


# ENVIRONMENTAL IMPACT ASSESSMENT

## STUDY REPORT FOR THE PROPOSED WATER HARVESTING AND UTILIZATION PROJECT AT THE SOUTH EASTERN UNIVERSITY COLLEGE (SEUCO), KITUI



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<p>26<sup>th</sup> July 2011</p>	

## DECLARATION FOR SUBMISSION

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### DECLARATION BY THE ENVIRONMENTAL CONSULTANT

I, **Dr. Johnson U. Kitheka**, EIA/Audit Lead Experts Reg. No. 2434 submit this Environmental Impact Assessment (EIA) project report for THE PROPOSED WATER HARVESTING AND UTILIZATION PROJECT AT SEUCO, KITUI. The Environmental Impact Assessment (EIA) Study has been carried out according to the Environmental Management and Coordination Act, 1999 and Environmental (Impact Assessment and Audit) Regulations, 2003. To my knowledge, all information contained in this report is accurate and a truthful representation of all findings as relating to the proposed infrastructural development.

*Signed at Kitui on this 26<sup>th</sup> day of July 2011*

*Signature* .....

Dr. Johnson U. Kitheka, PhD

**Designation:** EIA/Audit Lead Experts Reg. No. 2434

### DECLARATION BY THE PROPONENT

I, **Prof. Geoffrey Muluvi**, on behalf of **South Eastern University College (SEUCO)** submit this Environmental Impact Assessment (EIA) project report for WATER HARVESTING AND UTILIZATION PROJECT AT SOUTH EASTERN UNIVERSITY COLLEGE, KITUI. The Environmental Impact Assessment Project has been carried out according to the Environmental Management and Coordination Act, 1999 and Environmental (Impact Assessment and Audit) Regulations, 2003. To my knowledge, all information contained in this report is accurate and a truthful representation of all findings as relating to the proposed infrastructural development.

*Signed at Kitui on this 26<sup>th</sup> day of July 2011*

*Signature* .....

Prof. Geoffrey Muluvi, PhD

**Designation:** Principal- South Eastern University College (SEUCO)

**THE EIA PROJECT REPORT FOR THE PROPOSED WATER HARVESTING AND UTILIZATION  
PROJECT AT THE SOUTH EASTERN UNIVERSITY COLLEGE (SEUCO), KITUI**

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## ACRONYMS

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ArchiCAD	Architect Computer Aided Design
AutoCAD	Automatic Computer Aided Design
CAP	Chapter
EA	Environmental Audit
ERS	Economic Recovery Strategy
EIA	Environmental Impact Assessment
EMCA (1999)	Environmental Management and Coordination Act (1999)
EMP	Environmental Management Plan
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
Km	Kilometers
KShs	Kenya Shillings
LA21	Localizing Agenda 21
NEC	National Environment Council
NEMA	National Environment Management Authority
NET	National Environment Tribunal
PPE	Personal Protective Equipment
SEUCO	South Eastern University College
TOR	Terms of Reference

## TABLE OF CONTENTS

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DECLARATION FOR SUBMISSION-----	II
ACRONYMS-----	IV
TABLE OF CONTENTS-----	1
LIST OF APPENDICES-----	3
LIST OF TABLES-----	4
LIST OF FIGURES-----	4
LIST OF PLATES-----	4
EXECUTIVE SUMMARY-----	5
CHAPTER ONE-----	7
1.0 INTRODUCTION-----	7
1.1 BACKGROUND AND RATIONALE FOR AN ENVIRONMENTAL IMPACT ASSESSMENT-----	7
1.2 OBJECTIVES OF CARRYING OUT EIA ON THE PROJECT-----	8
1.3 TERMS OF REFERENCE (TOR) FOR THE EIA PROCESS-----	8
1.4 METHODOLOGY OUTLINE-----	9
1.4.1 <i>Environmental Screening</i> -----	9
1.4.2 <i>Environmental Scoping</i> -----	9
1.4.3 <i>Desk Study</i> -----	10
1.4.4 <i>Site Assessment</i> -----	10
1.4.5 <i>Data Analysis</i> -----	10
1.4.6 <i>Reporting</i> -----	10
CHAPTER TWO-----	11
2.0 PROJECT DESCRIPTION-----	11
2.1 INTRODUCTION-----	11
2.1.1 <i>SEUCO Vision</i> -----	11
2.1.2 <i>SEUCO Mission</i> -----	11
2.1.3 <i>Philosophy</i> -----	11
2.1.4 <i>Our Core Values</i> -----	11
2.2 PROJECT BACKGROUND-----	12
2.3 PROJECT JUSTIFICATION-----	12
2.4 PROJECT OBJECTIVES-----	14
2.5 PROJECT COMPONENTS-----	15
2.6 PROJECT BUDGET-----	22
CHAPTER THREE-----	24
3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK-----	24
3.1 INTRODUCTION-----	24
3.2 POLICY FRAMEWORKS-----	24
3.2.1 <i>Policy Paper on Environmental and Development</i> -----	24
3.2.2 <i>Physical Planning Policy</i> -----	24
3.2.3 <i>Education Policy</i> -----	24
3.2.4 <i>Public Health Policy</i> -----	25
3.2.5 <i>Other Relevant Policies Associated with the Project</i> -----	25
3.3 LEGAL FRAMEWORKS-----	25
3.3.1 <i>Environment Management and Coordination Act (EMCA 1999)</i> -----	25
3.3.2 <i>Waste Management Regulations 2006</i> -----	26
3.3.3 <i>Forestry Act (Cap 385)</i> -----	26

3.3.4	<i>The Wildlife Conservation and Management Act</i>	27
3.3.5	<i>Building Code 2000</i>	27
3.3.6	<i>Public Health Act (Cap. 242)</i>	27
3.3.7	<i>Local Authority Act (Cap. 265)</i>	28
3.3.8	<i>Physical Planning Act, 1999</i>	28
3.3.9	<i>Land Planning Act (Cap. 303)</i>	19
3.3.10	<i>Water Act, 2002</i>	19
3.3.11	<i>Electricity Power Act No. 11 of 1997</i>	30
3.3.12	<i>Penal Code Act (Cap.63)</i>	31
3.3.13	<i>Occupational Safety and Health Act, 2007</i>	31
3.3.14	<i>Food Drugs and chemicals substances Act (Cap 254)</i>	32
3.3.15	<i>The Water Act 2002 (no. 8 of 202); laws of Kenya</i>	33
3.4	INSTITUTIONAL FRAMEWORK	33
3.4.1	<i>National Environmental Management Authority (NEMA)</i>	33
3.3.4.1	<i>Provincial and District Environment Committees</i>	35
3.3.4.2	<i>Public Complaints Committee</i>	35
3.3.4.3	<i>National Environment Action Plan Committee</i>	35
3.3.4.4	<i>Standards and Enforcement Review Committee</i>	36
3.3.4.5	<i>National Environmental Tribunal</i>	37
3.3.4.6	<i>National Environmental Council (NEC)</i>	37
3.3.4.7	<i>National Environmental Action Plan (NEAP)</i>	37
3.3.4.8	<i>National Shelter Strategy to the Year 2000</i>	37
3.3.4.9	<i>The National Poverty Eradication Plan (NPEP)</i>	37
CHAPTER FOUR		39
4.0	ENVIRONMENTAL SETTING - BASELINE INFORMATION	39
4.1	BASIC RESOURCES AND INFRASTRUCTURE	39
4.2	PROPOSED PROJECT LOCATION AREA AND ITS DESCRIPTION	39
4.3	PHYSICAL AND AGRO-CLIMATIC CONDITION	40
4.4	REGIONAL SETTING	40
4.5	BIODIVERSITY	41
4.6	VEGETATION	42
4.7	GEOLOGY	42
4.8	HYDROLOGY AND WATER RESOURCES	44
4.9	POPULATION	45
4.10	ECONOMY	45
4.11	INDUSTRIES	45
CHAPTER FIVE		456
5.0	CONSULTATION AND PUBLIC PARTICIPATION	46
5.1	INTRODUCTION	46
5.2	OBJECTIVES OF THE CONSULTATION AND PUBLIC PARTICIPATION	46
5.3	PRELIMINARIES AND TERMS OF REFERENCE	46
5.4	METHODOLOGY	47
5.5	ISSUES RAISED	47
5.5.1	<i>Positive Issues Raised</i>	47
5.5.2	<i>NEGATIVE ISSUES RAISED</i>	48
CHAPTER SIX		50
6.0	IMPACTS OF THE PROJECT	50
6.1	OVERVIEW	50

6.2	SCALE	50
6.3	CONSTRUCTION PHASE IMPACTS	52
6.3.1	<i>Negative Environmental Impacts</i>	52
6.3.2	<i>Positive Environmental Impacts of Construction Phase</i>	54
6.4	OPERATIONAL PHASE IMPACTS	55
6.4.1	<i>Negative Environmental Impacts</i>	55
6.4.2	<i>Positive Environmental Impacts of Operational Phase</i>	56
6.5	DECOMMISSIONING PHASE IMPACTS	57
6.5.1	<i>Negative Environmental Impacts</i>	57
6.5.2	<i>Positive Environmental Impacts of Decommissioning Phase</i>	59
CHAPTER SEVEN		60
7.0	MITIGATION MEASURES	60
7.1	INTRODUCTION	60
7.2	MITIGATION MEASURES DURING THE PROJECT CYCLE	60
7.2.1	<i>Occupational Health &amp; Safety</i>	60
7.2.2	<i>Noise and Vibrations</i>	61
7.2.3	<i>Dust Generation</i>	61
7.2.4	<i>Exhaust Emission</i>	61
7.2.5	<i>Excess soils and rock from excavation</i>	61
7.2.6	<i>Clearance of Vegetation</i>	61
7.2.7	<i>Water Consumption</i>	62
7.2.8	<i>Water Quality</i>	62
7.2.9	<i>Debris and other Solid Wastes</i>	62
CHAPTER EIGHT		66
8.0	ANALYSIS OF PROJECT ALTERNATIVES	66
8.1	INTRODUCTION	66
8.1.1	<i>The No Action alternative</i>	66
8.1.2	<i>Alternative Sites</i>	66
8.1.3	<i>Technology and Procedures</i>	68
8.1.4	<i>Alternative Design</i>	68
8.1.5	<i>Alternative Materials and Inputs</i>	68
8.1.6	<i>Scale and Extent</i>	68
CHAPTER NINE		69
9.0	ENVIRONMENTAL MANAGEMENT PLAN	69
9.1	CONSTRUCTION PHASE EMP	689
CHAPTER TEN		73
10.0	DECOMMISSIONING PLAN	73
CHAPTER ELEVEN		75
11.0	CONCLUSION AND RECOMMENDATIONS	75
REFERENCES		76

## LIST OF APPENDICES

---

APPENDIX 1: QUESTIONNAIRE.....	80
APPENDIX 2: SCREENING CHECKLIST FOR ENVIRONMENTAL IMPACTS.....	82
APPENDIX 3: THE SPECIFIC IMPACTS OF THE PROJECTS.....	86
APPENDIX 4: LIST OF RESPONDENTS WHO WERE INTERVIEWED.....	89

## LIST OF TABLES

---

Table 1: Budget of the Project .....	22
Table 2: Levels of Scale used in the Study .....	51
Table 3: Summary of Impacts and Mitigation Measures.....	63
Table 4: Environmental Management Plan.....	70
Table 5: Details of Decommissioning Plan .....	74

## LIST OF FIGURES

---

Figure 1: Cross section of a sand dam and its dimensions.....	17
Figure 2: Cross sectional profile of a sand dam and its dimensions.....	17
Figure 3: A simplified sketch diagram of a rock catchment.....	18
Figure 4: A cross section of the fish ponds.....	19
Figure 5: Plan view showing the pegging positions for fish ponds .....	20
Figure 6: Location of Project Site in Kitui District.....	40

## LIST OF PLATES

---

Plate 1: A typical sand dam constructed elsewhere in Kitui District.....	59
Plate 2: Water abstraction from a sand dam constructed elsewhere in Kitui District.....	62
Plate 3: A typical rock catchment constructed elsewhere in Kitui District.....	69



## **EXECUTIVE SUMMARY**

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### **Introduction**

South Eastern University College (SEUCO), a Constituent College of the University of Nairobi, intends to implement a water harvesting and utilization project at its main campus situated in Lower Yatta in Kitui County. The project would involve the construction of a sand dam, rock catchment, fish ponds and associated water conveyance structures. The sand dam and rock catchment will provide water to fish ponds, greenhouses and tree nurseries at the university college. Once completed, all these facilities will assist in alleviating the current water shortage at the university college and at the same time enable the university college carry out research on how water harvesting technologies. The project would also function as a demonstration project of the university college aimed at disseminating information on the use of water harvesting for the promotion of fish farming, horticulture and agroforestry.

The Environmental Impact Assessment report for the proposed facilities has been prepared in accordance with the Environmental Management and Co-ordination Act (EMCA, 1999) and environmental (Impact Assessment and Audit) Regulations (2000). The aim of carrying out the Environmental Impact Assessment (EIA) was to ensure that the proposed projects at the university college do not negatively impact on the environment.

### **Anticipated Potential Environmental Impacts**

The activities to be carried out are bound to have both positive and negative environmental impacts. The potential impacts of the proposed project have been categorized into two: (1) Impacts on the natural environment and (2) Impacts on the human environment. Impacts on the natural environment include those on land, air and water, while the human impacts are largely social and economic in nature. Further classification of the impacts have been done based on the project life cycle i.e. impacts during construction, operation and decommissioning stages of the project.

The identified potential positive impacts of the project include provision of employment opportunities, increased business opportunities, increased water supply to the university, demonstration of income-generation activities to the local community, increased baseflow during dry seasons, creation of micro-climate, reduced land degradation, economic growth and poverty alleviation.

The identified potential negative impacts during construction of sand dams, rock catchment, and fish ponds include dust generation, soil erosion, increased surface runoff, risks of accidents and injuries to workers, clearance of natural vegetation and modification of streamflow. The clearing of natural vegetation will temporarily decrease the biological diversity around the sites earmarked for fish ponds and agroforestry/tree plantation. The potential negative impacts during operation phase of the project include risk of accidents

and injuries to both people and livestock. There will therefore be a need for proper management of the project sites during the operational phase of the project. During the decommissioning phase, the major impacts will be dust generation, noise pollution, risks of accidents and injuries.

### **Mitigation of Significant Environmental Impacts**

In order to ensure sustainability of the project, several mitigation measures have been suggested. The mitigation measures will include minimization of the disturbance to the surrounding natural habitat. Suggested mitigation measures during construction phase include sprinkling of the ground with water to minimize dust, proper servicing and turning of the machinery to reduce noise and vibrations; and the provision of construction workers with the necessary protective gear to ward off risks of accidents and injuries. Thereafter the project would introduce an agroforestry system that will involve planting of both exotic and indigenous trees in the already degraded sites. Also, project would carry out landscaping of the sites of sand dams, rock catchment and fish ponds in order to create balanced environment. There will be environmentally sound disposal of waste water from the fish ponds through conveyance of the water from fish ponds to the greenhouses and tree plantations. Solid waste would be disposed off in an incinerator that would be constructed at the project site. Also, a system for continuous monitoring of the project activities will be put in place throughout its life cycle. The implementation of the suggested mitigation measures will ensure that the significant impacts of the project activities are controlled to a large extent possible.

### **Environmental Management Plan**

A comprehensive environmental management plan has been prepared to assist the proponent and contractor address the identified adverse environmental impacts of the project. Strict adherence to the environmental management plan provided is recommended to ensure environmental sustainability of the project.

### **Conclusions and recommendations**

The proposed project involving the construction of a sand dam, rock catchment, water conveyance structures, fish ponds and agroforestry at the main campus of the South Eastern University College (SEUCO) will have both positive and negative impacts as outlined in this report. However, the EIA has established that the negative environmental impacts of the project can be mitigated through implementation of measures that are outlined in the Environmental Management Plan (EMP). It is recommended that the proponent of the project fully complies with all statutory and regulatory requirements of such projects. Considering the many benefits of the project, at local and national level, it is also recommended that the National Environment Management Authority (NEMA) does approve the EIA Project Report and grant the environmental impact assessment licence for it to continue.

# CHAPTER ONE

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## 1.0 INTRODUCTION

### *1.1 Background and Rationale for an Environmental Impact Assessment*

SEUCO was established as a Constituent College of the University of Nairobi through Legal Notice No. 102 of 18<sup>th</sup> July, 2008 which was signed by the President of the Republic of Kenya, Hon. Mwai Kibaki, on 15<sup>th</sup> July 2008 (SEUCO, 2011). SEUCO main campus is located in Kitui County at Kwa-vonza location. The main campus land starts about 4 km from Kwa-vonza market along Kitui-Machakos road, in a serene environment conducive for research and learning. The campus is located about 170 km from Kenya's Capital City, Nairobi. Kitui town is located about 40 km to west of the campus. The immediate neighbours of the campus include Kenyatta University Kitui Campus, the Goat and Sheep Project (GASP) and Nyumbani Village Children's Home. The main University College campus lies on 10,000 acres in Kitui County. The College also owns 4,919 acres of land in Emali, along the Nairobi-Mombasa road and two urban plots in Nairobi and Mombasa.

SEUCO is a successor to Ukamba Agricultural Institute (UKAI), which was upgraded to university college status through the above mentioned Legal Notice. This led to automatic and full transfer of "all rights, assets and liabilities held by or by anybody on behalf of UKAI" to SEUCO. UKAI came into being in the 1970s as one of the then, Kenya's Harambee Institutes of Technology that were aimed at building the capacity of the country's skilled and semi-skilled human labour for productive development. This was in realization of the fact that Kenya's economy was agriculture-based and for it to make headways, there was a need for training of lower cadre professionals in the agricultural sector. The Institute was registered in 1976 as an unaided school under the Ministry of Education, with the objective of "promoting sound management, utilization and conservation of biotic and abiotic dryland resources for the well-being of the local people." The Institute carried out general agricultural training at certificate and diploma levels in basic sciences, agricultural engineering, economics and farm management, animal and crop production, extension and education.

SEUCO is currently facing an acute shortage of water to cater for its increasing number of staff and students as well as carry out various research and extension activities. This problem is likely to get worse as the university college expands and the number of staff and students continues to increase. The University College thus intends to implement a water harvesting and utilization project that will involve the construction of: (1) a sand dam along the course of Mwitwa Syano River, (2) a rock catchment (3) five fish ponds and (4) a tree plantation (agroforestry) at sites located within the main campus. The proposed project activities are

consistent with SEUCO's Strategic Plan for the period 2010-2020 and are financed by the National Council for Science and Technology (NCST) through the Science, Innovation and Technology Grant.

According to Environmental Management and Coordination Act (EMCA) of 1999, the proposed project activities have to be subjected to Environmental Impact Assessment (EIA). The EIA is intended to establish the environmental status within the project area as well as the anticipated impacts of the project activities and their mitigation measures. The assessment was carried out by Environmental Impact Assessment Expert registered with the National Environment Management Authority (NEMA), who was assisted by other environmental specialists.

### **1.2 OBJECTIVES OF CARRYING OUT EIA ON THE PROJECT**

The objectives of the project environmental impact assessment are as follows:

- i. Assess the proposed project activities and identify all the potential impacts on both the human and natural environment.
- ii. Predict the magnitude and significance of the negative and positive impacts on the quality environmental management.
- iii. Measure the proponent's compliance with the legislation applicable to the proposed project activities.
- iv. Propose cost effective mitigation measures for the significant negative impacts of the project activities.
- v. Design an environmental management plan that the proponent will use to implement the proposed mitigation measures.

### **1.3 TERMS OF REFERENCE (TOR) FOR THE EIA PROCESS**

The EIA expert on behalf of the proponent (SEUCO) conducted the EIA by incorporating but not limited to the following Terms of Reference:

- Carry out an assessment of the location of the proposed sand dam, rock catchment, fish ponds and tree plantation.
- Provide a concise description of the national environmental legislative and regulatory frameworks, baseline information, and any other relevant information related to the project activities.
- Analyze the technologies, procedures and processes to be used in the implementation of the project activities.
- Establish the environmental effects of the project activities including the social and cultural effects and the anticipated short-term and long-term effects.
- Analyze the project alternatives including project sites, designs and technologies.
- Prepare an environmental management plan proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment, including the cost, timeframe and responsibility to implement the measures.

- Propose measures to prevent health hazards and to ensure security in the working environment for the staff, students, and visitors for the management in case of emergencies.

#### **1.4 METHODOLOGY APPLIED IN THE STUDY**

Due to the magnitude of the proposed project activities, a project report was opted in order to ensure completeness of the assessment. The assessment was carried out through desk study and field surveys. Literature review related to project activities was also carried out to determine such aspects as the policy, legal and regulatory frameworks relevant to the project activities. The field survey included physical inspection of the proposed sites of project and surrounding areas, collecting information on biological and physical features such as vegetation, wildlife, geology, soils, hydrology and water resources, landscape, neighbourhood character, public perceptions and social considerations.

The methodology employed during the assessment complied with EIA/EA regulations. The following steps were followed during the assessment:

- i. Environmental screening
- ii. Environmental scoping to identify critical physical, biological, socio-economic and land use issues that the proposed project activities are likely to impact, either positively or negatively.
- iii. Desk studies and interviews.
- iv. Physical inspection of the project sites and surrounding areas.
- v. Impact analysis and analysis of project alternatives.
- vi. Public participation/consultation.
- vii. Data analysis
- viii. Reporting.

##### **1.4.1 Environmental Screening**

This step was followed in order determine whether an EIA was required and what level of assessment was necessary. This was done bearing in mind the requirements of the EMCA, 1999, and specifically the second schedule. Issues considered included the physical location, sensitive issues and nature of anticipated impacts.

##### **1.4.2 Environmental Scoping**

The Scoping process helped the expert to narrow down onto the most critical issues requiring more serious attention during the environmental impact assessment. On the basis of scoping exercise, the environmental issues were categorized into physical, natural/ecological and social, economic and cultural aspects.

### **1.4.3 Desk Study**

This included review of documents related to the nature of the proposed activities. The documents that were reviewed included project proposal and project documents (showing the work plan, project activities, bills of quantities), engineering designs, relevant policy, regulatory and legislative frameworks, SEUCO's Strategic Plan, District Development Plans, among others. It also included discussions with Project Coordinators and design engineers based at the School of Water Resources Science and Technology of SEUCO.

### **1.4.4 Site Assessments**

Field visits were made to the proposed sites of the project in order to determine the characteristics of the proposed sites and the environmental status of the areas. Site assessment essentially helped the experts establish the baseline environmental conditions as well as the ecological, physical and human components of the environment that will be impacted by the project. The assessments of the sites of the project were further complimented by carrying out interviews with the local community and staff members within SEUCO, in order to gauge their perceptions on the project activities.

### **1.4.5 Data Analysis**

Data analysis involved the analysis of data collected during the site investigations as well as data collected through interviewing of the local community members who may be impacted by the project activities. The data collected from both the primary and secondary sources was also analyzed and applied in the report. The following sections present summaries of approaches that were applied.

#### ***1.4.5.1 Secondary Data***

The relevant secondary data was obtained from published sources such as books, official government documents and statutes, plans, reports and documentation from various institutions. The analysis of secondary data was carried out using standard approaches.

#### ***1.4.5.2 Primary Data***

Primary data was obtained through interviews, field observations, questionnaires and input from the project team. The analysis of the primary data was also carried out using standard approaches.

### **1.4.6 Reporting**

In the process of preparing this environmental assessment project report, several briefing and/or consultation meetings were held with the proponent, i.e. South Eastern University College. The final report was subsequently presented to the proponent for submission to NEMA as required by law.

## CHAPTER TWO

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### **2.0 PROJECT DESCRIPTION**

#### **2.1 INTRODUCTION**

The South Eastern University College (SEUCO) is organized into ten (10) schools and twenty eight (28) teaching departments. The university college admitted its first Joint Admission Board (JAB) and self-sponsored students in May 2010. The total student population is currently 400. However, as the University develops and expands, it is expected that student population will increase to about 6,000 in the next five years and 11,000 in the next ten years. The University College currently offers a diverse range of technology, science and art-based academic programmes.

At the moment, the university college is facing acute shortage of freshwater to cater for the student population as well as its various research activities at its main campus situated in Lower Yatta, Kitui. The university college therefore intends to improve its water supply facilities in order to enable it cater for the growing number of students as well as engage in research aimed at promoting fish farming, agroforestry and horticultural development. In order to achieve this goal, the university college intends to construct a sand dam at Mwitwa Syano river and a rock water catchment within the campus. Water harvested from these structures will be channelled to fish ponds, greenhouses and a tree plantation, also located within the main campus. The proposed projects are some of the projects defined in SEUCO's Strategic Plan 2010-2020, which also spells out the vision and mission of the institution with clear goals and objectives, guiding principles, and action plans.

##### **2.1.1 SEUCO Vision**

To be a globally competitive Centre of Excellence in Teaching, Research, Innovation and Service.

##### **2.1.2 SEUCO Mission**

To provide quality education through teaching, research, extension, innovation and entrepreneurship with emphasis on dryland agriculture, natural resources and environmental management.

##### **2.1.3 Philosophy**

Arid to Green

##### **2.1.4 Our Core Values**

In order to achieve its vision and mission, the SEUCO is guided by the following core values:

- a) **Professionalism:** In all our actions and interactions, we shall maintain ethical behaviour, courtesy and professional etiquette
- b) **Innovation:** Innovativeness shall be the hallmark of our business activities through fostering pro-activeness, creativity, and adaptability to change
- c) **Integrity:** We shall be honest, transparent and accountable always
- d) **Freedom of thought:** We shall promote and defend academic freedom
- e) **Teamwork:** We shall maintain a sense of unity and of common interests and responsibilities
- f) **Respect and conservation of environment:** We shall strive to respect and protect the natural and working environment

## **2.2 PROJECT BACKGROUND**

The broad goal of the proposed project is to construct water harvesting structures for the purpose of promoting the use of harvested water in agroforestry, horticulture and fish farming at the main campus of the South Eastern University College. The implementation of the project will be guided by a comprehensive project monitoring and evaluation system submitted to the National Council for Science and Technology. The scope of works will consist of: (1) construction a sand dam along Mwita Syano river with associated water conveyance structures, (2) construction of a rock catchment with associated water conveyance structures, (3) construction of five fish ponds, (4) establishment of a tree nursery and woodlot and (5) water conveyance to three greenhouses already established at SEUCO.

## **2.3 PROJECT JUSTIFICATION**

Kenya's agricultural productivity relies largely on rainfall and proper management of land/soil and water resources. The country has a per capita endowment of only 650 m<sup>3</sup> of fresh water annually which is gradually dwindling due to increasing population pressure, deforestation and the recurrent droughts mainly as a result of climatic variability (see also IPCC 2009). This scenario adversely affects the performance of the agricultural sector, hindering expansion of rain-fed agricultural production and productivity. As such, Kenya has experienced a persistent decline in agricultural growth since the 1980s leading to low crop productivity, chronic food shortages and rising poverty levels. As arable land becomes scarce due to rising population and continuous land sub-division, intensive agricultural production, aquaculture



and agroforestry will be the key factor in improving food security and alleviating poverty in line with the Millennium Development Goals (MDGs).

In Arid and Semi – Arid Lands (ASALS) such as Kitui County in South-eastern Kenya, water availability is low due to inadequate and poorly distributed rainfall (PriceWaterhouse Coopers, 2005). Sources of water are usually found far apart forcing local communities to walk long distances in search of water. The local communities usually waste most of the productive time searching for water, with the implication that vital socio-economic activities that can contribute to the alleviation of poverty are neglected.

The proposed project was necessitated by the need to demonstrate to the local communities how water harvesting can be used in poverty alleviation projects (see also Ministry of Water and Irrigation, 2005). The university college is surrounded by a community that has suffered high poverty levels (> 60%) due to unfavourable climatic conditions. This situation is made worse by the rapidly increasing population, degradation of the arid and semi-arid environment as well as deterioration of the surface water resources. Also, the university college intends to build its capacity for research on the appropriate water harvesting technologies for arid and semi arid lands of Kenya. The construction of the proposed water harvesting and utilization facilities will therefore play a critical role in enabling South Eastern University College fulfil its goals of becoming a modern institution of higher learning and research making significant contributions to the local community.

The development of aquaculture, horticulture and agroforestry which have the potential of transforming lives of communities in ASALS cannot succeed without adequate supply of water. While rainfall in arid and semi-arid lands is generally low, the amount that can be harvested at a given location is high considering the high intensity short duration rainfall that characterises the ASALS (see also Valentina 1996; Van Haveren, 2004). However, during periods when these areas receive abundant rainfall, most of the water is wasted due to lack of adequate water harvesting and storage infrastructure. This abundant water can be harvested through construction of sand dams and rock catchments, etc and used for various purposes (see also Louis Berger International Inc. 1983; Sharma et al., 1996; Lesage and Alerts, 2008).

This project intends to promote the harvesting of rainwater and surface runoff through construction of a sand dam and a rock catchment for the purpose of increasing the harvesting of water for use in income generating activities.

In summary, the project is considered vital on the basis of the following;

- a) The project will through educational and training programmes, promote the adoption of technologies for harvesting rainwater and surface runoff such as sand dams and rock catchments.
- b) The harvesting of rainwater and surface runoff and its subsequent utilisation in intensive agriculture, agroforestry and aquaculture can yield significant socio-economic benefits due to its potential to increase incomes of local communities and thus contribute to poverty alleviation.
- c) The project will yield essential data and information on the potential of rainwater and surface runoff harvesting including the applications in aquaculture, horticulture, and agroforestry.
- d) The study will generate information on the factors that have in the past limited local communities from adopting rainwater and surface runoff harvesting technologies. The unravelling of such factors is crucial in the formulation of appropriate rainwater and surface runoff harvesting policies and strategies at local level.
- e) The project is also consistent with the development objectives stipulated in the Kenyan Vision 2030 as well as the Economic Stimulus Programme (ESP). As such it will contribute to the realisation of the Millennium Development Goals (UNDG, 2005; Steiner, 2008) as well as the vision of the National Policy for the Sustainable Development of Arid and Semi-Arid Lands of Kenya.

#### **2.4 PROJECT OBJECTIVES**

The objectives of the proposed project are as follows;

- a) Assess surface runoff and rainwater harvesting potential of various water harvesting structures (sand dams and rock catchment).
- b) Demonstrate how harvesting of surface runoff and rainwater can be used in the development of agriculture, agroforestry and aquaculture in arid and semi arid lands.
- c) Identify challenges that have in the past limited application and dissemination of rainwater and surface runoff harvesting technologies in Kitui County.
- d) Create awareness among the local communities on the extent to which water harvesting can be used in high value aquaculture, horticulture and agroforestry development at community and household levels.

## **2.5 PROJECT COMPONENTS**

The project has several sub-components that are presented in the following sections.

### **2.5.1 Collection and Analysis of Geological and Hydro-Climatic Data**

The collection and analysis of data on the physical and chemical properties of soils and rocks will be carried out at the study area situated within the premises of the South Eastern University College (SEUCO) in Kitui West district. The representative areas will be selected following a thorough fieldwork and the assessment of their hydrological response similarities. Intensive and continuous monitoring of hydro-climatic variables will be carried out at designated areas where water harvesting structures will be constructed. In addition data collected by the Meteorology Department and the Ministry of Water and Irrigation will also be collected and used in the analysis of hydroclimatic variability and its influence on the variability of water volumes in the Mwita Syano river where a sand dam will be put in place.

The main climatic data that will be collected will include duration, intensity and amounts of rainfall, wind speed, relative humidity, minimum and maximum temperature, evaporation and evapotranspiration. The hydrologic data that will be collected will include hourly, daily, monthly and annual stream flow events. In addition, this data will form an important input to various hydrologic models that will be used to evaluate the potential of various surface runoff and rainwater harvesting structures. Other hydrologic data, which will be collected, are data on sediment yields and water quality in targeted streams. The analysis of samples of water and soil collected during field survey exercises will be carried out at the Water Quality and Pollution Control laboratory of the Ministry of Water and Irrigation.

### **2.5.2 Survey of Suitable Sites for Water Runoff Harvesting**

Data on land use and land cover patterns within the study area will be acquired by conducting actual ground surveys and the analysis of Landsat images. Digital Elevation Model (DEM) will be created and used to extract topographic features like slope, altitude, drainage areas and patterns and aspect among others. These features will be used to identify water accumulation points that are appropriate for runoff collection. Coordinate points will be acquired using Geographical Positioning System (GPS). This will assist in the georeferencing of various data layers. Furthermore, coordinate points for various water sources and sinks within the study area will be used in the construction of spatial water resources maps of the study area. These maps will be used to guide the selection and construction of surface runoff and rainwater collection structures. Rock outcrops in the study area will also be surveyed and their respective surface areas and runoff generation potential computed. These will assist in the identification of suitable rock catchments that will be targeted for construction of rainwater and surface runoff harvesting structures.

### **2.5.3 Environmental and Social Impact Assessment**

Activities of the magnitude proposed in this project (i.e. construction of a sand dam, rock catchment, fish ponds, woodlots, etc) will of essence require that a comprehensive Environmental and Social Impact Assessment (ESIA) study is carried so as to comply with the requirements of the Environmental Management and Coordination Act (EMCA, 1999), and in particular the Environmental Impact Assessment and Audit Regulations, 2003. In this regard, a detailed scoping of potential environmental and social impacts will be carried out at the beginning of the project. This will help in the identification of the likely impacts of the project. This will be followed by collection and analysis of environmental and social impacts data that will form the basis for an EIA Report that will be submitted to the National Environmental Impact Authority (NEMA) for the issuance of an EIA licence. The construction of water harvesting structures, fish ponds, etc will commence as soon as the EIA licence is issued by NEMA.

### **2.5.4 Design and Construction of Water Harvesting Structures**

The analysis of geological and hydro-climatic data will provide crucial inputs for determination of design parameters of various water harvesting structures. Such design parameters will include depth, area, volume and perimeter of surface runoff and rainwater collection structures. Empirical equations and hydrologic models will be used in the estimation of water volumes and sediment yields, which are critical in the design of water collection structures (see also Moonesinghe, 2004).

The surface runoff and rainwater collection structures that will be constructed will also be used to conduct studies on the performance and efficiency of such structures. Geological, soil and hydrological data will be obtained from Ministry of Water and Irrigation. The analysis of geological, soil and hydro-climatic data will be used in estimating the design volume of the rainwater collection structures. Hydrological models will also be used in a GIS environment to model the sediment transport and runoff volumes, including the identification of pour points.

### **2.5.5 Design and Construction of a Sand Dam**

The project will construct one (1) sand dam along the course of Mwita Syano River. The sand dam will be comprised of four main parts: the dam, spillway, wing walls and stilling basin (see Figures 1 and 2; see also Nelson, 1985; Stephens, 1991; Nissen-Petersen, 2000; Frima et al., 2002; Ertsen et al., 2005; Borst, 2006). The dam and spill way height will be determined by the maximum discharge and maximum flood height. The maximum discharge will be obtained using the manning equation.

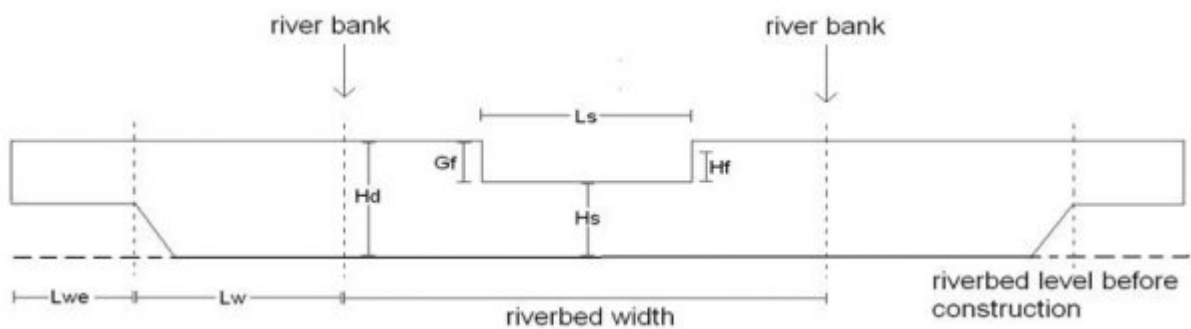
$$Q = 1/n * A * R^{2/3} * S^{1/2}$$

Where:  $Q$  = maximum discharge in riverbed section ( $m^3/s$ );  $n$  = Manning roughness coefficient of riverbed;  $A$  = wetted cross-sectional area ( $m^2$ );  $P$  = wetted perimeter (m);  $R$  = hydraulic radius (m) =  $A/P$ , and,  $S$  = slope of riverbed (m/m).

The spillway dimensions will be calculated using the equation below.

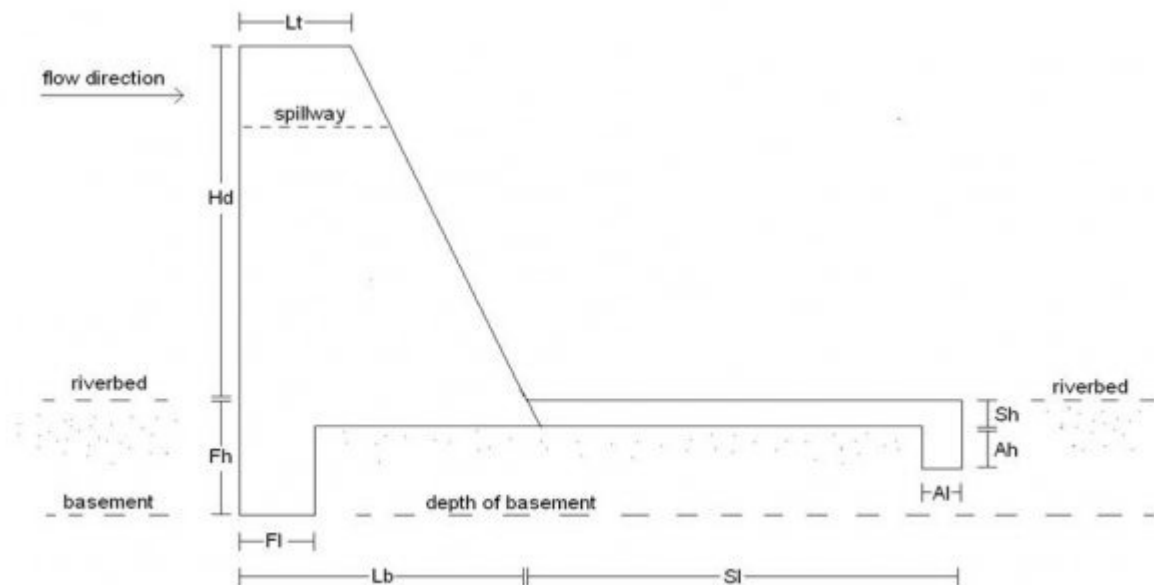
$$Q = c * L_s * H^{3/2}$$

Where:  $Q$  = maximum discharge in riverbed section ( $m^3/s$ );  $L_s$  = length of spillway (m);  $c$  = (constant depending on spillway shape, for broad crested weir 1.9 is used), and  $H$  = height of spillway (m).



**Figure 1: Cross section of a sand dam body and its dimensions**

$G_f$  = gross freeboard (m);  $L_w$  = length wing wall (m);  $L_{we}$  = length wing wall extension (m);  $L_s$  = length spillway (m);  $H_f$  = height freeboard (m);  $H_d$  = total height of dam (m);  $H_s$  = total height of spillway (m).



**Figure 2: Cross sectional profile of a sand dam body and its dimensions**

Hd = height of dam (m); Fh = height of foundation (m); Fl = length of foundation (m); Lt = length of top of dam (m); Lb = length of base of dam (m) = 1 m; Sl = length of stilling basin (m); Sh = height of stilling basin (m) (max of 0.3 m); Ah = height of anchor (m) = 0.3 m; Al = length of anchor (m).

Bank characteristics will be taken into account when deciding the extent to which the wing walls will extent into the banks (Munyao *et al*, 2004). To calculate the dimensions of the stilling basin, the following equation will be used

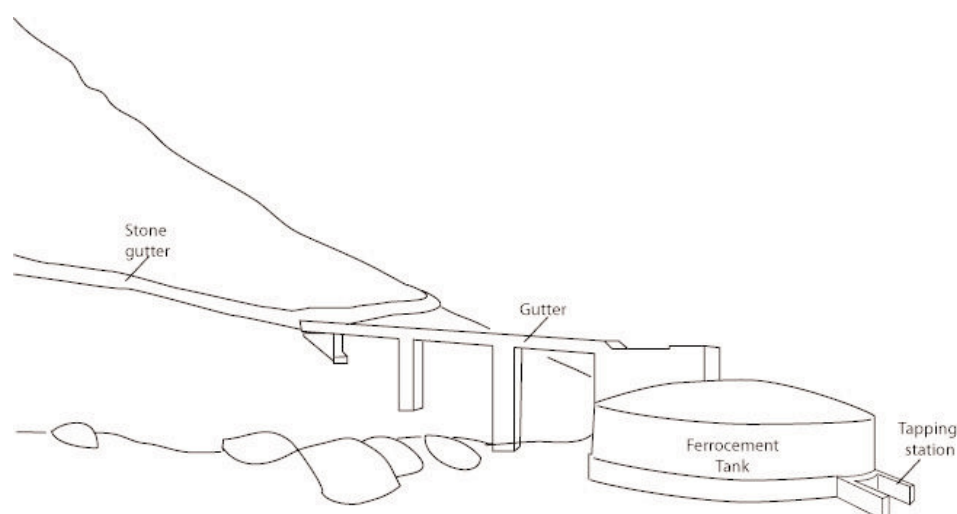
$$SL = c * L^{1/3} * H2^{1/2}$$

Where: SL = length of stilling basin (m); c = 0.96 (constant), H2 = height of freefall (m) = (height of water level upstream) – (height of water level downstream).

The construction of the sand dam will be of reinforced concrete and gabions will be used for slope stabilization. The preliminary calculations shows that the volume of water that can be harvested from the sand dam that will be put in place by the project is 300m<sup>3</sup> which is equivalent to 300,000 litres of water.

### 2.5.5 Rock Catchment for Rainwater and Surface Runoff Harvesting

A granitic rock outcrop situated within the main campus of the South Eastern University College with a large surface area (approx. 20,000m<sup>2</sup>) will be guttered to harvest rainwater and surface runoff that is generated on the rock surface. The harvested water will then be directed to a large storage structure (masonry or ferro-cement tank) that will be constructed at the base of the rock (see Figure 3 below). The volume of water that will is generated on the rock catchment is 10,000m<sup>3</sup> per annum equivalent to 10 million litres of water per year assuming an average rainfall of 400 mm per annum. This volume will guide the design of the water storage structure that will be constructed at the base of the rock.



**Figure 3: A simplified sketch diagram of a rock catchment water harvesting structure**

### 2.5.6 Utilization of Harvested Water

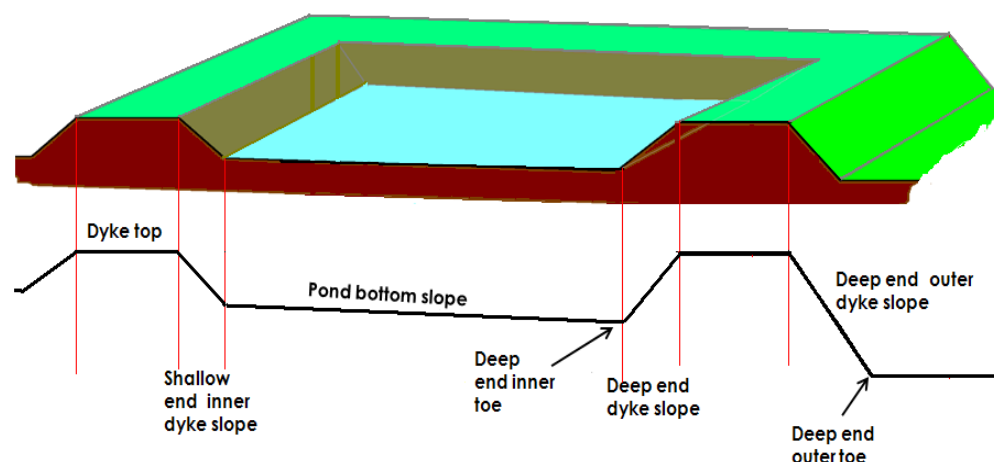
The water harvested from the sand dam and rock catchment will be conveyed to a storage tank and subsequently used to support aquaculture, horticulture, and agroforestry activities within the premises of the South Eastern University College. The following sections provide details on the specific activities and methodology for each of the sub-components:

#### (a) Utilization of Harvested Water for Aquaculture Fish Production

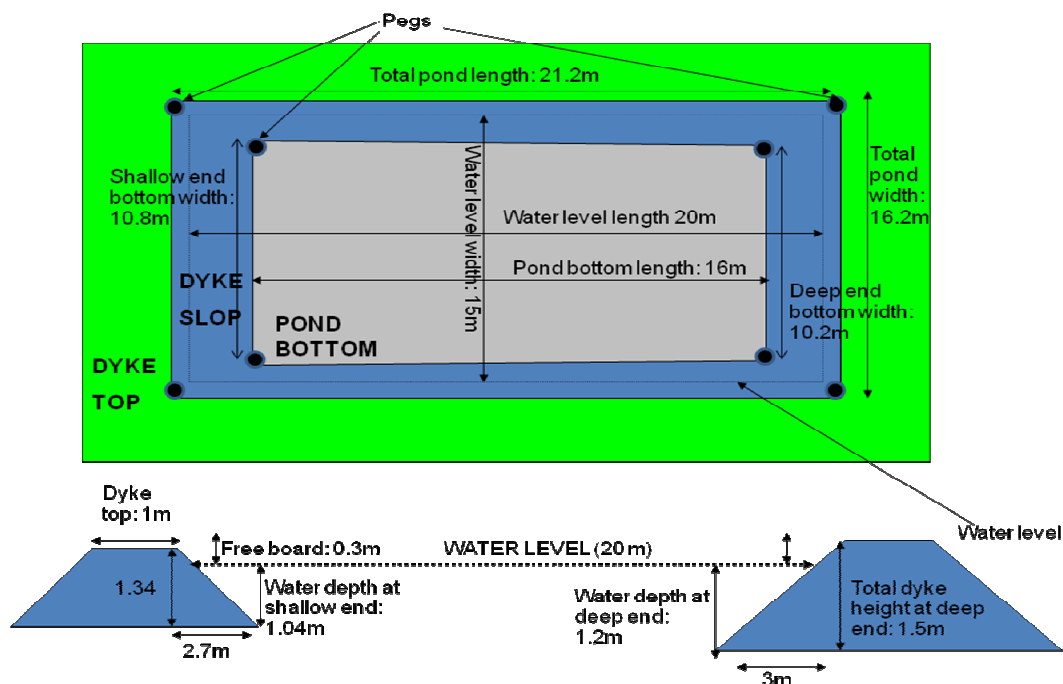
The harvested water will be used to support small-scale fish pond aquaculture at the main campus of the South Eastern University College. The harvested water will be channelled to fish pond production units where suitable species of fish will be farmed (Carballo, *et al.*, 2008). Local community will be involved in this fish farming exercise in a form of a community-researcher participatory initiative. This is essential as it will enable the local community eventually adopt technologies that will be developed at the university college.

A baseline survey will be carried out in the study area to identify suitable sites for pond constructions alongside that for determining the potential for surface runoff and rainwater harvesting potential. This will facilitate development of harvested water recipient channels to holding ponds and tanks for water storage. These will subsequently be used to support small-scale pond aquaculture production systems that include fry and fingerling hatchery ponds, fry and fingerling hatchery tanks, and production ponds (see also Carballo, *et al.*, 2008):

Pond design will be the prototype recommended by the Ministry of Fisheries Development as shown below in Figure 4, for 300 m<sup>2</sup> ponds and with dimensions as shown in Figure 5.



**Figure 4: A cross section of the prototype 300 m<sup>2</sup> earthen fish pond for the proposed project (Source Ministry of Fisheries Development, 2008)**



**Figure 5: Plan view showing the pegging positions for a 300 m<sup>2</sup> pond (Source Ministry of Fisheries Development, 2008).**

A total of five (5) earthen fish ponds will be constructed. The pond construction procedure is that of earth excavation followed by lining with PVC pond liners. Pond fertilization will be done using both conventional and non-conventional fertilizers. An initial batch of fingerlings for stocking the project culture units will be sourced from either Dominion Farm in Siaya or Sagana Aquaculture Center in Sagana. Fingerlings will be stocked in each of the five (5) fish production ponds at a rate of 5 fingerlings per m<sup>2</sup>, which will cater for mortalities during transport, stocking and within the culture period. This will ensure a survival rate of about 3 fish per m<sup>2</sup>. Thus, the total number of stocked fingerlings per pond of 300 m<sup>2</sup> is 1,500. The total stocked population in the five (5) production units will be 7,500 fishes.

The culture species for this project are *Clarias gariepinus*, *Oreochromis niloticus* and/or *Oreochromis variabilis*. Their selection is based on the known growth performance in other areas in Kenya of the similar climatic conditions as Kitui District. Culture period will be six (6) months based on the known growth performance of these species. Feeding regime will be twice daily for six months on locally available commercial fish feeds (i.e. pelleted diets containing minimum 26% crude protein).

Fish growth evaluation and water quality monitoring and management will involve use of a sensitive weighing balance of 0.01 precision, a measuring board for growth evaluation and a hydrolab for water quality monitoring. The water quality parameters that will be monitored



include Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Nitrate-Nitrogen, Nitrite-Nitrogen, Orthophosphates, Ammonia – Nitrogen, Ph, Total Dissolved Solids (TDS), and Turbidity. These parameters will be monitored on monthly basis.

Harvesting of fish in the ponds will be done after six to nine months of culture period by seining fish using hired community labour estimated at 4 persons per pond and a seine net. It is expected that after the first year, the project would generate an additional income of about kshs 700,000 from the sale of about 10,000 fish that will be harvested from the five (5) fish ponds. The generated income will be ploughed back to the project in order to ensure long-term sustainability of the project. In addition, these funds will also be used in undertaking research activities within the School of Water Resources Science and Technology.

### **(b) Use of Harvested Water in Agro-Forestry**

The project will establish a demonstration woodlot within the premises of the South Eastern University College. The tree species that will be planted are those that provides both ecological and economic benefits i.e. provide timber, fuel wood, poles/posts, fodder, increased soil organic matter, erosion control, bio-diversity, water retention and catchment soil conservation, bee forage, windbreaks, bird habitat, nitrogen fixation, nutrient cycling, environmental resilience. In addition, they should also provide for social needs (boundary delineation, shade, fruits etc.) to the community (cf. Armesto *et al.*, 2009; Mugwe, *et al.*, 2004; Kiptot *et al.*, 2006). Before planting tree seedlings, land will undergo double digging to mix in adequate amounts of manure and humus. Staking will be done using locally collected stakes from the project area. This will be followed by pitting.

The main woodlot crop will be composed of *Melia volkensii* (see Mulatya *et al.*, 2001). The spacing of the main crop will be 2 metres. To ensure the realization of the anticipated socio-economic and ecological functions, the woodlot will integrate two agroforestry systems: line planting and alley cropping (cf. Armesto *et al.*, 2009; Mugwe, *et al.*, 2004; Kiptot *et al.*, 2006). The two systems will bring on-board a diversity of agroforestry species to be intercropped with the main crop of *Melia volkensii*. Such diversity will not only increase the ecological and economic productivity but also the long-term stability and sustainability of the entire agroforestry practice (see also Svensson *et al.*, 2009).

The model woodlot will derive its water from the water harvesting structures that will be constructed along river Mwita Syano. Enrichment planting will be done on a 20m radius from the outlet of the seasonal river. Similar enrichment will be done around the rock catchment. Enrichment tree species that will be used are *Bambus vulgaris*, *Kochia* and *Atriplex spp.*, *Conocarpus lancifolius*, *Casuarina equisetifolia*, *Croton megalocarpus*, *Acacia albida*, *Acacia gerrardii*, *Acacia senegal*, *Acacia tortilis*, *Albizia gummifera*, *Gliricidia sepium*. The same

species will be used for strip planting along the river and rock catchment outlets to the model woodlot.

### **(c) Use of Harvested Water in Horticulture**

The harvested water will also be used in four (4) greenhouses that are already installed at the project site within the main campus of the South Eastern University College. The main aim would be to demonstrate the use of harvested water in the growing of high value crops such as tomatoes, onions, carrots, kales, etc. In order to rightly target the market in Kitui County, an initial market survey will be carried out for the purpose of establishing the crops that are in high demand in Kitui County and elsewhere that would be considered a priority.

The crops will be irrigated using an efficient drip irrigation system so as to conserve as much water as possible. The use of greenhouse for growing of high value crops significantly reduces the problems associated with pests and diseases and creates a unique micro-climate that is ideal for optimum crop production. Furthermore, the greenhouse helps in controlling water loss through evaporation/evapotranspiration.

It is expected that after the first year, the university college will generate an additional income of about Kshs 1.5 million from the sale of various crops grown in the four (4) greenhouses. The generated income will be ploughed back to the university college in order to ensure long-term sustainability of the income-generating projects. In addition, these funds will also be used in undertaking research activities within the university college.

## **2.6 Project Budget**

The budget for the construction of the water harvesting and utilization structures is estimated to be Kshs. 7million. Funds that were allocated for EIA Study amounts to Kshs 367,500. Funds for the project were provided by the Government of Kenya through the National Council for Science and Technology through a Science, Technology and Innovation grant.

**Table 1: The Project budget showing allocations for different project activities.**

<b>BREAKDOWN OF YEARLY BUDGET</b>	<b>AMOUNT (KSHS)</b>
<b>YEAR 1: February 2011- January 2012</b>	
1. Collection and Analysis of Baseline Data and Information	572,000
2. EIA Study	367,500
3. Construction of water harvesting infrastructure	1,016,000
4. Development of an agroforestry system	128,440
5. Development of horticulture facilities	40,500
6. Development of Aquaculture facilities	567,200

7. Education and Training Programme	122,000
8. Project Coordination/Technical Meetings	286,200
<b>Sub-Total</b>	<b>3,099,840</b>
<b>YEAR 2: February 2012 – January 2013</b>	
1. Collection and Analysis of Baseline Data and Information	0
2. ESIA Study	0
3. Construction of water harvesting infrastructure	1,524,000
4. Development of an agroforestry system	385,320
5. Development of horticulture facilities	54,000
6. Development of Aquaculture facilities	567,200
7. Education and Training Programme	244,000
8. Project Coordination/Technical Meetings	214,650
<b>Sub-Total</b>	<b>2,989,170</b>
<b>YEAR 3: February 2013-January 2014</b>	
1. Collection and Analysis of Baseline Data and Information	0
2. ESIA Study	0
3. Construction of water harvesting infrastructure	0
4. Development of an agro forestry system	128,440
5. Development of horticulture facilities	40,500
6. Development of Aquaculture facilities	283,600
7. Education and Training Programme	244,000
8. Project Coordination/Technical Coordination Meetings	214,650
<b>Sub-Total</b>	<b>911,190</b>
<b>GRAND TOTAL</b>	<b>7,000,200</b>

EIA Fees payable to NEMA for issuance of an EIA Licence is Kshs 10,000 as per the regulations.

## CHAPTER THREE

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### **3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK**

#### **3.1 INTRODUCTION**

Kenya's environment sector is governed by an elaborate policy, legal and institutional framework. Whereas sectoral policies, legislations and institutions have their own arrangements for the implementation of their respective mandates, all these are coordinated by NEMA through the EMCA (1999). Consequently, NEMA has an obligation of ensuring that all new development projects undergo Environmental Impact Assessment (EIA) and all on-going projects must carry out annual Environmental Audits (EAs).

EIAs are necessary for the identification of anticipated adverse environmental impacts arising from the proposed project. Both EIA and EAs are carried out in accordance with section 68 of EMCA (1999). The process is further guided by the EIA and EA Regulations under Legal Notice 101 of 13<sup>th</sup> June, 2003. Other relevant national policies and legislations also apply and the proponent must observe these as well.

#### **3.2 POLICY FRAMEWORKS**

The policies that are relevant to the proposed project include the following:

##### **3.2.1 Policy Paper on Environmental and Development (Sessional Paper No. 6 of 1999)**

This policy was formulated on the basis of the National Environment Action Plan (NEAP) process of 1994. The policy's major objective is to harmonize environmental and developmental concerns to ensure sustainability. Furthermore, this policy ensures that environmental issues are taken into consideration before the commencement of development policies, programmes, plans and projects. The proposed project is therefore consistent with the Sessional Paper No. 6 of 1999.

##### **3.2.2 Physical Planning Policy**

The current policy governs the development and approval all building plans as provided for in the Physical Planning Act (Cap 286). The proposed project will be subjected to the provisions of this policy and legislation.

##### **3.2.3 Education Policy**

Sessional Paper No. 1 of 2005 on Policy Framework for Education, Training and Research and the recent Sector Wide Approach (SWAP) to financing of education and training as well as the Kenya Education Sector Support Programme (KESP), all provides the need for providing

adequate facilities for education, training and research. Thus the proposed projects at the SEUCO to develop the office-Laboratory block, tuition block and student hostel-kitchen block, are consistent with Sessional Paper No. 1 of 2005 as indicated above.

### **3.2.4 Public Health Policy**

The prevailing public health policy calls upon the project proponent to ensure that buildings are adequately provided with utilities so that they are fit for human habitation. The proposed project at the South Eastern University College has been designed by professional engineers and architects and as such will have all amenities/utilities that are essential for safeguarding public health (both staff and students including visitors).

### **3.2.5 Other Relevant Policies Associated with the Project**

#### **Kenya Vision 2030**

Kenya Vision 2030 is the new country's development blueprint covering the period 2008 to 2030. It aims at making Kenya a newly industrializing 'middle income country providing high quality life for all its citizens by the year 2030'. The vision has been developed through an all-inclusive stakeholder consultative process, involving Kenyans from all parts of the country. The vision is based on three 'pillars' namely; the economic pillar, the social pillar and the political pillar. The vision 2030 comes after the successful implementation of the Economic Recovery Strategy for Wealth and Employment Creation 2003-2007 (ERS)

The Kenya Vision 2030 economic pillar aims at providing prosperity of all Kenyans through an economic development programme aimed at achieving an average GDP growth rate of 10% per annum over the next 25 years from the year 2008. The social pillar seeks to build 'a just and cohesive society with social equity in a clean and secure environment'. On the other hand, the political pillar aims at realizing a democratic political system founded on issue-based politics that respects the rule of law, and protects the rights and freedoms of every individual in the Kenyan society.

The proposed project at the South Eastern University College will make positive contributions to the three pillars of the vision. This is especially in the services' sector, research, in business management and development, and entrepreneurship training.

## **3.3 LEGAL FRAMEWORKS**

### **3.3.1 Environment Management and Coordination Act (EMCA 1999)**

This project report was prepared in accordance with section 58 of the EMCA. The EMCA of 1999 provides a legal and institutional framework for the management of the environmental

related matters, it is the framework law on the environment which was enacted on the 14th of January 1999 and its implementation commenced in January 2002.

Section 58(1) of the EMCA states that *“Notwithstanding any approval, permit or license granted under this Act or any other law in force in Kenya, any person, being a proponent of a project shall, before financing, commencing, proceeding with, carrying out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the second schedule to this Act, submit a project report to the Authority, in the prescribed form, giving the prescribed information and which shall be accompanied by the prescribed fee.”*

The Act provides a *locus standi* to the public in matters of environment. At the heart of EMCA is the guiding principle that every person has a right to a clean and healthy environment and can seek redress through the high court if this right is denied. Several principles such as public participation, international cooperation, inter- and intra-generational equity, polluter pays and pre cautionary principles guide decisions of the high court. EMCA mandates NEMA to disseminate information on environmental issues to the public through manuals, codes and guidelines.

### **3.3.2 Waste Management Regulations 2006**

The waste management regulations specify the responsibility of waste generator as follows:

- I. No person shall dispose off any waste on a public highway, street, road, and recreational area or in any public place except in a designated waste receptacle.
- II. Any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed off such waste in the manner provided for under these Regulations.
- III. Without prejudice to the foregoing, any person whose activities generates waste has an obligation to ensure that such waste is transferred to a person who is licensed to transport and dispose off such waste in a designated waste disposal facility.

### **3.3.3 Forest Act No 7 of 2005 (Cap 385)**

This Forestry Act is implemented by the ministry of environment and mineral resources and it has provisions for the establishment, control and regulation of central forest and other forests in Kenya. It encourages sustainable conservation of all types of vegetation. The Act is enforced by the conservator of forests while research issues are undertaken by the Kenya Forestry Research Institute.

### **3.3.4 The Wildlife Conservation and Management Act**

The Kenya Wildlife Service is responsible for the protection of Kenya's indigenous animals, plants and habitats. Its operations are guided by the Wildlife Conservation and Management Act. The act emphasizes the need to protect and or conserve Kenya's wildlife, including the associated habitats.

### **3.3.5 Building Code 2000**

This by-law recognizes the Local authorities as the leading planning agencies. It compels the potential developer to submit development application for the approval by a local authority. The local authorities are hence empowered to approve or disapprove any plans if they do or don't comply with the law respectively. The local authorities are also expected to enforce the building code.

### **3.3.6 Public Health Act (Cap. 242)**

Part IX, section 115, of the Public Health Act states that no person/institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Section 116 requires that Local Authorities take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition liable to be injurious or dangerous to human health.

Such nuisance or conditions are defined under section 118 as waste pipes, sewers, drainers or refuse pits in such state, situated or constructed as in the opinion of the medical officer of health to be offensive or injurious to health. Any noxious matter or waste water flowing or discharged from any premises into the public street or into the gutter or side channel or watercourse, irrigation channel, or bed not approved for discharge is also deemed as nuisance. Other nuisances are accumulation of materials or refuse which in the opinion of the medical officer of health is likely to harbour rats or other vermin.

On responsibility of the Local Authorities Part XI, section 129, of the Act states in part *"It shall be the duty of every local authority to take all lawful, necessary and reasonably practicable measures for preventing any pollution dangerous to health of any supply of water which the public within its district has a right to use and does use for drinking or domestic purposes"*.

Section 130 provides for making and imposing regulations by the local authorities and others the duty of enforcing rules in respect of prohibiting use of water supply or erection of structures draining filth or noxious matter into water supply as mentioned in section 129. This provision is supplemented by section 126a that requires local authorities to develop by-laws for controlling and regulating, among others private sewers, communication between

drains and sewers and between sewers as well as regulating sanitary conveniences in connection to buildings, drainage, cesspools, etc. for reception or disposal of foul matter.

Part XII, Section 136, states that *“all collections of water, sewage, rubbish, refuse and other fluids which permits or facilitates the breeding or multiplication of pests shall be deemed nuisances and are liable to be dealt with in the matter provided by this Act”*.

### **3.3.7 Local Authority Act (Cap. 265)**

Section 160 of the Local Authority Act helps local authorities ensure effective utilization of the sewages systems. It states in part that municipal authorities have powers to establish and maintain sanitary services for the removal and destruction of, or otherwise deal with kinds of refuse and effluent and where such service is established, compel its use by persons to whom the services is available. However, to protect against illegal connections, section 173 states that any person who, without prior consent in writing from the council, erects a building on, excavate or opens-up, or injures or destroys a sewers, drains or pipes shall be guilty of an offence. Any demolitions and repairs thereof shall be carried out at the expense of the offender.

Section 170, allows the right to access to private property at all times by local authorities its officers and servants for purposes of inspection, maintenance and alteration or repairs of sewers. To ensure sustainability in this regard, the local authority is empowered to make by laws in respect of all such matters as are necessary or desirable for maintenance of health, safety, and well being of the inhabitants of its area as provided for under Section 201 of the Act.

The Act under, section 176 gives powers to local authority to regulate sewage and drainage, fix charges for use of sewers and drains and require connecting premises to meet the related costs. According to section 174, any charges so collected shall be deemed to be charges for sanitary services and will be recoverable from the premise owner connected to the facility. Section 264 also requires that all charges due for sewage sanitary and refuse removal shall be recovered jointly and severally from the owner and occupier of the premises in respect of which the services were rendered. This in part allows for application of the “polluter-pays-principle”.

### **3.3.8 Physical Planning Act, 1999**

The Local Authorities are empowered under Physical Planning Act section 29, to reserve and maintain all land planned for open spaces, parks, urban forests and green belts. The same section, therefore allows for the prohibition or control of the use and development of land and buildings in the interest of proper and orderly development of an area.



Section 30 states that any person who carries out development without development permission will be required to restore the land to its original condition. It also states that no other licensing authority shall grant license for commercial or industrial use or occupation of any building without a development permission granted by the respective local authority.

Finally, section 36 states that if connection with a development application, local authority is of the opinion that the proposed development activity will have injurious impact on the environment, the application shall be required to submit together with the application an environment impact assessment (EIA) report. EMCA, 1999 echoes the same by requiring that such an EIA is approved by the NEMA and should be followed by annual environmental audits.

### **3.3.9 Land Planning Act (Cap. 303)**

Land Planning Act Section 9 of the subsidiary legislation (the Development and Use of Land Regulations, 1961), requires that before the local authorities submit any plans to then Minister for approval, steps should be taken as may be necessary to inquire with the owners of any land affected by such plans. Particulars of comments and objections made by the landowners should be submitted. This is intended to reduce conflict with the interest such as settlement and other social and economic activities.

### **3.3.10 Water Act, 2002**

Part II, section 18, of the Water Act 2002 provides for the establishment of a national monitoring and information system on water resources. Following on this, sub-section 3 allows the Water Resources Management Authority (WRMA) to demand from any person or institution, specific information, documents, samples or materials on water resources. Under these rules, specific records may required to be kept by a facility operator and the information thereof furnished to the authority.

The Water Act also vests the rights of all water to the state, and the power for the control of all body of water with the Minister, the powers is exercised through the Minister and the Director of water resources in consultation with the water catchments boards, it aims at among others been the provision of conservation of water and appointment and use of water resources.

Water Apportionment Board is a National Authority whose duty is to advise the Minister on issues with respect to water use. Permission to extract underground water for large-scale use lies with the board and the pollution of such water source is an offence. Failure to comply with directives of the board is an offence. The Minister is given the power to appoint undertakers of water supply, which in most cases are Town, Municipal and City Councils.

Further in order to provide security and supply of water, the Minister can declare a catchment's area of particular source of water as protected area and restrict activities in those areas. Such orders must be publicized in Kenya gazette.

Pollution of any water course is an offence and the Act also prohibits whoever throws, conveys, cause or permits throwing of rubbish, dirt, refuse, effluent, trade waste to anybody of water. It enhances the Ministry's capacity to enforce the Act by reviewing the water user fees.

Section 73 of the Act allows a person with a licence (licensee) to supply water to make regulations for the purposes of protecting against degradation of water resources. Section 75 and sub-section 1 allows the licensee to construct and maintain drains serves and other works for intercepting, treating or disposing of any foul water arising or flowing upon land for preventing pollution of water sources within his/her jurisdiction.

Section 76 states that no person shall discharge any trade effluent from trade premises into sewers of a licensee without the consent of the licensee upon application indicating the nature and composition of effluent, maximum quality anticipated, flow rate of the effluent and any other information deemed necessary. The consent shall be issued on conditions including payment of rates for discharge as may be provided under section 77 of the same Act.

### **3.3.11 Electricity Power Act No. 11 of 1997**

The Electric Power Act No. 11 enacted in 1997 deals with generation, transmission, distribution, supply and use of electrical energy as well as the legal basis for establishing the systems associated with these purposes. According to the Act, the Minister through the Electricity Regulatory Board is conferred with the legislative power to grant licenses and authorise works for generation or transmission of electrical energy. However, the provisions of section 4 of the Act require such authorization only for generating plants with a rating capacity exceeding 1000KW. Section 9 (3) of the Act address environmental integrity of the power generating systems which, must be considered by the board in recommending the grant of licences to the Minister.

In this respect, the following environmental issues will be considered before approval is granted:

- The need to protect and manage the environment, and conserve natural resources;
- The ability to operate in a manner designated to protect the health and safety of the project employees; the local and other potentially affected communities.

Under schedule 3 of the Electric Power (licensing) Regulations 2003, it is mandatory to comply with all safety, health and environmental laws. Moreover, schedule 2 (regulation 9) of the Electric Power (licensing) Regulations 2003 stipulates that licensing and authorisation to generate and transmit electrical power must be supported by the Environmental Impact Assessment Report (EIA) or Initial Environmental Audit Report (IEA) and Environmental Management Plan (EMP), all of which approved by NEMA.

### **3.3.12 Penal Code Act (Cap.63)**

Section 191 of the Penal Code states that if any person or institution that voluntarily corrupts or foils water for public springs or reservoirs, rendering it less fit for its ordinary use is guilty of an offence. Section 192 of the same Act says a person who makes or vitiates the atmosphere in any place to make it noxious to health of persons /institution is dwelling or business premises in the neighbourhood or those passing along public way, commit.

### **3.3.13 Occupational Safety and Health Act, 2007**

This Act applies to all workplace where any person is at work, whether temporarily or permanently. The purpose of this Act is to secure the safety, health and welfare of persons at work and protect persons other than persons at work against risk to safety and health arising out of, or in connection with the activities of persons. The following are specific issues dealt with by the Act;

#### **3.3.13.1 Health**

The premise must be kept clean, daily removal of accumulated dust from floors, free from effluvia arising from any drain, sanitary convenience or nuisance and without prejudice to the generality of foregoing provision. A premise must not be overcrowded, there must be in each room 350 cubic feet of space for each employee, not counting space 14 feet from the floor and a 9 feet floor-roof height.

The circulation of fresh air must secure adequate ventilation of workrooms. There must be sufficient and suitable lighting in every part of the premise in which persons are working or passing. There should also be sufficient and suitable sanitary conveniences separate for each sex, must be provided subject to conformity with any standards prescribed by rules. Food and drinks should not be partaken in dangerous places or workrooms.

Provision of suitable protective clothing and appliances including where necessary, suitable gloves, footwear, goggles, gas masks, and head covering, and maintained for the use of workers in any process involving expose to wet or to any injurious or offensive substances.

### **3.3.13.2 Safety**

Fencing of premises and dangerous parts of other machinery is mandatory. Training and supervision of inexperienced workers, protection of eyes with goggles or effective screens must be provided in certain specified processes. Floors, passages, gangways, stairs, and ladders must be soundly constructed and properly maintained and handrails must be provided for stairs.

Special precaution against gassing is laid down for work in confined spaces where persons are liable to overcome by dangerous fumes. Air receivers and fittings must be of sound construction and properly maintained. Adequate and suitable means for extinguishing fire must be provided in addition to adequate means of escape in case of fire must be provided.

### **3.3.13.3 Welfare**

An adequate supply of both quantity and quality of wholesome drinking water must be provided. Maintenance of suitable washing facilities, accommodation for clothing not worn during working hours must be provided. Sitting facilities for all female workers whose work is done while standing should be provided to enable them take advantage of any opportunity for resting.

Section 81 stipulates that every premise shall be provided with maintenance, readily accessible means for extinguishing fire and person trained in the correct use of such means shall be present during all working periods.

Section 103(3) (A) states that regular individual examination or surveys of health conditions of industrial medicine and hygiene must be performed and the cost will be met by the employer. This will ensure that the examination can take place without any loss of earning for the employees and if possible within normal working hours.

### **3.3.14 Food Drugs and chemicals substances Act (Cap 254)**

The Food, Drugs and Chemical Substances Act (CAP 254) whose purpose is to make provisions for the prevention of adulteration of food, drugs and chemical substances. This Act (which has been invoked for the consumption of genetically modified food), requires that food, drugs, cosmetics, devices and chemical substances should not be sold if they are unwholesome, poisonous, or adulterated. It further prohibits deceptive labelling.

The statute also gives powers to authorized officers to inspect and examine any premises for evidence of contravention of the provisions of the law. There is thus no explicit policy and legal frame-work for the development and introduction of modern biotechnology in Kenya.

### **3.3.15 The Water Act 2002 (no. 8 of 202)**

The Water Resource Management Authority (WRMA) has been established under the Water Act 2002 to among others, develop principles and guidelines for allocation of water resources; monitor and re-assess water resource management strategy; monitor and enforce permission attached to water use; regulate and protect resources quality from adverse impacts; manage and protect water catchments, and; liaise with other bodies for better regulation and protection of water resources.

The Water Act provides for the conservation and controlled use of water resources in Kenya. Under the Ministry of Water the Act prohibits pollution of water resources and controls the discharge of industrial and municipal effluents into the ocean and other water bodies. These affect developments in their impacts to water resources and in their ability to have the required demand of water consumption for their stated activities. The above Act guides the development of such infrastructure as the one proposed by the proponent.

### **3.4 INSTITUTIONAL FRAMEWORK**

Previously Kenya had over seventy legislations covering different aspects of natural resources and environmental management. This implied that all the different institutions and administrative arrangements worked without harmony and often led to sectoral overlaps and conflicts. At present there are over twenty (20) institutions and departments which deal with environmental issues in Kenya. Some of the key institutions include the National Environmental Council (NEC), National Environmental Management Authority (NEMA), the Kenya Forest Service (KFS), Kenya Wildlife Services (KWS), Water Resources Management Authority (WARMA), Regional Water Services Boards (e.g. TANATHI), Regional Development Authorities (e.g. TARDA) various sectoral ministries, among others.

There are also local and international NGOs involved in environmental issues in the country. After 1999, the Government through EMCA (1999) formulated a coordinated and harmonized institutional mechanism for environmental management. The Ministry of Environment and Mineral Resources is the parent ministry under which the EMCA-based organs described below operate.

#### **3.4.1 National Environmental Management Authority (NEMA)**

The objective and purpose for which NEMA is established is to exercise general supervision and co-ordinate all matters relating to the environment and to be the principal instrument of the government in the implementation of all policies relating to the environment. A Director General appointed by the president heads NEMA. The Authority is given the following responsibilities;

- Co-ordinate the various environmental management activities being undertaken by the lead agencies and promote the integration of environmental considerations into development policies, plan, programmes and projects with a view to ensuring the proper management and rational utilisation of the environmental resources on a sustainable yield basis for the improvement of the quality of human life in Kenya.
- Take stock of the natural resources in Kenya and their utilisation's and consult with the relevant lead agencies in the preparation of land use guidelines.
- Examine land use patterns to determine their impact on the quality and quantity of the natural resources.
- Carry out surveys, which will assist in the proper management and conservation of the environment.
- Advise the government on legislative and other measures for the management of the environment or the implementation of relevant international conservation treaties and agreements in the field of environment as the case may be.
- Advise the government on regional and international environmental convention treaties and agreements to which Kenya should be a party and follow up the implementation of such agreements where Kenya is a party.
- Undertake and co-ordinate research, investigation and surveys in the field of environment and collect and disseminate information about the findings of such research, investigation or survey.
- Mobilise and monitor the use of financial and human resources for environmental management.
- Identify projects and programmes or types of projects and programmes, plans and policies for which environmental audit or environmental monitoring must be conducted under EMCA.
- Initiate and evolve procedures and safeguards for the prevention of accidents, which may cause environmental degradation and evolve remedial measures where accidents occur.
- Monitor and assess activities, including activities being carried out by relevant lead agencies in order to ensure that the environment is not degraded by such activities, environmental management objectives are adhered to and adequate early warning on impending environmental emergencies is given.
- Undertake, in co-operation with relevant lead agencies programmes intended to enhance environmental education and public awareness about the need for sound environmental management as well as for enlisting public support and encouraging the effort made by other entities in that regard.
- Publish and disseminate manuals, codes or guidelines relating to environmental management and prevention or abatement of environmental degradation.
- Render advice and technical support, where possible to entities engaged in natural resources management and environmental protection so as to enable them to carry out their responsibilities satisfactorily.

- Prepare and issue an annual report on the state of the environment in Kenya and in this regard may direct any lead agency to prepare and submit to it a report on the state of the sector of the environment under the administration of that lead agency and,
- Perform such other functions as government may assign to the Authority or as are incidental or conducive to the exercise by the authority of any or all of the functions provided under EMCA.

NEMA's mandate is designated to the following committees:

#### ***3.3.4.1 Provincial and District Environment Committees***

According to EMCA, 1999 No. 8, the Minister by notice in the gazette appoints Provincial and District Environment Committees of the Authority in respect of every province and district respectively. The District Environment Committees are responsible for the proper management of the environment within the District in respect of which they are appointed. They are also to perform such additional functions as are prescribed by the Act or as may, from time to time be assigned by the Minister by notice in the gazette. The decisions of these committees are legal and it is an offence not to implement them. Like in the case of District Environment Committees, the Provincial Environment Committee is responsible for the proper management of the environment within the province, which they are appointed. They are also to perform such additional functions as are prescribed by this Act or as may from time to time be assigned by the Minister by notice in the gazette.

#### ***3.3.4.2 Public Complaints Committee***

The Committee performs the following functions:

- Investigate any allegations or complaints against any person or against the authority in relation to the condition of the environment in Kenya and on its own motion, any suspected case of environmental degradation and to make a report of its findings together with its recommendations thereon to the Council.
- Prepare and submit to the Council periodic reports of its activities which shall form part of the annual report on the state of the environment under section 9 (3) and
- To perform such other functions and exercise such powers as may be assigned to it by the council.

#### ***3.3.4.3 National Environment Action Plan Committee***

This Committee is responsible for the development of a 5-year Environment Action plan among other things. The National Environment Action Plan shall:

- Contain an analysis of the Natural Resources of Kenya with an indication as to any pattern of change in their distribution and quantity over time.
- Contain an analytical profile of the various uses and value of the natural resources incorporating considerations of intergenerational and intra-generational equity.
- Recommend appropriate legal and fiscal incentives that may be used to encourage the business community to incorporate environmental requirements into their planning and operational processes.
- Recommend methods for building national awareness through environmental education on the importance of sustainable use of the environment and natural resources for national development.
- Set out operational guidelines for the planning and management of the environment and natural resources.
- Identify actual or likely problems as may affect the natural resources and the broader environment context in which they exist.
- Identify and appraise trends in the development of urban and rural settlements, their impact on the environment, and strategies for the amelioration of their negative impacts.
- Propose guidelines for the integration of standards of environmental protection into development planning and management.
- Identify and recommend policy and legislative approaches for preventing, controlling or mitigating specific as well as general diverse impacts on the environment.
- Prioritize areas of environmental research and outline methods of using such research findings.
- Without prejudice to the foregoing, be reviewed and modified from time to time to incorporate emerging knowledge and realities and;
- Be binding on all persons and all government departments, agencies, States Corporation or other organ of government upon adoption by the national assembly.

#### ***3.3.4.4 Standards and Enforcement Review Committee***

This is a technical Committee responsible for environmental standards formulation methods of analysis, inspection, monitoring and technical advice on necessary mitigation measures.



Standards and Enforcement Review Committee consists of the members set out in the third schedule to the Environmental Management and Co-ordination Act. The Permanent Secretary under the Minister is the Chairman of the Standard and Enforcement Review Committee. The Director General appoints a Director of the Authority to be a member of the Standards and Enforcement Review Committee who is the Secretary to the committee and who provides secretarial services to the Committee.

#### ***3.3.4.5 National Environmental Tribunal***

This tribunal guides the handling of cases related to environmental offences in the Republic of Kenya. National Environmental Tribunal consists of the designated members as defined in EMCA 1999.

#### ***3.3.4.6 National Environmental Council (NEC)***

EMCA 1999 No. 8 Part III section 4 outlines the establishment of the National Environment Council (NEC). NEC is chaired by the Minister for Environment and Natural Resources. NEC is responsible for policy formulation and directions for purposes of EMCA; set national goals and objectives and determines policies and priorities for the protection of the environment and promote co-operation among public departments, local authorities, private sector, non-governmental organizations and such other organizations engaged in environmental protection programmes. It also performs such other functions as are assigned under EMCA.

#### ***3.3.4.7 National Environmental Action Plan (NEAP)***

The NEAP for Kenya was prepared in mid 1990s. It was a deliberate policy effort to integrate environmental considerations into the country's economic and social development. The integration process was to be achieved through a multi-sectoral approach to develop a comprehensive framework to ensure that environmental management and the conservation of natural resources are an integral part of societal decision-making.

#### ***3.3.4.8 National Shelter Strategy to the Year 2000***

This strategy followed the international Year of shelter for the homeless in 1987 and was formulated to advocate a change in policy in order to allow other actors to come in and assist the government in providing housing. The government was to simply facilitate other developers to invest in shelter.

#### ***3.3.4.9 The National Poverty Eradication Plan (NPEP)***

The NPEP has the objective of reducing the incidence of poverty in both rural and urban areas by 50 percent by the year 2015; as well as strengthening the capabilities of the poor

and vulnerable groups to earn income. It also aims to narrow gender and geographical disparities and create a healthy, better educated and more productive population. This plan has been prepared in line with the goals and commitments of the World Summit for the Social Development (WSSD) of 1995. The plan focuses on the four WSSD themes of the poverty eradication; reduction of unemployment; social integration of the disadvantaged people and the creation of an enabling economic, political, and cultural environment. This plan is to be implemented by the Poverty Eradication Commission (PEC) formed in collaboration with Government Ministries, community based organizations and private sector.

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## CHAPTER FOUR

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### 4.0 ENVIRONMENTAL SETTING - BASELINE INFORMATION

#### ***4.1 Basic Resources and Infrastructure***

SEUCO has a land resource base of 10,000 acres at Yatta in Kitui County and 4,919 acres at Emali in Makueni County. These two parcels of semi-arid land, characterized by agro-pastoral production typical of South Eastern lowlands of Kenya, are central to the mandate of SEUCO which is to enhance higher education, agricultural productivity, water resources conservation, mineral exploitation, and sustainable natural resources management. The utilization of the above properties is far from optimal. Since the appointment of key personnel from mid 2009, progress towards the development of the physical infrastructure and facilities has been given high priority.

SEUCO's Main Campus will in the near future be a beehive of activity in terms of construction work. Key facilities such as office and teaching facilities, workshops, laboratories and student hostels are at an advanced stage of planning. In addition, amenities such as human health clinic, guest house and staff recreational facilities are also been planned. These facilities will complement the existing lecture rooms, laboratories and student facilities inherited from UKAI. Physical development and resources such as electricity power mains, road network, piped water and communication system are also in the process of implementation. These include a standby diesel power generator, motor vehicles, and telephone and internet connections.

The university college is also in the process of establishing research and practical training facilities for students and local community groups. These facilities include green houses, home gardens, livestock enterprises and fish ponds. Local and national linkages for research and development have also been initiated as part of an effort towards the achievement of SEUCO strategic objectives on Science, Technology and Innovation (STI).

#### ***4.2 Proposed Project Location and its Description***

The proposed project is located in Lower Yatta Division of Kitui District (see Figure 1). The site for the construction of a sand dam is located at Mwita Syano about 5 km from the main Campus. The site for the proposed rock catchment is located about 1 km to the south of the main campus at an inselberg situated adjacent the SEUCO main gate. The proposed fish ponds, greenhouses and a woodlot sites will be located about 200m from main tuition block. The site slopes gently at approximately 3-5° and is largely covered by grass with few trees and degraded bushes. The sites are overlain by red well drained sandy loam soils which have

quartz and feldspar grains and felsic gravel rock fragments. The total areas to be covered by the project are 10 acres which is a small proportion of the 10,000 acres of total land area of the university college.

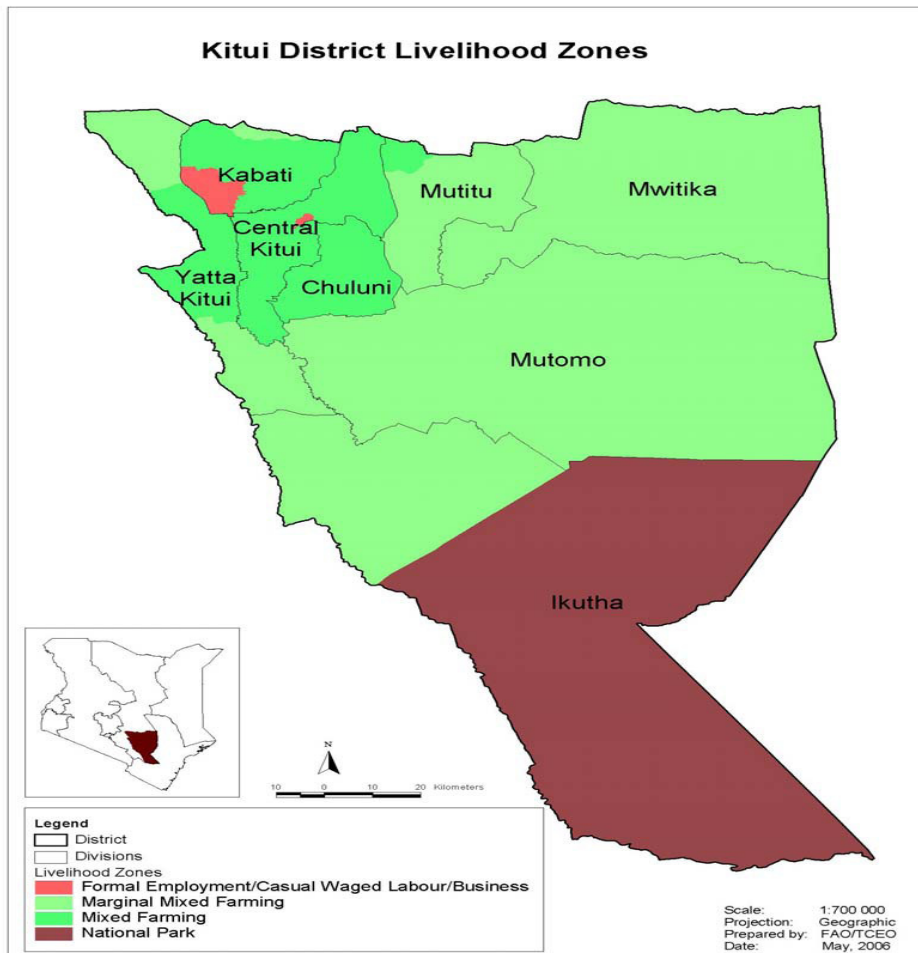


Figure 6: Location of Project Site in Kitui District

### 4.3 Physical and Agro-Climatic Conditions

The topography of the Kitui district can be divided into highland and lowland areas with altitude ranging from 400m and 1800m above sea level. The central part of the district is characterized by the hilly ridges separated by wide, low lying areas with an elevation of between 600m and 900m above sea level.

The project area is located to the west side of the district, where the main relief feature is the Yatta Plateau, which stretches from the north to the south separating the Athi and Tana River basins. The plateau is almost plain with wide shallow spaced valleys. This region

receives less rainfall as compared to the high altitude areas such Kitui Central, Mutitu Hills and Yatta Plateau.

The climate in the project area is hot and dry with very erratic and unreliable rainfall typical of arid and semi-arid climatic zone. The project area has two rainy seasons with two peaks in April-May (long rains) and November-December (short rains). The rest of the year is hot and dry. The rainfall ranges from 500 mm to 1050 mm with 40-percent reliability. The area falls under ecological zones IV and V. Zone IV is land with less potential for agriculture and carries essentially savannah woodland with an annual rainfall ranging 500-800mm. Zone V is typically rangeland dominated by Commiphora and Acacia species and bushes.

Air temperature ranges between 16°C and 34°C with mean maxima of 28°C and minima of 22°C. Relatively lower temperatures are experienced between June and August while high temperatures are experienced in January-March and September-October, peaking just before the onset of rains. The highest temperatures (of the order 34°C) are experienced in February. The prevailing wind is generally easterly but its direction at the site is often influenced by the many small hills found in its immediate vicinity. Wind speed is approximately 15 km hr<sup>-1</sup>.

#### **4.4 Regional setting**

The project area (Lower Yatta) is a semi-arid region situated 170 km East of Nairobi. The total project land area is approximately 10,000 acres. The elevation of the area varies between 1000 and 1200 metres a.s.l. Approximately 10,000 people inhabit the project area, most of them as squatters. The population growth rate is 2.2 percent a year (DDP, 2002).

#### **4.5 Biodiversity**

The proposed site for the project is already quite disturbed. Most of the natural vegetation was found to have been already cleared by squatters. Extensive livestock grazing and fire were found to be responsible for the disturbed nature of the natural vegetation. The site and its environment could only be serving as wildlife habitat in transient periods as no resident wildlife species were observed in the area. There is definitely below ground biodiversity as is the case for most tropical areas. However, in view of the fact that the proposed project will only occupy a marginal area, its impact on the below-ground biodiversity will be minimal. The project will therefore have minimum impact on biodiversity and wildlife species in the area.

#### **4.6 Vegetation**

The vegetation in the project area is characterized by a bushland composed of bushes, herbs, grasses and isolated stems of indigenous tree species. The vegetation has been negatively impacted by past and present anthropogenic activities. Some of the anthropogenic activities recorded include: charcoal making, grazing, fuelwood extraction, tree cutting, trampling of seedlings, debarking among others. Selective extraction of species important for charcoal making such as *Acacia mellifera*, *Terminalia brownii*, *Acacia tortilis* etc was noted. The remaining isolated trees such as *Balanites aegyptica*, *Juniperus procera*, *Lennae rivaie* etc are of very low economic value in terms of charcoal, fuelwood and timber.

The anthropogenic disturbances seem to have reshaped the ecology of the site by making it suitable for colonizer/invasive species of low economic value. Some of the colonizer/invasive species recorded on the sites include: *Dovyalis macrocalyx*, *Capparis sepiaria*, *Garcinia livingstonei*, *Grewia tembensis*, *Euclea divinorum*, *Acacia brevispica* among others. The aggressive invasion of the sites by these colonizer species has negatively affected the regeneration and recruitment processes on the sites.

Seedlings of native and important species that manage to germinate rarely survived to be recruited to the upper age cohorts. Most of them faced catastrophic mortalities or were surviving suppressed under the canopy of invader species. Heavy browsing of key savannah-woodland species such as *Acacia mellifera* and *Acacia tortilis* has affected the vegetation structure of the sites. As a result, these *Acacias* remain stunted at the seedling stage for years and are rarely recruited to sapling stage.

Riverine vegetation along the Mwitwa Syano river is characterized by a key riverine species; *Acacia eliotar*. In some cases, the species was also targeted for charcoal making. Exploitation of *Zanthoxylum chalybeum* through debarking for medicinal purposes was also evident. The sites have the capacity for recovery from past and present anthropogenic disturbances. Protecting the sites from these disturbances will promote regeneration and recruitment of the important native species thus restoring post-disturbance species composition, diversity and structure. It is important to monitor the succession processes taking place and take action against individualistic successional pathways that may be introduced by colonizer species.

#### **4.7 Geology**

The geology of the proposed sites for the project is presented below:

##### **(a) The geology of Rock Outcrops**

SEUCO rock outcrop is oval shaped rock outcrop (approximately 300m long, along an East – West direction and 100m wide, along a North – South direction) located about 200 m from

the main tuition block. It rises about 20m above the surrounding general elevation. It has patchy grass cover, some non-vegetated rock outcrops and some few trees found along scattered fractures. This rock outcrop is dominated by massive, non-foliated, light coloured metamorphic Granulites. The rock is highly impermeable, tough and of high compressive strength. It is composed quartz and feldspars (80%), red garnets (10%) and pyroxenes (10% or less). It is a crystalline rock whose fabric is interlocked and oriented in an approximate North West – South East direction. For all Engineering Geological qualities, the rock is essentially like granite and is ideal for constructing water harvesting facilities.

Kamosi hill located about 2km East of the SEUCO rock outcrop Hill, has two rock outcrops oriented East to West, oval in shape and separated by an approximate 30m wide depression. The hills are located on the left hand side of the new university road from Kwa Vonza market to SEUCO. The hill adjacent to the road (Hill 1) is well rounded and has no vegetation while the one farther away (Hill 2) has grass and some tree vegetation. Each hill is about 400m long and about 200m wide. They have a general elevation of about 40 to 50m above the surrounding topography. The rock outcrops are composed of high grade metamorphic granulites composed of quartz and feldspars (85%), mafic pyroxenes, biotite (5-10%) and red almandine garnets (5-10%). The rocks are greyish white in colour, form massive poorly foliated outcrops, which in the hill 1 (adjacent to the road) have been well rounded through exfoliation. Hill 2 (further away from the road), however has a more fractured and jointed surface which gives a rugged topography, with grass and tree patches. The soil cover on its surface, which hosts the vegetation, is estimated at 40% of the total surface. Soils at the foot of the two hills are also well drained reddish sandy loams which pose no challenges to engineering construction. For the construction of a rock catchment, rock outcrop on hill 1 was found to be more ideal.

***(b) The geology of the area between the SEUCO Hill and the Kamosi Hills.***

This is the area that is intended for the construction of fish ponds and establishment of a woodlot covering about 10 ha. This area is covered with well drained reddish sandy loam soils. Anthills scattered within this area have brought to the surface broken sand and bedrock particles as well as fragments. The topography is lowest close to the Kamosi hill. About 500 metres from Kamosi hill, is a stream which drains westwards into the Mwita Syano River. Close to this small tributary the soils are brownish in colour being composed of silt brought down from the slopy sides.

***(c) The geology of the course of Mwita Syano River***

The Mwita Syano river course has maintained a fairly constant width of about 20 – 30m along this entire length. The river banks are steep. The sands on the river bed are largely well sorted and mature without or with minimal silt/clay content; hence these sands are ideal in tapping and retaining water in their sub-surface pores. The geology of the river course is composed of high grade metamorphic granulites and gneisses. Upstream, there is a silt/clay

floodplain, approximately 100m wide on the left hand side of the river and it stretches for about 150m up streams where it tapers off. On the right hand side mafic granulites rich in garnets and black minerals, iron ore and pyroxenes have weathered into deep fresh red soils rich in black heavy sands. The soils do not contain much quartz sands. These mafic granulites give in to felsic granulites consisting of 80% quartz and feldspars, mafic biotite and pyroxenes, ~ 5-10% and garnets ~10%. These are characterized by reddish sandy loam soils. These rocks medium grey in color are vertically dipping but foliation planes are tight and do not allow much water to disappear into the ground. During the last distance of the geotraverse, about 400m, the soils are brownish and the rocks are well foliated biotite gneissies which allow some water into the ground. Kunkar limestone and white patches of sodium chloride are common along the river banks making the water slightly brackish. A geological evaluation shows that the entire length of the Mwita Syano River is ideal for the construction of a sand dam. In area along the river course that are covered with biotite gneissies unit, which is well foliated (has planer structures), shallow wells dug on the sandy river bed had a lot of water which signified replenishment from groundwater.

#### **4.8 Hydrology and Water Resources**

Due to limited rainfall, surface water sources are very scarce in the project area. The major sources of water are seasonal rivers, namely Mikuyuni and Mwita Syano Rivers that flows only during rainy seasons. Virtually all of the seasonal rivers in the project area drain into the Tana River drainage basin - Kenya's largest river that drains the Eastern flank of the Aberdares and the Southern slopes of Mount Kenya.

The river flows in the project area are characterised by very low flows (base flows) in dry season and high flows during rainy seasons, i.e. April-May and November-December. Most of the ephemeral streams generally become dry within one month after the rainy season (cf. Borst and De Haas, 2006). The flows are usually fast and turbid due to high sediment concentration associated with soil erosion in the catchment area.

There are also several sand dams along the course of Mwita Syano and Mikuyuni rivers in the project area that play a significant role in providing water to the local community particularly during dry seasons. However, most of the dams are small and dry up during the extended dry seasons due to the high water abstraction and evaporation rates.

#### **4.9 Population**

The population in Kitui District was 575,273 people in 2005, with a moderate annual growth rate of 2.2% (see also PriceWaterhouse Coopers, 2005). The population is largely rural-based with only 10% residing in the urban areas. In the location where the project will be implemented, the population is estimated to be less than 10,000 people. The settlement



patterns are greatly influenced by water availability and soils' agricultural potential. The area has high proportion of females to males (112:100) and a dependency ratio of 100:1135. The labour force is robust (47%) with youth comprising 21% of the population. The incidence of HIV/AIDS is estimated at 14% in 2001 with a life expectancy of 51 years as compared to 55 countrywide. More than 50% of the population lives below absolute poverty level.

Human activities such as clearing of land for agriculture, settlements, charcoal making and cutting of indigenous trees for carving has in the recent past promoted desertification. Perhaps of most serious consequence is the felling of trees for charcoal production that has reached commercial levels. The lower Yatta area is one of the main producer of charcoal, contributing to the 300,000 bags of charcoal that are produced in Kitui District every year. This causes loss of biodiversity and severe land degradation in the fragile ecosystem. The most affected areas include Kwa Vonza location where the project is located.

#### **4.10 Economy**

The vast majority of the local economy is based on sustenance farming, despite the fact that the agriculture is an extremely challenging activity given the sporadic and low rainfall. A logical move therefore would be a transition to non-agricultural industries. During a recent, informal survey of the businesses in the area, the following businesses were identified: Butcheries; food Staples (rice, corn meal); mini-markets (sells things like coca-cola, potatoes chips, bread, long-shelf milk); mechanics; pubs; hotel and restaurant, although most of them are small-scale enterprises with a small customer base.

#### **4.11 Socio-economic activities**

In 1997, the income of 58 percent of the Kitui district was beneath the poverty line of 2 dollars a day (PRSP, 2001). Kitui district in which the project area is located is one of the poorest regions of Kenya. The main economic activity is rainfed agriculture (Census, 1999). Irrigated agriculture only takes place on small plots on the Mikuyuni and Mwitwa Syano river banks. During prolonged dry periods, peasant farmers are usually dependent on relief food from the government and donors. In 2004 and 2005, up to 50 percent of the inhabitants of Kitui District received food aid (FEWS-NET). Besides farming, the other main economic activities are hawking, charcoal making, sand harvesting, brick making and basket weaving.

#### **4.11 Industries**

Within the project area, there are no specific industries. However, in Kitui town, there is a ginnery where cotton farmers from around the district can deliver their harvest. It is the only major industry in the district that was set up way back in 1935. Kitui is a semi-arid region and not many crops fare well apart from cotton, hence the Ginnery plays a major role of creating income for the farmers in the district.

## CHAPTER FIVE

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### 5.0 CONSULTATION AND PUBLIC PARTICIPATION

#### 5.1 INTRODUCTION

This chapter describes the process of the public consultation and participation that were followed in order to identify key issues and impacts of the proposed water harvesting and utilization project. As per the requirements of NEMA regulations, local community, owners and occupiers within the radius of 100m of the proposed project were consulted through standard questionnaires and interviews. The consultations and investigations examined the project activities and their potential impacts on the immediate surroundings. All people that were interviewed welcomed the proposal of harvesting water and utilization noting that the same can help in alleviating poverty in lower Yatta.

#### 5.2 OBJECTIVES OF THE CONSULTATION AND PUBLIC PARTICIPATION

The objective of the consultation and public participation was to:

- Disseminate information about the project activities and in particular inform the stakeholders about the key components of the project and their locations;
- Gather comments, suggestions and concerns of the interested and affected stakeholders, and;
- Incorporate in the project document as well as the environmental impact assessment report, all the information gathered from the stakeholders, with a view to ensuring that the concerns of the stakeholders are taken into consideration during the implementation of the project.

#### 5.3 PRELIMINARIES AND TERMS OF REFERENCE

Reference was made to the requirements for the project proponent to undertake the Environmental Impact Assessment (EIA) of the proposed water harvesting and utilization project, as per the EMCA requirement

For public participation and stakeholder consultations, the following activities were to be undertaken: socio-economic surveys; consultations with the general public about the project impacts; the analysis of project site and preparation of a report on the feedback received from the key stakeholders.

## **5.4 METHODOLOGY**

In order to accomplish the tasks, a General Public Participation Questionnaire was designed (See Appendices 3, 4 and 5). This was administered to 38 respondents comprising;

1. Local community leaders
2. Women representatives from the local community
3. Youth representatives from the local community
4. Men representatives from the local community

## **5.5 ISSUES RAISED**

This Sub-Section covers the views and opinions of the community, key stakeholders (local leaders, surrounding, institutions/organizations, interested persons or groups). It highlights both positive and negative socio-economic and environmental impacts anticipated during the construction and operational phases of the development. This is followed by suggested mitigation measures that the project proponent should incorporate to minimize environmental degradation and promote sustainable development. The section ends by highlighting the opinions and expectations of the stakeholders. However, these notwithstanding, some issues of concerns were raised as outlined below.

### **5.5.1 POSITIVE ISSUES RAISED**

Nearly all the interviewed respondents were in favour of the project due to its potential to create the following benefits:

#### **5.5.1.1 Creation of Employment Opportunities**

Most of the stakeholders noted that the project will open up new job opportunities during construction and operation phases of the project life cycle. This was noted to be an important benefit given that more than 50 percent of the local population lives below absolute poverty line.

#### **5.5.1.2 Improvement in research**

The new water harvesting facilities including the utilization facilities will allow SEUCOs research scientists to undertake research whose findings will contribute to SEUCO's philosophy of transforming arid lands to green. The research on water harvesting technologies, fish farming, agroforestry and horticulture that will be undertaken will also be of immense benefit to the local community and the nation at large.

### **5.5.1.3 Contribution to the Economic Growth**

The use of locally available materials and labour for the proposed water harvesting and utilization project will contribute towards growth of the local economy by contributing to the gross domestic product. The consumption of various materials, fuel oil and others will attract taxes including VAT which will be payable to the government hence increasing government revenue while the cost of these raw materials will be payable directly to the producers. The project will therefore make some significant contribution to the local economy in Kitui and national economy at large.

### **5.5.1.4 Alleviation of shortage of water**

The water harvesting facilities will reduce current acute shortage of water within the University. The increased availability of water will assist in improving the efficiency of SEUCO in delivering its services to its clients (staff, students and other stakeholders and local community). Currently, the university college uses buzzers to bring water all the way from Kitui town, a distance of 42 Km. This is costly and unsustainable and little water brought by buzzers cannot sustain intensive fish farming, horticulture and agroforestry activities.

### **5.5.1.5 Increased business activities**

People owning businesses in the vicinity of the proposed project sites observed that the project will open up business opportunities and attract more clients. This has a potential of leading to an improvement in the income levels of the local communities. This in the long run will contribute towards poverty alleviation.

### **5.5.1.6 Training Opportunities for local community**

The project would train local community on the various water harvesting technologies. It will also train them on how to use harvested water in fish farming, agroforestry and horticultural developments. These activities will have tremendous impacts in terms of poverty alleviation.

## **5.5.2 NEGATIVE ISSUES RAISED**

Majority of the respondents raised the following concerns about the proposed project:

### **5.5.2.1 Dust Generation**

During the project construction and decommissioning phases of the project activities, some amount of dust will be generated. Increased vehicular traffic, excavation works, use of cement, among others will generate substantial amount of dust which if not controlled could

lead to respiratory diseases. Respondents urged for measures to be undertaken to reduce dust pollution during the construction phase of the project.

#### **5.5.2.2 Clearing of vegetation**

SEUCO is located in a semi arid environment where vegetation growth is very slow due to the prevailing harsh climatic conditions. The area is already degraded due to past deforestation activities. The project will result in clearing of indigenous trees some of which have taken many years to grow. In addition, some indigenous tree species which are rare could become extinct if care is not exercised during the construction stage. The overall effect will not only be loss of valuable vegetation but also loss of biodiversity and aesthetics. Respondents urged for measures to be undertaken to protect rare and indigenous vegetation in the project site.

#### **5.5.2.3 Waste Generation**

Some of the consulted people were concerned on the unsightly scenarios associated with construction sites due to the presence of wastes scattered all over e.g. empty cement bags, rejected metals, wood, wrappings (plastic bags), glass, among others. These wastes cumulatively lead to a filthy situation which people would not like to see. Suggestions were made to the proponent to manage all the waste in an environmentally accepted manner.

#### **5.5.2.4 Modification of stream flow**

Some respondents noted that the project may interfere with the downstream flow of Mwita Syano river where a sand dam would be constructed. They recommended that adequate measures be taken to ensure that downstream flow of the river is not interfered with. It was however, noted that construction of the sand dam will increase the baseflow that will ensure the communities living downstream of the dam will be assured of a more dependable source of water.

## CHAPTER SIX

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### 6.0 IMPACTS OF THE PROJECT

#### 6.1 OVERVIEW

The potential impacts of the project have been categorized into two major categories. These are impacts on the natural environment on the one hand, and impacts on human environment on the other. The following is general description of environmental impacts and their scales.

(i) Natural Environment:

- Loss of Biodiversity.
- Pollution (soil and air).
- Modification of landforms/landscape.
- Streamflow modifications.

(ii) Impacts on human environment:

- Creation of employment opportunities.
- Introduction of secondary businesses.
- Improvement of infrastructural services and facilities.
- Increase in wealth and hence improvement of social status of the local community.

#### 6.2 SCALE

The magnitude and significance of impacts were gauged using an objective scale that took into consideration the following:

- Temporal – short term or long term.
- Spatial – Transboundary/local.
- Severity – Reversible/irreversible, temporary/permanent.

The scale that was applied in the analysis of impacts is shown in the following table.

**Table 2: Levels of Scale used in the Project**

Value	Description	Scale Description
0	No impact	This means that to the best knowledge of the expert, the particular activity/action will not have any known impact on the environment. Such an impact will not in any way affect the normal functioning of either the human or the natural systems and does not therefore warrant any mitigation.
1	Minimal impact	Any activity with little impact on the environment calls for preventive measures, which are usually inexpensive and manageable. Such activities have minimum impacts on either natural or human environment or both.
2	Moderate impact	A moderate impact will have localized effect on the environment. If the effect is negative and cumulative, action in form of mitigation measures needs to be put in place to ensure that it doesn't become permanent and /or irreversible.
3	High impact	An impact is high if it affects a relatively high area (spatial), several biological resources (severity) and/or the effect is felt for a relatively long period (temporal) e.g. more than one year. In case the effect is negative, such an impact needs to be given timely consideration and proper mitigation measures put in place to prevent further direct, indirect or cumulative adverse effects.
4	Very high impacts	Such an activity rates highly in all aspects used in the scale i.e., temporal, spatial and severity. If negative, it is expected to affect a huge population of plants and animals, biodiversity in general and a large area of the geophysical environment, usually having transboundary consequences. Urgent and specialized mitigation measures are needed. It is the experts' opinion that any project with very high negative impacts <b>MUST</b> be suspended until sufficient effective mitigation measures are put in place.
5	Not known	There are activities for which impacts are not yet known e.g. some chemicals are suspected to produce carcinogenic effects but this has not yet been confirmed.

## **6.3 NEGATIVE AND POSITIVE IMPACTS**

The EIA Project Team evaluated the potential positive and negative impacts that will result from the implementation of the proposed project. The impacts have been categorized into three distinct project phases namely; construction, operation and decommissioning phases. The construction impacts relate to activities carried out during project construction phase. Operational phase impacts are associated with the activities carried out during the project operation and/or occupation while decommissioning impacts are realized when the project becomes obsolete i.e. when the various facilities put up by the project will be dismantled. An overview of anticipated impacts during the different project phases and their rating are presented in the following sections.

### **6.3 CONSTRUCTION PHASE IMPACTS**

#### **6.3.1 Negative Environmental Impacts**

##### ***6.3.1.1 Risks of Accidents and Injuries to Workers***

Workers might be hurt by construction materials or equipments during construction phase of the proposed project. It is also expected that construction workers are likely to encounter occupational health hazards as a result of coming into contact with and handling hazardous waste. Because of the various construction activities including rock and metal grinding and cutting, concrete work, steel erection and welding, among others, construction workers will be exposed to risks of accidents and injuries. Such injuries can result from accidental falls from high elevations; injuries from hand tools and construction equipment; cuts from sharp edges of rocks, metal sheets and collapse of rocks among others. This impact will however be minimal (value of 1).

##### ***6.3.1.2 Clearance of Vegetation***

Before the construction of water harvesting and utilization structures begins, clearance of part of the existing vegetation cover at the construction sites has to occur. Direct impact from such disturbances may cause changes in temperature, light, moisture and nutrient levels; changes in natural community processes or invasion of non-native plant species. Loss of plant communities may also result leading to decreased water quality, increased soil erosion as a result of unstable soil, nutrient imbalances in the soil, and/or compaction of soil. It is recommended that the developer should replace the cleared vegetation with indigenous trees or other fast growing trees and grasses in strategic areas as part of the landscaping activities. This is in addition to the establishment of a woodlot in the area. This impact on the vegetation will be minimal (value of 1) since the vegetation is already degraded due to livestock grazing, cultivation, charcoal production, etc.



### ***6.3.1.3 Increased water use***

Both the workers and the construction works will create additional demand for water in addition to the existing demand within the university college. Water will mostly be used in the creation of concrete for construction works and for wetting surfaces or cleaning completed structures. This impact will however be minimal (value of 1) since there are very few existing water resources that will be directly impacted.

### ***6.3.1.4 Solid waste generation***

Some amounts of solid waste will be generated during construction of the project. These will include metal cuttings, rejected wood, rejected materials, surplus materials, surplus soil, excavated materials, paper bags, empty cartons, among others. Solid wastes if not well managed have a potential of causing disease outbreaks due to the fact that their presence provides suitable breeding conditions for vectors of certain diseases such as malaria, cholera and typhoid. Outbreak of diseases such as Malaria could also be exacerbated by the presence of open water ditches for breeding of anopheles mosquitoes. The major vulnerable groups are children who could be exposed to these conditions. The workers on site will also generate faecal waste during their day-to-day operations. The generated waste needs proper handling to prevent disease, such as cholera, typhoid and diarrhoea outbreak. Unless this is addressed, it can prove to be an environmental/health hazard. However, in view of precautionary measures to be undertaken, this impact is minimal (value of 1).

### ***6.3.1.5 Noise and vibrations***

The construction works will most likely be a noisy operation due to the moving machines (mixers, tippers, communicating workers) and incoming vehicles to deliver construction materials and workers to site. To some degree site workers and neighbours are likely to be affected since noise beyond some level is itself a nuisance and thus should be controlled within acceptable limits. However, in view of the fact that most of the construction works will take place far away from human settlements and office blocks, this impact will be minimal (value of 1).

### ***6.3.1.6 Dust generation***

Suspended particulate matter pollution is likely to occur during the site clearance, excavation and spreading of the topsoil, building of foundation, loading and transportation of the construction waste. There is a possibility of PM10 suspended and settle-able particles affecting the construction sites workers and even surrounding neighbours' health. However, in view of the fact that most of the construction works will take place far away from human settlements and tuition blocks, this impact will be minimal (value of 1).

### ***6.3.1.7 Exhaust emission***

Exhaust emissions are likely to be generated during the construction period by the various construction machinery and equipment. Motor vehicles used to mobilise the work force and materials for construction would impact on air quality by emitting pollutants through gaseous exhaust emissions. However, in view of the fact that most of the construction works will take place far away from human settlements and office blocks, and there will be minimal vehicular transport, this impact will be minimal (value of 1).

### ***6.3.1.8 Increased energy use***

The project will consume fossil fuels (mainly diesel) to run vehicles and construction machinery. Fossil fuel is non-renewable and its excessive use has environmental implications on its availability, price and sustainability. The projects construction phase will also use diesel to run generators. Since direct energy consumption during and after the construction of the project is minimal, this impact will be minimal (value of 1)

## **6.3.2 Positive Environmental Impacts of Construction Phase**

### ***6.3.2.1 Provision of market for supply of materials***

The project will require supply of large quantities of building materials such as stones, sand, ballast etc, many of which will be sourced locally. This will provide a ready market for building material suppliers such as women and youth groups, quarrying companies, hardware stores and individual suppliers.

### ***6.3.2.2 Business opportunity /Improved living standards***

Several opportunities will come up during the construction and implementation periods of such projects. The increase in revenues for the local community will improve money circulation within the project area. This will in turn lead to the initiation of several businesses by entrepreneurs within/around the University. Businesses such as food vendors, etc are expected to crop-up thus allowing businessmen to directly benefit from the project. The overall impacts of all these will be improved incomes and hence standard of living of the local community.

### ***6.3.2.3 Employment opportunities***

During construction phase of the project, there will be availability of employment opportunities especially to casual labourers and several other semi-skilled workers. Employment opportunities are of benefit both economically and socially. In the economic sense, it means that abundant unskilled labour will be used in construction works thus

improving their income levels. Several workers including casual labourers, masons, carpenters, joiners and plumbers are expected to work on the construction sites through the entire duration of the project. Apart from casual workers, semi skilled and unskilled labour, formal employees, etc are also expected to obtain gainful employment during the period of construction. Thus the project will contribute in reducing unemployment in Kitui District.

#### ***6.3.2.4 Increased cash flow in the project area***

Through the use of locally available materials during the construction phase of the project including cement, structural steel, concrete, timber, sand, ballast, etc, the project will contribute towards growth of the local economy. The consumption of these materials, fuel oil and others will attract taxes including VAT which will be payable to the government hence increasing government revenue. In addition, the cost of these raw materials will be payable directly to the producers.

### **6.4 OPERATIONAL PHASE IMPACTS**

#### **6.4.1 Negative Environmental Impacts**

##### ***6.4.1.1 Increased water use in fish ponds, horticulture and agroforestry***

The activities which will occur during the operation phase of the project will involve the use of large quantities of water. The harvested water will be used in fish ponds, greenhouses and woodlots. It is envisaged that measures will be taken to conserve water and hence this impact will be minimal (value of 1).

##### ***6.4.1.2 Modification of streamflow***

After completion of the project, the sand dam will trap a huge quantity of sand behind dam wall. Water will be stored in this sand. This has a potential of modifying the patterns of streamflow since during rainy season, surface flow will be hindered by the dam until a certain level is reached after which water spills over the dam. Also, there would be an increase in baseflow during dry season. The project will put measures to ensure there is only minimal modification of stream flow downstream. In this respect, this impact will be minimal (value of 1).

##### ***6.4.1.3 Modification of downstream sediment load***

The construction of a sand dam will to a certain extent modify sediment downstream of the project site. This is because during the initial stages, the dam will trap sand and other sediments leading to a reduction. However, the project will put up measures to ensure that the reduction in sediment load will only be for a short time since once the sand is filled with sand, excess sand will be flushed out of the dam and carried downstream, thereby enabling the recovery of the sediment budget of the river Mwita Syano.

#### ***6.4.1.4 Increased pressure on downstream water resources***

The harvesting of water from Mwita Syano river may put more pressure to the river given that it is already an important source of water for a large segment of the local community. However, construction of a sand dam will make more water available to the local community and there will be more baseflow downstream of the project area. This impact will be minimal (value of 1).

#### ***6.4.1.5 Modification of landscape***

The construction of fish ponds, woodlots including the sand dam and rock catchment will to a certain extent modify the existing landscape. However, measures will be taken to make sure that such developments are not out of character with the surrounding environment. These effects will however be moderate hence a value of 2.

#### ***6.4.1.6 Loss of riverine agricultural land***

The banks of Mwita Syano are used for cultivation of sugar cane, vegetables and other crops. The cultivation is done on small scattered plots. The total area covered is however small. There is a possibility that a small percentage of these farms may be lost as the sand dam fills up with sand. Since the impact is minimal, the value of 1 is given to this impact.

#### ***6.4.1.2 Loss of riverine macrophytes***

The banks of Mwita Syano are covered by macrophytes and some riverine vegetation. These also cover a small area. There is a possibility that a small percentage of the riverine vegetation may be lost as the sand dam fills up with sand. Since the impact is minimal, the value of 1 is given to this impact.

### **6.4.2 Positive Environmental Impacts of Operational Phase**

#### ***6.4.2.1 Provision of adequate water***

During the operational phase of the project, there will be supply of water to SEUCO thus allowing various research and training activities to be undertaken. Adequate supply of water will also reduce current high cost of bringing water from Kitui town. Additional sources of water will enable the university college focus on development orientated research activities such as fish farming. In addition to supplying water to SEUCO, the sand dam and the rock catchment will also make water available to the local community. This will reduce the conflicts in the use of Mwita Syano river.

#### ***6.4.2.2 Increase in income to the university college***

The university college will generate additional income from the sale of fish, various produces from greenhouses including timber from woodlots. The additional income will reduce the dependency of the university college on the exchequer for provision of budgetary support for various research activities.

#### ***6.4.2.3 Provision of sites for applied research***

The fish ponds, greenhouses and woodlots will be used for research purposes by both the academic staff and students. The structures will therefore be crucial in the training of science-based students in the Schools of Environment and Natural Resources, Water Resources Science and Technology and Agriculture and Veterinary Sciences. .

#### ***6.4.2.4 Optimal use of land***

The construction of the sand dam, fish ponds and woodlots within part of the 10,000 acres of the university college land, means that its expansive land will be put into good and beneficial use. Land is a precious resource in Kenya and proper utilization of idle institutional land is encouraged. The strategy of the university is to ensure that upcoming projects in its land have very minimal adverse environmental impacts.

#### ***6.4.2.5 Creation of employment opportunities***

Employment opportunities are one of the long-term major impacts of the project that will be realized during the operation and maintenance of the project. It is estimated that this project will create numerous jobs for laboratory technical staff and support staff, office staff, teaching staff, etc. Other indirect sources of employment will also arise.

#### ***6.3.2.1 Improved health status of the local community***

The sand dam and the rock catchment will also be supplying water to the local community. This has the potential of reducing the burden placed on women and children. This will also in the long run reduce water borne diseases. There is also a possibility of improvement in productivity of the local community since time wasted in searching for water will be spend in other economic activities.

### **6.4 DECOMMISSIONING PHASE IMPACTS**

#### **6.5.1 Negative Environmental Impacts**

##### ***6.5.1.1 Solid waste generation***

Demolition of the fish ponds, greenhouses, sand dam, rock catchment and associated water conveyance structures will result in large quantities of solid waste. The waste will contain materials that were used during the construction such as concrete, metal, drywall, wood, glass, paints, adhesives, sealants and fasteners. Although demolition waste is generally considered less harmful to the environment since they are composed of inert materials, there is growing evidence that large quantities of such waste may lead to release of certain

hazardous chemicals into the environment. This impact will however be moderate (value of 2).

#### **6.5.1.2 Noise pollution**

The decommissioning related activities such as demolition works will lead to significant deterioration of the acoustic environment within the project site and the surrounding areas. This will be as a result of the noise and vibration that will be experienced as a result of demolishing the proposed project buildings and related components. This impact will however be minimal (value of 1) since the effects will be short term.

#### **6.5.1.3 Loss of livelihood and economic ruin**

The establishment and operation of the project will bring about a lot of positive change to the lives of the people around it and also to the local economy. Decommissioning of the project will thus mean a reverse of these gains whereby many will lose their source of livelihood from jobs to business ventures hence directly leading to a decline of the area's economic stature and a drawback to the economy at large. This impact will however be minimal (value of 1) since other sources livelihood would have been established by the time decommissioning phase is reached.

#### **6.5.1.4 Occupational hazards**

Demolition works will inevitably expose workers and the public to occupational health and public safety risks. In particular, working with heavy equipment, handling and use of tools engender certain risks. The workers are also likely to be exposed to risk of accidents and injuries resulting from accidental falls, falling objects, injuries from hand tools and other equipment. This impact will be minimal (value of 1).

#### **6.5.1.5 Dust and exhaust emissions**

Large quantities of dust will be generated during demolition works. Particulate matter pollution is likely to occur during demolition and transportation of the demolition wastes. There is a possibility of suspended and settle-able particles affecting the site workers and the surrounding neighbours' health. Exhaust emissions are likely to be generated during the demolition period by the various machinery and equipment to be used as well as motor vehicles used for the exercise. This impact will however be minimal (value of 1).

#### ***6.5.1.6 Loss of research and demonstration facilities***

Demolition of the proposed facilities would lead to loss of research and demonstration sites for the SEUCO academic staff, loss of scientific experimental facilities for students and researchers. It is however, expected new facilities would have been developed to replace the old facilities that would be decommissioned. This impact is therefore minimal (value of 1).

### **6.5.2 Positive Environmental Impacts of Decommissioning Phase**

#### ***6.5.2.1 Aesthetics as a result of landscaping***

Upon decommissioning of the proposed project, rehabilitation of the project site will be carried out to restore the site to its original status or to a better state than it was originally. This will include replacement of topsoil and re-vegetation which will lead to improved visual quality of the area. This will also mean that alternative options can be utilized within the project site.

#### ***6.5.2.2 Employment Opportunities***

For decommissioning to take place properly and in good time, several people will be involved. As a result several employment opportunities will be created during the demolition phase of the proposed project.



*Plate 1: A typical sand dam constructed elsewhere in Kitui District*

## CHAPTER SEVEN

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### 7.0 MITIGATION MEASURES

#### 7.1 INTRODUCTION

On the basis of the anticipated impacts of the proposed project activities, several mitigation measures are suggested in this report. It is important that the suggested mitigation measures are fully implemented in order to significantly reduce the adverse impacts of the project during the construction, operational and decommissioning phases of the project. The summary of anticipated adverse environmental impacts and proposed mitigation measures is given in Table 3.

#### 7.2 MITIGATION MEASURES DURING THE PROJECT CYCLE

##### 7.2.1 Occupational Health and Safety

Incidents, accidents and dangerous occurrences to workers will be mitigated through:

- i. Provision of education and awareness on health and safety issues, complete with health and safety procedures.
- ii. Development, documentation and prominent display of an appropriate safety, health and environment (SHE) policy for construction works.
- iii. Enforcement and adherence to safety procedures and preparation of contingency plan for accident response.
- iv. Prudent procurement, storage, handling and use of building and other potentially hazardous materials, especially laboratory chemicals.
- v. Strict adherence to the building plans and building code to avoid collapse of the structures and consequential injury.
- vi. Provision of adequate drinking water and onsite sanitation facilities to avoid waterborne/water-based diseases.
- vii. Employment of only trained and authorized persons to operate construction and laboratory equipments.
- viii. Ensuring that only site workers that have received safety awareness briefing are allowed on site and laboratory preparatory room.
- ix. Use of Personal Protective Equipment (PPE) during the construction and operation phases of the project. These shall include working boots, overalls, laboratory coats, helmets, dust masks, goggles, earmuffs and gloves depending on the individual workers assignment.



### **7.2.2 Noise and Vibrations**

Noise and vibrations shall be mitigated by:

- i. Sensitizing construction vehicle drivers and machinery operators to switch off engines or machinery that are not being used.
- ii. Ensuring that construction machinery is kept in good condition to reduce noise generation.
- iii. Ensuring that workers wear ear muffs and other personal protective gear/equipment if working in noisy sections.
- iv. Ensuring machines are switched off when not in use, and;
- v. Undertaking loud noise and vibration level activities during off-peak hours (between 8.00 am and 5.00 pm).

### **7.2.3 Dust Generation**

Dust generation shall be mitigated through:

- i. Erection of dust screens.
- ii. Sprinkling of water on dry/dusty surfaces regularly.
- iii. Reuse of waste water to sprinkle at the site so as to reduce excessive dust.
- iv. Adherence to personal protective clothing such as dust masks.
- v. Ensuring strict enforcement of onsite speed limit regulations, and
- vi. Planting grass during the operation stage.

### **7.2.4 Exhaust Emission**

To mitigate exhaust emissions it will be mandatory to:

- i. Ensure machines and vehicles are properly and regularly maintained.
- ii. Discourage plant operators and drivers from unnecessary revving and idling.
- iii. Limit construction traffic movement and operations to efficient and necessary activities.
- iv. Sensitize construction drivers and machinery operators to switch off engines when not being used.

### **7.2.5 Excess soils and rocks from excavation**

- i. This will be used in landscaping the disturbed site after construction.

### **7.2.6 Clearance of Vegetation**

- i. Plant a diversity of plants (ornamental and indigenous) around the buildings once the project is complete.
- ii. Establish a woodlot composed of both indigenous and exotic plant varieties.

### 7.2.7 Water Consumption

- i. Install water conserving automatic taps and toilets.
- ii. Practice roof catchment water harvesting.

### 7.2.8 Water Quality

- i. Plant grasses and other plants to eliminate soil erosion/sediment transport from the site.
- ii. Direct waste water to the water treatment septic tanks.

### 7.2.9 Debris and other Solid Wastes

The technology which will be used will have very little liquid and solid wastes. During and after construction, a contracted waste handler will collect solid wastes regularly and dispose off in an approved manner. The proponent will provide waste collection bins.



*Plate 2: Water abstraction from a sand dam constructed elsewhere in Kitui District.*

**Table 4: Summary of Impacts and Mitigation Measures**

Project Phase	Possible Impacts	Mitigation Measures
<b>Construction</b>	<b>Soil erosion</b>	<ul style="list-style-type: none"> <li>• Control earthworks</li> <li>• Install drainage structures properly</li> <li>• Install sediment traps</li> <li>• Ensure management of soil extraction activities</li> <li>• Landscaping of surrounding area</li> </ul>
	<b>Air Pollution</b>	<ul style="list-style-type: none"> <li>• Stockpiles of earth be sprayed with water or covered during dry seasons</li> <li>• Provide dust masks for the personnel in dusty areas</li> <li>• Sensitize construction workers</li> </ul>
	<b>Noise pollution</b>	<ul style="list-style-type: none"> <li>• Sensitize workforce including drivers of construction vehicles</li> <li>• Place signs to indicate construction activities</li> <li>• Maintain/properly service all equipments</li> <li>• Workers in the vicinity of high level noise to wear safety and protective gear</li> <li>•</li> </ul>
	<b>Dust generation</b>	<ul style="list-style-type: none"> <li>• Spray stock piles of earth with water</li> <li>• Avoid pouring dust materials from elevated areas to the ground</li> <li>• Cover all trucks hauling soil, sand, and other loose materials</li> <li>• Provide dust screens where necessary</li> </ul>
	<b>Exhaust emissions</b>	<ul style="list-style-type: none"> <li>• Vehicle idling be minimised</li> <li>• Alternatively fuelled construction equipment be used where feasible</li> <li>• Equipment be properly tuned, serviced and maintained</li> </ul>
	<b>Loss of vegetation and</b>	<ul style="list-style-type: none"> <li>• Spare trees of high cultural value and plant grass, indigenous and exotic trees.</li> </ul>

	<b>or habitat for wildlife</b>	<ul style="list-style-type: none"> <li>Reserve and establish a forest on the Eastern, Northern, and Western parts of the site as an animal reserve/eco-tourist site. Fence and repopulate the area with species which may have migrated during construction</li> </ul>
	<b>Water sources</b>	<ul style="list-style-type: none"> <li>Management of water usage.</li> <li>Avoid unnecessary wastage of water (encourage reuse of wastewater)</li> <li>Avail water storage tanks</li> <li>Harvest rain water from roofs of buildings</li> <li>Construct earth dams or sand dams on the seasonal streams</li> </ul>
	<b>Site cleanliness and sanitary facilities, Road safety</b>	<ul style="list-style-type: none"> <li>Pay special attention to sanitary facilities on site</li> <li>Garbage should be disposed off periodically</li> <li>Install road signs on the main roads</li> <li>Enforce speed limits for construction vehicles</li> </ul>
	<b>Clearance of Vegetation</b>	<ul style="list-style-type: none"> <li>Landscape the site by planting grass, shrubs, flowers, and trees at all disturbed areas</li> <li>Maintain and care for the landscaped gardens and open spaces</li> </ul>
	<b>Loss of grazing land and browse trees and shrubs</b>	<ul style="list-style-type: none"> <li>Restrict traffic on designated paths</li> <li>Restrict vegetation clearance to required site only</li> <li>Establish fodder trees elsewhere on the university land</li> <li>Harvest ponds for livestock from trees located on site</li> <li>Harvest grass regularly on space near buildings and store appropriately.</li> <li>Relocate livestock to another site</li> </ul>

<b>Operation Phase</b>	<b>Increased Water Consumption</b>	<ul style="list-style-type: none"> <li>• Install water storage tanks</li> <li>• Promote water recycling</li> <li>• Install automatic water conserving taps and toilets</li> </ul>
	<b>Increased Energy Consumption</b>	<ul style="list-style-type: none"> <li>• Put off equipment (generators, concrete mixers,, etc) when not in use</li> <li>• Use high energy saving bulbs at night</li> </ul>
	<b>Waste Water</b>	<ul style="list-style-type: none"> <li>• Construct septic tanks</li> </ul>
	<b>Solid wastes</b>	<ul style="list-style-type: none"> <li>• Provide waste bins</li> <li>• Garbage should be disposed off periodically</li> </ul>
	<b>Public health and occupational safety</b>	<ul style="list-style-type: none"> <li>• Ensure proper solid disposal and collection facilities</li> <li>• Ensure dustbin cubicles are protected from animals, rains and are well covered</li> <li>• Provide suitable safety gear for all personnel, especially those working in the laboratory</li> <li>• Ensure proper disposal of waste water</li> </ul>
<b>Decommissioning Phase</b>	<b>Demolition works Excavation works</b>	<ul style="list-style-type: none"> <li>• Solid wastes disposed off appropriately</li> <li>• Landscaping and Rehabilitation of the area by planting appropriate plants</li> </ul>

## CHAPTER EIGHT

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### 8.0 ANALYSIS OF PROJECT ALTERNATIVES

#### 8.1 INTRODUCTION

The Environmental Impact Assessment Study also involved the examination of the alternatives to the proposed project. This is essential since it allowed the project proponent to make an informed decision regarding not only the location of the project, but also technologies that will be applied during the construction phase. This process also ensured that the project activities are located in suitable locations and are cost effective. The following sections provide the analysis of alternatives were considered in the case of the proposed water harvesting and utilization project at the South Eastern University College.

##### 8.1.1 The No Action alternative

In the case of no-action alternative, which in essence means that the proposed project would not take place, there would be various losses and foregone opportunities as presented below:-

- i. There will be financial losses to the project proponent (SEUCO) since the government has invested a lot of capital in terms of professional and statutory fees.
- ii. There will be inadequate water to cater for the increasing number of SEUCO staff leading to possible water borne diseases.
- iii. There will be no research facilities that are necessary for demonstrating to the local community the technologies for rainwater harvesting and use in income generation projects.
- iv. There would loss of opportunity to provide local community with opportunities for income-generation and poverty alleviation.
- v. There would be loss of an opportunity to create jobs for increasing number of school leavers and graduates.
- vi. The statutory bodies (e.g. NEMA) and other professional firms engaged in the project would lose out on the potential revenue.
- vii. The project would be unable to achieve its objectives as proposed to the National Council for Science and Technology.

##### 8.1.2 Alternative Sites

The EIA consultant considered the alternative sites for the various proposed activities of the project given that the university college has about 10,000 acres of land in the Lower Yatta

Division. In case of the selection of the location for the construction of a sand dam, two sites were considered; one located adjacent Kyua and the other one located at Koo. The selection of Koo Sand Dam site was rejected on the basis of the following considerations:

- (i) Although there will be relatively lower costs of rehabilitating Koo Sand Dam compared to Mwitasvano Sand Dam, basic water pumping infrastructure were found be lacking in the Koo Sand Dam.
- (ii) The Koo dam is located about 15Km from point of water use at the main campus of SEUCO. There are also likely to be higher insecurity problems at Koo Sand Dam because of the distance.
- (iii) Koo sand dam will be open to the local community as compared to Mwita Syano sand dam where the University may have some degree of control in the abstraction of water.
- (iv) The cost of pumping water from Koo Sand Dam to the University will be higher compared to Mwita Syano Sand Dam due long distance from the University.

In view of the above considerations, it was decided that the suitable site for the construction of a sand dam is that located at Mwita-Svano which is located about 5 km from SEUCOs main campus. The site has an old sand dam that will be rehabilitated by the project.

In case of the rock catchment, two rock outcrops located within SEUCO were considered. The first rock outcrop is located a short distance (100 m) from SEUCO main campus. However, the rock outcrop is highly fractured with loose soil rendering it unsuitable for surface runoff harvesting. Also, the area of the rock outcrop that is suitable for water harvesting was found to be too small to allow for a significant harvesting of surface runoff during rainy season. In addition, it was noted that recent construction activities in the area have contaminated the site to the extent that the water that will be generated on the rock outcrop will be contaminated and cannot be used for fish farming, among other proposed activities.

The second rock outcrop is located about 1 km from the main campus about 200 m from the SEUCOs main gate. This rock has a large surface area that is suitable for the harvesting of rainy water during rainy season. In addition, since most of the rock outcrop is bare (90%), there will be minimal clearance of the site. This rock was therefore chosen as the best site for the construction of a rock catchment for the harvesting of rain water. The proposed site has a close proximity to the main campus of SEUCO.

For the location of the sites of the fish ponds and agroforestry, several sites were also considered. However, the project proponent settled for the selected sites due to their accessibility and security.

### **8.1.3 Technology and Procedures**

The project team will make use of recommended standard technologies in the design, construction and operation phases of the water harvesting project (see details in Moonesinghe, 2004; Mutiso, 2002; Munyao et al., 2004; Nissen-Petersen, 2000; Nelson, 1985). The team will ensure that the project complies with all stipulated specifications and standards; and conforms to the principles of best practice. The architect and engineering team have utilized computer aided design technologies such as ArchiCAD and AutoCAD to come up with the best designs. The EIA project team is convinced that the technology and procedures adopted for the proposed project are sound and appropriate. Further details on various technologies and approaches to be applied in the project are provided in the project description section.

### **8.1.4 Alternative Design**

The designs that were selected for the construction of fish ponds, woodlots, rock catchment and sand dam proved to be the most feasible. They provide sufficient space requirements and facilities to meet the objectives of the project.

### **8.1.5 Alternative Materials and Inputs**

Choice of materials and inputs selected for the project was based on the stipulated laws, standards and specifications as commonly applied in a project of such nature. The selection of materials also takes into account design specifications and end user considerations.

### **8.1.6 Scale and Extent**

The scale and extent of the various proposed project activities ensures maximum utility of land as well as satisfaction of the project objectives. The chosen scale and extent is the most feasible given the context and operational time frame of the project.



## CHAPTER NINE

### 9.0 ENVIRONMENTAL MANAGEMENT PLAN

This Section presents the Environmental Management Plan (EMP) that will need to be implemented by SEUCO to prevent or reduce significant negative impacts to acceptable levels. Environmental Management Plan (EMP) for development projects provides a logical framework within which identified negative environmental impacts can be mitigated and monitored. In addition, the EMP assigns responsibilities of actions to various actors and provides a timeframe within which mitigation measures and monitoring can be done.

EMP is a vital output of an Environmental Impact Assessment as it provides a checklist for project monitoring and evaluation. The EMP outlined in the sections below has addressed the identified potential negative impacts and mitigation measures of the proposed SEUCO Infrastructural Developments, based on the findings presented in Chapters on Environmental Impacts and Mitigation Measures of the expected Negative Impacts.

#### 9.1 Construction Phase Environmental Management Plan

The necessary objectives, activities, mitigation measures, and allocation of costs and responsibilities pertaining to prevention, minimization and monitoring of significant negative impacts and maximization of positive impacts associated with the construction phase the proposed project are outlined in Table 4 below.



*Plate 3: A typical rock catchment constructed elsewhere in Kitui District.*

**Table 5: Environmental Management Plan**

Possible Impacts	Mitigation Measures	Time Schedule	Cost Estimates (KSH)	Responsibility
General exposure of workers to occupation health and safety risks	<ul style="list-style-type: none"> <li>Development of Health and safety plan.</li> </ul>	Before construction work starts for the contractor; and before operation starts for the proponent	Variable	Contractor and Proponent respectively
Exposure to risky equipments	<ul style="list-style-type: none"> <li>Create health and safety awareness among all workers</li> </ul>	Upon engagement for the contractor and during operation for the proponent	Variable	Contractor
Soil erosion	<ul style="list-style-type: none"> <li>Control earthworks</li> <li>Install drainage structures properly</li> <li>Ensure management of exaction activities</li> <li>Landscaping</li> </ul>	During construction	Variable	Contractor
Air Pollution	<ul style="list-style-type: none"> <li>Stockpiles of earth shall be sprayed with water or covered during dry seasons</li> <li>Provide dust masks for the personnel in dust generation areas</li> <li>Sensitize construction workers</li> </ul>	During construction	Variable	Contractor
Noise pollution	<ul style="list-style-type: none"> <li>Sensitize workforce including drivers of construction vehicles</li> <li>Put up signs to indicate construction activities</li> <li>Maintain all equipments</li> <li>Workers in the vicinity of high level noise to wear safety and protective gear</li> </ul>	During construction	Variable	Contractor
Dust generation	<ul style="list-style-type: none"> <li>Spray stock piles of earth with water</li> </ul>	During construction	Variable	Contractor

	<ul style="list-style-type: none"> <li>• Avoid pouring dust materials from elevated areas to the ground</li> <li>• Cover all trucks hauling soil, sand, and other loose materials</li> <li>• Provide dust screens where necessary</li> </ul>			
Exhaust emissions	<ul style="list-style-type: none"> <li>• Vehicle idling shall be minimised</li> <li>• Alternatively fuelled construction equipment shall be used where feasible</li> <li>• Equipment shall be properly tuned and maintained</li> </ul>	During construction	Variable	Contractor
Water sources	<ul style="list-style-type: none"> <li>• Management of water usage. Avoid unnecessary wastage of water</li> <li>• Install automatic water conserving taps and toilets</li> <li>• Avail water storage tanks</li> <li>• Allow for sand to spill over the sand dam</li> <li>• Harvesting of rain water</li> <li>• Water recycling</li> <li>• Connect to the septic tanks to dispose off the waste water</li> </ul>	During construction and operation	Variable	Contractor during construction and Proponent during operation
Site cleanliness and sanitary facilities, Solid Wastes Road safety	<ul style="list-style-type: none"> <li>• Special attention to sanitary facilities on site</li> <li>• Garbage shall be disposed off periodically</li> <li>• Road signs on main roads</li> <li>• Enforce speed limits for construction vehicles</li> </ul>	During construction and operation	Variable	Contractor during construction and Proponent during operation
Clearance of Vegetation	<ul style="list-style-type: none"> <li>• Landscape the site by planting grass, shrubs, flowers, and trees at all disturbed areas</li> <li>• Maintenance and care for the landscaped gardens and open spaces</li> </ul>	After construction work is over	Variable	Proponent

Fire Outbreak	<ul style="list-style-type: none"> <li>• The proponent shall ensure that the completed facility is fitted with safety facilities including fire fighting equipments and fire exits.</li> <li>• Install smoke detectors</li> <li>• Put fire extinguishers at strategic sites during, operation and decommissioning</li> <li>• Ensure adequate water stocks and operational pressures for fire fighting during operation</li> <li>• Post warning 'NO SMOKING' signs at fire prone areas</li> <li>• Mount safety signs to indicate the emergency exits and restricted areas.</li> </ul>	During operation	Variable	Proponent
Increased Energy Consumption	<ul style="list-style-type: none"> <li>• Put off electric machines when not in use</li> <li>• Use high energy saving bulbs</li> </ul>	During operation	Variable	Proponent
Noncompliance To environmental and other requirements Self auditing of environmental health and safety concerns	<ul style="list-style-type: none"> <li>• Set up self audit teams</li> <li>• Conduct scheduled self audits every 6 months</li> <li>• Conduct annual environmental self audits and submit report to NEMA</li> <li>• Undertake corrective and preventive actions and recommended improvements</li> </ul>	Every six months during operation	Variable	Proponent

## CHAPTER TEN

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### 10.0 DECOMMISSIONING PLAN

It is necessary to outline basic rehabilitation measures that will be required to be undertaken once the water harvesting and utilization structures become old and demolition becomes inevitable. To this end, the Table 5 below outlines the basic principles, which need to be adhered to during the rehabilitation process.

It should however be noted that such principles should not be viewed in isolation but rather as an extension of all actions identified in the operation phase. It should be noted that the site needs to be rehabilitated to a state that is equivalent or better than its original condition. As such, the following measures should be undertaken:

- i. Landscaping of open areas should be done. Such areas should be sealed from pits and other depressions and vegetation introduced.
- ii. All waste materials should be cleared and removed from the site and dispersed appropriately. There should be no such materials as wood, glass, stones, scrap metals, etc.
- iii. General rehabilitation of any excavated areas; quality vegetation should be introduced to add aesthetic value to the site. The planted vegetation should be watered regularly.
- iv. The demolished structures should be cleared and rubbed of any dust particles.
- v. All construction equipments and plants should be removed and the old ones sold to the scrap materials dealers.
- vi. Workers and the public should be pre-warned just before decommissioning and suitably compensated and assisted while seeking opportunities elsewhere.

Other details of decommissioning plan are given in Table 5.

**Table 5: Details of Decommissioning Plan**

<b>Activity/ Issue</b>	<b>Action Required</b>	<b>Responsible Party</b>	<b>Frequency</b>
EIA	Sand Dam, Rock Catchment, and Fish ponds decommissioning EIA	Proponent and NEMA	Once-off
Design	Sand Dam, Rock Catchment, and Fish ponds decommissioning design	Appointed decommissioner	Once-off
Excavation	Excavation of the entire structures	Appointed decommissioner	Once-off
Disposal	Disposal of materials	Appointed decommissioner	Once-off
Clean up	Clean up and rehabilitation of the site	Appointed decommissioner	Once-off
Rehabilitation	Areas under rehabilitation must be demarcated with danger tape to prevent vehicular and human access.  Refill the site and re-vegetate the land	Appointed decommissioner	Once-off
Removal of materials	All materials to be removed in an appropriate manner	Appointed decommissioner	Once-off
Monitoring	Post decommissioning monitoring	Proponent/ NEMA	Once-off

## CHAPTER ELEVEN

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### 11.0 CONCLUSION AND RECOMMENDATIONS

The EIA consultant assigned the responsibility of carrying out an EIA for the proposed project at SEUCO have fulfilled the requirements of the Terms of Reference (TOR). The TOR have been addressed through the literature review, field study, description of baseline environmental conditions, assessment of potential impact assessments, formulation of mitigation measures, and development of environmental management and monitoring plan. The information presented in this study report therefore describes the salient ecological and socio-economic features of the project area and the impacts of the proposed project.

The examination of the proposed project revealed that the implementation and operation phases of the proposed project will have positive impacts to the area and the country at large. The impacts will include employment to local community members; poverty alleviation, optimal use of land, creation of research and extension facilities, among others.

Although the proposed development will improve research at SEUCO and create employment in the area, there are environmental concerns that will be associated with its implementation. The proposed project will cause some negative impacts such as pollution (air and soil) mostly during construction phase, and streamflow modifications, soil erosion, among others. There was a need to identify negative environmental impacts of the project, during the early stages of planning and design. This strategy will ensure protection and conservation of the environment and guarantee a respectful and fair treatment of all people who will be affected by the project.

In order to minimize the negative impacts that will emanate from the implementation of the proposed project, a number of mitigation measures were proposed to be implemented during construction, operation and decommissioning phases of the project. The aim is to ensure that environmental management considerations are incorporated at every stage of the implementation.

Thus the EIA expert recommends that the project be allowed to go ahead provided that the outlined mitigation measures are fully implemented. The most important thing is to make sure the occurrence of adverse impacts that have the potential to degrade the environment are minimised as much as possible. This can be overcome through the implementation of the recommended Environmental Management Plan (EMP).

The project proponent will therefore need to work closely with the environmental experts including NEMA, the local community and the Kitui County Council to enhance the full implementation of recommendations of this EIA project.

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**APPENDICES**

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**APPENDIX 1: Questionnaire:**

**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR PROPOSED WATER HARVESTING AND UTILIZATION PROJECT  
AT THE SOUTH EASTERN UNIVERSITY COLLEGE (SEUCO)  
MAIN CAMPUS, KITUI COUNTY**

**Questionnaire for the Stakeholders and Local Community to be impacted by the Project**

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Our client and the proponent South Eastern University College (SEUCO) is proposing to construct a sand dam, rock catchment, fish ponds and agroforest at the Main Campus, Kitui County. As a member of the local community along/neighboring the Project, we request for your comments on the expected environmental and socio-economic impacts of the proposed project. As a requirement of EMCA 1999 Section 58, on Environmental Impact Assessment, public participation is an important exercise for achieving the fundamental principles of sustainable development.

1). a) What is the distance between your office/house/enterprise/residence and the Project site? (Tick where applicable)

(01). Less than 100m  (02). Between 100-500m  (03). Between 500-1000m  over 1km

b) Do you think you or your enterprise(s) will be affected by the above proposed project?

(01) YES  (02) NO

2). If YES, a) What positive socio-economic and environmental impacts do you anticipate during the Construction stages of the project?

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b) What positive socio-economic and environmental impacts do you anticipate during the operation stages of the project?

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3). a) What negative socio-economic and environmental impacts do you anticipate during the construction stages of the project?

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b) What negative socio-economic and environmental impacts do you anticipate during the operation stages of the project?

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4). a) Make suggestions on the measures the developer needs to put in place during the construction stages of the project

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b) Make suggestions on the measures the developer needs to put in place during the operation stages of the project

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5). What is your general opinion on the Project? .....

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Name: ..... Signature: .....

Full Address:..... Position/Designation.....

Tel.: ..... Date: .....

I.D/Passport No.: .....

**APPENDIX 2: SCREENING CHECKLIST FOR ENVIRONMENTAL IMPACTS**

<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
<b>1. Will initiation, operation or decommissioning of the water harvesting and utilization project involve actions which will cause physical changes in the locality topography, land use, changes in water uses in the locality?</b>		
<b>2. Will initiation or operation of the project use natural resources such as land, water, materials or energy, and other resources which are non-renewable or in short supply?</b>		
<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
<b>3. Will the project involve use, storage, transport, handling or production of substances or materials which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health?</b>		
<b>4. Will the project produce wastes during construction or operation or decommissioning? How will such wastes be disposed?</b>		
<b>5. Will the project release pollutants or any hazardous, toxic or noxious substances?</b>		
<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
<b>6. Will the project affect and cause changes in the composition of the riparian floristic lifeforms, eg. by introducing cosmopolitan invasive species?</b>		
<b>7. Will the project lead to risks of contamination of land or water from releases of pollutants onto the ground or into surface waters or ground waters?</b>		
<b>8. Will there be any risk of accidents during implementation or operation of the project which could affect human health or environment?</b>		
<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
<b>9. Will the project result in socio-economic changes, for example, in increased farming activities, traditional farming and market preferences, and employment?</b>		
<b>10. Are there any other factors which should be considered such as consequential development which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality?</b>		

11. Are there any areas on or around the location which are protected under international or national or local legislation for their ecological, landscape, cultural or other value, which could be affected by the project?		
<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
12. Are there any other areas on or around the location which are important or sensitive for reasons of their ecology e.g. wetlands, watercourses or other water bodies, Mountains, forests or woodlands, which could be affected by the project?		
13. Are there any areas on or around the location which are used by protected, important or sensitive species of fauna or flora e.g. for breeding, nesting, foraging, resting, over wintering, migration, which could be affected by the project?		
14. Are there any inland or underground waters on or around the location which could be affected by the project?		
<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
15. Are there any areas or features of high landscape or scenic value on or around the location which could be affected by the project?		
16. Are there any routes or facilities on or around the location which are used by the public for access to recreation or other facilities, which could be affected by the project?		
17. Are there any transport routes on or around the location which are susceptible to congestion or which cause environmental problems, which could be affected by the project?		
<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
18. Is the project in a location where it is likely to be highly visible to many people?		
19. Are there any areas or features of historic or cultural importance on or around the location which could be affected by the project?		
20. Is the project located in a previously underdeveloped/ undeveloped area where there will be loss of greenfield land?		
<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
21. Are there existing land uses on or around the location e.g. homes, gardens, other private property,		

industry, commerce, recreation, public open space, community facilities, agriculture, forestry, tourism, mining or quarrying which could be affected by the project?		
22. Are there any plans for future land uses on or around the location which could be affected by the project?		
23. Are there any areas on or around the location which are densely populated or built-up, which could be affected by the project?		
<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
24. Are there any areas on or around the location which are occupied by sensitive land uses e.g. hospitals, schools, places of worship, community facilities, which could be affected by the project?		
25. Are there any areas on or around the location which contain important, high quality or scarce resources e.g. ground water, surface waters, forestry, agriculture, fisheries, tourism, minerals, which could be affected by the project?		
26. Are there any areas on or around the location which are already subject to pollution or environmental damage e.g. where existing legal environmental standards are exceeded, which could be affected by the project?		
<b>BRIEF PROJECT DESCRIPTION</b>	<b>YES/NO/? BRIEFLY DESCRIBE</b>	<b>IS THIS LIKELY TO RESULT IN A SIGNIFICANT EFFECT? YES/NO/? – WHY?</b>
27. Is the project location susceptible to earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions e.g. temperature invasions, fogs, severe winds, which could cause the project to present environmental problems?		
28. What impacts are expected to be of particular interest to the general public?		
29. Any other impacts (specify)		

**SUMMARY OF FEATURES OR PROJECT AND OF ITS LOCATION INDICATING THE NEED FOR EIA**

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## **APPENDIX 3: THE SPECIFIC IMPACTS OF THE PROJECT SUB-COMPONENTS**

### **1. CONSTRUCTION/REHABILITATION OF A SAND DAM AT MWITA SYANO RIVER**

#### **A. Positive Impacts**

- (i) Increase water storage and holding capacity of the facility. This will be essential for the University college to meet its multiple water resources targets and, the adjacent local communities (for both domestic use and watering of livestock)
- (ii) Increase baseflow and enhance positive river regime alteration
- (iii) Increase vegetation cover along the banks upstream and this will definitely bring positive alteration of the riverine ecosystem, mostly by increasing biological diversity
- (iv) Hold sand and thereby decrease sand loss through flood erosion
- (v) Improve health status of the local community as a result of increased water availability leading to enhanced sanitation
- (vi) Reduce conflicts for water use
- (vii) Create more employment opportunities in brick making activities along the river course
- (viii) Reduce river erosion during floods

#### **B. Negative impacts**

- (i) Cause retention of sand/sediment load upstream, hence reduce amount and volume of sand for other sand dams downstream and that going to river banks downstream which will in turn cause loss of vegetation cover and decreased biodiversity downstream, as well as increased river erosion downstream
- (ii) Submerge riverine macrophytes and other vegetation which are food for livestock in the local area
- (iii) Cause loss of sugarcane and napier grass and other riverine macrophytes along the river banks
- (iv) Cause loss of rock from surrounding area due harvesting for dam weir construction
- (v) Cause dust (cement & rock) pollution leading to loss of biodiversity during the dam construction phase

#### **C. Mitigation Measures**

- (i) Construct spillway so that excess water and sand get way downstream during floods
- (ii) Lost vegetation to recover through ecological regeneration process after water is made available from constructed sand dam
- (iii) University College to initiate program to restore lost crop plants (sugar & napier grass)
- (iv) University to landscape the areas where rock is excavated
- (v) Cement mixing to be done far away from the river to prevent loss of biological diversity

### **2. CONSTRUCTION OF FISH PONDS AT SEUCO MAIN CAMPUS**

#### **A. Positive Impacts**

- (i) Increase fish production and income generation for both the University and local communities
- (ii) Facilitate extension services to the Kitui County communities which is important for technology transfer
- (iii) An added scientific research facility
- (iv) Create an important and positive microclimate
- (v) Increase dryland aquaculture information
- (vi) Increase employment creation and enhance poverty reduction

- (vii) Increase source of crop fertilizer and reduce the need for conventional fertilizer for the University's green houses and crop farms
- (viii) Increase land use activities (presently idle land)

**B. Negative Impacts**

- (i) Cause destruction of biodiversity through clearing of vegetation
- (ii) Increase erosion from runoff floods
- (iii) Cause dust pollution during pond excavation
- (iv) Increase water abstraction from Mwitasyano River (for filling the constructed ponds)

**C. Mitigation Measures**

- (i) More grass and other vegetation to be replanted
- (ii) PVC tunnels should be fixed after completion of pond construction
- (iii) Head and mouth masks should be provided to personnel doing pond construction; pond construction to be done during wet season
- (iv) Water abstraction from River Mwitasyano should be minimized during dry season and supplement with the alternative Masinga Dam piped water

**3. CONSTRUCTION OF A ROCK CATCHMENT AT SEUCO MAIN CAMPUS**

**A. Positive Impacts**

- (i) Generate permanent source of water for University activities and also for use by the adjacent local communities
- (ii) Through modification put into use the idle natural resource (rock)
- (iii) Increase the following activities due to water availability from the catchment
  - a) aquaculture development
  - b) horticulture development
  - c) water supply to local communities
  - d) amount of water for University livestock and crop farms
- (iv) Cause transformation of arid environment to green ecosystem

**B. Negative Impacts**

- (i) Destroy some vegetation cover, especially at the site where water holding facility of this catchment will be built (earth dam?)
- (ii) Cause air pollution during construction of ring catchment
- (iii) Pose potential accidents during ring construction
- (iv) Cause possible (forceful) transfer of human populations

**C. Mitigation Measures**

- (i) The area impacted will be small and therefore impact should not be significant, and planting of exotic trees will counter this insignificant impact
- (ii) Construction should be done during wet season, if not, then masks for engaged labourers should be provided
- (iii) Occupational health and safety measures should be observed during construction – e.g. provide boots
- (iv) Relocation/resettlement of affected human populations should be sought in advance i.e. prior to commencement of construction.

#### 4. THE AGROFORESTRY ACTIVITIES AT SEUCO MAIN CAMPUS

##### **Positive Impacts**

- i. Restoration of the site that is currently degraded due to deforestation and or devegetation, cultivation and burning.
- ii. Increased aesthetic value of the site will be improved by planting diverse tree species
- iii. The microclimate of the site will be improved
- iv. Control of soil erosion by increasing infiltration of water
- v. Shade will be available for humans and animals
- vi. Biodiversity (plant and animals) will be improved by introduction of new and diverse tree species
- vii. The project will provide fuelwood from thinning and prunings
- viii. the project will contribute towards achieving the university motto “Arid to Green”
- ix. Improved forest cover on the site will lead to carbon sequestration
- x. The project will help in extension and outreach activities to the local community
- xi. The project will serve as a site for research for staff and students
- xii. Improvement of soil fertility since most of the tree species to be planted are able to fix nitrogen.

##### **Negative Impacts**

- i. Land conversion from agriculture to forestry
- ii. Clearance of bushes and herbs will reduce plant biodiversity
- iii. After clearance, the bare ground may be prone to surface run-off hence soil erosion
- iv. The animal diversity on the site will be affected after clearance and introduction of new species.

##### **Mitigation Measures**

- i. The agricultural activities were not productive and reliable compared to the proposed agroforestry
- ii. The area to be affected is small
- iii. The agroforestry will entail introduction of diverse exotic and indigenous tree species
- iv. Most of the native tree species will be left intact during clearance
- v. Construction of terraces and trenches will reduce surface run-off
- vi. Excavated pits during planting will trap and accumulate most of the surface run-off thus reducing soil erosion
- vii. The project will ensure high diversity of tree species. This will translate to high diversity of animal species.

**APPENDIX 4: LIST OF RESPONDENTS WHO WERE INTERVIEWED**

<b>Name</b>	<b>ID. No.</b>	<b>Address</b>	<b>Position</b>
1) Regina Nzuki	20601280		Hostel cleaner
2) Evelyne Nguna	2806753	116, Katangi	Villager
3) Shadrack Mutisya		19100, Machakos	Cook
4) Maingi		170, Kitui	Security
5) Lazarus Muasya	22950132	335, Machakos	Student
6) Bonface kombo	11623641	170, Kitui	Villager
7) Patrick Kamau	27254400	137, Endarasha	Student
8) Edward Pele	1454645	170, Kitui	Security
9) Shedrack Muinde	25284557	13, Machakos	Contractor
10) Vicent Kyalo	22233977	20, Kivunga	Villager
11) Ann Mbithi			Villager
12) Regina Nzilani	20601280		Hostels
13) Mr Muuo		170, Kitui	Plumber
14) James Wachira		62, Gaturakwa	Student
15) Gladys Kavinya	20808676	101, Kitui	Business lady
16) Lazarus Muasya	22950132	335, Machakos	Student
17) Evalyne Ngina	28067053	116, Katangi	Villager
18) Savani Mutia	1863228	170, Kitui	Driver
19) Ruth Mutheu		38, Kiusyani	Villager
20) Festus Mutunga	25925645	15, Katangi	Student
21) Damaris Mwendu	25678810	170, Kitui	Security
22) Mercy Mukami	27899016	170, Kitui	Student
23) Christine Mutei		170, Kitui	Villager
24) Ruth Kisilu		38, Kitui	Villager
25) Koske Bonface		420, Kericho	Tank contractor
26) Ann Mutisya	22718097	33, kitui	Villager
27) Joshua Kimeu		137, Kitui	Villager
28) Urbanus Mutisya		30, Katangi	Student
29) Musengo Wambua		30, Katangi	Businessman
30) Mutuku Mutua	259215399	26, Katangi	Student
31) Patrick Musembi		170, Kitui	Clinical officer
32) Patrick Wambua	8056513	20, Kivunga	Supervisor
33) Mr. Patrick Nzioka	28240027		Contractor
34) Erick Musyimi	27872471	486, Nzukini	Janitor
35) Mbithe Mbithi		30, Ikombe	Villager
36) Salome Muli	4442673		Cleaner
37) Kamau Keanathai	27254400	137, Endarasha	Student