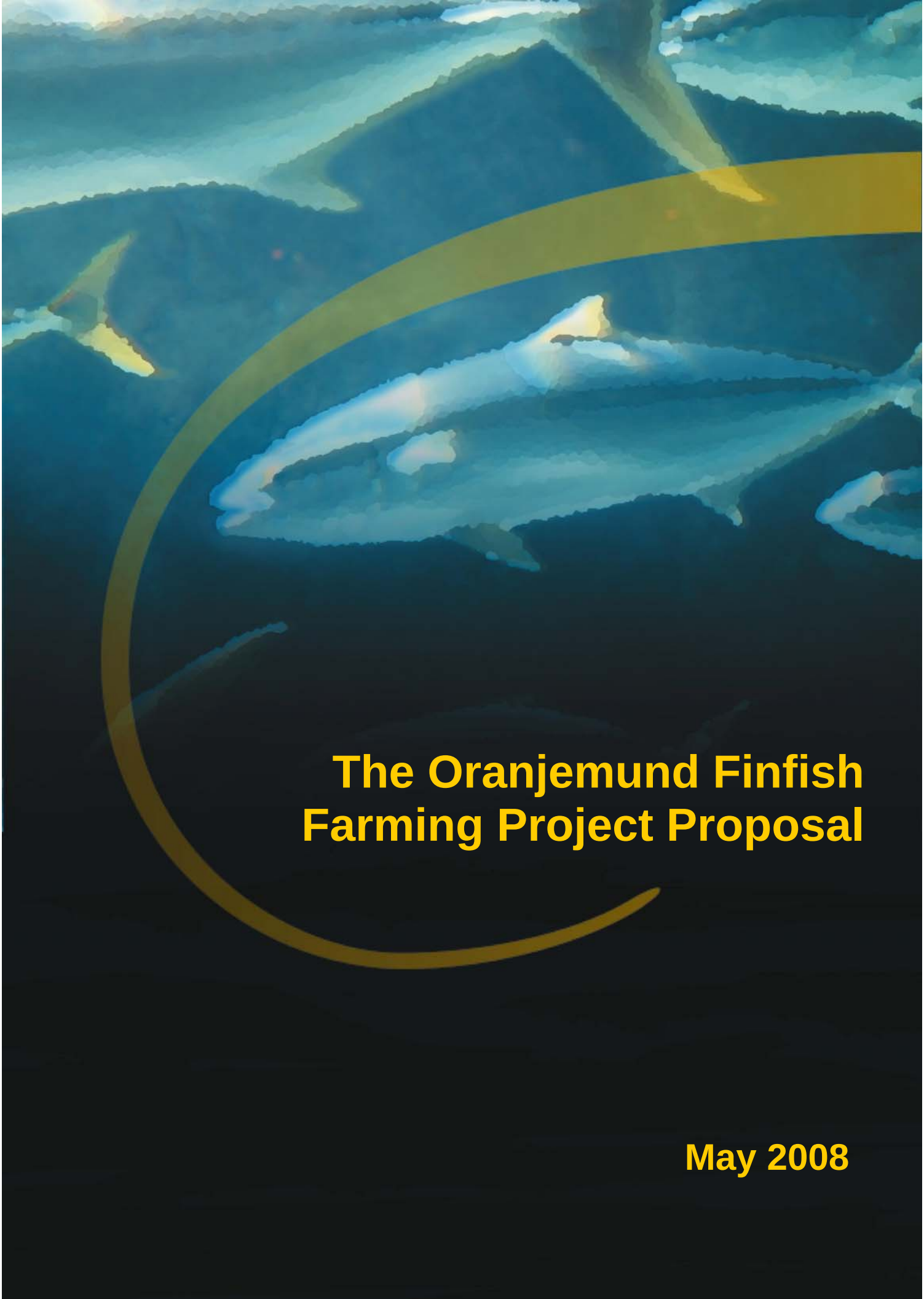

The Oranjemund Finfish Farming Project Proposal

May 2008

Prepared for:

The Oranjemund Town Management Company (Pty) Ltd
Oranjemund
Namibia

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Table of Contents

1. Executive Summary

The Division of Aquaculture, Stellenbosch University (SU) was commissioned jointly by Namdeb Diamond Corporation (Pty) Ltd (Namdeb) and the Oranjemund Town Management Company Limited (OTMCo) to assess the aquaculture potential of the mining area at Oranjemund in Namibia. There appears to be considerable potential and as such this document provides a proposal for the establishment of a marine finfish (yellowtail, *Seriola lalandi*) farm at Oranjemund. A 5 000 metric ton (mt) yellowtail farm would have a turnover of about N$ 115 million per year and provides direct employment for about 200 people.

The Government of Namibia has identified aquaculture as a prime priority development area. Both Vision 2030 and the NDP2 documents summon the country's urgency to develop aquaculture and as such the Namibian Government has created an enabling environment for investment in aquaculture. The marine finfish farming industry is the most important and valuable aquaculture sector in many countries and is expected to grow significantly over the medium term, offering exciting opportunities for investment and business participation.

Based on the assumptions in the model regarding the financial structuring of the business, the projected internal rate of return for a yellowtail farm at Oranjemund is around 17%. This is an indication that with the appropriate financial leverage (the mix of debt and equity employed to finance the business) it should be possible to structure the project in such a manner that attractive returns are generated for the equity investors. The total capital expenditure projected for the farm is N$ 16 562 300. The working capital requirements of the Oranjemund abalone farm were estimated at N$ 19 358 239 before the business becomes self-financing.

Several companies in South Africa are currently actively pursuing abalone aquaculture expansion opportunities along both the west and east coasts of the country. Key amongst these is the development of abalone farms at Hondeklip Bay and Port Nolloth in the Northern Cape Province of SA by HIK Abalone Farm (Pty) Ltd (HIK) and NewFarmers Development Company Limited (NewF). The development of a yellowtail farm at Oranjemund has been positioned as a further extension of the abovementioned initiative with HIK and NewF as potential operating, investment and development partners. The proposed business structure of the venture also provides investment opportunities for other institutional and Black Economic Empowerment (BEE) investors.

The yellowtail farm venture is part of a greater plan to develop a vertically integrated aquaculture cluster at Oranjemund. The cluster development will be conducted in two phases, with Phase 1 the establishment of a 150 mt abalone farm. Phase 2 is the development of a 5000 mt yellowtail farm. Subsequent phases will focus on extension to other species such as turbot (*Psetta Maxima*), rock lobster (*Jasus lalandi*) and oysters (*Crassostria gigas*). Bothe species developments will be preceded by 18 month pilot projects duration and will assess growth and survival in both commercial type land-based flow trough systems and in floating cages in reservoirs/ponds. It is anticipated that the pilot project will be jointly managed by Stellenbosch University and HIK Abalone Farm (Pty) Ltd.

The planned establishment of an **Oranjemund Yellowtail NewCo** with a reputation as a highly capable and experienced entrepreneurial operating partner with a successful investment track is essential in order to also develop and finance other aquaculture projects in Oranjemund. Aquaculture will only contribute meaningfully towards the sustainable economic development of Oranjemund if a planned abalone NewCo can expand and diversity its abalone business to eventually operate a vertically integrated business that also produces in excess of 5000 metric tonnes of marine finfish.

2. Introduction

The Division of Aquaculture, Stellenbosch University (SU) was commissioned jointly by Namdeb Diamond Corporation (Pty) Ltd (Namdeb) and the Oranjemund Town Management Company Limited (OTMCo) to assess the aquaculture potential of the mining area at Oranjemund in Namibia. This document provides a proposal for the establishment of a marine finfish (yellowtail, *Seriola lalandi*) farm at Oranjemund. There appears to be considerable potential and as such this document provides a proposal for the establishment of a marine finfish (yellowtail, *Seriola lalandi*) farm at Oranjemund. A 5 000 metric ton (mt) yellowtail farm would have a turnover of about N$ 115 million per year and provides direct employment for about 200 people.

Oranjemund is located immediately north of the Orange River at the most south-western corner of Namibia, approximately 1000 kilometers southwest of the capital, Windhoek. Namdeb currently operates an alluvial diamond mining operation along a 160 kilometer (km) stretch of the southern Namibia coastline, but is expected to downscale their activities significantly over the next 5 to 10 years.

Aquaculture, the cultivation of fish, shellfish and aquatic plants, is the fastest growing food producing industry in the world and has considerable potential to contribute to the establishment of a vibrant post-mining economy in Oranjemund. The marine finfish industry is the most important and valuable aquaculture sector in many countries and is expected to grow significantly over the medium term, thereby also offering exciting opportunities for investment and business participation.

The yellowtail farm venture is part of a greater plan to develop a vertically integrated aquaculture cluster at Oranjemund. The yellowtail development will be conducted in two phases, with Phase 1 the establishment of a pilot project to assess and confirm technical and financial feasibility. Phase 2 is the development of a 1 000 mt commercial farm. Other species being considered for development at Oranjemund include abalone (*Haliotis midae*), turbot (*Psetta Maxima*), rock lobster (*Jasus lalandi*) and oysters (*Crassostria gigas*).

Several companies in South Africa are currently actively pursuing aquaculture expansion opportunities along both the west and east coasts of South Africa. Key amongst these is the development of abalone farms at Hondeklip Bay and Port Nolloth in the Northern Cape Province of South Africa by HIK Abalone Farm (Pty) Ltd (HIK) and NewFarmers Development Company Limited (NewF). The development of abalone and yellowtail farming at Oranjemund has been positioned as a further extension of the abovementioned initiative with HIK, NewF and a finfish fingerling supplier as potential operating, investment and development partners. The proposed business structure of the project provides investment opportunities for both institutional and Black Economic Empowerment (BEE) investors as well as employee equity instruments.

Namibia's economic prospects for the future are bright given its stable economic performance, good regulatory framework, and robust private sector. The country has experienced steady growth, moderate inflation, strong external surpluses and low indebtedness over the past several years as a result of generally prudent fiscal policies, a stable political environment, a fairly developed infrastructure, and a strong legal and regulatory environment. Economic growth since independence (1991) has averaged 4.3% per annum, and the World Bank's Investment Climate Assessment Report currently notes that Namibia has a relatively attractive investment climate.

The Government of Namibia has identified aquaculture as a prime priority development area. Both Vision 2030 and the NDP2 documents summon the country's urgency to develop aquaculture and as such the Namibian Government has created an enabling environment for investment in aquaculture.

3. Project Objectives

Aquaculture offers significant developmental and economic opportunities for Namibia. This growth industry can improve food security, reduce poverty, create employment and increase inward investment to the country. In addition, aquaculture represents a sustainable economic use of Namibia's coastal and inland living aquatic resources – which means that aquaculture activities can be continued into the future, providing economic opportunity without depleting non-renewable resources.

The marine finfish farm development at Oranjemund will be conducted in two phases, with Phase 1 the establishment of a pilot project to assess and confirm technical and financial feasibility. Phase 2 is the development of a 1 000 mt commercial farm, with eventual expansion to 5 000 mt.

The specific objectives of the project are:

- To establish a 1 000 mt marine finfish farm in Oranjemund over the course of a 5 year period in collaboration with other investment partners
- To establish the Oranjemund Yellowtail NewCo as a highly capable and experienced entrepreneurial operating partner with a successful investment track record in order to also develop other aquaculture projects in Oranjemund

The broad objectives of the project are:

- To contribute towards the creation of a sustainable post-mining economy in Oranjemund in a manner consistent with the principles of ecologically and economically sustainable development
- To contribute towards development of a sustainable and competitive aquaculture industry in Namibia with international recognition for its product quality, environmental awareness and technical innovation
- To contribute to poverty reduction and empowerment of disadvantaged coastal communities through development of employment opportunities, skills training, and business participation (SMMEs, BEE)
- To contribute to the development of newly leveraged downstream industries that can create additional job and business opportunities

The specific objectives of the pilot project are:

- To confirm assessments regarding the suitability of proposed sites in terms of physical parameters including water quality, dissolved oxygen, temperature range and temperature fluctuations
- To determine yellowtail growth rates at proposed sites under commercial conditions. Abalone growth rates are a key indicator of economic viability and competitiveness. The pilot project results will be assessed against growth rates obtained at existing commercial farms
- To provide a platform for the training of personnel in animal husbandry methods
- To demonstrate fish husbandry, harvesting, post-harvesting and processing technology
- To develop procedures for interaction with mine security protocols as well as other general management procedures
- To design, construct and evaluate various culture production systems
- To investigate and evaluate the culture of other species such as abalone, oysters and seaweed by cost effectively through the sharing of pilot project overheads

4. Rationale

4.1. Aquaculture is a Profitable, Competitive and Growing Industry

Aquaculture development is market driven. It is clear that in the short to medium term, demand for fish will expand as populations and incomes grow. According to the United Nations' Food and Agriculture Organization (FAO), world total demand for fish and fishery products is projected to increase by almost 50 million tons, from 133 million tons in 2000 to 183 million tons by 2015.

It is widely acknowledged that fish supplies from traditional capture fisheries are unlikely to increase substantially in the future and that aquaculture production will have to rise further to help satisfy the growing world demand for fisheries products. According to the FAO, 32% of seafood consumed worldwide is currently produced through aquaculture, already the fastest growing global food producing industry. This is projected to rise to 45% by the year 2015. Concomitant with the rise in demand it is anticipated that seafood prices will probably continue to increase during the coming two decades, with baseline FAO scenario projections suggesting increases of 15 percent for high-value products.

Aquaculture producers are preferentially (competitively) meeting market demand through both non-price supply and product advantages. Supply advantages include, for example, the ability to control and thus predict supply. Farmers have far greater control over the timing, consistency and quantity of production than do fishermen. The pace advantages of farming create benefits to farmers in the form of better prices, more processing options, and higher quality.

Product advantages primarily refer to quality, traceability and food safety factors. Quality is probably the main competitive factor in the global seafood trade, with importers placing a premium on quality that feeds back into the production process and is characterized within Hazard Analysis and Critical Control Point (HACCP)-based regulations as well as the international standards, guidelines and recommendations put forward by the FAO/WHO *Codex Alimentarius.*

4.2. Aquaculture Contributes to Economic and Social Welfare

Aquaculture has significant potential to expand in Namibia. The country's strengths include unpolluted coastlines, productive marine resources, a wide climatic range, a large diversity of species available for culture, and a reputation for quality seafood.

There are many reasons to pursue this potential. Aquaculture offers important economic benefits to producing countries by increasing export income and reducing imports. At the micro-economic level aquaculture creates substantial opportunities for generating strong commercial returns. In addition, aquaculture provides diversity to a country's economic base and creates demand for technology, training, extension services, infrastructure and local goods.

The aquaculture industry is particularly important from a socio-economic perspective. Aquaculture contributes to food security, improved nutrition and poverty alleviation, directly by producing food fish, and indirectly by generating employment and income for the purchase of food. Jobs in commercial aquaculture are relatively well paid. The contribution of aquaculture to employment is even larger if multiplier effects are added. Ninety percent of aquaculture production and processing takes place in rural and coastal communities, providing economic stability and growth where economic development options are often limited, particularly in cases where yields from wild fisheries have declined.

5. Yellowtail Species Overview and Aquaculture Status

Classification, Distribution and Biology of Seriola Species. Yellowtail belong to the Genus *Seriola* and the Family *Carangidae*. There are three principal market species, *S. quinqueradiata* (Japanese amberjack; *hamachi, buri*), *S. dumerili* (greater amberjack; *kampachi*) and *S. lalandi* (yellowtail amberjack; *hiramasa*). *S. lalandi* is one of the most valuable species and has a non-equatorial distribution. In SA, *S. lalandi* occurs from the West Coast to southern KwaZulu-Natal, from the shore out to the continental edge. It is also found around Australia, New Zealand, India, and the west coasts of the Americas, from British Columbia to Chile. *S. quinqueradiata* is endemic to Japan and north Hawaii. *S. dumerili* is the largest member of the genus and occurs in the Mediterranean Sea and the Atlantic, Indian and Pacific Oceans.

Yellowtail are pelagic, schooling fish, usually seen as adults in small to large numbers. In general they inhabit rocky shores, reefs and islands and are often found adjacent sandy areas in coastal waters and occasionally entering estuaries. They are commonly found in water depths to 50 m, although they have been recorded from over 300 m deep. Young fish up to 7 kg are known to form shoals of up to several hundred fish and are generally found in offshore waters, often near or beyond the continental shelf.

In SA, yellowtail spawn over a wide area during their summer spawning season, from southern Kwazulu-Natal to Cape Point. The main spawning area appears to be the central Agulhas Bank, south of Cape Agulhas, where the stock concentrates in the summer months. All *Seriola* species show rapid growth rates. The natural diet of yellowtail larvae is almost exclusively planktonic crustaceans, particularly copepods. Intermediate and adult yellowtail primarily feed upon schooling fish (e.g. sardines), squid and crustaceans.

The Status of Yellowtail Aquaculture. *S. quinqueradiata* has been farmed in Japan since the 1920's. Japan (136 000 t; 1276 farms; average production of 106 t/farm) accounted for 99% of the global production in 2000 (FAO 2002a); the only other producers were Taiwan Province of China (633 t) and the Republic of Korea (494 t). The majority of Japanese farms are stocked with juveniles caught from the wild, although a small number of fish are now reared in hatcheries. Wild caught juveniles are reared on a diet of baitfish.

Commercial culture of *S. lalandi* commenced in Australia in 1998 when broodstock were collected, conditioned and spawned at Port Augusta by Spencer Gulf Aquaculture (Pty) Ltd. The Australian yellowtail farming industry has since undergone rapid expansion. It now boasts two commercial hatcheries, located at Port Augusta and Arno Bay. Grow-out to market size of 3 – 5+ kg is conducted in sea cage farms at Port Lincoln, Arno Bay, Franklin Harbor and Fitzgerald Bay. Total culture production of *S. lalandi* in Australia in 2005 was 5000 t. Other countries embarking upon yellowtail culture now include New Zealand (*S. lalandi*), Spain (*S. dumerili*), Ecuador (*S. mazatlana*) and the USA (*S. rivoliana*).

In SA I&J Group Limited has successfully developed the technology to spawn yellowtail from wild-caught broodstock and the company recently completed construction of a new commercial finfish hatchery at Gansbaai at a cost of R 5 million. In collaboration with SU, I&J is currently conducting a 72 mt pilot yellowtail sea cage farming project in the northern lee of Port Elizabeth harbor. The use of sea cages appears to be the preferred culture method for all yellowtail and has been widely implemented in Australia and Europe. Other yellowtail projects currently underway in SA include pilot scale pond production of yellowtail in Kwazulu-Natal and the grow-out of yellowtail by Espadon Marine in recirculation systems in East London. Yellowtail production in SA will probably reach 3 000 mt within the next 5 years.

6. Project Description

6.1. Overview

Generally, commercial aquaculture proceeds through a series of growth, development and maturity stages that relate to its level and degree of competitiveness and profitability. A typical business development cycle applicable to the Oranjemund Abalone NewCo is shown in Table 1.

Table 1: Typical aquaculture business development cycle

Stage of Development	Description
1. Seed/conceptualization	Develop, test and ready a product for production. Development of pilot project to determine technical and financial feasibility and to optimize production parameters.
2. Start-up/early expansion	Commence commercial business operations. Installation of infrastructure to facilitate approximately 40% of planned production, significant investment in human resource development and a specific focus on marketing. Anticipated production at Oranjemund during this phase is about 40 mt.
3. Development/growth/expansion	Expand an established and growing business. Expansion to 120 mt over the course of a five year period.
4. Later established	Continue expansion or extend to new species. Extension to other species, development of processing facilities.

The Oranjemund Yellowtail NewCo development will be conducted in two phases, with Phase 1 the establishment of a pilot project to assess and confirm the technical and financial feasibility of finfish farming. During the pilot phase other potential species such as abalone and oysters will also be trialed. Phase 2 is the development of a 5 000 mt commercial farm. The estimated pilot project duration is 18 months and will assess yellowtail growth and survival in both commercial type land-based flow through systems and in floating cages in reservoirs/ponds. The pilot project will be managed by Stellenbosch University and will also serve as a training platform for human resources capacity development.

6.2. Workplan

The project will be executed within the following main tasks:

i) **Project approval.** Project approval needs to be obtained from the Ministry of Fisheries and Marine Resources (MFMR), Namdeb and OTMCo.

ii) **Appointment and training of project personnel.** SU will provide on-site project management. The project will appoint a full-time on-site production manager as well as 1 technicians (farmhands). A small number of temporary workers will be utilized during regular intervals to assist with various tasks, including construction and maintenance activities. All project personnel will undergo specialist training as required.

iii) **Equipment selection, acquisition and delivery.** Much progress has already been made in the selection and where necessary, design of required equipment, including the sea cages, mooring system, nets and workboat. Throughout the course of the project preference will be given to sourcing equipment from local suppliers. It is however anticipated that a number of items will be imported, including the cage mooring system, cage brackets and cage nets.

iv) **Fingerling Production.** Fingerlings for the project will be produced at the I&J hatchery at Danger Point in Gansbaai and transported by road to Oranjemund. The project production plan has been based on the supply of 16 000 fingerlings. A second batch of fingerlings will be introduced after 12 months.

v) **Construction of land-based facilities.** The project plan provides for the installation of (or use of existing) temporary office, workshop, general storage and feed storage facilities. Accommodation arrangements will be made in conjunction with OTMCo.

vi) **Installation of cages.** 2 10m diameter high density polyethylene (HDPE) cages will be installed in a 2 x 1 mooring grid on the allocated site (1m water depth). A shore based mooring system will be used. A 4 tank Portapool system will be installed to demonstrate land-based culture. This system will utilize the abalone pilot project water supply system.

vii) **Growth / Husbandry trials.** Growth trials will be conducted for an 18 month period and will be assessed under conditions comparative to commercial operations. Optimization in terms of stocking densities, feed etc. will be conducted in the final 6 months of the pilot project. The growth trials include regular husbandry tasks such as sampling and grading and the development of standard operating procedures.

viii) **Harvesting.** Fish will be harvested on several occasions and submitted for physiological, disease, quality and processing analysis.

ix) **Data analysis.** SU will assume responsibility for the statistical analysis of growth and other data collected during the pilot project. To facilitate data collection, a number of fish will be tagged.

x) **Financial modeling.** A detailed financial model for a full scale commercial operation will be developed by an independent contractor. The financial feasibility of such an operation will be modeled for a 10 year period. In addition, an optimal financing strategy will be developed.

xi) **Business plan review.** The project has as its final output the delivery of a comprehensive investment orientated business plan.

6.3. Budget

The total estimated cost of the finfish pilot project is N$ 675 200. This assumes that the finfish pilot is done in conjunction with an abalone pilot project, thereby reducing overhead costs. By utilizing the same pump ashore infrastructure, the cost of a demonstration tanks system is also significantly reduced.

Table 2: Estimated yellowtail pilot project expenditure (All values N$)

No	Item	Unit Cost	Quantity	Total
1	**Project Management**			**50 000**

2	**Transport & travel**			**30 000**
3	**Production systems**			**189 600**
	Cage system	80 000	2	160 000
	Tank system	7 400	4	29 600
5	**Fish handling equipment**			**5 000**
6	**Net cleaner**	24 000	1	**24 000**
7	**Generator**	4 600	1	**4 600**
8	**Harvesting bins**	2 000	2	**4 000**
9	**Contingencies**			**50 000**
10	**Service barge**	80 000	1	**80 000**
16	**Fingerlings**	2	16 000	**32 000**
17	**Feed**	7	30 000	**210 000**
	TOTAL COST			**675 200**

6.4. Implementation

A proposed schedule for the implementation of the project is shown in Table 3. It should be noted that implementation is subject to the availability of funding and the completion of regulatory aspects. Should Phase 1 of the pilot project be concluded successfully, an extension phase will be developed and implemented.

Table 3: Description, duration and implementation date for the key project tasks.

Task	Description	Start Date & Duration
1	Project approval	Oct 2008
2	Fingerling production (Batch 1)	May – Oct 2008
3	Equipment design, selection & acquisition	Jul – Oct 2008
4	Appointment & training of project personnel	Sept – Nov 2008
5	Infrastructure installation	Sept – Oct 2008
6	Basic environmental assessment	Oct 2008 – Mar 2009
7	Introduction of fingerlings (Batch 1)	21 Oct 2008
8	Year 1 pilot production	Oct 2008 – Oct 2009
9	Data analysis	Nov 2009
10	Introduction of spat (Batch 2)	Nov 2009
11	Optimization of production parameters	Nov 2009 – Apr 2010
12	Business plan review	Oct 2009
13	Commercialization preparation	Nov 2009 – Apr 2010
14	Implementation of full scale commercial operation	Apr 2010

6.5. Research and Development

Although the project has as its primary objectives the demonstration and optimization of sea cage aquaculture technology and procedures, a number of biological (scientific) research tasks will also be conducted during the course of the project. They include the following:

- Determination of the growth rates for both candidate species
- Determination of feed conversion ratios
- Evaluation of different stocking densities
- Assessment of the changes in the proximate chemical composition of fish over the production cycle
- Comparison of the sensory (taste) attributes of cultured versus captured fish
- The collection and analysis of water-quality, weather and oceanographic data

7. Project Rationale

7.1. Aquaculture is a Profitable, Competitive and Growing Industry

Aquaculture development is market driven. It is clear that in the short to medium term, demand for fish will expand as populations and incomes grow. According to the United Nations' Food and Agriculture Organization (FAO), world total demand for fish and fishery products is projected to increase by almost 50 million tons, from 133 million tons in 2000 to 183 million tons by 2015.

It is widely acknowledged that fish supplies from traditional capture fisheries are unlikely to increase substantially in the future and that aquaculture production will have to rise further to help satisfy the growing world demand for fisheries products. According to the FAO, 32% of seafood consumed worldwide is currently produced through aquaculture, already the fastest growing global food producing industry. This is projected to rise to 45% by the year 2015. Concomitant with the rise in demand it is anticipated that seafood prices will probably continue to increase during the coming two decades, with baseline FAO scenario projections suggesting increases of 15 percent for high-value products.

Aquaculture producers are preferentially (competitively) meeting market demand through both non-price supply and product advantages. Supply advantages include, for example, the ability to control and thus predict supply. Farmers have far greater control over the timing, consistency and quantity of production than do fishermen. The pace advantages of farming create benefits to farmers in the form of better prices, more processing options, and higher quality.

Product advantages primarily refer to quality, traceability and food safety factors. Quality is probably the main competitive factor in the global seafood trade, with importers placing a premium on quality that feeds back into the production process and is characterized within Hazard Analysis and Critical Control Point (HACCP)-based regulations as well as the international standards, guidelines and recommendations put forward by the FAO/WHO *Codex Alimentarius.*

7.2. Aquaculture Contributes to Economic and Social Welfare

Aquaculture has significant potential to expand in Namibia. The country's strengths include unpolluted coastlines, productive marine resources, a wide climatic range, a large diversity of species available for culture, and a reputation for quality seafood.

There are many reasons to pursue this potential. Aquaculture offers important economic benefits to producing countries by increasing export income and reducing imports. At the micro-economic level

aquaculture creates substantial opportunities for generating strong commercial returns. In addition, aquaculture provides diversity to a country's economic base and creates demand for technology, training, extension services, infrastructure and local goods.

The aquaculture industry is particularly important from a socio-economic perspective. Aquaculture contributes to food security, improved nutrition and poverty alleviation, directly by producing food fish, and indirectly by generating employment and income for the purchase of food. Jobs in commercial aquaculture are relatively well paid. The contribution of aquaculture to employment is even larger if multiplier effects are added. Ninety percent of aquaculture production and processing takes place in rural and coastal communities, providing economic stability and growth where economic development options are often limited, particularly in cases where yields from wild fisheries have declined.

8. Feasibility Assessment

8.1. Relevant Legislation, Policies and Guidelines

Among others, cognizance has been taken in this study and in the project design of the following acts, codes, conventions, agreements, protocols and policy proposals:

- Namibian Marine Resources Act, 2000 (Act no. 27 of 2000)
- Namibian Aquaculture Act, 2002 (Act no 18 of 2002)
- Namibia's Aquaculture Strategic Plan
- Various FAO Codes including the FAO Code of Conduct for Responsible Fisheries
- Bangkok Declaration and Strategy for Aquaculture Development beyond 2000
- WWF Policy Proposals and Operational Guidance for Ecosystem Based Management of Marine Capture Fisheries

8.2. SWOT Analysis

A strategic assessment of the strengths, weaknesses, opportunities and threats in relation to both the pilot project and future finfish farming has been conducted and is shown below.

Table 4: Project SWOT analysis

Species	Geographical Location
Strengths	**Strengths**
1. High value product	1. Namibian company tax rates
2. Fast growing	2. Limited competition for sites
3. Established cage grow-out technology	3. Enabling regulatory environment
4. Hatchery technology available	4. Developed and available infrastructure
5. Pellet feeding	5. Environmentally disturbed area
6. Wide range of processing options	6. No disease record
7. Robustness	7. Good security
8. Growing culture worldwide	8. Social support network and infrastructure
Weaknesses	**Weaknesses**
1. Requires high dissolved oxygen levels	1. Capital intensive water intake required
2. Requires low turbidity water	2. Unreliable power supply
	3. Mine security procedures

	4. No aquaculture support services
	5. Site knowledge
	6. High transport costs, remoteness of area
	7. Industry skepticism
	8. Cold water; temperature variation in ponds
Opportunities	**Opportunities**
1. Growing international markets	1. Regulatory environment
2. Established regional markets	2. Use/conversion of mine infrastructure
3. Value adding	3. Ponds
4. Economy of scale scope	4. Some ranching
	5. Wind generated power
	6. Scale of production scope
Threats	**Threats**
1. Competition from SA, foreign producers	1. Import tariffs and bans
2. Global warming – environmental instability	2. Market volatility (Asian)
3. Increase in fuel prices	3. Lack of investor funds
4. Disease outbreak	4. Effect of downscaling and mine closure
5. Adequate and reliable power supply	5. Security of tenure
6. Increase in power costs	6. Orange river plume
7. Strong local currency	7. Political interference
8. Macro-economic settings and policies	8. More optimal sites
9. Asian market collapse	9. Competition from SA producers

8.3. Technical Feasibility

The technical feasibility of the project concept was assessed against four main parameters and is shown in Table 5:

Table 5: Factors affecting the technical feasibility of the project

Factor	Issue
1. Cage technology	Will existing cages survive expected sea conditions and allow a safe environment for both fish stock and farm workers?
2. Species bio-performance	Will yellowtail growth rates and survival allow profitable production?
3. Husbandry & management	Can existing fish husbandry techniques, procedures and equipment be used in conditions?
4. Environmental impact	Are potential impacts consistent with the principles of ecological sustainable development and does an environmental impact assessment study have a high likelihood of success?

Cage technology. Recent developments in cage systems, with improved mooring systems, better material selection and better designed assemblies, are making it possible to consider production in genuinely open-water conditions The pilot project will utilize high density polyethylene (HDPE) surface gravity-type fish grow-out cages. These cages are highly resilient to wave forces and have a long service life (15 – 20

years). They have now been well tried and tested for numerous years in some of the harshest marine environments yet conquered by aquaculture, including the west coasts of Scotland and Ireland, the open coastlines of a number of Mediterranean countries, the Canary Islands, and the Southern Ocean off Australia. HDPE pipe is made from high density polyethylene which is a crystalline polymer known for its flexibility, toughness and chemical resistance. These features make HDPE pipe particularly well suited for use in aquaculture where pipes that are strong, durable, corrosion resistant and yet flexible enough to be assembled and installed in exposed locations are required. The Mining Area 1 pond system is a particularly benign culture environment

Species bio-performance. Yellowtail are good candidates for commercial aquaculture because they are widely distributed, have a good domestic and international market profile, are highly fecund, and can tolerate a wide range of temperatures. Importantly they appear to have good attributes for grow-out in cages such as their preference for forming schools (suggesting a tolerance for high stocking densities) and ability to adjust to captivity, which makes inspection for diseases relatively easy. In cage conditions in Australia yellowtail has attained a market weight 1.5 kg (fillet size) in 12 months.

Husbandry and management. Husbandry and management practices are central towards maximizing production, optimizing operating cost efficiencies, and maintaining a high quality product and therefore market price. Worldwide, aquaculturists have had a successful history of innovation in husbandry and management practices since the intensification of sea cage aquaculture in the 1960's. Specific milestones include the development of improved feed delivery systems, net cleaning systems, cage monitoring systems, workboats and harvesting techniques.

Potential environmental impact. Aquaculture has been cited as a contributing factor to the collapse of fisheries stocks worldwide due to the use of wild fish as fish feed for culture species, through habitat modification, transmission of diseases and wild seed stock collection. Such accusations, although influential in a political sense, are not fully supported by scientific information and ignore the major advances and improvements in aquaculture technology, husbandry, hygiene, health and other management practices.

The type and scale of any ecological change associated with aquaculture development depends on the method of aquaculture, the level of production and the biological, chemical and physical characteristics of the affected area. Generally, small-scale coastal aquaculture has been a traditional and sustainable practice in many countries. Potential environmental impacts and their project/venture specific mitigation and management are shown in Table 6.

Table 6: Potential environmental impacts and their project/venture specific mitigation & management

Impact	Mitigation
Genetic	Current farm stock genetically close to wild stock; dilution effect
Disease	Low stocking density; biosecurity measures, improved diagnosis
Marine Fauna	Exclusion barriers, entanglement management program
Water Column	Low biomass production; biodegradable wastes; localized & reversible
Benthic Environment	Fallowing; in site cage rotation
Fisheries Resources	Existing effort; management measures

In recent years the expansion and diversification of aquaculture in Europe, Australia and elsewhere has been guided under carefully designed environmental controls. In addition the aquaculture industry is increasingly moving towards self regulation with for example the implementation of Codes of Good Practice. Rigorous environmental monitoring and recording standards have accordingly been implemented. Such controls have not necessarily been applied to other forms of activity and aquaculture operations have often been subjected to adverse impacts imposed by other forms of human activity and as a result the productivity and financial viability of operations have often been reduced. Indeed, the vulnerability of the proposed project to potential adverse impacts such as the introduction of pollutants and diseases from other less well regulated human activities is a specific concern.

Worldwide, customers are prepared to pay premium prices for healthy food, grown in a healthy environment and overseas buyers increasingly require environmentally certified products and the industry to be appropriately certified at world's best practice standards. A number of aquaculture companies in the rest of the world have already been accredited to the world environmental management standard, ISO 14001. These developments occurred concurrently with an increasing realization in the food processing industry that competing on price alone is not necessarily the most attractive business strategy. Increasingly companies are therefore including "clean and green" as part of their marketing strategy.

8.4. Market Feasibility

In 2004, global exports of fish and seafood products reached almost US$ 70 billion, whilst supply (particularly of quality seafood) cannot keep pace with demand. According to the FAO, in 2004 the total human consumption of seafood was approximately 128 million metric tons. Statistics show that annual global fish catches have plateaued at about 90 million metric tons and may even be declining. Over 60% of the marine fish stocks for which information is available are either fully exploited or overexploited, and 13 of the world's 15 major oceanic fishing areas are now fished at or beyond capacity. This leaves only aquaculture available to meet the increasing world demand for seafood. Although aquaculture has grown at an average annual rate of 8.8% from 1950 to 2004, it is, however, highly unlikely that even aquaculture is capable of filling the gap between demand and supply. Although the severity of the shortage would differ among countries, the overall effect would be a rise in the price of fish. Increases of up to 15% are projected for high-value finfish by the FAO.

In the short to medium term, the demand for fish will further expand as populations and incomes grow. Moreover, as people in developing countries increasingly enter the middle classes, they consume more protein, including seafood. According to the FAO, the global annual per capita consumption of fish has been predicted to increase from about 16 kgs in 2003 to 19 – 21 kgs by 2030. Other factors affecting the growth of seafood in international markets include changing consumer tastes, consolidation in retail and distribution sectors, the internet (distributors can get into direct contact with producers), decreases in export tariffs, and the nutritional and health benefits associated with seafood. The growing development of value-added products such as fillets; portion control and vacuum packs; as well as convenience items has also benefited the global seafood trade.

Excluding diadromous fish, the output of farmed marine fish grew by 350% from a very low base between 1985 and 2002 and could, according to the FAO, double again by 2010. Public research institutions and private companies are developing and marketing many new finfish species in marine environments, thus

contributing to the rising market share of this segment of the aquaculture industry. The rapid expansion of aquaculture into a diverse range of high-valued species reflects government and industry attention toward market opportunities.

Yellowtail are renowned for its white, firm quality flesh and high level of Omega 3 and other fatty acids. The market opportunities for ranched fresh yellowtail is substantial based on either its existing prominence as part of Japanese cuisine or it's marketing as a more general (but high end) use in the international fish market. Apart from fillet production, yellowtail can also be marketed overseas as sashimi, primarily to Japan and the USA. In Japan, for example, *S. lalandi* is ranked second only to southern bluefin tuna as a sashimi product. Yellowtail can obtain up to US$20 per kg in Japan. It is also anticipated that China will soon emerge as a huge fast growing market for sashimi style seafood products. Competition for export market share in Japan and China will predominantly come from Australia and New Zealand.

Apart from sashimi, the other preferred market forms for yellowtail is fillets and whole fish. There is currently strong demand for yellowtail from Europe with vacuum packed yellowtail fillets being sold in both supermarkets and gourmet shops. The growth of Japanese cuisine in European markets also offer exiting opportunities. In Italy for example, yellowtail can reach up to € 20/kg.

The domestic market also offers opportunities, with the live inventory processes of farming well suited to meeting market demand. A large majority of local high value seafood is exported, so SA wholesalers and distributors often have difficulty fulfilling the domestic demand for seafood. The fishing industry in SA will continue to remain an export driven market so long as the demand in the international market for quality fish remains high. In addition, the assumed depreciation of the South African Rand (and Namibian dollar) will tend to increase the relative competitiveness of Southern African seafood in export markets.

SA imported US$58 million of fish and seafood products in 2004, primarily from Thailand, the Philippines, Mozambique and India. Imports mainly consisted of crustaceans (US$19 million); squid ($15 million); and fish meat ($20 million). The SA packaged seafood market includes: canned fish (65.4%); value added fish (14.2%); packaged white fish (13.8%); and specialty seafood (6.7%). Demand for fresh fish in both the retail and food service sector has grown considerably due to the shortages in supply of white fish. The food service sector, i.e. restaurants, hotels, and franchises require a variety of whitefish menu options due to the increase in the local tourism trade as well as the growth in awareness in SA of the health characteristics of fish. Despite growing imports, per capita fish consumption in SA is low when compared to the rest of the world, generally indicating significant room to grow.

In SA, the anticipated channels of distribution for fresh cultured yellowtail are primarily to restaurants, retail outlets and wholesalers. The wholesale price for the fresh product will be between R45 and R60 per kilogram. It is anticipated that local competition will be the greatest threat to success in the sector because of the additional costs (including shipping, storage, time and tariffs) incurred by importers. Fishing companies in SA either catch and distribute the product themselves or pass the item on to alternative players to distribute on their behalf. Distributors supply the retail fresh fish counters, but the largest portion of their business involves supplying the foodservice sector. These distributors include various companies such as Blue Marine, Blue Continent, Sea World, Breco and Lusitania. I&J and Sea Harvest are also active in the distribution of fresh fish to the foodservice market.

The size of the South African market for fresh farmed yellowtail has been estimated at between 1500 and 2000 tons per year, with a 5 000 ton per year niche export market into Europe and the USA. The retail price for the fresh product will be between R45 and R60 per kilogram for the local market and between €15 and €20 per kilogram for a fillet size fresh farmed yellowtail on ice for the export market. This should result in a farm gate price, before processing, of between R30 and R45 per kilogram.

8.5. Financial Feasibility

Financial projections. In order to assess the underlying financial viability of sea cage marine finfish aquaculture, SU has developed a financial model based on the production of 1000 tons of yellowtail per annum. It was assumed that fingerlings will be bought from an existing producer at N$ 2.75 per fingerling. Other key assumptions are shown in Table 13. The projected IRR of the venture is conservatively expected to be around 17% to 21%. This is an indication that with the appropriate financial leverage it should be possible to structure a commercial venture in such a manner that attractive returns are generated for the equity investors.

The three most important factors influencing the model's future returns are the selling price of fish, the growth rate of the candidate species and changes in the price of feed. A 10% change in these variables has an impact of around 5 – 7% on the IRR. The assumptions in the model regarding all three these variables were conservative and it therefore appears that a reasonable probability exists to achieve higher than projected financial returns.

The total capital expenditure projected in the financial model is N$ 16 562 300. The majority total capital expenditure requirement is incurred in the first 3 years of operations. The working capital requirements were estimated at N$ 19 358 239 before the project becomes self-financing. The financial model was based on the total funding requirement being provided in the form of cash equity.

The income statement provides a useful financial summary of the projected operating results for the forecast period. An important indicator is the earnings before tax interest and depreciation (EBITDA). This profitability measure is not influenced by the assumptions regarding the financing structure (i.e. it is separating the financing effects from the operating effects) or the depreciation policy. It therefore provides a relatively cleaner measure of the underlying profitability potential of the venture. EBITDA is negative for the first 2 years, reaching a maximum loss of around N$ 9 871 157 (N$ 10 300 157 cumulative over the period). EBITDA becomes positive at N$ 4 265 238 in year 3.

The cash deficit from operations in the cash flow statement for each of the first two years confirms the relative long start-up phase of the venture.

Detailed financial statements as developed for the model are shown in Appendix C.

Business structure. The financial structuring of the funding requirement is very important as this provides specific opportunities for broad based BEE. In this regards significant debt financing (e.g. loans, overdrafts and preference shares) improve opportunities for BEE shareholding.

A business structure for a commercial venture based on the pilot project has not been finalized, but could include the following interest groups:

- An operating / technical partner

- Non BEE investors, e.g. financial institutions in the public and private sectors, private equity funds or individuals
- BEE investors, e.g. community trusts, entities such as companies and trusts, individuals, and workers trusts
- Management

9. Project Management and Collaboration

The project will benefit from the establishment of an efficient network of collaboration between research institutions, industrial partners, manufacturers and other role-players. The pilot project will be overseen by a standing Project Management Committee consisting of SU, HIK and OTMCo, other co-opted team members and an administrative official. The management committee will be responsible for project oversight, administration and financial management. To facilitate commercialization a dedicated project task team to be led by NewF will be created.

9.1. Division of Aquaculture, SU

The Division was established in 1989 with the aim of contributing to the development of the Southern African aquaculture industry through high standards of education and training, innovative research, and efficient services. The Division functions in an interdisciplinary manner through participation of various other University departments and external collaborators. The Division's outputs include systems engineering, biology and grow-out of marine and freshwater finfish and shellfish, environmental assessment of the potential impacts of aquaculture, genetic enhancement, the development of feed technology, fish health management, post-harvest technology, etc. Within the project context the Division is responsible for:

- Project coordination, including liaison between industry, government and OTMCo
- Project planning and implementation
- Provision of technical assistance and training services
- Implementation of other species activities
- Project reporting
- Assessment of technical and economic viability of the pilot project

9.2. Marine Finfish Producer

MFP was established in Cape Town in 1910. The company's core business is fishing, processing and marketing of the highest quality fish products. The company is a world-class player in the international frozen food industry, producing 240 different product lines for local and international markets. It has a presence on all 5 continents and exports to 28 countries, with international sales representing 65% of sales turnover. MFP currently operates a modern fishing fleet throughout South Africa's exclusive economic zone as well as in international and neighboring state waters of the Atlantic and Indian Oceans. The company's domestic fleet of 24 HACCP approved vessels includes 4 factory/freezer and 20 wet fish trawlers operating from Port Elizabeth in the East to Cape Columbine on the West Coast. In addition the company operates major fish processing facilities in Woodstock and Mossel Bay in the Western Cape.

MFP realized the potential of marine aquaculture over a decade ago and took a bold step in developing one of the first abalone farming operations in SA. The abalone farm is located at Danger Point, near Gansbaai,

south east of Cape Town and produces about 140 tons of abalone per annum. In addition, MFP is deeply involved in various research and development projects related to the farming of marine finfish.

- Evaluation of the technical feasibility of the project
- The provision of technical support services
- Training and development of personnel
- Facilitation of marketing arrangements
- The provision of project management services in collaboration with SU

9.3. NewFarmers Development Company Limited

NewFarmers is a private equity investor and catalyst in agribusiness. The company has an empowerment focus. NewFarmers invests in projects with strong earnings potential that provide an opportunity for the company to eventually profitably disinvest. NewFarmers' investment instruments include equity (preferably minority equity stakes of between 25 and 49 percent), debentures, preference shares and loans. A range of schemes is used to involve employees in a meaningful way, for example employee equity schemes. During the pilot project NewFarmers will be responsible for the following:

- Development and preparation of the project financial model
- Liaison with investment institutions
- Structuring of the business model

9.4. Oranjemund Town Management Company Limited

The Oranjemund Town Management Company (OTMCo) is a Namdeb initiative established in July 2004, with the objective and vision of developing the self-sustainability characteristic of Oranjemund, in order to ensure that the town remains in existence once the Namdeb era has reached its end. Key to this is the development of a diversified economic base in Oranjemund. The role of OTMCo during the pilot project is primarily focused on the provision of support services and includes the following:

- Provision of pilot project funding
- Liaison with Namdeb
- Provision of logistical support e.g. accommodation
- Administrative support
- Project promotion
- Participation in the project steering committee

10. Risk Management

Some of the key factors that tend to contribute to a successful commercial aquaculture operation (one that makes a profit on a sustained basis) include:

- Choosing the right species, or combination of species, according to carefully defined selection criteria, including growth rate, food conversion efficiency, culture technology and marketing;
- Selecting the optimum site according to carefully defined criteria that encompass water quality, topographic and hydrographic features and infrastructure availability;
- Producing a realistic, professional business plan;
- Securing sufficient capital and establishing a proper financing structure;
- Having a suitable operating plan with the appropriate degree of vertical integration;
- Establishing and practicing proper husbandry techniques such as feeding schedules and health and hygiene programs;
- Establishing a suitable program for access to hatchery stock;
- Properly managing the operations, particularly the monitoring and control of operating costs and establishing a suitable risk management program; and
- Establishing a research and development program to continuously increase operating efficiency and lower production costs, principally by minimizing mortality rates and maximizing feed conversion efficiencies and growth rates.

Risks inherent to fishing ventures, offshore aquaculture and the project are summarized in Table 7:

Table 7: Project risk analysis

Risk	Likelihood / Impact	Risk priority	Response
Species bio-performance	Low / High	High	Design based on historical data, pilot project
Failure of bio-technical aspects of production technology	Low / Medium	Low	Proven culture technologies and husbandry techniques; experienced operating partner
Disease outbreak	Low / High	High	Unpolluted water; biosecurity plans; insurance
Increase in production costs	Medium / High	Medium	Economies of scale; alternative production methods
Depressed international markets	Medium / Medium	Low	Alternative marketing strategies; established marketing networks
New entrants	Medium / Medium	Low	Financial, technological entry barriers significant
Delay in implementation	Medium / Medium	Medium	Mobilize additional resources
Loss of key personnel	Low / High	Low	Broad-based collaborative network; incentive schemes
Power failures	Medium / High		
Lack of government support	Low / Medium	Medium	Promote awareness of national socio-economic benefits

11. Conclusion

Looking to the future, if aquaculture is expected to develop and expand significantly in Namibia, and if it is to contribute to the development of sustainable post-mining economic activities in Oranjemund, it will most likely do so incorporating a strategy based on the production of high value products for niche markets such as abalone, as well as the production of marine finfish in reservoir cage or land-based cage systems.

The implementation of a pilot project is an essential step in assessing the technical and economic viability of the development of abalone and other species aquaculture in the Oranjemund area. Although marine aquaculture culture is well established internationally and regulated in accordance with good environmental principles, the development of the industry in Namibia is constrained by a number of entry barriers including high development costs, limited know-how, poor access to resources, and unproven technology, systems and procedures. A successful pilot project will contribute significantly towards removal of some of these barriers and will catalyze the roll out of sustainable commercial projects in Namibia. This is particularly important given that the post-mining economy in Oranjemund is limited in terms of its economic structure and socio-economic profile. Importantly, the development of aquaculture in Namibia and Oranjemund can contribute significantly towards the welfare of previously disadvantaged communities in the province through job creation, skills training, provision of services (SMMEs) and business participation (BEE).

The financial and technical feasibility of the proposed pilot project has been assessed by a knowledgeable and experienced project task team and appear to be favorable. From an investment perspective the project appears to offer acceptable returns. Good progress has also already been made with the implementation of the pilot project in as much as some regulatory aspects have been completed, and key relationships has been formed between industry, research and other government institutions, and manufacturers.

The commercial and investment potential of the development of an abalone venture at Oranjemund has been validated by a complete market and financial assessment and appears promising. The venture should also benefit from several competitive advantages, including:

- Competitive production costs because of lower electricity expenditure associated with lower pumpheads
- Improved water quality through utilization of Mining Area 1 ponds as settlement reservoirs
- Lower company tax rates than SA; enabling regulatory environment
- Use of existing mine infrastructure

As with any new venture, there are many opportunities associated with the development of marine aquaculture. There also just as many associated risks. SU, HIK and NewF appears to have the unique combination of skills and resources necessary to make a venture such as this work, with strengths including technical proficiency, adequate financial resources, environmental sensitivity, and a high level of managerial integrity.

The establishment of the **Oranjemund Yellowtail NewCo** as a highly capable and experienced entrepreneurial operating partner with a successful investment track is essential in order to also develop other aquaculture projects in Oranjemund. Aquaculture will only contribute meaningfully towards the economic development of Oranjemund if the Oranjemund Abalone NewCo can expand and diversity its abalone business to eventually operate a vertically integrated venture that also produces in excess of 5 000 mt of marine finfish.

Appendix A: Species Summary

Yellowtail – *Seriola lalandi* (Valenciennes, 1833)

Maximum Size	1290mm FL longest obtained in SA commercial samples, but known to attain 1500mm FL; Smith & Heemstra report it attaining 50.8 kg
Age at 50% Maturity	Approximately 2 – 3 years, both sexes (Penney, Unpublished data)
Maximum Age	9 – 10 years from otoliths, but possibly gets a few years older (Thomson and Penney, In prep)
Natural Mortality	M = ~0.3`year^{-1}
Resilience	Medium, minimum population doubling time 1.4 – 4.4 years (K=0.13; tm=2)
Environment	Benthopelagic; brackish; marine; depth range 50 – 300 m
Distribution	Circumtropical, entering temperate waters in some areas. Indo-Pacific: Japan, Great Australian Bight and southeastern Australia. Eastern Pacific: British Columbia, Canada to Chile. Eastern Atlantic: St. Helena, South Africa. 51°N - 46°S, 180° W - 180°
Biology	Yellowtail are pelagic, schooling fish, usually seen as adults in small to large numbers. In general they inhabit rocky shores, reefs and islands and are often found adjacent sandy areas in coastal waters and occasionally entering estuaries. Young fish up to 7kg are known to form shoals of up to several hundred fish and are generally found in offshore waters often near or beyond the continental shelf.
Morphology	Dorsal spines (total): 5 - 6; Dorsal soft rays (total): 33 – 35; Anal spines: 2 – 3; Anal soft rays: 20 – 21. The only jack without scutella on the caudal peduncle. Dark blue dorsally and almost white ventrally; with a well defined line of demarcation between the two colors.
Spawning Season (SA)	Strong October – March peak, with some gonad activity observed all year round (Penney, Unpublished data)
Reproductive Style	Gonochorist (Penney, Unpublished data)
Biological Reference Points	F_{MSY}: 0.4 year^{-1}; F_{SB25}: 0.6 year^{-1}; F_{SB40}: 0.45 year^{-1}; $F_{0.1}$: Unknown (Thomson and Penney, In prep)
Importance	Small scale commercial fisheries in SA; gamefish
Red List Status	Not in IUCN Red List

Appendix B: Production Plan

Table 9: Proposed production plan for yellowtail (*Seriola lalandi*)

Month	Average Weight (kg)	Number	Total Weight (kg)	Stocking density (kg/m^3)	Number of cages	Net mesh size (mm)	Feed
1	0.005	18000	90	0.1	1	10	-
2	0.015	17100	257	0.3	1	10	283
3	0.040	16245	650	0.6	1	10	669
4	0.080	15433	1235	1.2	1	10	994
5	0.170	14661	2492	2.5	1	32	2138
6	0.300	13928	4178	4.2	1	32	2866
7	0.500	13232	6616	6.6	1	32	4144
8	0.750	12570	9428	9.4	1	32	4780
9	0.950	11942	11345	11.3	1	32	3259
10	1.200	8027	9633	9.6	1	32	5590
11	1.500	7626	11439	11.4	1	32	3070
12	1.826	7245	13231	13.2	1	32	3046
13	1.973	6882	13582	13.6	1	32	598
14	2.126	6538	13898	13.9	1	32	478
15	2.283	6211	14180	14.2	1	32	419
16	2.445	5901	14426	14.4	1	32	419

Appendix C: Financial Model – Projected Financial Statements

Table 11: Financial model – 10 year discounted cash flow statement (ZAR)											
Description	**Rate**	**2 008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Yellowtail		0	0	23 241 535	23 241 535	23 241 535	23 241 535	23 241 535	23 241 535	23 241 535	23 241 535
Gross Income		**0**	**0**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**
Production Costs		**79 000**	**9 056 322**	**17 650 943**	**17 531 617**	**17 116 830**	**16 949 194**	**16 919 194**	**16 919 194**	**16 919 194**	**17 113 094**
Wages		0	205 920	752 675	752 675	752 675	752 675	752 675	752 675	752 675	752 675
Salaries		0	386 100	772 200	1 154 400	1 006 200	1 006 200	1 006 200	1 006 200	1 006 200	1 006 200
Staff training		50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000
Juveniles		0	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739
Feed	7.3	0	4 202 222	10 582 325	11 080 882	10 793 435	10 505 988	10 505 988	10 505 988	10 505 988	10 505 988
R&M		0	85 000	215 000	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645
Veterinary Supplies		0	100 000	156 000	158 000	158 000	158 000	158 000	158 000	158 000	158 000
Land Lease	0	0	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000
Sea Concession Lease	0	0	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000
Boat mooring fees	0	5 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000
Diving Contractors	0	24 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000
Electricity	0	0	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000
Fuel & oil	0	0	150 000	175 000	200 000	225 000	250 000	250 000	250 000	250 000	250 000
Oxygen	0	0	3 600	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
Potable Water	0	0	12 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Protective Clothing	0	0	7 200	10 000	10 000	20 000	20 000	20 000	20 000	20 000	20 000
Cleaning materials	0	0	5 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
Cleaning services and laundry	0	0	5 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
EMP	0	0	185 000	190 000	190 000	190 000	190 000	190 000	190 000	190 000	190 000
Security/Surveillance	0	0	84 000	168 000	168 000	168 000	168 000	168 000	168 000	168 000	168 000
Freight/Transport	0.15	0	0	119 146	150 176	150 176	150 176	150 176	150 176	150 176	150 176
Fixed Cost Recovery	0	0	0	0	0	0	0	0	0	0	0
Depreciation	0	0	1 090 224	1 568 991	1 568 991	1 568 991	1 568 991	1 418 991	1 318 991	1 318 991	1 318 991

Gross Margin		-79 000	-9 056 322	5 590 592	5 709 918	6 124 705	6 292 340	6 322 340	6 322 340	6 322 340	6 128 440
Admin Costs		**350 000**	**814 835**	**1 325 354**	**1 316 918**	**1 198 481**	**1 173 644**	**1 144 808**	**1 115 971**	**1 087 135**	**1 087 800**
Audit Fees		0	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Office Consumables		0	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000
Office R&M		0	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000
Telephone		0	18 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
Accountant		0	180 000	180 000	180 000	180 000	180 000	180 000	180 000	180 000	180 000
Receptionist/Secretary		0	108 000	108 000	108 000	108 000	108 000	108 000	108 000	108 000	108 000
Cleaner		0	26 400	26 400	26 400	26 400	26 400	26 400	26 400	26 400	26 400
Company Contributions		0	94 320	94 320	94 320	94 320	94 320	94 320	94 320	94 320	94 320
Permit		0	2 000	2 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000
SABS		0	15 000	30 000	45 000	45 000	45 000	45 000	45 000	45 000	45 000
Licensing		0	1 000	3 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000
Asset Insurance		0	156 115	238 583	210 147	181 710	156 873	128 037	99 200	70 364	71 029
Stock Insurance		0	0	409 051	409 051	409 051	409 051	409 051	409 051	409 051	409 051
Professional Fees		350 000	180 000	180 000	180 000	90 000	90 000	90 000	90 000	90 000	90 000
Depreciation		0	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000
Nett Margin		-429 000	-9 871 157	4 265 238	4 393 000	4 926 224	5 118 696	5 177 532	5 206 369	5 235 206	5 040 640
PBIT		-429 000	-9 871 157	4 265 238	4 393 000	4 926 224	5 118 696	5 177 532	5 206 369	5 235 206	5 040 640
Acc. PBIT		-429 000	-10 300 157	-6 034 920	-1 641 919	3 284 305	8 403 000	13 580 533	18 786 902	24 022 107	29 062 747
Tax	15%	0	0	0	0	0	533 115	1 899 895	1 912 608	1 929 670	1 770 702
Net Income		**-429 000**	**-9 871 157**	**4 265 238**	**4 393 000**	**4 926 224**	**4 585 581**	**3 277 637**	**3 293 761**	**3 305 535**	**3 269 938**
Add back Depreciation		0	911 806	1 466 330	1 466 330	1 466 330	1 516 330	1 486 330	1 486 330	1 486 330	1 680 230
Capital expenditure		0	9 268 056	5 545 244	0	0	350 000	0	0	0	1 789 000
Cash Flow		**-393 667**	**-17 799 004**	**-1 165 568**	**5 736 330**	**6 367 751**	**5 733 775**	**4 763 967**	**4 780 091**	**4 791 865**	**20 172 289**
Acc. Cash Flow		**-393 667**	**-18 192 671**	**-19 358 239**	**-13 621 909**	**-7 254 158**	**-1 520 383**	**3 243 584**	**8 023 676**	**12 815 541**	**15 976 709**
ROCE		**-255%**	**-47%**	**16%**	**19%**	**24%**	**29%**	**32%**	**36%**	**40%**	**38%**

Table 12: Financial Model – Capital expenditure requirements (N$)				
Item	**Rate**	**Expenditure**		
		2009	**2010**	**2011+**
Total Costs		**9 268 056**	**5 545 244**	**11 280 915**
Land & Building		**375 000**	**0**	**0**
Building upgrades / nursery enclosure		150 000		
Nursery tank surface preparations		75 000		
Pump Station		150 000		
Sea Equipment		**8 673 056**	**5 545 244**	**11 280 915**
Sea cages	11 284 300	**6 269 056**	**5 015 244**	**11 280 915**
18 x cage collar (22m dia)	3 213 000			
3 sets of 2 x Stingray mooring	3 145 800			
4 x 1.5 of 10mm juv nets	441 000			
6 x 1.5 of 18mm med nets	483 000			
12 x 1.5 of 25mm large nets	1 249 500			
18 x 1.2 predator nets	1 587 600			
Supplier installation costs	764 400			
I&J installation costs	400 000			
Ship warning reflector buoys	50 000	20 000	30 000	
Feeding cannon etc	50 000	50 000		
Tarpaulin	80 000	80 000		
Sweep net	30 000	30 000		
Fish harvesting/grading equipment	75 000	75 000		
Dip net	5 000			
Work bench	25 000			
Fish stunner	25 000			
Ice bins	20 000			
Fish Pump	50 000	50 000		
Diving equipment x 3	150 000	150 000		
Scuba tanks	50 000			
Wetsuits	15 000			
DV's, BC's etc	50 000			
Mask, fins, weights, bag etc	20 000			
Underwater equipment	15 000			
Miscellaneous equipment	10 000	10 000		
Land-based equipment				
Biofilter	65 000	65 000		
Recirculation pumps + pipes	50 000	50 000		
Water Treatment (drum filter)	50 000	100 000		
Boiler	110 000	110 000		
Electrical switchgear etc.	50 000	50 000		
Nursery Tanks 10 x 25m3	10 000	100 000		
Nursery tank pipes and fittings	2 000	20 000		
Suction Lines	250 000	250 000		
Pump	150 000	150 000		
Delivery lines	100 000	100 000		
Dosing pump	10 000	10 000		

Microscope	5 000	5 000		
Laboratory tests	15 000	15 000		
Water quality tests	5 000	5 000		
Oxygen + diffusers	50 000	50 000		
Oxy Reticulation	20 000	20 000		
1t plastic bins	750	9 000		
25kg bins	50	10 000		
Net washing equipment	150 000	150 000		
General tools	20 000	20 000		
Fish handling equipment	50 000	50 000		
Vehicles		**750 000**	**500 000**	
Feed / general purpose boat		100 000		
Barge		500 000	500 000	
LDV		150 000		
Office		**70 000**	**0**	
Office Equipment		50 000		
Office Furniture		20 000		
Professional Fees		**0**	**0**	
EIA				

Table 13: Financial model **–** Underlying assumptions

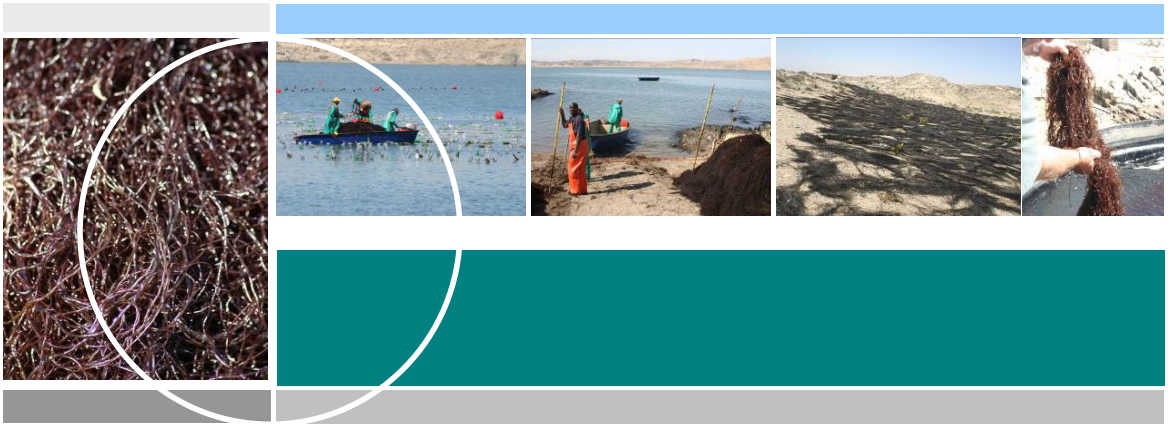
Description	Value
Projected tonnage	1000 tons
Maximum stocking density	15 kg.m^3
Cage volume	4 944
Average FCR	1.53
Feed price	N$ 7.30
Mortality rate	30%
Growth period in months	YT: 14
HOGO Yield	90%
Sales price	N$ 27.48
Juvenile cost	N$ 2.75
Taxation rate	15%

Table 14: Financial model – 10 year overheads (N$)											
Description	**Rate**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total Costs		**429 000**	**9 871 157**	**18 976 297**	**18 848 534**	**18 315 311**	**18 122 839**	**18 064 002**	**18 035 166**	**18 006 329**	**18 200 895**
Production Costs		**79 000**	**9 056 322**	**17 650 943**	**17 531 617**	**17 116 830**	**16 949 194**	**16 919 194**	**16 919 194**	**16 919 194**	**17 113 094**
Production		**0**	**0**	**896 565**	**896 565**	**896 565**	**896 565**	**896 565**	**896 565**	**896 565**	**896 565**
Production Cost/kg					**21**	**20**	**20**	**20**	**20**	**20**	**20**
Wages		0	205 920	752 675	752 675	752 675	752 675	752 675	752 675	752 675	752 675
- Sea based	2200	0	158 400	522 539	522 539	522 539	522 539	522 539	522 539	522 539	522 539
- Land based	2200	0	0	47 339	47 339	47 339	47 339	47 339	47 339	47 339	47 339
- Casuals	550	0	0	11 835	11 835	11 835	11 835	11 835	11 835	11 835	11 835
- Company Contributions	30%	0	47 520	170 963	170 963	170 963	170 963	170 963	170 963	170 963	170 963
Salaries		0	386 100	772 200	1 154 400	1 006 200	1 006 200	1 006 200	1 006 200	1 006 200	1 006 200
- Ops Manager	25000	0	150 000	300 000	300 000	300 000	300 000	300 000	300 000	300 000	300 000
- Supervisor	15000		90 000	180 000	360 000	360 000	360 000	360 000	360 000	360 000	360 000
- Foreman	9500		57 000	114 000	228 000	114 000	114 000	114 000	114 000	114 000	114 000
- Company Contributions	30%	0	89 100	178 200	266 400	232 200	232 200	232 200	232 200	232 200	232 200
Bonus Scheme	5%										
Staff training		50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000
Juveniles			1 965 062	1 886 460	1 827 508	1 768 556	1 768 556	1 768 556	1 768 556	1 768 556	1 768 556
Feed	7.3	0	4 482 635	11 211 794	9 693 789	9 451 154	9 208 519	9 208 519	9 208 519	9 208 519	9 208 519
R&M		0	85 000	215 000	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645
Veterinary Supplies		0	100 000	156 000	158 000	158 000	158 000	158 000	158 000	158 000	158 000
Land Lease		0	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000
Sea Concession Lease		0	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000
Boat mooring fees		5 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000
Diving Contractors		24 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000
Electricity		0	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000
Fuel & oil			150 000	175 000	200 000	225 000	250 000	250 000	250 000	250 000	250 000
Oxygen			3 600	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000

Potable Water		0	12 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Protective Clothing		0	7 200	10 000	10 000	20 000	20 000	20 000	20 000	20 000	20 000
Cleaning materials			5 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
Cleaning services			5 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
EMP		0	185 000	190 000	190 000	190 000	190 000	190 000	190 000	190 000	190 000
Security/Surveillance		0	84 000	168 000	168 000	168 000	168 000	168 000	168 000	168 000	168 000
Freight/Transport	0.15	0	0	119 146	150 176	150 176	150 176	150 176	150 176	150 176	150 176
Fixed Cost Recovery		0	0	0	0	0	0	0	0	0	0
Depreciation		0	904 806	1 459 330	1 459 330	1 459 330	1 509 330	1 479 330	1 479 330	1 479 330	1 673 230
Administration		**350 000**	**814 835**	**1 325 354**	**1 316 918**	**1 198 481**	**1 173 644**	**1 144 808**	**1 115 971**	**1 087 135**	**1 087 800**
Audit Fees		0	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Office Consumables		0	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000
Office R&M		0	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000
Telephone		0	18 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
Accountant	15 000	0	180 000	180 000	180 000	180 000	180 000	180 000	180 000	180 000	180 000
Receptionist/Secretary	9 000	0	108 000	108 000	108 000	108 000	108 000	108 000	108 000	108 000	108 000
Cleaner	2 200	0	26 400	26 400	26 400	26 400	26 400	26 400	26 400	26 400	26 400
Company Contributions	30%	0	94 320	94 320	94 320	94 320	94 320	94 320	94 320	94 320	94 320
Permit		0	2 000	2 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000
SABS		0	15 000	30 000	45 000	45 000	45 000	45 000	45 000	45 000	45 000
Vehicle and boat licenses		0	1 000	3 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000
Asset Insurance		0	156 115	238 583	210 147	181 710	156 873	128 037	99 200	70 364	9 600
Stock Insurance	3.20%	0	0	409 051	409 051	409 051	409 051	409 051	409 051	409 051	609 687
Professional Fees		350 000	180 000	180 000	180 000	90 000	90 000	90 000	90 000	90 000	90 000
Depreciation		0	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000

Project Proposal

Establishment of Commercial *Gracilaria* Farming Operations at Oranjemund in Namibia



Prepared for:

The Oranjemund Town Management Company (Pty) Ltd
Oranjemund
Namibia

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April 2008

Table of Contents

1. Executive Summary

The Division of Aquaculture, Stellenbosch University (SU) was commissioned jointly by Namdeb Diamond Corporation (Pty) Ltd (Namdeb) and the Oranjemund Town Management Company Limited (OTMCo) to assess the aquaculture potential of the mining area at Oranjemund in Namibia. This document provides a proposal for a 500 metric tonne seaweed farm to be implemented in the mining ponds at Oranjemund.

Namdeb operates an alluvial diamond mining operation at Oranjemund, which is situated at the south western extremity of Namibia. The mining activities of Namdeb are expected to decrease in scale over time and alternative economic activities aught to be identified and developed to sustain the livelihood of the citizens of Oranjemund.

The ponds that were created through the process of diamond mining present an opportunity to develop an aquaculture industry at Oranjemund. This could contribute in the effort of enabling an economically sustainable Oranjemund in the post mining era.

Gracilaria is a gelatinous red algae which are used for the production of agar with applications in the human food industry, as well as in specialized laboratory methods. *Gracilaria* is currently exported from Namibia to Japan and China in a dried and compressed format and the possibility also exist to develop a market for fresh *gracilaria* as a feed source for the abalone industry.

The proposed project consists of two phases. Phase 1 is a pilot project with a total estimated cost of N$78 000. This includes the capital cost which amounts to N$29 000. The duration of the pilot project is 12 months and the desired output is the confirmation of the technical feasibility and financial viability of commercializing the project in Phase 2. The commercial phase (Phase 2) will occupy up to 12.5 hectares and has an estimated total cost of N$2 499 068 with a capital expenditure of N$1 982 200. The annual turnover is expected to be N$2 250 000 with an estimated net profit of N$458 425.

The proposed method of farming is floating rope structures from which the *gracilaria* are suspended. These structures or culture units will be situated and secured inside the mining ponds. A total of twenty-five culture units will be installed.

Risks associated with seaweed culture are medium to low and the most significant technical risk for this project is the effect of the thermal fluctuation in the pond water on the growth of *gracilaria*.

The pilot project will benefit from a collaborative effort between an academic institution, an industry partner, potential investors and other role-players. It is proposed that Phase 1 of the *gracilaria* culture project be implemented by a management committee, consisting of Stellenbosch University, Rotaq Farming and OMTCo. The management committee will be responsible for project implementation, management, and administration and reporting. To facilitate commercialization (Phase 2) a dedicated project task team will be established once technical feasibility and financial viability has be confirmed.

The potential of the Oranjemund Seaweed Project can best be realized if sufficient interest and participation from industrial partners and investors can be generated. It is the responsibility of all involved in execution of the proposed pilot project to do so in a manner which will attract further investment interest to make aquaculture a reality in Oranjemund.

2. Introduction

The Division of Aquaculture, Stellenbosch University (SU) was commissioned jointly by Namdeb Diamond Corporation (Pty) Ltd (Namdeb) and the Oranjemund Town Management Company Limited (OTMCo) to assess the aquaculture potential of the mining area at Oranjemund in Namibia. This document provides a proposal for a 500 metric tonne seaweed farm to be implemented in the mining ponds at Oranjemund.

Namdeb operates an alluvial diamond mining operation at Oranjemund, which is situated at the south western extremity of Namibia. The mining activities of Namdeb are expected to decrease in scale over the next decade and alternative sources of income need to be developed to sustain the livelihood of the citizens of Oranjemund.

Aquaculture, which can be defined as the cultivation of aquatic organisms, is expanding on a global scale to meet the deficit between demand and the natural production of the world's seas and freshwater reservoirs. Aquaculture offers tremendous opportunities for Namibia. This growth industry can improve food security, reduce poverty, create employment and increase inward investment to the country. In addition, aquaculture represents a sustainable economic use of Namibia's coastal and inland living aquatic resources – which means that aquaculture activities can be continued into the future, providing economic opportunity without depleting non-renewable resources.

The infrastructure and seawater ponds left through the process of mining could provide the opportunity for marine aquaculture development in Diamond Area 1. This could contribute in the effort of enabling an economically sustainable Oranjemund in the post mining era.

Aquaculture in Namibia enjoys the support of government with aquaculture identified as a prime priority development area in the *Vision 2030* document. This is especially true for marine aquaculture which is promoted as a opportunity for economic development and a source of foreign income for Namibia.

Seaweed farming in Southern Africa is most often perceived as a polyculture by-product of the abalone industry. Rotaq Farming (Pty) Ltd specializes in the production of seaweed as primary product for the export market. Rotaq Farming is based in Luderitz where floating structures are used for the culture of *gracilaria.* Expansion of the industry in Southern Africa is limited by the availability of sites that are suitable for seaweed culture. The mining ponds at Oranjemund present an opportunity to culture seaweed on a commercial scale.

Gracilaria are processed to obtain agar, agarose and agaropectin. These seaweed products are used in the food industry as binding and gelling agents, and also form the base of various laboratory procedures. Natural harvesting of seaweeds is inconsistent and weather dependant. In addition to this, the quality of naturally harvested seaweeds is also inconsistent. Advancement in science and food industries creates a demand for quality seaweed products and creates opportunities for seaweed culture.

The proposed project is divided into two phases. Phase 1 consists of a pilot scale project to assess the commercial viability of *gracilaria* culture in the mining ponds. The proposed pilot phase will determine the production potential of the ponds and the biological performance of *gracilaria* in the fluctuating pond environment. Phase 2 is the establishment of a 500 mt *gracilaria* production unit. The outcome of Phase 1 will determine if the project will proceed to Phase 2.

3. Project Objectives

The *gracilaria* culture project at Oranjemund is aimed at establishing a sustainable commercial venture. Phase 1 will assess the technical feasibility and economic viability of *gracilaria* culture in the mining ponds and Phase 2 will be the commercial upscale of the pilot project to a production capacity of 500 mt.

The specific objective of the project is:

- To establish a 500 mt *gracilaria* culture facility in the mining ponds of Diamond Area 1. Project establishment will be done over a period of two years.

The broad objectives of the project are:

- To contribute towards development of a sustainable and competitive aquaculture industry in Namibia with international recognition for its product quality, environmental awareness and technical innovation
- To contribute towards the creation of a sustainable post-mining economy in Oranjemund in a manner consistent with the principles of ecologically sustainable development
- To contribute to poverty reduction and empowerment of disadvantaged coastal communities through development of employment opportunities, skills training, and business participation (SMMEs, BEE)
- To contribute to the development of newly leveraged downstream industries that can create additional job and business opportunities
- To ensure competitiveness on global markets through the development of advanced processing technology to improve product quality, diversification, value-adding and traceability.

The specific objectives of the pilot project are:

- To confirm the technical viability assessments regarding the suitability of the mining ponds as culture units for seaweed production
- To determine the growth rate of *gracilaria* under commercial conditions
- To assess the nutrient availability inside the ponds and determine possible enrichment procedures
- To provide a platform for the training of personnel in *gracilaria* farming practices
- To develop procedures for interaction with mine security protocols as well as other general management procedures
- To assess the possibility of integrated aquaculture practices.

4. Rationale

4.1. Aquaculture is a Profitable, Competitive and Growing Industry

Aquaculture development is market driven. It is clear that in the short to medium term, demand for fish and aquatic products will expand as populations and incomes grow. According to the United Nations' Food and Agriculture Organization (FAO), world total demand for fish and fishery products is projected to increase by almost 50 million tons, from 133 million tons in 2000 to 183 million tons by 2015.

It is widely acknowledged that fish supplies from traditional capture fisheries are unlikely to increase substantially in the future and that aquaculture production will have to rise further to help satisfy the growing world demand for fisheries products. According to the FAO, 32% of seafood consumed worldwide is currently

produced through aquaculture, already the fastest growing global food producing industry. This is projected to rise to 45% by the year 2015. Concomitant with the rise in demand it is anticipated that fish prices will probably continue to increase during the coming two decades, with baseline FAO scenario projections suggesting increases of 15 percent for high-value products.

Aquaculture producers are preferentially (competitively) meeting market demand through both non-price supply and product advantages. Supply advantages include, for example, the ability to control and thus predict supply. Farmers have far greater control over the timing, consistency and quantity of production than do fishermen. The pace advantages of farming create benefits to farmers in the form of better prices, more processing options, and higher quality.

4.2. Aquaculture Contributes to Economic and Social Welfare

Aquaculture has significant potential to expand in Namibia. The country's strengths include unpolluted coastlines, productive marine resources, a wide climatic range, a large diversity of species available for culture, and a reputation for quality seafood.

There are many reasons to pursue this potential. Aquaculture offers significant economic benefits to producing countries by increasing export income and reducing imports. At the micro-economic level aquaculture creates substantial opportunities for generating strong commercial returns. In addition, aquaculture provides diversity to a country's economic base and creates demand for technology, training, extension services, infrastructure and local goods.

The aquaculture industry is particularly important from a socio-economic perspective. Aquaculture contributes to food security, improved nutrition and poverty alleviation, directly by producing food fish, and indirectly by generating employment and income for the purchase of food. Jobs in commercial aquaculture are relatively well paid. The contribution of aquaculture to employment is even larger if multiplier effects are added. Ninety percent of aquaculture production and processing takes place in rural and coastal communities, providing economic stability and growth where economic development options are often limited, particularly in cases where yields from wild fisheries have declined.

5. *Gracilaria* Species Overview and Aquaculture Status

The genus of *Gracilaria* incorporates gelatinous red algae. In most species, this seaweed grows from a holdfast in the substrate from where branches or thalli arise. The thalli of most species are cylindrical and the external appearance of the thalli may be used to identify the different species.

The genus of *Gracilaria* is cosmopolitan in distribution, and has been reported from the arctic, temperate and tropical regions. The number of reported *Gracilaria* species worldwide has reached about 150.

Propagation of *gracilaria* is done through the release of spores that develops and settles to form new plants. Vegetative propagation also occurs and is the preferred method of aquaculture production in many regions.

The cultivation of the agarophytic red alga *Gracilaria* is now of major importance in several parts of the world, such as Asia, South America and Southern Africa. China is leading *gracilaria* culture. Farmed aquatic plant production in 2000 reached 10.1 million mt. The growth in the industry has been steady with an average 8.2% per year from 1970 until 2000.

6. Project Description

6.1. Overview

Generally, commercial aquaculture proceeds through a series of growth, development and maturity stages that relate to its level and degree of competitiveness and profitability. A typical business development cycle applicable to the Oranjemund Seaweed Project is shown in Table 1.

Table 1: Aquaculture business development cycle

Stage of Development	Description
1. Seed/conceptualization	Develop, test and ready a product for production. Development of pilot project to determine technical and financial feasibility and to optimize production parameters.
2. Start-up/early expansion	Commence commercial business operations. Installation of infrastructure to facilitate approximately 50% of planned production, significant investment in human resource development and a specific focus on marketing. Anticipated production capacity of about 500 mt at Oranjemund during this phase.
3. Development/growth/expansion	Expand an established and growing business. Expansion to 1000 mt over the course of a five year period.
4. Later established	Continue expansion or development of further and advanced processing facilities.

The two proposed phases of the Oranjemund Seaweed Project are in accordance with the first two stages of aquaculture development, as set out in Table 1 above. The pilot phase (Phase 1) will assess the technical viability of producing *gracilaria* in the mining ponds. Phase 2 should be a continuation of Phase 1 with the expansion of the pilot scale *gracilaria* production unit to a commercial unit of 500 mt. The pilot phase will run for 12 months before development of the commercial phase. The selected operating period for the pilot phase will allow for, amongst other, the assessment of the effect of season on *gracilaria* production in the ponds. It is anticipated that the pilot project will be jointly managed by Stellenbosch University and Rotaq Farming (Pty) Ltd. The pilot project will also serve as a training platform for human resources capacity development.

Commercial seaweed farming involves the suspension of tufts of *gracilaria* in the water. The tufts grow and multiply through the absorption of nutrients from the water and are expected to increase tenfold in weight over an eight week period. The *gracilaria* from one production unit is harvested and a small amount (10%) is used to seed the unit for the next production cycle. The remainder of the harvested *gracilaria* is spread out to dry before being compressed and baled. These bales of *gracilaria* are shipped to Japan for the production of agar.

6.2. Project Workplan

The project will be executed within the following main tasks:

i) **Project approval.** Authorization to implement the project has to be obtained under the relevant legislation regulating aquaculture development in Namibia. This process is clear and well set out in the report under section dealing with Aquaculture legislation.

Authorization and approval from Namdeb is required and the technical requirements for operating in an active mining area needs to be established.

ii) **Appointment and training of project personnel.** Seaweed cultivation does not require a high level of technical knowledge. It is proposed that the majority of the staff be sourced from the local community of Oranjemund. Supervisors and machine operators should however be trained at an existing seaweed producer, such as Rotaq Farming (Pty) Ltd. In Luderitz. Incorporating a commercial partner in the implementation of this project highly advised. Stellenbosch University, as lead agency, will oversee the pilot project and conduct related R&D and evaluation.

iii) **Equipment selection, acquisition and delivery.** Equipment required for seaweed cultivation is low technology and all equipment can be obtained in Namibia and South Africa. The absence of strong currents in the mining ponds allows for the use of relatively light anchors and buoys. All the culture structures will be assembled on site.

iv) **Seed Stock**. The culture units are seeded by placing tufts of *gracilaria* through the mesh openings of suspended nets. The initial seed stock can be obtained from the wild or from Rotaq Farming (Pty) Ltd. in Luderitz. Future seeding of the culture units is done through retaining a small percentage of each harvest cycle as seed stock for the next cycle. It is however recommended to collect new seed stock from the wild on a regular basis.

v) **Construction of land-based facilities.** The land based facility will consist of a sheltered area constructed from poles and shade cloth, as well as a small storage room and office. Two tanks with a capacity of 10 000 litres will be erected, alternative two floating cages can be constructed. These will hold the harvested *gracilaria* to be used as seed stock for the next culture cycle. The shaded area is used for seeding the culture nets during the day and for storage of boats and equipment. These structures will have to be erected at each pond where seaweed culture is practiced. Adjacent ponds could however share land based facilities.

vi) **Installation of culture units.** A total of three culture units will be assembled and installed in the allocated ponds. Each structure will have a size of half a hectare (5 000 m^2) and a production potential of 20 mt (dry weight) per annum. A culture unit or structure consists of a rope grid that is anchored on the ends and kept taught with buoys. The culture lines are suspended from this rope grid. The rope grid is a permanent fixture and the culture lines are removed for seeding and harvesting. The installation of this system is uncomplicated and can be done with the service boats that will be used for daily management practices.

vii) **Harvesting.** Each of the twenty-five culture units will be harvested in eight week intervals. Freshly harvested *gracilaria* will be spread out next to the ponds to dry. The drying process is usually completed within 48 hours, depending on the weather conditions.

viii) **Processing.** Processing of *gracilaria* consists of tumbling and baling. The *gracilaria* is tumbled to remove impurities such as sand and dust that could have attached during the drying process. The clean *gracilaria* are then hydraulically compressed and baled for export. The processing will be done outside the mining area in Oranjemund.

6.3. Pilot Phase Budget

The estimated budget for Phase 1 is given below.

The total estimated cost of the pilot project is N$ 78 000. This includes capital expenditure costs of N$ 29 000, and general administrative costs (including wages) of N$ 49 000.

Table 2: Estimated *gracilaria* pilot project expenditure

No	Item	Unit Cost	Quantity	Total
1	**Project Management**			**N$ 20 000**
2	**Transport & travel***			**N$ 6 000**
3	**Infrastructure***			**N$ 14 000**
	Mooring Blocks	*N$ 1 000*	*6*	*N$ 6 000*
	Ropes and Buoys	*N$ 18 000*	*1*	*N$ 18 000*
4	**Wages**			**N$ 18 000**
7	**Contingencies**			**N$ 5 000**
9	**Storage***			**N$ 5 000**
10	**Tools & equipment***			**N$ 10 000**
	TOTAL COST			**N$ 78 000**

*** Cost based on shared overheads between pilot project components (seaweed, abalone, oyster, finfish)**

6.4. Implementation

A proposed schedule for the implementation of the project is shown in Table 3. It should be noted that implementation is subject to the availability of funding and the completion of regulatory aspects. Should Phase 1 of the pilot project be concluded successfully, an extension phase will be developed and implemented.

Table 3: Description, duration and implementation date for the key project tasks.		
Task	**Description**	**Start Date & Duration**
1	Project approval	Oct 2008
2	Equipment design, selection & acquisition	Jul – Oct 2008
3	Appointment & training of project personnel	Aug – Nov 2008
4	Infrastructure installation	Sept – Oct 2008
5	Basic environmental assessment	Oct 2008 – Mar 2009
6	Introduction of seed stock	21 Oct 2008
7	Production parameter optimization	Oct 2008 – Mar 2009
8	Data analysis	Apr 2009
9	Business plan review	May 2009
10	Commercialization preparation	May 2009 – August 2009
11	Implementation of full scale commercial operation	August 2009

7. Feasibility Assessment

7.1. Relevant Legislation, Policies and Guidelines

Among others, cognizance has been taken in this study and in the project design of the following acts, codes, conventions, agreements, protocols and policy proposals:

- Namibian Marine Resources Act, 2000 (Act no. 27 of 2000)
- Namibian Aquaculture Act, 2002 (Act no 18 of 2002)
- Namibia's Aquaculture Strategic Plan
- Various FAO Codes including the FAO Code of Conduct for Responsible Fisheries
- Southern African Development Community Protocol on Fisheries (and related protocols on shared resources etc.)
- Bangkok Declaration and Strategy for Aquaculture Development beyond 2000

7.2. General Aquaculture Investment Constraints

Namibia's aquaculture sector, if it is to deliver sustainable industry growth, will require substantial capital investment. A number of reports have identified a lack of investment as one of the aquaculture sector's perceived weaknesses. Problems associated with attracting investment in aquaculture are shown in Table 4.

Table 4: Common problems associated with attracting investment in aquaculture	
Constraint	**Comment**
Ownership structure of aquaculture enterprises	The prevalence of private companies, partnerships or trusts in aquaculture may create serious obstacles to financing by preventing access to equity financing from the public or from institutional investors

Long start-up phase	Aquaculture experiences great variations in returns, especially in the start-up phase.
Production risk	Apart from the normal risks faced by any production business, the aquaculture industry has an extra dimension of uncertainty associated with climatic and other environmental factors. Droughts, floods, water temperature, water quality and disease all represent factors that are largely beyond the control of individual farmers. The only option for farmers is to anticipate and, where possible, put in place economic and production risk management procedures.
Security of tenure	Where aquaculture depends on access to public resources, some degree of security of tenure or access is required to underpin an investment by the farmer or additional investors.
Macro-economic settings and policies	The aquaculture industry is highly sensitive to general economic conditions. New investment and sales are subject to financial factors, such as the prevailing interest rates and the taxation arrangements that apply to primary industries.

7.3. SWOT Analysis

A strategic assessment of the strengths, weaknesses, opportunities and threats of the project has been conducted and is shown below.

Table 5: Project SWOT analysis

Species	Geographical Location
Strengths	**Strengths**
1. Relatively low capital requirements	1. Namibian company tax rates
2. Short production cycle	2. Limited competition for sites
3. Low risk marine aquaculture	3. Enabling regulatory environment
4. Technology available	4. Developed and available infrastructure
5. Occurs naturally in the area	5. Environmentally disturbed area
6. Ability to utilise the shallow nature of ponds	6. Good security
7. Robustness	7. Social support network and infrastructure
8. Local species farming knowledge	
Weaknesses	**Weaknesses**
1. Specialized marketing strategy	1. Mine security procedures
2. Movement of large quantities of product	2. No aquaculture support services
3. Low value species	3. Site knowledge
4. Labour intensive	4. High transport costs, remoteness
5. Large culture areas required	5. Industry scepticism
	6. Water temperature variation in ponds

Opportunities	Opportunities
1. Value adding through advanced processing	1. Regulatory environment
2. Polyculture joint ventures could increase production	2. Use/conversion of mine infrastructure
3. Processing facility in Oranjemund	3. Ponds
4. Develop market as abalone feed	4. Scale of production scope
5. Limited competition for site	5. Joint marketing efforts
Threats	**Threats**
1. Extreme water temperature fluctuations	1. Market volatility (Asian)
2. Low nutrient replacement rate in ponds	2. Lack of investor funds
3. Competition from foreign producers	3. Effect of downscaling and mine closure
4. Global warming – environmental instability	4. Security of tenure
5. Strong local currency	5. Orange river plume
6. Macro-economic settings and policies	6. Political interference

7.4. Technical Feasibility

The technical feasibility of the project was assessed against four main parameters and is shown in Table 6:

Table 6: Factors affecting the technical feasibility of the project

Factor	Issue
1. Culture technologies	Is existing *gracilaria* grow-out technology efficient, competitive and available?
2. Species bio-performance	Will *gracilaria* growth rates and survival allow profitable production?
3. Husbandry & management	Can existing culture techniques, procedures and equipment be used in the available conditions and production environment? Is existing human resource capacity adequate?
4. Environmental impact	Are potential impacts consistent with the principles of ecological sustainable development and does an environmental impact assessment study have a high likelihood of success?

Culture technologies. The culture technologies for *gracilaria* have been proven by Rotaq Farming in Luderitz. The proposed *gracilaria* culture system is based on a floating rope system from which the gracilaria is suspended in the water body. Each culture unit consists of a rope structure which is kept in place through sets of anchors and buoys. Culture ropes, from which the *gracilaria* grows, are attached to the rope structure. Various floats are used to keep the complete structure suspended at the correct depth. The culture ropes are removed from the main structure for harvesting and seeding practices.

Species bio-performance. *Gracilaria* performs well under culture conditions and has the potential to increase tenfold in weight over a period of eight weeks. The local species is however intolerant towards

high water temperatures and a decrease in growth can be expected when the water temperature exceeds 20°C. A factor in *gracilaria* farming is the presence of epiphytes. Epiphytes are a macro alga that grows on the thalli of the *gracilaria*. These compete for nutrients and sunlight and retards *gracilaria* growth.

Husbandry and management. Husbandry and management practices are central towards maximizing production, optimizing operating cost efficiencies, and maintaining a high quality product and therefore market price. Worldwide, aquaculturists have had a successful history of innovation in husbandry and management practices since the intensification of aquaculture in the 1960's. Rotaq Farming has skill to develop and manage *gracilaria* farms. This knowledge and experience has been acquired and perfected to the level where consistent commercial results are obtained.

Potential environmental impact. Seaweed growth relies on available sunlight and adequate amounts of dissolved nutrients in the water. Under normal culture conditions, no additional nitrogen is added to the water body and therefore seaweed culture has a negligible effect on the surrounding environment. This does however change when additives are used, as well as the introduction of foreign seaweed species to the culture area.

The landlocked nature of the ponds mitigates the risk of foreign species being introduced to the wild. This will also limit the available nutrients required for plant growth. It is foreseen that additives (fertilizers) will be required in the nutrient poor environment of the ponds. The effect of this should be negligent; permitting that the *gracilaria* absorbs these dissolved additives to sustain growth.

7.5. Market Feasibility

In 2004, global exports of seafood products reached almost US$ 70 billion, whilst supply (particularly of quality seafood) cannot keep pace with demand. According to the FAO, in 2004 the total human consumption of seafood was approximately 128 million metric tons. Statistics show that annual global fish catches have plateaued at about 90 million metric tons and may even be declining. Over 60% of the marine fish stocks for which information is available are either fully exploited or overexploited, and 13 of the world's 15 major oceanic fishing areas are now fished at or beyond capacity. This leaves only aquaculture available to meet the increasing world demand for seafood. Although aquaculture has grown at an average annual rate of 8.8% from 1950 to 2004, it is, however, highly unlikely that even aquaculture is capable of filling the gap between demand and supply. Although the severity of the shortage would differ among countries, the overall effect would be a rise in the price of seafood. Increases of up to 15% are projected for high-value products by the FAO.

The increasing global demand for agar, agarose and agaropectin is primarily due to the development of new applications of these seaweed products in the food industry, in specialized laboratory methods such as immunodiffusion, diffusion and chromatography techniques, bio-engineering, microbiology and biochemistry. A stable source of raw materials for the manufacture of these seaweed products is essential to meet this increasing global demand.

At present, there are two major sources of agar-producing seaweeds, namely from gathering natural stocks and from farming/culturing of these species. Production through gathering of natural stocks depends on the availability of harvestable stocks; this is greatly influenced by seasonal changes in the weather which in turn make supply seasonal. In addition, production is highly influenced by the harvest pressure of the previous season. These factors lead to a tendency for production from natural stocks to be unreliable.

Production through culturing is more predictable and stable, and targeted outputs are easily attained (FAO).

The major markets for dried and semi-processed seaweed products are Japan and China. Product quality is the major criteria affecting the selling price of seaweeds which varies between R4 500 and R5 500 per metric ton (dry weight). Seaweeds are sold in a dry format.

In addition, local markets for seaweed as a feed for the growing abalone industry could be developed. *Gracilaria* are well accepted by abalone as a feed source and it is providing a better feed conversion rate than kelp, which is the traditional feed for several abalone farms. The continuous availability of cultured *gracilaria* could be seen as an added benefit for the abalone industry, as kelp harvesting is weather dependant. Fresh seaweed, as opposed to artificial feed, has the added advantage of staying alive in the water column and improving water quality parameters inside the abalone tanks.

7.6. Financial Feasibility

Detailed financial statements as developed for the model are shown in Annexure B. The financial model is for a 500 metric tonne production unit and does not include the proposed pilot project.

The total cost for the commercialization of the project is estimated at N$ 2 499 068 with a capital expenditure of N$ 1 982 200.

Business structure. The financial structuring of the funding requirement is very important as this provides specific opportunities for broad based BEE. In this regards significant debt financing (e.g. loans, overdrafts and preference shares) improve opportunities for BEE shareholding.

This model is partly funded through a loan of N$ 600 000. The remaining N$ 1 899 068 will have to be funded through direct investment.

Table 7: Projected Income Statement

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Sales	**1 350 000**	**2 250 000**	**2 250 000**	**2 250 000**	**2 250 000**	**2 250 000**
Less COGS	195 000	325 000	325 000	325 000	325 000	325 000
Gross profit	**1 155 000**	**1 925 000**	**1 925 000**	**1 925 000**	**1 925 000**	**1 925 000**
Overheads	1 218 445	1 244 445	1 244 445	1 244 445	1 244 445	1 244 445
EBITDA	**-63 445**	**680 555**	**680 555**	**680 555**	**680 555**	**680 555**
Less depreciation	187 625	187 625	187 625	187 625	187 625	187 625
EBIT	**-251 070**	**492 930**	**492 930**	**492 930**	**492 930**	**492 930**
Less interest raised	187 538	187 538	187 538	187 538	187 538	0
EBT	**-438 608**	**305 392**	**305 392**	**305 392**	**305 392**	**492 930**
Less tax	0	21377	21377	21377	21377	34505
EAT / Net income	**-438 608**	**284 014**	**284 014**	**284 014**	**284 014**	**458 425**

The base line assumption on which the financial modelling are based is presented in Table 8.

Table 8: Base line scenario assumptions

Description	Value
Annual harvest (metric tonnes, mt)	500
Dry weight (%)	10%
Sales (N$/mt dry weight)	N$ 4 500
Freight (N$/mt)	N$ 650
Interest Rate	17%
Effective tax rate (%)[a]	7%
Operating contingency (%)	20%
Capex contingency (%)	10%

[a]The Namibian company tax rate is 35%. The tax benefit for exporting semi- and processed goods amounts to the taxation of 20% of products exported at the general rate of 35%. Since all products from this venture are exported, the taxation is only applicable to 20% of the revenue, which effectively amounts to 7%.

Details of the capital costs requirements in presented in Table 9.

Table 9: Summary of Capital expenditure

Item	Number	Total cost
Culture units	25	1 000 000
Work boats	8	172 000
Outboard motors	8	120 000
Pick-up	2	240 000
Truck	1	150 000
Hydraulic baling press	1	40 000
Tumbler	1	15 000
Containers (offices)	2	50 000
Safety equipment	25	15 000
Contingency	10%	180 200
Total		**1 982 200**

The sensitivity of base case scenario financial performance measures was examined in relation to changes in the following key model parameters: product price, product transport and annual production. Product transport includes the transport from Oranjemund to Cape Town via Luderitz. A summary of outcomes is presented in Table 10.

Table 10: Summary of sensitivities in relation to the base case scenario

Parameter	% Change	Value	GP	NP
Product Price	-25%	3 375	1 362 500	-64 700
N$/mt	-10%	4 050	1 700 000	249 175
	Baseline	4 500	1 925 000	458 425
	+10%	4 950	2 150 000	667 675
	+25%	5 625	2 487 500	981 550
Product transport	-25%	488	2 006 250	533 987
N$/mt	-10%	585	1 957 500	488 650
	Baseline	650	1 925 000	458 425
	+10%	715	1 892 500	428 200
	+25%	813	1 843 750	382 862
Parameter	**% Change**	**Value**	**GP**	**NP**
Production per annum	-25%	375	1 443 750	10 862
	-10%	450	1 732 500	279 400
Metric tonnes	Baseline	500	1 925 000	458 425
	+10%	550	2 117 500	637 450
	+25%	625	2 406 250	905 987

8. Project Management and Collaboration

The pilot project will benefit from a collaborative effort between an research institution, an industry partner, potential investors and other role-players. It is proposed that Phase 1 of the *gracilaria* culture project be implemented by a management committee, consisting of Stellenbosch University as lead agency, together with Rotaq Farming and OMTCo. The management committee will be responsible for project implementation, management and administration and reporting. To facilitate commercialization (Phase 2) a dedicated project task team will be established.

8.1. Division of Aquaculture, SU

The Division was established in 1989 with the aim of contributing to the development of the Southern African aquaculture industry through high standards of education and training, innovative research, and efficient services. The Division functions in an interdisciplinary manner through participation of various other University departments and external collaborators. The Division's outputs include systems engineering, biology and grow-out of marine and freshwater finfish and shellfish, environmental assessment of the potential impacts of aquaculture, genetic enhancement, the development of feed technology, fish health management, post-harvest technology, etc. Within the project context the Division is responsible for:

- Project coordination, including liaison between industry and government
- Coordination and administration of the pilot project
- Provision of technical assistance, evaluation and training services
- Assessment of technical and economic viability of the pilot project

8.2. Rotaq Farming (Pty) Ltd

Rotaq Farming operates a successful *gracilaria* culture operation in Second Lagoon, Luderitz. The culture technologies were initially developed to augment the natural harvest of *gracilaria* from the Luderitz area.

Rotaq Farming exports their entire production to Japan and has established marketing channels for cultivated *gracilaria*. It is foreseen that Rotaq Farming be responsible for the following:

- Assessment of the technical feasibility of the project
- The provision of technical support services
- Training and development of personnel
- Facilitation of marketing arrangements
- The provision of project management and supervision in collaboration with SU

8.3. Oranjemund Town Management Company Limited

The Oranjemund Town Management Company (OTMCo) is a Namdeb initiative established in July 2004, with the objective and vision of developing the self-sustainability characteristic of Oranjemund, in order to ensure that the town remains in existence once the Namdeb era has reached its end.

The purpose of the OTMCo is fourfold:

- To implement and manage the town proclamation process to establish Oranjemund as a Local Authority in terms of the Local Authorities Act (Act 23 of 1992)
- To build capacity for effective town management and administration to ensure that when the Local Authority is established, the town has the necessary knowledge, skill and experience for a smooth transition from a mining town to a local authority.
- To initiate and develop a diversified economic base for Oranjemund to ensure that the town will continue to exist without the mining activity.
- To Administer and manage well-established municipal and other related services as a forerunner of a local authority.

The contribution of OTMCo in relation to the pilot project will focus primarily on the provision of support services and includes the following:

- Provision of pilot project funding
- Liaison with Namdeb
- Provision of logistical support e.g. accommodation
- Administrative support
- Project promotion
- Participation in the project steering committee

9. Risk Management

Some of the key factors that tend to contribute to a successful commercial aquaculture operation (one that makes a profit on a sustained basis) include:

- Choosing the right species, or combination of species, according to carefully defined selection criteria, including growth rate, food conversion efficiency, culture technology and marketing;
- Selecting the optimum site according to carefully defined criteria that encompass water quality, topographic and hydrographic features and infrastructure availability;
- Producing a realistic, professional business plan;
- Securing sufficient capital and establishing a proper financing structure;
- Having a suitable operating plan with the appropriate degree of vertical integration;
- Establishing and practicing proper husbandry techniques such as feeding schedules and health and hygiene programs;
- Establishing a suitable program for access to hatchery stock;
- Properly managing the operations, particularly the monitoring and control of operating costs and establishing a suitable risk management program; and
- Establishing a research and development program to continuously increase operating efficiency and lower production costs, principally by minimizing mortality rates and maximizing feed conversion efficiencies and growth rates.

Risks inherent to aquaculture projects of this nature are summarized in Table 5:

Table 12: Project risk analysis

Risk	Likelihood / Impact	Risk priority	Response
Species bio-performance	Medium / High	High	Design based on historical data, pilot project
Failure of bio-technical aspects of production technology	Low / Medium	Medium	Proven culture technologies and husbandry techniques; experienced operating partner
Disease outbreak	Low / Medium	Low	Unpolluted water; no known diseases affecting *gracilaria*. Copepods could affect production.
Increase in production costs	Medium / High	Medium	Economies of scale; alternative production methods
Depressed international markets	Medium / Medium	Low	Alternative marketing strategies; established marketing networks
New entrants	Low / Low	Low	Site availability limited.
Delay in implementation	Medium / Medium	Medium	Mobilize additional resources
Loss of key personnel	Low / Medium	Low	Low technology industry; incentive schemes
Lack of government support	Low / Medium	Medium	Promote awareness of national socio-economic benefits

10. Conclusion

The mining ponds at Oranjemund hold potential for aquaculture development. The enabling regulatory environment as promoted by the Namibian government and the availability of infrastructure in the area contributes to the attractiveness of developing this industry.

Implementing Phase 1 of this project will determine the viability of commercial *gracilaria* culture in the mining ponds. *Gracilaria* culture in the mining ponds seems technically feasible, but the large temperature fluctuations could however affect growth to the extent where financial feasibility is not achievable. The natural productivity of the ponds, combined with other factors such as the logistics of transporting large volumes of product will become evident with the implementation of the pilot project.

Gracilaria is a relatively low value product and a sufficient economy of scale has to be reached to achieve financial viability of such a project. Although the culture technology is uncomplicated and proven, experienced and effective management of such a project is key to its success. It is proposed that an industry partner such as Rotaq Farming is involved on a management level of the *gracilaria* culture project. In addition to management skill and technology, Rotaq Farming has developed the marketing channels for *gracilaria* and could facilitate a joint marketing effort for *gracilaria* produced at Oranjemund.

The risks involved with seaweed farming are medium to low. The event of *gracilaria* underperforming in the pond environment is the highest risk and will be mitigated through implementing the pilot project.

The potential of the Oranjemund Seaweed Project can only be realized if enough interest and participation from industrial partners and investors are generated. It is the responsibility of all involved in execution of the proposed pilot project to do so in a manner which will attract further investment interest to make aquaculture a reality in Oranjemund.

Annexure A: Photo Sheet

Figure 1 A close-up of freshly harvested *gracilaria.*

Figure 2 Workers harvesting *gracilaria* from a culture unit. The large red buoys are used to tighten the main structure and the bottles are used to regulate the depth of the culture lines beneath the water surface.

Figure 3 Harvested *gracilaria* drying in the sun before processing and packing.

Figure 4 Workers with a fully laden boat. The small boats used are easily maneuverable and inexpensive to operate.

Annexure B: Financial Statements

The following gives an indication of sales and expenses during the first six years of commercial operation.

Year 1

Income	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Year 1
Revenue (Rands)	0	0	67 500	90 000	112 500	112 500	135 000	144 000	157 500	157 500	187 500	187 500	1 351 500
Sales (mt)	0	0	15	20	25	25	30	32	35	35	42	42	300
Expenses													
Chemicals	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	24000
Depreciation	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	187 625
Electricity	250	250	250	250	250	250	250	250	250	250	250	250	3000
Financial Services	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	24 000
Repair & Maintenance	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	21 600
Safety	400	400	400	400	400	400	400	400	400	400	400	400	4800
Salaries & Wages	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	772 800
IT & Telephone	450	450	450	450	450	450	450	450	450	450	450	450	5400
Transport and Product Transport	8 000	8 000	17 750	21 000	24 250	24 250	27 500	28 800	30 750	30 750	35 083	35 083	291 000
Loan Repayments	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	187 538
Contingency	18 987	18 987	20 937	21 587	22 237	22 237	22 887	23 147	23 537	23 537	24 404	24 404	266 845
Expenses	129 551	129 551	141 251	145 151	149 051	149 051	152 951	154 511	156 851	156 851	162 051	162 051	1 788 608
Profit / loss Before Tax	-129 551	-129 551	-73 751	-55 151	-36 551	-36 551	-17 951	-10 511	649	649	25 449	25 449	-437 108

Year 2

Income	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Year 2
Revenue (Rands)	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	2 250 000
Sales (mt)	42	42	42	42	42	42	42	42	42	42	42	42	500
Expenses													
Chemicals	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	24000
Depreciation	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	187 625
Electricity	250	250	250	250	250	250	250	250	250	250	250	250	3000
Financial Services	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	24 000
Repair & Maintenance	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	21 600
Safety	400	400	400	400	400	400	400	400	400	400	400	400	4800
Salaries & Wages	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	772 800
IT & Telephone	450	450	450	450	450	450	450	450	450	450	450	450	5400
Transport and Product Transport	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	421 000
Loan Repayments	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	187 538
Contingency	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	292 845
Expenses	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	1 944 608
Profit / loss Before Tax	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	305 392

Year 3

Income	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Year 3
Revenue (Rands)	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	2 250 000
Sales (mt)	42	42	42	42	42	42	42	42	42	42	42	42	500
Expenses													
Chemicals	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	24000
Depreciation	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	187 625
Electricity	250	250	250	250	250	250	250	250	250	250	250	250	3000
Financial Services	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	24 000
Repair & Maintenance	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	21 600
Safety	400	400	400	400	400	400	400	400	400	400	400	400	4800
Salaries & Wages	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	772 800
IT & Telephone	450	450	450	450	450	450	450	450	450	450	450	450	5400
Transport and Product Transport	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	421 000
Loan Repayments	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	187 538
Contingency	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	292 845
Expenses	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	1 944 608
Profit / loss Before Tax	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	305 392

Year 4

Income	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Year 4
Revenue (Rands)	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	2 250 000
Sales (mt)	42	42	42	42	42	42	42	42	42	42	42	42	500
Expenses													
Chemicals	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	24000
Depreciation	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	187 625
Electricity	250	250	250	250	250	250	250	250	250	250	250	250	3000
Financial Services	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	24 000
Repair & Maintenance	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	21 600
Safety	400	400	400	400	400	400	400	400	400	400	400	400	4800
Salaries & Wages	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	772 800
IT & Telephone	450	450	450	450	450	450	450	450	450	450	450	450	5400
Transport and Product Transport	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	421 000
Loan Repayments	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	187 538
Contingency	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	292 845
Expenses	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	1 944 608
Profit / loss Before Tax	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	305 392

Year 5

Income	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Year 5
Revenue (Rands)	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	2 250 000
Sales (mt)	42	42	42	42	42	42	42	42	42	42	42	42	500
Expenses													
Chemicals	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	24000
Depreciation	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	187 625
Electricity	250	250	250	250	250	250	250	250	250	250	250	250	3000
Financial Services	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	24 000
Repair & Maintenance	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	21 600
Safety	400	400	400	400	400	400	400	400	400	400	400	400	4800
Salaries & Wages	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	772 800
IT & Telephone	450	450	450	450	450	450	450	450	450	450	450	450	5400
Transport and Product Transport	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	421 000
Loan Repayments	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	15 628	187 538
Contingency	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	292 845
Expenses	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	162 051	1 944 608
Profit / loss Before Tax	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	25 449	305 392

Year 6

Income	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Year 6
Revenue (Rands)	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	187 500	2 250 000
Sales (mt)	42	42	42	42	42	42	42	42	42	42	42	42	500
Expenses													
Chemicals	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	24000
Depreciation	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	15 635	187 625
Electricity	250	250	250	250	250	250	250	250	250	250	250	250	3000
Financial Services	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	24 000
Repair & Maintenance	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	21 600
Safety	400	400	400	400	400	400	400	400	400	400	400	400	4800
Salaries & Wages	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	64 400	772 800
IT & Telephone	450	450	450	450	450	450	450	450	450	450	450	450	5400
Transport and Product Transport	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	35 083	421 000
Loan Repayments	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	24 404	292 845
Expenses	146 423	146 423	146 423	146 423	146 423	146 423	146 423	146 423	146 423	146 423	146 423	146 423	1 757 070
Profit / loss Before Tax	41 078	41 078	41 078	41 078	41 078	41 078	41 078	41 078	41 078	41 078	41 078	41 078	492 930

Project Proposal

for the

Establishment of Commercial Abalone Farming Operations at Oranjemund in Namibia

May 2008

Prepared for:

The Oranjemund Town Management Company (Pty) Ltd
Oranjemund
Namibia

Prepared by:

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Cover Photo: Land-based tank abalone farm at Hermanus South Africa [Photo: HIK Abalone Farm (Pty) Ltd]

Table of Contents

1. Executive Summary

The Division of Aquaculture, Stellenbosch University (SU) was commissioned jointly by Namdeb Diamond Corporation (Pty) Ltd (Namdeb) and the Oranjemund Town Management Company Limited (OTMCo) to assess the aquaculture potential of the mining area at Oranjemund in Namibia. There appears to be considerable potential and as such this document provides a proposal for the establishment of a land-based abalone (*Haliotis midae*) farm at Oranjemund. A 120 metric ton (mt) abalone farm would have a turnover of between N$ 21 million and N$ 39 million per year and provide direct employment for about 100 people.

The Government of Namibia has identified aquaculture as a prime priority development area. Both Vision 2030 and the NDP2 documents summon the country's urgency to develop aquaculture and as such the Namibian Government has created an enabling environment for investment in aquaculture. The abalone farming industry is the most important and valuable aquaculture sector in Southern Africa and is expected to grow significantly over the medium term, offering exciting opportunities for investment and business participation.

Based on the assumptions in the model regarding the financial structuring of the business, the projected internal rate of return for an abalone farm at Oranjemund is around 13%. This is an indication that with the appropriate financial leverage (the mix of debt and equity employed to finance the business) it should be possible to structure the project in such a manner that attractive returns are generated for the equity investors. The total capital expenditure projected for the farm is N$ 23.8 million. The working capital requirements of the Oranjemund abalone farm were estimated at N$ 25 million before the business becomes self-financing.

Several companies in South Africa are currently actively pursuing abalone aquaculture expansion opportunities along both the west and east coasts of the country. Key amongst these is the development of abalone farms at Hondeklip Bay and Port Nolloth in the Northern Cape Province of SA by HIK Abalone Farm (Pty) Ltd (HIK) and NewFarmers Development Company Limited (NewF). The development of an abalone farm at Oranjemund has been positioned as a further extension of the abovementioned initiative, with HIK and NewF as potential operating, investment and development partners. The proposed business structure of the venture also provides investment opportunities for other institutional and Black Economic Empowerment (BEE) investors.

The abalone farm venture is part of a greater plan to develop a vertically integrated aquaculture cluster at Oranjemund. The cluster development will be conducted in two phases, with Phase 1 the establishment of a 150 mt abalone farm. Phase 2 is the development of a 5 000 mt yellowtail farm. Subsequent phases will focus on extension to other species such as turbot (*Psetta Maxima*), rock lobster (*Jasus lalandi*) and oysters (*Crassostria gigas*). Both species developments will be preceded by 18 month pilot projects and will assess growth and survival in both commercial type land-based flow trough systems and in floating cages in reservoirs/ponds. It is anticipated that the abalone pilot project will be jointly managed by Stellenbosch University and HIK Abalone Farm (Pty) Ltd.

The successful implementation of a pilot project is essential to catalyze the development of aquaculture at Oranjemund. The support of Namdeb and of experienced private sector partners are crucial for the execution of a pilot project in a manner that will establish a level of confidence that will ensure both BEE and private sector participation during commercialization of abalone and other species aquaculture in Oranjemund. An integrated 4 species pilot project has a projected total cost of **N$ 3 411 200** and accordingly, this amount is requested from Namdeb over a two year period to fund such a pilot project.

2. Introduction

The Division of Aquaculture, Stellenbosch University (SU) was commissioned jointly by Namdeb Diamond Corporation (Pty) Ltd (Namdeb) and the Oranjemund Town Management Company Limited (OTMCo) to assess the aquaculture potential of the mining area at Oranjemund in Namibia. There appears to be considerable potential and as such this document provides a proposal for the establishment of a land-based abalone (*Haliotis midae*) farm at Oranjemund. A 120 metric ton (mt) abalone farm would have a turnover of between N$ 21 million and N$ 39 million per year and provide direct employment for about 100 people.

Oranjemund is located immediately north of the Orange River at the most south-western corner of Namibia, approximately 1 000 kilometers southwest of the capital, Windhoek. Namdeb currently operates an alluvial diamond mining operation along a 160 kilometer (km) stretch of the southern Namibia coastline, but is expected to downscale their activities significantly over the next 5 to 10 years.

Aquaculture, the cultivation of fish, shellfish and aquatic plants, is the fastest growing food producing industry in the world and has considerable potential to contribute to the establishment of a vibrant post-mining economy in Oranjemund. The abalone farming industry is the most important and valuable aquaculture sector in Southern Africa and is expected to grow significantly over the medium term, offering exciting opportunities for investment and business participation.

The abalone farm venture is part of a greater plan to develop a vertically integrated aquaculture cluster at Oranjemund. The abalone development will be conducted in two phases, with Phase 1 the establishment of a pilot project to assess and confirm technical and financial feasibility. Phase 2 is the development of a 120 mt commercial farm. Subsequent phases will focus on extension to other species such as yellowtail kingfish (*Seriola lalandi*), turbot (*Psetta Maxima*), rock lobster (*Jasus lalandi*) and oysters (*Crassostria gigas*).

Several companies in South Africa are currently actively pursuing abalone aquaculture expansion opportunities along both the west and east coasts of South Africa. Key amongst these is the development of abalone farms at Hondeklip Bay and Port Nolloth in the Northern Cape Province of South Africa by HIK Abalone Farm (Pty) Ltd (HIK) and NewFarmers Development Company Limited (NewF). The development of an abalone farm at Oranjemund has been positioned as a further extension of the abovementioned initiative with HIK and NewF as potential operating, investment and development partners. The proposed business structure of the project provides investment opportunities for other institutional and Black Economic Empowerment (BEE) investors as well as employee equity instruments.

Namibia's economic prospects for the future are bright given its stable economic performance, good regulatory framework, and robust private sector. The country has experienced steady growth, moderate inflation, strong external surpluses and low indebtedness over the past several years as a result of generally prudent fiscal policies, a stable political environment, a fairly developed infrastructure, and a strong legal and regulatory environment. Economic growth since independence (1991) has averaged 4.3% per annum, and the World Bank's Investment Climate Assessment Report currently notes that Namibia has a relatively attractive investment climate.

The Government of Namibia has identified aquaculture as a prime priority development area. Both Vision 2030 and the NDP2 documents summon the country's urgency to develop aquaculture and as such the Namibian Government has created an enabling environment for investment in aquaculture.

3. Project Objectives

Aquaculture offers significant developmental and economic opportunities for Namibia. This growth industry can improve food security, reduce poverty, create employment and increase inward investment to the country. In addition, aquaculture represents a sustainable economic use of Namibia's coastal and inland living aquatic resources – which means that aquaculture activities can be continued into the future, providing economic opportunity without depleting non-renewable resources.

The abalone farm development at Oranjemund will be conducted in two phases, with Phase 1 the establishment of a pilot project to assess and confirm technical and financial feasibility. Phase 2 is the development of a 120 mt commercial farm.

The specific objectives of the project are:

- To establish a 120 mt land-based abalone (*Haliotis midae*) farm in Oranjemund over the course of a 5 year period in collaboration with other investment partners
- To establish the Oranjemund Abalone NewCo as a highly capable and experienced entrepreneurial operating partner with a successful investment track record in order to also develop other aquaculture projects in Oranjemund

The broad objectives of the project are:

- To contribute towards the creation of a sustainable post-mining economy in Oranjemund in a manner consistent with the principles of ecologically and economically sustainable development
- To contribute towards development of a sustainable and competitive aquaculture industry in Namibia with international recognition for its product quality, environmental awareness and technical innovation
- To contribute to poverty reduction and empowerment of disadvantaged coastal communities through development of employment opportunities, skills training, and business participation (SMMEs, BEE)
- To contribute to the development of newly leveraged downstream industries that can create additional job and business opportunities

The specific objectives of the pilot project are:

- To confirm assessments regarding the suitability of proposed sites in terms of physical parameters including water quality, dissolved oxygen, temperature range and temperature fluctuations
- To determine abalone growth rates at proposed sites under commercial conditions. Abalone growth rates are a key indicator of economic viability and competitiveness. The pilot project results will be assessed against growth rates obtained at existing commercial farms
- To provide a platform for the training of personnel in animal husbandry methods
- To assess the reliability of electricity supply to the project
- To develop procedures for interaction with mine security protocols as well as other general management procedures
- To design, construct and evaluate an alternative pond based abalone grow-out system
- To investigate and evaluate the culture of other species such as yellowtail, oysters and seaweed by cost effectively through the sharing of pilot project overheads

4. Rationale

4.1. Aquaculture is a Profitable, Competitive and Growing Industry

Aquaculture development is market driven. It is clear that in the short to medium term, demand for fish will expand as populations and incomes grow. According to the United Nations' Food and Agriculture Organization (FAO), world total demand for fish and fishery products is projected to increase by almost 50 million mt, from 133 million mt in 2000 to 183 million mt by 2015.

It is widely acknowledged that fish supplies from traditional capture fisheries are unlikely to increase substantially in the future and that aquaculture production will have to rise further to help satisfy the growing world demand for fisheries products. According to the FAO, 32% of seafood consumed worldwide is currently produced through aquaculture, already the fastest growing global food producing industry. This is projected to rise to 45% by the year 2015. Concomitant with the rise in demand it is anticipated that seafood prices will probably continue to increase during the coming two decades, with baseline FAO scenario projections suggesting increases of 15% for high-value products.

Aquaculture producers are preferentially (competitively) meeting market demand through both non-price supply and product advantages. Supply advantages include, for example, the ability to control and thus predict supply. Farmers have far greater control over the timing, consistency and quantity of production than do fishermen. The pace advantages of farming create benefits to farmers in the form of better prices, more processing options, and higher quality.

Product advantages primarily refer to quality, traceability and food safety factors. Quality is probably the main competitive factor in the global seafood trade, with importers placing a premium on quality that feeds back into the production process and is characterized within Hazard Analysis and Critical Control Point (HACCP)-based regulations as well as the international standards, guidelines and recommendations put forward by the FAO/WHO *Codex Alimentarius.*

4.2. Aquaculture Contributes to Economic and Social Welfare

Aquaculture has significant potential to expand in Namibia. The country's strengths include unpolluted coastlines, productive marine resources, a wide climatic range, a large diversity of species available for culture, a reputation for quality seafood and an enabling regulatory environment.

There are many reasons to pursue this potential. Aquaculture offers important economic benefits to producing countries by increasing export income and reducing imports. At the micro-economic level aquaculture creates substantial opportunities for generating strong commercial returns. In addition, aquaculture provides diversity to a country's economic base and creates demand for technology, training, extension services, infrastructure and local goods.

The aquaculture industry is particularly important from a socio-economic perspective. Aquaculture contributes to food security, improved nutrition and poverty alleviation, directly by producing food fish, and indirectly by generating employment and income for the purchase of food. Jobs in commercial aquaculture are relatively well paid. The contribution of aquaculture to employment is even larger if multiplier effects are added. Ninety percent of aquaculture production and processing takes place in rural and coastal communities, providing economic stability and growth where economic development options are often limited, particularly in cases where yields from wild fisheries have declined.

5. Abalone Species Overview and Aquaculture Status

Abalone are marine gastropod molluscs. Approximately 56 species of abalone occur worldwide, and all are included within the genus Haliotis. Six species occur in Southern Africa. Of these only one, *Haliotis midae*, is exploited commercially and farmed in Southern Africa. They occur off rocky shores, from the low tide mark to a depth of about 10 meters, along much of the coast from around Dwesa on the east coast of SA to St Helena Bay on the west coast of SA. Abalone does not occur naturally in Namibia.

Abalone production now occurs in many parts of the world (including Australia, Chile, China and Japan) with farmed production (about 12 000 mt) exceeding that from wild capture (about 10 000 mt).

Over-exploitation and rampant poaching have all but decimated Southern Africa's wild abalone stocks and future abalone production will be entirely dependent on aquaculture. The Southern African abalone aquaculture sector started in the early 1990's with the first 10 mt of cultured abalone being produced in 1997. The abalone sector expanded rapidly thereafter and by 2001, it had already become the most important and valuable single aquaculture sector in Southern Africa.

The sector currently comprises 14 established operations, including 10 land-based tank farming systems in the Western Cape, two in the Eastern Cape and one ranching operation in the Northern Cape. There is a single operational abalone farm in Namibia, with an annual production of about 40 mt. SA produced 833 mt of farmed abalone in 2007, with a farm gate value of approximately R198 million and a unit value of about R220/kg. Production is expected to increase to more than 1 200 tonnes in 2010. It should be noted that the sector is becoming increasingly consolidated with fewer larger companies accounting for a large share of production and benefiting from increased economies of scale.

South Africa is a world leader in abalone aquaculture technology and systems development. At present, abalone are on-grown in tanks on land at most of the abalone farms in Southern Africa. Seawater is pumped from the sea into a settlement pond or swirl separator, through a mechanical filter (usually a drum filter or sand filter) and gravity fed into tanks containing the abalone. The abalone tanks are usually rectangular in shape, with typical dimensions of 5m (L) x 2m (W) x 1m (H), They contain baskets, which in turn contain a number of plate racks, to which the abalone attach themselves. Water is introduced into the tanks at a number of points, usually above a basket. Effluent water drains out from the end of the long axis of the tank, taking accumulated waste with it. The wastewater flows back to the sea. The tanks are aerated to replenish the dissolved oxygen in the water of the tanks, to remove carbon dioxide from the water and to increase water quality homogeneity through mixing. Current abalone research and development (R&D) is focused on improved efficiency of production systems and husbandry procedures; as well as improved quality and value-adding of products. Other specific R&D programs include genetic improvement, health management, feed development and development of processing technology.

Services to the Southern African abalone sector such as feed and seed supplies, veterinary services, equipment, processing, etc. are well established and improving. The sector is well structured and represented by the Abalone Farmers Association of Southern Africa (AFASA).

Entry barriers to the sector include high capital requirements, key technologies, access to sites, the availability of kelp/feed, regulatory matters, key technologies, trained personnel and market access. The main risks are related to exchange rates, environmental conditions and market stability in Asia. Continued expansion of global production could affect margins in the long term.

6. Project Description

6.1. Overview

Generally, commercial aquaculture proceeds through a series of growth, development and maturity stages that relate to its level and degree of competitiveness and profitability. A typical business development cycle applicable to the Oranjemund Abalone NewCo is shown in Table 1.

Table 1: Typical aquaculture business development cycle

Stage of Development	Description
1. Seed/conceptualization	Develop, test and ready a product for production. Development of pilot project to determine technical and financial feasibility and to optimize production parameters.
2. Start-up/early expansion	Commence commercial business operations. Installation of infrastructure to facilitate approximately 40% of planned production, significant investment in human resource development and a specific focus on marketing. Anticipated production at Oranjemund during this phase is about 40 mt.
3. Development/growth/expansion	Expand an established and growing business. For abalone, expansion to 120 mt over the course of a five year period.
4. Later established	Continue expansion or extend to new species. At Oranjemund extension to other species, development of processing facilities.

The Oranjemund Abalone NewCo development will be conducted in two phases, with Phase 1 the establishment of a pilot project to assess and confirm the technical and financial feasibility of abalone farming. During the pilot phase other potential species such as yellowtail and oysters will also be trialed. Phase 2 is the development of a 120 mt commercial farm. The estimated pilot project duration is 18 months and will assess abalone growth and survival in both commercial type land-based flow through systems and in floating cages in reservoirs/ponds. It is anticipated that the pilot project will be jointly managed by Stellenbosch University and HIK Abalone Farm (Pty) Ltd. The pilot project will also serve as a training platform for human resources capacity development.

The commercial abalone production process starts in the hatchery with the spawning and fertilization of broodstock abalone. The larvae are then conditioned and are settled onto feed (algal) prepared plates. After 3 months the spat are then moved into a weaning section for a six month period where they are fed an artificial diet to increase growth. Once they reach 25 mm SL, they are taken out to the grow-out section of the farm and put into baskets in tanks supplied with water by means of a flow through system. The tanks in which the abalone are kept are cleaned on a weekly basis. Each basket of abalone is fed daily. Every four months the abalone are size sorted and their growth are monitored. This routine is repeated until the abalone reach market size.

6.2. Pilot Project Workplan

The pilot project will be executed within the following main tasks:

i) **Project approval.** Project approval needs to be obtained from the Ministry of Fisheries and Marine Resources (MFMR), Namdeb and OTMCo.

ii) **Appointment and training of project personnel.** SU will provide on-site project management, with support from HIK. The project will appoint a full-time on-site production manager as well as four technicians (farmhands). Specialist services will be contracted as required. A small number of temporary workers will be drawn from unemployed local persons during regular intervals to assist with various tasks, including construction and maintenance activities. All project personnel will undergo specialist training as required.

iii) **Equipment selection, acquisition and delivery.** Much progress has already been made in the selection and where necessary, design of required equipment, including the water supply system, grow-out tanks, water run-off system and other land-based facilities. Throughout the course of the project preference will be given to sourcing equipment from local suppliers. It is however anticipated that a number of items will be imported from SA.

iv) **Spat Production.** Spat for the project will be produced at the HIK hatchery at Hermanus and flown to Oranjemund. The project production plan has been based on the supply of at least 120 000 spat of different sizes. A 120 mt abalone farm requires an annual supply of about 1.2 million 10 mm spat.

v) **Construction of land-based facilities.** The project plan provides for the installation of (or use of existing) temporary office, workshop, general storage and feed storage facilities. Accommodation arrangements will be made in conjunction with OTMCo.

vi) **Installation of infrastructure.** Twenty 4x2m tank units will be installed. Each tank unit holds 12 abalone baskets. A water supply system consisting of sieve cage, pump room, water supply line, swirl separator, drum filter, foam fractionator and header tanks will be installed. An electricity supply grid will also be installed. All installations will be undertaken by SU and HIK personnel.

vii) **Growth / Husbandry trials.** Growth trials will be conducted for an 18 month period and will be assessed under conditions comparative to commercial operations. A control group will be maintained at the HIK farm in Hermanus. Optimization in terms of stocking densities, feed etc. will be conducted in the final 6 months of the pilot project.

viii) **Harvesting.** Abalone will be harvested on several occasions and submitted for physiological, disease, quality and processing analysis.

ix) **Data analysis.** SU will assume responsibility for the statistical analysis of growth and other data collected during the pilot project. To facilitate data collection, a number of abalone will be tagged.

x) **Financial modeling.** A detailed financial model for a full scale commercial operation will be developed by an independent contractor. The financial feasibility of such an operation will be modeled for a 10 year period. In addition, an optimal financing strategy will be developed.

xi) **Business plan review.** The pilot project has as its final output the delivery of a comprehensive investment orientated business plan.

6.3. Budget

The total estimated cost of a stand alone pilot project is N$ 1 799 940 (Table 2). This includes capital expenditure costs of N$ 721 340, and general administrative costs (including wages) of N$ 1 078 600. It is, however, recommended that an integrated 4 species pilot project (abalone, yellowtail, oysters, and seaweed be undertaken at Oranjemund. **Such a multi-species approach would have an estimated budget of N$ 3 411 200 and is shown in Appendix A.**

Table 2: Estimated abalone pilot project expenditure (All values N$)

No	Item	Unit Cost	Quantity	Total
1	**Project Management**			**250 000**
2	**Transport & travel**			**215 000**
3	**Construction**			**45 000**
	Fence			20 000
	Building materials			15 000
	Plastic welding			10 000
4	**Infrastructure**			**491 340**
	Water intake sieve cage & valves	*2 000*	*1*	*2 000*
	Pipeline (suction - water)	*250*	*10*	*2 500*
	Pipeline (suction - land)	*110*	*10*	*1 100*
	Pipeline (delivery - land)	*110*	*20*	*2 200*
	Pipeline brackets (Stainless steel)	*200*	*10*	*2 000*
	Vacuum pump	*8 000*	*1*	*8 000*
	Water pumps	*20 000*	*2*	*40 000*
	Electrical installation	*50 000*	*1*	*50 000*
	Emergency generator	*55 000*	*2*	*110 000*
	Fuel tank system	*5 000*	*1*	*5 000*
	Pipeline (Fuel)	*150*	*10*	*1 500*
	Swirl separator	*30 000*	*1*	*30 000*
	Foam fractionator	*7 000*	*1*	*7 000*
	FF pumps	*2 000*	*4*	*8 000*
	Drumfilter & motor	*70 000*	*1*	*70 000*
	Header tanks	*12 000*	*2*	*24 000*
	Pipeline (run-off)	*5 000*	*1*	*5 000*
	Tanks (grow-out)	*6 360*	*14*	*89 040*
	Pipeline (tank supply)	*20 000*	*1*	*20 000*

	Blowers	*7 000*	*2*	*14 000*
	Airlines	*20*	*100*	*10 000*
5	**Diesel**			**20 000**
6	**Electricity**			**120 000**
7	**Wages**			**159 600**
8	**Telephone & internet**			**14 000**
9	**Accommodation**			**40 000**
10	**Contingencies**			**150 000**
11	**EIA (Basic assessment)**			**65 000**
12	**Oxygen meter**			**10 000**
13	**Containers (Office & storage)**			**70 000**
14	**Tools & equipment**	30 000	1	**35 000**
15	**Service vehicle**	90 000	1	**90 000**
16	**Inflatable boat (with engine)**	25 000	1	**25 000**
	TOTAL COST			**1 799 940**

6.4. Implementation

A proposed schedule for the implementation of the project is shown in Table 3. It should be noted that implementation is subject to the availability of funding and the completion of regulatory aspects.

Table 3: Description, duration and implementation date for the key project tasks.

Task	Description	Start Date & Duration
1	Project approval	Oct 2008
2	Seed production (Batch 1)	May – Oct 2008
3	Equipment design, selection & acquisition	Jul – Oct 2008
4	Appointment & training of project personnel	Sept – Nov 2008
5	Infrastructure installation	Sept – Oct 2008
6	Basic environmental assessment	Oct 2008 – Mar 2009
7	Introduction of spat (Batch 1)	21 Oct 2008
8	Year 1 pilot production	Oct 2008 – Oct 2009
9	Data analysis	Nov 2009
10	Introduction of seed (Batch 2)	Nov 2009
11	Optimization of production parameters	Nov 2009 – Apr 2010
12	Business plan review	Oct 2009
13	Commercialization preparation	Nov 2009 – Apr 2010
14	Implementation of full scale commercial operation	Apr 2010

7. Feasibility Assessment

7.1. Relevant Legislation, Policies and Guidelines

Among others, cognizance has been taken in this study and in the project design of the following acts, codes, conventions, agreements, protocols and policy proposals:

- Namibian Marine Resources Act, 2000 (Act no. 27 of 2000)
- Namibian Aquaculture Act, 2002 (Act no 18 of 2002)
- Namibia's Aquaculture Strategic Plan
- Various FAO Codes including the FAO Code of Conduct for Responsible Fisheries
- Southern African Development Community Protocol on Fisheries (and related protocols on shared resources etc.)
- Bangkok Declaration and Strategy for Aquaculture Development beyond 2000

7.2. Investment Constraints

As an emerging industry, aquaculture has at times struggled to find access to development capital. Aquaculture development at Oranjemund if it is to deliver sustainable growth will require substantial capital investment. Common problems associated with attracting investment in aquaculture are shown in Table 4.

Table 4: Common problems associated with attracting investment in aquaculture

Constraint	Comment
Ownership structure of aquaculture enterprises	The prevalence of private companies, partnerships or trusts in aquaculture may create serious obstacles to financing by preventing access to equity financing from the public or from institutional investors
Long start-up phase	Aquaculture experiences great variations in returns, especially in the startup phase.
Production risk	Apart from the normal risks faced by any production business, the aquaculture industry has an extra dimension of uncertainty associated with climatic and other environmental factors. Droughts, floods, water temperature, water quality and disease all represent factors that are largely beyond the control of individual farmers. The only option for farmers is to anticipate and, where possible, put in place economic and production risk management procedures.
Security of tenure	Where aquaculture depends on access to public resources, some degree of security of tenure or access is required to underpin an investment by the farmer or additional investors.
Macro-economic settings and policies	The aquaculture industry is highly sensitive to general economic conditions. New investment and sales are subject to financial factors, such as the prevailing interest rates and the taxation arrangements that apply to primary industries.

7.3. SWOT Analysis

A strategic assessment of the strengths, weaknesses, opportunities and threats of the project has been conducted with inputs from various stakeholders and is shown below.

Table 5: Project SWOT analysis

Species	Geographical Location
Strengths	**Strengths**
1. High value product	1. Namibian company tax rates
2. Potential for genetic improvement	2. Limited competition for sites
3. Potential for technology development	3. Enabling regulatory environment
4. Hatchery technology available	4. Developed and available infrastructure
5. Pellet feeding	5. Environmentally disturbed area
6. Wide range of processing options	6. No disease record
7. Robustness	7. Good security
8. Local species farming knowledge	8. Social support network and infrastructure
Weaknesses	**Weaknesses**
1. Does not occur naturally in area	1. Capital intensive water intake required
2. Slow grow-out period; long start-up phase	2. Unreliable power supply
3. High capital expense; poor start-up cash flow	3. Mine security procedures
4. Labor intensive	4. No aquaculture support services
5. Non-optimal production systems and methods	5. Site knowledge
6. Lack of understanding of animal physiology	6. High transport costs, remoteness of area
7. Electricity requirements	7. Industry skepticism
8. Skilled staff requirements	8. Cold water; temperature variation in ponds
Opportunities	**Opportunities**
1. Investment in R&D to improve production	1. Regulatory environment
2. Breeding programs to reduce grow-out time	2. Use/conversion of mine infrastructure
3. Value adding	3. Ponds
4. Abalone ranching	4. Some ranching
5. Develop SA market	5. Wind generated power
6. Limited competition for site	6. Scale of production scope
Threats	**Threats**
1. Competition from SA, foreign producers	1. Import tariffs and bans
2. Global warming – environmental instability	2. Market volatility (Asian)
3. Increase in fuel prices	3. Lack of investor funds
4. Disease outbreak	4. Effect of downscaling and mine closure
5. Adequate and reliable power supply	5. Security of tenure
6. Increase in power costs	6. Orange river plume
7. Strong local currency	7. Political interference
8. Macro-economic settings and policies	8. More optimal sites
9. Asian market collapse	9. Competition from SA producers

7.4. Technical Feasibility

The technical feasibility of the project was assessed against four main parameters and is shown in Table 6:

Table 6: Factors affecting the technical feasibility of the project

Factor	Issue
1. Culture technologies	Is existing abalone grow-out technology efficient, competitive and available?
2. Species bio-performance	Will abalone growth rates and survival allow profitable production?
3. Husbandry & management	Can existing fish husbandry techniques, procedures and equipment be used in the available conditions and production environment? Is existing human resource capacity adequate?
4. Environmental impact	Are potential impacts consistent with the principles of ecological sustainable development and does an environmental impact assessment study have a high likelihood of success?

Culture technologies. HIK has proven its culture technology. The proposed abalone production system is based on a flow through system and has been in operation for 15 years. It has continuously been improved. Apart from a header tank there are no other fixed structures and the system can be readily modified to adapt to new knowledge. It is a simple system requiring low levels of operating expertise. The HIK system has consistently produced abalone of the highest quality in the industry, with low mortality rates and exceptional growth rates and is currently being installed on several other farms

SU and HIK are also well endowed with technical expertise. Three of the five senior managers at HIK were intimately involved in HIK's development and the other two managers have brought experience at other abalone farms and hatcheries to the management mix. One of the senior managers is a qualified civil engineer and will be responsible for the development of the infrastructure of the Oranjemund farm.

Species bio-performance. Abalone are good candidates for commercial aquaculture because they are widely distributed, have a good domestic and international market profile, are highly fecund, and can tolerate a wide range of temperatures. Importantly they have good attributes for grow-out in tank systems. In addition, oceanographical conditions at Oranjemund do not appear to be inimical for the culture of the species. *Haliotis midae* are also particularly robust. Expected growth rates are 1.8 mm per month, well within achieved industry maximums of 2.5 mm per month. This is in accordance with results obtained from a pilot project currently being undertaken in similar conditions about 250 km south of Oranjemund. In a related project, ranched (no feed input) abalone has survived in an area approximately 100 km south of Oranjemund and obtained growth rates of 1.5mm per month.

Husbandry and management. Husbandry and management practices are central towards maximizing production, optimizing operating cost efficiencies, and maintaining a high quality product and therefore market price. Worldwide, aquaculturists have had a successful history of innovation in husbandry and management practices since the intensification of aquaculture in the 1960's. Specific milestones include

the development of improved feed delivery systems, cleaning systems, monitoring systems, and harvesting techniques.

Potential environmental impact. Aquaculture has been cited as a contributing factor to the collapse of fisheries stocks worldwide due to the use of wild fish as fish feed for culture species, through habitat modification, transmission of diseases and wild seed stock collection. Such accusations, although influential in a political sense, are not fully supported by scientific information and ignore the major advances and improvements in aquaculture technology, husbandry, hygiene, health and other management practices.

The type and scale of any ecological change associated with aquaculture development depends on the method of aquaculture, the level of production and the biological, chemical and physical characteristics of the affected area. Generally, land-based pump ashore aquaculture has been a sustainable practice in many countries. Potential environmental impacts and their project/venture specific mitigation and management are shown in Table 7.

Table 7: Potential environmental impacts and their project/venture specific mitigation & management

Impact	Mitigation
Genetic	Current farm stock genetically close to wild stock; dilution effect; no wild stock
Disease	Low stocking density; biosecurity measures, improved diagnosis
Marine Fauna	Land based production system
Water Column	Low biomass production; biodegradable wastes; localized & reversible
Benthic Environment	Water treatment in sedimentation dams
Fisheries Resources	Existing effort; management measures; certified sourcing

In recent years the expansion and diversification of aquaculture in Europe, Australia and elsewhere has been guided under carefully designed environmental controls. In addition the aquaculture industry is increasingly moving towards self regulation with for example the implementation of Codes of Good Practice. Rigorous environmental monitoring and recording standards have accordingly been implemented. Such controls have not necessarily been applied to other forms of activity and aquaculture operations have often been subjected to adverse impacts imposed by other forms of human activity and as a result the productivity and financial viability of operations have often been reduced. Indeed, the vulnerability of the proposed project to potential adverse impacts such as the introduction of pollutants and diseases from other less well regulated human activities is a specific concern.

Worldwide, customers are prepared to pay premium prices for healthy food, grown in a healthy environment and overseas buyers increasingly require environmentally certified products and the industry to be appropriately certified at world's best practice standards. A number of aquaculture companies in the rest of the world have already been accredited to the world environmental management standard, ISO 14001. These developments occurred concurrently with an increasing realization in the food processing industry that competing on price alone is not necessarily the most attractive business strategy. Increasingly companies are therefore including "clean and green" as part of their marketing strategy.

Several permits have already been allocated for abalone aquaculture in Namibia.

7.5. Market Feasibility

In 2004, global exports of seafood products reached almost US$ 70 billion, whilst supply (particularly of quality seafood) cannot keep pace with demand. According to the FAO, in 2004 the total human consumption of seafood was approximately 128 million metric tons. Statistics show that annual global fish catches have plateaued at about 90 million metric tons and may even be declining. Over 60% of the marine fish stocks for which information is available are either fully exploited or overexploited, and 13 of the world's 15 major oceanic fishing areas are now fished at or beyond capacity. This leaves only aquaculture available to meet the increasing world demand for seafood. Although aquaculture has grown at an average annual rate of 8.8% from 1950 to 2004, it is, however, highly unlikely that even aquaculture is capable of filling the gap between demand and supply. Although the severity of the shortage would differ among countries, the overall effect would be a rise in the price of seafood, with increases of up to 15% projected for high-value products by the FAO.

In the short to medium term, the demand for seafood will further expand as populations and incomes grow. Moreover, as people in developing countries increasingly enter the middle classes, they consume more protein, including seafood. According to the FAO, the global annual per capita consumption of seafood has been predicted to increase from about 16 kg in 2003 to 19 – 21 kg by 2030. Other factors affecting the growth of seafood in international markets include changing consumer tastes, consolidation in retail and distribution sectors, the internet (distributors can get into direct contact with producers), decreases in export tariffs, and the nutritional and health benefits associated with seafood. The growing development of value-added products such as fillets; portion control and vacuum packs; as well as convenience items has also benefited the global seafood trade.

It is well known that over fishing, disease, habitat loss, and failed governing body management of the illegal catch have all contributed to the decline of the world abalone fisheries catch over the past 3 decades. Global abalone catches were steady at approximately 18 000 mt annually during the 1960's. The global abalone supply from fisheries declined by more than 30% between 1989 and 2004 from about 14 800 mt to 10 800 mt respectively and it is expected to decrease further. The demand for abalone has, however, increased steadily over the years, particularly in the Far East (Japan, Hong Kong and China) where it is considered to be one of the most preferred seafood delicacies. It is strong in prestige and religious symbolism. Based on this strong global demand world abalone production from farming has increased significantly from less than 1000 mt in 1989 to about 12 000 mt in 2004. Worldwide, more than 15 species are now being commercially cultivated with over 1 000 individual farms with individual production ranging from less than 1 mt to over 200 mt.

The South African abalone fishery commenced in the 1950's, exploiting its resource at unsustainable levels, and thereby causing production to drop from 4 000 mt per annum in the mid 1960's to below 1 000 mt by the 1980's. During the early 1990's the official quotas were set at below 600 tons with poaching estimated at another 800 tons. In 2000/1 the abalone quota was set below 500 mt and in 2007 the commercial fishery for abalone in SA was finally closed. The current total estimated demand for *Haliotis midae* is about 4 000 mt per annum. It is unlikely that the commercial abalone fishery in SA will be reinstated and it is also unlikely that current levels of poaching can be sustained. As such it is anticipated that the market for farmed *Haliotis midae* could reach about 5 000 mt.

The world market for cultured abalone is primarily for live individuals in the size range 50g – 100g. In SA abalone is typically harvested after a 3 – 4 year production cycle and sold live, frozen or canned. Current sales are primarily to the Far East (Hong Kong, Japan and Singapore) where the SA abalone enjoys high acceptability because of its excellent quality (taste, color and texture).

It is anticipated that the Oranjemund Abalone NewCo will sell its entire product through Midae Marketing (Pty) Ltd (MM), a joint venture abalone marketing company partly owned by HIK. MM currently sells abalone on behalf of six existing Southern African abalone farms and has a market volume of about 550 mt. Over the course of the past 10 years MM has established a large, varied and reliable clientele in a number of countries.

The Southern African abalone, *Haliotis midae* are robust animals and travel well, which places them in a special niche market for live abalone. MM exports live abalone to a number of centers, including Hong Kong, Mainland China, Taiwan and Japan. Live product is sold in sizes ranging from 50g to 200g per abalone. Approximately 60% of abalone marketed by MM is sold on the live market (mostly sized between 70g and 120g). The live abalone are strictly graded according to various weight and quality categories. The abalone are purged for 3 – 7 days prior to shipment with mortalities for live shipping at less than 1%.

Approximately 30% of abalone marketed by MM is supplied to the canned market. Canned products are divided into two main categories, 213g drained weight or 165g drained weight; with both categories sold as 425 grams net weight cans. The market for canned abalone is expanding and seems to be a lucrative market for the farmed product given its smaller size, and reduced freight costs.

MM also markets frozen raw abalone meats and abalone frozen in the shell (whole frozen). In both cases, the abalone is IQF (individually quick frozen) and glazed to produce a high quality frozen product. All frozen products are produced from live abalone to ensure top quality. The freezing process is conducted in a blast freezer at -35°C. The factory where the processing takes place operates a HACCP system and is accredited by the international regulatory body. The frozen abalone are produced in various product size ranges. MM markets dried abalone as well, primarily to Hong Kong, Malaysia and China.

Abalone prices in Japan, China and Hong Kong average between US$ 28 per kg and US$ 36 per kg. Given the supply – demand dynamics of the global industry, prices are expected to remain fairly stable in the medium to long term. The current price for *Haliotis midae* is between US$ 33 and US$ 38 per kilogram (live weight). The most popular Japanese species, *Haliotis discus hannai,* currently commands a 15% premium to the South African abalone that in turn carry a 20% premium to most other abalone species

Competition for export market share in Japan and China will predominantly come from Australia and Chile. The Australian abalone fishery currently produces about 2 500 mt of abalone per annum. Farmed Australian abalone is not currently competitive because of high production costs. Abalone farming has increased significantly in Chile and with low production costs could become a significant future threat. The United States of America and Korea produce *Haliotis discus hannai*, the indigenous Japanese abalone. This creates competition for the South African product particularly in Japan since the Japanese prefer their own species above other species. Although global abalone production is increasing, the position of the South African abalone *Haliotis midae* appears secure in international markets as a high quality niche product renowned for its taste, texture, color and processing options.

7.6. Financial Feasibility

NewF was commissioned jointly by SU and HIK to develop a financial model which could be used to assess the underlying financial viability of the potential abalone farm to be established at Oranjemund. The financial model was developed based on information obtained from mainly two sources: SU made the results of a research project undertaken by them at Hondeklip Bay in SA available to NewF, whilst more detailed financial and operational information regarding similar operations was obtained from an established abalone farm in the Hermanus area.

Given that the model is based on the results of an extensive research project in an area similar to where the Oranjemund abalone farm could potentially be established and quantitative data obtained from an established abalone farm, albeit at a different location, it could reasonably be assumed that the model gives a fair indication of the financial viability of the project. However, the relevance of the model in practice will be influenced by and be directly linked to the actual decisions made by the promoters when they implement the project and by the operational decisions of its management. These decisions will ultimately determine the financial characteristics and the financial viability of an abalone farm at Oranjemund.

7.6.1. Important Underlying Assumptions

The base scenario assumes that the first intake of spat will be in month 14, i.e. it provides for an initial construction and establishment period of thirteen months.

Although the capacity of the farm provides for a monthly intake of 130 000 spat, the financial model was based on a scaled down monthly intake of 110 000 (85%). It is important to note that it would be possible to operate the farm at full capacity without additional infrastructural cost and with a minimal increase in fixed overheads. This means that the additional working capital for such a scenario would mainly originate from the increase in direct variable expenses.

It was also assumed that the farm would not have its own hatchery, but that spat will be purchased at N$ 1.32 (adjusted for inflation) each. All indications are that having its own hatchery would have a positive impact on the financial performance of the farm. The decision to build a hatchery should, however, be carefully considered as it would require specialized and dedicated management.

The increment in spat size was taken at 1.8mm per month, which is in line with the results obtained by US-HIK during their research. It was assumed that the abalone will be marketed at a weight of around 100g. Based on the monthly increment and growth curve, this will approximately be 40 months after intake. Given this, and that the first intake is in month 14, the first abalone will only be sold in month 53. The long period before the farm starts generating income and the high initial capital expenditure are two of the most significant factors influencing the calculation of the internal rate of return (IRR) of the project.

The abalone farm will export its entire harvest. The exchange rate and the price achieved per kilogram are therefore very important assumptions to evaluate the financial performance of the project. It was conservatively assumed that the N$/US$ exchange rate in the first year will be N$7.63/$ and that it will weaken to N$8.59/$ in year 5 when marketing starts. A conservative approach was also taken with regard to pricing by assuming that the current price for abalone of US$32 will remain unchanged.

Assumptions regarding the semi-variable costs (electricity, chemicals, maintenance, etc) and other

overheads were based on information available from farms that are currently operational. This was adjusted for circumstances that are different because the farm will be situated at Oranjemund (for example higher cost to recruit management, higher transport cost due to longer distances, etc).

The total capital expenditure projected for the farm is N$ 23.8m. Almost 50% of this will be incurred in the first two years to enable the first intake of spat. Thereafter provision is made for establishing additional tanks and baskets in line with the monthly intake of spat and establishing a cannery, which would be required before marketing commences.

The working capital requirements of the Oranjemund abalone farm were estimated at N$ 25m before the project becomes self-financing. This amount was based on the assumptions regarding operational expenses as discussed, the long period before income is generated from sales, and assuming a creditor payment period of 45 days and debtor collection period of 21 days. The collection period seems short, but is in line with the actual collection period obtained from existing farms exporting abalone.

7.6.2. Funding Requirement and Financing Structure

The total funding requirement of N$ 48.8 million was based on the working capital of N$ 25m required until the project becomes self financing and the Capex for the first five years of N$ 23.8m.

The financial structuring of the funding requirement is very important as this provides the link between the decision of the providers of equity and debt to invest in the project and their expectations on risk, return and value. *Although the target capital structure could only be finalized after negotiations with potential investors, it is useful to obtain a view of the projected results based on a potential capital structure*. In this regard various scenarios were tried on the model to find a capital structure which provides the optimal financial leverage based on the other assumptions and the projected income stream. With this as background, it was assumed that the project will be financed with around 50% debt (a N$ 1.5m overdraft facility, and other loans totaling N$22 886 968) and 50% equity (N$ 24 386 968) in the form of ordinary share capital and loans by shareholders which will be subordinated and back ranked. It was assumed that the long term debt will be repayable over 120 months at an interest rate equal to a prime interest rate of 15%. Regarding preference shares, it was assumed that the annual coupon rate will be 16.65% and that the capital will be redeemable after 34 months.

7.6.3. Projected Results

The income statement provides a useful financial summary of the projected operating results for the 11 year forecast period. An important indicator is the earnings before tax interest and depreciation (EBITDA). This profitability measure is not influenced by the assumptions regarding the financing structure (i.e. it is separating the financing effects from the operating effects) or the depreciation policy. It therefore provides a relatively cleaner measure of the underlying profitability potential of the project.

EBITDA is negative for the first 4 years, reaching a maximum of loss of around N$ 5.4 million (N$13.9 million cumulative over the period). EBITDA becomes positive at N$ 11 million in year 5 when the project is expected to start selling the abalone.

The EBITDA of the project, given the assumptions regarding the operation, should be around N$ 20 million to N$ 22 million when it is in it full production cycle (years 10 to 11). At that stage the cash

conversion cycle (the time it takes from the intake of spat until payments are received from debtors and creditors are paid) is around 1440 days (nearly 4 years). This is in line with the long production period and is also an important factor contributing to the high working capital requirements of the project.

The cash deficit from operations in the cash flow statement for each of the first four years confirms the relative long start-up phase of the project until it starts to generate income in year 5. Although the projected bank account shows a positive balance in some of these earlier years, this is not generated by operational activities, but as a result of the positive cash flows from financing. It is also important to note that the projected cash balance will change if the assumptions regarding the financial structuring are changed. The detail model provides for monthly detail. In this regard, the maximum overdraft in a specific month was set to N$ 3 million in line with the assumptions regarding the financing structure.

As the balance sheet provides a summary of the assets of the projects and the financing thereof, it is particularly vulnerable to the assumptions regarding the financing structure. The balance sheet and the ratios based on it must therefore be interpreted carefully. However, it shows that the project could reasonably be expected to redeem all its debt finance during the first 10 to 11 years and still be in a position to accumulate a healthy reserve. This is shown by the projected retained earnings of N$ 76m in year11 which will be available for distribution to its ordinary shareholders.

Although there are many methods to evaluate a project from an investor's perspective, the internal rate of return (IRR) is a very useful tool. It is defined as the discount rate that equates the present value of expected future cash flows of a project with the initial investment associated with the project.

The IRR can be calculated from the viewpoint of all the claimholders in the project (referred to as the IRRF) by using the expected cash flows to the project or purely from the perspective of the equity investors (IRRE) by using the cash flows to equity in the calculations. Given that the IRRE of a project could also be distorted by the assumptions regarding the financial structuring of the business, it is more useful to use the IRRF. The projection shows that the IRRF for the proposed Oranjemund abalone farm could be conservatively expected to be around 12.4%. Although this appears low, it must be noted that the relatively long period before any positive cash flows are generated, has a significant impact on the calculation of the IRR because of the time value of money.

Based on the assumptions in the model regarding the financial structuring of the project, the projected IRRE is around 17%. This is an indication that with the appropriate financial leverage (the mix of debt and equity employed to finance the business) it should be possible to structure the project in such a manner that attractive returns are generated for the equity investors.

7.6.4. Sensitivity Analysis

A sensitivity analysis was done for the project based on a few key variables. The sensitivity analysis is useful in getting a feel for the variability of return (IRR in this case) in response to a 10% positive and negative change in the identified variables, keeping the other variables constant.

The project is the most sensitive to changes in the US$ price and the exchange rate. A 10% change in these variables has an impact of around 13% on the IRRF. Given the relative conservative assumptions regarding these variables, linked to the fact that an improvement in it would not require additional working capital, it appears that a reasonable probability exists for the IRRF to be higher than the 13% projected.

An important assumption in the model is that the projections are based on 85% of the potential full production capacity. From the sensitivity analysis it is clear that this assumption leaves room for a significant improvement in the IRR. This is shown by the sensitivity of the IRR to a change in the magnitude of the production. A 10% change in the projected capacity results in a 10% to 11% change in the IRR.

Only two other variables stand out in the sensitivity analysis, namely the weight at which the abalone will be sold and the monthly increment in spat size. The IRR changes with around 8% and 4% respectively if these variables change with 10%. An interesting observation is the relative small sensitivity of the IRR to the spat purchase price. A 10% change in the price affects the IRR only with around 1%. This is an indication that careful consideration must be given to the cash flow implications if a decision is taken by the project promoters to establish a hatchery for the project.

8. Project Management and Collaboration

The project will benefit from the establishment of an efficient network of collaboration between research institutions, industrial partners, manufacturers and other role-players. The pilot project will be overseen by a standing Project Management Committee consisting of SU, HIK, NewF and OTMCo, other co-opted team members and an administrative official. The management committee will be responsible for project oversight, administration and financial management. To facilitate commercialization a dedicated project task team to be led by NewF will be created.

8.1. Division of Aquaculture, SU

The Division was established in 1989 with the aim of contributing to the development of the Southern African aquaculture industry through high standards of education and training, innovative research, and efficient services. The Division functions in an interdisciplinary manner through participation of various other University departments and external collaborators. The Division's outputs include systems engineering, biology and grow-out of marine and freshwater finfish and shellfish, environmental assessment of the potential impacts of aquaculture, genetic enhancement, the development of feed technology, fish health management, post-harvest technology, etc. Within the project context the Division is responsible for:

- Project coordination, including liaison between industry, government and OTMCo
- Project planning and implementation
- Provision of technical assistance and training services
- Implementation of other species activities
- Project reporting
- Assessment of technical and economic viability of the pilot project

8.2. HIK Abalone Farm (Pty) Ltd

HIK Abalone Farm (Pty) Ltd was established in 1997 and is based in New Harbor, Hermanus. The company is one of the largest abalone producers in South Africa with sales of 120 tonnes of abalone in 2007 and an estimated production of 140 tonnes in 2008. The company is also one of the most experienced live abalone exporters in South Africa, exporting live abalone to markets in Japan, China and Hong Kong. Apart from its live production HIK Abalone Farm also supplies frozen in-shell abalone, cooked

and vacuum packed abalone, as well as two sizes of canned abalone. Marketing of its products is through co-operative arrangements with other abalone producers, including AquaFarm Development (Pty) Ltd. HIK Abalone Farm most recently partnered with a BEE group, Empowco (Pty) Ltd and AquaFarm Development (Pty) Ltd to acquire the Roman Bay abalone farm in Gansbaai. In 2007 the Roman Bay abalone farm also produced 120 tonnes of abalone. HIK has since 2005 partnered with SU to establish 2 abalone farms in the Northern Cape Province of SA. HIK has a wide range of skills to contribute to the Oranjemund Abalone NewCo, including: business management and technical know-how; hatchery expertise, stock management, processing and access to markets. During the pilot project HIK will be responsible for the following project tasks:

- Evaluation of the technical feasibility of the project
- The provision of technical support services
- Training and development of personnel
- Facilitation of marketing arrangements
- The provision of project management services in collaboration with SU

8.3. NewFarmers Development Company Limited

NewFarmers is a private equity investor and catalyst in agribusiness. The company has an empowerment focus. NewFarmers invests in projects with strong earnings potential that provide an opportunity for the company to eventually profitably disinvest. NewFarmers' investment instruments include equity (preferably minority equity stakes of between 25 and 49 percent), debentures, preference shares and loans. A range of schemes is used to involve employees in a meaningful way, for example employee equity schemes. During the pilot project NewFarmers will be responsible for the following:

- Development and preparation of the project financial model
- Liaison with investment institutions
- Structuring of the business model

8.4. Oranjemund Town Management Company Limited

The Oranjemund Town Management Company (OTMCo) is a Namdeb initiative established in July 2004, with the objective and vision of developing the self-sustainability characteristic of Oranjemund, in order to ensure that the town remains in existence once the Namdeb era has reached its end. Key to this is the development of a diversified economic base in Oranjemund. The role of OTMCo during the pilot project is primarily focused on the provision of support services and includes the following:

- Facilitate Namdeb funding
- Liaison with Namdeb
- Project planning
- Provision of logistical support e.g. accommodation
- Administrative support
- Project promotion
- Participation in the project steering committee

9. Risk Management

Some of the key factors that tend to contribute to a successful commercial aquaculture operation (one that makes a profit on a sustained basis) include:

- Choosing the right species, or combination of species, according to carefully defined selection criteria, including growth rate, food conversion efficiency, culture technology and marketing
- Selecting the optimum site according to carefully defined criteria that encompass water quality, topographic and hydrographic features and infrastructure availability
- Producing a realistic, professional business plan
- Securing sufficient capital and establishing a proper financing structure
- Having a suitable operating plan with the appropriate degree of vertical integration
- Establishing and practicing proper husbandry techniques such as feeding schedules and health and hygiene programs
- Establishing a suitable program for access to hatchery stock
- Properly managing the operations, particularly the monitoring and control of operating costs and establishing a suitable risk management program
- Establishing a research and development program to continuously increase operating efficiency and lower production costs, principally by minimizing mortality rates and maximizing feed conversion efficiencies and growth rates.

Risks inherent to aquaculture and the project are summarized in Table 8:

Table 8: Project risk analysis

Risk	Likelihood / Impact	Risk priority	Response
Species bio-performance	Low / High	High	Design based on historical data, pilot project
Failure of bio-technical aspects of production technology	Low / Medium	Low	Proven culture technologies and husbandry techniques; experienced operating partner
Disease outbreak	Low / High	High	Unpolluted water; biosecurity plans; insurance
Increase in production costs	Medium / High	Medium	Economies of scale; alternative production methods
Depressed international markets	Medium / Medium	Low	Alternative marketing strategies; established marketing networks
New entrants	Medium / Medium	Low	Financial, technological entry barriers significant
Delay in implementation	Medium / Medium	Medium	Mobilize additional resources
Loss of key personnel	Low / High	Low	Broad-based collaborative network; incentive schemes
Power failures	Medium / High	High	Evaluate wind energy options
Lack of government support	Low / Medium	Medium	Promote awareness of national socio-economic benefits

10. Conclusion

Looking to the future, if aquaculture is expected to develop and expand significantly in Namibia, and if it is to contribute to the development of sustainable post-mining economic activities in Oranjemund, it will most likely do so incorporating a strategy based on the production of high value products for niche markets such as abalone, as well as the production of marine finfish in reservoir cage or land-based cage systems.

The implementation of a pilot project is an essential step in assessing the technical and economic viability of the development of abalone and other species aquaculture in the Oranjemund area. Although marine aquaculture culture is well established internationally and regulated in accordance with good environmental principles, the development of the industry in Namibia is constrained by a number of entry barriers including high development costs, limited know-how, poor access to resources, and unproven technology, systems and procedures. A successful pilot project will contribute significantly towards removal of some of these barriers and will catalyze the roll out of sustainable commercial projects in Namibia. This is particularly important given that the post-mining economy in Oranjemund is limited in terms of its economic structure and socio-economic profile. Importantly, the development of aquaculture in Namibia and Oranjemund can contribute significantly towards the welfare of previously disadvantaged communities in the province through job creation, skills training, provision of services (SMMEs) and business participation (BEE).

The financial and technical feasibility of the proposed pilot project has been assessed by a knowledgeable and experienced project task team and appear to be favorable. From an investment perspective the project appears to offer acceptable returns. Good progress has also already been made with the implementation of the pilot project in as much as some regulatory aspects have been completed, and key relationships has been formed between industry, research and other government institutions, and manufacturers.

The commercial and investment potential of the development of an abalone venture at Oranjemund has been validated by a complete market and financial assessment and appears promising. The venture should also benefit from several competitive advantages, including:

- Competitive production costs because of lower electricity expenditure associated with lower pumpheads
- Improved water quality through utilization of Mining Area 1 ponds as settlement reservoirs
- Lower company tax rates than SA; enabling regulatory environment
- Use of existing mine infrastructure

As with any new venture, there are many opportunities associated with the development of marine aquaculture. There also just as many associated risks. SU, HIK and NewF appears to have the unique combination of skills and resources necessary to make a venture such as this work, with strengths including technical proficiency, adequate financial resources, environmental sensitivity, and a high level of managerial integrity.

The establishment of the **Oranjemund Abalone NewCo** as a highly capable and experienced entrepreneurial operating partner with a successful investment track is essential in order to also develop other aquaculture projects in Oranjemund. Aquaculture will only contribute meaningfully towards the economic development of Oranjemund if the Oranjemund Abalone NewCo can expand and diversity its abalone business to eventually operate a vertically integrated venture that also produces in excess of 5 000 mt of marine finfish.

Appendix A: Pilot Project Budget – 4 Species

Table 9: Estimated Budget for a Combined 4 Species Pilot Project (N$)

Item	Abalone	Yellowtail	Oyster	Seaweed	Total
Overheads					
Project Management (SU @ 12.5%)					350 000
Travel & Accommodation					28 600
EIA					65 000
Containers (Office & storage)					70 000
Service vehicle (MA1)					90 000
Barge (with engine)					100 000
Tools & equipment					35 000
Project Manager (OMD)					378 000
Wages					129 600
Telephone & internet					18 000
Project Costs					
Transport & travel (OMD)	215 000	30 000	6 000	6 000	257 000
Construction	45 000	18 000	0	0	63 000
Consultancies	50 000	20 000	10 000	10 000	90 000
Infrastructure	500 000	200 000	24 000	24 000	748 000
Diesel (Generator standby)	20 000	10 000	0	0	30 000
Electricity	120 000	20 000	0	0	140 000
Seed stock	120 000	36 000	5 000	0	161 000
Feed	30 000	250 000	0	0	280 000
Fish handling equipment		40 000	0	0	40 000
Oxygen meter	10 000	10 000	0	0	20 000
Scales	4000	4000	0	0	8 000
Contingencies (10%)					310 000
TOTAL COST	**1 114 000**	**638 000**	**45 000**	**40 000**	**3 411 200**
Income	180 000	600 000	50 000	8 000	838 000
10% (Project manager OMD)					83 800
4% (Project workers OMD)					33 520

Appendix B: Financial Model: Assumptions

Table 10: Spat Purchase Price			
	Spat Purchase Price Inflation	**N$/kg Standard Intake**	**N$/kg Initial Intake**
Year 1	11.0%	1.32	1.35
Year 2	10.0%	1.47	1.50
Year 3	9.0%	1.61	
Year 4	8.0%	1.76	
Year 5	7.0%	1.90	
Year 6	6.0%	2.03	
Year 7	6.0%	2.15	
Year 8	6.0%	2.28	
Year 9	6.0%	2.42	
Year 10	6.0%	2.56	
Year 11	6.0%	2.72	

Table 11: Tank Purchase Price		
	Tank Purchase Price Inflation	**N$/Unit**
Year 1	11.0%	1.32
Year 2	10.0%	1.47
Year 3	9.0%	1.61
Year 4	8.0%	1.76
Year 5	7.0%	1.90
Year 6	6.0%	2.03
Year 7	6.0%	2.15
Year 8	6.0%	2.28
Year 9	6.0%	2.42
Year 10	6.0%	2.56
Year 11	6.0%	2.72

Table 12: Number of spat purchased per month						
Month	**1 / 7**	**2 / 8**	**3 / 9**	**4 / 10**	**5 / 11**	**6 / 12**
Year 1	0	0	0	0	0	0
	0	0	0	0	0	0
Year 2	0	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000
Year 3	110 000	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000
Year 4	110 000	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000
Year 5	110 000	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000
Year 6	110 000	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000
Year 7	110 000	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000
Year 8	110 000	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000
Year 9	110 000	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000
Year 10	110 000	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000
Year 11	110 000	110 000	110 000	110 000	110 000	110 000
	110 000	110 000	110 000	110 000	110 000	110 000

Table 13: Stock	
Mortality	
%	5.00%
Basis for calculation of mortality:	2

1 = Over the period, based on weight at the end of a month	
2 = Spread evenly over the period	
Minimum operational tank requirement	
Up to 12 months	77
Up to 29 months	124
>29 Months	184
Length at start	10.00 mm
Increment	1.80 mm/month
Weight to market	101.36 g

Table 14: Feed Purchase Price

	Feed Purchase Price Inflation	N$/Kg Mass Gain
Year 1	11.0%	15.95
Year 2	10.0%	17.70
Year 3	9.0%	19.48
Year 4	8.0%	21.23
Year 5	7.0%	22.94
Year 6	6.0%	24.55
Year 7	6.0%	26.03
Year 8	6.0%	27.59
Year 9	6.0%	29.24
Year 10	6.0%	30.99
Year 11	6.0%	32.85

Table 15: Sales and Marketing

	Sales Price	Exchange Rate
	US$/Kg	**N$/US$**
Year 1	32.00	7.63
Year 2	32.00	7.86
Year 3	32.00	8.09

Year 4	32.00	8.34
Year 5	32.00	8.59
Year 6	32.00	8.85
Year 7	32.00	9.11
Year 8	32.00	9.38
Year 9	32.00	9.67
Year 10	32.00	9.96
Year 11	32.00	10.25
Provision for losses		0%
Confidentials		2%
Marketing Fee		4%

Table 16: Transport – Refrigerated Truck	
Capacity to transport (tons)	4.0
Daily rate	N$ 491
Insurance per day	N$ 165
Km tariff	N$ 4.91
Km per trip	800
Cost per trip	N$ 4 580
Transport inflation	8.6%

Table 17: Electricity calculation		
Water requirement	3.20 Kl/tank/hr	
Kw - water	12.00 Kl/Kw/hr	
Kw - Air	0.16 Kw/tank	
Cost of Electricity	**Inflation**	**N$/Kw-hr**
Year 1	11.0%	0.4
Year 2	10.0%	0.48
Year 3	9.0%	0.53
Year 4	8.0%	0.58

Year 5	7.0%	0.62
Year 6	6.0%	0.67
Year 7	6.0%	0.70
Year 8	6.0%	0.75
Year 9	6.0%	0.79
Year 10	6.0%	0.84
Year 11	6.0%	0.89

Table 18: Labor

Wages	**Inflation**	**N$/hr**
Year 1	11.0%	7.70
Year 2	10.0%	8.50
Year 3	9.0%	9.40
Year 4	8.0%	10.25
Year 5	7.0%	11.07
Year 6	6.0%	11.84
Year 7	6.0%	12.55
Year 8	6.0%	13.31
Year 9	6.0%	14.10
Year 10	6.0%	14.95
Year 11	6.0%	15.85
Factor to compensate for CTC		**1.35**

Table 19: Manpower: Admin and Management (monthly)

		Salaries			**Management Fee**	
	Inflation	**Senior managers**	**Middle managers**	**Assistant managers**	**Inflation**	**N$**
Year 1	11.0%	39 600	19 800	7 700	11.0%	50 000
Year 2	10.0%	43 956	21 978	8 547	10.0%	55 500
Year 3	9.0%	48 356	24 178	9 403	9.0%	61 056

Year 4	8.0%	52 718	26 359	10 251	8.0%	71 908
Year 5	7.0%	56 951	28 475	11 074	7.0%	76 970
Year 6	6.0%	60 960	30 480	11 853	6.0%	81 584
Year 7	6.0%	64 615	32 307	12 564	6.0%	0
Year 8	6.0%	68 489	34 244	13 317	6.0%	0
Year 9	6.0%	72 594	36 297	14 116	6.0%	0
Year 10	6.0%	76 946	38 473	14 962	6.0%	0
Year 11	6.0%	81 559	40 780	15 859	6.0%	0

Table 20: Other running costs (monthly; N$)

	Maintenance	**Chemical & Consumables**	**Security**
Year 1	221	459	2 292
Year 2	358	458	2 292
Year 3	559	1 100	5 500
Year 4	1 100	1 650	7 700
Year 5	2 200	2 200	11 000
Year 6	3 300	3 300	11 550
Year 7	5 500	4 400	13 200
Year 8	6 600	5 500	13 860
Year 9	8 800	7 700	14 553
Year 10	9 900	8 800	16 500
Year 11	11 000	11 000	17 325

Table 21: Other overheads (monthly, unless otherwise indicated)

	Bank charges	**Professional Fees**	**HR**	**Protective clothing**	**Testing and research**	**Monthly accounts**	**Audit fees (annual)**
Year 1	963	10 176	917	205	0	13 200	27 500
Year 2	1 008	1 100	1100	563	1 054	14 341	29 878

Year 3	1 100	1 100	1 100	990	2 017	15 581	32 461
Year 4	1 100	1 100	1 100	1 702	3 300	16 928	35 267
Year 5	1 650	1 650	1 650	2 060	4 400	18 392	38 316
Year 6	2 200	1 650	1 650	2 266	4 400	19 982	41 629
Year 7	2 200	2 200	2 200	2 492	5 500	21 710	45 228
Year 8	3 300	2 200	2 200	2 742	6 600	23 587	49 139
Year 9	3 300	3 300	3 300	3 016	10 633	25 626	53 387
Year 10	3 300	3 300	3 300	3 317	7 700	27 841	58 003
Year 11	3 300	3 300	3 300	3 649	11 000	30 249	63 018

Table 22: Other overheads continued (monthly, unless otherwise indicated)

	Motor vehicle & fuel	**Print Stationary Subs.**	**Telephone**	**Rent**	**Insurance**	**Sundries**
Year 1	4 034	303	1 513	4 034	2 292	2 017
Year 2	4 437	1008	3 025	4 033	1 303	2 017
Year 3	4 840	1 100	3 300	4 400	3 907	2 200
Year 4	4 400	1 100	3 300	5 500	7 813	2 200
Year 5	4 400	1 650	3 850	6 600	9 376	3 300
Year 6	5 500	2 200	4 400	7 700	12 501	4 400
Year 7	6 600	2 200	5 500	8 800	12 501	4 400
Year 8	7 700	3 300	6 600	11 000	15 627	6 600
Year 9	8 800	3 300	7 150	13 200	15 627	6 600
Year 10	8 800	3 300	7 150	13 200	15627	6 600
Year 11	8 800	3 300	7 150	15 400	15 627	6 600

Table 23: Other Assumptions

Creditor Payment Period (days)		
All creditors		45.0
Debtors Collection Period (days/%)		
Majority of debtors	20.0	97.5%

Remaining debtors	60.0	2.5%
Value Added Tax		
VAT rate		14.0%
% of sales that are vatable		2.5%
Number of months that assets are depreciated		**72.00**
Prime Interest Rate		**15%**
Interest on savings account > than N$ 50 000		**6.5%**
Tax rate		**7%**
STC rate		**10%**
General inflation rate		**8.65%**

Table 24: Capital Expenditure (N$)

	Years 1 - 5 **23 762 759**	**Year 6+** **1 883 954**	**Total 1 - 11** **25 646 713**	**Inflation per annum**
Setup	358 646	0	358 646	8.60%
Legal fees	308 646	0	308 646	8.60%
Walls, fencing, security	825 938	0	825 938	8.60%
Ground Leveling, professional fees	617 292	0	617 292	8.60%
Header Tank	1 200 000	0	1 200 000	8.60%
Buildings, shading	1 544 094	0	1 544 094	8.60%
Land	600 000	0	600 000	8.60%
Cannery	6 412 232	0	6 412 232	8.60%
Pumps, Sump & Piping	1 617 292	1 449 195	3 066 487	8.60%
Tanks & baskets etc	7 653 409	0	7 653 409	8.60%
Outflow & settlement	525 938	0	525 938	8.60%
Air, electrical, genset	1 456 198	434 759	1 890 957	8.60%
Contingencies	643 076	0	643076	8.60%

Appendix B: Financial Model: Detailed Financial Statements

Table 25: Projected Income Statement

INCOME STATEMENT	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
KG Sales	**0**	**0**	**0**	**0**	**84,738**	**127,107**	**127,107**	**127,107**	**127,107**	**127,107**	**127,107**
KG Stock	**0**	**2,234**	**20,084**	**80,692**	**116,903**	**116,903**	**116,903**	**116,903**	**116,903**	**116,903**	**116,903**
N$/kg: Gross Sales	0.00	0.00	0.00	0.00	274.80	283.05	291.54	300.29	309.29	318.57	328.13
N$/kg: Turnover	**0.00**	**0.00**	**0.00**	**0.00**	**258.32**	**266.07**	**274.05**	**282.27**	**290.74**	**299.46**	**308.44**
N$/kg: Production inputs	0.00	0.00	0.00	0.00	35.76	38.22	41.22	44.13	47.02	49.89	52.88
N$/kg: Gross Profit	**0.00**	**0.00**	**0.00**	**0.00**	**222.55**	**227.85**	**232.83**	**238.14**	**243.72**	**249.57**	**255.56**
N$/kg: Overheads, depreciation and other	0.00	0.00	0.00	0.00	92.50	66.75	64.61	54.34	51.61	47.58	44.20
N$/kg: Net interest	0.00	0.00	0.00	0.00	48.62	22.66	20.03	17.45	14.44	10.93	6.83
N$/kg: PBT	0.00	0.00	0.00	0.00	35.99	107.56	122.36	145.43	159.45	181.39	203.42
GROSS SALES	0	0	0	0	23,286,360	35,977,427	37,056,749	38,168,452	39,313,505	40,492,911	41,707,698
Less: Confidentials	0	0	0	0	465,727	719,549	741,135	763,369	786,270	809,858	834,154
Net sales	0	0	0	0	22,820,633	35,257,878	36,315,614	37,405,083	38,527,235	39,683,052	40,873,544
Less: Marketing and Distribution Fees	0	0	0	0	931,454	1,439,097	1,482,270	1,526,738	1,572,540	1,619,716	1,668,308
Turnover	**0**	**0**	**0**	**0**	**21,889,179**	**33,818,781**	**34,833,344**	**35,878,345**	**36,954,695**	**38,063,336**	**39,205,236**
Less: Direct Production Inputs	0	0	0	0	3,030,439	4,857,958	5,238,946	5,609,402	5,976,703	6,341,237	6,721,394
GROSS PROFIT	**0**	**0**	**0**	**0**	**18,858,739**	**28,960,823**	**29,594,398**	**30,268,943**	**30,977,992**	**31,722,099**	**32,483,842**
Total Overheads	**2,279,684**	**2,670,118**	**3,835,261**	**5,373,795**	**7,838,648**	**8,762,649**	**9,388,774**	**9,074,347**	**9,760,917**	**10,312,433**	**10,999,531**
Semi-variable Costs	175,985	449,523	1,029,665	2,116,803	3,778,518	4,287,684	4,562,373	4,853,323	5,174,758	5,501,369	5,860,718
Maintenance	2,647	4,290	6,710	13,200	26,400	39,600	66,000	79,200	105,600	118,800	132,000
Security	27,507	27,507	66,000	92,400	132,000	138,600	158,400	166,320	174,636	198,000	207,900
Manpower: Admin and Management	1,405,200	1,559,772	2,006,041	2,309,994	2,925,783	3,179,171	3,369,763	2,534,075	2,685,993	2,847,018	3,017,697
Other Administrative Overheads	668,346	629,027	726,845	841,398	975,947	1,117,594	1,232,238	1,441,429	1,619,930	1,647,246	1,781,216
EBITDA	**-2,279,684**	**-2,670,118**	**-3,835,261**	**-5,373,795**	**11,020,092**	**20,198,174**	**20,205,624**	**21,194,596**	**21,217,076**	**21,409,665**	**21,484,311**
Depreciation	709,311	1,333,223	1,675,353	2,762,323	3,850,572	3,926,057	3,282,344	2,658,432	2,316,302	1,229,332	141,083
Amortisation	0	0	0	0	0	0	0	0	0	0	0
PBIT	**-2,988,995**	**-4,003,342**	**-5,510,614**	**-8,136,118**	**7,169,520**	**16,272,117**	**16,923,280**	**18,536,164**	**18,900,774**	**20,180,333**	**21,343,228**
Interest Received	76,770	826,230	893,682	563,140	0	278,615	1,175,792	2,167,413	3,201,235	4,264,795	5,381,083

Interest Paid	152,508	1,775,244	1,946,272	3,290,249	4,120,149	2,879,735	2,545,756	2,217,845	1,835,341	1,389,153	868,679
PBT	**-3,064,733**	**-4,952,356**	**-6,563,204**	**-10,863,227**	**3,049,371**	**13,670,997**	**15,553,317**	**18,485,731**	**20,266,668**	**23,055,975**	**25,855,632**
Tax and STC	0	0	0	0	0	0	478,112	1,294,001	1,418,667	1,613,918	1,809,894
PAT	**-3,064,733**	**-4,952,356**	**-6,563,204**	**-10,863,227**	**3,049,371**	**13,670,997**	**15,075,205**	**17,191,730**	**18,848,001**	**21,442,057**	**24,045,738**
Dividends	0	0	0	0	0	0	0	0	0	0	0
Preference shares	0	0	0	0	0	0	0	0	0	0	0
Ordinary Shares	0	0	0	0	0	0	0	0	0	0	0
NET PROFIT	**-3,064,733**	**-4,952,356**	**-6,563,204**	**-10,863,227**	**3,049,371**	**13,670,997**	**15,075,205**	**17,191,730**	**18,848,001**	**21,442,057**	**24,045,738**
% of Net Sales	%	%	%	%	%	%	%	%	%	%	%
Turnover	0.0%	0.0%	0.0%	0.0%	95.9%	95.9%	95.9%	95.9%	95.9%	95.9%	95.9%
Direct Production Inputs	0.0%	0.0%	0.0%	0.0%	13.3%	13.8%	14.4%	15.0%	15.5%	16.0%	16.4%
Gross Profit	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**82.6%**	**82.1%**	**81.5%**	**80.9%**	**80.4%**	**79.9%**	**79.5%**
Overheads	0.0%	0.0%	0.0%	0.0%	34.3%	24.9%	25.9%	24.3%	25.3%	26.0%	26.9%
EBITDA	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**48.3%**	**57.3%**	**55.6%**	**56.7%**	**55.1%**	**54.0%**	**52.6%**
Net Profit	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**13.4%**	**38.8%**	**41.5%**	**46.0%**	**48.9%**	**54.0%**	**58.8%**

Table 26: Projected Cash Flow Statement

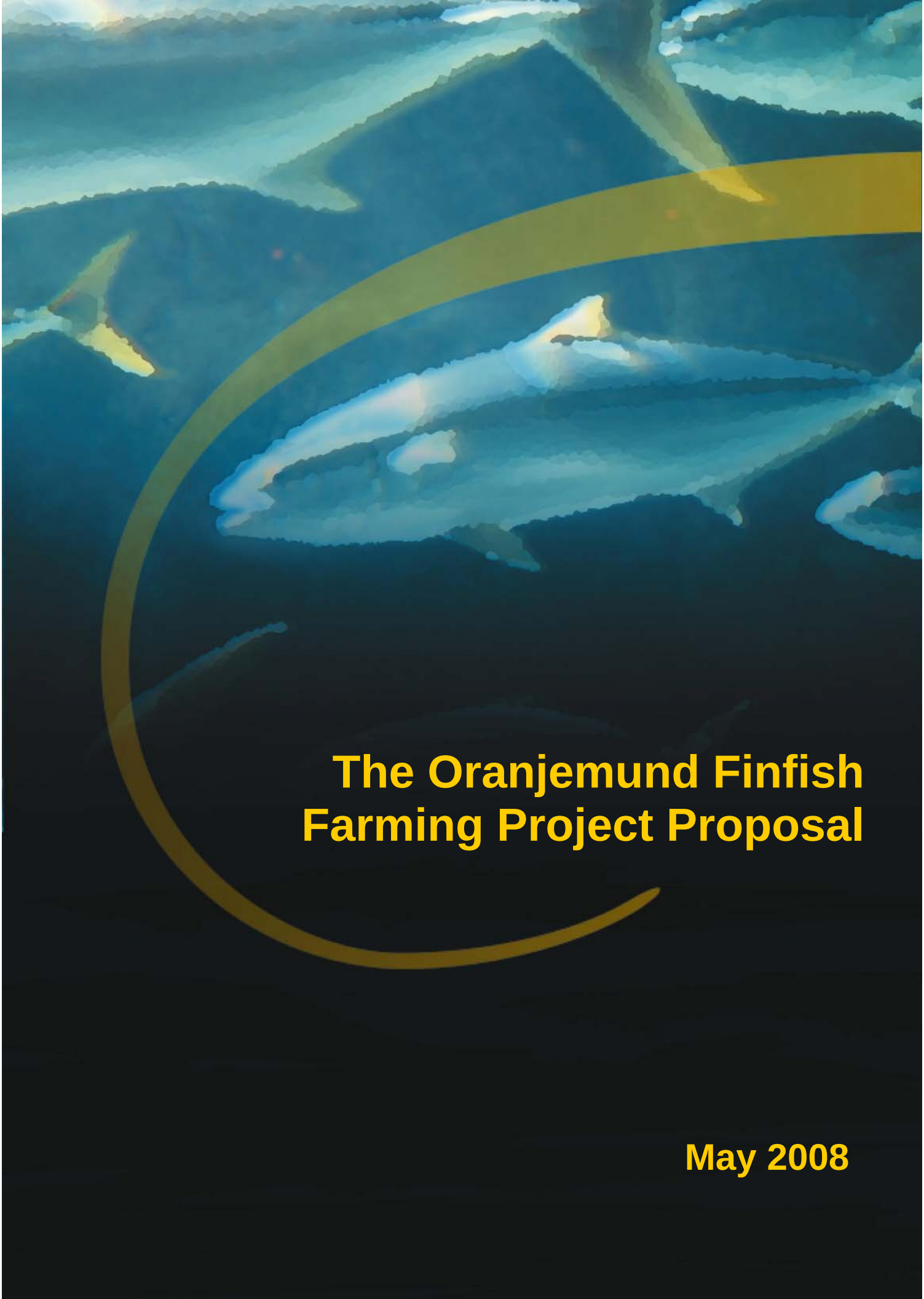
CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Net profit/(loss) before interest and dividends	**-2,988,995**	**-4,003,342**	**-5,510,614**	**-8,136,118**	**7,169,520**	**16,272,117**	**16,445,169**	**17,242,163**	**17,482,107**	**18,566,415**	**19,533,334**
Add back depreciation and amortization	709,311	1,333,223	1,675,353	2,762,323	3,850,572	3,926,057	3,282,344	2,658,432	2,316,302	1,229,332	141,083
Change in working capital	122,031	-1,506,736	-2,238,449	-3,151,458	-3,753,055	-734,924	-219,311	142,951	-557,427	-540,153	-569,449
Cash flow from operations	**-2,157,653**	**-4,176,855**	**-6,073,709**	**-8,525,253**	**7,267,036**	**19,463,251**	**19,508,202**	**20,043,545**	**19,240,982**	**19,255,594**	**19,104,968**
Fixed assets (bought) /sold	-6,597,700	-3,006,021	-2,072,181	-10,707,261	-1,379,597	-787,170	0	0	0	-1,096,784	0
Intangible assets (bought) /sold	0	0	0	0	0	0	0	0	0	0	0
Interest Received	76,770	826,230	893,682	563,140	0	278,615	1,175,792	2,167,413	3,201,235	4,264,795	5,381,083
Investments	0	0	0	0	0	0	0	0	0	0	0
Cash flow from investments	**-6,520,930**	**-2,179,791**	**-1,178,499**	**-10,144,121**	**-1,379,597**	**-508,555**	**1,175,792**	**2,167,413**	**3,201,235**	**3,168,011**	**5,381,083**
Cash flow before financing	***-8,678,583***	***-6,356,646***	***-7,252,208***	***-18,669,374***	***5,887,439***	***18,954,696***	***20,683,994***	***22,210,958***	***22,442,216***	***22,423,606***	***24,486,051***
Equity increase/(decrease)	1,166,218	1,950,957	1,760,218	0	0	0	0	0	0	0	0
Ordinary Share Capital	1,166,218	1,950,957	1,760,218	0	0	0	0	0	0	0	0
Preference share capital	0	0	0	0	0	0	0	0	0	0	0

Dividends paid	0	0	0	0	0	0	0	0	0	0	0
Ordinary charged to income statement	0	0	0	0	0	0	0	0	0	0	0
Preference charged to income statement	0	0	0	0	0	0	0	0	0	0	0
Preference Dividend Accrued	0	0	0	0	0	0	0	0	0	0	0
Increase/(decrease) in loans	4,664,872	18,767,742	17,837,038	-1,240,856	-1,447,447	-1,688,434	-1,969,542	-2,297,453	-2,679,957	-3,126,145	-3,646,619
Subordinated shareholder loans	4,664,872	7,803,830	7,040,873	0	0	0	0	0	0	0	0
Debentures	0	0	0	0	0	0	0	0	0	0	0
Other Loans	0	10,963,912	10,796,166	-1,240,856	-1,447,447	-1,688,434	-1,969,542	-2,297,453	-2,679,957	-3,126,145	-3,646,619
Interest paid	-152,508	-1,627,440	-1,798,468	-3,290,249	-4,120,149	-2,879,735	-2,545,756	-2,217,845	-1,835,341	-1,389,153	-868,679
Interest charged to income statement	-152,508	-1,775,244	-1,946,272	-3,290,249	-4,120,149	-2,879,735	-2,545,756	-2,217,845	-1,835,341	-1,389,153	-868,679
Non cash interest: Debentures	0	0	0	0	0	0	0	0	0	0	0
Non cash interest: Other Loans	0	147,804	147,804	0	0	0	0	0	0	0	0
Cash flow from financing	**5,678,582**	**19,091,259**	**17,798,788**	**-4,531,106**	**-5,567,596**	**-4,568,169**	**-4,515,298**	**-4,515,298**	**-4,515,298**	**-4,515,298**	**-4,515,298**
Net cash surplus/(shortage)	**-3,000,001**	**12,734,614**	**10,546,580**	**-23,200,480**	**319,843**	**14,386,527**	**16,168,696**	**17,695,660**	**17,926,918**	**17,908,308**	**19,970,753**
Opening balance -bank	0	-3,000,001	9,734,613	20,281,194	-2,919,286	-2,599,443	11,787,084	27,955,780	45,651,440	63,578,358	81,486,665
Closing balance -bank	**-3,000,001**	**9,734,613**	**20,281,194**	**-2,919,286**	**-2,599,443**	**11,787,084**	**27,955,780**	**45,651,440**	**63,578,358**	**81,486,665**	**101,457,418**

Table 27: Projected balance sheet

BALANCE SHEET	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Non-current assets	**5,888,389**	**7,561,186**	**7,958,014**	**15,902,952**	**13,431,977**	**10,293,090**	**7,010,746**	**4,352,315**	**2,036,013**	**1,903,465**	**1,762,381**
Fixed Assets	5,888,389	7,561,186	7,958,014	15,902,952	13,431,977	10,293,090	7,010,746	4,352,315	2,036,013	1,903,465	1,762,381
Intangibles	0	0	0	0	0	0	0	0	0	0	0
Investments	0	0	0	0	0	0	0	0	0	0	0
Current assets	**24,292**	**11,611,539**	**24,618,980**	**7,917,869**	**12,036,811**	**24,678,864**	**41,389,611**	**59,865,437**	**78,586,052**	**97,327,451**	**118,179,240**
Inventory	0	1,796,159	4,221,101	7,731,477	9,829,891	10,606,239	11,337,127	12,054,392	12,783,301	13,549,660	14,361,962
Trade debtors	0	0	0	0	1,976,345	2,035,635	2,096,704	2,159,606	2,224,394	2,291,125	2,359,859
Receiver of Revenue	24,292	80,767	116,685	186,391	230,575	249,906	0	0	0	0	0
Cash and equivalents	0	9,734,613	20,281,194	0	0	11,787,084	27,955,780	45,651,440	63,578,358	81,486,665	101,457,418
	5,912,681	**19,172,725**	**32,576,993**	**23,820,820**	**25,468,789**	**34,971,954**	**48,400,358**	**64,217,752**	**80,622,065**	**99,230,915**	**119,941,621**
Interest Free Debt	**146,323**	**492,220**	**714,632**	**1,143,256**	**1,509,144**	**1,629,190**	**1,951,930**	**2,875,047**	**3,111,316**	**3,404,254**	**3,715,841**
Trade creditors	146,323	492,220	714,632	1,143,256	1,509,144	1,629,190	1,741,803	1,869,613	2,002,649	2,118,973	2,256,765

Other creditors		0	0	0	0	0	0	0	0	0	0
Receiver of Revenue	0	0	0	0	0	0	210,127	1,005,433	1,108,667	1,285,281	1,459,076
Interest Bearing Debt and long term instruments	**3,000,001**	**11,111,717**	**22,055,687**	**23,734,116**	**21,966,826**	**17,678,949**	**15,709,407**	**13,411,954**	**10,731,997**	**7,605,852**	**3,959,234**
Bank	3,000,001	0	0	2,919,286	2,599,443	0	0	0	0	0	0
Debentures	0	0	0	0	0	0	0	0	0	0	0
Other Loans	0	11,111,717	22,055,687	20,814,830	19,367,383	17,678,949	15,709,407	13,411,954	10,731,997	7,605,852	3,959,234
Total Debt	**3,146,324**	**11,603,937**	**22,770,319**	**24,877,373**	**23,475,970**	**19,308,138**	**17,661,336**	**16,287,001**	**13,843,313**	**11,010,106**	**7,675,074**
Equity	**2,766,357**	**7,568,788**	**9,806,675**	**-1,056,552**	**1,992,819**	**15,663,816**	**30,739,021**	**47,930,751**	**66,778,752**	**88,220,809**	**112,266,547**
Ordinary Share Capital	1,166,218	3,117,175	4,877,394	4,877,394	4,877,394	4,877,394	4,877,394	4,877,394	4,877,394	4,877,394	4,877,394
Preference share capital	0	0	0	0	0	0	0	0	0	0	0
Subordinated shareholder loans	4,664,872	12,468,702	19,509,574	19,509,574	19,509,574	19,509,574	19,509,574	19,509,574	19,509,574	19,509,574	19,509,574
Retained Income (Loss)	-3,064,733	-8,017,089	-14,580,293	-25,443,520	-22,394,149	-8,723,152	6,352,054	23,543,784	42,391,784	63,833,841	87,879,579
	5,912,681	**19,172,725**	**32,576,993**	**23,820,820**	**25,468,789**	**34,971,954**	**48,400,358**	**64,217,752**	**80,622,065**	**99,230,915**	**119,941,621**
Collection period	0.0 days	0.0 days	0.0 days	0.0 days	20.9 days	21.0 days	21.0 days	21.0 days	21.0 days	21.0 days	21.0 days
Payables payment period	44.3 days	44.8 days	45.0 days	45.0 days	45.0 days	45.0 days	45.0 days	45.0 days	45.0 days	45.0 days	45.0 days
Inventory turnover	0.0 days	183.7 days	526.6 days	947.4 days	1358.6 days	1399.6 days	1416 days	1424 days	1426 days	1426 days	1426 days
Cash conversion cycle	-44.3 days	138.9 days	481.6 days	902.4 days	1334.5 days	1375.6 days	1392.days	1400 days	1402 days	1402 days	1402 days
Asset Turnover (Sales/Assets)	0.0 : 1	0.0 : 1	0.0 : 1	0.0 : 1	0.9 : 1	1.0 : 1	0.8 : 1	0.6 : 1	0.5 : 1	0.4 : 1	0.3 : 1
Leverage (Assets/Equity including s/holders loans)	2.1 : 1	2.5 : 1	3.3 : 1	-22.5 : 1	12.8 : 1	2.2 : 1	1.6 : 1	1.3 : 1	1.2 : 1	1.1 : 1	1.1 : 1
Debt/Equity (including s/holders loans)	1.1 : 1	1.5 : 1	2.3 : 1	-23.5 : 1	11.8 : 1	1.2 : 1	0.6 : 1	0.3 : 1	0.2 : 1	0.1 : 1	0.1 : 1
ROA ((EAT+Int(1-t))/Total assets)	-49.4%	-17.2%	-14.6%	-32.8%	27.0%	46.7%	36.0%	30.0%	25.5%	22.9%	20.7%
ROE (EAT/equity including s/holders loans)	-110.8%	-65.4%	-66.9%	1028.2%	153.0%	87.3%	49.0%	35.9%	28.2%	24.3%	21.4%
TIE coverage breakeven point	-19.6	-2.3	-2.8	-2.5	1.7	5.7	6.6	8.4	10.3	14.5	24.6



The Oranjemund Finfish Farming Project Proposal

May 2008

Prepared for:

The Oranjemund Town Management Company (Pty) Ltd
Oranjemund
Namibia

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Table of Contents

1. Executive Summary

The Division of Aquaculture, Stellenbosch University (SU) was commissioned jointly by Namdeb Diamond Corporation (Pty) Ltd (Namdeb) and the Oranjemund Town Management Company Limited (OTMCo) to assess the aquaculture potential of the mining area at Oranjemund in Namibia. There appears to be considerable potential and as such this document provides a proposal for the establishment of a marine finfish (yellowtail, *Seriola lalandi*) farm at Oranjemund. A 5 000 metric ton (mt) yellowtail farm would have a turnover of about N$ 115 million per year and provides direct employment for about 200 people.

The Government of Namibia has identified aquaculture as a prime priority development area. Both Vision 2030 and the NDP2 documents summon the country's urgency to develop aquaculture and as such the Namibian Government has created an enabling environment for investment in aquaculture. The marine finfish farming industry is the most important and valuable aquaculture sector in many countries and is expected to grow significantly over the medium term, offering exciting opportunities for investment and business participation.

Based on the assumptions in the model regarding the financial structuring of the business, the projected internal rate of return for a yellowtail farm at Oranjemund is around 17%. This is an indication that with the appropriate financial leverage (the mix of debt and equity employed to finance the business) it should be possible to structure the project in such a manner that attractive returns are generated for the equity investors. The total capital expenditure projected for the farm is N$ 16 562 300. The working capital requirements of the Oranjemund abalone farm were estimated at N$ 19 358 239 before the business becomes self-financing.

Several companies in South Africa are currently actively pursuing abalone aquaculture expansion opportunities along both the west and east coasts of the country. Key amongst these is the development of abalone farms at Hondeklip Bay and Port Nolloth in the Northern Cape Province of SA by HIK Abalone Farm (Pty) Ltd (HIK) and NewFarmers Development Company Limited (NewF). The development of a yellowtail farm at Oranjemund has been positioned as a further extension of the abovementioned initiative with HIK and NewF as potential operating, investment and development partners. The proposed business structure of the venture also provides investment opportunities for other institutional and Black Economic Empowerment (BEE) investors.

The yellowtail farm venture is part of a greater plan to develop a vertically integrated aquaculture cluster at Oranjemund. The cluster development will be conducted in two phases, with Phase 1 the establishment of a 150 mt abalone farm. Phase 2 is the development of a 5000 mt yellowtail farm. Subsequent phases will focus on extension to other species such as turbot (*Psetta Maxima*), rock lobster (*Jasus lalandi*) and oysters (*Crassostria gigas*). Bothe species developments will be preceded by 18 month pilot projects duration and will assess growth and survival in both commercial type land-based flow trough systems and in floating cages in reservoirs/ponds. It is anticipated that the pilot project will be jointly managed by Stellenbosch University and HIK Abalone Farm (Pty) Ltd.

The planned establishment of an **Oranjemund Yellowtail NewCo** with a reputation as a highly capable and experienced entrepreneurial operating partner with a successful investment track is essential in order to also develop and finance other aquaculture projects in Oranjemund. Aquaculture will only contribute meaningfully towards the sustainable economic development of Oranjemund if a planned abalone NewCo can expand and diversity its abalone business to eventually operate a vertically integrated business that also produces in excess of 5000 metric tonnes of marine finfish.

2. Introduction

The Division of Aquaculture, Stellenbosch University (SU) was commissioned jointly by Namdeb Diamond Corporation (Pty) Ltd (Namdeb) and the Oranjemund Town Management Company Limited (OTMCo) to assess the aquaculture potential of the mining area at Oranjemund in Namibia. This document provides a proposal for the establishment of a marine finfish (yellowtail, *Seriola lalandi*) farm at Oranjemund. There appears to be considerable potential and as such this document provides a proposal for the establishment of a marine finfish (yellowtail, *Seriola lalandi*) farm at Oranjemund. A 5 000 metric ton (mt) yellowtail farm would have a turnover of about N$ 115 million per year and provides direct employment for about 200 people.

Oranjemund is located immediately north of the Orange River at the most south-western corner of Namibia, approximately 1000 kilometers southwest of the capital, Windhoek. Namdeb currently operates an alluvial diamond mining operation along a 160 kilometer (km) stretch of the southern Namibia coastline, but is expected to downscale their activities significantly over the next 5 to 10 years.

Aquaculture, the cultivation of fish, shellfish and aquatic plants, is the fastest growing food producing industry in the world and has considerable potential to contribute to the establishment of a vibrant post-mining economy in Oranjemund. The marine finfish industry is the most important and valuable aquaculture sector in many countries and is expected to grow significantly over the medium term, thereby also offering exciting opportunities for investment and business participation.

The yellowtail farm venture is part of a greater plan to develop a vertically integrated aquaculture cluster at Oranjemund. The yellowtail development will be conducted in two phases, with Phase 1 the establishment of a pilot project to assess and confirm technical and financial feasibility. Phase 2 is the development of a 1 000 mt commercial farm. Other species being considered for development at Oranjemund include abalone (*Haliotis midae*), turbot (*Psetta Maxima*), rock lobster (*Jasus lalandi*) and oysters (*Crassostria gigas*).

Several companies in South Africa are currently actively pursuing aquaculture expansion opportunities along both the west and east coasts of South Africa. Key amongst these is the development of abalone farms at Hondeklip Bay and Port Nolloth in the Northern Cape Province of South Africa by HIK Abalone Farm (Pty) Ltd (HIK) and NewFarmers Development Company Limited (NewF). The development of abalone and yellowtail farming at Oranjemund has been positioned as a further extension of the abovementioned initiative with HIK, NewF and a finfish fingerling supplier as potential operating, investment and development partners. The proposed business structure of the project provides investment opportunities for both institutional and Black Economic Empowerment (BEE) investors as well as employee equity instruments.

Namibia's economic prospects for the future are bright given its stable economic performance, good regulatory framework, and robust private sector. The country has experienced steady growth, moderate inflation, strong external surpluses and low indebtedness over the past several years as a result of generally prudent fiscal policies, a stable political environment, a fairly developed infrastructure, and a strong legal and regulatory environment. Economic growth since independence (1991) has averaged 4.3% per annum, and the World Bank's Investment Climate Assessment Report currently notes that Namibia has a relatively attractive investment climate.

The Government of Namibia has identified aquaculture as a prime priority development area. Both Vision 2030 and the NDP2 documents summon the country's urgency to develop aquaculture and as such the Namibian Government has created an enabling environment for investment in aquaculture.

3. Project Objectives

Aquaculture offers significant developmental and economic opportunities for Namibia. This growth industry can improve food security, reduce poverty, create employment and increase inward investment to the country. In addition, aquaculture represents a sustainable economic use of Namibia's coastal and inland living aquatic resources – which means that aquaculture activities can be continued into the future, providing economic opportunity without depleting non-renewable resources.

The marine finfish farm development at Oranjemund will be conducted in two phases, with Phase 1 the establishment of a pilot project to assess and confirm technical and financial feasibility. Phase 2 is the development of a 1 000 mt commercial farm, with eventual expansion to 5 000 mt.

The specific objectives of the project are:

- To establish a 1 000 mt marine finfish farm in Oranjemund over the course of a 5 year period in collaboration with other investment partners
- To establish the Oranjemund Yellowtail NewCo as a highly capable and experienced entrepreneurial operating partner with a successful investment track record in order to also develop other aquaculture projects in Oranjemund

The broad objectives of the project are:

- To contribute towards the creation of a sustainable post-mining economy in Oranjemund in a manner consistent with the principles of ecologically and economically sustainable development
- To contribute towards development of a sustainable and competitive aquaculture industry in Namibia with international recognition for its product quality, environmental awareness and technical innovation
- To contribute to poverty reduction and empowerment of disadvantaged coastal communities through development of employment opportunities, skills training, and business participation (SMMEs, BEE)
- To contribute to the development of newly leveraged downstream industries that can create additional job and business opportunities

The specific objectives of the pilot project are:

- To confirm assessments regarding the suitability of proposed sites in terms of physical parameters including water quality, dissolved oxygen, temperature range and temperature fluctuations
- To determine yellowtail growth rates at proposed sites under commercial conditions. Abalone growth rates are a key indicator of economic viability and competitiveness. The pilot project results will be assessed against growth rates obtained at existing commercial farms
- To provide a platform for the training of personnel in animal husbandry methods
- To demonstrate fish husbandry, harvesting, post-harvesting and processing technology
- To develop procedures for interaction with mine security protocols as well as other general management procedures
- To design, construct and evaluate various culture production systems
- To investigate and evaluate the culture of other species such as abalone, oysters and seaweed by cost effectively through the sharing of pilot project overheads

4. Rationale

4.1. Aquaculture is a Profitable, Competitive and Growing Industry

Aquaculture development is market driven. It is clear that in the short to medium term, demand for fish will expand as populations and incomes grow. According to the United Nations' Food and Agriculture Organization (FAO), world total demand for fish and fishery products is projected to increase by almost 50 million tons, from 133 million tons in 2000 to 183 million tons by 2015.

It is widely acknowledged that fish supplies from traditional capture fisheries are unlikely to increase substantially in the future and that aquaculture production will have to rise further to help satisfy the growing world demand for fisheries products. According to the FAO, 32% of seafood consumed worldwide is currently produced through aquaculture, already the fastest growing global food producing industry. This is projected to rise to 45% by the year 2015. Concomitant with the rise in demand it is anticipated that seafood prices will probably continue to increase during the coming two decades, with baseline FAO scenario projections suggesting increases of 15 percent for high-value products.

Aquaculture producers are preferentially (competitively) meeting market demand through both non-price supply and product advantages. Supply advantages include, for example, the ability to control and thus predict supply. Farmers have far greater control over the timing, consistency and quantity of production than do fishermen. The pace advantages of farming create benefits to farmers in the form of better prices, more processing options, and higher quality.

Product advantages primarily refer to quality, traceability and food safety factors. Quality is probably the main competitive factor in the global seafood trade, with importers placing a premium on quality that feeds back into the production process and is characterized within Hazard Analysis and Critical Control Point (HACCP)-based regulations as well as the international standards, guidelines and recommendations put forward by the FAO/WHO *Codex Alimentarius.*

4.2. Aquaculture Contributes to Economic and Social Welfare

Aquaculture has significant potential to expand in Namibia. The country's strengths include unpolluted coastlines, productive marine resources, a wide climatic range, a large diversity of species available for culture, and a reputation for quality seafood.

There are many reasons to pursue this potential. Aquaculture offers important economic benefits to producing countries by increasing export income and reducing imports. At the micro-economic level aquaculture creates substantial opportunities for generating strong commercial returns. In addition, aquaculture provides diversity to a country's economic base and creates demand for technology, training, extension services, infrastructure and local goods.

The aquaculture industry is particularly important from a socio-economic perspective. Aquaculture contributes to food security, improved nutrition and poverty alleviation, directly by producing food fish, and indirectly by generating employment and income for the purchase of food. Jobs in commercial aquaculture are relatively well paid. The contribution of aquaculture to employment is even larger if multiplier effects are added. Ninety percent of aquaculture production and processing takes place in rural and coastal communities, providing economic stability and growth where economic development options are often limited, particularly in cases where yields from wild fisheries have declined.

5. Yellowtail Species Overview and Aquaculture Status

Classification, Distribution and Biology of Seriola Species. Yellowtail belong to the Genus *Seriola* and the Family *Carangidae*. There are three principal market species, *S. quinqueradiata* (Japanese amberjack; *hamachi, buri*), *S. dumerili* (greater amberjack; *kampachi*) and *S. lalandi* (yellowtail amberjack; *hiramasa*). *S. lalandi* is one of the most valuable species and has a non-equatorial distribution. In SA, *S. lalandi* occurs from the West Coast to southern KwaZulu-Natal, from the shore out to the continental edge. It is also found around Australia, New Zealand, India, and the west coasts of the Americas, from British Columbia to Chile. *S. quinqueradiata* is endemic to Japan and north Hawaii. *S. dumerili* is the largest member of the genus and occurs in the Mediterranean Sea and the Atlantic, Indian and Pacific Oceans.

Yellowtail are pelagic, schooling fish, usually seen as adults in small to large numbers. In general they inhabit rocky shores, reefs and islands and are often found adjacent sandy areas in coastal waters and occasionally entering estuaries. They are commonly found in water depths to 50 m, although they have been recorded from over 300 m deep. Young fish up to 7 kg are known to form shoals of up to several hundred fish and are generally found in offshore waters, often near or beyond the continental shelf.

In SA, yellowtail spawn over a wide area during their summer spawning season, from southern Kwazulu-Natal to Cape Point. The main spawning area appears to be the central Agulhas Bank, south of Cape Agulhas, where the stock concentrates in the summer months. All *Seriola* species show rapid growth rates. The natural diet of yellowtail larvae is almost exclusively planktonic crustaceans, particularly copepods. Intermediate and adult yellowtail primarily feed upon schooling fish (e.g. sardines), squid and crustaceans.

The Status of Yellowtail Aquaculture. *S. quinqueradiata* has been farmed in Japan since the 1920's. Japan (136 000 t; 1276 farms; average production of 106 t/farm) accounted for 99% of the global production in 2000 (FAO 2002a); the only other producers were Taiwan Province of China (633 t) and the Republic of Korea (494 t). The majority of Japanese farms are stocked with juveniles caught from the wild, although a small number of fish are now reared in hatcheries. Wild caught juveniles are reared on a diet of baitfish.

Commercial culture of *S. lalandi* commenced in Australia in 1998 when broodstock were collected, conditioned and spawned at Port Augusta by Spencer Gulf Aquaculture (Pty) Ltd. The Australian yellowtail farming industry has since undergone rapid expansion. It now boasts two commercial hatcheries, located at Port Augusta and Arno Bay. Grow-out to market size of 3 – 5+ kg is conducted in sea cage farms at Port Lincoln, Arno Bay, Franklin Harbor and Fitzgerald Bay. Total culture production of *S. lalandi* in Australia in 2005 was 5000 t. Other countries embarking upon yellowtail culture now include New Zealand (*S. lalandi*), Spain (*S. dumerili*), Ecuador (*S. mazatlana*) and the USA (*S. rivoliana*).

In SA I&J Group Limited has successfully developed the technology to spawn yellowtail from wild-caught broodstock and the company recently completed construction of a new commercial finfish hatchery at Gansbaai at a cost of R 5 million. In collaboration with SU, I&J is currently conducting a 72 mt pilot yellowtail sea cage farming project in the northern lee of Port Elizabeth harbor. The use of sea cages appears to be the preferred culture method for all yellowtail and has been widely implemented in Australia and Europe. Other yellowtail projects currently underway in SA include pilot scale pond production of yellowtail in Kwazulu-Natal and the grow-out of yellowtail by Espadon Marine in recirculation systems in East London. Yellowtail production in SA will probably reach 3 000 mt within the next 5 years.

6. Project Description

6.1. Overview

Generally, commercial aquaculture proceeds through a series of growth, development and maturity stages that relate to its level and degree of competitiveness and profitability. A typical business development cycle applicable to the Oranjemund Abalone NewCo is shown in Table 1.

Table 1: Typical aquaculture business development cycle

Stage of Development	Description
1. Seed/conceptualization	Develop, test and ready a product for production. Development of pilot project to determine technical and financial feasibility and to optimize production parameters.
2. Start-up/early expansion	Commence commercial business operations. Installation of infrastructure to facilitate approximately 40% of planned production, significant investment in human resource development and a specific focus on marketing. Anticipated production at Oranjemund during this phase is about 40 mt.
3. Development/growth/expansion	Expand an established and growing business. Expansion to 120 mt over the course of a five year period.
4. Later established	Continue expansion or extend to new species. Extension to other species, development of processing facilities.

The Oranjemund Yellowtail NewCo development will be conducted in two phases, with Phase 1 the establishment of a pilot project to assess and confirm the technical and financial feasibility of finfish farming. During the pilot phase other potential species such as abalone and oysters will also be trialed. Phase 2 is the development of a 5 000 mt commercial farm. The estimated pilot project duration is 18 months and will assess yellowtail growth and survival in both commercial type land-based flow through systems and in floating cages in reservoirs/ponds. The pilot project will be managed by Stellenbosch University and will also serve as a training platform for human resources capacity development.

6.2. Workplan

The project will be executed within the following main tasks:

i) **Project approval.** Project approval needs to be obtained from the Ministry of Fisheries and Marine Resources (MFMR), Namdeb and OTMCo.

ii) **Appointment and training of project personnel.** SU will provide on-site project management. The project will appoint a full-time on-site production manager as well as 1 technicians (farmhands). A small number of temporary workers will be utilized during regular intervals to assist with various tasks, including construction and maintenance activities. All project personnel will undergo specialist training as required.

iii) **Equipment selection, acquisition and delivery.** Much progress has already been made in the selection and where necessary, design of required equipment, including the sea cages, mooring system, nets and workboat. Throughout the course of the project preference will be given to sourcing equipment from local suppliers. It is however anticipated that a number of items will be imported, including the cage mooring system, cage brackets and cage nets.

iv) **Fingerling Production.** Fingerlings for the project will be produced at the I&J hatchery at Danger Point in Gansbaai and transported by road to Oranjemund. The project production plan has been based on the supply of 16 000 fingerlings. A second batch of fingerlings will be introduced after 12 months.

v) **Construction of land-based facilities.** The project plan provides for the installation of (or use of existing) temporary office, workshop, general storage and feed storage facilities. Accommodation arrangements will be made in conjunction with OTMCo.

vi) **Installation of cages.** 2 10m diameter high density polyethylene (HDPE) cages will be installed in a 2 x 1 mooring grid on the allocated site (1m water depth). A shore based mooring system will be used. A 4 tank Portapool system will be installed to demonstrate land-based culture. This system will utilize the abalone pilot project water supply system.

vii) **Growth / Husbandry trials.** Growth trials will be conducted for an 18 month period and will be assessed under conditions comparative to commercial operations. Optimization in terms of stocking densities, feed etc. will be conducted in the final 6 months of the pilot project. The growth trials include regular husbandry tasks such as sampling and grading and the development of standard operating procedures.

viii) **Harvesting.** Fish will be harvested on several occasions and submitted for physiological, disease, quality and processing analysis.

ix) **Data analysis.** SU will assume responsibility for the statistical analysis of growth and other data collected during the pilot project. To facilitate data collection, a number of fish will be tagged.

x) **Financial modeling.** A detailed financial model for a full scale commercial operation will be developed by an independent contractor. The financial feasibility of such an operation will be modeled for a 10 year period. In addition, an optimal financing strategy will be developed.

xi) **Business plan review.** The project has as its final output the delivery of a comprehensive investment orientated business plan.

6.3. Budget

The total estimated cost of the finfish pilot project is N$ 675 200. This assumes that the finfish pilot is done in conjunction with an abalone pilot project, thereby reducing overhead costs. By utilizing the same pump ashore infrastructure, the cost of a demonstration tanks system is also significantly reduced.

Table 2: Estimated yellowtail pilot project expenditure (All values N$)

No	Item	Unit Cost	Quantity	Total
1	**Project Management**			**50 000**

2	**Transport & travel**			**30 000**
3	**Production systems**			**189 600**
	Cage system	80 000	2	160 000
	Tank system	7 400	4	29 600
5	**Fish handling equipment**			**5 000**
6	**Net cleaner**	24 000	1	**24 000**
7	**Generator**	4 600	1	**4 600**
8	**Harvesting bins**	2 000	2	**4 000**
9	**Contingencies**			**50 000**
10	**Service barge**	80 000	1	**80 000**
16	**Fingerlings**	2	16 000	**32 000**
17	**Feed**	7	30 000	**210 000**
	TOTAL COST			**675 200**

6.4. Implementation

A proposed schedule for the implementation of the project is shown in Table 3. It should be noted that implementation is subject to the availability of funding and the completion of regulatory aspects. Should Phase 1 of the pilot project be concluded successfully, an extension phase will be developed and implemented.

Table 3: Description, duration and implementation date for the key project tasks.

Task	Description	Start Date & Duration
1	Project approval	Oct 2008
2	Fingerling production (Batch 1)	May – Oct 2008
3	Equipment design, selection & acquisition	Jul – Oct 2008
4	Appointment & training of project personnel	Sept – Nov 2008
5	Infrastructure installation	Sept – Oct 2008
6	Basic environmental assessment	Oct 2008 – Mar 2009
7	Introduction of fingerlings (Batch 1)	21 Oct 2008
8	Year 1 pilot production	Oct 2008 – Oct 2009
9	Data analysis	Nov 2009
10	Introduction of spat (Batch 2)	Nov 2009
11	Optimization of production parameters	Nov 2009 – Apr 2010
12	Business plan review	Oct 2009
13	Commercialization preparation	Nov 2009 – Apr 2010
14	Implementation of full scale commercial operation	Apr 2010

6.5. Research and Development

Although the project has as its primary objectives the demonstration and optimization of sea cage aquaculture technology and procedures, a number of biological (scientific) research tasks will also be conducted during the course of the project. They include the following:

- Determination of the growth rates for both candidate species
- Determination of feed conversion ratios
- Evaluation of different stocking densities
- Assessment of the changes in the proximate chemical composition of fish over the production cycle
- Comparison of the sensory (taste) attributes of cultured versus captured fish
- The collection and analysis of water-quality, weather and oceanographic data

7. Project Rationale

7.1. Aquaculture is a Profitable, Competitive and Growing Industry

Aquaculture development is market driven. It is clear that in the short to medium term, demand for fish will expand as populations and incomes grow. According to the United Nations' Food and Agriculture Organization (FAO), world total demand for fish and fishery products is projected to increase by almost 50 million tons, from 133 million tons in 2000 to 183 million tons by 2015.

It is widely acknowledged that fish supplies from traditional capture fisheries are unlikely to increase substantially in the future and that aquaculture production will have to rise further to help satisfy the growing world demand for fisheries products. According to the FAO, 32% of seafood consumed worldwide is currently produced through aquaculture, already the fastest growing global food producing industry. This is projected to rise to 45% by the year 2015. Concomitant with the rise in demand it is anticipated that seafood prices will probably continue to increase during the coming two decades, with baseline FAO scenario projections suggesting increases of 15 percent for high-value products.

Aquaculture producers are preferentially (competitively) meeting market demand through both non-price supply and product advantages. Supply advantages include, for example, the ability to control and thus predict supply. Farmers have far greater control over the timing, consistency and quantity of production than do fishermen. The pace advantages of farming create benefits to farmers in the form of better prices, more processing options, and higher quality.

Product advantages primarily refer to quality, traceability and food safety factors. Quality is probably the main competitive factor in the global seafood trade, with importers placing a premium on quality that feeds back into the production process and is characterized within Hazard Analysis and Critical Control Point (HACCP)-based regulations as well as the international standards, guidelines and recommendations put forward by the FAO/WHO *Codex Alimentarius.*

7.2. Aquaculture Contributes to Economic and Social Welfare

Aquaculture has significant potential to expand in Namibia. The country's strengths include unpolluted coastlines, productive marine resources, a wide climatic range, a large diversity of species available for culture, and a reputation for quality seafood.

There are many reasons to pursue this potential. Aquaculture offers important economic benefits to producing countries by increasing export income and reducing imports. At the micro-economic level

aquaculture creates substantial opportunities for generating strong commercial returns. In addition, aquaculture provides diversity to a country's economic base and creates demand for technology, training, extension services, infrastructure and local goods.

The aquaculture industry is particularly important from a socio-economic perspective. Aquaculture contributes to food security, improved nutrition and poverty alleviation, directly by producing food fish, and indirectly by generating employment and income for the purchase of food. Jobs in commercial aquaculture are relatively well paid. The contribution of aquaculture to employment is even larger if multiplier effects are added. Ninety percent of aquaculture production and processing takes place in rural and coastal communities, providing economic stability and growth where economic development options are often limited, particularly in cases where yields from wild fisheries have declined.

8. Feasibility Assessment

8.1. Relevant Legislation, Policies and Guidelines

Among others, cognizance has been taken in this study and in the project design of the following acts, codes, conventions, agreements, protocols and policy proposals:

- Namibian Marine Resources Act, 2000 (Act no. 27 of 2000)
- Namibian Aquaculture Act, 2002 (Act no 18 of 2002)
- Namibia's Aquaculture Strategic Plan
- Various FAO Codes including the FAO Code of Conduct for Responsible Fisheries
- Bangkok Declaration and Strategy for Aquaculture Development beyond 2000
- WWF Policy Proposals and Operational Guidance for Ecosystem Based Management of Marine Capture Fisheries

8.2. SWOT Analysis

A strategic assessment of the strengths, weaknesses, opportunities and threats in relation to both the pilot project and future finfish farming has been conducted and is shown below.

Table 4: Project SWOT analysis

Species	Geographical Location
Strengths	**Strengths**
1. High value product	1. Namibian company tax rates
2. Fast growing	2. Limited competition for sites
3. Established cage grow-out technology	3. Enabling regulatory environment
4. Hatchery technology available	4. Developed and available infrastructure
5. Pellet feeding	5. Environmentally disturbed area
6. Wide range of processing options	6. No disease record
7. Robustness	7. Good security
8. Growing culture worldwide	8. Social support network and infrastructure
Weaknesses	**Weaknesses**
1. Requires high dissolved oxygen levels	1. Capital intensive water intake required
2. Requires low turbidity water	2. Unreliable power supply
	3. Mine security procedures

	4. No aquaculture support services
	5. Site knowledge
	6. High transport costs, remoteness of area
	7. Industry skepticism
	8. Cold water; temperature variation in ponds
Opportunities	**Opportunities**
1. Growing international markets	1. Regulatory environment
2. Established regional markets	2. Use/conversion of mine infrastructure
3. Value adding	3. Ponds
4. Economy of scale scope	4. Some ranching
	5. Wind generated power
	6. Scale of production scope
Threats	**Threats**
1. Competition from SA, foreign producers	1. Import tariffs and bans
2. Global warming – environmental instability	2. Market volatility (Asian)
3. Increase in fuel prices	3. Lack of investor funds
4. Disease outbreak	4. Effect of downscaling and mine closure
5. Adequate and reliable power supply	5. Security of tenure
6. Increase in power costs	6. Orange river plume
7. Strong local currency	7. Political interference
8. Macro-economic settings and policies	8. More optimal sites
9. Asian market collapse	9. Competition from SA producers

8.3. Technical Feasibility

The technical feasibility of the project concept was assessed against four main parameters and is shown in Table 5:

Table 5: Factors affecting the technical feasibility of the project

Factor	Issue
1. Cage technology	Will existing cages survive expected sea conditions and allow a safe environment for both fish stock and farm workers?
2. Species bio-performance	Will yellowtail growth rates and survival allow profitable production?
3. Husbandry & management	Can existing fish husbandry techniques, procedures and equipment be used in conditions?
4. Environmental impact	Are potential impacts consistent with the principles of ecological sustainable development and does an environmental impact assessment study have a high likelihood of success?

Cage technology. Recent developments in cage systems, with improved mooring systems, better material selection and better designed assemblies, are making it possible to consider production in genuinely open-water conditions The pilot project will utilize high density polyethylene (HDPE) surface gravity-type fish grow-out cages. These cages are highly resilient to wave forces and have a long service life (15 – 20

years). They have now been well tried and tested for numerous years in some of the harshest marine environments yet conquered by aquaculture, including the west coasts of Scotland and Ireland, the open coastlines of a number of Mediterranean countries, the Canary Islands, and the Southern Ocean off Australia. HDPE pipe is made from high density polyethylene which is a crystalline polymer known for its flexibility, toughness and chemical resistance. These features make HDPE pipe particularly well suited for use in aquaculture where pipes that are strong, durable, corrosion resistant and yet flexible enough to be assembled and installed in exposed locations are required. The Mining Area 1 pond system is a particularly benign culture environment

Species bio-performance. Yellowtail are good candidates for commercial aquaculture because they are widely distributed, have a good domestic and international market profile, are highly fecund, and can tolerate a wide range of temperatures. Importantly they appear to have good attributes for grow-out in cages such as their preference for forming schools (suggesting a tolerance for high stocking densities) and ability to adjust to captivity, which makes inspection for diseases relatively easy. In cage conditions in Australia yellowtail has attained a market weight 1.5 kg (fillet size) in 12 months.

Husbandry and management. Husbandry and management practices are central towards maximizing production, optimizing operating cost efficiencies, and maintaining a high quality product and therefore market price. Worldwide, aquaculturists have had a successful history of innovation in husbandry and management practices since the intensification of sea cage aquaculture in the 1960's. Specific milestones include the development of improved feed delivery systems, net cleaning systems, cage monitoring systems, workboats and harvesting techniques.

Potential environmental impact. Aquaculture has been cited as a contributing factor to the collapse of fisheries stocks worldwide due to the use of wild fish as fish feed for culture species, through habitat modification, transmission of diseases and wild seed stock collection. Such accusations, although influential in a political sense, are not fully supported by scientific information and ignore the major advances and improvements in aquaculture technology, husbandry, hygiene, health and other management practices.

The type and scale of any ecological change associated with aquaculture development depends on the method of aquaculture, the level of production and the biological, chemical and physical characteristics of the affected area. Generally, small-scale coastal aquaculture has been a traditional and sustainable practice in many countries. Potential environmental impacts and their project/venture specific mitigation and management are shown in Table 6.

Table 6: Potential environmental impacts and their project/venture specific mitigation & management

Impact	Mitigation
Genetic	Current farm stock genetically close to wild stock; dilution effect
Disease	Low stocking density; biosecurity measures, improved diagnosis
Marine Fauna	Exclusion barriers, entanglement management program
Water Column	Low biomass production; biodegradable wastes; localized & reversible
Benthic Environment	Fallowing; in site cage rotation
Fisheries Resources	Existing effort; management measures

In recent years the expansion and diversification of aquaculture in Europe, Australia and elsewhere has been guided under carefully designed environmental controls. In addition the aquaculture industry is increasingly moving towards self regulation with for example the implementation of Codes of Good Practice. Rigorous environmental monitoring and recording standards have accordingly been implemented. Such controls have not necessarily been applied to other forms of activity and aquaculture operations have often been subjected to adverse impacts imposed by other forms of human activity and as a result the productivity and financial viability of operations have often been reduced. Indeed, the vulnerability of the proposed project to potential adverse impacts such as the introduction of pollutants and diseases from other less well regulated human activities is a specific concern.

Worldwide, customers are prepared to pay premium prices for healthy food, grown in a healthy environment and overseas buyers increasingly require environmentally certified products and the industry to be appropriately certified at world's best practice standards. A number of aquaculture companies in the rest of the world have already been accredited to the world environmental management standard, ISO 14001. These developments occurred concurrently with an increasing realization in the food processing industry that competing on price alone is not necessarily the most attractive business strategy. Increasingly companies are therefore including "clean and green" as part of their marketing strategy.

8.4. Market Feasibility

In 2004, global exports of fish and seafood products reached almost US$ 70 billion, whilst supply (particularly of quality seafood) cannot keep pace with demand. According to the FAO, in 2004 the total human consumption of seafood was approximately 128 million metric tons. Statistics show that annual global fish catches have plateaued at about 90 million metric tons and may even be declining. Over 60% of the marine fish stocks for which information is available are either fully exploited or overexploited, and 13 of the world's 15 major oceanic fishing areas are now fished at or beyond capacity. This leaves only aquaculture available to meet the increasing world demand for seafood. Although aquaculture has grown at an average annual rate of 8.8% from 1950 to 2004, it is, however, highly unlikely that even aquaculture is capable of filling the gap between demand and supply. Although the severity of the shortage would differ among countries, the overall effect would be a rise in the price of fish. Increases of up to 15% are projected for high-value finfish by the FAO.

In the short to medium term, the demand for fish will further expand as populations and incomes grow. Moreover, as people in developing countries increasingly enter the middle classes, they consume more protein, including seafood. According to the FAO, the global annual per capita consumption of fish has been predicted to increase from about 16 kgs in 2003 to 19 – 21 kgs by 2030. Other factors affecting the growth of seafood in international markets include changing consumer tastes, consolidation in retail and distribution sectors, the internet (distributors can get into direct contact with producers), decreases in export tariffs, and the nutritional and health benefits associated with seafood. The growing development of value-added products such as fillets; portion control and vacuum packs; as well as convenience items has also benefited the global seafood trade.

Excluding diadromous fish, the output of farmed marine fish grew by 350% from a very low base between 1985 and 2002 and could, according to the FAO, double again by 2010. Public research institutions and private companies are developing and marketing many new finfish species in marine environments, thus

contributing to the rising market share of this segment of the aquaculture industry. The rapid expansion of aquaculture into a diverse range of high-valued species reflects government and industry attention toward market opportunities.

Yellowtail are renowned for its white, firm quality flesh and high level of Omega 3 and other fatty acids. The market opportunities for ranched fresh yellowtail is substantial based on either its existing prominence as part of Japanese cuisine or it's marketing as a more general (but high end) use in the international fish market. Apart from fillet production, yellowtail can also be marketed overseas as sashimi, primarily to Japan and the USA. In Japan, for example, *S. lalandi* is ranked second only to southern bluefin tuna as a sashimi product. Yellowtail can obtain up to US$20 per kg in Japan. It is also anticipated that China will soon emerge as a huge fast growing market for sashimi style seafood products. Competition for export market share in Japan and China will predominantly come from Australia and New Zealand.

Apart from sashimi, the other preferred market forms for yellowtail is fillets and whole fish. There is currently strong demand for yellowtail from Europe with vacuum packed yellowtail fillets being sold in both supermarkets and gourmet shops. The growth of Japanese cuisine in European markets also offer exiting opportunities. In Italy for example, yellowtail can reach up to € 20/kg.

The domestic market also offers opportunities, with the live inventory processes of farming well suited to meeting market demand. A large majority of local high value seafood is exported, so SA wholesalers and distributors often have difficulty fulfilling the domestic demand for seafood. The fishing industry in SA will continue to remain an export driven market so long as the demand in the international market for quality fish remains high. In addition, the assumed depreciation of the South African Rand (and Namibian dollar) will tend to increase the relative competitiveness of Southern African seafood in export markets.

SA imported US$58 million of fish and seafood products in 2004, primarily from Thailand, the Philippines, Mozambique and India. Imports mainly consisted of crustaceans (US$19 million); squid ($15 million); and fish meat ($20 million). The SA packaged seafood market includes: canned fish (65.4%); value added fish (14.2%); packaged white fish (13.8%); and specialty seafood (6.7%). Demand for fresh fish in both the retail and food service sector has grown considerably due to the shortages in supply of white fish. The food service sector, i.e. restaurants, hotels, and franchises require a variety of whitefish menu options due to the increase in the local tourism trade as well as the growth in awareness in SA of the health characteristics of fish. Despite growing imports, per capita fish consumption in SA is low when compared to the rest of the world, generally indicating significant room to grow.

In SA, the anticipated channels of distribution for fresh cultured yellowtail are primarily to restaurants, retail outlets and wholesalers. The wholesale price for the fresh product will be between R45 and R60 per kilogram. It is anticipated that local competition will be the greatest threat to success in the sector because of the additional costs (including shipping, storage, time and tariffs) incurred by importers. Fishing companies in SA either catch and distribute the product themselves or pass the item on to alternative players to distribute on their behalf. Distributors supply the retail fresh fish counters, but the largest portion of their business involves supplying the foodservice sector. These distributors include various companies such as Blue Marine, Blue Continent, Sea World, Breco and Lusitania. I&J and Sea Harvest are also active in the distribution of fresh fish to the foodservice market.

The size of the South African market for fresh farmed yellowtail has been estimated at between 1500 and 2000 tons per year, with a 5 000 ton per year niche export market into Europe and the USA. The retail price for the fresh product will be between R45 and R60 per kilogram for the local market and between €15 and €20 per kilogram for a fillet size fresh farmed yellowtail on ice for the export market. This should result in a farm gate price, before processing, of between R30 and R45 per kilogram.

8.5. Financial Feasibility

Financial projections. In order to assess the underlying financial viability of sea cage marine finfish aquaculture, SU has developed a financial model based on the production of 1000 tons of yellowtail per annum. It was assumed that fingerlings will be bought from an existing producer at N$ 2.75 per fingerling. Other key assumptions are shown in Table 13. The projected IRR of the venture is conservatively expected to be around 17% to 21%. This is an indication that with the appropriate financial leverage it should be possible to structure a commercial venture in such a manner that attractive returns are generated for the equity investors.

The three most important factors influencing the model's future returns are the selling price of fish, the growth rate of the candidate species and changes in the price of feed. A 10% change in these variables has an impact of around 5 – 7% on the IRR. The assumptions in the model regarding all three these variables were conservative and it therefore appears that a reasonable probability exists to achieve higher than projected financial returns.

The total capital expenditure projected in the financial model is N$ 16 562 300. The majority total capital expenditure requirement is incurred in the first 3 years of operations. The working capital requirements were estimated at N$ 19 358 239 before the project becomes self-financing. The financial model was based on the total funding requirement being provided in the form of cash equity.

The income statement provides a useful financial summary of the projected operating results for the forecast period. An important indicator is the earnings before tax interest and depreciation (EBITDA). This profitability measure is not influenced by the assumptions regarding the financing structure (i.e. it is separating the financing effects from the operating effects) or the depreciation policy. It therefore provides a relatively cleaner measure of the underlying profitability potential of the venture. EBITDA is negative for the first 2 years, reaching a maximum loss of around N$ 9 871 157 (N$ 10 300 157 cumulative over the period). EBITDA becomes positive at N$ 4 265 238 in year 3.

The cash deficit from operations in the cash flow statement for each of the first two years confirms the relative long start-up phase of the venture.

Detailed financial statements as developed for the model are shown in Appendix C.

Business structure. The financial structuring of the funding requirement is very important as this provides specific opportunities for broad based BEE. In this regards significant debt financing (e.g. loans, overdrafts and preference shares) improve opportunities for BEE shareholding.

A business structure for a commercial venture based on the pilot project has not been finalized, but could include the following interest groups:

- An operating / technical partner

- Non BEE investors, e.g. financial institutions in the public and private sectors, private equity funds or individuals
- BEE investors, e.g. community trusts, entities such as companies and trusts, individuals, and workers trusts
- Management

9. Project Management and Collaboration

The project will benefit from the establishment of an efficient network of collaboration between research institutions, industrial partners, manufacturers and other role-players. The pilot project will be overseen by a standing Project Management Committee consisting of SU, HIK and OTMCo, other co-opted team members and an administrative official. The management committee will be responsible for project oversight, administration and financial management. To facilitate commercialization a dedicated project task team to be led by NewF will be created.

9.1. Division of Aquaculture, SU

The Division was established in 1989 with the aim of contributing to the development of the Southern African aquaculture industry through high standards of education and training, innovative research, and efficient services. The Division functions in an interdisciplinary manner through participation of various other University departments and external collaborators. The Division's outputs include systems engineering, biology and grow-out of marine and freshwater finfish and shellfish, environmental assessment of the potential impacts of aquaculture, genetic enhancement, the development of feed technology, fish health management, post-harvest technology, etc. Within the project context the Division is responsible for:

- Project coordination, including liaison between industry, government and OTMCo
- Project planning and implementation
- Provision of technical assistance and training services
- Implementation of other species activities
- Project reporting
- Assessment of technical and economic viability of the pilot project

9.2. Marine Finfish Producer

MFP was established in Cape Town in 1910. The company's core business is fishing, processing and marketing of the highest quality fish products. The company is a world-class player in the international frozen food industry, producing 240 different product lines for local and international markets. It has a presence on all 5 continents and exports to 28 countries, with international sales representing 65% of sales turnover. MFP currently operates a modern fishing fleet throughout South Africa's exclusive economic zone as well as in international and neighboring state waters of the Atlantic and Indian Oceans. The company's domestic fleet of 24 HACCP approved vessels includes 4 factory/freezer and 20 wet fish trawlers operating from Port Elizabeth in the East to Cape Columbine on the West Coast. In addition the company operates major fish processing facilities in Woodstock and Mossel Bay in the Western Cape.

MFP realized the potential of marine aquaculture over a decade ago and took a bold step in developing one of the first abalone farming operations in SA. The abalone farm is located at Danger Point, near Gansbaai,

south east of Cape Town and produces about 140 tons of abalone per annum. In addition, MFP is deeply involved in various research and development projects related to the farming of marine finfish.

- Evaluation of the technical feasibility of the project
- The provision of technical support services
- Training and development of personnel
- Facilitation of marketing arrangements
- The provision of project management services in collaboration with SU

9.3. NewFarmers Development Company Limited

NewFarmers is a private equity investor and catalyst in agribusiness. The company has an empowerment focus. NewFarmers invests in projects with strong earnings potential that provide an opportunity for the company to eventually profitably disinvest. NewFarmers' investment instruments include equity (preferably minority equity stakes of between 25 and 49 percent), debentures, preference shares and loans. A range of schemes is used to involve employees in a meaningful way, for example employee equity schemes. During the pilot project NewFarmers will be responsible for the following:

- Development and preparation of the project financial model
- Liaison with investment institutions
- Structuring of the business model

9.4. Oranjemund Town Management Company Limited

The Oranjemund Town Management Company (OTMCo) is a Namdeb initiative established in July 2004, with the objective and vision of developing the self-sustainability characteristic of Oranjemund, in order to ensure that the town remains in existence once the Namdeb era has reached its end. Key to this is the development of a diversified economic base in Oranjemund. The role of OTMCo during the pilot project is primarily focused on the provision of support services and includes the following:

- Provision of pilot project funding
- Liaison with Namdeb
- Provision of logistical support e.g. accommodation
- Administrative support
- Project promotion
- Participation in the project steering committee

10. Risk Management

Some of the key factors that tend to contribute to a successful commercial aquaculture operation (one that makes a profit on a sustained basis) include:

- Choosing the right species, or combination of species, according to carefully defined selection criteria, including growth rate, food conversion efficiency, culture technology and marketing;
- Selecting the optimum site according to carefully defined criteria that encompass water quality, topographic and hydrographic features and infrastructure availability;
- Producing a realistic, professional business plan;
- Securing sufficient capital and establishing a proper financing structure;
- Having a suitable operating plan with the appropriate degree of vertical integration;
- Establishing and practicing proper husbandry techniques such as feeding schedules and health and hygiene programs;
- Establishing a suitable program for access to hatchery stock;
- Properly managing the operations, particularly the monitoring and control of operating costs and establishing a suitable risk management program; and
- Establishing a research and development program to continuously increase operating efficiency and lower production costs, principally by minimizing mortality rates and maximizing feed conversion efficiencies and growth rates.

Risks inherent to fishing ventures, offshore aquaculture and the project are summarized in Table 7:

Table 7: Project risk analysis

Risk	Likelihood / Impact	Risk priority	Response
Species bio-performance	Low / High	High	Design based on historical data, pilot project
Failure of bio-technical aspects of production technology	Low / Medium	Low	Proven culture technologies and husbandry techniques; experienced operating partner
Disease outbreak	Low / High	High	Unpolluted water; biosecurity plans; insurance
Increase in production costs	Medium / High	Medium	Economies of scale; alternative production methods
Depressed international markets	Medium / Medium	Low	Alternative marketing strategies; established marketing networks
New entrants	Medium / Medium	Low	Financial, technological entry barriers significant
Delay in implementation	Medium / Medium	Medium	Mobilize additional resources
Loss of key personnel	Low / High	Low	Broad-based collaborative network; incentive schemes
Power failures	Medium / High		
Lack of government support	Low / Medium	Medium	Promote awareness of national socio-economic benefits

11. Conclusion

Looking to the future, if aquaculture is expected to develop and expand significantly in Namibia, and if it is to contribute to the development of sustainable post-mining economic activities in Oranjemund, it will most likely do so incorporating a strategy based on the production of high value products for niche markets such as abalone, as well as the production of marine finfish in reservoir cage or land-based cage systems.

The implementation of a pilot project is an essential step in assessing the technical and economic viability of the development of abalone and other species aquaculture in the Oranjemund area. Although marine aquaculture culture is well established internationally and regulated in accordance with good environmental principles, the development of the industry in Namibia is constrained by a number of entry barriers including high development costs, limited know-how, poor access to resources, and unproven technology, systems and procedures. A successful pilot project will contribute significantly towards removal of some of these barriers and will catalyze the roll out of sustainable commercial projects in Namibia. This is particularly important given that the post-mining economy in Oranjemund is limited in terms of its economic structure and socio-economic profile. Importantly, the development of aquaculture in Namibia and Oranjemund can contribute significantly towards the welfare of previously disadvantaged communities in the province through job creation, skills training, provision of services (SMMEs) and business participation (BEE).

The financial and technical feasibility of the proposed pilot project has been assessed by a knowledgeable and experienced project task team and appear to be favorable. From an investment perspective the project appears to offer acceptable returns. Good progress has also already been made with the implementation of the pilot project in as much as some regulatory aspects have been completed, and key relationships has been formed between industry, research and other government institutions, and manufacturers.

The commercial and investment potential of the development of an abalone venture at Oranjemund has been validated by a complete market and financial assessment and appears promising. The venture should also benefit from several competitive advantages, including:

- Competitive production costs because of lower electricity expenditure associated with lower pumpheads
- Improved water quality through utilization of Mining Area 1 ponds as settlement reservoirs
- Lower company tax rates than SA; enabling regulatory environment
- Use of existing mine infrastructure

As with any new venture, there are many opportunities associated with the development of marine aquaculture. There also just as many associated risks. SU, HIK and NewF appears to have the unique combination of skills and resources necessary to make a venture such as this work, with strengths including technical proficiency, adequate financial resources, environmental sensitivity, and a high level of managerial integrity.

The establishment of the **Oranjemund Yellowtail NewCo** as a highly capable and experienced entrepreneurial operating partner with a successful investment track is essential in order to also develop other aquaculture projects in Oranjemund. Aquaculture will only contribute meaningfully towards the economic development of Oranjemund if the Oranjemund Abalone NewCo can expand and diversity its abalone business to eventually operate a vertically integrated venture that also produces in excess of 5 000 mt of marine finfish.

Appendix A: Species Summary

Yellowtail – *Seriola lalandi* (Valenciennes, 1833)

Maximum Size	1290mm FL longest obtained in SA commercial samples, but known to attain 1500mm FL; Smith & Heemstra report it attaining 50.8 kg
Age at 50% Maturity	Approximately 2 – 3 years, both sexes (Penney, Unpublished data)
Maximum Age	9 – 10 years from otoliths, but possibly gets a few years older (Thomson and Penney, In prep)
Natural Mortality	M = ~0.3`year^{-1}
Resilience	Medium, minimum population doubling time 1.4 – 4.4 years (K=0.13; tm=2)
Environment	Benthopelagic; brackish; marine; depth range 50 – 300 m
Distribution	Circumtropical, entering temperate waters in some areas. Indo-Pacific: Japan, Great Australian Bight and southeastern Australia. Eastern Pacific: British Columbia, Canada to Chile. Eastern Atlantic: St. Helena, South Africa. 51°N - 46°S, 180° W - 180°
Biology	Yellowtail are pelagic, schooling fish, usually seen as adults in small to large numbers. In general they inhabit rocky shores, reefs and islands and are often found adjacent sandy areas in coastal waters and occasionally entering estuaries. Young fish up to 7kg are known to form shoals of up to several hundred fish and are generally found in offshore waters often near or beyond the continental shelf.
Morphology	Dorsal spines (total): 5 - 6; Dorsal soft rays (total): 33 – 35; Anal spines: 2 – 3; Anal soft rays: 20 – 21. The only jack without scutella on the caudal peduncle. Dark blue dorsally and almost white ventrally; with a well defined line of demarcation between the two colors.
Spawning Season (SA)	Strong October – March peak, with some gonad activity observed all year round (Penney, Unpublished data)
Reproductive Style	Gonochorist (Penney, Unpublished data)
Biological Reference Points	F_{MSY}: 0.4 year^{-1}; F_{SB25}: 0.6 year^{-1}; F_{SB40}: 0.45 year^{-1}; $F_{0.1}$: Unknown (Thomson and Penney, In prep)
Importance	Small scale commercial fisheries in SA; gamefish
Red List Status	Not in IUCN Red List

Appendix B: Production Plan

Table 9: Proposed production plan for yellowtail (*Seriola lalandi*)

Month	Average Weight (kg)	Number	Total Weight (kg)	Stocking density (kg/m^3)	Number of cages	Net mesh size (mm)	Feed
1	0.005	18000	90	0.1	1	10	-
2	0.015	17100	257	0.3	1	10	283
3	0.040	16245	650	0.6	1	10	669
4	0.080	15433	1235	1.2	1	10	994
5	0.170	14661	2492	2.5	1	32	2138
6	0.300	13928	4178	4.2	1	32	2866
7	0.500	13232	6616	6.6	1	32	4144
8	0.750	12570	9428	9.4	1	32	4780
9	0.950	11942	11345	11.3	1	32	3259
10	1.200	8027	9633	9.6	1	32	5590
11	1.500	7626	11439	11.4	1	32	3070
12	1.826	7245	13231	13.2	1	32	3046
13	1.973	6882	13582	13.6	1	32	598
14	2.126	6538	13898	13.9	1	32	478
15	2.283	6211	14180	14.2	1	32	419
16	2.445	5901	14426	14.4	1	32	419

Appendix C: Financial Model – Projected Financial Statements

Table 11: Financial model – 10 year discounted cash flow statement (ZAR)											
Description	**Rate**	**2 008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Yellowtail		0	0	23 241 535	23 241 535	23 241 535	23 241 535	23 241 535	23 241 535	23 241 535	23 241 535
Gross Income		**0**	**0**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**	**23 241 535**
Production Costs		**79 000**	**9 056 322**	**17 650 943**	**17 531 617**	**17 116 830**	**16 949 194**	**16 919 194**	**16 919 194**	**16 919 194**	**17 113 094**
Wages		0	205 920	752 675	752 675	752 675	752 675	752 675	752 675	752 675	752 675
Salaries		0	386 100	772 200	1 154 400	1 006 200	1 006 200	1 006 200	1 006 200	1 006 200	1 006 200
Staff training		50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000
Juveniles		0	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739	2 085 739
Feed	7.3	0	4 202 222	10 582 325	11 080 882	10 793 435	10 505 988	10 505 988	10 505 988	10 505 988	10 505 988
R&M		0	85 000	215 000	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645
Veterinary Supplies		0	100 000	156 000	158 000	158 000	158 000	158 000	158 000	158 000	158 000
Land Lease	0	0	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000
Sea Concession Lease	0	0	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000
Boat mooring fees	0	5 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000
Diving Contractors	0	24 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000
Electricity	0	0	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000
Fuel & oil	0	0	150 000	175 000	200 000	225 000	250 000	250 000	250 000	250 000	250 000
Oxygen	0	0	3 600	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
Potable Water	0	0	12 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Protective Clothing	0	0	7 200	10 000	10 000	20 000	20 000	20 000	20 000	20 000	20 000
Cleaning materials	0	0	5 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
Cleaning services and laundry	0	0	5 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
EMP	0	0	185 000	190 000	190 000	190 000	190 000	190 000	190 000	190 000	190 000
Security/Surveillance	0	0	84 000	168 000	168 000	168 000	168 000	168 000	168 000	168 000	168 000
Freight/Transport	0.15	0	0	119 146	150 176	150 176	150 176	150 176	150 176	150 176	150 176
Fixed Cost Recovery	0	0	0	0	0	0	0	0	0	0	0
Depreciation	0	0	1 090 224	1 568 991	1 568 991	1 568 991	1 568 991	1 418 991	1 318 991	1 318 991	1 318 991

Gross Margin		-79 000	-9 056 322	5 590 592	5 709 918	6 124 705	6 292 340	6 322 340	6 322 340	6 322 340	6 128 440
Admin Costs		**350 000**	**814 835**	**1 325 354**	**1 316 918**	**1 198 481**	**1 173 644**	**1 144 808**	**1 115 971**	**1 087 135**	**1 087 800**
Audit Fees		0	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Office Consumables		0	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000
Office R&M		0	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000
Telephone		0	18 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
Accountant		0	180 000	180 000	180 000	180 000	180 000	180 000	180 000	180 000	180 000
Receptionist/Secretary		0	108 000	108 000	108 000	108 000	108 000	108 000	108 000	108 000	108 000
Cleaner		0	26 400	26 400	26 400	26 400	26 400	26 400	26 400	26 400	26 400
Company Contributions		0	94 320	94 320	94 320	94 320	94 320	94 320	94 320	94 320	94 320
Permit		0	2 000	2 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000
SABS		0	15 000	30 000	45 000	45 000	45 000	45 000	45 000	45 000	45 000
Licensing		0	1 000	3 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000
Asset Insurance		0	156 115	238 583	210 147	181 710	156 873	128 037	99 200	70 364	71 029
Stock Insurance		0	0	409 051	409 051	409 051	409 051	409 051	409 051	409 051	409 051
Professional Fees		350 000	180 000	180 000	180 000	90 000	90 000	90 000	90 000	90 000	90 000
Depreciation		0	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000
Nett Margin		-429 000	-9 871 157	4 265 238	4 393 000	4 926 224	5 118 696	5 177 532	5 206 369	5 235 206	5 040 640
PBIT		-429 000	-9 871 157	4 265 238	4 393 000	4 926 224	5 118 696	5 177 532	5 206 369	5 235 206	5 040 640
Acc. PBIT		-429 000	-10 300 157	-6 034 920	-1 641 919	3 284 305	8 403 000	13 580 533	18 786 902	24 022 107	29 062 747
Tax	15%	0	0	0	0	0	533 115	1 899 895	1 912 608	1 929 670	1 770 702
Net Income		**-429 000**	**-9 871 157**	**4 265 238**	**4 393 000**	**4 926 224**	**4 585 581**	**3 277 637**	**3 293 761**	**3 305 535**	**3 269 938**
Add back Depreciation		0	911 806	1 466 330	1 466 330	1 466 330	1 516 330	1 486 330	1 486 330	1 486 330	1 680 230
Capital expenditure		0	9 268 056	5 545 244	0	0	350 000	0	0	0	1 789 000
Cash Flow		**-393 667**	**-17 799 004**	**-1 165 568**	**5 736 330**	**6 367 751**	**5 733 775**	**4 763 967**	**4 780 091**	**4 791 865**	**20 172 289**
Acc. Cash Flow		**-393 667**	**-18 192 671**	**-19 358 239**	**-13 621 909**	**-7 254 158**	**-1 520 383**	**3 243 584**	**8 023 676**	**12 815 541**	**15 976 709**
ROCE		**-255%**	**-47%**	**16%**	**19%**	**24%**	**29%**	**32%**	**36%**	**40%**	**38%**

Table 12: Financial Model – Capital expenditure requirements (N$)				
Item	**Rate**	**Expenditure**		
		2009	**2010**	**2011+**
Total Costs		**9 268 056**	**5 545 244**	**11 280 915**
Land & Building		**375 000**	**0**	**0**
Building upgrades / nursery enclosure		150 000		
Nursery tank surface preparations		75 000		
Pump Station		150 000		
Sea Equipment		**8 673 056**	**5 545 244**	**11 280 915**
Sea cages	11 284 300	**6 269 056**	**5 015 244**	**11 280 915**
18 x cage collar (22m dia)	3 213 000			
3 sets of 2 x Stingray mooring	3 145 800			
4 x 1.5 of 10mm juv nets	441 000			
6 x 1.5 of 18mm med nets	483 000			
12 x 1.5 of 25mm large nets	1 249 500			
18 x 1.2 predator nets	1 587 600			
Supplier installation costs	764 400			
I&J installation costs	400 000			
Ship warning reflector buoys	50 000	20 000	30 000	
Feeding cannon etc	50 000	50 000		
Tarpaulin	80 000	80 000		
Sweep net	30 000	30 000		
Fish harvesting/grading equipment	75 000	75 000		
Dip net	5 000			
Work bench	25 000			
Fish stunner	25 000			
Ice bins	20 000			
Fish Pump	50 000	50 000		
Diving equipment x 3	150 000	150 000		
Scuba tanks	50 000			
Wetsuits	15 000			
DV's, BC's etc	50 000			
Mask, fins, weights, bag etc	20 000			
Underwater equipment	15 000			
Miscellaneous equipment	10 000	10 000		
Land-based equipment				
Biofilter	65 000	65 000		
Recirculation pumps + pipes	50 000	50 000		
Water Treatment (drum filter)	50 000	100 000		
Boiler	110 000	110 000		
Electrical switchgear etc.	50 000	50 000		
Nursery Tanks 10 x 25m3	10 000	100 000		
Nursery tank pipes and fittings	2 000	20 000		
Suction Lines	250 000	250 000		
Pump	150 000	150 000		
Delivery lines	100 000	100 000		
Dosing pump	10 000	10 000		

Microscope	5 000	5 000		
Laboratory tests	15 000	15 000		
Water quality tests	5 000	5 000		
Oxygen + diffusers	50 000	50 000		
Oxy Reticulation	20 000	20 000		
1t plastic bins	750	9 000		
25kg bins	50	10 000		
Net washing equipment	150 000	150 000		
General tools	20 000	20 000		
Fish handling equipment	50 000	50 000		
Vehicles		**750 000**	**500 000**	
Feed / general purpose boat		100 000		
Barge		500 000	500 000	
LDV		150 000		
Office		**70 000**	**0**	
Office Equipment		50 000		
Office Furniture		20 000		
Professional Fees		**0**	**0**	
EIA				

Table 13: Financial model **–** Underlying assumptions

Description	Value
Projected tonnage	1000 tons
Maximum stocking density	15 kg.m^3
Cage volume	4 944
Average FCR	1.53
Feed price	N$ 7.30
Mortality rate	30%
Growth period in months	YT: 14
HOGO Yield	90%
Sales price	N$ 27.48
Juvenile cost	N$ 2.75
Taxation rate	15%

Table 14: Financial model – 10 year overheads (N$)											
Description	**Rate**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total Costs		**429 000**	**9 871 157**	**18 976 297**	**18 848 534**	**18 315 311**	**18 122 839**	**18 064 002**	**18 035 166**	**18 006 329**	**18 200 895**
Production Costs		**79 000**	**9 056 322**	**17 650 943**	**17 531 617**	**17 116 830**	**16 949 194**	**16 919 194**	**16 919 194**	**16 919 194**	**17 113 094**
Production		**0**	**0**	**896 565**	**896 565**	**896 565**	**896 565**	**896 565**	**896 565**	**896 565**	**896 565**
Production Cost/kg					**21**	**20**	**20**	**20**	**20**	**20**	**20**
Wages		0	205 920	752 675	752 675	752 675	752 675	752 675	752 675	752 675	752 675
- Sea based	2200	0	158 400	522 539	522 539	522 539	522 539	522 539	522 539	522 539	522 539
- Land based	2200	0	0	47 339	47 339	47 339	47 339	47 339	47 339	47 339	47 339
- Casuals	550	0	0	11 835	11 835	11 835	11 835	11 835	11 835	11 835	11 835
- Company Contributions	30%	0	47 520	170 963	170 963	170 963	170 963	170 963	170 963	170 963	170 963
Salaries		0	386 100	772 200	1 154 400	1 006 200	1 006 200	1 006 200	1 006 200	1 006 200	1 006 200
- Ops Manager	25000	0	150 000	300 000	300 000	300 000	300 000	300 000	300 000	300 000	300 000
- Supervisor	15000		90 000	180 000	360 000	360 000	360 000	360 000	360 000	360 000	360 000
- Foreman	9500		57 000	114 000	228 000	114 000	114 000	114 000	114 000	114 000	114 000
- Company Contributions	30%	0	89 100	178 200	266 400	232 200	232 200	232 200	232 200	232 200	232 200
Bonus Scheme	5%										
Staff training		50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000
Juveniles			1 965 062	1 886 460	1 827 508	1 768 556	1 768 556	1 768 556	1 768 556	1 768 556	1 768 556
Feed	7.3	0	4 482 635	11 211 794	9 693 789	9 451 154	9 208 519	9 208 519	9 208 519	9 208 519	9 208 519
R&M		0	85 000	215 000	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645	1 827 645
Veterinary Supplies		0	100 000	156 000	158 000	158 000	158 000	158 000	158 000	158 000	158 000
Land Lease		0	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000
Sea Concession Lease		0	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000
Boat mooring fees		5 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000
Diving Contractors		24 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000
Electricity		0	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000	120 000
Fuel & oil			150 000	175 000	200 000	225 000	250 000	250 000	250 000	250 000	250 000
Oxygen			3 600	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000

Potable Water		0	12 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Protective Clothing		0	7 200	10 000	10 000	20 000	20 000	20 000	20 000	20 000	20 000
Cleaning materials			5 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
Cleaning services			5 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000
EMP		0	185 000	190 000	190 000	190 000	190 000	190 000	190 000	190 000	190 000
Security/Surveillance		0	84 000	168 000	168 000	168 000	168 000	168 000	168 000	168 000	168 000
Freight/Transport	0.15	0	0	119 146	150 176	150 176	150 176	150 176	150 176	150 176	150 176
Fixed Cost Recovery		0	0	0	0	0	0	0	0	0	0
Depreciation		0	904 806	1 459 330	1 459 330	1 459 330	1 509 330	1 479 330	1 479 330	1 479 330	1 673 230
Administration		**350 000**	**814 835**	**1 325 354**	**1 316 918**	**1 198 481**	**1 173 644**	**1 144 808**	**1 115 971**	**1 087 135**	**1 087 800**
Audit Fees		0	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Office Consumables		0	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000
Office R&M		0	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000
Telephone		0	18 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
Accountant	15 000	0	180 000	180 000	180 000	180 000	180 000	180 000	180 000	180 000	180 000
Receptionist/Secretary	9 000	0	108 000	108 000	108 000	108 000	108 000	108 000	108 000	108 000	108 000
Cleaner	2 200	0	26 400	26 400	26 400	26 400	26 400	26 400	26 400	26 400	26 400
Company Contributions	30%	0	94 320	94 320	94 320	94 320	94 320	94 320	94 320	94 320	94 320
Permit		0	2 000	2 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000
SABS		0	15 000	30 000	45 000	45 000	45 000	45 000	45 000	45 000	45 000
Vehicle and boat licenses		0	1 000	3 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000
Asset Insurance		0	156 115	238 583	210 147	181 710	156 873	128 037	99 200	70 364	9 600
Stock Insurance	3.20%	0	0	409 051	409 051	409 051	409 051	409 051	409 051	409 051	609 687
Professional Fees		350 000	180 000	180 000	180 000	90 000	90 000	90 000	90 000	90 000	90 000
Depreciation		0	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000
