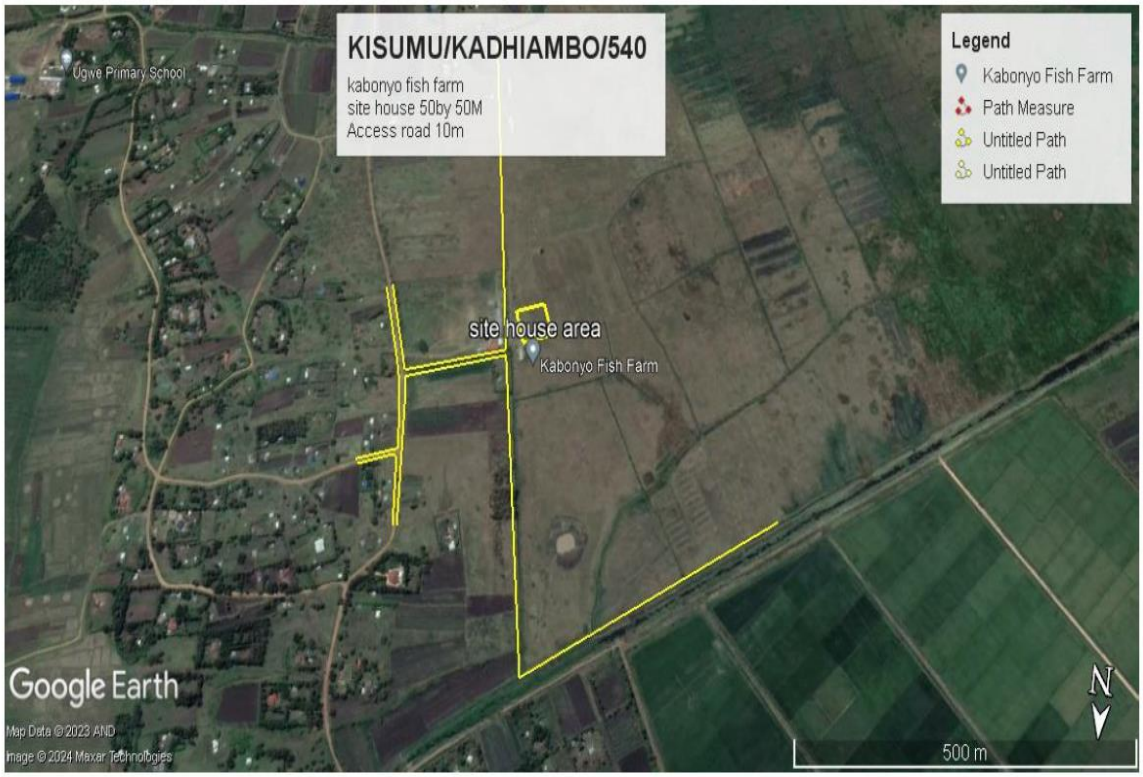
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY REPORT FOR

THE PROPOSED KABONYO FISHERIES AND AQUACULTURE SERVICES AND TRAINING CENTER OF EXCELENCE (KFASTCE) IN KABONYO VILLAGE, KANYAGWAL WARD, NYANDO SUB-COUNTY(KADIBO SUB COUNTY CURRENTLY)

ON LR NO KISUMU/KADHIAMBO/540– IN KISUMU COUNTY



Prepared by:	Prepared for:
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This EIA Report is submitted to the National Environment Management Authority (NEMA) in accordance with the requirements of EMCA, CAP 387 and the Environmental (Impact Assessment and Audit) Regulations, 2003

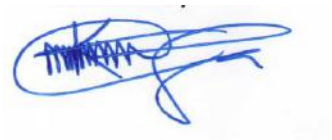
August, 2024

GPS Points: 704922.83 m E 9974632.50 m, Elevation 36M.

CERTIFICATION

Certification by Lead Expert

We hereby certify that this Environmental and Social Impact Assessment for the State Department for Fisheries, Aquaculture and the Blue Economy in Kabonyo On LR No Kisumu/Kadhiambo/540 in the Kabonyo village, Kanyagwal Ward, Nyando Sub County within Kisumu County, has been done under our supervision and that the EIA criteria, methodology and content reporting conform to the requirements of the Environmental Management and Coordination Act, 1999-Revised 2015 and legal notice No. 101 of June 2003 (Environmental Impact Assessment and Audit Regulations).



Signed: _____

Date_____

Kevin Musiega (NEMA 1682)

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Certification by Proponent

We, **State Department of Fisheries and Blue Economy** hereby confirm that the contents of this Environmental Impact Assessment (ESIA) report are true to the best of our knowledge, and we will implement the environmental management plan (EMP) proposed in this report and undertake to implement further mitigation measures as NEMA may direct in relation to the findings of this EIA and future inspections by the Authority.

Signed for and on behalf of**: The State Department of Fisheries and Blue Economy**

Name: **……**Signature**: ……**

Position**: ……...**Date**: ……**

ACRONYMS AND ABBREVIATIONS

BMU	Beach Management Unit
EIA	Environmental Impact Assessment
CPP	Consultation and Public Participation
EA	Environmental Audit
EHS	Environment, Occupational Health and Safety
EIA/EA	Environmental Impact Assessment/Environmental Audit Regulations, 2003
EMCA	Environmental Management and Coordination Act, 1999
EMS	Environmental Management System
ERP	Emergency Response Plans
EMP	Environmental Management Plan
ISO	International Standards Organizations
IAP	Interested and Affected Parties
LR	Land Registration
LVFO	Lake Victoria Fisheries Organization
TOR	Terms of Reference
NEMA	National Environment Management Authority
NEAP	National Environmental Action Plan
NET	National Environmental Tribunal
NETF	National Environmental Trust Fund
NEC	National Environment Council
PSP	Private Sector Participation
KPLC	Kenya Power and Lighting Company
DITTO	Same as Above
SEM	Sustainable Environmental Management
PPE	Personnel Protective Equipment
HDPE	High Density Polyethylene

EXECUTIVE SUMMARY

Introduction

Kenya boasts a vast network of freshwater resources comprising lakes, rivers, dams/reservoirs, streams, and wetlands all suitable for different types of aquaculture development[1]. Dams are standing waters that have been created as a result of erected barriers to stop or restrict the flow of water or underground streams. In terms of size, dams are usually greater than 1.0 ha, but less than 100 ha with a depth of not less than 2 meters[2]. In terms of size, dams are usually greater than 1.0 ha, but less than 100 ha with a depth of not less than 2 meters[3]. Dams contribute to socioeconomic development and environmental sustainability through fisheries and aquaculture, tourism, and other activities that are dependent upon the existence of water masses. Cognizant of the ever-dwindling capture fisheries resources against the rapid growth in demand for fish protein in Kenyan households, deliberate efforts have been made to increase fish production, mainly through land-based fish farms in the past. While such efforts have inherent challenges of competing interests on land and lake water resources, there exist several vast inland water masses whose fish production potential has not been fully utilized.

Aquaculture is a key pillar in the production sector and an important contributor to wealth creation, food security, economic growth and poverty reduction. It directly addresses SDG 1 – no poverty; SDG 2 - zero hunger, SDG3 - good health and well-being; and SDG 13 – climate action. These strategies also support the Africa's agenda 2063 on rural food production, the Kenya's vision 2030 and closer home, the Government's Economic Transformation Agenda in its endeavor to support farmers raise productivity and enable them to not only feed themselves, but also generate a surplus that contributes to national food security and the economy.[4] Aquaculture production bridges the widening gap between fish demand and supply. In 2020, the global aquaculture production, including aquatic plants, was approximately 214 million tonnes, with an estimated value of USD 424 billion. The contribution of Africa aquaculture production to global production was estimated at 2196 million tonnes in 2018 5. In 2018, the aquaculture sector contributed 13.3% (19,945 tonnes) of the country's total fish production output[5]. Dams/ponds have a great role in the development of fish productivity and biodiversity by providing new habitats and niches for their survival and growth in a suitable environment. Dams/ponds have great potential for fisheries and play a significant role in the sustainable growth of inland fisheries, productivity of the dams leads to economic wealth 7. The growing number of mainstream dams in the world's major river basins and their potential impact on riparian communities has received a lot of attention in recent years. However, the role of dams in aquaculture has been largely neglected, and the current national fish production statistics do not include all dams. Also, the role of dams in reducing rural poverty has not been adequately explored. Dam/ponds management harbors the potential to enhance sustainable food production opportunities, local employment for the youth and the Vulnerable Marginalized Groups (VMGs), nutrition, and resilience in the Kenyan aquaculture and fisheries sector. Fish consumption is crucial for human health because it supplies essential elements, which are necessary for the reduction of malnutrition or deficiencies, thus contribute to a healthy nation and vibrant economy. This Framework for Community-based Dam Aquaculture (FCODA) provides a systematic approach to manage community dam resources sustainably, so that the community can benefit from all activities that can be supported by such a resource. Given the immense benefits expected from the proposed project, the

[1] 1KMFRI, 2021, The State of Aquaculture Report in Kenya 2021: Towards Nutrition Sensitive Food Production Systems

[2] DMS, 2020. Dams Management Strategy (DMS). Funded by the International Fund for Agricultural Development (IFAD) and The Government of Kenya through the Aquaculture Business Development Programme (ABDP). Submitted to The Programme Coordinator (PC),

[3] THE PLAN The Bottom Up Economic Transformation Agenda 2022 - 2027

[4] THE PLAN The Bottom Up Economic Transformation Agenda 2022 - 2027

[5] Kenya National Bureau of Statistics, 2021, Economic Survey 2021

Kenyan government acting through State Department for Fisheries, Aquaculture and The Blue Economy; is interested in developing the aquaculture industry in the Kabonyo area and establishing the key project to encourage freshwater fish production by the private sector and smallholder fish growers in the Lake Victoria's region as well as establish a modern aquaculture training center and a laboratory.

The project will address all production steps of the fish culturing process, including: fingerlings production, fish maturing, veterinary services, quality control. The project will implement the aquaculture technology for culturing of Nile tilapia ((Oreochromis niloticus), African catfish (Clarias gariepinus) and Ewaso Nyiro barb (Enteromius mimus) The planned Nile tilapia and African catfish and Ewasso Nyiro Barb fingerling production farm in Kabonyo productivity should be intended to produce the following amounts per crops:

- swim-up fry 5,000,000 pieces or
- 3-4 weeks old, 1" long nursed fry 2,500,000 pieces or
- 10 g big fingerling 1,500,000 pieces or
- 40-50 g big fingerling 950,000 pieces or
- 150 g big fingerling 585,000 pieces or
- market size fish 351,000 pieces.

It is expected to harvest 3 crops annually, coming to a total of 15 million of swim-up fry, 7,5 million of 3-4 weeks old, 1" long nursed fry or 4,5 million of 10 g big fingerling yearly. As per the project feasibility study, the proponent shall construct 20 production ponds within one exterior dyke, all ponds together being 2 hectares in area, to be constructed for Kabonyo Fish Farm for the production ponds.. A width of 50m and length of 10m has been recommended for each of the 20 ponds.

Potential water supply sources to Kabonyo fish farm include the existing borehole together with a pump house, rain water harvesting structures and rain water tank, irrigation canals via Lake Victoria and River Miriu. Out of these supply systems, borehole water could be used for drinking and domestic activities while water water from rive Miriu could serve the ponds. River Miriu has been recommended since it is the most accessible source compared to Lake Victoria which is already being utilized by Ahero Irrigation canal and might require negotiations with initial users to avoid conflict. Harvested ran water may compliment borehole. It should also be noted that river Miriu has a greater potential for continuous water supply to the proposed fish farm.

A stocking density of the broodstock 25/m2 was advisable for the proposed fish farm assuming the rate of mortality would be 10%. Due to cycle duration of the recommended fish species, each rearing pond would be stocked only three in a year; and also there will be 3 production cycles per year. Rearing pond cycles lasts 13 weeks but it is assumed that fingerlings born in the second half of breeding season will stay longer in rearing ponds, waiting for production pond to be ready for stocking. Catfish may be nursed in the same ponds as Tilapia. A product mix of 70% Tilapia and 30% Catfish was recommended mainly because Tilapia is more acceptable to the people than Catfish. Moreover Catfish production per given area is more compared to Tilapia.[6]

The project is expected to have various positive impacts like creation of employment, market for construction materials, improved land value, general economic development, Creation of income for investors, contractors, professional, technicians, artisans and manual workers, Increase in cultural and social interactions, Better land utilization, Increased business shall be realized, Improvement of infrastructural systems within the neighborhood, Transfer of skills to the locals and a contribution to

[6] Ministry of Fisheries Development, 2011, Feasibility Study

vision 2030 flagship project.[7] However, there will also be negative impacts that include: loss of biodiversity, surface water contamination, likely accidents, increased water demand, noise, dust and related occupation and safety health risks. These shall be mitigated through actions such as; replanting trees and grass, minimizing consumption of energy and water, compliance with health and safety laws and proper use of protective gears, among others.

Pursuant to the prevailing legal requirements as envisaged in the EMCA, Act revised in 2015 and to ensure sustainable environmental management, the project proponent commits to fully implement the Environmental and Social Management Plan (ESMP) and also conduct regular monitoring and self-audits.

Project Objectives

Kenya has vast fish resources (in marine, inland capture and aquaculture) the exploitation of which is providing a wide variety of benefits to the country in terms of revenue, employment and general contribution to socio economic growth and development. However, the capture fisheries of the country have generally demonstrated oscillations in total catch with a general tendency of declining catches in recent years. Therefore, the proposed project is expected to boost fish production levels in a sustainable manner, create an aquaculture training center, a modern hatchery and laboratory.

Requirement for EIA

This Environmental Assessment Project Report study was undertaken pursuant to the requirements stipulated by the National Environmental Management Authority (NEMA) under the Environmental Management and Coordination Act (2015) that requires all proposed development projects listed under Schedule II of the EMCA, to undergo an Environmental Impact Assessment Study to determine the potential adverse impacts of a project and thereby devising appropriate mitigation measures. The proposed Kabonyo/Kanyaguel aquaculture training center is among developments that require the critical and strategic assessment as stipulated in the Environmental Management and coordination (amendment) Act, 2015 and Environmental Impact Assessment and audit regulation (2003).

Project Location

The Kabonyo Fish Farm is located in Nyando District (current Nyando Sub-County in Kisumu County), on the eastern shores of Lake Victoria near the West Kano Rice irrigation Paddies. This is a government farm which was proposed for development in 1980 to serve the Western Kenya fish farming and development needs, and also to act as a fish farming training centre for the region. The **GPS location is - 0.2306851 34.8434370**

Relevant Policies and Regulatory Frameworks

Project related national policies and regulatory frameworks reviewed and analysed include: -

- Sessional Paper No. 10 of 2014 on National Environment Policy, 2014;
- Kenya Fisheries Policy 2023,
- National Aquaculture Policy, 2011,
- National Water Policy, 2021,
- National Aquaculture Strategy and Development Plan, 2010,
- Kenya Vision, 2030

Legislative and Regulatory Framework

- Environmental Management and Coordination Act Cap 387 and other subsidiary regulations,

[7] Ministry of Fisheries Development, 2011, Feasibility Study

- Fisheries Management and Development Act No 35, 2016, Revised 2024
- Water Act 2016,
- Physical and Land Planning Act, 2019,
- Public Health Act, Cap 242 Revised edition 2012,
- Occupational Health and Safety Act, 2007,
- Lake Basin Development Authority Act, cap 442

Methodology

A mixed methods approach was used in the study to address all pertinent environmental and safety aspects of the project on the biophysical and socio-economic aspects. The following data collection methods were used:

- **Remote Sensing and GIS Analysis** – Remote sensing was undertaken and ground-truthing done by the consultant at the time of the site visit. Remote sensing was based on available satellite imagery of the project area.
- **Desk Reviews**–A literature review was undertaken based on the findings of the reconnaissance process, which involved reviewing legislation, policies, the County Integrated Development Plan (CIDP), (Technical Design Documents), and previous EIAs studies carried out in the project area to determine the baseline conditions and establish the legal, institutional, and biophysical/socio-economic environmental setting of the project area. The desk-based study also included the development of fieldwork tools and fieldwork schedules as well as the approach to stakeholder engagement.
- **Site Visits** – A site investigation was undertaken during which detailed Environmental and Social Baseline data was gathered and collected.
    - **Stakeholder Engagement**–Various stakeholders were engaged (Proponent, State Department of fisheries and Blue Economy, Kenya Marine and Fisheries Research, County Government representatives, area MCA, representative of the area Member of parliament, Beach Management Units, project management team amongst other opinion leaders), and data was collected through: Focus group discussion and KIIs.
    - Questionnaires administration– people living within a radius of 4 kilometer of the proposed project area; and

Photography – was used to record the salient features and baseline conditions at the proposed project site and surroundings. These included checklists, matrices, and observations.

<u>Impact Assessment Methodology</u>

<u>Overview</u>

A detailed analysis of beneficial and adverse impacts of various components of the project on the physical, biological, and human (*social, cultural, and economic*) environments was conducted based on analysis of project interaction with the baseline conditions. **Appropriate mitigation measures** were then identified **to prevent, minimize, mitigate, or compensate for adverse environmental and social impacts**. Consequently, **enhancement measures for positive impacts were developed to improve project environmental and social performance**. In addition, the roles, and responsibilities in the implementation of the mitigation measures were clearly defined, costs of implementing such measures as well as the costs for environmental and social capacity building for effective implementation of mitigations measures by the respective agencies. The sources of such financial resources will be clearly outlined in the mitigation plan.

Stakeholder Engagement

Stakeholder engagement ensures that the views and concerns of diverse stakeholders (including the community) are incorporated as early as possible into the project development (i.e., at the planning, implementation, and operational phases), to minimize any potential or unexpected opposition to the proposed development. It also helps incorporate the views of key stakeholders into the design process.

The main objective of the stakeholder engagement process is to inform stakeholders and the public about the proposed project and its likely effects, while incorporating their inputs, views, and concerns into project planning.

Summary of the Project Impacts

Positive Impacts

Impact	**Narrative**
Employment, skills transfer and human resource capacity development	Implementation of this project will involve the use of both skilled, semi-skilled and unskilled labour. Different expertise will be required for the project. Provision of employment will contribute to raising the socioeconomic well-being of the people living and working around the project.
Impact on human nutrition on local and national level	The supply of fish will contribute to filling the country's need for proteins, a commodity which is not adequate now.
Diversifying community livelihoods	Beneficiary businessmen and middlemen will have an alternative livelihood thus offering cushion against shortcomings of the current agricultural activities in the area

Negative Impacts

Component/Activity	**Mitigation/Management**
Water quality impacts because of feed wastage.	• Only high-quality aquaculture feeds must be purchased from recognized feed producers; Information on the nutrient makeup, primary ingredients and production techniques, e.g. extrusion, should be available, • Feeding rates must be correlated to water quality sampling to allow detection and alteration of over-feeding. This will be done by the water quality monitoring programme to be implemented; • Correct feed pellet size must be used to ensure low levels of feed wastage.
Chemical spills and incorrect application of chemicals	• The handler must wear appropriate Personal Protective Equipment (PPE); • Dosages, application methods and resultant outcome must be known and recorded in a treatment register; • Expired chemicals must be disposed of at a suitable hazardous waste disposal site; • The advice of a recognized fish pathologists or aquaculturists must be sought where the application of chemicals is uncertain;
Health and Safety of	• Workers should be provided with full personal protective equipment

Component/Activity	**Mitigation/Management**
Workers	(PPE) to beef up their health and safety standards
Endangering predators	• No traps may be used to injure any predators of aquaculture organisms. Traps may only be set if these predators can be caught live (without injury) for translocation to alternative areas. This may only be done under the supervision of recognized organizations or authorities i.e. KWS; • Ensure no poisons is left out for aquaculture predators; • Ensure no animals that prey on the aquaculture species is shot • The main aquaculture predators and their control methods include cover netting for birds (Kingfishers, Fish Eagles, Herons, Storks and others) and fencing
Generation of Waste	• The soil generated will be used to level the area of land around the dam as well as landscaping some areas in the farm. • Waste bins need to be provided for collection of wastes such as cement packaging bags.
Enhanced erosion / changes in topography due excavation.	• Have soil erosion prevention mechanisms in place, such as compaction of soil on the base of the reservoir and its embankment to reduce chances of erosion.

Project Cost

The project cost is approximated at KES 1,300,000,000.00 (Kenya Shillings One Billion, Three Hundred-Million only. The Cost is summarized and **attached in the appendix.**

Conclusion:

The environmental impact assessment process has identified and assessed a range of potential impacts to the bio-physical and socio-economic environments. Where impacts have been identified, mitigation and enhancement measures for those impacts have been outlined in this ESIA and complimentary studies. Most of the identified negative impacts are either of moderate or minor significance, even prior to the application of appropriate mitigation/management measures. With proper implementation of the proposed recommended mitigation/management measures, the significance of the potential or likely residual impacts looks set to be reduced to a minor or negligible level. The project will bring into productive use a high potential resource, the unitized 200 hectares of land. The project will boost fish production and improve incomes in the project area. The experts recommend to the authority that the project be approved.

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1 INTRODUCTION AND BACKGROUND

1.1 Background

Aquaculture is a key pillar in the production sector and an important contributor to wealth creation, food security, economic growth and poverty reduction. It directly addresses SDG 1 – no poverty; SDG 2 - zero hunger, SDG3 - good health and well-being; and SDG 13 – climate action. These strategies also support the Africa's agenda 2063 on rural food production, the Kenya's vision 2030 and closer home, the Government's Economic Transformation Agenda in its endeavor to support farmers raise productivity and enable them to not only feed themselves, but also generate a surplus that contributes to national food security and the economy.[8] Aquaculture production bridges the widening gap between fish demand and supply. In 2020, the global aquaculture production, including aquatic plants, was approximately 214 million tonnes, with an estimated value of USD 424 billion. The contribution of Africa aquaculture production to global production was estimated at 2196 million tonnes in 2018 5. In 2018, the aquaculture sector contributed 13.3% (19,945 tonnes) of the country's total fish production output[9]. Dams/ponds have a great role in the development of fish productivity and biodiversity by providing new habitats and niches for their survival and growth in a suitable environment. Dams/ponds have great potential for fisheries and play a significant role in the sustainable growth of inland fisheries, productivity of the dams leads to economic wealth 7. The growing number of mainstream dams in the world's major river basins and their potential impact on riparian communities has received a lot of attention in recent years. However, the role of dams in aquaculture has been largely neglected, and the current national fish production statistics do not include all dams. Also, the role of dams in reducing rural poverty has not been adequately explored. Dam/ponds management harbors the potential to enhance sustainable food production opportunities, local employment for the youth and the Vulnerable Marginalized Groups (VMGs), nutrition, and resilience in the Kenyan aquaculture and fisheries sector.

Fish consumption is crucial for human health because it supplies essential elements, which are necessary for the reduction of malnutrition or deficiencies, thus contribute to a healthy nation and vibrant economy. The production of farmed fish in Sub-Saharan Africa has expanded more than sixteen-fold, mostly due to the expansion of tilapia pond aquaculture.

The fisheries potential of aquaculture ponds remains underexploited in most developing countries as they are least investigated and often excluded from fisheries management plans. However, these ponds could significantly increase productivity and fisheries yield and contribute to food security. This would in turn bridge the fish consumption deficit per capita of 10 kg/person/year nationally. Development of Aquaculture in dams/ponds bears good prospects for diversification of livelihood streams for the local communities thereby creating employment and generating tax revenue from both direct and indirect aquaculture activities along the fisheries value chain (Multiplier effect). Coupled with efficient and reduced production costs, the costs of creating jobs will be significantly reduced as envisioned in the Government's Economic Transformation.[10]

With the rapid human population growth in Kenya and the increasing demand for food, the fisheries sector has a vital role in meeting the nutritional requirement of the population. However, the capture fisheries sector in Kenya has been in decline because of myriad challenges ranging from overfishing, environmental degradation and limited investment. Aquaculture is poised to play an increasingly important role in bridging the shortfall in fish production. Kenya is ranked fourth in aquaculture

[8] THE PLAN The Bottom Up Economic Transformation Agenda 2022 - 2027

[9] Kenya National Bureau of Statistics, 2021, Economic Survey 2021

[10] Aura, C.M., Mwarabu, R.L., Nyamweya, C.S., Owiti, H., Ongore, C.O., Guya, F., et al (2022) Exploring the potential of small water bodies as an integrative management tool for fisheries production. Fisheries Management and Ecology, 29, 254–268. https://doi.org/10.1111/fme.12529

production in Africa, mainly from Nile tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus). Aquaculture production in Kenya is low despite the high potential in aquatic resources and fish demand. Based on available data, only nearly 20,000 ha of potential aquaculture area (1.4 million ha) are under aquaculture, and 95% of aquaculture is practised in small-scale earthen ponds with low productivity. Thus, there is a need to expand the area under aquaculture to increase fish production from this sector[11].

Aquaculture Ponds/Dams and reservoirs in Kenya have the potential for fish production through culture and restocking initiatives. With this realization, the government and private sector are focusing on aquaculture ponds/dams for aquaculture fisheries as critical drivers of the blue economy and food and nutrition security. However, it is important to promote sustainable fisheries development that does not degrade the environment and safeguards the interests of all stakeholders. Sustainable aquaculture from ponds and dams require a multi-stakeholder approach within a framework that guides investment and operations.

The Kenyan government acting through State Department for Fisheries, Aquaculture and The Blue Economy; is interested in developing the aquaculture industry in the Kabonyo area and establishing the key project to encourage freshwater fish production by the private sector and smallholder fish growers in the Lake Victoria's area. The project will address all production steps of the fish culturing process, including: fingerlings production, fish maturing, veterinary services, quality control. The project will implement the aquaculture technology for culturing of Nile tilapia ((Oreochromis niloticus), African catfish (Clarias gariepinus). It's against this background that, the proponent engaged the experts to conduct a full ESIA study and complimentary technical studies to guide the authority in licensing the project.

1.2 Background and Rational of the EIA

There has been a remarkable and refreshing interest in environmental issues in the recent past with the publication of the 1987 Report of the World Commission on Environment and Development (the Brundtland Report titled, "Our Common Future"). This is particularly so due to the increasing realization that man's unsustainable production and consumption patterns are largely responsible for the unprecedented rate of environmental degradation that is threatening mankind. Some of the negative consequences of mankind's irresponsible interaction with the environment include climate change, desertification, loss of biological diversity, pollution of air, water, and land/soil; diminishing indigenous forest cover and loss of natural habitats; among others. The concern for environment made evident the necessity for the planning authorities to count on sound information about possible environmental consequences of development actions[12].

Environmental Impact Assessment (EIA) can be broadly defined as the systematic identification and evaluation of the potential impacts (effects) of proposed projects, plans, programmes, or legislative actions relative to the physical-chemical, biological, cultural, and socioeconomic components of the total environment. EIA systematically examines both beneficial and adverse consequences of the project and ensures that these effects are considered during project design. EIA is both a decision-making process and a document that provides a systematic, reproducible, and interdisciplinary evaluation of the potential effects of a proposed action and its practical alternative on the physical, biological, cultural, and

[11] Opiyo, M. A., Marijani, E., Muendo, P., Odede, R., Leschen, W., & Charo-Karisa, H. (2018). A review of aquaculture production and health management practices of farmed fish in Kenya. *International Journal of Veterinary Science and Medicine*, *6*(2), 141-148.

[12] Singh et al., 2007. In: Environmental bioremediation technologies, Singh, S. N.; Tripahti, R. D. (Eds) Springer, 223-258

socioeconomic attributes of a particular locality[13]. An EIA aims to predict environmental, social, and economic impacts at an early stage in project planning and design, find ways to reduce adverse impacts, shape project to suit local environment and recommend suitable options to decision makers.

The purpose is to ensure that important environmental resources are recognized early in the planning process and protected through proper planning and decision-making. As a decision-making tool, EIA provides a means for all stakeholders in an action to be heard and to participate in the process of selection of alternatives and mitigation of adverse impacts. EIA gives decision makers more alternative courses of action that may better achieve several instead of just one set of goals.

1.3 Proposed Project Objectives

The proposed project construction of Kabonyo/Kanyaguel aquaculture training center. The proposed project was subjected to a comprehensive project assessment and the report prepared in accordance with the *Environmental Management and Coordination Act (EMCA) Cap 387 of 1999 (amended 2015) and Environmental (Impact Assessment) and Audit regulations of 2019* which categorizes the proposed project as medium risk and can be approved by National Environmental Management Authority (NEMA) though preparation of a comprehensive project report (CPR).

1.4 Terms of Reference for the EIA

- A critical look into project objectives.
- Assessment of the proposed location of the project.
- A concise description of the baseline information, national environmental policy, legislative and regulatory framework, and any other relevant information related to the project.
- Evaluation of the technology, procedures and processes to be used, procedures and processes to be used in the implementation of the project.
- Evaluation of the materials to be used in the construction and implementation of the proposed project and their extended sources.
- Description, evaluation and analysis of the foreseeable potential environmental effects of the proposed project broadly classified into physical, ecological/biological and socio-economic aspects (direct, indirect, cumulative, irreversible, short-term and long-term effects anticipated)
- Evaluation of waste management.
- Evaluation and analysis of alternatives including the proposed project, no project alternative, project site, design and technologies.
- An Environmental Management Plan (EMP), proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment.
- Propose measures to prevent health and safety hazards and to ensure security in the working environment for the employees and the management in case of emergencies. This encompasses prevention and management of foreseeable accidents and during both the construction and operational phases.
- Such other matters as NEMA may require.

1.5 Objectives and Scope of the Project Report.

The ESIA of the proposed developments was conducted to:

- Determine the Impacts the proposed project may have on the biophysical Environment.

[13] Wamukoya, G. M, and Ludeki, J., 2003. Environmental Impact Assessment in Kenya. Understanding Environmental Impact Assessment Process. CREEL Publications No 3. Nairobi.

- Assist decision makers arrive at a decision whether to grant or deny a license for the proposed project.
- Propose cost-effective mitigation measures for the significant negative impacts of the proposed project on the environment.
- Coming up with an Environmental Management Plan (EMP) to address environmental and social impacts of the proposed project to the affected population during construction, operational and decommissioning phases of the project.

1.5.1 Reporting

This report is an output of the whole EIA project report including public consultation. The proponent will have to submit ten copies of this report alongside a soft copy to the National Environment Management authority. All the materials and workmanship used in the execution of the work shall be of the best quality and description. Any material condemned by the planners shall be removed from the site at the contractor's cost. Environmental concerns need to be part of the planning and development process and not an afterthought. It is therefore advisable to avoid land use conflicts with the surrounding area through the implementation of the EMP.

1.5.2 Study Team

Table 1 Study Team

	Name	**Role**
1.	Kevin Musiega	Lead EIA Expert / Team leader
2.	Ruth Muhonja	Aquaculture expert and associate expert
3.	Edward Adino	Chemical Analyst and a lead expert
4.	Juliana Akinyi	Socio-Economist Expert
5.	Wycliff Oloo	GIS expert and a planner
6.	John Ambuya	Lead Expert and Green Business Enthusiast

2 ENVIRONMENTAL LEGISLATIVE AND REGULATORY FRAMWORK

2.1 Brief Overview

Applicable national statutes and regulations on environmental conservation and management suggest that the operation of the project must have a legal duty and social responsibilities to ensure that the operation of the sub-project does not compromise the status of the natural resources in the area, health and safety of the surrounding community. This position enhances the importance of this ESIA study to check on the compliance level of the sub-project. The key national laws that govern the management and conservation of environmental resources in the country have been discussed briefly below.

2.2 Policy Framework

2.2.1 The Constitution of Kenya, 2010

Article 42 of the Constitution states that every person has the right to a clean and healthy environment, which includes the right:

1. To have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69;
2. To have obligations relating to the environment fulfilled under Article 70. Article 69(2) states that every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources. Article 70 (1) states that If a person alleges that a right to a clean and healthy environment recognized and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress in addition to any other legal remedies that are available in respect to the same matter.

2.2.2 The Sessional Paper No. 10 of 2014 on National Environment Policy, 2014

Contained in Sessional Paper No. 10 of 2014, the Environment Policy aims at integrating environmental aspects into national development plans. Its broad objectives include, among others, optimal and sustainable use of natural resources and integrated environmental management. It's also meant to harmonize environmental management and development goals to ensure sustainability. It provides guidelines and strategies for government action regarding environment and development.

2.2.3 Kenya Fisheries Policy 2023

The policy aims to sustainably maximize utilization of the fisheries and aquaculture resources for socio-economic development. The Policy acknowledges the low adoption of aquaculture technologies including; Recirculating Aquaculture Systems, hatcheries, aquaponics, aquaparks, breeding and feed formulation, particularly among the small-scale fish farmers and inadequate platforms for dissemination of research information and weak linkages between aquaculture research and management.

The proposed project is anticipated to contribute towards the policy objectives by promoting and upscaling sustainable aquaculture technologies.

2.2.4 National Aquaculture Policy, 2011

The Policy highlights the fact that the government recognizes the contribution aquaculture makes to food security and income generation to millions, poverty reduction and economic development in the country. It sets out the aquaculture sector's primary goal of ensuring for increased, sustainable and safe fish production and utilization in a sound environment.

The Policy's overall objective is to enhance the aquaculture sub-sector's contribution to wealth creation, increased employment for all especially for youth and women, food security and income generation

through effective private, public and community partnerships. It aims at promoting the development of small scale, medium scale and large-scale aquaculture enterprises; achieving self-sufficiency in fish and ensuring that the domestic market is always adequately supplied; ensuring that gender issues, HIV/AIDs and other lifestyle diseases and cross cutting issues in aquaculture are addressed through establishment of social development programmes in aquaculture in collaboration with relevant stakeholders and partners.

It underlines in its strategies, the need to zone aquaculture resources by identifying, mapping and regulating zones of aquaculture practices in terms of species, systems, climatic and ecological diversities, and promoting the establishment of aquaculture parks (aquaparks) as well. It has strategies in place to promote marketing of aquaculture products through development of physical infrastructure and information systems; encouraging the maintenance of disease-free zones, biosecurity, fish safety and quality assurance management systems; promoting aquaculture produce value addition; and finally, promoting participation of the relevant stakeholders in aquaculture development.

2.2.5 The Kenya National Fisheries Policy, 2020

The policy is designed to improve the management and development of the fisheries sector in Kenya. The policy provides guidance on sustainable management of fisheries resources, enhancement of fish production, and promotion of socio-economic development in the fishing communities. The policy emphasizes the need for effective governance, stakeholder participation, and the use of modern technologies to improve the efficiency and profitability of the sector. It also aims to enhance the value chain of the fisheries sector, improve market access, and promote trade and export opportunities for Kenyan fish products. The policy also recognizes the role of women and youth in the fisheries sector and seeks to empower them through capacity building and access to financing.

The proposed project is aligned to the vision and mission of this policy.

2.2.6 National Water Policy, 2021

The overall goal of the policy is to guide the achievement of sustainable management, development, and use of water resources in the country. The overall objective of the policy is to provide a framework that is dynamic, innovative, and effective for re-engineering the water sector. It was developed to address missing gaps in water resources management. Finally, the policy geared towards and to builds on the successes, challenges, and lessons learnt from the previous policies of 1999, 2012, and the provisions of the Kenya Vision 2030 on water conservation and management.

The proponent will abide by the provisions of the Policy.

2.2.7 National Aquaculture Strategy and Development Plan, 2010 – 2015

Under the banner of filling the fish supply gap for food security, income and healthy living, the National Aquaculture Strategy proposes means and methods of addressing critical issues relating to aquaculture development vis-à-vis input supply (e.g., production and delivery of feeds and seeds as well as the availability of farm credit) and access to extension support and markets within the context of prevailing macro and micro-economic, social and cultural conditions involving a wide range of partners in the public and private sectors. These four critical issues entail the need for institutional reforms such as fostering public and private sector partnerships; strengthening the regulatory framework for aquaculture;) developing an enabling environment for expansion of the sector; and developing requisite human resource.

The strategy is in line with Vision 2030, the long-term national development blueprint that aims to transform the country into an industrialized middle-income economy providing high quality life for its entire citizenry by the year 2030 as well as programmes already put forward by the Ministry of Fisheries Development. This, it attains through its primary objectives which, among others, is to increase fish

production through expanded aquaculture resource base and ensure for the availability of quality and adequate feeds by facilitating feed distribution networks.

2.2.8 Sessional Paper No 4 of 1981 on National Food Policy

The rapid expansion of the population and a shortage of un-exploitable arable land in the main high potential areas are beginning to expose a potentially dangerous imbalance in the relationship between the national supply of and demand for food.

In these circumstances, there is a clear need for a national food policy which will set guidelines for decision-making on all major issues related to food production and distribution. The overall objective of this policy is to maintain a position of broad self-sufficiency in the main foodstuffs to enable the nation to be fed without using scarce foreign exchange on food imports; achieve a calculated degree of security of food supply for each area of the country; ensure that these foodstuffs are distributed in such a manner that every member of the population has a nutritionally adequate diet.

2.2.9 The Kenya Vision 2030

One of the aims of the vision is to raise incomes in agriculture, livestock and fisheries even as industrial production and the service sector expand. This will be done by processing and thereby adding value to her products before they reach the market. She will do so in a manner that enables her producers to compete with the best in other parts of the world. This will be accomplished through an innovative, commercially oriented and modern agriculture, livestock and fisheries sector. These interventions are expected to generate an additional KSh.80-90 billion increase in GDP, mainly through better yields in key crops, increased smallholder specialization in the cash crop sector (2-3crops per plot), utilization of a million hectares of currently uncultivated land, and new cultivation of up to 1.2 million hectares of newly opened lands. Specific strategies will involve the following:

1. transforming key institutions in agriculture and livestock to promote household and private sector agricultural growth; and
2. Increasing productivity of crops and livestock. Kenya will also introduce new land use policies through:
    a. Better utilization of high and medium potential lands by her farmers;
    b. Preparation of new land for cultivation by strategically developing more irrigable areas in arid and semi-arid lands for both crops and livestock; and
    c. By improving market access for small holders through better marketing.

The proposed Aquaculture training center project is in line with the country's aspirations of increasing agricultural productivity.

2.3 Legislative and Regulatory Framework

2.3.1 Environmental Management and Coordination Act (EMCA, Cap 387)

The Environmental Management and Coordination Act (EMCA), Cap 387, is the framework law on environmental management and conservation. The National Environment Management Authority (NEMA) was established as the principal instrument of government charged with the implementation of all policies relating to the environment, and to exercise general supervision and coordination over all matters relating to the environment. In consultation with the lead agencies, NEMA is empowered to develop regulations, prescribe measures and standards, and issue guidelines for the management and conservation of natural resources and the environment. The Act provides for environmental protection through:

- Environmental impact assessment;
- Environmental audit and monitoring; and

- Environmental restoration orders, conservation orders, and easements.

Part VI under Section 58 of the Act directs that any proponent for any project listed on the Second Schedule of the Act should undertake and submit to NEMA an Environment Impact Assessment (unless exempted by NEMA), who in turn issues a license as may be appropriate.

The proponent has contracted Lakers Consultancy Ltd to undertake the EIA and prepare the report for submission to NEMA. The proponent shall obtain an EIA license before the commencement of works.

Table 2: EMCA Subsidiary Legislations Requirements

Relevant Regulations	Narratives
The Environmental (Impact Assessment and Audit) Regulations, 2003	These regulations outline the procedures and guidelines for carrying out environmental impact assessments and audits. The regulation requires that the EIA/EA be conducted by a registered lead or firm of experts in accordance with the terms of reference developed during the scoping exercise. These regulations have been amended by the Environmental (Impact Assessment and Audit) (Amendment) Regulations, 2019. The amendment list projects into Low, Medium, and High Risk. For the low -risk projects, an environmental impact assessment Summary Project Report (SPR) is prepared while for medium-risk projects Comprehensive Project Report (CPR) must be prepared. For the high-risk projects, a full study report (FSR) is prepared and submitted to NEMA. ***The environmental consultant shall undertake an EIA study in accordance with the general environmental impact assessment guidelines provided for in Part III of the regulations***.
EMCA (Water Quality) Regulations, 2006	Described in Legal Notice No. 120 of the Kenya Gazette Supplement No. 68 of September 2006, these regulations apply to drinking water, water used for industrial purposes, agricultural purposes, recreational purposes fisheries and wildlife and any other purposes. The Regulations outline various water quality standards in relation to use and discharge. Regulation 24 of these regulations prohibit discharge or apply any poison, toxic, noxious or obstructing matter, radioactive wastes, or other pollutants or permit any person to dump or discharge any such matter into water meant for fisheries, wildlife, recreational purposes or any other uses unless such discharge, poison, toxic, noxious or obstructing matter, radioactive waste or pollutant complies with the standards set out in the Third Schedule to these Regulations.
EMCA (Air Quality) Regulations, 2014	The objective of the Regulations is to provide for prevention, control, and abatement of air pollution to ensure clean and healthy ambient air. It provides for the establishment of emission standards for various sources such as mobile sources (e.g., motor

Relevant Regulations	Narratives
	vehicles) and stationary sources (e.g., industries) as outlined in the Environmental Management and Coordination Act, 1999. It also covers any other air pollution source as may be determined by the Cabinet Secretary in consultation with the Authority. Emission limits for various areas and facilities have been set. The regulations provide the procedure for designating controlled areas, and the objectives of air quality management plans for these areas. ***Fish processing is prone to foul smell and therefore, the proponent will ensure no foul smell emanates from the proposed activities.***
Environmental Management and Coordination (Wetlands, Riverbanks, Lake Shores and Sea Shore Management) Regulations (2009)	These Regulations make provision for the management, conservation and sustainable use of wetlands and wetland resources and the sustainable utilization and conservation of (resources on) riverbanks, lake shores, and the seashore. ***Permit to be obtained for activities set out in section 42 of EMCA;*** No person shall carry out any of the activities stipulated in that section without a permit issued by the relevant lead agency and an EIA license issued by NEMA; and Projects having a significant impact on a wetland, riverbank, lake shore or the seashore also require an EIA.
The Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulations (2006)	The Act states that no person shall engage in any activity that may have an adverse impact on any ecosystem, lead to the introduction of any exotic species, or lead to unsustainable use of natural resources, without an EIA License. Relevance: the proponent shall abide by the provision of this regulation.

2.3.2 The Fisheries Management and Development Act No. 35 of 2016

The main aim of the Act is to promote conservation, management and development of fisheries and other aquatic resources to enhance the livelihood of the communities dependent on fishing. This is to be achieved through establishment of Kenya Fisheries Service. The act also highlights the functions of the two levels of governance of significance to this sub-project component is the function of National government to develop mariculture related infrastructure and resource mobilization for conservation management of the fisheries development. And the function of the county government is to spearhead the development of mariculture at county level.

The proponent has obtained approvals from the County Government of Kisumu County.

Regulations under Fisheries Management and Development Act

Table 3 Regulations under Fisheries Management and Development Act

Regulation	Narrative
Fisheries (Beach Management Units)	These Regulations, made under section 37 of the Fisheries Management and Development Act, provide for establishing beach management units for a

Regulation	Narrative
Regulations, Legal Notice no. 55 of 2024.	designated fish landing station, in order to: strengthen the management of fish landing stations, fishery resources and the aquatic environment; support the sustainable development of the fisheries sector; improve planning and resource management, good governance, democratic participation and self-reliance; ensure production of safe and quality fish and fishery products; build capacity of the members for the effective co-management of fisheries; reduce or resolve conflicts in the fisheries sector.
Fisheries Management and Development (Aquaculture) Regulations, Legal Notice no. 62 of 2024.	These Regulations, made under provisions of section 74 (1) and (2) of the Fisheries Management and Development Act, apply to any person engaged in any aquaculture activity, the sustainable-use, protection, conservation and management and development of inland, coastal and marine, lake and river basin aquaculture operations, occurring on private, public or community land. The objectives of these Regulations are: promoting the integration of wise-use of aquaculture resources and operations in the local, county, and national management; strengthening participatory conservation of aquaculture resources in Kenya; ensuring the protection of the diversity of aquaculture habitats, flora and fauna; promoting awareness creation, education, research, indigenous knowledge and partnerships with other relevant institutions in the management of aquaculture systems; maintaining an up-to-date inventory and database of aquaculture operations; protecting aquaculture operations on land, in river basins, lakes and coastal zones from pollution including siltation, agricultural and infrastructural developments, overexploitation, alien and invasive species, and other activities likely to degrade such ecosystems.

2.3.3 Occupational Safety and Health Act (OSHA), 2007

The Acts aim to ensure the safety, health, and welfare of persons at work and non-workers as well as cushion workers against loss of income or livelihood due to occupational accidents or diseases. The Act shall be applied for the safety of workers and the public to be ensured during project implementation, operation, and decommissioning phases. The site shall be registered under the Act as a workplace at all phases of the project before commencement of any activities.

2.3.4 Public Health Act, Cap 242 (Revised edition 2012)

The Act addresses matter of sanitation, hygiene, pollution, and general environmental health and safety, which are directly related to cases of pollution and contamination of water sources, be it ground or surface. The management of wastewater or any effluent that shall be generated should be managed in a way that shall not cause any public nuisance.

2.3.5 The Water Act (2016)

The new Water Act (2016) of the Laws of Kenya seeks to make better provision for the conservation, control of pollution; apportionment and use of the water resources in Kenya, and for purposes they are incidental thereto and connected therewith. The Act vests ownership and control of water in government subject to any rights of user. Under this provision the responsibility to regulate access, use and control of water resources is vested in the Water Resources Authority (WRA).

Part 2, Section 18 provides for national monitoring and information systems on water resources. The Water Act protects water bodies and sources from pollution and controls their use by the project. It ensures that the projected required amount of water that can be provided by the existing water system and that the project designer will work to conserve the available water both during construction and operation phases.

2.3.6 The Physical and Land Planning Act, 2019

The Act provides for planning and controlling for physical development in the country in general. The Act read together with the county government Act 2012 will assist in synchronizing the national, local, and project physical planning, controlling for any possible conflicts.

The project shall be approved by the relevant County departments after meeting the requirements of the Act.

2.3.7 Land Titles Act Cap 282

Section 10(1) of the Act states that there shall be appointed and attached to the Land Registration Court, a qualified surveyor who, with such assistants as may be necessary, shall survey land, make a plan or plans thereof and define and mark the boundaries of any areas therein, as when and where directed by the Recorder of Titles, either before, during or after the termination of any question concerning land or any interest connected therewith, and every area so defined and marked shall be further marked with a number of other distinctive symbol to be shown upon the plan or plans for the purposes of complete identification and registration thereof, as is herein-after prescribed.

Section 27 further provides that every certificate of title shall set out a description of the immovable property therein referred to, with figures and references necessary to identify it on the plan or map of the area, in which it is situated, and a correct statement of the right, title or interest of the person to whom it is issued. Sub section 4 requires that there shall be attached to every certificate of ownership, a plan of the land, the subject of the certificate, and the plan shall be signed by the Recorder of Titles and the Director of Surveys or such officer as the Director of Surveys may appoint.

2.3.8 County Governments Act, 2012

The Act empowers county governments to protect the environment and natural resources with a view to establishing a durable and sustainable system of development. In addition, the county governments are responsible for development planning and control including the county spatial plans. The proponent will work in liaison with Kisumu County Government to ensure compliance with land use requirements within the county.

2.3.9 The Agriculture Act, Cap 318

The Agriculture Act Cap 318 of the Laws of Kenya seeks to promote and maintain a stable and sustainable agriculture, to provide for the conservation of the soil and its fertility and to stimulate the development of agricultural land in accordance with the accepted practices of good land management and good husbandry. This Act primarily guides and regulates farming practices especially in relation to the proximity of farming within the riparian section. The Act specifies that no agricultural activity is allowed and or permitted within the riparian area of a wetland, river or Lake. The Agriculture Act is the principal land use statute covering, inter- alia, soil conservation, and agricultural land use in general.

2.3.10 The Penal Code, Cap. 63

Section 191 of the Penal Code makes it an offence for any person or institution that voluntarily corrupts, or foils water for public springs or reservoirs rendering it less fit for its ordinary use. Similarly, section 192

of the same act prohibits making or vitiating the atmosphere in any place to make it noxious to health of persons/institution in dwellings or business premises in the neighborhood or those passing along a public way.

2.3.11 Lake Basin Development Authority (LBDA) Act, Cap 442

The LBDA Act that established the Authority stipulates among others, that the Authority shall coordinate the abstraction and use of natural resources and set up an effective monitoring system; effect the protection and utilization of water and soils; ensure water and soil conservation measures are undertaken; identify and collect all data related to water uses and other resources for efficient forward planning; examine the hydro-geological and ecological effects of development and evaluate how they affect economic activities of the persons dependent on river and lake water development; Consider all aspects of development of the area and their effects on lake inflows and outflows; and monitor the operation and provide technical reports on the operations of any agreement or other arrangements between Kenya and other states on the use of the waters of the Nile and Lake Victoria.

2.3.12 HIV/AIDS Prevention and Control Act, 2006

This is an Act of Parliament providing measures for the prevention, management, and control of HIV and AIDS, to provide for the protection and promotion of public health, and for the appropriate treatment, counseling, support, and care of persons infected or at risk of HIV and AIDS infection, and for connected purposes**.**

Requirements of the Act will ensure that the proponent together with Kisumu County public health department provide VCT services for employees and locals where appropriate and promote public awareness. This will go a long way in ensuring stigmatization of HIV and AIDS is reduced as well as managed during the operation period.

2.4 International Conventions

The United Nations and other international institutions have drafted several international treaties and conventions aimed at enhancing social economic development, environmental sustainability and promoting fundamental human rights. Due to their ecological and economic significance to the Kenyan Nation, the Government of Kenya has found it befitting to be signatory to various global conventions on conservation of wetlands and biodiversity. These conventions include:

- The Convention on Conservation of Wetlands, or the Ramsar Convention (1971);
- The Convention on Conservation of Biological Diversity (Nairobi, 1992);
- The Convention on the Conservation of Migratory Species and Wildlife (Bonn 1979); and
- The Conservation of Important Bird Areas, (IBAs) of these, the following are the most relevant for the project under review.

2.4.1 Convention of Biological Diversity

The convention was made in Nairobi in 1992, of which Kenya is a signatory. The approach of conservation of biodiversity is basically broad. Parties to the convention are required to adopt, national strategies, plans and programmes for the conservation and sustainable use of biological diversity into their relevant sectoral and cross-sectoral plans, programmes and policies. The Flood Control and Afforestation project should ensure the rare and endangered species in the project area and its environs are conserved.

2.4.2 The Protocol on Environment and Natural Resources (EAC, 2010)

Specific to the management of floods and flood-related disasters such as sedimentation, the protocol in article 112 (c) of the management of the environment take necessary disaster preparedness, management, protection and mitigation measures especially for the control of natural and manmade disasters. These

include oil spills, biohazards, floods, earthquakes, marine accidents, and drought and bush fires. For purposes of paragraph 1 of this Article, the Partner States undertake to: (e) adopt environmentally sound management techniques for the control of land degradation, such as soil erosion, desertification and forest encroachment. These directly relate to sound management of land practices that reduce incidents of soil erosion that leads to flooding and sedimentation.

2.4.3 Convention on the Conservation of Migratory Species

The convention on migratory species (CMS) was adopted to conserve migratory species of wild animals given that migratory species are seen as international resources. Such species may be terrestrial or marine. The conventions agreement on the conservation of African-Eurasian Migratory water birds is specific on the need to protect the feeding, breeding and wintering habitats, the main ones being wetlands and open water bodies. Kenya observes the convention.

2.4.4 Important Bird Areas (IBAs)

The Lake Victoria region has five out of the sixty sites that have been identified as an IBA of Kenya. Nature Kenya, Birdlife international and Global Environment Facility (GEF) have identified the sites. The Important Bird Areas Program is a worldwide initiative working for the conservation of biological diversity and sustainability of human use of natural resources. The project is expected to recognize these sites and protect them where they occur in the project area or its environs.

2.4.5 ILO Convention No. 184 on Safety & Health in Agriculture

This is the first time that waged agricultural workers – whether permanent, temporary or seasonal – are guaranteed in international law the same rights and levels of protection as other categories of workers, even though the agricultural industry is one of the three most dangerous in the world and has the largest workforce of any.

2.5 Institutional Framework

2.5.1 NEMA

NEMA is the National body charged with coordinating matters of implementation of policy issues relating to the environment. This body was established under the EMCA, Cap 387. Other departments that deal with environmental issues in Nyanza Province include the Kenya Forests Service (KFS), Kenya Wildlife Services (KWS), County Government of Kisumu, among others.

2.5.2 National Environmental Council (NEC)

The NEC was set up under the EMCA 1999 and is responsible for policy formulation and directions; sets national goals and objectives and determines policies and priorities for the protection of the environment; promotes cooperation among public departments, local authorities, private sector, NGOs and such other organizations engaged in environmental protection programmes among other functions assigned under EMCA 1999. This Council is appointed by the Minister.

2.5.3 National Environment Complaints Committee (NECC)

The NECC[14] investigates allegations and complaints of suspected cases of environmental degradation. The Committee also prepares and submits to the NEC periodic reports of its activities.

Members of the public can register or appeal to this committee regarding any aspects of the project that violates the law and its licenses.

[14] https://www.necc.go.ke

2.5.4 National Environmental Action Plan (NEAP) Committee

The NEAP is responsible for the development of a 5-year Environmental Action Plan among other things.

2.5.5 Standards and Enforcement Review Committee (SERC)

The SERC is a technical committee that is responsible for the environmental standards formulation, methods of analysis, inspection, monitoring and technical advice on necessary mitigation measures.

2.5.6 National Environmental Tribunal (NET)

NET[15] reviews administrative decisions made by NEMA relating to issuance, revocation or denial of license and conditions of license. It also provides legal opinion to NEMA on complex matters where the Authority seeks such advice. In addition, the Tribunal has powers to change or give an order and direction regarding environmental issues in dispute.

2.5.7 The East African Community (EAC)

The EAC is a regional forum that brings together Kenya, Tanzania, Uganda, Rwanda, Burundi, Democratic Republic of Congo (DRC), Somalia and South Sudan into an economic block. There are also plans to turn EAC into a regional political body. The EAC together with the donors are in the forefront of promoting sustainable development of the Lake Victoria Basin.

2.5.8 Lake Victoria Fisheries Organization (LVFO)

This is one of the projects of the EAC that is specifically responsible for promoting proper management and optimum utilization of the fishery resources of the Lake Victoria. Its establishment was achieved through the funding of the LVEMP courtesy of the three East African countries, the FAO, the European Union (EU), World Bank/GEF. It has the responsibility of enhancing partnership and collaboration with institutions and stakeholders for the betterment of Lake Victoria's ecosystem for sustainable fisheries resource utilization and socioeconomic development of the riparian communities.

2.5.9 Lake Victoria Environment Management Project (LVEMP)

This is a Global Environmental Facility (GEF) funded project whose second phase is currently underway. The first phase was completed in 2004 with a total funding to the tune of USD 75,636,000, of which the three East African states contributed 10%. Specific objectives of LVEMP Phase I were to maximize the sustainable benefits to the riparian communities from using resources within the basin to generate food, employment and income; to supply safe water and sustain a disease free environment; to conserve biodiversity and genetic resources for the benefit of the riparian communities; to harmonize national and regional management programs in order to achieve to the maximum extent possible the reversal of environmental degradation; and to promote regional co-operation.

2.5.10 The Lake Victoria Fisheries Research Project (LVFRP)

This was established in 1997 courtesy of the funding from the European Union. The principal aim of the Project was to assist the LVFO in establishing a framework for the rational management of Lake Victoria's fisheries. The specific objectives of the project were to carry out stock assessment, to train fisheries researchers, to rehabilitate and construct research vessels, to equip the research institutes and to investigate socio-economic issues related to the Lake and its fisheries.

2.5.11 The Nile Basin Initiative (NBI)

This initiative, funded by donors (e.g., World Bank, Norway and Sweden) comprises ten countries which make up the Nile River Basin, namely, Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia,

[15] https://www.judiciary.go.ke/the-national-environment-tribunal/

Kenya, Rwanda, Sudan, Tanzania and Uganda. Its aim is to promote the exploitation of the development potential of the Nile River in a way that focuses on gaining mutual benefits from developments rather than on defending rights.

3 PROJECT DESCRIPTION, DESIGN AND IMPLEMENTATION

Kenyan government acting through State Department for Fisheries, Aquaculture and The Blue Economy; is interested in developing the project in Kabonyo/Kanyaguel area to encourage freshwater fish production by the private sector and smallholder fish growers in the Lake Victoria's region as well as establish a modern aquaculture training center and a laboratory.

3.1 Construction Inputs and Activities

Table 4 Construction Inputs and Activities

The project inputs	• **Construction raw materials –** The construction of the aquaculture training center shall consist of local construction materials. All these will be to the approved standards and shall be obtained from licensed dealers and especially those that have complied with the environmental management guidelines and policies; and • **Labour** – Construction labor force of both skilled and non-skilled will be prioritized locally.
Construction activities	Construction activities will entail: • water inlet and outlet channel with flood gates; • pump station; • storage ponds; • broodfish and growing ponds; • Hatchery • Laboratory and Training • Storage facilities • Staff facilities

3.2 Project Description

The project will feature all production steps of the fish culturing process, including: fingerlings production, fish maturing, veterinary services, quality control. The project will implement the aquaculture technology for culturing of Nile tilapia ((Oreochromis niloticus), African catfish (Clarias gariepinus) and Ewaso Nyiro barb (Enteromius mimus) . The planned Nile tilapia and African catfish and Ewasso Nyiro Barb fingerling production farm in Kabonyo productivity should be intended to produce the following amounts per crops:

- swim-up fry 5,000,000 pieces or
- 3-4 weeks old, 1" long nursed fry 2,500,000 pieces or
- 10 g big fingerling 1,500,000 pieces or
- 40-50 g big fingerling 950,000 pieces or
- 150 g big fingerling 585,000 pieces or
- market size fish 351,000 pieces.

It is expected to harvest 3 crops annually, coming to a total of 15 million of swim-up fry, 7,5 million of 3-4 weeks old, 1" long nursed fry or 4,5 million of 10 g big fingerling yearly. As per the project feasibility study, the proponent shall construct 20 production ponds within one exterior dyke, each pond being 0.05 hectares in area, to be constructed for Kabonyo Fish Farm for the production ponds.

Potential water supply sources to Kabonyo fish farm include the existing borehole together with a pump house, rain water harvesting structures and rain water tank, irrigation canals via Lake Victoria and River Miriu. Out of these supply systems, borehole water could be used for drinking and domestic activities while water water from rive Miriu could serve the ponds. River Miriu has been recommended since it is the most accessible source compared to Lake Victoria which is already being utilized by Ahero Irrigation canal and might require negotiations with initial users to avoid conflict. Harvested ran water may compliment borehole. It should also be noted that river Miriu has a greater potential for continuous water supply to the proposed fish farm.

A stocking density of 25/m2 was advisable for the proposed fish farm assuming the rate of mortality would be 10%. Due to cycle duration of the recommended fish species, each rearing pond would be stocked only twice in a year; and also there will be 2 production cycles per year. Rearing pond cycles lasts 13 weeks but it is assumed that fingerlings born in the second half of breeding season will stay longer in rearing ponds, waiting for production pond to be ready for stocking. Catfish may be nursed in the same ponds as Tilapia. A product mix of 70% Tilapia and 30% Catfish was recommended mainly because Tilapia is more acceptable to the people than Catfish. Moreover Catfish production per given area is more compared to Tilapia.[16]

3.2.1 Pond Design

The planned fish pond system for culturing Nile tilapia, catfish, and Ewasso Nyiro barb species is located on Kabonyo Farm near Kisumu, Kenya. The facility utilizes 23.5 hectares of land with a water canal on the southern boundary, which supplies water to the ponds and facilitates drainage. The pond system includes 20 ponds, each with a water surface area of 500 m^2. A water reservoir will be constructed to store double the volume of water required to fill the ponds, using a gravity-fed system with a floating pump station for water supply.

The site's elevation ranges between 1,137.0 to 1,141.5 meters above sea level. Approximately 4.5 hectares will undergo landscaping to create a level of 1,140.0 meters for the pond construction. Earth from the landscaping process will be used to build the pond dykes, with all soil transported to the location. The southern boundary canal has a 1.0-meter-high landfill that protects the area from biannual floods during the rainy season, and the water level is generally 0.5 meters below the ground for 80% of the year. In the absence of a detailed survey, a water level of 1,139.0 meters is assumed for planning.

The technical specifications for the pond system are as follows:

Pond layout: 20 ponds in two lines, each with an oval shape and a water surface area of 0.05 hectares.

Dyke construction: The dykes will have a top width of 3.0 meters and a slope ratio of 1:1, with a planned height differential to accommodate a water level of 1,141.0 meters and a total pond water volume of 8,820 m^3.

Water reservoir: Measuring 150 x 120 meters with a depth of 1.0 meter, the reservoir is designed to store 18,000 m^3 of water, with the same dyke parameters as the ponds. Geotextile will be used for slope protection, and the water inlet point will be reinforced with concrete to prevent soil erosion.

For water supply, a floating pump station (such as the NEPTUN Flotation system) will be installed in the canal, delivering up to 500 liters per second via a pressure pipe. Water from the reservoir will be directed

[16] Ministry of Fisheries Development, 2011, Feasibility Study

into the ponds using a concrete inlet channel placed centrally between the two rows of ponds. Each pond will have its own concrete water gate for filling and draining, with fish grids installed.

3.2.2 A drainage system will be in place to manage water seeping through the dykes, with a concrete-covered drainage channel at the foot of the dyke. An additional water gate will be installed at the canal's outlet to prevent backflow during floods.Water Supply System

The system will be needed to furnish portable water to the staff and unchlorinated water to the hatchery shed. The existing four possible sources of water supply for Kabonyo fish Farm include:

1. River Miriu

2. Borehole

3. Rainwater harvesting

4. Lake Victoria through Ahero Irrigation Canal

Rainwater harvesting needs more catchments and is still considered feasible as an additional source of water. Lake Victoria as a source of water supply, through Ahero irrigation scheme, could have distinct advantage because of the efficiency of using mostly existing facilities, though major potential negative aspect of this alternative would be possible conflict with water usage already dedicated to irrigation plans. Miriu channel is likely to be the most acceptable source, in spite of some apparent additional costs and problems associated with using the channel in dual capacities for supply and drainage. The Miriu channel and borehole have already been explored at Kabonyo Fish Farm due to their continuity in supply. Figure 3.3 shows the existing water supply structures on site

Fig 3.3 a. Borehole housed at Kabonyo

Fig 3.3 b. Water dam from R. Miriu

Fig 3.3c. Steel tank

Figure 3.3 Existing Water Supply Structures at Kabonyo Fish Farm

3.2.3 Additional Facilities

1. Water reservoir

2. Two broodfish tanks 2x2x0.8m

3.Twenty Zuger hatching jars

4. Twenty hatching tray for Tilipia, 5 larva balloon and 5 riffles

5. Two 0.5hp pumps

6. One blower for aerating the tanks

7. One hatchery building with head tank

8. Buildings (Offices and Laboratory, Stores, , Dormitory Training room, Staff apartments)

3.2.4 Specific Farm Design Details

All the ponds will be regular shaped, flat bottomed and slight slope along their width. Based on the standard capacity of 25 *fish/m²* the

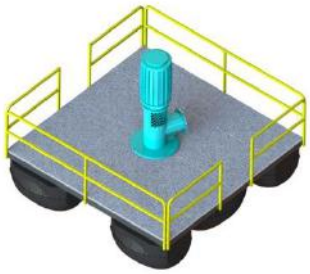
Design Calculation of Excavations

No	Title and specification	Unit	Quantity
1.	Landscaping, carrying out large-scale earthwork before the construction of fish ponds, pushing earth max. At a distance of 200.0 m Appropriation: 2,0 ha x 0,5 m = 10.000 m^3	m^3	**10.000,0**
2.	Making plowing on an orderly ground level for the purpose of foundation before onstruction of dykes under storage pond dyke 2 x (120+150) x 11,0 = 5.940,0 m^2 under fish ponds dykes 20 x 122 x 10,0 = 24.400 m^2 total: 30.340 m^2	m^2	**30.340,0**
3.	Delivery of soil required for dykes construction to the construction site from ?????? km soil requirement of storage pond 540,0 x 10,9 = 5.886 soil requirement of fish ponds 122,0 x 10,9 = 1.330 20% calculation with soil compression difference: total: 7.216 x 1,2 = 8.658 m^3	m^3	**8.660,0**
4.	Dyke construction between reservoirs and fish ponds with a top width of 3.0 m, and 1:2 slope angle without transportation and compression similar with point number 3	m^3	**8.660,0**
5.	Compression by layers to Tr 85% on small surface with compression machine similar with point number 3	m^3	**8.660,0**
6.	For protection of storage and production ponds inside laying 100 g/m^2 UV resistant geotextile 122,0 m x 4,0 x 20 pieces = 9.760 m^2	m^2	**9.760,0**
7.	Construction of harvesting sump by excavation (small-scale earthwork with excavation, without	m^3	**150,0**

No	Title and specification	Unit	Quantity
	transport) 10 db x 20,0 x 5,0 x 0,3 / 2 = 150,0 m^3		
8.	Construction of bottom and slope of inlet canal with excavation, slope arrangement (2 x 2,2 + 1,0) x 170,0 = 918,0 m^2	m^2	**920**
9.	Concrete covering of slope with minimum. C 8/10 – XN(H) – 32 – F1 quality concrete. 170,0 x / (2x2,2x0,1)+(1x0,3)+(2x0,2x0,2)/= 170,0 x /0,44+0,3+0,08/=170,0 x 0,82 = 140,0 m^3	m^3	**140**
10.	Construction of external and internal sample decking with a flat surface for water gates 20 x /(1,35x1,5)x4 + 1,0x1,5 + 0,6x1,5/ + 20 x /(1,35x1,7)x4 + 1,0x1,7 + 0,6x1,7/ = 20 x /8,1+1,5+0,9/+/9,2+1,7+1/ = 20 x /10,5+11,9/ = 448,0 m^2	m^2	**450**
11.	Construction of open drainage channel, with dry excavation between 1.1 and 6.0 m2 with 1.0 m bottom width and 1:2 slope angle (165,0 + 120,0 + 365,0) x 1,0 = 650,0 x 1,0 = 650,0 m^3	m^3	**650,0**
12.	Construction a sandy gravelly bed under slope covering and water gates in water inlet channel 0,25 x 162,0 x 5,0 = 202,5 m^3 in water outlet channel at the point of connection with water gates 0,15 x 20 x 2x(1,0 + 0,5x2) = 0,15 x 20 x 2x2 = 12,0 m^3 Under water gates 10db x 0,20 x 2x(8,4+6,35) x 0,6 = 10 x 0,2 x 29,5 x 0,6 = 35,4 total: 122 + 12 + 35,4 = 169,4 m^3	m^3	**170,0**
13.	To prevent leaching in drainage and inlet channels (receiving) in watercourse, construction a concrete covering on the bottom and slope with minimum C 8/10- XN(H) – 32 – F1 quality concrete in outlet channel	m^3	**21,0**

No	Title and specification	Unit	Quantity
	20 x 0,2 x 2x(1,0 + 0,5x2) = 20 x 0,2 x 4 = 16,0 m^3 in watershed(appropriation) 10,0 x 0,2 = 5,0 m^3 total: 21,0 m^3		
14.	Preparation of precast concrete, up to 10 cm thickness from minimum C8/10 - XN(H) 16 F1 quality reinforced concrete under water gates water gate of storage pond (1,6 x 1,0) x 0,2 = 0,32 m^3 outlet water gate (2,0 x 1,0) x 0,2 = 0,4 m^3 Total:0,72 m^3	m^3	**1,0**
15.	Concreting of ponds filling and drainaging water gates minimum C 16/20 – XN(H) – 16 – F1 quality of concrete 1,35x1,0x0,2 + 1,0x0,2x1,7 + 2x1,35x0,2x1,7/ + 1,35x1,0x0,2 +1,5x1,0x0,2 + 2x1,35x0,2x1,5 = 1,53 + 1,38 = 2,91 m^3 Together: 20 pieces x 2,91 = 58,2 m^3	m^3	**60**
16.	Water inlet and outlet water gates with pipe space with 0.40 m size from PVC or PE material 2x10 pieces x (8,45 + 6,35) m = 296,0 m	m	**300,0**
17/1	Construction of inlet and outlet water gates according to detailed plan with NÁ60 pipe culvert, shuttering, concreting with minimum C 16/20 – XN(H) – 16 – F1 quality concrete Outlet water gate of storage pond: siding: 0,8x1,5x4 + 1,0x1,5 + 0,6x1,5 = 4,8+1,5+0,9 = 7,2m2 sandy gravelly bedding 6,1 x 1,0 x 0,2 = 1,22 m3 concreting: 1,0x1,6x0,2 + 2x(1,5x0,8x0,2)+ 0,6x1,5x0,2 = 0,32+0,48+0,18 = 0,98 m3	stock	**1**

No	Title and specification	Unit	Quantity
	NÁ60 concrete pipe culvert 4,50 m 1 piece 0,6x0,8 water closing gate  insoles of temporary closing 0,2x0,6x1,5x2db = 0,36 m3		
17/2	Construction of inlet and outlet water gates according to detailed plan with NÁ60 pipe culvert, on sandy and gravelly bedding with approaching concrete, siding, concreting /from C 16/20 – XN(H) – 16 – F1 quality. concretel/ with making temporary insole outlet water gate of leaking channel: siding 0,8x2,0x4 + 1,0x2,0 + 0,6x2,0 = 6,4+2,0+1,2 = 9,6m2 sandy, gravelly bedding: 9,5 x 1,0 x 0,2 = 1,9 m3 concreting: 1,0x2,0x0,2 + 2x(2,0x0,8x0,2)+ 0,6x2,0x0,2 = 0,4+0,64+0,24 = 1,28 m3 NÁ60 concrete pipe culvert 7,50 m 1 piece 0,6x0,8 water closing gate  insoles of temporary closing: 0,2x0,6x1,5x2db = 0,36 m3	stock	**1**
18.	Floating pump station (water collection point) with unique construction (NEPTUN Flotation floating pump station as an example)	piece	**1**

No	Title and specification	Unit	Quantity
	 1 piece		
19.	Electric pump with 500 l/min capacity with 500 m NÁ 150 PE pushing pipe (Flygth N 3400 only an example) 1 piece	piece	**1**

4 BASELINE INFORMATION

4.1 Position and Size

Kisumu County lies between longitudes 33020'E and 350 20'E and latitude 00 20' South and 00 50' South. The County is bordered by Homa Bay County to the South, Nandi County to the North East, Kericho County to the East, Vihiga County to the North West, Siaya County to the West and surrounded by the second largest freshwater lake in the World; Lake Victoria. Kisumu County covers approximately 567 km2 on water and 2086km2 land area, representing 0.36% of the total land area of Kenya's 580,367km2.

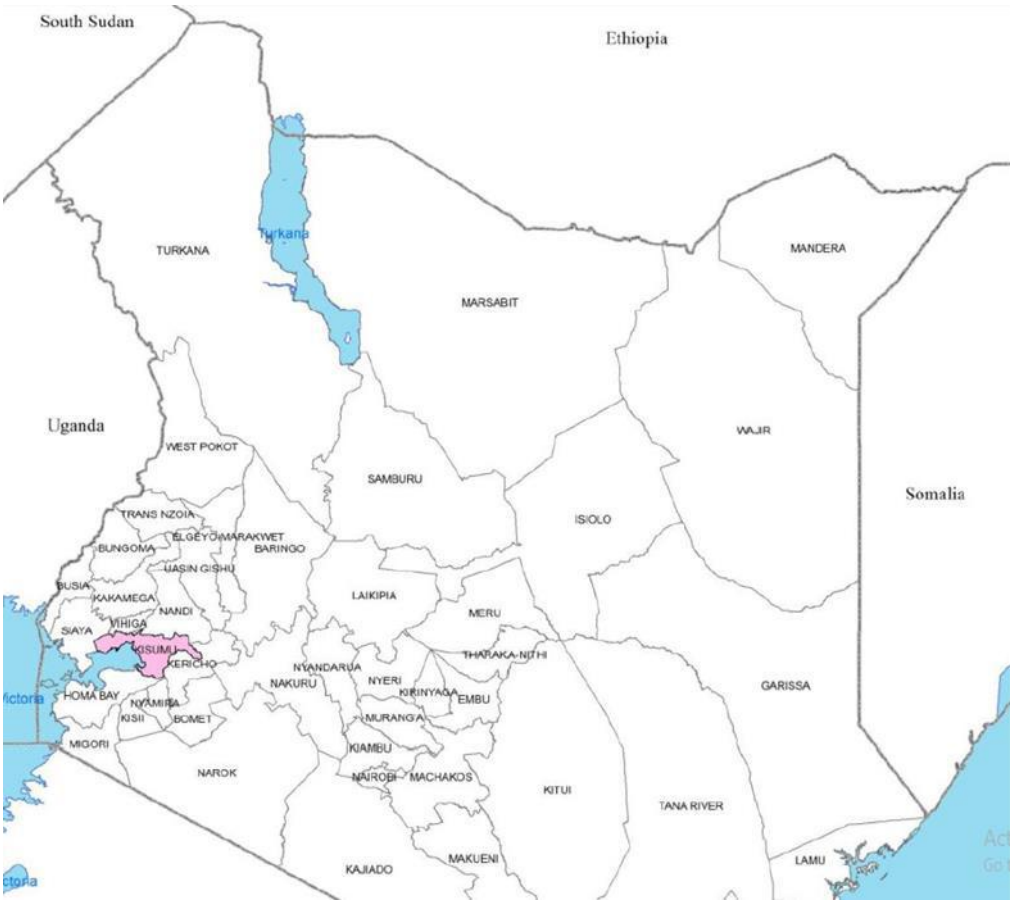


Figure 3.5: Position of Kisumu County in Kenya

4.1.1 County Overview

Kisumu County is one of the 47 counties created through the devolved system of governance by the Constitution of Kenya 2010 delineated as County number 42. The population is estimated at 1,224,531 persons as at the start of the plan period 2018. The county has a diverse background comprising of urban and rural set-ups as well as rich ethnic, racial and cultural diversity with the Luo being the dominant community. The county's strategic position serves as a gateway for Kenya into the rest of the African Great Lakes region. It is located on the shores of Lake Victoria and serves as the main commercial and transport hub for the Western part of Kenya and the East African region. The county hosts the third largest city in Kenya, Kisumu city, which serves as the County's headquarters. There are five major urban centers; Ahero, Katito, Muhoroni, Chemilil, and Maseno. Other emerging fast-growing centers include Awasi, Pap-Onditi, Holo, Kombewa and Sondu. The project site is in Kabonyo/Kanyaguel Ward, Nyando Sub-County, Kisumu County.

4.2 Administrative and Political Units

Table 5 Area of the Sub-County by Division and Respective Population (Source: KNBS)

Sub-County Name	Sub-County (projected 2018) Population	Sub County area in sq. Km^2 (approx)	Ward Name	Ward Population (projected 2018)	Ward Area in sq. Km^2 (approx)	Ward description (sub-locations)
Kisumu East	189,730	135.90	Kajulu	51,660	38.30	Got Nyabondo, Kadero, Okok, Konya Wathorego
			Kolwa East	26,904	57.80	Buoye, Chiga & Mayenya
			Manyatta "B"	35,326	2.50	Manyatta "B"
			Nyalenda "A"	35,727	3.20	Nyalenda "A"
			Kolwa Central	40,113	34.10	Nyalunya, Kasule
Kisumu West	165,872	212.90	South West Kisumu	27,963	50.40	Ojolla, Osiri Kanyawegi
			Central Kisumu	48,189	30.30	Kogony, Korando "A" Korando "B"
			North Kisumu	31,457	40.60	Dago. Mkendwa, Bar "A" Bar "B" & Nyahera
			West Kisumu	27,990	56.40	Newa, Upper Kadongo, Lower Kadongo, south Kapuonja & north Kapuonja
			North West Kisumu	30,275	35.20	West Karateng' East Karateng', Sunga & Marera
Kisumu Central	213,450	32.70	Railways	44,138	15.10	Kanyakwar, Bandari and Nyawita
			Migosi	25,057	1.90	Migosi
			Shaurimoyo-Kaloleni	18,712	2.10	Kaloleni
			Market Milimani	23,889	6.50	Northern & Southern
			Kondele	60,669	2.40	Manyatta "A"
			Nyalenda "B"	40,986	4.70	Nyalenda "B"
Seme	124,872	266.70	West Seme	35,963	77.10	West Reru, East Reru, West Ngere, East Ngere, Ang'oga, Alwala, Kadinga West, East Kadinga, North Alungo, and South Alungo
			Central Seme	29,337	63.60	West Kanyadwera, East Kanyadwera, Upper Kombewa, East Othany, West Othany &Lower Kombewa
			East Seme	27,410	55.70	West Kolunje, East Kolunje, Kaila, Kitmikayi, Koker/
			North Seme	32,162	70.90	East Katieno, Kadero, West Katieno, North Kowe, South Kowe, North Ratta & South Ratta
Nyando	178,246	413.20	East Kano Wawidhi	21,907	101.90	Magina, Nyakongo, Katolo, Achego & Ayueyo
			Awasi Onjiko	32,949	94.50	Kobong'o, Border1, Border2, Ayucha, Kakmie & Wang'anga
			Ahero	45,884	51.80	Kakola, Ahero, Kakola Ombaka, Tura, South Kochogo, Kochogo Central and Kochogo North
			Kabonyo-Kanyagwal	31,678	87.00	Kabonyo Irrigation Scheme, Kapiyo, Upper Bwanda, Kwakungu, Central Bwanda, Kolal, Anyuro, Ogenya, Ugwe, Nduru and Kadhiambo
			Kobura	45,828	77.90	Kotieno, Kamayoga, Lela, Masogo, Nyamware North, Nyamware South, Rabuor, Kochieng'& Okana

		667.30	Miwani	24,551	132.30	East Kabar, central Kabar, West Kabar, Miwani North Miwani East, Miwani Central and Miwani West.
Muhoroni	184,220		Ombeyi	33,247	92.50	Obumba, Kang'o, Ramula, Kore& Ahero Irrigation Scheme
			Masogo/ Nyang'oma	41,069	106.10	Wang'aya1, Wang'aya 2, Kamswa North, Kamswa South, Sidho1 & Sidho East 2
			Chemelil	33,337	185.50	Songhor East, Songhor West, Upper Tamu, Lower Tamu, Kibigori, Chemelil, Nyangore, Got Abuoro
			Muhoroni/ Koru	52,015	183.10	Muhoroni town, Orego, Owaga, Tonde, Nyando, Koru, Ochoria, Fort- Ternan & Homaline
			South West Nyakach	21,892	50.90	Kajimbo, Ramogi, Gari & West Kadiang'a
Nyakach	168,140	357.30	North Nyakach	42,347	110.40	Rarieda, Lisana, Kasae, Jimo Middle, Gem Rae, Gem Nam, Agoro East, Jimo East, Awach, Agoro West and Kandaria

4.3 Population and Settlement

The population of the County according to the 2009 Kenya National Population and Housing Census was 968,909 persons with 474,687 (49.0 percent) males and 494,222 (51.0 percent) females. The projections for the start of the plan year 2018; mid of the plan year 2020 and the end of the plan year 2022 have been tabulated with a population growth rate of 2.6 percent basing on the 2009 population census.

4.3.1 Population Distribution by Sub-County

Table 6 Population Distribution by Sub-County

Sub-county	2009 (Census)		2018 (Projected)		2020(Projected)		2022 (Projected)	
	Population	Density	Population	Density	Population	Density	Population	Density
Kisumu East	150,124	1,105	189,730	1,397	199,872	1,471	210,540	1,550
Kisumu West	131,246	616	165,872	779	174,738	820	184,065	864
Kisumu Central	168,892	5,165	213,450	6,528	224,859	6,877	236,861	7,244
Seme	98,805	519	124,872	469	131,547	494	138,568	520
Nyando	141,037	341	178,246	431	187,773	454	197,796	478
Nyakach	133,041	372	168,140	470	177,128	495	186,582	522
Muhoroni	145,764	218	184,220	276	194,067	290	204,425	306
Total	968,909	483	1,224,530	610	1,289,984	642	1,358,837	677

Source: Economic Planning CGK (2018)

4.4 Physiographic and Natural Conditions

4.4.1 Physical and Topographic Features

The county's topography is undulating and characterized by Kano-Plains which is a flat stretch lying on the floor of the Rift Valley, the Nyabondo Plateau and the over-hanging huge granite rocks at Riat hills, Maseno and Seme areas. Due to flash flooding, the Kano-Plains have rich alluvial soils which favour agricultural production in horticulture and rice. Granites on the other hand, find their use essentially in the building and road construction industry.

The county is endowed with the second largest freshwater lake in the world; L. Victoria with two major rivers; Nyando and Sondu-Miriu and seven permanent rivers, Awach-Kano, Oroba/Ombeyi, Kibos,

Awach-Seme, Kisian, and Mugru, in its catchment. These resources provide a big potential for development of blue economy. Impala sanctuary, Ndere is land, the legendary Luanda Magere and Kit-Mikayi sites are among the unique topographical features. Kano Plains is predominantly black cotton soil which is poorly drained and unstable though suitable for rice, horticulture and sugarcane production. Seme and the lower parts of Nyakach Sub-counties are dominated by lake sediments, commonly sand and clay soils while Kisumu West Sub-county and upper-Nyakach are predominantly red-loamy soils suitable for agricultural production. The lake shores are generally swampy and offer fertile ground for horticulture and fish breeding.

Plate 1 Key Features of Kisumu County

4.5 Geological and Soil Characteristics

4.5.1 Geological Formation of Kisumu

The investigated site is underlain by the Nyanzian System rocks, which mainly consists of volcanics as basalts, andesites and rhyolites. Intrusives mainly granitic rocks locally sheared and well jointed also outcrops in the area. Kavirondian system rocks which are derivatives of Nyanzian system rocks and overlie the Nyanzian system rocks. Deposits of the sediments took place in several stages, mainly during pluvial periods, alternated by erosion phases during inter-pluvial periods. Kisumu County forms part of the old African Craton, built up out of Precambrian rocks. Since the time those rocks were formed and the area emerged above sea level, for a long time no major geological activities took place. Until the Miocene, when major tectonic activities started to affect the area. The same forces which initiated the formation of the East African Rift valley in Kenya had only minor influence in this part of the country. Rocks in the project area range from early Precambrian to Quaternary. The Precambrian rocks which include mainly volcanic series. The main geological feature in the area is the Kavirondo Rift. This rift ranches from the main north-south orient Kenya Rift Valley system, trending east-west and northeast to southwest towards Lake Victoria. Rocks in Kisumu North District can be divided into three well-defined groups, based on their relative age and lithology:

- Recent deposits.

- Tertiary volcanic rocks

- Kavirondian system

- Intrusives

- Precambrian Nyanzian System rocks.

Rocks of the Nyanzian System are the oldest exposed in the area, covering large areas of southern Kisumu North District. The rock of the system mainly consists of volcanics as Basalts, andesites and rhyolites.they are folded along northwest –southeast striking axes and underwent low-grade metarmorphism. Two major phases of intrusions have been identified in Kisumu North District: one of the post –Nyanzian /pre-Kavirondian age and one of post –Kavirondian pre- Bukoban age. Those intrusives are mainly granitic rocks, locally sheared and well jointed. The intrusives, due to typical granite weathering, now form erosional remnants rising above the general ground level (ridges, tors, bare rock surfaces and iserlbergs). At some locations doleritic dyke intrusions are found, generally parallel to major fracture trends. Rocks of Kavirondian system are sedimentary derivates of the Nyanzian System and post Nyanzian intrusives.the rocks consist of conglomerates, grits and mudstones and occur as inliers within the rocks of the Nyanzian System. The Kavirondian sedimentary rocks mainly are exposed in the northern part of the Kisumu North District covering large areas of Ukwala and Yala Divisions. They are believed to be deposited under continental torrential conditions, after the Nyanzian deposits had emerged above sea level.

4.5.2 Area Soil

The project area is mainly dominated by sandy and clay soils. It is part of the Kano Plains, with dark-brown and grey soils are poorly drained, and usually very deep and firm. The black cotton soils constitute more than 70% of all soil types found in Kisumu County. These soils enable the production of commercial crops such as rice, horticulture and sugarcane but are very difficult to manage because of susceptibility to water logging in rainy season and cracking up in dry season

4.6 Drainage (Surface Water)

he county's topography is characterized by Kano-Plains which is a flat stretch lying on the floor of the Nyanza Rift system, the Nyabondo Plateau and the over-hanging huge granite rocks at Riat hills, Maseno and Semeareas. The county is endowed with the second largest freshwater lake in the world; L. Victoria with two majorrivers- Nyando and Sondu-Miriu and seven permanent rivers, Awach-Kano, Oroba/Ombeyi, Kibos, Awach-Seme, Kisian, and Mugruk, in its catchment. This creates potential for irrigation which has not been fully tapped.Altitudes vary from 1144 metres on the plains to 1525 metres in the Maseno and Lower Nyakach areas, stronglyinfluencing rainfall and temperatures in the County

Plate 2 Section of Nyando River

4.7 Climate

The climate of the County is generally warm with minimal monthly variation in temperatures between 23^{0}C and 33^{0}C throughout the year. The rainfall is determined by a modified equatorial climate characterized by long rains (March to May) and short rains (September to November). The average annual rainfall varies from 1000-1800mm during the long rains and 450-600mm during the short rains. The altitude in the County varies from 1,144 meters above the sea level on the plains to 1,525 meters above sea level in the Maseno and Lower Nyakach areas. This greatly influences temperatures and rainfall in the County.

Climatic Condition	Unit	2014
Rainfall (annual average)	Mm	725-1200
Long rains (average)	Mm	1000-1800
Short rains(average)	Mm	450-600
Temperature (annual average)	^{0}C	17-26.5
Temperature (annual average highest)	^{0}C	23-33
Temperature (annual average lowest)	^{0}C	16-18

Source: Metrological Department, Kisumu County (2014)

4.7.1 Winds

Generalized wind speeds average about 4m/sec and have certain regularity due to the convection effect of the large water body of the lake that borders the often-hot dry land.

4.7.2 Temperatures

Temperature typically varies with altitude and proximity to the lake and tends to increase towards the lowland with an average of 18.3^{0}C to 29.4^{0}C and it rarely goes below 16.6^0 or above 32.2^{0}C. Temperatures are highest between December and March with the hottest weather being experienced in February and the lowest in April and November. (*Kisumu CIDP, 2019).*

4.8 Biological Resources (Fauna and Flora)

The vegetation is largely of acacia woodland and bush land growing over expansive black cotton soils that cover most of the Kisumu County apart from the hilly areas which have rock outcrops. The vegetation of acacia woodland is characteristic of the kind of vegetation cover found in areas of dominate black cotton soils. There is also an assortment of species of indigenous species of trees. A lot of trees are grown within the urban and peri-urban areas for the conservation of the environment. However, since agriculture is still exercised in most parts of the Kisumu county, crops also form part of vegetation cover as do grass in open fields and homesteads and compounds or courtyards, as well as trees planted for landscaping like the jacaranda dot the landscape of the Kisumu county. It is to be noted that the water hyacinth in the lake can also be considered available vegetation, but this is subject to winds as sometimes it is blown further into the lake, but mostly it covers a large tract of the shoreline.

4.8.1 Habitat (Flora)

The most critical ecosystems in Kisumu County include forests, freshwaters, wetlands, and hills. Within these ecosystems are key natural and cultural heritage resources which support diverse biodiversity and provide natural capital for economic development and support livelihoods. Freshwater resources and wetlands form an important part of the county's natural resources with considerable provisioning, regulatory and supporting services. Their provisioning services include the storage and retention of water for domestic, agricultural and industrial use. Their regulating services include modifying water flows, recharging and discharging groundwater resources and diluting or removing pollutants. Their supporting services are important for soil formation and retention as well as nutrient cycling. These ecosystems also provide habitats for a great number of plant and animal species.

4.8.2 Wildlife (Fauna)

Wildlife resources contribute directly and indirectly to the local and national economy through employment, revenue generation and wealth creation. The increasing population, growing numbers of refugees, human-wildlife conflicts, widespread pollution, climate change and the transformation of vast wildlife areas into other land-uses threaten the continued existence of wildlife in the county. Human-wildlife conflict is a growing concern and provides a major challenge to wildlife conservation in Kisumu. Conflicts are prevalent as human population increases, development expands, the global climate change and other human and environmental factors put people and wildlife at greater direct competition for a shrinking resource base especially living space and food. The impacts are often huge. People lose their crops, livestock, property and sometimes their lives. The animals, many of which are threatened or endangered, are often killed in retaliation or to 'prevent' future conflicts. Despite the efforts made to reduce conflicts the losses remain high and some of the conflict mitigation measures that are in place for instance fencing and compensation for losses, demand for increased financial resources.

4.9 Economic Activities and Household Income

Kisumu County is predominantly lower midland (LM1-LM5) agro ecologically, with pockets of upper midland (UM1-UM4) agro-ecological zones on the eastern edges of the county and on hilltops/slopes. The agro-ecological zones range from dry ones with only one cropping season near Lake Victoria, to wet ones with permanent cultivation possibilities in the eastern parts of the County.

The County has the potential to produce a wide variety of crops. Some of these include sugarcane, maize, and beans in the wetter LM1 and LM2 belt. The drier LM3 and LM4 belts have the potential for cotton, finger millet, sorghum, and ground nuts. The climate is suitable for upland rice and oil palm. Sweet potato, a major food security crop, is produced in the entire county. Major economic activities taking place within Kisumu include trading and wholesale, retail, hawking, microenterprise, touting, non-motorized transport business. The local communities practice subsistence farming, livestock rearing and fishing. Approximately 89% of the population practice agriculture for consumption and income generation. The main crops grown in the area include cassava, and maize. Livestock rearing is also practiced where cattle, goats, donkeys, and chicken are kept.

Plate 3 Paga beach in South West Kisumu Ward

4.10 Environment Issues

4.10.1 Water Pollution

The pollution of Lake Victoria is a critical issue. The lake, being a huge system fed by rivers that originate from far-off areas, has elements of both on-site and off-site pollution:

- Agro chemicals/ fertilizer (non-point sources of pollution of the lake)
- Water hyacinth menace
- Direct draining of sewers into the lake
- Car washing in town (run-off to main sewer)
- Clothes washing and bathing in the lake
- Agro-based industrial water release on rivers

Proposed Mitigation Measures

- Proper management of sewage
- Ensure riparian reserves are protected
- Efforts to rid the lake of hyacinth urgently

4.10.2 Air Pollution

Air pollution within the area is minimal; however, there are notable problems and challenges which include;

- Dust during constructions

- Stench from fish mortality
- Burning of wastes such as polythene bags, tyres
- Smoking in public places
- Exhaust fumes from un-roadworthy automobiles

Opportunity for improvement

- Enforcement of laws for hoarding construction sites
- Watering during construction to reduce the dust levels
- Provision of waste disposal facilities
- Improve public awareness, especially on the advantages of environmental conservation
- Designating smoking zones within the County.
- Promotion of circular economy

4.11 Cross Cutting Socio-Economic Issues

4.11.1 Water

Though there is a considerable access to portable water within urban areas, rural communities continue to consume raw water from the lake, rivers and quarry dams hence contributing to water borne diseases.

4.11.2 Sanitation

- Lack of adequate toilets is a big problem in rural areas
- Pit latrines collapse due to lose soils in most parts of Kano plains.

4.11.3 Solid waste

The project area is not served with a sewer system

4.11.4 Poverty

Poverty in the KisunuCounty is exemplified through the following factors:

- Lack of food security
- Poor housing conditions
- Mushrooming of slums and squatter settlements
- Increased insecurity
- Dwindling health standards, high under-5 mortality rates, low life expectancy and high prevalence of HIV-AIDS
- Inequitable resource distribution

5 METHODOLOGY OF THE STUDY

The EIA experts used site surveys and perused documents relevant to the EIA to come up with data and information regarding the proposed development and expected effects on the water and land resources and socio-cultural environment.

5.1 Methodology Outline

The general steps followed during the assessment were as follows: -

- Environment screening, in which the project was identified as among those requiring environmental impact assessment under schedule 2 of EMCA, Cap 387
- Environmental scoping that provided the key environmental issues
- Desktop studies and interviews
- Stakeholders' engagement and distribution of questionnaires
- Physical inspection of the site and surrounding areas
- Reporting

5.2 Site Surveys

It was important that the Environment Experts carry out a detailed study of the proposed site. Observation enabled the expert to determine what environment factors were most likely to be impacted.

5.2.1 Interviews and Focused Group Discussion

To determine the part of the extent of the proposed project, the expert consulted in depth with the proponent, to determine, size, and objectives of the proposed project. Proponent elucidated his vision for the project and dialogued with the environment expert who advised concerning application of all relevant laws and by-laws related to the project.

For the proposed project to see light at the end of the tunnel, the team of EIA expert sought the views of the professionals and government agencies as well as those of the individuals from different social classes in the community; using structured interviews and focused group discussion to further in depth understanding of the perception to the locals regarding the proposed project.

5.2.2 Perusal of Documents

The environment expert explained to the proponent the importance in acquiring the proper documents associated with the proposed projects. The environment expert perused the following documents:

- County Approvals
- Project layout designs
- State department of fisheries aquaculture guidelines
- The proponent development concept
- Feasibility Studies
- Hydrological surveys
- Noise and air quality assessment documents

5.2.3 Secondary Data

Various literatures were used in aiding the successful completion of the report. They include EMCA-Cap 387, The Physical Planning Act (Cap 286) Laws of Kenya, The Factories and Other places of Work Act,

The Public Health Act, Cap 242 and Environmental Management and Co-ordination (Waste Management) Regulations, 2006 Legal Notice No. 12. And Fisheries Development Management Act, 2016.

5.3 Actual EIA Public Consultation

Public participation is enshrined in Kenyan constitution. It has also demonstrated that projects that go through this process will acquire high level of public acceptance and accrue benefits for a wider section of the society. Public consultation forms a useful component of gathering, understanding and establishing impacts of projects; determine community and individual preferences and selecting mitigations. Furthermore, it makes it possible to enhance project designs and ensure sustainability of projects.

5.3.1 Process of Public Consultation

The Consultant developed questionnaires for the proposed Kabonyo/Kanyaguel aquaculture project to gather concerns from the community living in the project area and the entire community. Comments from the Project Implementation Committee, community, political leadership and national government administration were sought and incorporated in the report. The study team also sought comments from key informants in the fisheries sector.

5.3.2 Objective of Public Consultation

The consultations with the relevant and affected persons were conducted with a view to: -

- Inform the community, stakeholders and relevant parties of the proposed project.
- Seek the views of the residents proposed project area;
- To seek their opinions on any positive or negative impacts from the establishment of such a project;
- To find out if there are any issues that the project could negatively or positively impact on the lives of the residents and the public.
- Explain to the community and stakeholders the nature of the proposed project, its objectives and scope;
- Obtain suggestions from the public on possible ways that they feel potential negative impacts can be effectively mitigated.

There was a positive reaction over the proposed project with the residents giving no objection to its establishment. The residents could clearly see the benefits of the existing project and thus supported the establishment of the aquaculture training centre project

5.3.3 Salient Issues

The respondents expressed several positive impacts they expect from the proposed project. There were also negative impacts that the respondents expected, and these have been adequately addressed in the Environmental Management Plan. The major issues raised include:

- Will interfere with water quality
- Will hamper free navigation
- May cause disease outbreak
- Pollution of the lake waters
- Injuries and accidents
- Involvement of the local community in project implementation
- Infrastructural development

- Employment of locals
- Use certified fingerlings and feeds.
- Create a buffer zone for biosecurity
- Adopt advanced feeder technology
- Site project clear of navigation route
- Minimizing feed waste
- Keep proper sanitation at the around the project area
- Control use of chemical drugs
- Proper disposal of human wastes
- Limitation of the grazing area
- Fastening the implementation of the project that has been pending since 1982.

5.3.4 Consultation & Public Participation (CPP)-analysis

The public interviewed welcomed the development and were optimistic that the project will create employment opportunities, boost food security at the beach as well as improving the incomes from sale of fish, stimulate the growth of national economy by boosting other sectors of business and lead to better standards of living. There was no major negative issue raised as far as the flood control project is concerned. The participation from the stakeholders, the public and neighbors were very successful, and the participants were very cooperative. Therefore, the project is commendable for approval by NEMA

5.3.5 Reporting and Documentation

A comprehensive EIA Study Report containing the findings has been compiled by the consultant in accordance with NEMA guidelines for consideration and approval by the authority.

5.3.6 Key Stakeholders Consulted

Table 7 Key Stakeholders Consulted

Name of Stake Holder	Organization
County Fisheries Department	Kisumu Bay County Government
Lands Office	Kisumu-Land Office-Through search certificate
Water Analyst	Water Resources Authority Lab
State Department of Fisheries and Blue Economy	Kisumu Regional Office
Aquaculture Specialist	Part of the experts
Immediate Neighbors	Neighboring residents
Ministry of Interior and National Government Coordination	Chief, Sub-Chief and Nyumba kumi
Local Community	Local Fishing Community
Member of County Assembly	Kabonyo/Kanyaguel

Media Houses	Newspaper, Radio and Kenya Gazette outlets

5.3.7 Summarized Methods, Tools and Techniques for Stakeholder Engagement

Stakeholder Category	**Engagement**				
	Communication strategist	**Information Disclosure**	**Consultation**	**Participation**	**Negotiation and Partnership**
Project Implementation Committee (PIC)	General meeting, FGD and KIIs (Shared Minutes)		Informed and in-depth individually	PIC	Minutes for participation
All residents of the project area	General meeting, FGD and KIIs (Shared Minutes)	-	General meeting with questions and answers	PIC and local leadership	Group
Fishermen in the project area	Key informants' interviews (KIIs)		General meeting with questions and answers	Group	Group
Government Stakeholders	NEMA public consultation	Newspaper adverts	Meeting and letters	Lead agencies	Lead agencies
The general public	Posters, general meetings, minutes, reports and flyers distributed through PIC offices, shops, and chief's baraza and office, websites and documents and reports at county information		Meeting	Representatives	Ministry of Interior and National Coordination County government

5.4 Feedback and Outcome of Public Consultation

Detailed analysis of administered questionnaires and outcome of public meetings and Barazas are annexed in the report.

6 PROJECT ALTERNATIVES

This Chapter analyses the proposed project alternatives in terms of culture sites, species, and culture systems, project designs, technology scale and waste management options.

6.1 Project Alternatives Considered

This section analyses the project alternatives in terms of site, technology scale and waste management options.

6.1.1 Relocation Option

Relocation option to a different site is an option available for the project implementation. At present the proponent has alternative sites but the current site is the best according to the surveys done. However, this means that he must look for another site and this will take more time and resources. The proponent already secured Kabonyo/Kanyaguel site from authorities through relocation of residents in 1982.

6.1.2 No Project Option

The No Project option in respect to the proposed project implies that the status quo is maintained. This option is the most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions. This option will, however, involve several losses both to the proponent and the community. The No Project Option is the least preferred from the socio-economic and partly environmental perspective due to the following factors:

- The proponent will not benefit from the revenue expected from the project.
- The economic status of the Kenyans and the local people would remain unchanged.
- The local skills would remain underutilized.
- No recreational center and job opportunities will be created for thousands of Kenyans who will work and live in the proposed project.
- Increased urban and rural poverty and crime in Kenya.
- Discouragement for investors to produce this level of affordable facility to the public.

From the analysis above, it becomes apparent that the No Project Option is no alternative to the proponent, Local people, Kenyans, and the government of Kenya.

6.1.3 Analysis of Alternative Construction Materials and Technology

The project shall be constructed from a variety of materials but mainly dykes from the excavated soils. There will be civil works involving standard construction materials both for buildings, ponds and dykes.

6.1.4 Materials

- Excavated soils
- Cement
- Blocks
- Steel
- Timber
- Iron sheets

6.1.5 Wastewater management alternatives

The project is expected to have very insignificant waste water because it's mainly fish production in an area that is naturally permanent with water. However, the experts have recommended bio digester system to treat waste water from buildings and hatchery, which can then be re-used for gardening.

6.1.6 Project site location

The project site is a government land that is owned by the state department of Fisheries and Blue economy in Kabonyo/Kanyaguel, Nyando Kisumu County. The land size is over 100 Acres and had been earmarked for a fisheries project since 1982. The site that proponent has earmarked is in most suitable location for aquaculture training center and fish farming. It is therefore recommended to develop the aquaculture project as earlier planned.

6.1.7 The Proposed Development Option

Under the Proposed Development Option, the developer of the proposed project would be issued with an EIA License. In issuing the license, NEMA would approve the proponent's proposed development of the project, provided all environmental measures are complied with during the construction period and operational phases. This alternative consists of the applicant's final proposal with the inclusion of the NEMA regulations and procedures as stipulated in the environmental impacts to the maximum extent practicable.

7 PROJECT POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

7.1 Introduction

This Chapter provides the potential ecological effects associated with the project in Kabonyo/Kanyaguel, Nyando, Kisumu County. The potential impacts were based on proposed design including activities planned during project implementation.

7.2 Positive Impacts

Table 8 Positive Impacts

Impact	Narrative
Employment, skills transfer and human resource capacity development	Implementation of this project will involve the use of both skilled, semi-skilled and unskilled labour. Different expertise will be required for the project. Provision of employment will contribute to raising the socioeconomic well-being of the people living and working around the project.
Impact on human nutrition on local and national level	The supply of fish will contribute to filling the country's need for proteins, a commodity which is not adequate now.
Diversifying community livelihoods	Beneficiary businessmen and middlemen will have an alternative livelihood thus offering cushion against shortcomings of the current agricultural activities in the area
Improvement of infrastructure in the area	The project will improve access roads within the area
Increase in Land Value	The project will also increase the land value within the project area

7.3 Negative Impacts – Farm Design and Construction Phase

7.3.1 Disturbance of Benthic Habitat

The project implementation may result in some localized disturbance of the riparian land because it borders the lake shore line. Construction activities might increase suspension of sediment and substrate materials within Lake Victoria waters. The destruction of habitats for the establishment of aquaculture training center will be negative if the habitat is considered ecologically or economically important. Such areas would include breeding, nesting, nursery and foraging areas for a range of species with emphasis on rare and endangered species and species of conservation importance.

Mitigation Measures

- Sensitive habitats such as bird nesting or fish breeding areas, must be identified prior to project implementation and protected,
- The design of the project should make the project area remain as much natural as possible, and
- The proponent should avoid unnecessary excavation and soil disturbance

7.3.2 Machinery Mobilization

During the machinery mobilization process, movements should be strictly within the designated areas to avoid possible impacts on the benthic substrate as follows. Disturbance of fauna and flora (turbidity in the water column)

7.4 Negative Impacts – Farm Operation and Management Phase (Impacts)

7.4.1 Water Quality Deterioration

Construction of Dykes and ponds may introduce pollutants in the Lake.

Mitigation Measures

- The contractor should strictly follow the designs.

7.4.2 Ecological Effects

Fish farming sometimes requires the addition of artificial diets in the form of fish feed pallets. Therefore, most ecological effects on the water column are related to the Tilapia farming waste products such as uneaten feed and excreted ammonia entering the Lake riparian system and changing the concentrations of nutrients. Particulate wastes expelled into the water column are also expected to settle onto the seabed in proximity to the farm. The buildup of organic matter on the Lakebed primarily may cause physico-chemical and ecological impacts. The deposition of faeces and uneaten feed can lead to localized over-enrichment of the Lake riparian area.

Mitigation Measures

- Ensure feeds selection are of high utilization rates to reduce the nutrient pollution from uneaten feed and excreta,
- Feed shall include balanced levels of amino-acids and other nutrients appropriate for age of the fish, high palatability to stimulate consumption and high stability to prevent rapid nutrient release,
- Medicated feeds shall be used only when necessary for the control of specific diseases,
- Feeding management shall be in conformity with carrying capacity, stocking density and size of the fish, and
- Good feeding practices shall be employed to ensure minimal feed wastage.

7.4.3 Habitat Modification or Exclusion

The presence of the proposed aquaculture training center structures and their associated aquaculture activities can potentially exclude or modify how particular species of both flora and fauna. The project may also affect critical and sensitive habitats, including foraging or feeding areas, resting or nursery areas, and migration routes. Habitat modification may also lead to aggregations of scavenging or predatory organisms.

7.4.4 Fish Mortalities

Bacterial action and autolysis of dead fish results in the excretion of ammonia in lake waters. Live fish preying on dead fish could result in the spread of diseases if the dead body died of a disease. Mortality attracts fish predators e.g. birds at the fish ponds. Another possible cause of diseases is the risk of people using water near the ponds for domestic purposes and swimming.

Mitigation Measures

Conduct a daily routine of collecting mortalities and dispose the waste through biological processes.

7.4.5 Attraction to Artificial Lighting

The use of lighting may attract or repel specific types of animals. Caution should be placed in strategic areas warning people of likely movements of dangerous mammals like hippopotamus.

7.4.6 Waste from fish feeds

The following practices shall be adopted to maintain water quality, improve efficiency of feeds and feed management and at the same time reduce the number of wastes discharged into the environment.

Mitigation

- Feeds shall be selected for their high utilization rates to reduce the nutrient pollution from uneaten feed and excreta.
- The proponent will employ a qualified expert to deal with issues of feed formulation that will ensure feed efficiency, low feed conversion ratios, maximum feed floatability
- Feed shall include balanced levels of amino-acids and other nutrients appropriate for age of the fish, high palatability to stimulate consumption and high stability to prevent rapid nutrient release.
- Feed shall be stored in cool and dry areas to prevent contamination.
- Feeding management shall be in conformity with carrying capacity, stocking density and size of the fish.
- Use species and system-specific feeds to maximize food conversion ratios (and minimize waste)
- Monitor fish feeding behavior and particulate matter deposition, adapt the feeding strategy to maximize feeding efficiency and minimize particulate matter fallout.
- Undertake ongoing, detailed water quality and benthic monitoring, including baseline surveys at control and impact sites.

7.5 Impacts on Biodiversity

Most farmed species are genetically different from native species and there is always concern about genetic contamination from the release of farmed species into the wild. Domestic fish are bred for traits that may not be optimal for survival in the wild. If some escape into the wild, for example, the viability of wild populations may be threatened by inter-breeding. The proponent must adhere strictly to biosecurity and biosafety measures.

7.5.1 Impacts on Wild Fish

The project shall be located on a riparian land next to Lake Victoria with a significant shoreline. Possibilities of interference with wild fish populations can lead to genetic contamination.

Mitigation Measures

- To avoid escape of farmed fish into the wild, the proponent shall follow biosecurity protocols as guided by the department of fisheries and blue economy as well as Kenya Marine and Fisheries Research institute.
- Proper dykes should be put in place to avoid flooding from the lake
- Maintain genetic compatibility (similar levels of variation) between wild and cultured stock and ensure adequate genetic monitoring,
- Proponent will use Oreochromis niloticus, which is a species already present in the lake

- Reduce the number of escapees by maintain farm integrity through regular maintenance and replacement and training of staff.
- Develop and implement recovery procedures should escapes occur.
- The proponent shall collaborate local research institutions to stay updated on emerging diseases and best practices.

7.5.2 Disease and parasites

Potential disease and parasite transmission to wild stocks could have negative impacts throughout the natural distributional range of the species, the magnitude of the potential impact will be high as it could alter wider natural (ecosystem impacts) and social functions (fisheries), and the impact will be ongoing.

Mitigation

- Maintain strict bio-security measures within the aquaculture training center.
- Ensure all fry undergoes a health examination prior to stocking in fish ponds
- Regularly inspect stock for disease and/parasites as part of a formalized stock health monitoring programme and take necessary action to eliminate pathogens using therapeutic chemicals or improved farm management. This will require focused research effort into the identification, pathology and treatment of diseases and parasites infecting farmed species, both within culture and wild stocks.
- Maintain comprehensive records of all pathogens and parasites detected as well as logs detailing the efficacy of treatments applied. These records should be made publicly available to facilitate rapid responses by other operators to future outbreaks.
- Treat adjacent ponds simultaneously even if infections have not yet been detected.

7.6 Social Risks

7.6.1 User Conflict

The main social issues relating to aquaculture and the intensification thereof are due to the conflicts over use of land, water and other natural resources (Boyd et al., 2008). Land rights and land ownership vary within Counties and communities, and within the case of Western Kenya many people are dependent on Lake Victoria for their livelihoods. Any intensification that takes place without formal permission (land ownership) or blocked the pathway to popular fishing sites would likely cause tension within the communities.

Farmers involved in the intensification must comply with regulated environmental standards and implement the recommended monitoring and management measures to ensure that their practices do not negatively impact on their neighbours' resources, and ultimately livelihoods. For example, the discharge of water and/or contamination of the domestic water supply would prove an issue to all users reliant on the resource especially if the quality of drinking water deteriorated. It is important that State Department of Fisheries and Blue Economy (Proponent) establishes a communication channel for complaints (a grievance mechanism), so that should a member of the public, fishermen, have a concern are promptly addressed.

Mitigation

- Continuous Community Engagement
- Regular maintenance of fish ponds and farm infrastracture
- The proponent shall hold regular stakeholder engagement sessions to proactively address concerns.

7.6.2 Occupational Health and Safety

As a general approach, health and safety management planning should include the adoption of a systematic and structured approach for prevention and control of physical, chemical, biological, and radiological health and safety hazards. Occupational health and safety hazards related to the daily operations of the aquaculture sector are physical hazards like drowning, effects from use of chemicals.

Mitigation

- Provide lifejackets and harnesses with safety clips that lock on to lines or fixed points;
- Ensure that workers/personnel are experienced swimmers;
- Train personnel in safety at the aquaculture center, including procedures for supervision of personnel;
- Always require that personnel wear lifejackets on exposed sites.
- Appropriate signage and warnings in potential risk areas shall be provided;
- Appropriate Personnel Protective Equipment (PPE) shall be provided to the workers where applicable;
- The Proponent shall develop and implement detailed and site-specific emergency response plans; and
- The Proponent shall endeavor to create health and safety awareness among residents.

7.6.3 Air Emissions

It is difficult to predict air emission impacts at this stage of the project. Fish feed mills are, however, known to generate dust. Auxiliary equipment such as diesel generators or boilers would also require investigation. A detailed Baseline Air Quality Measurement was conducted in the preliminary stages of the EIA phase of the programme. The objective was to assess and document the existing levels of key air pollutants in the area surrounding the proposed fish farm expansion.

The results of the baseline air quality assessment conducted at the project site indicate that all monitored pollutants are within the permissible limits set by the Environmental Management and Co-ordination (Air Quality) Regulations, 2014 (EMCA, 2014) as outlined in the table below. The fact that these pollutants are within regulated thresholds suggests that the current air quality poses no significant risk to the environment or public health in the vicinity of the proposed expansion site.

Table 9 Air quality test results

Company	KFASTEC
Purpose of Analysis	Baseline Assessment
	Environmental Monitoring - Residential, Rural & Other area

Sample Location	CO	CO2	HC	NO	NO2	NO_X	O2	O3	PM10	PM2.5	SO2
	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	mg/m3	mg/m3	ppm
Kabonyo fisheries I	0.00	131.18	0.00	0.19	0.17	0.35	20.95	0.00	8.80	6.86	3.42
Kabonyo fisheries II	0.00	133.40	0.00	0.19	0.16	0.35	20.94	0.00	7.54	5.13	2.80
Limit	**4.0**	**9000.0**	**NP**	**NP**	**0.2**	**150.0**	**NP**	**0.1**	**100.0**	**NP**	**80.0**

Legend: ppm: Parts per million.; mg/m3: milligrams per cubic metre; % - percentage concentration, ppb - parts per billion

KABONYO FISHERIES I

	Average Pollutant	Average in Standard units	TWA OEL -RL	Remarks
Carbon Monoxide (CO)	0.00 ppm	0.00 ppm	50 ppm	Within Limit
Carbon Dioxide (CO_2)	285.11 ppm	285.11 ppm	5000 ppm	Within Limit
Hydrocarbons (C_xH_y)	0.00 ppm	0.00 ppm	NP	Not Provided
Nitrogen Monoxide (NO)	5.24 ppb	0.00 ppm	25 ppm	Within Limit
Nitrogen Oxides (NO_2)	3.25 ppb	0.00 ppm	3 ppm	Within Limit
Nitrogen Oxides (NO_x)	8.49 ppb	0.00 ppm	NP	Not Provided
Oxygen (O_2)	20.95 %	20.95 %	NP	Not Provided
Ozone (O_3)	0.00 ppb	0.00 ppm	0.1 ppm	Within Limit
Particulate Matter (PM_{10})	26.01 $\mu g/m^3$	0.01 mg/m^3	10 mg/m^3	Within Limit
Particulate Matter ($PM_{2.5}$)	6.86 $\mu g/m^3$	0.00 mg/m^3	5 mg/m^3	Within Limit
Sulphur Dioxide (SO_2)	3.86 ppb	0.00 ppm	2 ppm	Within Limit
Relative humidity (RH)	54.20 %			
Temperature	25.20 °C			
Wind direction	211.53 °			
Wind speed	4.05 kph			

KABONYO FISHERIES II

	Average Pollutant	Average in Standard units	TWA OEL -RL	Remarks
Carbon Monoxide (CO)	0.00 ppm	0.00 ppm	50 ppm	Within Limit
Carbon Dioxide (CO_2)	289.93 ppm	289.93 ppm	5000 ppm	Within Limit
Hydrocarbons (C_xH_y)	0.00 ppm	0.00 ppm	NP	Not Provided
Nitrogen Monoxide (NO)	5.63 ppb	0.00 ppm	25 ppm	Within Limit
Nitrogen Oxides (NO_2)	2.80 ppb	0.00 ppm	3 ppm	Within Limit
Nitrogen Oxides (NO_x)	8.43 ppb	0.00 ppm	NP	Not Provided
Oxygen (O_2)	20.94 %	20.94 %	NP	Not Provided
Ozone (O_3)	0.00 ppb	0.00 ppm	0.1 ppm	Within Limit
Particulate Matter (PM_{10})	22.28 $\mu g/m^3$	0.01 mg/m^3	10 mg/m^3	Within Limit
Particulate Matter ($PM_{2.5}$)	5.13 $\mu g/m^3$	0.00 mg/m^3	5 mg/m^3	Within Limit
Sulphur Dioxide (SO_2)	3.16 ppb	0.00 ppm	2 ppm	Within Limit
Relative humidity (RH)	54.29 %			
Temperature	25.19 °C			
Wind direction	257.31 °			
Wind speed	4.09 kph			

Mitigation Measures

- The proponent is advised to stick to the provisions of EMCA (Air Quality) 2014 by conducting annual air quality assessment and filing the same with NEMA as part of the annual Environmental Audit.
- Monitor dust levels while conducting land based aquaculture activities.

- If operating feed mill, ensure all emission controls are in place and maintained (dust collectors, exhaust fans, scrubbers etc.
- Based on the findings, it is recommended that KFASTEC continue to monitor air quality levels regularly to ensure ongoing compliance with environmental standards. Regular maintenance of equipment to prevent unnecessary pollution and providing training for staff on air quality regulations can also contribute to maintaining acceptable air quality levels at the site.

8 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

8.1 Significance of an EMP

An Environmental Management and Monitoring Plan (EMP) provides a mechanism to address any negative environmental impacts of a proposed project and aims to promote benefits. The EMP provides a document that assists in detecting the development of any negative environmental issues through the monitoring of environmental parameters. The document defines the responsibilities and evaluates performance. As with the proponent, an EMP document needs to be designed for a specific project (in this case farm), as the monitoring requirements need to be tailored to the activities, the size of the farm and the location. All of these will in turn determine the frequency of sampling, methods and the details thereof (parameters and positions).

8.2 The objectives of the EMP:

- To militate against the possible degradation of the riparian ecosystem during the operation of the proposed aquaculture training center project by reducing negative impacts and enhancing positive effects.
- To ensure that the proposed project does not result in excessive enrichment of Lake Victoria shoreline thereby modifying the ecosystem integrity
- To outline mitigation measures, to manage environmental impacts associated with the project
- To ensure that the aquaculture project will comply with relevant environmental legislation of the country and other requirements throughout its operational phase
- To identify roles and responsibilities and the cost involved and
- To propose mechanisms for monitoring compliance

8.3 Water Quality Monitoring and Management

Best practice guidelines must be used for monitoring water bodies potentially impacted by the proposed project. It is especially important to take samples of the fish farm sites to ensure that any impacts relating to feed and return effluents are identified. The water quality variables of concern (to be monitored) are as follows.

Table 10 Water quality variables to be monitored

Variables	**Methods**
Temperature (°C)	In situ using a temperature meter
Dissolved oxygen (mg/ℓ)	In situ using a dissolved oxygen meter
pH	In situ PH using a water pH tester
Turbidity (NTU)	Standard Methods in laboratory
Secchi (m) – Visibility	In situ using Secchi Disk
Nutrients (mg/ℓ, ortho-phosphates, total phosphates, nitrate, nitrite, ammonia)	Standard Methods in laboratory
Algal identification	Standard Methods in laboratory

Table 11: EMP for Construction Phase and operation of the proposed aquaculture training center project

Component/Activity	Component/Activity	Mitigation/Management	Responsibility	Monitoring Mechanism	COST
Health and Safety of Workers	Workers Safety and wellbeing	• Workers should be provided with full personal protective equipment (PPE) to beef up their health and safety standards. • Well stocked first aid boxes should be availed in case of any incidents or accidents and a general register should be available to record such occurrences. • The area should be fenced off to keep away unwanted persons.	Proponent and Contractor	Observations and Reports	500,000
Generation of Waste	Excavations	• The soil generated will be used to level the area of land around the ponds as well as landscaping some areas in the farm. • Waste bins need to be provided for collection of wastes such as cement packaging bags. • Extra soil excavated can be used in construction of dykes	Proponent and Contractor	Observation and reports	1000,000
Noise Pollution	Excavations and Machinery	• Such noise emissions should	Proponent and	Reports and noise	100,000

Component/Activity	Component/Activity	Mitigation/Management	Responsibility	Monitoring Mechanism	COST
	Operation	be minimized as much as possible from the source point while workers should be provided with appropriate personal protective equipment especially if the levels exceed 85dB for a continuous eight hours exposure. • Ensure that machines are switched off when not in use.	Contractor	monitoring plans	
Generation of exhaust emissions	Machinery Operation	• Proper and prompt maintenance of construction plants and equipment to control emission of hazardous fumes and noise emanating from machines. • Ensure that machines are switched off when not in use.	Proponent and Contractor	Exhausts Monitoring reports	200,000
Storm water and backflow from the Lake Victoria	Excavations	• Drainage channels should be dug on the area lying on the upper side if the dam to ensure storm water does not enter the excavated area in case of rain •	The contractor and the proponent	Design Monitoring plan	2000,000
Enhanced erosion / changes in	Excavations	• Have soil erosion prevention mechanisms in place, such as	Contractor and proponent	Design Monitoring Plan	2000,000

Component/Activity	Component/Activity	Mitigation/Management	Responsibility	Monitoring Mechanism	COST
topography due excavation.		compaction of soil on the base of the reservoir and its embankment to reduce chances of erosion.			
Fish feeding	Water quality impacts because of feed wastage.	• Only high-quality aquaculture feeds must be purchased from recognized feed producers; Information on the nutrient makeup, primary ingredients and production techniques, e.g. extrusion, should be available, • Feeding rates must be correlated to water quality sampling to allow detection and alteration of over-feeding. This will be done by the water quality monitoring programme to be implemented; • Correct feed pellet size must be used to ensure low levels of feed wastage.		Water quality monitoring programme.	Water quality results which fall within the predetermined parameters
Chemical and Drug treatments	Chemical spills and incorrect application of chemicals	• The handler must wear appropriate Personal Protective Equipment (PPE); • Dosages, application methods and resultant	Proponent/Accredited aquaculture pathologist	Specific inspection of the suitability of chemical stores (expiry dates, etc.) must be done once in three months	Chemical spills

Component/Activity	Component/Activity	Mitigation/Management	Responsibility	Monitoring Mechanism	COST
		outcome must be known and recorded in a treatment register; • Expired chemicals must be disposed of at a suitable hazardous waste disposal site; • The advice of a recognised fish pathologists or aquaculturists must be sought where the application of chemicals is uncertain;		and according to the relevant MSDSs	
	Fish mortalities	• All mortalities must be recorded and the associated behavior of the remainder of the organisms monitored, e.g. loss of appetite; • A database must be kept of the numbers of dead organisms and the behavioral patterns of the population.	Proponent	• Conduct a daily routine of collecting mortalities on the farm. • All mortalities be transported to the the company's licensed organic waste site for composting. • Establish a Black Soldier Fly (BSF) Breeding facility at the waste	Outbreak of disease Accumulation of predators

Component/Activity	Component/Activity	Mitigation/Management	Responsibility	Monitoring Mechanism	COST
				licensed site to produce animal feeds.	
	Endangering predators	• No traps may be used to injure any predators of aquaculture organisms. Traps may only be set if these predators can be caught live (without injury) for translocation to alternative areas. This may only be done under the supervision of recognized organizations or authorities i.e. KWS; • Ensure no poisons is left out for aquaculture predators; • Ensure no animals that prey on the aquaculture species is shot • The main aquaculture predators and their control methods include cover netting for birds (Kingfishers, Fish Eagles, Herons, Storks and others) and fencing	Proponent	Specific consideration and inspection of all fences, predator netting	Predator injury or death
	Health and safety compliance at the project site	• All involved personnel need to have adequate floatation safety gear and need to be	Proponent		Health and safety incidents

Component/Activity	Component/Activity	Mitigation/Management	Responsibility	Monitoring Mechanism	COST
		fully trained in health and safety codes related to water borne activities; and • Skippers need to be licensed			
	Disease from processed fish waste	• The waste generated in the primary processing of the harvested fish (heads, gills and intestines) and the mortalities experienced from production must be ensiled to produce a stable and odour free high protein supplement for animal feeds through breeding of Black Soldier Flies. • Excess waste should also be composted at the Company's licensed organic waste facility located at Kinyasaga.	Proponent	Audit	Disease free processing facilities which have been audited.

Additional Environnmental Management Plan measures During Operation of Aquaculture Training Center project

Expected Negative Impacts	**Mitigation Measure**	**Responsibility**	**Time Frame**	**Cost**
Breeding Site for Mosquitoes	• Monitor and control the possible creation of mosquito breeding site.	Proponent and Contractor	Throughout the operation Period	TBD
Aerobic and Anaerobic Waste.	Ensure no wastes enter the ponds especially due to run-off by having a point to sieve all incoming wastes .	Proponent and Contractor	Throughout the operation Period	TBD
Risk of Drowning	• Fencing off the project area to ensure it is only accessible to the required personnel.	Proponent and Contractor Development Company Limited's Management	One off	25,000,000

Table 12 Environmental Management Plan for Decommissioning

Expected Negative Impacts	**Mitigation Measures**	**Responsible**	**Cost**
Scrap materials	Waste generated will be characterized in compliance with standard waste management procedures Disposal locations will be selected by the licensed contractor	Site supervisor and Licensed Waste Disposal Contractor	1000,000
Scrap materials and other debris	Equipment and structures that will not be used for other purposes should be removed and reused or sold to scrap material dealers	Project Manager and site supervisor	1000,000
Rehabilitation of Project Site			
Site water quality disturbed	Remove project materials and debris from the lake to restore the site to its original condition	Project Manager and site supervisor	400,000
Project site Rehabilitation to near natural state	Ensure all dug out areas are properly filled	Contractor and Proponent	40,000,000

9 CLIMATE RISK VULNERABILITY ASSESSMENT

This chapter details the climate profile of the Project area. Specifically, it looks at the impact of climate stressors on the Project and beyond. A climate stressor is a climate factor that can affect the functioning of a system. For example, rising temperatures and greater rainfall variability may affect agricultural productivity, with implications for food security. Climate stressors can also limit the potential success of development interventions.

9.1 Climate Change

Climate change has resulted in alterations in temperature and rainfall patterns worldwide. Although it is still very difficult to assess the consequences of these changes at a local level, it is evident that whatever the magnitude of the phenomenon, aquatic fauna will be affected.

9.2 Key Climate Policies

- Constitution of Kenya (2010)
- National Climate Change Response Strategy, NCCRS (2010)
- 2nd National Communication to the UNFCCC (2015)
- National Adaptation Plan, NAP (2015- 2030)
- Nationally Determined Contributions, NDC (2016)
- Green Economy Strategy and Implementation Plan, GESIP (2016-2030)
- National Climate Change Framework Policy (2016)
- Climate Change Act (2019)
- Kisumu County Climate Change Policy 2021
- Kisumu County Climate Change Action Plan (CCCAP) 2021-2026
- National Policy on Climate Finance (2016)
- Low Carbon Development Strategy espoused in Kenya's Second National Communication (2015).

9.2.1 General Circulation Model Projections for Kenya

According to a climate change study conducted for the United Nations Development Programme (UNDP) in 2010, an increase in mean annual temperature and an increase in annual rainfall is projected for Kenya as outlined in the sub sections below:

a) Temperature

The mean annual temperature is predicted to increase by 1.0 to 2.8°C by the end of 2060s, and by 1.3 to 4.5°C by the 2090s; All projections indicate increases in the frequency of days and nights that are considered 'hot' in current climate; and All projections indicate decreases in the frequency of days and nights that are considered 'cold' in current climate (McSweeney *et al.*, 2010).

b) Precipitation

The projections indicate an increase in annual rainfall in Kenya. The range spans changes of -1 to +48% by the 2090s; Projected increases in total rainfall are largest in the short rainfall season (-3 to +49 mm per month), but the proportional changes are largest in January-February (-7 to +89%); The models consistently project increases in the proportion of annual rainfall that falls in heavy events. The increases range from 1 to 13% in annual rainfall by the 2090s; and the models consistently project increases in 1- and 5-day rainfall annual maxima by the 2090s of up to 25 mm in 1-day events, and 3 to 32 mm in 5-day events.

9.3 Kisumu County Climate Change Profile

9.3.1 Climate change and variability: historic and future trends

The County is home to the third largest city[2] in Kenya, Kisumu, and covers a total land area of 2085.9 square kilometres (km2)[3] (GoK, 2012). It is bordered by Homa Bay County to the South, Nandi County to the North East, Kericho County to the East, Vihiga County to the North West and Siaya County to the West. Agriculture plays a major role in the economic growth and development of the County, contributing 47% to household income. Slightly less than two thirds (62%) of all households in Kisumu County[4] depend on crop farming for their livelihoods (GoK, 2012). On average, agricultural income amounts to 82,482 Kenyan shillings (KES) per household per year and is generated from crop faming (40% of on-farm income), fish (23%), and livestock (11%).

Fishing is one of the key economic activities in Kisumu County, especially around Lake Victoria. With the introduction of aquaculture, households have been increasingly investing in pond construction and maintenance. There are over 1,330 fish farms, 3,275 fishermen, and 189 fish farm families in the County. The most common fish include omena, tilapia, and Nile perch, which generate incomes of KES12 million, 28 million, and 11 million per year, respectively. The fish is sold locally[9] and also processed for export (GoK, 2013).

There is some variation in precipitation throughout Kisumu County, with the southern areas further from Lake Victoria receiving the most precipitation around 1750 mm, and the northern areas closer to Lake Victoria receiving 1000-1250 mm of precipitation per year. The temperature is consistently warm throughout the year. Precipitation also consistent throughout the year, although the first wet season (January-June) receives a slightly greater amount. Intense precipitation and heat stress are both hazards that contribute to agricultural risk in the County throughout the year, whereas dry spells are more an issue in the second wet season. Annual mean temperatures are 20.2- 20.80C with average annual rainfall being relatively high at 1050-1400mm.

Historic analysis of weather in Kisumu County shows that both dry spells and extreme precipitation are hazards in the County. Dry spells are on average longer during the second wet season and consistently close to 60 consecutive days of moisture stress, whereas moisture stress is consistently less than 30 days during the first wet season. Extreme precipitation and flood risks10 are moderate to low in both seasons, with most years receiving between 10 and 25 mm of precipitation on the wettest day.

Climate has already been observed to change slightly in the County. Since 1981, the first wet season—the predominant rains of the year—have experienced a moderate (1ºC) increase in mean temperature and associated reduction in crop cycle, and a small (~10%) decrease in precipitation on average. The combination of increased temperatures and decreased precipitation make for an increase in drought risk. The second wet season experienced a mild (~0.5ºC) increase in temperature, and a significant (20–30%) increase in precipitation. This has resulted in increased risk of flooding.

Looking to the future in the years of 2021-2065 (by the early 2040's), temperature is projected to increase by 0.4ºC, with the first wet season projected to experience even greater changes. And by this time, precipitation is projected to increase by 0.7% in the first wet season, and 3% in the second wet season[17].

[17] 1 Note that this is 20 mm on average over the entire County, so specific parts of the County will have experienced greater than this (possibly much greater), whereas other parts will have experienced less.
12 The two RCPs, RCP2.6 and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6 and +8.5 W/m2, respectively). The pathways are used for climate modelling and research. They describe two possible climate futures, considered possible depending on how much greenhouse gases are emitted in the years to come. RCP 2.6 assumes that global annual GHG emissions (measured in CO2-equivalents) peak between 2010 and 2020, with emissions declining substantially thereafter. In RCP 8.5, emissions continue to rise throughout the 21st century

Prolonged moisture stress is projected to occur in the first season of the year, whereas intense precipitation looks to change little in either season. Consecutive days of moisture stress is projected to almost double in the first wet season from approximately 25 days to around 45-50. In contrast, moisture stress in the second wet season is projected to decrease from 60 consecutive days of moisture stress to approximately 50 days. These projections of future climate change under the two climate scenarios—RCP 2.6 and RCP 8.512—show some small differences, but generally show the same future projections, suggesting climate change impacts will be similar during this time frame irrespective of greenhouse gas emissions.

9.3.2 Climate and Environmental Risks of Kisumu County

The County's strategic plan identifies population dynamics, environmental degradation, and climate change (amongst others) as key development challenges. Like all the communities around the Lake Victoria Basin (LVB), a large proportion of the County's residents depend on the Lake to support agriculture, fisheries, livestock and other livelihoods. The adverse effects of climate change disproportionately affect marginalized and rural communities, especially women and youth, by reducing the productivity of agriculture and wetlands, the abundance of fish in Lake Victoria and its tributaries, and loss of other ecosystem functions.

Effects of climate change includes;

- Threat to freshwater ecosystems, due to pollution and proliferation of invasive species
- Deteriorating water quality and quantity, declining fish stocks and loss of biodiversity, and
- Increased climate change-induced migration

9.3.3 Effect of Climate Change on Aquaculture

Most fish are poikilothermic, meaning that their body temperatures vary with the ambient temperature. Any changes in habitat temperatures will therefore significantly affect their metabolism and, consequently, growth rate, total production, reproduction seasonality and possibly reproductive efficacy, and susceptibility to diseases and toxins (FAO, 2008).

Impacts on aquaculture could be positive or negative, arising from direct and indirect impacts on the natural resource's aquaculture requires, namely water, land, seed, feed and energy. As fisheries provide significant feed and fingerling inputs, the impacts of climate change on them will also, in turn, affect the productivity and profitability of aquaculture systems (FAO, 2008). Vulnerability of aquaculture-based communities will stem from their resource dependency and exposure to extreme weather events.

The predicted increase in heavy rainfall events may result in flooding which can cause physical damage to farm structures, and consequential loss of fish. In addition, floods can cause great changes to water quality such as siltation or the transportation of pesticide residues from nearby agricultural practices. Flood waters may introduce predators into a farm, or new pathogens, and may also provide an opportunity for fish to escape confinement. Severe storms over Lake Victoria could damage project infrastructure including dykes and ponds resulting in the release of fish stock into the natural environment. Depending on the species and genetics of the fish farmed, this could have negative impacts on the wild fish stock.

Inland aquatic environments are critically dependent upon rainfall. Thus, any change in climate will have major consequences for the water balance that can cause an increase or reduction in aquatic habitats. In the case of drought, a decline in water resources will limit the carrying capacity of the ponds. Ponds located near the shore line could also be at risk. This could possibly drop the functioning of fish farm training center operations below profitable levels. The extraction of water for aquaculture during drought will exacerbate water shortages and could result in user conflict. Changes in temperature can also have significant impacts on the reproductive cycles of fish, including the speed at which they reach sexual

maturity, the timing of spawning and the size of the eggs they lay. Ultimately, the success of a fish farm operation is highly dependent on temperature, water quality and quantity. It is therefore imperative that the fish farmers are well informed of the climate characteristics specific to their regions and associated risks, such as 100-year flood levels and drought (FAO, 1989).

9.3.4 Climate Change Management Measures

For most climate change-related impacts, improved management and better aquaculture practices would be the best and most immediate form of adaptation, such as the ecosystem approach to aquaculture (EAA) management (FAO, 2008). Genetic knowledge and management in aquaculture are not as developed as in other husbandries and provide both a major challenge and an opportunity. Genetics can be improved resulting in more efficient feeding and diet specificity, and for increasing species resistance to higher temperature, lower oxygen and pathogens. Climate change may increase pathogen risks and so biosecurity and prevention measures need to change accordingly. Early identification and detection mechanisms may need to be improved, and suitable treatment strategies and products developed (FAO, 2008).

Table 13 Climate change-related impacts and potential adaptation measures in aquaculture

Climatic change element	**Impacts on aquaculture or related function**	**Adaptive measures**
Warming	Raise temperature above optimal tolerance range of farmed species	• Selective breeding and genetic improvements for higher temperature tolerance.
	Increase in eutrophication- mortality of farmed stock	• Improve planning and siting to conform to climate change predictions; and • Establish regular monitoring and emergency procedures
	Increased virulence of dormant pathogens and expansion of new diseases	• Set up biosecurity measures; • Monitor to reduce health risks; • Improve treatments and management strategies; and • Make genetic improvements for higher resistance
Extreme weather events	Destruction of facilities; loss of stock; loss of business; mass scale escape with the potential to impact on biodiversity	• Improve siting and design to minimize damage, loss and mass escapes; • Encourage use of indigenous species to minimize impacts on biodiversity; and • Use non-reproducing stock in farming systems

10 LIMNOLOGY, SOIL ANALYSIS AND BIOSECURITY/BIOSAFETY PLAN

This chapter details the limnology of the Project area, analysis of the laboratory analysis of the sampled lake sediment and biosafety/biosecurity plan of the proponent. The term Limnology is derived from Greek word; Limne means lake and logos means knowledge. Limnology is often regarded as a division of ecology or environmental science. It is however, defined as "the study of inland waters" (running and standing waters fresh and some times saline; natural or man made). This includes the study of lakes, ponds, rivers, reservoirs, swamps, streams, wet lands, bogs, marshes etc. Hence, it is commonly defined as that branch of science which deals with biological productivity of inland waters and with all the causal influences which determine it (Welch, 1963). Biological productivity, as used in this definition, includes its qualitative and quantitative features and its actual and potential aspects.

10.1 Baseline Parameters of the project area

The proponent's aquaculture training center project is to be located in Kabonyo/Kanyaguel ward, next to Lake Victoria shore line in Nyando Subcounty, Kisumu County. Lake Victoria is the largest lake in Africa (68,000 KM^2) with an average depth of 40M (130 Ft). The lake's shoreline is long (about 3,500 km) and convoluted, enclosing innumerable small, shallow bays and inlets, many of which include swamps and wetlands, which differ a great deal from each other and from the lake itself. The lake has a wide land catchment area, which is almost three times the size of the lake, and extends over the three East African countries together with Rwanda and Burundi. This is the area from which rivers carry water, nutrients, sediments and pollutants into the lake and is about 193000 km2 ; of which the catchment area in Kenya covers 42460 km2.

Lake Victoria has numerous wetlands on the edges of its shore as well as open beaches and islands. The coastline ranges from papyrus swamps to rocky and sandy beaches. The wetlands are important for fish breeding and growth; for filtering river waters; the wetlands plants are harvested for building materials by the riparian communities and are food for wildlife. The lake serves as an important reservoir for the region and for the larger Nile Basin. Because the lake is shallow (Fig. 2), its volume is substantially less than that ofother African Great Lakes, which have much smaller surface areas. Its total volume is about 2,760 km3 , only 15% of the volume of Lake Tanganyika, even though the latter has less than half its surface area. In the Winam Gulf of Lake Victoria, 8.1 billion m3 of water comes from rainfall over its surface and in-flowing rivers contribute 9.2 billion m3 . The rivers, which originate from and enter the Lake in the Kenyan catchment contribute 38% of the total river discharge entering Lake Victoria from land catchment, however River Mara, which enters the lake in Tanzania and contributes about 5% is mainly from the Kenyan catchment, therefore total contriution of Kenyan catchment is estimated at about 42% of land catchment input. Consequently activities in Kenya catchments potentially affect a substantial portion of the river discharge to the lake and especially in Winam Gulf. The table below indicates the discharges of several rivers that feed into Lake Victoria.

River discharges and their % contribution to Lake Victoria land catchment input.

River	Discharge, m^3s^{-1}	% Kenya basin	% Whole basin
Sio	11.4	3.5	1.5
Nzoia	115.3	35.0	14.8
Yala	37.6	11.4	4.8
Nyando	18.0	5.5	2.3
North Awach	3.7	1.1	0.5
Sondu-Miriu	5.9	1.8	0.8
South Awach	42.2	12.8	5.4
Kuja-Migori	58.0	17.6	7.5
Mara	37.5	11.4	4.8
Total, whole basin	778.3	100	42.4

Source: J .O. Okungu, et al

Studies on the water exchange between the Winam Gulf and the open lake have been undertaken under the water quality component. Measurements and modelling of the hydraulic conditions at the Rusinga channel has been a major objective to understand water fluxes and movements of water borned materials between the littoral and pelagic areas of the lake. The largest loss of Lake Victoria water (76%) is through evaporation from the lake surface the rest leaves the lake through the outflow into Victoria Nile at Jinja. The greatest input of water into the lake is from direct rainfall onto the lake surface (82%). Therefore only about 18% of combined rainfall and river inflow water exits the lake at the Nile. The Nile provides critical water supplies for nations beyond the basin and so there is continuous interest internationally, as well as in the basin, in the quantity and quality of water leaving Lake Victoria (***Khisa, et al.,***)

The literature on limnology of the Kenyan waters of Lake Victoria is rather scanty. However, xtensive measurements of water currents, temperature dissolved oxygen and winds on the Kenyan waters of the lake were done by Ochumba (1996). Hypolimnion temperatures as low as 23.5ºC observed in 1928 by Worthington (1930) in the 1950s (Fish 1957) and in 1960-61 (Talling, 1966) were not seen, suggesting a response of Lake Victoria to a possible warning trend in the climate of East Africa. Ochumba (1996) also reported that oxygen conditions have deteriorated since 1950. Hecky et al. (1994) concluded that low oxygen conditions are now more extensive and persistent than previous investigators had found. Aware of these immense benefits of lake Victoria, the proponent has taken every measure to conduct baseline studies to determine physio-chemical conditions of the project site before implementing the project. Regular water quality assessment have been carried out. Zooplankton dynamics in Lake Victoria was outline by Bransrator et al (1996), who suggested that the composition of cladocerans, calanoid copepods and cyclopoid capepods in the modern community were largely unchanged from historical conditions although the proportions may have changed

10.2 Fisheries Resources in the project area

Since the 1970s total fish catches have increased by between four and five times after the introduction of exotic species such as the Nile Perch (Mbuta). However, catch per fishing effort has been dropping while effort has continued increasing, indicating that the maximum sustainable yield is below the present level of exploitation. Furthermore, introduction of exotic species of fish has altered the food web structure of Lake Victoria, which has led to a dramatic decline in diversity of indigenous fish species. A number of original 300 species of fish are now extinct or facing depletion. Other factors which have affected the status of lake and riverine fisheries in the project area are: overfishing by use of small mesh nets and harvesting of brood stocks; destruction of fish habitats through river engineering; siltation due to

deforestation, algal blooms due to nutrient enrichment, pollution, wetland conversion and development, fish pathogens and water hyacinth infestation. It is important to note that the project area is on a government owned land measuring over 100 acres with mainly swampy black cotton soils and shrubs of vegetation. The site is currently used by locals for grazing and its prone to flooding during rainy seasons.

10.3 Project Site Soil Analysis

As mentioned previously, Lake Victoria receives waters of varying quality from several rivers, precipitation, recharge from groundwater; industrial and domestic waste treatment and disposal systems, urban and agricultural run-offs. These waters, rich in nutrients encourage biological activities within the lake that are a source of biogenic sediments. To a small extent, shoreline erosion is also responsible for the sediments found in the lake. The need to carry out sedimentation and sediment characteristics at the project site was to generate baseline information on bio-physical parameters of the project area sediments. This was important because of future monitoring of project/s impact on the lake sediment. The table below shows the results analysis of the sampled sediment in the project area:

Client:	**KFASTEC**	**Sample Type:**	Soil
Contact Details:	**0720985654**	**Sampler:**	CSI International Ltd
Sample ID:	Soil	**Sampling Date:**	30/08/2024
Lab Batch No.:	24/0520	**Lab. Ref. No.:**	CSI11771
Date Received:	30/08/2024	**Date Analysis Started:**	02/09/2024
Date Analysis Completed:	09/09/2024	**Date Released:**	19/09/2024

PARAMETER	METHOD	RESULTS	[1]STANDARD (Max Limits)
Physical Parameters			
pH	CSITP 002	7.12	np
Electrical Conductivity, µS/cm	CSITP 004	164	np
Total Dissolved Solids (TDS), mg/L	CSITP 012	107	np
Salinity, µS/cm	CSITP 004	Non-saline	np
Sodium as Na^{+}, % me	CSITP 003	0.46	np
Iron as Fe^{2+}, ppm	CSITP 003	<0.01	np
Zinc as Zn^{2+}, ppm	CSITP 003	0.99	np
Calcium as Ca^{2+}, % me	CSITP 003	3.36	np
Magnesium as Mg^{2+}, % me	CSITP 003	5.75	np
Copper as Cu^{2+}, ppm	CSITP 003	<0.01	np
Manganese as Mn^{2+}, % me	CSITP 003	0.38	np
Potassium as K^{+}, % me	CSITP 003	0.27	np
Sulphates as SO_4^{2-}, ppm	CSITP 014	5.00	np
Total Nitrogen as N, % (min)	CSITP 017	<0.01	np
Phosphorus as P, ppm	CSITP 018	9.05	np
Sodium Absorption Ratio (SAR), mg/Kg	AAS	0.06	np
Organic Carbon, %	CSITP 070	<0.01	np
Cation Exchange Capacity (CEC), meq/100g	CSITP 065	1.88	np
Exchangeable Sodium Percentage, %	CSITP 065	6.67	np

np - No standard reference for the parameter

Sediment Analysis Results

10.1 Biosafety/Biosecurity Plan

The proponent's biosecurity plan aims to prevent disease, improve fish welfare, and increase productivity and profitability. The biosecurity measures are designed to improving fish welfare and productivity to increase the efficiency of inputs and the sustainability of the system.

The objectives of the plan are to:

- better fish health and improved performance;
- mitigate the transmission and amplification of diseases between Fish ponds;
- allow for early disease detection so that impacts can be reduced;
- support claims of freedom from diseases that impact marketability and market access;
- facilitate translocation within and between production sites;
- reduce the risk of diseases from being introduced to the farm, spreading within the farm, or escaping from the farm;

- have emergency response protocols in place for serious disease outbreaks.

The biosecurity plan fulfills the legal requirement mandated by the Kenya Fisheries Service (KFS) and ensures that during project implementation, off-shore concessions are chosen and designed in line with the surrounding topography, assuring optimum water quality conditions for animal welfare. Ponds shall be spaced in order to assure water quality within each pond, reduce the risk of disease transmission, and minimize environmental impacts. Biosecurity and Biosafety plan covers both lake based and land based aquaculture of the proponent. All broodstock shall be produced on the farm and maintained within the fish farm. Upon maturation, broodstock will be moved to breeding ponds, allowing the tilapia to practice their natural breeding behaviours, including burrowing and mouth-breeding. Eggs shall be collected from the females' mouths and incubated in a hatchery building, where optimum water quality shall be assured through a recirculating aquaculture system (RAS).

10.1.1 Traceability

The proponent shall record for traceability all broodstock group that produced those eggs. Groups of broodstock shall be kept kept separately in ponds, and eggs from that pond will be labelled and identified by the pond of origin and date of collection. This identifying information shall be retained with the fry and fingerlings upon transfer to the pond nursery.

Disease checkpoints

Staff shall record observations for indications of disease at all lifecycle stages. Broodstock and fish at nursery and grow-out stages shall be observed for lesions, physical abnormalities, and irregular swimming and eating behaviours. Eggs and fry shall be observed for physical or other developmental abnormalities. Observations shall be reported to management and recorded. At all stages, mortalities shall be promptly removed from the environment and disposed of using biosecure disposal protocols. The daily number of mortalities shall be recorded for each pond.

10.1.2 Annual Biosecurity Risk Assessment

The proponent shall conducts an annual biosecurity risk assessment. The resulting report shall be stored in the main office and is used to inform annual revisions to the biosecurity plan. Audit reports shall also be stored in the main office.

10.2 HISTORICAL FLACTUATIONS OF LAKE VICTORIA WATER LEVELS VIS A VIS KABONYO/KANYAGUEL PROJECT SITE

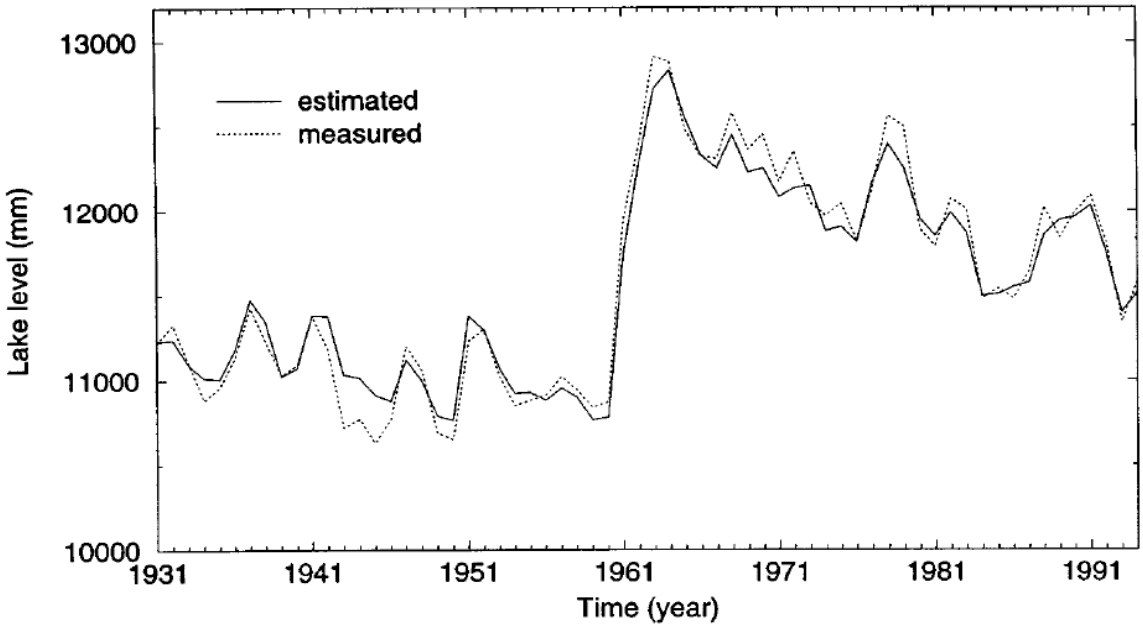
Lake Victoria is a resource shared by the three East African countries: Kenya, Uganda and Tanzania and supports a livelihood of about 30 million people living around it. Its fish products, (i.e., Tilapia and Nile Perch) are exported the world over. Its role as an indicator of environmental and climate change on long-term scales together with its global significance are documented, e.g., in Nicholson et al. (2000, 2001) and Awange and Ong'ang'a (2006). Though the lake has continued to attract worldwide attention due to its significance and other environmental phenomenon such as water hyacinth, the recent recede of its waters. The major rivers, namely; Sondu Miriu, Nyando, Nzoia and Yala, discharge into the Lake from the Kenyan side of the Lake while Kagera runs all the way from Rwanda and empties its waters in Uganda

Fluctuations of Lake Victoria have been recorded since 1780. Levels since 1896 are based on modern measurements and earlier years are reconstructed from historical references. The East African lakes have exhibited dramatic fluctuations on both historical and paleoclimatic time scales. Levels of these lakes, and other historical indicators in Africa, suggested that environmental conditions in the nineteenth century were much more extreme than anything evident in the modern record. Water balance model is used to estimate the rainfall associated with these conditions, based on the Lake Victoria record.

Dramatic fluctuations occurred during the nineteenth century (Nicholson, 1995, 1998a,b, 1999, 2000), suggesting a period of continent-wide desiccation in the first decades and markedly wet conditions in the

last few decades. The Figure below shows reconstructions of lake levels since 1800 spanning latitude 15_ N to 22_ S.

Figure 1: Predicted year-to-year changes in lake level, 1931 to 1994.



Source: Nicholson et al (2001)

Water balance model indicates Lake level changes during four historical and two modern periods and the corresponding changes in evaporation and over-lake rainfall

Figure 2: Lake level change during four historical and two modern periods and the corresponding changes in evaporation and over-lake rainfall

Period	$\overline{H}$ (m)	$\delta\overline{H}$ (m)	$\overline{P_w}$ (mm)	ΔP (%)	ΔE (mm)
1785–1835	10.75	–1.5	1552	–13	+228
1858–1878	12.65	+3.3	1941	+9	–160
1875–1878	12.95	+2.7	2433	+37	
1879–1889	12.00	–3.6	1528	–14	+248
1960–1968	12.48	+1.7	1939	+9	
1978–1986	11.84	–1.1	1651	–7	

The interpretation of the above table is that; for the historical periods rainfall is predicted by the model; for the modern periods it is assessed from actual rainfall data. The second column is the mean height from the end of the first indicated year to the end of the second indicated year, the third is the change in level between those years, and the fourth is the mean rainfall during the period bracketed by those years (i.e., for lake level changes between 1858–1878, mean rainfall calculated by the model is for the years 1859 to 1878). The fifth column expresses this as a percent of the 'modern' mean for the period 1956 to 1978. The final column indicates the change in evaporation that could produce the change in lake level indicated in the third column.

The model predicts means of 2433 and 1941 mm (historical and modern periods) respectively. Thus, the moderate rise of about 3.3 meters during the longer period could have been produced by persistent wet conditions with rainfall only 10% above the modern mean, but the abrupt 2.7 m rise in the late 1870s would have required that rainfall for the five-year period be about 37% higher than the modern mean. During the period 1879–1889, when the lake fell nearly 4 m in ten years, rainfall would have been about 1528 mm, or 14% below the modern mean.

The 2 m lake level rise from 1961–1968 was associated with an increase in rainfall of about 10% (Figure II). The 1 m rise in 1961 occurred as a consequence of over-lake rainfall on the order of 2486 mm/year (Nicholson et al., 2000), hence 41% above the long-term mean. Exceedingly high rainfall in a single year (such as 1878 or 1961) can produce high stands that can be maintained with much more moderate rainfall. Hence even single El Niño events can trigger persistent changes in the lakes. In fact, the lake level rise in 1876 to 1878 occurred during one of the strongest El Niño events of the last few centuries (Quinn, 1992). This is consistent with the well known association between El Niño and abnormally high rainfall in East Africa (Nicholson, 1996). The high levels of the early 1960s were also coincident with two major El Niños in 1963 and 1965 and the dramatic rise in 1961 was coincident with an El Niño-like warming in the Atlantic and Indian Oceans surrounding Africa. The study has demonstrated that the lake levels fluctuate annually and seasonally with significant drops during drought seasons and rapid rise during periods of above average rainfall in the region.

Bearing in mind the above historical context of Lake Victoria water level fluctuations due to environmental conditions and with respect to the Kabonyo/Kanyaguel Fisheries and aquaculture project, parts of the delineated project area are near permanently swampy and water logged due to mainly back flow from the lake and bursting of the river Nyando . Due to the low altitude of the project site, the area experiences a near permanent swampy features, thus proper water engineering model needs to be adopted for viability of the project. It shall be important for the master plan to protect riparian zones. If any development shall be allowed within the riparian, then it must be in harmony with the existing ecosystem and within the existing regulatory framework.

11 GEOLOGICAL MAPPING AND HYDROLOGICAL PROFILING

This Chapter describe Geological mapping and Hydrogeological investigation conducted at Kabonyo Regional Fisheries and Aquaculture Service Training Centre of Excellence (KRFASTCE), State Department for Fisheries Aquaculture & Blue Economy-Kisumu Region. Project area is within Kabonyo Kanyagwal village, Ugwe Sub-location, Kawino location, Kadibo Division, Lake Victoria South Catchment area, Lake Victoria South Water Works Development Agency, Nyando Sub-County, Kisumu County, Nyanza Province, Kenya. The main objective is to establish Geological rock formation, coverage, overburden, Physiography, Geomorphology, water bearing zones (aquifer zones), within the project area. Detailed Geological mapping and Hydrogeological investigation executed in the project area, lithological the area is underlain by lacustrine and alluvial sediment ,overlain by thick black clayey silt loam soil, Hydrogeologically aquifers penetration up to 250 (m), groundwater potentiality is good, adequately developed point sources serves all the year round. Regional Geology consist of Nyanzian System, Kavirondian System, Granitic Intrusive, and sediments.

11.1 Approach

This involved compilation of existing data, reports etc..., covering all aspects of water resource in the Project area (i.e meteorology, geology, hydrology, drainage, hydrogeology, soils, vegetation, land-use and demographic data); this included an exhaustive literature review. Unfortunately aerial photographs for the area were not available at the time of the investigation.

A field reconnaissance at every site was conducted initially geophysical investigation was done. The purpose of the field reconnaissance was to verify the interpretation of the geological and hydrogeological data obtained from the inventory and check on further geological and hydrogeological conditions. It provided the basis for the detailed geophysics fieldwork in the area which was to follow. The geology is one the key controls to aquifer occurrence and some deductions on the basis of bedrock mineralogy, petrology and structure assisted in the interpretations of the geophysical surveys. Lineaments were correlated with conducive features in the resistivity traverses.

Geophysical field measurements were carried out. This included electromagnetic profiling and both horizontal resistivity profiling and deep vertical soundings. The results provided information on underground conditions and the likelihood or striking sufficient water for a borehole. Results are presented on detailed site maps at an appropriate scale, mainly 1:50,000 and 1:25,000.

11.2 Ground Water Investigation

The approach for the groundwater investigation focused on:

a) Assessment of hydrogeological in the immediate vicinity of the village by analyzing geological data and borehole records to map important indicators of geological and hydrogeological conditions, structural weakness zones (lineations), rainfall , catchment conditions and boundaries, soils and vegetation. On the basis of this analysis combined with all other relevant available data a pre- selection of the site/sites for detailed geophysical investigations could be made.

b) Hydrogeological fieldwork, local conditions were inspected and observations made through mapping of existing shallow wells and seepage zones. In addition observations on relief and vegetation were made.

c) Shallow groundwater. Evidence of its occurrence may be apparent from a variety of featured, both natural and anthropogenic, but some hydrogeological interpretation is necessary to assess its significance. Shallow groundwater above thick regolith or weathered bedrock is indicative of greater groundwater potential since the sequence can be assumed to be saturated from shallow depths.

d) Geology. The geology is one the key controls to aquifer occurrence and some deductions on the basis of bedrock mineralogy, petrology and structure assisted in the interpretations of the geophysical surveys. Lineaments were correlated with conducive features in the resistivity traverses.

e) Geophysical fieldwork focused on areas selected from the reconnaissance survey. Initially traverses by means of resistivity profiling or electromagnetic profiling were carried out at promising sites where fault zones or deep weathering was suspected; resistivity soundings were used on a limited scale to verify observed anomalies, determine depth of weathering and the lithological nature of the regolith.

f) Data evaluation and site recommendation focused on sites with thickets weathering profile and greatest depth of fresh rock, or by preference on deep seated fracture zones. Regional characteristics of groundwater flow were considered seriously when selecting a drill site.

11.3 GEOMORPHOLOGY

Geomorphologically Nyanza region is divided into three different parts;-

- A gently sloping plain in the south-west bordering Winam and Nyakach Sub-County
- -A slightly steeper sloping plain in the north, bordering Muhoroni Sub-County
- -An elevated area in the East

Geomorphologically Kabonyo Regional Fisheries and Aquaculture Service and Training Centre of Excellence (KRFASTCE) is located within Kano Plain , underlain by lacustrine and alluvial sediment ,overlain thick black clayey silt loam soil.

In the larger part of the Kano Plain is covered by Pleistocene deposits upto 20(m) alluvium, **lithological formation encountered in the project area-(Kabonyo Kanyagwal)**. The Pleistocene deposits are nearly all lacustrine of origin, they vary from gravels to mudstones derived from erosion of the neighboring land masses .Deposition of the sediments took place in several stages, mainly during pluvial periods alternated by erosion phases during inter-pluvial periods. And aquifers penetration is up to 250 (m) of varying sequences of siltstones, sandstone, gravel and claystone.

The analyzed Geophysical data, revealed a possible prospective, exploitative weathered fractured zone. The four points investigated are viable for borehole development, the results acquired and analyzed data, revealed viable borehole penetration up to 250 (m), at any point Investigated in the project area .

11.4 Ground Water Characteristics

Although there is no data to draw piezometric maps, it can be deduced that groundwater flows from the volcanic and Basement aquifer to the alluvial aquifer in the Kano plains. During high rainfall, water percolates from the surface down to the groundwater aquifer storage. The groundwater level rises and the aquifer expands both laterally and vertically.

During periods of moderate rainfall, subsurface outflow from the area occurs through base flow along ephemeral drainage channels and groundwater flow from the aquifer into the alluvial plains. During low rainfall periods no surface outflow is observed. The aquifer discharges water only through slow groundwater flow, and evapotranspiration. During the dry season no recharge is experienced and the aquifer maintains its low salinity through hydrodynamic balance in such a way that the aquifer shrinks in size laterally and there is vertical decline in water levels.

When rainfall, runoff soil moisture changes and evapotranspiration data is known, the amount of water which is yearly added to the permanent ground can be estimated (recharge). For an accurate water balance calculations very precise and extensive hydrological data of the concerned area is required, which is rarely available. The present water balance study can only be regarded as estimation

11.5 Water Demand and Supply Analysis

Water demand is calculated by multiplying the overall activity level by a water consumption rate. Activity levels or water consumption rates can be projected using functions describing the specific characteristics of each demand site or activity level. As earlier stated, Kabonyo Regional Fisheries and Aquaculture Service and Training Center (KRFASTCE) project site is bordering Lake Victoria with a shore line of over 100 Acres of land. The project area is naturally swampy with a lot of water that comes from River Nyando flooding, and back flow of the Lake water during rainy seasons.

The average water demand shall be determined by the project population, activities and water usage patterns. This shall be determined after a detailed project design is out. The following formula shall be used to arrive at daily water demand of the project:

$$\mathrm{ADD} = \mathrm{LPCD} \times P + 10\% \times P$$

where:

- ADD — Average daily water demand;
- LPCD — Liter per capita per day; and
- P — Size of the population.

In addition, managing maximum daily water demand shall be crucial to ensure a reliable water supply during periods of high consumption. Strategies such as water conservation campaigns, peak load management, and infrastructure upgrades shall be implemented to effectively meet peak water demand while maintaining a sustainable water supply for all users of KRFASTCE project.

11.6 Traffic Impacts and management plan

KRFASTCE project shall be located in rural Kabonyo Ward, Nyando Sub-county, Kisumu County. The project is thus rural based. However, the project is expected to generate relatively high volumes of traffic during the construction phase in particular. It is therefore important to ensure that traffic is managed in a manner that facilitates efficiency as well as ensuring the safety of personnel and the local community. The vehicular traffic generated as a result of the Project not only requires management on Site itself, but also insofar as traffic impacts may be experienced along local road networks and in rural residential areas.

11.6.1 Licensing, Roads and Maintenance

The proponent shall ensure:

• All Project vehicles comply with relevant traffic and transport licencing requirements (such as with regard to licensing requirements relating to the transportation of over-sized loads or hazardous materials, including hazardous waste).

• All drivers of vehicles used during the Project shall have the requisite licences to operate any vehicle (or machinery) operated by them on Site or on any public roads.

- All Project vehicles shall have valid roadworthy certificates and licences.

11.6.2 Roads

Existing road infrastructure shall be used, wherever possible for providing access to the proposed project site. Where no road infrastructure exists on Site, new roads should be placed within existing disturbed areas, where possible. Environmental considerations shallbe taken into account when determining the alignment of roads to ensure the minimum amount of damage is cause to natural habitats. Any hard road surfaces constructed on Site shall be as narrow as possible and shall be designed so that (1) changes to surface water run-off are avoided, (2) erosion is not initiated; and (3) existing drainage is minimally altered. Internal access roads constructed for the purposes of the project shall be located away from drainage bottoms, wetlands and stream crossings shall be avoided, where feasible.

11.6.3 Vehicle Maintenance

All vehicles and machinery used during the Project shall be regularly maintained and repaired where necessary. In this regard, all construction and passenger vehicles used during the Project shall be inspected by an appropriately qualified mechanic every six months following the commencement of the Project. The Project Managers shall ensure that regular inspections are undertaken of construction and passenger vehicles to ensure that they are in good working order and are not overloaded. Road and storm water management infrastructure on Site shall be maintained by the proponent and contractor so as to facilitate traffic safety. Road borders shall also be regularly maintained to ensure vegetation remains short. This will enable roads to function as firebreaks. Gravel roads shall be sprayed with water to limit the generation of dust (where economically viable and environmentally acceptable). If the utilisation of water to limit dust generation on gravel roads is not possible for these reasons, an appropriate dust suppressant must be used for this purpose. Any potential road hazard or vehicle defect which may render a vehicle or road unsafe for use shall be immediately reported to the Project Managers who shall ensure that the vehicle/road is not used until the necessary repairs have been undertaken. Road borders shall be regularly maintained to ensure that vegetation remains short and that the roads serve as an effective firebreak.

11.6.4 Routing and direction of traffic and site access

The movement of all vehicles to and from Site shall be along designated public roads and site access roads. The most appropriate route for large Project vehicles (such as trucks and buses) transporting equipment, materials and employees (along public roads) to and from the Site shall be determined by by the contractor in consultation with the local county government, local road traffic authorities and the local community. Any anticipated or scheduled traffic delays occasioned by Project vehicles (such as abnormal loads, i.e. the transformers) shall also be co-ordinated with local traffic authorities in advance.

The speed limit on the Site and access roads shall be 30km/h for construction vehicles and 40km/h for light vehicles and passenger vehicles. All speed limits applicable to public roads shall be strictly adhered to by all drivers operating vehicles as part of the Project. The failure to adhere to the prescribed speed limits is an offence and disciplinary action may be taken by the proponent and the contractor.

It is the responsibility of the Project Managers in consultation with the Construction Safety Officer to ensure that signage is conspicuously placed at appropriate locations along all access roads, and public roads (in consultation with the relevant traffic authorities) to indicate the following:

- Road hazards such as blind corners or loose gravel;

- Appropriate speed limits;
- Turning traffic;
- The Site access;
- Routes to be used by construction vehicles, where appropriate;
- That caution should be taken by motorists or pedestrians;
- No-go areas for vehicles; and
- Any traffic control information which may be relevant in the circumstances.

Any signage erected in terms of this Plan must be secured against being blown over or out of position by the wind or by passing traffic. In addition, they should be located so as to provide adequate warning of hazards. Signs located on two-way roads should be visible to traffic traveling in both directions, and care should be taken to ensure that signs are not obscured by vegetation or dirt.

Vehicle and pedestrian safety shall be emphasised in the Safety Induction Training required to be provided by the Contractor. All employees and construction personnel shall be trained and informed as to the dangers and risks posed by construction and other traffic, such training shall also include appropriate precautionary measures required to be undertaken to facilitate safe and efficient traffic management (e.g. checking for traffic before crossing roadways and utilizing designated pedestrian routes). Drivers shall be adequately trained in the recognition and avoidance of road hazards, vehicle maintenance and safety requirements.

The traffic safety procedures, transport routes and construction schedules intended to be applied during the construction phase shall be finalized in consultation with members of the local community, the local authority and affected landowners prior to the commencement of construction activities. The scope of such engagement should include the designation of routes for construction vehicles, procedures for complaints and emergency procedures shall be concluded in consultation with local community members, affected land owners and local emergency and traffic authorities.

11.6.5 Emergency Responses and Reporting of Hazards

In the event that any traffic hazard is identified on Site by any person or Project personnel, such hazard shall be immediately reported to the Site Manager who shall take the appropriate measures to avoid an incident or accident being caused. Drivers of project vehicles will be required to undertake first aid training and all project vehicles shall carry first aid supplies which should be adequate to cater for the number of passengers carried on the vehicle in question. In the event that an accident occurs on-site or off-site, the on-site emergency procedure shall be followed. In the event that an accident occurs off-site, it shall immediately be reported to the relevant emergency service providers by the driver, and in the event that the driver is incapacitated, by any other passenger on such vehicle.

11.6.6 Review of this Plan

During the operational phase, the Plan shall be reviewed annually by the Project Manager unless there is an accident, in which case the Plan shall be reviewed immediately after the accident and appropriate corrective measures are incorporated into this Plan to avoid similar accidents in the future.

12 CONCLUSION AND RECOMMENDATIONS

12.1 Recommendations

From this EIA process, the project's potential shall be beneficial to the community and has attracted the attention various stakeholders including government, politicians and civil society. The proposed project will provide employment and additional income to local fishers and increase the supply of fish protein, enable technology transfer in terms of aquaculture training and generally improve the economy of the region. Its main effect will be to reduce pressure on native fish by diverting fishers from fishing of wild stocks to aquaculture and thus provide alternative livelihoods. However, like in other aquaculture systems, there are several constraints which limit the implementation of the project. Poor road network in the area, expansive construction materials, swampy soils and flooding are among the various challenges the project will face.

As more fishers turn into fish farmers, it will be necessary for provision of more support to local community and neighboring regions to learn and implement the knowledge that will be acquired from the project. Because fish feeds are still unavailable in most Kenyan markets, farmers could start production of their own feeds. The results of land based aquaculture production trials within the area indicate a relatively high growth of fish using pond culture technologies. Thus, aquaculture can be practiced in Kenya can be economically and environmentally sustainable with proper production and marketing value chains.

12.1.1 Specific Recommendations

From the detailed environmental and socio-economic analysis of this project, the experts are of the opinion that this is a viable project, hence we recommend that NEMA approves it and issues an EIA license; since the EIA process reveals that this project does not have serious negative environmental impacts, and for the impacts identified, adequate mitigation measures have been spelt out in the EMP.

We further recommend that the proponent and contractors implement the recommendations in the environmental management plan and those in the health, safety and accident prevention action plan. This is to ensure that the potentially affected environment is well managed and that accidents are prevented during project implementation.

The proponent needs to continue complying with the relevant legal and policy requirements about project implementation. NEMA and other relevant authorities need to continue raising public awareness of EIA requirements.

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ANNEXTURES

1. Copy of Title Deed
2. Copy of Approved Tor
3. Evidence of Public Participation
4. Geological Mapping Hydrological Investigation
5. Air Quality Assessment Report
6. Noise and Vibrations Report
7. Base Project Soil Analysis Report
8. Recent Land Survey Report
9. Land Resettlement Compensation Gazzette Notice
10. Engineering Site Visit Report
11. Approved Bill of Quantities