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Preliminary Design & Detailed Technical & Financial Feasibility Study for the proposed cage-based AquaPark in Mwena, Kalangala district, UGANDA

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Under the coordination of

Agrotec spa

Context

The contents of this document are in direct reply to the formal awarding of a Short-Term Technical Assistance (STTA) to Nicolas De Wilde, Senior Aquaculture Consultant at **AquaBioTech Group**, for the undertaking of a Preliminary Design and Detailed Technical & Financial Feasibility Study for a proposed AquaPark site in Mwena, Kalangala District, Uganda.

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Disclaimer

The contents of this publication are the sole responsibility of the author and can in no way be taken to reflect the views of the European Union.

List of Acronyms & Abbreviations

ACF	Agricultural Credit Facility
AfDB	African Development Bank
AquaPark	Aquaculture Park
CAPEX	Capital Expenditures
DAIMWAP	Department of Agricultural Infrastructure, Mechanization and Water for Agricultural Production
DAMD	Department of Aquaculture Management & Development
DiFR	Directorate of Fisheries Resources
DSIP	Agriculture Sector Development Strategy and Investment Plan
EU	European Union
EUD	European Union Delegation in Uganda
EDF	European Development Fund
ESIA	Environmental Social Impact Assessment
FAO	United Nations Food and Agricultural Organisation
FCR	Feed Conversion Ratio
g	grams
HDPE	high density polyethylene
IRR	Internal Rate of Return (Financial Internal Rate of Return)
MAIFF	Ministry of Agriculture, Animal Industry and Fisheries
$mg.L^{-1}$	Milligrams per litre
MoFPED	Ministry of Finance, Planning & Economic Development
MTTI	Ministry of Tourism, Trade & Industry
MWE	Ministry of Water & Environment
NaFIRRI	National Fisheries Resources Research Institute
NARO	National Agricultural Research Organization
NPV	Net Present Value
OPEX	Operational Expenditures
P	Phosphorous
$[P]_i$	Phosphorous (initial)
$[P]_f$	Phosphorous (final)
P_{feed}	P content of feeds
P_{fish}	P content fish carcasses
P_{env}	P loses to the environment
PAT	Profit After Tax
PESCA	Promoting Environmentally Sustainable Commercial Aquaculture in Uganda project
PO	Producer Organizations
PPP	Public Private Partnership
PVC	Polyvinyl chloride
RAS	Recirculated Aquaculture System
ROA	Return on Assets
STTA	Short Term Technical Assistance

TiLV	Tilapia Lake Virus
TORs	Terms of Reference
UGX	Ugandan Shillings
UIA	Uganda Investment Authority
USA	United States of America
USD	United States Dollars
UWA	Uganda Wildlife Authority
WACC	Weighted Average Cost of Capital

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1. Executive summary

Background

Fish is one of the priority commodities that MAAIF has identified within the Agriculture Sector Development Strategy and Investment Plan (DSIP) 2010/11 – 2014/15, and preliminary discussions on the new Agriculture Sector Support Plan 2015/16 – 2020/21 confirm that fish will continue to be a priority commodity for the Government of Uganda. Alongside this recognition, aquaculture is seen by the Government as a vital sub-sector, aiming to improve livelihoods, provide jobs and improve food and nutrition security for its people.

The Project Promoting Environmentally Sustainable Commercial Aquaculture (PESCA) in Uganda, which is funded by the European Union under the 11th EDF, emphasizes that the future commercial aquaculture sub-sector will be dominated by and operated by the private sector with profit and return on investment as the driving catalyst for this to happen.

In the context of PESCA, this Preliminary Design & Detailed Feasibility Study conducted for the proposed AquaPark development project in Kalangala is intended to follow the principles and concept developed by the previous report prepared by Poseidon and submitted in final form in early 2013. It is also intended to look in more detail at what is the reality on the ground in the particular locations and sites to be developed and inform of the financial feasibilities of different size of cage farming operations under a public-private partnership type of organisation.

Site suitability and carrying capacity

Mwena bay, on Kalangala island, hosts a fish landing site that was established under an afDB find in 2004 and which was selected to be the headquarters of the AP operations due to a number of facilities already available. NaFIRRI implemented field surveys to assess water quality and site suitability of the areas around Mwena landing site. The results of these assessment show that the sites are suitable for the establishment of cage-based commercial operations.

A carrying capacity assessment was developed based on field data and a set of realistic assumptions where data were not available. The model estimated a nearly 21,000 tons/year production capacity for the selected area around Mwena Landing site.

Sites that would ensure best operating performances of modern commercial cage farming were identified within the perimeter of the study area and preliminary specifications were developed for the water-based equipment (cages, mooring, platform, boats) as well as for the land-based support functions. The current perimeter of the landing site will need to be extended in order to accommodate the required extra facilities, such as the feed store, net store, etc.

Business model and financial assessment

The business model proposed in the Poseidon study (Poseidon, 2013) was followed and updated based on industry standards and realistic KPIs observed in similar aquaculture operations in Africa and Uganda in particular, whereby the fish farmers would operate as outgrowers. A cooperative company would provide key operational inputs (feed, seed) and services (management, fish processing, marketing and sales). Production models for three sizes of operators, Small – Medium – Large were developed in order to assess their corresponding financial performances. The total combined production of these three operators reaches nearly 2,200 tons/year.

Detailed investment, revenue and costing analysis were developed for each of the business entities and comprehensive financial models developed to inform business planning. The emphasis was put on realistic assumptions and KPIs feeding the financial assessment.
In terms of budget available through the current project programme estimate (MAOPE), it was indicated that the cost of such an operation established through this study, should not be limited by the MAOPE budgets, but to outline what is required to put a professional and up to date production operation on the ground (as it is to be used as a model for future investment). Extra funds required, if any, would be assumed from other sources.

The sensitivity analysis shows that the key variables driving the financial viability of all fish farming operations are the feed price, the food conversion ratio (FCR), and the fish price. Due to the assumptions used and the careful analysis that has ensued, it can be seen from this report that there is a *fine line* between achieving profitable operations and losses.

Nevertheless, in the context of the current sector in terms of its development stage in the country, there is a profound issue of costs of production versus market prices. Current prices and those used as a base case in this study, together with feed costs achievable at the current time, result in positive profit for all partners as presented in table I. The NPV and IRR are positive for all three models of outgrowers, indicating that the investments are financially viable.

Table I: Summary of financial performances of the 4 entities under **the base-case** considered in the cooperative business model.

		Small Grower	Medium Grower	Large Grower	AP Cooperative
Production capacity	**tons/year**	**104**	**312**	**1,743**	**2,159**
Capex	UGX	395,675,922	1,235,753,953	6,804,507,182	10,114,517,381
Normalized Financial performances (15 years average)					
Yearly revenue	UGX / year	1,223,763,668	3,671,291,003	20,493,962,221	18,210,542,544
Operating profit	%	20.2%	14.9%	21.1%	3.0%
Net Income	UGX / year	174,133,972	387,069,016	3,036,411,013	338,828,628
Net Income	%	13.7%	10.0%	14.3%	1.9%
ROA	%	20%	17%	20%	3.7%
Current Ratio		8.0	6.2	8.3	n/a
IRR	%	56%	40%	56%	15%
NPV (*including post tax grant)		321,309,905	532,847,614	5,670,229,218	1,450,696,555*
Break-even point (production / year)	tons/year	31	156	420	
Pay-back period	years	2.63	2.66	2.63	8.28

Focus on the key determining factors for success, as indicated here, are now a major step to bring the sector to its full potential, including ensuring investment in the sub-sector is attractive to larger investors – itself an overall objective of the PESCA project.

In summary key components of the study outcome relate to:

- PESCA grant funds covering the set-up capital for a proportion of the infrastructure
- Key financial inputs required for Working Capital – various items are covered, but the key Working Capital cost is the upfront cost of feed, prior to selling the fish – this Working Capital input is required for the main core operator, as well as the out-growers: Where does this money come from? The study assumes it comes from equity and debt from those investing in the AquaPark.
- Current sales price achieved (UGX 8,000 per kg) is used as a starting point in the model with 0.5% annual increase, but it is largely affected by competitive forces from the capture fishery tradition and distribution approaches
- Current feed prices are used
- FCR of 1.6 (grow-out) – which is representative of what is being achieved in Uganda at this time – is used as a starting point and gradually improving year after year to reach 1.4
- Tax payments are assumed
- Consequent results suggest that with these and other assumptions used as the base case the profitability and financial viability of the projects are possible.
- In the absence of funding to cover the infrastructure and equipment expenditures, the project is financially non feasible.

Way forward

It is suggested that the Project now reviews in detail the results of this study and that possible scenarios are envisaged as to a way forward, keeping the overall project objectives in mind and in the context of potential changes during the project period related to the key success factors identified. The outputs of the Project are all focused on these key success factors, so we can expect improvement as a result.

2. Background & scope

2.1. Background

Fish is one of the priority commodities that MAAIF has identified within the Agriculture Sector Development Strategy and Investment Plan (DSIP) 2010/11 – 2014/15, and preliminary discussions on the new Agriculture Sector Support Plan 2015/16 – 2020/21 confirm that fish will continue to be a priority commodity for the Government of Uganda. Alongside this recognition, aquaculture is seen by the Government as a vital sub-sector, aiming to improve livelihoods, provide jobs and improve food and nutrition security for its people.

It is also recognised that as a commercial industry aquaculture remains underdeveloped, albeit with significant potential for development into a viable sector in Uganda. This is also interpolated to indicate that the sub-sector could produce critical volumes of fish to fill the growing gap in national fish supply, as wild fish catches continue to decline, the national population grows and the demand for raw material for fish value addition continues.

The role of imported fish, which also has a valuable contribution to the overall food and nutrition security requirement for the country, will continue, although trends in imports of certain species can have a negative effect on farmed fish species if not carefully controlled. Tilapia imported very cheaply to the region, including Uganda, is deemed to be having a key negative effect on business investment for farming fish in the region, as price competition is significant and therefore it increases perceived risks for investment in the aquaculture sector. Trade limitations on cheaper tilapia imports, primarily from Asia, are being implemented, but still this fish is entering the regional markets, including reportedly Uganda.

Generally, countries tend to export high value products and import more affordable products, thus satisfying the need for foreign currency, whilst maintaining a focus on national food and nutrition security; a balance has to be struck with national production and imported food, to cater for the various layers and segmentation of markets, which are determined mainly by the willingness and ability to pay, as well as geographical location and access to suitable supplies in local markets. Cheaper imports of tilapia have a place, where a population seeking fish, but unable to afford locally produced fish, will benefit. Post-harvest losses from fisheries is also significant and means quality and volume that could be available fails to reach markets for human consumption. As a source of protein, reducing these loses has huge potential to feed the growing populations.

Within the context of the Project Promoting Environmentally Sustainable Commercial Aquaculture (PESCA) in Uganda, which is funded by the European Union under the 11th EDF, it is recognised and captured in the various project documents, that Uganda has great potential for developing aquaculture beyond small volume production models into larger commercial scale production operations using both cages and land-based systems for tilapia (cages) and catfish and tilapia (land-based ponds). A small number of small-scale commercial level farms are beginning to emerge in Uganda and also surrounding countries, not least Kenya, Rwanda and DR Congo, which are taking advantage of lake waters and various sites for pond production. At this stage, most of these commercial enterprises remain relatively small in relation to what is envisaged in the coming years; the largest producer in Uganda at this time is approaching 1,000 Mt per year production.

PESCA emphasises and recognises that the future commercial aquaculture sub-sector will be dominated by and operated by the private sector with profit and return on investment as the driving catalyst for this to happen. In conjunction with this, value chain development throughout, which has core inputs (seed, feed, capital), production (fish grow-out) and marketing (post-harvest, distribution, logistics) components, together with the critical support mechanisms from the government side, where legal frameworks, policies and regulatory structures will need to be established, promoted and well-enforced to support the value chains as they expand. The various value chain activities that will emerge as either private sector or government led are part of the process that the Project hopes to address, with again, emphasis on having private sector recognise the potential for various core value chain inputs.

In general, global markets for fish and fishery products are expanding, representing a growing potential source of foreign currency earnings for many developing countries such as Uganda. Generally, noticeable trends include:

- There is a rise in share of total trade from developing countries with the principle markets being the EU, USA and Japan; these markets have been the modern focus for fish exports from many countries, as they are deemed to have a large population and are willing to pay higher prices for fish. With this focus, continued and increasing competition in these particular markets, means that these traditional international markets are becoming less profitable and attractive as a key market focus.
- Production of food fish from aquaculture on a global scale is now over-taking production from capture fisheries, indicating a significant shift in supply;
- There is a significant increase in regional trade in developing countries, which has been attributed to the increasing costs of exporting to the more distant, more sophisticated markets (such as EU/USA/Japan), in terms of transport costs but importantly the costs associated with compliance with import standards and legislation in those markets. A shift to regional markets is beginning to be an easier option for many up-and-coming suppliers of fish and competition regionally is less daunting as it is still in a less developed marketing system and rules are easier to comply with. Shorter distances make management and distribution less complicated as well, although in many instances on the continent of Africa, international road transportation systems in particular is still a major cost barrier, and this coupled with long and arduous border procedures remain a negative in the profit equation.

- Competitively, Tilapia, as with a few other farmed fish species (salmon, prawn) is a global commodity. A commodity level market must compete on consistency of supply and importantly on price. To join such a marketing system, farmed fish must align a number of factors if price competitiveness is to be achieved. Cost reduction is a key component of such a competitive market environment, which with fish farming means growing fish to market size as fast as possible for the least cost. This entails breed selection processes to ensure faster growing fish are used for production. Feed costs, as a large percentage of overall costs, are critical and quality and feed conversion ratios have to be superior. These factors together with superior operational efficiencies, technology and economies of scale during production and distribution allow entry into such markets. Volume production and low margins dictate success in these commodity-based production systems. At this time, Uganda is not part of this system as it lacks most of the factors described above. A particular constraint at this early stage in commercial fish farming is the high cost of appropriate fish feed mixes for particular growth stages of fish, which has forced most serious players to seek feed from outside the country.

Whilst these trends are not new news, it does remind us that as Uganda starts to develop a commercial sector, national and regional markets are a more realistic starting point than the more distant global markets, and with a diverse national/ regional customer base, focused attention to market segmentation (based on price), value addition where appropriate to differentiate with existing capture fisheries, which still have a hold on the market in terms of price and consumer preference. These key demand dynamics and supply realities have to come together.

Regionally Uganda is surrounded by substantial population that extends from Sudan to South Africa and is certainly worthy of consideration for fish marketing and sales strategy development. Within this on the West is DR Congo, with an insatiable demand for fish products from the whole region and will be perhaps the most significant buyer of fish for years to come. Within reach is a wider region that includes the Middle East, where consumers and standards of living are pushing fish prices higher and certainly have shown interest in products from the Great Lakes region in East Africa and a high unsatisfied demand due to lack of local sources of fish. Generally, in the region a developing middle class is showing its beginnings as a potential market for better quality products, not least food products, thus offering potential for a higher paying customers and value addition strategies targeting such buyers.

A benefit that has come from previous success, and more recent failure is the well-documented case of Nile Perch in the region, particularly from Lake Victoria. Exports of Nile perch fillets to Europe provided significant revenue to Uganda, as well as Kenya and Tanzania, and for a while was a great success for the region, but competition from Asian fish in Europe (notably *pangasius*) has slowed this success to a point now when many factories are closing or operating at very low capacity and profit levels; without new options these factories (fish processing plants) will surely be out of business. The legacy of the now dwindling Nile perch processing industry is however a well-established processing knowledge and infrastructure (landing sites, processing facilities, transportation, laboratories and certification systems) that meets the higher standards from Europe and other markets; this is now under-utilised through a lack of fish and markets for fish to utilise this capacity. Potential clearly exists to merge this former processing industry with a burgeoning fish farming sector.

Uganda is in transition between a capture fishery, with significant international exports from Nile perch and local food production from Tilapia and others, and now potential for fish farming to take over that position. Whilst efforts to revitalise capture fisheries are ongoing and may show some success, the real future will be fish farming; this statement is made with the proviso that market demand, fish price, ability to pay and physical availability/ access will have the same impact as they have always had and approaches to marketing will dominate how production, sourcing of inputs, and their management is organised, if businesses are to be profitable and the sector is to grow.

Aquaculture Parks

The PESCA project has been informed from an important feasibility study undertaken (Poseidon, 2013) that Aquaculture Parks (AquaParks) have the potential to be part of a structural strategy sector to increase fish production in the country. Countries such as Vietnam, Philippines, Indonesia and others have utilised this approach very successfully in terms of fast growth of production. Inspiration from this feasibility study has resulted in the EDF 11 funding for Uganda, which is now underway as the PESCA Project. A key output established under Result 2 of the project is to develop this concept in the Uganda context, detail studies, designs and final construction and operation of two such AquaParks in the country. These are to be located in Kalangala District at Mwena landing site; water-based (cages for tilapia), and in Apac District; land-based (ponds for catfish and tilapia). These are to be then operated under a PPP style arrangement with Government of Uganda, together with a core technical operators and other sub-operators focused more on production. This AquaParks concept is currently being developed and this study in particular is looking at the preliminary design and technical/ financial feasibility for the cage-based AquaPark in Kalangala. The AquaParks will focus on demonstrating production techniques that are modern, have professional management and with a community perspective and strategy for growth of production. Through these *pilot* fish farming models, the Project hopes to stimulate further interest in commercial fish farming from serious investors, who might follow a similar AquaPark model to produce fish at a commercial scale in Uganda.

Objectives of this assignment

Within the context of the information provided above, a Detailed Feasibility Report, including preliminary design is the key objective of this particular contract. It is a key stage in the preparation for final detailed designs for the AquaPark in Kalangala District and will inform the process of procurement for actual construction of buildings and equipment critical to its operations. The Feasibility Study is to be a robust and defensible document that will be carefully reviewed and approved before the next stages can commence.

This assignment has included missions to Uganda for site visits and data collection, and has worked in tandem with site suitability studies, including calculations of carrying capacity and assessments of existing facilities at the site (a fish landing site), as its main base for the land component of the cage-based AquaPark. This report provides details of all activities undertaken, analysis and results, and presents the preliminary design, technical and financial analysis. This Feasibility Study is the step before commencing the detailed engineering design and equipment specification for the AquaPark in Mwena; once it is approved, the detailed engineering will proceed.

Annex 5 presents the Terms of Reference (TORs) for this work.

2.2. Objectives of the AquaParks in the Uganda context

2.2.1. The concept of AquaParks

Commercial aquaculture is quite a recent industry in the country, and sourcing quality feed at reasonable price is one of the biggest challenges that one can face when launching a fish farming activity. The same apply for seeds, with limited suppliers of good quality fingerlings. On the market side, access to fair price is equally challenging due to the intermediate traders who tend to maximize their margins by pushing the fish farmers' prices down. Hence, such business activity can look challenging to step into for small-scale farmers or new entrants in the sector.

Producer Organizations (PO) provide the opportunity to overcome these challenges. The primary intention of such organizations is to improve competitiveness of their members by providing services or inputs at competitive pricing thanks to the economies of scale they generate by gathering farmers together in the value chain. The increased bargaining power allows to negotiate prices with suppliers on one side, and with customers on the other side.

There are various forms of PO possible, such as the association, the cooperative, the company, or a combination of these. Small scale farmers will benefit from the PO at the condition that they can meet the requirements and foresee an increased profitability. It can also benefit nonmembers of the community by generating workforce requirements and generating new services requirements. Following the previous feasibility study undergone in 2013 (Poseidon,2013) and recommending the establishment of a cooperative-like business model to operate the AquaPark, this is the model of PO that will be further discussed and assessed in the financial study.

A cooperative is defined as a business or organization that is owned by and operated for the benefit of those using its services. Cooperatives are common in the agriculture, food, grocery retail, healthcare, service, retail, and many other industries. The cooperative approach intends to improve the skills, efficiency, and competitiveness of its members by acting as an intermediary on their behalf in the value chain. The main economic and sustainability benefits are:

- lower costs through economies of scale
- increased access to input and output markets and services
- increased bargaining power
- increased confidence and influence

In the case of the AquaPark, the cooperative would provide business-oriented services as listed below:

- Input supply: procure feed at more competitive prices thanks to bulk orders directly from suppliers without passing by local traders and produce fingerlings directly onsite that are sold at production cost plus a small commission (lower than from private hatcheries).
- Production services: supply of equipment (harvesting boat and team) and extension services (trainings)
- Coordinating production: support farmers with production management
- Marketing strategies: research on market trends, opportunities, negotiation
- Processing services: provide facilities and manpower for processing fish prior to sales (sorting, washing, chilling and packing)

- Quality control: monitoring quality of fish ready for sales
- Credibility: legal entity selling fish

Other services that the cooperative could provide in the future:

- financial services by providing inputs of credit basis or providing loans
- Retailing: detailed sales at higher prices than bulk sales.
- Trading: buying and selling fish from non-members
- Social services

The cooperative plays an important role in the marketing of the end products, developing new sales strategies, and staying informed of the market trends and requirements. It is therefore important to have experienced and skilled management in business and marketing.

The farmers gathered in a cooperative will elect a board of directors. That board of directors will then hire managers to be responsible for operating and monitoring the technical and financial performances of the organization. Generally, the managers are not selected from the farmers themselves but rather hired for their expertise.

The profits from sales of the cooperative can be either transferred as retained earnings and used by the organization for its future needs, or shared back to the members in two ways:

- on an investment basis: depending on the amount each farmer has invested in the cooperative;
- on the patronage principle: depending on the product share each farmer supplied

As with any collective actions, operating a cooperative will have its own costs and risks, the main ones being listed below:

- Internal transaction costs: the PO purchase, provides or delivers inputs and services for its members incurring internal cost to the organization, which can be very high especially in the case that the cooperative is not managed efficiently (Oxfam source)
- Free riding: some farmers may abuse the system and provide lower quality products than others, benefiting from the efforts of most of the farmers.
- Increased profile: operating as a business means incurred costs (taxes, etc.), which other small farmers may not have to cover or at lower cost.

Therefore, the profitability of the organization depends on the balance between costs and benefits of services provided: they have to be attractive for its members while still being able to cover the costs involved.

2.2.2. Objectives of the AquaParks in Uganda

The National Investment Policy for Aquaculture Parks in Uganda (MAIFF, 2012) sets specific policy objectives along with strategies and recommendations for its effective implementation. It clearly targets the development of commercial AquaParks and intends to attract and enhance their development. The concept of the Aquaculture Park value chain developed by MAIFF is presented in figure 1.

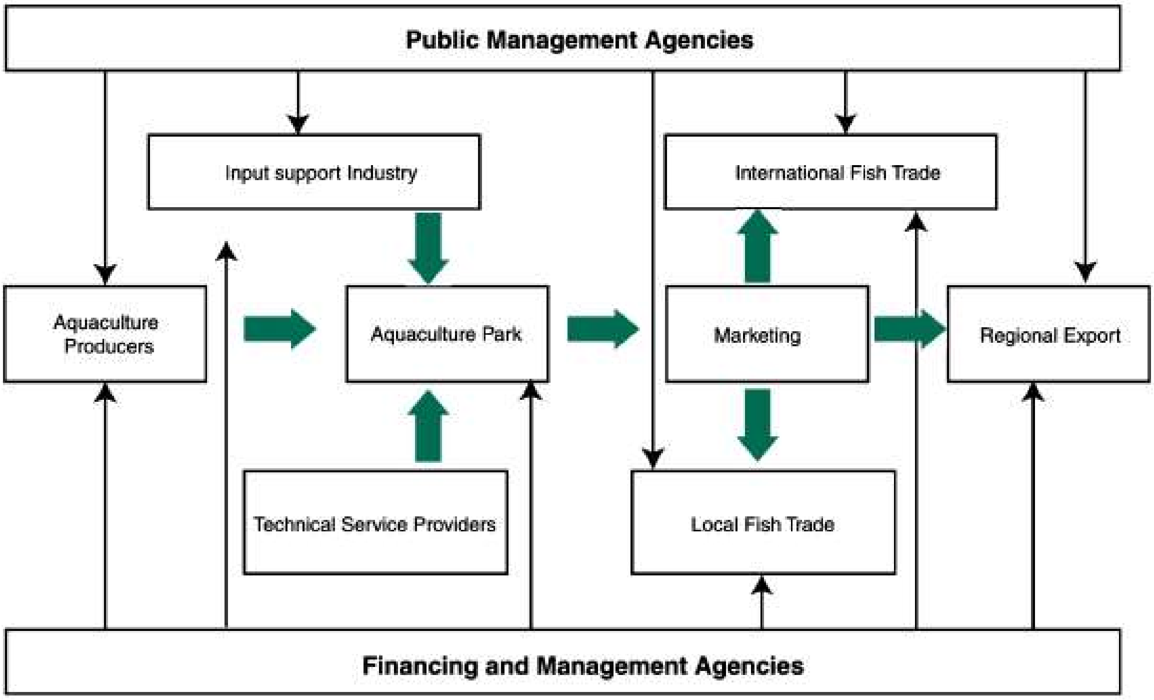

Figure 1: The concept of AquaParks value chain (MAIFF, 2012).

2.3. Regulatory framework

A number of laws, regulations and policies have been developed to stimulate and support the development of aquaculture activities - and Aquaculture Parks in particular - in Uganda.

The key institutions and authorities involved in the coordination and implementation of the Aquaculture Parks policies and monitoring of their activities are:

- The National Planning Authority of the Ministry of Finance, Planning and Economic Development;
- The Ministry of Agriculture, Animal Industry and Fisheries through the Directorate of Fisheries Resources;
- The Directorate of Water Resources within the Ministry of Water and Environment (MWE);
- The Ministry of Lands and Urban Development;
- The Ministry of Tourism, Trade and Industry (MTTI);
- The National Environment Management Authority (NEMA);
- Uganda Investment Authority (UIA);
- Uganda Wildlife Authority (UWA).

Isyagi summarized the principle policies and regulations governing the development of Aquaculture Parks (Isyagi, 2017) and these summaries are presented in Annex 1. The key regulations to be followed for the establishment of any fish farming activities in Uganda are (NaFIRRI, 2018):

- The Fish Act, 2000
- Fish and Aquaculture Rules, 2003
- Water Act, 1997
- The National Environment Management Act, 1995.

All permits and licensing required for aquaculture activities are presented in the Fish and Aquaculture Rules, 2003.

3. Tilapia cage farming technologies

3.1. Biological characteristics and farming procedures

Tilapia is the common name for tropical freshwater fish of the Cichlidae family presenting very interesting characteristics for production. Tilapias have been farmed under extensive, semi-intensive and intensive conditions on every continent and are now the second largest group of fish farmed after carps. Out of all tilapia species, Nile tilapia, *Oreochromis niloticus,* is the most widely farmed. Its growth performances and adaptability to various farming environment have made it a target species for most of the aquaculture project developments in tropical areas in the last 30 years, for both artisanal and commercial interest.

Nile tilapia can adapt to temperature ranging from 12°C to close to 40°C, though optimum for farming is in the range of 26°C to 32°C. Below 24°C, reproduction will stop. The production cycle is easily reproduced in captivity allowing for large production of fingerlings at regular interval. Fingerling production takes about 8 weeks from eggs to 1.5-2g fingerlings. The Brooders are mixed at a male to female ratio of 1:2 to 1:3 either in hapas in ponds or in tanks, and eggs are collected at regular intervals depending on the water temperature (optimum at 28°C). Eggs are incubated for a period of 5-8 days in artificial incubators with constant water exchange ensuring the best hatching rates. After the incubation period, the fish are transferred to rearing units (hapas in ponds, directly in ponds, or in tanks) for a period of approximately 7 weeks. Feeding is undertaken on a daily basis using commercial feeds to optimise growth and regular grading will ensure homogeneity of the batches.

From 1.5 to 2g, the fingerlings are ready to be transferred for pre-growing (juvenile) phase and later to the on-growing phase to reach market size.

Depending on the farming technology selected (cage, ponds, tanks), the level of intensification (supply of artificial feeds, artificial aeration and water exchange…), and most importantly the water quality parameters (temperature, oxygen, ammonia), the production cycle from 2g to 400g ranges from 5 to 8 months or more.

Table 1: ranges for optimal water quality and environmental parameters for cage culture of tilapia *O. niloticus*

Description		Criteria
Optimal Average temperature	°C	28-30
Optimal Average Salinity	‰	0
Optimal Dissolved Oxygen	mg/l	5-7.5 (minimum 4)
Optimal Dissolved Oxygen	%	70-100
Optimal Average pH		6.8-8
Maximum Ammonia NH_3	mg/l	0.1
Maximum TAN -NH3/NH4+ (pH dependent)	mg/l	2
Maximum NO_3- -N	mg/l	300
Maximum NO2-	mg/l	0.1
Maximum CO2	mg/l	40
Calcium hardness	mg/l	50-100
Chloride	mg/l	100-300
Alkalinity	mg/l	100-250

Water depth	m	Minimum 8m, dependant on cage net depth
Current speed	m/s	1-10
Exposure to waves		Minimal

This feasibility study focusing on the development of a cage-based AquaPark, only the relevant cage farming technologies are described below.

3.2. Cage farming technologies

3.2.1. Metal frame square cages

The development of commercial cage aquaculture in South East Asia and Africa has been largely based on metal frame square cages, as their frames are easy to build, using affordable materials and equipment locally available. The square shape allows to easily combine them in lines or clusters, reducing mooring requirements and facilitating husbandry procedures.

The frame is generally made of galvanized pipes welded together to make "ladder" frames, to which empty plastic drums are fixed as floaters using ropes. Boards of hard wood can be fixed to the frames to serve as walkways. Square net pens are tightened directly to the frame and hanging in the water, keeping their shape by using sinking weights (sinkers) attached to ropes weaved onto the nets. Figure 2 below shows an example of this type of cage installed in clusters on lake Volta, Ghana.

Figure 2: Picture of galvanised square cages on lake Volta in Ghana. Source Nicolas De Wilde

This type of cage proved to be performing well and to be economically viable in protected areas where waves and wind are limited, allowing for simple mooring lines using thick 24mm nylon ropes, plastic drums as mooring buoys and blocks of concrete as anchors. Installation of these cages doesn't require the use of a grid system as is common with high density polyethylene (HDPE) cages.

The length and width dimensions of galvanised square cages range from 2m x 2m to 5m x 5m or 6m x 6m, the latter being the most widely used for on-growing tilapia in commercial farms due to better production costs.

The frames need regular inspection to prevent breakage, and repair is usually undertaken every two years to replace weakened components.

The nets used for these types of cages are generally nylon nets purchased locally or imported. It is important to use two nets, one inner net keeping the fish (the production net), and one outer net (protection net) to prevent predators from reaching the inner net. Both nets are weighted down with sinkers tied to ropes weaved onto the nets.

3.2.2. Offshore type HDPE cages

When the potential site for cage installation is exposed to waves and winds, the cages and mooring systems need to be upgraded to resist strong forces and currents and be able to absorb swell movements. The cages made of high-density polyethylene (HDPE) provide these characteristics thanks to the resistance of the plastic and the flexibility of the components. Moreover, HDPE is resistant to Ultra Violet light (UV) and durable, which in return requires less maintenance than cages made of galvanized pipes.

Although widely used in the rest of the world, HDPE cages have only been recently introduced in aquaculture operations in Africa, not only to replace galvanised cages due to their better robustness, but also to install cages in more exposed locations, for example further away from the shores of large lakes.

HDPE cage frames are made of a set of rings for the collar (floating pipes), a top ring pipe (handrail), and brackets as visible in figure 3. The resistance of plastic cage relies on the robustness of the brackets as these hold all the pipes together and allow for movements as well as shock absorbance.

- pipes: their diameter is calculated based on the buoyancy expected for the cage. Buoyancy needs to be higher in more exposed sites to avoid the collar from being submerged by waves, hence larger pipe diameters need to be used. The pression nominal (PN) (nominal pressure) indication used by suppliers relates to the pressure capacity of the HDPE pipe, which depends on the thickness of the pipe wall. Thicker pipes will have a stronger resistance but more weight.
- brackets: there are different manufacturing process to produce brackets, from simpler welded plastic components, to rotational moulded plastics, injection moulded plastics, or metal brackets. The most commonly used types are the rotational moulded plastic as they provide a good compromise between strength, resistance to shock and weight compared to the injection moulded ones. The welded plastic brackets are easier to manufacture but present higher risk for breakage at butt welding connections. These can be used on less exposed sites. Finally, metal brackets can be used in sheltered locations, but they are less robust than plastic and present a higher risk of damaging the collar pipes due to repetitive friction and abrasion.
- sinkers: the sinkers (weights) help to keep the shape of the net pen despite water current forces. They are generally made of PVC (polyvinyl chloride) pipe filled with concrete and hung at regular intervals from the cage collar using a rope that is longer than the cage net

depth. Special ropes weaved onto the net can then be tied to the sinker ropes. It is extremely important to ensure the weights are not tied directly on the net itself but always on ropes. The weight of the sinkers depends on the current flow rates, net dimension and mesh size.

- Anchors and mooring lines: depending on the quality of the lake/sea bed, different types of anchors can used. For sandy or muddy bottoms,

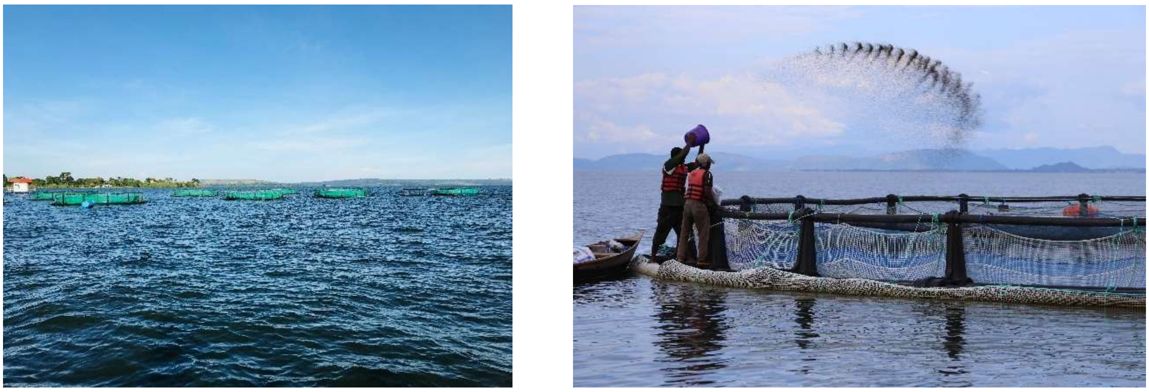

Figure 3: Pictures of HDPE cages on Lake Victoria, Uganda (left) and Lake Volta, Ghana (right). Source Nicolas De Wilde

3.2.3. General operations of a cage-based farm

Irrespective of the size of the cage farm, a number of key routine activities have to be undertaken. These activities are briefly described below.

Dead fish collection

Mortalities occur after handling, transfer, or in case of water quality issues. It is very important to collect on regular basis any dead fish floating at the surface of the cage to prevent disease development. In the case of young fish, it is also important to inspect the bottom of the nets as dead fingerlings will sink before floating.

Schedule: daily or twice a day depending on mortalities

Feeding

Feed is collected from the feedstore and loaded onto a boat to be delivered to the cages. Based on the feeding requirements and the boat's loading capacity, several feed-boat deliveries might be needed in the course of the day. In aquaculture operations, feed usually represents between 60 to 70% of the production cost, and therefore any wastage would severely impact the farm's economic performance. For that reason, it is important to ensure the feeder personnel are trained in good feeding practices.

Schedule: daily

Nursery stocking

Fingerlings are transferred from the hatchery to the nursery cages by boat, either in tanks or in plastic bags with oxygen.

Schedule: based on production schedule

Nursery grading and transfer

When reaching approximately 20 grams, the fish are graded and transferred to the grow-out cages. Transfer can be done:

- by boat using tanks supplied with oxygen in case nursery and grow-out sites are distant from each other;
- by towing the nursery cage next to the grow-out cage and transferring the fish after giving them a minimum of 24h rest post cage-towing;
- by direct transfer in case the nursery and grow-out cages are located in the same cluster of cages.

Schedule: based on production schedule

Sampling

Sampling is undertaken in order to assess the growth of the fish and predict the harvest schedule. The cage production net is gently bagged to crowd the fish, a seine net is cast in the cage and a number of fishes are collected for individual sampling.

Schedule: minimum four weeks interval

Cage nets inspection

Cage nets inspection is undertaken by divers in order to spot any potential holes and mend them. Cages must be inspected by experienced divers using appropriate diving gear.

Schedule: minimum two weeks interval

Harvest

Harvest is undertaken with seine nets or by means of harvest equipment to crowd and collect the fish. The fish are stored in ice bins, or directly in crates and transferred to the shore for post-harvest processing.

Schedule: based on production schedule

A general flow chart covering all the production phases of the pilot AquaPark is presented in Annex 2, and can be used as a guideline for the farmers.

For the good operation and coordination of the above listed activities, a number of key equipment and tools are required, including but not limited to large boats for feed and fish transfer, small boats for feeders or divers, husbandry items (scoop nets, buckets, scales…), fish grading and harvesting tools and diving gear.

3.3. Supporting functions to production

The development of a cage-based AquaPark requires auxiliary functions and activities to support production, facilitate operations and reduce the production costs of fish farmers by grouping the efforts. These include the following:

- feedstore

- net washing platform and net storing area
- jetty access to boats
- workshop for servicing and maintenance of various equipment
- processing facility to sort/process/package the harvested fish
- ice machine and ice storage
- offices and staff quarters
- diving team

In the case of a fully integrated AquaPark, a hatchery will also be developed to produce fingerlings.

Finally, it is advisable to include a training room where fish farmers can attend trainings and workshops regularly.

3.4. Environmental impact

In open-cage systems, fish are reared in the natural environment and so impact to the environment is not negligible. Fish produce faeces, which are transported with the current, and it is well known that a percentage of the feed distributed also escapes the cage due to waves and currents. When settling on the lake bed, these two are the main components of environmental pollution from a cage-based farm, along with dissolved nutrients. The site selection, based on a series of biological and environmental parameters, intends to find the best suitable site to maximise production while minimising pollution.

An Environmental Social Impact Assessment (ESIA) must be developed for the selected site in order to assess the quality of the environment prior to starting farming operations, and frequent monitoring must be implemented in order to assess and evaluate environmental changes due to pollution coming from the cages. The content and approach to the ESAI is mandated by NEMA in Uganda and must use appropriately certified individuals to conduct the study. This leads to approval prior to establishing the farm.

A series of measure can be implemented preventively to minimize the impact of cage farming on the environment, including alternating farming sites to allow natural remediation of the lake bottom over a period of time. This remains difficult and expensive to implement as it requires moorings readily available at different sites.

The ESIA for the proposed pilot cage AquaPark in Kalangala district needs to be developed and submitted for approval to the National Environment Management Authority. This is currently being undertaken separately from this Feasibility Study.

3.5. Diseases

Tilapia are often reported as fish that are highly resistant to poor water quality and diseases, but this characteristic seems to fade as several cases of mass mortalities have been observed in commercial operations around the world and linked with disease infestation. In recent years, the most virulent disease affecting tilapia farming are streptococcosis and Tilapia Lake Virus disease also called TiLV.

Vaccines have been developed to prevent infections from *streptococcus* (Brudeseth, 2013) and mass vaccination is now implemented in commercial operations, but it is still expensive making it difficult to implement for small-scale farmers.

Table 2 below presents a summary of the main diseases affecting tilapia farming.

Table 2: Summary of the main disease affecting tilapia farming. Source FAO 2005, OIE 2018.

DISEASE	AGENT	TYPE	SYMPTOMS	TREATMENT
Tilapia Like Virus (TiLV)	*Orthomyxo-like virus*	Virus	Inflammation of eyes and brain, liver damage, red skin. Mortality reaching 80-100% of infected fish.	No treatment has been found yet. Recommendations from OIE and FAO are to restrict movements of tilapia from farms and countries which are known to be infected with TiLV.
Motile Aeromonas Septicaemia (MAS)	*Aeromonas hydrophila* & related species	Bacteria	Loss of equilibrium; lethargic swimming; gasping at surface; haemorrhaged or inflamed fins & skin; bulging eyes; opaque corneas; swollen abdomen containing cloudy or bloody fluid; chronic with low daily mortality	$KMnO_4$ at 2-4 mg/litre indefinite immersion or 4-10 mg/litre for 1 hour; antibiotics (need 'extra-label use permit' in the USA), e.g. Terramycin® in feed at 50 mg/kg fish/d for 12-14 d, 21 d withdrawal
Vibriosis	*Vibrio anguillarum* & other species	Bacteria	Same as MAS; caused by stress & poor water quality	Antibiotic in feed
Columnaris	*Flaviobacterium columnare*	Bacteria	Frayed fins &/or irregular whitish to grey patches on skin &/or fins; pale, necrotic lesions on gills	$KMnO_4$ as with MAS; indefinite immersion with $CuSO_4$ at 0.5-3 mg/litre, depending on alkalinity
Edwardsiellosis	*Edwardsiella tarda*	Bacteria	Few external symptoms; bloody fluid in body cavity; pale, mottled liver; swollen, dark red spleen; swollen, soft kidney	Antibiotic in feed
Streptococcosis	*Streptococcus iniae* & *Enterococcus sp.*	Bacteria	Lethargic, erratic swimming; dark skin pigmentation; exophthalmia with opacity & haemorrhage in eye; abdominal distension;	Antibiotic in feed, e.g. Erythromycin at 50 mg/kg fish/d for 12 d (requires 'extra-label use' permit in the USA), or vaccination by injection

			diffused haemorrhaging in operculum, around mouth, anus & base of fins; enlarged, nearly black spleen; high mortality.	
Saprolegniosis	*Saprolegnia parasitica*	Fungus	Lethargic swimming; white, grey or brown colonies that resemble tufts of cotton; open lesions in muscle	$KMnO_4$ or $CuSO_4$treatments; use 1 mg/litre of $CuSO_4$ for every 100 mg/litre alkalinity up to 3.0 mg/litre $CuSO_4$; formalin at 25 mg/litre indefinite immersion or 150 mg/litre for 1 h
Ciliates	*Ichtyophtirius multifiliis; Trichodina* and others	Protozoan parasite	Occurs on gills or skin	$KMnO_4$, $CuSO_4$ or formalin treatments
Monogenetic trematodes	*Dactylogyrus* spp.; *Gyrodactylus* spp.	Protozoan parasite	Occurs on body surface, fins or gills	$KMnO_4$, $CuSO_4$ or formalin treatments

4. Site suitability and carrying capacity

4.1. Site selection

4.1.1. Cage Sites

In 2013, a preliminary feasibility study (Poseidon, 2013) highlighted the potential for a cage-based AquaPark to be developed around Mwena bay, Kalangala district, allowing it to make use of a current fish landing site available in Mwena village. The focus of the current work is to confirm the technical and financial viability of a pilot cage AquaPark in that same area. For that purpose, a review of the environmental parameters of the selected site is presented below.

In order to have a clear understanding of the variations of biological and environmental parameters prior to farming operations, an assessment is generally implemented at regular interval over a minimum of a 12 month period. Data collected over a year for the same parameters would then highlight periodic / seasonal variations which could potentially affect livestock.

The site suitability reports provided by NaFIRRI (PESCA, 2018) presents bathymetry, physical and chemical data and observations at certain times of the year (May and November 2018), without continuous monitoring. The report concludes that the proposed sites and waters around Mwena bay are favourable for cage fish farming, with considerations to be taken on fish densities to be implemented based on depths and currents of the selected sites.

Due to the lack of continuous monitoring of critical biological and physical parameters (dissolved oxygen, temperatures, pH, turbidity and currents), general limnologic, hydrologic and weather data collected from literature and online data sources are being used to evaluate potential seasonal variations and effects on livestock.

Water temperature

Figure 4 shows that the average temperature of the lake varies between 22°C and 24°C, with a maximum and minimum ranging from 26°C to 29°C and from 18°C to 20°C respectively. The NaFIRRI report presented highest temperature in the bays measured at 27.2°C, while the lowest was 24.6°C.

These temperatures are in the range of acceptable temperature to farm tilapia, though slightly on the lower side, which tends to slow growth.

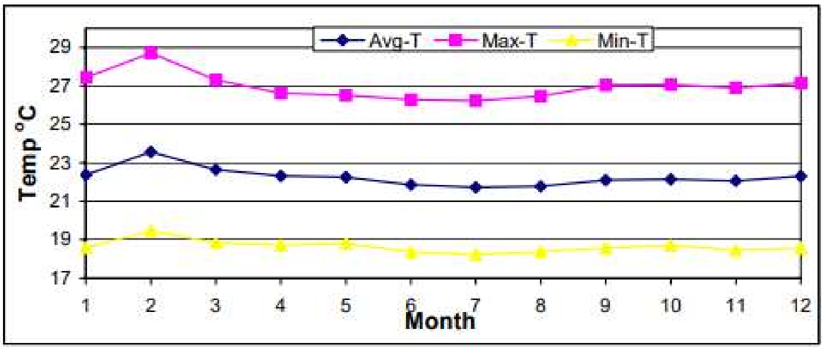

Figure 4: Maximum, minimum and average water temperatures over the Ugandan part of Lake Victoria basin. source: *Hydro-meteorological observations over the Ugandan portion of Lake Victoria, Okonga J.R., Water Quality and Quantity Synthesis Final Report, LVEMP December 2005.*

Wind, current and waves

Water current speed and direction are used to design the anchoring systems of the cages to the lake bed, as well as to estimate direction and area of dispersion of the wastes (faeces, uneaten food). The only available data from the Site Suitability report (PESCA, 2018) being velocity measured at various locations, literature data on prevailing winds were sought to assess the possible current direction as a result of wind influences.

Based on seasonal wind direction patterns over Lake Victoria presented in figure 6, it is estimated that the main direction pattern for the wind around Mwena bay will be South / South-West, as represented on figure 7.

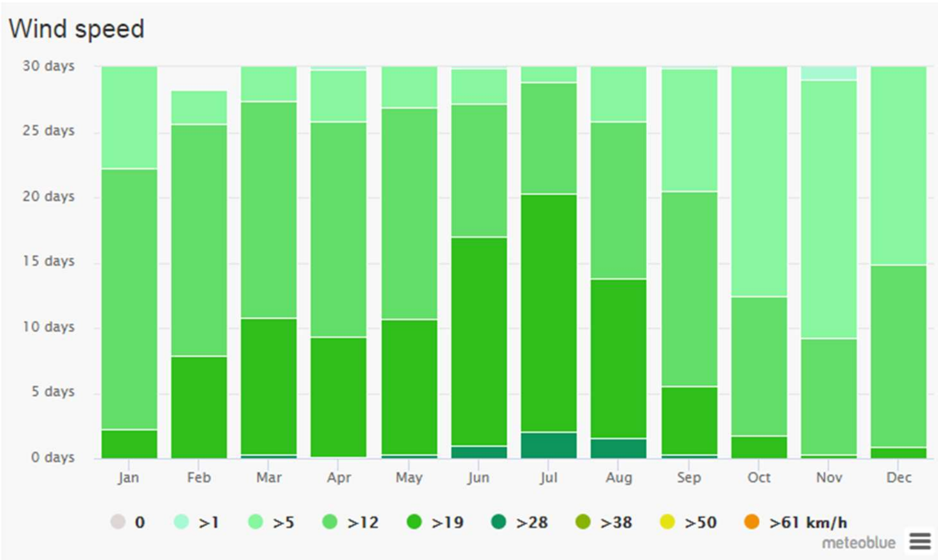

Figure 5: Seasonal wind speed variation over Lake Victoria.

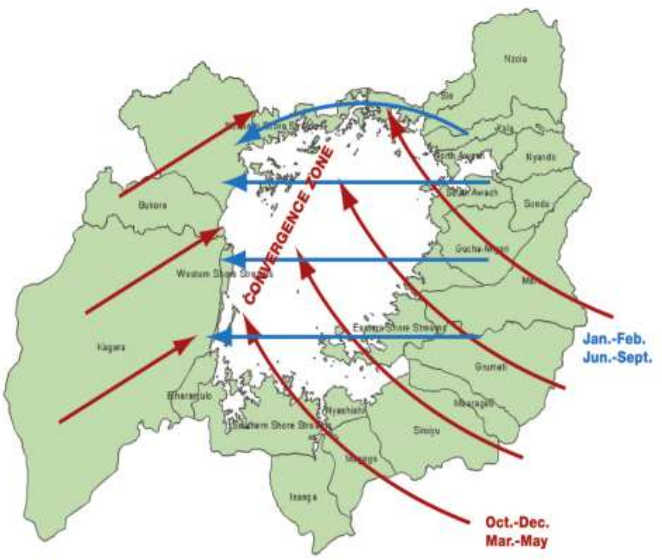

FIG. 3. Seasonal wind patterns influencing the hydrological processes in Lake Victoria Basin (adopted from the Intergrated Water Quality and Limnology Study of Lake Victoria 2002).

Figure 6: Seasonal wind patterns influencing the hydrological processes in Lake Victoria Basin. Source: Hydro-meteorological observations over the Ugandan portion of Lake Victoria, Okonga J.R., Water Quality and Quantity Synthesis Final Report, LVEMP December 2005.

Depth

Figure 7 presents a bathymetric map of the lake area around Kalangala island and was produced using ArcGIS and depth data collected by NaFIRRI reported on the map. It clearly identifies that all the bays around Kalangala have a depth below 10-12 meters, and depth increases with increasing distances from the shores.

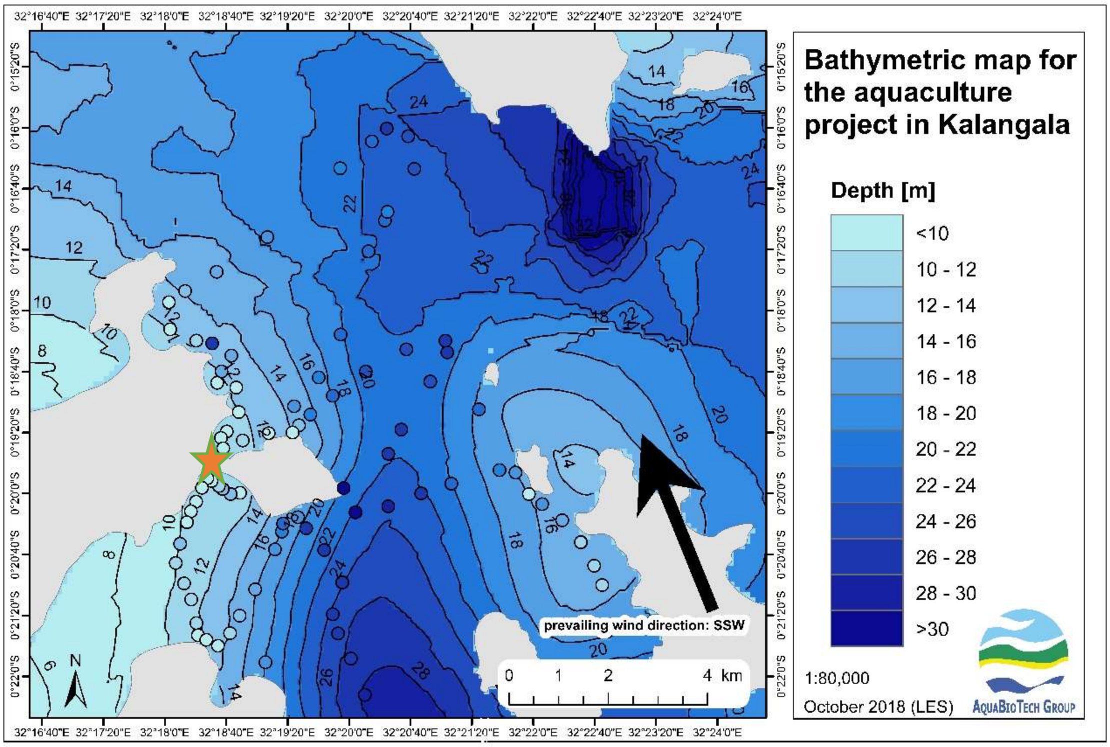

Figure 7: Bathymetric map of Lake Victoria around Kalangala Islands. The dots represent sampling points from the NaFIRRI report. The black arrow indicates the prevailing wind direction. The red star indicates Mwena landing site. This map is provided in A3 format drawing in annex. Source: ArcGIS Basemap.

Dissolved oxygen

The NaFIRRI reports indicates that dissolved oxygen levels measured in various locations of the study area around Mwena bay are all within the recommended acceptable range, with the minimum being recorded at 6.1 mg.L^{-1} and the maximum recorded at 7.5 mg.L^{-1}. Although largely acceptable for cage farming, these dissolved oxygen data reflect sampling at only two different times of the year. It is advised to pursue regular monitoring over a 12 months period to highlight potential seasonal variations which could affect livestock.

Algae blooms

Algae blooms are observed at regular intervals on Lake Victoria and it was reported by all farmers interviewed that during these phytoplankton developments, which can last for several days, feed consumption by the fish is reduced. It was also reported that mortalities can occur.

Annex 3 presents the average Chlorophyll a concentration for the section of Lake Victoria around Kalangala Island at different months from July 2016 to September 2018 and indicates the intensity of the blooms depending on the month of the year. The seasonal variations can be explained by variations in rainfall and consequent farms' run-off discharges into the lake.

The algae blooms are indeed signs of high nutrient level in the water, enhancing rapid growth of the phytoplankton. The resulting risk is severe depletion of dissolved oxygen in surface waters at night due to the large oxygen consumption, which can eventually lead to fish mortalities.

Proposed site selection

Based on the observations and data reported and discussed above, as well as the environmental requirements for tilapia cage farming, the survey focused on sites presenting the characteristics below:

- minimum depth of 20 meters for the grow-out cages;
- minimum depth of 12 meters for the nursery cages.

Some areas have been identified and are presented in figure 8.

Site 1 was identified for the setup of nursery cages. It presents the advantage of not being directly in Mwena bay yet close to the shore providing better shelter whilst having a depth of around 12 meters. Distance from the landing site is approximately 1 km.

Site 2 was identified as primary site for the setup of grow-out cages thanks to its position directly in front of Mwena bay and being located on 20 to 22 meters depth. Distance from the landing site is approximately 4.5 km.

Site 3 was identified as a secondary option for the set-up of grow-out cages. It is located on a 20 to 24 meters depth area but on the opposite site of the peninsula, at approximately 6 kms from the landing site. Considering that this site is not directly visible from Mwena bay, it presents a higher insecurity risk.

Site 4 was identified for the setup of small-scale grow-out farmers in the perimeters of small bays, despite a depth of only 12-14 meters.

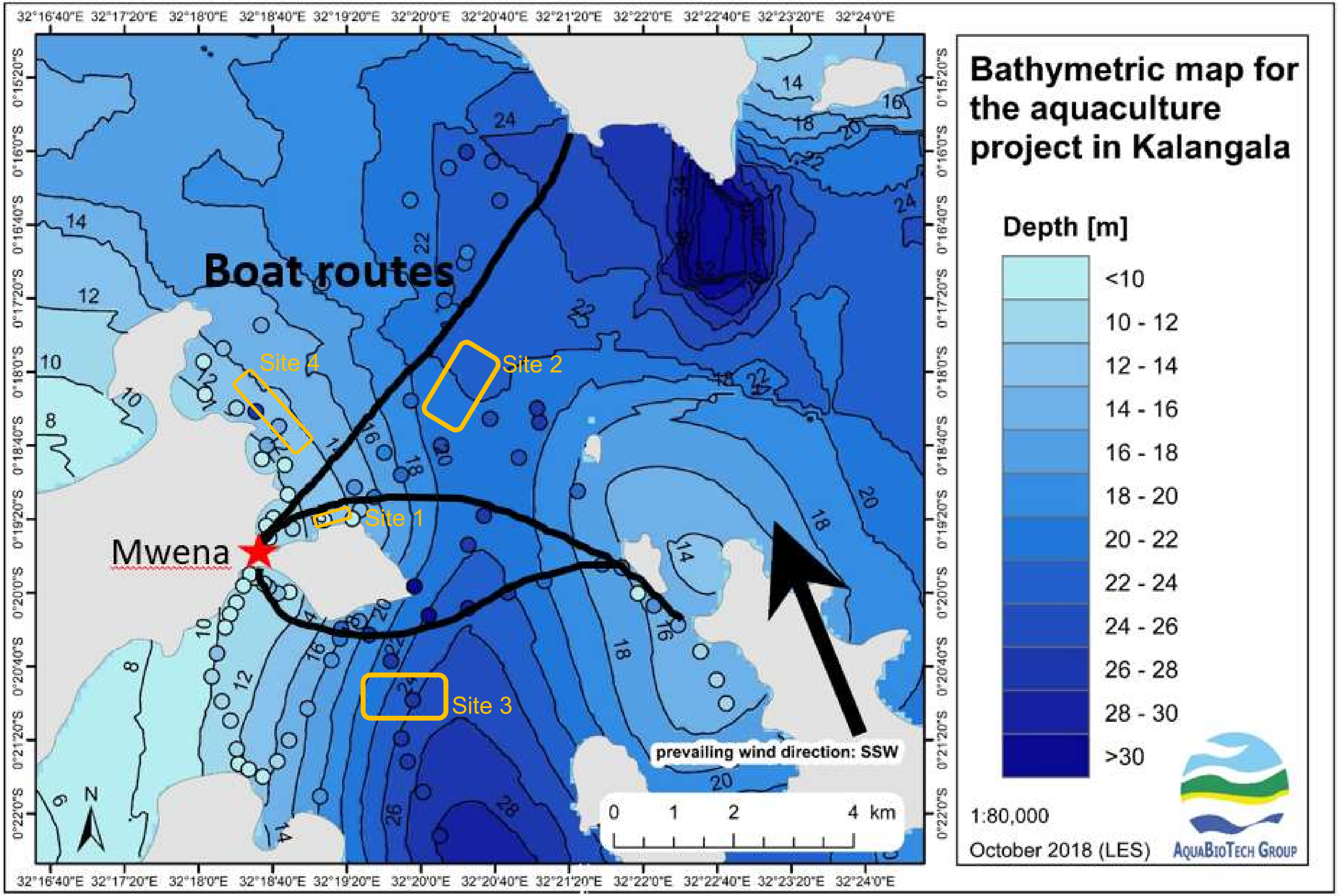

Figure 8: bathymetric map of the bays around Mwena showing the identified sites for the pilot aquapark. The current boat routes used for transport of people and goods between the nearby islands are indicated with black lines. Site 1 is identified for nursery cages, site 2 and site 3 are identified for grow-out cages. This map is provided in A3 format drawing in annex.

4.1.2. Land site

Mwena bay hosts a fish landing site that was established under an AfDB fund in 2004 and was suggested to be the headquarters of the AquaPark operations due to a number of facilities already available. The current facilities include:

- a jetty
- a post-harvest fish handling shed for sorting / washing
- a drying platform
- an ice plant composed of 2 ices machines (5mt capacity) and 2 ice storage rooms
- a pumping station
- a water tower (water tank)
- an office block
- a pit latrine
- lavatories
- a concrete rubbish storage bin
- a canteen
- a paved driveway for truck access to the post-harvest shed

The landing site is entirely fenced with three gates, which access the jetty, the pump station and the main site entrance.

One important consideration to be noted is that the premises of the Mwena landing site are located in the centre of Mwena town, with several activities happening on a daily basis in the neighbourhood. Generally, aquaculture sites are located out of town in areas where there is limited external disturbance in order to provide the best environment to rear fish. This close proximity is also a source for potential stealing, especially of feed or fish. This has been reported by some farmers and is often observed in any aquaculture operations.

An assessment of the facilities and infrastructure was undertaken in January 2019 by a team of technical staff from the MAAIF DAIMWAP and Department of Aquaculture Management and Development (DAMD). The report of this assessment, shared with the consultant, provides details on the condition and status of the buildings, equipment and infrastructure, including the condition of the road access to the Mwena site. It highlights that most of the facilities, though being in good condition, require some level of renovation and upgrade to reach up-to-date standards for the good operations of the AquaPark. The road equally needs to be upgraded, especially for the one leading to the potential new hatchery land.

Additional buildings and facilities required to support aquaculture operations of the AquaPark include:

- a hatchery
- a feed store
- a net washing platform and net inspection area

- a workshop
- a fuel store
- a backup power supply area
- it is also advised to include a training room for fish farmers from the AquaPark to attend training sessions and workshops.

The hatchery that needs to supply fingerlings to the AquaPark would ideally be suited on the premises of the current site, but availability of space being limited it implies to have a hatchery with a limited footprint. The possible solution is to develop a hatchery operating under the technology called RAS (recirculated aquaculture system) instead of the traditional pond-based hatchery.

If a pond-based hatchery is selected, it will need to be located on separate land to allow for pond space. A parcel of new land has already been identified for that purpose and a topographical survey has been undertaken.

In view of the opportunities available by the rehabilitation of the infrastructures of Mwena landing site, along with additional land possibilities, it is confirmed that the landing site is appropriate for the set-up of support functions to the cage AquaPark operations. The preliminary design and recommendations for the landing site operations are further discussed in section 5.2. below.

Figure 9: pictures of the facilities at Mwena landing site. Top left: Site entrance showing the water tower, office and security blocks. Top right: processing area. Bottom left: ice machine and ice storage. Bottom right: jetty and access gate to the site.

4.2. Carrying Capacity

The area around Mwena and the Kalangala island was identified prior to the feasibility study assignment for the instalment of the pilot cage AquaPark. The study area was therefore delimited and is presented in figure 9.

Carrying Capacity models for temperate and tropical freshwaters are based on phosphorus concentration as this is the principal factor, along with light, limiting natural production of water bodies (Beveridge, 1984).

Phosphorus is present at certain levels in the natural environment, and any addition or uptake will lead to a change in natural productivity. Hence, the capacity of a water body for intensive cage farming is the difference between phosphorus concentration prior to exploitation $[P]_i$, and the acceptable concentration once fish farming is established $[P]_f$.

Fish require phosphorus (P) to grow and it is provided through the feed. Feed producers will have a different range of P content depending on raw materials used and target fish species for a certain feed type. For tilapia, the P content generally varies between 1.3% and 2.5% of the feed.

Release of phosphorus in the environment results from:

1. the fish via digestion and excretion of surplus or non-assimilable forms of P in the diet
2. while working with nets to contain fish, it is inevitable that some feed will be lost in the water due to current and water turbulences created by fish while distributing the feed. When decomposing, this feed releases its P content in the water.

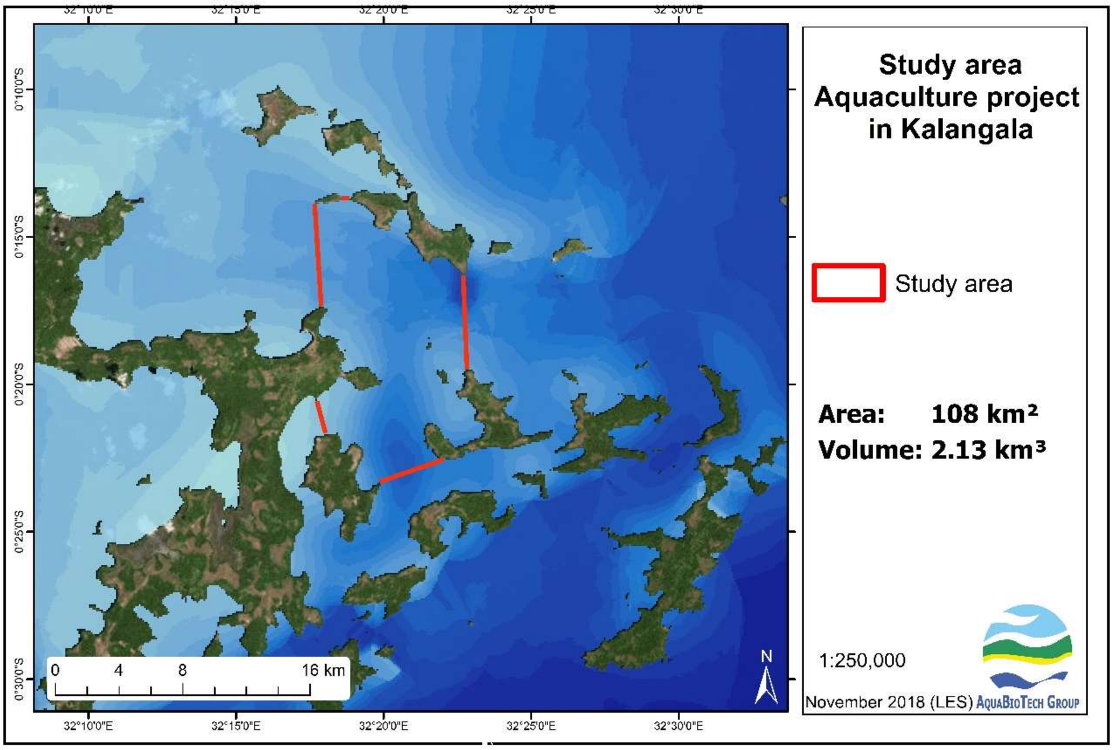

Figure 10: identification of the selected study area for the carrying capacity assessment. Source: ArcGIS Basemap.

For this study, quantification of P losses to the environment due to cage farming in the AquaPark and the corresponding production carrying capacity is done following the Dillon Rigler model (1974), as advised by Beveridge (2004).

Theoretical calculations based on an average P content of feeds (P_{feed}) usually available and purchased for tilapia farming in Uganda, along with forecasted food conversion ratio (FCR), and usual P content of fish carcasses (P_{fish}) allow to quantify the P losses to the environment due to cage farming (P_{env}).

The corresponding mass balance formula is presented below, along with assumptions used:

$$P_{env} = (P_{feed}\ X\ FCR) - P_{fish}$$

P_{feed}	1.41%	
1 ton of feed contains	14.1	kg P
FCR	1.6	
P_{feed}	22.56	kg tonne fish $^{-1}$
P_{fish}	0.41%	
	4.1	kg tonne fish $^{-1}$
P_{env}	18.46	kg tonne fish produced $^{-1}$

The Dillon Rigler model was used to calculate the total P concentration in a water body based on the following parameters:

- P loading
- Size of the water body (area, mean depth)
- The flushing rate
- And the fraction of P lost to the sediments.

The formulas and calculation are presented in table 3 below:

$$[P] = \frac{L\,(1 - R)}{\bar{z}\rho}$$

Where $[P]$ is total phosphorus (g/m3), L is area loading (g/m2) per year, z is the mean depth, ρ is the flushing rate and R is the fraction of total phosphorus retained by the sediment. This model was adjusted according to Beveridge (1986, 2004) to include total phosphorus loss due to solids deposition to the sediment (feeds and faeces) and a fraction of the dissolved phosphorus lost based on the retention coefficient.

Finally, the fish production capacity is calculated as:

$$Fish\ production = \frac{L\ A}{Penv}$$

Details of the equations and inputs are described in table 3.

The resulting carrying capacity is estimated to be nearly 21,000 tonne.year $^{-1}$ for the studied area. This figure does not take into consideration any current aquaculture production within the area.

Table 3: Dillon-Rigler model equations, inputs and results.

V	2,130,000,000	m^3	Volume of water body
A	108,000,000	m^2	Surface area
Q_o	789,376,259,952	$m^3\ yr^{-1}$	Average total volume outflowing

$\bar{z}$	19.7	m	$\frac{V}{A}$	Mean depth
ρ	371	yr^{-1}	$Q_o \div V$	Flushing rate
$[P]_i$	20	mg m^3	$[P] = \frac{L\,(1-R)}{\bar{z}\rho}$	*[P]* prior to establishment
$[P]_f$	250	mg m^3		Max. acceptable level when culture established
$\Delta[P]$	230	mg m^3	$= [P]_i - [P]_f$	Difference in P due to cultivation
Lfish		mg $m^{-2}\ y^{-1}$	$L = \frac{\Delta[P]\ \bar{z}\rho}{(1-R)}$	P Loading from fish cultivation
R	0.06		$= \frac{1}{1\,(0.747\rho^{0.507})}$	Phosphorus retention coefficient
X	50%			Quantity of total incoming P lost permenantly to sediment due to deposition
Rfish	0.53		$= x + [(1-x)R]$	Quantity of total P waste from fish permentantly lost to sediments due to deposition
Lfish	3,586,476	mg $m^{-2}\ y^{-1}$	$= \frac{\Delta[P]\ \bar{z}\rho}{(1-R_{fish})}$	Total P from fish
	3,586	g $m^{-2}\ y^{-1}$		
La	3.87339E+11	g y^{-1}	$= Lfish X\ A$	Acceptable P loading
Carrying capacity	**20,982,631**	kg y-1	$= \frac{L_a}{P_{envfish}}$	

A set of assumptions had to be taken in order to assess the carrying capacity of the area of interest (figure 10). These assumptions are described below.

1. $[P]_i$: phosphorus loading prior to fish farming establishment was assumed to be 20 mg.m^{-3}

2. $[P]_f$: acceptable phosphorus loading when fish farming is established was set at 250 mg.m^{-3} according to international standards for multiuse water bodies.

3. Average total volume outflow: assumption was taken that the studied area is considered as one containment where all incoming water enters through sections 2, 3 and 4 and all water

exit through sections 1 and 5 listed on figure 10. This assumption was taken considering direction of the prevailing wind and assumed effect on direction of the current.

The average total volume outflowing Q from the water body is then estimated using the formula below:

Q = A x V

A = sum of areas of cross sections 1 and 5 computed using QGIS software

V = average of the velocities measured in the area and reported in the NaFIRRI reports, calculated at 23.3 cm/s.

Cross section No.	Length [m]	Av. Depth [m]	Area [m2]
1	6,660	17.1	100,769
2	5,451	24.7	134,676
3	3,920	26.2	103,183
4	1,962	9.3	18,155
5	486	13.7	6,660

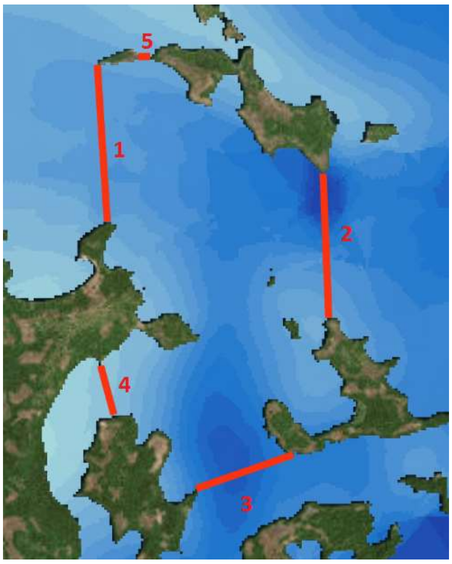

Figure 11: Data used to estimate the average total volume outflowing from the study area.

It must be noted that data collection over long period of time and from different areas of the water body is key to have a proper carrying capacity assessment. The assumptions used need to be refined by the final users in order to generate more accurate results.

5. Production systems and preliminary design

5.1. Summary of production models

During the mission in Uganda, the consultant visited a number of farms and conducted interviews with the farms' owners or employees to assess their production performances and discuss their challenges.

Based on the environmental data reported in section 4.1.1 above, industry standards and data collected from the farmers, the production model suggested for the AquaPark is based on three stages of production:

1. Land-based breeding and hatchery: the hatchery, operated under the AquaPark cooperative structure, is expected to produce fingerlings on a weekly basis to match the lake nursery and grow-out production plan. The broodstock is reared in ponds or tanks, eggs collected and artificially incubated, and larvae reared in ponds or tanks until they reach 2 grams.
2. Lake Nursery: the fish are transferred from the hatchery at approximately 2 grams and stocked in the nursery cages for a period of 60 days. When they reach 20 grams they will be transferred into grow-out cages.
3. Grow-out: the juvenile fish are then transferred into grow-out cages for a period of 200 days until they reach the harvest size of 420 grams.

A set of assumptions have been taken to develop the production model and design of the pilot AquaPark, which are then used to feed in the financial analysis. These production assumptions, presented in table 4, focus on the cage production stages (lake nursery and grow-out).

Table 4: production assumptions used for the technical and financial analysis.

		Nursery cages	Grow out cages
density	kg/m3	3.2 – 5	30
growth	grams per day	0.3	2.2
stocking size	grams	2	20
harvest size	grams	20	420
survival		80%	88%
FCR		1.2	1.60 to 1.41
crop per cage		5.5	2.0

Three conceptual production systems and production plans have been developed for the small, medium, and large-scale farmers and are available in the respective Excel models provided. A summary of the key figures of both grow-out and nursery production models are presented in section 5.1.1. and 5.1.2. below. Operational plans and preliminary designs are then developed for each entity of the AquaPark cooperative structure.

The cage designs are suggested based on industry standards for commercial intensive tilapia cage culture which have proved to be technically and financially viable in similar context, within Uganda and in other African countries (Ghana, Kenya, Zimbabwe, Zambia). Note that the harvest size from grow-out cages is not based on a final marketing approach, which will change the overall models, for instance different sized fish harvested for different market segments.

5.1.1. Nursery production models

The nursery production model for each three type of operators are presented in table 5.

Table 5: production plan for the nursery stage of three sizes of operators within the AquaPark

	Unit	Small Grower	Medium Grower	Large Grower
Cage type	m	Metal Square	HDPE square	HDPE square
Cage size	m	6m x 6m	6m x 6m	6m x 6m
depth	m	3	6	6
volume	m3	108	216	216
final density	kg/m3	4.5	3.5	5.0
transfer weight	g	20	20	20
growth	g/day	0.3	0.3	0.3
stocking weight	g	2.0	2.0	2.0
culture period	days	60	60	60
	weeks	8.6	8.6	8.6
	month	2.0	2.0	2.0
maintenance day	days	3	6	6
Final Fish no./ cage	pcs	21,600	34,560	48,600
Nursery survival		80%	80%	80%
Initial fish no. / cage	pcs	27,000	43,200	60,750
Initial fish No. / batch	pcs	21,916	21,916	122,338
No. of Crops / cage		5.8	5.5	5.5
Cages needed / batch		0.8	0.5	2.0
No. of batches /year		1.4	2.2	0.5
Total Juvenile cages needed		**2**	**4**	**16**

5.1.2. Grow-out production models

The grow-out production planning and assumption are presented in table 6 for each type of operator.

Table 6: production plan for the grow-out stage of three sizes of operators within the aquapark.

	Unit	Small Grower	Medium Grower	Large Grower
Cage type	m	Metal Square	HDPE square	HDPE round
Cage size	m	6m x 6m	6m x 6m	16m diameter
Depth	m	6	6	6
Cage volume	m3	216	216	1206
Number of cages		**8**	**24**	**24**
Final density	kg/m3	30	30	30
Harvest weight	g	420	420	420
Growth	g/day	2.2	2.2	2.2
Stocking weight	g	20	20	20
Culture period	days	182	182	182
	weeks	29	29	29
	months	6.7	6.7	6.7
Maintenance days	days	0	0	0
No. of crops /cage		2.0	2.0	2.0
No. of batches / year		16.1	48.2	48.2
Survival		88%	88%	88%
Fish harvested /cage	pcs	15,429	15,429	86,126
Fish stocked /cage	pcs	17,532	17,532	97,870
Production per cage per crop	kgs	6,480	6,480	36,173
Total yearly tilapia production	**Kgs**	**104,069**	**312,206**	**1,742,806**
	tons	**104**	**312**	**1,743**

The production capacity of the AP is the resulting sum of the production of the three farmers, small-medium-large, with the assumption that there will be one operator of each size in the aquapark. Present production total under that model is **2,159 tons.year^{-1}**. Considering the carrying capacity of the selected area (21,000 tons.year-1) and the potential sites identified, there are opportunities to expand the size or number of farmers after the pilot phase of the project.

5.2. Large-scale operator

5.2.1. Detailed production plan

The production schedule presented in figure 11 describes the sequence of stocking nursery cages and grow-out cages. It is optimised in order to have the harvest at regular intervals and maximum usage of the nursery capacity. Fish from two nursery cages will be transferred to stock one production cage.

5.2.2. Nursery cages

Cage Specifications	Floating HDPE cages, 6m x 6m frames with handrail
Cage quantity	18
Equipment	Square HDPE floating cages with handrails production net 6m depth predator net 6.5m depth bird net sinkers mooring system: anchors, chains, ropes, buoys walkways galvanized pipe 7m long for net bagging husbandry equipment
Considerations	the nursery cages can be organized in clusters to facilitate husbandry

5.2.3. Grow-out cages

Cage Specifications	Floating HDPE cages, 16m diameter, 6m depth
Cage quantities	24
Equipment	circular HDPE floating cages production net 6m depth predator net 7m depth bird net sinkers mooring system: anchors, chains, ropes, buoys walkways seine nets for harvest husbandry equipment
Considerations	

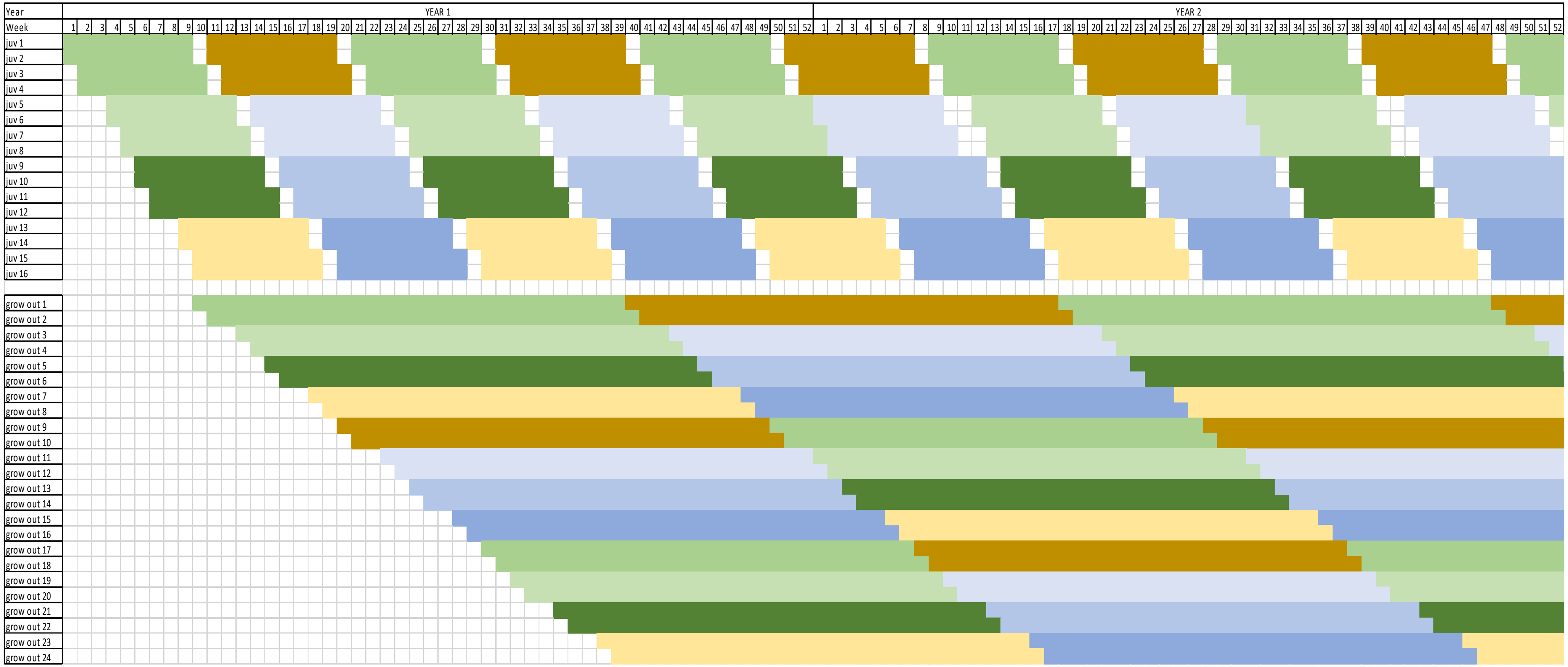

Figure 12: production schedule for a large-scale cage farmer (16 nursery cages and 24 grow-out round cages).

5.2.4. Operational equipment and infrastructure

Lake platform

Platform Specifications	Floating platform, deck area of approximately 50 sqm
Equipment	Metal floating platform Roof at approximate height of 2.5m mooring system: anchors, chains, ropes
Considerations	

Harvest vessel

Specifications	Boat with large flat deck to load/unload feed, nets and fish crates or ice bins
Equipment	Metal boat or barge Crane
Considerations	

5.2.5. Human resources

The staff will focus purely on production operations including fingerlings transfer, grading, feeding, harvesting, and maintenance of the cages.

Production / Operations		
Grow-out + Nursery		
	Manager	2
	Supervisor	4
	Foreman / Feeder	10
	Diver	4
	Farm hand	20
	Boat operator	4
Security		
	Supervisor	1
	Security guards	8
Total		**53**

5.3. Medium-scale operator

5.3.1. Production plan

The production schedule presented in figure 12 describes the sequence of stocking nursery cages and grow-out cages. It is optimised in order to have the harvest at regular interval and maximum usage of the nursery capacity. In this scenario, the juvenile fish from one nursery cages will be split to stock two production cages.

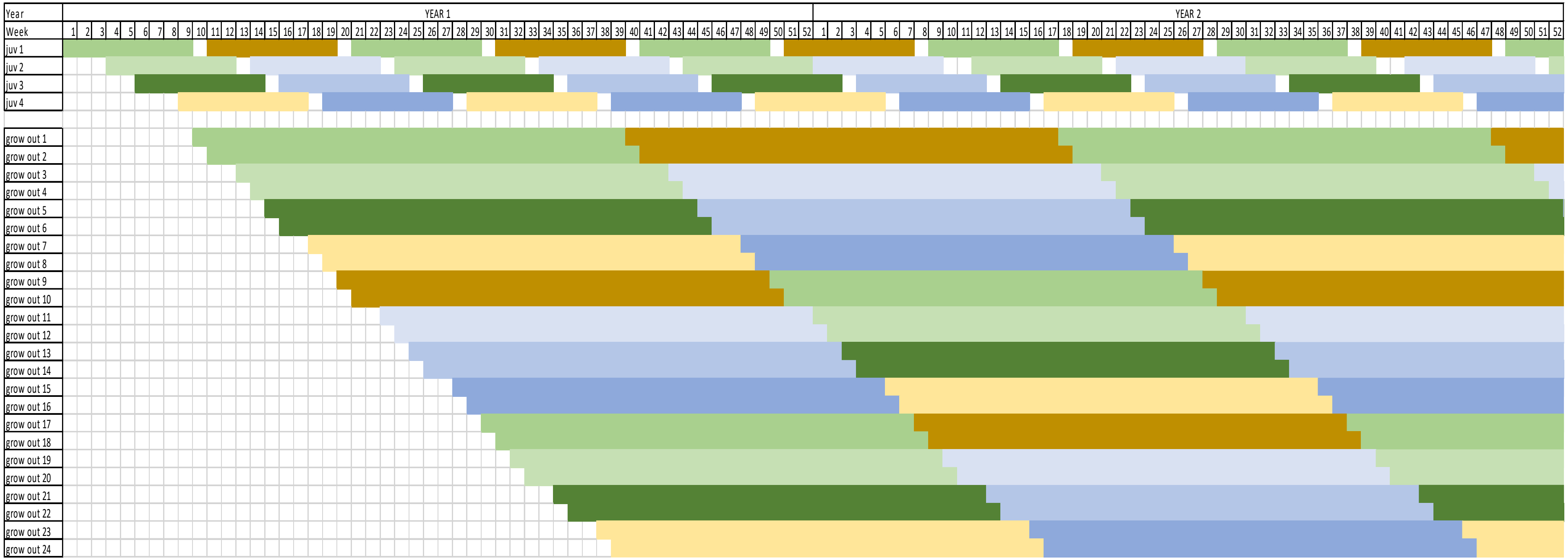

Figure 13: production schedule for a medium-scale cage farmer (4 nursery cages and 24 grow-out square cages).

5.3.2. Nursery cages

Cage Specifications	Floating HDPE cages, 6m x 6m frames with handrail
Number of cages	4
Equipment	Square HDPE floating cages with handrails production net (hanging from the handrail) 6m depth predator net 6.5m depth bird net sinkers mooring system: anchors, chains, ropes, buoys walkways galvanized pipe 7m long for net bagging husbandry equipment
Considerations	the cages can be organized in one cluster to facilitate husbandry.

5.3.3. Grow-out cages

Cage Specifications	Floating HDPE cages, 6m x 6m frames with handrail
Number of cages	24
Equipment	Square HDPE floating cages with handrails production net (hanging from the handrail) 6m depth predator net 6.5m depth bird net sinkers mooring system: anchors, chains, ropes, buoys walkways galvanized pipe 7m long for net bagging husbandry equipment
Considerations	the cages should be organized in lines or in grid with spaces between each cage to allow maximum water exchange.

5.3.4. Operational equipment and infrastructure

The medium-scale farmer will own two boats for his daily operations.

5.3.5. Human resources

The staff will focus purely on production operations including fingerlings transfer, grading, feeding, harvesting, and maintenance of the cages.

Production / Operations		
Grow-out + Nursery		
	Manager	1
	Supervisor	2
	Foreman / Feeder	6
	Diver	2
	Farm hand	8
	Boat operator	2
Security		
	Supervisor	1
	Security guards	4
Total		**26**

5.4. Small-scale operator

5.4.1. Production plan

The production schedule presented in figure 13 describes the sequence of stocking nursery cages and grow-out cages. It is optimised in order to have the harvest at regular interval and maximum usage of the nursery capacity. In this scenario, the juvenile fish from one nursery cage will be stocked in one production cage.

Considering that there is an estimated downtime of approximately five weeks on the production cages, it could be possible that the small-scale farmers grow their fish to bigger sizes than the 420g used in the production plan in order to maximise usage of the equipment. With an additional four (4) weeks of growth, fish would reach nearly 500g.

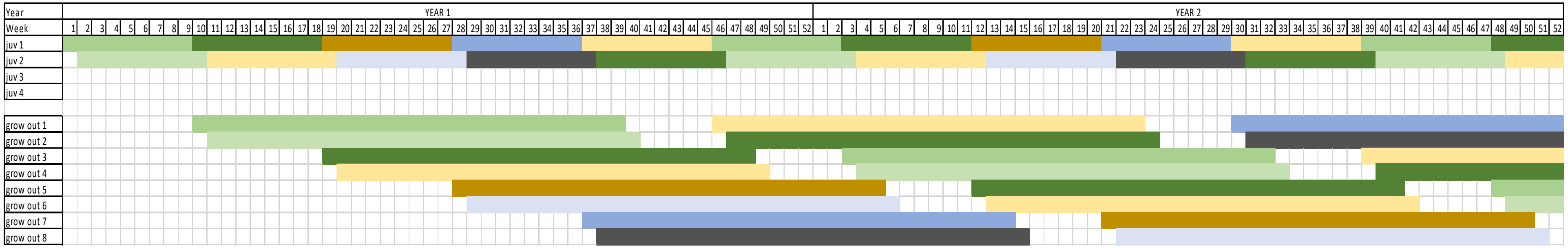

Figure 14: production schedule for a small-scale cage farmer (2 nursery cages and 8 grow-out square cages).

5.4.2. Nursery cages

Due to a limited number of cages required and to ease husbandry operations, it is advised that all cages (nursery and grow-out) are grouped in a cluster, reducing the mooring requirements.

Cage Specifications	Floating metal cages, 6m x 6m frames with handrail
Number of cages	2
Equipment	Square galvanized cage frames with handrails, plastic drums used to float the frames production net (hanging from the handrail) 3m depth predator net 3.5m depth bird net sinkers mooring system: anchors, chains, ropes, buoys walkways galvanized pipe 7m long for net bagging husbandry equipment
Considerations	the cages can be organized in one cluster with the grow-out cages to facilitate husbandry.

5.4.3. Grow-out cages

Cage Specifications	Floating metal cages, 6m x 6m frames with handrail
Number of cages	8
Equipment	Square galvanized cage frames with handrails, plastic drums used to float the frames production net (hanging from the handrail) 6m depth predator net 6.5m depth bird net sinkers mooring system: anchors, chains, ropes, buoys walkways galvanized pipe 7m long for net bagging husbandry equipment
Considerations	the cages can be organized in one cluster with the nursery cages to facilitate husbandry.

5.4.4. Operational equipment and infrastructure

The small-scale farmer will own only one small boat for his daily operations.

5.4.5. Human resources

Production / Operations		
Grow-out + Nursery		
	Manager	-
	Supervisor	-
	Foreman / Feeder	1
	Diver	-
	Farm hand	4
	Boat operator	-
Security		
	Supervisor	-
	Security guards	-
Total		**5**

5.5. AquaPark Cooperative – Land based facilities

As mentioned earlier, the Cooperative will provide a number of services and support functions for the farmers within the AquaPark. A preliminary layout drawing of the required land facilities is presented in figure 15 taking into consideration that the current land premises will be extended according to negotiations with the Kalangala Local Council.

5.5.1. Land based hatchery

The hatchery is expected to produce tilapia (*O. niloticus*) fingerlings on weekly basis that will then be transferred to the nursery cages.

The hatchery should have rearing facilities for broodstock, egg incubation, sex reversal and nursery. Choice of ponds or tanks systems should be made to best suit the site, expected production capacity and operations. The capacity of the facility should cover for an increase in production of the AquaPark over time.

Eggs will be collected on a weekly basis from the breeders, stocked in hatching jars to hatch for a 5 - 7 days period, then stocked in rearing units for sex reversal for 21 days and nursery rearing units for another 40 days to reach 2 grams.

Preliminary calculations have been done to assess the area required for the hatchery, based on two scenarios:

- **Hapa-based**: the fish are reared in hapas (cage nets) located in green-water ponds. This technique requires the construction of ponds and therefore has a large footprint.
- **Tank-based**: the fish are reared in tanks, with the possibility to partially recirculate the water. This technique is more intensive and energy consuming but requires a much smaller footprint.

Table 7 presents a summary of the footprint estimation for the two hatchery options listed above, with calculations for three different production capacities of the AquaPark, (2,000 MT, 3,000 MT and 5,000 MT). Details of the calculations are available in the hatchery production model excel sheet.

Table 7: Estimation of the footprint required for the hatchery based on two technology scenarios

Hatchery solution		Tank-based			Hapa-based		
AquaPark annual production capacity	MT	**2,000**	**3,000**	**5,000**	**2,000**	**3,000**	**5,000**
Fingerlings weekly production capacity	pcs	**129,580**	**194,370**	**323,950**	**129,580**	**194,370**	**323,950**
Fingerlings annual production capacity	pcs	**6,738,160**	**10,107,240**	**16,845,400**	**6,738,160**	**10,107,240**	**16,845,400**
Areas estimation per section							
Broodstock	m2	293	439	390	3,489	5,234	8,723
Incubation	m2	200	200	200	200	200	200
Sex reversal	m2	190	285	474	457	952	1,587
Nursery 1	m2	747	1,121	1,868	7,055	10,583	17,638
Nursery 2	m2	-	-	-	12,266	18,399	30,665
Total Footprint	**m2**	**1,430**	**2,044**	**2,933**	**23,467**	**35,368**	**58,813**

Water heating must be included for the egg incubation unit to ensure water temperature is sustained between 26°C and 30°C all year long.

For the egg incubation unit to function the water entering the system will require a high level of water treatment to produce clear, filtered water. The detailed design of the inlet water treatment should be based on the water characteristics as shown in the water quality requirements in table 1 and the water characteristics required for rearing eggs and fingerlings of tilapia.

Figure 15: picture of a feed store area with stack of bags on pallet. Source Nicolas De Wilde

5.5.2. Feed store

A dry feed store with storage capacity of at least 500 t of feed (sacks of feed approximately 25 kg each) at any given time. Feed will be delivered to site in 40 ft containers, be offloaded manually and organised in stacks or on pallets (see figure 14 as an example). The feed store should have large opening doors to facilitate circulation of people carrying bags, pallet movers for internal movement and arrangements.

The store should be of metal frame design and suitable high roofing (approximately 4 m), be water proof, have a concrete floor with a 1% slope, include ventilation and air extraction and be pest-proof. Lighting and ventilation to meet the room requirements and safety legislation will also be installed.

The location of any infrastructure requirements such as wall partitions, electrical distribution boards and drains if required should be specified in the designs.

Internal staff areas, for seating, guarding, storage of handling equipment and other small items, record keeping should be included in the design.

The dimensions of the feedstore are calculated based on the footprint (area) of a feedbag, how many can be packed in one layer, and the number of layers on top of each other in the building. Details are presented in table 8 below. The calculation shows that a 25m x 15m area used at 85% capacity allows to store 545 tons of feed.

Table 8: Details of feed store dimensioning

Feed bag dimension		
bag length	0.65	m
bag width	0.45	m
bag thickness	0.13	m
bag area	0.29	m
Feeding requirements	3,374	tons feeding / year
	281	tons feeding / month
	9.4	tons feeding / day
Calculation of feed store requirement		
feed store length	25	m
feed store width	15	m
area of feed store at 85% use	318.75	m2
number of bags per layer	1090	bags
number of layers	20	layers
estimated height of the stack	2.6	m
total stock capacity	545	tons stock
corresponding daily feeding capacity with 50% extra	14.1	tons feeding/day
corresponding number of days stock	38.8	days stock

5.5.3. Net cleaning / repair area

It is envisaged that the current platform initially planned to be used for drying fish can be retrofitted as the net washing platform. The slab will have to be smooth concrete with a 1% slope starting from the centre and going to the drains at the edges, for water evacuation. Drains are required all around the washing platform to collect water and channel it towards a collection /discharge point.

The platform doesn’t need roofing structure as the nets after being washed will need to dry under the sun.

The location of any infrastructure requirements such as drains and pipelines if required should be specified in the designs.

5.5.4. Net store

A net store should have a floor area of approximately 280 sqm. Nets will be stored individually after being washed, dried, and inspected. Nets will be delivered to the store by using a small truck and be discharged by hand. The net store should have large opening doors to facilitate circulation of people, easy access by a small truck and eventually the circulation of a forklift truck.

The store should be water proof, have a concrete floor with a 1% slope, high roof, include ventilation and air extraction and be pest-proof. Lighting and ventilation to meet the room requirements and safety legislation will also be installed.

The location of any infrastructure requirements such as wall partitions, electrical distribution boards and drains if required should be specified in the designs.

5.5.5. Workshop and storage area

It is envisaged that the workshop facility should have an area of minimum 250 sqm to store outboards engines needing servicing or repair, as well as any other equipment needing maintenance.

The room will be closed and have a roof at standard heights.

The location of any infrastructure requirements such as wall partitions, electrical distribution boards and drains if required should be specified in the designs. Lighting and ventilation to meet the room requirements and safety legislation will also be installed.

5.5.6. Fuel Store

The fuel store should have an area of minimum 40 sqm to store fuel drums and engine oil drums, full ones on one side and empty ones on the other. The store will consist of a concrete platform with fencing, and a double door access to allow easy discharge of full drums. It will have a roof at standard heights.
Optionally, a fuel tank can be included in order to store large amount of fuel.

5.5.7. Jetty

The existing jetty needs renovation in order to make it fully operational. Lighting, water supply and fuel storage should be included / upgraded.

5.5.8. Pumping station

The current pumping station provides water to the water tower, which then feeds the ice machine. It needs renovation and upgrade to meet the requirements of the site.

5.5.9. Offices

The current office block needs minor repair and repainting. New office furniture needs to be provided to accommodate for the administration staff of the AquaPark company, as well as the management team of the farmers.

5.5.10. Post-harvest processing facility

After harvest the fish will be brought back to shore for post-harvest processing. At the early stage of the AquaPark development the processing should only involve sorting to remove the deformed fish and excessively small fish, weighing and putting the fish on ice in crates.

In the future, it is advised to develop more detailed sorting by sizes as discussed in section 6.1.5.

5.5.11. Ice machine and ice store

The current maximum ice production capacity is installed at 10 tons per day, with 2 x 5 t ice machines in place. The current ice storage capacity is approximately 3 times the installed production capacity. This facility should be renovated, all equipment upgraded to as new, or new operational capacity, with ice store doors in as new condition.

It is anticipated that the ice requirement will be in the range of 40 tons per week when the AquaPark reaches a yearly production of 2,000 t, and in the range of 60 to 70 tons per week when it reaches 3,500 tons per year.

Design should include the extra ice production requirement as stated above.

Areas around the store should be accessible for ice access and delivery to the fish sorting areas, with washing facilities for ice barrows, boxes and other items available. Storage areas for ice boxes and associated equipment to be provided adjacent to the ice store.

5.5.12. Staff rest area and canteen

An area is to be established for staff rest, canteen, lunch breaks, etc. with areas for preparing food. The area should have a simple structure, covered for shade from the sun/ rain and areas for seats, tables, etc.

5.5.13. Staff accommodation

It is envisaged that a new accommodation block be built onsite to accommodate part of the staff. The block should be a two-storey building, with stair access to the upper floor, allowing views of the bay and general site operations, including bedrooms, one living room, one separate kitchen, shower facilities, bathrooms and separate toilets.

The block should accommodate eight (8) staff (bedrooms and associated facilities, furnishings and space for storage of personal items).

Figure 16: preliminary design layout of Mwena landing site presenting the current facilities and additional facilities required. This drawing is provided in A3 in annex 5.

5.5.14. Power supply

An adequate space with concrete platform and fencing needs to be established to accommodate for the backup power generator. The power back-up is necessary to ensure the ice store and cold-storage would remain powered in case of power-cut.

5.5.15. Fencing

The site's existing fencing should be renovated where needed and made secure. The current land is to be extended along the lake front and fencing should be extended to include these new areas.

The bushes located on the beach front of the premises should also be cleared to keep full view of the water shores.

It must be noted that the landing site in Mwena does not provide adequate space for large HDPE cage construction, especially for large diameter HDPE cages as it is suggested to use for the pilot AquaPark. Access to another site with adequate space, power supply and 24/7 security will be required for construction of the cages.

5.5.16. Human resources

The staff hired by the cooperative will be employed in the administration, the hatchery, and the post-harvest processing facility. The staff number for the processing of fish after harvest is estimated in Full Time Equivalent (FTE) but would actually be part-timers working approximately 5 hours per day on harvest days only.

Administration		
Operations Manager		1
Admin / HR		1
Accountant		1
Secretary		1
Cashier		1
Cleaner		1
Driver		1
Marketing		
Sales Manager		1
Sales staff		2
Hatchery / Production / Operations		
Hatchery		
	Manager	1
	Supervisor	1
	Hatchery Technician	3
	Farm hand	6
	Boat operator	1
Processing / Post-harvest		
	Supervisor	1
	Foreman	1
	Employees (FTE)	*10*
Security		
	Supervisor	1
	Security guards	8
Total		**43**

6. Financial study

Fish farming as a commercial activity is a capital-intensive business due to the level of investment required to launch the activity and the long start-up period requiring a substantial amount of capital to finance operations prior to first incomes are generated. Hence, prior to launching such activity, it is important to assess its financial viability and funding requirements.

The pilot AquaPark project pursued in Kalangala island intends to set the basis for further similar development in Uganda. This feasibility study assesses the financial viability of different sizes of operators under a cooperative-like management and operational structure over a period of fifteen years. The purpose of the cooperative model is to provide economies of scale to all farmers. The financial analysis has therefore been developed around a business model where the cooperative provides services and farm inputs to the operators (farmers), who contributes back to the cooperative through the retribution of commissions. The financial assessment is based on a set of inputs for the below categories :

- Biological model and production plan
- Market data
- Capital expenditures (CapEx)
- Operational expenditures (OpEx)

As mentioned earlier in the report, the biological model was set similarly for all type of operators and is based on a set of data and realistic assumptions that were agreed on during the validation meeting held with the various stakeholders of the Mwena cage AquaPark project.

A set of Excel spreadsheets have been developed for each of the four business operators (large – medium – small scale operators and the AquaPark cooperative) and include the following:

- revenue workings
- operating workings
- manpower
- CapEx
- Income statement
- Cashflow
- Balance sheet
- Analysis and ratios

6.1. Key assumptions

6.1.1. Business model of the Cooperative

In the developed business models, it is assumed that the Cooperative holds the following functions to support all farmers registered within the AquaPark:

- licencing and permits,
- production and supply of quality fingerlings,

- procurement and supply of quality feed,
- leasing of cages,
- providing post-harvest processing infrastructure,
- marketing and sales of fish.

The assumptions taken in the 2012 feasibility study with regards to commissions charged by the AquaPark Cooperative to the farmers for the above support were applied similarly in the current financial assessment and are presented in table 9.

Table 9: Assumptions on commissions charged by the Aquapark cooperative to the farmers.

Fingerlings supply	10% of production cost
Feed supply	3% of delivered feed cost
Lease on infrastructures and cages	3% of production capacity
Marketing fee	5% of revenue (fish sales)

6.1.2. Biological assumptions

Table 10: Biological assumptions used for the technical and financial analysis.

		Nursery cages	Grow out cages
density	kg/m3	3.2 - 5.0	30
growth	grams per day	0.3	2.2
stocking size	grams	2	20
harvest size	grams	20	420
survival		80%	88%
FCR		1.2	1.6 to 1.41
crop per cage		5.5	2

6.1.3. Exchange rates

The financial analysis is developed in Ugandan Shillings (UGX). When cost estimation of prices used in the financial analysis are based on United States dollars (USD), or for quick comparison against international standards, the following USD to UGX exchange rate has been used:

USD	1
UGX	3700

6.1.4. Operational costs

Operational costs include all main inputs to the farms. Some inputs are procured by the operators themselves, and some are sourced through the cooperative. In the latter case, the commissions charged by the cooperative are included in the farmers' operational costs. The list of operational costs with assumptions and rational behind them is available in table 11 and table 12 respectively for the farmers (operators) and the cooperative.

Of major importance is the feed cost, which was broken down in two stages considering the procurement process for imported feed. Firstly the cost of feed delivered to Mombasa, Kenya which is the closest port of delivery. This cost was set at 750 USD/ton, based on data collected from the field. Secondly, cost of shipping a container of feed (24 tons) from Mombasa to Uganda was taken into account at 3,500 USD/container based on field data collected. This resulted in a feed price of approximately 920 USD/ton delivered to Uganda, which was agreed on with the stakeholders present at the validation meeting. Further discussions referred to this cost being to low for feed delivered to Kalangala. A scenario will be assessed with feed cost of 1,050 USD/ton delivered to Kalangala.

6.1.5. Product forms and sales price

Based on data collected during the site visit, it is understood that farmed tilapias are generally sold at around 400 to 500 grams for an average price fluctuating between 8,000 UGX and 9,000 UGX. The large producers tend to sort the fish into a maximum of 2 sizes prior to sales, generally below 350 grams and above 350 grams in order to target different customers with different prices.

Sale prices tend to fluctuate based on seasonal tilapia captures from Lake Victoria, and based on the market targeted. For instance, large farmers now target markets in foreign countries due to a relatively low demand, or low-price opportunity in Uganda.

Following discussion held at the validation meeting, it was agreed for the purpose of the financial analysis to set the starting average selling price for farm gate whole round fresh tilapia on ice at 8,000 UGX/kg in year 1, corresponding to a price of 2.16 USD/kg, for a target harvest size of 420 grams. Despite being low, this assumption seems realistic and even on the higher side compared than the current context of tilapia sales in Uganda.

This average price has been used across the board for all three models of operators (small, medium, large) considering that they all sell their fish through the AquaPark cooperative. Yearly increase of fish price was included in the model based on the inflation rate.

It is highly advised to pursue sorting of the fish post-harvest in order to segment sales into different size categories, which would generate higher revenues to the farmers. In other African countries, farmed tilapias are sorted into up to five or six different size categories. As an example, the following size categories could be implemented, and different prices applied:

Size 1	Size 2	Size 3	Size 4	Size 5
below 200g	200-350g	350-480g	480-600g	600g +

Table 11: Description of the baseline operational costs to be assumed by the Operator. The same cost assumptions have been used for all three size of operators.

Cost to	Item	Cost Assumption	Unit	Comments	Rational
Operator	Fingerlings	100	UGX/ pcs	production cost per 2g fingerlings	assumption based on field data collection
Operator	Fingerlings - Coop. charge	10%		% of fingerlings production cost charged by the Cooperative for the production and supply of fingerlings	assumption
Operator	Feed	2,775,000	UGX / ton	cost of imported feed delivered to Mombasa, Kenya	assumption based on field data collection
Operator	Feed shipment	12,950,000	UGX / container	cost of shipping one 24 mt feed container from Mombasa to Uganda	assumption based on field data collection
Operator	Feed - Coop. charge	3%		commission charged by the Cooperative on cost of feed purchased and delivered	assumption
Operator	Production consumables			budget for various consumables	assumption
Operator	Vehicles and boats	60 - 450	liter/month	range of fuel consumption based on vehicle or boat and usage. Detailed in the excel file	assumption based on experience and industry standards
Operator	Fuel costs - Diesel	3,800	UGX / liter		assumption based on field data collection
Operator	Fuel costs - Petrol	4,000	UGX / liter		assumption based on field data collection
Operator	Engine Oil	15,000	UGX / liter		assumption based on field data collection
Operator	Lease on cages and infrastructures	3%		% of production capacity (assumed equivalent to revenue) charged by the Cooperative for the lease of cages and use of the land-based infrastructures	assumption

Table 12: Description of the baseline operational costs to be assumed by the Aquapark Cooperative

Cost to	Item	Cost Assumption	Unit	Comments	Rational
Cooperative	Fingerlings	100	UGX/ pcs	production cost per 2g fingerlings	assumption based on field data collection
Cooperative	Feed	2,775,000	UGX / ton	cost of imported feed delivered to Mombasa, Kenya	assumption based on field data collection
Cooperative	Feed shipment	12,950,000	UGX / container	cost of shipping one 24 mt feed container from Mombasa to Uganda	assumption based on field data collection
Cooperative	Vehicles and boats	60 - 450	liter/month	range of fuel consumption based on vehicle or boat and usage. Detailed in the excel file	assumption based on experience and industry standards
Cooperative	Fuel costs - Diesel	3,800	UGX / liter		assumption based on field data collection
Cooperative	Fuel costs - Petrol	4,000	UGX / liter		assumption based on field data collection
Cooperative	Engine Oil	15,000	UGX / liter		assumption based on field data collection
Cooperative	Broodstock	500	UGX / pcs	when purchasing new broodstock for the hatchery	assumption
Cooperative	Ice - Harvest	-		1 kg of ice used for 1 kg of fish harvested. cost of ice production is part of the electricity cost assumption	it relies purely on pumping water and operating the ice machine
Cooperative	Electricity	850	UGX / kWh	electricity cost assumed by the cooperative.	Overall budget is assumed at this stage
Cooperative	Generator	6.5	liters / hour	average fuel consumption at full capacity	assumption based on experience
Cooperative	Generator	2	hours runtime /day	average forecasted	assumption
Cooperative	Permits and License	2,000,000 - 5,000,000	UGX / year		assumption based on field data collection

6.1.6. Cost of sales

Cost of sales is calculated based on the commission taken by the cooperative for the marketing of the fish supplied by the farmers. It is set at 5% of the total revenues of the farmer.

6.1.7. Income tax

The corporate income tax was set at 30% without minimum income limit according to the current legislation in Uganda.

6.1.8. Exit price (exit point)

In order to assess the success of each investment (small – medium – large – AquaPark company) using the NPV and IRR methods, it is necessary to estimate the value the projects at the end of the assessment period. This value, called exit price or exit point, is dependant on a large number of factors and on the strategy of the investors.

Considering that the farmers have a long-term plan and do not intend to sell their farms, assumption was taken on 5% annual growth in the business value, and the exit point for each investment was calculated using a ratio of the initial investment injected into each business entity (small – medium – large – AquaPark company). The ratio after the 15 years assessment was calculated using the formula below :

$$\text{Ratio} = (1+5\%)^{\wedge 15}$$

6.1.9. Inflation, Cost of debt and WACC

Inflation

An inflation rate of 5% was included from year 2 onward for all operational expenses for the 15 years period of the assessment.

The sale price of fish was equally inflated by 5% to compensate for the increase in operational costs.

Cost of debt

It was assumed that while capital expenditures for the infrastructure and development of the pilot AquaPark facilities will be funded by the EU, through the MAAIF/PESCA grant, the farm operators will be providing the working capital and provision for contingencies required to launch and sustain their operations during the first 12 months of activity.

The cost of debt (interest rate) assumes that the Agricultural Credit Facility (ACF) would be sought for loans contracted for projects engaged in agriculture or agro-processing, offering a better interest rate of 10% instead of the generally offered 22% for commercial loans.

Loan Instalment	10
Moratorium	2
Interest Rate	10%

Considering that cost of debt is advantageous, the investment requirements were assumed to be provided through 40% debt and 60% equity.

Weighted average cost of capital (WACC)

With a cost of equity capital estimated at 25% and the cost of debt assumed at 10%, the WACC was calculated at 19%.

	Contribution in Capex	Cost	Contribution in WACC
Equity	60%	25%	15%
Debt	40%	10%	4%
Total WACC			19%

Nevertheless, it was advised during the DFR review meeting that the anticipated WACC for this type of project in Uganda would be in the range of 24% and this figure was therefore used for the analysis.

6.2. Capital expenditure

A summary of the capital expenditure for the four business entities is presented in table 13, with a breakdown of the infrastructure & buildings and cage systems in table 15 and 14, respectively.

Based on the assumption that the AquaPark cooperative will own property of the cages and lease them to the operators, it is assumed that it will bear all the corresponding CAPEX estimated at 3.7 billion Ugandan shillings.

Table 13: CAPEX analysis for the small - medium - large growers and the AP cooperative.

		Small Grower	Medium Grower	Large Grower	AP Cooperative
Production capacity	tons	104	312	1,743	2,159
Infrastructure & Buildings	UGX	-	-	-	**2,537,500,000**
Vehicles & Boats	UGX	**9,000,000**	**52,000,000**	**104,000,000**	**138,500,000**
Operations Equipment	UGX	**410,000**	**6,700,000**	**16,400,000**	**175,820,000**
Cage Systems	UGX	-	-	-	**4,262,400,000**
Office Equipment & Furniture	UGX	-	-	-	**28,860,000**
Working Capital	UGX	334,656,019	1,015,868,655	5,796,562,767	1,652,152,506
Provision for Contingencies	UGX	51,609,903	161,185,298	887,544,415	1,319,284,876
Grand Total	UGX	**395,675,922**	**1,235,753,953**	**6,804,507,182**	**10,114,517,381**
	USD	106,939	333,988	1,839,056	2,733,653
Financed by:					
Grant	UGX	-	-	-	7,143,080,000
Equity	UGX	237,405,553	741,452,372	4,082,704,309	1,782,862,429
Debt	UGX	158,270,369	494,301,581	2,721,802,873	1,188,574,953
Grant	USD	-	-	-	1,930,562
Equity	USD	64,164	200,393	1,103,434	481,855
Debt	USD	42,776	133,595	735,622	321,236

Similarly, the AquaPark cooperative will bear the CAPEX for the infrastructure and buildings, which include the renovation of the current facilities at Mwena landing site, along with the addition of the required buildings as presented in section 5.5. above.

Working capital covers the total operating costs for the first 12 months of activity of the farmers, and for 3 months in the case of the AquaPark Cooperative and provision for contingency was set at 15%.

Table 14: Details of the cage systems CAPEX estimation per operator size

		Small Grower	Medium Grower	Large Grower	Grand Total
Grow-out cages	UGX	59,200,000	1,332,000,000	1,776,000,000	3,167,200,000
Nursery cages	UGX	14,800,000	192,400,000	888,000,000	1,095,200,000
Total	**UGX**	**74,000,000**	**1,524,400,000**	**2,664,000,000**	**4,262,400,000**
	USD	20,000	412,000	720,000	1,152,000

Table 15: Details of the infrastructure and buildings CAPEX estimations

Infrastructure & Buildings	UGX	2,537,500,000
Jetty renovation	UGX	37,000,000
Fencing renovation & Extension	UGX	37,000,000
Road renovation	UGX	148,000,000
Feed store	UGX	74,000,000
Net store	UGX	37,000,000
Net washing platform	UGX	29,600,000
Workshop and tools	UGX	44,400,000
Pumping station renovation	UGX	55,500,000
Shore bushes clearing	UGX	7,400,000
Office block renovation	UGX	29,600,000
Accommodation block	UGX	148,000,000
Hatchery	UGX	555,000,000
Generator	UGX	148,000,000
Ice machine	UGX	592,000,000
Borehole	UGX	40,000,000
Harvest vessel	UGX	444,000,000
Transport tanks	UGX	74,000,000
Lake platforms	UGX	37,000,000

6.3. Operational expenditure

Table 16 and 17 below compare the cost of production per size of operators and informs on the cost centres share of revenue and the detail cost structure of the business entities.

Considering that the AquaPark cooperative bears the costs of the land-based facility operations (including electricity and broodstock supply), these items are listed but kept to zero in the farmers' operational costs. From the analysis, it appears, as expected, that feed is the main cost centre representing around 60% of the revenues generated by the farmers. These costs-share figures for feed are in the industry standards for similar cage production operations in Africa, though on the lower side which is due to the FCR being assumed to improve from 1.6 down to 1.4 over the years, reducing the share of the feed costs in the overall cost structures.

Table 16: Cost of production and cost centres share of revenue (normalized averages over the 15 years assessment period).

		Small Grower	Medium Grower	Large Grower	AP Cooperative
Production capacity		**104**	**312**	**1,743**	**2,159**
Cost of production	UGX/kg	10,313	10,995	10,219	n/a
Cost centers of revenues					
Fingerlings		4.7%	4.7%	4.7%	5.9%
Broodstock		0.0%	0.0%	0.0%	0.3%
Feed		61.7%	61.7%	61.3%	82.3%
Production Equipment		0.3%	0.2%	0.1%	0.0%
Electricity		0.0%	0.0%	0.0%	0.1%
Manpower		3.3%	8.7%	3.1%	2.3%
Fuel & Lubricants		1.5%	1.5%	0.9%	0.3%
Lease on infrastructures		3.0%	3.0%	3.0%	0.0%
Permits & Licenses		0.0%	0.0%	0.0%	0.0%
Maintenance Costs		0.3%	0.3%	0.3%	1.5%
Total Cost		**74.7%**	**80.1%**	**73.5%**	**92.8%**
Movement in Inventory		-0.7%	-0.9%	-0.7%	n/a
Cost of Goods Sold		**74.0%**	**79.2%**	**72.8%**	**92.8%**

Comparing the small and medium versus large operations, the results demonstrate the economies of scale generated by larger operations. With a higher production capacity, the variable costs, capital requirements and capital expenditures are diluted resulting in lower production costs. However, it appears that the increase in production between the small and medium operators doesn't result in economies of scale. This is the result of the increase cost of manpower required to undertake activities of the farm, which is also reflected in the labour requirement estimated at 0.05, 0.08 and 0,13 staff/ton produced for the small, medium, and large grower respectively. On the AP company side, the labour requirement is estimated at 0.02 staff per ton of fish processed.

The AP Company acts as a service provider and supplier, hence its major cost is the purchase of feed, representing 81.2% share of its total costs, followed by the production of fingerlings representing 6% of its total cost.

Table 17: Cost structures (normalized averages over the 15 years assessment period).

Cost structure	Small Grower	Medium Grower	Large Grower	AP Cooperative
Fingerlings	5.3%	5.1%	5.4%	6.0%
Broodstock	0.0%	0.0%	0.0%	0.3%
Feed	70.9%	67.9%	71.0%	83.9%
Production Equipment	0.3%	0.2%	0.1%	0.0%
Electricity	0.0%	0.0%	0.0%	0.1%
Manpower	3.8%	9.6%	3.6%	2.3%
Fuel & Lubricants	1.7%	1.6%	1.0%	0.3%
Lease on infrastructures	3.5%	3.3%	3.5%	0.0%
Permits & Licenses	0.0%	0.0%	0.0%	0.0%
Maintenance Costs	0.4%	0.4%	0.4%	1.6%
General expenses and Administration	0.4%	0.4%	0.9%	1.0%
Sales & Marketing	5.8%	5.5%	5.8%	0.5%
Insurance	0.0%	0.0%	0.0%	0.0%
Depreciation & Amortization	0.4%	0.5%	0.4%	2.7%
Interest	0.7%	0.7%	0.8%	0.3%
Tax	6.8%	4.8%	7.1%	0.8%
TOTAL	100.0%	100.0%	100.0%	100.0%

6.4. Financial results

6.4.1. Profitability measures

Net farm income

Net farm income, also called Profit After Tax (PAT) measures the return to the operator's equity or capital. It is calculated from deducting all the expenses required to operate the business to the total revenue.

$$Net\ income\ = Total\ revenue - total\ expenses$$

Rate of return on assets

The rate of Return on Assets (ROA) measures the profits obtained from the use of all capital (debt and equity) invested in the business by comparing the profits to the value of the assets of the business.

$$ROA = \frac{Adjusted\ net\ farm\ income}{Current\ assets}$$

$$Adjusted\ net\ farm\ income\ =\ Net\ farm\ income\ +\ interest\ expense$$

Current ratio

Current ratio informs of a company's liquidity by comparing the value of current farm assets against the value of current farm liabilities. The formula is:

$$Current\ ratio = \frac{Current\ farm\ assets}{Current\ farm\ liabilities}$$

current farm assets: those that will generate or will be able to generate saleable products in the near future
current farm liabilities: upcoming financial obligations

Net Present Value NPV

The NPV is a method for valuation of the business done using the income approach (discounted cashflow approach). The NPV is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. It analyses the profitability of a projected investment of project.

A positive NPV indicates that the investment is profitable as the projected earnings generated exceeds the anticipated costs, while a negative NPV indicates that the project will results in net loss.

The NPV is calculated using the built-in excel formula.

Payback period

The payback method calculates how long it will take to repay the original investment, with the limitation that it doesn't account for the time value of money.

The payback period is calculated

Internal Rate of Return (IRR)

The IRR is a discount rate that makes the NPV of all cash flows from the project equal to zero. To indicate the profitability of a project, the IRR needs to be positive and higher than the cost of investment (WACC).

The IRR is calculated using the built-in excel formula.

6.4.2. Comparison of financial performances

The results presented in table 18 demonstrate that based on the set of assumptions taken in this base scenario, the project is profitable for the three sizes of operators with positive NPVs and IRR higher than the WACC. The payback period for the farmers is in the range of 2.6 years. These results are better than previously anticipated as the assumptions for the financial assessment have been reviewed and it was decided to remove from the start-up costs the working capital required to finance activities in year 1. The project costs and NPV analysis therefore only takes into consideration the PPE Capex costs that need to be covered by each business entity.

Taking into consideration the grant to finance cages and infrastructures, the AquaPark company has a positive NPV but an IRR lower than the WACC, indicating the AquaPark company will generate profit over the course of the project but at a lower return than the cost of capital.

In the absence of the grant, the NPV for the AP Cooperative is -3,549,459,445, which clearly indicates that the project is not financially viable without funding for the equipment and infrastructures.

In order to improve the IRR of the AP Company, it is advised that the lease commission charged by the cooperative to the outgrowers could be based on a percentage of the corresponding Capex equipment (cages) being leased instead of on the actual revenue of the farmers. This would reduce the risk of the cooperative receiving variables income from that source due to potential poor performance of the farmers. For example the lease commissioning could be 5%/year of the actual cages cost leased to each farmers.

Table 18: Financial performances of the 4 entities considered in the cooperative business model under the base model scenario.

		Small Grower	Medium Grower	Large Grower	AP Cooperative
Production capacity	**tons/year**	**104**	**312**	**1,743**	**2,159**
Capex	UGX	395,675,922	1,235,753,953	6,804,507,182	10,114,517,381
Normalized Financial performances (15 years average)					
Yearly revenue	UGX / year	1,223,763,668	3,671,291,003	20,493,962,221	18,210,542,544
Operating profit	%	20.2%	14.9%	21.1%	3.0%
Net Income	UGX / year	174,133,972	387,069,016	3,036,411,013	338,828,628
Net Income	%	13.7%	10.0%	14.3%	1.9%
ROA	%	20%	17%	20%	3.7%
Current Ratio		8.0	6.2	8.3	n/a
IRR	%	56%	40%	56%	15%
NPV (*including post tax grant)		321,309,905	532,847,614	5,670,229,218	1,450,696,555*
Break-even point (production / year)	tons/year	31	156	420	
Pay-back period	years	2.63	2.66	2.63	8.28

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6.4.3. Sensitivity analysis

A sensitivity analysis was undertaken to assess the outcome of variations of a set of key operating and financial variables on net profitability (Net Profit margin in %, normalized over the 15 years assessment period) of the different operators. The results are presented in tables 19, 20, 21 and 22 respectively for the large – medium - small scale operators and the AP cooperative.

Fish price appears to be the key variable that has the biggest impact on financial performances of each farmer. A decrease in sale price would result in net profitability plunging between -4.4% and -13.3% depending on the size of the operation. On the contrary, an increase in sale price would result in increased net profit ranging from 20.9% to 24.3%.

As expected, the next key variables that largely drive the profitability of each farmers' operations are cost of feed and FCR. The feed being the largest cost-centre of the operations (around 70% of total costs), a substantial reduction in FCR and feed cost will significantly reduce costs and increase profitability.

The other variables tested in the sensitivity analysis (number of cages, stocking density, marketing fee and equity part of the capex) have a less important effect on the net profitability of the farmers.

Regarding the AquaPark company, and considering that it acts as a fish trader and feed supplier mainly, decreases in feed and fish costs would result in a slight reduction in profitability, and increase in the same costs would increase its revenues and profitability.

Marketing strategies need to be developed to ensure a sustained fish price around 8,000 UGX/kg, which combined with a lower feed price and a lower FCR would ensure financial viability of all investments.

Table 19: Sensitivity analysis for the large-scale operator within the AP Cooperative business model. Net profitability is the average normalized profitability over 10 years.

Large scale - grower - AquaPark model		base case	Net profitability	25% less	Net profitability	25% more	Net profitability
1. Number of grow-out cages	nbr	24	14.3%	18	13.3%	30	14.9%
2. feed cost	UGX/kg	3399	14.3%	2691	23.4%	4106	5.1%
3. fish price	UGX/kg	8000	14.3%	6000	-4.4%	10000	24.3%
4. FCR		1.6	14.3%	1.2	22.3%	2	3.7%
5. Stocking Density Grow out	kg/m3	30	14.3%	22.5	13.2%	37.5	14.9%
6. Marketing Fee to AP company	%	5%	14.3%	3.8%	15.2%	6.30%	13.4%
7. Equity part of capex	%	60%	14.3%	45.0%	14.1%	75.00%	14.5%
8. Grow-out survival	%	88%	14.3%	66.0%	13.5%	100.00%	14.6%

Table 20: Sensitivity analysis for the medium scale operator within the AP Cooperative business model. Net profitability is the average normalized profitability over 10 years.

Medium scale - grower - AquaPark		base case	Net profitability	25% less	Net profitability	25% more	Net profitability
1. Number of grow-out cages	nbr	24	10.0%	18	7.5%	30	11.4%
2. feed cost	UGX/kg	3399	10.0%	2691	19.1%	4106	0.3%
3. fish price	UGX/kg	8000	10.0%	6000	-13.3%	10000	20.9%
4. FCR		1.6	10.0%	1.2	17.9%	2	-1.4%
5. Stocking Density Grow out	kg/m3	30	10.0%	22.5	7.5%	37.5	11.5%
6. Marketing Fee to AP company	%	5%	10.0%	3.8%	10.8%	6.30%	9.1%
7. Equity part of capex	%	60%	10.0%	45.0%	9.8%	75.00%	10.2%
8. Grow-out survival	%	88%	10.0%	66.0%	9.1%	100.00%	10.3%

Table 21: Sensitivity analysis for the small-scale operator within the AP Cooperative business model. Net profitability is the average normalized profitability over 10 years.

Small scale - grower - AquaPark		base case	Net profitability	25% less	Net profitability	25% more	Net profitability
1. Number of grow-out cages	nbr	8	13.7%	6	12.5%	10	14.4%
2. feed cost	UGX/kg	3399	13.7%	2691	22.9%	4106	4.5%
3. fish price	UGX/kg	9150	13.7%	6000	-6.7%	10000	23.8%
4. FCR		1.6	13.7%	1.2	21.6%	2	3.1%
5. Stocking Density Grow out	kg/m3	30	13.7%	22.5	12.5%	37.5	14.4%
6. Marketing Fee to AP company	%	5%	13.7%	3.8%	14.6%	6.30%	12.8%
7. Equity part of capex	%	60%	13.7%	45.0%	13.5%	75.00%	13.9%
8. Grow-out survival	%	88%	13.7%	66.0%	12.8%	100.00%	14.0%

Table 22: Sensitivity analysis for the AquaPark company within the AP Cooperative business model. Net profitability is the average normalized profitability over 10 years.

AquaPark Cooperative - AquaPark		base case	Net profitability	25% less	Net profitability	25% more	Net profitability
1. Number of grow-out cages	nbr	56	1.89%	42	0.55%	70	2.67%
2. feed cost	UGX/kg	3399	1.89%	2691	1.89%	4106	1.82%
3. fish price	UGX/kg	8000	1.89%	6000	0.37%	10000	3.35%
4. FCR		1.6	1.89%	1.2	1.90%	2	1.82%
5. Stocking Density Grow out	kg/m3	30	1.89%	22.5	-0.04%	37.5	2.91%
6. Marketing Fee to AP company	%	5%	1.89%	3.8%	1.10%	6.3%	2.67%
7. Grow-out survival	%	88%	1.89%	66.0%	1.77%	97.00%	1.93%

7. Conclusions

This Preliminary Design & Detailed Feasibility Study conducted for the proposed AquaPark development project in Kalangala is intended to follow the principles and concept developed by the previous report prepared by Poseidon and submitted in final form in early 2013. It is also intended to look in more detail at what is the reality on the ground in the particular locations and sites to be developed.

Additionally, through direction provided from field missions, a stakeholder validation meeting and discussion with the EUD in Kampala, various assumptions have been made regarding basic expectations of the project; production volumes, cost and revenue parameters and management set-up (core operator and out-growers).

In terms of budget available through the current project programme estimate (MAOPE), it was indicated that the cost of such an operation established through this study, should not be limited by the MAOPE budgets, but to outline what is required to put a professional and up to date production operation on the ground (as it is to be used as a model for future investment). Extra funds required, if any, would be assumed from other sources.

Due to the assumptions used for the base case scenario and the careful analysis that has ensued, it can be seen from this report that the intended pilot phase of the AquaPark in Kalangala is feasible and financially viable for the operators.

Nevertheless, in the context of the current sector in terms of its development stage in the country, there is a **serious risk of costs of production versus market prices**. Current prices and those used as a base case in this study, together with feed costs achievable at the current time, result in positive profit for all partners.

Assumptions can be adjusted in many ways, but as indicated the key factors of sales price achievable, Feed Conversion Ratio (FCR) and direct feed costs dictate significantly the overall potential of such an operation. Two other scenarios, worst-case and best-case, have been assessed to highlight the financial performances of the project when these three key variables are adjusted The results are presented in table 23 and 24 below.

In the worst-case scenario, table 23, assumptions were taken for a lower fish sale price starting at 7,000 UGX, and a cost for feed delivered to Kalangala at 1,050 USD/ton, based on some recommendations from the DFR review meeting. These resulted in negative NPV and IRR lower than the discount rate for all three farmers, informing that the investments are not financially viable.

Table 23: Financial performances of the 4 entities considered in the cooperative business model under **the worst-case scenario.**

Feed cost (delivered to Kalangala)	USD/ton UGX/ton	1,050
FCR (starting point)		1.6
Fish sale price	UGX/kg	7000

		Small Grower	Medium Grower	Large Grower	AP Cooperative
Production capacity	**tons/year**	**104**	**312**	**1,743**	**2,159**
Capex	UGX	429,980,474	1,338,667,610	7,371,761,028	10,289,664,071
Normalized Financial performances (15 years average)					
Yearly revenue	UGX / year	1,070,793,209	3,212,379,628	17,932,216,943	19,744,672,848
Operating profit	%	2.1%	-4.0%	3.1%	2.0%
Net Income	UGX / year	10,409,844	-150,486,871	345,877,799	225,845,919
Net Income	%	0.2%	-5.6%	1.2%	1.2%
ROA	%	6%	-11%	7%	2.8%
Current Ratio		2.3	2.2	2.8	n/a
IRR	%	11%	2%	13%	14%
NPV (*including post tax grant)		-175,482,517	-1,100,930,393	-2,604,466,511	1,196,140,020
Break-even point (production / year)	tons/year	1,220	1,195	1,002	n/a
Pay-back period	years	14.03	14.74	12.97	9.08

The best case-scenario (table 24) assumed a cost of feed delivered to Kalangala at 820 USD/ton (nearly 3,000,000 UGX/ton), along with a starting FCR of 1.4 improving to 1.2 and a fish price starting at 8,000 UGX/kg with an annual increase of 0.5%. These assumptions reflect a scenario where quality feed would be produced locally in Uganda resulting in lower overall feed cost, and a strong increasing demand for farmed tilapia allowing for an annual increase in fish price above the inflation rate. In that scenario, the NPV are positive and IRR rise to excellent levels, with payback periods of less than two years.

The performances of most current farm operations today in Uganda reflects small, if any, profits being achieved. Globally, as a commodity, fish farming businesses work on small margins and even with all items aligned, still have to worry about daily fluctuations in exchange rates and spikes in logistical costs for feed delivery to maintain profit. Whereas Uganda is not at this level of commercial development with fish farming, it highlights that **the basics** have to be in place as a first step; FCR/ Feed cost efficiency, coupled with careful and strategic market segmentation to ensure the most margins comes from each gram of fish sold.

The sector is currently operating on perceived potential, which is real, but to compete with current markets and others in the region, fish farming has to have an improved FCR, more effective feed management practices, and a marketing approach that balances fish size and segmentation with costs of production to ensure profit margins are achieved as fish are sold.

Table 24: Financial performances of the 4 entities considered in the cooperative business model under the **best-case scenario**.

Feed cost (delivered to Kalangala)	USD/ton UGX/ton	820 3,016,000
FCR (starting point)		1.4
Fish sale price	UGX/kg	8000 + 0.5% annual increase

		Small Grower	Medium Grower	Large Grower	AP Cooperative
Production capacity	**tons/year**	**104**	**312**	**1,743**	**2,159**
Capex	UGX	321,980,841	1,014,668,709	5,579,027,899	9,745,522,331
Normalized Financial performances (15 years average)					
Yearly revenue	UGX / year	1,273,127,954	3,819,383,862	21,320,649,470	14,578,031,428
Operating profit	%	36.9%	31.8%	37.8%	3.6%
Net Income	UGX / year	332,063,018	860,667,982	5,683,752,249	310,679,489
Net Income	%	25.5%	21.9%	26.1%	2.2%
ROA	%	27%	25%	27%	3.8%
Current Ratio		15.6	12.8	16.0	n/a
IRR	%	116%	91%	114%	14%
NPV (*including post tax grant)		768,821,947	1,875,216,488	13,172,394,565	1,168,849,709
Break-even point (production / year)	tons/year	18	91	257	n/a
Pay-back period	years	1.61	1.47	1.64	8.82

Changes in cost structures between the core operator and the out-growers (largely related to various overheads, and support offered through the structure), can make a small difference, but it would not be significant in terms of overall profitability. Focus on the key determining factors for success, as indicated here, are now a major step to bring the sector to its full potential, including ensuring investment in the sub-sector is attractive to larger investors – itself an overall objective of the PESCA project.

Throughout the project period, given the various focused activities planned, such as applied research, legislation/ regulation, training and various market related enhancements, this is likely to improve on the situation during the project period particular, with sufficient focus, the said ingredients for a competitive commercial aquaculture environment can be achieved.

Something that is key and has to be coupled with the market component of the project is some aggressively aligned marketing/ promotional activities that capture the potential for farmed fish as an alternative to capture fisheries. This will allow for more creative pricing for different sizes of fish farmed and significantly help with margins at the farm level.

In summary key components of the study outcome relate to:

- PESCA grant funds covering the set-up capital for a proportion of the infrastructure
- Key financial inputs required for Working Capital – various items are covered, but the key Working Capital cost is the upfront cost of feed, prior to selling the fish – this Working Capital

input is required for the main core operator, as well as the out-growers: Where does this money come from? The study assumes it comes from equity and debt from those investing in the AquaPark.

- Current sales price achieved is used throughout the modelling at UGX 8,000 per kg and is largely affected by competitive forces from the capture fishery tradition and distribution approaches
- Current feed prices are used
- FCR of 1.6 (grow-out) is used as a starting point and improving to 1.4 over the years – which is representative of what is being achieved in Uganda at this time
- Tax payments are assumed
- Consequent results suggest that with these and other assumptions used as the base case that the AquaPark project is financially viable.
- In the absence of funding to cover the infrastructure and equipment expenditures, the project is financially non feasible.

Way forward

It is suggested that the Project now reviews in detail the results of this study and that possible scenarios are envisaged as to a way forward, keeping the overall project objectives in mind and in the context of potential changes during the project period related to the key success factors identified. The outputs of the Project are all focused on these key success factors, so we can expect improvement as a result.

8. Sources

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Annex 1 – Summary of the principle policies and regulations governing the development of AquaParks in Uganda.

Adapted from Isyagi, N. 2017. Aquaculture Parks in Uganda.

Policy	Overall Goals
The National Fisheries Policy, 2004	To ensure increased and sustainable fish production and utilization by properly managing capture fisheries, promoting aquaculture and reducing post-harvest losses.
The National Aquaculture Parks Investment Policy, 2012	To create a competitive, market-oriented and environmentally responsible aquaculture industry.
The National Water Policy, 1999	To attain an integrated and sound water resources management regime that balances economic, ecological and health priorities. This includes water for agricultural production, under which water for aquaculture use falls.
The National Policy for Water for Agricultural Production, 2011 (draft)	The provision of water for increased agricultural production and productivity through coordinated interventions targeting water for crops, livestock and aquaculture. The need for this policy was realized based on the fact that the quantity and quality of water resources available to boost and sustain agriculture were receding due to an array of factors that included poor watershed management, inadequate water, harnessing capacity and rational use of water resources.
The National Agricultural Policy, 2013	To promote food, nutrition security and household incomes through coordinated interventions that focus on enhancing productivity and value addition, providing employment opportunities, and promoting domestic and international trade.
The National Environment Management Policy, 1994	This provides the overall policy framework to ensure sustainable social and economic development in the country that maintains or enhances environmental quality and resource productivity without compromising ability of present and future generations to meet their needs.
The National Policy for the Conservation and Management Wetland Resources, 1995	To ensure the protection and sustainable use of wetland resources so as to maintain their ecosystem function to include long-term interests of future generations.
The National Trade Policy, 2007	To develop and nurture private sector competitiveness, to support the productive sectors of the economy to trade at both domestic and international levels, with the ultimate objective of creating wealth, employment, enhancing social welfare and transforming Uganda from a poor peasant society into a modern and prosperous society.

The Uganda National Land Policy, 2013	To ensure efficient, equitable and optimal use as well as management of land resources for poverty reduction, wealth creation and overall socioeconomic development. The sustainable exploitation of land resources while safeguarding environmental sustainability is stressed.
Science and Technology Policy, 2009	To strengthen national capability to generate, transfer and apply scientific knowledge, skills and technologies that ensure sustainable utilization of natural resources for the realization of Uganda's development objectives.
The Uganda Food and Nutrition Policy, 2003	To ensure food security and adequate nutrition for all the people in Uganda.
The Public-Private Partnership Framework Policy, 2010	To enable the public and private sectors to work together to improve public service delivery through private sector access to public infrastructure and related services.

Law	Content
The Constitution of Uganda, 1995	The main legislative body of the country offers every Ugandan the right to and responsibility for creating a clean and healthy environment.
The Fisheries Act, 1970	Provides the framework for the management and sustainable use of fishery resources so that sustainable benefits are realized for the people of Uganda. It covers fisheries, access to lakes for fishing and aquaculture.
The Water Act, 1997	Provides the framework for the management of water resources in the country, its use and quality control.
The National Environmental Act, 1995	Relates to the protection and preservation of the environment. It provides for various strategies and tools for environment management that include Environmental Impact Assessments.
The Land Act, 2010	Provides the framework with which land, ground water, natural streams, wetlands are held, managed and utilized for the common good of the people of Uganda.
The Local Government Act, 1997	Provides for the decentralization and devolution of Government functions, powers and services from the central to local governments and sets the political and administrative functions of local governments. The local governments therefore are responsible for the protection of the environment at local levels.
Uganda Wildlife Act, 2000	Protects the wildlife resources of the country (wild plant and animal species native to Uganda or that migrate through Uganda). It provides the framework for the sustainable management of these resources.

Regulation	Content
The Fish (Aquaculture) Rules, 2003	Stipulates the guidelines for the farming, breeding and marketing of fish and other aquaculture products. Permits and licensing procedures for aquaculture are provided for in these rules.
Uganda Statute on BMUs, 2003	Guides community involvement in fisheries management. Enables fishing communities to have rights of access and decision-making in the use of fishery resources within the framework of the National Fisheries Policy.
The Water Resources Regulations, 1998	The water resources regulations provide for the control of the extraction, discharge and pollution.
The Environmental Impact Assessment Regulations, 1998	Regulate in consultation with the Lead Agencies the use of the country's natural resources to ensure compliance with the National Environment Act. It provides criteria and guidelines under which EIAs should be undertaken, evaluated and monitored.

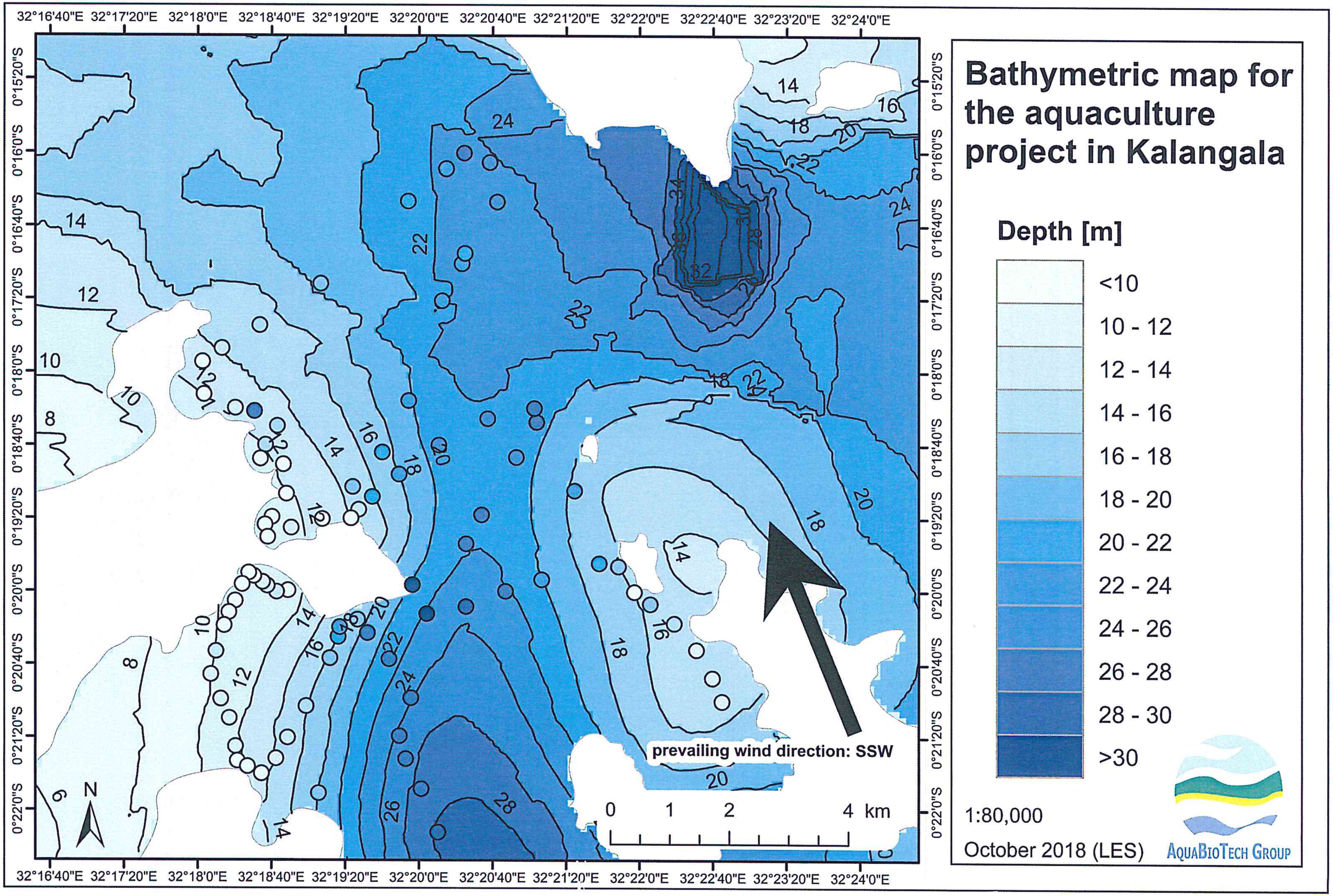
Annex 2 – Drawings

Drawing D1: Bathymetric map of Lake Victoria for the project in Kalangala islands

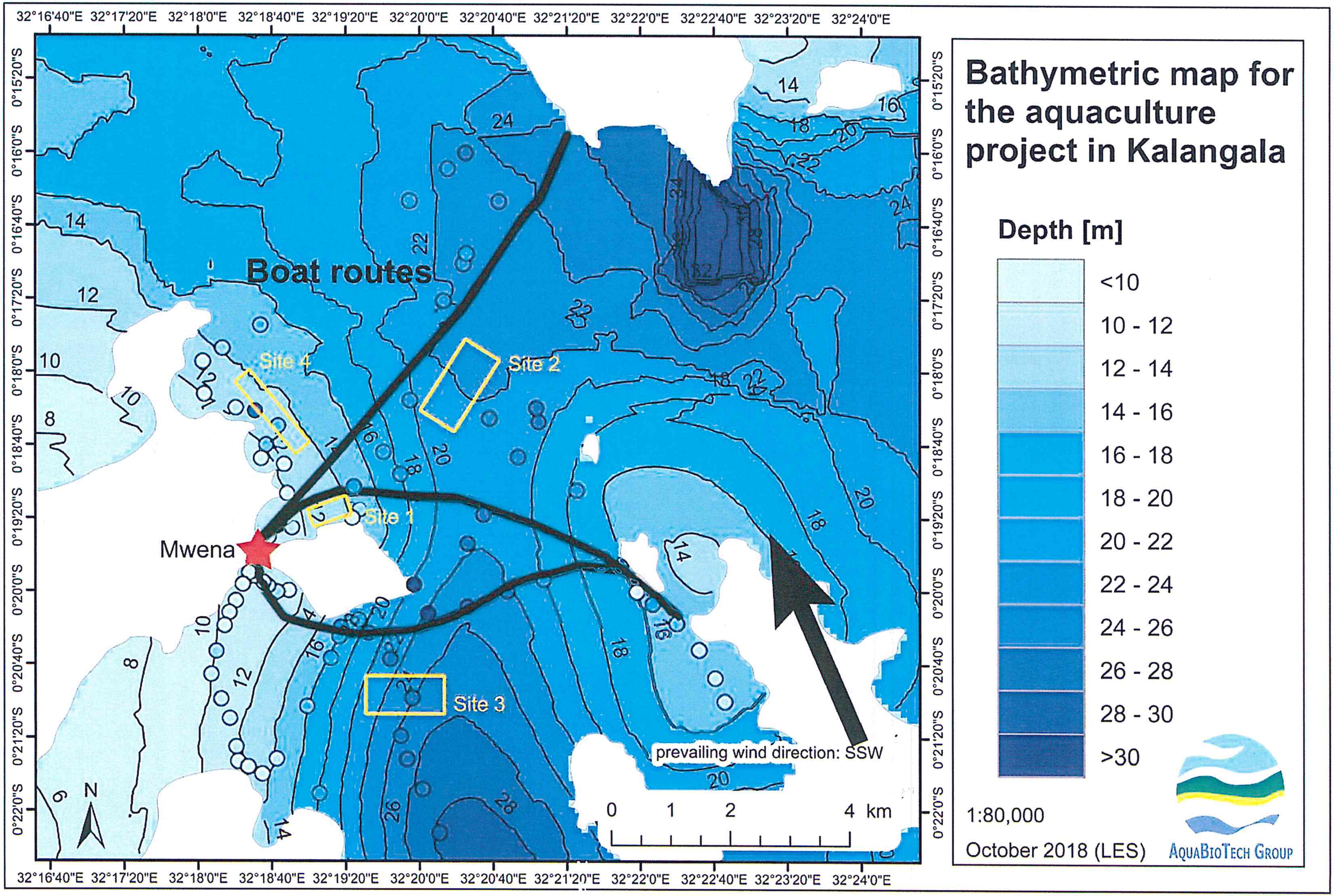
Drawing D2: Bathymetric map of Lake Victoria around Kalangala Island showing the identified sites for the pilot AquaPark

Drawing D3: Preliminary cages layout for the large-scale operator

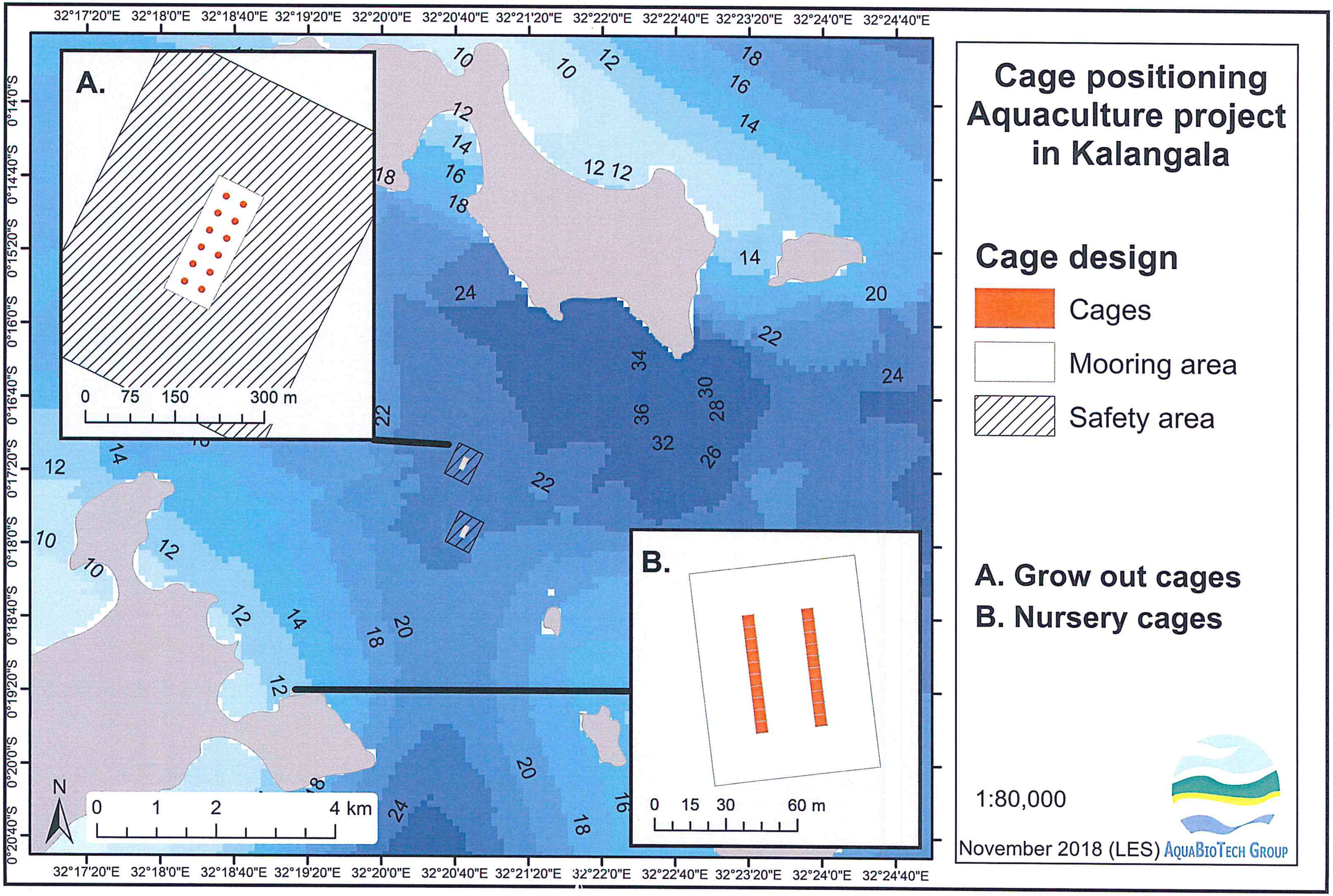
Drawing PL01 rev3: Preliminary layout design for Mwena landing site



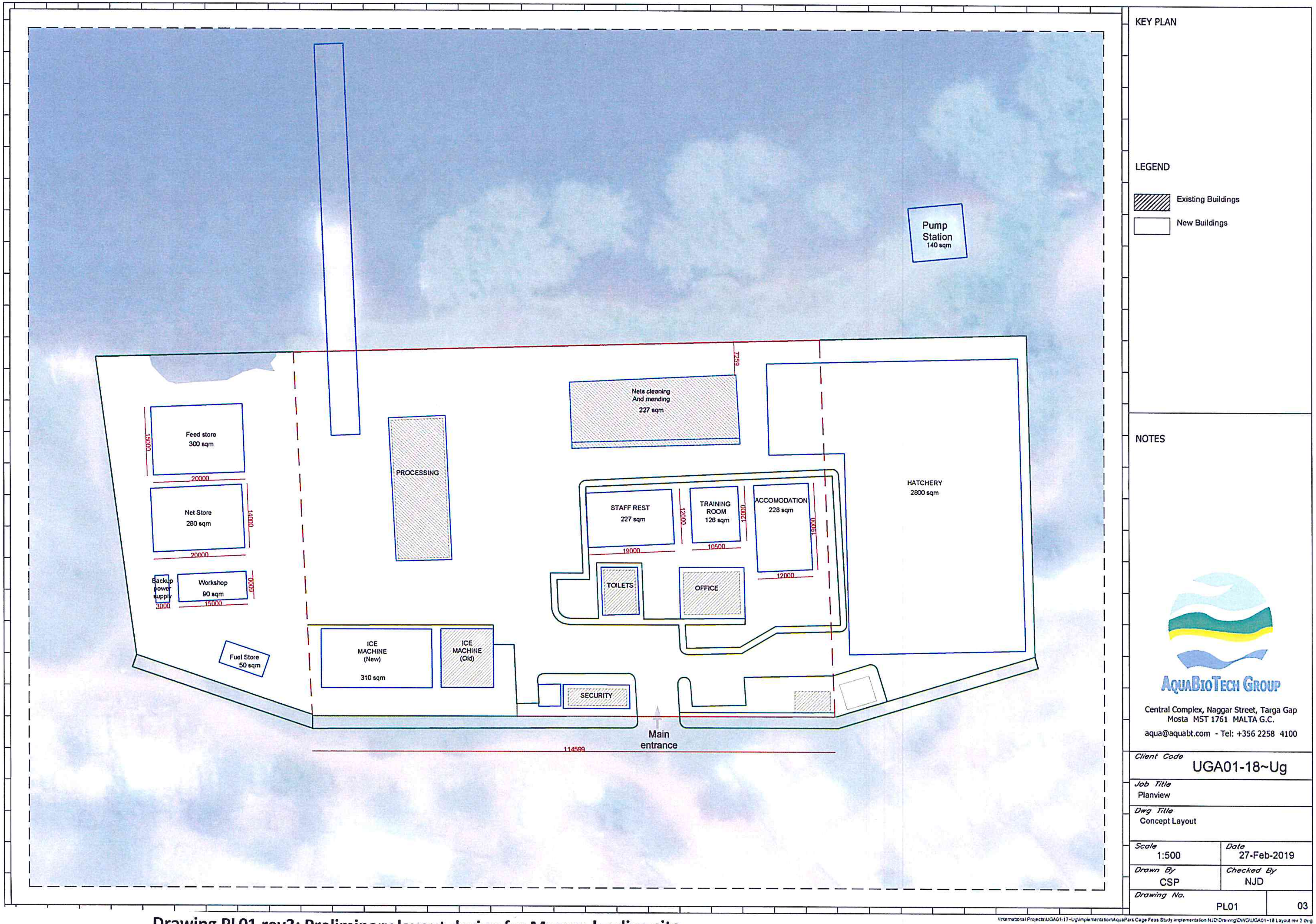
Drawing D1: Bathymetric map of Lake Victoria for the project in Kalangala islands



Drawing D2: Bathymetric map of Lake Victoria around Kalangala Island showing the identified sites for the pilot AquaPark



Drawing D3: Preliminary cages layout for the large-scale operator



Drawing PL01 rev3: Preliminary layout design for Mwena landing site

Annex 3 – Income statements and balance sheets

Income statement for the small-scale operator

Income Statement (UGX)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Normalized average
Revenue	191,486,592	878,340,672	926,649,409	977,615,126	1,031,383,958	1,088,110,076	1,147,956,130	1,211,093,717	1,277,703,872	1,347,977,585	1,422,116,352	1,500,332,751	1,582,851,053	1,669,907,861	1,761,752,793	1,273,127,954
Cost																
Fingerlings	38,716,071	40,651,875	42,684,469	44,818,692	47,059,627	49,412,608	51,883,239	54,477,400	57,201,270	60,061,334	63,064,401	66,217,621	69,528,502	73,004,927	76,655,173	
Broodstock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Feed	273,917,220	572,066,422	574,882,627	578,289,105	592,906,934	607,969,722	610,768,728	607,308,279	622,974,227	619,000,554	635,141,457	646,264,711	657,365,597	669,642,168	681,974,450	
Production Equipment	1,296,960	1,316,616	3,201,572	1,451,569	3,529,733	1,600,355	3,891,531	1,764,391	4,290,412	1,945,241	4,730,180	4,710,138	5,215,023	5,192,927	5,749,563	
Harvest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Manpower	2,381,170	30,002,742	31,502,879	33,078,023	34,731,924	36,468,520	38,291,946	40,206,544	42,216,871	44,327,714	44,327,714	44,327,714	44,327,714	44,327,714	44,327,714	
Fuel - Generator	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Fuel - Vehicle & boats	11,520,000	12,096,000	12,700,800	13,335,840	14,002,632	14,702,764	15,437,902	16,209,797	17,020,287	17,871,301	18,764,866	19,703,109	20,688,265	21,722,678	22,808,812	
Oil	1,080,000	1,134,000	1,190,700	1,250,235	1,312,747	1,378,384	1,447,303	1,519,668	1,595,652	1,675,434	1,759,206	1,847,167	1,939,525	2,036,501	2,138,326	
Lease on infrastructures	5,744,598	26,350,220	27,799,482	29,328,454	30,941,519	32,643,302	34,438,684	36,332,812	38,331,116	40,439,328	42,663,491	45,009,983	47,485,532	50,097,236	52,852,584	
Permits & Licenses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Maintenance Costs	-	-	20,500	1,851,097	1,851,097	3,071,495	3,071,495	4,889,792	4,889,792	6,101,990	6,101,990	6,101,990	6,101,990	6,101,990	6,101,990	
Total Cost	334,656,019	683,617,875	693,983,029	703,403,015	726,336,212	747,247,150	759,230,828	762,708,684	788,519,628	791,422,897	816,553,305	834,182,433	852,652,148	872,126,142	892,608,612	780,327,997
Movement in Inventory	- 189,237,856	- 2,208,521	- 2,598,919	- 2,091,883	- 5,795,593	- 5,246,853	- 2,824,441	- 516,386	- 6,576,470	- 360,472	- 4,755,339	- 4,356,334	- 4,798,092	- 5,284,268	- 5,557,918	- 3,783,678
Cost of Goods Sold	145,418,163	681,409,354	691,384,110	701,311,132	720,540,619	742,000,297	756,406,387	762,192,297	781,943,158	791,062,425	811,797,966	829,826,099	847,854,056	866,841,873	887,050,694	776,544,319
Gross Profit	46,068,429	196,931,318	235,265,299	276,303,995	310,843,339	346,109,779	391,549,743	448,901,420	495,760,714	556,915,160	610,318,386	670,506,652	734,996,997	803,065,987	874,702,099	496,583,635
General expenses and Administration	1,673,280	3,418,089	3,469,915	3,517,015	3,631,681	3,736,236	3,796,154	3,813,543	3,942,598	3,957,114	4,082,767	4,170,912	4,263,261	4,360,631	4,463,043	
Sales & Marketing	9,574,330	43,917,034	46,332,470	48,880,756	51,569,198	54,405,504	57,397,807	60,554,686	63,885,194	67,398,879	71,105,818	75,016,638	79,142,553	83,495,393	88,087,640	
Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other income	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EBITDA	34,820,819	149,596,195	185,462,914	223,906,223	255,642,460	287,968,039	330,355,783	384,533,191	427,932,922	485,559,166	535,129,802	591,319,103	651,591,184	715,209,964	782,151,416	429,025,597
Depreciation & Amortization	6,197,657	6,197,657	6,197,657	6,060,990	6,060,990	6,060,990	6,060,990	6,060,990	6,060,990	6,060,990	-	-	-	-	-	3,915,875
EBIT (Operating Profit, Operating Income)	28,623,162	143,398,538	179,265,257	217,845,233	249,581,470	281,907,049	324,294,792	378,472,201	421,871,932	479,498,176	535,129,802	591,319,103	651,591,184	715,209,964	782,151,416	425,109,723
Interest	7,913,518	15,827,037	15,035,685	13,452,981	11,870,278	10,287,574	8,704,870	7,122,167	5,539,463	3,956,759	2,374,056	791,352	-	-	-	6,783,016
PBT	20,709,644	127,571,501	164,229,572	204,392,252	237,711,192	271,619,475	315,589,922	371,350,034	416,332,469	475,541,417	532,755,746	590,527,751	651,591,184	715,209,964	782,151,416	418,326,707
Tax	6,212,893	38,271,450	49,268,872	61,317,676	71,313,358	81,485,842	94,676,977	111,405,010	124,899,741	142,662,425	159,826,724	177,158,325	195,477,355	214,562,989	234,645,425	125,498,012
PAT	14,496,751	89,300,051	114,960,700	143,074,576	166,397,835	190,133,632	220,912,945	259,945,024	291,432,728	332,878,992	372,929,022	413,369,426	456,113,829	500,646,974	547,505,991	292,828,695

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Balance sheet for the small-scale operator

Balance Sheet (UGX)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Assets															
PPE	54,822,246	48,624,589	42,426,932	36,365,942	30,304,951	24,243,961	18,182,971	12,121,981	6,060,990	-	-	-	-	-	-
Cash & bank	193,618,545	270,939,502	317,043,483	377,497,087	447,019,285	528,791,909	627,642,854	747,618,784	879,114,079	1,035,665,682	1,203,613,330	1,391,563,641	1,616,340,522	1,862,980,344	2,132,858,912
Account receivable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological Asset	189,237,856	191,446,378	194,045,297	196,137,180	201,932,774	207,179,627	210,004,067	210,520,454	217,096,923	217,457,395	222,212,734	226,569,068	231,367,160	236,651,429	242,209,347
Total Assets	**437,678,647**	**511,010,469**	**553,515,713**	**610,000,209**	**679,257,010**	**760,215,497**	**855,829,892**	**970,261,219**	**1,102,271,993**	**1,253,123,077**	**1,425,826,064**	**1,618,132,710**	**1,847,707,683**	**2,099,631,772**	**2,375,068,259**
Equity & Liabilities															
Equity	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553	237,405,553
Retained Earnings	14,496,751	59,146,776	116,627,126	188,164,415	271,363,332	366,430,148	476,886,621	606,859,133	752,575,497	919,014,993	1,105,479,504	1,312,164,217	1,540,221,131	1,790,544,618	2,064,297,614
Legal reserves	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shareholder Equity	**251,902,304**	**296,552,330**	**354,032,680**	**425,569,968**	**508,768,885**	**603,835,701**	**714,292,174**	**844,264,686**	**989,981,050**	**1,156,420,546**	**1,342,885,057**	**1,549,569,770**	**1,777,626,684**	**2,027,950,171**	**2,301,703,167**
Amended Equity	251,902,304	296,552,330	354,032,680	425,569,968	508,768,885	603,835,701	714,292,174	844,264,686	989,981,050	1,156,420,546	1,342,885,057	1,549,569,770	1,777,626,684	2,027,950,171	2,301,703,167
Debt	158,270,369	158,270,369	142,443,332	126,616,295	110,789,258	94,962,221	79,135,184	63,308,148	47,481,111	31,654,074	15,827,037	-	-	-	-
Account payables	27,505,974	56,187,771	57,039,701	57,813,946	59,698,867	61,417,574	62,402,534	62,688,385	64,809,832	65,048,457	67,113,970	68,562,940	70,080,998	71,681,601	73,365,091
Total liabilities & Equities	**437,678,647**	**511,010,469**	**553,515,713**	**610,000,209**	**679,257,010**	**760,215,497**	**855,829,892**	**970,261,219**	**1,102,271,993**	**1,253,123,077**	**1,425,826,064**	**1,618,132,710**	**1,847,707,683**	**2,099,631,772**	**2,375,068,259**
Check	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Income statement for the medium-scale operator

Income Statement (UGX)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Normalized average
Revenue	574,459,776	2,635,022,016	2,779,948,227	2,932,845,379	3,094,151,875	3,264,330,228	3,443,868,391	3,633,281,152	3,833,111,616	4,043,932,755	4,266,349,056	4,500,998,254	4,748,553,158	5,009,723,582	5,285,258,379	3,819,383,862
Cost																
Fingerlings	116,148,214	121,955,625	128,053,406	134,456,077	141,178,880	148,237,824	155,649,716	163,432,201	171,603,811	180,184,002	189,193,202	198,652,862	208,585,505	219,014,781	229,965,520	
Broodstock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Feed	821,751,660	1,716,199,266	1,724,647,881	1,734,867,314	1,778,720,801	1,823,909,165	1,832,306,184	1,821,924,837	1,868,922,682	1,857,001,661	1,905,424,370	1,938,794,134	1,972,096,790	2,008,926,504	2,045,923,349	
Production Equipment	3,666,960	3,561,348	6,253,115	3,926,386	6,894,060	4,328,841	7,600,701	4,772,547	8,379,773	5,261,733	9,238,699	8,417,880	10,293,417	9,393,851	11,467,289	
Harvest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Manpower	20,843,027	258,745,221	251,247,265	263,809,629	277,000,110	290,850,115	305,392,621	320,662,252	336,695,365	353,530,133	353,530,133	353,530,133	353,530,133	353,530,133	353,530,133	
Fuel - Generator	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Fuel - Vehicle & boats	33,120,000	34,776,000	36,514,800	38,340,540	40,257,567	42,270,445	44,383,968	46,603,166	48,933,324	51,379,991	53,948,990	56,646,440	59,478,762	62,452,700	65,575,335	
Oil	3,105,000	3,260,250	3,423,263	3,594,426	3,774,147	3,962,854	4,160,997	4,369,047	4,587,499	4,816,874	5,057,718	5,310,604	5,576,134	5,854,941	6,147,688	
Lease on infrastructures	17,233,793	79,050,660	83,398,447	87,985,361	92,824,556	97,929,907	103,316,052	108,998,435	114,993,348	121,317,983	127,990,472	135,029,948	142,456,595	150,291,707	158,557,751	
Permits & Licenses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Maintenance Costs	-	-	335,000	6,931,559	6,931,559	11,329,265	11,329,265	17,724,824	17,724,824	17,724,824	17,724,824	17,724,824	17,724,824	17,724,824	17,724,824	
Total Cost	1,015,868,655	2,217,548,371	2,233,873,177	2,273,911,291	2,347,581,680	2,422,818,417	2,464,139,503	2,488,487,308	2,571,840,627	2,591,217,200	2,662,108,408	2,714,106,824	2,769,742,160	2,827,189,441	2,888,891,887	2,533,818,307
Movement in Inventory	- 577,376,068	- 44,060,828	- 3,762,429	- 8,926,728	- 18,655,846	- 19,080,874	- 9,877,862	- 5,272,163	- 21,283,309	- 3,923,219	- 12,145,712	- 12,107,849	- 15,096,649	- 15,588,320	- 16,742,959	- 14,751,768
Cost of Goods Sold	438,492,587	2,173,487,542	2,230,110,748	2,264,984,563	2,328,925,834	2,403,737,543	2,454,261,641	2,483,215,146	2,550,557,318	2,587,293,981	2,649,962,696	2,701,998,975	2,754,645,512	2,811,601,121	2,872,148,929	2,519,066,539
Gross Profit	135,967,189	461,534,474	549,837,479	667,860,816	765,226,041	860,592,685	989,606,750	1,150,066,007	1,282,554,298	1,456,638,773	1,616,386,360	1,798,999,279	1,993,907,647	2,198,122,461	2,413,109,450	1,300,317,323
General expenses and Administration	5,079,343	11,087,742	11,169,366	11,369,556	11,737,908	12,114,092	12,320,698	12,442,437	12,859,203	12,956,086	13,310,542	13,570,534	13,848,711	14,135,947	14,444,459	
Sales & Marketing	28,722,989	131,751,101	138,997,411	146,642,269	154,707,594	163,216,511	172,193,420	181,664,058	191,655,581	202,196,638	213,317,453	225,049,913	237,427,658	250,486,179	264,262,919	
Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other income	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EBITDA	102,164,857	318,695,631	399,670,701	509,848,991	598,780,539	685,262,082	805,092,633	955,959,512	1,078,039,514	1,241,486,050	1,389,758,365	1,560,378,832	1,742,631,278	1,933,500,334	2,134,402,072	1,096,679,038
Depreciation & Amortization	23,551,863	23,551,863	23,551,863	21,318,530	21,318,530	21,318,530	21,318,530	21,318,530	21,318,530	21,318,530	-	-	-	-	-	14,023,817
EBIT (Operating Profit, Operating Income)	78,612,994	295,143,768	376,118,838	488,530,461	577,462,009	663,943,552	783,774,103	934,640,983	1,056,720,984	1,220,167,520	1,389,758,365	1,560,378,832	1,742,631,278	1,933,500,334	2,134,402,072	1,082,655,221
Interest	24,715,079	49,430,158	46,958,650	42,015,634	37,072,619	32,129,603	27,186,587	22,243,571	17,300,555	12,357,540	7,414,524	-	-	-	-	21,007,817
PBT	53,897,915	245,713,610	329,160,188	446,514,827	540,389,390	631,813,949	756,587,516	912,397,411	1,039,420,429	1,207,809,980	1,382,343,841	1,560,378,832	1,742,631,278	1,933,500,334	2,134,402,072	1,061,647,404
Tax	16,169,374	73,714,083	98,748,056	133,954,448	162,116,817	189,544,185	226,976,255	273,719,223	311,826,129	362,342,994	414,703,152	468,113,650	522,789,383	580,050,100	640,320,622	318,494,221
PAT	37,728,540	171,999,527	230,412,132	312,560,379	378,272,573	442,269,764	529,611,261	638,678,188	727,594,300	845,466,986	967,640,689	1,092,265,183	1,219,841,895	1,353,450,234	1,494,081,450	743,153,183

Balance sheet for the medium-scale operator

Balance Sheet (UGX)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Assets															
PPE	196,333,435	172,781,572	149,229,709	127,911,179	106,592,649	85,274,119	63,955,589	42,637,060	21,318,530	-	-	-	-	-	-
Cash & bank	583,269,044	747,528,038	834,435,145	956,967,782	1,105,391,695	1,285,517,916	1,515,730,309	1,803,686,802	2,124,939,973	2,517,231,214	2,945,302,363	3,434,170,790	4,033,567,856	4,699,426,347	5,434,795,548
Account receivable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological Asset	577,376,068	621,436,896	625,199,325	634,126,053	652,781,899	671,862,773	681,740,636	687,012,798	708,296,107	712,219,326	724,365,038	736,472,887	751,569,535	767,157,855	783,900,814
Total Assets	**1,356,978,547**	**1,541,746,506**	**1,608,864,179**	**1,719,005,014**	**1,864,766,243**	**2,042,654,808**	**2,261,426,535**	**2,533,336,660**	**2,854,554,610**	**3,229,450,540**	**3,669,667,401**	**4,170,643,676**	**4,785,137,391**	**5,466,584,202**	**6,218,696,361**
Equity & Liabilities															
Equity	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372	741,452,372
Retained Earnings	37,728,540	123,728,304	238,934,369	395,214,559	584,350,845	805,485,728	1,070,291,358	1,389,630,452	1,753,427,602	2,176,161,095	2,659,981,440	3,206,114,031	3,816,034,978	4,492,760,095	5,239,800,821
Legal reserves	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shareholder Equity	**779,180,912**	**865,180,675**	**980,386,741**	**1,136,666,931**	**1,325,803,217**	**1,546,938,099**	**1,811,743,730**	**2,131,082,824**	**2,494,879,974**	**2,917,613,467**	**3,401,433,812**	**3,947,566,403**	**4,557,487,350**	**5,234,212,467**	**5,981,253,192**
Amended Equity	779,180,912	865,180,675	980,386,741	1,136,666,931	1,325,803,217	1,546,938,099	1,811,743,730	2,131,082,824	2,494,879,974	2,917,613,467	3,401,433,812	3,947,566,403	4,557,487,350	5,234,212,467	5,981,253,192
Debt	494,301,581	494,301,581	444,871,423	395,441,265	346,011,107	296,580,949	247,150,791	197,720,632	148,290,474	98,860,316	49,430,158	0	0	0	0
Account payables	83,496,054	182,264,250	183,606,015	186,896,818	192,951,919	199,135,760	202,532,014	204,533,203	211,384,161	212,976,756	218,803,431	223,077,273	227,650,041	232,371,735	237,443,169
Total liabilities & Equities	**1,356,978,547**	**1,541,746,506**	**1,608,864,179**	**1,719,005,014**	**1,864,766,243**	**2,042,654,808**	**2,261,426,535**	**2,533,336,660**	**2,854,554,610**	**3,229,450,540**	**3,669,667,401**	**4,170,643,676**	**4,785,137,391**	**5,466,584,202**	**6,218,696,361**
Check	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Income statement for the large-scale operator

Income Statement (UGX)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Normalized average
Revenue	3,206,762,127	14,709,278,454	15,518,288,769	16,371,794,651	17,272,243,357	18,222,216,741	19,224,438,662	20,281,782,789	21,397,280,842	22,574,131,288	23,815,708,509	25,125,572,477	26,507,478,963	27,965,390,306	29,503,486,773	21,320,649,470
Cost																
Fingerlings	648,365,143	680,783,400	714,822,570	750,563,699	788,091,883	827,496,478	868,871,301	912,314,867	957,930,610	1,005,827,140	1,056,118,497	1,108,924,422	1,164,370,643	1,222,589,176	1,283,718,634	
Broodstock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Feed	4,530,803,016	9,522,429,957	9,568,166,398	9,623,668,765	9,866,933,155	10,117,602,383	10,162,869,752	10,103,228,592	10,363,848,549	10,295,504,036	10,563,967,016	10,748,974,138	10,933,609,210	11,137,798,834	11,342,915,052	
Production Equipment	16,829,670	14,332,154	18,455,487	15,801,200	20,347,174	17,420,823	22,432,759	19,206,457	24,732,117	21,175,119	27,267,159	25,911,078	30,062,043	28,566,963	33,143,402	
Harvest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Manpower	378,362,074	496,206,081	480,145,952	504,153,249	529,360,912	555,828,957	583,620,405	612,801,425	643,441,497	675,613,571	709,394,250	744,863,962	782,107,161	821,212,519	862,273,144	
Fuel - Generator	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Fuel - Vehicle & boats	115,200,000	120,960,000	127,008,000	133,358,400	140,026,320	147,027,636	154,379,018	162,097,969	170,202,867	178,713,010	187,648,661	197,031,094	206,882,649	217,226,781	228,088,120	
Oil	10,800,000	11,340,000	11,907,000	12,502,350	13,127,468	13,783,841	14,473,033	15,196,685	15,956,519	16,754,345	17,592,062	18,471,665	19,395,248	20,365,011	21,383,261	
Lease on infrastructures	96,202,864	441,278,354	465,548,663	491,153,840	518,167,301	546,666,502	576,733,160	608,453,484	641,918,425	677,223,939	714,471,255	753,767,174	795,224,369	838,961,709	885,104,603	
Permits & Licenses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Maintenance Costs	-	-	820,000	31,058,332	31,058,332	51,217,221	51,217,221	80,963,553	80,963,553	80,963,553	100,794,442	120,953,330	120,953,330	120,953,330	120,953,330	
Total Cost	5,796,562,767	11,287,329,946	11,386,874,069	11,562,259,834	11,907,112,544	12,277,043,840	12,434,596,649	12,514,263,030	12,898,994,137	12,951,774,713	13,377,253,342	13,718,896,864	14,052,604,652	14,407,674,322	14,777,579,548	12,825,304,106
Movement in Inventory	- 3,291,429,409	111,638,156	- 23,471,249	- 39,002,830	- 86,692,466	- 93,531,397	- 35,615,783	- 14,376,154	- 97,567,305	- 7,044,395	- 81,907,455	- 82,142,887	- 91,002,114	- 96,827,499	- 100,873,155	- 52,744,038
Cost of Goods Sold	2,505,133,358	11,398,968,102	11,363,402,820	11,523,257,004	11,820,420,078	12,183,512,443	12,398,980,866	12,499,886,876	12,801,426,832	12,944,730,318	13,295,345,887	13,636,753,977	13,961,602,538	14,310,846,823	14,676,706,393	12,772,560,068
Gross Profit	701,628,770	3,310,310,352	4,154,885,948	4,848,537,647	5,451,823,279	6,038,704,298	6,825,457,796	7,781,895,913	8,595,854,010	9,629,400,971	10,520,362,622	11,488,818,500	12,545,876,425	13,654,543,484	14,826,780,381	8,548,089,402
General expenses and Administration	57,965,628	112,873,299	113,868,741	115,622,598	119,071,125	122,770,438	124,345,966	125,142,630	128,989,941	129,517,747	133,772,533	137,188,969	140,526,046.52	144,076,743	147,775,795	
Sales & Marketing	160,338,106	735,463,923	775,914,438	818,589,733	863,612,168	911,110,837	961,221,933	1,014,089,139	1,069,864,042	1,128,706,564	1,190,785,425	1,256,278,624	1,325,373,948	1,398,269,515	1,475,174,339	
Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other income	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EBITDA	483,325,036	2,461,973,130	3,265,102,769	3,914,325,316	4,469,139,986	5,004,823,022	5,739,889,897	6,642,664,143	7,397,000,027	8,371,176,659	9,195,804,663	10,095,350,908	11,079,976,430	12,112,197,225	13,203,830,246	7,353,803,887
Depreciation & Amortization	104,621,108	104,621,108	104,621,108	99,154,442	99,154,442	99,154,442	99,154,442	99,154,442	99,154,442	99,154,442	-	-	-	-	-	64,523,093
EBIT (Operating Profit, Operating Income)	378,703,927	2,357,352,022	3,160,481,661	3,815,170,875	4,369,985,544	4,905,668,581	5,640,735,455	6,543,509,701	7,297,845,585	8,272,022,217	9,195,804,663	10,095,350,908	11,079,976,430	12,112,197,225	13,203,830,246	7,289,280,794
Interest	136,090,144	272,180,287	258,571,273	231,353,244	204,135,215	176,917,187	149,699,158	122,481,129	95,263,101	68,045,072	40,827,043	-	-	-	-	115,676,622
PBT	242,613,784	2,085,171,735	2,901,910,388	3,583,817,631	4,165,850,329	4,728,751,394	5,491,036,297	6,421,028,572	7,202,582,485	8,203,977,146	9,154,977,620	10,095,350,908	11,079,976,430	12,112,197,225	13,203,830,246	7,173,604,172
Tax	72,784,135	625,551,520	870,573,116	1,075,145,289	1,249,755,099	1,418,625,418	1,647,310,889	1,926,308,572	2,160,774,745	2,461,193,144	2,746,493,286	3,028,605,272	3,323,992,929	3,633,659,168	3,961,149,074	2,152,081,252
PAT (Net Income)	169,829,649	1,459,620,214	2,031,337,272	2,508,672,341	2,916,095,230	3,310,125,976	3,843,725,408	4,494,720,000	5,041,807,739	5,742,784,002	6,408,484,334	7,066,745,635	7,755,983,501	8,478,538,058	9,242,681,172	5,021,522,920

AQUABIOTECH GROUP

Agrotec spa

Balance sheet for the large-scale operator

Balance Sheet (UGX)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Assets															
PPE	903,323,307	798,702,199	694,081,091	594,926,649	495,772,208	396,617,766	297,463,325	198,308,883	99,154,442	-	-	-	-	-	-
Cash & bank	3,256,013,931	4,653,379,235	5,486,199,152	6,542,921,915	7,769,595,276	9,188,506,334	10,914,676,954	12,981,182,876	15,263,115,330	17,958,775,219	20,843,900,490	24,051,030,423	27,865,448,097	32,037,073,436	36,587,944,036
Account receivable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological Asset	3,291,429,409	3,179,791,253	3,203,262,501	3,242,265,332	3,328,957,798	3,422,489,195	3,458,104,978	3,472,481,133	3,570,048,437	3,577,092,833	3,659,000,288	3,741,143,175	3,832,145,289	3,928,972,788	4,029,845,943
Total Assets	**7,450,766,647**	**8,631,872,686**	**9,383,542,744**	**10,380,113,896**	**11,594,325,282**	**13,007,613,294**	**14,670,245,257**	**16,651,972,892**	**18,932,318,209**	**21,535,868,052**	**24,502,900,778**	**27,792,173,598**	**31,697,593,386**	**35,966,046,223**	**40,617,789,979**
Equity & Liabilities															
Equity	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309	4,082,704,309
Retained Earnings	169,829,649	899,639,756	1,915,308,392	3,169,644,562	4,627,692,177	6,282,755,165	8,204,617,869	10,451,977,869	12,972,881,739	15,844,273,740	19,048,515,907	22,581,888,725	26,459,880,475	30,699,149,504	35,320,490,090
Legal reserves	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shareholder Equity	**4,252,533,958**	**4,982,344,065**	**5,998,012,701**	**7,252,348,871**	**8,710,396,486**	**10,365,459,474**	**12,287,322,178**	**14,534,682,179**	**17,055,586,048**	**19,926,978,049**	**23,131,220,216**	**26,664,593,034**	**30,542,584,785**	**34,781,853,813**	**39,403,194,399**
Amended Equity	4,252,533,958	4,982,344,065	5,998,012,701	7,252,348,871	8,710,396,486	10,365,459,474	12,287,322,178	14,534,682,179	17,055,586,048	19,926,978,049	23,131,220,216	26,664,593,034	30,542,584,785	34,781,853,813	39,403,194,399
Debt	2,721,802,873	2,721,802,873	2,449,622,585	2,177,442,298	1,905,262,011	1,633,081,724	1,360,901,436	1,088,721,149	816,540,862	544,360,575	272,180,287	-	-	-	-
Account payables	476,429,816	927,725,749	935,907,458	950,322,726	978,666,784	1,009,072,096	1,022,021,642	1,028,569,564	1,060,191,299	1,064,529,428	1,099,500,275	1,127,580,564	1,155,008,602	1,184,192,410	1,214,595,579
Total liabilities & Equities	**7,450,766,647**	**8,631,872,686**	**9,383,542,744**	**10,380,113,896**	**11,594,325,282**	**13,007,613,294**	**14,670,245,257**	**16,651,972,892**	**18,932,318,209**	**21,535,868,052**	**24,502,900,778**	**27,792,173,598**	**31,697,593,386**	**35,966,046,223**	**40,617,789,979**
Check	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

AquaBioTech Group

Agrotec spa

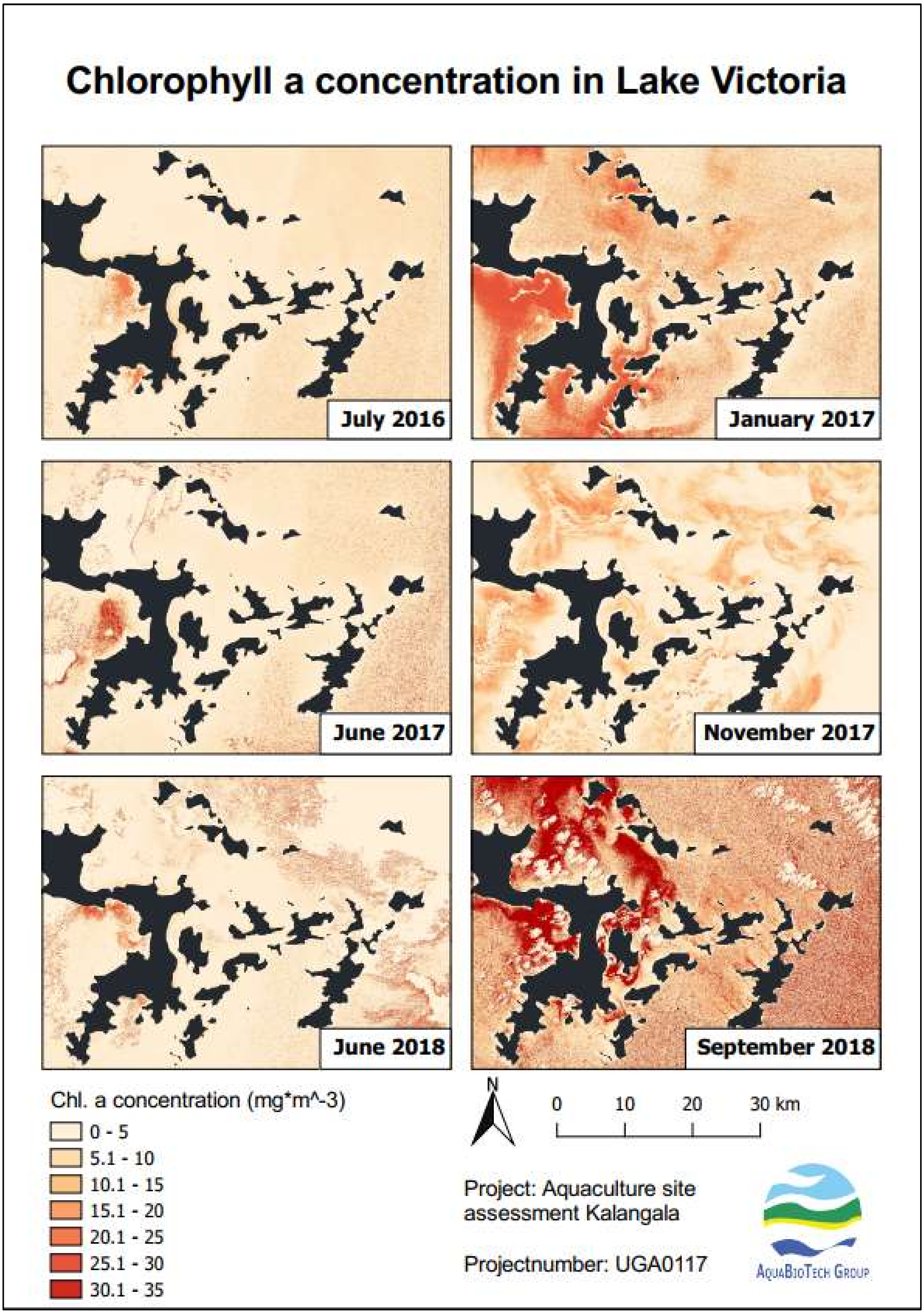
Income statement for the AP cooperative

Income Statement (UGX)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Normalized average
Revenue	6,747,518,004	14,039,210,636	14,185,217,697	14,347,449,334	14,746,589,045	15,159,427,569	15,322,547,687	15,360,695,993	15,800,833,630	15,838,931,757	16,300,053,378	16,663,694,595	17,033,223,536	17,433,677,852	17,842,284,942	15,719,559,832
Cost																
Fingerlings	730,208,571	766,719,000	805,054,950	845,307,698	887,573,082	931,951,736	978,549,323	1,027,476,789	1,078,850,629	1,132,793,160	1,189,432,818	1,248,904,459	1,311,349,682	1,376,917,166	1,445,763,025	
Broodstock	83,452,408	-	92,006,280	-	101,436,924	-	111,834,208	-	123,297,215	-	135,935,179	-	149,868,535	-	165,230,060	
Feed	5,462,594,074	11,466,694,801	11,522,035,831	11,589,150,663	11,882,097,951	12,183,962,398	12,238,781,228	12,167,438,550	12,481,306,270	12,399,520,631	12,722,847,420	12,945,663,091	13,168,030,676	13,413,949,035	13,660,983,350	
Production Consumables	4,000,000	4,200,000	4,410,000	4,630,500	4,862,025	5,105,126	5,360,383	5,628,402	5,909,822	6,205,313	6,515,579	6,841,357	7,183,425	7,542,597	7,919,726	
Harvest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Electricity	15,000,000	15,750,000	16,537,500	17,364,375	18,232,594	19,144,223	20,101,435	21,106,506	22,161,832	23,269,923	24,433,419	25,655,090	26,937,845	28,284,737	29,698,974	
Manpower	275,703,969	299,801,540	314,791,617	330,531,198	347,057,758	364,410,645	382,631,178	401,762,737	421,850,873	442,943,417	465,090,588	488,345,117	512,762,373	538,400,492	565,320,516	
Fuel - Generator	18,031,000	18,932,550	19,879,178	20,873,136	21,916,793	23,012,633	24,163,264	25,371,428	26,639,999	27,971,999	29,370,599	30,839,129	32,381,085	34,000,140	35,700,147	
Fuel - Vehicle & boats	18,720,000	19,656,000	20,638,800	21,670,740	22,754,277	23,891,991	25,086,590	26,340,920	27,657,966	29,040,864	30,492,907	32,017,553	33,618,430	35,299,352	37,064,320	
Oil	900,000	945,000	992,250	1,041,863	1,093,956	1,148,653	1,206,086	1,266,390	1,329,710	1,396,195	1,466,005	1,539,305	1,616,271	1,697,084	1,781,938	
Lease on infrastructures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Permits & Licenses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Maintenance Costs	-	-	8,791,000	142,075,618	142,075,618	175,648,563	258,573,763	303,658,580	303,658,580	425,596,180	479,246,180	479,246,180	479,246,180	479,246,180	479,246,180	
Total Cost	6,608,610,022	12,592,698,891	12,805,137,405	12,972,645,790	13,429,100,977	13,728,275,969	14,046,287,458	13,980,050,303	14,492,662,895	14,488,737,683	15,084,830,695	15,259,051,282	15,722,994,504	15,915,336,783	16,428,708,236	14,353,322,777
Movement in Inventory	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cost of Goods Sold	6,608,610,022	12,592,698,891	12,805,137,405	12,972,645,790	13,429,100,977	13,728,275,969	14,046,287,458	13,980,050,303	14,492,662,895	14,488,737,683	15,084,830,695	15,259,051,282	15,722,994,504	15,915,336,783	16,428,708,236	14,353,322,777
Gross Profit	138,907,982	1,446,511,745	1,380,080,292	1,374,803,544	1,317,488,069	1,431,151,600	1,276,260,229	1,380,645,691	1,308,170,735	1,350,194,074	1,215,222,683	1,404,643,313	1,310,229,033	1,518,341,069	1,413,576,706	1,366,237,056
General expenses and Administration	94,067,694	133,216,960	138,626,219	144,139,285	150,769,718	157,191,363	170,036,068	169,837,356	177,770,054	184,472,882	193,311,494	201,237,006	210,401,829	219,140,498	229,250,336	
Sales & Marketing	28,850,397	65,025,439	67,164,804	69,428,986	72,263,970	75,228,186	77,799,893	80,233,929	83,589,832	86,265,436	89,917,058	93,510,188	97,258,386	101,218,891	105,353,682	
Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other income	7,254,080,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EBITDA	7,270,069,891	1,248,269,346	1,174,289,268	1,161,235,274	1,094,454,382	1,198,732,050	1,028,424,268	1,130,574,405	1,046,810,849	1,079,455,756	931,994,131	1,109,896,119	1,002,568,818	1,197,981,680	1,078,972,687	1,105,975,645
Depreciation & Amortization	574,723,392	574,723,392	574,723,392	516,116,725	516,116,725	516,116,725	516,116,725	516,116,725	516,116,725	516,116,725	365,834,000	365,834,000	365,834,000	365,834,000	365,834,000	470,816,704
EBIT (Operating Profit, Operating Income)	6,695,346,500	673,545,954	599,565,877	645,118,549	578,337,657	682,615,325	512,307,543	614,457,680	530,694,124	563,339,031	566,160,131	744,062,119	636,734,818	832,147,680	713,138,687	635,158,941
Interest	47,095,245	132,287,720	127,578,196	118,159,147	108,740,098	99,321,049	89,902,000	80,482,951	71,063,902	61,644,853	52,225,804	42,806,755	38,097,230	38,097,230	38,097,230	78,464,583
PBT	6,648,251,254	541,258,234	471,987,681	526,959,402	469,597,559	583,294,276	422,405,544	533,974,730	459,630,222	501,694,178	513,934,327	701,255,364	598,637,588	794,050,450	675,041,457	556,694,358
Tax	1,994,475,376	162,377,470	141,596,304	158,087,821	140,879,268	174,988,283	126,721,663	160,192,419	137,889,067	150,508,253	154,180,298	210,376,609	179,591,277	238,215,135	202,512,437	167,008,307
PAT	4,653,775,878	378,880,764	330,391,377	368,871,582	328,718,291	408,305,994	295,683,881	373,782,311	321,741,155	351,185,925	359,754,029	490,878,755	419,046,312	555,835,315	472,529,020	389,686,051

Balance sheet for the AP cooperative

Balance Sheet (UGX)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Assets															
PPE	7,932,683,859	7,357,960,467	6,783,237,075	6,267,120,350	5,751,003,625	5,234,886,900	4,718,770,175	4,202,653,450	3,686,536,725	3,170,420,000	2,804,586,000	2,438,752,000	2,072,918,000	1,707,084,000	1,341,250,000
Cash & bank	-	1,445,447,076	2,273,832,054	3,078,397,683	3,866,559,074	4,721,381,028	5,465,129,074	6,255,393,470	7,041,193,402	7,813,982,941	8,494,374,426	9,271,216,191	10,094,228,823	11,031,707,092	11,912,265,026
Account receivable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological Asset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Assets	**7,932,683,859**	**8,803,407,543**	**9,057,069,130**	**9,345,518,033**	**9,617,562,699**	**9,956,267,928**	**10,183,899,249**	**10,458,046,920**	**10,727,730,127**	**10,984,402,941**	**11,298,960,426**	**11,709,968,191**	**12,167,146,823**	**12,738,791,092**	**13,253,515,026**
Equity & Liabilities															
Equity	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353	1,412,857,353
Retained Earnings	4,653,775,878	5,032,656,642	5,363,048,019	5,731,919,600	6,060,637,891	6,468,943,885	6,764,627,765	7,138,410,076	7,460,151,232	7,811,337,156	8,171,091,185	8,661,969,940	9,081,016,252	9,636,851,567	10,109,380,587
Legal reserves	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shareholder Equity	**6,066,633,231**	**6,445,513,994**	**6,775,905,371**	**7,144,776,953**	**7,473,495,244**	**7,881,801,237**	**8,177,485,118**	**8,551,267,429**	**8,873,008,584**	**9,224,194,509**	**9,583,948,538**	**10,074,827,293**	**10,493,873,605**	**11,049,708,919**	**11,522,237,939**
Amended Equity	6,066,633,231	6,445,513,994	6,775,905,371	7,144,776,953	7,473,495,244	7,881,801,237	8,177,485,118	8,551,267,429	8,873,008,584	9,224,194,509	9,583,948,538	10,074,827,293	10,493,873,605	11,049,708,919	11,522,237,939
Debt	941,904,902	941,904,902	847,714,412	753,523,921	659,333,431	565,142,941	470,952,451	376,761,961	282,571,471	188,380,980	94,190,490	-	-	-	-
Account payables	543,173,426	1,035,016,347	1,052,477,047	1,066,244,859	1,103,761,724	1,128,351,450	1,154,489,380	1,149,045,230	1,191,177,772	1,190,855,152	1,239,849,098	1,254,168,599	1,292,300,918	1,308,109,873	1,350,304,787
Total liabilities & Equities	**7,932,683,859**	**8,803,407,543**	**9,057,069,130**	**9,345,518,033**	**9,617,562,699**	**9,956,267,928**	**10,183,899,249**	**10,458,046,920**	**10,727,730,127**	**10,984,402,941**	**11,298,960,426**	**11,709,968,191**	**12,167,146,823**	**12,738,791,092**	**13,253,515,026**
Check	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Annex 3 – Chlorophyll a levels around Kalangala islands



Annex 4 – Agenda of the site visits

Site visits in Uganda from the 6th November 2018 to the 15th November 2018

Day 1: Arrival in Entebbe, meeting with EU, visit of NaFIRRI Kajjensi Research station

Day 2: Meeting with MAIFF and DAMD, travel to Kalangala

Day 3: Mwena site visit, meeting with CAO of Kalangala District, visit of IFISH, data collection

Day 4: Meeting with Kalangala District Fisheries Officer, lake site survey, data collection

Day 5: Data analysis

Day 6: Return to Entebbe

Day 7: Visit of SON Farm and NAM Farm

Day 8: Visit of Greenfields farm and hatchery, visit of Matugga hatchery

Day 9: Data collection in Entebbe, data analysis

Day 10: Debriefing meeting with EU and with MAIFF / DAMD

Day 11: Return to Malta

Annex 5 – Agenda of the stakeholders' validation meeting

Support to Promoting Environmentally Sustainable

Commercial Aquaculture Project in Uganda

Validation meeting: *Feasibility Studies of* Water based Aquaculture Park
12 December, 2018

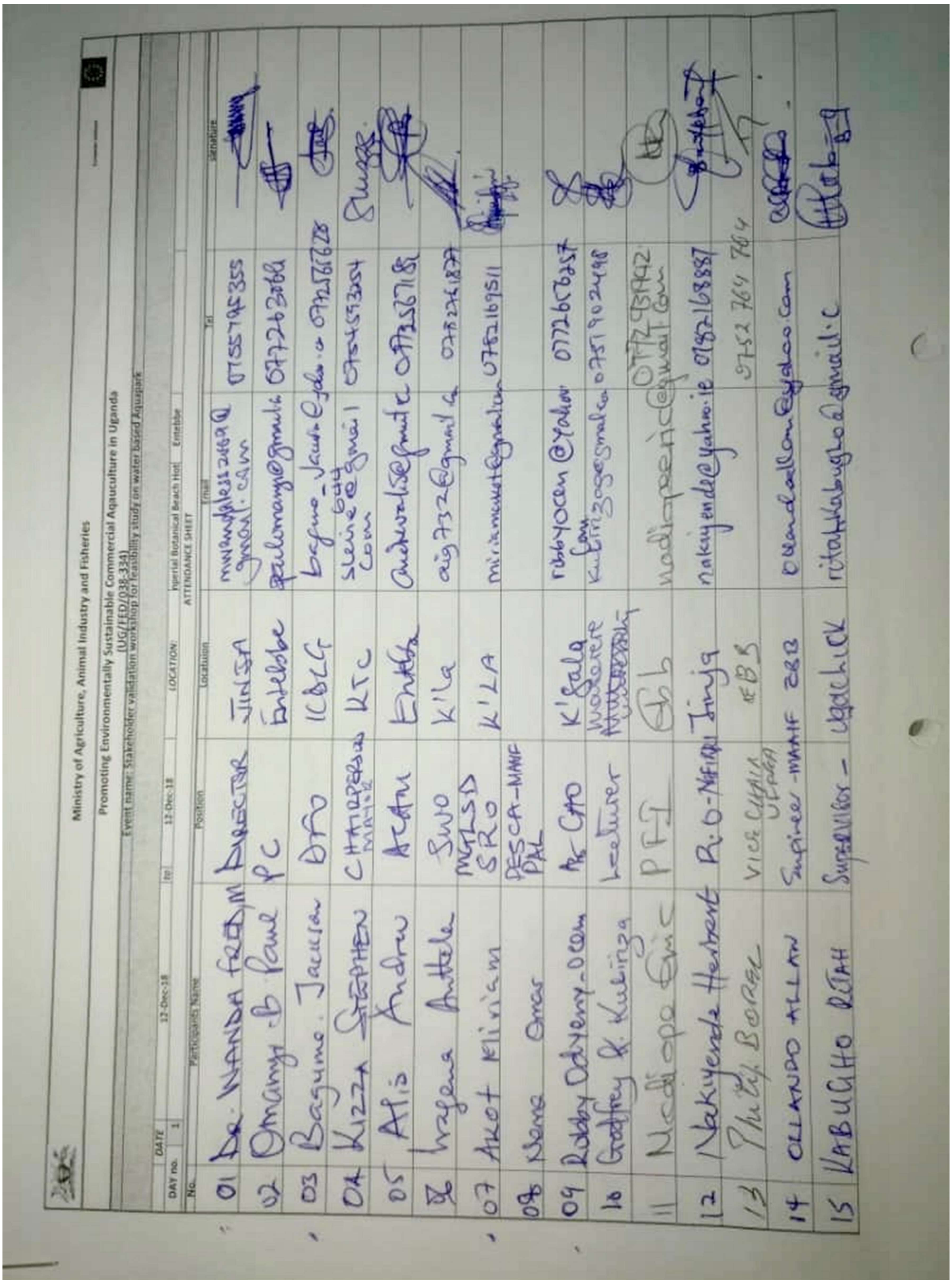
Imperial Botanical Beach Hotel, Entebbe
AGENDA

Time	Activity	Who
08:00 – 08:30	Registration	Accountant/ Rapporteurs
08:30 – 09:00	Welcome/ introductions / practical information	PMU/ TAT
09:00 – 09:30	Formal welcome speeches Group Photo	MAAIF/DAMD, EUD NAO
09:30 – 10:00	Project Background, Outline & Context, Description Aquparks- water based - cage system	PMU/ TAT
10.00-10:30	Site Suitability Report	Nkambo Mujib/NaFIRRI
10:00 – 10:30	Tea break	
10:30- 11:20	Preliminary Design & Detailed Feasibility Study	STE/Agrotec
11:20- 12:00	Questions and Ans from two presentations	STE/Agrotec
12:00- 12: 30	Economic and Financial Analyses	STE/Agrotec
12:30- 13:00	Group work	All
13:00 – 14:00	Lunch	All
14:30 – 15:30	Group Presentations and discussion	All
15:30- 16:00	Way forward	STE/Agrotec
14: 30	Closing remarks	MAAIF/DAMD,

Following the meeting:

- Thematic team leader - Prepare Registration list
- Accountant – Prepare transport refund and periderm
- Thematic team leader - Rapporteur report preparation and discussion with PMU/ TAT
- Consultant prepare Final technical report & Presentations

Annex 6 - Stakeholders validation meeting participants list



Ministry of Agriculture, Animal Industry and Fisheries

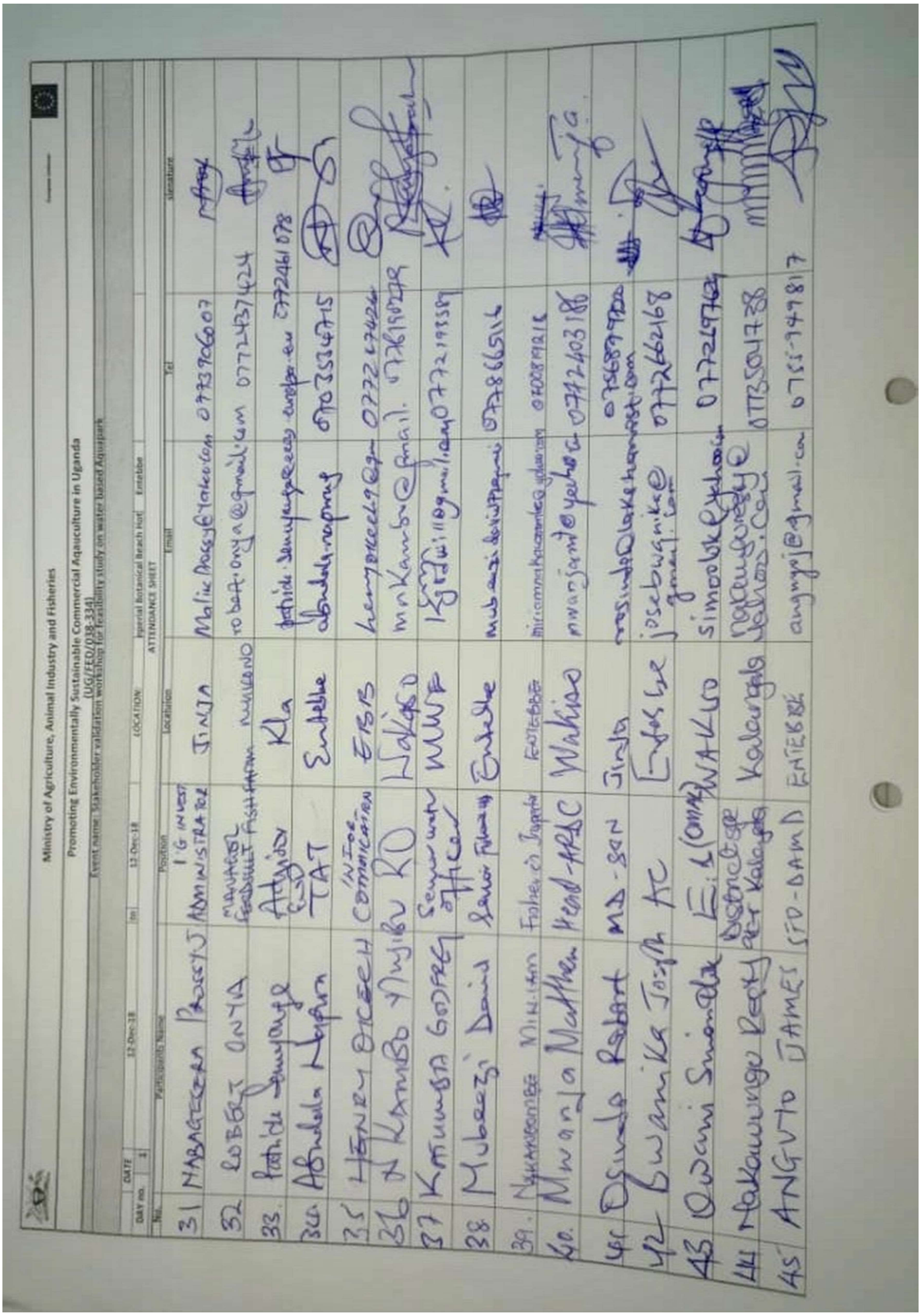
Promoting Environmentally Sustainable Commercial Aqauculture in Uganda
(UG/FED/038-334)

Event name: Stakeholder validation workshop for feasibility study on water based Aquapark

DATE	12-Dec-18	to	12-Dec-18	LOCATION:	Imperial Botanical Beach Hotel Entebbe
DAY no.	1				

ATTENDANCE SHEET

No.	Participants Name	Position	Location	Email	Tel	Signature
16	ORUKAN SAMUEL	Managing Director Rock Springs F.F.	TORORO	rocks-farm@yahoo...	0776985322	[signature]
17	Omuwujakk... [illegible]	Dev Director	〃	–	0772550221	[signature]
18	Nicolas DE WILDE	CONSULTANT	[illegible]	njde aquabt.com	–	[signature]
19	Tukamuhebwa William	Economist	Kampala	william.tukamuhebwa @finance.go.ug	0782559755	[signature]
20	[illegible]	M&E	MAAIF	alex.[illegible]@gmail.com	0772-354135	[signature]
21	KIKOOLA DANIEL	RDC	Kalangala	dkikoola@gmail.com	0772610446	[signature]
22	HUGO HOBBI-B WILLY	LC V	KALANGALA	bageyente@yahoo.com	0772627644	[signature]
23	Musisi Tadeo	Sec. Prod.	Kalangala	[illegible]2019@gmail	07711992[illegible]	[signature]
24	Justus Rutaisire	Ag Scientist	Wakiso	jusruta@mail.com	0772501227	[signature]
25	WABUSANI STEVEN	SCO	MTIC	wabusanis@yahoo.com	0772-863-984	[signature]
26	Obem Charles	SFO	MAAIF	[illegible]@yahoo.com	0785709145	[signature]
27	Tom Mutebi	P Accountant	PESCA	tmutebi[illegible]@gmail.com	0772659549	[signature]
28	CHRIS SHIRT	TAT	PESCA			[signature]
29	Anita Amanyasiika	EAO	Kampala	anita.amanyasiika enema.go.ug	0772521859	[signature]
30	Joyce Ikwaput Nyeko	Com	MAAIF	joyikwaput@hotmail.com	0772482599	[signature]



Ministry of Agriculture, Animal Industry and Fisheries

Promoting Environmentally Sustainable Commercial Aqaculture in Uganda (UG/FED/038-334)

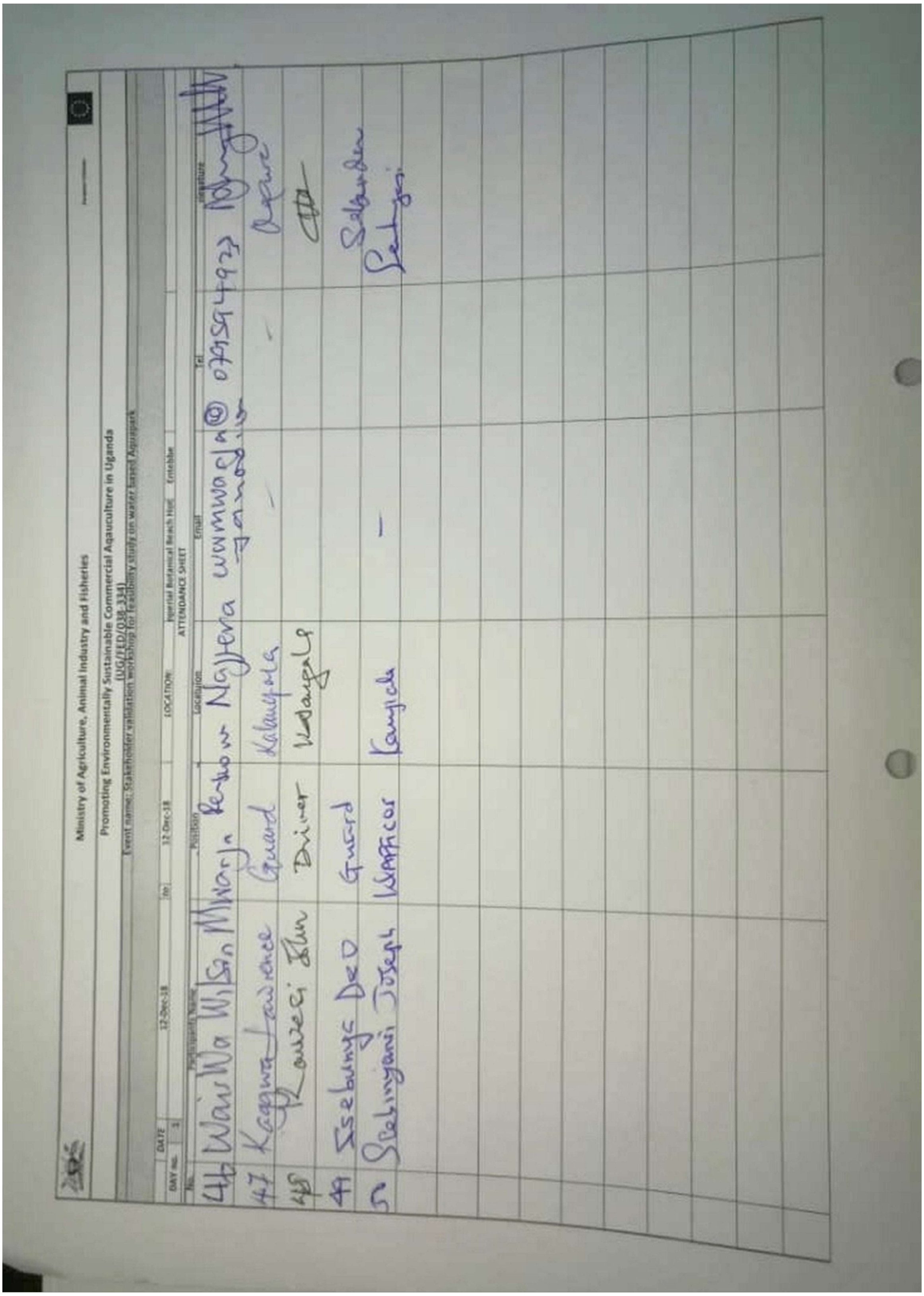
Event name: Stakeholder validation workshop for feasibility study on water based Aquapark

DATE 12-Dec-18 to 12-Dec-18 LOCATION: Imperial Botanical Beach Hotel Entebbe

DAY no. 1

ATTENDANCE SHEET

No.	Participants Name	Position	Location	Email	Tel	Signature
31	NABAGEREKA PROSSY J	I.G INVEST ADMINISTRATOR	JINJA	MalicProssy@Yahoo.com	0773906007	[signature]
32	ROBERT ONYA	MANAGER FEEDBELT FISH FARM	MUKONO	robert.onya@gmail.com	0772437424	[signature]
33	Patrick Senyange	Advisor EUD	Kla	patrick.senyange@eeas.europa.eu	0772461078	[signature]
34	Abudala Napiru	TAT	Entebbe	abudala.napiru@	0703534715	[signature]
35	HENRY OKEECH	IN FOR COMMUNICATION	EBS	henryokeech19@gm	0772674026	[signature]
36	N Kambo Mujibu	RO	Wakiso	mnKambo@gmail.	0776190278	[signature]
37	KATUMBA GODFREY	Senior water officer	MWE	kgodwill@gmail.com	0772193359	[signature]
38	Mubeezi David	Senior Fisheries	Entebbe	mubeezi.david@	0778665116	[signature]
39	NAKAKOOMBE MIRIAM	Fisheries Inspector	ENTEBBE	miriamnakakoombe@yahoo.com	0700819218	[signature]
40	Mwanja Matthew	Head-ARDC	Wakiso	mwanjamt@yahoo.com	0772403186	[signature]
41	Osinde Robert	MD-SON	Jinja	rosinde@lakeharvest.com	0756879900	[signature]
42	Bwanika Joseph	AC	Entebbe	josebwanika@gmail.com	0772662168	[signature]
43	Owani Simon Ola	E.A (OMA)	WAKISO	simoolok@yahoo.com	0772197769	[signature]
44	Nakawungu Betty	District Senior AGT Kalangala	Kalangala	nakawunguetty@yahoo.com	0773504738	[signature]
45	ANGUTO JAMES	SFO-DAMD	ENTEBBE	angutoj@gmail.com	0755-949817	[signature]



Ministry of Agriculture, Animal Industry and Fisheries

Promoting Environmentally Sustainable Commercial Aqaculture in Uganda

(UG/FED/038-334)

Event name: Stakeholder validation workshop for feasibility study on water based Aquapark

DATE	12-Dec-18	to	12-Dec-18	LOCATION:	Imperial Botanical Beach Hotel	Entebbe
DAY no.	1					

ATTENDANCE SHEET

No.	Participants Name	Position	Location	Email	Tel	Signature
46	Waiswa Wilson Mwanja	[illegible]	Najjera	wwmwanja@yahoo.co	0779594923	
47	Kaggwa Lawrence	Guard	Kalangala	–	–	
48	Kaweesi John	Driver	Kalangala			
49	Ssebunya Deo	Guard				Sebanden
50	Ssebinyani Joseph	WAFFicor	Kanyiola	–		Sentyesi

Annex 7 - TORs of the STTA (extract)

Specific work

1. Site Suitability / Preliminary Design & Detailed Feasibility Study for AquaPark sites in Uganda

- Review the AquaPark concept within the context of the identified site for cage culture (Mwena, Uganda), to make final determinations and confirmations about site suitability, carrying capacity and other dynamics affecting optimal production of fish and environmental sustainability. This component of the study will be undertaken by expertise from NaFIRRI / DiFR, which has previously undertaken site surveys and data analysis of the water sites. This will involve:
  a) Confirming site suitability studies on the proposed water-based site including topography, bathymetry, water quality, flow characteristics and associated factors for environmentally sustainable and aligned operations from previous work and elaborating as required, to finalise the data requirements for site development and production planning; and
  b) Conducting carrying capacity analyses (technical/social/environmental) on the identified AquaPark zone using modelling to determine the maximum production the chosen site can sustain, whilst ensuring environmental protection and sustainable, profitable operations. It is envisaged that various lake sites, bays and waters will be available for cages or various sizes as best determined by the studies, sufficient data to cover the areas as well as potential expansion is therefore required.

The STE under this contract and the national team will work together to ensure information is clear and collaborative towards a final AquaPark site, design and operational structure. During this process, final confirmation of land availability to the Project will be concluded, although it is not foreseen that this will delay activities. The land confirmation is to be handled and finalised through the Project PMU.

- Define the critical components to finalize the preliminary design for all aspects of the AquaPark facilities and operations and how the site will be developed in terms of achieving the physical structures and support infrastructure required. Prepare final preliminary designs ready for commencement of detailed design (engineering) activities and investment promotion components of the AquaPark activity. This will involve:
  a) Utilize information provided, as well as site visits to develop and finalize the AquaPark's preliminary design in terms of exact site location and required details for operational and functional elements including, but not limited to fish production (cage locations, sizes, design requirements), fish breeding / seed production/ delivery, quality feed production/ delivery, laboratory, fish receiving areas and basic processing (assuming a marketing / sales function will be managed from this site), management offices, power (including back-up), water and waste management, site security /access requirements, other structures to ensure a functioning, operationally sustainable facility is achieved;
  b) Prepare a preliminary design defining the key elements, infrastructure including a sketch drawing and budget cost elements (capital and operating costs) suitable for the feasibility analysis. The design prepared should be such that it can be passed to design engineers for the detailed design and preparation for the construction phase of the work. Detailed design is to be undertaken by an engineering consulting firm scheduled to follow this feasibility study. This study is critical to approval of final layouts and facilities, so as to move quickly to the detailed engineering phase, that indicates acceptance of the final AquaPark set-up;
  c) During the study, adequate suitability for expansion should be a key criterion in addition to the biological, hydrological, infrastructure in place, services

availability, market access and other key criteria that would affect the ultimate commercial performance of the site; and

d) The basis for design must bear in mind the need to attract investment to the sector in Uganda, so the site should be of a modern, professional standard and image that is oriented towards an expanding commercial aquaculture sector in the country; future-oriented and regionally competitive in all aspects. It is not envisaged that current production styles and approaches are to be adopted, but rather current, world-class designs and structures looking to promoting a professional future to the sub-sector in Uganda.

- Business modelling for sustainable, profitable operations is required as part of the financial analysis from the perspective of both the core operating partner and sub-partners who invest in, rent, or lease cages, whilst they are involved in the AquaPark arrangement. This will be achieved through developing the best options for site design and costing and fully analysing the financial feasibility and operational activities required for each of the partners. Basically, a well-presented detailed feasibility study aligned to the various actors involved.
- Detailed and professional revenue/costing analysis is a critical requirement establishing the approach to how the AquaPark will be managed using a suitable PPP arrangement. This will include:
    a) Carry out a detailed technical feasibility study analysis for operating the AquaPark, with development of detailed financial models to inform business planning and attract investors. Analysis should include well-structured identification and description of capital costs, operating costs, financial performance indicators, such as ROI, NPV and IRR, as well as detailed sensitivity analysis for key performance factors. Realistic growth scenarios (in terms of production of fish) of the site should be shown, with appropriate injection of capital to achieve any step-wise growth, as required;
    b) Financial modelling should be presented in MS EXCEL with all formulas and calculations available for review in editable form, so that information presented in the final report can be analysed independently and where necessary formulas checked and further model development instigated. The financial modelling should span at least a 15 years period, with realistic inclusion of possible start-up lag-time, problems related to loss of fish due to issues of disease or other factors, poor management performance and other delays and disruption that might occur, as well as repair and maintenance cycles that allow for associated costs and risks to be taken into account during the analysis. In short, the financial model needs to be realistic and based on an objective assessment of potential in the national context, given that this is for the first AquaParks to be set-up in Uganda and taking into account realistic growth based on realistic market scenarios. It should be borne in mind that various fish farms in Uganda and in the region have yet to show significant growth, partly for reasons of unfulfilled market performance;
    c) Sensitivity analysis has to be backed by analysis of risk factors, particularly related to competitive pricing from national and regional development of the sector, as well as the import of other forms of protein (including fish), from for instance Asia. Pricing is particularly important in the analysis, as the profile of markets in Uganda is very price sensitive and volumes of sales should not be assumed without appropriate review of such market forces and comparison to other producers. Preliminary market data will be provided to the consultants, based on a current situation analysis which will guide realistic production planning;
    d) Reference to domestic and regional markets must therefore form part of this assignment, with creative and innovative market approaches to ensure sustainable revenue is achieved. Serious consideration of imported fish (tilapia), particularly from Asia, as well as the competitive environment and production trends in the region must be undertaken during this component of the study to find the best fit and approach for the business model to be outlined. Particular

attention should be given to marketing processes and related logistics to ensure efficient market access bearing in mind fish preservation and quality aspects of the products to be sold. It is expected that another STE will be undertaking a Market Assessment at the same time as this contract and so up to date information will be forthcoming for this purpose;

e) Inclusion of an examination of funding options based on a Public Private Partnership (PPP) model, that would attract investments in aquaculture, such as equity financing (large investors) and/or grant scheme (Aquaculture Production Grant Scheme) funding, and others. Consideration for large and small investors is imperative in this component of the study; and

f) During the planning of funding options and with respect to financial performance models developed in this study, indications of realistic repayment options are to be described in the context of management structure and contractual arrangements for such a PPP arrangement. This should align with potential requirements and expectations of PPP ownership partners and their respective motivations and limits. Critical input from private sector investors should form the backbone of this component of the study.

- Consideration in terms of regulatory requirements concerning environment, legal status of land and water to provide an understanding for such requirements for the development of AquaParks. Highlight in detail, all requirements for alignment with the existing policy and regulatory environment and indicate where requirements for updates are required, especially with respect to the strategic objective of attractiing serious investors to the sector in Uganda.
- Market positioning for performance of the AquaPark should be considered. This project is not intended to prove that production of fish is possible in an AquaPark structure per se, but to rather pilot Aquaparks as a production engine that can produce and sell the fish produced at the best possible price and profit, targeting suitable and reliable national and regional markets. Therefore, the operating designs and approaches should be based on a profit and investment return motive and this will affect feed and seed production and quality, as well as determination of preferred fish market size requirements for minimising costs, whilst maximising revenues for various market segments. Facility design also needs to be cost effective in its operational aspects to maximise this objective. Mwena in particular has potential and is moving towards solar power as a source that would be a useful inclusion if viable.
- A draft report will be prepared and a stakeholder validation process (timing to be determined) will be an important step. Comments and further inputs will inform the Final report preparation.

Assignment outputs

a) Comprehensive report covering all aspects described herein to be prepared, including editable financial analysis component in MS EXCEL format with all formulas available in that presentation.

b) Agreed table of contents and detail requirements to be prepared before commencement together with the Project Management Unit in Uganda.

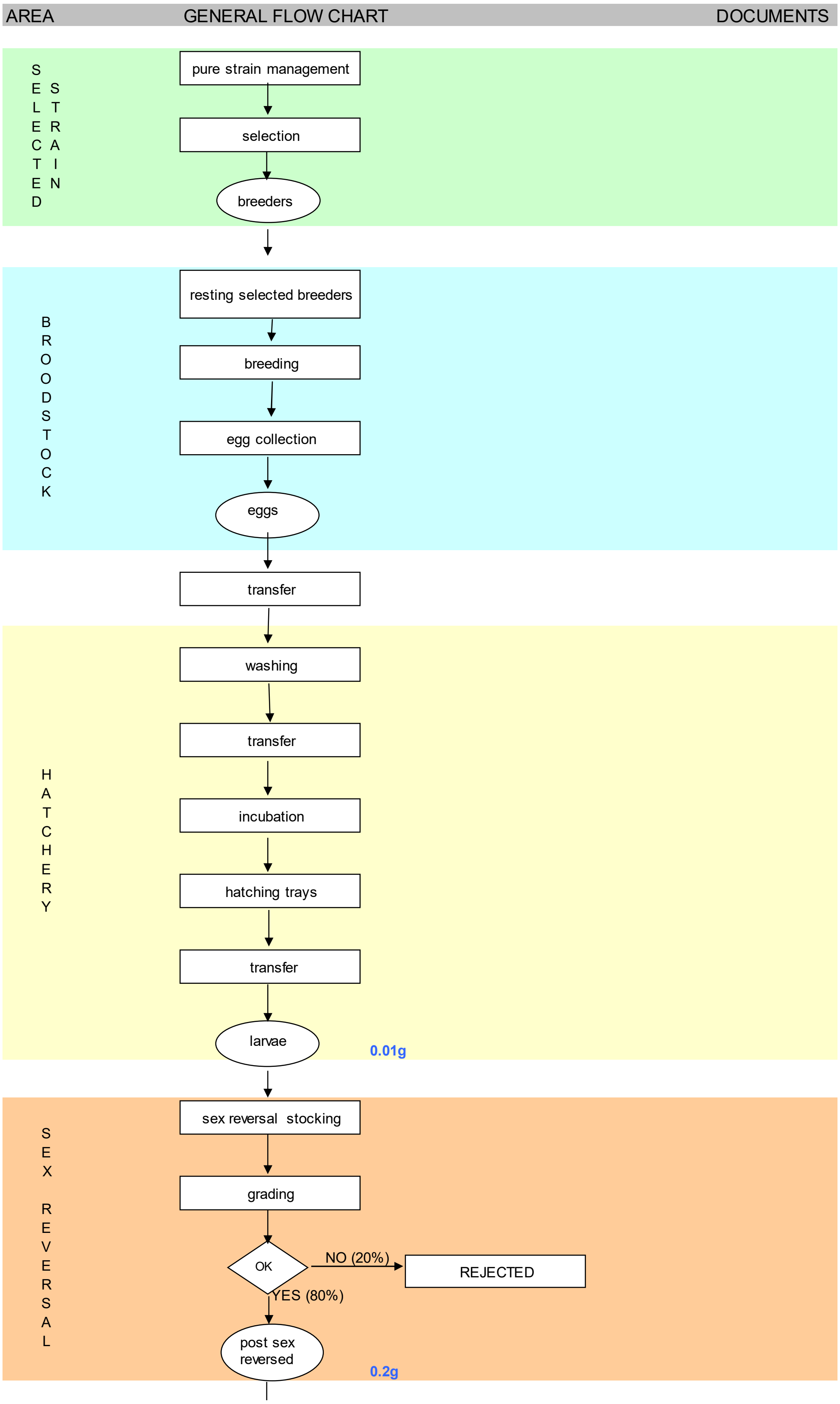
c) Quality preliminary design drawings and cost estimates are critical for future project planning as provided by part of this study.

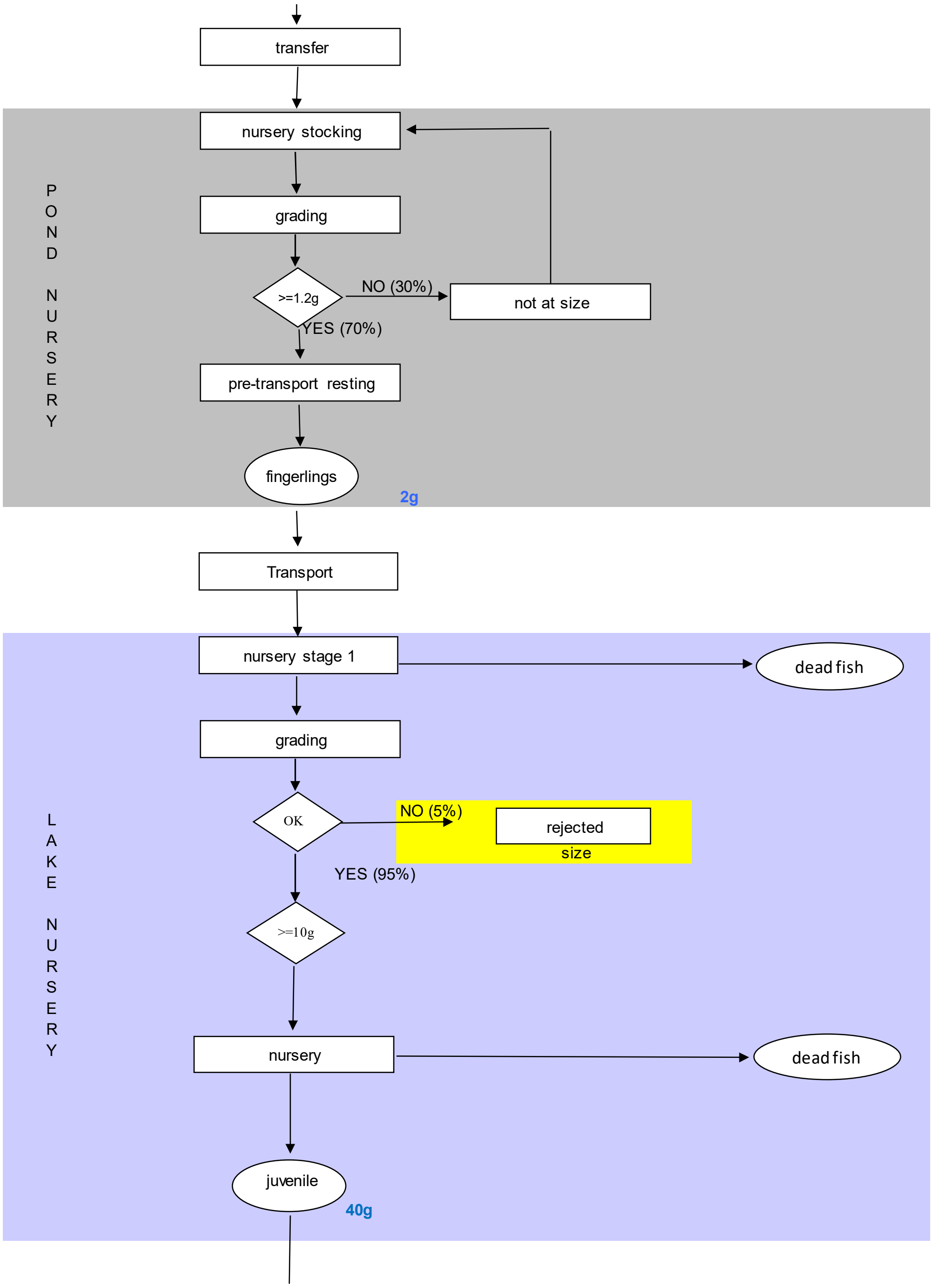
d) Presentation to be provided to various stakeholders for feedback / validation.

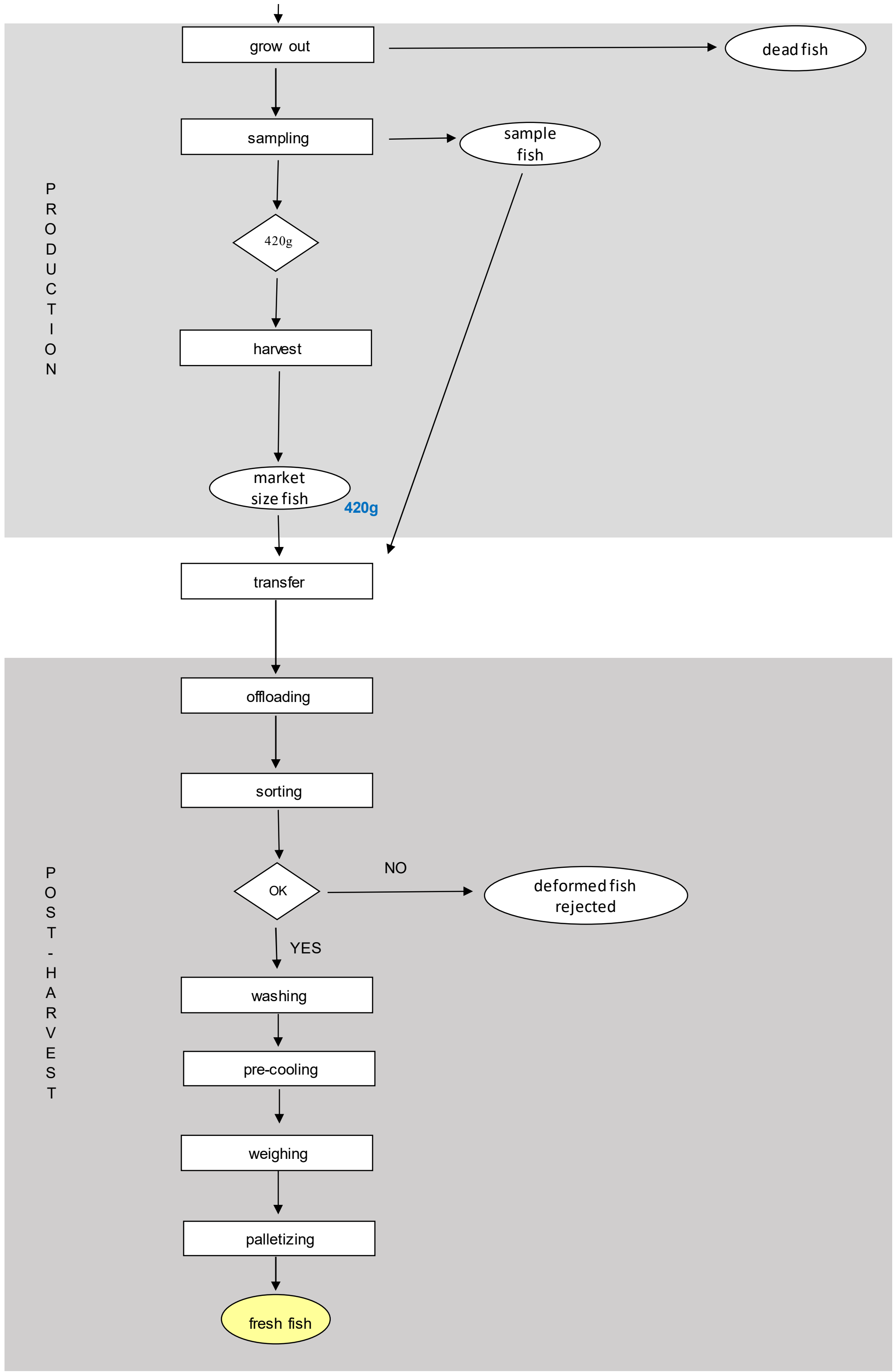
e) Draft Report preparation and Final Report following comments.

Annex 8 – General operations flow chart

GENERAL OPERATIONS FLOW CHART




transfer
nursery stocking
P O N D N U R S E R Y
grading
>=1.2g
NO (30%)
not at size
YES (70%)
pre-transport resting
fingerlings
2g
Transport
nursery stage 1
dead fish
grading
L A K E N U R S E R Y
OK
NO (5%)
rejected
size
YES (95%)
>=10g
nursery
dead fish
juvenile
40g


PRODUCTION
grow out
dead fish
sampling
sample fish
420g
harvest
market size fish
420g
transfer
POST-HARVEST
offloading
sorting
OK
NO
deformed fish rejected
YES
washing
pre-cooling
weighing
palletizing
fresh fish

Annex 9 – Draft Validation meeting notes/comments (answers from the consultant in blue)

1. Number of days allotted to the different stages of production need revisiting as 60 days are on the lower end and the 200 days for the juveniles to reach 420gms are understated. It is also important to look at the genetic make of the fingerlings
   The growth has been reviewed from 2.0 gpd to 2.2 gpd for the grow-out stage.
2. Biomass should be consistent in kg/biomass
   Biomass is expressed appropriately where needed.
3. Adjustment of the depth of the cage bags to 3m from 6m
   6m depth is more appropriate for juvenile to grow faster
4. What is the comparative analysis of the Ugandan aqua in terms of production and productivity inside and outside the aqua parks? In addition, the study should undertake a time series analysis of the fish prices over time in the region to establish the trend
   Out of scope. Market study to assess market trends.
5. Hatchery capacity should be 10,000,000 fry per year
   Table 7 in the report presents scenarios and footprint requirement for 3 hatchery capacities, including a scenario for 10,000,000 fry per year (194,370 / week x 52 weeks =10,107,240 fry)
6. The financial analysis of the model indicates that there are some gaps. Therefore, the figures used in the analysis should be based on Uganda's experience for example feed cost is costed from Mombasa. They should cost at the landed cost thus $1,050. and be factual
   - ✓ Feed $1,050
     It is clearly mentioned that feed cost in the model is based on feed cost delivered to Mombasa plus shipping cost to Uganda (3500 USD/container). Data based on factual information collected in Uganda.
     A final scenario assesses the feasibility of the project in the case of feed delivered to site at $1,050 as advised.
   - ✓ Stocking densities used in the study are too low. The sensitivity analysis has three critical items yet the stocking density and survival rate are essential and ought to be added (Survival rate is 85%) The study ought to revisit the stocking densities. (refer to Uganda private sector research)
     - Production stocking densities of small cages should be between 35-40, medium 30- 35 and large 25-30
     - Grading frequency should at least be 3 – 4 weeks depending on the size of the fish in the cages

     Production densities are advised as the more appropriate in the context of the current site and based on the limited water quality parameters available to the consultant at the time of the study.

   - ✓ Cost of seed e.g. 2gm = 200UGX market price ref omal
     200 UGX per 2grams fingerlings is the cost when purchasing fingerlings, which is different from the production cost. From data collected during the site

visit, it is understood that the production cost for a 2 grams fish is in the range of 100 UGX. The business model uses production cost as the cooperative will be producing fingerlings for the farmers and selling them at cost + 10%.

- ✓ FCR is at 1. it's the function of feed and best management practices (this should also be included in the sensitivity analysis) at grow out and 1.2 in Nursery

  FCR is already included in the sensitivity analysis and has been adjusted realistically in the model starting at 1.6 in year 1 and gradually improving to 1.4 in year 10.

- ✓ Growth rate 2.2% (all the figures used should be referenced)

  Growth rate is not 2.2% but 2.2 gpd (grams per day) which represent the average of the growth performance of the fish over the period of farming. It is the common unit used to estimate growth of fish over a period of time.

7. Do not merge the different production systems in terms of investment thus presentation of different stages or Break down of the model into;
   i. Hatchery
   ii. Nursery
   iii. Grow out

   The scope of the study looks at the general financial performances of the aquapark and the farmers in the aquapark.

8. The pricing of feeds at 2.7m per ton is an underestimate as feeds in grow out cost UGX 3.3m per ton. Therefore, the breakdown of the inputs would be a good indicator to the investor to make right decisions. In addition, the proposed feed store should be able to hold at least 550 tonnes to provide for buffer stock. It should also include the calculation for the required space.

   Refer to point 6. Calculation to estimate the area required is now included in the report.

9. The study should consider the environmental holding capacity base on the phosphorus levels (20,000 tone in this site) not the lowest production indicated in the report of less tthan 2000tons

   The study assesses the financial performances of three sizes of farms operating under the aquapark. The area can accommodate production of 21,000 tons which can be shared among various farm sizes.

10. Calculate the minimum number of cages required as per the available resources and how many can be accommodated according to the carrying capacity

    Refer to point 9. Number of cages depends on sizes of farms developed.

11. The lay out of the cages in different sizes(large, medium and small) for the different sites should be included in the report

    Layout for the large-scale operator pilot phase was included

12. There is need to define the carrying capacity of the existing cage system

    The carrying capacity of the proposed aquapark is the sum of the production capacity by the number of farms of each size.

13. The study should consider the option of ice production on land and the current ice production

    Ice production is planned at the landing site

14. What is the estimated labour requirement per unit of production? - This will provide information on the job creation and employment levels

These figures are now included in the report.

15. The model does not follow the agreed PPP modal of the VODP which is the Ministry adopted modal across all commodity value chains in Agriculture sectors thus the nucleus principle of production with out-grower segments

    This requirement was not communicated to the consultant, it was instead requested to reassess the results from the Poseidon study, which is the reason why the similar model was used.

16. Does the analysis determine the number of cages by amount available in the project or by the number needed to break even? Please provide the minimum cages needed to breakeven at agreed at cage fish productivity.

    Refer to point 9 for the scope of the study. Breakeven is assessed in terms of production capacity (tonnage) for each of the farmers size.

17. The study should make a provision for a fuel tank under the land-based facilities

    Included

18. Prices should factor in inflation as well as depreciation rates for machinery and maintenance cost on related equipment and buildings. In addition, there is need to simplify and breakdown the operating costs

    Inflation was included at 5% per year on all costs except feed (imported with 2% inflation rate annually). Inflation was equally factored in on the fish price to compensate for costs increase.

19. The different pictures from Ghana should be replaced with Uganda to bring the context back home.

    Pictures from Ghana are purely for information only.

20. What is the origin of the working capital as evidenced in Table 12, is there equity funding, what is its effect on the growth of sales vis vie production? - It was proposed to remove the working capital

    Working capital is needed to finance all the operating costs from start till cash flows in from first sales, otherwise who will pay for the feed, salaries etc.. ? Working capital is part of the investment brought in by the farmer, as explained in chapter 6.2 and in table 12.

    Why the variations between the Poseidon report (2013) and this study in terms of production levels of 3000 tonnes vis a vis 1963? The breakeven of 600 tonnes and 450 tonnes?

    Refer to point 9.

21. What is the effect of subsidies and tax holidays on the model?

    EU Grant was included in the CAPEX of the AP cooperative company to finance all the cages.

22. The comparison of different production systems and Aquapark Cooperative company(Table 1) does note make sense because the latter is a n investment modal not a production a modal.

    The cooperative model is farmers cluster (farmers organisation) with clear purposes and functions focusing on providing business-oriented services as explained in chapter 2.2.1, it is not an investment model.

23. The economic analysis is completely lacking in the report , however, the CTA noted that this was not included in the ToR.

    Out of scope of the study

Annex 10 – Final notes/comments (answers from the consultant in blue)

S/No	Validation meeting notes/comments	Status of incorporation of comments as checked by DAMD (in blue comments from the Consultant)	Further additions
1	Number of days allotted to the different stages of production need revisiting as 60 days are on the lower end and the 200 days for the juveniles to reach 420gms are understated. It is also important to look at the genetic make of the fingerlings	To raise minimum of 350g (lowest market segment) is around 180 days (5-6months). Average production cycle in nursery needs segmentation ie 0.1-2g on land 2g-10g on land 10-20g in nursery in water (To raise 20g needs 100days) The growth models were already presented during the validation meeting in December and in Draft report, and agreed on. Raising of fish from 2-10g must occur in hatchery (land) to prevent use of powdered feed in water which may cause pollution Feed used from 2 to 10 grams is not powder but crumble feed (small pellets). Growing fish to 10g on land would require much more space than available. Hatchery operation should be run independent of grow out farmers and production must continue to supply other farmers in the district and region. Hatchery operations are independent and taken care of by the cooperative, not by the grow-out farmers. (page 32)	
2	Biomass should be consistent in kg/biomass	Addressed	

3	Adjustment of the depth of the cage bags to 3m from 6m	(Page 33) Depth of cage bag of nursery must be constant at 3m for small scale, medium and large scale. Deep nursery cages cause variation in size due to lots of energy spent swimming in water column Density of fish in nursery is on low end, need to increase. Low density allows for fast growth of juvenile fish. 6 m depth cages is recommended and advised.	
4	What is the comparative analysis of the Ugandan aqua in terms of production and productivity inside and outside the aqua parks? In addition, the study should undertake a time series analysis of the fish prices over time in the region to establish the trend	To be referred to marketing STE	
5	Hatchery capacity should be 10,000,000 fry per year	Include pg on which correction has been made Page 43-44 table 7	
6	24. The financial analysis of the model indicates that there are some gaps. Therefore, the figures used in the analysis should be based on Uganda's experience for example feed cost is costed from Mombasa. They should cost at the landed cost thus $1,050. and be factual ✓ Feed $1,050 ✓ Stocking densities used in the study are too low. The sensitivity analysis has three critical items yet the stocking density and survival rate are essential and ought to be added (Survival rate is 85%) The study ought to revisit the stocking densities. (refer to Uganda private sector research) o Production stocking densities of small cages should be between 35-40, medium 30- 35 and large 25-30 o Grading frequency should at least be 3 – 4 weeks depending on the size of the fish in the cages	Financial analyst, please comment	

	✓ Cost of seed e.g. 2gm = 200UGX market price ref omal ✓ FCR is at 1. it's the function of feed and best management practices (this should also be included in the sensitivity analysis) at grow out and 1.2 in Nursery ✓ Growth rate 2.2% (all the figures used should be referenced)		
7	25. Do not merge the different production systems in terms of investment thus presentation of different stages or Break down of the model into; iv. Hatchery v. Nursery vi. Grow out	Incorporate segmentation of nursery operations raised in issue one (1) Study and report are based on TORs.	
8	The pricing of feeds at 2.7m per ton is an underestimate as feeds in grow out cost UGX 3.3m per ton. Therefore, the breakdown of the inputs would be a good indicator to the investor to make right decisions. In addition, the proposed feed store should be able to hold at least 550 tonnes to provide for buffer stock. It should also include the calculation for the required space.	Use UGX 3.7-4.0m per tonne of feed Feed price is used based on data collection at time of the field mission, approved at December validation meeting and includes inflation rates.	
9	The study should consider the environmental holding capacity base on the phosphorus levels (20,000 tone in this site) not the lowest production indicated in the report of less than 2000tons	Addressed	
10	Calculate the minimum number of cages required as per the available resources and how many can be accommodated according to the carrying capacity	Not necessary	
11	The lay out of the cages in different sizes(large, medium and small) for the different sites should be included in the report	NEED Insert for cages how they will be arranged in water See drawings. Final design is taken care of by the cage supplier.	
12	There is need to define the carrying capacity of the existing cage system	Not necessary	
13	The study should consider the option of ice production on land and the current ice production	Addressed	
14	What is the estimated labour requirement per unit of production? - This will provide information on the job creation and employment levels	Addressed	
15	The model does not follow the agreed PPP modal of the VODP which is the Ministry adopted modal across all commodity value	STE for aquapark management structure to complete	

	chains in Agriculture sectors thus the nucleus principle of production with out-grower segments		
16	Does the analysis determine the number of cages by amount available in the project or by the number needed to break even? Please provide the minimum cages needed to breakeven at agreed at cage fish productivity	Addressed	
17	The study should make a provision for a fuel tank under the land-based facilities	Addressed	
18	Prices should factor in inflation as well as depreciation rates for machinery and maintenance cost on related equipment and buildings. In addition, there is need to simplify and breakdown the operating costs	Financial analyst, please comment. Inflation and depreciation rates are included throughout the analysis.	
19	The different pictures from Ghana should be replaced with Uganda to bring the context back home	Addressed	
20	What is the origin of the working capital as evidenced in Table 12, is there equity funding, what is its effect on the growth of sales vis vie production? - It was proposed to remove the working capital	Financial analyst, please comment Working capital is needed to finance the operations prior to incomes being generated. Details on equity and debt are presented in table 13 pg 58.	
21	26. Why the variations between the Poseidon report (2013) and this study in terms of production levels of 3000 tonnes vis a vis 1963? The breakeven of 600 tonnes and 450 tonnes?	What model did consultant use? Phosphorous input relating to eutrophication or Physical parameters? The study assesses the financial performances of 3 sizes of grow out operations, it doesn't mean the production capacity is limited to 2000 tons. See pg 34. Carrying capacity is calculated based on phosphorus level as described in the report.	