LAKE TURKANA WIND POWER PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT STUDY REPORT

May 2008

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- Prof. Francis M. Muthuri – Environmentalist / Team Leader
- Ms. Pauline Ikumi – Socialist
- Mr. Frank Msafiri – Resource Assessment Expert/ Botanist

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ABBREVIATIONS AND ACRONYMS

ADB	African Development Bank
AIDS	Acquired Immuno-defficiency Syndrome
AIC	African Inland Church
ALRMP	Arid Lands Resource Management Project
ASAL	Arid and Semi-arid Land
BOD	Biochemical Oxygen Demand
BP	Before Present
CAPEX	Capital Expenditure
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CFC	Credit Finance Corporation
CICU	Chemical and Industrial Consultancy Unit
CIFA	Community Initiatives Facilitation Assistance
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CV	Curriculum Vitae
dBA	Decibels
DDC	District Development Committee
DDO	District Development Officer
DDP	District Development Plan
DO	Dissolved Oxygen
DO	District Officer
DRSRS	Department of Resource Surveys and Remote Sensing
€	Euro
EA	Environmental Audit
EBITDA	Earnings Before Interest Tax Depreciation Amortisation
EC	Electrical Conductivity
EMCA	Environmental Management and Coordination Act
Eo	Average Annual Potential Evaporation
EER	Emerging Energy Research
EIA	Environmental Impact Assessment
ERB	Electricity Regulatory Board
ERS	Economic Recovery Strategy
EU	European Union
FHI	Food for Hungry International
GDP	Gross Domestic Product
GoK	Government of Kenya
GWh	Giga Watts per Hour
GTZ	German Technical Agency
Ha	Hectare
HH	Household
HIV	Human Immuno – deffieciency Virus
IGA	Income Generating Activities
IPAL	Integrated Project in Arid Lands
IPP	Independent Power Producers
IRR	Internal Rate of Return
ISO	International Standards Organization
IT	Information Technology
KenGen	Kenya Energy Generating Company
Kg	Kilogramme

KNBS	Kenya Bureau of Statistics
Km	Kilometre
KPLC	Kenya Power and Lighting Company
KSh	Kenya Shilling
Kv	Kilovolts
kW	Kilowatts
KWS	Kenya Wildlife Service
l	litre
£	British Pound
LDC	Location Development Committee
Ltd	Limited
LTWP	Lake Turkana Wind Power Project
m	metre
MAB	UNESCO Man and Biosphere Programme
m asl	metres above sea level
mg/l	milligram per litre
mm	millimetre
MoE	Ministry of Energy
MoENR	Ministry of Environment and Natural Resources
MoH	Ministry of Health
MoNPD	Ministry of National Planning and Development
MOSARETU	El Molo, Samburu, Rendille and Turkana Women Group
MoU	Memorandum of Understanding
µS	micro Siemens
Mt.	Mountain
MW	Mega Watt
N	North
NASCOP	National Aids Control Programme
NEAP	National Environmental Action Plan
NEMA	National Environmental Management Authority
NGO	Non Governmental Organizations
NMK	National Museums of Kenya
O_2	Oxygen
OHSAS	Occupational Health and Safety Standards
PAYE	Pay As You Earn
PISP	Pastoralist Integrated Support Programme
PPE	Personal Protective Equipment
PRA	Participatory Rural Appraisal
r	Average Annual Rainfall
STD	Sexually Transmitted Diseases
STD	Subscribers Telephone Services
SS	Suspended Solids
TB	Tuberculosis
UNICEF	United Nations Children Educational Fund
UNESCO	United Nations Education, Scientific and Cultural Organization
US$	United States of America Dollars
VAT	Value Added Tax
VIP	Ventilated Improved Pit Latrine
WC	Water Closet
WFP	World Food Programme
WHO	World Health Organization

EXECUTIVE SUMMARY

Introduction

The Lake Turkana Wind Power Project will be the biggest energy project involving exploitation of wind resource for generation of electric power in Kenya and the whole of the Africa Continent. This project will be situated in the Loiyangalani Division of the Marsabit District in Eastern Province of Kenya. The project will be developed and operated by the Lake Turkana Wind Power Ltd (LTWP), a consortium of foreign and local entrepreneurs. The project will be constructed in three phases in accordance to the following schedule:

- Phase 1: Installation of 40 turbines and full connection to the Kenyan grid (operational in 2009/10);
- Phase 2: Installation of 30 additional turbines (operational in 2010/11); and
- Phase 3: Installation of 30 turbines added to the above turbines (operational in 2012/13).

As a possible alternative, LTWP is considering the installation of 300 turbines of about 1 MW each.

Project Objective

The aim of the Turkana Wind Power Project is to construct a power plant (east of southern tip of Lake Turkana in Marsabit District) in order to generate electricity from wind powered turbines to feed into national grid. The project mainly involves developing a wind park which consists of a hundred turbines each with a capacity of 3 Megawatts (MW). The total power that the project will generate amounts to 300MW. This power output will add 30% to the existing capacity that is currently available in Kenya.

Study objective

The entry of the Lake Turkana Wind Power Ltd into the Kenya power mix will help the country to address power shortage and enhance further economic growth. However, large scale production of power as projected in the Lake Turkana Wind Power Project is likely to have significant impact on environment of the project area. Hence a need to carry out Environmental Impact Assessment for the proposed project in accordance to the National Environment Management Authority (NEMA) Guidelines.

Legal Requirements

The Environmental (Impact Assessment and Audit) Regulations of 2003, contained in Kenya Gazette Supplement No. 56, Legal Notice 101, have been used to guide the methodology and provide the framework for the Environmental Impact Assessment of the proposed Lake Turkana Wind Power Project. This environmental impact assessment report has been prepared in accordance to the outline contained in Part 1V of the above regulations stating:

- The proposed location of the project;
- A concise description of the national environmental legislative and regulatory framework, baseline information, and any other relevant information related to the project;
- The objectives of the project;
- The technology, procedures and processes to be used, in the implementation of the project;
- The materials to be used in the construction and implementation of the project;

- The products, by-products and wastes generated by the project;
- A description of the potentially affected environment;
- The environment effects of the project including the social and cultural effects and the direct, indirect, cumulative, irreversible, short-term and long-term effects anticipated;
- Alternative technologies and processes available and reasons for preferring the chosen technology and processes;
- Analysis of alternatives including project site, design and technologies and reasons for preferring the proposed site, design and technologies.
- An environmental management plan proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment; including the cost, time frame and responsibility to implement the measures;
- Provision of an action plan for the prevention and management of foreseeable accidents and hazardous activities in the cause of carrying out activities or major industrial and other development activities;
- The measures to prevent health hazards and to ensure security in the working environment for the employees and for the management of emergencies;
- An identification of gaps in knowledge and uncertainties which were encountered in compiling the information;
- An economic and social analysis of the project;
- An indication of whether the environment of any other state is likely to be affected and the available alternatives and mitigating measures; and
- Such other matters as the Authority may require.

Salient Findings

The potential environmental impacts of the proposed project are summarised in the environmental impact matrix shown below. The implementation of the Lake Turkana Wind Power Project in the project area will lead to a variety of socio-economic benefits including stabilization of electricity in Kenya, promotion of economic growth, contribution to the Government revenue, increased employment and improvement of roads and other benefits in the project area.

Against the benefits brought about by the project, there will be some negative impacts emanating from both the construction and operation activities of the proposed project. The increase in number of people in the project area following the commissioning of the project will lead to a number of negative socio-economic impacts including cultural contamination, visual intrusion, increased incidences of diseases, insecurity, and community conflicts, challenges of labour force management, and increased accidents and occupational hazards.

The project activities are likely to cause minor negative impacts on the environment of the project area including loss of habitat, destruction of floral and faunal communities, disturbance to livestock, soil erosion and potential siltation of aquatic habitats, pollution, ponding conditions and increase in noise. Perhaps the most serious negative impact the project is likely to have on the project area is the potential for birds' mortality through collisions with the turbines.

The study has proposed several measures to reduce negative impacts including amelioration of social negative impacts, noise abatement, waste management, reduction of visual intrusion, restoration of habitat and biodiversity, reduction of soil erosion and siltation and prevention of accidents and health hazards. In addition,

measures have been proposed with regard to the siting of the wind park in order to reduce collision of birds with turbines.

A summary of the affected key environmental variables and the intensity of impacts is summarised in the matrix below:

Environmental Impact Matrix

Environmental Parameters	Intensity of Impact
Stabilization of electricity sector	+3
Promotion of economic growth	+3
Contribution to the Government revenue	+3
Increased employment	+2
Improved communication	+2
Visual intrusion	-1
Cultural contamination	-1
Increased incidences of diseases	-1
Labour force management challenges	-1
Increased accidents	-1
Loss of habitat,	-1
Destruction of flora and fauna	-1
Disturbance to livestock	-1
Soil erosion and siltation	-1
Pollution	-1
Ponding conditions	-1
Increase in noise levels.	-1
Birds' mortality through collisions	-2

Interpretation

+3 Highly Positive Impact – Impact with national or international benefits
+2 Moderately Positive Impact – Likely to impact on quality of life within the region / project area
+1 Light Positive impact – Minor impact but of significant local benefit
0 No Impact
-1 Light Negative Impact – Minor negative impact at the local level
-2 Moderate Negative Impact – A negative impact likely to adversely affect the environment or quality of life in the region / project area if not mitigated
-3 Severe negative impact with national or international implications

Environmental management including monitoring has been identified as an important process in the protection of environment of the project area. This will reveal changes and trends brought about by the presence and operations of the installed wind park facility. The total cost for the protection of the environment and other related activities is estimated at KSh.19,800,000 (€204,117) for the first year project operation. The break down of the cost estimates is presented in the Table below:

Cost Estimates for the Environmental Management (One Year Operation)

Project Activity		Cost Estimate (KSh)
1	Remuneration for environmental officer to implement the proposed management plan	2,500,000
2	Purchase of a vehicle and other transportation requirements for environmental officer	4,500,000
3	Support for community awareness and sensitization programme	1,500,000
4	Project social responsibility programme (support to fisheries, community water supply, environmental conservation, health, education etc.)	4,000,000
5	Cost of monitoring activities including a one-year baseline field study on impacts of the wind park on birds.	1,500,000
6	Sample analysis (chemical and biological, and other samples)	100,000
7	Purchase of consumables (computer, sampling apparatus, field equipment etc.	300,000
8	Purchase of stationery, documentation and report writing	100,000

9	General landscaping works including construction of soil traps	1,500,000
10	Waste management activities including purchase of an incinerator	2,000,000
11	Contingencies (10% of the total cost of the proposed environmental management plan)	1,800,000
Total Estimated Cost for Environmental Management		**KSh 19,800,000**

Recommendations

The Consultants have proposed the following recommendations that will enhance sustainable implementation of the proposed Lake Turkana Wind Power Project and protect the environment of the project area:

1. Due to the increased population in the project area and the subsequent high demand of fuel wood resources, there will be a need to encourage the workers to use alternative sources of energy during the implementation of the project in order to protect the scarce wood resources of the project area.

2. Given the high level of expectations created in the community about the project, it is recommended that the community's expectations are managed by having candid dialogue with them right from the start.

3. The project needs to sensitize the local community on potential cultural contamination and other negative impacts in the project area, in order to protect the local community from the negative habits and customs of outsiders.

4. As part of its social responsibility, the project should develop a plan to assist the marginalised communities in the project area, in accordance to the local community felt needs. However before any social responsibility work is carried out, a Participatory Rural Appraisal (PRA) should first be carried out to identify the communities needs.

5. Through out the project life, the developer needs to support the implementation of environmental management (including mitigation plan and monitoring) in order to protect the environment of the project area from the negative impacts of project implementation.

6. In order to conduct a sustainable environmental management in the project area, there will be a need to engage an Environmental Officer to be stationed at Loiyangalani. The proposed environmental officer will put in place mechanisms to initiate and operationalize the proposed mitigation plan and environmental monitoring on a regular basis.

7. Since the major land use of the project area is livestock keeping, measures should be put in place to avoid disturbance of livestock activities especially grazing/browsing and access to watering points. Except for the small area fenced around the substation, there should be no fencing around the wind park perimeter.

8. In order to avoid impacts of birds' collisions with turbines, the project developer should put in place mechanisms for a careful design and siting of the wind park. The wind park design should allow for wide corridors between a cluster of turbines. The wind park will need to be sited away at least 3km

from the shore of Lake Turkana and at least 1km away from the nearest canyon.

9. The project needs to carry out investigations to verify predictions made during the course of environmental impact assessment study especially with regards to the impacts on the avifauna of the project area. In this regard it is recommended that a minimum one-year baseline field study needs to be undertaken to determine the use of the study area by migrating and over wintering species of birds and to identify species that may be adversely affected by wind park presence.

1. INTRODUCTION

Lake Turkana Wind Power Project (LTWP) will be the biggest energy project involving exploitation of wind resource in Kenya and the whole of Africa Continent. The project is located on the south eastern border of Lake Turkana in the northern Kenya. The proposed project will generate 300MW from wind energy to be injected into the Kenyan national grid.

1.1 Project Background

The Lake Turkana Wind Project preparatory phase effectively started towards the end of 2005 when the project location was first visited by the principal investors (KP&P, ANSET Africa Ltd and Mr. Dolleman) with subsequent signing of the Memorandum of Understanding (MoU) for joint cooperation. Thereafter the project partners requested and were granted (in April 2006) exclusive rights by national authorities to study the wind resources in the area concerned. In order to facilitate the wind study, an 80 metre high guy mast was erected with all the necessary equipment for measuring and recording wind resources at prescribed heights. Wind measurements for 12 months commenced in November 2006. In the same year, an initial infrastructure review was made by the Dutch Company, Mammoet. This involved an assessment of the route from the seaport of Mombasa to Lake Turkana in order to determine the effort required for logistical operation of transporting the masts and turbines. In addition, initial review of electricity grid was carried out. Finally discussions were held with Kenya Power and Lighting Company (KPLC) and a letter of interest to purchase the power generated by the Lake Turkana Wind Power project was subsequently issued.

Having successfully completed the preparatory phase, the project entered the feasibility phase from November, 2006. Since then several project activities have been either initiated or are currently in various stages of development. They include:

- Wind measurements on site;
- Economic feasibility;
- Electricity grid analysis; and
- Environmental impact assessment.

1.2 The Need for the Project

The current energy policy objectives in Kenya emphasize the need for energy availability and accessibility at cost effective prices. The policy also supports sustainable socio-economic development while protecting and conserving the environment. The main sources of energy in Kenya are electricity, wood fuel, petroleum and renewable energy. Of the total energy requirements in the country, the bulk (68%) of the country's primary energy consumption comes from wood fuel and other biomass sources. This is followed by petroleum at 22%, electricity at 9% and other sources at 1%.

Of the above main sources of energy in Kenya electricity is very crucial for the economic development of the nation. The provision of inexpensive and reliable supply of electricity is the lifeblood of our economy. However, today Kenya's electricity supplies are unreliable and expensive. This has arisen for a variety of reasons including ineffective management of power purchase agreements leading to extremely high tariffs of privately generated power, inequitable distribution of operating costs, weak and ineffective management of power, bloated workforce, wasteful and cost ineffective procurement, failure to invest in system reinforcement,

poor maintenance and distribution infrastructure and poor governance among other problems afflicting the energy sector.

Since 1994 a number of reforms have been carried out to streamline the electric power sector. These include review of tariff, retrenchment in the key utility institutions, liberalization of the electric power generation and separation of power distribution from generation and regulatory services. The public sector organizations in the electric power sub-sector have been re-organized into one company for generation (KenGen) and a company for transmission and distribution (KPLC). The electric Power Act of 1997 provided for the establishment of the Electricity Regulatory Board (ERB) whose functions include setting and reviewing consumer tariff, approving power purchase agreements, and promoting environmental health and safety regulations. It should be noted that the Kenya Government has started restructuring the electricity sector focusing on ending the public monopoly of KPLC over the distribution of electricity. In addition a need has been expressed to privatize the organization over the medium term.

One of the strategies to streamline the power sector is to implement liberalization of the power generation. Towards the implementation of this strategy, there are at present four (4) operational private and independent power producers (IPPs). The IPPs include Iberiafrica Power, Westmont Power, Orpower 4, and Tsavo Power Company. However, the IPPs serve only a small fraction of the power market with a combined installed capacity of 187MW when compared to Kenya's total installed capacity of 1094MW.

Currently the electricity sector in Kenya only reaches an estimated 10% of the population. Further electricity generation is therefore necessary in order to reach a greater percentage of the population and support economic growth. The situation is aggravated by the fact that 60% of the electric power produced is based on hydropower which has been often unreliable especially during the dry seasons. For example in 1999 and 2002, severe droughts greatly affected the power production of the hydroelectric dams and nearly brought economic activities to a standstill. The above experience underscores the need to increase power production and to diversify the power sources. The entry of the Lake Turkana Wind Power Ltd into the Kenya power scenario will help the country to address power shortage and enhance further economic growth. Towards this objective, the implementation of the proposed Lake Turkana Wind Power Project will provide the country with a large (300MW) and relatively cheap source of energy.

1.3 Project Objectives

The aim of the Turkana Wind Power Project is to construct a power plant (south east of Lake Turkana in Marsabit District) in order to generate electricity from wind powered turbines to feed into national grid. This project mainly involves developing a wind park which consists of a hundred turbines each with a capacity of 3 Megawatts (MW). The total power that the project will generate amounts to 300MW. This power output amounts to 30% of the existing capacity that is currently available in Kenya. The project is scheduled to be constructed in three phases as follows:

- Phase 1: 40 turbines and full connection to the Kenyan grid (operational in 2009/10);
- Phase 2: 30 turbines added to the park (operational in 2010/11); and
- Phase 3: 30 turbines added to the park (operational in 2012/13).

As a possible alternative, LTWP is considering the installation of about 300 turbines of about 1MW each with a total capacity of 300MW.

The Lake Turkana Wind Park will be built and operated by Lake Turkana Wind Power Ltd. The KPLC has expressed the interest to buy this capacity at rates which will be favourable to the consumer. Despite the remoteness of the project location, the wind park will be incorporated into the national grid through the connection to the Ol Karia Geothermal Power Station, near Naivasha.

1.4 Study Objectives

As stared above, the entry of the Lake Turkana Wind Power Ltd into the Kenya power mix will help the country to address power shortage and enhance further economic growth. Towards this objective, the implementation of the proposed Lake Turkana Wind Power Project will provide the country with a large (300MW) and relatively cheap source of energy. However, large scale production of wind power as projected in the Lake Turkana Wind Project is likely to have significant impact on environment of the project area. Hence a need to carry out Environmental Impact Assessment (EIA) for the proposed project in accordance to the National Environment Management Authority (NEMA) Guidelines.

2. LEGAL, REGULATORY AND ADMINISTRATIVE FRAMEWORK

2.1 Introduction

Kenya is a developing country where about 80% of population live in rural areas and derive their livelihood from agriculture through crop and livestock production, fishing, forestry and exploitation of other natural resources. According to the 1999 population census report, Kenya's population was about 28.4 million people, and is projected to reach 37.5 million people by the Year 2010. About 70% of Kenyan population lives in 12% of the total land area (referred to as high potential area) while the remaining 30% of the population live in arid and semi-arid areas (ASALs), which account for 88% of the total land area in Kenya.

Today Kenya is faced with grave environmental problems and challenges that include land degradation, loss of biodiversity, environmental pollution and water management and desertification among other challenges. There is a growing concern that many forms of development activities cause damage to the environment and the natural resources upon which the bulk of national economy is based. A major national challenge today is how to maintain sustainable development without damaging the environment. It is now accepted both nationally and globally that development projects must be economically viable, socially acceptable and environmentally sound. In order to protect the environment from negative impacts of development, it is a condition of the Kenya Government for the developers and proponents of projects to conduct environmental impact assessment on the proposed development projects and environmental audits for the ongoing projects.

Until recently, Kenya did not have a consolidated legislation for the protection and management of environment. The legal provisions on environmental protection were scattered in 77 statutes, which touched on various aspects of environment. This set up did not offer adequate protection of the environment mainly due to weak legal and institutional frameworks. Significant progress has, however, been accomplished towards arresting this situation. This advancement commenced with the finalization of the National Environmental Action Plan (NEAP) in 1993.

2.2 The National Environmental Action Plan (NEAP)

In 1993, National Environment Environmental Action Plan (NEAP) was finalized under the Ministry of Environment and Natural Resources (MoENR). NEAP addressed environment and conservation challenges, through appropriate legislative and institutional mechanisms. It provided not only a strategy for achieving sustainable development in Kenya but also served as a basis for domesticating Agenda 21 – the Global Programme of Action on Environment and Development. NEAP's main objectives were to coordinate stakeholders in the preparation of a national environmental legislation and establish a single institution with legal authority to coordinate the management of environmental resources that were at that time managed by different sectoral statutes. The adoption of the NEAP in 1994 marked an important step towards integrating environmental matters in the development planning process. Following the adoption of NEAP, the Environmental Management and Coordination Act (EMCA) of 1999 was enacted.

2.3 Environmental Management and Co-ordination Act (EMCA)

The main objective of the Environmental Management and Coordination Act (EMCA) is to provide for the establishment of an appropriate legal and institutional framework for the management of the environment in Kenya. EMCA further aims to improve the

legal and administrative co-ordination of the diverse sectoral initiatives in the field of environment so as to enhance the national capacity for effective environmental management. In addition, the Act is set to harmonize the 77 sector specific legislations touching on the environment in a manner designed to ensure greater protection of the environment in line with national objectives. The ultimate objective is to provide a framework for integrating environmental considerations into the country's overall economic and social development. The major institution established to implement and operationalize the objectives of EMCA is the National Environmental Management Authority (NEMA)

2.4 National Environmental Management Authority (NEMA)

In July 2002, the Government established the National Environmental Management Authority (NEMA), a body corporate under the Ministry of Environment and Natural Resources for the purpose of the administration of EMCA. The NEMA is headed by a Director General appointed by the President. Its functions include coordination of various environmental management activities, initiation of legislative proposals and submission of such proposals to the Attorney General. NEMA is involved in conducting research, investigations and surveys in the field of environment. In addition, NEMA has instituted Environmental Impact Assessments (EIAs) and Environmental Audits (EAs) as normal practices in Kenya.

2.5 Environmental Impact Assessment (EIA)

The EMCA makes it mandatory for any person being a proponent of a project to submit a project report to NEMA in a prescribed format. Of immediate relevance with regard to conducting EIA are Part VIII, Section 58 (1&2) and the Second Schedule of the EMCA. Section 58 (1) states that: "Notwithstanding any approval, permit of licence granted under this Act or any other law in force in Kenya, any person, being a proponent of the project, shall before financing, commencing, proceeding with, carrying out, executing or conducting or causing to be financed, commenced, proceeding with, carried out, executed or conducted by another person any undertaking specified in the Second Schedule to this Act, submit a project report to the Authority in the prescribed form, giving the prescribed information and which shall be accompanied by the prescribed fees".

Section 58(2) states that the proponent of a project shall undertake or cause to be undertaken at his own expense an environmental impact assessment study and prepare a report thereof. In accordance to the Section 147 of the above Act, Environmental and (Impact Assessment and Audit) Regulations, 2003 have now been formulated and gazetted in Kenya. Gazette Supplement No. 56. Part IV, Section 18 (1) states that a proponent shall submit to the Authority, an environmental impact assessment study report incorporating but not limited to the following information:

- The proposed location of the project;
- A concise description of the national environmental legislative and regulatory framework, baseline information, and any other relevant information related to the project;
- The objectives of the project;
- The technology, procedures and processes to be used, in the implementation of the project;
- The materials to be used in the construction and implementation of the project;

- The products, by-products and waste generated by the project;
- A description of the potentially affected environment;
- The environment effects of the project including the social and cultural effects and the direct, indirect, cumulative, irreversible, short-term and long-term effects anticipated;
- Alternative technologies and processes available and reasons for preferring the chosen technology and processes;
- Analysis of alternatives including project site, design and technologies and reasons for preferring the proposed site, design and technologies.
- An environmental management plan proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment; including the cost, time frame and responsibility to implement the measures;
- Provision of an action plan for the prevention and management of foreseeable accidents and hazardous activities in the cause of carrying out activities or major industrial and other development activities;
- The measures to prevent health hazards and to ensure security in the working environment for the employees and for the management of emergencies;
- An identification of gaps in knowledge and uncertainties which were encountered in compiling the information;
- An economic and social analysis of the project;
- An indication of whether the environment of any other state is likely to be affected and the available alternatives and mitigating measures; and
- Such other matters as the Authority may require.

2.6 Other Relevant Legislation

While the Environmental Management and Coordination Act supersedes all other environmental legislation, numerous other laws and regulations will influence the various aspects and activities of the proposed Lake Turkana Wind Power Project. The most important legislation that will guide the development and implementation of this project is the Electric Power Act (1998). Other relevant legislation with regard to this project includes:

- Workmen's Compensation Act (rev. 1988);
- Geothermal Resources Regulations (1990);
- Public Health Act (rev 1972);
- Physical Planning Act (1996);
- Water Act (2002);
- Geothermal Resources Act (1982)
- Wildlife (Conservation and Management) Act (1985)
- Building Code (1997);
- Local Government Act (rev. 1998);
- Local Government Regulations (1963);
- Factories Act (rev. 1972); and
- Lakes and Rivers Act (rev. 1983) among other pieces of legislation.

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

- OP 4.01 Environmental Assessment;
- OP 4.04 Natural Habitats;
- Environmental Assessment Sourcebook; and
- Pollution Prevention and Abatement Handbook, 1998.

2.7 Relevant International Conventions and Agreements

Several international conventions and agreements are relevant to this study. The most notable include:

- Convention on biological diversity (CBD);
- Convention on the wetlands of international importance;
- Convention on the conservation of migratory species of wildlife animals; and
- African convention on the conservation of nature and natural resources.

2.7.1 Convention on biological diversity (CBD)

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.

2.7.2 Convention on the wetlands of international importance as waterfowl habitats

This convention is also referred to as Ramsar Convention. Its main objective is to promote conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world. Kenya ratified the Convention on 5th June 1990.

2.7.3 Convention on the conservation of migratory species of wildlife animals

This Convention is also referred to as Bonn Convention. It is intended to ensure that migratory species of wild animals spelt out on Appendix I and II to that convention are protected from extinction. The Convention requires inter-governmental cooperation to ensure that the species are allowed to migrate as their nature and their habit is preserved. The Convention was adopted on 23rd June 1979 and came to force on 1st November 1983.

2.7.4 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 the above resources. The convention was adopted in Algiers on 15th September, 1968 and came into force on 16th June 1969.

2.8 The Proposed Environmental Impact Assessment

Environmental impact assessment for the proposed Lake Turkana Wind Power Project was carried out in accordance with prescribed procedures and requirements of NEMA as stipulated above. A major objective of the proposed EIA is to ensure that the proposed wind park development in Loiyangalani in Marsabit District will be environmentally sound and sustainable, and that any environmental issues or consequences of the proposed development are recognized early and taken into account in the project design.

3. APPROACH AND METHODOLOGY

The consulting team started by conducting scoping exercise with various stakeholders as well as securing and reading through several documents that deal with the wind power resource and environmental characteristics of the project area. A list of documents consulted in the course of this study is presented in Annex 1. Environmental conditions of the project area were investigated during the field trip made into the project area, Loiyangalani Location between 16th to 25th November, 2007. During the above field trip, the team made relevant observations and carried out detailed survey of appropriate attributes of the project area including physical and biological parameters. Photographs were taken where appropriate. The environmental attributes of the project area captured during the field study are presented in a series of photographic plates as presented in Annex 2.

In order to acquire further information, the consulting team employed consultative approach through meetings, interviews and focused discussions with a wide range of stakeholders. In particular the team held interviews and discussions with the following key organisations and people:

- National Environmental Management Authority (NEMA): Meetings with Director, Compliance and Enforcement and District Environmental Officer, Marsabit District.
- Government Departments: Ministry of Cooperatives, Livestock and Fisheries, Office of the President - Arid Lands Resource Management Project (ALRMP) in Marsabit, District Development Officer (DDO), Marsabit, and Department of Social Development, Gender and Sports, Marsabit.
- Parastatal organisations including the Kenya Wildlife Service (KWS), National Museums of Kenya (NMK) and Kenya Power and Lighting Company (KPLC).
- Provincial administration and local community leaders including meeting with the Chief, Loiyangalani Division, the Assistant Chief for Loiyangalani and Moiyet sub locations.
- Non Governmental Organizations: Food for the Hungry International (FHI), Community Initiatives Facilitation Assistance (CIFA) and Pastoralist Integrated Support Programme (PISP).
- Lake Turkana Wind Power Ltd Management.

The team held meetings and interviews with local communities in the project area including the Yammo Manyatta Community (Turkana), Nakuame Kwi Manyatta (Turkana), Kiwanja Ndege Manyatta (Samburu and Rendille) and El Molo Community (originally from Komote Laiyeni Village) that are likely to be affected in one way or another by the project. In this regard key informant interviews and the focal group discussions were held with the youth, women and men groups to be served by the project. The team held meetings with several CBOs in the project area where concerns about the proposed project were discussed. The CBOs consulted included Mosaretu Women Group, Kifaru Women Group and Nayori Environmental Conservation Rehabilitation Youth Group. Most of people interviewed raised concerns related to employment opportunities, potential accidents from the project, negative impacts of the project on livestock and social considerations including supply of water and support for enhancement of fisheries in the project area.

Plant specimens collected in the project area were identified at the herbarium at the Department of Resource Surveys and Remote Sensing (DRSRS) and the East African Herbarium at the National Museums of Kenya (NMK).

Photo 1. An Interview with Sr. Chief Loiyangalani Location, Mr. Christopher K. Lekapana.

Photo 2. Discussions with the Yammo Manyatta Community

Analysis for water quality from Lake Turkana and Loiyangalani Spring (the water sources likely to be affected by the operations of the proposed project) was carried out in the Chemical & Industrial Consultancy Unit (CICU) of the University of Nairobi Chemistry Department, Chiromo Campus. This laboratory is recognized by the

NEMA as having adequate capacity and competence to carry out water quality analysis in accordance to Section 119 of the EMCA.

A list of people and organizations consulted in the course of conducting the environmental impact study are presented in Annex 3.

Following the completion of field study and drafting of the EIA study report, copies of the draft report were distributed to a wide cross section of stakeholders (Annex 10a) to review and communicate their comments to the Team Leader within a period of three weeks. A stakeholders' meeting was subsequently held in Loiyangalani between 21 and 22nd April 2008 and attended by fifty four (54) participants (Annex 10b). Several issues touching on the proposed project including the project negative impacts on livestock, Lake Turkana and vegetation and the siting of the wind farm, job opportunities and other benefits to the community among other issues were exhaustively discussed during the workshop. Issues discussed in the Stakeholders' Meeting were recorded in the minutes presented in Annex 11.

Photo 3. A Section of the Participants at the Stakeholders' Meeting (21-22 April 2008)

4. BASELINE INFORMATION AND DECRIPTION OF THE POTENTIALLY AFFECTED ENVIRONMENT

4.1 The Location of the Project Area

The project area for the Lake Turkana Wind power Project is situated in the Loiyangalani / Mt. Kulal Locations of Loiyangalani Division in Marsabit District of the Eastern Province of Kenya. On a closer view the project area is located between the foot slopes of Mt Kulal and the south-eastern end of Lake Turkana in Loiyangalani Location as shown on the Maps 1 – 3. The project site covers an area of 150 km^2 (15km by 10km). The project area has been leased from the Government of Kenya (GoK) for a period of 99 years. The leased land runs south east from the south eastern shores of Lake Turkana and passes between Mts. Kulal and Nyiru. The area has unique geographical conditions in which daily temperature fluctuations generate strong predictable wind streams between the Lake Turkana (with relatively constant temperature) and the desert hinterland (with steep temperature fluctuations). The project area covers a valley between Mt Kulal and Mt. Nyiru that effectively acts as a funnel in which the wind streams are accelerated to high speeds.

4.2 Climatic Conditions

The climatic conditions prevailing in the project area and other areas of the Marsabit District are summarised in Table 1. The climate of the project area is hot and very dry. The whole of the project area belongs to what is referred to as Agro climatic Zone VII. This zone is characterised by very low rainfall and very high evapotranspiration as seen in Table 1.

Table 1. Main Features of the Agro climatic Zones in Marsabit District

Zone	r/Eo (%)	r (mm)	Eo (mm)	Climatic designation
III	50-55	900 - 960	1750 - 1800	Semi-humid
IV	40 - 50	750 - 900	1800 - 2095	Semi-humid to semi-arid
V	25 - 40	525 - 750	11890 - 2095	Semi-arid
VI	15 - 25	320 - 525	2095 - 2150	Arid
VII	<15	170 - 320	2150 - 2280	Very arid

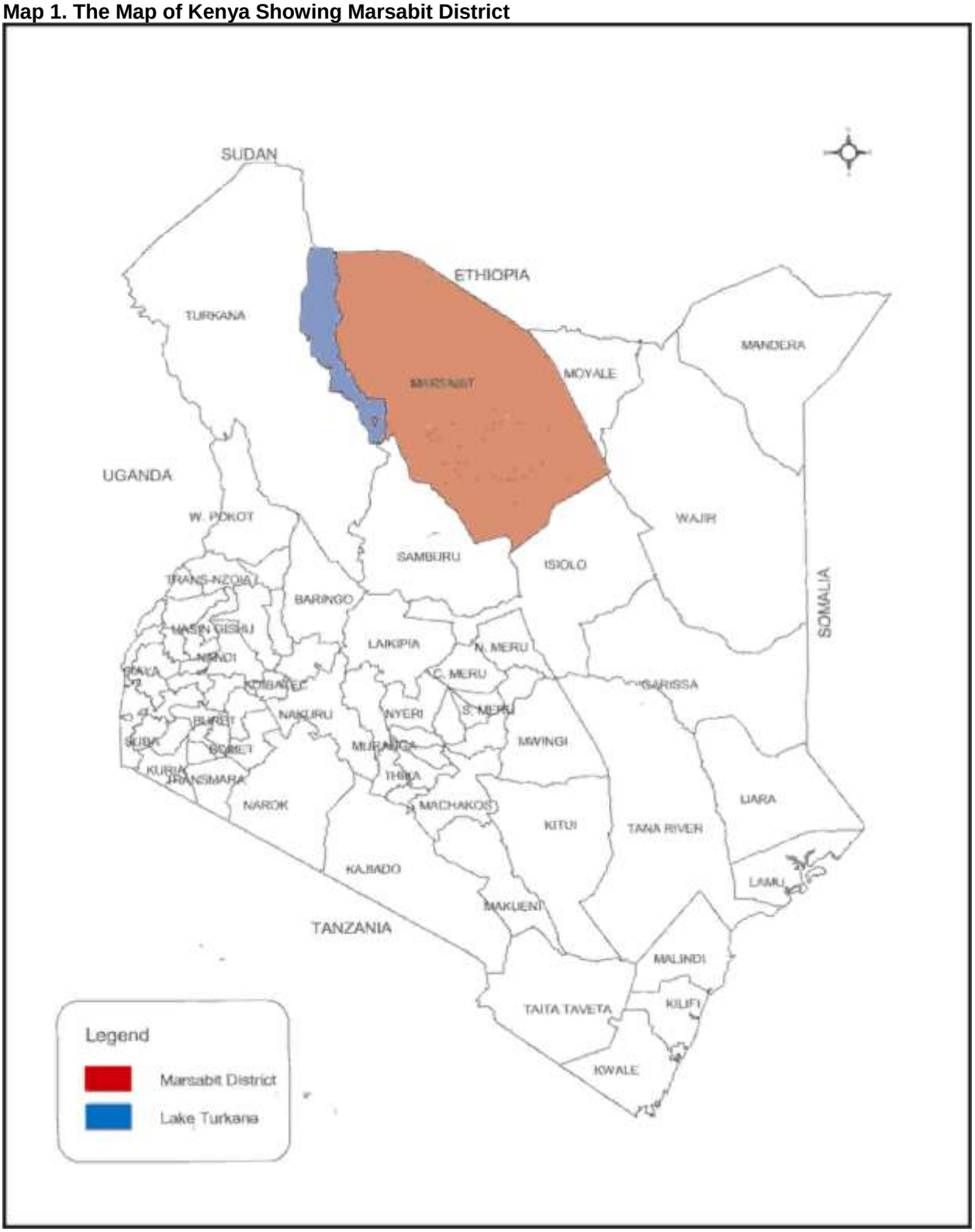
Source: A.J. van Kekem: Soils of the Mt. Kulal Marsabit Area

Legend:
r – average annual rainfall (mm)
Eo – average annual potential evaporation (mm)

4.2.1 Rainfall

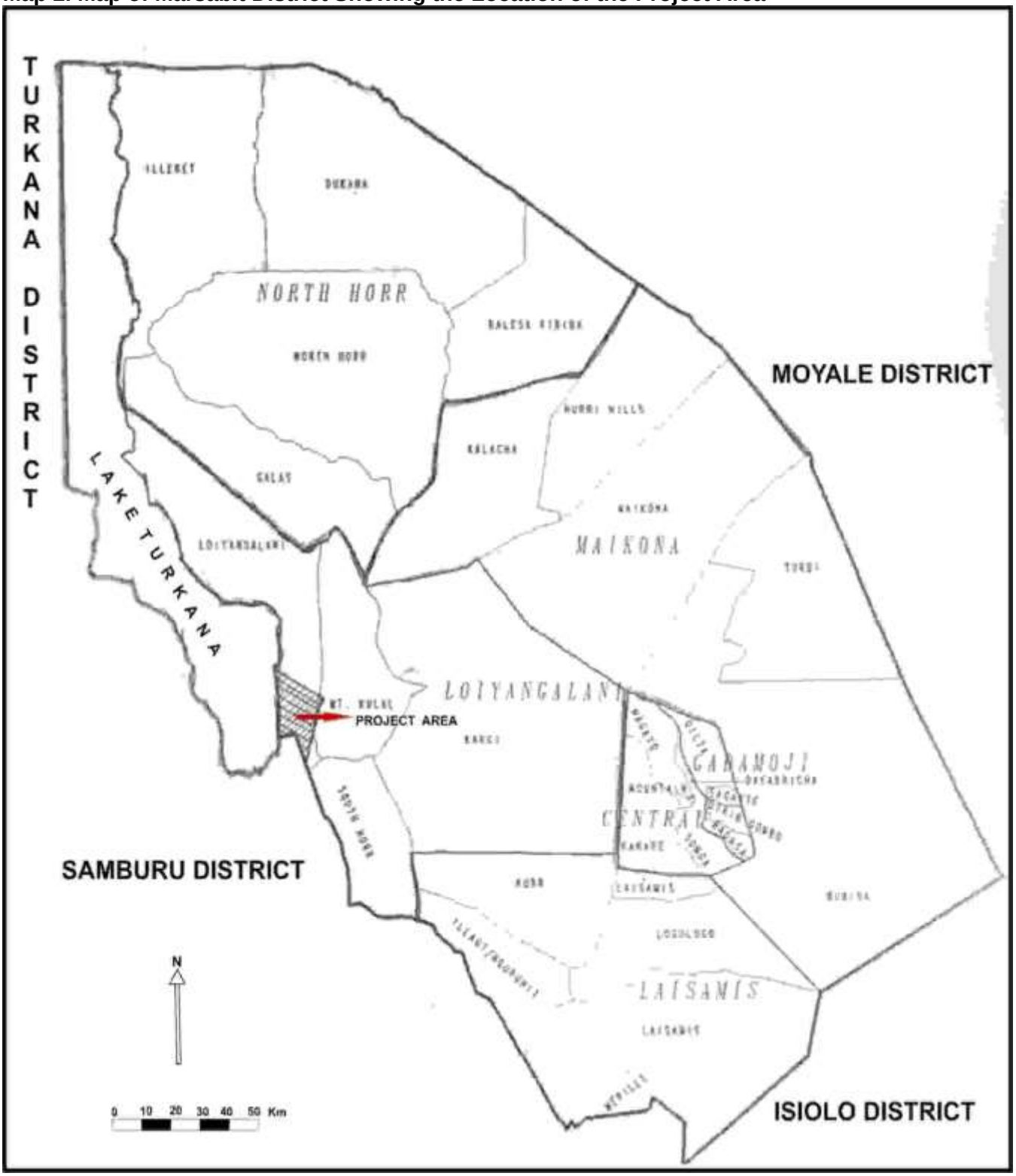
The general patterns of rainfall in several areas in Marsabit District are presented in Table 2. It is noted that there are no operational meteorological stations in the project area (covering the Agroclimatic Zone VII). For comparison the nearest station with long-term records is North Horr which shares the same Agroclimatic zone (VII) with the project area and where rainfall records have been collected since 1959. Based on the rainfall characteristic of the Agroclimatic Zone VII as recorded in the North Horr Station, the project area rainfall is also very low, with a mean annual rainfall of less than 200mm.

Map 1. The Map of Kenya Showing Marsabit District



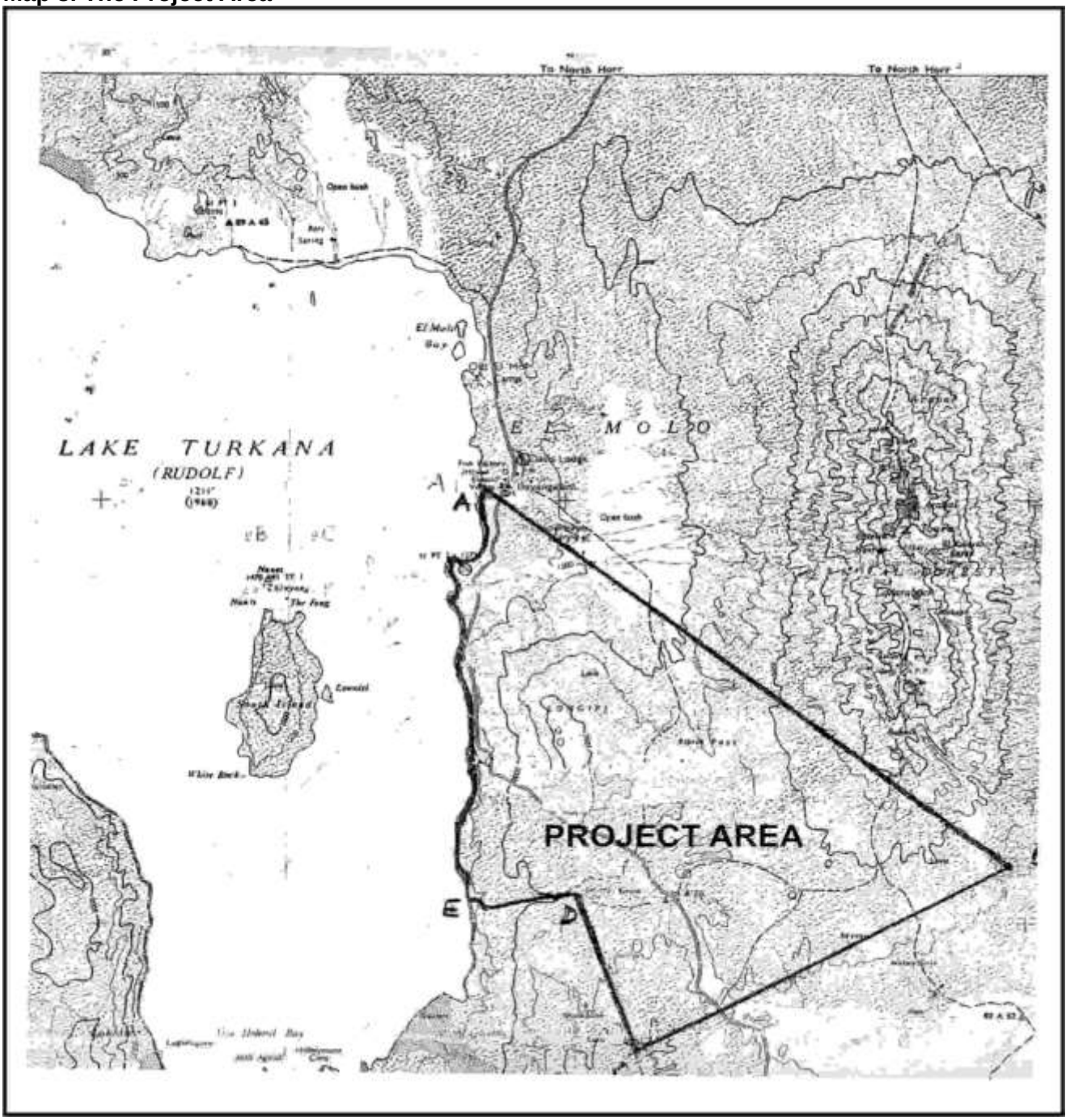
Source: Adapted from ETC East Africa, 2002.

Map 2. Map of Marsabit District Showing the Location of the Project Area



Source: Marsabit Development Plan 2002 – 2008

Map 3. The Project Area



Source: Survey of Kenya: South Horr, Series Y503 Sheet NA – 37 – 5 Edition 2-SK.

The rainfall of the project area shows a distinct bimodal distribution pattern. The main wet season normally starts in March/April and lasts until May. The short rains start in October/November and last until December. An important characteristic of the rainfall in the project area is the high variability. This includes monthly rainfall variability or deviations from the mean as well variability in altitude and spatial distribution. Although no data is available for the project area, it is evident that evaporation is very high and the crop water requirement exceeds rainfall in all months of the year.

Table 2. Rainfall Patterns of Marsabit District

Station	Period of Record	No. of Years	Rainfall (mm)		
			Mean	Maximum	Minimum
North Horr	1959 - 1981	22	157	385	5
Moyale	1915 – 1981	64	713	1290	387
Marsabit	1918 – 1981	53	859	1816	324
Lodwar	1919 - 1981	62	178	498	19

Source: Source: A.J. van Kekem: Soils of the Mt. Kulal Marsabit Area

4.2.3 Temperature

Generally temperatures of the project area are high. The temperature patterns usually follow the general trends in the tropics where diurnal changes are greater than annual temperatures. The mean monthly temperature of the project area are in the range of 27 - 29^{o}C, the mean minimal lie around 13 – 20^{o}C and the mean maxima are 26 – 35^{o}C. The coolest months are July and August while February, March and October are the hottest months.

4.2.4 Wind

Wind is an important factor with regard to the development of this project. Compared to the rest of Kenya, winds in the project area are very strong. The winds are generated by a low level jet called the Turkana Channel jet. The jet stream (discovered in 1981 by J. Kinuthia of the Kenyan Meteorological Department), is caused by the much larger East African low level jet. The Turkana Channel jet blows all year round from the South East through the valley between the East African and the Ethiopian Highlands stretching from the Ocean to the deserts in Sudan. The wind is accelerated locally between Mt. Kulal (2300m asl) and the Mt Nyiru Range (2750m asl). Due to thermal effects the wind slows down during mid day and is at full force during the night.

Lake Turkana Wind Power Project has been measuring wind speeds and frequency in the project area for the last 12 months at 40, 60 and 80 metres altitude. The average wind speed in the project area has been recorded to be 11 metres per second. These are among the highest wind speed averages recorded in the world.

4.3 Topography

The project area lies between 450 metres at the shore of Lake Turkana to 2300metres above sea level (m asl) on the foot slopes of Mt. Kulal. The topographical features of the project area are quite variable. The common features of the project area as described by van Kekem (1986) include plains, foot slopes, plateaus, hills and minor scarps and footridges.

4.3.1 Plains

Around Loiyangalani Township and bordering Lake Turkana the topographical feature are mainly dissected lacustrine plain, floodplain and piedmont plains. The plains have a relief intensity of 5-20 and slopes of 0-8%. The relief of the plains ranges from flat to very gently udulating, gently undulating and undulating.

4.3.2 Hills and minor scarps

To the south of the plains around the Ongipi massif and bordering Lake Turkana the main topographic features are hills and minor scarps with relief intensity of 50 to 300m and slopes from 8 to 30%. The relief of the area is rolling to hilly.

4.3.3 Plateaus

South of the Ongipi massif in the vicinity of the Sirima Lagga and the area further south, the main relief is mainly non-dissected plateaus with relief intensity of less than 20m and slopes of 0-5%. The relief of the plateau is flat to very gently undulating to gently udulating. This feature covers a greater part of the project area than any other feature. This area is the most suited place for the siting of the wind park if wind conditions are optimal.

4.3.4 Footslopes

Towards the east of the project area between the hills and minor scarps of the Ongipi massif to the north and the plateaus in the south and the lower reaches of Mt. Kulal, the topographic features are dominated by footslopes. These are the footslopes of Mt. Kulal with relief intensity of less than 10m and slopes of 1-8%. The relief of the footslopes is mainly very gently udulating, gently undulating and undulating.

4.3.5 Footridges

To the east of the project area and above the southern footslopes of Mt. Kulal the main topographic features are footridges. These are mainly the dissected middle slopes of Mt. Kulal where relief intensity is 50-200m. The slopes of the crests of the footridges are 2-8% while the slopes of the valley sides are over 16%. The slopes of the footridges range from gently undulating, undulating, and rolling to hilly.

4.4 Geology

Although geological surveys have been carried out in the South Horr (Dodson, 1963) and Laisamis (Randel, 1970) region, the geology of the Loiyangalani part of Marsabit District, including the project area has not been systematically mapped and is therefore only partially known. Much of what is known is, however, derived from the work of van Kekem (1986) - Soils of Mt. Kulal Marsabit Area. Some information was derived from earlier geological surveys of Northern Kenya by Dixey (1948). From these references, the rocks underlying the project area and surroundings fall within three main categories, the Basement system, the relatively recent volcanic rocks and sedimentary rocks. The main geological features of the project area are presented in Map 3.

4.4.1 Precambrian rocks

The Precambrian rocks underlie the project area and surroundings. These rocks belong to the Basement System and represent metamorphosed sequence of several types of rocks. The less resistant members of the Basement rocks have been eroded to lowlands in the course of successive geological cycles while the more resistant types form rock intrusions, upland masses and isolated plateaus bearing evidence of peneplanation.

4.4.2 Volcanic rocks

During the Paleozoic and Mesozoic eras, erosion and peneplanation took place periodically in the Marsabit area and this continued up to early Tertiary. The onset of volcanic activity in Miocene to Holocene dramatically changed the physiography of this area. In the initial stages, basaltic extrusions from fissures and small vents formed lava plateaus. For example, massive basaltic plateaus form large aprons at the foot of Mt. Marsabit, Mt. Asie and Mt. Kulal (which is in the vicinity of the project area). The second phase in the development of volcanic activity is marked by formation of the shield volcanoes of Mt. Asie, Mt. Kulal and Mt. Marsabit. These multicentre volcanoes developed over the pre-existing plateau lavas and have characteristic parasitic cones and explosion craters on their flanks. The volcanoes form basaltic ranges in more or less linear fashion as they erupted along zones of crustal weakness parallel to the Lake Turkana axis.

4.4.3 Sedimentary rocks

The basins in the project area and the surroundings contain sediments derived from Precambrian Basement system of rock mixed with sediments originating from erosion of Cenozoic volcanic material. Sedimentary cover over the bedrock varies in thickness from 30m at the periphery to more than 200m in the centre of basins. At different altitudes along the shore of Lake Turkana, lake sediments are found, sometimes in between or mixed with volcanic layers. Paleo-lake sediments are found near Loiyangalani at about 100m above the present lake. The occurrence of peperites in the Loiyangalani sediments shows that volcanic extrusion products were deposited in the paleo lake together with lacustrine sediments.

4.5 Soils

The distribution of soil types is largely determined by physiography and parent material. Soil types of the project area are presented in Map 4. The nomenclature of soil types in the project area follow the physiographic units described in Section 4.3.2 – Topography. They include:

- Soils of the hills and minor scarps;
- Soils of the plateaus;
- Soils of the footridges;
- Soils of the foot slopes, and
- Soils of the plains.

4.5.1 Soils of the hills and minor scarps

Soils developed on the hills and scarps include the Regosols and Vermosols.

- **Regosols -** Soils developed on pyroclastic rocks (calcaric Regosols – HP2P) - Excessively drained, shallow, reddish brown to brown, strongly calcareous, slightly sodic, very stony and gravelly, sandy loam to clay.

- **Yermosols -** Soils developed on various volcanic rocks (haplic Vermosols - HVP) - Somewhat excessively drained, shallow to deep, dark reddish brown, friable, strongly calcareous, rocky, stony to very stony clay, with an exceedingly bouldery surface; in places moderately saline and sodic.

4.5.2 Soils of the plateaus

Soils developed in the plateaus of the project area include haplic Vermosols and orthic Solonetz and Orthic Solonchanks.

- **Vermosols -** Soils developed on various volcanic rocks (haplic Vermosols – LnV3p) – Very well drained, moderately deep, reddish brown to dark reddish brown, very friable, strongly calcareous, slightly sodic, very stony and / or very gravely to slightly gravely, clay loam.
- **Orthic Solonetz and Orthic Solonchanks -** Moderately well drained, moderately deep to very deep, dark reddish brown, friable, strongly calcareous, slightly to strongly saline, strongly sodic, clay loam to clay with an exceedingly bouldery and/ or exceedingly stony surface; in places very stony (LnV4p).

4.5.3 Soils of the footslopes

Soils developed on various volcanic rocks (calcic Vermosols - FVIP) – Somewhat excessively drained to well drained, shallow to moderately deep, reddish brown to dark brown, very friable, strongly calcareous. Slightly to moderately saline, slightly to strongly sodic, stony and very gravely, sandy loam to sandy clay.

4.5.4 Soils of the footridges

Soils developed on various volcanic rocks. The soils of the footridges form an association of Phaeozems, Cambisols and Xerosols (RVA).

- **Phaeozems –** Well drained, moderately deep, dark reddish brown to dark brown, very stony, clay loam to clay, with a stony to exceedingly stony surface; in some places strongly calcareous. Mainly haplic and calcaric phaeozems.

- **Cambisols –** Well drained, shallow to deep, dark reddish brown, friable, very bouldery to stony, clay loam to clay; in some places moderately to strongly calcareous; on middle to upper slopes. Mainly eutric and chromic Cambisols.

- **Xerosols –** Well drained, shallow to moderately deep, dark reddish brown to dark brown, very friable, strongly calcareous, very stony and or very gravely, sandy loam to sandy clay with a very stony and /or very gravely surface on the lower slopes.

4.5.5 Soils of the plains

There are several soils that are developed on the plains of the project area. They include the loamy soils, Fluvisols and Yermosols.

- **Soils developed on sediments derived from various parent materials -** These soils are a complex of excessively drained to well drained, shallow to deep, dark brown to yellowish brown, loose to friable, strongly calcareous, moderately to strongly saline, moderately to strongly sodic, very stony and / or very gravely, loamy sand to clay and in certain places stratified - (PldXC).

- **Soils developed on alluvial deposits –** Somewhat excessively drained very deep, dark brown, loose, moderately calcareous, stratified, very stony and very gravely, loamy sand. The soils are also referred to as calcaric Fluvisols (AA1)

- **Soils developed on colluvium and alluvium derived from various volcanic rocks –** These are well drained, moderately deep to very deep, brown, very friable, strongly calcareous, slightly saline moderately sodic, very stony, to very gravely sandy clay loam, with an exceedingly stony surface. Usually referred to as calcic Yermosols (YVIp).

- **Soils developed on various volcanic rocks –** Somewhat excessively drained to well drained, shallow to moderately deep, reddish brown to dark brown, very friable, strongly calcareous, slightly to moderately saline, slightly to strongly sodic, stony and very gravelly, sandy loam to sandy clay. (calcic Vermosols FV1P). In addition there is a soil type of drained, moderately deep to deep, dark reddish brown, very friable, strongly calcareous, slightly to moderately sodic, very rocky clay, with an exceedingly bouldery surface; in places very stony and / or cracking (Haplic Vermosols - FV2p)

4.6 Hydrology

Occurrence of surface water is very rare in the project area. Only after heavy rains, shallow pools and seasonal water courses may be filled with water for a few and probably up to a maximum of a few weeks. The drainage ways in the project area are dry river beds referred to as laggas. These drainage ways have bouldery and stony riverbeds. Many laggas in the project area seem to be too wide for the existing climatic conditions. They have wide beds with braided characteristics and changing stream channels. Sometimes, once in every 5 to 10 years, the laggas are filled up completely. The Lagga Yammo and Lagga Sirima are important drainage ways in the project area.

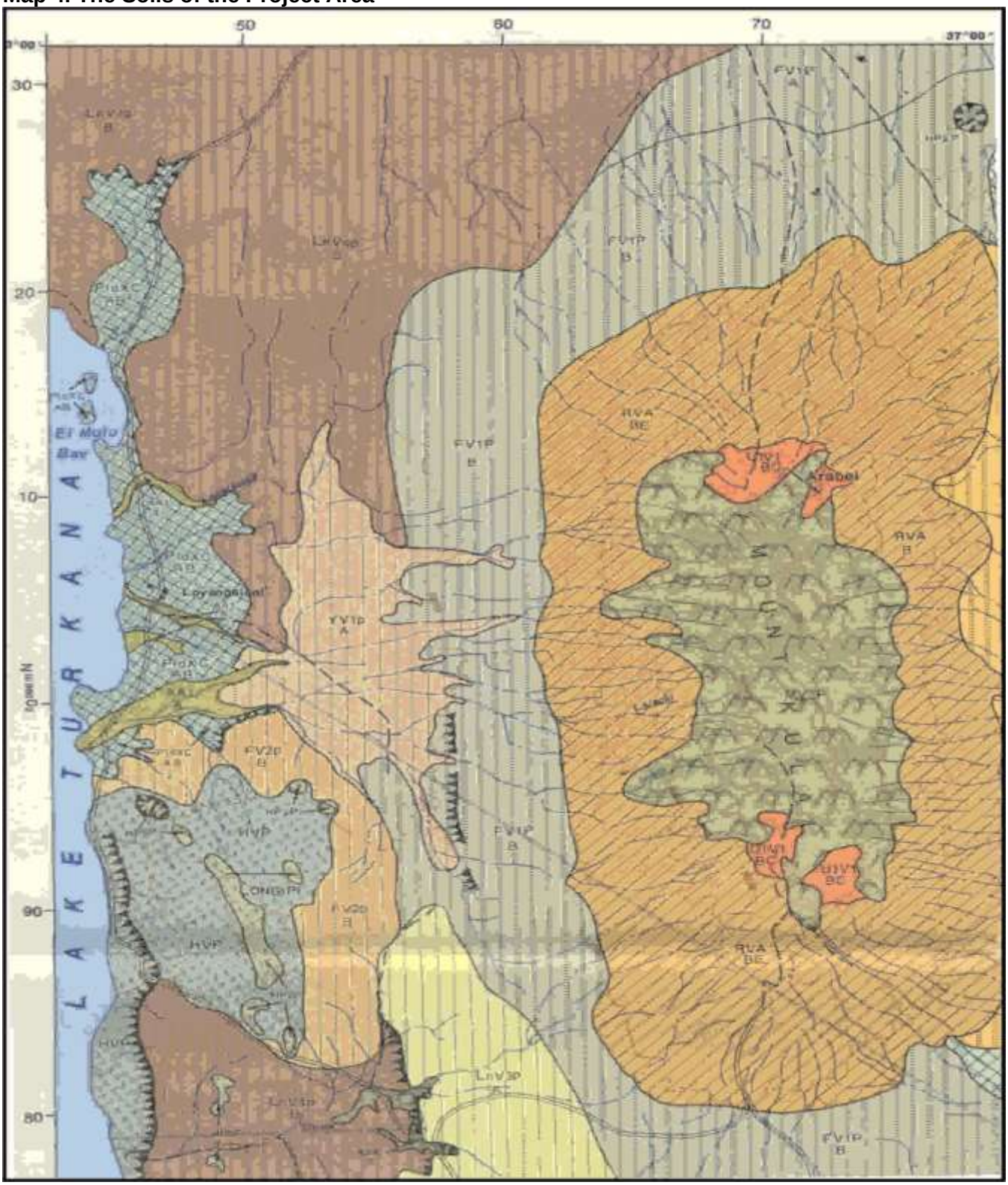
There are a variety of sources of water for the population and livestock in the project area. They consist of permanent springs, boreholes and waterholes dug in the riverbeds. An important source of permanent water is Loiyangalani Spring that provides water for the community around this area. Permanent surface water is found on the top of Mt. Kulal but this source of water is outside the project area.

Lake Turkana (6,750 km^2) is the largest body of water in the project area. This lake has been in existence since at least early Miocene but has varied in size since then. For example it was greatly expanded between 9000 and 7500 B.P. when it covered the Lotikipi Plains to the west and drained to the Nile. It was this temporary connection that permitted the ingress of a nilotic fauna to the lake. The lake is fed by 12 principal rivers of which the largest affluent is the Omo River. This river originates from the Ethiopian highlands, flows south down the Rift Valley and enters the northern extremity of the lake through a large and swampy delta. The Omo River contributes more than 90% of the total riverine inflow. The Kerio and Turkwell Rivers, although perennial rivers in the upper reach, both discharge into the lake for a few months each year.

4.7 Water Quality

In the project area where water scarcity is very high, the importance of the quality of available water supplies can not be overstated. Even of greater significance is the fact that the lake water is used by a section of local community for domestic purposes and for watering of livestock. Indeed the El Molo and the Turkana already attribute some of their health problems to the use of water from Lake Turkana.

Map 4. The Soils of the Project Area



Source: Soils of the Mt. Kulal Marsabit Area, 1986. The labelling of the soil types (e.g. FVIP, RVA, pldCX) are explained in the text (Section 4.2.7 – Soils).

Results of biological, chemical and physical analysis of several parameters of water sampled from various sources in the project area are presented in Appendix 4a (tap

water and surface flowing water from Loiyangalani Springs and Lake Turkana Lake water) and 4b (water from other sources in the project area).

4.7.1 Water quality of Loiyangalani Springs

Water from the Loiyangalani Springs (both the tap water and surface flowing water) is chemically suitable for domestic purposes. However, both the tap water and the flowing surface water are contaminated with coliforms. In this regard the surface flowing water carries a heavier load of contamination (770 coliforms per 100 ml and 32 *E.coli* per 100 ml). The tap water has less contamination with 28 coliforms per 100 ml and no *E. coli* contamination. Coliform bacteria are usually used as indicator organisms for bacteriological water quality. When coliform bacteria are found in water it indicates fairly fresh faecal contamination. During the field trip it was found that the area surrounding the Loiyangalani Springs is polluted with human material of faecal origin. This is likely to be the source of water contamination. Water from Loiyangalani therefore requires disinfection / boiling in order to render it suitable for drinking.

4.7.2 Water of Lake Turkana

Lake Turkana water has high concentrations of total dissolved solids (2381Mg/l) and high pH values (9.56). Although moderately soft, it is saline and requires de – mineralization and pH adjustment before being used for domestic consumption. The northern end of the lake, however, tends to be less saline and more productive than the southern end. The lake is well oxygenated and well mixed due to strong winds which blow over the lake every morning.

It is noted that the salinity of the Lake Turkana water is at a level critical to various fauna. This lake is interesting in the fact that it is the most saline lake in East Africa containing a normal fish fauna. In addition the lake is at the extinction limit for molluscs and at higher salinities, dwarfism of fish would occur.

4.7.3 Water from other sources

The above analysis shows that many sources of water in the project area and surroundings have higher levels (1.7 – 3.8 mg / l) of fluoride than maximum values (1.5mg / l) recommended for drinking water. Other water constituents that exceed guidelines recommended for drinking water are hardness for Nguruset (476 mg / l) and sodium levels for Muliko Springs (2600 mg / l) and Loiyangalani Beach (807 - 1300 mg / l). There is therefore a need to conduct chemical, physical and biological; water analysis of the available water sources and advice the local community on suitability for human consumption.

4.8 Environmental Degradation

Both natural and human induced environmental degradation is currently taking place in the project area.

4.8.1 Natural degradation

The project area has undergone tremendous natural degradation in form of erosion. Erosional processes including gully, rill and stream bank erosion are common in the project area. In addition, erosional processes by strong winds (Aeolian) in the project area are quite rampant.

- **Gully erosion –** Steeper slopes with increased runoff are susceptible to gully erosion. The footslopes and footridges (mainly outside the project area) are mainly affected by this type of erosion.
- **Rill erosion –** Rill erosion is common all over the project area. The process of rill erosion becomes more serious where natural vegetation has been damaged. In such cases small rills resulting from splash and rill wash erosion may join and form the beginning of somewhat deeper rill.
- **Stream bank erosion –** Fluvial processes are limited to riverbeds especially the laggas in the project area. A decrease in vegetation cover increases runoff and the amount of eroded materials especially during heavy rains. This has a net effect of enhancing stream bank erosion. During heavy floods the riverbeds often change their courses.
- **Wind (Aeolian) erosion –** Due to the strong winds prevailing in the project area, aeolian processes are common. Presence of aeolian erosion in the project area is an indicator of overgrazing and desertification. To the south of the project area winds move sand which accumulates around dwarf shrubs thus forming small obstacle dunes as seen in Annex 2, Plate 17.

4.8.2 Human induced degradation

Although the above erosional processes are basically natural, the inhabitants of the project area have enhanced degradation in this area. The cutting of trees and shrubs by the pastoralists for construction of houses and for fuel is a major cause of degradation in the project area. In addition, overstocking of the fragile area causes unbalanced use of vegetation by livestock thus causing overgrazing and degradation of the environment of the project area.

Around Loiyangalani, trees such as *Acacia tortilis*, *Salvadora persica* and *Hyphaene compressa* are under tremendous pressure of exploitation for building materials. In addition the area is now being polluted with heterogeneous solid wastes, including paper, plastic ware, metallic cans, pieces of textiles, broken bottles, bottle tops and other forms of solid wastes. In addition, this area and areas surrounding manyattas are polluted with material of faecal origin.

An interesting development in the project area is the introduction of an alien invasive species commonly referred to as prosopsis (*Juliflora prosopsis*). This plant is currently spreading and has already covered substantial areas in Loiyangalani township where there is availability of water. At Loiyangalani, the plant is utilized as live fences in several compounds. If no steps are taken to eradicate it, prosopsis may turn out to be an environmental and health hazard. This has happened in other areas such as Baringo, Turkana and Tana River districts. In there areas, the plant has established and colonises large areas to the exclusion of indigenous plants. It has been reported that livestock at times die upon feeding on the pods and wounds inflicted by the thorns are difficult to heal.

4.9 Biological Environment

The biological environment of the project area encompasses the biodiversity of this arid area and the aquatic life. The most prominent biodiversity components of the project area are the terrestrial flora and fauna and the fish of Lake Turkana.

4.9.1 Flora

The annotated flora of the project area and surroundings is presented in Annex 5. Most of the project area is covered by deciduous dwarf shrubland. There are also large areas of barren land where vegetation is very scarce. The common plant species of the project area include shrubs such as *Indigofera spinosa, Duosperma eremophilum, Sericocomopsis hildebrandtii, Acacia reficiens, Acacia mellifera* and *Commiphora africana.* The most prominent tree of the project area is the *Acacia tortilis* which is found along the laggas and along the drainage areas. Occasionally *Delonix alata* is also found along the laggas. Around Loiyangalani area where there are water springs, *Hyphaene compressa* is well established. Annual grasses are common especially during the rainy season. They include *Aristida mutabilis*, *Aristida adscensionis* and the species of *Eneopogon* and *Cencrus*. Along and close to Lake Turkana the salt tolerant grass *Sporobolus spicatus* is the common.

Although the vegetation is scarce, plants play an important role in the life of pastoralists of the project area. They provide firewood, materials for the construction of the houses and livestock enclosures (Photo 3) and feed for livestock including camels, sheep and goats. The plants found in this area are also valued for edible and medicinal products and as a valuable source of fibre for rope making and gum. Uses of some common plants in the project area are outlined below as follows:

- *Acacia reficiens* is relatively unpalatable but is the main source wood for pastoralist communities.
- The foliage of *Acacia tortilis* and *Acacia mellifera* is browsed by camels and goats while the fallen leaves and flowers are eaten by sheep.
- The fruits of *Acacia tortilis* are eaten by all livestock species.
- *Salvadora persica*, *Cordia sinensis*, *Sericocomopsis hildebrandtii, Indigofera spinosa* and *Acacia senegal* provide browse for livestock ;
- Thorny trees such as *Acacia* and some *Commiphora* are lopped to provide boma materials.
- Soft-timber trees such as *Delonix*, *Commiphora* and E*rythrina* are used for making milk pots, bowls, stools and drinking troughs.

The vegetation of the project area is currently under great pressure of exploitation. Based on discussions with members of local community, human and livestock population of the project area has been growing steadily in recent years. This is mainly due to increased insecurity brought about by conflicts among certain ethnic groups in the area and subsequent increased settlements close to Loiyangalani where adequate security is available. This trend is currently causing high demand for fuel wood and building materials. As the human and livestock pressure increases, there is sharp increase in over harvesting of plant materials further away from Loiyangalani. The increased resource utilization and degradation has brought about dwindling vegetation cover and encroachment of desertification related phenomenon. Indeed the local community looks back with nostalgia when the project area used to have sufficient vegetation cover and along the laggas there were sufficient woodland stands, the community preferred to call forests.

Photo 4. Use of Local Plant Material in Construction of a Boma in the Project Area

4.9.2 Fauna

The project area suffers from paucity of wildlife. This is mainly due to increasing population with subsequent increase in poaching activities especially for the big game. For example, Elephants *(Loxodonta africana)* and black rhinoceroses *(Diceros bicornis)* were once plentiful on the lower slopes of Mt. Kulal until 1976 but have now been exterminated by poaching. Other wildlife species including Greater kudu *(Tragelaphus strepsiceros)* Oryx *(Oryx beisa), G*erenuk *(Litocranius walleri),* Grant's gazelle *(Gazella granti), G*iraffe *(Giraffa camelopardalis) and* Grevy's zebra *(Equus grevyi)* occurred on the middle and upper slopes of Mt. Kulal. The last buffaloes *(Syncerus caffer),* which lived in the higher levels of the montane forest, were seen in 1976 and the species is apparently extinct on Mt. Kulal now. However, in the course of this EIA field survey, it was reported by the residents that two buffaloes had been sighted on top of Mt. Kulal. The same were later reported to have moved further north towards El Molo Gulf and there was fear that they might be poached as well.

During the field study, we were only able to see an occassional dikdik and hare within the project area. However, the team saw gerenuk, stripped hyaena, jackal and ostrich between the project area (Loiyangalani) and Marsabit (outside the project area). The exceptionally low densities of wildlife especially the megafauna within the project area is attributed to poaching and intense competition between the wildlife and livestock.

The project area, however has many species of reptiles including venomous snakes such as saw scaled viper, night and puff adder and cobra and lizards. The scorpions (Photo 4) and other invertebrate fauna are also common in the project area.

Photo 5. A Scorpion in the in the Project Area

Lake Turkana to the west of the project area harbours a great variety of aquatic animals including crocodiles, hippos, fish and birds. It is also an important waterbird site. Eight four bird species including 34 Paleartic migrants have been recorded in and around the shores of Lake Turkana. Twenty three (23) aquatic bird species including Goliath Heron and African Skimmer breed on the shores of the lake. The common aquatic birds found in Lake Turkana including the project area are presented in Annex 6.

Outside the project area in other parts of Marsabit District, there is a variety of animal species protected in Marsabit National Park and Reserve, Sibiloi National Park, Central Island and South Island National Parks. For example, Marsabit National Park and Reserve is a refugee for elephant, buffalo, Oryx, genet cat, klipspringer, caracal, common duiker, Grants gazelle, bush buck, Grevy's zebra, lion and several monkey species. Over 66 species of birds are protected in the Marsabit Forest. Wildlife to the north of the project area is protected in Sibiloi National Park covering an area of 10,000 km^2. This park also contains pre-historic sites where important fossils of early man and animals have been discovered. The South Island National Park (38km^2), (to the west of the project area) has a unique herd of wild goats. It is also an important breeding ground for crocodiles and other aquatic life.

4.9.3 Aquatic Life

Aquatic life of the project area is mainly confined to Lake Turkana, the largest of the Kenyan Rift Valley lakes. Around the shore of the lake, grasses such as *Sporobolus spicatus* and *Paspalidium geminatum* cover the seasonally exposed shallows and provide important nurseries for fish. Although the lake does not support any significant growths of aquatic macrophytes, beds of potamogeton (*Potamogeton pectinatus*) are found in most sheltered muddy bays. The open lake contains an array of phytoplankton, the main link in primary production of the lake ecosystem. The phytoplankton assemblage is dominated by cyanophytes, chiefly *Microcystis*

aeruginosa. Other important phytoplankton species include *Anabaena criminalise* and *Botryococcus braunii*.

The zooplankton of Lake Turkana is an important component of the lake ecosystem. Many species of fish (at least during some part of their lives) feed on the zooplankton. The zooplankton of the lake is dominated by the crustaceans and protozoans. By far the most abundant zooplankton in terms of biomass is the calanoid copepod (*Tropodiaptomus banforanus*). Other important zooplankton of the lake include the herbivorous cyclopoid copepod (*Thermocyclops hyalinus*), the carnivorous cyclopod copepod (*Mesocyclops leuckarti*), cladocera (*Diaphanosoma excisum*, *Ceriodaphnia rigaudi* and *Moina brachiata*), rotifera (*Hexarthra* sp. , *Brachionus pala*, *Felinia limnetica*) and various types of planktonic protozoa (loricate protozoa – *Thuricola folliculata*, vorticellid protozoa and the fillipod - *Raphidiophrys* sp.).

In Lake Turkana the invertebrate fauna form a particularly important link between primary production and fish production. There are two shrimps, *Caradina nilotica* and *Macrobrachium niloyicum*. The benthic fauna is poor but widespread. It mainly consists of five species of gastropod molluscs two of the most common being *Cleopatra pirathi* and *Melanoides tuberculata.* It should be noted that molluscs in Lake Turkana are actually struggling (their shells are thinner) against low calcium levels (due to precipitation associated with high conductivities) prevalent in the lake. In addition the lake supports four species of chironomids and five species of ostracods. Oligochaetes like other benthic invertebrates are also sparse in the lake.

Lake Turkana is rich in fish species. Forty eight fish species have been identified in the lake of which 30 are widespread Soudanian types, 8 have restricted distribution and 10 are endemic. Common species include *Alestes baremose*, *Alestes dentex*, *Bagrus bayad*, *Barbus bynni*, *Citharinus citharus*, *Clarias lazera*, *Haplochromis rudolfianus*, *Hydrocynus forskalii*, *Lates longispinis*, *Lates niloticus*, Serotherodon niloticus and *Synodontis schall*. The fish in turn support a large population of the Nile Crocodile (*Crocodylus niloticus*). It is noted that prior to the upper Pleistocene, the lake level was higher than present level and its waters overflowed to the northwest into the Nile River through Sobat River. This past connection to the Nile river system explains the characteristic nilotic fish fauna in Lake Turkana.

4.5 Socio-economic Environment

The socio-economic characteristics of the project area are discussed in terms of existing services, population, education, health, poverty situation, land use, commercial / economic activities and identified development strategies.

4.5.1 Existing Services

The project area is located in a rather remote part of the country where services (like all other areas in Marsabit District) are poor. Most of the available basic services are concentrated in Loiyangalani Town (Photo 5) situated to the west of the project area. There are no tarmac roads in the project area and Loiyangalani is connected to other areas through dry weather roads connecting Loiyangalani to North Horr, Loiyangalani to Baraga (to the south), Loiyangalani to Qatab and the Loiyangalani to Marsabit via Kargi. In many areas, these roads are prone to seasonal floods, which make them impassable during heavy rains. Loiyangalani is served by an air strip which is used for non scheduled air services by light aircraft.

Photo 6. Loiyangalani Town from the Air

Loiyangalani is not served by subscribers (STD) telephone services but has sub-post offices which offer postal and bank services. Safaricom provides a reliable cell phone communication service in the area. The project area does not have electric power connection. However, electricity is generated by diesel powered generators in several institutions including schools, missionary stations, hospitals, tourist facilities and in some private households. Commercial activities involving exchange of goods and services are carried out mainly in the Loiyangalani market centre. Educational services are mainly provided by Loiyangalani primary and secondary schools while health services are available at the Loiyangalani Health Centre.

The major tourist facility in the project area is provided by the Oasis Lodge. This facility is located towards the southern end of Lake Turkana at Loiyangalani town. The lodge offers 15 luxury bungalows (with private bath and electricity), two spring – fed swimming pools and car and boat hire facilities. There are other (low cost) tourist facilities including the Palm Shade Camp (Plate1, Annex 2).

4.5.2 Population

The project area which falls in Loiyangalani Location of Loiyangalani Division in Marsabit District is inhabited by four main ethnic groups including the Turkana, Samburu, Rendille and El Molo. According to population census of 1999 (Table 3), population in the Loiyangalani Division was 16,965 people with a density of 1.1 people per km^2, the lowest population density in Marsabit District. The population is now estimated to be in the tune of 20,000 people with a density of a 1.32 persons per

km^2. The low population density in the project area is attributed to harsh climatic conditions and insecurity prevailing in the area.

Table 3a. Population Distribution and Density in Marsabit District

Division	Male	Female	Total	No. HH	Persons/HH	Density (persons per km^2)
Central	12,644	12,436	25,100	5,583	5	17
Laisamis	11,148	12,863	24,011	6,482	4	3
Maikona	10,051	9,467	19,518	4,916	4	1
Loiyangalani	**8,339**	**8,626**	**16,965**	**4,161**	**4**	**1**
North Horr	12,656	10,833	23,539	6,097	4	1
Gadamoji	5,184	7,685	12,869	7,052	4	13

Source: Central Bureau of Statistics 2001 (HH=Household(s)

Table 3b. Population Density Projections (persons per km^2) by Division

Division	1999	2002	2004	2006	2008
Central	18.1	19.2	20.1	21	22
Gadamoji	21.3	22.7	23.65	24.67	25.73
Laisamis	3.2	3.4	3.55	3.7	4.0
Maikona	1.1	1.17	1.22	1.27	1.32
Loiyangalani	**1.1**	**1.17**	**1.22**	**1.27**	**1.32**
North Horr	1.1	1.7	1.22	1.27	1.32
Average	**2.0**	**2.13**	**2.22**	**2.31**	**2.41**

Source: District Planning Unit, Marsabit, 2001

4.5.3 Education

Education is not well developed in the project area. Although the data is not current, education facilities in Loiyangalani Division are few when compared to other divisions of the Marsabit District (Table 4) and the rest of the country. In both primary and secondary schools, enrolment has always been low. Analysis by gender shows that there has been a consistent trend of having fewer girls enrolled in all the institutions. This is influenced by preference of parents to educate boys since they argue that education of girls will only benefit the in-laws. However, this view is now changing, but at a very slow pace.

Table 4. Distribution of Education Facilities in the District

Division	Pre-Primary	Primary	Secondary	Youth-Polytechnic	Total
Central	39	11	3	1	54
Gadamoji	21	9	-	-	30
Laisamis	19	7	1	-	27
Loiyangalani	**12**	**6**	**1**	**-**	**18**
Maikona	6	6	1	-	13
North Horr	5	7	1	-	13
Total	**102**	**46**	**7**	**1**	**155**

Source: District Education Office records 2001

Loiyangalani Primary School is an important educational facility in the project area. Table 5. shows the enrolment characteristics of the above school. As is common in the district and many other parts of arid and semi-arid areas in Kenya, there are generally fewer girls enrolled in Loiyangalani Primary School than the boys. This low enrolment is more drastic as the girls approach classes 7 and 8. This is attributed to the fact girls leave the school to get married.

Table 5a. Loiyangalani Primary School Enrolment (2003)

Class	1	2	3	4	5	6	7	8	Total
Boys	54	33	28	49	29	23	23	17	256
Girls	58	28	27	32	15	18	9	7	194
Total	**112**	**61**	**55**	**81**	**44**	**41**	**32**	**24**	**450**

Table 5b. Loiyangalani Primary School (2004)

Class	1A	1B	2A	2B	3	4A	4B	5	6	7	8	**Total**
Boys	26	27	16	16	25	25	27	26	20	21	15	244
Girls	30	30	24	25	33	17	12	22	20	13	05	230
Totals	**56**	**57**	**40**	**41**	**58**	**42**	**39**	**48**	**40**	**34**	**20**	**471**

Table 5c. Loiyangalani Primary School (2006)

Class	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Totals**
Boys	53	33	25	37	50	27	28	21	274
Girls	52	34	39	32	37	12	17	05	238
Totals	**105**	**67**	**64**	**69**	**87**	**39**	**45**	**26**	**512**

Source Loiyangalani Primary School

A combination of several factors bring about serious impediment to the learning process in the project area. They are outlined below as follows:

- Social cultural factors such as early marriages, forced marriages, early pregnancies and early initiation into adulthood;
- The children accompany their parents during the long distance walks in search of water and pasture.
- Formal education is not considered a priority to the pastoralists and the prevailing school curriculum has no immediate relevance to the pastoralist community source of livelihood.
- To the community, education is a long term investment which has no immediate returns especially in the current situation where lack of employment is rampant.
- Long distance to school is a deterrent factor to consistent school attendance.

4.5.4 Health conditions of the project area

Information on the health conditions of the project area is derived from the records maintained at the Catholic Church supported Loiyangalani Health Centre. The causes of out patient morbidity in the project area in 2007 as recorded by the above facility are shown in Table 6. The three most common diseases of the project area are upper respiratory diseases, malaria and diarrhoea. Of the above ailments, the diseases of the upper respiratory system was the leading cause of out patient morbidity between the months of January to October, 2007. Most of the diseases are caused by a combination of different factors including poor living conditions, drinking of contaminated water and poor sanitation. It should be pointed out that the Loiyangalani Health Centre does not record incidences of HIV/AIDS, a disease/condition that is currently affecting a large section of community in Kenya.

Table 6. Disease Incidence at Loiyangalani Health Centre (Catholic Mission) Jan – Oct 2007

Disease	**Disease Incidence**									
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Diseases of the upper respiratory system	137	84	41	38	62	61	86	81	64	63
Malaria	57	57	82	27	98	36	35	74	37	44
Diarrhoea	35	28	21	27	98	36	55	42	43	36
Skin diseases	88	24	23	15	28	26	23	18	24	22
Pneumonia	12	4	10	5	5	9	2	14	3	3
Eye infections	28	22	10	5	11	5	14	16	13	14
Accidents	17	22	11	7	22	11	14	14	13	11
Ear infections	4	11	5	4	2	0	6	4	4	3
Rheumatism	20	14	0	7	14	4	7	6	6	7
Gonorrhoea	7	4	7	7	7	0	6	4	7	6
Snake / Scorpion bites	0	0	11	13	7	8	3	3	3	5
Urinary tract diseases	3	4	3	1	6	7	4	3	4	5

Source: Loiyangalani Catholic Mission Health Centre November 2007

The situation of the poor health conditions of the project area is aggravated by the poor nutritional status prevalent in the project area. According to Food for the Hungry International (FHI) relief report for 2001, many people in arid and semi-arid areas experience acute food shortage. Virtually, there is a total household food deficiency in the pastoral communities, a situation that also affects the project area. Consequently, local communities in the project area depend on relief food distribution. Indeed during the field study we observed a high dependency on relief food among the local communities in the project area. Although relief food is a welcome respite during times of severe drought, it must be emphasized that relief food dependency has significant social implications for the future of the communities in the project area.

4.5.5 Poverty situation

Loiyangalani is a poverty stricken area. It is one of the poorest divisions in Marsabit District which itself is one of the poorest districts in Kenya. Acute poverty prevailing in the project area creates a situation where individuals or households cannot afford basic food and non-food items. Thus they cannot satisfy their basic needs such as food, shelter, clothing, health and education for their children. The main causes of poverty in the project area include:

- Severe droughts;
- Inadequate water for domestic and non-domestic use;
- Undeveloped livestock/livestock products markets and unwillingness to sell livestock;
- Lack of employment opportunities;
- Over-dependency on relief food;
- Socio-political conflicts including ethnic clashes, banditry, cattle rustling, illiteracy and gender inequality.

4.5.6 Land use

The land use of the project area is determined by the climatic conditions and the natural resources available in the area. Being a rangeland, the nomadic pastoralism is the main occupation of the local residents in the in the project area. The majority of the pastoralists found in the actual project area are the Turkana community who derive their livelihood from keeping of the camels, goats and sheep. Donkeys are mainly used for carrying water and other transport purposes.

Fisheries is a main occupation of the inhabitants of the project area surroundings especially among the El Molo and the Turkana communities. The fisheries is confined to Lake Turkana which lies to the west of the project area. This lake has vast fishing potential but currently it is poorly exploited. Twelve of the forty eight fish species found in the lake are of various economic importance. They include *Labeo horie*, *Serotherodon niloticus*, *Lates niloticus*, *Barbus bynni*, *Bagrus bayad*, *Synodontis schall*, *Citharinus citharas*, *Elastase* spp, *Heterodontis* spp, *Distichodus niloticus*, *Hydrocyrius forskali* and *Clarias lezera*. In Loiyangalani, however, the main fish species harvested for commercial purposes are *Serotherodon niloticus* (tilapia), *Labeo horie* (labeo) *Lates niloticus* (Nile perch) and Barbus *bynni* (barbus). Tilapia is particularly numerous on the eastern shore and forms significant proportion of the fisherman's catch. The main landing beaches are at Loiyangalani. Processing is mainly through sun-drying along the shores of the lake. The fish so processed is sold mainly to traders outside the district in Kisumu. Details of the type of the fish caught, their dry weight (Kg) and value (KSh) between 2006 and 2007 are presented in

Annex 7. According to the Marsabit District Development Plan (1997 - 2001), the lake has potential of producing 170 tons of fish annually. However, fish production is impeded mainly by inadequate fishing boats, local unavailability of nets and hooks, poor handling methods, lack of cold storage and the poor conditions of the roads to the lake town of Loiyangalani. This situation discourages potential investors. Hence the fishery resources of the lake are under utilized.

The local trees especially the *Acacias* found in the project area are exploited to meet the energy requirements of the local population. Firewood collected in the area is utilized mainly for domestic use although some firewood is sold in Loiyangalani market. Charcoal produced in the project area is mainly for income generation as the charcoal burners usually use firewood in their homes. The charcoal burners who are mainly Turkana women use a very inefficient mode of burning charcoal.

4.5.7 Commercial / economic activities

Commercial activities involving exchange of goods and services are carried out mainly in Loiyangalani market centre. There are several traders in the market selling a wide range of products including foodstuff, clothes, beverages and household goods among other products. Although livestock rearing is the main economic activity of the project area, the off take of livestock is low. Many pastoralists are reluctant to sell their stock since the number of livestock is a measure of wealth and status among the local community of the area. However, there are still livestock traders involved in selling stock out of the project area for the local consumption of meat and to larger markets in Marsabit and other outlets. As a whole there are a number of constraints to effective market flow of livestock from the project area including:

- Lack of stable terminal markets;
- Poor roads;
- Difficulties associated with long hours of trekking;
- Frequent quarantine restrictions;
- Lack of reliable market information;
- Scarcity of handling facilities; and
- Poor terms of trade for pastoral procedures.

There are no financial institutions including banks, insurance and credit institutions at Loiyangalani and the rest of the project area. Consequently, borrowing capacity of the majority of the population from the banks is quite low as most of them lack the security required like buildings or land. Most of the traders do not even operate bank accounts and prefer keeping the money to themselves. The project area, however, has a fisherman's co-operative society, the Loiyangalani Fisheries Cooperative Society although its management and operations are suboptimal.

4.5.8 Development strategies in the project area

In accordance to the current District Development Plan (2002 – 2008), several priority areas for development have been proposed for Loiyangalani Division which represents the project area. Priority areas for development include the following three main sectors of fisheries, environment conservation and development of natural resources and cooperatives.

Fisheries improvement

Currently the fisheries sector of the project area is fraught with many constraints including lack of patrol boats and vehicles for effective management of lake resources, inaccessibility to credit facilities by the fishing community/groups, inadequate technical personnel, very poor access roads, absence of promotional

schemes for fish and fish products, inadequate capacity building for all resource users, negative cultural altitudes of the pastoralists to fish eating, insecurity and lack of fishing equipments. There is therefore a need to put in place strategies to improve sustainable exploitation of fish resources as outlined below:

- Improvement of the supervision/management of lake resources and revenue collection
- Improvement of fish harvesting efficiency in order to increase income and revenue
- Improvement of technical services closer to the fishing communities
- Improvement of shelf life of fish/ fish products on shore and en-route to distant markets
- Training of fishermen and fish traders on sustainable fishing methods, water safety (boating) gear technology, preservation in stores and transport
- Development of physical access to the lake and markets.

Environmental conservation and development of natural resources

The project area suffers from inadequate physical structures leading to low sectoral performance. In addition, there is public ignorance in conservation aspects and unsustainable exploitation natural resources. There is a need therefore to improve natural resources utilization and management. This can be achieved through promotion of natural resources conservation, provision of adequate personnel to enforce protection of forest resources, create awareness in conservation needs and extend rural afforestation.

Promotion of cooperatives

Some of the factors that affect cooperative movement in Loiyangalani Division include expensive transportation costs, mismanagements and low market prices. In order to promote cooperative movement in the project area, there is a need to improve relevant marketing avenues and enhance natural resources production. There is also a need to mobilize and conduct training to cooperative members on several aspects of management.

5. TECHNOLOGIES, PROCEDURES AND PROCESSES TO BE USED IN THE IMPLEMENTATION OF THE PROJECT

This chapter describes a wide range of related issues with regard to the technology used in the various project components, procedures employed and the processes of the plant operations. Other related attributes of the chapter includes materials used in the construction phase and products, by-products and wastes generated by the project. In addition, it covers analysis of alternative technologies, project sites and project design.

5.1 Project Components

This project has several components including preliminary activities, installation of masts, road improvements, equipment transportation, and development of wind farm, power generation and transmission.

5.1.2 Preliminary activities

Several preliminary project activities have already been carried out. Having identified the project area, one of the first priorities of the project developer was to secure the exclusive rights from the relevant national authorities to study the wind resources of the area of interest. The exclusive rights were formally granted by the Ministry of Energy (MoE) in April 2006. Later on there followed favourable discussions with Kenya Power and Lighting Company (KPLC) which subsequently resulted in a letter of interest to purchase the power generated by the wind park. Currently the following feasibility studies are in an advanced stage:

- Finalization of the economic feasibility of the project;
- Environmental impact assessment; and
- Assessment of the national electricity grid.

5.1.3 Installation of a mast

Following the granting of the exclusive rights to study the wind resources of the project area, an 80 meter – high guy mast was erected at Loiyangalani with all the necessary equipment and data registration facility to measure the actual characteristics of the wind resources of the project area. Other two masts have been erected on the slopes of Mt. Kulal for a similar purpose. The wind measurements of variables such as wind speed, wind direction, temperature and other attributes commenced in November 2006.

5.1.4 Road improvements

At present the road conditions of the project area are very poor. The project will improve the roads conditions in order to facilitate smooth transportation of wind power equipment. The rehabilitated road will also improve communication and help in the subsequent operations of the installed wind park facility. Towards this endeavour, an initial infrastructure review has been made by the Dutch Company, Mammoet. The review includes an assessment of the route in order to determine the efforts required for the logistical operation of transporting the masts and turbines from the sea port of Mombasa to project area near Lake Turkana. The route to be rehabilitated will stretch from Marsabit through Kargi, traversing the Laisamis Division to the project area in Loiyangalani. In this connection there will be 200 km of road upgrade plus strengthening of various bridges

5.1.5 Equipment transportation

Transportation and installation of the mast, wind turbine and other equipment and components will be carried out by Mammoet, a Dutch company that is currently a world leader in wind energy services. Based in the Netherlands, Mommoet has been involved in relevant activities with regard to world heavy lift and transport projects in Europe, North and South America, Asia, the Middle East and South Africa. Its client include civil industry, offshore industry, petro-chemical concerns and power generation and distribution. Mommoet resources include cranes, SPMT Axle-lines and conventional axle-lines, jacking and skidding equipment and a wide range of transport and lifting equipment. In this project Mammoet will transport different equipment components from the sea port of Mombasa to the actual location in the project area where different components will be assembled.

5.1.6 Installation of wind farm and power generation

Following the transportation of different power components, Mammoet will assemble and install the power generating units at the project site. The Lake Turkana wind farm is expected to consist of 100 turbines, each with an installed capacity of 3 MW. Selected wind turbine is Vestas V90 – 3MW. The total foreseen power generated by the project will therefore amount to 300 MW. This amounts to 30% of the existing electric energy capacity currently available in the country. The project is scheduled to be constructed in three phases as follows:

- Phase 1: 40 Turbines and full connection to the grid (operational in 2009 / 10;
- Phase 2: 30 turbines added to the park (operational in 2010/11); and
- Phase 3: 30 turbines added to the park (operational in 2012 / 13.

5.1.7 Power transmission

Despite the remoteness of the project area, the power generated from the wind park will be incorporated into the existing national electricity grid. There will be a local substation for the distribution of power to the surrounding areas including Loiyangalani and Marsabit. However, the bulk of power will be transmitted through 220 kV lines to the national grid from a substation in Naivasha. KPLC has expressed interest in buying the generated power at rates that will be favourable to the consumer. Further options of the connection to the national grid are under study. There will be the installation of 400 km (250 miles) of transmission line from Loiyangalani to Naivasha. Details of the proposed transmission line from Loiyangalani to Naivasha will be a subject of another study.

5.2 Technology

In this section the technology that will be employed in the development of the proposed wind farm in the project area is discussed in terms of historical advancement of the wind turbines, the choice of the wind turbines, and the basic attributes of the preferred V90 – 3.0 MW turbine.

5.2.1 Historical advancement of the wind turbines

For centuries humans have utilized wind energy through traditional windmills. In this regard, the Netherlands has played a prominent role in the development of this sector due to its geographical conditions. The traditional windmill has for long kept its original design comprising a horizontal shaft connected to the wind vanes, which in

turn is connected to a vertical shaft through right angle transmission. The rotating shaft is utilized for the particular purpose of the windmill.

Towards the end of 1970s and early 80s the windmill was developed into modern turbine for generating electricity. Subsequently, various test wind parks were built that became a remarkable alternative method for generation of electricity. However, the first significant wind turbines had only a small capacity of 100 kW and were driven by steel wind blades.

Since 1990s, developments in wind technology have accelerated tremendously. Computer systems have been incorporated to optimize the utilization and efficiency of the wind turbines. The turbine capacity has increased significantly with new, larger mills and better materials. The safety of the turbines has also drastically improved by using stronger but lighter materials. In addition the advancement in knowledge and insight of the wind streams and climatological circumstances has further allowed modern wind turbines to better withstand the rapidly changing conditions during showers, storms and other turbulent situations.

The size and scale of today's wind turbines have also continued to grow. Whereas the largest wind turbine in 1990 had a capacity of 225kW, today's turbines are in range of up to 6 MW each. In addition, the diameter of the rotor has increased from 27 to 112 metres, and the shaft height (hub height) from 30 to 125 metres. The latest turbine models are equipped with sensors to gauge undesired vibrations and allow the computer controlling system to take preventive measures. The sensors also control the rotors individually, adjusting the angle per blade independently during each rotation thus improving the turbine efficiency.

5.2.2 The choice of the wind turbine for the proposed project

The choice of the wind turbines to be used in the Lake Turkana wind park takes into account the latest technology in the market. The choice is based on the following criteria:

- Technology that is widely utilized and has proven reliability in practice under the most difficult circumstances;
- Technology that is able to operate under the prevailing extreme conditions of dust, high temperature and high wind speeds;
- Low maintenance; and
- Technology with reliable supplier with local servicing possibilities, excellent track record and able to secure maintenance continuity.

Based on the above criteria, a suitable candidate to supply the preferred turbines is Vestas, a global market leader in wind turbines. A Vestas wind turbine (Photo 7) consists of the following five main components:

- Foundation unit;
- Tower;
- Blade;
- Nacelle (turbine housing); and
- Rotor.

The Vestas V 90 turbine with a capacity of 3 MW was first launched in Sweden in 2002. The novelty of the Vestas V 90 turbine is its transmission technology which has been improved significantly. The main shaft of the turbine is better supported over a longer length and less torsion occurs in the shaft. Occurring forces on the shaft are also better absorbed over the length. In addition, the Vestas V 90 uses new and

better materials. In addition the aerodynamics attributes have been improved, resulting in a decreased total weight.

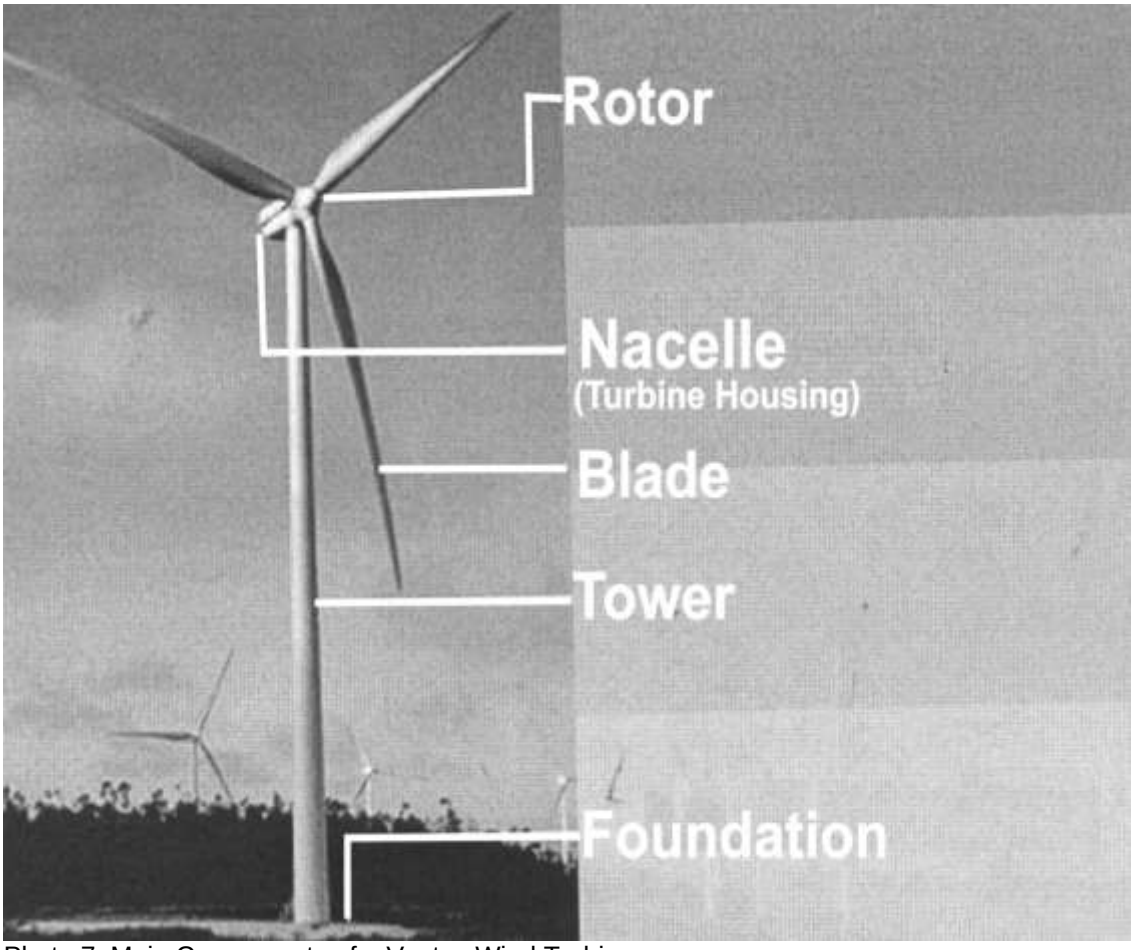


Photo 7. Main Components of a Vestas Wind Turbine

5.2.3 Other attributes of the V90 – 3.0 MW turbine

Unlike the older models, the Vestas design of the V90 – 3.0 MW turbine has been carried out with emphasis on reducing the weight of the wind turbine. This is due to the fact that the heavier the wind turbine, the greater the costs for production, material transport and installation. The turbine blades for the V90 are some of the lightest blades manufactured in the market. This is achieved by introducing several new light weight materials, most notably the carbon fibre for the load bearing spars. The carbon fibre is intrinsically lighter than the fibreglass it replaces. The design of the blade has also been improved tremendously to factor in a feature of a new plane shape and a curved back edge that results into increased output. All this has improved the wind turbine quality including energy production, operational availability, power production and reduction in sound output level.

5.3 Procedures and Processes

5.3.1 Procedures

The procedures for operationalizing the Lake Turkana Project are covered in the section 5.1 – Project Components. The laid down procedures include initiation of

preliminary activities, installation of the mast, road improvements, equipment transportation, development of wind farm, power generation and power transmission. Two of the above procedures including preliminary activities and installation of the mast have already been accomplished.

5.3.2 Processes

Once installed, the process of generating electricity in the proposed Lake Turkana wind farm is triggered by the blades which capture the wind and turn. The turbines begin to produce energy when wind speeds reach about 4m / s. When the wind strikes the blade, there is positive pressure on the front of the blade and negative pressure behind it. As the wind pushes against the front edge, it creates a suction effect behind the blade, which makes the rotor turn. The turbine stops when the wind exceeds a speed of 25m / s, since wind speeds above this level place too much strain on turbine components. The generator is connected via the turbine's electrical control system. The electrical output is led through a high voltage transformer to the grid, which supplies electricity to the users.

5.4 Analysis of Alternatives

Analysis of alternatives touch on several aspects including the main electric power source alternatives prevailing in the country, wind technology alternatives and alternative sites for the exploitation of wind resources in Marsabit.

5.4.1 Electric power alternatives

As discussed above in Section 1.2 – Need for the Project, the generation of adequate and affordable electricity is a very crucial factor for the economic development of the country. Indeed the current energy policy puts emphasize on the need for energy availability and accessibility at cost effective prices. Currently, there are several alternatives for generation of electric power including, hydro, geothermal, thermal, solar energy, bio gas, and wind and power alcohol. The bulk (60%) of the electric power capacity in Kenya is, however, based on hydropower while geothermal and thermal power virtually supply the rest of the power requirements. Faced with the current situation where Kenya's electricity supplies are unreliable and expensive, the installation of Lake Turkana Project will play a significant role in the stabilization of power situation in the country. More importantly, the introduction of 300MW in the Kenyan grid will alleviate power outages especially during the dry seasons and help to reduce the country heavy reliance on the power production from the oil and diesel power generators.

5.4.2 Technology alternatives

Wind energy has been used in Kenya primarily for water lifting since the beginning of the 19th Century. However, its use declined with the advent of the oil fired internal combustion engines. This situation is now changing due to the rising cost of oil, a factor which is making the exploitation of wind energy attractive. Nevertheless, use of wind turbines for the generation of electricity in Kenya is currently at rudimentary stage. Only a few wind turbines are known to be operational in the country especially in Marsabit and Ngong areas. The wind turbines currently in use are all of previous generation of wind turbines. The technology of the wind turbine (Vestas V 90) that will be employed in this project is much more advanced than the above turbines that are currently operational in the country.

5.4.3 Alternative project sites

A quick look at the National Wind Resource Atlas as compiled by the Ministry of Energy (MoE) shows that as a whole Marsabit District is well endowed with potential extractable wind power to the tune of 450 – 750 Watts m^{-2}. Based on this information several sites in Marsabit District were explored for suitability of wind power generation. The present site in Loiyangalani location was selected due to several suitable attributes including the strength and stability of the winds prevailing in the area, security of the area, fresh water availability and road accessibility among other suitable characteristics.

5.5 Raw Materials

Use of raw materials in the development of the Lake Turkana Wind Power Project is seen in the context of the installation of the mechanical equipment, construction of buildings and rehabilitation of roads.

5.5.1 Mechanical equipment

The mechanical equipment for the Lake Turkana Project mainly consists of the various components of the wind turbine which consists of the following four large main parts:

- Foundation unit;
- Tower (mast);
- Nacelle (turbine housing);
- Rotor; and
- Blades.

Except for the foundation unit, the tower, nacelle, rotor and blades will be imported from Denmark, the Netherlands, Germany and other European countries. The foundation unit will be a concrete structure constructed from the local materials. This will include ballast and sand from Loiyangalani and cement from either Bamburi Cement or East Africa Portland Cement in Nairobi.

5.5.2 Buildings

All the project buildings will be constructed in masonry walls, brick roofing and finished in paintwork. Floors will be finished in concrete and polyvinyl in office areas, terrazzo for toilets and polyvinyl finish for residential houses for the members of staff. Low cost options for the building include the use of simple concrete and wall finishes using plaster and screed mortar. Stones for the masonry work will be sourced locally in Loiyangalani where possible while paints, polyvinyl, terrazzo and other materials will be procured in either in Marsabit or in Nairobi.

5.5.3 Roads and paved areas

Rehabilitation of the roads will be done to murrum grading level. In some sections, however, there will be use of concrete especially in the construction of bridges and drifts across the laggas. Murrum, ballast and sand for road rehabilitation will be sourced locally while cement will be procured from the companies mentioned above.

In the project built up area, paved areas will be completed in medium duty concrete blocks for vehicular traffic and light duty concrete blocks for walk ways. There will be no use of tar as a type of finish on the roads or paved areas.

5.6 Products and By-products

The product of the Lake Turkana Wind Project is the generation of power (3MW per turbine) amounting to a total of 100MW at the completion of Phase 1 and generation of 300MW at the end of Phase 3. The power generated will mainly be fed to the national grid. There will be no by-products of the proposed power development.

5.7 Wastes Produced and Methods of Waste Disposal

The proposed facility including the built up area will produce three main types of wastes. These are solid wastes, waste water and domestic sewage. However, due to the nature of the project and the very few personnel required for the operation and maintenance of the wind farm facility, the wastes produced will be minimal.

A combination of methods will be utilized in the disposal of generated wastes. The bulk of solid wastes will be efficiently burned through use of an incinerator. Human sewage and waste water will be channelled into septic tanks. Noise pollution will not be an issue since it will be controlled by use of efficient modern equipment. The turbines will not produce any air emissions. The details of disposal of wastes generated by the proposed facility are covered in Section 9.1.6 – Waste management.

5.8 Design of the Wind Park Facility

The proposed wind power will be situated in the Loiyangalani Location between the foot slopes of Mt Kulal and the south-eastern end of Lake Turkana in Loiyangalani Location as shown on the Map 3. The project site covers an area of 150 km^2 (15km by 10km). The wind park is scheduled to be constructed in three phases as follows:

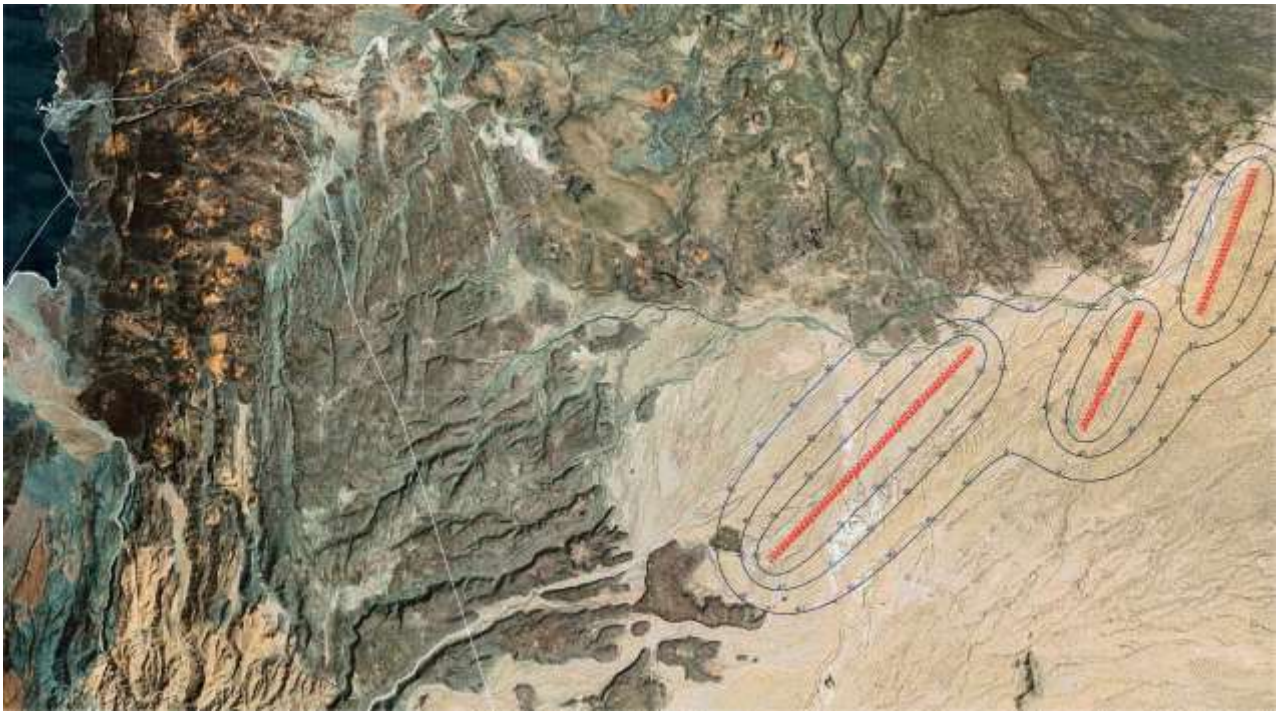
- Phase 1: 40 Turbines and full connection to the grid (operational in 2009 / 10;
- Phase 2: 30 turbines added to the park (operational in 2010/11); and
- Phase 3: 30 turbines added to the park (operational in 2012 / 13.

The design of the proposed wind park will be based on the proven technology of the Vestas 90 wind turbine. As seen in Section 5.2.3, the Vestas 90 design has been carried out with emphasis on reducing the weight of the wind turbine. This is due to the fact that the heavier the wind turbine, the greater the costs for production, material, transport and installation. The turbine rotor diameter is 90 metres, the turbine tower is 80 metres high while the nacelle, which houses the generator weighs approximately 90 tonnes. Each of the blade weighs 6.7 tonnes. The turbine foundation will be octagon shaped with each side measuring 17 metres and a depth of 3 metres. Each of the foundation will require 1.4 million kilogrammes of concrete to build.

The pilot plant of the proposed wind park facility will consist of 40 Vestas V-90 turbines each with a capacity of 3MW and a total capacity of 120 MW. It will be sited to the south of Ongipi massif in the plateau between the foot slopes of Mt. Kulal and Mt. Nyiru and about 10 kilometres away from Lake Turkana. The satellite picture below shows a possible lay-out of the wind farm. The red crosses represent the relative positions of wind turbine clusters. The approximate positions of each of the 100 turbines are presented in Annex 8.

Shown in the satellite picture are also the noise contours that result from the noise emission from the turbines. The contours represent noise values (dBA). The inner contour (closest contour to the turbine) denotes 50 dBA and the outer contour

(farthest from the turbine) denotes 40 dBA. The maximum distance from the turbines to the outer contour is approximately 3000m.



Map 5: Lay out of the Proposed Wind Farm Facility

In addition to the area occupied by the turbines, the wind park facility will accommodate several ground level flat buildings. The buildings will comprise an office block, storage area, workshop, control room and a restaurant. The total floor area for the buildings will be about 400 m^2. In addition to the above buildings there will be living quarters for permanent staff. The wind park facility will also include a fenced area for a substation.

6. SOCIO-ECONOMIC ANALYSIS OF THE PROJECT

The socio-economic analysis of the project touches on several related attributes including social trends in Kenya, social synthesis in the project area, trends in national economy, trends in generation of electricity in Kenya and economic analysis of the project.

6.1 Social Trends in Kenya

Kenya is a developing country where about 80% of population live in rural areas and derive their livelihood from agriculture through crop and livestock production, fishing, forestry and exploitation of other natural resources. According to the 1999 population census report, Kenya's population was estimated to be 28.4 million people. Currently the Kenyan population estimated at 33 million people and is projected to reach 37.5 million people by the Year 2010. The capital city, Nairobi has an estimated population of 2.7 million people. About 70% of Kenyan population lives in 12% of the total land area while the remaining 30% of the population live in dry lands, which account for 88% of the total land area in Kenya. The high potential areas in Kenya including central highlands, western Kenya, parts of Rift Valley are characterized by high population density of about 300 people per km^2 while the dry lands are sparsely populated with as low as 3 people per km^2.

A great percentage of Kenyan population lives below the poverty line (less than a US Dollar per day) and the situation seems to be worsening. The population in absolute poverty was estimated to be 44.7% in 1992, 52% in 1997 and 56% by 2002. Kenya's population is characterized by high mortality rates, low and declining life expectancy, increased fertility rates, high infant mortality and death rates and declining population growth rates (probably attributed to the HIV/AIDS pandemic). Presently the country is faced with a high dependence burden with over 50% of the population below 15 years of age. This has resulted in high dependency ratios placing high demands on food and social services such as primary education and health care.

6.2 Social Analysis of the Project

This project is located in a remote part of the country characterised by poor communication, low population density, poor health and education services and high levels of poverty.

6.2.1 Integration of social issues

To a large extent social analysis for this project has been integrated into Chapter 4. Baseline Information and Description of the Potentially Affected Environment, where several social attributes including local administrative set up, population and demographic characteristics, land use and health profile have been extensively described. Other aspects of social analysis are discussed in Chapter 7 - Environmental and Socio-economic Impacts and Chapter 8 - Environmental Management Plan.

6.2.2 Public consultations

Public consultation was viewed as an important activity of this study. The team carried out public consultations with the local community with the main objective of getting the stakeholders' views on the perceived social effects of the project on the project area and their ideas on how the negative impacts can be mitigated. In this

regard, the consulting team held several meeting with a wide range of stakeholders as discussed in Chapter 3 Approach and Methodology. A list of all stakeholders consulted is presented in Annex 3 and Annex 10b. Based on the outcome of the public consultations it is evident that the local communities are very poor. The poverty levels are so severe that most of the populations of the project area are now dependent on relief food.

The local population is very positive about the project and they welcome its installation in the project area. Indeed the people feel that the project is an event that will solve their many problems including relief dependency syndrome. The project, however, is likely to create very high expectations among the local community in the project area and surroundings. It was also noted that despite all the consultations and awareness raising about the project, community has still "fear of unknown" about the project. This is mainly due to the the fact that:

- the project has no precedent in the area;
- the local community is still very conservative; and
- the local community suffers from lacks exposure on what is happening to the rest of the country and beyond

6.2.3 Social considerations

Due to the remoteness of the project area, the high levels of poverty and other prevailing problems, it will be important for the project developer to put in place mechanisms for social considerations in order to enhance the welfare of the marginalised communities in the project area. The local community has expressed a dire need to be considered for assistance in the following areas:

- Employment opportunities for the local community during the construction and operation phases of the project;
- Rehabilitation of existing poor roads in the area in order to facilitate the local community to access external markets for their livestock and fish products.
- Assistance in acquisition of cold storage facilities for the fish caught in Lake Turkana. This will facilitate better storage for the fish, eliminate the need for sun drying fish and increase the returns from the fisheries sector.
- Since some sections of the local community use the lake water for domestic purposes, the marginalised communities have expressed a need for the project to help them acquire good quality water for domestic use.
- Assistance in the development of health facilities in order to improve health conditions of local community especially the marginalised groups.

Full details of the nature and magnitude of social considerations will be discussed and agreed upon between the local community and the project developer.

6.2.4 Need for stakeholders' meeting

Due to the importance of this project to the Client, the local community in the project area and the nation at large, there is a need to convene a stakeholders' workshop for the project in Loiyangalani. This will provide a forum for all interested parties and individuals to discuss the project openly and give views on pertinent issues associated with the project development, presence and operations of the proposed wind farm facility. It is therefore envisioned that the Client will formally invite all the major stakeholders and make available the environmental impact assessment report for a reasonable period of time for their perusal prior to the commencement of the proposed stakeholders' workshop at Loiyangalani. The consulting team will assist in facilitation of the stakeholders' meeting.

Indeed a stakeholders' meeting was held in Loiyangalani between 21 and 22nd April 2008 and attended by fifty four (54) participants (Annex 10b). Several issues touching on the proposed project including the project negative impacts on livestock, Lake Turkana and vegetation and the siting of the wind farm, job opportunities and other benefits to the community among other issues were exhaustively discussed during the workshop. Issues discussed in the Stakeholders' Meeting were recorded in the minutes presented in Annex 11.

6.3 Trends in National Economy

The Kenyan economy is largely agricultural-based, with the sector accounting for 25% of the Gross Domestic Product (GDP). Agricultural sector contributes over 80% of employment and 57% of national income both directly and indirectly. The number of people living below poverty line and who subsist predominantly on environment resources was about 57% in 2002. Although Kenya achieved most of its development targets in the first decade after independence, the subsequent three decades recorded dismal performance. GDP growth declined to 2.5% between 1990 and 1995 and to 1.98 between 1996 and 2000. After posting a positive growth of 1.2% in 2001 (from negative of 0.2% in 2000), the economy grew by 1.1% in 2002. In all these years, economic growth has consistently been lower than population growth rate. A survey of 2005 (MoNPD, 2005), however, shows that the economy has been on a recovery path since 2002. Gross Domestic Product (GDP) expanded by 4.3% in 2004 as compared to 2.8% in 2003. The sectors that made a major contribution to this impressive growth were manufacturing (4.1%), construction (3.5%), trade (9.5%), tourism and hotels (15.1%) as well as transport and communications (9.7%). In 2005 GDP expanded to 5.7% and in 2006 the economy posted a GDP of 6.1%. However, all these gains in economic growth may now have now been lost due to the post election violence Kenya has witnessed following the December 2007 general elections.

The relatively slow rate in economic growth coupled with increasing inequality in the distribution of income has led to a rise poverty levels such that about 17 million Kenyans (56%) of the population live below the poverty line (ERS, 2005). With 500,000 job seekers entering the job market, every year, while only about, 80,000 formal sector jobs were created in the last six years or so, unemployment rates continue to rise. Today the economy faces the challenge of creating adequate and gainful employment opportunities for a rapidly growing labour force. In addition, the rising poverty levels and poor performance of agricultural sector have worsened food security situation in the country.

The recent improved performance in various sectors of the economy has been reflected in the creation of new jobs in both the modern and informal sector. Overall the economy generated 469,000 new jobs in 2006 an increase of 5.7% from 2005 levels (KNBS, 2007). Again all these gains in the job market have greatly been eroded by the post election violence of 2007-2008 which has left tourism, agriculture, commercial and industrial sectors reeling from the impact of the violence.

6.4 Analysis of Electricity Generation in Kenya

It is noted that the project under study pertains to energy development, a factor that influences the project's socio-economic analysis. Hence a need for analysis of electricity generation in Kenya. The most important electricity producer in Kenya is the state owned parastatal, Kenya Electricity Generating Company (KenGen). Besides KenGen there are 4 independent power producers (IPPs) including

Iberiafrica, Westmont, Tsavo Power and Orpower. The Kenya Power and Lighting Company (KPLC), a state owned parastatal has the monopoly over the transmission, distribution and sale of electricity in Kenya. The power regulator in Kenya is the Electricity Regulatory Board (ERB).

Table 9. presents existing power production in Kenya. At present Kenya produces a total of 1194.78 MW of electricity. Most of this production (579.28MW) is hydro power. Most of this hydro power is generated in several stations along the Tana River. Other hydro power stations include the Turkwell Gorge and other minor stations including the Gogo, Sosiani and Mesco stations. The geothermal power station at Olkaria near Naivasha produces 128MW. The diesel/ oil plants with a capacity of 318 MW are located at the Coast and Nairobi. Kenya imports 20-30MW of power from Uganda.

Table 7. Power Production in Kenya

Name of Power Station	Power in (MW)	Type of Power	Location	Year of Commissioning
Olkaria I	45	Geothermal	Hells Gate	1981
Olkaria II	70	Geothermal	Hells Gate	2003
OLkaria III	13	Geothermal	Hells Gate (IPP)	2000
Subtotal Geothermal Power	**128**			
Kipevu 6	30	Diesel	Mombasa	1972
Kipevu 7	33	Diesel	Mombasa	1976
Kipevu 1	73.5	Heavy oil	Mombasa	1999
Kipevu GTI	31	Diesel	Mombasa	1987
Kipevu GT2	32	Diesel	Mombasa	1990
Nairobi South	13.5	Diesel	Nairobi	1972
Subtotal Thermal Power	**213**			
IPP - Kipevu II Diesel Tsavo	74.5	Heavy oil	Mombasa	2001
IPP - Kipevu Westmont	44	Diesel	Mombasa	
IPP - Iberafrika	56	Diesel	Mombasa	
Subtotal Thermal IPP Power	**174.5**			
Subtotal Oil Power	**387.5**			
Gogo	2	Hydro	Migori	1952
Sosiani	0.4	Hydro	Sosiani	1955
Mesco	0.38	Hydro	Maragua	1919
Ndula	2	Hydro	Thika	1924
Ndula	2	Hydro	Thika	1924
Sagana	1.5	Hydro	Tana River	1952
Turkwel Gorge	106	Hydro	Turkwel River	1991
Wanjii	7.4	Hydro	Maragua	1955
Tana	14.4	Hydro	Tana River	1940 / 53
Masinga	40	Hydro	Tana River	1981
Kamburu	94.2	Hydro	Tana River	1974
Gitaru	225	Hydro	Tana River	1978
Kindaruma	40	Hydro	Tana River	1968
Kiambere	144	Hydro	Tana River	1988
Subtotal Hydro Power	**679.28**			
Total Power Production	**1194.78**			

Source: Feasibility for Turkana Wind Park in Kenya, 2007

Further to the above power production, the country has planned an additional 422 MW generation capacity within the next three years as follows:

- 210 MW thermal power;
- 110 MW hydro power; and
- 72.5 MW geothermal power.

It is noted that nearly 60% of the current power capacity is hydro. Over the last seven years the country has paid a high price over heavy reliance on single source of

power, the Tana River system. In 1999 and again in 2002, severe droughts nearly brought the Kenyan economy to a standstill after the hydro – power dams dried out leaving power rationing in its in its wake. This experience has underscored the need to diversify the power sources in Kenya.

6.5 Economic Analysis of the Project

The economic analysis of the proposed project is presented in terms of its technical feasibility and financial feasibility.

6.5.1 Project technical feasibility

Based on the success and versatility of the of Vestas Wind Systems A/S of Denmark, the proposed project will be technically feasible. Vestas Wind Systems A/S based in Randers, Denmark, is among the world leaders in wind technology and a pioneer in the development of the wind power industry. Today Vestas Wind Systems A/S has installed more than 30,000 wind turbines in over 50 countries. The company had registered a turnover of approximately £ 2.5 billion in 2005 and currently has a global market share of 35%. The success experience of the Vestas Wind Systems and lessons learnt from many parts of the world will be replicated in the Lake Turkana Wind power Project.

6.5.2 Project financial feasibility

A recent financial analysis made by Emerging Energy Research (EER), on behalf of Vestas Wind Systems A/S concludes that based on economic and risk analysis of power generation; wind technology can no longer be marginalised in the power mix. Thus wind power should be supported in its penetration of the conventional power market to ensure a cleaner, more balanced energy supply in future. The EER analysis makes the following conclusions:

- In a carbon constrained world, wind power can be competitive with several conventional power technologies; and
- All things considered wind power is a superb supplement to the current power mix as it increases the supply of electricity, reduces the consumption of conventional fuels, has little or no carbon footprint and is an inexhaustible local resource.

With regard to the proposed power development, so far no serious setbacks have been encountered that pose a vital threat to feasibility of the project. The potential for the Lake Turkana Wind Power Project to materialize look most promising. Indeed the energy sector in particular renewable energy is an attractive sub sector that has and will continue to attract investors in Kenya.

Economic feasibility study of the proposed project is now complete. The internal rate of return (IRR) for the proposed project is estimated to be 28%. The proposed project is therefore financially viable. Consequently investment funds are now being raised with relevant institutions.

7. POSITIVE IMPACTS OF THE PROPOSED PROJECT

In investing in the project area, the Turkana Wind Power Project is in line with the current Government strategic plan of developing the Arid and Semi-arid Land (ASAL) areas of Kenya. This investment will have significance positive environment impacts when compared to other forms of power production including the thermal power production through burning of fossil fuel. The major positive impacts of the project will include stabilization of electricity in Kenya, promotion of economic growth in the country, contribution to the Government revenue, increased employment and improvement of roads in the project area.

7.1 Stabilization of Electricity

The development of the Lake Turkana Power Project will play a significant role in the stabilization of power situation in the country. The project will add 30% of total power production in Kenya, a relatively cheap power source (second cheapest source of power in Kenya after hydro power). Despite the fact that hydro power development is relatively cheap, there is a scarcity of suitable hydropower sites for exploitation in Kenya.

The introduction of 300MW in the Kenyan grid will alleviate power outages especially during the dry seasons and help to reduce the country heavy reliance on the power production from the oil and diesel power generators. At its full capacity production (operation of 100 wind turbines, each with a capacity of 3MW), the project will create a major positive impact during dry years when use of thermal oil is drastically reduced. This will reduce oil generated energy from an estimated 2271 GWh to 1178 GWh. The project is expected to reduce carbon emissions by 16,000,000 tons.

7.2 Promotion of Economic Growth

This project will play a significance role in stimulating economic growth in Kenya. The power input will contribute significantly to the Kenya's Rural Electrification Programme which has potential to promote spin-off effects on rural economy in Kenya. The project also has power export potential to the neighbouring countries including Uganda, Tanzania, Ethiopia and Southern Sudan.

Today the energy situation in Kenya is unsatisfactory as evidenced by the frequent unplanned power outages, an important circumstance which slows down the economic development in the country. Power produced by this project will to a large extent change this situation.

Nearly 60% of the power capacity in Kenya is based on hydropower. As stated in Section 1.2: The Need for the Project, over the last ten years or so the country has paid a heavy price for over reliance on hydropower. For example, between 1999 and 2002, severe droughts nearly brought economic activity in Kenya to a stand still after the hydropower dams along the Tana River nearly dried out leaving power rationing in its wake. Reduction of hydro power production during the dry spells was compensated by increasing the power production of the diesel plants and of course rationing of power. This increased the cost of power production. In addition there was a resultant loss of economic production due to rationing. In 2000 (a very dry year), KenGen rented 100MW extra diesel generators. The total extra cost for power generation was US$ 632 million and the lost production due to rationing was estimated to be US$ 1,400 million. These experiences have underscored the need to diversify the power sources in Kenya. Installation of this project will enhance

promotion of economic growth at this time when Kenyan economy is expanding with a remarkable growth rate of more than 6%.

7.3 Increased Employment Opportunities

This project will create job opportunities in the project area and beyond. Direct job opportunities will be available for high calibre professionals including engineers, information technology (IT) personnel, mechanics and consultants. It is, however, unlikely that the local community will benefit from this calibre of specialised job market. Of greater relevance to the local community will be job opportunities involving unskilled and semi-skilled labour especially during the rehabilitation of the roads and the construction of the wind park and staff buildings. During the road rehabilitation and construction phases of the project, over 400 hundred members of local communities in the project area will be hired by the project as drivers, masons, loaders, carpenters, cooks, security personnel and other assorted personnel.

Indirectly the project will create opportunities for self employment in the project area especially during the rehabilitation of the roads and the construction of the wind park facility. Since the project will require local materials for the above project activities, the local community stand to benefit from their engagement in several activities including the making of ballast, collection of sand, mining of murrum, cutting of building stones, making of blocks and transportation of goods and building materials. Other employment opportunities in the project area will spring from spin-off activities including trade, accommodation, and supply of goods and services to both the skilled and unskilled labour.

7.4 Increased Contribution to Government Revenue

The project will contribute toward the boosting of Government revenue in the form of tax revenue. Lake Turkana Wind power Project will pay corporation tax at 30% of net income. The project will generate income to the Government through 0.01% fee to NEMA and withholding tax from remuneration paid to employees at graduated scale rates. Through engagement of employees, the project will generate revenue for the Government in the form of Pay as You Earn (PAYE). The project will pay Value added tax (VAT) at most of the items bought. In addition, there will be other taxes including operating licences.

7.5 Improvement of Roads in the Project Area

Currently the road conditions of project area are in a very poor state. In order to facilitate smooth transportation of wind power equipment, the project will improve the roads from Marsabit Town via Kargi to Loiyangalani. The rehabilitated road will improve communication in the project area and promote economic activities including livestock trade. A major beneficiary of an improved roads system will be the Loiyangalani fisheries. This sector has a huge potential which has never been exploited due to poor roads conditions between the lake and potential markets. Due to the poor road system the fishermen are not able to sell fresh fish. Instead, the local fishermen sun dry the caught fish and sell them to the only available market for dry fish, Kisumu. It is noted that the total fish catch from Loiyangalani for the year 2006 was 156,998 Kg dry weight earning a total of KSh 6,181,122. With a rehabilitated road system the Lake Turkana fishermen will be able to transport fresh fish to Marsabit and other markets including Nairobi and fetch a higher price for them.

7.6 Provision of Electricity in the Project Area and Surroundings

Although the bulk of electric power generated from the Lake Turkana wind park will be connected to the national grid at Naivasha, some power will be distributed in the project area and surrounding areas. This will generate economic and trade opportunities among the marginalised communities in the northern Kenya. Although many members of local community will not afford the power (power will be sold at commercial rates), it will, nevertheless make a significant positive impact in the project area and the surroundings. Many institutions, including the schools, hospitals, government offices, tourist facilities, hotels, shops and some private homes will benefit from the power connection. For example, the Loiyangalani fisheries will realize tremendous enhancement from the power connection. Availability of power in the project area will facilitate the Loiyangalani Fisheries Cooperative Society to install cold storage facilities. Consequently the caught fish will store for a longer period. Subsequently, the fresh fish can be sold to other market destinations (other than Kisumu) including Marsabit, Isiolo, Moyale, and Nairobi and for a higher price than the sun dried fish.

8. NEGATIVE IMPACTS OF THE PROPOSED PROJECT

Although this project will realise tremendous economic benefits and other positive impacts as outlined above, it will also have negative effects on the environment of the project area. The negative impacts of the project are discussed in three broad categories including socio-economic negative impacts, biophysical negative impacts and impacts beyond national boundaries.

8.1 Negative Impacts on Socio-economic Environment

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

8.1.1 Cultural contamination

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

8.1.2 Increased exploitation of natural resources

During the construction phase there will be high number of people in the project area. The increased number of workers will make high demand on fuel wood resources of the project area. This demand will be made at a time when the local people are currently experiencing an acute shortage of fuel wood especially around Loiyangalani town. There will be a dire need to explore alternative source of energy for workers during the implementation of the project.

8.1.3 Increased insecurity and community conflicts

Although Loiyangalani Division including the project area, is a relatively a calm zone, to the north of the division insecurity brought about by tribal clashes is a big problem. In the October 2007, El Molo were invaded and left their home area to seek refuge in Loiyangalani Township close to the project area. Indeed the displaced El Molo community was still camped in Loiyangalani during the course of the field trip for this study. Given the traditional livestock rustling among the communities in northern Kenya and normal competition for scarce resources in arid areas, the relationships among pastoral communities are in many situations restrained to some extent. The proposed project could exacerbate this delicate situation if it is perceived to benefit

certain communities more than others. This could lead to community conflicts and an increase of insecurity in the project area.

8.1.4 Increased incidences of diseases

The influx of people in the project area and environs is likely to increase the incidences of diseases between Marsabit and Loiyangalani. The situation will be aggravated by the entry of commercial sex workers into the area with the commencement of project activities. There is therefore the risk of contracting sexually transmitted diseases (STDs) especially the dreaded Human Immuno-deficiency Virus / Acquired Immuno-deficiency Syndrome (HIV/AIDS) among the project workers. This will have serious health implications for the project workers and the local community in the project area and surroundings.

8.1.5 Visual intrusion

The road rehabilitation activities will create disfigured landscapes along the road route and around the sites of the quarries and borrow pits of the project area. In addition there will be large spoils along the road, around the quarries and periphery of the borrow pits. The resultant disfigured landscapes and mounds of spoils are visually intrusive. Wind power construction activities will also lead to landscape disfiguration. The soil mounds, presence of machinery, and other equipments and materials on the project site will be visually intrusive.

The completed wind park facility in otherwise an unspoilt natural environment could be visually intrusive to some people and has the potential to detract observers from the normal scenery. However, the wind park is not an ordinary sight and being a novelty, could be appealing to a wide cross- section of local community, other Kenyans and even foreign visitors. Indeed it could as well be a local attraction drawing many observers beyond the project area.

8.1.6 Potential impact of labour force

Depending on the mode of human management in the project site, the project workers especially during the road rehabilitation phase and the wind park construction stages are likely to indulge in activities that are likely to cause negative impacts on the environment of the project area. The construction of the labour camps may require building materials from the project area. Consequently this is likely to result in harvesting wood resources from the plant communities around the project area. The constructed labour camps are usually fraught with sanitation and waste disposal problems that are likely to have negative impacts on the environment. Wastes generated by the construction workers including food remains and human wastes could attract animal pests and vermin including rats, crows, flies etc. to the construction sites with resultant implications on spread of diseases. As a whole the establishment of labour camps in the project area and along the road earmarked for rehabilitation will definitely present serious management challenges to the Contractor and Resident Engineer.

8.1.7 Increased accidents and occupational hazards

Implementation of the project will definitely increase volume of human and motor traffic in this remote area. The increase in human and motor traffic will be aggravated by the transportation of construction materials and plant accessories and other equipment required to install the wind park facility. This is likely to result in a higher

risk of accidents occurring in the area of operation during the road rehabilitation, wind park construction and wind park operation phases.

During the implementation of the road rehabilitation and wind park construction phases, several activities including vehicular transport, operation of heavy machineries and blasting of hard rock in quarries have potential for accidents risks both among the project workers and the local community. Factors that may exacerbate this situation are inadequate appropriate working gear for project workers including the helmets, overalls, boots and gloves.

Due to the nature of technology involved, the wind park operation and maintenance activities will be minimal. Nevertheless, there are potential occupational hazards with regard to work force engagement in both day-time and/or night-time activities albeit on a small scale. The nature of occupational hazards will include:

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

8.2 Negative Impacts on Bio-physical Environment

Project activities during the road rehabilitation and construction of the wind park and subsequent operation of the same will cause negative effects on the bio-physical environment of the project area albeit on a limited scale. The site preparation activities for the installation of the wind park and subsequent construction activities of the proposed project facilities will to some extent alter the present salient features of the project area. These activities involve the clearing and trampling of vegetation, excavation of soils and other geological formations, levelling of landscape and construction work. The above activities will have immediate negative impacts including loss of habitat, destruction of floral and faunal communities, soil erosion and other related impacts. In addition there is likely to be far-reaching effects on the adjacent lacustrine habitat associated with Lake Turkana through the potential effect of run off and subsequent siltation processes and pollution effects.

8.2.1 Potential impacts of wind turbine on external environment

External environment in this context pertains to situations associated with the project but outside the project area. Potential impact of the wind turbine on the external environment is divided two phases as follows:

- The production phase, which covers the period from obtaining the raw materials to the production of turbine and other components; and
- Transport of equipment components to the project site.

Impacts during production phase

The production phase of wind turbine and other equipment covers the extraction of raw materials as well as production of wind turbine and other components by suppliers. This is perhaps the phase that generates the greatest impact on the environment. The external environment is affected particularly by extraction of iron ore for the production of steel. The manufacture of epoxy materials (made using crude oil) used in blade production is another aspect of the production phase that generates environmental impact. It should, however, be emphasized that the

production of the wind turbines and the components are made in Europe and impacts associated with wind turbine production phase are confined elsewhere and will not affect the project area.

Impacts during transport of equipment to the site
Impacts associated with the transport of the wind turbine components (blades, masts, nacelle and other components) and subsequent erection phase mainly involves fuel consumption and subsequent gaseous emissions. Gaseous emissions emanate from lorries and other vehicles used in transportation and the cranes used in loading and erection of the turbine itself. However, this type of impact is not confined to the project area alone. Gaseous emissions will be dissipated all the way from the port of Mombasa to the project area.

8.2.2 Increased soil erosion

Increased soil erosion is likely to occur in the project area during the road rehabilitation, operations of borrow pits and quarries, construction of the wind park and buildings and installation of turbines. Although the project area is very arid, soil erosion could turnout to be a significant negative impact depending on prevailing environmental conditions during the implementation of the above activities. The presence of loose earth (resulting from the above activities) coupled with prevailing strong winds and occasional rains could lead to acute and chronic soil erosion problems in the project area. The situation is aggravated by the poor vegetation cover in the whole of the project area.

8.2.3 Increased siltation of the lacustrine habitats

Some of the excavated sediments from the project site and the construction spoils emanating from excess excavated material and construction debris are likely to impart negatively on the environment of the project area and the nearby lacustrine habitat associated with Lake Turkana. Despite the fact that this is a dry area, it is likely that the generated spoils and other excavated material could be washed into the shore of Lake Turkana through an occasional runoff and the effect of winds. Subsequently increased siltation of the lake water will have some limited ecological implications on the aquatic habitat. Siltation effect, however, will depend on the closeness of the impacted area to Lake Turkana.

The silt particles entering Lake Turkana aquatic system through runoff and silt laden winds can increase water turbidity and reduce the lake water transparency. The suspended material will cut down light penetration thus reducing the photosynthetic capabilities of the primary producers including the phytoplankton, benthic algae, periphyton and other aquatic flora. However, the amount of silt emanating from the project is likely to be low when compared with the volume of water in the lake.

8.2.4 Ponding

The road rehabilitation, wind park construction and other project activities may lead to creation of stagnant water bodies in quarries, borrow pits and depressions created during the construction works. Although water collected in the depressions may be a respite for the pastoralist, the resultant stagnant water bodies are likely to be suitable habitats for the breeding of mosquitoes and snails that are disease vectors for malaria and bilharzias respectively.

8.2.5 Loss of habitat

Although wind turbines may not directly cause mortality, the presence of wind turbines may indirectly affect local fauna and bird populations by decreasing the area of habitat available to breeding, feeding, nesting, resting etc. Habitat loss is mainly brought about by land taken for the construction of infrastructure including staff houses, access roads, turbine bases and substations. This brings about the fragmentation of populations of terrestrial fauna and avifauna. However, this impact is of greater significant where large number of turbines are sited on sensitive habitats such as forests, wetlands and sandbanks. This will not be the case for this project. Due to the small area occupied by the wind farm facility, the loss of or damage to habitat resulting from wind farm infrastructure is generally not perceived to be a significant environmental concern in the project area.

8.2.6 Destruction of floral communities

Due to the aridity of the project area, vegetation is scanty. It must, however, be emphasized that the existing vegetation plays an important role in maintenance of life in the project area and its surroundings. It is the resource upon which the pastoralist and their livestock populations depend on for their survival. Despite the importance of vegetation in the project area, project activities are likely to destroy some vegetation with subsequent loss of some trees, shrubs and grasses from the area of operation. The plants likely to be affected mostly are trees such as *Acacia tortilis* and shrubs such as *Acacia refciens*, *Indingofera spinosa* and *Sericocomopsis hildebrantii*. Destruction of the floral community will result in the loss of habitat for some animals such as dikdiks and the hare, the avifauna, insect community and other forms of life found in the project area. In addition there will also be a loss of feed for the livestock especially the camels, goats, sheep and donkeys. The local community will also lose an invaluable source for firewood, building material for the manyatta and fencing material for animal enclosures. However, it should be noted that the actual area covered by the proposed 100 turbine foundations will in total cover only about 0.5 acres of land. This area is a very small amount of land lost when compared to the land covered by the project area and surroundings that cover thousands of acres.

8.2.7 Impact on terrestrial fauna

This project will not have any significant impact on the terrestrial fauna of the project area. Other than the presence of livestock including the camels, goats, sheep and donkeys, the project area has a pronounced scarcity of charismatic wild fauna. During the field study, the team was only able to see an occasional dikdik and hare within the boundaries of the project area. However, the project may have some impacts on the migration of avifauna as described below.

8.2.8 Impacts on avifauna

The project is likely to interfere with migration of birds. The project area is close to Lake Turkana which is an important bird area in Kenya. Eight four (84) waterbird species including thirty four (34) Paleartic migrants have been recorded around Lake Turkana (Bennun and Njoroge, 1999). According to Rose and Scott (1997), over 100,000 Little Stints (representing more than 10% of entire East African / South East Asia population may winter here. Lake Turkana also supports many wintering Palaearctic migrants and is a key stopover site for birds on passage.

From experience in other parts of the world, it is known that wind turbines pose a risk to birds. The potential impacts on bird populations could be serious if the turbines are built in areas where large concentrations of birds occur especially migrating birds, large raptors or other large soaring species especially eagle and vulture populations. The main potential hazards to birds from wind farms are:

- Disturbance leading to displacement or exclusion of birds; and
- Collisions.

Disturbance

Disturbance potentially may arise from increased human activity in the vicinity of wind farm especially during construction, maintenance visits and facilitation of access roads in the project area. The presence of turbines and the presence of noise from turbines may also deter birds from using the area close to the turbines. This, however, may not affect the migrating birds that are associated with Lake Turkana including the shoreline aquatic habitats.

Collisions

Following the construction of the wind park, it is likely that birds may be killed when colliding with turbines while others will be killed by collision with power cables at the wind park. Collision mortality of birds at poorly sited wind farms are likely to have negative impacts on the populations of the susceptible species. Cumulative mortality from multiple wind installations may also contribute to population decline. It should, however, be noted that several factors including wind speed and direction, air temperature and humidity, flight type, distance and height, time of day and topography, all influence the risk of collisions. The bird species type, age, behaviour, and stage of the bird's annual cycle also influence the risk of collision. Collision risk is greatest in poor flying conditions, such as strong winds, that affect the birds' ability to control flight manoeuvres, or in rain, fog, and on dark night when visibility is reduced. Lighting of turbines has the potential to attract birds, especially in bad weather, thereby potentially increasing the risk of collision. The lit turbines and other lit structures at night disorientate the nocturnal migrant birds thus increasing the collision mortality.

It should, however, be noted that the turbines will be located at least 10km from the shore of Lake Turkana on the plateau behind the Ongipi massif. Since migrating and over wintering birds are normally associated with Lake Turkana shoreline and aquatic habitats, collision risk of birds is expected to be low.

8.2.9 Impacts on protected areas

The nearest protected areas to the project area are Mt. Kulal Biosphere Reserve and the South Island National Park which are situated away to the east and west of the project area respectively.

Mt. Kulal Biosphere Reserve

Mt. Kulal lies 25km east of the southern end of Lake Turkana. It is an isolated volcanic mountain that rises abruptly from the surrounding semi-desert plain to an altitude of 2,300m asl. Mt. Kulal and its surroundings are designated as a Biosphere Reserve under the UNESCO Man and Biosphere (MAB) programme. Mt. Kulal Reserve does not have high concentrations of megafauna. However, Greater Kudu (*Tragelaphus strepsiceros*) are recorded in the forest. The African Elephant (*Loxodonta africana*) may occur in the forest from time to time. Mt. Kulal Forest used to hold a population of Black Rhinoceros (*Diceros bicornis*) but is now locally extinct.

The avifauna of Mt. Kulal forest is typical of the Afro tropical highlands biome but remains impoverished (Bennun and Njoroge, 1999). However, Mt. Kulal is unusual among Kenya's northern 'island ' forests in having an endemic bird taxon, the Kulal White-eye (*Zosterops kulalensis*). The Kulal White eye is recognised as a globally threatened and restricted range species. Hence its conservation significance can not be overstated.

South Island National Park
The South Island National Park was established in 1983 mainly to protect the island's crocodile population, the venomous snakes, hippos and a wide range of avifauna. Crocodiles breed on the shore of the South Island National Park between April and May. There are many species of reptiles including saw scaled viper, night and puff adder and cobra. The Island provides a suitable feeding and breeding habitat to large concentration of birdlife. The goliath heron and African skimmer breed here while the African open-billed stork duck and gulls feed on the shores. In addition the diverse habitats of the South Island National Park attract the lesser flamingo and the birds of prey.

As seen from Map 4. the two protected areas are located away from the project area. The nature of the project activities during the road rehabilitation, construction of the wind park and subsequent operation of the installed facility are unlikely to affect either the Mt. Kulal Biosphere Reserve or the South Island National Park.

8.2.10 Cumulative and long-term effects of wind farm installations

The likely increase in incidences of HIV / AIDS and increased cultural contamination among the local community in the project area, are likely to cause long-term and cumulative social impacts if no attempts are carried out to contain the situation at an early stage of project development.

Cumulative and long-term effects of wind farm installations may be considerable if bird movements are consequently displaced. This may lead to the disruption of ecological links between feeding, breeding and roosting areas. Cumulative loss of or damage to sensitive habitats may be significant, if multiple, large developments are sited in such locations, e.g. in sandbanks in shallow waters or in wetlands. Further, direct habitat loss may be additive to disturbance exclusion. This, however, is not the case for the project area. The type of design for the proposed wind park and its siting are unlikely to cause any significant cumulative and long-term impacts in the project area.

8.2.11 Potential disturbance in livestock activities

The major land use of the project area is livestock keeping especially the rearing of camels, goats, sheep and donkeys. The livestock activities are likely to be disturbed by both construction, presence of wind turbines and operations of project activities. During the project construction stage there will be increased disturbance to livestock emanating from increased number of people, vehicles and machinery in the project area. The project may indirectly affect livestock by decreasing the grazing area due to land taken for the construction of infrastructure including access roads, turbine bases, staff houses and substations. Livestock movements especially towards the watering points are likely to be affected by fencing of the project area.

It should, however, be noted that the project area will not be fenced. Only about 0.5 acre will be fenced only for the substation.

8.2.12 Increased noise levels

The proposed facility has the potential to generate noise levels which could affect close residential areas and other noise-sensitive receptors. Noise levels are likely to increase in the project area both during the construction and operation phases of the proposed project.

High levels of noise will prevail in the project area due to the use of heavy machinery in road construction activities. In addition the operations at the quarries, borrow pits and crushing plant will generate high levels of noise. During the construction phase increased noise levels will emanate from the road rehabilitation activities, turbine installation activities and general construction work.

During the operation phase, there will be wind turbine noise that will emanate from several sources including:

- Cooling fans;
- Generators;
- Blades;
- Power converter;
- Hydraulic pumps;
- Yaw motors; and
- Bearings.

However, it should be noted that modern Vestas turbines are associated with low noise levels. In addition these turbines mainly emit low frequency sound or the so called infrasound in which human beings require high levels for perception.

Of particular importance in this project is whether the noise levels produced by project activities reach the staff houses or houses (Manyattas) belongong to the local community in the project area. According to the WHO guidelines, noise impacts within dwellings include annoyance, speech interference and sleep disturbance. WHO considers that for bedrooms, the critical effect is sleep disturbance. Guidelines values for bedrooms are 30 dBA for continuous noise. This happens to be the magnitude of noise the Vestas 90 wind turbines produce at the wind park site. Considering that for most types of dwelling the noise attenuation through the walls of the building is at least 10 dBA, a noise level of 40 dBA is acceptable at the walls outside dwellings. In general distance between the wind turbines and the nearest dwelling should be at least about 400 meters. In the project area the distance between the turbines and the nearest dwelling will be 40 km or so. It is therefore unlikely that there will be any noise disturbance emanating from the presence and operations of the proposed wind park facility in the project area.

8.2.13 Air emissions

Road construction activities will contribute to air pollution through gaseous emissions. This will emanate mainly from exhaust pipes for vehicles and machinery used in road construction. The construction and operation of the power plant is likely to release air emissions from construction machinery, turbines, vehicles, diesel generators, workshops and camps sites. The composition of gases released to the environment will include carbon dioxide, water vapour, organic acids, ammonia and traces of carbon monoxide, nitrogen oxides and sulphur oxides among other substances.

8.2.14 Dust pollution

Road rehabilitation activities and to some extent the wind park construction activities have the potential to generate high levels of dust in the project area. The situation will be aggravated by the aridity and the scarce vegetation cover in the project area. Areas where high dust production is likely to take place include sections where construction is taking place and in both quarries and borrow pits sites. The crushing plant also has great potential to generate high quantities of dust thus creating a hostile environment and a health hazard to the workers.

8.2.15 Potential increase in pollution from solid wastes and effluent discharge

It is expected that various solid and liquid waste streams will be generated from activities associated with the road rehabilitation, construction and operation of the power plant. It is envisaged that the major waste streams are likely to be:

- Domestic effluent; and
- Miscellaneous solid wastes.

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

8.3 Impacts Beyond National Boundaries

The Lake Turkana Wind Power Project will be located in Marsabit District of the Eastern Province of Kenya. The project area is situated more than 200 km from Ethiopia border, the nearest country to the project area. The impacts of this project are not likely to adversely affect the environment of Ethiopia or any other state.

It should, however, be noted that some of the avifauna found in Lake Turkana have migrated from other countries. For example, thirty four (34) Paleartic migrants have been recorded around Lake Turkana and over 100,000 Little Stints (representing more than 10% of entire East African / South East Asia bird population) may winter here. There is therefore potential to affect the migration of birds, over wintering birds and birds on passage to other countries. As stated above in Section 8.2.8: Impacts on avifauna, the design and siting of the proposed wind park facility is unlikely to have any impacts birds. It is also unlikely that there will be any impacts of the proposed project beyond the national boundaries.

8.4 Impacts of Disposal of the Turbines during Project De-commissioning

Generally the disposal of the turbine components during project de-commissioning has the potential to affect the environment. However, this may not be the case for the project area. It is likely that the turbine will be dismantled and re-exported, since 88% by weight of the turbine can be re-used. This means that the environment is spared extra extraction of non renewable resources. However, there will be wasted energy used to break down the turbine from the project site. In addition de-commissioning activities will some minor negative impacts on the flora and physical environment of

the project area. Following the de-commissioning of the turbines, buildings belonging to the project will be acquired by the Government or other selected stakeholders in the project area.

Alternatively, the wind farm will be in the project area for a very long time. After 20-25 years, new wind mills will replace the old ones. The buildings will last about 50 years before they are replaced.

9. PROPOSED ENVIRONMENTAL MANAGEMENT PLAN

As seen from the previous chapter (Chapter 8), the negative impacts emanating from construction activities and subsequent presence and operations of the proposed wind park, have the potential to adversely affect the environment of the project area. The basic objective of the management plan is to institute measures to address the negative impacts and sustainably manage the environment of the project area. Environmental management plan involves the implementation of the following two important processes:

- Mitigation plan and
- Environmental monitoring.

9.1 Measures to Mitigate Negative Impacts

In order to promote sustainable development and maintain a health environment in the project area, the developer will undertake to institute several measures to reduce or alleviate the negative impacts of project development as described below.

9.1.1 Amelioration of socio-economic negative impacts

In order to maintain harmony among various communities in the project area, there will be a dire need to raise awareness about the project. Of special importance is awareness with regard to project benefits that different communities stand to gain. The project should guard against raising expectations that can not be met. All communities need to be kept abreast of all project development activities and should sufficiently be consulted on all maters that concern them. The project should engage a neutral person who is accepted by all the communities in the project area to interact with communities, raise awareness on the project activities and to resolve any conflicts that may arise between the project and the communities involved.

9.1.2 Reduction of the utilization of wood resources

As stated in the report, the increased population in the project area will make high demand of fuel wood resources. There is therefore a need for the provision of alternative source of energy during the implementation of the project to ensure that uncontrolled utilization woody resources does not take place in the project area. In addition there will be a need to explore more efficient ways of making charcoal through efficient kilns and saving energy through the use of efficient stoves such as **Kuni Mbili.** The project should encourage the local population through support of the relevant local CBOs to conserve the plant resources including participation in planting of trees in the project area.

9.1.3 Reduction of incidences of diseases

With regard to the influx of commercial sex workers into project area following the project activities, the project should be prepared for an increase in the prevalence of HIV/AIDS. To prevent the spread of HIV/AIDS in the project area, the developer and other stakeholders including the administration, community leaders, opinion leaders, and other stakeholders must organize and support education programmes to increase awareness and change public attitudes towards HIV/AIDS and other sexually transmitted diseases (STDs). In order to protect the project workers, there will be a need for the project developer to supply the workers with STD prevention devices including the male and female condoms.

9.1.4 Reduction of visual intrusion

All degraded areas resulting from the road rehabilitation and wind park construction activities including the quarries, borrow pits, cuts and fills and other disfigured surfaces in the project area and environs, need to be landscaped and suitable grass, shrubs and trees planted to blend with the environment.

The presence of the wind park facility in otherwise an unspoilt natural environment is likely to be visually intrusive to some people. It has the potential to detract observers from the normal scenery. It is therefore necessary to paint the turbine, mast, blades and other components with colours that blend with the environment especially shades of pale green, brown and gray in order to further reduce visual intrusion in the project area.

It may, however, be noted that the wind park is not an ordinary sight and being a novelty, could be appealing to a wide cross- section of local community, other Kenyans and even foreign visitors. Indeed it could as well be a local attraction drawing many observers from beyond the project area.

9.1.5 Management of labour force

The labour force engaged in the rehabilitation of the road and construction of the wind park have potential to degrade the environment of the project area as discussion in earlier sections of the report. The project management should therefore put in place mechanisms to deter the work force from engaging in cutting of trees for fuel wood, charcoal burning, and building material and for any other purposes. Due to the sensitivity and vulnerability of the project area, the developer / contractor should use pre-fabricated material (which can later be retrieved at the end of the project) in building the labour camps. This will deter the labour force from unnecessary cutting and trampling of vegetation and enhance the protection of the scanty natural vegetation of the project area.

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

9.1.6 Waste management

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

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

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

9.1.7 Noise abatement

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

As discussed in Section 8.2.12: Increased noise levels, modern Vestas turbines are associated with low noise levels. These turbines mainly emit low frequency sound or the so called infrasound in which human beings require high levels for perception. It is therefore unlikely that there will be any noise disturbance emanating from the presence and operations of the proposed wind park facility in the project area.

9.1.8 Control of dust and gaseous emissions

The dust particles and the chemical substances contained in gaseous emissions may cause eye and throat irritations even at low levels. Respiratory illness, lung damage and other health hazards are likely to occur when the workers are exposed to high concentrations of the dust and gaseous emission pollutants and for a long time.

To mitigate air quality impacts during the road construction, emissions of dust, smoke and other substances should be limited through good practices. These include watering of access routes, deviations and other disturbed sites, use of dust extractors and covering of lorries transporting construction materials. Appropriate selection of machinery will also minimise pollution from the gaseous emissions. Workers involved in construction activities that generate dust and gaseous emissions should be provided with appropriate protective devices to cut down on dust and gaseous emissions inhaled. These will include masks, helmets and appropriate overalls.

Gaseous emissions produced during the operations of the wind park facility will be minimal. Wind energy is very clean energy when compared to other modes of energy. For example, it has been shown that wind turbine produces 8 grammes of carbon dioxide (CO_2) when generating 1KWh of electricity, while the corresponding amount for the coal fired power station is 826 grammes of CO_2 .

9.1.9 Reduction of ponding conditions

The road rehabilitation, wind park construction and other project activities may lead to creation of stagnant water bodies in quarries, borrow pits and other depressions created during the construction works. Although water collected in the depressions may be a respite for the pastoralist, the resultant stagnant water bodies are likely to

be suitable habitats for the breeding of mosquitoes and snails that are disease vectors for malaria and bilharzias respectively. Measures should therefore be put in place to improve impeded drainage in the project area through landscaping and filling in the created depressions.

Although the project area is situated in an arid zone, occasional high volume of runoff in the laggas should be adequately accommodated in the road design which should allow for bridges, culverts and drifts at appropriate locations. In addition, the road design should also provide side drains, and mitre drains to direct the runoff away from the rehabilitated road.

9.1.10 Reduction of soil erosion and siltation

As seen from above, increased soil erosion is likely to occur in the project area following the road rehabilitation activities, operations of borrow pits and quarries, construction of the wind park and installation of turbines and other associated activities. There is therefore a need to carry out a serious programme to rehabilitate the degraded environment. A major environmental problem will emanate from the disposal of loose earth which is likely to be a source of silt in the run off especially during the rainy season. Immediate action should therefore be taken to address the issue of soil erosion and the potential for the siltation of the shore environment of Lake Turkana. In this connection the following measures need to be carried out:

- Silt traps to be installed to prevent sediments from entering the laggas leading into Lake Turkana;
- Proper terracing and landscaping of the affected area; and
- Planting of sediment binding grasses such as *Sporobolus spicatus* and other suitable grasses on the exposed slopes and other surfaces.

9.1.11 Restoration of habitat and biodiversity

Following the implementation of the project activities, the natural vegetation in the disturbed areas have virtually no chances of survival. The project management should therefore undertake to restore the lost biodiversity on the disturbed area. This needs to be done through planting of appropriate trees such as *Acacia tortilis and shrubs such as Acacia nilotica, Acacia reficiens, Indigofera spinosa* and *Sericocomopsis hildebrantii* on the landscaped area in order to increase plant biodiversity and enhance aesthetic value of the wind park.

9.1.12 Measures to avoid disturbance of livestock activities

Since the major land use of the project area is livestock keeping, measures should be put in place to avoid disturbance of livestock activities especially grazing/browsing and access to watering points. In addition, the wind park should be designed in such a way that it will not significantly decrease the livestock grazing/browsing area. In order to avoid any disturbance to livestock activities, the project developer should not undertake to fence the wind park, thus allowing the livestock to graze/browse and move freely within the project area. However, a small area (10mX10m) around the turbine foundation will be fenced to avoid interference of the wind turbines by the livestock or other animals. The developer will avoid siting the wind park facility across the livestock watering pathways.

9.1.13 Reduction of impacts of wind park on birds

The main environmental concerns when constructing wind parks has been birds colliding with the turbines especially in areas where large numbers of migratory birds pass. Most of the potential impacts of wind park on birds can be reduced to acceptable levels through careful siting, design and mitigation as outlined below:

- It should be noted that cumulative effects of large wind farm installation may be considerable especially where wind park acts as a barrier and bird movements are consequently displaced. This may lead to the disruption of ecological links between feeding, breeding and roosting areas. A suitable wind park design can alleviate barrier effect to birds by allowing wide corridors between clusters of turbines.

- In order to avoid or minimize birds' collisions, the project developer should retain unattractiveness of the wind park site and its vicinity to birds. For example within a radius of 2-5 km around the wind park, the developer should avoid any introduction of open water habitats, sewage ponds, or open dumps.

- Perhaps the most important mitigation measure against birds' collisions in the project area is the siting of the wind park. Siting of the wind park should be done as early as possible in the planning stage. The wind park should be sited away several kilometres (at least 3km) from Lake Turkana shore and also away from the forested areas of Mt Kulal (at least 1km) and other mountains and hills of the project area.

- Lighting of turbines has the potential to attract birds, especially at night and in bad weather, thereby potentially increasing the risk of collisions. Any intensive lighting of the wind turbines should be avoided to reduce attractiveness to nocturnal bird migrants.

9.2 Action Plan for Prevention of Accidents, Health Hazards and Management of Security and Fire Outbreak in the Project Area

9.2.1 Prevention of accidents

Implementation of the project will definitely increase volume of human and motor traffic in this remote area. The increase in human and motor traffic will be aggravated by the transportation of construction materials and plant accessories and other equipment required to install the wind park. This is likely to result in a higher risk of accidents occurring in the area of operation during the road rehabilitation, wind park construction and wind park operation phases. There will therefore be a need for the developer to design and implement safety measures and emergency plans to contain accidents risk associated with project activities including vehicular transport, operation of machinery, equipment and other related activities.

Workers need to be educated on the use of unfamiliar machinery, equipment and tools that may cause a danger to the users. In addition, the workers should be provided with safety instruction manuals and other essentials to contain accidents. Proper and appropriate road traffic signs, markings, and road furniture should be installed on the rehabilitated road. Workers should be provided with protective clothing (nose and mouth masks, ear muffs, overalls, industrial boots and gloves) and helmets.

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

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

9.2.2 Health hazards

During both the construction and operation phases of the proposed project, significant health hazards and incidents are likely to occur among workers. Therefore attention must be focused on the health of workers in order to attain health conditions that will permit them to lead socially and economically productive lives. Proper disease control, disease prevention and treatment and methods of raising awareness must be employed among the project workers in order to minimize disease incidences and reduce morbidity.

Of particular importance to the project workers are health issues relating to HIV/AIDS in the project area. AIDS (Acquired Immunno-deficiency Syndrome) was first diagnosed in Kenya in 1984 and now has become a serious health and economic problem in the country. The project workers and the surrounding local community must be educated on the strategies of minimizing the risk of contracting HIV/AIDS including the use of male and female condoms.

In order to enhance health conditions in the project area, there is need for the Lake Turkana Wind Power Project to set up a local medical unit to provide health care to both the project workers and the local community.

9.2.3 Security

Despite the fact that Loiyangalani including the project area is a relatively peaceful area, the surrounding areas especially to the north are fraught with insecurity problems. The developer should therefore take precautions to beef up the security of the wind park and the staff quarters. There will be a need to hire services of the local guards. However, the local guards will need to be reinforced by a more professional security force from the leading security firms in Kenya. In addition an alarm system will be installed as a back up for the above outlined security measures. Even more important, the project management should cultivate harmonious co-existence between itself and the local communities in the project area.

9.2.4 Fire protection

Adequate measures should be taken against the potential fire hazards in the project area. They include installation of functional fire protection systems such as water based fire fighting system with water hydrants strategically placed to cover the whole wind park premises. In addition, CO_2 based portable and fixed fire extinguishers need to be sited at strategic positions to cover the staff premises. The above fire protection systems should be backed by a reliable service provider to service the appliances at least on a quarterly basis.

9.2.5 Other measures to enhance health and occupational safety

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

- Provision of a fully equipped first aid kits in the project area during the project construction and operational phases ;
- Provide medical cover for all staff in order to enhance health standards at the wind park facility;
- The health staff, environmental officer and other relevant workers should be well trained to act as Safety Officers after acquiring adequate knowledge and experience on first aid training and excellent knowledge of safety regulations;
- The Contractor should have Workmen's Compensation Cover for the workers;
- The project should conduct health and safety audits regularly for all the workers on an annual basis;
- Take measures against risks of electrical shock;
- Conduct environmental audits for the wind park in accordance to the requirements of NEMA;
- Put in place mechanisms aimed at acquiring ISO 14001 certification on environmental management and Occupational Health and Safety Standard Certification (OHSAS 18001) for the Turkana Wind Park; and
- Conduct training programmes covering several aspects of safety, customer care, defensive driving, first aid, AIDS, environmental awareness, swimming and life saving activities among other training aspects.

9.3 Environmental Monitoring

Monitoring is envisioned as an important process in the protection of environment of the project area. It will reveal changes and trends brought about by the presence and operations of the installed wind park facility. The project management will therefore undertake to conduct sustained environmental monitoring of the project area during the life of the Lake Turkana Wind Park Project. The basic attributes for the proposed monitoring programme will involve the following:

- Collection and analysis of appropriate environmental data;
- Preparation of periodical reports and liaison with other relevant bodies;
- Identification of unexpected environmental impacts; and
- Formulation of counter-measures to mitigate the unexpected negative impacts.

9.3.1 Focus areas for monitoring

The developer is expected to will carry out monitoring on both terrestrial and aquatic environment of the project area and surroundings including Lake Turkana with a focus on the following environmental variables:

- Changes in biodiversity;
- Avifauna mortality;
- Any changes in livestock activities;
- Changes in water quality including increase in pollution;
- Soil erosion and siltation;
- Noise levels;
- Increase in social problems; and
- Other relevant ecological, socio-economic and environmental attributes.

It should be emphasized that during the monitoring process, there will be a need to carry out investigations to verify predictions made during the course of environmental impact assessment study especially with regards to the impacts on the avifauna of the project area. In this regard it is proposed that a minimum one-year baseline field study should be undertaken to determine the use of the study area by birds and to identify, if any bird species that may be adversely affected by wind park presence and operations. With respect to the ecology of birds, monitoring of the project will encompass at least the following:

- Effects of habitat loss, disturbance and displacement on birds of the project area;
- Barriers to birds movement;
- Birds collision mortality; and
- Effectiveness of different wind park layout and turbine design on the mitigation of negative impacts.

9.3.2 The need to recruit an environmental officer

In order to conduct a sustainable environmental monitoring of the project area and thus protect environment from negative impacts of operations of the proposed project, there will be a need to engage an Environmental Officer to be stationed at the project area. This officer will initiate and operationalize the proposed mitigation plan and make plans to conduct environmental monitoring on a regular basis. In addition he /she will make plans to sensitize the local community on the socio-economic impact of the wind park development. The recruited environmental officer will possess appropriate training and experience on environment and socio-economic background with at least a Masters degree in environmental sciences, socio-economics or natural resources management.

9.3.3 Terms of reference for environmental officer

The main responsibility of the proposed environmental officer is to carry out a sustainable environmental management of the project area on a daily basis in order to ensure healthy environment for the workers and protect the environment of the project area from negative impacts of project implementation. He /she is expected to carry out the following main duties:

- Conduct surveys and monitor the environment of the wind park facility on a regular basis;
- Facilitate regular collection and analysis water, waste water and other ecological samples through use of suitable laboratories;
- Liaise and establish networks for exchange of information and ideas with relevant institutions including the KenGen, KPLC, Government Chemist, National Environmental Management Authority (NEMA), Nature Kenya, KWS, Universities, Meteorological Department, Marsabit County Council, and the National Museums of Kenya among other relevant institutions on matters concerning environment;
- Prepare environmental reports and briefs to the project management on the state of the environment of the project area and emerging trends if any; and
- Formulate strategies and counter measures to protect the environment from unforeseen impacts.

9.3.4 Cost estimates of environmental management

The cost estimates for the proposed environmental management will include variables such as remuneration for the proposed environmental officer, transport expenses, construction of silt traps, landscape of relevant areas in the project area, waste management, purchase of incinerator, purchase of consumables, payments for sample analysis, report writing and other documentation and miscellaneous expenses. The total cost for the protection of the environment and other related activities is estimated at KSh.19,800,000 (€204,117). A summary of cost estimates is presented below in Table 8.

Table 8 Cost Estimates for the Proposed Environmental Management (One Year Operation)

Project Activity		**Cost Estimate (KSh)**
1	Remuneration for environmental officer	2,500,000
2	Purchase and running of a vehicle and other transportation requirements for environmental officer	4,500,000
3	Support for community awareness and sensitization programme	1,500,000
4	Project social responsibility programme (support to fisheries, community water supply, environmental conservation, health, education etc.)	4,000,000
5	Baseline field study on impacts of the wind park on birds.	1,500,000
6	Sample analysis (chemical and biological, and other samples)	100,000
7	Purchase of consumables (computer, sampling apparatus, field equipment etc.	300,000
8	Purchase of stationery, documentation and report writing	100,000
9	General landscaping works including construction of soil traps	1,500,000
10	Waste management activities including purchase of an incinerator	2,000,000
11	Contingencies (10% of the total cost of the environmental management plan)	1,800,000
Total Estimated Cost for Environmental Management		**19,800,000**

9.3.5 Time frame for the implementation of the management plan

At this stage of wind park development it is rather difficult to put a time frame to the implementation of the proposed management plan. It should, however, be noted that implementation of the management plan will basically be a continuous activity during the life time of the project. It starts with the commencement of the construction works and continues through the operation phase. On an annual basis the Client is expected to conduct Environmental Audit (EA) of the wind park in accordance with EMCA Regulations and Guidelines. The environmental management activities will cease following the de-commissioning of the plant.

9.3.6 Responsibility for the implementation of management plan

The overall responsibility for the implementation of the management plan lies with the Client, Lake Turkana Wind Power Project. This responsibility could, however, be delegated to the Client's agents. During the construction phase the project contractor under supervision from the Client's agents (project engineer, architect and consultant environmentalist) is expected to implement relevant environmental mitigation measures including rehabilitation of quarries and borrow pits, landscaping grassing and planting of trees among other relevant activities. The Contractor should ensure that all the installations are functional for at least a period of one year after the completion of construction activities.

During the operation phase, the implementation of the management plan is expected to be under direct supervision of the Client through the recruited Environmental Officer. In the initial stages, however, there may be a need to hire the services of an

independent and well experienced environmental consultant to guide the newly recruited Environmental Officer and put systems in place for the implementation of the management plan especially the environmental monitoring.

10. GAPS IN KNOWLEDGE AND UNCERTAINTIES ENCOUNTERED IN THE COMPILATION OF THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Gaps in knowledge and uncertainties associated with the environmental impact assessment of this project and compilation of the report touch on two main aspects including acquisition of data and information and consultations.

10.1 Acquisition of Data and Information

In carrying out this assignment, the consulting team made extensive use of the secondary data and information. For obvious reasons this section will be treated in a general format and no actual examples will be given. Acquisition of required secondary data and information presented unique challenges to the consulting team. In many cases the available data was scanty and whatever was available was scattered in several repositories. Hence the consultants spend valuable time in several institutions trying to acquire bits and pieces here and there. This situation was aggravated by the extensive protocols and bureaucracy involved in getting permission to acquire the relevant data and information from the relevant officers. This situation was also complicated by the many appointments that for one reason or another were not honoured and the many cancellations effected on very short notices.

It should be emphasized that collection of data involves resources and several government institutions do not have adequate resources to collect data on a sustainable basis. Consequently many gaps do exist in the available data bases. In other cases there was no current data and the consultants had to do with data collected several years back which may not adequately reflect the current environmental situation. Against this background, there was the issue of the quality of the data available to the consultants. Due to constraints in time and lack of other alternatives the consultant had to do with available data and information.

10.2 Public Consultations

The main objective of public consultations is to sensitize the stakeholders on the proposed project and get their views on the perceived social effects and impacts of the proposed development on the local community. In addition public consultations are conducted to get the people's ideas on how the negative impacts of the proposed project can be mitigated. During public consultations with the local community who are mainly pastoralists, the consultants were faced with the challenge of communication. To get the message across, the consulting team had to rely on local interpreters. At times it was not clear whether the consultants' explanation of the project's workings, the impacts generated and the mitigation measures proposed were well understood by the local members of the local community in the project area.

11. CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

The following conclusions are drawn with regard to the environmental assessment of the proposed Lake Turkana Wind Power Project:

1. The major positive impacts of this project will include stabilization of electricity in Kenya, promotion of economic growth in the country, contribution to the Government revenue, increased employment, improvement of roads in the project area, improvement of medical services and promotion of improvement of environment in the project area.

2. The increase in number of people in the project area following the commissioning of the project will lead to a number of negative socio-economic impacts including cultural contamination, increased incidences of diseases, insecurity and community conflicts, challenges of labour force management and increased accidents and occupational hazards.

3. The project activities are likely to cause albeit on a small scale loss of habitat, destruction of floral and faunal communities, disturbance to livestock, soil erosion and potential siltation of aquatic habitat, pollution, ponding conditions and increase in noise. Perhaps the most serious negative impact is the potential for birds' mortality through collisions with the turbines.

4. The study has proposed several measures to reduce negative impacts including amelioration of social negative impacts, noise abatement, waste management, reduction of visual intrusion, restoration of habitat and biodiversity, reduction of soil erosion and siltation, prevention of accidents and health hazards and provision of health care services. In addition, measures have been proposed with regard to the siting of wind park in order to reduce collision of birds with turbines.

5. Monitoring has been identified as an important process in the protection of environment of the project area since it will reveal changes and trends brought about by the presence and operations of the installed wind park facility.

6. The total cost for the protection of the environment is estimated at KSh.18,150,000 (€181,300).

11.2 Recommendations

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

1. Due to the increased population in the project area and the subsequent high demand of fuel wood resources, there will be a need to encourage the workers to use alternative source of energy during the implementation of the project in order to protect the scarce wood resources of the project area. There will be a need also to explore more efficient ways of making charcoal through efficient kilns and use of efficient stoves including **Kuni Mbili** stoves.

2. Given the high level of expectations among the local community about the project, it is recommended that the communities' expectations are managed by having candid dialogue with them right from the start.

3. It is recommended that broad community sensitization regarding potential cultural contamination and other negative impacts of the proposed project need to be carried out in the project area, in order to prepare the people to develop a coping mechanism.

4. As part of its social responsibility, the project should put in place mechanisms to assist the marginalised communities in the project area, in accordance to the identified needs of the community. However before any social responsibility work is carried out, a Participatory Rural Appraisal (PRA) should first be carried out to identify the community felt needs.

5. The developer needs to support the implementation of environmental management (including mitigation plan and monitoring) in order to protect the environment of the project area from the negative impacts of project implementation.

6. In order to conduct a sustainable environmental management in the project area, there will be a need to engage an Environmental Officer to be stationed at Loiyangalani. The engaged officer will put in place mechanisms to initiate and operationalize the proposed mitigation plan and environmental monitoring on a regular basis.

7. Since the major land use of the project area is livestock keeping, measures should be put in place to avoid disturbance of livestock activities especially grazing/browsing and access to watering points. Except for the small areas (10mX10m) around the turbine foundation, there should be no fencing of the wind park facility.

8. In order to avoid impacts of birds' collisions with turbines, the project developer should put in place mechanisms for a careful design and siting of the wind park. The wind park design should allow for wide corridors between a cluster of turbines. The wind park will need to be sited away at least 3km from the shore of Lake Turkana and at least 1km away from the nearest canyon.

9. The project needs to carry out investigations to verify predictions made during the course of environmental impact assessment study especially with regards to the impacts on the avifauna of the project area. In this regard it is recommended that a minimum one-year baseline field study needs to be undertaken to determine the use of the study area by migrating and over wintering species of birds and to identify species that may be adversely affected by wind park presence.

ANNEXES

This section of the report comprises the following annexes:

Annex 1. References.

Annex 2. Photographic Plates Showing the Salient Features of the Project Area.

Annex 3. People and Institutions Consulted During the Study Process.

Annex 4a. Analysis of Waters from Loiyangalani Springs and Lake Turkana.
Annex 4b. Water Quality in the Project Area and Surrounding Areas.

Annex 5. Common Flora Identified within the Project Area and Surroundings.

Annex 6. Common Water Birds of Lake Turkana.

Annex 7a. Fisheries of Loiyangalani (2006).

Annex 7b. Fisheries of Loiyangalani (2007).

Annex 8 Positions (UTM Coordinates) of the Vestas 90 Turbines in the Project Area.

Annex 9 Stakeholder Consultations in the Project Area.

Annex 10a. A List of Persons Invited for the EIA Stakeholders' Meeting (21-22 April 2008).

Annex 10b. Participants of the EIA Stakeholders Meeting.

Annex 11 Minutes of the EIA Stakeholders' Meeting.

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Annex 2. Photographic Plates Showing the Salient Features of the Project Area

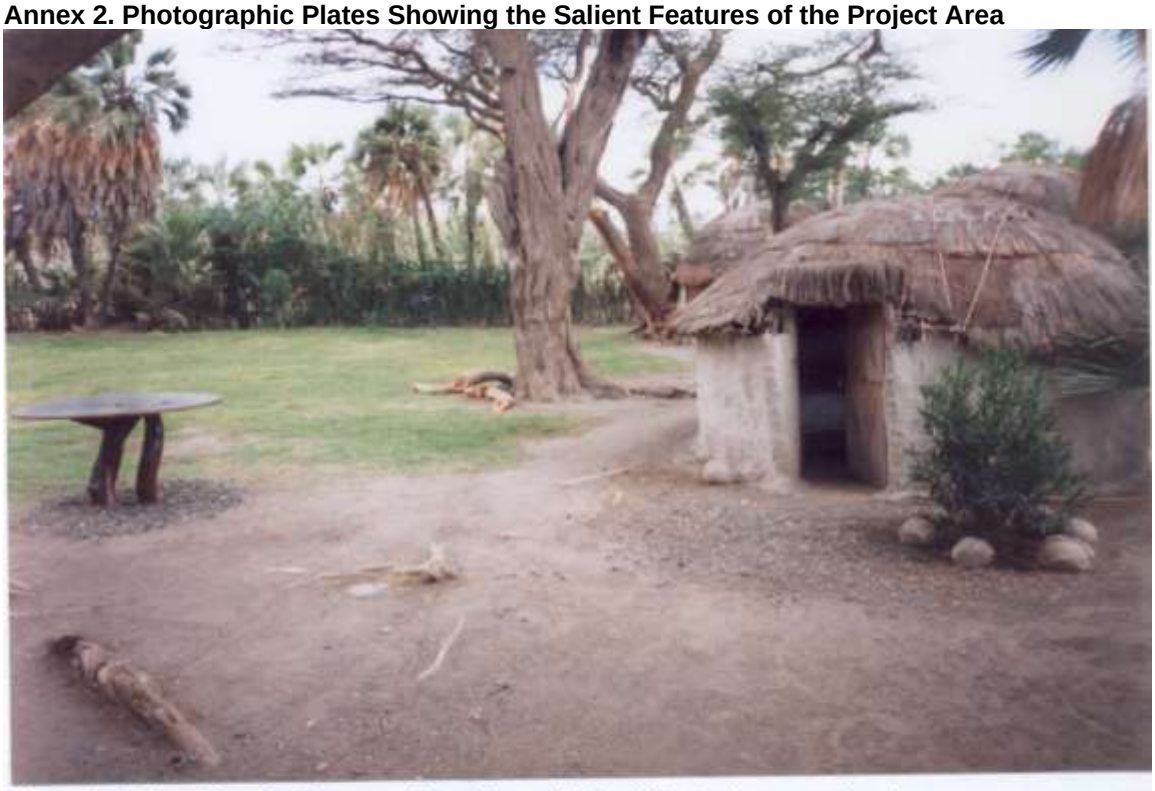

Plate 1: Palm Shade Camp, a local tourist facility in Loyangalani

Plate 2: A water spring at Loyangalani

Plate 3: Community consultative meeting at Yammo Manyatta, Loyangalani.

Plate 4: A Turkana Community receiving water from the Consulting Team

Plate 5: Loyangalani Road close to southern end of Lake Turkana.

Plate 6: Lake Turkana Windpower mast at Loyangalani.

Plate 7: A Fisherman with a fish catch on the shore of Lake Turkana

Plate 8: Turkana Fishermen set on a fishing mission. On the foreground is Southern Island

Plate 9: The area around the southern shoreline of Lake Turkana. The dominant shrub is *Sericocomopsis*.

Plate 10: Shoreline of Lake Turkana. Note the paucity of aquatic vegetation

Plate 11: Lagga Yammo. The large trees are *Acacia tortilis* and the dwarf shrub is *Sericocomopsis*

Plate 12: Lagga Sirma with *Acacia tortilis* trees

Plate 13: Camels in the Project Area.

Plate 14: Goats grazing in the Project Area

Plate 15: A water hole in the Project Area

Plate 16: Earth dam for the watering of cattle at the periphery of the project area on the way to Qatab, Mt Kulal region

Plate 17: Miniature sand dunes to the south of the project area. The dwarf shrub is *Jatropha.*

Plate 18: *Acacia reficiens* near Kaisut area.

Plate 19: Acacia (*Acacia drepanolobium*) woodland to the east of the project area on the way to Qatab.

Plate 20: Mt. Kulal Forest to the east but outside of the project area.

Annex 3. People and Institutions Consulted During the Study Process

1. Aggrey Ogosi: Finance Assistant, Farm Africa, P.O.BOX 159, Marsabit, Tel. 0721412747.
2. Benedict Leurare: Loiyangalani Catholic Mission, Tel. 0723867205.
3. Benedict Orbora: Manager, Palms Shade Camp, Loiyangalani, Tel. 0728966620.
4. Benina Ekusi (Mrs.): Resident Loiyangalani, Tel. 0710 734281.
5. David Muriuki Njamweah: District Cooperative Officer, Marsabit, Tel. 0722 562702.
6. C.K. Lekapana: Senior Chief, Loiyangalani Location, P.O. Loiyangalani, Tel No. 17 Loiyangalani.
7. Dominic Mbuvi: Livestock Coordination Officer, Food for the Hungry, Kenya, dmbuvi@fhi.net, P.O.BOX 125, Marsabit.
8. El Molo Community in Loiyangalani
9. Esther E. Chiwe: District Gender & Social Development Officer, Marsabit, Tel. 0725769706.
10. Frederick Mbithi Kitema: District Officer (DO1) Marsabit, Tel. 0722894298.
11. Gabriela Lakapana (Nurse), Loiyangalani Health Centre (catholic Mission), Loiyangalani.
12. Godona J. Doyo: Arid Lands Development Project (AlRMP), Marsabit, Tel. 0724369880.
13. Ibrahim Adan: Chief Executive Officer, Community Initiative Facilitation and Assistance (CIFA), Tel. 0734 168010.
14. Kifaru Women Group, Loiyangalani.
15. Jacinta Alia Lebasha, Teacher and Member of Kifaru Womens Group, Loiyangalani.
16. Jane Saka Orbora: Assistant Fisheries Officer Loiyangalani, Tel. 0728 966620
17. Jeremiah Omechi Onchera: District Development Officer, Marsabit, Tel. 0725995812.
18. Jim L. Teasdale: African Inland Church (AIC) Pastor at Loiyangalani, Tel. 0722-790264.
19. John Kagwi: Assistant Director, Northern Conservation Area, Tel. 0722 293216.
20. Juma Makopa: Chemistry Department, University of Nairobi.
21. Leparsanti S. Teresalba: Teacher, Loiyangalani Primary School, Tel. 0728626812.
22. Mamo Boru Mamo: District Environmental Officer, Marsabit. National Environmental Management Authority (NEMA). P.O. BOX 204, Marsabit, Tel. No. 0735 433860.
23. Mosaretu Women Group, Loiyangalani.
24. Nachukul Longolob Ekal: Kenya Wildlife Service Ranger, Sibiloi National Park (Southern Island National Park), Tel 0720222774.
25. Nayori Environmental Conservation Rehabilitation Youth Group, Loiyangalani.
26. Peter Lengewa: Loiyangalani Fishermen Cooperative Society, P.O. BOX 13 Loiyangalani.
27. Peter N. Gakunyi: Pastoralist Integrated Support Programme (PISP), Tel. 0692201.
28. Rebecca Lepalat Lebasha, Forest Department, Loiyangalani Division
29. Samburu and Rendille Elders of Kiwanja Ndege Manyatta, Loiyangalani.
30. Turkana Community at Nakuame Kwi Manyatta, Loiyangalani.

31. Turkana Yammo Manyatta Community, Loiyangalani
32. Veronica Lenges (Mrs.): Resident Loiyangalani Town, P.O. BOX 1, Loiyangalani.

4a. Analysis of Waters from Loiyangalani Springs and Lake Turkana

Parameters	Unit	Results		
		Tap Water – Palm Shade Camp - Loiyangalani	**Surface Flowing Spring Water - Loiyangalani**	**Lake Turkana Water - Loiyangalani**
pH	pH scale	8.52	8.75	9.56
Colour	mgPt/l	< 5	< 5	< 5
Turbidity	NTU	1	6	7
Permanganate value (20 min boiling)	MgO_2 / l	< 0.4	1.58	1.58
Conductivity (25^oC)	µS / cm	247	385	3840
Iron	Mg / l	0.03	0.14	0.09
Manganese	Mg / l	< 0.01	< 0.01	0.01
Calcium	Mg / l	7.2	7.2	0.8
Magnesium	Mg / l	15	23.3	33.5
Sodium	Mg / l	19	34.2	807
Potassium	Mg / l	1.4	2.4	20
Aluminium	Mg / l	0.29	0.34	0.43
Total Hardness	Mg / $CaCO_3$	80	114	140
Total Alkalinity	Mg / $CaCO_3$	100	150	1364
Chloride	Mg / l	9	15	345
Fluoride	Mg / l	0.3	0.28	0.26
Nitrate	MgN / l	0.8	2.5	6.2
Nitrite	MgN / l	< 0.01	0.04	< 0.01
NH_3	Mg NH_3 / l	1.25	1.02	1.94
Lead	Mg / l	0.04	0.04	0.03
Sulphate	Mg / l	5.7	10.9	38
Free Carbon Dioxide	Mg / l	Nil	Nil	Nil
Total Phosphorus	Mg / l	0.04	0.08	0.18
Total Dissolved Solids	Mg / l	239	1347	2381
Coliforms	Per 100 ml	28	770	2419
E. coli	Per 100 ml	Nil	32	Nil

Annex 4b. Water Quality in the Project Area and Surrounding Areas

Physico-Chemical Parameters	Source of Water Samples							
	Loiyangalani Springs	Adab Well	Muliko Springs	Arapal Springs	Allya Abbay Beach	Ileret Well	Nguruset Springs	Loiyangalani Beach
pH	8.23	7.72	8.69	6.37	7.51	7.62	8.06	8.63
Odour	None	None	None	None	None	None	None	None
Aluminium	0.1						0.01	
Ammonia	24.5	10.5		15.75		2.63	7.0	20.13
Calcium	22.0	45.0	3.6	2.9	52.0	29.0	27	4.9
Chlorides	12.0	44.0	432.0		108	4.0	4.0	198
Fluorides	2.1	2.3	3.8	1.7	2.5	2.0	2.2	3.0
Hardness	52.0	88.0	852.0	8.0	76.0	72.0	476	468
Iron	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Magnesium	23	47	35	0.8	53	4.8	12	100
Manganese						0.08		0.02
Nitrates	1.46	0.93			2.98	0.71	0.62	0.09
Phosphorus	2.9	4.3	4.3	3.2	4.2	2.7	3.7	5.0
Potassium	8.3	3.7	80	2.8	2.1	6.6	2.8	46
Sodium	82	150	2600	11	230	120	19	1300
Sulphates	7.89	15.78	218		30	7.89		88.41
Zinc		0.03	0.01	0.04	0.45	0.02		0.02
Coliforms	1			1				
E. coli	1	1	1	1	1	1	1	1

Source: Conservation and Community Development Programme – Lake Turkana, 2003.

Annex 5. Common Flora Identified within the Project Area and Surroundings.

CAPPARACEAE

- ***Boscia coriacea* Pax** (Eedung-Turkana): Short tree, seeds edible by local communities (Turkana) especially during severe drought. Common in the project site within the deciduous shrubland

- ***Cadaba farinosa* Forssk** (Eireng-Turkana): Shrub growing to 3m in height. Occasional in deciduous woodland. Good browse by cattle.

- ***Cadaba glandulosa* Forssk.** Emakak (Turkana): Short evergreen shrub found in riverbeds. Forage liked by camels due to its salt content.

- ***Capparis tomentosa* Lam.** Ekorokorait (Turkana) : Shrub on rocky outcrops and within deciduous woodland

- ***Maerua crassifolia* Forssk.** Ereng (Turkana): Short shrub, 2-3m. Good browse by camels. Occasional on rocky outcrops.

- ***Maerua decumbens (Brongn.)* De Wolf** Eerut (Turkana): Shrub to 3m in height. Common on dry river beds. Fruit said to be edible.

- ***Maerua oblongifolia* (Forssk.) A. Rich. :** Epipa (Turkana): Shrub to 4-7m in height. Occasional among *Acacia reficiens* shrubland

MORINGANGACEAE

- **Moringa rivae Chiov. :** Small tree, 3-5m in height. Found only in lava areas east of L. Turkana

POLYGALACEAE

- ***Polygala erioptera* DC. :** Annual or short-lived herb found on rocky dwarf shrubland areas.

AIZOACEAE

- ***Gisekia pharnaceoides* L.:** A trailing or shortly erect hairless annual with oblong-linear leaves. Common in dwarf shrubland dominated by *Indigofera spinosa* and *Sericocomopsis hildebrandtii.*

- ***Zaleya pentandra(L.)* Jeffrey:** A spreading or erect sub-succulent annual herb. Leaves narrow-or broad-elliptic. Rarely in rocky outcrops and on sand dunes.

PORTULACACEAE

- ***Portulaca oleracea* L.:** A hairless annual with many prostrate branches and alternate, obovate to spoon-shaped leaves. Used as green vegetables. Common in dwarf wooded shrubland and semi-deciduous bushland

- ***Portulaca quadrifida* L.:** A prostrate annual or stoloniferous perennial herb. Common in wet places and within dwarf shrubland areas and semi-deciduous bushland

- ***Talinum portulacifolium* (Forsk.) Schweinf.:** A hairless, loosely rooted perennial herb or small shrub. Leaves narrow, fleshy. Flowers purple-pink and in long terminals. Common in woodland and along river channels.

POLYGONACEAE

- ***Oxygonum sinuatum* (Meisn.) Dammer:** Annual herb with oblanceolate or obovate leaves. Flowers pink. Common in abandoned manyattas, roadsides and semi-deciduous bushland

CHENOPODIACEAE

- ***Chenopodium opulifolium* Koch & Ziz.:** Annual or perennial herb often woody below. Common in deciduous woodland and in abandoned manyattas.

AMARANTHACEAE

- ***Achyranthes aspera* L.:** An annual or perennial, short- or long-hairy, herb or shrub. Leaves lanceolate. Common in abandoned manyattas.

- ***Aerva lanata* (L.) Schultes:** A woolly erect woody herb or shrub with few branches. Leaves often spoon shaped. Flowers woolly-white. Common as a weed in abandoned manyattas and in semi-deciduous bushland

- ***Sericocomopsis hildebrandtii* Schinz:** A much branched bushy shrub with obovate to spathulate leaves and terminal racemes of sessile cymes. The inflorescence is white unlike in S. pallida. Good browse for camels and goats. Common among *Duosperma eremophilum* and *Indigofera spinosa in s*emi-deciduous bushland

- ***Sericocomopsis pallida* (S. Moore) Schinz:** A much branched, bushy dwarf shrub with white hairs on ovate-elliptic leaves. Inflorescence grey. Common in wooded dwarf shrubland

ZYGOPHYLLACEAE

- ***Tribulus terrestris* L.:** A hairy annual herb with trailing branches and leaves bearing 4-8 pairs of leaflets. Fruits almost spherical with sharp horned spines that are nuisance on bare foot. Common in deciduous woodland

- ***Tribulus cistoides* L.:** A trailing perennial or annual herb with unequal leaves bearing 4-8 pairs of leaflets. Fruits with two pairs of wicked spines. Common in grasslands with shrub such as *Acacia, Commiphora* and *Jatropha*

GERANIACEAE

- ***Pelargonium alchemilloides* (L.) Ait.f:** A perennial hairy herb with slightly swollen rootstock. Leaves alternate below, opposite above. Found in evergreen & semi-deciduous bushland

NYCTAGINACEAE

- ***Boerhavia coccinea* Mill.:** A prostrate or scrambling, annual herb. Flowers pink. Common in saline soil and in deciduous shrubland.

PASSIFLORACEAE

- ***Adenia venenata* Forssk. -** Olmurrilengiron, Loisinkiriatshoi (Samburu)): Creeper or climber 4-8m from a bottle-shaped swollen lower trunk with many branches arising from its top. Leaves 3-5-lobed. Flowers cream. Rare in deciduous wooded bushland (Acacia-Commiphora community).

CUCURBITACESE

- ***Coccinia grandis* (L.) Voigt:** Hairless perennial from a tuberous rootstock, the stems develops corky bark when mature. Leaves 3-5-lobed. Flowers yellow to orange, fruits normally egg-shaped, edible. Found in wooded dwarf shrubland and along dry riverbeds.

- ***Cucumis prophetarum* L. :** Perennial herb with bristly, not spiny, hairs; leaves kidney-shaped in outline; fruit yellowish densely covered with bristle-tipped, often curved projections. Found in wooded shrubland.

- ***Kedrostis gijef* (J. F. Gmel.) C. Jeffrey -** Sokodume(Samburu), Eiyarabos (Turkana)): Climber with ridged stems. Leaves 3-5-lobed; flowers yellow; fruit orange or red. Common in mixed shrubland; used by Turkana as eye medicine; root used to neutralize snake poison.

- ***Momordica boivinii* Baill.:** A hairy climber from tubers, with simple or divided tendrils and heart-shaped leaves. Found in deciduous woodland and along dry riverbeds.

OCHNACEAE

- ***Ochna ovata* F. Hoffm.:** Shrub or tree 9m in height; Leaves reddish when young, slightly ovate. Flowers yellow; fruits with black drupelets. Common in shrubland and on rocky outcrops.

COMBRETACEAE

- ***Combretum aculeatum* Vent. -** Ekabekebeke (Turkana): Shrub with curved spines. Common in *Acacia-Commiphora-Duosperma w*ooded dwarf shrubland

- ***Combretum molle* G. Don -** Eguren, Ekamiro (Turkana)): Tree, 8m in height; bark greyish, rough/fissured; young leaves and flowers appearing at the same time. Flowers yellow, in axillary spikes. Common on rocky areas on the slopes of Mt. Kulal in *Acacia-Commiphora* woodland.

TILIACEAE

- ***Grewia nematopus* K. Schum. (*G. tembensis* Fres.):** Shrub, 5m in height with virgate branches. Leaves elliptic to slightly obovate, margin serrated; flowers white tinged pink. Common in *Acacia-Commiphora* mixed bushland.

- ***Grewia tembensis* Fres. -** Irii (Samburu), Emalaker (Turkana)): Shrub 4m. Leaves slightly obovate, elliptic or almost round, margin serrate slightly sandpapery above; flowers white, pink or pale lilac. Common in bushland and along riverines.

- ***Grewia tenax* (Forsk.) Fiori -** Iri, Lairipai (Samburu), Eng'omo (Turkana): Shrub 3-5m in height. Leaves round, obovate, base rounded; flowers white; fruits orange-red. Found in bushland and on dry river courses and wooded dwarf shrubland

- ***Grewia bicolor* Juss. -** Siteti (Samburu), Ekali (Turkana): Shrub 7m in height with dark purple-brown bark, deeply fissured and peeling. Leaves obovate, base unequal; flowers yellow, in few-flowered axillary cymes; fruits orange or red brown-edible. Common in wooded dwarf shrubland.

- ***Grewia villosa* willd. -** Lpupoi (Samburu), Epongai (Turkana): Shrub 5m in height. Leaves round or broadly elliptic, base subcordate, margin serrate sandpapery or pubescent above; flowers yellowish, fruit orange or red, edible. Common in *Commiphora-Acacia* deciduous woodland.

- **Grewia trichocarpa A.Rich. -** Siteti (Samburu): Shrub or tree 6m in height. Bark silver grey. Leaves elliptic, base (unequally); flowers yellow; fruits orange-edible. Common in riverine woodland.

- ***Triumfetta flavescens* A. Rich. -** Ekwiyen (Turkana): Shrub 2m in height. Older branches with black lines often forming a characteristic reticulation. Leaves broadly ovate; flowers yellow, in a long terminal or leafy-opposed spike-like inflorescence; fruit ellipsoid with short bristles. Common in mixed bushland.

STERCULIACEAE

- ***Hermannia kirkii* Mast.:** A glandular hairy annual herb or shrub with oblong-lanceolate leaves; flowers pink-purple. Grassland with dwarf shrubs associated with *Acacia and Commiphora*

- ***Melhania ovata* (Cav.) Spreng. -** A grey-hairy woody herb or shrub with ovate or circular leaves; flowers sulphur yellow to orange. Common in mixed woodland.

- ***Sterculia africana* (Lour.) Fiori -** Etete (Turkana): Shrub or tree to 8m in height. Bark grey or liver red, smooth, flaking to show yellow-green under bark. Leaves spaced on young shoot; flowers in clusters terminal panicles; fruit with three-5 follicles. Balk yields fibre used to make strings. Rare in wooded bushland.

- ***Sterculia stenocarpa* H. Winkl. -** Ikalaasia (Samburu): Shrub or tree to 10m in height. Bark smooth (reddish purple or grey) flaking or peeling to show a pale green or grey under bark; trunk sometimes swollen. Leaves clustered on short shoots. Flowers yellow-green with reddish streaks. Fruit grey-green of 4-5 follicles. Rare in Acacia/Commiphora mixed bushland and wooded dwarf shrubland.

MALVACEAE

- ***Abutilon mauritianum* (Jacq.) Medic.:** Woody herb or shrub, 3m in height; leaves broadly ovate, base cordate. Flowers yellow. Occasional in bushland and along river channels.

- ***Hibiscus fuscus* Garcke:** An erect, sparsely-branched woody herb or shrub. Leaves ovate-triangular, simple or rarely 3-lobed; flowers white or purple. Common in mixed bushland under shade.

- ***Pavonia arabica* Boisso -** A densely glandular-hairy annual or short lived perennial; leaves ovate; flowers pink. Occasional in wooded dwarf shrubland of *Commiphora and Jatropha*.

- ***Sida ovata* Forsk. -** A densely hairy shrub, or short-lived perennial or woody; leaves ovate-elliptic, blunt ended; flowers pale orange-yellow. Rare in deciduous woodland.

MALPIGHIACEAE

- ***Caucanthus albidus* (Niedenzu) Niedenzu. -** Nakora (Turkana): Shrub or scrambler 2-4m in height; leaves obovate or circular, densely silvery-hairy beneath. Flowers white or cream, in racemes; fruit with a circular wing. Occasional in *Acacia reficiens-Duosperma rocky shrubland.*

EUPHORBIACEAE

- **Acalypha fruticosa Forssk. -** Eteteleit (Turkana): Short shrub to 2m in height. Locally found along the river channels. Used locally by Turkana to heal wounds.

- ***Clutia abyssinica* Jaub. & Spach -** Echiato (Turkana): Shrub to 2m in height. Leaves turning orange when drying. Common within *Acacia-Commiphora* mixed bushland.

- ***Croton dichogamus* Pax -** Kekelwa (Turkana): A multi-stemmed shrub or low tree with silvery leaves beneath. A common shrub forming thickets within mixed bushland.

- ***Croton somalensis* Vatke & Pax;** Shrub to 2m in height. Leaves silvery beneath and also turning orange like in *C. dichogamus*.

- ***Erythrococca bongensis* Pax -** Ekoromwai (Turkana): Shrub or tee 4m in height; bark pale brown, flaking in small sections; leaves ovate or elliptic; fruits yellow or red, 3-lobed. Common shrub in bushland especially along riverbeds.

- ***Euphorbia candelabrum* Kotschy -** Yoopong (Turkana): Succulent milky stout tree to 5m in height. Common in bushland along the slopes of Mt. Kulal.

- ***Euphorbia cuneata*** Vahl - **Lokilei** (Turkana): Spiny shrub with lots of latex. Common in *Acacia-Commiphora-Duosperma* bushland.

- ***Euphorbia gossypina*** Pax - Scrambring shrub with cylindrical branches. Branches breaks easily producing white sap. Common in the eastern part of project area dwarf shrubland.

- **Euphorbia heterochronma Pax -** Succulent spiny shrub, 4-6 angled. Common on rocky outcrop in eastern side of the project area.

- **Jatropha pelargoniifolia Courb. -** Ebulon (Turkana): Shrub to 1.5m in height, sap pale yellow turning reddish. Leaves palmately 3-5 lobed. Flowers yellow-green. Common on rocky areas.

- ***Jatropha parvifolia* Chiov. -** Ebulon (Turkana): Shrub 2m in height. Bark purple, sap clear to reddish yellow. Spines slightly curved, leaves clustered on short shoots. Flowers yellow-green, fading to pink. Common on *Acacia/Commiphora* rocky shrubland.

- **Jatropha dichtar Mic Bv. -** Laparana (Samburu), Etirah (Turkana): Shrub with many erect branches from the base, bark dark reddish-purple, papery-peeling, latex clear, milky or red. Spines straight, flowers pale yellow, fading to pink. Occasional in *Commiphora* mixed shrubland and on sand dunes.

- ***Jatropha fissispina* Pax. -** Short shrub 0.5m high. Leaves palmately lobed, flowers yellow-green. Common on flood prone rocky areas with silt deposited soil.

- ***Phyllanthus fischeri*** Pax: Shrub 3m in height, sometimes scrambling. Leaves elliptic, base rounded or slightly cuneate. Flowers yellow-green or greenish white in few-flowered fascicles. Common in bushland and along dry riverbeds.

- ***Flueggea virosa*** (Willd.) Voigt. [*Securinega virosa* (Willd.) Baill.] **-** Elakis (Turkana): Shrub (rarely a tree) 5m in height. Leaves obovate, base cuneate; flowers yellow-green or cream, in sparse to very densely axillary fascicles; fruits white. Common in dwarf shrubland

LEGUMINOSAE
Sub family: CAESALPINIOIDEAE

- *Delonix elata* (L.) Gamble - Ekurinchanait (Turkana): A common tree over 10m in height and with spreading crown. Flowers white with yellow petals. A very striking tree along riverbeds and on rocky wooded dwarf shrubland. Also commonly found in the eastern part of project area.

LEGUMINOSAE
Sub family: MIMOSOIDEAE

- ***Acacia mellifera* (Vahl) Benth. -** Embenyo (Turkana): Multi-stemmed shrub. Common in all types of habitat especially in the eastern part of the project area. .

- ***Acacia senegal* (L.) Willd. -** Ekunoit (Turkana): Shrub to 4m in height and with prickles emerging below the nodes. Common in *Acacia-Commiphora* bushed woodland.

- ***Acacia brevispica* Harms:** Scrambling shrub commonly found in semi-deciduous bushland

- ***Acacia drepanolobium* Sjoestedt:** Eiyellel (Turkana): Tree with purple (young) or black (mature) swollen base (gulls). Common on the eastern side of Mt. Kulal forming good woodland.

- ***Acacia ethaica* Schweinf. -** Eliwo (Turkana): Short tree, sometimes becoming a tree to 4m in height. Common in rocky outcrops and in deciduous woodland

- ***Acacia nilotica* (L.) Del. -** Ekapelimen (Turkana): Tree to 4m in height. Crown flat or umbrella-shaped. Bark fissured in narrow strips. Fruit black. A common *Acacia* in deciduous woodland

- ***Acacia reficiens* Wawra -** Shrub to 3m in height forming obconical and flat topped crown. A very common *Acacia* in the eastern part of the project area.

- ***Acacia tortilis* (Forsk.) Hayne -** Tree to 15 m in height. Common on dry riverbeds forming riverine woodland, fruit pale brown, twisted or contorted. Pods liked by goats and local community shake the branches to let the pods drop for the goats.

LEGUMINOSAE
Sub family: PAPILIONOIDEAE (FABACEAE)

- ***Rhynchosia minima* (L.) DC. -** A short-hairy trailing or twining herb with stiff leaflets. A rare occurrence in the project area.

- ***Vigna frutescens* A. Rich. -** Perennial with a woody tuber and stems trailing; inflorescences long-stalked; flowers lilac-mauve. Herb in rocky wooded dwarf shrubland bushland

- ***Indigofera hochstetteri* Bak. -** Hairy annual herb; leaflets 3-5; racemes many-flowered; pods hanging, curved, flat. Common in dwarf wooded grassland.

- ***Indigofera schimperi* Jaub. & Spach -** Perennial, 1m with dense appressed silvery hairs; leaflets 5-10, alternate; raceme-many flowered. Occasional in semi-deciduous bushland

- ***Indigofera spinosa* Forsk. -** Very branched silvery shrublet hardly 0.5m in height with dense aprressed hairs. A very common dwarf shrub in the entire project area. Good browse for all browsers.

- ***Indigofera cliffordiana* Gillett -** Silvery shrublet to 50cm; leaflets 3, raceme 10-20-flowered, orange. Locally dominant on shallow river channels. Commonly associated with *Indigofera spinosa*, *Duosperma* and *Acacia reficiens*.

- ***Ormocarpum trichocarpum* (Taub.) Engl. -** Shrub or tree 5m in height often with twigs. Leaves in tufts, with 7-15 leaflets; flowers mauve-blue or cream with blue veins; fruit oblong, straight and covered in stiff golden-brown hairs. Common in dwarf wooded shrubland.

MORACEAE

- ***Ficus sycomorus* L. -** Tree to over 15m in height, bark yellowish; leaves ovate or elliptic, margin entire and sandpapery above. Figs in leaf-axils; figs yellow or reddish. Common riparian tree on the slopes of Mr. Kulal and on rocky outcrops.

CELASTRACEAE

- ***May*tenus *heterophylla* (Eckl. & Zeyh.) N. Robson -** Ekalamoran (Turkana): Shrub or small tree. Occasional on dry bushland and along riverbeds.

- ***May*tenus *senegalensis* (Lam.) Exell -** Ekaburu (Turkana): Shrub to 8m in height. Common along riverine and bushland.

SALVADORACEAE

- ***Salvadora persica* L. -** Esokon (Turkana): Semi-scandent evergreen shrub. Branchlets used as teeth-braches. Fruits edible. Twigs used for construction of local community housed.

OLACACEAE

- ***Ximenia americana* L. -** Elamai (Turkana): Shrub to 3m in height. Leaves alternate or clustered on spur shoots. Fruit orange-red. Common in mixed bushland and on rocky outcrops.

SANTALACEAE

- ***Osyris lanceolata* Hochst. & Steud. -** Shrub to 4m in height. Leaves bluish green or yellow green. Usually on rocky outcrops especially on the slopes of Mt. Kulal. The wood is used as a substitute for sandalwood. Endangered species. Occasionally harvested illegally as sandalwood. There was no sign of such harvesting in the project site although the communities claim that it is used as a substitute for tea-leaves.

RHAMNACEAE

- ***Helinus integrifolius* (Lam.) Kuntze -** Ekabaru (Turkana): Climber or decumbent shrub to 5. in height. Common in bushland as a scrambler.

- ***Scutia myrtina* (Burm. f.) Kurz -** Shrub, often forming impenetrable bush due to its hooked spines. Common on the slopes of Mt. Kulal in semi-deciduous bushland. Fruits edible.

- ***Ziziphus mauritiana* Lam. -** Ekalale (Turkana): Shrub or tree with pairs of thorns on its nodes. Common in riverine woodland.

- ***Ziziphus mucronata* Willd. -** Amaleri (Turkana): Shrub or tree to 10m in height. Bark grey-brown, reticulate-scaly. Young branches zigzag with thorns in pairs on the nodes. Common along dry riverbeds. Fruits edible, wood used for construction.

VITACEAE

- ***Cissus rotundifolia* (Forsk.) Vahl -** Lorodo (Turkana): Succulent climber with 4-5-angled stems and forked tendrils. The bark is used for rope; roasted leaves are used to reduce swellings (e.g. Bee stings) Common scrambler on dense thickets and woodland.

- ***Cissus quadrangularis* L. -** Egis (Turkana): Succulent climber with 4 angled-stems and the wings at the angles. Tendrils simple, leaves only rarely present. A root infusion is employed against chest pain and as a pesticide against termites by Turkana. Common in dwarf bushland.

RUTACEAE

- ***Vepris glomerata (F. Hoffm.) Engl. -*** Ekuri, Emalitenyit (Turkana): Short shrub or tree with 3-foliolate. Rare in rocky outcrops and dry riverbeds.

BALANITACEAE

- *Balanites aegyptiaca* (L.) Del. - Eroronyit (Turkana): Tree to 5m in height with smooth and green bark. Fruit edible, red and yield oil. The fruit is liked by goats. Common in deciduous woodland eastern project area.

BURSERACEAE

- ***Boswellia neglecta* S. Moore *(B. hildebrandtii* Engl.):** Tree to 7m tall with horizontal branches. Branches break easily. Common in deciduous shrubland.

- ***Commiphora africana* (A. Rich.) Engl. -** Ekadeli (Turkana): Spiny shrub or tree to 4-8m tall. A cylindrical trunk. Leaves serrate, smooth. Bark peeling in shiny reddish brown or grey scrolls. Common all over the project area especially to the eastern side.

- ***Commiphora schimperi* (Berg) Engl. -** Spiny shrub with cylindrical trunk, outer bark peeling in dull yellow or grey curved flakes from the green under bark. Leaves hairy. Common on rocky shrubland in the eastern part of the project site.

- **Commiphora campestris Engl. -** Etopojo (Turkana): Spiny shrub or short tree to 10m in height with massive, irregular, angled trunks; outer bark yellowish, breaking away in rather small flakes from the greenish under bark. Common in *Acacia-Commiphora* mixed shrubland east of the project area.

- ***Commiphora edulis Kl. Engl. Ssp boiviniana (*Engl.) Gillett:** Shrub branching from the base; bark pale grey, smooth. Common in *Acacia-Commiphora* mixed bushland and on rocky areas.

MELIACEAE

- ***Turraea mombassana* C.DC. -** Enampapapa (Turkana): Shrub, rarely in rocky and riverbeds.

SAPINDACEAE

- ***Allophylus rubifolius* (A. Rich.) Engl. -** Ekarai (Turkana): Shrub in dense bushland and riverine habitat.

- ***Dodonaea angustifolia L.f. -*** Shrub 2m in height with glossy sticky leaves. Fruits pinkish or reddish, 2-3-winged. Occasional in bushland north-east of the project area. Plant with hard wood used for tool handles and walking sticks.

- ***Pappea capensis* Eckl. & Zeyh. -** Etolerk (Turkana): Shrub or tree to 7m in height. Common on rocky outcrops in the eastern part of project site.

ANACARDIACEAE

- ***Lannea triphylla* (A. Rich.) Engl. – Etopojo (Turkana):** Shrub with spreading crown. Bark grey, smooth. Fruit and root edible. Common in *Acacia-Commiphora* mixed bushland.

- ***Rhus natalensis* Krauss -** Shrub to 4m in height. Branchlets pale grey or whitish. Fruit edible. Common in bushland and riverbeds.

- ***Rhus vulgaris* Meikle:** Shrub to 5m in height with smooth, dark brown bark. Fruits edible. Common in bushland and on riverbeds.

EBENACEAE

- ***Diospyros scabra* (Chiov) Cuf. -** (Elim-Turkana; Lgotoi-Samburu): Shrub or tree to 10m tall; bark grey, corrugated-platy. Common along luggas and on rocky places.

- ***Euclea divinorum* Hiern:** Evergreen shrub or tree to 8m in height; bark dark-grey and fissured. Leaves smooth and shining above. Common in river channels on the slopes of Mt. Kulal.

MYRSINACEAE

- ***Marine africana* L. -** Easy (Turkana); Skeet (Samburu): Shrub, 2m tall with grey-brown branches. Rarely on rocky outcrops.

APOCYNACEAE

- ***Addendum obese* (Forsk.) Rome. & Schultz. (Desert Rose) -** Eagles (Turkana); Parental (Samburu): Shrub with bulbous stems and white, pink or reddish flowers. Common in *Acacia-Commiphora* mixed bushland. The whole plant is poisonous especially roots that are used for making fish and arrow poison.

- ***Carissa edulis (Forssk.)* Vahl -** Ekamuria (Turkana); Lmuria/Lmuriel (Samburu): Shrub, occasionally scrambling to 5m tall. Bark grey and spines rarely forked. Flowers white inside and pink to red outside. Fruits edible, red when unripe and black when ripe. Common on rocky areas.

ASCLEPIADACEAE

- ***Caralluma acutangula* (Decne) N.E.Br. -** An erect, 4-angled stems succulent. Common on rocky areas especially eastern part of the project site.

- ***Sarcostemma viminale* (L.) R.Br. -** A twining shrub with cylindrical thin green stems. Flowers greenish. Common and forming dense clumps in rocky areas especially in the eastern project area.

RUBIACEAE (Coffee Family)

- ***Vangueria apiculata* K. Schum. -** Emaler (Turkana): Shrub or tree to 8m tall; bark smooth , grey-brown. A rare plant in project area though found along river channels and on rocky area. Fruit green when unripe and changing to purple-black when ripe.

COMPOSITAE

- **Kleinia squarrosa Cuf**: A freshy, sprawling stem-succulent up to 2m in height. Leaves appearing on the very young shoots which are soon shed. Flower heads cylindrical, born 2-8 together in umbels at the end of branches. A very conspicuous species in dwarf bushland associated with *Duosperma eremophilum, Indigofera spinosa, Plectranthus igniarius, Euphorbia uhligiana, E. nubica* and *Sesamothamnus busmans.*

- ***Gutenbergia cordifolia* Olivo *(Erlangea cordifolia* (Oliv.) S. Moore):** A small erect herb with alternate simple leaves. Flower heads solitary with purple florets. Rarely under shrubs on the slopes of Mt. Kulal.

- ***Vernonia brachycalyx* o. Hoffm.:** Shrub to 3m tall. Common in dry bushland.

- ***Vernonia cinerascens* Sch.B~.R. -** Esirilipong/Ejulot (Turkana); Torau Magifi (Samburu): Woody herb under shade in *Acacia-Commiphora* mixed bushland.

- ***Vernonia lasiopus* O. Hoffm. -** Nkaputi (Samburu): Woody herb under shade on the edge of shrubs

- ***Conyza steudelii* Sch. Bip. :** A stiff, often big coarse herb. Common on the slopes of Mt. Kulal in a mixed bushland.

- ***Conyza stricta* Willd.:** An erect annual; rarely found on the western slope of Mt. Kulal in *Acacia-Commiphora* mixed bushland.

- ***Psiadia punctulata* (DC.) Vatke -** Laba, Labai (Samburu): Shrub, 2m tall with sticky shining leaves. Flowers yellow in many flowered heads. Fairly common on the slopes of Mt. Kulal in mixed bushland.

- ***Helichrysum glumaceum* DC.:** A slender low perennial, grey-hairy with linear, pointed leaves. Heads white or pink in tight clusters. Rarely found under mixed woody bushland.

- ***Aspilia mossambicensis* (Oliv.) Wild:** Woody herb or shrub, usually much branched with stalked rough-hairy. Heads yellow. Rarely found in mixed bushland and along river channels.

- ***Bidens pilosa* L.:** Annual herb on shade. Commonly found around abandoned settlements.
- ***Lactuca inermis Forsk.*:** *An erect herb with few high branches. Common under shade and in abandoned settlements.*

- ***Sonchus bipontini* Aschers.:** A robust erect or trailing herb, heads almost stalk less, in tight terminal clusters and with white wool below the orange-yellow heads. Common under thickets in *Acacia-Commiphora* bushland.

BLUMBAGINACEAE

- ***Ceratostigma abyssinica* Asch. :** A low rough-hairy shrub with stiff, elliptic-oblanceolate sharply pointed leaves. Rare in rocky areas.

BORAGINACEAE

- ***Cordia monoica Roxb. (Cordia ovalis* DC.) -** Etuntun, Elkaisekiseki (Turkana); Lmantume (Samburu): Evergreen shrub or small tree 6m tall. Bark smooth or rough, flaking-very sandpapery above, pubescent-sandpapery beneath. Common along water channels and on rocky areas.

- ***Cordia sinensis* Lam. *(C. gharaf* (Forsk.) -** Edome (Turkana), Ilgoita (Samburu): Shrub or small tree, bark smooth, leaves sub-opposite and elliptic; sandpapery. Common in the eastern portion of project site.

- ***Heliotropium longiflorum (A.DC.) Jaub. & Spach. (H. somalense Vatke)*:** Erect, minutely hairy perennial herb with flat, linear to lanceolate leaves. Common along seasonally streams and under shades.

SOLANACEAE

- ***Lycium europaeum* L. -** Lokei (Samburu), Ekake-bekeke (Turkana): Shrub with spines to 3m in height. Flowers white fading to cream or lilac. Fruits orange or red. Common on rocky outcrops and along dry riverbeds.

- ***Solanum incanum* L. -** Ltulerlei (Samburu), Etulelo (Turkana): Short shrub to 2m in height. Common in abandoned manyattas and on the slopes of Mt. Kulal in evergreen & semi-deciduous bushland

- ***Withania somnifera* (L.) Dunal -** Lesayet (Samburu), Emotoe (Turkana): Woody herb or shrub to 3m in height. Young leave densely hairy but later glabrous. Flowers yellow-green, fruits orange or red. Common on abandoned manyattas and under shade.

CONVOLVULACEAE

- ***Convolvulus sagittatus* Thunb. -** Perennial herb with white petals. Rarely under shade and on rocky crevices.

- ***Hildebrandtia obcordata* S. Moore -** Egong (Turkana): A very conspicuous shrub when blossoming, 2-3m in height. Flowers white cream. Common in bushed dwarf shrub among *Acacia-Comminphora* mixed community.

- ***Ipomoea cicatricosa* Baker -** Ekuyenit (Turkana): Shrub growing to 3m in height. Very attractive when in flower. Flowers pink, mauve or purple. Common in eastern side of project area on rocky outcrops.

- ***Ipomoea kituiensis* Vatke -** Eneket (Turkana): Climbing shrub to 6m in height. Flowers cream to pale yellow, with mauve or purple centre. Common in *Acacia tortilis* wooded shrubland, occasionally in open grassland.

SCROPHULARIACEAE

- ***Cycnium tenuisectum* (Standi.) O. J. Hansen *(Rhamphicarpa tenuisecta* Standi.):** Annual herb. Common on wet grounds and along river channels.

PEDALIACEAE

- ***Sesamonthamnus rivae* Engl. -** Loborea (Turkana): Shrub or small tree to 4m in height. Bark smooth, grey, branches arching, sparsely spiny. Flowers scented, white. Fruits brown, slightly obovate, splinting easily when dry. Rarely found in deciduous shrubland among *Acacia and Commiphora mixed bushland.*

ACANTHACEAE

- ***Asystasia gangetica* (L.) T. Anders -** Perennial herb to 1m in height. Flowers blue. Common under shade in *Commiphora-Acacia* mixed bushland.

- ***Blepharis maderaspatensis* (L.) Roth -** Perennial creeping herb under bushes. Rare in semi-deciduous bushland

- ***Duosperma eremophilum* (Milne-Redh.) Brummitt -** Sapani (Samburu), Emerkwi (Turkana): Dwarf shrub 1m in height. Very common dwarf shrub in the whole of project area. One of the most important browse for all species of livestock in the region.

- ***Dyschoriste radicans* Nees:** A trailing herb, common in dwarf shrubland.

- ***Barleria acanthoides* Vahl:** Short shrub with almost stalk less. Locally common wooded dwarf shrubland

- ***Justicia flava* Vahl:** A trailing or erect hairy woody perennial. Flowers small, bright yellow. Common under shade and along water channels.

- ***Justicia odora* (Forsk.) Vahl:** Lodto (Samburu): Woody shrub to 1m in height. Leaves narrow, elliptic to slightly obovate. Flowers yellow. Common on rocky outcrops and under bushes.

- ***Ruttya fruticosa* Lindau -** Shrub, 4m in height. Leaves ovate or elliptic. Flowers red, rarely yellow with black throat. Rarely in rocky outcrops and along dry riverbeds.

VERBENACEAE

- ***Clerodendrum myricoides (Hochst.)* Vatke -** Makutikuti (Samburu), Gobetie (Turkana): Shrub 4m in height. Leaves opposite or in three/fours, ovate or slightly obovate. Flowers blue or purple, occasionally greenish with one lobe blue, or blue with two lobes white. Common in semi-deciduous bushland

- ***Leucas glabrata* (Vahl) R.Br -** Short-or long hairy annual or perennial herb or weak shrub with elliptic to ovate leaves and clusters of flowers. Common in dwarf shrubland.

- ***Leucas tomentosa* Guerke -** A white woolly erect or ascending shrub. Leaves narrow at base, flowers white. Common among the *Duosperma eremophilum* dwarf shrubland.

- ***Lantana trifolia* L. -** Sekechewo (Turkana): Woody herb. Leaves opposite and occasionally sandpapery. Flowers mauve or purple. Common under shade on the slopes of Mt. Kulal.

- ***Lantana viburnoides* (Forsk.) Vahl -** Woody herb. Leaves opposite, ovate, base cuneate or attenuate. Flowers white (rarely pale pink). Common under shade in semi-deciduous bushland and wooded dwarf shrub land.

- ***Lippia kituiensis* Vatke *(L.ukambensis Vatke sensu Baker et al* -** (Sinoni (Samburu): Shrub, 3m in height. Leaves opposite (rarely in three), aromatic. Flowers white with yellow throat. Rarely under shade and along dry riverbeds in evergreen & semi-deciduous bushland.

- ***Premna resinosa (Hochst.)* Schauer -** Ikorderedet (Turkana): Shrub 3-5m in height. Leaves opposite, aromatic, ovate or (broadly) elliptic. Flowers (greenish) cream or white. Fruits purple to black. Common in *Acacia/Commiphora* bushland.

LABIATAE

- ***Tinnea aethiopica* Hook. f. -** Shrub to 4m in height, sometimes weakly scandent. Leaves ovate to obovate, base cuneata or attenuate. Flowers blackish purple. Fruiting calyx membranous. Common in evergreen & semi-deciduous bushland and on rocky places.

- ***Becium obovatum* (E. Mey.) N.E.Br. -** An erect or trailing herb or wiry shrub from a woody rootstock. Leaves oblong, flowers white and pink. Common in woodland and open shrubland.

- ***Hoslundia opposita* Vahl -** Labai (Samburu): Spreading shrub with white or yellowish flowers. Fruit with yellow to red fleshy calyx. Occasional in mixed bushland and along dry riverbeds.

- ***Ocimum suave* Willd. -** Lemurran (Samburu), Loguru or Ichoke (Turkana): Woody herb or shrub to 3m in height. Leaves ovate or elliptic, base cuneata, apex acute. Flowers whitish or pale purple. Common in mixed bushland.
- ***Plectranthus igniarius (*Schweinf.) Agnew -** Akurau or Nakhwara (Turkana): Shrub slightly freshy, often with arching branches, often flowers when leafless, 2-3m in height. Leaves broadly elliptic. Flowers blue or violet. Common on rocky outcrops in eastern part of the project site.

COMMELINACEAE

- ***Commelina africana* L. -** Fleshy prostrate perennial herb. Leaves narrow and small yellow to orange flowers. Rarely in bushland

- ***Commelina benghalensis* L. -** Freshy herb with ascending or erect branches. Leaves usually short stalked and oblique-based. Flowers blue. Rarely under bushes on the slopes of Mt. Kulal.

LILIACEAE (Aloeceae)

- ***Aloe secundiflora* Engl. -** A large stem less rosette, usually solitary, of green unspotted, more or less glossy leaves. Flowers red with minute translucent spots. Common in bushland and on rocky shrubland.

- ***Aloe turkanensis* Christian -** A clump of rosettes on short stems which lean or falls. Leaves spotted, very smooth. Common under shade in dense bushland.

ASPARAGACEA

- *Asparagus falcatus* ***L. (inc aethiopicus* L.) -** Straggling or climbing herb from rhizomes bearing edible tubers. Flowers minute, cream to white. Rarely in dense bushland

- *Asparagus africanus* **Lam. -** Scrambling woody shrub with brown spines from a fibrous rootstock, stems smooth or grooved, grey-brown. Flowers white. Common in dense bushland.

CYPERACEAE

- ***Bulbostylis boecklerana* (Schweinf.) Beetle** - Evergreen bush land.

- ***Cyperus alternifolius* L. -** Bushland community.

- ***Cyperus blysmoides* Hochst. -** Evergreen bushland.

- ***Cyperus giolii* Chiov. -** Deciduous woodland.

- ***Cypera kilimandscharicus* Kuek. -** Evergreen bushland and deciduous woodland.

- ***Cyperus obtusiflorus* Vahl -** Evergreen bushland

- ***Cyperus teneriffae* Poir. -** Evergreen bushland and wooded dwarf shrubland.

- ***Kyllinga alba* Nees (incl. var. *alata* (Nees) C.B.Cl.) -** Deciduous woodland.

- ***Mariscus amauropus* (Steud.) Cuf. (incl. *M. leptophyllus* -** Semi-deciduous bushland and deciduous woodland.

- ***Mariscus macropus* (Boeck.) C.B.Cl. -** Deciduous woodland.

GRAMINEAE (POACEAE) ;TRIBE *ANDROPOGONEAE*

- ***Andropogon schirensis* A. Rich. -** Deciduous woodland.

- ***Bothriochloa insculpta* (A. Rich.) A. Camus *(Dichanthium insculptum* (A. Rich.) W.D. Clayton) -** Evergreen & semi-deciduous bushland.

- ***Chrysopogon plumulosus* Hochst. -** Deciduous woodland and wooded dwarf shrubland.

- ***Heteropogon contort*us (L.) Roem. & Schult. -** Evergreen bushland.
- ***Hyparrhenia gazensis* (Rendille) Stapf -** Evergreen bushland.
- ***Hyparrhenia hirta* (L.) Stapf -** Evergreen bushland.
- ***Hyparrhenia papillipes* (A. Rich.) Stapf -** Evergreen bushland (3) composite bushland.
- ***Ischaemum afrum* (J.F. Gmel.) -** Dandy Perennial grassland.
- ***Sehima nervosum* (Rottl.) Stapf -** Evergreen & semi-deciduous bushland.
- ***Sorghum arundinaceum* (Desv.) Stapf -** Deciduous shrubland.

TRIBE PANICEAE

- ***Brachiaria deflexa* (Schumach.) C.E. Hubbard -** Evergreen bushland.
- ***Brachiazia leersioides* (Hochst.) Stapf -** Evergreen bushland.
- ***Brachiaria semiundulata* (A. Rich.) Stapf -** Deciduous bushland.
- ***Brachiaria serrata* (Spreng.) Stapf. (incl. *var.gossypina* (A.Rich.) Stapf) -** Evergreen bushland and deciduous woodland.
- ***Cenchrus ciliaris* L. -** Evergreen bushland and deciduous woodland.
- ***Digitaria abyssinica* (A.Rich.) Stapf -** Evergreen bushland and deciduous woodland.
- ***Digitaria macroblephara* (Hack.) Stapf -** Semi-deciduous bushland and Deciduous woodland.
- ***Digitaria rivae* (Chiov.) Stapf -** Evergreen bushland and deciduous woodland.
- ***Digitaria velutina* (Forsk.) P. Beauv. -** Evergreen & semi-deciduous bushland.
- ***Panicum coloratum* L. -** Deciduous bushland.
- ***Panicum deustum* Thunbo -** Evergreen & semi-deciduous bushland.
- ***Panicum maximum* Jacq. -** Evergreen bush.
- ***Pennisetum mezianum* Leeke -** Semi-deciduous bushland and Deciduous woodland.
- ***Pennisetum stramineum* Peter -** Evergreen & semi-deciduous bushland.
- ***Setaria sphacelata* (Schumach.) M. B. Moss *(S. trinervia* Stapf) -** Evergreen bushland and deciduous bushland

OTHER TRIBES:

- ***Aristida adscensionis* L. -** Annual grass in open grassland areas.

- ***Aristida mutabilis* Trin. & Rupr. -** Annual grass. Open grassland.
- ***Aristida adoensis* A. Rich. -** Evergreen bushland.
- ***Chloris pycnothrix* Trin. -** Semi-deciduous bushland.
- ***Cynodon dactylon* (L.) Pers. -** Evergreen bushland.
- ***Dactyloctenium aegyptium* (L.) Willd. -** Semi-deciduous bushland and wooded dwarf shrubland.
- ***Eleusine multiflora* A. Rich. -** Evergreen bushland.
- ***Enneapogon cenchroides* (Roem. & Schult.) Hubbard -** Deciduous shrubland.
- ***Enneapogon desvauxii* P. Beauv. -** Deciduous woodland and Wooded dwarf shrubland.
- ***Enneapogon schimperanus* (A. Rich.) Renv. -** Deciduous shrubland.
- ***Eragrostis braunii* Schweinf. -** Evergreen bushland and deciduous woodland.
- ***Eragrostis cilianensis* (All.) F.T. Hubb. -** Evergreen bushland.
- ***Eragrostis macilenta* (A.Rich.) Steud. -** Evergreen bushland.
- ***Eragrostis minor* Host -** Evergreen bushland.
- ***Eragrostis papposa* (Roem. & Schult.) Steud. -** Evergreen & semi-deciduous bushland and Deciduous woodland.
- ***Eragrostis superba* Peyr. -** Evergreen bushland.
- ***Eragrostis tenuifolia* (A. Rich.) Steud. -** Evergreen bushland and along roadsides.
- ***Eustachys paspaloides* (Vahl) Lanza & Mattei -** Semi-deciduous bushland.
- ***Harpachne schimperi* A. Rich. -** Evergreen & semi-deciduous bushland.
- ***Leptothrium senegalense* (Kunth) W. D. Clayton *(Latipes senagalensis* Kunth) -** Deciduous shrub land and Wooded dwarf shrubland.
- ***Oropetium minimum* (Hochst.) Pilger -** Wooded dwarf shrubland.
- ***Sporobolus agrostoides* Chiov. -** Evergreen & semi-deciduous bushland.
- .
- ***Sporobolus pyramidalis* P. Beauv. -** Evergreen bushland.
- ***Sporobolus stapfianus* Gand. -** Deciduous woodland.
- ***Tragus berteronianus* Schult. -** Deciduous woodland.
- ***Tricholaena teneriffae* (L.f.) -** Wooded dwarf shrub land.

Annex 6. Common Water Birds of Lake Turkana

1. African Fish Eagle
2. African Jacana
3. Africa Skimmer
4. African Spoonbill
5. Black – crowned Night Heron
6. Black – headed Gull
7. Black Heron
8. Black – tailed Godwit
9. Caspian Plover
10. Caspian Tern
11. Cattle Egret
12. Common Planticole
13. Common Sandpiper
14. Common Stilt
15. Curlew Sandpiper
16. Egyptian Goose
17. Eurasion Avocet
18. Eurasion Wigeon
19. Fulvous Whistling Duck
20. Glossy Ibis
21. Goliath Heron
22. Great Cormorant
23. Great White Egret
24. Greater Flamingo
25. Green Shank
26. Grey – headed Gull
27. Grey Heron
28. Grey Plover
29. Gull-billed Tern
30. Hammercop
31. Herring Gull
32. Hottentot Teal
33. Kittlitz Plover
34. Lesser Black – headed Gull
35. Lesser Flamingo
36. Little Egret
37. Little Grebe
38. Little Stint
39. Little Tern
40. Long – tailed Cormorant
41. Marsh Sandpiper
42. Northern Pintail
43. Northern Shoveller
44. Osprey
45. Pied Kingfisher
46. Pink – backed Pelican
47. Pink – headed Pelican
48. Red – knobbed Coot
49. Redshank

50. Ringed Plover
51. Ruddy Turnstone
52. Ruff
53. Sacred Ibis
54. Sandering
55. Saunder's Tern
56. Senegal Thicknee
57. Spur Winged Lapwing
58. Squacco Heron
59. Yellow – billed Stork
60. Whiskered Tern
61. White – faced Whistling Duck
62. White-winged Black Tern

Annex 7a. Fisheries of Loiyangalani (2006)

Month	Fish Caught (Sun dried)	Dry Weight (Kg)	Value (KSh)	Comments
January	Tilapia	3,474.80	138,992.00	Boats – 14 Foot Fishermen - 23
	Labeo	1,219.20	39,014.40	
	Barbus	738.75	14775.00	
	Nile Perch Fillet	642	51,360.00	
	Total	**6,264.75**	**245,091.40**	
February	Tilapia	7,201.8	288,072.00	Boats – 22 Foot Fishermen - 32
	Labeo	2,914.25	93,256.00	
	Barbus	1,096.25	21,925.00	
	Nile Perch Fillet	613.00	49,040.00	
	Total	**12,138.80**	**458,563.00**	
March	Tilapia	5,612.80	224,512.00	Boats – 18 Foot Fishermen - 24
	Labeo	2,013.25	64,424.00	
	Barbus	232.50	4,650.00	
	Nile Perch Fillet	496.00	39,680.00	
	Total	**8,410.80**	**334,176.00**	
April	Tilapia	6,215.40	248,616.00	Boats – 20 Foot Fishermen - 19
	Labeo	1,843.50	58,992.00	
	Barbus	-	-	
	Nile Perch Fillet	602	48,160.00	
	Total	**8,660.9**	**355,758.00**	
May	Tilapia	8,418	336,720.00	Boats – 24 Foot Fishermen - 32
	Labeo	3,000.75	96,240.00	
	Barbus	-	-	
	Nile Perch Fillet	908	72,640	
	Total	**12,326.75**	**505,600.00**	
June	Tilapia	15,292.00	611,680.00	
	Labeo	3,540.5	113,296.00	
	Barbus			
	Nile Perch Fillet	325	42,000.00	
	Total	**19,357.5**	**766,976.00**	
July	Tilapia	9,118.2	364,456.00	
	Labeo	3,118.5	99,792.00	
	Barbus			
	Nile Perch Fillet	428	34,240.00	
	Total	**12,664.50**	**498,488**	
August	Tilapia	13,949.20	557,968	Boats – 36 Foot Fishermen – 43
	Labeo	3,310.50	105,936	
	Barbus			
	Nile Perch Fillet	150	15,000	
	Total	**17,409.70**	**678,904**	
September	Tilapia	5133	328,528	Boats – 27 Foot Fishermen - 39
	Labeo	1509	48,288	
	Barbus			
	Nile Perch Fillet	120	12,000	

	Total	**6,762**	**388,816**	
October	Tilapia	13,706.60	548,264.00	Boat – 36 Foot Fishermen - 21
	Labeo	5020	160,640	
	Barbus			
	Nile Perch Fillet	435	4350.00	
	Total	**19,161.60**	**713,254.00**	
November	Tilapia	10,322.2	412,888	Boats – 36 Foot Fishermen - 21
	Labeo	6,360.75	160,640	
	Barbus			
	Nile Perch Fillet	620	62,000	
	Others			
	Total	**17,302.95**	**635,528**	
December	Tilapia	12,070.6	482,824	
	Labeo	3,660.75	117,144	
	Barbus			
	Nile Perch Fillet	805	80,500	
	Others	**-**	**-**	
	Total	**16,536.35**	**599,968.00**	

Annex 7b. Fisheries of Loiyangalani (2007)

Month	**Fish Caught (Sun dried)**	**Dry Weight (Kg)**	**Value (KSh)**	**Comments**
January	Tilapia	8,391.6	335,664.00	Boat trips – 20 Foot Fishermen - 31
	Labeo	1,760.5	56,336.00	
	Barbus			
	Nile Perch Fillet	504.00	75,600.00	
	Others			
	Total	**10,656.10**	**467,600**	
February	Tilapia	13,130	525,200.00	Boat trips – 45 Foot Fishermen - 84
	Labeo	2,189	70,048.00	
	Barbus			
	Nile Perch Fillet	618	92,700.00	
	Others			
	Total	16,507	687,948.00	
March	Tilapia	15,019	600,760.00	Boat trips – 51 Foot Fishermen - 30
	Labeo	2,475	79,200.00	
	Barbus			
	Nile Perch Fillet	575	86,250.00	
	Others			
	Total	**18,069**	**766,210.00**	
April	Tilapia	16,757.4	670,296.00	Boat trips – 50 Foot Fishermen - 102
	Labeo	53,398.75	172,760.00	
	Barbus			
	Nile Perch Fillet	768	115,200	
	Others			
	Total	**22924.15**	**958,256**	
May	Tilapia	22,523	900,920.00	Boats – Foot Fishermen
	Labeo	3,313	106,016	

	Barbus			- 127
	Nile Perch Fillet	473	70950.00	
	Others			
	Total	**26,309**	**1,077,886**	
June	Tilapia	14,457.40	578,296.00	
	Labeo	6,038.75	193,240.00	Boat trips – 38
	Barbus			Foot Fishermen
	Nile Perch Fillet	608	91,200.00	- 102
	Others			
	Total	**21,104.15**	**862,736**	
July	Tilapia	**12,736**	**509,440.00**	Boats – 46
	Labeo	**7,035.75**	**225,144.00**	Foot Fishermen
	Barbus			– 107
	Nile Perch Fillet	**502**	**75,300.00**	
	Others			
	Total	**20,273.75**	**809,884.00**	
August	Tilapia	18,899	755,960.00	Boats – 50
	Labeo	10,795	345,440.00	Foot Fishermen
	Barbus			–153
	Nile Perch Fillet	709	106,350.00	
	Others			
	Total	**30403**	**1,207,750**	
September	Tilapia	22,036	881,440.00	Boat trips - 51
	Labeo	5,604.75	179,352.00	Foot Fishermen
	Barbus			- 123
	Nile Perch Fillet	550	82500.00	
	Others			
	Total	**28,190.75**	**1,143,292.00**	
October	Tilapia	17,944.8	717,792.00	Boat trips – 52
	Labeo	4,916.5	157,328.00	Foot Fishermen
	Barbus			- 103
	Nile Perch Fillet	615	92,250.00	
	Others			
	Total	**23,476.3**	**967,370.00**	

Annex 8: Positions (UTM Coordinates) of the Vestas 90 Turbines in the Project Area

Turbine No.	Turbine Type	Eastings (m)	Northings (m)
1	V90	267105	263256
2	V90	267229	263398
3	V90	267371	263536
4	V90	267499	263680
5	V90	267634	263818
6	V90	267770	263957
7	V90	267900	264095
8	V90	268031	264232
9	V90	268159	264370
10	V90	268292	264510
11	V90	268422	264650
12	V90	268553	264789
13	V90	268685	264922
14	V90	268811	265064
15	V90	268942	265200
16	V90	269075	265339
17	V90	269208	265479
18	V90	269340	265617
19	V90	269476	265754
20	V90	269601	265896
21	V90	269732	266036
22	V90	269867	266174
23	V90	269993	266314
24	V90	270128	266453
25	V90	270261	266589
26	V90	270394	266726
27	V90	270531	266868
28	V90	270655	267013
29	V90	270785	267153
30	V90	270916	267290
31	V90	271049	267428
32	V90	271179	267568
33	V90	271310	267707
34	V90	271445	267845
35	V90	271575	267985
36	V90	271708	268122
37	V90	271839	268260
38	V90	271969	268397
39	V90	272109	268558
40	V90	272247	268693
41	V90	272377	268833
42	V90	272510	268971
43	V90	272641	269110
44	V90	272769	269250
45	V90	272909	269385
46	V90	273037	269528
47	V90	273175	269678
48	V90	273308	269827
49	V90	273450	269961

50	V90	273568	270102
51	V90	277309	267600
52	V90	277393	267768
53	V90	277479	267933
54	V90	277560	268104
55	V90	277647	268271
56	V90	277733	268437
57	V90	277812	268602
58	V90	277898	268765
59	V90	277980	268933
60	V90	278064	269101
61	V90	278143	269269
62	V90	278232	269432
63	V90	278313	269600
64	V90	278399	269765
65	V90	278486	269931
66	V90	278567	270101
67	V90	278649	270266
68	V90	278730	270432
69	V90	278814	270600
70	V90	282895	275955
71	V90	278901	270765
72	V90	278984	270933
73	V90	279068	271096
74	V90	279152	271264
75	V90	281138	271401
76	V90	281208	271576
77	V90	281275	271749
78	V90	281341	271923
79	V90	281408	272103
80	V90	281476	272275
81	V90	281546	272452
82	V90	281613	272632
83	V90	281681	272811
84	V90	281751	272986
85	V90	281818	273163
86	V90	281884	273340
87	V90	281951	273518
88	V90	282024	273692
89	V90	282089	273869
90	V90	282156	274042
91	V90	282222	274219
92	V90	282292	274394
93	V90	282359	274569
94	V90	282424	274743
95	V90	282494	274914
96	V90	282562	275086
97	V90	282627	275261
98	V90	282690	275436
99	V90	282755	275610
100	V90	282825	275783

Annex 9. Stakeholder Consultations in Project Area

1. Issues Raised by theYammo Manyatta Community

This was a marginalised Turkana community near the Yammo Lagga. They lost most of their livestock during drought and mostly depend on relief food which they get once a month. Some of the men in the manyatta are fishermen and they sell their fish at Loiyangalani town. They use the lake as a source of domestic water supply and watering for their livestock. Despite free education, most of the children do not go to school instead assist their parents in looking after the livestock. Women travel long distances to collect firewood from the mountains which they sell at KSh 20-70 per a pile in Loiyangalani. They use the money for mainly buying food stuff to supplement the Government food relief.

A few of the elders of the community heard about the proposed project through a chief's baraza. Although they did not expect to have electric power in the manyatta, they expression the following expectations from the project:

- Employment as unskilled labourers for both men and women especially in the road construction activities; and
- Assistance to acquire fish cold storage to facilitate them fetch a higher price for the caught fish.

2. Meeting with Turkana Community at Nakuame Kwi Manyatta

Like the Yammo community, this community lost a large percentage of the livestock during drought and tribal raids. They also have fishermen in the community. The community also depends on relief food which they get once a month. The community has heard about the project from community elders who attended the barazas where the project was discussed. They felt that as long as the project did not interfere with livestock activities they see no problem with its implementation. The community, however, felt that the proposed development is likely to bring the following problems in the project area:

- The youth will imitate outsiders and their cultures may start to change; and
- There will be an increase in prostitution and HIV / AIDS.

The community, however, cited several areas where the community could benefit from the proposed project including:

- Employment of youth as unskilled labourers
- Improvement of the roads in order to reduce transport costs and promote business in the project especially the enhancement of livestock trade;
- Assistance of women in income generating activities (IGA);
- Assistance to fishermen to acquire fish cold storage facilities.

3. Discussions with the Samburu and Rendille Elders of Kiwanja Ndege Manyatta

This was a mixed manyatta consisting of members of both Samburu and Rendille communities situated near the Loiyangalani Airstrip. Although they are pastoralists, a few of them have become fishermen. This community also depends on relief food which they get once a month. Women from this manyatta travel long distances to collect firewood which is sold in Loiyangalani. Some of the money from the sale of firewood is utilized in the purchase of food for supplementing the relief food.

The elders of this manyatta have heard about the proposed project although they did not have details. They were not sure whether really understood the benefits of electricity but they believed that the project would bring development to the project area. Their major concern related to the fencing a big area since this would interfere with grazing activities of their livestock. They expressed their expectations from the project as follows:

- Increased employment opportunities for the youth;
- Assistance to procure fish storage facilities so as to sell them fresh and for a higher price;
- Improvement of roads in order to promote trade in livestock products
- Assistance to develop schools and the dispensaries; and
- Promotion of income generating activities including the production of ballast from local stones available;

4. Meeting with the El- Molo Community:

The El-Molo is a marginalised community that originally come from Komote Laiyeni Village. However, due to insecurity situation in their area, they moved temporarily to Loiyangalani in October 2007 following tribal raids. The men of El-molo are mainly fishermen although a few of them own some livestock. Women are engaged in domestic chores but some women are now engaged in buying and selling fish. Due to lack of fresh water sources, the El Molo use water from the lake for their domestic purposes. Like all other communities in the project area, the El Molo receive the relief food on a monthly basis. They expressed concerns on the following:

- The project is likely to increase the incidences of diseases such as HIV/AIDS;
- The youth will copying outside culture and forget their rich cultural attributes; and
- Accidents could occur during project installation and hurt people;

The El Molo community felt that the project has several positive attributes. They stand to benefit from opportunities such as:

- Assistance to the fishermen to procure cold storage facilities for their fish;
- Promotion of income generating activities (IGA) including ballast production;
- Employment of youth as unskilled labourers in road construction and other construction work;
- Promotion of tourism activities especially the production of beads and curios for sale to tourists;

5. Meeting with The Mosaretu Women group, Loiyangalani

Mosaretu is a woman group comprising of over 50 members. It stands for El-Molo, Samburu, Rendille and Turkana women group. This group runs a tourist camp and a curio. In addition the members organize traditional dances for tourists and prepare traditional food for visitors. The group felt that the project will bring positive impacts in the project area including:

- Provision of electricity in Loiyangalani, a development that will promote tourism and attract more visitors in the project area, all leading to an increase in income of the group and other tourism operators;
- Improvement of the road will also bring in many more visitors to the project area with resultant boost in local tourism activities;

However, the group felt that with the implementation of the project, there will be increase in prostitution and sexually transmitted diseases such as HIV / AIDS. They suggested that the local community should be sensitized and educated through songs and drama

on the dangers of such diseases in the project area. Due to their past experience, the group felt that they actually could play this role.

6. Meeting with Kifaru Women Group, Loiyangalani

This group has 40 members who are active in curio selling, vegetable gardening and development of tourist bandas and camps. Generally the group was very positive about the project. They felt the project will bring the following benefits to the project area:

- Provision of electricity to the tourist t camps and other areas;
- Increase in direct employment opportunities and source of income to the local communities;
- Increase in economic spin-off effects including the production of ballast; and
- Increase in income from the provision of services to the project workers.

The group, however, cautioned against negative impacts of the project especially the increase in HIV / AIDS and other sexually transmitted diseases (STDs) and the need to sensitize the local community and raise levels of awareness and education in the project area.

7. Meeting with Nayori Environmental Conservation Rehabilitation Youth Group

This is a youth group registered as a Community based organization (CBO) in 2005. The group is currently involved in improving the environment and fighting desertification in the project area through planting indigenous trees. The group identified a wide range of project benefits to the local community as follows:

- Provision of electricity will promote small businesses such as hotels, tourist facilities, salons, small garages and barber shop among others. In addition electricity will benefit school and hospital activities;
- Installation of cold storage facilities for fish caught in Lake Turkana and subsequent improvement in fish sales;
- Improvement of roads will promote livestock trade in the project area;
- Increase in employment opportunities during road rehabilitation and construction activities.

The group, however, felt that the development of the project will have some limited negative impacts including contamination of local culture, increase in diseases and drug abuse among other negative effects.

8. Discussion with Sr. Chief Loiyangalani, Mr. Christopher Kayema Lekapana

The Sr. Chief was very positive about the project. He confirmed that the project has been discussed in several fora by the community elders, administration and the Lake Turkana Power Company. He believes the proposed project will bring benefits in the project area and surroundings. He gave an example where the improvement on the roads will trigger an increase in business activities especially in livestock and fish products. This would also increase the flow on commodities especially from Nyahururu and Loysangalani.

He recommended that during the construction the elders need to be consulted for their inputs before implementation of project activities in order to avert any misunderstandings between the developer and the local community.

With regard to social considerations, the Sr. Chief strongly felt that the project should give priority for certain marginalised communities in the project area. Such consideration

should, however, be given following consultations with the community elders and other relevant stakeholders. He singled out water supply as a crucial target area where the project assistance would make a difference in improving the welfare of the marginalised groups.

9. Meeting with Sr. Maria Antonia Pira and Nurse Gabriela Lakapana of Loiyangalani Health Centre (Catholic Mission)

The Sister felt that problems affecting the local communities in the project area are scarcity of firewood, water and food. Transport is also a problem especially during the rainy season. Health conditions are poor with malaria, diarrhoea and respiratory diseases being the major causes of morbidity in the project area.

The Sister felt that the proposed project could contribute in improving the welfare of the people of the project area. The community in the project area, which currently rely on relief food should be taught how to invest on their livestock property in order to come out of the dependency syndrome. The project could play a significant role in encouraging the local communities in the project area on how to become self reliant.

10. Meeting with Madam Leparsanti S. Teresalba – Loiyangalani Primary School

Like other stakeholders we interviewed, Madam Teresalba has positive views about the project. She felt that the Loiyangalani Primary School stands to benefit from supply of electricity since the students will have more reading activities at night. The project will also create job opportunities in the project area.

Against the background of positive impacts Madam Teresalba, was concerned about the increase in noise levels, occurrence of accidents and fencing of the area and its potential negative impacts on livestock activities.

She proposed that there was need to educate the children especially the youth on the negative and positive impacts of the proposed project who will in turn take the information back to their parents

11. Discussion with Mrs. Orbora, Assistant Fisheries Officer, Loiyangalani

Mrs. Orbora painted a grime picture of the fisheries of the Loiyangalani. Most of the fishermen are poor and fishing is done on a small scale. Although the fishermen are served by the Loiyangalani Fisheries Cooperative Society (mainly in storing fish), returns from the fish sales are very low. The marketing of the fish is poorly developed. Most of the fish caught from the lake is sun dried and sold in Kisumu (the only market for sun dried fish). The situation is aggravated by poor road system in the project area which is made worse when it rains.

Mrs. Orbora was very positive about the proposed project. The project will promote the fisheries of the Loiyangalani. The provision of electricity and the subsequent installation of cold storage facilities will help to store fish for longer periods and sell them fresh. This improvement will empower the fishermen to sell their fish to wider markets and for higher prices. The rehabilitated road will facilitate quick transport of fresh fish to various destinations and at the same time encourage fish traders to come to Loyangani to procure fish.

12. Discussions with Assistant Chief Loiyangalani – Mr. Sarai Fecha

Mr. Fecha was aware of the proposed project and indeed several meeting were held between the community elders and the Lake Turkana Wind power project. He said initially there were concerns about the potential negative impacts of the project including interference in livestock grazing activities and accidents to the inhabitants of the project area. However, after discussions with representatives of the project developers, the community is positive about the project especially after being assured that there would be no fencing and the livestock would graze freely.

Mr. Fecha felt the local community would benefit from the implementation of the project in several ways including:

- Increase in employment opportunities especially for the unskilled labourers;
- Increase in spin-off economic activities including ballast production using the local rock material;
- Rehabilitation of the road will improve communication in the project area and promote trade in livestock and fisheries;
- Provision of electricity in the project area will stimulate economic growth.
- Electricity will facilitate installation of fish cold storage facilities and improve the fisheries of Loiyangalani; and
- The tourist camps will expand following provision of electricity in the project area.

Mr. Fecha, however, expressed concern that following the implementation of the project, the local community may be exposed to accidents from the installed facility and that the influx of people in the project area may result in cultural contamination as the youth imitate the culture of other people. He hoped the project in conjunction with the administration will play their role sensitizing the local community on the negative effects of the project.

Annex 10a: A List of Persons Invited to attend the EIA Stakeholders' Meeting

1. Aggrey Ogosi: Finance Assistant, Farm Africa, P.O.BOX 159, Marsabit, Tel. 0721412747 / Director Farm Africa
2. Benedict Orbora: Manager, Palm Shade Camp, Loiyangalani, Tel. 0728966620.
3. Chairman, Marsabit County Council
4. C.K. Lekapana: Senior Chief, Loiyangalani Location, P.O. Loiyangalani, Tel No. 17 Loiyangalani.
5. Councillor Marko Ekale, Loiyangalani Ward
6. David Muriuki Njamweah: District Cooperative Officer, Marsabit, Tel. 0722 562702.
7. David Loburgiali, Nayori Environmental Conservation Rehabilitation Youth Group.
8. District Fisheries Officer, Marsabit District
9. District Livestock Officer, Marsabit District
10. District Officer, Loiyangalani Division
11. Dominic Mbuvi: Livestock Coordination Officer, Food for the Hungry, Kenya, dmbuvi@fhi.net, P.O.BOX 125, Marsabit.
12. Esther E. Chiwe: District Gender & Social Development Officer, Marsabit, Tel. 0725769706.
13. Father Andrew Ndirangu, Catholic Mission, Loiyangalani
14. Frederick Mbithi Kitema: District Officer (DO1) Marsabit, Tel. 0722894298 / District Commissioner, Marsabit District.
15. Fatuma Kurewa, Chairlady, Kifaru Women Group, Loiyangalani
16. Godona J. Doyo: Arid Lands Development Project (ALRMP), Marsabit, Tel. 0724369880.
17. Hon. Joseph Lekuton, Member of Parliament, Laisamis Constituency
18. Ibrahim Adan: Chief Executive Officer, Community Initiative Facilitation and Assistance (CIFA), Tel. 0734 168010.
19. Jacinta Alia Lebasha, Teacher and Member of Kifaru Womens Group, Loiyangalani
20. Jane Saka Orbora: Assistant Fisheries Officer Loiyangalani, Tel. 0728 966620
21. Jeremiah Omechi Onchera: District Development Officer, Marsabit, Tel. 0725995812.
22. Jim L. Teasdale: African Inland Church (AIC) Pastor at Loyangalai, Tel. 0722-790264.
23. John Kagwi: Assistant Director, Northern Conservation Area (KWS), Tel. 0722 293216.
24. Leparsanti S. Teresalba: Teacher, Loiyangalani Primary School, Tel. 0728626812. / Headmaster Loiyangalani Primary School
25. Mamo Boru Mamo: District Environmental Officer, Marsabit. National Environmental Management Authority (NEMA). P.O. BOX 204, Marsabit, Tel. No. 0735 433860.
26. Nachukul Longolob Ekal: Kenya Wildlife Service Ranger, Sibiloi National Park (Southern Island National Park), Tel 0720222774.
27. Peter Lengewa: Loiyangalani Fishermen Cooperative Society, P.O. BOX 13 Loiyangalani.
28. Peter N. Gakunyi: Pastoralist Integrated Support Programme (PISP), Tel. 0692201. / Coordinator PISP.
29. Rebecca Lepalat Lebasha, Forest Department, Loiyangalani Divison
30. Sarai Fecha, Assistant Chief, Loiyangalani Location

31. Sister Maria Antonia Pira, Loiyangalani Health Centre (Catholic Mission)
32. Sendeo Baltor, Chairlady, Mosareto Women Group, Loiyangalani
33. Wolfgang Deschler, Managing Director, Oasis Lodge, Loiyangalani

Annex 10b. Participants of the EIA Stakeholders' Meeting (21-22 April 2008)

LAKE TURKANA WIND POWER PROJECT

EIA Stakeholders' Workshop List of Participants (21st April 2008)

SN	Name	Address			Signature
		Telephone	E-mail	Box No.	
1	David M. Njamweah	0722562702	-	75 Marsabit	
2	Anthony Mutua	0728393266	-	140 MARSABIT	
3	MATHIAS M MWAVITA	0725638568	mwavita2001@yahoo.co.uk	42 MARSABIT	
4	ORAGE COLLINS	0722462625	collinsorage@hotmail.com	1 Mbt	
5	WIJASS .M. DWUDA	0711378833	-	75 Marsabit	
6	MUSA OKANGO	0727212443		1 MARSABIT	
7	CLLR MARKO EKALE	0726368576	Markoekale@Yahoo.com	15 LOIYANGALANI	
8	PETER LENGEWA	0729964140		13 Loiyangalani	
9	TIM HADS				
10	ONYANGO				
11	DHAHIR LENTIPAN				
12	Benedict Lewoye	0723867205	[illegible]@yahoo.com	c/o 1 LOIYANGALANI	
13	James Lemuratunya	0723229280		15 Loiyangalani	
14	[illegible]	0722 [illegible]		[illegible]	
15	JAMES LOPEYOK	0710898453		Loiyangalani	
16	SIMON L LENAIRE			BOX 21028 NRB	
17	MAKAMBO LOTOROBO	0725 324935	lotorobo@yahoo.com	Box 40658 NRB	
18	PATRICK LESAS	0729676245	patricklesance@yahoo.com	Box 1 LOIYANGALANI	
19	Shedrick Lesh[illegible]	0722915264		Box 21028 NAIROBI	
20	James Lesi [illegible]			Box 21028 NAIROBI	
21	Jacinta Alia Lebabe	0729668209		BOX 15 LOIYANGALANI	
22	BENEDICT ORBORA	0726714768		Box 19 LOIYANGALANI	
23	ANGELO BABALEN	0725080847	Angelo@yahoo	BOX 1 LOIYANGALANI	

LAKE TURKANA WIND POWER PROJECT

EIA Stakeholders' Workshop List of Participants (21st April 2008)

SN	Name	Address			Signature
		Telephone	E-mail	Box No.	
1	[illegible] LOOTIA			LOIYANGALANI	
2	CH. LEKAPEPA	0729620547		"	
3	JUSTUS ONDIMU	0721681096		Box 9, MARSABIT	
4	Sendeyo Bette	0729624111		Box 1 Loiyangalani	
5	BARAKI FECHA	0728004585		1 Loiyangalani	
6	NAPULO O LOKOL	0725561426		Box Loiyangalani	
7	ODYANSO OKEDY	0711463806		Box Loiyangalani	
8	JOSEPH L LEPALO	0728 752 840		Box 15 loiyangalani	
9	WILLIAM EBUKUT	0729534139		Box 13 Loiyangalani	
10	JANE SAKAM	0729966620		Box [illegible] MARSABIT	
11	PETER LENGEWA	0729964170		Box 13 Loiyangalani	
12	REBECCA LEBACHA	0727086880		Box 10 Loiyangalani	
13	M · K · OKANYO	0727212443		Box 1 Loiyangalani	
14	MICHAEL B. LEKAPANA	0721087798		Box 322, MARSABIT	
15	DAVID M. LOBURTILAN			Box 1 Loiyangalani	
16	LENGUE LOCHORAPAL			Box 1 Loiyangalani	
17	PETER LEPALI	0728729295		Box 20 Loy	
18					
19					
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21					
22					
23					

	NAME:	TEL:	E-MAIL	BOX NO:	SIGNATURE:
24	STEPHEN NAKENO	0720077689	—	—	[signature]
25	DAVID LOBURJIAI	[illegible] —	—	BOX 1	[signature]
26	CORNELIUS EBUKUT	0725819860	—	—	[signature]
27	Rebecca Reete	0728510234	—	BOX 4	[signature]
28	ORBORA STEPHEN	0728804635	—	BOX 28 MBT.	[signature]
29	JAMES TEASDALE	0722.790.264	emmteasdale@auplos.com	21028 UBI	[signature]
30	Rita Lowa	0725696003			[signature]
31	Asha mohamed	0723070276		BOX 15 LOIYangalani	ASHA MOHAMED
32	Rembes Leaburia	[illegible]		BOX 15 Loiyangalani	Rembes.
33	Saadhia mohamed			BOX 15 Loiyangalani	[illegible]
34	Apita Ekidor			BOX 15 Loiyangalani	Apita Edor
35	JANE ORBORA	0728966620		BOX 84, MBT.	[signature]
36	MRS FATUMA KIREWA	0729958759		BOX 1 LOIYANGANI	
37	REBECA LEPALAT	0727086880		BOX 1 LOIYANGANI	[signature]
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Annex 11. Minutes of the EIA Stakeholders' Meeting

Venue of the Meeting: The Palm Shade Camp (Conference Hall), Loiyangalani.

Date of the Meeting: 21 – 22 April 2008

Attendance: Full List of Attendants is attached in Annex 10b. .

Facilitator / Translator: Pastor James Teasdale (Africa Inland Church – Loyangalani)

Rapporteur: Mr. Adrian Babault

Project Proponent Representatives: Mr. Willem Dolleman and Mr Harry Wassenaar

EIA Study Team Leader and Report Presenter: Professor Francis M. Muthuri

Apologies

1. Member of Parliament for the Laisamis Constituency - Honourable Joseph Lekuton
2. District Environmental Officer, Marsabit District – Mr. Mamo Boru Mamo
3. Marsabit County Council Officials: The Vice Chairman, Treasurer and the Clerk to the County Council.

Notes

1. Meeting attendants had received a draft copy of the Environmental Impact Assessment Report two weeks prior to the meeting.
2. The Meeting started at 2.45pm, after a lunch session for the attendants.

Meeting Deliberations

Resource Person / Participant	Comment / Issues Raised
Facilitator	Brief introduction of the project and thanked those who travelled far to attend the stake holders' meeting.
	Invited a participant to lead the meeting in prayer.
	Conveyed apologies from the Hon. Joseph Lekuton, the Member of Parliament for the Laisamis Constituency
Rapporteur	Introduction of the people who travelled all the way from Marsabit to attend the meeting.
Presenter	Started by thanking all the participants for attending the meeting.
	Emphasized that sustainable development involves projects that are economically viable, socially acceptable and environmentally sound.
	Outlined the project objective: To build a wind farm for generation of 300MW of electric power to feed into national grid.
	Outlined the study objective: Carry out environmental impact assessment in accordance to the NEMA guidelines.
	Introduced the project area: 150 km^2 of land located between footslopes of Mt. Kulal and south-eastern Lake Turkana mainly in Loiyangalani Division of new Laisamis District.
	Emphasized that the project area was much larger than the actual area to be occupied by the proposed wind farm.
Asst. Chief Moite	Asked whether the turbines will be scattered over the area or whether they will be in one place.
Mr. Willen Dolleman	That they will in a line facing the prevailing wind and that each will have a footprint of 8m x 8m.
Mr. William Ebkot	Asked what the existing masts are doing in the project area
Presenter	The masts are currently used for recording wind data to help in choosing the specific site.
Mr. William Ebkot	Wanted to know the number of windmills to be erected in the project area.
Presenter	100 wind turbines are planned to be erected in the project area, although the project is considering the alternative of installing more than 100 wind turbines with each producing less power, with a total power production of 300MW.
Rapporteur	Drew attention to the arrival of the attendants from Gatab (Mt Kulal Location).
Snr. Chief, Mr. Lenaragusho	Apologised for their late arrival and asked the Presenter to briefly recount what they missed.
Presenter	Summarised the deliberations as requested.
Mr. William Ebkot	Suggested that since the issues presented are very important, the meeting should be extended to cover 2 to 3 days.
Presenter	It was assumed that all the participants had read draft EIA Report. The Team had not received any comments on the despite the request on the cover letter.
Snr. Chief Loyangalani, Mr. C.K. Lekapana	Recommended that the Presenter should continue with the presentation of the EIA findings.

Loyangalani Cllr., Marko Ekale	Defended the project as essential to the development of the area. He wondered whether adequate consultations were carried out with regard to this project.
Presenter	The Team Leader felt that adequate consultations with regard to this project had been made. Prior to the EIA study several meetings had been held between administration and local community and the project proponents. During the EIA study, the team visited the administration, local community in their manyattas, all CBOs operating in the in the project area, church leaders, community leaders and health and schools leaders among other stakeholders. Relevant Government institutions and NGOs were consulted in Marsabit District. On the whole over 30 organisations were consulted. He assured the meeting that raising awareness on the project was constantly ongoing.
Snr. Chief, Mr. Lenaragusho	Commented that the 3 new masts are in his location, Mt. Kulal location.
Presenter	Replied that the masts were only recording data and in total they occupied less than an acre of land.
Headmaster, Gatab Primary School	Emphasized that 1 acre of the land is important to pastoralists.
Facilitator	Stated that the Professor be allowed to continue with his report.
Mr. William Ebkot	Commented that this was their (stakeholders) meeting and that they could take a week over it if they so wished.
Presenter	The Presenter continued and elaborated on the physical characteristics of the potentially affected environment of the project area including (climatic conditions – rainfall, temperature and wind), topography, geology, soils and hydrology.
	He elaborated on the terrestrial flora. He emphasized the importance of floral resources including shrubs and trees of *Acacia*, *Commiphora*, *Indigofera*, *Salvadora* etc. to livestock and the local communities.
	The Presenter emphasized the paucity of wild fauna in the project area to the extent that only an occasional dikdik and hare were observed as representatives of wildlife in the project area.
	He depicted Lake Turkana as an important habitat for an abundant crocodile population, 84 bird species including 35 Palaearctic migrant bird species and 48 species of fish. He spoke of the phytoplankton, zooplankton, invertebrate fauna and their crucial role in the aquatic food chain of the lake. He elaborated on the importance of fish such as Tilapia, Nile Perch, Barbus and Labeo in the fisheries of Loiyangalani beach.
	The Presenter briefly described socio economic environment of the project area including population, existing services, education, health, poverty, land use and commercial and economic activities.
	He emphasized pastoralism the crucial land use and source of livelihood for the local community of the project area.
	The Presenter concluded that the description of the environmental characteristics of the project area was an important yardstick against which future variances could be used as measures of the impact of the project

	He described the positive impacts of the project including stabilization of electricity, promotion of economic growth, increased employment opportunities, increased contribution to government revenue, improvement of roads in the project area and surroundings and provision of electricity in the project area and surroundings. The Presenter stressed that the electricity produced in this project will stabilise Kenya's power supply and will reduce the dependence on hydro power produced on Tana River system especially during the dry seasons.
	He further stated the wind project will contribute significantly in the promotion of the Kenya's Rural Electrification Programme and the Vision 2030.
A Lady Participant	Stated that she didn't understand English and wanted the presentation translated into Swahili.
Facilitator	Provided a summary in Swahili.
Presenter	The Presenter continued with the positive impacts stating that there would be significant job employment opportunities in the project area. He further said that although the " high calibre" labour would be imported, the stakeholder community would benefit more from semi skilled and unskilled opportunities and that many jobs would be created from "spin offs" and "multiplier effects" including sand collecting, gravel making and the huge increase in trade and accommodation needs.
Facilitator	Carried out the translation and added that the proposed laboratory that was planned to be built in Loiyangalani in conjunction with the Kijabe Hospital could not be built without a reliable power source, a problem this project will solve when completed.
Presenter	Asserted that the benefits would be much greater than the predicted 400 or more direct jobs created.
Ms. Jacinta Lebasha, Kifaru Womens Group.	Asked whether the production of gravel would be detrimental to the environment.
Presenter	The issue was addressed as a component of negative impacts.
Loyangalani Cllr., Mr. Marko Ekale	Asked whether the benefits would include the improvement in the districts roads. He suggested that contracts should be awarded to groups and not concentrate on the employment of people.
Presenter	Replied that transport links may improve but that that would be secondary to fact that the roads would be built primarily to transport project materials.
Facilitator	Carried out the translation and supported comments made by the councillor and suggested that as many contracts as possible should be awarded locally.
Mr Benedict Orbora	Stated that the report showed that the primary access road would branch of the main Marsabit – Isiolo road at Laisamis, and would head to the project area via the towns of Kargi.
Facilitator	Cautioned that that the road survey had not been completed but that it was unlikely that the project materials would ascend Mt. Marsabit.
Presenter	Continued with the presentation of positive impacts stating that the project would contribute substantially to government revenue through taxes such as VAT and PAYE. He specifically mentioned that 0.1% of the project cost would be paid to NEMA.
Facilitator	Translation

Presenter	Continued presentation and stated that the Consultant Road Engineer will define the access route, but that whichever route was chosen the improved access would improve transport with benefits in the transportation fish and livestock. Especially fish could be transported frozen as electricity from the project would power cold storage.
Facilitator	Carried out the translation and added that currently cattle and camels could not be transported by road since the livestock broke their legs due to the poor road surface. A situation that would overturned by better roads.
Presenter	He added that local power provision would supply schools, hospitals, hotels and private homes but cautioned that it would have to paid for at normal rates.
	Stated the project would extend social responsibility and highlighted marginalised communities like that at El Molo as potential beneficiaries of social schemes.
Facilitator	Translation.
Mr. William Ebkot	Asked who would distribute the electricity.
Presenter	The Kenya Power and Lighting Company (KPLC) would distribute the electricity. He added that Turkana Wind Power Project would only generate electricity.
Facilitator	Translated and added that KPLC had published an offer for private sector partners to generate electricity on their behalf. He also enlightened the attendants that Turkana Wind Power Project partners had risked their own money and were busy raising huge sums of money more for the project for the benefit of all the stakeholders. He also reminded the audience that wind power was clean power as opposed to diesel and oil generators. He also stated that electricity would be charged according to the law.
	He added that Safaricom wasn't free yet most people still used their services. He went on to say Loyangalani had too much to gain from the project to also ask for discount for the electricity they use.
Presenter	Introduced the negative impacts of the project. Highlighted the influx of people in the project area and the subsequent increase in exploitation of natural resources as the underlying key processes that will cause social negative impacts.
Mr. Lotorobo Makambo	Added that the project will also use water as a natural resource.
Presenter	Added that an increase in insecurity in the area could occur if the project was perceived to benefit certain communities more than others. He said the communities in the neighbourhood of the project area are prone to conflicts and described how during the EIA field survey in November, 2008, the El Molo community had taken shelter in Loiyangalani following attacks from another community from further north.
Facilitator	Translated and added that the jealousy of the project of non beneficiary surrounding communities may induce revolt.
Presenter	Continued with social negative impacts and added that an increase in sexually transmitted diseases in the project area was likely with an increase in migrant workers and influx of the commercial sex workers.
	He highlighted visual intrusion emanating from disfigured landscapes associated with earth works, spoils, quarries and borrow pits. He stated that although some people may view the wind farm as visually intrusive, the wind farm could turn out to be a spectacle that would draw tourists from as far away as Mombasa.

Facilitator	Translated and added that Holland, whose wind farm experts were very involved in this project, was the home of Windmills where they had been made for the last 600 years. He also added that many tourists were attracted to Holland just to see the windmills there and that the proposed wind farm may also have a similar effect.
Presenter	Continued with the presentation of negative impacts and added that the influx of migrant labour force would lead to an increase in effluent and domestic waste. He cautioned that this would need careful management. In addition, an increased population would add to the pressure on already depleted resources.
	The Presenter spoke of increased accident numbers and occupational hazards following the commissioning of the project.
Facilitator	Translation
Presenter	Introduced the bio-physical impacts of the project including physical environmental damage and trampling on plants.
	He added that an increase in soil erosion and siltation were likely in the project area and emphasized the threat posed to aquatic life from the effect of siltation at the Lake Turkana shore line.
Facilitator	Translation
Presenter	He described the dangers caused by ponding in the project area since creation of stagnant waters in depressions could serve as breeding grounds for snails and mosquitoes that are vectors of bilharzia and malaria respectively. He described that a main environmental impact when constructing the proposed wind park could be collision of birds with turbines. Stated that disturbance to livestock will not constitute any appreciable negative impact in the project area since there will be no fencing.
Loyangalani Cllr., Mr. Marko Ekale	He felt that ponds left after road construction activity could provide water for livestock in the project area.
Presenter	He agreed with the Councillor and illustrated how whole communities had benefited from water filled pits left after the construction of the Garsen Cause Way in the Tana River District near Lang la Simba.
Facilitator	He cautioned that areas around waterholes could trigger overgrazing.
Presenter	Reminded the participants that sustainable projects are socially acceptable, economically viable and environmentally sound. He felt that the wind project has the potential to be sustainable.
Facilitator	Added that the Global Development Forum in New York considered this project as one of the top priority 100 development projects worldwide. And of the 100 projects it attained 1st position.
Presenter	Presented on the computer display of the Environmental Impact Matrix and described its relevance in depicting the intensity of the predicted positive and impacts of the project.
Facilitator	Supported the Presenter's use of the environmental impact matrix as a good measure for depicting the magnitude of the proposed environmental impact of the project.
Presenter	Introduced Environmental Management Plan to the participants.

Mr. William Ebkot	Was concerned the meeting was more of a lecture than a discussion.
Facilitator	Reminded the participants that any one was free to interrupt the Presenter and make a comment or ask any question. He suggested that the meeting continue the following morning at 9 am to provide the attendants with more time to participate.
Presenter	Continued with the proposed Environmental Management Plan introducing important processes such as environmental mitigation and monitoring.
Snr. Warden Marsabit Park, Mr. Matthias Mauvita	Requested that in the process of implementing environmental management plan, the project should develop a tree nursery to combat desertification in the project area.
Presenter	The Presenter agreed with the Senior Warden. He outlined proposed measures to reduce or alleviate negative impacts including reduction Sexually Transmitted Diseases, reduction of the utilization of wood resources, community awareness, reduction of visual intrusion and management of labour force among other negative impacts.
Facilitator	Translation.
Presenter	Highlighted noise abatement and stressed that most noise will emanate from the road construction activities. He further stated that Vestas turbines are associated with low noise levels and therefore it was unlikely that noise levels will cause any disturbance during the operation of the wind farm.
Facilitator	Translated and added that modern trucks should be used as they are better silenced.
Presenter	Spoke of dust control measures including watering of the roads and use of protective cover such as masks, helmets, goggles and overalls to protect workers. He suggested measures to reduce ponding through landscaping and filling in the created depressions. He further recommended planting of indigenous and appropriate trees, shrubs and grasses in order to restore the habitat and biodiversity.
Facilitator	Translation.
Presenter	Assured the participants that the project will virtually have no effect on livestock since there is no fencing. Also he said the area taken by the construction of the wind farm is extremely very small.
	The Presenter introduced mitigation measures against potential effects to birdlife. He stated that the wind farm will be sited no closer than 3km from Lake Turkana and I km away from mountains. He also suggested that aspects of the project that attracted birds like ponds and dumps should be eliminated.
	Emphasized the importance of environmental monitoring and outlined the focus areas for monitoring in the project area.
	Recommended the hiring of an Environmental Officer supervise the monitoring of the environment with specific attention to changes in biodiversity including baseline field study on birds.
	Explained to the audiences the breakdown of the proposed cost for environmental management plan including environmental monitoring as detailed in EIA report.
	In conclusion, the Presenter stated that the environmental impact assessment study of the proposed project has not come across any negative impact that can not be mitigated.
	He once again thanked the participants for attending the meeting and said he was privileged to have had the

	opportunity to speak to them.
Facilitator	He thanked the participants and closed the day's session at 7.20 p.m. .
Meeting Resumes at 9.50am on the 22nd of April 2008	
Facilitator	Made introductory remarks and invited a participant to lead the meeting in prayer.
Participant	Led the meeting in prayer.
Presenter	Did a recap of the previous day deliberations and outlined the objective of the day's meeting: receive inputs and views from the stakeholders which eventually would be incorporated into the final EIA report that would be submitted to NEMA.
Facilitator	Did the translation and challenged all the participants to speak up including even those with negative and divergent views and perceptions on the proposed project.
Snr Warden Marsabit Park, Mr. Matthias Mauvita	Felt that the Lake Turkana Wind Power Project was a good project for the project area and surroundings and will be essential for the development of the area. He was however, concerned about the natural resources of the area including the siltation threat to Lake Turkana and concerns over the birdlife.
	In addition, he expressed concern over the current depletion of vegetation cover in the area due to increased production of charcoal and collection of firewood. He requested the project to assist Nayori Conservation Group to start tree nurseries in order to rehabilitate the degraded environment and increase the biodiversity of the area. He further requested the project to work with the local community and help them in capacity building and empower them in sustainable development.
Presenter	Assured the Senior Warden of the commitment of the project proponent to environmental conservation of the project area. He added that this commitment is captured in the Environmental Management Plan contained in the EIA Report including strategies to arrest soil erosion and siltation, location of the wind farm away from the lake, the recruitment of environmental officer and the proposed funding of tree nurseries as part of the environmental management plan.
Facilitator	Translation.
District Development Officer, Marsabit	Stated that the project was good and would improve the economy of the area. He however, cautioned that the project has not been registered in his office as required by the District Development Committee (DDC). He suggested a closer relationship between the project and his office.
Presenter	The Presenter agreed that the proponent should make a follow up on this issue and register the project with DDO. He insisted, however, that meetings and barazas with the local administration had been regularly held and that steady consultations with Marsabit County Council had ensured their constant involvement in the project. He added that during the EIA study, the district administration and government department in the Marsabit District were intensively consulted.
Facilitator	Carried out the translation and also emphasised the openness of the project in whose record was extensive coordination. In comparison, he felt that this project was much better in distributing information than various aid projects.
District Development Officer	Said that the project coordinator should sit with DDO committee and get its endorsement. A meeting should have

Marsabit	been held with the Location Development Committee (LDC) to seek its endorsement prior to approaching the District office.
Presenter	Once again the Presenter agreed that the project will fulfil DDO requirements.
Facilitator	Did the translation of the issues raised and added that a meeting with LDC was held and that the minutes were available.
Loyangalani Cllr., Mr. Marko Ekale	Stated that the DDO cannot endorse a motion without local agreement and that the County Council was the 'custodian of the land'. Suggested that the project should conduct research on the fish stocks in the lake and the human population in the project area.
Presenter	The Presenter reminded the participants that approach and methodology for conducting the EIA study is contained in the Draft EIA report. A great percentage of information used in the compilation of the EIA report comes from secondary data sourced from Government Departments and other institutions. For example the Loiyangalani fish data (2006 – 2007) used in the report was derived from the Fisheries Department while population records were derived from the Government 1999 Census and subsequent projections.
Facilitator	Translation.
Mr. Collins Orage, DO2 Marsabit District	Stated he was very impressed with the EIA report. He appreciated the naming of plants in the project area both by their scientific names and Turkana names. However, he wondered what would happen to the project area following the destruction of plants.
Presenter	The Presenter confirmed that some plants especially along the road where construction will take place will be destroyed. He, however assured the participants that there were no rare, threatened or endemic plant species that were likely to be destroyed in the project area. The plants likely to be destroyed commonly occur in the arid and semi-arid of the northern Kenya. He reminded the participants that Environmental Officer would carry out plant restoration in the affected areas as recommended in the EIA report.
Facilitator	Translation.
Mr. William Ebkot	Asked if minutes of the meeting were being taken. He added that data collection also needs to be done at the 'grassroots' level. He stated that the fish data at the Fisheries Office did not include those fish caught for local consumption.
	Stated that the stakeholders wanted to see the proposed site of the wind farm. He also asked whether it was a wind farm or a wind park as he understood that a farm was a small area but that a park was enormous.
Presenter	Quelled Ebkots fears of the size of area and described how the masts would be laid out in rows. There was no difference between a wind farm and a wind park and the two terms can be used interchangeably.
Mr. William Ebkot	He was concerned that the park should not be located on religious or burial site or on an area that harboured rare wildlife or that contained good grazing.
Presenter	Replied that the wind farm area will be located on the plateau behind the Ongip massif but the exact wind farm site has not been selected yet. The local community will be consulted and involved on the actual selection of the specific wind farm site in due course.

Mr. William Ebkot	Suggested that the site be identified and debated immediately.
Presenter	Stated that at present only the general location of the wind farm site could be considered.
Loyangalani Cllr., Mr. Marko Ekale	Said that the real cause of concern over the site was that the local community were not consulted prior to the installation of the existing masts.
Mr. Benedict Orbora	He felt the presentation had been excellent and that the stakeholders were well informed of the details of the project to convey to the rest of the population. He went on to say that the local people feared the unknown and were originally baffled and concerned by the huge amount of information in the EIA draft report. However, the Presenter had translated most of the technicality into something which everyone could relate.
Mr. Willem Dolleman	Told the meeting of how the data collected from the existing masts was helping to narrow the area for the wind farm site location. When the data collected had reduced the area into a specific site then the local community would be informed and consulted.
Facilitator	Translated the issues raised and added that the individual turbines at the site will be 400 metres apart to ensure each received 'clean air'. He spoke of the area behind Ongipi massif as a barren site covered with volcanic lava and unproductive for livestock grazing.
	Stated he had lived among local community for enough years to feel he was worthy of trust particularly as he had tried to be a good neighbour. He went on to say that as an American he originally came from a power dependant society well aware of the costs of electricity, and added that nobody else could ever afford to supply power to this area. With that in mind the local community should work out means of encouraging the project proponents to establish a sub station in Loiyangalani.
Snr. Chief Loiyangalani, Mr. C.K. Lekapana	Confirmed that the whole of Loiyanglani wanted the project. He requested that more information needs to be provided and more meetings should be held in the future. He requested that a copy of the EIA report be left in the school library as reference material. He added that project was at its very beginning.
Loyangalani Cllr., Mr. Marko Ekale	Felt that the report did not mention much about the history of the area and that environmental management budget did not provide enough for local sensitisation on the project.
Presenter	Felt that the allocation was adequate since the proposed figures referred only to the first year of operation of the proposed environmental management plan.
Mr. Loyangalani Cllr. Mr. Marko Ekale	Suggested the budget should include allocation for the Chief's barazas.
Mr. Wijass Owour, District Cooperatives Officer, Chalbi District	He started by saying that he was proponent of "Integrated Development" and that Lake Turkana Wind Power Project (LTWPP) was a very good project. He added that in the new District Development Plan prepared by the Laismis District Office, the LTWPP was of the highest priority followed by tourism and livestock development projects.
	He was, however, concerned that the local population are likely to be spectators and not participants in the project. He illustrated the benefits of the project by predicting that the current district earnings of 6.1million from fish sales would increase to 24 million following the improved roads and the provision of electricity for fish storage facilities. He requested the project to help in finding alternative energy sources to fuel wood. He described how successful

	the reforestation programmes around the town of Korr had been achieved and how he hoped to see the same in this project.
Presenter	Added that there could be a window of opportunity for other parties including development partners, the Government and NGOs to provide further funding in order to expand the environmental management programme.
Coffee / Tea Break	
Mr. David Nyamweah, District Cooperative Officer – Marsabit	Started by saying that from experience in the Kiambere Hydro Power project, he was confident that most of the benefits projected in this project would be realised. He also felt that an uplift in the standard of living of the local people should be one of the objectives of the social responsibility of the project. He proposed that the support from the project should be given to institutions that govern quality of life, like cooperatives.
Mr. Benedict Lengui, Loiyangalani Peace Committee	Felt that the community was slow to react to the potential of the project and should show its support by readily facilitating of the project.
Mr. Sarai Fetcha, Assist. Chief, Loiyangalani	Asked how the power distribution will be done as was concerned about of the dangers of high voltage cables.
Facilitator	Stated that the cables from the generators would run underground to a collection centre, and then over ground cables on pylons would transmit electricity to the national grid.
Mr. M. Masinga Natapana, Rtd Education Officer	Wanted to see more emphasis on assistance to pastoralists and livestock in the project.
Presenter	He appreciated many of the stakeholders concerns and suggested that there was a need for a Participatory Rural Appraisal (PRA) to facilitate the local community identify felt needs.
Facilitator	Carried out a translation of the raised issues and added that social responsibility will be implemented with full participation of the local community.
Mr. Steven Naikeino	Wanted to find out the project component that will be implemented first and when the implementation will commence. Requested that the project include training of local people as a priority.
Presenter	The Presenter deferred to Willem Dolleman (one of the project partners), on the issue of project timings.
Mr. Willem Dolleman	Stated that the execution of the project would start when all agreements and licences were in place. He perceived that the road construction would constitute the first phase, followed by the transmission line and then the installation of the wind turbines.
Facilitator	Translation.
Mr. David Lobujula	Asked how funds would be raised for the community development.
Mr Benedict Orbora	Extended Mr. Lobujula's thoughts by suggesting that that the salaries of the employees should be taxed and the monies generated to be used for community development.
Mr. William Ebkot	Warned the project against using child labour. He was concerned youngsters are likely to leave school for job opportunities in the project. He wanted to be given more time to read the EIA report.
Mr. Willem Dolleman	Stated that as an investor and partner in the project, he would ensure that international law would be applied particularly in areas such as the prevention of child labour.

Presenter	Reminded the participants that they had the EIA report for the last here weeks. He informed them he wanted to submit the revised EIA report within the coming week or so. He requested the participants to give him any further comments before then.
Facilitator	Translated the raised issues and added that Loiyangalani should move fast to keep pace with the rest of the world.
Presenter	Upon requests for out of pocket allowance for the participants, the Presenter felt it was not a sustainable practice. However, he invited the project partner to make a comment on the issue.
Mr. Willem Dolleman	Added that huge sums of money had already been spent and that the community should encourage the proponents to establish the project. He felt the provision of lunches for the stakeholders and payments for accommodation and for the conference room were good gestures from the project.
Snr. Chief Loiyangalani, Mr. C.K. Lekapana	Asked when the PRA would take place. Proposed that the community would prepare a list of priorities that could be discussed in another stakeholders meeting.
Presenter	Was pleased to hear what the chief said. PRA would commence with the commissioning of the project. He added that the community's proposal for the PRA would be well received by the project.
Facilitator	Translation
Loyangalani Cllr., Mr. Marko Ekale	The Councillor summarised many issues that had been previously raised. He appealed to project to help the community protect the lagga banks which were currently widening and posed a threat to buildings. He spoke of the increase of population in Loiyangalani and requested the project to help in planning the town. He was concerned about the stalled museum project. He felt that the project needed a presence in Loiyangalani and that a project office needs to be opened. In addition the project needs to print project T shirts and banners. He raised the issue of whether the project will be located in Loiyangalani or Mt Kulal locations. He predicted some tension over location of the project.
Presenter	Referred the Councillor to the Environmental Management Plan contained in the EIA report. Added that the proposed Environmental Officer would work with the community to address a wide range of environmental issues of the project area including the problem of the laggas. In this case, there may be a need to prepare a proposal for funding from the Government and other development agents. He appreciated the problems raised by the Councillor but cautioned the participants against high expectations as the Lake Turkana Wind Power Project was a commercial initiative and should not be equated to an aid agency. Reminded the Councillor that the decision on the actual location of the wind farm site has not been decided.
Facilitator	Translated the response from the Presenter and extended his concern over the issue of the widening lagga by voicing his support for action to halt its spread.
Presenter	Again the Presenter thanked the participants and wished stakeholders success in the implementation of the environmental management in collaboration with the project.
Facilitator	Without any further business the Facilitator closed the stakeholders' meeting at 1.57 pm on the 22nd of April 2008.