to majority of the people in the area.

SN	Sub Location	Issues and Concern	Response from the consultant team
		request for drilling of boreholes was raised in order to avert the problem.	• Point noted and will be forward to the project proponent for consideration.
		• The area around Ahero where the meeting was being held lacked public toilets for use by the inhabitants therefore a request for assistance to the project proponent to construct one for the community to run and generate revenue. These would be a sustainable source of revenue for a youth group in the area.	• Point noted and will be forwarded to the project proponent for consideration.
		• Request was made to the project proponent to sub contract local businesses to supply locally available materials such as sand and building stones.	• Point noted and will be forward to the project proponent for consideration.
		• GDC had previously assured the community that carbon credit fund would be made available thus they wanted to know when it will be available.	• Consultation would be raised with GDC on the matter.
		• Clarification was sought as to whether Corporate Social Responsibility would be part of the project.	• CSR program would be recommended to the project proponent.
		• In recognition that Water supply from NAWASCO was available in the area at the water kiosks, a request was made on the possibility of provision of water mains to be directly connected to individual homes.	• Point noted and will be forward to the project proponent for consideration.
		• Persons living next to the Caldera were inhaling bad odour and being affected by the high noise levels and vibrations. Consequently, clarification was sought on appropriate intervention measures.	• The ESIA study report will recommend mitigation measure will be implemented by the project proponent to minimize impacts on air quality and noise and vibrations.

7 IMPACT ASSESSMENT AND MITIGATION MEASURES

7.1 General

Actual and potential environmental and social impacts associated with geothermal power plant in Menengai are presented in this chapter. Impacts have been divided into positive and negative environmental, social, health and safety during the construction and operation phases of the project.

Cumulative impacts of the project are also assessed by considering effects of various planned activities of the project.

7.2 Methodology for Impact Assessment

An environmental impact is any change to the existing condition of the environment caused by human activity or an external influence. Impacts may be:

- Positive (beneficial) or negative (adverse);
- Direct or indirect, long-term or short-term in duration, and wide-spread or local in the extent of their effect.

Impacts are termed cumulative when they add incrementally to existing impacts. In the case of the project, potential environmental impacts would arise during the construction and the operations phases of the project and at both stages positive and negative impacts would occur.

7.2.1 Impact Identification

The study has predicted and evaluated anticipated impacts using internationally acceptable standard methods of impact prediction and evaluation. Constant reference to a checklist of project activities was made and scores were assigned in an assessment table in order to make an objective assessment of how each of the project activities would impact on a particular environmental and social medium. The significance of impacts is subjective, but the value judgments required were best arrived at by consensus.

The study team used several approaches such as brainstorming and use of checklists and matrices, to identify the main sources and establish the potential impacts from the proposed main project activities. Public participation and consultation was also conducted to reduce uncertainty.

7.2.2 Impact significance

The purpose of this ESIA study report is to identify the significant impacts related to the project or activity under consideration and then to determine the appropriate means to enhance those which are positive, and avoid or mitigate those which are negative.

Significant impacts are defined, not necessarily in order of importance, as being those which:

a) Are subject to legislative control;
b) Relate to protected areas or to historically and culturally important areas;
c) Are of public concern and importance;
d) Are determined as such by technically competent specialists;
e) Trigger subsequent secondary impacts;
f) Elevate the risk to life threatening circumstances; and
g) Affect sensitive environmental factors and parameters.

7.2.3 Impact Assessment Scoring

To systematically identify, predict, evaluate and determine the significance of impacts resulting from the project construction and operation, a generic criteria developed by Haug *et al* (1984) was adopted as presented in Table 7-1. Precautionary principle was used to establish the significance of impacts and their management and mitigation i.e. where there is uncertainty or insufficient information, the Environmentalist erred on the side of caution.

Table 7-1: Criteria for assessing significance

SEVERITY OF IMPACT	*RATING*	*CONSEQUENCE*
Insignificant / non-harmful / less beneficial	-1/ +1	
Small/ Potentially harmful / Potentially beneficial	-2/ +2	
Significant / slightly harmful / Significantly beneficial	-3/ +3	
Great/ harmful / beneficial	-4/ +4	
Disastrous/ extremely harmful / extremely beneficial	-5/+5	
SPATIAL SCOPE OF IMPACT	RATING	
Activity specific	-1/ +1	
Right – of – way specific (within right – way)	-2/ +2	
Local area (within 5km of the project)	-3/ +3	
Regional	-4/ +4	
National	-5/+5	
DURATION OF IMPACT	RATING	
One day to one month	-1/ +1	
One month to one year	-2/ +2	
One year to ten years	-3/ +3	
Life of operation	-4/ +4	
Post closure	-5/+5	
FREQUENCY OF ACTIVITY / DURATION OF ACTIVITY	*RATING*	*LIKELIHOOD*
Annually or less / low	-1/ +1	
6monthly / temporary	-2/ +2	
Monthly / infrequent	-3/ +3	
Weekly/ life operation/ regularly / likely	-4/ +4	
Daily / permanent / high	-5/+5	
FREQUENCY OF IMPACT	RATING	
Almost never/ almost impossible	-1/ +1	
Very seldom / highly unlikely	-2/ +2	
Infrequent / unlikely/seldom	-3/ +3	
Often / regularly/ likely/ possible	-4/ +4	
Daily / highly likely/ definitely	-5/+5	

Table 7-2: Significance rating matrix

	CONSEQUENCE (Severity+ Spatial Scope + Duration)														
LIKELIHOOD (Frequency of activity + Frequency of impact)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 7-3: Negative mitigation ratings

Significance Ratings	*Value*	*Negative Impact Management Recommendation*	*Positive Impact Management Recommendation*
Very High	**126-150**	Improve proposed management	Maintain proposed management
High	**101-125**	Improve proposed management	Maintain proposed management
Medium - High	**76-100**	Improve proposed management	Maintain proposed management
Low - Medium	**51-75**	Maintain proposed management	Improve proposed management
Low	**26-50**	Maintain proposed management	Improve proposed management
Very low	**1-25**	Maintain proposed management	Improve proposed management

7.3 Positive Impacts during construction

7.3.1 Creation of Employment Opportunities

The construction phase of the project will be characterised by recruitment of significant numbers of skilled and unskilled people to work with the contractor. Some skilled persons likely to be recruited include engineers, project managers, masons, carpenters, mechanics etc. There will also be an influx of new people into the project area. The projected number of construction staff is 300 persons. An increase in population of this magnitude will create a corresponding increase in demand for goods and services such as food for construction workers, housing, healthcare and need for transport. These needs will be satisfied by people living within the project area where local women will provide food vending services, homes will rent out spaces for the new population and shops will also benefit from increase of sales. All these avenues are bound to create new employment opportunities.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+5*
Spatial scope of impact	*+5*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+5*
Result	***+130 Very High***

Enhancement measures

In order to improve employment opportunities and make the project attractive to the people living in the area, the following are vital:

- All construction workers should be employed and remunerated in accordance with the provisions of Kenyan labour laws and best international practices as contained in ILO and IFC Performance Standard 2: Labour and Working Conditions;
- Capacity building and training of men, women and youth on specialised labour that will be required during construction;
- Gender mainstreaming during the recruitment process of workers to work in the construction process;
- Spreading administrative units to areas that are not going to benefit directly from the construction works so as to facilitate distribution of economic activities;
- Establishment of a strong quota system of allocation of jobs for persons living in the neighbouring locations both in Rongai and Nakuru North sub counties even after relocation to a new place to facilitate equal spread of opportunities.

7.3.2 Income Generating Opportunities for local community

7.3.2 Income Generating Opportunities for local community

During construction phase the neighbouring local community (particularly the women) to the project sites will get an opportunity to start small income generating activities such as:

- Sale of food to the construction staff; and
- Opening up shops to sell basic necessities to the construction staff.

This will increase and diversify income streams for the communities hosting the project and improve socio-economic status of their families.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+4*
Spatial scope of impact	*+3*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+5*
Result	***+100 High***

Enhancement

- It is proposed that water should be provided at the catering area through a Water Tank or stand pipe to improve hygienic conditions; and
- Women who want to participate be advised to get clearance from local Public Health offices in Rongai and Nakuru North sub counties.

7.3.3 Improved Local Economy

With project increased earnings of both the local population and the new population coming in search for labour, the amount of money in circulation will increase. With the increased earnings, purchases of local goods and services by the construction labour force will positively impact the local economy. Similarly, increase in imports of construction and process equipment and in the supply of local construction materials will change economic dynamics of the entire Nakuru County. This will therefore have a positive impact in terms of economic development. Improvement of the quality of life of the local community during construction is anticipated to arise from improved local socio-economy.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+4*
Spatial scope of impact	*+4*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+4*
Frequency of impact	*+4*
Result	***+88 Medium - High***

7.3.4 Local Market Opportunities

This is an advantage to the sellers of construction materials who will get contracts to supply the materials and services during construction phase. In addition, the local people will be selling food and other merchandise to the construction workforce. This means therefore that there will be an increase in revenue opportunities for the local population due to the presence of non-resident workers.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+4*
Spatial scope of impact	*+3*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+4*
Result	***+90 Medium - High***

7.3.5 Improved infrastructure and Social Services

The development of access roads for use during the geothermal exploration and production wells development by GDC has already improved access across villages and open up areas that have been lacking efficient access such as the Wanyororo. This is a development attested by the consultees contacted during the study.

The projected increase in population and subsequent revenue growth from power plant construction is also likely to lead to development of social amenities such as improved water supply, development of social halls within established town centres and improvement of standards and number of medical facilities.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+3*
Spatial scope of impact	*+3*
Duration of impact	*+4*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+4*
Result	**+ 90 *Medium - High***

7.3.6 Information, Education and Communication

With the implementation of the power plant, there will be development of additional skills for those taking advantage of new opportunities. There will also be diffusion of know-how from the more qualified personnel to the local personnel who participate in the construction activities.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+3*
Spatial scope of impact	*+4*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+2*
Frequency of impact	*+3*
Result	**+ 50 *Low***

7.4 Negative Impacts during construction

7.4.1 Impact on Flora

(a) Loss of vegetation cover

The vegetation will be cleared during construction of power plant, associated substation, office buildings, transmission lines, and access roads. However, this impact is short-term and not significant because the spatial extent will be limited to the small plant areas and can be readily

minimised by ensuring that vegetation disturbance is confined to construct sites. Further, the project sites can be re-vegetated with the same species after construction. The proposed plant area is covered by mainly by bushes and the presence of the endangered East African sandalwood (*Osyris lanceolata*) at this site was not established.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-4*
Result	***-36 Low***

Mitigation measures

- Any sandal wood identified on site should be marked out and made known to the engineers and contractor;
- Ensure that construction site is clearly demarcated and there is selective clearing of the vegetation to allow future re-growth and regeneration. This will ensure minimal disruption of wild fauna's natural movement, territoriality, and other ecological processes;
- It is desirable to re-vegetate disturbed areas along roads, pipelines and steam lines and other construction sites. While the invasive *Datura stramonium* will rapidly colonize the disturbed bare grounds and still act as surrogate habitat for some fauna species, it is still desirable to minimize/discourage it's dominance by planting native trees such as *Croton megalocarpus*-. Additionally, *Digitaria sp* a native grass commonly growing at the site can be very used in checking soil erosion especially on loose soil dumps or bare slopes created during construction.
- There is need to create awareness among the local communities and discourage them from engaging in charcoal burning which is reportedly on the increase within the caldera;
- QPEA in liaison with GDC's Environmental and community liaison section should monitor regeneration of natural vegetation as well as the appearance/spread of invasive or opportunistic species within the disturbed areas. Monitoring should include spotting and uprooting of unwanted germinating plants.

7.4.2 Impact on Fauna

The project area is part of a protected forest housing wildlife such as monkeys, leopards, several bird species and reptiles (Appendix IV and Appendix V). The most significant effect of geothermal power plant operation on the environment is noise, power transmission cables and air pollution. These may disturb the habitat, interfere with breeding and displace the animals and thus increase animal-human conflicts. However, given the relatively low presence of fauna in the project area the impacts are not expected to be very significant.

(a) **Impacts on Macro fauna (mainly Mammals)**

The major impacts on mammals like monkeys, baboons and leopards during the construction phase include (but not limited to) the following:

- Loss and disturbance of habitat/vegetation may lead to disappearance of some rare wildlife such as leopards known to occur in the area;
- Scaring mammals from the caldera into nearby farming communities thereby increasing human-wildlife conflicts;
- Increased vehicle and human traffic in this area may result in many resident species leaving the area. Many forms of human-wildlife conflicts may occur e.g. poaching and accidents due to the high human and vehicle traffic in the area; and

- Dust during the construction phase may cause poor visibility which may result to wild animals being knocked by vehicles.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-4*
Result	***-36 Low***

Mitigation measures

- KWS, QPEA and GDC should monitor wildlife abundance, distribution and movement in relation to this infrastructural development during construction and operation stages to aid in decision making.
- Limit speed of construction traffic within the caldera e.g. through erection of bumps in wildlife crossing zones;
- Vehicular disturbances such as hooting should be discouraged accordingly;
- Incident records (of poaching, accidents and other human wildlife conflicts etc) should be kept by monitoring and taking of corrective measures;
- Roads into/out of the Caldera area should be maintained as routes for tourist's activities and wildlife management;
- Access for earthmoving machines should be regulated;
- Liaison with Menengai forest office to ensure that forest rules are enforced within the caldera throughout; and
- Brine ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact

(b) Impact on Avifauna

The impacts on birds during the construction phase include (but not limited to) the following:

- Fugitive dust from roads settling on perching and nesting sites may push some birds from the site;
- As a result of vegetation clearing habitat for birds that occur in thickets will be lost. The loss may create habitats for species associated with more open areas especially along the steam pipelines and roads;
- Migrating bird's species within the general rift valley area may be affected by transmission lines erected across their fly ways where they are either electrocuted or collides with transmission lines.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-4*
Result	***-36 Low***

Mitigation measures

- The project site has gorges, valleys and hillsides which form some of the keystone habitat features for raptors (Vultures and Eagles) as they enable

them to soar high using thermal currents while in search of prey. These should therefore be retained as intact as possible;

- High voltage transmission lines should be fitted with wire markers and flappers to alert birds on flight; and
- High heat points and emission vents within the project area should be sheltered or fitted with inhibitors to deter birds which may get killed as a result of using such areas

(c) Impacts on Herpetofauna

The major impacts on reptiles during the construction phase include (but not limited to) the following:

- Clearing of vegetation on higher grounds may lead to excessive run off at lower elevations which may lead to washing out and/or filling the breeding burrows of reptiles (and other animals);
- Site clearing may result to movement and relocation of surface materials such as rocks, which are ideal keystone habitat features used by cold blooded reptiles for sun basking e.g. by the endangered African rock python noted in the area; and
- Ground vibrations during the construction phase are also bound to negatively affect reptiles.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-3*
Result	***-56 Low - Medium***

Mitigation measures

- QPEA and GDC should liaise with KWS to capture any reptile encountered hiding under rocks and sheltered terrains such as *Python sebae* and safely release them in suitable habitats.

(d) Impacts on Invertebrates

The major foreseen impacts on invertebrates are not limited to the following:

- Vegetation clearing may in turn lead to increased run off, which may wash away important invertebrate groups;
- Affected insects may interfere with vital ecosystem functions and processes such as pollination hence vegetation regeneration.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-2*
Result	***-49 Low***

Mitigation measures

- Re-vegetation of the cleared vegetation.

(e) Impact on Livestock

From observations, it was noted that livestock grazing by the communities adjoining the Menengai caldera is a common place. From consultations, it was reported that the development of access road by GDC during the preceding stages of geothermal wells exploration and development have enhanced access to the caldera by herders. If animals graze at any contaminated sites, the chemical might accumulate in the animal body and cause side effects such as mineral imbalances leading to anaemia. However, geothermal effluents from the proposed project will be re-injected and sites will be fenced off. Ultimately animals' access to any contaminated sites should not be encouraged and therefore potential impacts are unlikely to occur.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-5*
Frequency of activity / duration of activity	*-1*
Frequency of impact	*-3*
Result	***-44 Low***

Mitigation measures

- Ensure all brine ponds and any waste water holdings are fenced off; and
- Liaise with KFS in controlling access of herders into the caldera

7.4.3 Landscape Character Impacts

During the construction process vegetation and other natural elements shall be cleared from the project area resulting in a change of the landscape character. Creation of new ground levels during construction shall also result in a minor change in the area topography.

This landscape character area has been identified as having medium landscape sensitivity. It forms part of tourist attraction with an established crater view point. Overall, the predicted magnitude of change in landscape resource is medium. Therefore, the predicted significance of landscape impact is moderate.

(a) Visual Impacts

The assessment of the existing visual environment and the impact of the proposed development and its various components on visual receptors have established that there will be potential visual impacts during construction and operation. It is notable that the caldera has a view point at the eastern rim from which tourists enjoy its scenic features. The elements that shall intrude the scenic view are;

- Above-ground steam pipes above the ground from the storm wells to the power station;
- Power Station Structures;
- Site Lighting – During construction and operation; and
- Construction Equipment – Temporary during construction.

Visual sensitivity for the area can be described as medium as activities already undertaken by GDC have had visual intrusion and the total plant area is relatively small in size (140x180m). Overall, the predicted magnitude of change in visual resource is low.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-1*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-4*
Result	***-48 Low***

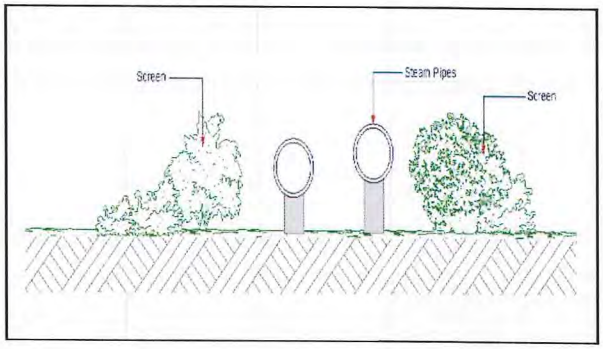
Mitigation measures

The mitigation measures proposed to deal with the anticipated impacts are shown in the table below:

Impact	Mitigation
Loss of Vegetation Cover	• Limiting vegetation clearing to defined construction areas only; • Preparation of a landscape planting plan for the entire project area. Planting plan to be comprised of 75% indigenous species and to be rid of any invasive species
Topography Change	• Limitation of earthworks to construction areas only
Soil disturbance	• Stripped topsoil to be preserved and used during landscaping. • All embankments to be vegetated or stone pitched to prevent soil erosion.

(b) Visual Environment

Visual impacts shall be mitigated by physical and visual integration of the proposed development and associated features into surrounding landscape. This mitigation measures shall include the following:

Impact	Mitigation
Typical visual intrusion by steam pipes from wells to a power station 	• Planting appropriate vegetation screen along the steam pipes to reduce visual intrusion across the landscape. • Pipeline colouring should be greened or given appropriate colour 
View intrusion by the power station structures	• The colour of structures within the project area should be carefully selected to reduce visual impact. Neutral, non reflective colours blend well with the surrounding landscape.
Lighting	• Lighting to be switched off when not required; • Lighting of temporary working areas and site compounds during periods of darkness to be minimised where possible.

(c) Residual Impacts

If a proper post construction planting plan is developed, implemented fully and new vegetation establishes well, there shall be minimum residual impact on the landscape character. Likewise if the visual impact mitigation measures are implemented, the visual impact shall be significantly reduced ensuring there are minimal residual effects.

Mitigation measures

- QPEA and GDC should undertake holistic studies on cumulative visual impacts to the entire caldera, in this coherent mitigation measures should be proposed.

7.4.4 Soil Erosion

This Project will involve earthworks and truck movements on unpaved surfaces which are bound to result in significant amounts of loose soil materials prone to erosion through surface runoff, especially during rainy seasons and by wind. However, with implementation of appropriate and timely erosion control measures, this can be arrested and associated soli loss and siltation minimized.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-3*
Result	***-49 Low***

Mitigation measures

(a) Site Soil Conservation Measures

Site clearing or disturbance of the natural vegetation will be planned and approved as part of project management process. Among the areas that require immediate restoration, the Contractor will allow minimal vegetation clearing and disturbance on the slopes to avoid difficulties during restoration.

Areas inevitably disturbed, cleared, excavated, or/and exposed during construction will be re-vegetated using native grass species, preferably of species growing in the immediate pristine environment like *Digitaria sp* to allow harmony with the surrounding and minimize duration for watering and care. The restoration period will require monitoring of the re-vegetated sites to assess impacts of heavy foraging, patch growth as well as gulley formation. For instance, tussock grass becomes dominant mid slope up to the valley bottoms hence preferred as the grass cover restoration for such an area.

Isolated sites with installations and frequent human presence that require re-vegetation will be surrounded by less palatable native species to act as plant screens and reduce pressure from wildlife and livestock foraging. Presence of well rooted vegetation will act as soil stabilization for the areas. *Croton sp* is recommended among the woody species.

(b) Other Mitigation Measures during Construction

- No grey water runoff or uncontrolled discharges from the site/working areas (including wash down areas) to adjacent watercourses and/or water bodies shall be permitted;

- Water containing pollutants such as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from site;
- Runoff loaded with sediment and other suspended materials from the site/working areas should be prevented from discharging to adjacent watercourses and/or water bodies must be prevented;
- Potential pollutants of any kind and in any form shall be kept, stored and used in such a manner that any escape can be contained and the water table not endangered;
- Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas (including groundwater) are not polluted.

7.4.5 Impact on natural sources of raw materials

No materials sites (quarry and other borrow areas) have been confirmed for the project. Some materials may be sourced within the existing GDC quarries within the caldera while others from outside. If such sites are not reinstated and rehabilitated after project completion, cause landscape scarring, dangers of overhanging cliffs and falling rocks which creates environmental, health and safety hazards.

From consultations, it was established that some of the quarries already existing in the site neighbourhoods immediately outside the crater e.g. in Maili sita, have been associated with public safety concerns and structural integrity of nearby buildings. If the contractor sources materials from such quarries, the locals will develop resentment towards the project as this will be seen as promoting risky activities.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-3*
Result	***-45 Low***

Mitigation measures

- Appropriate authorisation including from NEMA and Mines and Geology department to do or use any new borrows pits and quarries will be obtained before commencing activities;
- Any new borrow pits and quarries shall be located more than 100 meters from watercourses in a position that will facilitate the prevention of storm-water runoff from the site from entering the watercourse;
- Notice will be given 14 days to nearby communities of intention to excavate in the borrow pits or quarries;
- Borrow rehabilitation plans, will be prepared prior to use and approved by the local authorities;
- Storm-water and groundwater controls through appropriate drainage shall be implemented to prevent runoff entering streams and the slumping of soil from hillside above;
- The use of borrow pits or quarries for material spoil sites must be approved by the local authorities (and/or with the appropriate consent of the "landowner"). Where this occurs, the materials spoiled in the borrow pit shall be profiled to fit into the surrounding landscape covered with topsoil and re-vegetated.

In the event that blasting for rock will be done the following mitigation measures are proposed:

- A current and valid authorisation from the Department of Mines prior to any blasting activity shall be obtained;
- A qualified and registered blaster by the Department of Mines and Geology shall supervise all blasting and rock-splitting operations at all times;

- The Contractor shall ensure that appropriate pre blast monitoring records are in place (i.e. photographic and inspection records of structures in close proximity to the blast area);
- QPEA and the Contractor shall ensure that emergency services are notified, in writing, a minimum of 24 hours prior to any blasting activities commencing on Site;
- QPEA and the Contractor shall take necessary precautions to prevent damage to special features and the general environment, which includes the removal of fly-rock. Environmental damage caused by blasting/drilling shall be repaired at the Contractor's expense;
- The Contractor shall ensure that adequate notification is provided to the local communities immediately prior to all blasting. It is preferable that warning / informative signage and billboards be erected at the site indicating operation hours as well as commencement and end of operations. All signals shall also be clearly given;
- QPEA and the Contractor shall use blast mats for cover material during blasting. Topsoil shall not be used as blast cover.
- Precautionary and corrective measures will be taken to avert defacing and deformation of the land features.

7.4.6 Water Resources

The major water supplies in the project area are from underground abstractions developed by GDC and supplemented by NAWASCO. Currently there are no supply constraints. The project will require water during the construction and operation stage. The construction water requirements have not been quantified. Construction activities may result to misuse of water resources if conservation measures are not adopted.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-1*
Spatial scope of impact	*-3*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-3*
Result	***-42 Low***

Mitigation measures

For good practice the following mitigation measures are proposed, which the same are as proposed for the construction of the Menengai power plant:

- Continued monitoring of underground water levels;
- Accidental leakages and bursts of water supply pipelines should be reported and repaired immediately;
- Recycle water as much as possible should be encouraged for example water used for curing of concrete can be used for spraying dusty roads;
- Control of the water flows and the water consumption records must be kept and availed to the supervising and QPEA Resident Engineers at the end of working day;
- All employees should be sensitized on water usage practices like discouraging unnecessary opening of taps;
- Monitoring of taps and their efficiency should be done regularly;
- Curing of concrete should be done in conservancy tank to avoid wastage;
- Harvest water during rainfall times;
- GDC and the Contractor shall ensure that necessary approvals/permits from the water authorities for the abstraction of water is adhered to;
- The Contractor will be required to comply with the water quality regulations;
- No grey water runoff or uncontrolled discharges from the site/working areas (including wash-down areas) to adjacent watercourses and/or water bodies shall be permitted;
- Water containing pollutants such as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from site;

- The Contractor shall instruct their staff and sub-contractors that they must use toilet provided and not the bush or watercourses; and
- Reduction of baseline water quality through construction actions/activities shall be prevented (for example coffer dams, silt traps or plastic lining).

7.4.7 Air Quality and Dust

During construction the main emission sources include dust from earthworks and batching plants and tail gases from construction equipment and vehicles. The dust will settle on flora, and can cause increased incidence of respiratory problems (currently the leading illness in the general project area) and nuisance for local residents. However, given that the caldera is isolated and not densely settled (with exception of few temporary settlements by herders), the key dust impacts will mainly be realized in limited settlements along haulage routes outside the caldera which include the routes through Wanyororo sub location (via Bahati gate) and Mercy Njeri sub location (Via the Kabarak gate). Given the unpaved nature of the roads, dust impact could be of medium to high significance depending on the dry or wet weather periods.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-3*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-3*
Result	***-49 Low***

Mitigation measures

The following mitigation measures will be implemented to minimize or reduce impact on air quality for proposed projects:

- Mobile machinery or vehicle maintenance and services should be undertaken away from project site in a yard set aside for this or by an approved garage or service station to prevent any incident of oil and fuel spills that could contaminate soils and possibly ground water quality.
- Daily monitoring of air quality standards;
- All construction machinery shall be maintained and serviced in accordance with the manufactures specifications;
- Workers shall be trained / sensitized on dust minimization techniques and management of air pollution from vehicles and machinery;
- The removal of vegetation shall be avoided until such time as clearance is required and exposed surfaces shall be re-vegetated or stabilized as soon as practically feasible;
- Frequent watering of exposed surfaces, haulage routes through settled areas and piles of soil to prevent airborne dust emissions;
- All vehicles accessing the site shall observe low speed limits;
- Minimize idling time for construction vehicles;
- Incorporate dust/fumes arrestors in the batching plant e.g. use of dust nets
- Provision of appropriate protective personal equipment including respirators and aprons to affected personnel

7.4.8 Noise and vibration

There are several sources of noise during construction and operation. Noise may not only be a nuisance but can also be detrimental to the health of exposed persons depending on the magnitude and exposure period. In addition, excessive vibrations may be detrimental to structural integrity of nearby/affected installations.

Construction related activities that will impact on environmental noise and vibration levels typically include bulk earthworks, metal works, concrete works, traffic-generated noise and electrical works associated with the establishment of production wells, plant infrastructure, office buildings and support infrastructure. Noise levels have been monitored in connection to the operation of the Menengai geothermal wells drilling in the recent past as indicated in section 3.1.7. Existing noise levels are already beyond the NEMA limits. However, any construction noises will be intermittent and mainly affect people working within the caldera and rarely those settled along the haulage routes. With appropriate mitigation measures for occupational exposure, the net impacts of noise and vibration are anticipated to be low - medium in magnitude.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-4*
Result	***-72 Low - Medium***

Mitigations

- Encourage the adoption of low noise technology and practice for construction machines;
- All diesel powered construction equipment and plant vehicles must be kept at a high level of maintenance. This must particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment must serve as trigger for withdrawing it for maintenance;
- Limit construction activities to the day time only (indicated in NEMA license conditions to be between 0800 Hrs and 1700 Hrs) since noise impacts are most significant during the night; and
- Provide appropriate Personal Protective Equipment (PPEs) to all workers exposed to elevated noise levels and enforces usage.

7.4.9 Solid wastes

The construction phase will generate two types of solid wastes: spoils and household refuse. Construction spoils will consist of building materials, concrete, paper and plastic (for example from packaging materials and lagging), timber, scrap metal, etc. Disposal of the same solid wastes off-site could also be a social inconvenience if done in the wrong places. The off-site effects could be aesthetic, pest breeding, pollution of physical environment, invasion of scavengers and informal recycling communities.

During construction the Contractors will setup various facilities for temporary accumulation, which have to be removed and dismantled on completion of the works. Adopt recycle and reuse measures for some of the spoils generated such as woody spoils generated from construction work will be stock piled to manageable size on regular intervals, valued and given to surrounding community as fuel wood as a cost effective measure. This will require a strategic and mutual understanding between the involved parties that is the local community, QPEA, GDC and the Contractor. All waste shall be removed from the site for appropriate disposal through licensed waste handlers.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-3*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-4*
Result	***-48 Low***

Mitigation

Identifying environmentally acceptable spoil sites for spoil materials and approval by GDC taking into consideration the following:

- Preferably to be located on land already cleared wherever possible.
- Diligence on the part of the Contractors during construction activities will minimise the amount of debris, and also will ensure that debris is disposed of in a sensible manner, at a specified and approved dump site.
- The tender documents should specify the proper disposal of waste during construction.
- The tender documents should also ensure that the Contractors leaves the site in a clean condition on completion of works. The Contractors should be required to restore and landscape all areas to the satisfaction of the GDC and QPEA.
- All solid waste generated during construction and operation should be carefully monitored, collected, stored, and taken out of the park for disposal.
- Waste generated during the operation of the plant must be segregated at source, inventorised and appropriate methods of disposal determined.
- The development and rehabilitation of spoil areas shall include the following activities:
    - Stripping and stockpiling of topsoil;
    - Removal (to a nominal depth of 500mm) and stockpiling of subsoil;
    - Placement of spoil material;
    - Contouring of spoil site to approximate natural topography and drainage and/or reduce erosion impacts on the site;
    - Placement of excavated subsoil and then topsoil over spoil material;
    - Contouring and re-vegetation;
    - The Contractor shall ensure that the placement of spoil is done in such a manner to minimise the spread of materials and the impact on surrounding vegetation and that no materials 'creep' into 'no-go' areas.

7.4.10 Spread of communicable diseases

During the construction phase there is a risk of spread of communicable diseases such as tuberculosis, diarrhoea, Upper respiratory tract infections and pulmonary infections. Aspects of the physical environment that promote transmission of diseases include: inadequate housing, disposal of wastes, increased interactions between locals and construction workers, dusty environment and ventilation which are likely to occur during the construction phase of the project especially at the contractor's camp. Diarrhoea for instance is already a common public health problem within the project area.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-3*
Result	***-48 Low***

Recommendations

- The Community Liaison Office should organize for community and workers training and sensitization programs in conjunction with the Sub-County Public Health Officer. This will facilitate development of more sanitation facilities within the community and also increase usage;
- Covering and / rehabilitation of borrow pits to prevent breeding of mosquitoes that spread malaria;
- Dust proofing of earth roads within the construction site through three (3) times watering a day. This can be done in the Morning, Noon and Afternoon or through spreading of grave/ballast or temporary tarmacking
- Formation of peer groups from among the project staff to ensure continuity in training and awareness raising; and
- The contractor should ensure that the project workers are sensitised on the local culture.

7.4.11 Increase in Amount and Tonnage of Traffic

The traffic to and from the caldera is currently limited to vehicles used by GDC and various contractors in geothermal exploration and drilling. Construction traffic for the power plant within the caldera is bound to increase from the commencement to completion of construction phase of power plant. This traffic will vary from fast, light vehicles used for transport of supervisors, minibuses transporting workers to site, pickups, tracked excavators, fuel tankers, and tipping trucks (dump trucks).

All the roads used for access to and within the caldera are of murram or of gravel type. The roads also have a number of blind meanders. These are likely to result in dusty environment and noise pollution within the area as a result of the anticipated heavy traffic along the roads during construction phase. The negative health and aesthetic effects will be on residents along these roads and the natural environment respectively.

The impact of increased traffic will be felt past the project site level to the neighbouring communities in Mercy Njeri and Wanyororo villages. This will be through increase in the number of fast moving vehicles in these areas. These can also lead to frequent accidents involving materials, vehicles, people and animals. However, the traffic is not anticipated to have significant impacts on the main Nakuru-Nairobi-Bahati and Nakuru-Kabarak-Kampi Ya Moto roads which are some of the busiest roads in close proximity to the project area.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-4*
Result	***-54 Low - Medium***

Mitigation measures

- Upgrading of existing roads where necessary to take care of the new traffic;
- Erection of proper signage along all roads exploited for the construction process and at approaches to junctions with the main roads;
- Construction of bumps along speed bumps along Bahati entrance road and the roads within the caldera;
- Sensitization and training of construction drivers;
- Monitoring, enforcement and disciplinary action of offenders;
- Use of escort and chase vehicles for abnormally sized loads.

7.4.12 Occupation and general public health and safety

The construction process is estimated to take 2 years. These activities may involve employment of hundreds of workers in site, increasing chances of workplace accidents, injuries and illnesses. Such accident and injuries could result from:

- Accidents involving construction machinery;
- Falls and slips from elevated work positions;
- Electrical and welding equipment;
- Exposure to abnormally high amounts of Hydrogen sulphide, dust, excessive noise and vibrations etc.

Health and safety of workers at the work place is a sure motivator to enhance productivity. It will thus be paramount that the contractor adheres to best practices in occupational health and safety.

The general public using the access roads and those near borrow sites could also be exposed to accidents involving construction traffic and quarry activities respectively. However, with appropriate management policies and implementation of safe working systems, these impacts area readily manageable reducing them to insignificant levels.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-5*
Spatial scope of impact	*-3*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-3*
Result	***-66 Low - Medium***

Recommendation / Mitigation

- Contractor must develop Construction Safety and Health Policy in compliance with OSHA, IFCs Environmental, Health and Safety Guidelines among other international best practices;
- Undertake comprehensive assessment for PPE requirements, provide and enforce usage of all ranges of required PPEs;

- Contractors to establish a comprehensive Health and Safety Policy which should be in compliance with GDC's Occupation Health and Safety Policies and be approved by Environment, Health and Occupation Manager from GDC and Nakuru DOSH office;
- Ensure compliance with all standards and legally required Safety and Health regulations in line with OSHA;
- QPEA to include standard best practice health and safety provisions in the construction contract. The provisions should include insurance to enable the contractor to pay for any and all treatments required by his workers including those of all sub-contractors, together with any subsequent lifelong disability payments in line with WIBA;
- Employ a full time qualified Safety and Health advisor;
- Include a specific and independent task in the supervision contract concerning H&S supervision and compliance, together with the staff resources to carry this out;
- Establish and enforce a strict code of conduct for all project drivers including outside suppliers delivering materials. The code should focus on safety, especially speed, and loading, especially banning all carriage of staff, workers and passengers except in seats;
- Implement the specified H&S programme throughout the construction period. This should incorporate but not limited to:
    - an emergency response procedure and display at conspicuous sites in all work areas. This is likely to require one vehicle on site equipped as an ambulance and a paramedic on site at all times during construction activities;
    - Provision of a standard first aid kit at the site office at all times;
    - Provision of fire-fighting equipment available at the workers camp;
    - Provision of medical facilities for staff;
    - Installation of appropriate safety signage for all work sites;
    - Registration of the work place;
    - Maintain an accident register;
    - Carry out accident and incidents investigations and implement corrective actions;
    - Establishment of Occupational Health and Safety Committee;
    - Staff and visitor induction;
    - Toolbox and monthly safety meetings;
    - Routine inspections.

7.4.13 HIV / AIDs and Sexually Transmitted Infections

The current prevalence rates of HIV/AIDS in Rongai 2.8% sub county while that in Nakuru County as a whole is 5.3%. During construction, the project is likely to bring in a significant population of new people in the project area. Chances are high that new infection rates will increase. This is due to the fact that the traders, workers and business people will have money to spend and some may use it to attract resident from the project area in a bid to solicit for sex, thereby creating avenues for spread of HIV/AIDS.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-3*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-4*
Result	***-90 Medium-High***

Recommendation / Mitigation

The Contractor should ensure that prevention and management of sexually transmitted diseases as a result of social interaction between immigrant workers and local populations is conducted through:

- Education and sensitisation of workers and the local communities on HIV/AIDs and STIs in conjunction with Rongai and Nakuru North Sub-County Public Health Officers;
- Provision of condoms to the construction workers, project team and the public. This should be kept in places that are not locked and are accessible to the above persons;
- Where possible conduct regular sensitisation campaigns and monitoring and evaluation of the modes used during course of the project;
- Formation of peer groups from among the project staff to ensure continuity in training and awareness raising;
- The contractor has to institute HIV/AIDS awareness and prevention campaign amongst workers for the duration of the contract e.g. erect and maintain HIV/AIDS information posters at prominent locations as specified by the Resident Engineer in consultation with the GDC Community Liaison Office;
- The contractor has to ensure that staff are made aware of the risks of contracting or spreading sexually transmitted diseases;
- The contractor should ensure that the project workers are sensitised on the local culture;

7.4.14 Contractors' camps

The project contractor will need to establish a camp for effective management of construction works as one already established within the caldera by drilling crew. A typical contractor's camp has facilities including site offices, workshops, stores, vehicle parking, and staff accommodation. The camp site is bound to have high human activity, material storage facilities, sanitary facilities, waste generation and disposal. All these are potential pollution agents that need adequate management. At worst, waste from the camp may be dispose of into the natural bush land or streams.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-3*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-4*
Result	***-60 Low - Medium***

Recommendation / Mitigation

To mitigate on the above it is therefore proposed that:

- The contractor's camp should have a comprehensive waste management and sanitation plan and facilities commensurate with population of workers and activities in the camps;
- Any storage tanks and equipment should have correct labels and Material Safety Data Sheets;
- Adequate Emergency Response Plan should be in place in the camps;
- The contractor should employ best practice management "housekeeping" (site cleanliness, waste disposal etc.) at all times;
- The contractor's facilities should be completely removed from site after use and the land restored to its previous condition or better; and
- All fuel storage and dispensing areas must be laid on hard standing.

7.4.15 Risks of wildfires

Consultations established that the vegetation within the caldera is prone to natural wildfires. Activities of power plant construction staff including improper disposal of any cleared vegetation and of cigarette buts are likely to increase incidences of wildfires within the caldera especially during dry spells. This will negatively affect forage available for both wildlife and livestock.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-3*
Duration of impact	*-1*
Frequency of activity / duration of activity	*-1*
Frequency of impact	*-3*
Result	***-32 Low***

Mitigation

- Include an adequate fire buffer zone around the proposed power plant construction site. This could be open bare ground/un-vegetated areas and planting fire resistant trees e.g. Mexican green ash (*Fraxinus sp*) around the plant should be maintained throughout during the construction and the operation period; and
- Liaise with the Menengai KFS office to sensitize construction and operation staff on wildfires and train on emergency responses

7.4.16 Impacts of fuel and chemical storage on site

During the construction period for the Menengai Power Plant, oil spills may occur from the various equipment using petroleum based fuels and lubricants. Spilled chemicals can contaminate soil as well as pollute water resources within the caldera and hazardous and flammable substances (e.g. diesel oil, paints, thinner, solvents, etc.) when improperly stored and handled on the site become potential health hazards. It is anticipated that refuelling and maintenance of large vehicles will take place on the construction site and that, correspondingly, there will be storage of fuel and lubricants on the site.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-2*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-3*
Result	***-45 Low***

Mitigation measures

- Ensure that the employees on site are aware of the company procedures for dealing with spills and leaks from oil storage tanks for the construction machinery though induction and safety training;
- In case of spillage, isolate the source of oil spill and contain the spillage using sandbags, sawdust, absorbent material and/or other materials approved by NEMA;
- Ensure that there is always a supply of absorbent material such as saw dust on site during construction, readily available to absorb/breakdown spill from machinery or oil storage;
- All vehicles and equipment should be kept in good working order, serviced regularly and stored in an area approved site by GDC and QPEA;
- Ensure that filling areas, Oil storage drums / products storage areas have a smooth impermeable (concrete or thick plastic covered in gravel) floor. The floor should be

bunded and sloped towards a sump to contain any spillages of substances in accordance with *The Kenya Bureau of Standards (KEBS) KS 1969: 2006 The Petroleum Industry -The installation of underground storage tanks, pumps/dispensers and pipe work at service stations and consumer installations - Code of Practice.*

7.4.17 Potential Impacts on archaeological features

No archaeological sites have been recorded and no surface artefacts were seen on the proposed development site. However, since the absence of artifacts on the surface does not exclude the possibility existence of artifacts or features buried in the ground, there is a chance of encountering buried artefacts during excavation and other earthwork construction activities. Without proper planning in place to manage such encounters, any artefacts encountered by chance may be interfered with. The anticipated impacts are therefore rated insignificant.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-2*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-2*
Result	***-36 Low***

Mitigation measures

- The developer shall notify NMK if any artefacts or bones are uncovered in the course of excavations. This is in accordance with the National Museums of Kenya Chance Finds Procedure which aims to minimize damage to objects accidentally uncovered during the construction phase;
- If something is discovered in the course of excavation, the exercise must be stopped to determine whether a rescue operation needs to be carried out. This requires a pause in the construction and removal of the objects in question and only then can the construction continue. Any questionable objects must be shown to the archaeologist on duty in order to determine its value, and any of the management options outlined in the procedure applied;
- Decisions regarding cultural heritage must be consistent with the requirements of IFC Performance Standard 8 and the UNESCO 1972 World Heritage Convention.

7.4.18 Land take and displacement

The proposed power plant will be located in Menengai caldera which is a gazetted government forest reserve under the management of KFS. As such there will be no displacement of any settlements to pave way for the power plant construction. Further, geothermal exploration drilling by GDC is already on-going in the caldera and the proposed plant therefore fits on the existing land use. No change of user will be necessary for the proposed project.

From both noise and air quality modelling outcomes, no adverse public health impacts are anticipated on the nearest sensitive receptors (settlements) hence no resettlement is anticipated based on community heath concerns.

It is however notable that way leave will be required for transmission of power generated from the plant to the national grid. The land requirement for the transmission line is outside the scope of the current study and is handled separately by KETRACO, the agency charged with construction and maintenance of such lines in Kenya. KETRACO has already undertaken ARAP studies for the transmission line as discussed in section 4.1.4 of this report.

7.5 Positive Impacts during operation

7.5.1 Increased power supply to the national grid

The key positive operation impact will be meeting the development objective. The objective of Menengai geothermal power project is to construct a 35 MW geothermal power plant with associated infrastructure. This will then be connected to the national grid towards meeting the ever increasing demand for electric power in the country. The project will partly contribute to realisation of vision 2030 through enhancing the country's energy security. Further, electricity generation via geothermal energy exploitation is regarded as environmentally-friendly and sustainable.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+5*
Spatial scope of impact	*+5*
Duration of impact	*+4*
Frequency of activity / duration of activity	*+5*
Frequency of impact	*+5*
Result	***+140 Very High***

It also recommended that the proponent considers registering the project under the CDM to earn associated benefits both to the locals and the nation.

7.5.2 Creation of employment opportunities

The project will create direct and indirect employment opportunities in its operation phase. Direct employment opportunities will include operation and maintenance workers in the geothermal plant, labour force employed in supporting business such as transportation. It is estimated that a maximum of 15 operation staff will be stationed at the facility permanently. These opportunities will lead to local increases in trade and hence general economic development in the project area and reduced unemployment.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+5*
Spatial scope of impact	*+5*
Duration of impact	*+4*
Frequency of activity / duration of activity	*+4*
Frequency of impact	*+5*
Result	***+126 Very High***

QPEA should emphasize the use of local labour in plant O&M as far as feasible to enhance benefits for the local population and develop national capacity.

7.5.3 Opportunities for enhanced tourism

The project is located within a caldera with existing tourist attraction being the scenic view of Menengai crater from the rim of the caldera and associated nature trails. Feedback from consultations with the local forest management office indicated that there are plants to enhance tourism activity at the area through establishment of a model ecotourism site at the rim of the caldera with KFS branding Menengai view point.

Operation of the project is likely to enhance tourist attractions with visitors taking opportunity to also tour the geothermal project.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+4*
Spatial scope of impact	*+5*
Duration of impact	*+4*
Frequency of activity / duration of activity	*+4*
Frequency of impact	*+4*
Result	***+104 Very High***

This can be enhanced through coordinated management of the nature trail and the power plant visitor between the KFS, GDC and the IPPs.

In addition, educational expeditions could also be enhanced in conjunction with learning institutions.

7.5.4 Potential for Carbon Market

Geothermal power stations are eligible for CDM because they release lower greenhouse gases than thermal power plants. When the Menengai Power Station will be included as a CDM project, community projects around the area are likely to benefit from revenue generated from CDM through financing of community projects.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*+3*
Spatial scope of impact	*+4*
Duration of impact	*+3*
Frequency of activity / duration of activity	*+4*
Frequency of impact	*+3*
Result	**+ 70 *Low - Medium***

7.6 Negative Impacts during operation

7.6.1 Impact on Flora

The major impacts on flora during the operation phase include (but not limited to) the following:

- Invasive species such as *Datura stramonium* may encroach on the cleared areas including road sides and areas near the plant. This may alter the physiognomy and the aesthetic appeal of the original area;
- Non-condensable Gases such as hydrogen sulphide (H_2S), sulphur dioxide (SO_2), ammonia (NH_3) and carbon dioxide (CO_2) released in escaping steam are known to have some impacts on the vegetation in the long term especially when produced in high concentrations (Thompson and Kats 1978) though some plants have been shown to be more tolerant (EPA, 1977; El-Hinnawi, 1981);
- High levels of H_2S, SO_2, NH_3 and CO_2 may result to the formation of acid rains although this has not been recorded in similar plants existing in Kenya like the Olkaria geothermal plants (Marani 1995);
- Brine may have deleterious effects on plants due to its chemical composition and the fact that it is usually at high temperature. Brine flows and ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact.

At worst, such adverse impacts may be very significant if the planted forest from the rim of the caldera is affected.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-40 Low***

Mitigation measures

- Monitor invasive plant species at the project area and uproot unwanted germinating plants;
- Assess concentration geothermal gaseous effluents such as H_2S, SO_2, NH_3 and CO_2 (e.g. by use of automatic sensors) and continually test for any evidence of acid rain
- Plant soil-erosion preventing grass species such as *Cynodon dactylon, Digitaria abyssinica, Pennisetum clandestinum* and *Hyparrhenia sp* at bare sloppy grounds or loose soil dumps;
- Steam pipe insulations should have a well camouflaged colours that are maintained so that animals don't perceive pipelines as barriers
- Brine flows and ponds should be located close to the source. Distant flow should be transmitted through closed pipes
- Rehabilitate disturbed areas along roads, pipelines and abandoned campsites etc by planting native plant species such as *Acacia mearnsii, Psidium guajava* and *A. melanoxylon*– this should be done as soon as practicable to avoid colonization by invasive and opportunistic pioneer species;
- Create awareness among the local communities on the importance of vegetation cover and discourage them from engaging in charcoal burning.

7.6.2 Impacts on Macrofauna

The major impacts on Macrofauna (Mammals) during the operation phase include (but not limited to) the following:

- Due to the high human and vehicle traffic in the area, there may be incidences of wildlife poaching;
- The noise from emission power plant installations will scare away many animal species;
- Brine in sumps or flowing into open surfaces may lead to contamination of the animal's drinking water;
- Strong flood lights if covering a large area may interfere with natural behaviour of both diurnal and nocturnal animals.

Given the relatively low density of mammals in the immediate project area and absence of any special habitat/range and migratory corridor, the anticipated impacts will not be very significant.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-3*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-36 Low***

Recommendation / Mitigation

- QPEA, GDC and KWS should monitor wildlife abundance, distribution and movement in relation to this infrastructural development during construction and operation stages to aid in decision making;
- Erect bumps in wildlife crossing zones;
- Vehicular disturbances such as hooting should be discouraged accordingly;
- Incident records (of poaching, accidents and other human wildlife conflicts etc) should be kept by monitoring and taking of corrective measures;
- Forest rules should be enforced within the caldera;
- Brine ponds should be located close to the source. Distant flow should be piped to prevent animal or vegetation contact;

7.6.3 Impact on Avifauna

The major impacts on bird during the operation phase may include but not limited to the following:

- Powerful flood/security lights that are directed/shining upwards or covering a large area may interfere with birds that move by night;
- Also when visible e.g. during the day, the swaying of the lines in the wind, their reflective properties and the humming sounds may probably scare away many birds – resulting in a huge area devoid of the flying creatures; and
- High-voltage transmission lines may cause death to birds through electrocution or as a result of direct collision.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-32 Low***

Recommendation / Mitigation

- High heat points and emission vents should be sheltered or fitted with inhibitors to deter birds from perching or hovering around exposing them to accidents and even death;
- QPEA, GDC and KETRACO in liaison with KWS should develop and implement an avifauna monitoring scheme, assessing bird population trends and direct hazards relating to the project;
- The project site has gorges, valleys and hillsides which form some of the keystone habitat features for raptors (Vultures and Eagles) as they enable them to soar high using thermal currents while in search of prey. These should therefore be retained as intact as possible; and
- High voltage transmission lines should be fitted with wire markers and flappers to alert any birds on flight.

7.6.4 Impacts on Herpetofauna

The major foreseen impacts of this project on herpetofauna during operation phase include:

- Brine flows should be piped to the brine ponds rather than being let to freely flow on open channels as this negatively affects herpetofauna in the area e.g. direct burning of slow moving species or alteration of water quality;
- Brine ponds and cold re-injection sites should be monitored to ascertain their utilization as suitable habitat by amphibians like toads and frogs.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-2*
Spatial scope of impact	*-2*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-32 Low***

Recommendation / Mitigation

- Water and steam pipe lines should be laid across (perpendicular to) the valleys rather than running along them – as this will mean destroying large patch of this ecologically sensitive keystone habitat for many species;
- It is desirable to re-vegetate disturbed areas along roads, pipelines and steam lines and other construction sites;
- Create awareness among the local communities and discourage them from engaging in charcoal burning which is evidently on the increase in this area.

7.6.5 Operation wastes

Operation of the geothermal power plant is not anticipated to generate significant amount of wastes. Geothermal technologies do not generate significant volumes of solid waste. Typical wastes generated during the operational phase include:

- Maintenance wastes include:
  - Waste oils and lubricants
  - Scrap metal
  - Waste electrical and electronic components.
  - Batteries
  - Contaminated rags
  - (Potentially) Contaminated spill response equipment
  - Contaminated safety clothing, gloves, masks, and equipment
  - Waste wood
  - Waste paints and solvents
  - Contaminated plant and machinery, including filters
- Domestic and food wastes (from operation staff estimated to be a maximum of 15)
- Sewage wastes.
- Sludges (potentially contaminated with silica compounds, chlorides, arsenic, mercury, vanadium, nickel, and other heavy metals could be generated).
- Oily water and run-off.
- Elemental sulphur from the treatment of H_2S.
- Geothermal brine.

Since the surrounding area is an open veld, storm water will be allowed to flow on the ground as a sheet flow. Domestic waste generated by the operation staff estimated to be a maximum of 15. The proposed domestic waste water management system is presented in section 4.2 while solid wastes will be regularly collected for disposal by a contracted waste handler. The major industrial waste is brine (the wastewater from geothermal plants). Hydrocarbon-based wastes (e.g. spent lubricants, used oil etc.) generated through regular maintenance of the turbine and associated machines are hazardous.

Improper handling of these wastes could be very detrimental to the biophysical environment like:

- The chemical concentration of brine for instance has the potential to harm flora and fauna; thus, the disposal mechanism should allow reduce chances of harmful contact;
- The release of wastewater (from existing well drilling activities) via gullies and natural drainage lines has resulted in erosion effects.

With existing operations, there have been allegations by some consulted stakeholders that the materials used for lining brine ponds are of poor quality and are also regularly vandalised exposing receiving environments to brine pollution.

However, with proper implementation of proposed mitigation measures, the anticipated impacts will be insignificant. The proposed long-term method of wastewater disposal is by deep re-injection into a number of purpose drilled or unused production wells, which should have minimal surface impact as well as minimize contact with ground flora and fauna. The level of re-injection will be below aquifer levels used for water supply in the locality and there is little possibility of surface or groundwater pollution. One advantage of the fact that the brine will have been cooled is that the re-injection line can be buried. This is recommended so that the pipeline does not become a barrier to wildlife movement, particularly since the proposed re-injection wells lie some distance from the production field wells.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-2*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-3*
Result	***-72 Low-Medium***

Mitigation measures

- Brine ponds should be sited close to the source;
- Any brine ponds constructed should be lined with durable impervious materials of suitable quality and protected from any form of vandalism;
- Brine re-injection through re-injection wells into underground reservoir;
- Chemical composition and parameters of the brine should be regularly monitored.

7.6.6 Fire risk

With the installation of the power plant and related substations and transmission lines, there is likely to be a fire risk during operation. This may not only be detrimental to the development and energy supply to the national grid but also to the safety of operation staff. However, with implementation of best industry practices, the anticipated impact will be significantly reduced.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-2*
Duration of impact	*-1*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-28 Low***

Mitigation measures

- Ensure best international industry practice;
- A fire protection system of fire water tanks, fire extinguishers, fire hydrants, hose reels, fire alarms and sprinklers;
- Formulate a fire emergency response plan;
- Train some staff to be fire marshals;
- Carry out fire drills -Inspect fire fighting equipment; and
- Ensure regular safety audits by independent experts.

7.6.7 Accidental chemical spills

During plant operation, hydrocarbons and other chemicals such as solvents, coolants, acids, and, alkalis will be used. Accidental spillage or improper disposal of these hydrocarbons can be harmful to the receiving environments.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-2*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-36 Low***

Mitigation measures

- Spill and drip trays used during servicing of machinery
- Use septic tanks while ensuring doesn't flow to the surface
- Response plans for accidental spills to be formulated and routinely tested
- Bunded storage areas and secondary containment for oil and chemicals
- Use of an oil interceptor in the plant
- Place hazardous materials up to 2 kilometres away from the public water supply reservoirs such as in Ol Banita groundwater reservoirs. Also avoid placing within flood levels;
- Storage of fuel and other flammable materials shall comply with standard fire safety regulations;
- A secured compound shall be provided for storage tanks for chemicals and fuel. All chemicals and fuels shall be stored with manufacturer's instructions in mind as per the material safety data sheets;
- Storage areas or secondary containment shall be constructed of waterproof reinforced concrete or approved equivalent, which is not adversely affected by contact with chemicals captured within them;
- The minimum volume for secondary containment shall be 110% of the capacity of the largest tank system, plus 10% of the total capacity of all other separate tanks and containers within the bund wall with closed valves for controlled draining during rains;
- Pipe-work carrying product from the tank to facilities outside the containment shall be provided with secondary containment;
- Tank equipment such as dispensing hoses, valves, meters, pumps, and gauges shall be located within the containment or provided with own containment.

7.6.8 Occupation health and safety

Due to the fact that there are going to be staff working in different areas of the plant, accidents may likely to occur within the plant area. Some workers will also be likely exposed to high levels of noise, heat and H_2S which are detrimental to health. Noise and H2S exposure are the major occupational safety and health hazards identified so far.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-1*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-4*
Result	***-63 Low - Medium***

Mitigation measures

- Formulate a plant occupational safety and health management plan. The plan as a minimum MUST have and require:
- Identification of all potential hazards;
- Compliance with GDC Health, Safety and Environment policy;
- Compliance with OSHA, 2007;

- Continuous H_2S monitoring within the plant premises;
- Equipping employees with necessary Personal Protective Equipment (PPE) including personal H_2S monitors for workers in exposed environments;
- Regular and induction training, of members of the safety committee and new staff respectively on First Aid;
- Ensure the plant and office blocks have adequate supply of First Aid Kits;
- Location of appropriate safety and warring signs around the plant;
- Inspections on conditions of machinery and equipment -Register the plant as a workplace with DOSH;
- Medical examination of all employees before, during and after termination of employment;
- Emergency evacuation plan; and
- Regular independent Occupational Health and Safety audits.

7.6.9 Impacts on groundwater resources

Consultations with the regional office of Water Resources Management Authority and the existing bulk water service provider in the area, NAWASCO pointed out that since geothermal wells in the Menengai caldera were commissioned, the water temperature from the boreholes near the proposed power plant have been recording increased temperatures. This has impacted on operation and maintenance cost of the bulk water service providers and complaints from water consumers. It is notable that underground water is the main water supply to the locals and the nearby Nakuru town. If confirmed, such impacts would be significant in affecting the local waster supplies.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-4*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-3*
Frequency of impact	*-4*
Result	***-84 Medium-High***

Mitigation

- GDC, NAWASCO and the water resources management authority should undertake joint studies to investigate possibility of thermal contamination of underground water aquifers within the area with geothermal steam production and institute appropriate mitigations where necessary

7.6.10 Ground subsidence and seismic risks

In geothermal development, geothermal fluids withdrawal rate may surpass the natural rate of replenishment. Ultimately pressure drop in the reservoir as a result of fluid withdrawal could occur leading subsidence.

In general, subsidence is greater in liquid-dominated fields because of the geological characteristics typically associated with each type of field. Ground subsidence can affect the stability of pipelines, drains, and well casings. It can also cause the formation of ponds and cracks in the ground and, if the site is close to a populated area, it can lead to instability of buildings. The presence of numerous fault lines within the caldera may also contribute to increased seismic risks. Fluid re-injection at proper rates and pressures reduces subsidence potential significantly.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-4*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-44 Low***

Mitigation

- Continuous monitoring of seismic activity in the caldera by GDC; and
- GDC to formulate community risk management plan including trigger levels and communication strategy. The plan should incorporate other relevant government agencies like mines and geology department, national disaster coordinating agency and the County Government of Nakuru.

7.6.11 High socio-economic interest by communities

Public consultations revealed that the local communities have high socioeconomic interests and a lot of expectations with the geothermal power development activities going on within the Menengai caldera. Some expectations and even false information are held by the communities. These include but are not limited to:

- Employment opportunities to benefit majority of the locals but never realised due to favouritism and nepotism;
- Political interest by different leaders; and
- Feeling that even basic contracts are awarded to non locals.

Improper handling and misrepresentation of facts about the project area likely to hurt the good standing with the community and overall performance.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-4*
Duration of impact	*-3*
Frequency of activity / duration of activity	*-2*
Frequency of impact	*-2*
Result	***-44 Low***

Mitigation

- Develop and implement a community liaison strategy with proper communication and feedback mechanism. Any community social responsibility should be communicated through this strategy;
- Develop a clear and transparent employment policy for the local communities and ensure its fair implementation: and
- The expectation that many community members will be employed during the construction phase of the project needs to be managed. Community members should be informed of the limited employment opportunities. If at all possible the project should notify community members of the number of jobs available, the skills required, employment period and the selection criteria of the project. In doing so community members would be well informed of the actual employment opportunities. This would reduce expectations and prevent disappointment thereby instilling community trust in the project. This is essential if the project is to maintain healthy and cooperative relationships with the communities.

7.6.12 Impact on Air Quality

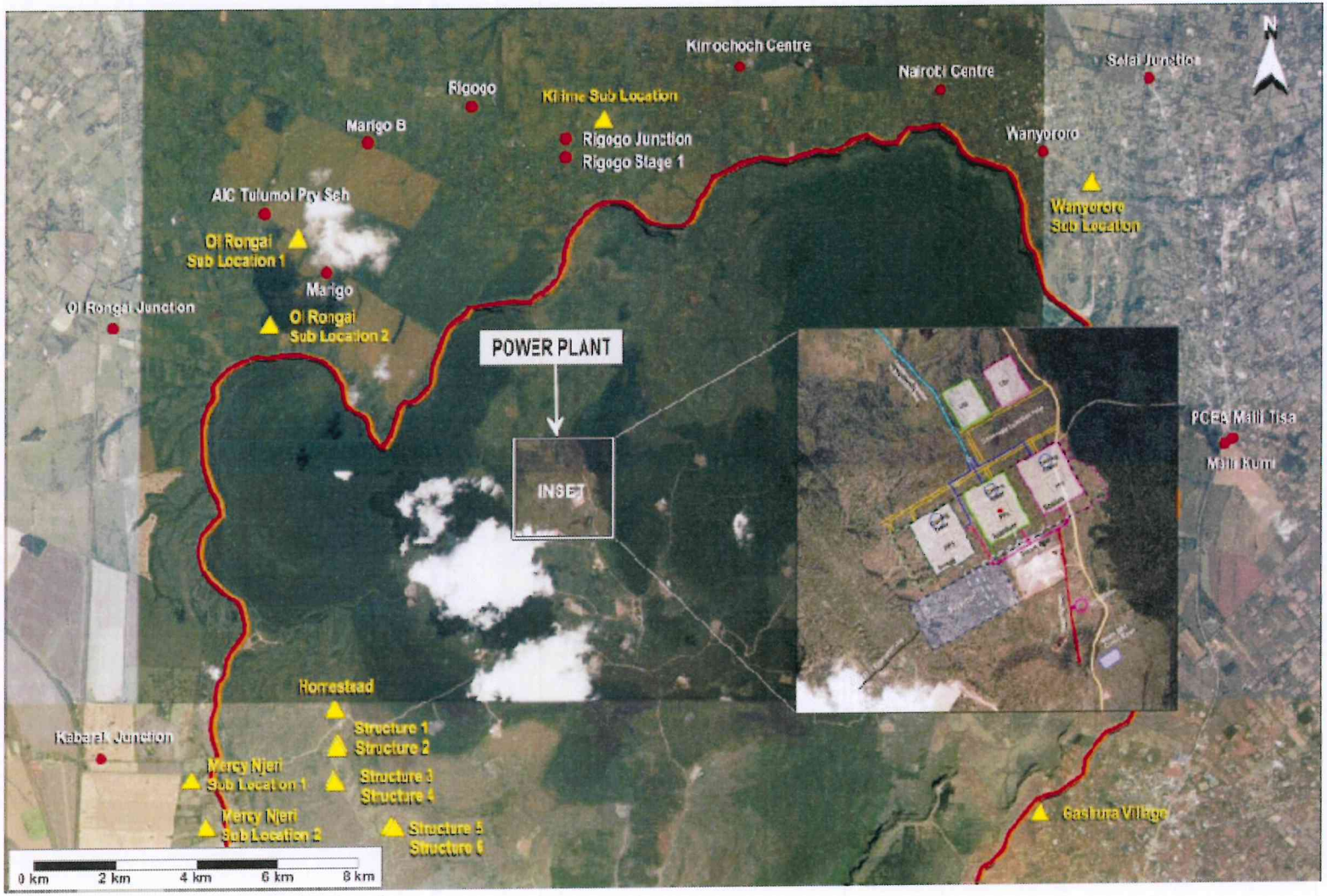
The most significant emissions from the Power Plant operation will potentially include the release of NCGs from steam vents and cooling towers/NCGs stacks. Although these can be considered 'natural' in the sense that they are already emitted from numerous existing fumaroles and vents, the power station will emit these in larger quantities than might be experienced naturally. Additionally, pipeline failures due to damage or corrosion could result in unplanned releases of steam and NCGs.

The composition of NCGs of the Menegai wells is shown in Table 4-2. H_2S and CO_2 are the predominant NCGs. H_2S is an odorous compound commonly found in geothermal areas and released through natural sources. It presents an unpleasant, typically "rotten eggs" odour at relatively low concentrations and is toxic in higher concentrations. CO_2 is not significant in terms of direct impact to human health but is a greenhouse gas. Studies on the effects of elevated CO_2 levels on vegetation around geothermal power plants in the US have shown that growth and productivity of commercial crops actually increased.

Combustion gas emissions during operation will be limited to emergency generators, firewater pumps, and service vehicles required for transporting any maintenance equipment and materials.

Air quality impact assessment study established the potential receptors as follows:

- The area is dominated by winds from the SSE and NNW. Long term air quality impacts are therefore expected to be the most significant to the NNW and SSE of proposed operations.
- Ambient air quality monitoring conducted at the wells by the University of Eldoret indicated ambient air pollutant levels that exceed the odour threshold as well as the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 1 ppm.
- Several AQSRs are situated within the vicinity of the proposed power plant (Figure 7-1).



Source; Airshed Planning Professionals

Figure 7-1: Study area, site layout, AQSRs and NSRs

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the project's operations on the receiving environment. A summary of quantified emissions and source input parameters are summarised in Table 7-4. Whereas there was an idea of the arrangements Quantum will be installing, no information was available for the other two IPPs (i.e. Ormat and Sosian) for the modelling exercise and assumptions were made for those two plants. Table 7-5 shows possible scenarios that may be encountered.

Table 7-4: Estimated stack parameters and emission rates per IPP

Equipment and arrangement options	Stack parameters				Stack emissions		
	Height (m)	Diameter (m)	Velocity (m/s)	Temp (°C)	H_2S per stack (g/s)	H_2S total (g/s)	H_2S total (tpa)
Assuming dispersal from single stack	30	0.4	13	33	76 - 92	76 - 92	2397-2901
Assuming dispersal from 4 cooling tower fans	13.9	9.75	8.5	36.8	19-23 per cooling tower fan	76 - 92	2397-2901

Table 7-5: Scenarios considered form the three IPPs

Scenario	Equipment and arrangement options	IPP and Emission Point		
		Ormat	Quantum	Sosian
1	Assuming all 3 IPPs dispersal from single stack (NCG 3.3%)	Single stack	Single stack	Single stack
2	Assuming all 3 IPPs dispersal from single stack (NCG 4%)	Single stack	Single stack	Single stack
3	Assuming all 3 IPPs dispersal from 4 cooling tower fans (NCG 3.3%)	Cooling tower fans	Cooling tower fans	Cooling tower fans
4	Assuming all 3 IPPs dispersal from 4 cooling tower fans (NCG 4%)	Cooling tower fans	Cooling tower fans	Cooling tower fans
5	Assuming Quantum stack and other 2 IPPs dispersal from 4 cooling tower fans (NCG 3.3%)	Cooling tower fans	Single stack	Cooling tower fans
6	Assuming Quantum and Sosian stack and other IPP dispersal from 4 cooling tower fans (NCG 3.3%)	Cooling tower fans	Single stack	Single stack
7	Assuming Quantum and Ormat stack and other IPP dispersal from 4 cooling tower fans (NCG 3.3%)	Single stack	Single stack	Cooling tower fans

Although all scenarios were simulated, not all the scenarios are reported in the results. Those that show the minimum and maximum impact are included.

(a) Screening of Simulated Human Health Impacts from H_2S

For Scenario 1, with all the three IPPs emitting from a single stack (at 3.3 % NCG in steam), simulated 24-hour ambient H_2S concentrations exceed the Iceland guideline of 50 µg/m³ at some of the AQSRs. However, the WHO daily guideline value of 150 µg/m³ is not exceeded at any of the AQSRs. Simulated annual average ambient H_2S concentrations exceed the OEHHA screening level for chronic exposure (10 µg/m³) at some of the AQSRs. Similar impacts are experienced for Scenario 2, at higher emissions because of 4 % NCG in steam (Table 7-6). Isopleth plots for are shown in Figure 7-2 and Figure 7-3.

Table 7-6: Simulated ambient H_2S concentrations during operation for Scenario 1.

AQSRs		Simulated Ambient H_2S Concentrations During the Operational Phase	
Number	Description	2nd Highest 24-hour Ground Level Conc. (µg/m³)	Annual Ave. Ground Level Conc. (µg/m³)
1	Structure 1	70	6
2	Structure 2	70	6
3	Structure 3	66	5
4	Structure 4	68	5
5	Structure 5	58	5
6	Structure 6	56	5
7	Mercy Njeri Sub Location 1	53	4
8	Mercy Njeri Sub Location 1	54	3
9	Homestead	79	6
10	Wanyororo Sub Location	27	3
11	Kirima Sub Location	80	11
12	Rongai Sub Location 1	85	14
13	Rongai Sub Location 2	108	13
14	Gashura Village	41	2
15	Kabarak Junction	53	3
16	Ol Rongai Junction	87	8
17	Marigo	102	17
18	AIC Tulumoi Pry	76	12
19	Marigo B	90	18
20	Rigogo	104	19
21	Rigogo Junction	101	13
22	Rigogo Stage 1	108	14
23	Kimochoch Centre	46	6
24	Nairobi Centre	30	2
25	Wanyororo	26	2
26	Solai Junction	19	2
27	PCEA Maili Tisa	21	1
28	Maili Kumi	22	1
	Criteria	50 (Iceland) 150 (WHO)	10 (OEHHA)

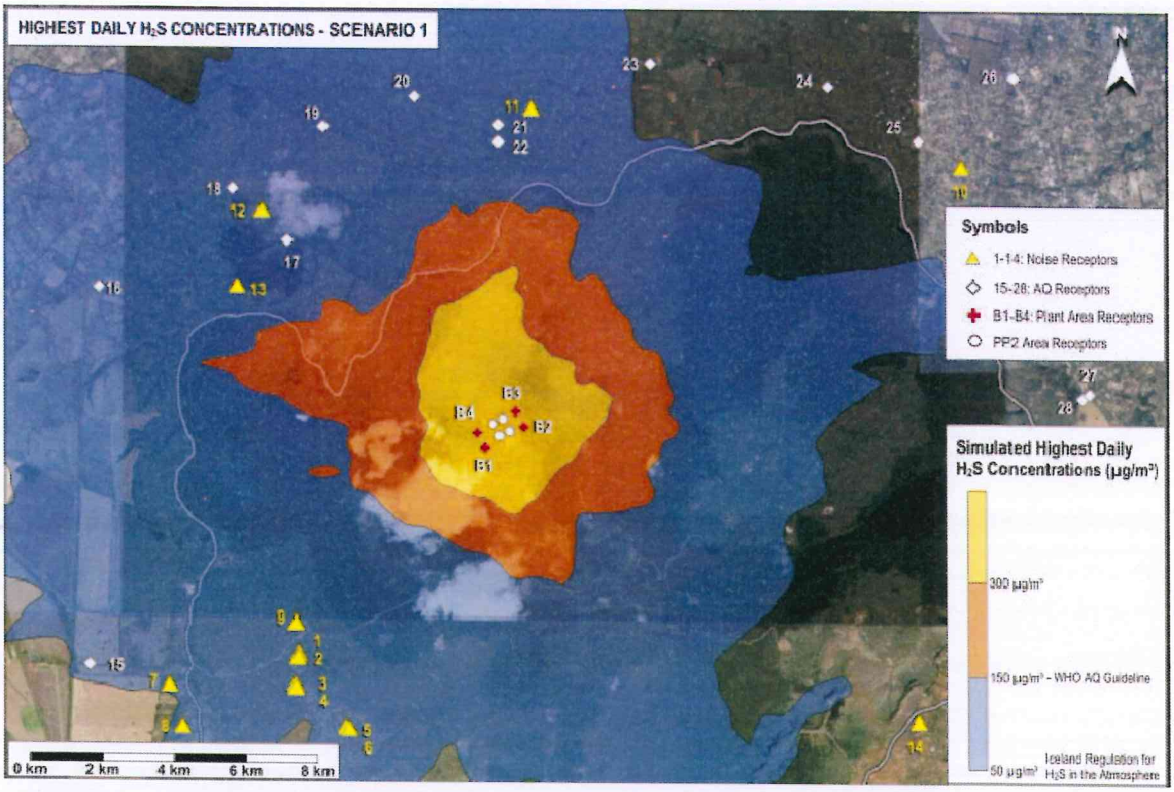


Figure 7-2: Highest daily ground level H_2S concentrations – Scenario 1

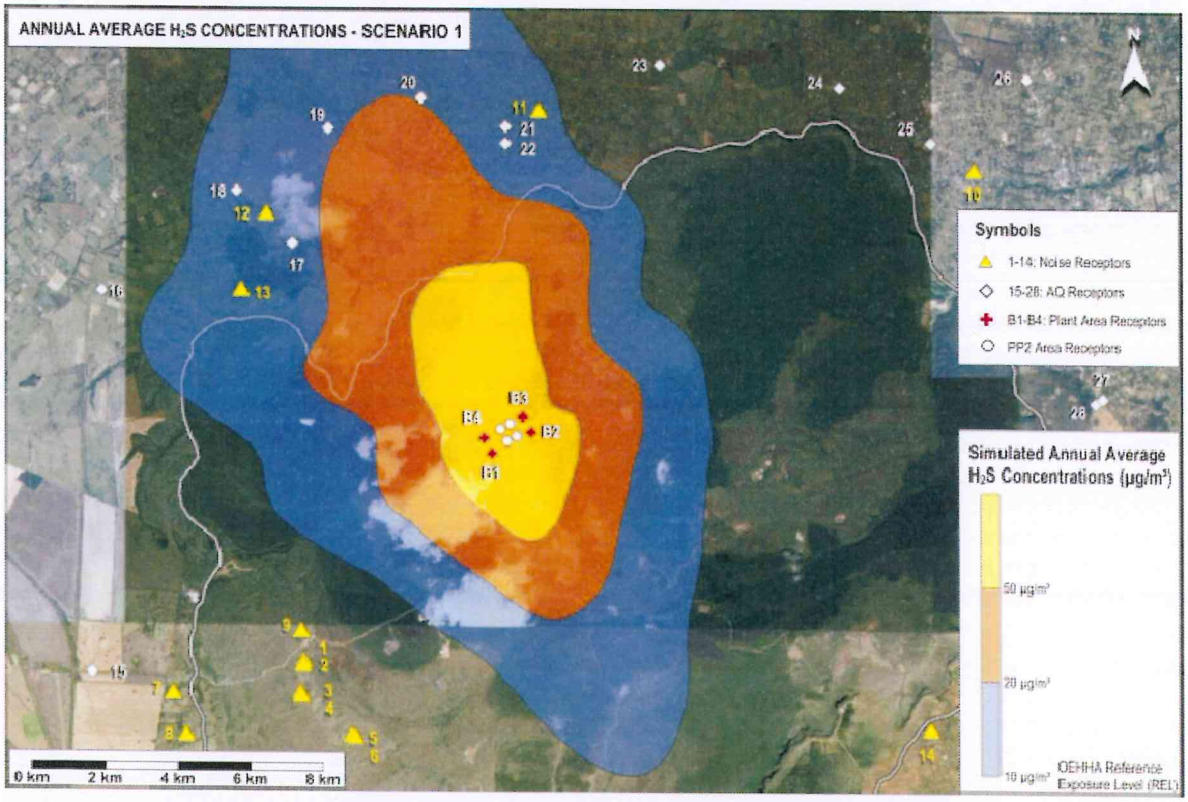


Figure 7-3: Annual average ground level H_2S concentrations – Scenario 1

For Scenario 3, with all the three IPPs emitting from cooling tower fans (at 3.3 % NCG in steam), simulated 24-hour ambient H_2S concentrations do not exceed the Iceland guideline of 50 µg/m³ or the WHO daily guideline value of 150 µg/m³ at any of the AQSRs. Simulated annual average ambient H_2S concentrations do not exceed the

OEHHA screening level for chronic exposure (10 µg/m³) at any of the AQSRs. Similar impacts are experienced for Scenario 4, at higher emissions because of 4 % NCG in steam (Table 7-7). Isopleths are shown in Figure 7-4 and Figure 7-5.

Table 7-7: Simulated ambient H_2S concentrations during operation for Scenario 3

AQSRs		Simulated Ambient H_2S Concentrations During the Operational Phase	
Number	Description	2nd Highest 24-hour Ground Level Conc. (µg/m³)	Annual Ave. Ground Level Conc. (µg/m³)
1	Structure 1	20	2
2	Structure 2	20	2
3	Structure 3	19	2
4	Structure 4	19	2
5	Structure 5	17	2
6	Structure 6	17	2
7	Mercy Njeri Sub Location 1	15	1
8	Mercy Njeri Sub Location 1	20	1
9	Homestead	25	2
10	Wanyororo Sub Location	8	1
11	Kirima Sub Location	17	2
12	Rongai Sub Location 1	28	5
13	Rongai Sub Location 2	20	3
14	Gashura Village	11	1
15	Kabarak Junction	11	1
16	Ol Rongai Junction	14	2
17	Marigo	32	5
18	AIC Tulumoi Pry	23	4
19	Marigo B	33	9
20	Rigogo	35	8
21	Rigogo Junction	23	4
22	Rigogo Stage 1	24	4
23	Kimochoch Centre	14	1
24	Nairobi Centre	9	1
25	Wanyororo	8	1
26	Solai Junction	7	1
27	PCEA Maili Tisa	7	0
28	Maili Kumi	7	0
	Criteria	**50 (Iceland)** 150 (WHO)	**10 (OEHHA)**

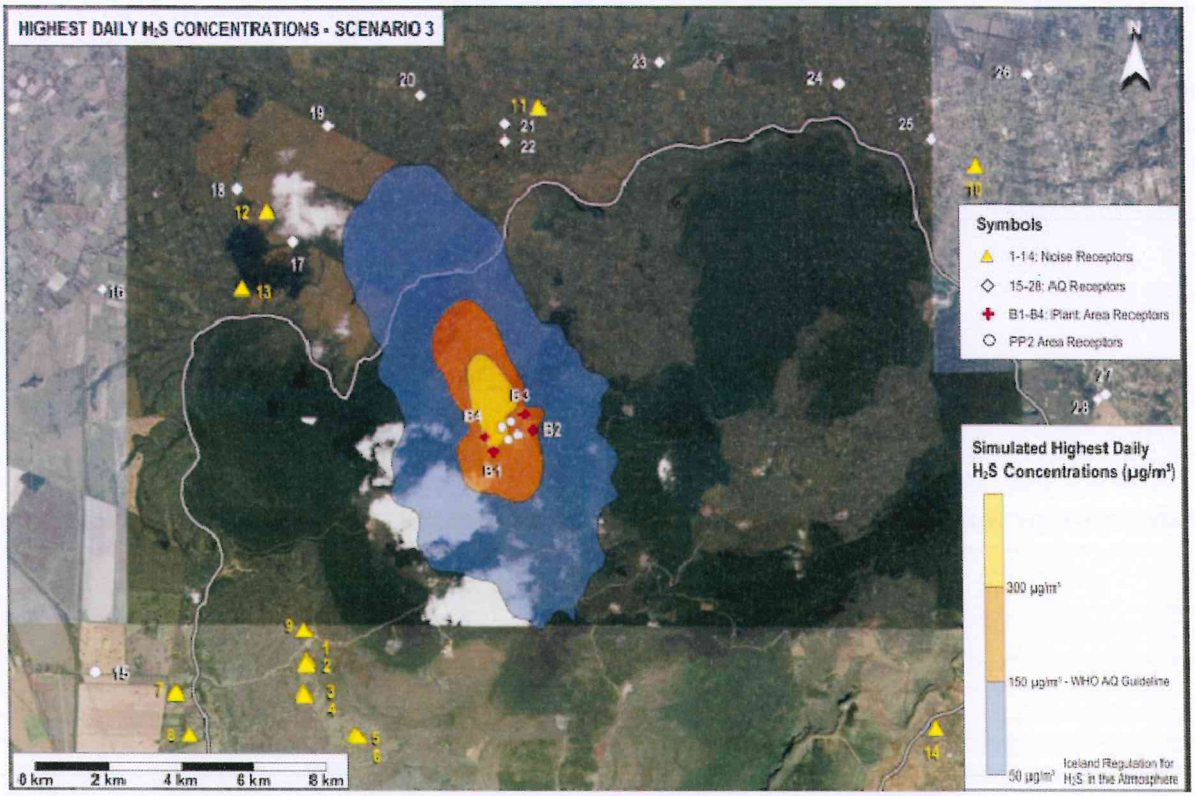


Figure 7-4: Highest daily ground level H_2S concentrations – Scenario 3

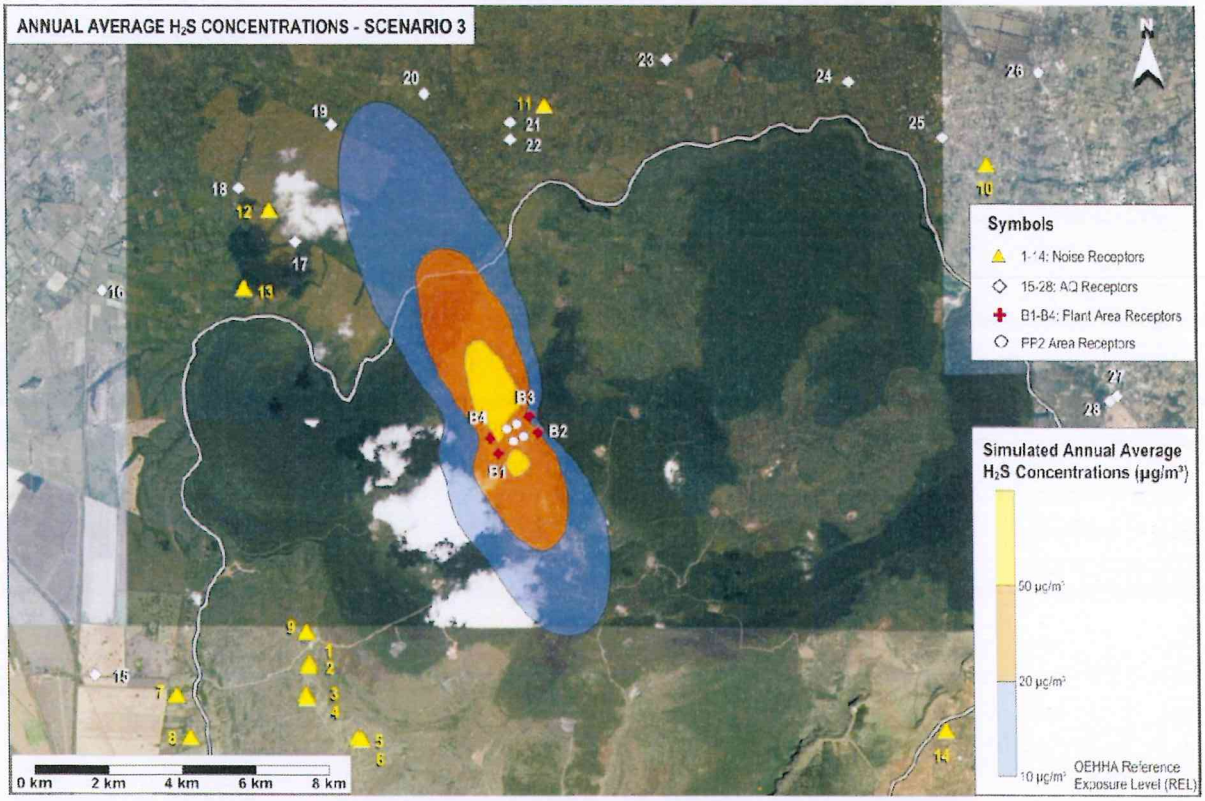


Figure 7-5: Annual average ground level H_2S concentrations – Scenario 3

For Scenario 5, with QPEA emitting from a single stack and the other two IPPs emitting from cooling tower fans (at 3.3 % NCG in steam), simulated 24-hour ambient H_2S concentrations do not exceed the Iceland guideline of 50 µg/m³ or the WHO daily guideline value of 150 µg/m³ at any of the AQSRs. Simulated annual average ambient

H_2S concentrations exceed the OEHHA screening level for chronic exposure (10 µg/m³) at Marigo B and Rigogo (Table 7-8).

For Scenario 6 and 7, with 2 of the IPPs emitting from single stacks, the impacts would be higher than Scenario 5 (i.e. would result in exceedences of the health screening levels at some of the AQSRs). Isopleth plots for are shown in Figure 7-6 and Figure 7-7.

Table 7-8: Simulated ambient H_2S concentrations during operation for Scenario 5

AQSRs		Simulated Ambient H_2S Concentrations During the Operational Phase	
Number	Description	2nd Highest 24-hour Ground Level Conc. (µg/m³)	Annual Ave. Ground Level Conc. (µg/m³)
1	Structure 1	33	3
2	Structure 2	32	3
3	Structure 3	29	3
4	Structure 4	30	3
5	Structure 5	26	3
6	Structure 6	26	3
7	Mercy Njeri Sub Location 1	26	2
8	Mercy Njeri Sub Location 1	27	2
9	Homestead	36	4
10	Wanyororo Sub Location	14	1
11	Kirima Sub Location	29	5
12	Rongai Sub Location 1	38	8
13	Rongai Sub Location 2	43	6
14	Gashura Village	18	1
15	Kabarak Junction	25	2
16	Ol Rongai Junction	31	4
17	Marigo	44	9
18	AIC Tulumoi Pry	33	7
19	Marigo B	43	12
20	Rigogo	45	12
21	Rigogo Junction	45	7
22	Rigogo Stage 1	48	7
23	Kimochoch Centre	23	3
24	Nairobi Centre	14	1
25	Wanyororo	12	1
26	Solai Junction	9	1
27	PCEA Maili Tisa	12	1
28	Maili Kumi	13	1
	Criteria	50 (Iceland) 150 (WHO)	10 (OEHHA)

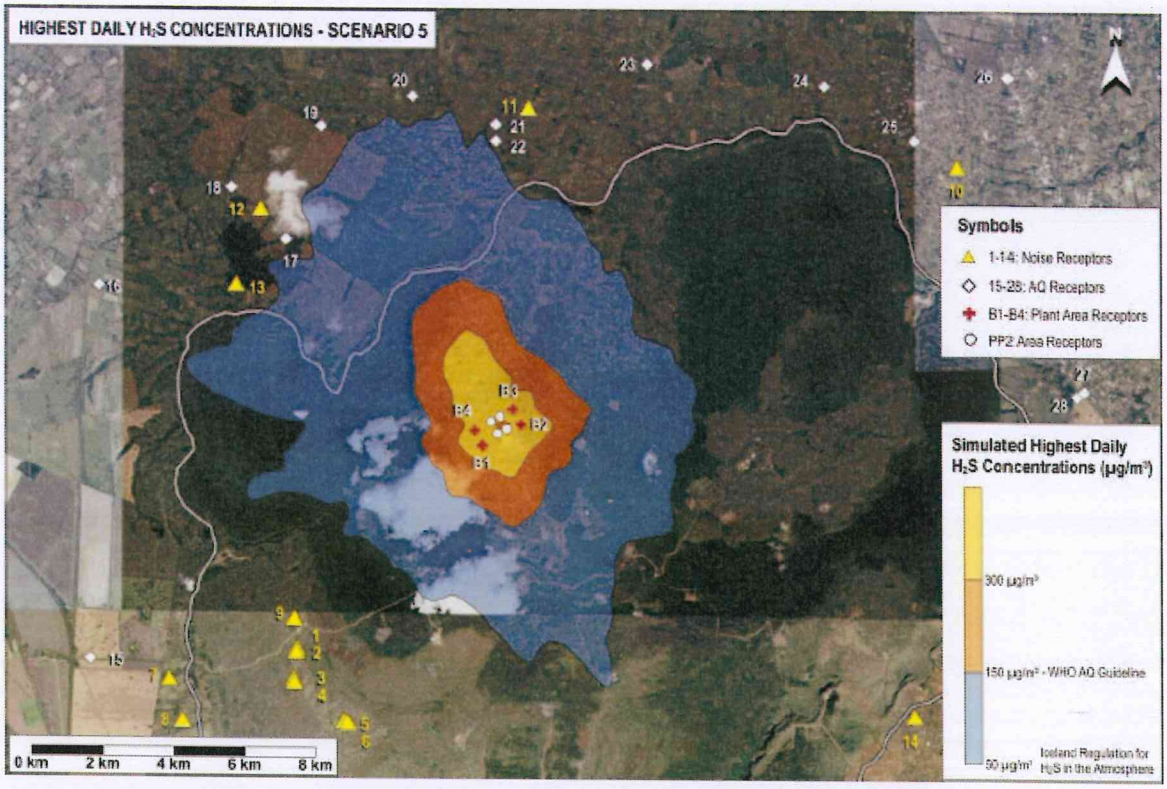


Figure 7-6: Highest daily ground level H_2S concentrations – Scenario 5

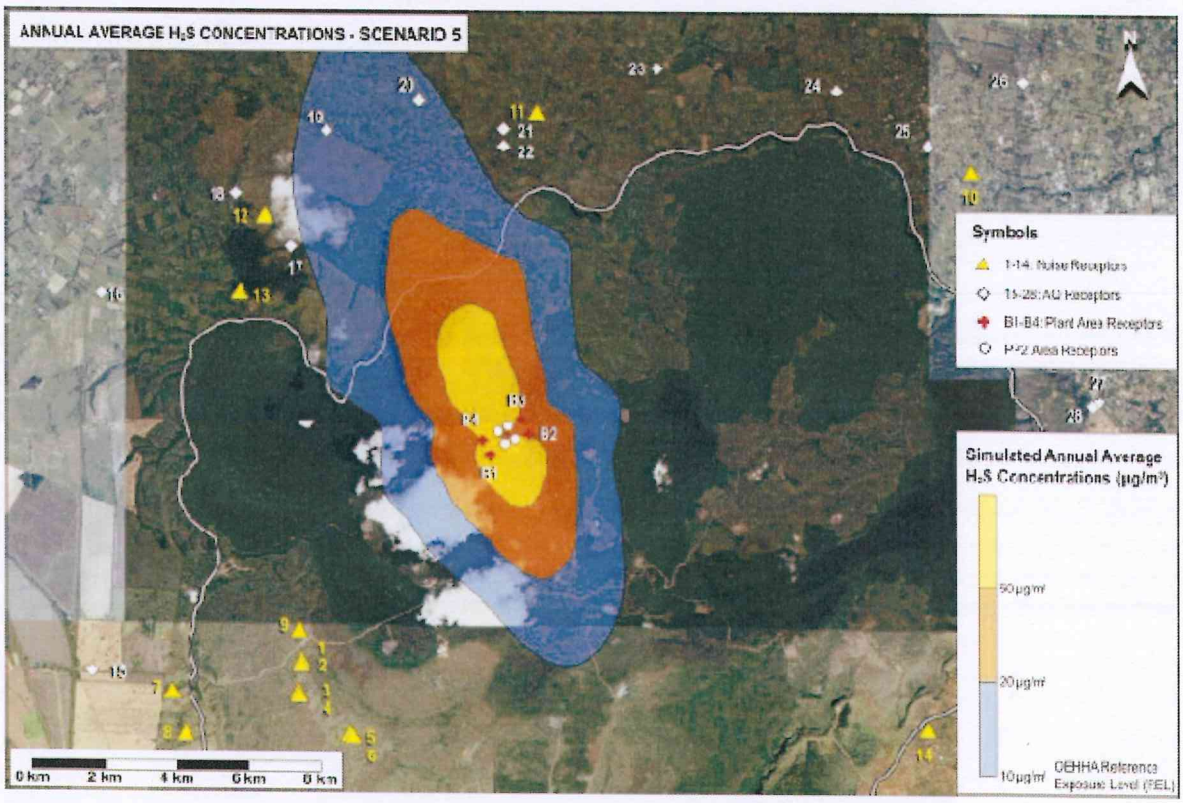


Figure 7-7: Annual average ground level H_2S concentrations – Scenario 5

(b) Analysis of H_2S Emissions for Occupational Health Impact

To assess occupational health only the plant boundary is considered (Table 7-9). For Scenario 1, the ACGIH TLV of 1ppm (1500 µg/m³) is exceeded both on-site as well as ~ 1 km from the site boundary. For Scenario 2, the TLV is not exceeded. For Scenario 3, the ACGIH TLV of 1ppm (1500 µg/m³) is exceeded in the vicinity of the three IPPs (Figure 7-8 to Figure 7-10). None of the scenarios exceed the WHO lowest observable adverse effect level (LOAEL) of 15 mg/m³ (15 000 µg/m³) or 10 ppm.

Table 7-9: Simulated occupational H_2S concentrations during operation for Scenario 1, 3, 5

AQSRs		2nd Highest 8-hour Ground Level Conc. (µg/m³)		
Number	Description	Scenario 1	Scenario 3	Scenario 5
B1	Power Plant Area 1	3680	677	1439
B2	Power Plant Area 2	2211	284	919
B3	Power Plant Area 3	2686	400	1047
B4	Power Plant Area 4	1817	804	1040
	Criteria	1500 (ACGIH)		

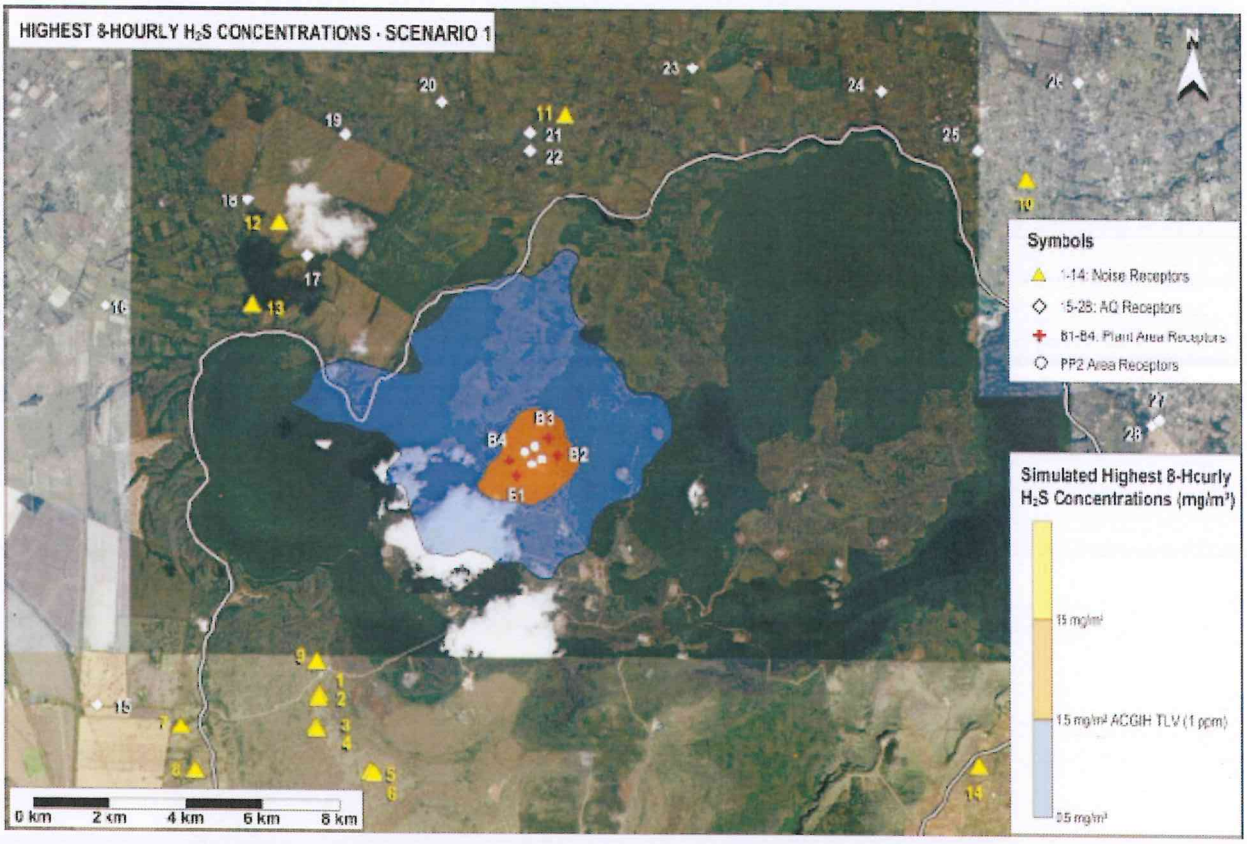


Figure 7-8: Highest 8-hr ground level H2S concentrations – Scenario 1

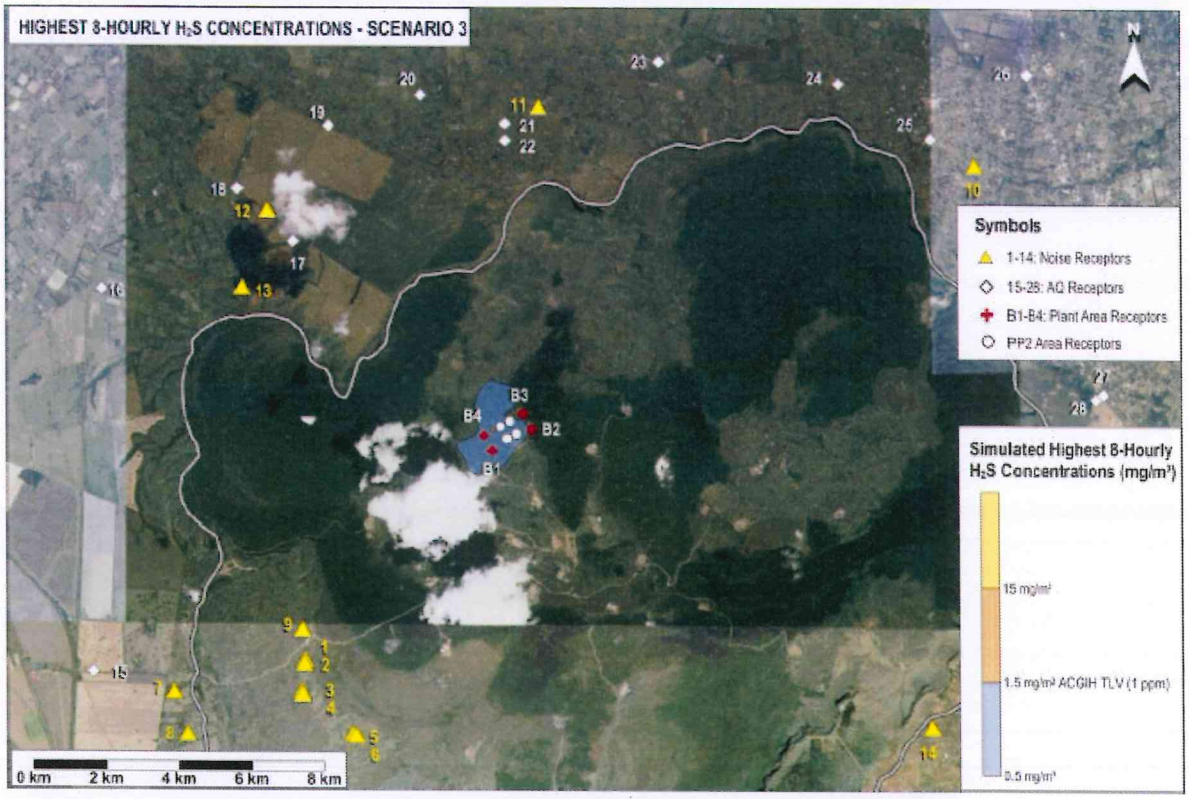


Figure 7-9: Highest 8-hr ground level H2S concentrations – Scenario 3

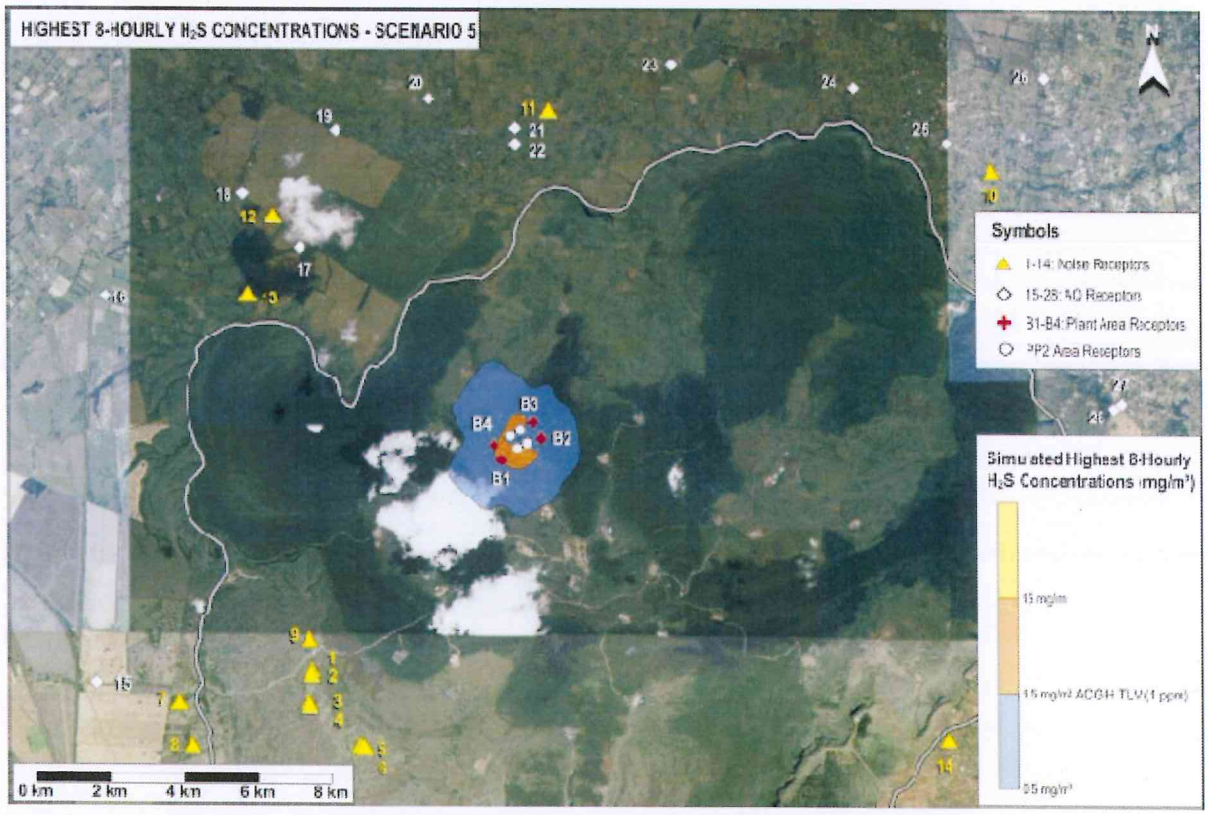


Figure 7-10: Highest 8-hr ground level H2S concentrations – Scenario 5

(c) Simulated Odour Impacts from H_2S

The results of the modelling suggest a possibility that there will be H_2S odour concentrations that will be smelt by local residents and has the potential under certain meteorological conditions to be regarded as a nuisance (offensive or objectionable). For Scenario 3, the New Zealand guideline value (70 µg/m³ for geothermal areas) is not exceeded at the sensitive receptors on the eastern side of the caldera.

Table 7-10: Simulated highest hourly H_2S concentrations during operation for Scenario 1, 3, 5

AQSRs		2nd Highest 1-hour Ground Level Conc. (µg/m³)		
Number	Description	Scenario 1	Scenario 3	Scenario 5
1	Structure 1	964	155	367
2	Structure 2	944	154	356
3	Structure 3	822	139	325
4	Structure 4	843	137	329
5	Structure 5	678	146	226
6	Structure 6	695	145	231
7	Mercy Njeri Sub Location 1	647	118	256
8	Mercy Njeri Sub Location 1	669	146	269
9	Homestead	1000	146	380
10	Wanyororo Sub Location	189	56	83
11	Kirima Sub Location	923	121	360
12	Rongai Sub Location 1	902	111	358
13	Rongai Sub Location 2	961	123	378
14	Gashura Village	591	100	236
15	Kabarak Junction	596	140	236
16	Ol Rongai Junction	784	99	280
17	Marigo	992	116	393
18	AIC Tulumoi Pry	831	104	331
19	Marigo B	847	114	338
20	Rigogo	912	125	345
21	Rigogo Junction	970	138	374
22	Rigogo Stage 1	1015	141	387
23	Kimochoch Centre	353	95	164
24	Nairobi Centre	171	60	74
25	Wanyororo	182	56	78
26	Solai Junction	147	54	74
27	PCEA Maili Tisa	141	60	66
28	Maili Kumi	146	60	69
	Criteria	70 (New Zealand)		

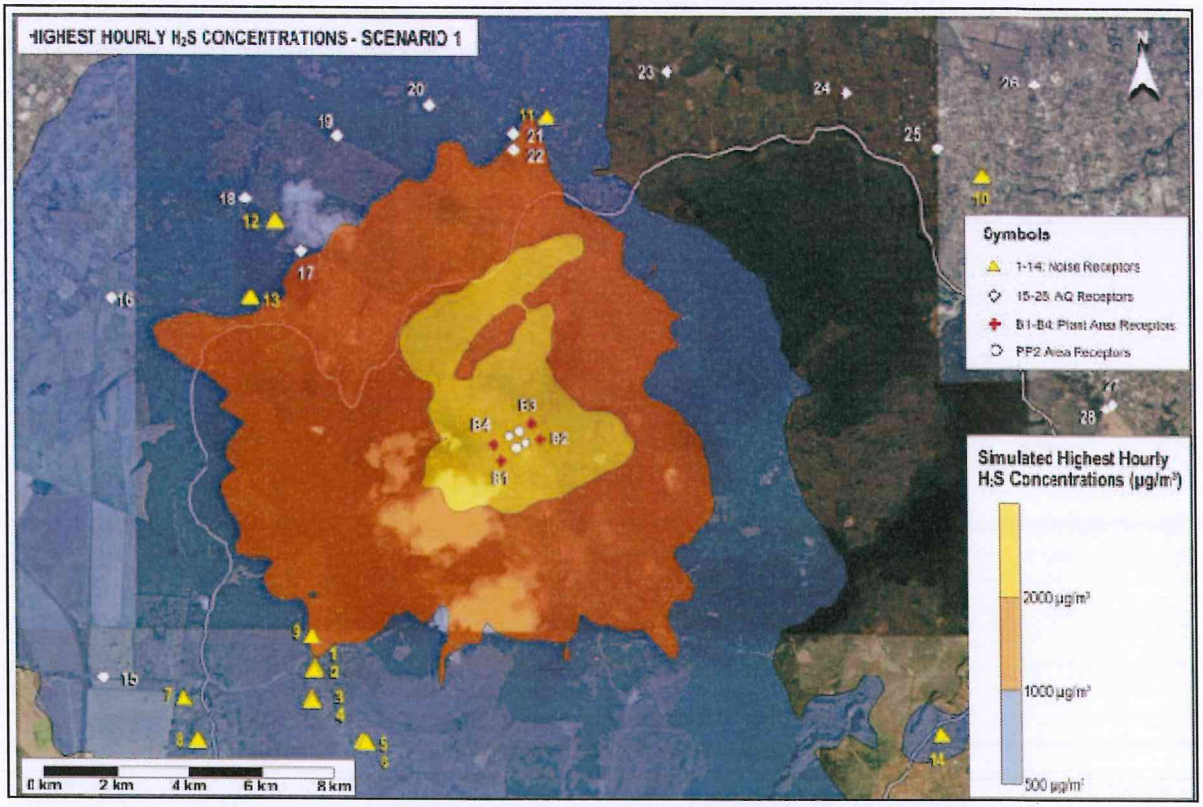


Figure 7-11: Highest hourly ground level H_2S concentrations – Scenario 1

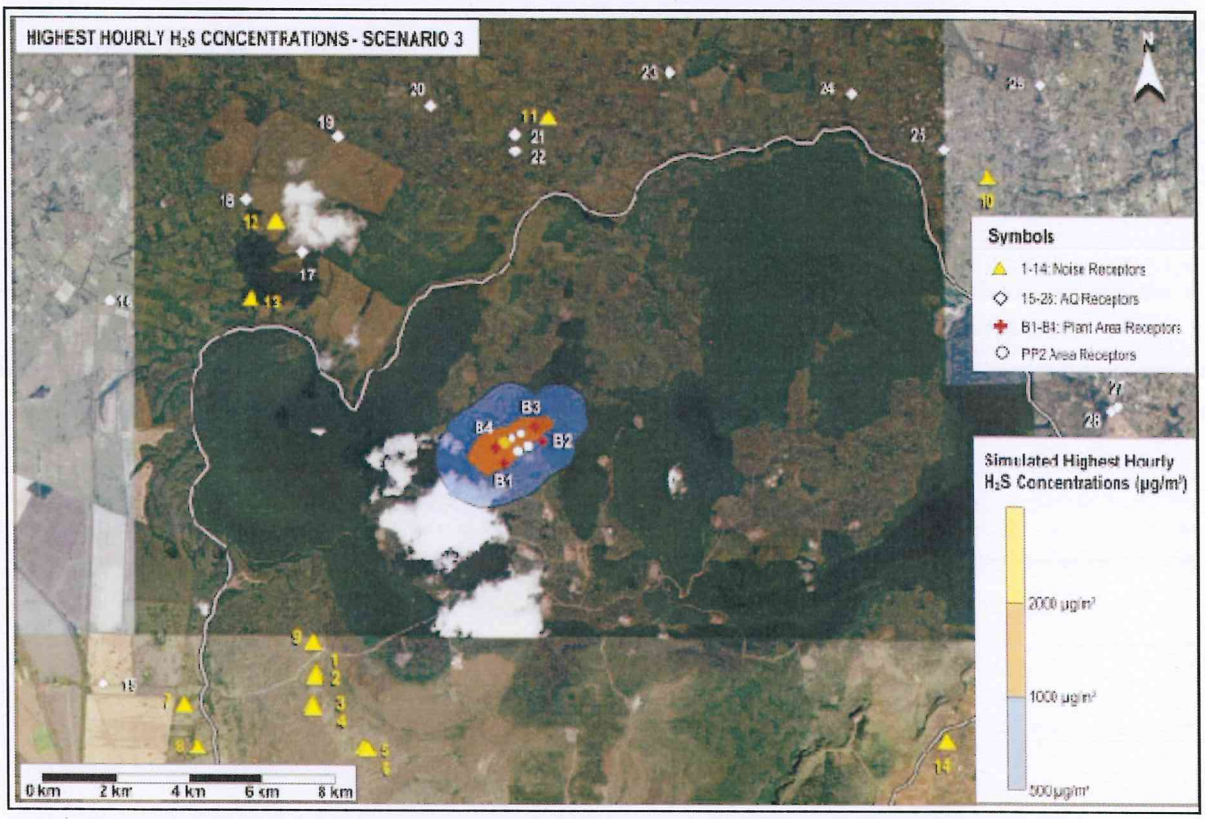


Figure 7-12: Highest hourly ground level H_2S concentrations – Scenario 3

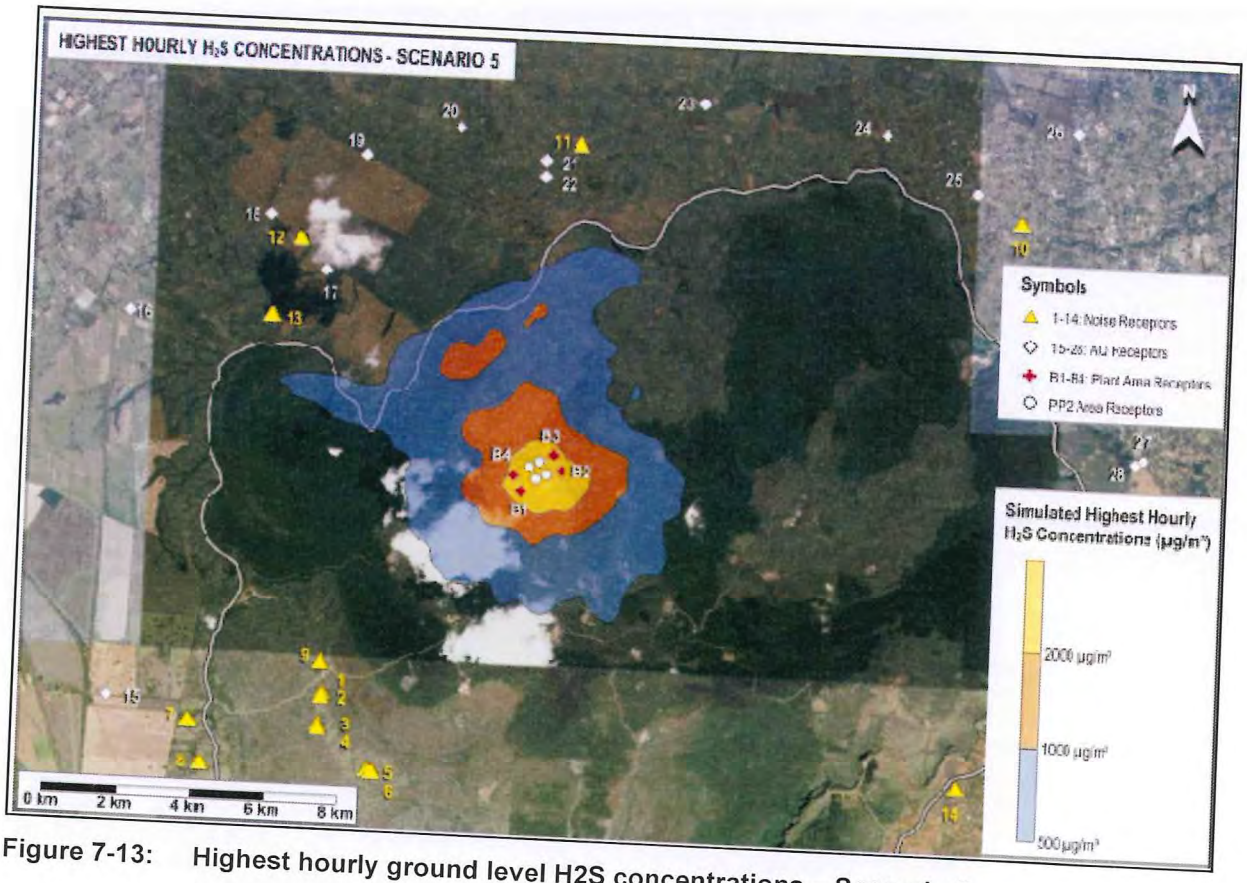


Figure 7-13: Highest hourly ground level H2S concentrations – Scenario 5

(d) Summary of findings

(i) Public Health Impact

- For Scenario 1, with all three IPPs emitting from a single stack (at 3.3 % NCG in steam), simulated 24-hour ambient H_2S concentrations exceed the Iceland guideline of 50 µg/m³ at some of the AQSRs. However, the WHO daily guideline value of 150 µg/m³ is not exceeded at any of the AQSRs. Simulated annual average ambient H_2S concentrations exceed the OEHHA screening level for chronic exposure (10 µg/m³) at some of the AQSRs. Similar impacts are experienced for Scenario 2, at higher emissions because of 4 % NCG in steam.
- For Scenario 3, with all three IPPs emitting from cooling tower fans (at 3.3 % NCG in steam), simulated 24-hour ambient H2S concentrations do not exceed the Iceland guideline of 50 µg/m³ or the WHO daily guideline value of 150 µg/m³ at any of the AQSRs. Simulated annual average ambient H2S concentrations do not exceed the OEHHA screening level for chronic exposure (10 µg/m³) at any of the AQSRs. Similar impacts are experienced for Scenario 4, at higher emissions because of 4 % NCG in steam.
- For Scenario 5, with Quantum emitting from a single stack and the other two IPPs emitting from cooling tower fans (at 3.3 % NCG in steam), simulated 24-hour ambient H2S concentrations do not exceed the Iceland guideline of 50 µg/m³ or the WHO daily guideline value of 150 µg/m³ at any of the AQSRs. Simulated annual average ambient H2S concentrations exceed the OEHHA screening level for chronic exposure (10 µg/m³) at Marigo B and Rigogo.
- For Scenario 6 and 7, with 2 of the IPPs emitting from single stacks, the impacts would be higher than Scenario 5 (i.e. would result in exceedences of the health screening levels at some of the AQSRs).

(ii) Occupational Impact:

For Scenario 1, the ACGIH TLV of 1ppm (1500 µg/m³) is exceeded both on-site as well as ~ 1 km from the site boundary. For Scenario 3, the TLV is not exceeded. For Scenario 5, the ACGIH TLV of 1ppm (1500 µg/m³) is exceeded in the vicinity of the three IPPs. None of the scenarios exceed the WHO Lowest Observable Adverse Effect Level (LOAEL) of 15 mg/m³ (15 000 µg/m³) or 10 ppm.

(iii) Odour Impact:

The results of the modelling suggest it is possible that there will be a H_2S odour impact at the AQSRs. For Scenario 3, the New Zealand guideline value (70 µg/m³ for geothermal areas) is not exceeded at the sensitive receptors on the eastern side of the caldera.

(e) Conclusions

It is notable that the three power plants will be operating simultaneously. From the air quality impact assessment (in which plant arrangement fro the other two plants were assumed), Scenario 3 and 4, with all three IPPs emitting from cooling tower fans is the preferable equipment arrangement with regards to air quality impacts.

QPEA has proposed as part of its plant design, NCGs dispersal through cooling tower fans (Table 4-1). This plant equipment arrangement is represented in the modelling by scenarios 3 and 4. The modelling results for the scenarios show that the WHO daily guideline value of 150 µg/m³ is not exceeded at any of the AQSRs even with the highest NCGs concentration in the steam of 4%. This indicates that no adverse public health impacts are anticipated with H_2S emissions from the plant's operation relative to WHO standards. Further, the power plant will allow for the re-injection of spent geothermal steam as a strategy to enhance sustainability of the geothermal reservoir. This will inadvertently result in reduced NCGs emissions as some will be captured within the fluids for re-injection, contributing to reduced significance of the emissions. QPEA has also incorporated two separate H_2S safety systems for the plant: the human hazard detection system consisting of one central unit with 4 ports and 4 fixed detectors for 1-500 ppm H_2S level; and equipment protection system designed for 1-1000 ppb H_2S detection. This will facilitate continuous monitoring and allow any further mitigation interventions where necessary. None the less, precautionary principle requires that adequate mitigation measures be put in place.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-4*
Spatial scope of impact	*-3*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-4*
Frequency of impact	*-5*
Result	***-99 Medium - High***

Mitigation measures

The following options have been provided by the IFC (2007) EHS Guidelines for Geothermal Plants to manage emissions to air:

- Total or partial re-injection of gases with geothermal fluids is one of the measures recommended for mitigating H_2S impacts. Re-injection of geothermal fluids has already been proposed in the plant design. Consider partial or toal re-injection of the NCGs with the geothermal fluid;
- When total re-injection is not feasible, venting of H_2S and other NCGs will be based on an assessment of potential impact to ambient concentrations, such that pollutant levels will not exceed applicable safety and health standards;

- If necessary, use of abatement systems to remove H_2S and Hg emissions from NCGs. Examples of H_2S controls can include wet or dry scrubber systems or a liquid phase reduction / oxidation system, while Hg emissions controls may include gas stream condensation with further separation or adsorption methods.

To ensure the lowest possible impact on AQSRs and the environment it is recommended that an air quality management plan should be adopted. This includes:

- The mitigation of sources of emission;
- The management of associated air quality impacts; and
- Ambient air quality monitoring.

An option to reduce H_2S emissions is the combustion of gases which would reduce 99% of emissions and convert it into elemental sulphur.

For occupational health impacts, it is certain that some workers will occasionally be exposed to elevated H2S concentrations. Mitigations measures proposed include:

- Daily monitoring of H2S within the Plant boundaries and other active activity sites within the caldera;
- Training of all workers on the dangers exposure to H2S;
- Installation of H2S monitors with alarm system including use of personal monitors by staff in potentially dangerous areas

For odour impacts, liaison strategy for communication with communities who may be affected by nuisance is proposed.

7.6.13 Operation Noise impacts

During operation phase noise will be generated by a number of elements at the plant. The main sources of noise will include:

- The steam turbine;
- The generator;
- The droplet separator;
- The steam strainer;
- Valves (main and stop valves);
- Pumps (incl. oil pumps, vacuum pumps, hotwell pumps and cooling water pumps)
- Ejectors;
- The main condenser;
- The cooling towers; and
- Transformers

It is notable that from the existing activities in the caldera presented in section 3.4 and the pre-development noise levels in section 3.1.7, the existing noise levels are already above the NEMA thresholds. Any power plant generated noise will thus only serve to add to the existing situation.

(a) Noise Sensitive Receptors

From atmospheric conditions of the project area, noise impacts are expected to be most notable to the north-north-west and south-south east during the day. During the night it is expected to be most significant to the north-north-west of proposed operations. Location of likely NSRs is shown in Figure 7-1. These include single homesteads, villages, small towns as well as community locations. The closest NSRs are situated approximately 3.5 km north-west of the facility on the crater rim at Marigo. Within the crater itself the individual homestead and structures to the south-west

(approximately 3.7 km from the facility) are the closest. No area designated as silent zone is within immediate proximity of the proposed power plant.

(b) Noise modelling Results

Table 7-11 gives a summary of modelled maximum downwind distances over which NEMA recommended sound level limits and IFC noise level guidelines are exceeded should the QPEA Geothermal Power Plant be operational on its own and with the Sosian and Ormat facilities.

Table 7-11: Maximum downwind distances over which Kenyan and IFC noise criteria are exceeded

Source	Kenya Sound Level Limits		IFC Noise Level Guidelines	
	Day-time (50 dBA)	Night-time (35 dBA)	Day-time (55 dBA)	Night-time (45 dBA)
QPEA (Quantum) Geothermal Power Plant				
Incremental	50 dBA at 760 m	35 dBA 2 430 m	55 dBA at 520 m	45 dBA at 1 250 m
Cumulative (in addition to baseline)	Baseline of 55.2 dBA exceeds limit	Baseline of 45.2 dBA exceeds limit	Baseline of 55.2 dBA exceeds guideline	Baseline of 45.2 dBA exceeds guideline
Increase above baseline	Not applicable	Not applicable	3 dBA at 510 m	3 dBA at 1 230 m
QPEA (Quantum), Sosian and Ormat Geothermal Power Plants				
Incremental	50 dBA at 1 080 m	35 dBA 3 160 m	55 dBA at 730 m	45 dBA at 1 760 m
Cumulative (in addition to baseline)	Baseline of 55.2 dBA exceeds limit	Baseline of 45.2 dBA exceeds limit	Baseline of 55.2 dBA exceeds guideline	Baseline of 45.2 dBA exceeds guideline
Increase above baseline	Not applicable	Not applicable	3 dBA at 730 m	3 dBA at 1 720 m

From Table 7-11 it is evident that even with all the three power plants operating simultaneously the overall maximum increase in noise level over the baseline will reduce to 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 NSRs are situated at least 3 km away from these sites it is however unlikely a change in day or night time noise levels will be detected at these locations. SANS 10103 (2008) indicates that at an increase of between 0 and 5 dBA, sporadic complaints with little or no community action may be expected.

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. galvanised steel sheet cladding of building that contains major noise sources), and the absence of permanent NSRs within 2 km radius from site.

It can therefore be concluded that, when referring to noise levels and increases in ambient noise levels as a result of the geothermal power plants' operational design parameters, such as turbine hall cladding with galvanised steel sheets, will be sufficient to ensure that no annoyance will be caused at the closest NSRs.

It was concluded that, provided the management plan recommend in this report is adopted, NSR's will not be affected negatively or find noise from the facility annoying. The cladding of the turbine hall with galvanised steel sheeting is considered sufficient from an environmental noise perspective i.e. impacts at NSRs.

Impact Analysis Matrix

Impact without Mitigation	
Severity of impact	*-3*
Spatial scope of impact	*-3*
Duration of impact	*-4*
Frequency of activity / duration of activity	*-5*
Frequency of impact	*-5*
Result	***-100 Low***

Mitigation measures

In order to minimize and ensure low impacts of both construction and operational noise on the receiving environment it is recommended that the following measures be adopted as part of the noise management plan.

Good Engineering and Operational Practices

- To minimize noise generation, equipment vendors must 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;
- A plan to monitor noise levels, record and respond to complaints and mitigate impacts should be developed. This to include regular monitoring of noise levels will need to be made during operation as per current practice in existing GDC operations.

Monitoring

It is recommended that short term 24-hour to 1-week sampling be conducted at the facility boundaries as well as nearest NSRs. Monitoring should be conducted in accordance with the procedures specified by the IFC (2007). Samples, at least 24-hours in duration should include the following parameters: L_{Aeq}, L_{A90}, and the un-weighted octave band sound pressure levels (L_{Zeq}). In the interpretation and reporting of sampled environmental noise levels, use should be made of a trained specialist. In addition to ambient noise monitoring it is recommended that source noise measurements of turbine building facades and sources located inside and outside buildings be sampled to verify L_W's applied in noise modeling study.

7.7 Negative Impacts during Decommissioning

Decommissioning will involve take out of the power plans and associated infrastructures after useful life. QPEA tender agreement with GDC is to install the power Plant on a Build Own and Operate (BOO) basis for 25 years, a typical economic design life of the major project equipment. However, it is not uncommon for power plant such as the proposed development to operate for 40 years or more.

The decision to decommission the Power Station will depend on its economic viability and continued well productivity. Decommissioning must take account of the environmental legislation and the technology available at the time.

The notable adverse impact at this phase is leaving abandoned plant, equipment and buildings without any attempt to rehabilitate leading to the deterioration of habitat. Unplanned, careless and disorganised site decommissioning can result in interference of habitat. Site decommissioning will involve closure and removal of facilities and disconnection from wells, including infrastructures such as roads and pipelines and finally vegetation restoration and landscaping. Vegetation can restore naturally through succession or intervened rehabilitation to achieve average status with the neighbouring area. An additional problem is the abandoned wells (holes) which can be fall off for wildlife and human.

A lot of solid waste will also be generated during decommissioning. The majority of the solid wastes generated will be similar to the construction phase of the project. These include;

- Demolition rubble;
- Top soils and excavation wastes;
- General demolition wastes;
- Waste metal (including, disc cutters etc, piping etc.);
- Waste oils and lubricants;
- Waste paints and solvents;
- Empty paint, oil and chemical/ solvent containers;
- Wood;
- Plastics;
- Electrical cabling and electrical components;
- Domestic wastes, including food wastes;
- Sewage effluent;
- Paper;
- Empty oxygen and acetylene tanks (if oxy-acetylene welding and cutting required); and
- Glass.

QPEA would develop a decommissioning plan incorporating both safety and environmental management and the works would be undertaken in accordance with an Environmental Management Plan.

The first step of decommissioning will be to make the plant safe for work in accordance with relevant safety procedures. The Power Station would be de-energised in conjunction with the electricity network operators, Kenya Power and KETRACO. Disused equipment and materials would be sold where possible or disposed of off-site by a licensed contractor. Closed vessels, pipes and other areas which could have hazardous gases present would be vented in accordance with normal operating procedures. These would then be tested to ensure that they are safe for entry or removal.

Once the plant is completely disconnected, and all hazardous materials removed, it will be handed over to a competent contractor (or contractors) to complete the dismantling and demolition work.

These decommissioning steps may be summarised and involve the following steps presented below;

- Make the site safe – ensure all electrical connections and supplies are disconnected and any dangerous chemical stores are identified and made safe;
- Removal and sale/recycling of plant and materials;
- Disposal of waste materials by appropriate methods in accordance with waste management regulations; and
- Re-instatement and landscaping of the power plant site with suitable mix of indigenous species. This should be done in liaison with the local KFS office.

QPEA must prepare and submit a decommissioning plan to NEMA for approval at least three months before decommissioning.